

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
OVERHEAD SIGN SUPPORTS  
HIGHWAY 401 WESTBOUND COLLECTOR  
REHABILITATION  
TORONTO, ONTARIO  
MTO GWP 2074-13-00**

**GEOCRES No. 30M11-258**

**Report to**

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**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted for the detailed design of overhead sign (OHS) supports to be installed at the Highway 401 and Bayview Avenue interchange area, the Highway 401 and Yonge Street interchange area, and about 1.1 km east of Jane Street adjacent to the westbound collectors. A total of six (6) OHS will be constructed at these locations. The installation of the supports is a part of the Highway 401 Westbound Collector Lanes project which also involves rehabilitation of the westbound collector pavement and replacement of several sections of noise barrier walls.

The purpose of this investigation was to explore the subsurface conditions at the proposed locations of the overhead signs and, based on this data, to provide borehole locations plans, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber was retained by MMM Group Limited (MMM) to carry out the foundation investigation at these sites on behalf of the Ministry of Transportation Ontario (MTO) under Purchase Order No. 2013-E-0045.

Reference has been made to previous information on subsurface conditions for the proposed sign at the Highway 401 and Yonge Street interchange. The information is contained in a previous foundation report prepared by others. The title of the report is listed as follows:

- Foundation Investigation and Design Report for Proposed High Mast Lighting Hoggs Hollow Structure Infill, G.W.P. 48-99-00, Highway 401/Yonge Street Area, Toronto, Ontario, Submitted to Delcan Corporation by AGRA, Geocres No. 30M14-284, Ref. No. TT99860, dated February 9, 2000. (Reference 1).

## 2 PROJECT AND SITE DESCRIPTION

A total of six (6) overhead signs are proposed at the following locations:

Overhead Sign (OHS)	Location
1	Highway 401 WBL Collector, approximately 1.1 km east of Jane Street.
2	Northwest quadrant of Highway 401 and Bayview Avenue interchange (ramp)
3	Northeast quadrant of Highway 401 and Bayview Avenue interchange (ramp)
4	Southwest quadrant of Highway 401 and Bayview Avenue interchange (ramp)
5	Southeast quadrant of Highway 401 and Bayview Avenue interchange (ramp)
6	Highway 401 and Yonge Street interchange

\* Signs are labelled 1 to 6 for the purpose of this report.

The sites are located within the Highway 401 corridor adjacent to areas of residential and commercial developments.

According to the Physiography of Southern Ontario by L.J. Chapman and D.F. Putnam, 1984, the project sites are located within the physiographic region known as the South Slope. The South Slope is a smooth and drumlinized till plain that has formed as a result of glacial action and deposition of till materials just south of the Oak Ridges Moraine. The South Slope contains a variety of soils that have been deposited over glacial till. The depth of overburden is generally more than 50 m.

## 3 SITE INVESTIGATION AND FIELD TESTING

The field investigation for this project was carried out on October 19, 21 and 23, 2015 and consisted of drilling and sampling five boreholes (numbered OHS15-01 to OHS15-05)) near the locations of five (5) of the proposed OHS. Boreholes OHS15-02 to OHS15-05, were located at the ramps of the Highway 401 and Bayview interchange, and Borehole OHS15-01 was located on the Highway 401 WBL Collector shoulder to the east of Jane Street. The boreholes drilled during the present investigation were extended to depths ranging from 9.2 m to 9.8 m.

Boreholes 2 and 3, drilled during the investigation conducted in 2000 (Reference 1), were referenced for OHS 6, which will be located at the Highway 401 and Yonge Street interchange. just north of the WBL collectors.

The following table indicates the designated borehole for each Overhead Sign support.

Overhead Sign Support (OHS)	Designated Borehole
1	OHS15-01
2	OHS15-02
3	OHS15-03
4	OHS15-04
5	OHS15-05
6*	2 and 3

\* Boreholes from a previous investigation (Reference 1).

The approximate locations of the boreholes drilled during the present investigation are shown on the attached Borehole Locations Plans in Appendix D. The coordinates and elevations of the boreholes are presented on the drawings and on the individual Record of Borehole Sheets in Appendix A. The two selected boreholes drilled during the previous investigations (Reference 1) are also shown. It is important to note, however, that the previous boreholes had been drilled 15 years ago, and that changes of the subsurface conditions at these locations are possible. Records of the previous boreholes are included in Appendix C.

The borehole locations of the current investigation were marked in the field and utility clearances were obtained prior to drilling.

A truck mounted D90 drill rig was used for this investigation. Solid stem augers were used to advance the boreholes. Soil samples were obtained at selected depth intervals using a 50 mm nominal diameter split spoon sampler in conjunction with the the Standard Penetration Test (SPT).

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. Standpipe piezometers, each consisting of a 19 mm diameter Schedule 40 PVC pipe with a 3.0 m long slotted screen, were installed and embedded in filter sand in two selected boreholes to permit longer term groundwater level monitoring. The completion details of the piezometers and boreholes are summarized in Table 3.1.

**Table 3.1 – Piezometer and Borehole Completion Details**

Borehole Number	Piezometer Tip Depth / Elevation (m)	Completion Details
OHS15-01	None installed	Backfilled with bentonite holeplug and auger cuttings to 0.2 m, then asphalt to ground surface.

<b>Borehole Number</b>	<b>Piezometer Tip Depth / Elevation (m)</b>	<b>Completion Details</b>
OHS15-02	None installed	Backfilled with bentonite holeplug and auger cuttings to 0.2 m, then asphalt to ground surface.
OHS15-03	9.1/163.4	Backfilled with filter sand from 9.8 to 5.2 m, bentonite holeplug from 5.2 m to 0.15 m, then cement to ground surface.
OHS15-04	9.1/161.5	Backfilled with filter sand from 9.7 to 5.9 m, bentonite holeplug from 5.9 m to 0.15 m, then cement to ground surface.
OHS15-05	None installed	Backfilled with bentonite holeplug and auger cuttings to 0.2 m, then asphalt to ground surface.

Once groundwater monitoring is completed, all piezometer installations will be decommissioned in general accordance with Ministry of the Environment (MOE) Regulation 903 and its Amendments (the water well regulation under the OWRA).

#### **4 LABORATORY TESTING**

All recovered soil samples were subjected to visual identification and to natural moisture content determination. At least 25% of the recovered soil samples were subjected to grain size distribution analysis. Atterberg Limits tests were carried out on selected samples of native cohesive soils to determine the plasticity characteristics. The results of the laboratory testing are summarized on the Record of Borehole sheets and are also presented on the figures included in Appendix B.

#### **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented on these records. Approximate borehole locations are shown on “Borehole Locations” plans included in Appendix D. An overall description of the stratigraphy encountered near the locations of the proposed overhead sign supports is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the subsurface stratigraphy at the boreholes consists of pavement structure (asphalt, concrete and granular road base) overlying stiff to very stiff silty clay fill and occasional loose silty sand fill. Below the fill, native stiff to hard silty clay was found interlayered with compact to very dense silty sand to sand. A deposit of very stiff to hard silty clay till underlies the above soils. A very dense sandy silt till was encountered below the silty clay till in one borehole. The groundwater level was generally at or below 4 m depth in the boreholes.

### **5.1 Pavement Structure**

All the boreholes were drilled through the paved surface of the Highway 401 at Bayview Avenue ramps and the Highway 401 WBL Collector shoulder. The pavement structure revealed in the boreholes consisted of 50 to 150 mm of asphalt. In Boreholes OHS15-02 and OHS15-05, a 300 mm thick layer of concrete was encountered below the asphalt. All five boreholes encountered a layer of granular road base consisting of sand, some silt and trace gravel. The thickness of the granular road base ranged from 0.8 to 1.0 m.

Moisture contents measured in samples of the granular road base ranged from 3% to 15%.

### **5.2 Topsoil**

Borehole 2 and 3 drilled during the previous investigation, at the Highway 401 and Yonge Street interchange, encountered surficial topsoil. The topsoil was 50 and 130 mm thick, respectively. The topsoil thickness may vary between and beyond the borehole locations.

### **5.3 Fill**

Surficial fill was contacted below the pavement structure in Boreholes OHS15-01, 15-04 and 15-05. The fill is a predominantly brown silty clay containing some to with sand, trace gravel. Occasional rootlets were encountered within the silty clay fill. The thickness of the silty clay fill ranged from 0.2 to 1.5 m. The depth to the base of the silty clay fill ranged from 1.4 to 2.5 m (Elevations 148.4 to 168.1 m).

A 600-mm thick layer of silty sand fill was contacted at 2.5 m depth in Borehole OHS15-04. The depth to the base of the silty sand till was at 3.1 m (Elevation 167.5 m).

SPT 'N' values measured in the silty clay fill typically ranged from 10 to 26 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency. An SPT 'N' value of 9 blows per 0.3 m of penetration was measured in the silty sand fill, indicating a loose state.

Measured moisture contents in the fill ranged from 7% to 12%

Clayey silt fill was contacted just below the surface in Boreholes 2 and 3 at the time of drilling of the previous investigation. This fill varied in thickness from 0.6 to 1.1 m. The SPT 'N' values were 13 and 27 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency.

A samples of silty clay fill was subjected to gradation analysis. A grain size distribution curve for this sample is presented on the Record of Borehole sheets and on Figure B1 in Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	4
Sand	39
Silt	34
Clay	23

#### 5.4 Silty clay

A layer of native brown to grey silty clay was contacted below fill in Boreholes OHS15-02 to OHS15-04, at depths ranging from 1.0 to 3.1 m. A lower silty clay layer was also contacted in Borehole OHS15-03 at 4.7 m depth and at 7.2 m depth in Borehole OHS15-01. The thickness of the silty clay varies from 0.9 to 2.9 m. The depth to the base of the silty clay ranged from 2.9 to 5.8 m (Elevations 166.7 to 169.7 m) in Boreholes 15-02 to 15-04. Borehole OHS15-01 was terminated within the silty clay at 9.8 m depth (Elevation 140.1 m).

SPT 'N' values measured for the silty clay in Boreholes OHS15-01 and OHS15-04, were 11 and 12 blows per 0.3 m of penetration, indicating a stiff consistency. SPT 'N' values ranging from 34 to 90 blows per 0.3 m of penetration, indicating hard consistency, were measured in Boreholes OHS15-02 and OHS15-3. Moisture contents measured in the silty clay ranged from 10% to 27%.

A sample of the silty clay was subjected to gradation analysis and Atterberg Limits testing. The grain size distribution curve for this sample is presented on the Record of Borehole sheets in Appendix A and on Figure B2 in Appendix B. Atterberg Limit test results are presented on Figure B5 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	0
Silt	53
Clay	47

Soil Particles	Percentage (%)
Liquid Limit	36
Plasticity Index	16

The results indicate that silty clay has medium plasticity (CI).



### 5.5 Silty Clay Till

Brown to grey silty clay till with sand and trace gravel was contacted below the fill, silty clay and silty sand at depths ranging from 1.4 to 7.2 m in Boreholes OHS 15-01 to 15-05. Where fully penetrated, the thickness of the silty clay till was 5.8 and 7.2 m in Boreholes OHS15-01 and OHS15-05, respectively. The depth to the base of the silty clay till was at 7.2 and 8.7 m (Elevations 142.7 to 160.3 m) in these two boreholes. Boreholes OHS15-02 to OHS15-04 were terminated within the silty clay till at depths ranging from 9.2 to 9.8 m (Elevations 160.9 to 164.4 m).

SPT 'N' values measured in the silty clay till typically ranged from 12 to 55 blows per 0.3 m of penetration, indicating a very stiff to hard consistency. SPT 'N' values of 50 blows to greater than 100 blows for less than 0.3 m of penetration were measured in Boreholes OHS15-02 and 15-04, indicating the possible presence of cobbles and/or boulders within the tills. Measured moisture contents of samples of the silty clay till ranged from 8% to 24%.

Samples of silty clay till were subjected to gradation analysis and Atterberg Limits testing. Grain size distribution curves for samples of silty clay till are presented on the Record of Borehole sheets in Appendix A and on Figure B3 in Appendix B. Atterberg Limit test results are presented on Figure B6 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	9 to 41
Silt	36 to 42
Clay	22 to 55

Soil Particles	Percentage (%)
Liquid Limit	19 to 37
Plasticity Index	7 to 14

The results indicate that the silty clay till has typically low plasticity (CL). One sample of the silty clay till revealed medium plasticity (CI).

Glacial tills inherently contain cobbles and boulders.

### 5.6 Silty Sand

Brown to grey silty sand containing trace clay was contacted at 4.0 and 2.9 m in Boreholes OHS15-02 and OHS15-03, respectively. The thickness of the silty sand varied from 1.8 to 2.6 m. The depth to the base of the silty sand was 6.6 and 4.7 m (Elevations 167.0 to 167.8m) in Boreholes OHS15-02 and OHS15-03, respectively.

SPT 'N' values measured in the silty sand ranged from 23 to 68 blows per 0.3 m of penetration, indicating a compact to very dense condition. The moisture content in the silty sand was 18%.

Two samples of the silty sand were subjected to gradation analysis. The grain size distribution curves for these samples are presented on the Record of Borehole sheets in Appendix A and on Figure B4 in Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	67 to 71
Silt	23 to 30
Clay	3 to 6

### 5.7 Sand

A 1.4-m thick layer of brown sand containing some silt was contacted at 5.8 m depth in Borehole OHS15-03. The depth to the base of the sand was 7.2 m (Elevation 165.4 m).

An SPT 'N' value measured in the sand was 89 blows per 0.275 m of penetration, indicating a very dense condition. A moisture content measured for the sand was 12%.

### 5.8 Sandy Silt Till

Grey sandy silt till containing some clay and trace gravel was encountered at 8.7 m depth in Borehole OHS15-05, which was terminated within the sandy silt till at 9.8 m (Elevation 159.2 m).

An SPT 'N' value measured in the sandy silt till was 68 blows per 0.3 m of penetration, indicating a very dense condition. The moisture content in the sand was 8%.

Glacial tills inherently contain cobbles and boulders.

### 5.9 Clayey Silt Till

Grey-brown clayey silt till with sand, trace gravel and sand seams was contacted below the fill in Boreholes 2 and 3 at the time of the previous investigation.

Both boreholes were terminated within the clayey silt till at 10.8 to 10.9 m depth (Elevations 162.5 and 164.4 m).

SPT 'N' values measured in the clayey silt till varied from 15 blows to between 50 and 100 blows for less than 0.3 m of penetration, indicating a stiff to hard consistency. Some of the higher blow counts indicate the probable presence of cobbles and/or boulders.

Glacial tills inherently contain cobbles and boulders.

### 5.10 Groundwater Levels

Free standing water was observed in some open boreholes upon completion of the drilling operations. Standpipe piezometers were installed in Boreholes OHS15-03 and OHS15-04 to monitor water levels after completion of drilling. The water levels observed in the open boreholes and the water levels reported in Borehole 2 (previous investigation) are included in Table 5.1. The piezometric levels in Boreholes OHS15-03 and OHS15-04 will be measured in the next round of monitoring and provided in the final report.

**Table 5.1 – Water Level Measurements**

Borehole Number	Date	Water Levels		Comment
		Depth (m)	Elevation (m)	
OHS15-01	October 23, 2015	7.4	142.4	Open borehole
OHS15-02	October 23, 2015	4.3	169.3	Open borehole
OHS15-03	October 19, 2015	5.3	167.2	Open borehole
OHS15-05	October 21, 2015	9.0	160.0	Open borehole
2*	October 25, 1999	6.8	168.5	Piezometer
	November 9, 1999	6.7	168.6	

\* Previous investigation

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

## 6 MISCELLANEOUS

Borehole locations were established in the field based on information provided by MMM Group Limited (MMM). The coordinates at all as-drilled borehole locations were established by Thurber upon completion of drilling. The ground surface elevations of the as-drilled locations were provided by MMM. Underground utility clearances were obtained for the borehole locations prior to drilling.

DBW Drilling of Ajax, Ontario supplied a truck-mounted drill rig, and conducted the drilling, sampling and in-situ testing operations.

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The field investigation was supervised by Ms. Eckie Siu of Thurber. Geotechnical laboratory testing was carried out in Thurber's laboratory.

Planning and co-ordination of the field program was conducted by Mr. Stephane Loranger, C.E.T. Overall direction of the program was provided by Mr. Sydney Pang, P.Eng. Interpretation of the data and preparation of this report was carried out by Ms. R. Palomeque Reyna, P.Eng.

The report was reviewed by Mr. Sydney Pang, P.Eng. and Mr. P.K. Chatterji, P.Eng., who is a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.



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OVERHEAD SIGN SUPPORTS  
HIGHWAY 401 WESTBOUND COLLECTOR  
REHABILITATION  
BAYVIEW AVENUE AND YONGE STREET  
TORONTO, ONTARIO  
MTO GWP 2074-13-00**

**GEOCRES No. 30M11-258**

**PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**7 GENERAL**

This section of the report presents foundation recommendations for the design of the proposed Overhead Sign (OHS) supports. This project includes a total of six (6) OHS supports to be installed at the locations indicated in the following table:

<b>Overhead Sign Support (OHS)</b>	<b>Location</b>
1	Highway 401 WBL Collector, approximately 1.1 km east of Jane Street.
2	Northwest quadrant of Highway 401 and Bayview Avenue interchange
3	Northeast quadrant of Highway 401 and Bayview Avenue interchange
4	Southwest quadrant of Highway 401 and Bayview Avenue interchange
5	Southeast quadrant of Highway 401 and Bayview Avenue interchange
6	Highway 401 and Yonge Street interchange

Information on the proposed locations of the signs was provided to Thurber by MMM. Selected boreholes from a previous investigation conducted in 2000, near the proposed OHS 6, were also utilized for preparation of this report (Reference 1). It should be noted that ground conditions surrounding a previous borehole may have been modified after 15 years. The Record of Borehole sheets for these boreholes are presented in Appendix A.

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## 8 FOUNDATION DESIGN PARAMETERS

Design of the sign support foundations should be carried out in accordance with the following document:

- Ministry of Transportation, Ontario (2015) “Sign Support Manual”, Highway Standards Branch, Bridge Office (Reference 2)

Reference should also be made to the following documents:

- Ministry of Transportation, Ontario (2004) “Guidelines for the Design of High Mast Pole Foundation”, Fourth Edition, BRO-009, Engineering Standards Branch, Bridge Office (Reference 3).
- Canadian Highway Bridge Design Code and Commentary (2010). CAN/CSA-S6-00 and S6.1-00 (Reference 4).

It is understood that a typical overhead sign consists of two conventional augered caisson (drilled shafts). Table 1 following the text of this report presents the recommended foundation design parameters for the design of such caissons. Table 1 also contains recommended design groundwater levels based on water level observations in the relevant boreholes. Should a standard configuration as shown on SS118-3 to 118-5 in Reference 2 be used as a basis for the caisson design, the recommended parameters in conjunction with the methods in References 2 and 3 should be used to check the validity of the standard design.

In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of a caisson within the upper 1.2 m below final grade should be neglected in the foundation design. It is recommended that all topsoil and organics be neglected in determining lateral resistance.

Where downward sloping fill or native soil exists in front of a caisson, reduction of lateral passive resistance should be taken into account during design. For foundation design at the caissons, it should be assumed that full lateral resistance can only be mobilized where the width of the soil in front of or behind the caisson is equal to or greater than approximately four (4) times the diameter of the caissons. For sloping ground in front of a caisson, the magnitude of the mobilized passive resistance can be estimated by interpolating between zero passive resistance at the level where the slope face intersects the pile, and full passive resistance at the level where the slope face is equal to or greater than four (4) times the diameter of the caisson.

Where an unconfined compressive strength,  $q_u$  is provided for a cohesive soil (clayey silt to silty clay fill, silty clay to silty clay till), the ultimate lateral passive resistance should be calculated in conjunction with the total soil unit weight. When designing for portions of the caissons below the groundwater level in cohesionless sands and silts, the submerged soil unit weight,  $\gamma'$  should be used. The required depth of the drilled shaft will be governed by lateral loads, including wind loads, acting on the sign. The length of the caisson should also be sufficient to counteract frost jacking (upward) forces.

An equivalent caisson width equal to two (2) times the caisson diameter may be assumed for lateral resistance calculations. Appropriate load and resistance factors should be applied for caisson design.

### **8.1 Caisson Installation**

Caisson installation should generally be carried out in accordance with OPSS 903.

The contract documents should contain an NSSP alerting the contract bidders of the specific aspects relating to caisson construction for overhead sign foundation supports. Suggesting wordings for this NSSP are provided in Appendix E.

Caisson installation equipment must be able to dislodge, handle, remove cobbles, to penetrate obstructions within the fills, and to drill through hard or very dense layers, where encountered.

The short term groundwater levels were determined to range from about 4 to 7 m depth below existing ground surface. The stabilized groundwater levels may be higher. Soil sloughing and water seepage may occur in unsupported holes especially in sands and silts below the groundwater level. Temporary liners must be available to support the caisson sidewalls and to provide seepage cut-off where required. Any accumulated water may have to be pumped out from the hole prior to placing concrete. Should it be considered impractical to remove the accumulated water inside the hole, it is recommended that the concrete be placed by the tremie method.



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## **8.2 Construction Considerations**

Caisson construction for the sign supports mainly involve the handling and removal of obstructions in the fills, cobbles, drilling through hard or very dense soils, soil sloughing and water seepage from caisson sidewalls, and basal instability. Recommendations on how to address these issues have been outlined in the previous section.

Caisson construction should be monitored by qualified geotechnical personnel, as per OPSS 903, to verify the soil conditions and to confirm that those conditions are consistent with the design assumptions in this report.

## **9 CLOSURE**

Engineering analysis and preparation of the report were carried out by Ms. R. Palomeque Reyna, P.Eng.

The report was reviewed by Dr. Sydney Pang, P.Eng. and Dr. P. K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.



Rocío Palomeque Reyna, P.Eng.  
Geotechnical Engineer



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Report Reviewed by:  
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Review Principal, Designated MTO Contact

**TABLE 1**

**TABLE 1**  
**GEOTECHNICAL DESIGN PARAMETERS**  
**OVERHEAD SIGN SUPPORTS**  
**HIGHWAY 401 WESTBOUND COLLECTOR REHABILITATION**

Overhead Sign (OHS)	Borehole Number	Reference Simplified Subsurface Stratigraphy for Design	Depth Below Existing Highway Grade (m)	Geotechnical Design Parameters						Groundwater Depth (m)
				$C_u$ (kPa)	$\phi'$ (deg.)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$n_h$ (kN/m <sup>3</sup> )	$K_p$	
1 Highway 401 WBL Collector	OHS15-01	Sand fill/Silty clay fill	0.0 – 1.5	-	30	20	-	2,500	3.0	5 (below ground surface)
		Silty clay till (very stiff to stiff)	1.5 – 7.0	75	-	20	-	-	-	
		Silty clay (stiff)	7.0 – 10.0	60	-	19	-	-	-	
2 and 3 Northwest and northeast quadrants of Highway 401 and Bayview Avenue interchange	OHS15-02	Sand fill	0.0 - 1.0	-	30	20	-	2,500	3.0	4 (below ground surface)
		Silty clay (hard)	1.0 – 4.0	100	-	20	-	-	-	
	OHS15-03	Silty sand to sand (compact to dense)	4.0 – 7.0	-	32	21	11	4,000	3.2	
		Silty clay till (hard)	7.0 – 10.0	150	-	21	-	-	-	

**TABLE 1 (cont'd)**  
**GEOTECHNICAL DESIGN PARAMETERS**  
**OVERHEAD SIGN SUPPORTS**  
**HIGHWAY 401 WESTBOUND COLLECTOR REHABILITATION**

Overhead Sign (OHS)	Borehole Number	Reference Simplified Subsurface Stratigraphy for Design	Depth Below Existing Highway Grade (m)	Geotechnical Design Parameters						Groundwater Depth (m)
				$C_u$ (kPa)	$\phi'$ (deg.)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$n_h$ (kN/m <sup>3</sup> )	$K_p$	
4  Southwest quadrant of Highway 401 and Bayview Avenue interchange	OHS15-04	Sand fill	0.0 – 1.0	-	30	20	-	2,500	3.0	5 (below ground surface)
		Silty clay fill (very stiff)	1.0 – 2.5	75	-	20	-	-	-	
		Silty clay (stiff)	2.5 – 4.0	50	-	19	-	-	-	
		Silt clay till (very stiff to hard)	4.0 – 10.0	100	-	21	-	-	-	
5  Southwest quadrant of Highway 401 and Bayview Avenue interchange	OHS15-05	Sand fill	0.0 – 1.0	-	30	20	-	2,500	3.0	5 (below ground surface)
		Silty clay fill (stiff)	1.0 – 1.5	50	-	20	-	-	-	
		Silty clay till (very stiff to hard)	1.5 – 9.0	90	-	20	-	-	-	
		Sandy silt till (very dense)	9.0 – 10.0	-	34	21	11	6,000	3.5	
6	3*	Clayey silt fill	0.0 – 1.0	50	-	19	-	-	-	3
		Clayey silt till (very stiff to hard)	1.0 – 5.0	90	-	21	-	-	-	
		Clayey silt till (hard)	5.0 – 10.0	100	-	21	-	-	-	

\* Previous investigation

Legend:

$C_u$	=	undrained shear strength = 0.5 x unconfined compressive strength, $q_u$
$\phi'$	=	angle of internal friction
$\gamma$	=	bulk unit weight
$\gamma'$	=	submerged unit weight
$K_p$	=	coefficient of passive earth pressure

Notes:

- This table must be read in conjunction with the report. In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.2 m below final grade should be neglected in the foundation design.
- All groundwater levels are reported as the depth below the ground surface in metres at the time of the borehole investigation.

**Appendix A**  
**Records of Boreholes**  
**(Present 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

C<sub>pen</sub>

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

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

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
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

TERMS	
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 OHS 15-01

1 OF 2

METRIC

W.P. 2074-13-00 LOCATION Overhead Sign Supports N 4 842 248.9 E 305 277.9 ORIGINATED BY ES  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.10.23 - 2015.10.23 CHECKED BY RPR

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 ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					
149.8	GROUND SURFACE												
0.0	ASPHALT: (150mm)												
0.2	SAND, some silt, trace gravel Brown Moist (FILL)		1	GS			149						
148.7			1	SS	14								
1.2	Silty CLAY, some to with sand, trace gravel, occasional rootlets												
148.4	Stiff Brown Moist (FILL)		2	SS	21		148						
1.4	Silty CLAY, with sand, trace gravel Very Stiff to Stiff Brown to Grey Moist (TILL)		3	SS	27		147						
			4	SS	12								0 33 40 27
							146						
			5	SS	12		145						
							144						
	Moist to Wet		6	SS	19								
							143						
142.7	Silty CLAY Stiff Grey Wet		7	SS	12		142						0 0 53 47
7.2							141						
			8	SS	11								
140.1													
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

# RECORD OF BOREHOLE No OHS 15-01

2 OF 2

METRIC

W.P. 2074-13-00 LOCATION Overhead Sign Supports N 4 842 248.9 E 305 277.9 ORIGINATED BY ES  
 HWY 401 BOREHOLE TYPE Soild Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.10.23 - 2015.10.23 CHECKED BY RPR

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			20	40	60	80	100					
	Continued From Previous Page																
	WATER LEVEL IN OPEN BOREHOLE AT 7.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.																

# RECORD OF BOREHOLE No OHS 15-02

1 OF 2

METRIC

W.P. 2074-13-00 LOCATION Overhead Sign Supports N 4 847 213.3 E 313 837.6 ORIGINATED BY ES  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.10.23 - 2015.10.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			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				WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	20	40					
173.6	GROUND SURFACE																		
0.0	ASPHALT:(50mm)																		
173.3	CONCRETE:(300mm)																		
0.3	SAND, some silt, trace gravel Very Dense Brown Moist (FILL)		1	GS															
172.5			1	SS	71														
1.1	Silty CLAY, some to with sand, trace gravel Hard Brown Moist																		
			2	SS	74														
			3	SS	33														
	Dark Grey																		
			4	SS	35														
169.7																			
4.0	Silty SAND, trace clay Very Dense to Dense Grey Wet																		
			5	SS	68												0 67 30 3		
			6	SS	49														
167.0																			
6.6	Silty CLAY, some sand Hard Grey Moist (TILL)																		
			7	SS	102/ 0.225												0 13 36 51		

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 OHS 15-03

1 OF 2

METRIC

W.P. 2074-13-00 LOCATION Overhead Sign Supports N 4 847 207.4 E 313 979.8 ORIGINATED BY ES  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.10.19 - 2015.10.19 CHECKED BY RPR

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						
172.5	GROUND SURFACE							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>						
0.0	ASPHALT:(125mm)							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>						
0.1	SAND, some silt, trace gravel, trace clay Very Dense Brown Moist (FILL)		1	GS			172							
171.6														
1.0	Silty CLAY, some to with sand, trace gravel, occasional sand seams Hard Dark Grey Moist		1	SS	51		171							
			2	SS	90									
			3	SS	34		170							
169.7														
2.9	Silty SAND, trace clay Compact Brown Moist		4	SS	23		169							0 71 23 6
							168							
167.8	Silty CLAY, some sand, trace gravel Hard Grey Moist		5	SS	34		167							
166.7														
5.8	SAND, some silt Very Dense Brown Moist		6	SS	89/ 0.275		166							
165.4	Silty CLAY, trace sand Hard Grey Moist (TILL)		7	SS	52		165							0 9 36 55
			8	SS	55		164							
							163							
162.8														
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

# RECORD OF BOREHOLE No OHS 15-03

2 OF 2

METRIC

W.P. 2074-13-00 LOCATION Overhead Sign Supports N 4 847 207.4 E 313 979.8 ORIGINATED BY ES  
 HWY 401 BOREHOLE TYPE Soild Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.10.19 - 2015.10.19 CHECKED BY RPR

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			20	40	60	80	100					
	Continued From Previous Page  WATER LEVEL IN OPEN BOREHOLE AT 5.3m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.  WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m)  Nov 15/ 15      6.7      165.8																

ONTMT4S 19-5161-216.GPJ 2015TEMPLATE(MTO).GDT 11/17/15



# RECORD OF BOREHOLE No OHS 15-04

1 OF 2

METRIC

W.P. 2074-13-00 LOCATION Overhead Sign Supports N 4 846 872.7 E 313 782.7 ORIGINATED BY ES  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.10.21 - 2015.10.21 CHECKED BY RPR

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										
170.6	GROUND SURFACE							20	40	60	80	100						
0.0	ASPHALT:(130mm)							20	40	60	80	100						
0.1	SAND, some silt, trace gravel Brown Moist (FILL)		1	GS			170											
169.6			1	SS	16		169											
1.0	Silty CLAY, some to with sand, trace gravel Very Stiff Brown Moist (FILL)		2	SS	26		169											
168.1			3	SS	9		168											
2.5	Silty SAND, trace gravel Loose Brown Moist (FILL)		4	SS	11		167											
167.5			5	SS	21		166											
3.1	Silty CLAY, some sand, trace gravel, occasional roots and rootlets, topsoil stained Stiff Brown Moist		6	SS	38		165											
166.7			7	SS	100/ 0.250		163											
4.0	Silty CLAY, with sand, occasional sand seams Very Stiff to Hard Brown Moist (TILL)		8	SS	53		162											
160.9							161											
9.7	END OF BOREHOLE AT 9.7m.																	

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS 15-04

2 OF 2

METRIC

W.P. 2074-13-00 LOCATION Overhead Sign Supports N 4 846 872.7 E 313 782.7 ORIGINATED BY ES  
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2015.10.21 - 2015.10.21 CHECKED BY RPR

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					
								20	40	60	80	100					
	Continued From Previous Page  Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m)  Nov 15/ 15 5.5 165.1																

# RECORD OF BOREHOLE No OHS 15-05

1 OF 2

METRIC

W.P. 2074-13-00 LOCATION Overhead Sign Supports N 4 846 867.7 E 313 930.4 ORIGINATED BY ES  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.10.21 - 2015.10.21 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W <sub>P</sub>	W	W <sub>L</sub>			WATER CONTENT (%)
169.0	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT:(50mm)																
0.1																	
168.6	CONCRETE:(300mm)																
0.3	SAND, some silt, trace gravel Brown Moist (FILL)		1	GS													
167.9			1	SS	10		168										
1.1	Silty CLAY, some to with sand, trace gravel Stiff Brown Moist (FILL)																
167.4			2	SS	20		167										
1.5	Silty CLAY, with sand Very Stiff to Hard Brown Moist (TILL)																
			3	SS	18		166										0 41 37 22
			4	SS	22												
							165										
			5	SS	42		164										
	Grey																
							163										
			6	SS	20												0 34 42 24
							162										
			7	SS	36		161										
160.3																	
8.7	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)						160										
			8	SS	68												
159.2																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

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

## 2 OF 2

METRIC

[illegible]

## **Appendix B**

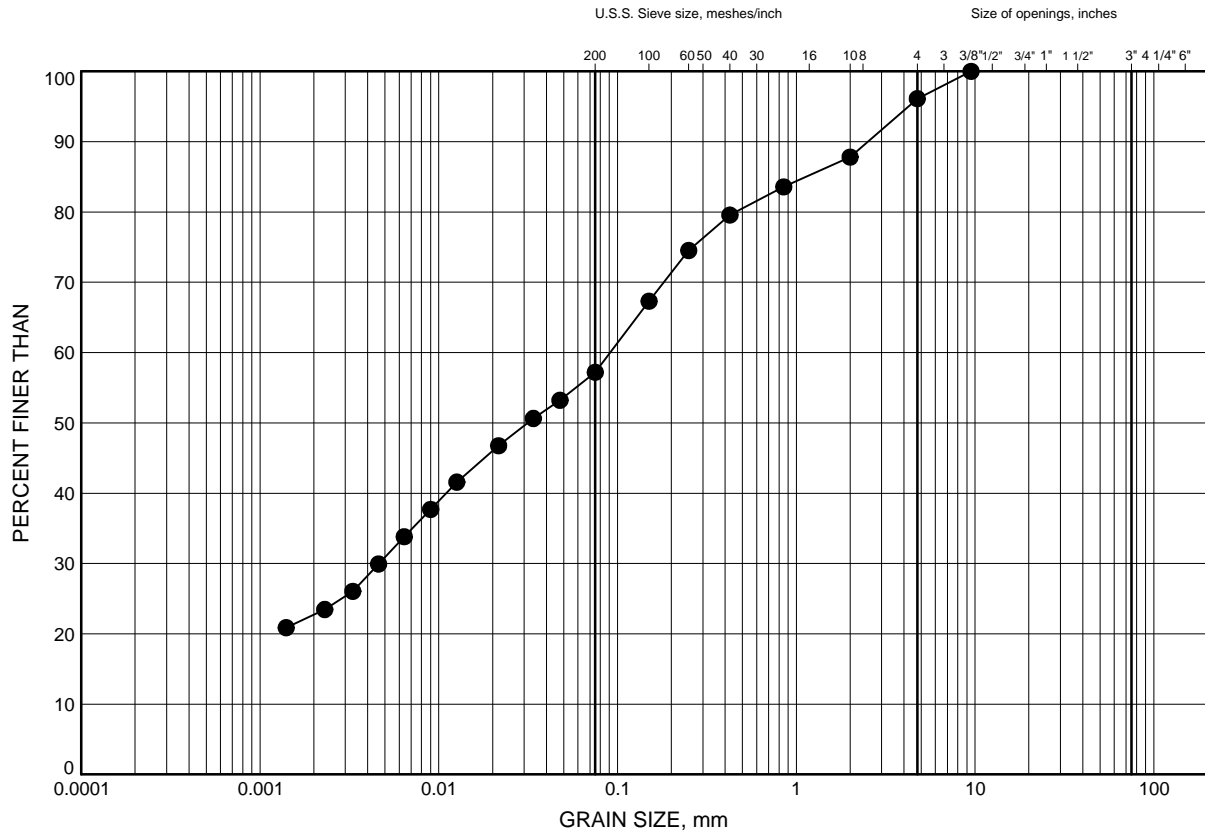
### **Geotechnical Laboratory Test Results (Present Investigation)**

# Hwy 401 WBL Coll Rehab Bayview to Jane

## GRAIN SIZE DISTRIBUTION

FIGURE B1

### Silty CLAY FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS 15-04	1.83	168.80

Date November 2015  
W.P. 2074-13-00



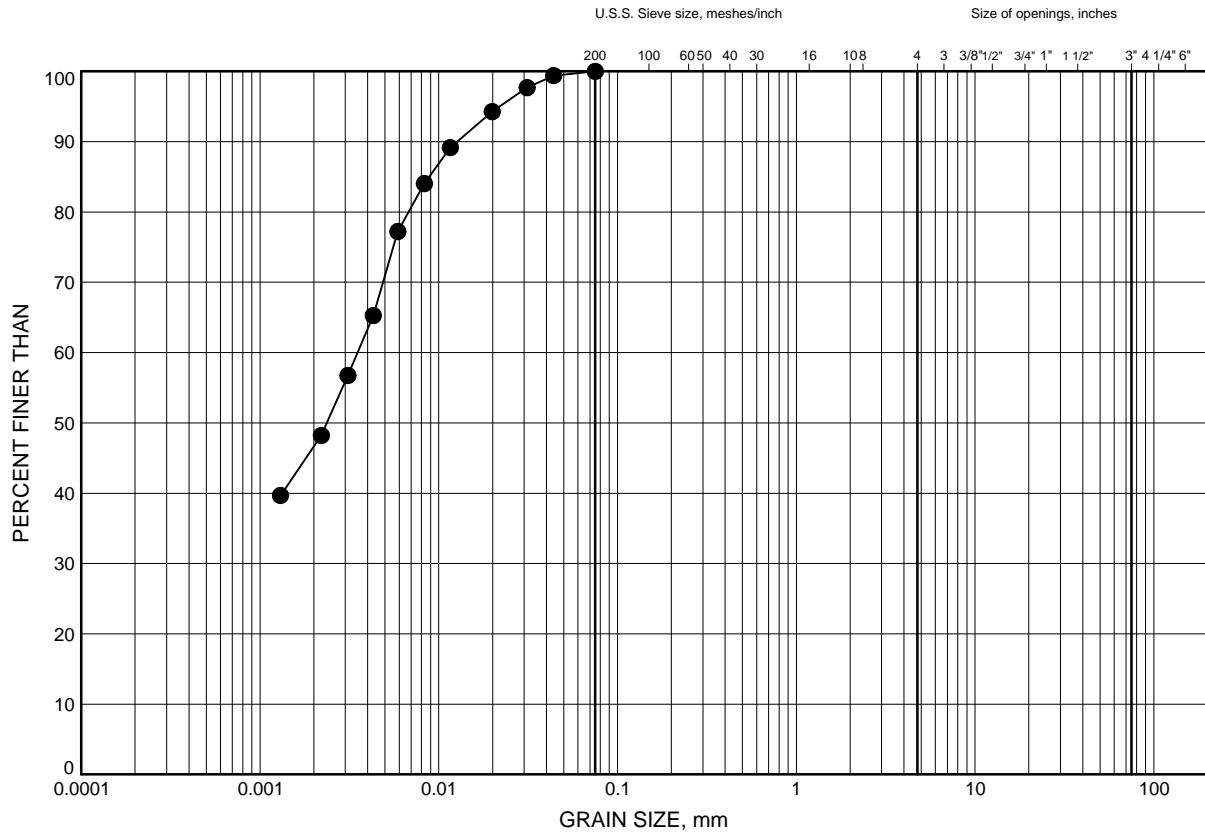
Prep'd AN  
Chkd. RPR

# Hwy 401 WBL Coll Rehab Bayview to Jane

## GRAIN SIZE DISTRIBUTION

FIGURE B2

### Silty CLAY



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS 15-01	7.92	141.91

Date November 2015  
W.P. 2074-13-00



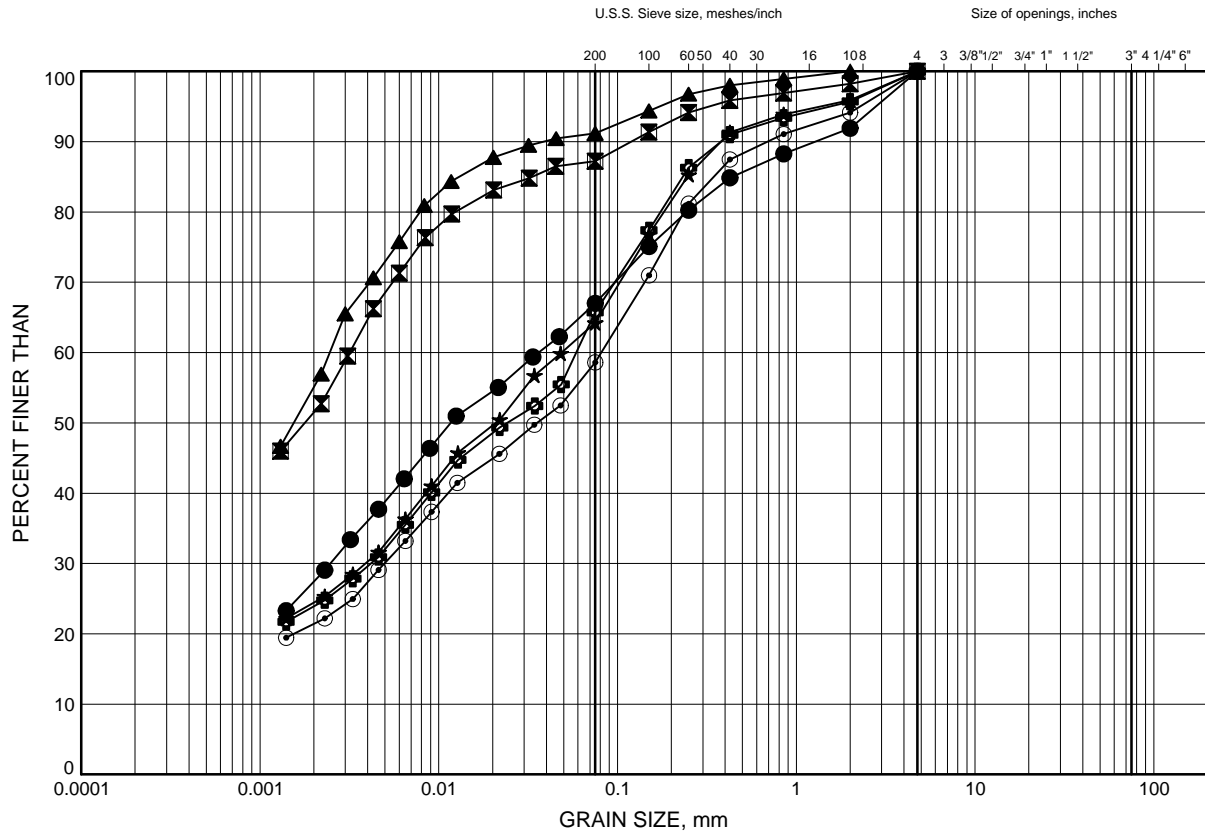
Prep'd AN  
Chkd. RPR

# Hwy 401 WBL Coll Rehab Bayview to Jane

## GRAIN SIZE DISTRIBUTION

FIGURE B3

### Silty CLAY TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS 15-01	3.35	146.48
⊠	OHS 15-02	7.92	165.71
▲	OHS 15-03	7.92	164.62
★	OHS 15-04	6.40	164.23
⊙	OHS 15-05	2.59	166.36
⊕	OHS 15-05	6.40	162.55

Date November 2015  
W.P. 2074-13-00



Prep'd AN  
Chkd. RPR

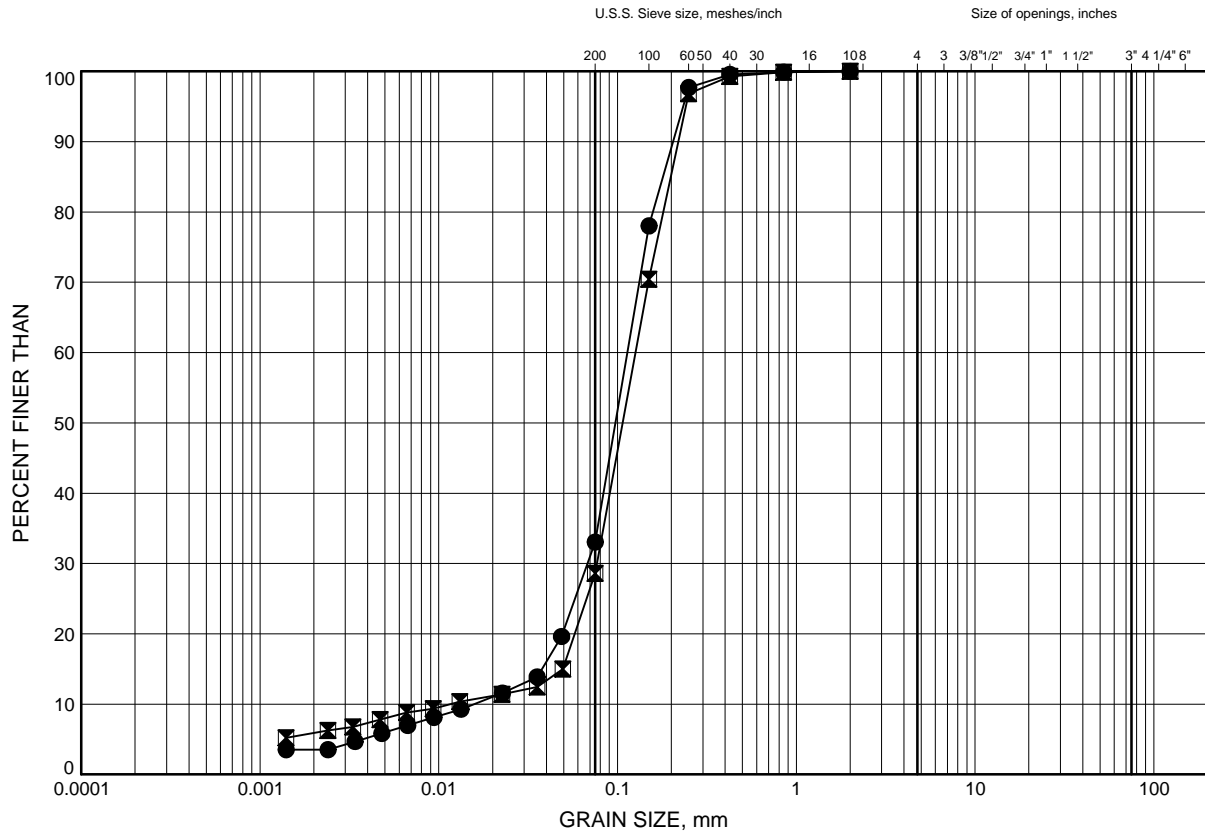


# Hwy 401 WBL Coll Rehab Bayview to Jane

## GRAIN SIZE DISTRIBUTION

FIGURE B4

### Silty SAND



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS 15-02	4.88	168.75
⊠	OHS 15-03	3.35	169.19

Date November 2015  
W.P. 2074-13-00

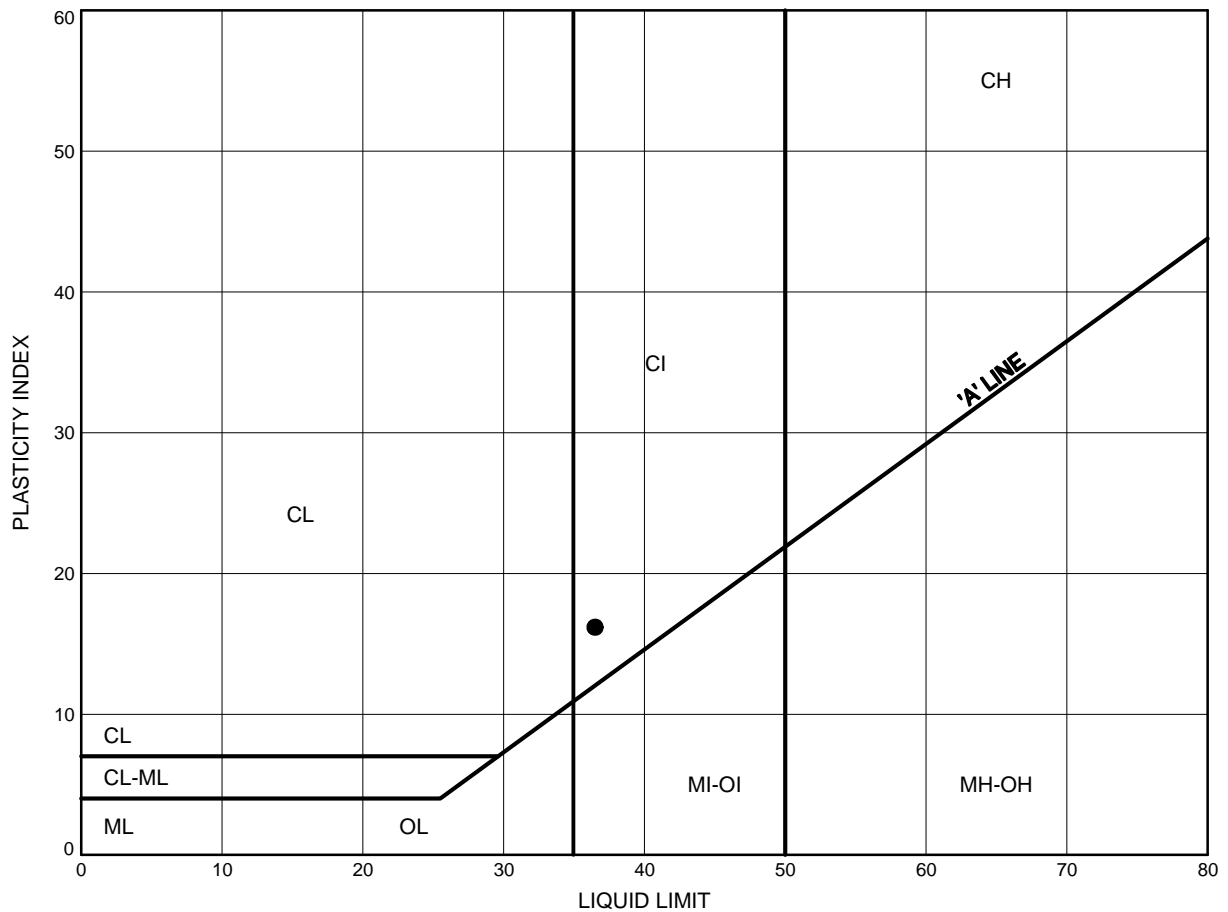


Prep'd AN  
Chkd. RPR

Hwy 401 WBL Coll Rehab Bayview to Jane  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B5

Silty CLAY



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS 15-01	7.92	141.91

Date November 2015  
W.P. 2074-13-00

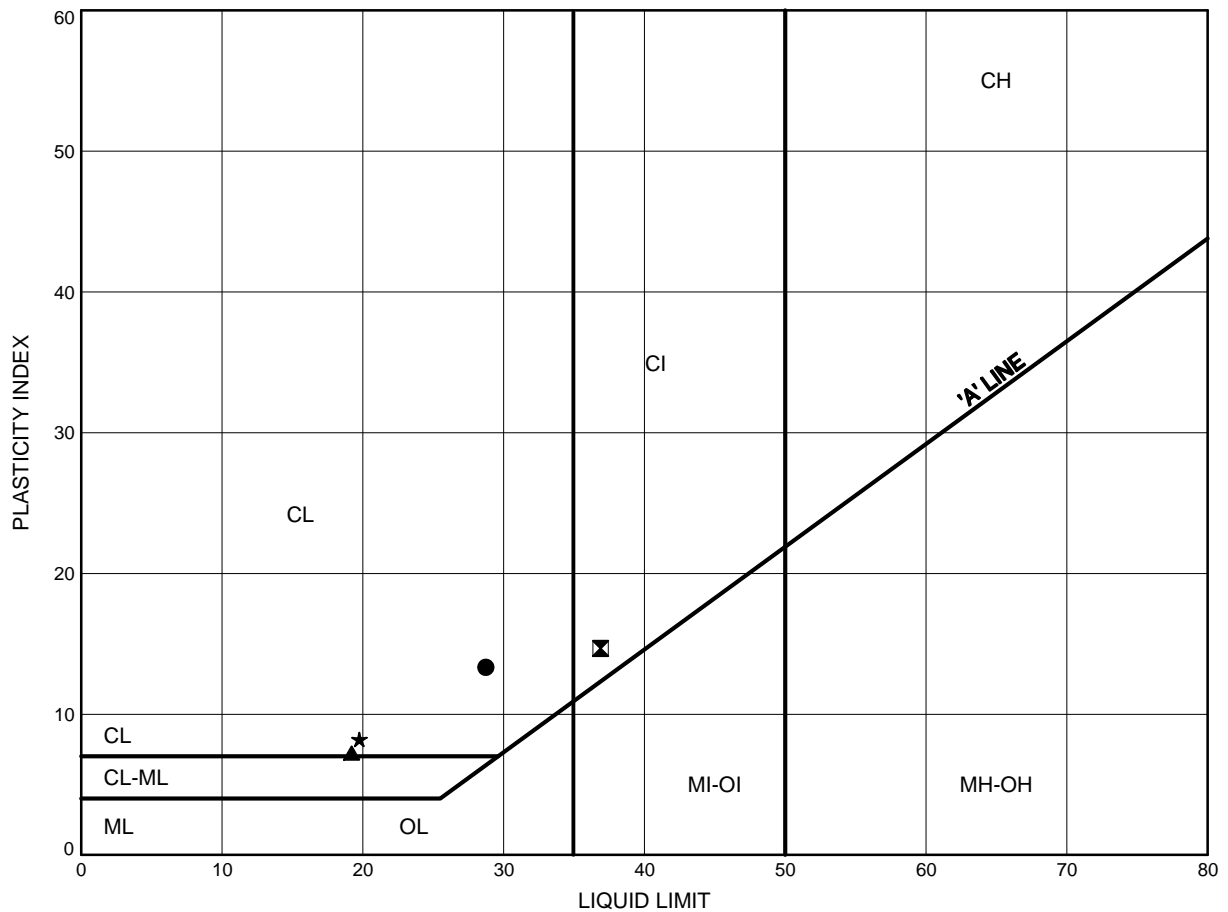


Prep'd AN  
Chkd. RPR

Hwy 401 WBL Coll Rehab Bayview to Jane  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B6

Silty CLAY TILL



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS 15-01	3.35	146.48
⊠	OHS 15-03	7.92	164.62
▲	OHS 15-04	6.40	164.23
★	OHS 15-05	6.40	162.55

Date November 2015  
W.P. 2074-13-00



Prep'd AN  
Chkd. RPR

## **Appendix C**

### **Records of Boreholes (Previous Investigation)**

RECORD OF BOREHOLE No 2										1 OF 1		METRIC	
W.P. 48-99-00		LOCATION N 4 846 192 E 312 158				ORIGINATED BY DT							
DIST _____ HWY 401		BOREHOLE TYPE Solid Stem Augering				COMPILED BY MA							
DATUM Geodetic		DATE 13 October 1999				CHECKED BY SP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>			WATER CONTENT (%)	
175.3	0.05m TOPSOIL		1	SS	27								
174.2	grey brown Clayey Silt, some sand FILL some polyethylene fragments		2	SS	39								
1.1	grey brown CLAYEY SILT with sand, trace gravel occasional sand seams hard dry to moist (GLACIAL TILL)		3	SS	95/28		174						
			4	SS	92/28								
			5	SS	70/15		172						
			6	SS	60/15								
	grey moist		7	SS	50/14		170						
			9	SS	82/21								
	fine to medium Sand trace gravel compact, wet		10	SS	19		168						
	Silty Sand, trace clay compact, wet		11	SS	36		166						
164.4	END OF BOREHOLE		12	SS	50/10								
10.9	Water Level in Piezometer: Oct. 25/99: 6.8m depth Nov. 9/99: 6.7m depth Elev. 168.6m												

**RECORD OF BOREHOLE No 3**


1 OF 1

**METRIC**

W.P. 48-99-00 LOCATION N 4 846 087 E 312 131 ORIGINATED BY DT  
 DIST HWY 401 BOREHOLE TYPE Solid Stem Augering COMPILED BY MA  
 DATUM Geodetic DATE 13 October 1999 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					
173.3	0.13m TOPSOIL		1	SS	13												
0.0	grey brown Clayey Silt FILL		2	SS	22												
172.7	grey brown CLAYEY SILT		3	SS	45												
0.7	with sand, trace gravel some oxidized fissures very stiff to hard moist to dry (GLACIAL TILL)		4	SS	44												
	grey moist		5	SS	29												
			6	SS	25												
			7	SS	15												
			8	SS	50/8												
	hard		9	SS	98/28												
	some sand seams		10	SS	50/11												
			11	SS	50/14												
162.5	END OF BOREHOLE																
10.8																	

**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SPECIFIED  
IN KILOMETRES - METRES

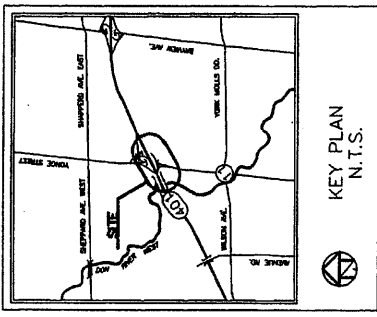
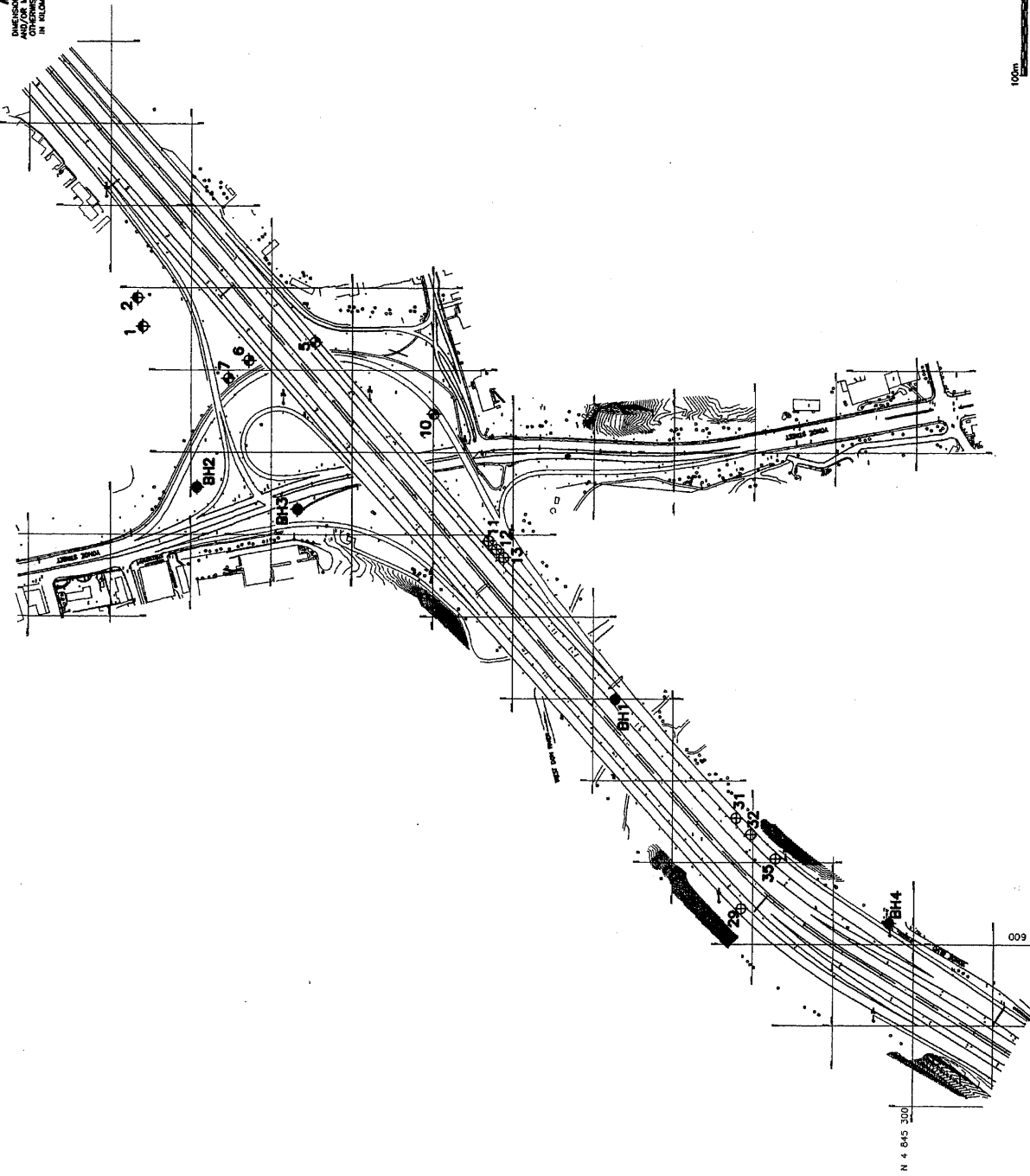


**CONT. No.**  
**W.P. No. 48-99-00**

**INTL 401**

**BORE HOLE LOCATIONS FOR  
HIGH MAST LIGHTING POLES**

AGRA Earth & Environmental Ltd.



- LEGEND**
- Bore Hole (Current Investigation)
  - ⊕ Bore Hole (Geocore 30M14-121)
  - ⊕ Bore Hole (Geocore 30M14-122)
  - ⊕ Bore Hole (Geocore 30M14-123)

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
BH1	138.14	4 845 672	311 000
BH2	175.28	4 846 192	312 158
BH3	173.34	4 846 067	312 131
BH4	170.34	4 845 331	311 625

**NOTE-**  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

**NOTE:** The complete foundation investigation and design report for this project and other related documents may be obtained at the project location. The design report and related documents are included in this report and related documents is specifically excluded in accordance with the conditions of Section 02.01 of OPS Gen-Cond.



NOTE: Bore Hole locations are approximate.  
REF: May 401

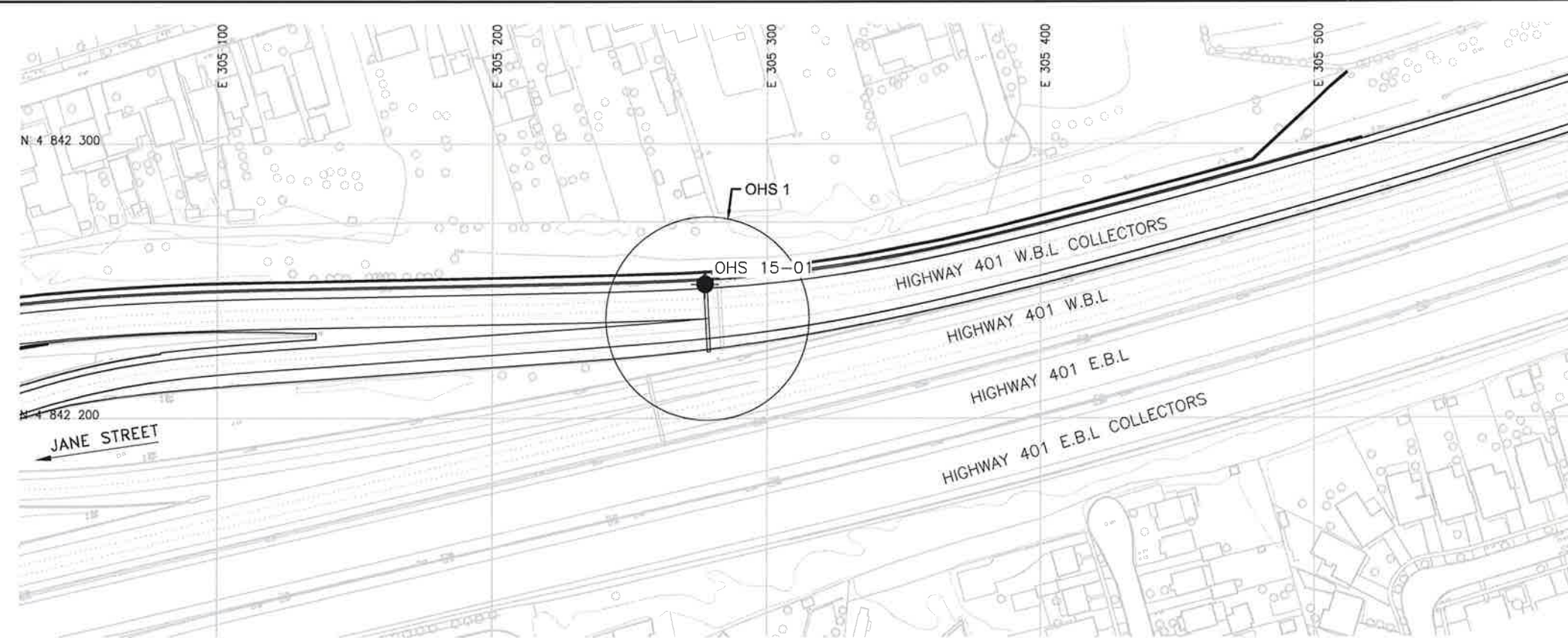
DATE	BY	DESCRIPTION

REV	NO	DATE	BY	DESCRIPTION

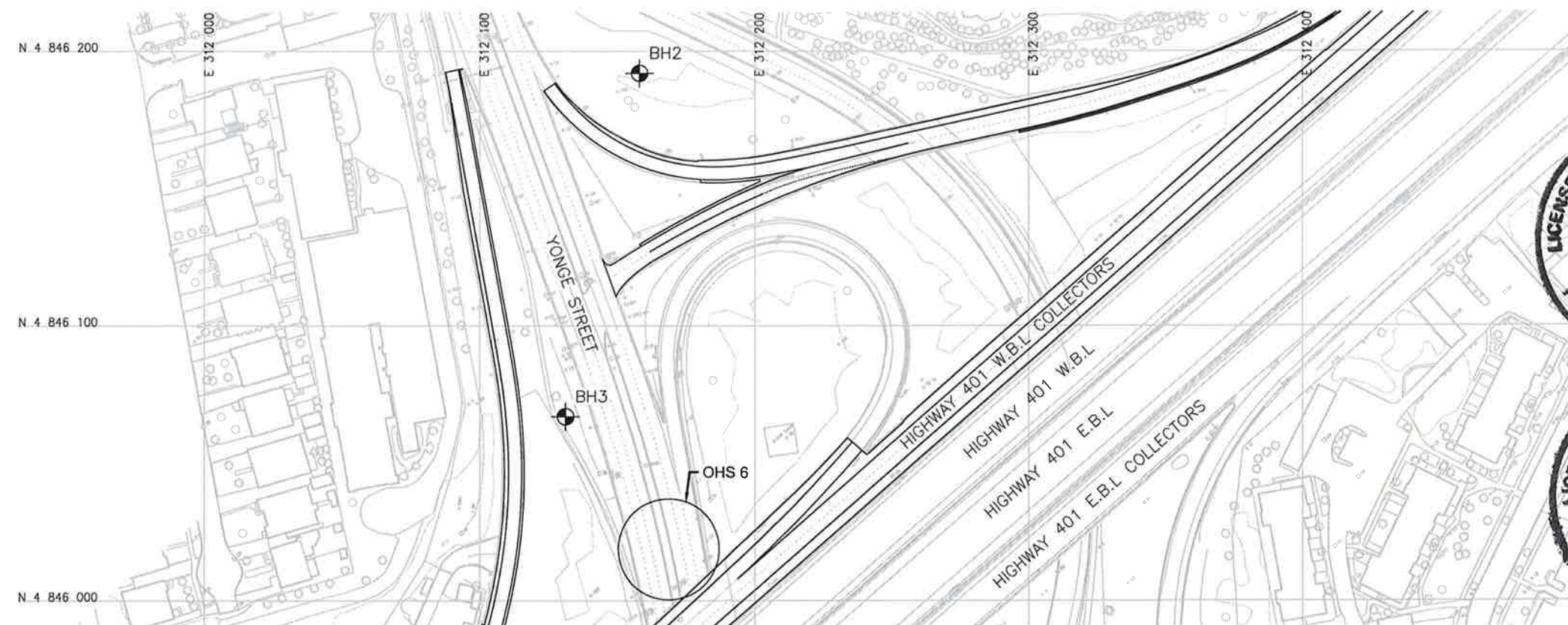
## **Appendix D**

### **Drawings titled “Borehole Locations Plan”**





PLAN



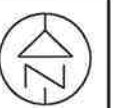
PLAN



METRIC

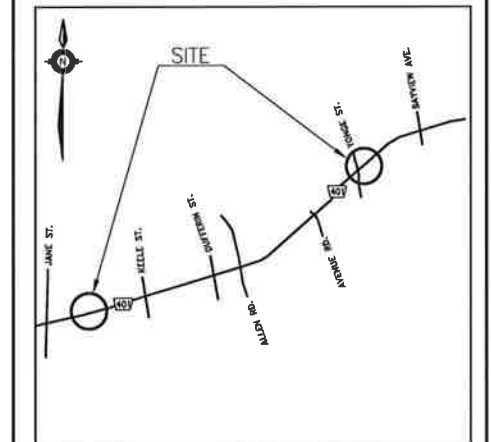
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
GWP No 2074-13-00



HWY 401 WBL COLLECTORS  
OVERHEAD SIGN SUPPORTS  
BOREHOLE LOCATIONS PLAN

SHEET



KEYPLAN

LEGEND

	Borehole (Present Investigation By Thurber)
	Borehole (Previous Investigation By Others)
	Blows /0.3m (Std Pen Test, 475J/blow)
	Blows /0.3m (60' Cone, 475J/blow)
	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
	Rock Quality Designation (RQD)
	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
OHS 15-01	149.8	4 842 248.9	305 277.9
OHS 15-02	173.6	4 847 213.3	313 837.6
OHS 15-03	172.5	4 847 207.4	313 979.8
OHS 15-04	170.6	4 846 872.7	313 782.7
OHS 15-05	169.0	4 846 867.7	313 930.4
BH2	175.3	4 846 192.0	312 158.0
BH3	173.3	4 846 067.0	312 131.0

-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.
- 3) \* Estimated coordinates.

GEOCRES No. 30M11-258



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK RPR	CODE
DRAWN	AN	CHK SKP	SITE
			STRUCT
			DWG 1
			DATE DEC 2015



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

CONT No  
GWP No 2074-13-00

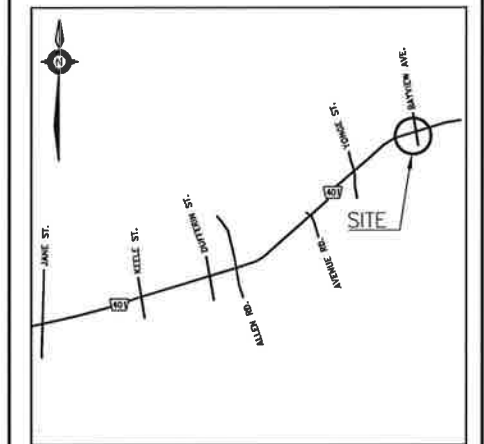


HWY 401 WBL COLLECTORS  
OVERHEAD SIGN SUPPORTS  
BOREHOLE LOCATIONS PLAN

SHEET








**THURBER ENGINEERING LTD.**



## KEYPLAN

### LEGEND

	Borehole (Present Investigation By Thurber)
	Borehole (Previous Investigation 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
OHS 15-01	149.8	4 842 248.9	305 277.9
OHS 15-02	173.6	4 847 213.3	313 837.6
OHS 15-03	172.5	4 847 207.4	313 979.8
OHS 15-04	170.6	4 846 872.7	313 782.7
OHS 15-05	169.0	4 846 867.7	313 930.4
BH2	175.3	4 846 192.0	312 158.0
BH3	173.3	4 846 060.0	312 131.0

-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.
- 3) \* Estimated coordinates.

**GEOCRES No. 30M11-258**



## PLAN

[illegible]

## **Appendix E**

### **List of Special Provisions and Suggested Text for NSSP**

**List of OPSS Documents Referenced in this Report**

- OPSS 903

**Suggested Text for Nssp on:**

***“Augered Caisson Construction”***

The Contractor is advised that variable types of subsurface materials may be encountered at the locations of the overhead sign support foundations. Cobbles and boulders amongst other obstructions is potentially present within the fill and the underlying glacial tills. For additional information regarding subsurface conditions, the Contractor is referred to the Foundation Investigation Report.

For bidding purposes, the Contractor shall assume the following:

1. The subsurface conditions at an augered caisson location are the same as those encountered in the borehole closest to the subject caisson location.
2. Cobbles and boulders may be encountered within the glacial till deposits. Obstructions including cobbles and boulders may also be present within the fills. The soil matrix is anticipated to become harder or denser with depth. Caisson installation equipment must be able to dislodge, handle, remove or otherwise penetrate these obstructions and hard/very dense layers.
3. Water seepage and/or soil sloughing into the caisson hole will occur from existing fill and cohesionless soils. The cohesionless soils would be susceptible to disturbance under conditions of unbalanced hydrostatic head. Temporary liners shall be available on site, or be made available on very short notice, to support the caisson sidewalls and provide seepage cut-off where required. All concrete shall be placed in the dry.

The Contractor is responsible for constructing the sign support foundations without disturbing the material at the sides or bases of the foundations.