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Highway 427 Expansion – Package 9 (100% Submission)  
Albion Road Overpass and Hwy 427 Ramp 407EW – 427S (Structures B05/B06)

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## Statement of Limitations and Conditions

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## 1. INTRODUCTION

This report presents the results of a foundation investigation and provides foundation recommendations for the design and construction of the proposed widening of NBL and SBL of the Highway 427/Albion Road Overpass and reconstruction of the Highway 427 Ramp Structure 407EW–427S over Albion Road.

This project is part of the proposed widening and extension of Highway 427 from Finch Avenue to Major Mackenzie Drive in the City of Vaughan, Ontario.

Recommendations on the foundation aspects of the bridge design presented in this report were based on the interpretation of the subsurface information obtained during the recent foundation investigation by Thurber Engineering (Thurber) as well as previous investigations as listed below:

1. GEOCREs No. 30M12-164, Geotechnical Investigation, Proposed Albion Road Underpass Structure at Highway 427, W.P. 153-80-03, District 6 (Toronto) Central Region, dated March 1982, prepared by Peto MacCallum Ltd.
2. GEOCREs No. 30M12-167, Foundation Investigation Report for Ramp Structure 407S-427EW over Albion Road Bridge #20, W.P. 88-78-21, Site 37-1114, Hwy 427/407, District 6, Toronto, dated August 19, 1982.
3. GEOCREs No. 30M12-168, Foundation Investigation Report for Ramp Structure 407EW-427S over Albion Road Bridge #23, W.P. 88-78-22, Site 37-1115, Hwy 427/407, District 6, Toronto, dated August 19, 1982.
4. GEOCREs No. 30M12-290, Foundation Investigation and Design Report, Highway 427 Widening from Fasken Drive to Steels Avenue, Albion Road Overpass, Toronto, Ontario, G.W.P. 202-95-00, dated November 29, 2009, prepared by Thurber Engineering Ltd.

Foundation recommendations presented in this report were prepared based on General Arrangement (GA) drawings H427-D-N-9-STR-B05-DWG-700-A and H427-D-N-9-STR-B06-DWG-800-A, dated January 12, 2018, provided by WSP.

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 600 to 700 m south of the Highway 427 / Highway 407 interchange, and approximately 300 m north of the Highway 427 CNR Halton Overhead in Vaughan, Ontario.

The existing Albion Overpass structures carry the northbound and southbound lanes (NBL and SBL) of Highway 427 over Albion Road. Based on the General Arrangement (GA) drawings, both existing structures are single span, welded steel box girder bridges approximately 32.5 m in length. The 407EW-427S Ramp Structure is also a similar single span bridge, 32.4 m in length carrying traffic from Highway 407 EBL and WBL to Highway 427 SBL. Each bridge is supported on abutments founded on spread footings. The approach embankments are in the order of 7 to 7.5 m above the roadway surface of Albion Road with 2H:1V side slopes.

The topography of the site is a flat to gently undulating plain. Lands surrounding the site have been developed for commercial and industrial uses.

The site is situated within the physiographic region known as the Peel Plain (*The Physiography of Southern Ontario* by L. J. Chapman and D.F. Putnam, 1984). The subsurface conditions in the region generally comprise clayey silt to silty clay till (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 at depth by shale bedrock of the Georgian Bay Formation with siltstone and limestone interlayers.

### 3. GEOTECHNICAL INVESTIGATIONS

#### 3.1 Current Geotechnical Investigation

The recent field investigation was conducted on July 19 and 20, 2017, and consisted of two (2) boreholes, designated as Boreholes 407-17-01 and 407-17-02 drilled to depths of 15.3 m and 15.7 m, respectively.

Borehole coordinates and ground surface elevations at the borehole locations were derived from topographic drawings provided by WSP. The Record of Borehole sheets and the Borehole Locations and Soil Strata Drawings are included in the appendices. The locations of boreholes noted on the logs and drawings are provided in MTM NAD 83, Zone 10 coordinates.

Track mounted CME 55 drill rig supplied by Landshark Drilling Ltd. of Ontario was used to advance the boreholes. Soil samples were obtained at selected intervals using a 50mm nominal inner diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT) procedures as per ASTM D1586.

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 representative to the site conditions. Two standpipe piezometers (shallow and deep) were installed in Boreholes 407-17-01. Borehole CNR17-01 was backfilled as per Ontario Reg. 903.

The Record of Borehole sheets, Lab Testing figures and the Borehole Locations and Soil Strata drawings are presented in Appendices A to D.

#### 3.2 Previous Geotechnical Investigations

The subsurface information collected from previous investigations conducted in 1982 has been used for the preparation of this report. Twelve (12) boreholes were advanced at this site from the original ground surface prior to any embankment and bridge construction. The Record of Borehole sheets from the previous investigations are included in Appendix B. The boreholes were prefixed with the numbers 164, 167 and 168, indicating relevant Geocres Numbers. Boreholes 164-1 to 164-6 represent the subsurface conditions at the overpass structure and Boreholes 168-1 to 168-3 are located within the general area of the Ramp Structure 407EW-427S. The subsurface information represented by Boreholes 167-1 to 167-3 located to the east of the overpass structure was also incorporated to aid in understanding of the subsurface conditions in the general area.

### 4. SUBSURFACE CONDITIONS

A general description of the site stratigraphy based on the results of current and previous investigations is given in the following paragraphs. It should be noted that the factual data presented on the Record of Borehole sheets takes precedence over this general description. Subsurface conditions may vary between and beyond borehole locations.

In summary, the native soil stratigraphy encountered at this site comprises surficial silty clay overlying till deposits. The upper cohesive till consists of clayey silt to silty clay with sand till and in turn overlies cohesionless till ranging in composition from silty sand to sand and silt with gravel and trace to some clay. Occasional cobbles and boulders were reported in the till deposit. The recent two boreholes were drilled west of the existing 407EW-427S Ramp Structure on the shoulders of Albion Road.

More detailed descriptions of the individual strata are presented below.

#### 4.1 Surficial Silty Clay

A layer of brown silty clay was encountered in Boreholes 407-17-01 and 407-17-02. Trace to some sand, trace gravel and trace rootlets were noted in this layer. The silty clay layer was 0.8 m thick with the base at Elev. 172.2.

SPT 'N' values recorded in this layer were 13 and 17 blows per 0.3 m penetration, indicating a stiff to very stiff

consistency. Moisture contents measured on two samples of this layer were 8 and 10%.

#### 4.2 Clayey Silt to Silty Clay with Sand Till

Brown to grey clayey silt to silty clay till was encountered below the surficial silty clay in Boreholes 407-17-01 and 407-17-02. Trace to some sand and trace gravel were noted in the deposit. The till was 9.6 m and 7.9 m thick in Boreholes 407-17-01 and 407-17-02 with the base at depths of 10.4 m (Elev. 162.6) and 8.7 m (Elev. 164.3), respectively.

In the previous boreholes, the cohesive till was encountered below the topsoil in Boreholes 164-1 to 164-6, and from the ground surface in the other boreholes. The thickness of this cohesive till ranged from 4.3 to 7.0 m and the base of this till ranged from Elevations 165.1 to 168.1.

Typically, SPT 'N' values in the till ranged from 15 to 83, indicating a very stiff to hard consistency. SPT 'N' values ranging between 7 and 10 were obtained in the upper 1 to 2 m of the till in some boreholes, indicating a firm to stiff consistency. The till was generally firm to stiff to approximately 4 m depth (Elev. 169.0), and then became very stiff to hard. The natural moisture contents of the silty clay till samples ranged from approximately 8 to 30%, typically 10 to 20%. The higher moisture content values were often obtained in the upper zone of the till.

Grain size analyses in previous boreholes indicate that the cohesive till contains 0 to 10% gravel, 13 to 38% sand, 34 to 52% silt and 20 to 45% clay.

The Atterberg Limits testing resulted in liquid limits ranging from 19 to 57% and plasticity indices from 7 to 30%. The above results indicate that the silty clay with sand till is typically of low to medium plasticity with a group symbol of CL-Cl.

Glacial tills inherently contain cobbles and boulders which should be expected to be present within the deposit.

#### 4.3 Cohesionless Till

A deposit of cohesionless till ranging in composition from silty sand to sand and silt with gravel and trace to some clay was encountered underlying the cohesive till below a depth varying from 4.9 to 10.4 m (from Elevations 162.6 to 168.1). Layers of sand and gravel with occasional cobbles and boulders were encountered within this till deposit.

All previous boreholes were terminated within this till at depths of 9.4 to 18.6 m (Elevations 153.8 to 163.4 m). The recent Borehole 407-17-01 was terminated in the silty sand till at a depth of 15.3 m (Elev. 157.7). The cohesionless till in Borehole 407-17-02 was 4.7 m thick and extended to a depth of 13.4 m (Elev. 159.6).

SPT 'N' values ranging from 51 to greater than 100 indicate that the cohesionless till is very dense. The natural moisture contents of the silty sand to sand and silt till samples ranged from 2 to 15%. Grain size distribution analyses in previous boreholes indicated that the till contained 0 to 33% gravel, 30 to 65% sand, 22 to 45% silt and 3 to 13% clay. Occasional cobbles and boulders were reported throughout the till.

#### 4.4 Lower Clayey Silt Till

Underlying the cohesionless till in Borehole 407-17-02 was a cohesive till deposit classified as clayey silt with trace gravel and trace to some sand. Cobbles and boulders should also be expected in the till deposit.

SPT 'N' values recorded in this layer were greater than 100 blows per 0.3 m penetration indicating a hard consistency of the deposit. Moisture contents measured on two samples of this layer were 12 and 14%. Borehole 407-17-02 was terminated in the lower clayey silt till at a depth of 15.7 m (Elev. 157.3).

#### 4.5 Groundwater Levels

The groundwater levels measured in the boreholes upon completion of drilling and water levels measured in the piezometers during recent and previous investigations are summarized in Table 1, below.

Table 1 – Groundwater Level Measurements

Foundation Element	Borehole	Date	Water Level (m)		Comment
			Depth (m)	Elevation (m)	
Overpass Structure					
South Abutment	164-1	February 13, 1982	7.3	165.0	In piezometer installed in silty sand till
		February 19, 1982	6.9	165.4	
		February 26, 1982	5.3	167.0	
	164-2	February 19, 1982	Dry		In open borehole
Mid Span	164-3	February 18, 1982	8.6	163.9	In open borehole
	164-4	February 19, 1982	6.8	165.8	In open borehole
North Abutment	164-5	February 19, 1982	3.0	169.9	In piezometer installed in silty sand till
		February 26, 1982	2.4	170.5	
		164-6	February 18, 1982	9.8	163.5
Ramp 407EW – 427S					
North Abutment	407-17-02	July 20, 2017	Dry		In open borehole
	168-1	May 13, 1982	0.6	171.5	In open borehole
Mid Span	168-2	May 14, 1982	1.1	171.0	In open borehole
South Abutment	407-17-01 (S)	August 9, 2017	0.4	172.6	In piezometers: Shallow (cohesive till)
		Oct 25, 2017	0.3	172.7	
	407-17-01 (D)	August 9, 2017	4.0	169.0	Deep (cohesive till)
		Oct 25, 2017	4.0	169.0	
	168-3	May 14, 1982	1.2	171.0	In open borehole
East of Overpass (Ramp 427S – 407EW)					
North Abutment	167-1	May 12, 1982	1.8	170.8	In open borehole
Mid Span	167-2	May 12, 1982	2.1	170.7	In open borehole
South Abutment	167-3	May 17, 1982	Dry		In open borehole

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

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall. Further, perched water may be encountered at higher levels in pockets or zones of more permeable sands and silts within the heterogeneous tills, or within the embankment fill.

## 5. GEOTECHNICAL RECOMMENDATIONS

### 5.1 General

The project involves widening of the Highway 427/Albion Road Overpass and relocation of the existing Highway 427 Ramp 407EW – 427S bridge to the west. Each bridge is a single span structure supported on abutments founded on spread footings.

The Overpass was originally constructed as single span, welded steel box girder twin bridges. Under MTO Contract 2014-2016, the overpass was widened by filling the median between the twin bridges. The widened portions of the bridges were founded on spread footings.

The current proposed work will involve widening of the existing Overpass structure on both east and west sides. Based on the GA drawings, the Overpass will be widened by approximately 6.73 m on both east and west sides.

The footings are proposed to be placed at the same level as the existing footings, i.e., Elev. 171.0. The proposed wingwalls will consist of RSS walls up to 5 m in height.

The existing 407EW–427S Ramp will be relocated/reconstructed to the west by 5.5 m to accommodate the widening of the Overpass.

The GA drawings indicate that the widened portions of the abutments will be aligned with the existing ones. The approach embankments are up to about 7.5 m in height with a design slope inclination of 2H:1V. The approach embankments will be widened on both sides to accommodate the bridge widening and relocation.

## 5.2 Foundation Design

Spread footings placed at the same level as the existing foundations are considered appropriate for the support of the abutments of Overpass and Ramp structures at this site.

### 5.2.1 Spread Footing on Silty Clay Till

#### 5.2.1.1 Geotechnical Resistance and Reaction

It is understood that the existing abutment footings were designed to be founded on very stiff to hard native silty clay till at approximate Elevation 171.0 m for the SBL and NBL. The same approximate founding elevation was indicated for the structure carrying Highway 427 Ramp 407EW–427S. Based on the GA drawings, the new footings will be 6.75 m wide for the Overpass Structure and 6.25 m wide for the Ramp Structure. The length of each widened footing will be 6.8 m at the Overpass, and 5.5 m at the Ramp Structure. The grade of Albion Road at the centerline was indicated at approximate Elev. 173.0.

The native, undisturbed silty clay till is typically stiff to hard in consistency at all borehole locations below Elev. 171.0. To avoid undermining of the existing footings, all new footings should be founded at similar elevations as the existing footings.

For a footing with 6.75 m or 6.25 m width founded on the very stiff to hard till may be designed in accordance with the elevations and geotechnical resistances recommended in Table 2, below.

**Table 2 – Founding Elevations and Geotechnical Resistances for Spread Footings**

Foundation Element		Reference Borehole	Founding Elevation (m)	Factored ULS (kPa)	Factored SLS (kPa)	Founding Soil
Overpass Structure						
South Abutment	SBL	164-1	171.0	450	300	Very stiff silty clay with sand till
	NBL	164-2				
North Abutment	SBL	164-5	171.0	450	300	
	NBL	164-6				
Highway 427 Ramp 407EW – 427S						
South Abutment		168-3, 407-17-01	171.0	450	300	Very stiff silty clay to clayey silt till
North Abutment		168-1, 407-17-02				

The value of factored Geotechnical Reaction at SLS given above is for up to 25 mm of settlement. The value of factored Geotechnical Resistance at ULS was assessed assuming a Consequence Factor equal to 1 (Typical), and a Resistance Factor equal to 0.5 (Typical degree of understanding of the subsurface conditions), as per CHBDC 2014. The factored Geotechnical Reaction at SLS was assessed assuming a Resistance Factor of 0.8 for typical degree of understanding of the subsurface conditions.

The above geotechnical resistances are applicable for concentric, vertical loads only. In the case of eccentric or



inclined loading, the geotechnical resistances should be calculated as indicated in the CHBDC 2014 Clause 6.10.3 and Clause 6.10.4.

### 5.2.1.2 Lateral Resistance

The lateral resistance of the footings founded on clayey silt/silty clay with sand till may be computed using an unfactored friction coefficient of 0.45 for cast-in-place concrete. This value of friction coefficient is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance.

### 5.2.1.3 Subgrade Preparation for Spread Footings

Removal of the existing retaining walls and wingwalls as well as excavation of a portion of the existing embankment slopes will be required to reach the founding levels for the new footings.

It is anticipated that most of the excavation will be carried out within the temporary roadway protection system. After the foundation excavation reaches the design elevation, the exposed subgrade should be inspected by qualified geotechnical personnel to confirm that the subgrade is suitable and uniformly competent. The silty clay till encountered in Borehole 164-1 located near the south abutment of the SBL Overpass Structure was noted to be firm with an SPT-N value of 7 blows per 0.3 m penetration at the founding level. This material must be excavated to reach a competent stratum (very stiff to hard till). In addition, any remaining fill, topsoil, soft and disturbed soils and deleterious materials within the foundation footprints must be removed and replaced with well compacted granular ‘A’ material or mass concrete. It is important to note that care must be taken not to undermine the existing footings. A layer of at least 100 mm thick mass concrete should be placed over the subgrade for protection. Once the subgrade is prepared, construction equipment should not travel on the subgrade.

The work should be carried out in accordance with OPSS 902 and construction must be carried out in the dry.

### 5.2.2 Frost Protection

The design depth of frost penetration at this site is 1.2 m. All footing base should be provided with a minimum of 1.2 m of earth cover or an equivalent thickness of synthetic insulation.

### 5.2.3 Backfill to Abutments

The 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.

### 5.2.4 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)
$K$	=	lateral 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 6.12.3 of the CHBDC2014, a compaction surcharge should be added.

Earth pressure coefficients for backfill to the abutment wall are dependent on properties of the granular fill used as the backfill. Typical values are shown in Table 3, below.

**Table 3 – Coefficients of Lateral Earth Pressure (K)**

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.

### 5.3 Seismic Considerations

Based on the encountered subsurface conditions from the previous investigation, Site Class C should 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 0.110 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 4 may be used:

**Table 4 – 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 generally very stiff to hard silty clay till and very dense silty sand to sand and silt till, the potential for liquefaction is considered low at this site.

### 5.4 Retained Soil Systems

It is understood that retained soil system (RSS) walls up to 5 m high will be installed at the abutments. As indicated on the General Arrangement drawing, RSS walls used in conjunction with the new abutments should have the following attributes: “High Performance” and “High Appearance”.

As per MTO’s RSS Design Guidelines, the underside of the levelling pad should be placed at least 0.5 m below finished grade (40% of frost depth) in front of the wall. To provide an acceptable foundation performance, the RSS mass should be founded on competent soils or engineered fill. The adequate preparation of the foundation for



the entire RSS mass should be considered, i.e. from the face of the wall to the furthest extent of the reinforcement.

The borehole information indicates that the soil conditions at the proposed RSS base levels will generally consist of stiff to hard silty clay with sand till. The RSS walls founded on the stiff to hard silty clay with sand till should be designed for a factored Geotechnical Resistance at ULS of 300 kPa and a factored Geotechnical Reaction at SLS of 200 kPa. The resistance values assume that the length of RSS wall reinforcement will extend for a distance equal at least 70% height behind the wall face.

A minimum 500 mm thick layer of bedding material conforming to OPSS Granular “A” requirements should be provided under the RSS mass to provide a uniform subgrade condition. Engineered fill placed under the RSS mass to achieve the design founding level should consist of OPSS Granular “A” compacted to 100% of its SPMDD at a moisture content within 2% of optimum. The engineered fill pad should extend at least 500 mm beyond the limits of the levelling strip. Any topsoil, organic matter and soft/loose fill or native material should be stripped from the footprint of the RSS block.

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

The RSS blocks should also be designed against various modes of failure including sliding and overturning. Sliding resistance along the base of the wall on silty clay till and engineered granular fill may be estimated using ultimate friction coefficients of 0.45 and 0.55, respectively. The internal stability of the RSS wall should be analysed by the supplier/designer of the proprietary product selected for this site.

The global stability of the RSS wall placed on the very stiff to hard silty clay with sand till is not considered to be an issue.

## 5.5 Roadway Protection

Roadway protection will be required during construction for widening of both structures. The temporary roadway protection system should be designed and constructed in accordance with OPSS 539. A Performance Level 2 is should be considered for both Overpass and Highway 427 Ramp structure protection.

Temporary protection system consisting of soldier piles and lagging wall or sheet pile wall may be considered for this site. It is anticipated that the soldier piles or sheet piles will need to be installed into the very stiff to hard silty clay with sand till or very dense silty sand/sand and silt till to develop the required toe resistance.

A temporary soldier pile and lagging wall may be designed using the parameters given below:

$\gamma$	=	21 kN/m <sup>3</sup> (unit weight above groundwater level)
$\gamma'$	=	11 kN/m <sup>3</sup> (unit weight below groundwater level)
$K_a$	=	0.36 (coefficient of active earth pressure of road embankment fill)
	=	0.32 (coefficient of active earth pressure of silty clay with sand till)
$K_p$	=	2.8 (coefficient of passive earth pressure of road embankment fill)
	=	3.1 (coefficient of passive earth pressure of silty clay with sand till)

Fill composition of the existing embankment has not been fully investigated. Boreholes advanced through the embankment fill in the vicinity of this site encountered cohesive fill; therefore, it can be assumed that the embankment fill may consist of cohesive soils excavated on site and reused for construction.

## 5.6 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 soils within the likely depth of excavation at this site may be

classed as Type 3 soils for fill and Type 2 for native stiff to hard silty clay till.

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

Earth excavations required at this site will penetrate through a fill and into native clayey silt/silty clay with sand till. The embankment fill and native till may contain cobbles and boulders. Where space permits, temporary shallow excavation through most soils at this site may be formed unsupported with side slopes not steeper than 1H: 1V. Flatter slopes may be required at locations where the soils are less competent or where water seepage affects surficial stability.

The water level in shallow piezometer (tip at 4.5 m) installed in Borehole 407-17-01 was at 0.4 m depth (Elev. 172.6) and in deep piezometer (tip at 10.7 m) was at 4.0 m depth (Elev. 169.0) below the existing ground surface. The water level in open boreholes during the 1982 investigations varied with the shallower level noted at Elev. 171.0. The bases of temporary excavations for footing construction will be located near the water levels measured in the shallow piezometer and open boreholes. In addition, perched groundwater may be present in the embankment fill. Given the consistency and low permeability of the silty clay till, groundwater control measures such as perimeter ditches and pumping from filtered sumps may prove to be effective to remove any accumulation of water from the excavation bases and lower the groundwater table to below the base of excavation prior to placing concrete. The possibility exists that additional pumps may be required if localized zones of high volume of perched groundwater are encountered.

All footings should be constructed in the dry.

## 5.7 Widening of Approach Embankments

The existing approach embankments will be widened by approximately 6.8 m on both sides of the overpass structure as well as to the west of the existing Hwy 427 Ramp 407EW – 427S.

The approach embankments will be placed on foundation soils consisting of stiff to hard clayey silt/silty clay with sand till underlain by dense to very dense cohesionless till. Both north and south approach embankments are as high as 7.5 m at the overpass and ramp structures.

Embankment widening should be in accordance with OPSS.PROV 206. Existing fill slopes should be benched in accordance with OPSD 208.010 prior to placing new fill.

### 5.7.1 Embankment Settlement

Total settlement of the approach embankment is a combination of self-compression of the fill material and settlement of the subgrade soil. Embankment settlement due to fill compression is estimated to be 0.5% of the full fill height for granular fill or earth fill compacted to 100% of their respective 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 10 to 20 mm at this site will occur after construction. The settlement of the prepared foundation subgrade is expected to be less than 25 mm.

To meet MTO's Embankment Settlement Criteria for Design (March 2, 2010) as per PA Schedule 15-2, a waiting period of a minimum of 2 months should be allowed after backfilling the structure for the embankment settlement to take place prior to approach slab construction and final paving.

The maximum differential settlement along the RSS wall face is estimated to be less than 1:200. The supplier/designer of the proprietary product must review the estimated settlements such that the RSS walls can be designed to withstand ground settlement within tolerable limits while maintaining structural integrity.

### 5.7.2 Embankment Stability

The global, internal and surficial stability of the approach embankment fills will depend on the slope geometry and to a large degree on the material used to construct the embankments. The existing embankments appear stable.

We understand that it is the contractor's intention to reuse the excavated clay till as embankment fill. Embankments constructed with cohesive earth fill compacted as per OPSS.PROV 501 will be stable at inclinations not steeper than 2H:1V with short-term and long-term Factors of Safety exceeding 1.3 and 1.5, respectively. Slope face treatment/surficial erosion protection should be provided in general accordance with OPSS.PROV 804.

All topsoil and organic soils should be stripped from the footprint of the approach fills within 20 m of the bridge abutments. Attention should be paid to removing all softened material from existing ditches that fall within the footprint of the new embankment.

### 5.8 Instrumentation and Monitoring

Pre-construction condition survey of the existing abutments should be carried out to document the prevailing conditions.

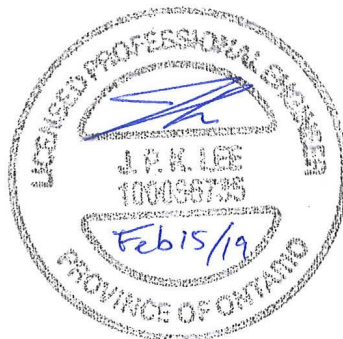
Baseline conditions involving settlement monitoring of the existing abutments should be established prior to construction. Monitoring of potential vertical and lateral movements of the abutments during construction activities, as well as monitoring of the protection system should be conducted. The allowable movements that can be tolerated by the existing structures must be established by the structural designers.

Visual inspection of the side slopes of the approach embankments at the both structures should be carried out regularly to confirm stability.

### 5.9 Construction Concerns

Potential construction concerns include, but not necessarily limited to:

- All footings should be constructed in the dry. Clayey subgrade should be inspected as soon as practical upon exposure and be protected from any disturbances that could weaken the material.
- If any soft to firm native cohesive soils and any remaining fill, topsoil, soft and disturbed soils and deleterious materials is required to be removed within the widening foundation footprints, attention must be paid not to undermine the existing footings.



## 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 – Recent 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


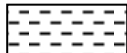



- (1) SPT 'N' Value      Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT      Dynamic Cone Penetration Test – Continuous 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 <sub>L</sub> < 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 <sub>L</sub> < 30%).
		CI	Inorganic clays of medium plasticity, silty clays. (30% < W <sub>L</sub> < 50%).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS W <sub>L</sub> > 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	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				

<u>TERMS</u>						
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty Can be peeled by a pocket knife, crumbles under firm blows of geological pick. Indented by thumbnail	
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750		
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.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150		
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen					
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.					

## METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W P W W L	WATER CONTENT (%)			
173.3 0.0	GROUND SURFACE												
172.5 0.8	Silty <b>CLAY</b> , trace sand, trace gravel Very Stiff Brown Moist		1	SS	17								
			2	SS	11								
			3	SS	14								
			4	SS	14								
			5	SS	13								
			6	SS	60								
			7	SS	54								
			8	SS	31								
			9	SS	49								

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

# RECORD OF BOREHOLE No 407-17-01

2 OF 2

METRIC

W.P. \_\_\_\_\_ LOCATION HWY 427 - Ramp 407EW - 427 S N 4 845 345.0 E 294 264.8 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tri-cone COMPILED BY AN  
 DATUM Geodetic DATE 2017.07.19 - 2017.07.19 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					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
162.9	Continued From Previous Page																
10.4	SAND and SILT, trace clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/ 0.125												
			11	SS	51												
			12	SS	63												
158.0			13	SS	100/ 0.050												
15.3	END OF BOREHOLE AT 15.3m. Piezometer installation consists of two 25mm diameter Schedule 40 PVC pipe with 3.05m (Deep) and 1.52m (Shallow) slotted screen.  <b>DEEP</b> WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.08.09 4.0 169.0 2017.10.25 4.0 169.0  <b>SHALLOW</b> WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.08.09 0.4 172.6 2017.10.25 0.3 172.7																

# RECORD OF BOREHOLE No 407-17-02

1 OF 2

METRIC

W.P. \_\_\_\_\_ LOCATION HWY 427 - Ramp 407EW - 427 S N 4 845 376.4 E 294 264.4 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tri-cone COMPILED BY AN  
 DATUM Geodetic DATE 2017.07.20 - 2017.07.20 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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							
173.7	GROUND SURFACE						20	40	60	80	100	PLASTIC LIMIT w <sub>P</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	
0.0	Silty <b>CLAY</b> , some sand, trace gravel, trace rootlets Stiff Brown Moist		1	SS	13										
172.9															
0.8	Clayey <b>SILT</b> to Silty <b>CLAY</b> , trace to some sand, trace gravel Firm to Hard Brown to Grey Moist (TILL)		2	SS	9										
			3	SS	4										
			4	SS	12										
			5	SS	12										
			6	SS	62										
			7	SS	33										
			8	SS	18										
165.0															
8.7	Silty <b>SAND</b> , some clay, some gravel Very Dense Grey Moist (TILL)		9	SS	100/ 0.225										

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

## METRIC

[illegible][illegible]

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 12/12/17

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



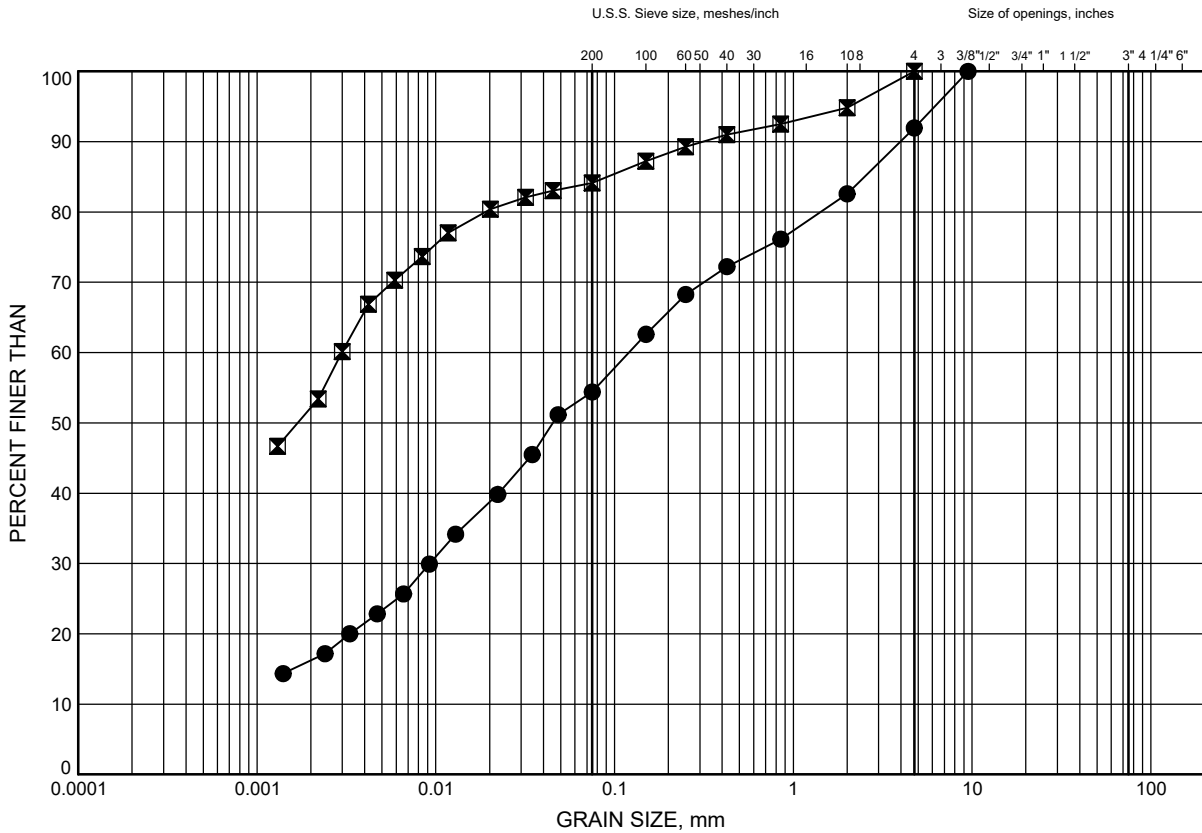
## Appendix B

### Lab Testing Results - Recent Investigation

# HWY 427 - Ramp 407EW - 427 S GRAIN SIZE DISTRIBUTION

FIGURE B1

Clayey SILT to Silty CLAY, with SAND TILL



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	407-17-01	6.4	166.9
⊠	407-17-02	2.6	171.1

Date December 2017  
W.P.

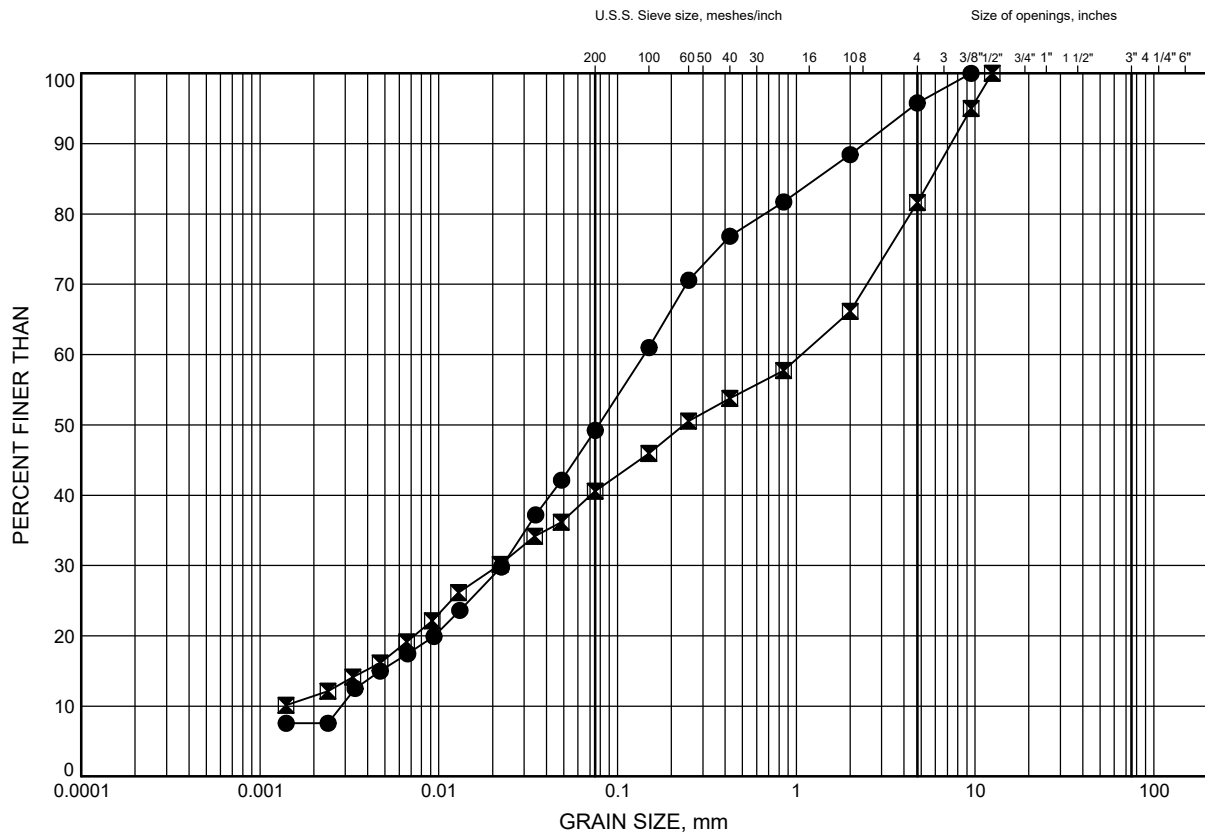


Prep'd AN  
Chkd. GRL

# HWY 427 - Ramp 407EW - 427 S GRAIN SIZE DISTRIBUTION

FIGURE B2

### Cohesionless TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	407-17-01	14.0	159.3
◻	407-17-02	9.3	164.4

Date December 2017  
W.P.



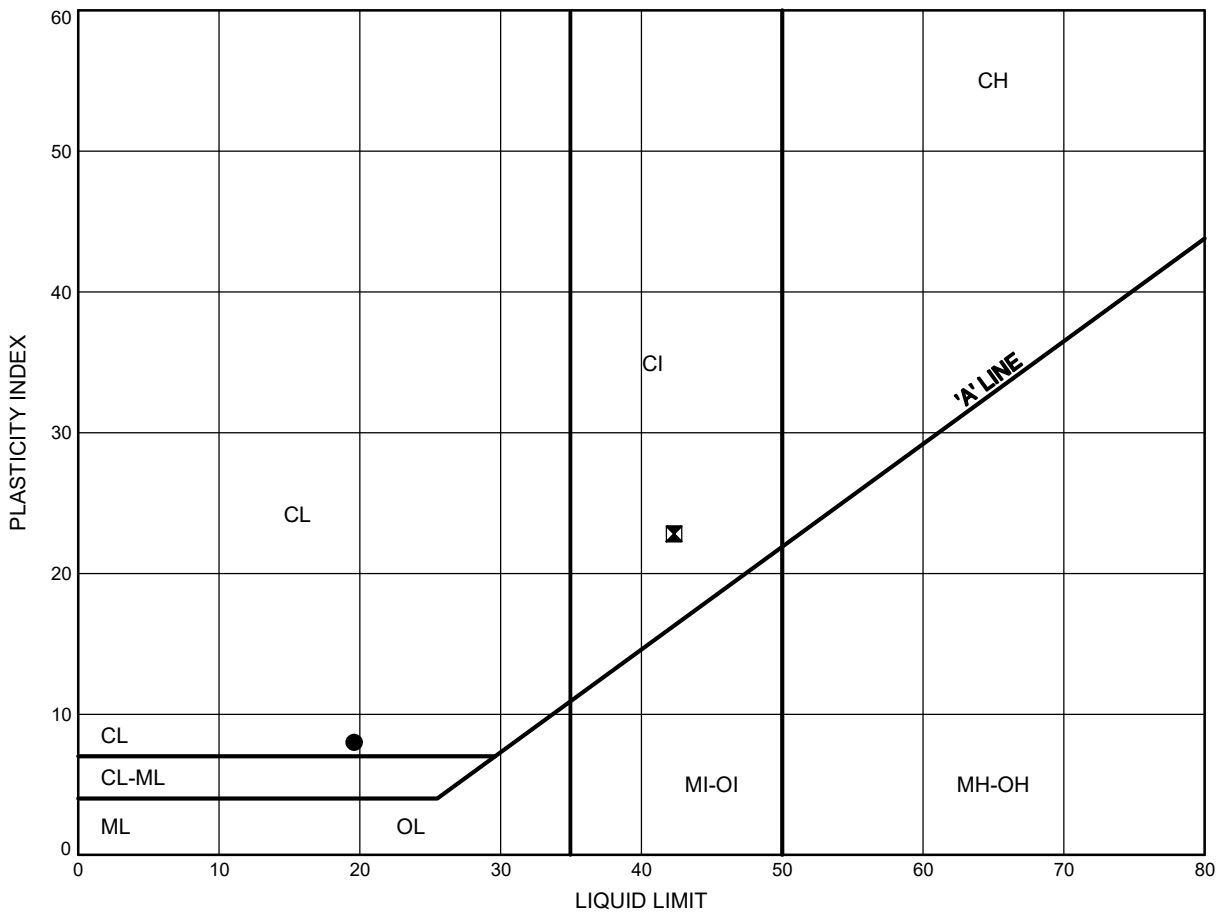
Prep'd AN  
Chkd. GRL

HWY 427 - Ramp 407EW - 427 S

# ATTERBERG LIMITS TEST RESULTS

FIGURE B3

Clayey SILT to Silty CLAY, with SAND TILL



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	407-17-01	6.4	166.9
⊠	407-17-02	2.6	171.1

Date December 2017  
W.P. ....

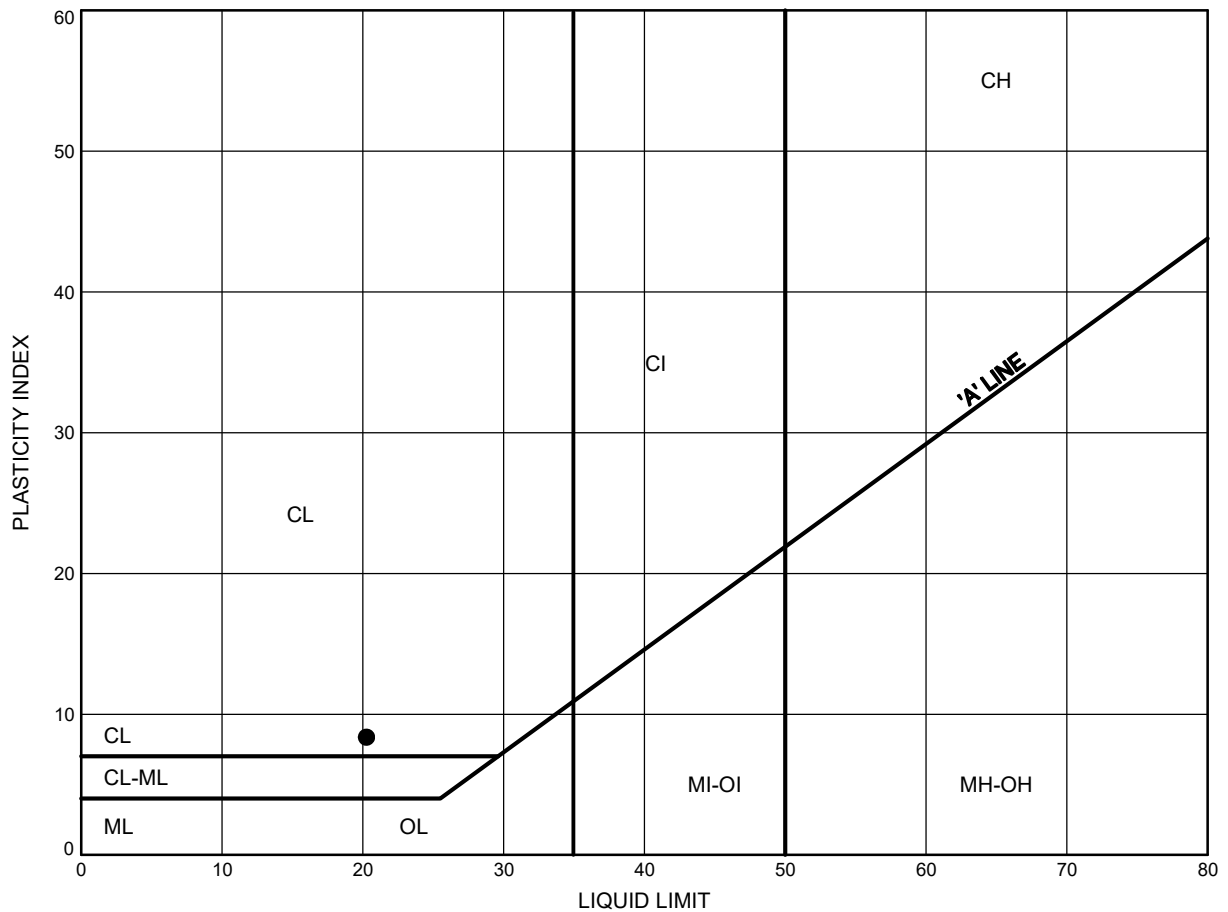


Prep'd AN  
Chkd. GRL

HWY 427 - Ramp 407EW - 427 S  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B4

Lower Clayey SILT TILL



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	407-17-02	15.5	158.3

Date December 2017  
 W.P. ....



Prep'd AN  
 Chkd. GRL

## Appendix C

### Record of Borehole Sheets – Previous Investigations



BH 164-1

RECORD OF BOREHOLE No 1

Metric

W P 153-80-02 LOCATION Co-ords, 4,845, 115N; 294, 281E ORIGINATED BY M.R.  
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.P.  
DATUM Geodetic DATE February 17, 1982 CHECKED BY SP

SOIL PROFILE			SAMPLES		GR. UND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			N' VALUES						20 40 60 80 100	WATER CONTENT (%)	GR SA SI CL					
172.32	Ground Level																			
172.01	Topsoil, silty clay, low organic, dark brown		1	SS	10						19.1	0 17 38 45								
0.31	Silty clay with sand, trace gravel, fissured, thin fine sand layers, (Glacial Till)		2	SS	7															
170.19	Intermediate plasticity Stiff to Firm, Brown			SS	37															
2.13	Silty clay with sand, trace gravel, fissured, thin sand layers (Glacial Till) Low plasticity		4	SS	53						22.2	1 19 52 28								
162.75	Hard Brown		5	S	30															
4.57	becoming very stiff, Grey		6	SS	26															
			7	SS	27															
165.31																				
7.01	Silty sand fine to coarse with gravel, (Glacial Till)		8	SS	93						22.4	28 40 29 3								
	Very Dense Grey		9	SS	100/280 mm															
			10	SS	100/200 mm							14 44 37 5								
			11	SS	100/280 mm															
			12	SS	100															
			13	SS	100/200 mm															
156.17																				
16.15	Sand, fine with silt, occasional thin layers of silty clay		14	SS	80/180 mm							0 65 22 13								
153.75	Very Dense Grey		15	SS	100/280 mm															
18.57	End of Borehole																			
<p>Note: 1/2 hr. after sample 11, water at elevation 160.42 inside augers</p> <p>Upon completion of augering, water at elevation 161.42 inside augers</p> <p>Piezometer installed at elevation 154.03 seal at elevation 163.48</p> <table><tr><th>Date</th><th>Water Elevation</th></tr><tr><td>Feb. 13/82</td><td>165.02</td></tr><tr><td>Feb. 19/82</td><td>165.42</td></tr><tr><td>Feb. 26/82</td><td>167.02</td></tr></table>													Date	Water Elevation	Feb. 13/82	165.02	Feb. 19/82	165.42	Feb. 26/82	167.02
Date	Water Elevation																			
Feb. 13/82	165.02																			
Feb. 19/82	165.42																			
Feb. 26/82	167.02																			

+3, x5; Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

BH 164-2

RECORD OF BOREHOLE No 2

Metric

W P 153-80-02 LOCATION Co-ords. 4,845, 119N; 294, 317E ORIGINATED BY B.L.K.  
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.P.  
DATUM Geodetic DATE February 19, 1982 CHECKED BY SP

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH				WATER CONTENT (%)				
172.70	Ground Level							20	40	60	80	100				
172.00	Topsoil, silty clay, low organic Dark Brown						172									
0.61	Silty clay with sand, trace gravel, fissured, thin fine sand layers (Glacial Till)		1	SS	18											
	Intermediate plasticity		2	SS	28											
169.65	Very Stiff Brown		3	SS	28		170									
3.05	Silty clay with sand, trace gravel, fissured, thin fine sand layers (Glacial Till)		4	SS	42											
	Low plasticity		5	SS	32											
			6	SS	35		168									
	Hard Brown to Grey		7	SS	41		166									
165.69																
7.01	Silty sand fine to coarse with gravel (Glacial Till)		8	SS	100		164									
163.28	Very Dense Grey		9	SS	100/130 mm											
9.42	End of Borehole															
<p>Note: After removal of augers upon completion of drilling, borehole caved at elevation 164.24, no free water</p>																

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



BH 164-3

RECORD OF BOREHOLE No 3

Metric

W P 153-80-02 LOCATION Co-ords. 4, 845, 141 N; 294, 277E ORIGINATED BY B.L.K.  
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.P.  
DATUM Geodetic DATE February 18, 1982 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
172.57	Ground Level																
171.81	Topsoil, silty clay, low organic, Dark Brown		1	SS	30		172										
0.76	Silty clay with sand, trace gravel, fissured, thin fine sand layers (Glacial Till)		2	TW	PH												
169.52	Intermediate plasticity Very Stiff to Hard Brown		3	SS	34		170										
3.05	Silty clay with sand, trace gravel, fissured, thin fine sand layers (Glacial Till)		4	SS	55												
	Low plasticity		5	SS	48												
	Hard to Brown		6	SS	25		168										
166.17	Very Stiff to Grey		7	SS	44												
6.40	Silty sand fine to coarse with gravel (Glacial Till)		8	SS	100/250 mm		166										
63.18	Very Dense Grey		9	SS	100/250 mm		164										
9.39	End of Borehole																
Note: After removal of augers upon completion of drilling, water level at elevation 163.89 Borehole caved at elevation 164.04																	

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

BH 164-4

RECORD OF BOREHOLE No 4

Metric

W P 153-80-02 LOCATION Co-ords. 4, 845, 145 N. 294, 313E ORIGINATED BY R.J.K.  
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.P.  
DATUM Geodetic DATE February 19, 1982 CHECKED BY SP

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
172.59	Ground Level															
172.28	Topsoil, silty clay, low organic Dark Brown		1	SS	18		172									
0.31	Silty clay with sand, trace gravel, fissured, thin fine sand layers (Glacial Till)		2	SS	21											
	Intermediate plasticity			SS	28		170									
168.93	Very Stiff Brown		4	SS	24											
3.66	Silty clay with sand, trace gravel, fissured, thin fine sand layers, (Glacial Till)		5	SS	39											
	Low plasticity		6	SS	45		168									
166.49	Hard Grey		7	SS	91		166									
6.10	Silty sand fine to coarse with gravel (Glacial Till)		8	SS	88											
163.09	Very Dense Grey		9	SS	100/200 mm		164									
9.50	End of Borehole															
<p>Note: After removal of augers on completion of drilling, water level and elevation 165.78 and borehole caved at elevation 165.68</p>																

OFFICE REPORT ON SOIL EXPLORATION



BH 164-5

RECORD OF BOREHOLE No 5

Metric

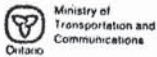
W P 153-80-02 LOCATION Co-ords. 4, 845, 161N; 294, 274E ORIGINATED BY B.L.K.  
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.P.  
DATUM Geodetic DATE February 18, 1982 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	WATER CONTENT (%)	GR	SA	SI	CL
172.89	Ground Level																					
172.28	Topsoil, silty clay, low organic Dark Brown																					
0.61	Silty clay with sand, trace gravel, fissured, thin fine sand layers (Glacial Till) Intermediate plasticity Very Stiff		1	SS	26																	
			2	SS	27																	
169.84	Hard Brown		3	SS	31																	
3.05	Silty Clay with sand, trace gravel, fissured, thin fine sand layers, (Glacial Till) low plasticity		4	SS	49																	
			5	SS	59																	
168.01	Hard Brown		6	SS	43																	
4.88	Silty sand, fine to coarse with gravel (Glacial Till)																					
			7	SS	63																	
			8	SS	93																	
163.36	Very Dense Grey		9	SS	100/230 mm																	
9.53	End of Borehole																					
<p>Note: After removal of augers upon completion of drilling, water level at elevation 164.97 and borehole caved at elevation 165.57 Piezometer installed at elevation 163.44 seal at elevation 171.06</p> <table><tr><th>Date</th><th>Water Elevation</th></tr><tr><td>Feb. 19/82</td><td>169.92</td></tr><tr><td>Feb. 26/82</td><td>170.51</td></tr></table> <p>(possible perched water infiltration)</p>																	Date	Water Elevation	Feb. 19/82	169.92	Feb. 26/82	170.51
Date	Water Elevation																					
Feb. 19/82	169.92																					
Feb. 26/82	170.51																					

+3, x5: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

BH 164-6



## RECORD OF BOREHOLE No 6

Metric

W P 153-80-02 LOCATION Co-ords. 4, 845, 168N; 294, 309E ORIGINATED BY B.L.K.  
 DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.P.  
 DATUM Geodetic DATE February 17/18, 1982 CHECKED BY

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			20	40					
173.22	Ground Level												
172.61	Topsoil, silty clay, low organic Dark Brown												
0.61	Silty clay with sand, trace gravel, fissured, thin fine sand layers (Glacial Till)		1	SS	15	172						20.1	
	Intermediate plasticity		2	SS	21								
170.48	Very Stiff Brown		3	TV	PH								
2.74	Silty clay, with sand, trace gravel, fissured, thin fine sand layers, (Glacial Till)		4	SS	59	170							
	Low plasticity		5	SS	52								
168.14	Hard Brown to Grey		6	SS	27	168							
5.18	Silty sand, fine to coarse with gravel (Glacial Till)		7	SS	89	166							
	Very Dense Grey		8	SS	100	164							
			9	SS	100	162							
			10	SS	100	160							
			11	SS	94	158							
			12	SS	100								
157.57			13	SS	100								
15.65	End of Borehole												
Note: After removal of auger upon completion of drilling, water level at elevation 163.47 and borehole caved at elevation 167.43													

OFFICE REPORT ON SOIL EXPLORATION

3, x5: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 1										METRIC				
W P 88-78-21		LOCATION Co-ords. N 4 845 127.0; E 294 349.1		ORIGINATED BY R.Z.										
DIST 6 HWY 427		BOREHOLE TYPE Hollow Stem Augers & Cone Test		COMPILED BY R.Z.										
DATUM Geodetic		DATE 82 05 12		CHECKED BY										
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
172.6	Ground Surface													
0.0	(Glacial Till)													
	Silty Clay of Low Plasticity with Sand Trace of Gravel	Mottled	1	SS	20									4 17 34 45
			2	SS	17									3 22 43 32
			3	SS	40									
			4	SS	42									
		Brown	5	SS	31									
		Gray	6	SS	28									
166.8	Very Stiff to Hard													
5.8	Alternating Layers of Silty Sand		7	SS	46									31 42 23 4
	(Glacial Till)													
	Silt to Silty Clay and Sand Varying amounts of Gravel Occasional Cobbles and Boulders throughout		8	SS	41									
			9	SS	85									
			10	SS	66									
	Hard		11	SS	100	25 cm								
158.7			12	SS	100	20 cm								
13.9	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2										METRIC		
W P 88-78-21		LOCATION Co-ords. N 4 845 146.7; E 294 331.8		ORIGINATED BY R.Z.		DIST 6 HWY 427		BOREHOLE TYPE Solid Stem Augers		COMPILED BY R.Z.		
DATUM Geodetic		DATE 82 05 12		CHECKED BY								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT		UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	W <sub>p</sub>	W		
172.8	Ground Surface											
0.0	(Glacial Till)											
	Mottled		1	SS	22							
	Silty Clay of Low Plasticity with Sand Trace of Gravel		2	SS	20							1 13 42 44
			3	SS	19							6 27 39 28
	Brown		4	SS	45							
	Grey		5	SS	51							
	Very Stiff to Hard		6	SS	37							
166.9	Layers of Silty Sand		7	SS	100/20 cm							
5.9	Boulder											
	(Glacial Till)		8	SS	92							8 42 38 12
	Silt to Silty Clay and Sand											
	Varying amounts of Gravel		9	SS	100/20 cm							
	Occasional Cobbles and Boulders throughout											
	Hard		10	SS	80/10 cm							
160.4												
			11	SS	100/23 cm							
12.4	End of Borehole											
	Note: Borehole re-located upon meeting refusal to augering on a boulder at elevation 166.3											

RECORD OF BOREHOLE No 3										METRIC				
W P 88-78-21		LOCATION Co-ords. N 4 845 166.6; E 294 343.4		ORIGINATED BY R.Z.										
DIST 6 HWY 427		BOREHOLE TYPE Hollow Stem Augers & Cone Test		COMPILED BY R.Z.										
DATUM Geodetic		DATE 82 05 17		CHECKED BY <i>CP</i>										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)				
173.2	Ground Surface													
0.0	Mottled (Glacial Till)		1	SS	18		172							18 24 42 16
	Silty Clay of Low Plasticity with Sand Trace of Gravel Very Stiff to Hard		2	SS	24									
			3	SS	32									
			4	SS	43		170							
	Brown Grey		5	SS	29									4 24 43 29
			6	SS	18		168							
166.8	Boulder (Glacial Till)		7	SS	49/18 cm									
6.4	Silt to Silty Clay and Sand Varying amounts of Gravel Occasional Cobbles and Boulders through- out		8	SS	100/18 cm		166							13 39 38 10
			9	SS	101		164							
162.4	Hard		10	SS	107/8 cm									
10.8	End of Borehole													
<p>Note: Borehole re-located upon meeting refusal to augering on a boulder at elevation 166.6</p> <p>* Water table not established.</p>														


OFFICE REPORT ON SOIL EXPLORATION



**BH 168-1**

**RECORD OF BOREHOLE No 1**

**METRIC**

W P 88-78-22 LOCATION Co-ords. N 4 845 158.3; E 294 253.5 ORIGINATED BY R.Z.  
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers & Cone Test COMPILED BY R.Z.  
DATUM Geodetic DATE 82 05 13 CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
172.1	Ground Level													
0.0	(Glacial Till)						172							
	Silty Clay Firm		1	SS	8									
	with Sand		2	SS	19		170							
	Trace of Brown		3	SS	45									
	Gravel Grey		4	SS	32									
	occ. Sand Seams		5	SS	56		168							
	Very Stiff to Hard		6	SS	38									
	Alternating Layers of		7	SS	40		166							
165.1	Silty Sand													1 38 35 26
7.0	(Glacial Till)						164							
	Silt to Silty Clay		8	SS	76									
	and Sand													
	varying amounts of		9	SS	70		162							4 45 45 6
	Gravel		10	SS	50									
	occ. Cobbles and						160							
	Boulders throughout		11	SS	97									
	Silty Sand													
	Layers													
157.9	Hard		12	SS	101/	23 cm	158							
14.2	End of Borehole													

+3, x5: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

BH 168-2

RECORD OF BOREHOLE No 2

METRIC

W P 88-78-22 LOCATION Co-ords. N 4 845 140.9; E 294 264.6 ORIGINATED BY R.Z.  
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY R.Z.  
DATUM Geodetic DATE 82 05 14 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
172.1	Ground Level															
0.0	(Glacial Till)															
	Mottled Firm		1	SS	7											
	Silty Clay with Sand		2	SS	20											
	Trace of Gravel		3	SS	45											
	Brown Grey		4	SS	58											
	occ. Sand Seams		5	SS	47											
	Very Stiff to Hard		6	SS	52											
165.7			7	SS	100/	28 cm										
6.4	(Glacial Till)															
	Silt to Silty Clay		8	SS	100											
	and Sand															
	Varying amounts of															
	Gravel															
	occ. Cobbles and															
	Boulders Hard		9	SS	100/	23 cm										
162.5																
9.6	End of Borehole															

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



# BH 168-3



## RECORD OF BOREHOLE No 3

METRIC

W P 88-78-22 LOCATION Co-ords. N 4 845 120.1; E 294 263.4 ORIGINATED BY R.Z.  
 DIST 6 HWY 427 BOREHOLE TYPE Solid Stem Augers & Cone Test COMPILED BY R.Z.  
 DATUM Geodetic DATE 82 05 14 CHECKED BY CP

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
172.2	Ground Level											
0.0	Mottled Firm (Glacial Till) Silty Clay with Sand, Trace of Gravel occ. Sand Seams Stiff to Hard Brown Grey		1	SS	7							57
			2	SS	14							10 22 48 20
			3	SS	57							
			4	SS	41							
			5	SS	41							
			6	SS	35							
165.8			7	SS	72							
6.4	(Glacial Till) Silt to Silty Clay and Sand Varying Amounts of Gravel occ. Cobbles and Boulders Hard		8	SS	100/	23 cm						33 30 33 4
			9	SS	50/	8 cm						
161.1			10	SS	100/	28 cm						
11.1	End of Borehole											

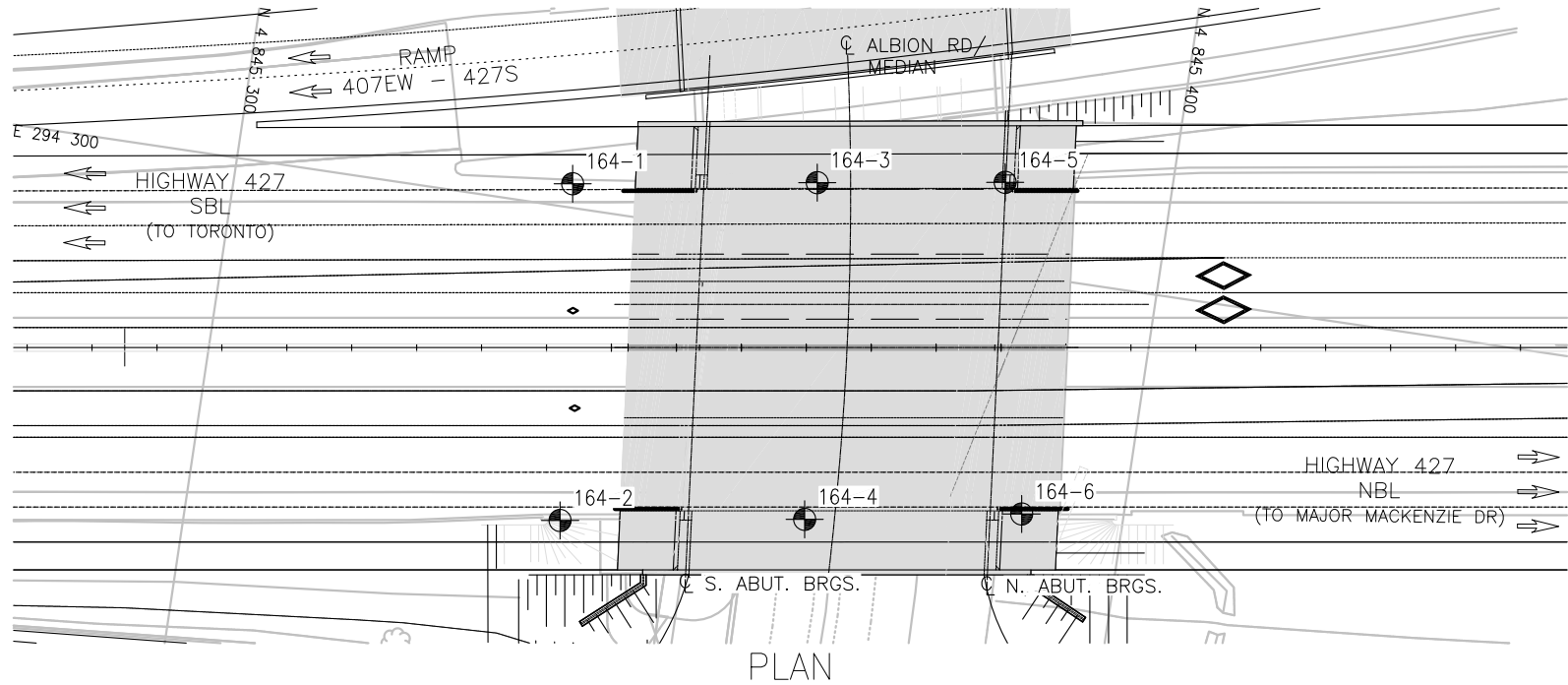
+3, x<sup>5</sup>: Numbers refer to Sensitivity

20  
15  
10  
5  
0  
5 (%) STRAIN AT FAILURE

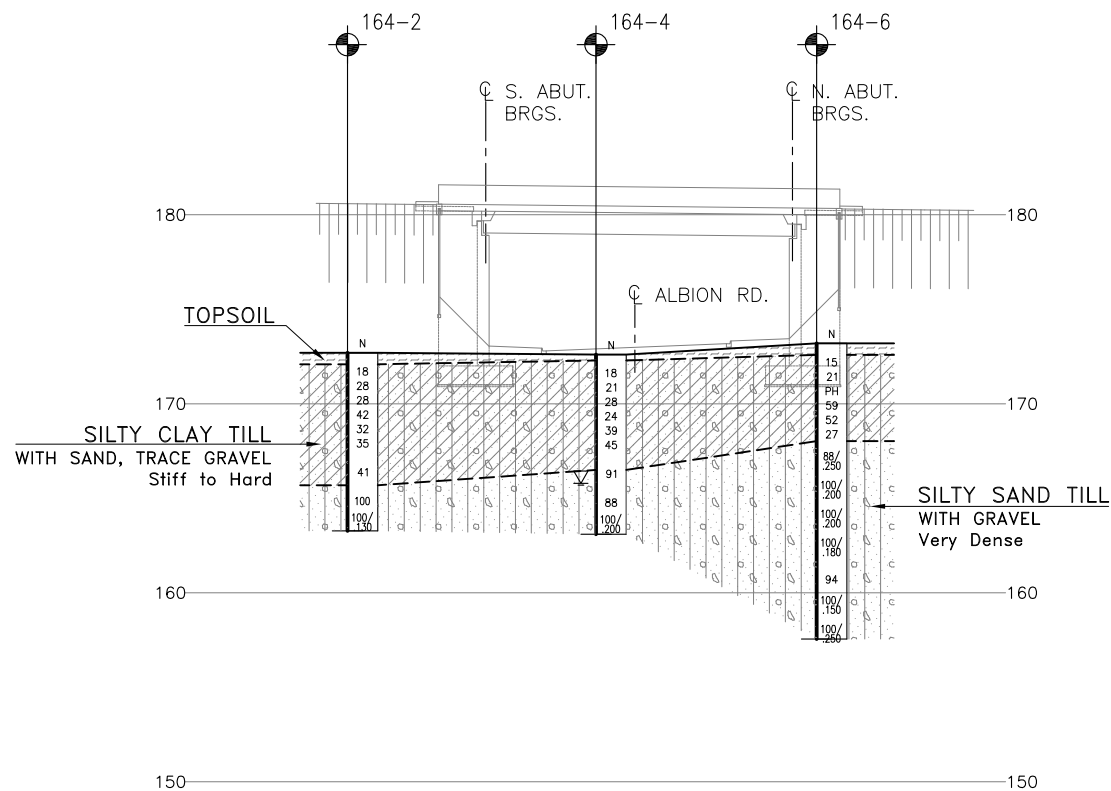
OFFICE REPORT ON SOIL EXPLORATION

## Appendix D

### Borehole Locations and Soil Strata Drawings

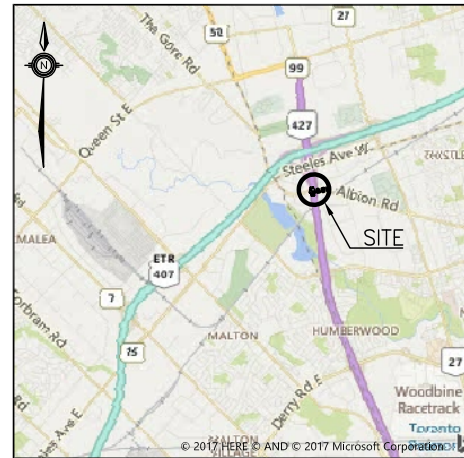


PLAN



PROFILE ALONG HWY 427 NBL

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
164-1	172.3	4 845 336.1	294 297.4
164-2	172.7	4 845 340.1	294 333.4
164-3	172.6	4 845 362.1	294 293.4
164-4	172.6	4 845 366.1	294 329.4
164-5	172.9	4 845 382.1	294 290.4
164-6	1732.2	4 845 389.1	294 325.4

-NOTES-

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

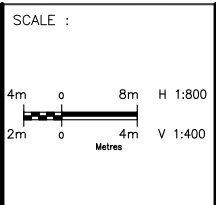
GEOCRES No.

HWY 427 EXPANSION  
HWY 427 / ALBION ROAD OVERPASS  
NORTH BOUND LANE  
REHABILITATION AND WIDENING  
BOREHOLE LOCATIONS AND SOIL STRATA I

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	H	9	STR	B05	DWG	701	A

FILENAME: H:\Drafting\19000\19484\1\ED19484-PLPR-HWY 427 Albion Rd Overpass.dwg  
PLOTDATE: 2/13/2019 5:00 PM

NO.	DATE	REVISIONS	BY	CHK	LEAD DES.	PRJL MAN.
A	19/02/15	100% SUBMISSION TO CA	KS	JL	JL	PB

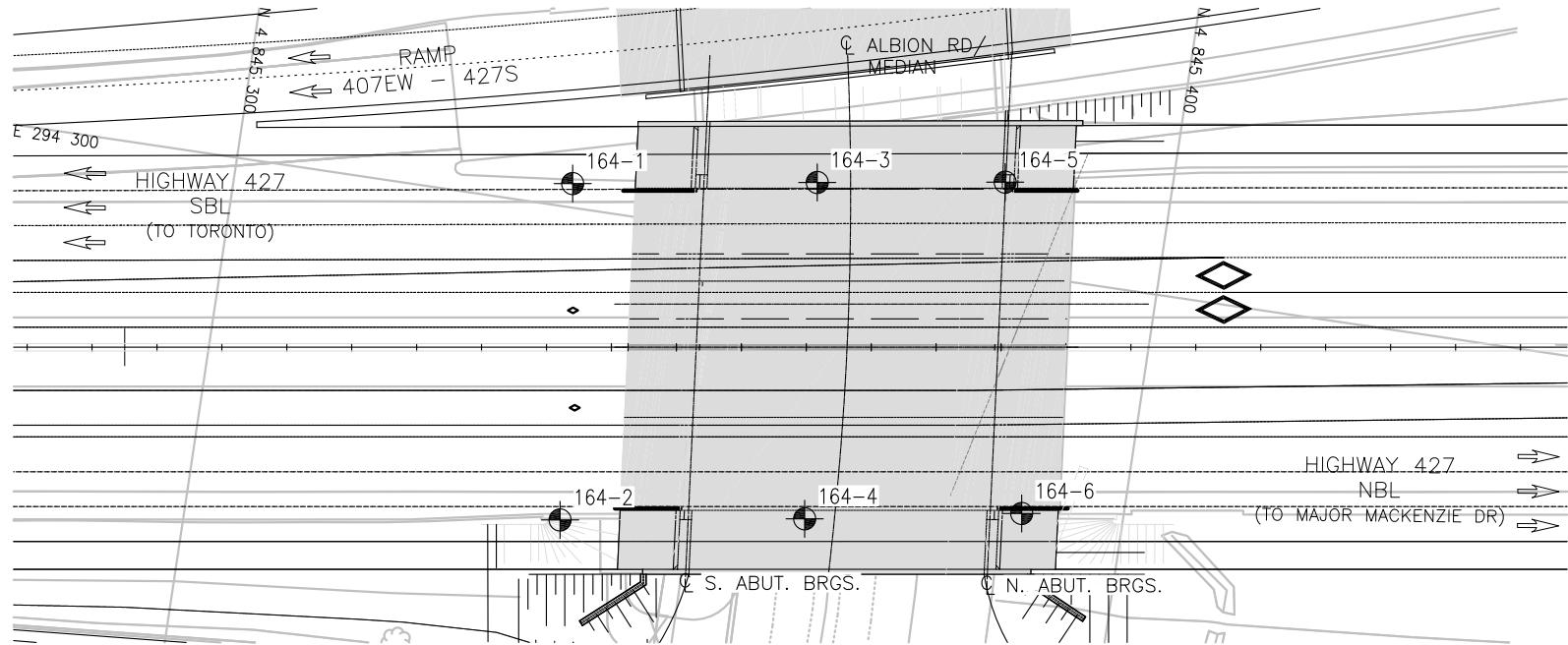


DESIGNED	K. SH	KS	19/02/15
DRAWN	A. NOOR	AN	19/02/15
CHECKED	J. LEE	JL	19/02/15
APPROVED LEAD ENGINEER	J. LEE	JL	19/02/15
APPROVED PRJL. MANAGER	P. BAMFORTH	PB	19/02/15
NAME (PRINT)	INIT.	DATE	

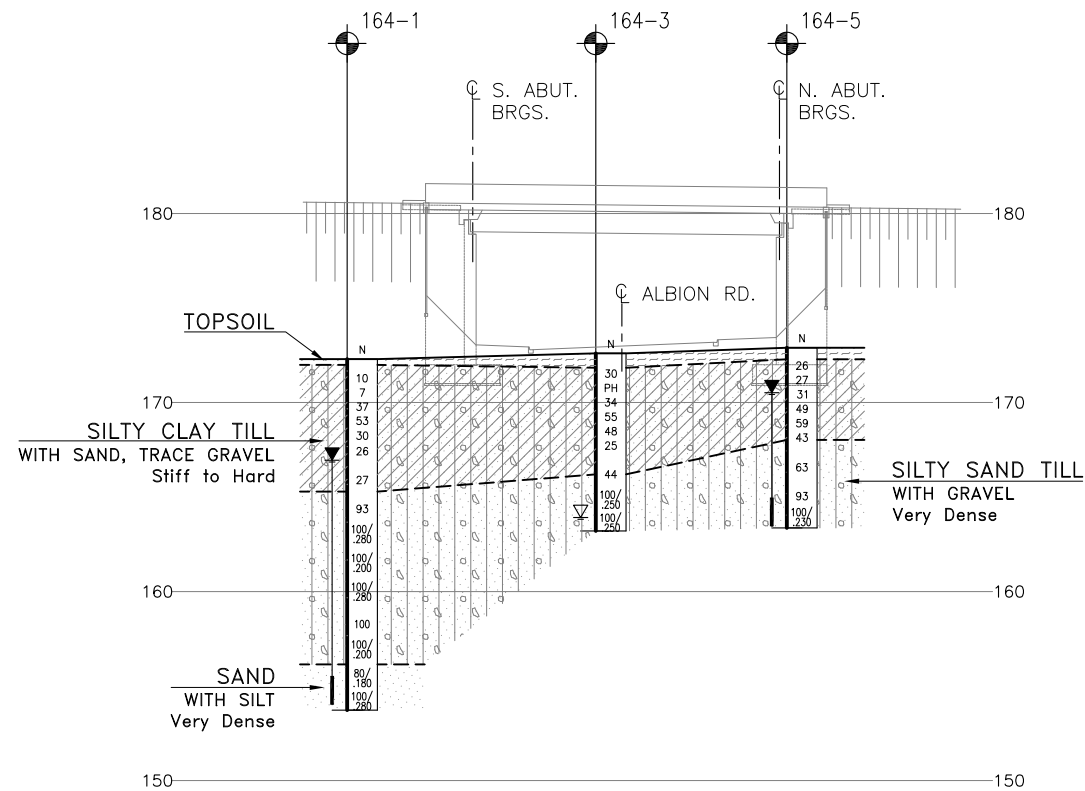


PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	H	9	STR	B05	DWG	701	A



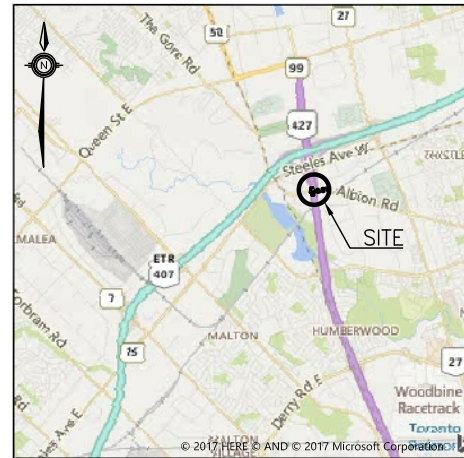


PLAN



PROFILE ALONG HWY 427 SBL

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
164-1	172.3	4 845 336.1	294 297.4
164-2	172.7	4 845 340.1	294 333.4
164-3	172.6	4 845 362.1	294 293.4
164-4	172.6	4 845 366.1	294 329.4
164-5	172.9	4 845 382.1	294 290.4
164-6	1732.2	4 845 389.1	294 325.4

-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.

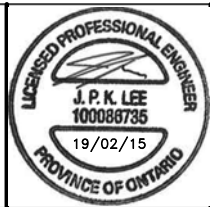
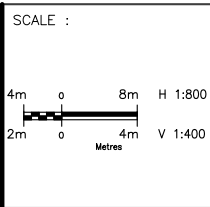
GEOCRIS No.

HWY 427 EXPANSION  
HWY 427 / ALBION ROAD OVERPASS  
SOUTH BOUND LANE  
REHABILITATION AND WIDENING  
BOREHOLE LOCATIONS AND SOIL STRATA II

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	H	9	STR	B05	DWG	702	A

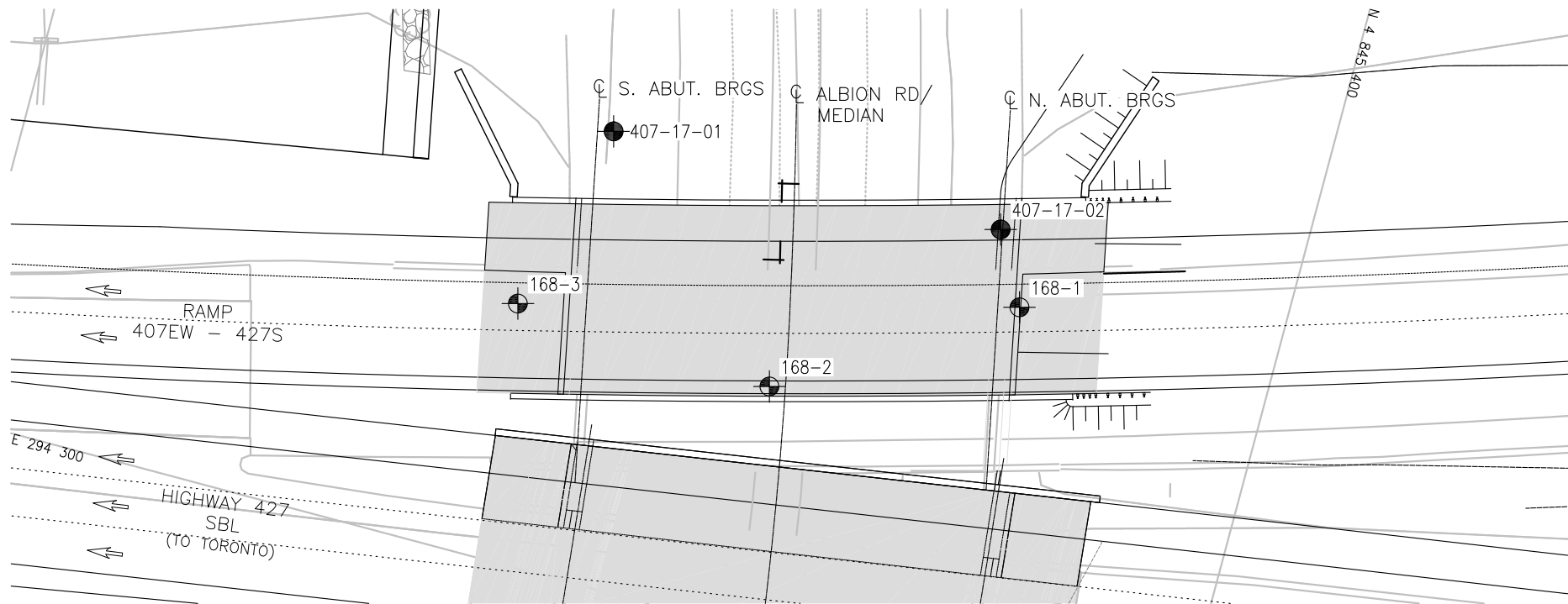
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PLOTDATE: 2/13/2019 5:01 PM

NO.	DATE	REVISIONS	BY	CHK	LEAD	PRJL
A	19/02/15	100% SUBMISSION TO CA	KS	JL	JL	PB

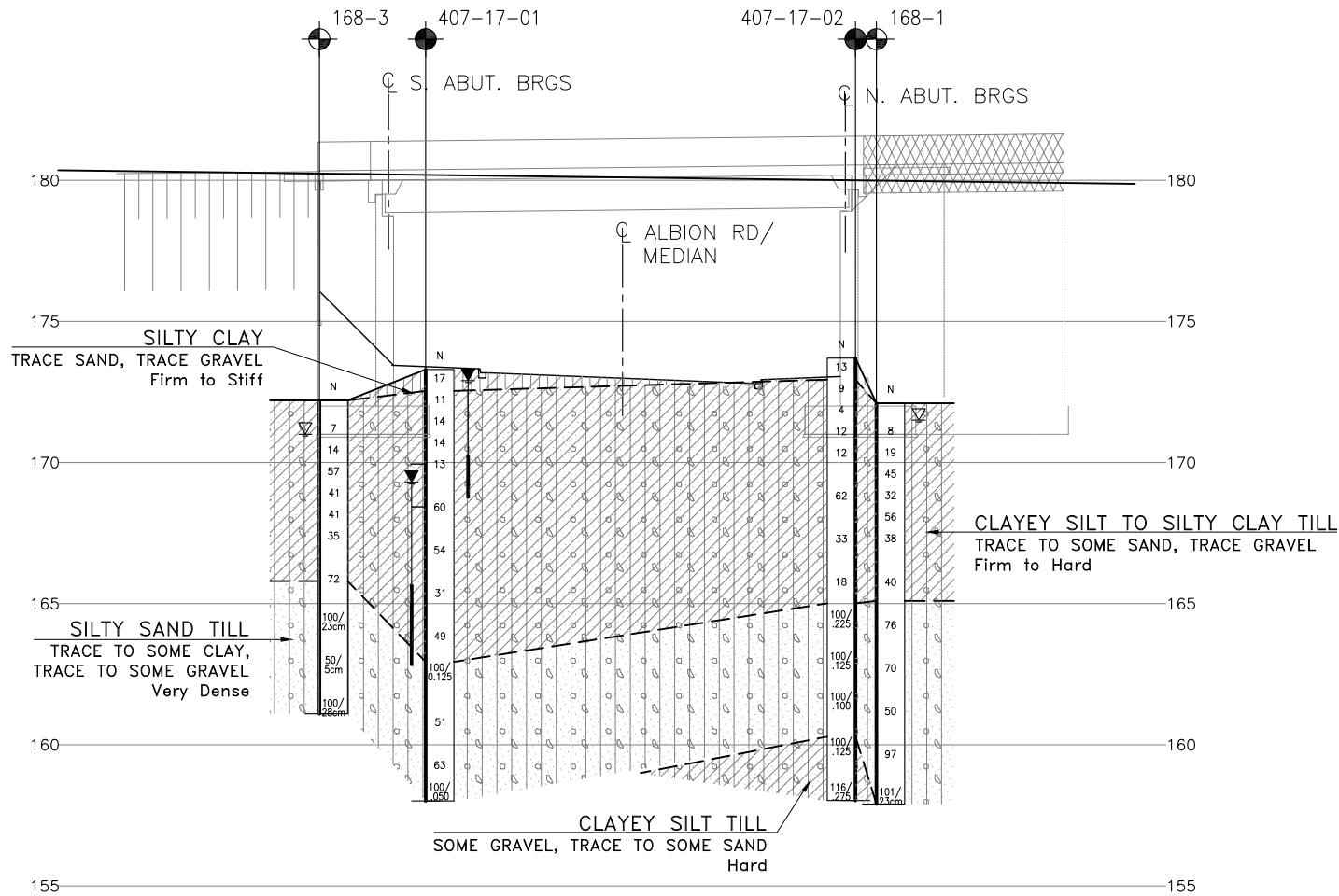


DESIGNED	K. SH	KS	19/02/15
DRAWN	A. NOOR	AN	19/02/15
CHECKED	J. LEE	JL	19/02/15
APPROVED	J. LEE	JL	19/02/15
APPROVED	P. BAMFORTH	PB	19/02/15
NAME (PRINT)	INIT.	DATE	



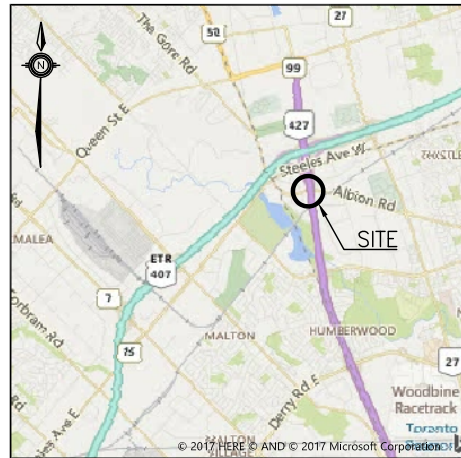


PLAN



PROFILE ALONG C RAMP 407EW-427S

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
W	Water Level
↓	Head Artesian Water
⊥	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
168-1	172.1	4 845 379.4	294 269.9
168-2	172.1	4 845 362.0	294 281.0
168-3	172.2	4 845 341.2	294 279.8
407-17-01	173.3	4 845 345.0	294 264.8
407-17-02	173.7	4 845 376.4	294 264.4

-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.

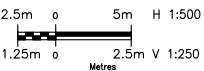
HWY 427 EXPANSION  
HWY 427 RAMP 407EW-427S  
OVER ALBION ROAD  
REHABILITATION R - 1  
BOREHOLE LOCATIONS AND SOIL STRATA

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION
H427-D	H	9	STR	B06	DWG	801	A

FILENAME: H:\Drafting\19000\19484\1ED19484-PLR-HWY 427 Ramp 407EW-427S.dwg  
PLOTDATE: 2/13/2019 5:05 PM

NO.	DATE	REVISIONS	BY	CHK	LEAD	PRJL
A	19/02/15	100% SUBMISSION TO CA	KS	JL	JL	PB

SCALE :



DESIGNED	KELI SHI	KS	19/02/15
DRAWN	ANNAIS NOOR	AN	19/02/15
CHECKED	JASON LEE	JL	19/02/15
APPROVED	JASON LEE	JL	19/02/15
PRJL. MGR	PETER BAMFORTH	PB	19/02/15
NAME (PRINT)	INIT.	DATE	

