



## REPORT

# Foundation Investigation and Design Report

*QEW Burlington Skyway Southbound Lane*

*Overhead Sign Relocation*

*City of Burlington, Halton Region*

*Ministry of Transportation, Ontario*

*GWP 2385-15-00*

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**PART A**

Foundation Investigation Report  
QEW Burlington Skyway  
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Ministry of Transportation, Ontario  
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## 1.0 INTRODUCTION

WSP Golder (formerly Golder Associates Ltd., now a member of WSP Canada Inc.) has been retained by WSP Canada Inc. on behalf of the Ministry of Transportation, Ontario (MTO) to provide detail design foundation engineering services for the relocation of one overhead sign structure as part of the QEW Burlington Skyway Southbound Lane (SBL) rehabilitation.

The QEW Burlington Skyway SBL rehabilitation includes widening of QEW by one lane between the North Shore Boulevard and the Burlington Skyway Bridge including re-alignment of the QEW Niagara bound collector lane. To support the collector lane re-alignment, the existing overhead sign spanning across both the QEW Niagara bound collector lane and Eastport Drive will need to be re-located.

The purpose of this investigation is to assess the subsurface conditions near the location of the new sign through borehole drilling, in-situ testing, and laboratory testing on selected soil samples.

This report summarizes the factual results of field and laboratory work (including field investigation procedures, borehole stratigraphy, and geotechnical and analytical laboratory test results) and provides a description of the interpreted soil and groundwater conditions at the proposed sign location.

## 2.0 SITE DESCRIPTION

The orientation (i.e., north, south, east, and west) stated in the text of this report is referenced to project north and therefore may differ from magnetic north shown on Drawing 1. For the purpose of this report, QEW is considered to be oriented in a north-south direction with the proposed overhead sign perpendicular to the highway in a generally west-east direction.

The existing sign OHS is located on the QEW Niagara Bound Collector at about Station 10+060 (approximately 600 m south of North Shore Boulevard) and the new sign location is to be located about 130 m to the north at Station 9+932. The ground surface conditions at the proposed sign location are shown in Photographs 1 to 3.

## 3.0 INVESTIGATION PROCEDURE

The fieldwork for this subsurface exploration program was carried out on December 11 and 12, 2022 at which time a total of two boreholes (designated OHS-1 and OHS-2) were advanced near the proposed foundation elements of the overhead sign support structure. The approximate locations of the boreholes are shown in Drawing 1.

The boreholes were advanced using a CME 75 truck-mounted drilling rig, supplied and operated by Geo-Environmental Drilling Inc. (GEDI) of Acton, Ontario. Traffic control was performed in accordance with the Ontario Traffic Manual Book 7 – Temporary Conditions by Direct Traffic Management Inc. of Hamilton, Ontario.

Boreholes OHS-1 and OHS-2 were advanced using 108 mm and 57 mm hollow stem augers, respectively. Soil samples were generally obtained at 0.75 metre (m) and 1.5 m intervals of depth, using 50 mm outside diameter split-spoon samplers driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586)<sup>1</sup>. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions.

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<sup>1</sup> ASTM D1586/D1586M-18 Standard Test Method for Standard Penetration Test (SPT) and Split Barrel Sampling of Soils.

The groundwater conditions were noted in the boreholes during and upon completion of drilling and were backfilled in accordance with Ontario Regulation 903 Wells (as amended), and the ground surface restored to near original condition as practicable.

The field work was observed by members of WSP Golder's engineering and technical staff, who located the boreholes in the field, arranged for the clearance of underground utilities, supervised the drilling and sampling operations, logged the boreholes, and examined the soil samples. The soil samples were identified in the field, placed in individually labelled containers, and transported to WSP Golder's geotechnical laboratory in Mississauga for further examination and laboratory testing. Index and classification testing consisting of water contents, grain size distributions, and Atterberg limits determinations were carried out on selected soil samples. The geotechnical laboratory testing was completed according to MTO LS standards, as applicable. Further, two soil samples were obtained using appropriate protocols and submitted to a specialist analytical laboratory under chain of custody procedures for testing a suite of parameters including pH, resistivity, conductivity, chlorides, sulphates, and sulphides.

The as-drilled borehole locations and corresponding ground surface elevations were surveyed on-site by WSP personnel using a Trimble Geo7 GPS unit and the measurements are accurate to within 0.5 m horizontally and 0.1 m vertically. The NAD83 Canadian Spatial Reference System (CSRS) V6:2010 MTM Zone 10 northing and easting coordinates, World Geodetic System 1984 (WGS 84) geographic coordinates, ground surface elevations referenced to the Canadian Geodetic Vertical Datum (CGVD 1928), and borehole depths at each location are presented on the borehole records in Appendix A and are summarized below.

Borehole No.	Location (NAD 83 MTO Zone 10)		Location (WGS 84)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting	Latitude (°)	Longitude (°)		
OHS-1	4796877.3	280071.4	43.311372	-79.804844	77.6	9.8
OHS-2	4796877.8	280081.8	43.311376	79.804712	78.0	8.2

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

Based on the Surficial Geology of Southern Ontario<sup>2</sup> mapping, the Burlington Skyway site is located within a coarse-textured lacustrine deposit, primarily consisting of sand and gravel with minor silt and clay and littoral deposits. This section of the QEW is located on a baymouth sand bar that crosses the west end of Lake Ontario, extending from Burlington to Hamilton, as delineated in the Urban Geology of Canadian Cities (Karrow and White, 1998)<sup>3</sup>

Based on geological mapping by the Ministry of Northern Development and Mines (MNDM)<sup>4</sup>, the site is underlain by bedrock belonging to the Queenston formation consisting of shale, limestone, dolostone and siltstone.

<sup>2</sup> Ministry of Natural Resources, Surficial Geology of Southern Ontario. Ontario Geological Society Electronic Mapping.

<sup>3</sup> Geological Association of Canada, 1998. *Urban Geology of Canadian Cities*. GAC Special Paper 42, Editors P.F. Karrow and O.L. White.

<sup>4</sup> Ministry of Northern Development of Mines. Bedrock Geology of Ontario – Southern Sheet, Ontario Geological Survey – Map 2544.

## 4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of the in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix A. The detailed results of the geotechnical laboratory testing are contained in Appendix B. The results of the in-situ field tests (i.e., SPT 'N' values), as presented in the Record of Borehole sheets and in the subsections below, are uncorrected. The stratigraphic boundaries shown in the Record of Borehole sheets are inferred from non-continuous sampling and therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

In summary, the subsurface conditions consist of the existing pavement structure (i.e., asphalt, sand fill and clayey sand fill) underlain by deposits of sand to silty sand, organic silt, and gravel.

### 4.2.1 Asphalt

A 100 mm and 130 mm thick layer of asphalt was encountered at the ground surface (i.e., Elevations 77.6 m and 78.0 m) in Boreholes OHS-1 and OHS-2, respectively.

### 4.2.2 SAND (SP) FILL

A layer of brown, moist, gravelly sand fill, trace silt was encountered below the asphalt in Boreholes OHS-1 and OHS-2. The granular fill was encountered at Elevations 77.5 m and 77.9 m and was 0.7 m and 0.6 m thick, extending to Elevations 76.8 m to 77.3 m, in Boreholes OHS-1 and OHS-2, respectively.

SPT 'N'-values measured within the gravelly sand fill were 22 blows and 40 blows per 0.3 m of penetration, indicating a compact to dense state of compactness.

### 4.2.3 CLAYEY SAND (SC) FILL

A layer of reddish brown, moist, clayey sand fill, trace to some gravel was encountered below the gravelly sand fill in Boreholes OHS-1 and OHS-2. The clayey sand fill was encountered at Elevations 76.8 m and 77.3 m and was 0.7 and 0.6 m thick, extending to Elevations 76.2 m to 76.6 m in Boreholes OHS-1 and OHS-2, respectively.

SPT 'N'-values measured within the clayey sand fill were 12 blows and 16 blows per 0.3 m of penetration, indicating a compact state of compactness.

The water contents measured on two samples of the clayey silt fill was 13% and 14%.

Grain size distribution testing was carried out on a sample of the clayey sand fill and the results are presented on Figure B-1 in Appendix B. Atterberg limits testing was carried out on two samples of the fill and the results are presented on Figure B-2. The Atterberg limits tests measured liquid limits of 26% and 27%, plastic limits of 17% and 21%, and corresponding plasticity indices of 6% and 9%, indicating the fines portion of the clayey sand fill has a borderline to low plasticity.

### 4.2.4 SAND (SP-SM) to SILTY SAND (SM)

A deposit of reddish brown to grey, moist to wet, sand, trace silt to silty sand was encountered below the clayey sand fill in Boreholes OHS-1 and OHS-2. The sand to silty sand deposit was encountered at Elevations 76.2 m and 76.6 m and was approximately 4.2 m and 3.1 m thick, extending to Elevations 73.5 m and 72.0 m.

SPT 'N'-values measured with the sand to silty sand deposit ranged from 1 blow to 14 blows per 0.3 m of penetration, indicating very loose to compact state of compactness.



The water contents measured on five samples of the sand to silty sand deposit range from 6% to 35%.

Grain size distribution testing was carried out on three samples of the sand to silty sand deposit and the results are presented on Figure B-3 in Appendix B.

Atterberg limits testing was carried out on the fines portion of a sample of the silty sand, which returned a non-plastic test result.

#### **4.2.5 ORGANIC SILT (OL)**

A deposit of brown, wet, sandy organic silt to organic silt and sand was encountered below the sand to silty sand deposit in Boreholes OHS-1 and OHS-2. The organic silt was encountered at Elevations 72.0 m and 73.5 m in Boreholes OHS-1 and OHS-2, respectively. In Borehole OHS-1, the organic silt was 3.1 m thick, extending to Elevation 68.9 m. Borehole OHS-2 was terminated at Elevation 69.8 m after penetrating 2.6 m into the deposit and encountering a methane gas pocket.

The SPT 'N'-values measured within the organic silt deposit ranged from 3 blows to 9 blows per 0.3 m of penetration, indicating a very loose to loose state of compactness.

The water contents measured on three samples of the organic silt range from 63% to 118%.

Grain size distribution testing was carried out on a sample of the organic silt deposit and the results are presented on Figure B-4 in Appendix B.

Organic content testing on two samples of the organic silt yielded organic contents of 14% and 19%.

#### **4.2.6 GRAVEL (GW-GM)**

A deposit of reddish brown, wet, gravel and sand was encountered below the organic silt in Borehole OHS-1. The gravel deposit was encountered at Elevation 68.9 m and Borehole OHS-1 was terminated at Elevation 67.8 m after penetrating 1.1 m into the deposit.

An SPT 'N'-value measured within the gravel deposit was 25 blows per 0.3 m of penetration, indicating a compact state of compactness.

The water content measured on a sample of the gravel deposit was 11%.

Grain size distribution testing was carried out on a sample of the gravel deposit and the results are presented on Figure B-5 in Appendix B.

### **4.3 Groundwater Conditions**

The unstabilized groundwater level was measured in Borehole OHS-1 at a depth of 3.4 m below the existing ground surface (i.e., Elevation 74.2 m) upon completion; however, wet samples were observed below Elevation 75.3 m during drilling, which could be indicative of a slightly higher groundwater level. The unstabilized groundwater level was not measured in Borehole OHS-2, as the borehole was terminated and abandoned after encountering a methane gas pocket; however, wet samples were observed in Borehole OHS-2 below Elevation 75.7 m.

Groundwater levels are subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year.

## 4.4 Analytical Testing

The results of analytical testing of four soil samples, which were submitted to Bureau Veritas (an accredited analytical testing laboratory), are detailed in the laboratory test report (Certificate of Analysis) included in Appendix C and are summarized below.

Borehole and Sample No.	Depth / Elevation (m)	Resistivity (ohm-cm)	Conductivity (µmho/cm)	pH	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (mg/kg)
OHS-1 Sample No. 4	2.6 / 75.0	700	1430	7.41	830	<20 <sup>1</sup>	13.1
OHS-2 Sample No. 4	2.6 / 75.4	1200	817	7.44	470	<20 <sup>1</sup>	3.3

Note 1: Sulphate concentrations are less than the reportable detection limit (RDL) of 20 µg/g.

## 5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Ankaren Maheswaran, EIT under the overall direction of Mr. Mark Henderson, P.Eng. This Foundation Investigation Report was prepared by Mr. Ankaren Maheswaran, E.I.T. and Mr. Mark Henderson, P.Eng., provided a technical review of the report. Mr. David Muldowney, P.Eng., an MTO Foundations Designated Contact and Principal Geotechnical Engineer of WSP Golder, conducted an independent technical and quality control review of the report.

## Signature Page

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[https://golderassociates.sharepoint.com/sites/140379/project files/6 deliverables/2. reports/3. final/21451904-r-rev0\\_final ohs qew burlington\\_-\\_jun2023.docx](https://golderassociates.sharepoint.com/sites/140379/project%20files/6%20deliverables/2.%20reports/3.%20final/21451904-r-rev0_final%20ohs%20qew%20burlington_-_jun2023.docx)

**PART B**

Foundation Design Report  
QEW Burlington Skyway  
Southbound Lane  
Overhead Sign Relocation  
City of Burlington, Halton Region  
Ministry of Transportation, Ontario  
GWP 2385-15-00

## 6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

### 6.1 General

This section of report provides geotechnical engineering parameters and foundation recommendations for the relocation of an overhead sign (OHS) on the QEW Burlington Skyway. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the subsurface exploration. The discussion and recommendations presented are intended for to provide the designer with sufficient information to assess the feasible foundation alternatives and carry out the design of the OHS foundations, as may be required. The Foundation Investigation Report, discussions and recommendations are intended for the use of the MTO and shall not be used or relied upon for any other purposes or by any other parties, including the construction or design-build contractor. The contractor must make their own interpretation based on the factual data in the Foundation Investigation Report (i.e., Part A of the report). Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions may be required in the Contract Documents. Those requiring information on the aspects of construction must make their own interpretation of the factual information provided, as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

### 6.2 Design of Overhead Sign Foundation

Support for the overhead sign should be designed in accordance with MTO Sign Support Manual (2019). Based on discussions with WSP, we understand that a ground-mounted tri-chord (Type I) sign support will be utilized. The standard sign foundation design for the ground-mounted tri-chord sign support consists of a “standard” drilled shaft (caisson). As per Standard Drawing SS18-3, the caissons are to extend a minimum of 5 m below the design frost depth. As per Drawing Aid DA 4-2 (Contours for Frost Depths of Southern Ontario), the estimated depth of frost penetration in the Burlington area is approximately 1.2 m. As such, the caissons for this sign support will need to extend a minimum depth of 6.2 m below finished ground surface.

The assumed minimum soil parameters (below the frost layer) for the “standard” caisson design, as outlined in the 2019 Sign Support Manual are as follows:

- **Case 1 (Cohesionless Soils):** Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the caisson foundation and sand with a friction angle of 30 degrees surrounding the lower third of the caisson.
- **Case 2 (Cohesive Soils):** Soft clay with an undrained shear strength of 25 kPa surrounding the upper two-thirds the caisson and soft clay with a friction angle of 30 degrees surrounding the lower third of the caisson.

Based on the review of the subsurface information, the soils near the location of the replacement OHS are cohesionless in nature. The subsurface soils satisfy the minimum required soil conditions in the upper two-thirds of the caisson, but do not meet the requirements for the lower portion of the caisson; therefore, a site-specific design is required.

The site-specific design may be determined using the following equations to calculate the unfactored passive lateral earth pressure,  $P_p$  (kPa), distributed along the depth of the caisson foundation; this earth pressure distribution is triangular with depth:

$$\begin{aligned}
 P_p &= K_p \gamma d && \text{above the groundwater table, and} \\
 P_p &= K_p \gamma d_w + K_p \gamma' (d - d_w) && \text{below the groundwater table.}
 \end{aligned}$$

where:

$$\begin{aligned}
 K_p &= \text{passive earth pressure coefficient;} \\
 \gamma &= \text{bulk unit weight (kN/m}^3\text{);} \\
 \gamma' &= \text{effective unit weight below the groundwater level (kN/m}^3\text{);} \\
 d &= \text{depth below the ground surface (m); and} \\
 d_w &= \text{depth to the groundwater level (m).}
 \end{aligned}$$

The unfactored passive lateral resistance should be calculated assuming an equivalent pile width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to the unfactored lateral resistance to obtain the factored lateral geotechnical resistance at the Ultimate Limit State (ULS).

Alternatively, the resistance to lateral loading may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction,  $k_h$  (kPa/m), is based on the equation below. However, the response of a drilled shaft/caisson to lateral loads is highly non-linear and methods that assume linear behavior (such as subgrade reaction theory) are only appropriate where the maximum drilled shaft deflections are less than 1% of the pile or drilled shaft diameter, where the loading is static (no cycling) and where the pile material is linear (CFEM, 2006).

For cohesionless soils:

$$k_h = \frac{n_h z}{B}$$

where:

$$\begin{aligned}
 n_h &= \text{coefficient related to soil density (kPa/m)} \\
 z &= \text{depth of the caisson below finished grade (m), and,} \\
 B &= \text{width of pile or diameter of drilled shaft (m)}
 \end{aligned}$$

The stratigraphy and design parameters for the subsurface conditions encountered in the boreholes at the sign support location, including the values of  $n_h$  (Terzaghi, 1955) to be incorporated into the calculations of the coefficient of horizontal subgrade reaction ( $k_h$ ) within the native overburden, are given in Table 1 following the text of this report. The passive resistance in front of the caisson within the upper 1.2 m below ground surface should be neglected in the design of the foundations to account for frost action.

## 6.3 Construction Considerations

### 6.3.1 Foundations

Construction of the caisson foundations for the sign support structures should be in accordance with Ontario Provincial Standard Specification, Provincially Oriented (OPSS.PROV) 915 (Sign Support Structures) and OPSS.PROV 903 (Deep Foundations), as amended by Standard Special Provision (SSP) 109F57.

### 6.3.2 Control of Soil and Groundwater

The unstabilized groundwater level measured in Borehole OHS-1 at Elevation 74.2 m. A potentially higher groundwater level at about Elevation 75.5 m was inferred due the presence of wet samples in Boreholes OHS-1 and OHS-2. Water-bearing non-cohesive soils, as encountered in the boreholes at this site, should be expected to run or flow into the drillholes during caisson installation. Therefore, appropriate equipment and procedures, such as

use of casings and/or water/drilling fluid to maintain a positive head of pressure within the drilled hole, will be required to minimize ground loss and/or to control base disturbance / basal heave due to groundwater pressures / seepage. Further, placement of concrete by tremie methods will be required in wet conditions. It is recommended that a Notice to Contractor be included in the Contract Documents to alert the Contractor to the potential for water-bearing non-cohesive soils. A sample Notice to Contractor is included in Appendix D.

### **6.3.3 Natural Gas Pockets**

The presence of methane gas was observed during advancement of Borehole OHS-2. Methane forms an explosive mixture with air and is a potential hazard for excavation and construction work. Changes in groundwater pressure, which may be caused by dewatering or seepage into excavations, can lead to migration/release of gaseous or dissolved methane. It is recommended that a Notice to Contractor be included in the Contract Documents to alert the Contractor to the presence of methane gas. A sample Notice to Contractor is included in Appendix D.

## **6.4 Corrosion Assessment and Protection**

The results of analytical testing on selected soil samples from each OHS borehole are presented in Section 4.4 and the analytical laboratory test report is included in Appendix C. The suite of parameters tested is intended to allow the design engineer to assess the requirements for the appropriate type of cement to be used in construction and the need for corrosion protection of steel elements.

The analytical test results for sulphate were compared to CSA A23.1 Table 3 ("Additional requirements for concrete subjected to sulphate attack") to assess the potential severity of sulphate attack on concrete during its service life. The sulphate concentration measured on the submitted soil samples are less than 0.002%, which is below the "moderate" degree of exposure (i.e., below the Class S-3 exposure limits) and the degree of sulphate attack is considered "negligible" according to Table 7.2 in MTO's Gravity Pipe Design Guidelines (2014). Therefore, based on the soil samples tested, when the designer is selecting the exposure class for the concrete structure, the effects of sulphates from within the site soils in contact with any portion of the proposed structures constructed below the ground surface may not need to be considered.

The measured pH was 7.41 and 7.44. According to the MTO Gravity Pipe Design Guidelines (2014), a pH less than 5.5 is considered strongly acidic while a pH greater than 8.5 is considered strongly alkaline; both of which are indicative of an increased potential for corrosion. It should be noted that the water levels in the area are subject to seasonal fluctuations and variations due to the precipitation events and the soil/water chemistry could also be variable.

The resistivity measured in the tested soil samples were 700 ohm-cm and 1,200 ohm-cm, which indicates that the soil corrosiveness is severe ( $2,000 > R$ ) as per Table 3.2 of the MTO Gravity Pipe Design Guidelines (2014). Further, given that the structure foundations could be exposed to de-icing salts from the adjacent highways and/or interchange ramps, consideration should be given by the designer to designing for a "C" type exposure class as defined by CSA A23.1 Table 1.

These recommendations are provided as guidance only; the structural designer should take the results of the laboratory testing and the potential for corrosion into consideration as part of the materials selection. Ultimately, it is the designer's decision to determine the appropriate exposure class and to ensure that all aspects of CSA A23.1 Section 4.1.1 (Durability Requirements) are satisfied.

## 7.0 CLOSURE

This Foundation Design Report was prepared by Mr. Mark Henderson, P.Eng., and Mr. David Muldowney, P.Eng., an MTO Foundations Designated Contact, conducted an independent technical and quality control review of the report.



## Signature Page

### WSP Golder



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### ASTM International

ASTM D1586	Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils
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### Ontario Provincial Standard Specifications (OPSS)

OPSS.PROV 903	Construction Specification for Deep Foundations
OPSS.PROV 915	Construction Specification for Sign Support Structures

### Ontario Water Resource Act

Regulation 903	Wells (as amended)
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Table 1: Geotechnical Design Parameters for Tri-Chord Overhead Sign Support

Borehole ID	Ground Surface Elevation (m)	Stratum	Depth (m) <sup>1</sup>	Elevation (m)	Design Groundwater Elevation (m)	Design Parameters <sup>2, 3</sup>				
						n <sub>h</sub> (kPa/m)	Φ' (°)	γ (kN/m <sup>3</sup> )	γ' (kN/m <sup>3</sup> )	K <sub>p</sub>
Borehole OHS-1	77.6	Compact gravelly sand fill	0.1 - 0.8	77.5 - 76.8	75.5	6,600	35	21	11	3.7
		Compact clayey sand	0.8 - 1.4	76.8 - 76.2		2,200	29	19	9	2.9
		Loose sand to silty sand (above GWL)	1.4 - 2.1	76.2 - 75.5		2,200	30	20	10	3.0
		Very loose to loose sand to silty sand (below GWL)	2.1 - 5.6	75.5 - 72.0		1,300	30	20	10	3.0
		Very loose to loose organic silt	5.6 - 8.7	72.0 - 68.9		1,000	28	19	9	2.8
		Compact gravel and sand	8.7 - 9.8	68.9 - 67.8		4,400	35	21	11	3.7
Borehole OHS-2	78.0	Dense gravelly sand fill	0.1 - 0.7	77.9 - 77.3	75.5	6,600	35	21	11	3.7
		Compact clayey sand	0.7 - 1.4	77.3 - 76.6		2,200	29	19	9	2.9
		Loose to compact sand to silty sand (above GWL)	1.4 - 2.5	76.6 - 75.5		2,200	30	20	10	3.0
		Very loose to loose sand to silty sand (below GWL)	2.5 - 4.5	75.5 - 73.5		1,300	30	20	10	3.0
		Very loose to loose organic silt and sand	4.5 - 8.2	73.5 - 69.6		1,000	28	19	9	2.8

NOTES:

1. Depths are given at the existing borehole location; the ground surface elevation at the borehole location should be compared to the ground surace at the actual sign support location, and the depths of the soil strata should be adjusted accordingly.
2. Design parameters:

φ'

= effective friction angle (degrees);

γ

= bulk unit weight (kN/m3);

γ'

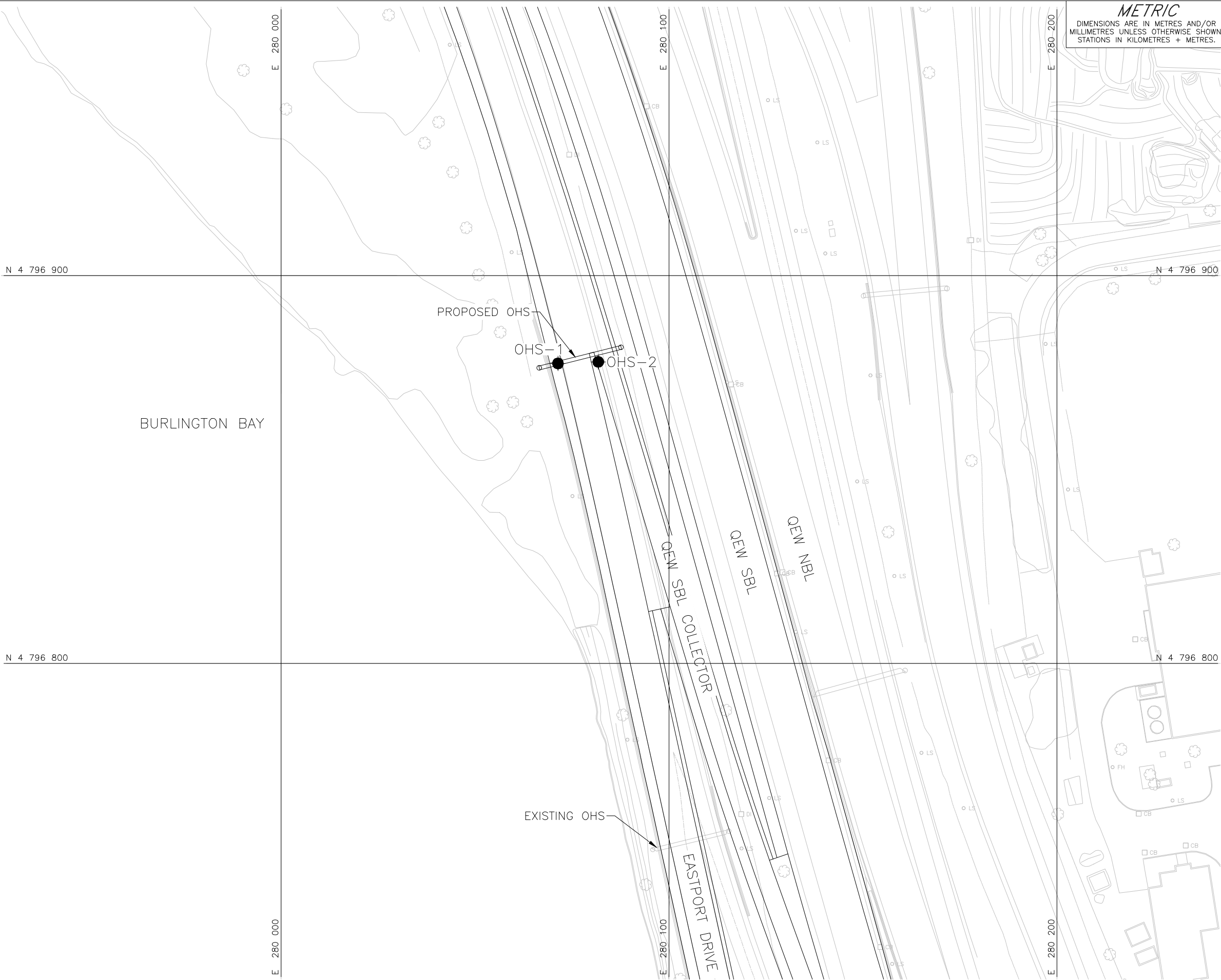
= effective unit weight below the groundwater level (kN/m3);

n<sub>h</sub>

= constant of horizontal subgrade reaction (kPa/m);

K<sub>p</sub>

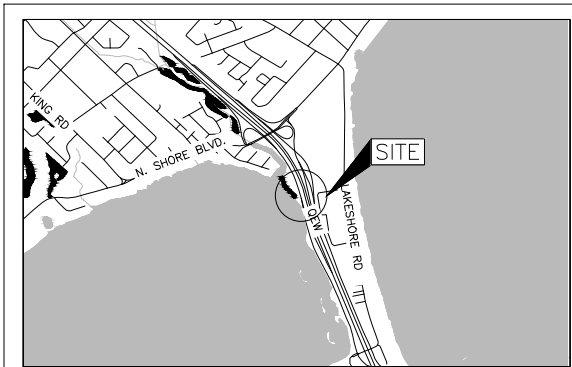
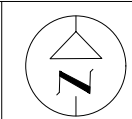
= passive earth pressure coefficient; and
3. Although the passive resistance in the upper 1.2 m is neglected to account for frost action, values of c, Φ', and K<sub>p</sub> are given in the event that the ground surface elevation varies significantly between the borehole and the sign support location.



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

CONT No. .  
GWP No. 2385-15-00

QEW – BURLINGTON SKYWAY  
REHABILITATION  
OVERHEAD SIGN RELOCATION  
BOREHOLE LOCATION PLAN



KEY PLAN  
SCALE

500 0 500 1000 m

LEGEND

● Borehole – Current Investigation

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
OHS-1	77.6	4796877.3	280071.4
OHS-2	78.0	4796877.8	280081.8



NOTES

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

REFERENCE

Base plan provided in digital format by WSP, drawing file no. XB01.dwg, received January 25, 2023.  
Design plan provided in digital format by WSP, drawing file no. 211-09860-00\_XN01.dwg.

NO.	DATE	BY	REVISION
Geocres No. 30M-353			
HWY. QEW	PROJECT NO. 21451904		DIST. .
SUBM'D. AM	CHKD. AM	DATE: 05/31/2023	SITE: .
DRAWN: DD/SA	CHKD. MH	APPD. DAM	DWG. 1





**Photograph 1: Existing Overhead Sign Location, facing south**



**Photograph 2: Proposed Overhead Sign Location, facing south**



**Photograph 3: Proposed Overhead Sign Location, facing north**

**APPENDIX A**

# Record of Boreholes

# ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

## MINISTRY OF TRANSPORTATION, ONTARIO

### PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

### MODIFIERS FOR SECONDARY COMPONENTS<sup>1,2</sup>

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component ( <i>i.e.</i> , SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some ( <i>i.e.</i> , some sand)
≤ 10	trace ( <i>i.e.</i> , trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

### PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

#### Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance ( $q_t$ ), porewater pressure ( $u$ ) and sleeve friction ( $f_s$ ) are recorded electronically at 25 mm penetration intervals.

#### Dynamic Cone Penetration Resistance (DCPT); $N_d$ :

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

### SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

### SOIL TESTS

w	water content
PL, $w_p$	plastic limit
LL, $w_L$	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
$D_R$	relative density (specific gravity, $G_s$ )
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
Y	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

### COARSE-GRAINED SOILS

#### Compactness<sup>1</sup>

Term	SPT 'N' (blows/0.3m) <sup>2</sup>
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

1. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

2. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

### FINE-GRAINED SOILS

#### Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' <sup>1,2</sup> (blows/0.3m)
Very Soft	< 12	0 to 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	> 200	> 30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

### Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.



# LIST OF SYMBOLS

## MINISTRY OF TRANSPORTATION, ONTARIO

Unless otherwise stated, the symbols employed in the report are as follows:

### I. GENERAL

$\pi$	3.1416
$\ln x$	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

### II. STRESS AND STRAIN

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta\sigma$
$\varepsilon$	linear strain
$\varepsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	Poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

### III. SOIL PROPERTIES

#### (a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
$\gamma'$	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )
$D_R$	relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ )
e	void ratio
n	porosity
S	degree of saturation

#### (a) Index Properties (continued)

w	water content
$w_L$ or LL	liquid limit
$w_P$ or PL	plastic limit
$I_P$ or PI	plasticity index = $(w_L - w_P)$
NP	non-plastic
$w_s$	shrinkage limit
$I_L$	liquidity index = $(w - w_P) / I_P$
$I_C$	consistency index = $(w_L - w) / I_P$
$e_{max}$	void ratio in loosest state
$e_{min}$	void ratio in densest state
$I_D$	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

#### (b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

#### (c) Consolidation (one-dimensional)

$C_c$	compression index (normally consolidated range)
$C_r$	recompression index (over-consolidated range)
$C_s$	swelling index
$C_{a(e)}$	secondary compression index
$C_a$	rate of secondary compression
$C_{a(e)}$	modified secondary compression index
$m_v$	coefficient of volume change
$C_v$	coefficient of consolidation (vertical direction)
$C_h$	coefficient of consolidation (horizontal direction)
$T_v$	time factor (vertical direction)
U	degree of consolidation
$\sigma'_p$	pre-consolidation stress
OCR	over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$

#### (d) Shear Strength

$\tau_p, \tau_r$	peak and residual shear strength
$c'$	effective cohesion
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	coefficient of friction = $\tan \delta$
$c_u, s_u$	undrained shear strength ( $\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
$p'$	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q or $q'$	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
$q_u$	compressive strength $(\sigma_1 - \sigma_3)$
$S_t$	sensitivity

\* Density symbol is  $\rho$ . Unit weight symbol is  $\gamma$ .  
where  $\gamma = \rho \cdot g$  (i.e., mass density multiplied by  
acceleration due to gravity)

Notes: 1  
2

$\tau = c' + \sigma' \tan \phi'$   
shear strength = (compressive strength)/2

PROJECT	21451904	LOCATION	N 4796877.3; E 280071.4 NAD83 / MTM Zone 10 (LAT. 43.311372; LONG. -79.804840)	RECORD OF BOREHOLE No. OHS 1	Sheet 1 of 1	METRIC
G.W.P.	2385-15-00	BOREHOLE TYPE	108 mm ID Hollow Stem Augers	ORIGINATED BY	AM	
DIST	Central HWY QEW	DATE	Dec 11, 2022	COMPILED BY	AM	
DATUM	Geodetic			CHECKED BY	MH	

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W <sub>p</sub>	NMC W	LL W <sub>L</sub>						
77.6								20	40	60	80	100	20	40	60						
0.0	ASPHALT (100 mm)																				
77.5	Gravelly SAND (SP), trace silt (FILL)		1	SS	22		77														
0.1	Compact																				
76.8	Brown																				
0.8	Moist		2	SS	12																
76.2	CLAYEY SAND (SC), trace gravel (FILL)																				
1.4	Compact																				
	Reddish brown																				
	Moist		3	SS	7		76														
	SAND (SP-SM) to SILTY SAND (SM)																				
	Very loose to loose																				
	Reddish brown																				
	Moist		4	SS	7		75														
	- 2.3 m: Becoming grey and wet																				
			5	SS	4		74														
			6	SS	1		73														
			7	SS	2																
72.0							72														
5.6	Sandy ORGANIC SILT (OL) to ORGANIC SILT (OL)		8	SS	3		71														
	and sand, trace clay																				
	Very loose to loose																				
	Brown																				
	Wet		9	SS	9		70														
68.9							69														
8.7	GRAVEL (GW-GM) and sand, trace silt																				
	Compact																				
	Reddish brown																				
	Wet		10	SS	25		68														
67.8																					
9.8	End of Borehole																				
	Note:																				
	1. Borehole caved to a depth of 3.4 m below ground surface (Elev. 74.2 m) upon completion of drilling.																				
	2. Water level measured at a depth of 3.4 m below ground surface (Elev. 74.2 m) upon completion of drilling.																				

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

METRIC

CHECKED BY                      MH

[illegible]

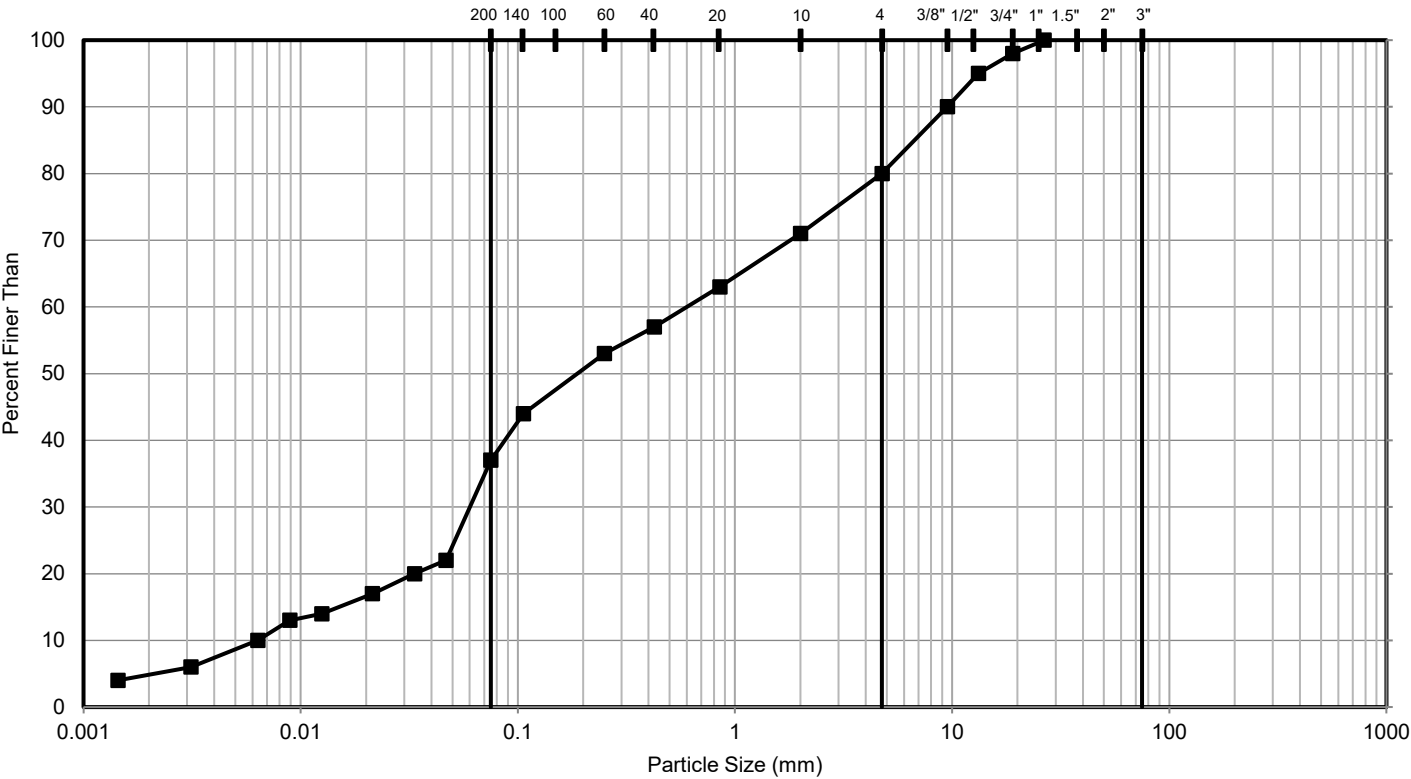
<sup>+</sup>, x<sup>3</sup> : Numbers refer to Sensitivity    o<sup>3</sup>% STRAIN AT FAILURE

**APPENDIX B**

# Geotechnical Laboratory Test Results


PATH: https://goldeassociates.sharpoint.com/sites/140379/Project Files/6 Deliverables/2. PreDraft/Appendix B - Geotech Lab/Working Files | FILE NAME: 21451904\_Laboratory Particle Size Distribution MTO.xlsm

GRAIN SIZE DISTRIBUTION - CLAYEY SAND (SC) (FILL)

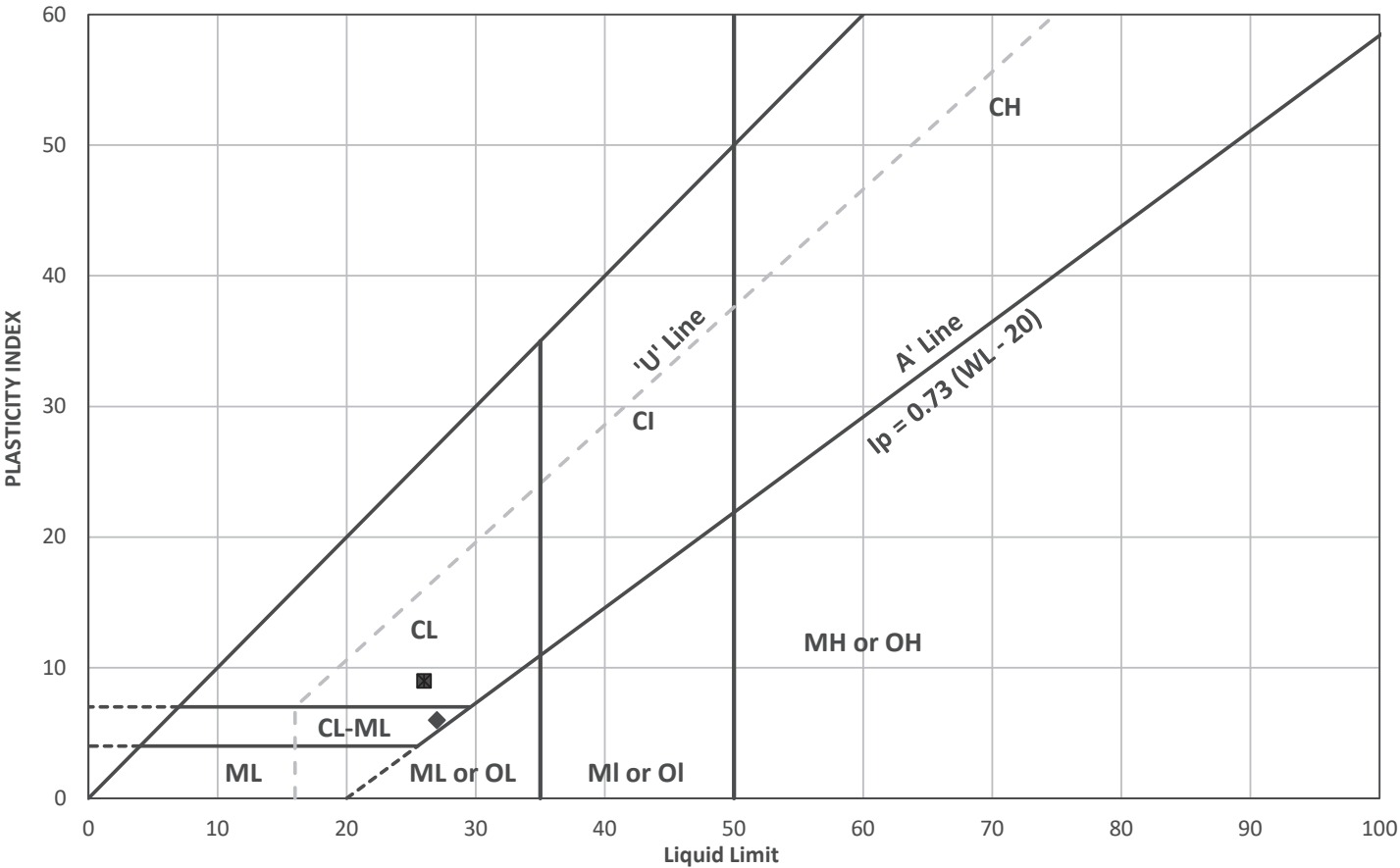


FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		


Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	OHS 2	2	0.8 - 1.4	77.6 to 77.0

CLIENT		PROJECT	
WSP Canada Inc. / MTO		QEW BURLINGTON SKYWAY SOUTHBOUND LANE OVERHEAD SIGN RELOCATION	
CONSULTANT	YYYY-MM-DD	2023-02-23	
	DESIGNED	AM	
	PREPARED	AM	
	REVIEWED	MH	
	APPROVED	DAM	
		TITLE	
		GRAIN SIZE DISTRIBUTION CLAYEY SAND (SC) (FILL)	
PROJECT NO.		CONTROL	REV.
21451904		0	0
		FIGURE	
		B-1	

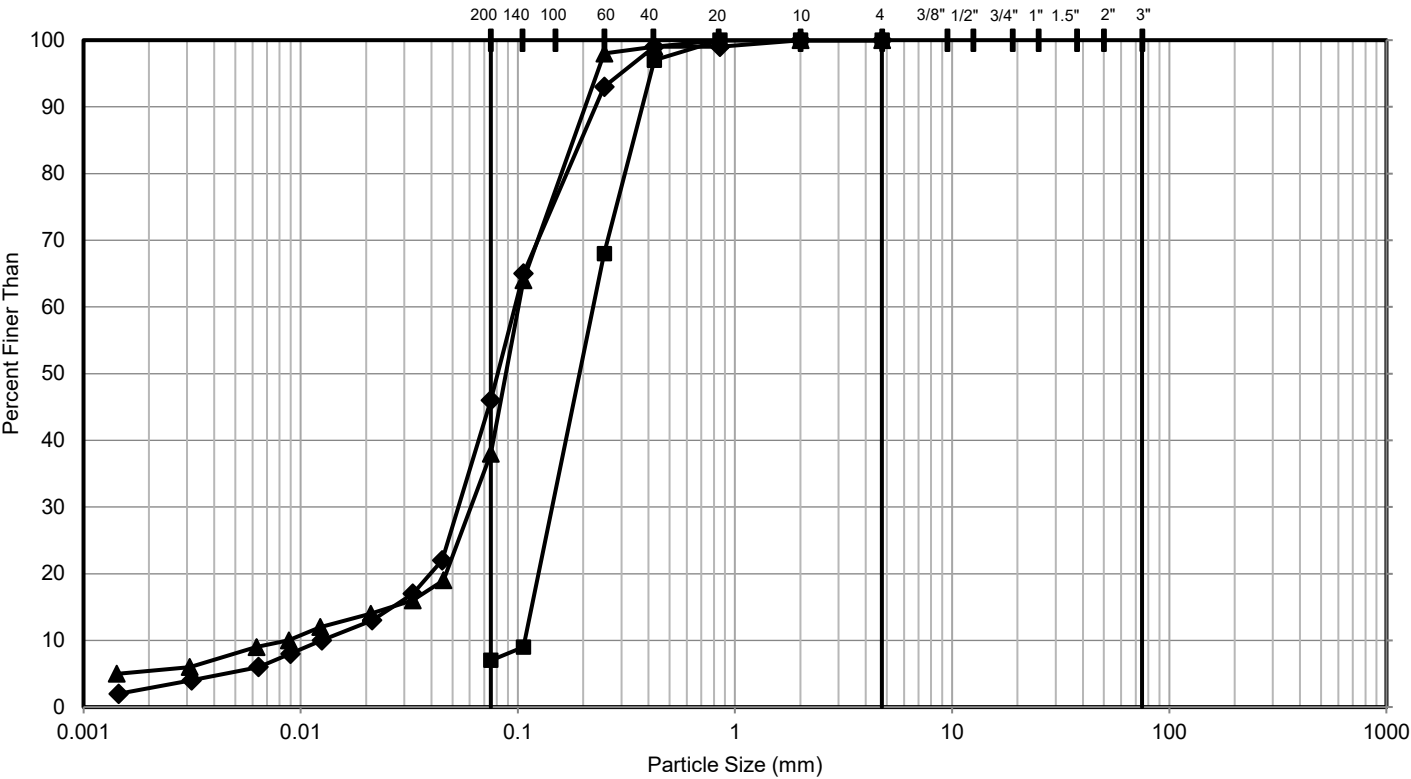
PLASTICITY CHART - CLAYEY SAND (SC) (FILL)



	Sample Location	Sample / Specimen Number	Elevation (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	OHS 1	2	77.26 to 76.65	13.9	26	17	9	-0.34
◆	OHS 2	2	77.63 to 77.02	13.1	27	21	6	-1.32

CLIENT			PROJECT					
WSP Canada Inc. / MTO			QEW BURLINGTON SKYWAY SOUTHBOUND LANED OVERHEAD SIGN RELOCATION					
	CONSULTANT	YYYY-MM-DD	2022-11-10	TITLE				
		DESIGNED	AM	PLASTICITY CHART				
		PREPARED	AM	CLAYEY SAND (SC) (FILL)				
		REVIEWED	MH	PROJECT NO.				
		APPROVED	DAM	21451904		CONTROL	REV.	FIGURE
				0		0	B-2	

GRAIN SIZE DISTRIBUTION - SAND (SP-SM) to SILTY SAND (SM)



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	OHS 1	3	1.5 - 2.1	76.5 to 75.9
◆	OHS 1	5	3.0 - 3.7	75.0 to 74.4
▲	OHS 2	4	2.3 - 2.9	76.1 to 75.5

CLIENT

WSP Canada Inc. / MTO

CONSULTANT



YYYY-MM-DD 2023-02-23

DESIGNED AM

PREPARED AM

REVIEWED MH

APPROVED DAM

PROJECT

QEW BURLINGTON SKYWAY SOUTHBOUND LANE  
OVERHEAD SIGN RELOCATION

TITLE

GRAIN SIZE DISTRIBUTION  
SAND (SP-SM) to SILTY SAND (SM)

PROJECT NO.

21451904

CONTROL

0

REV.

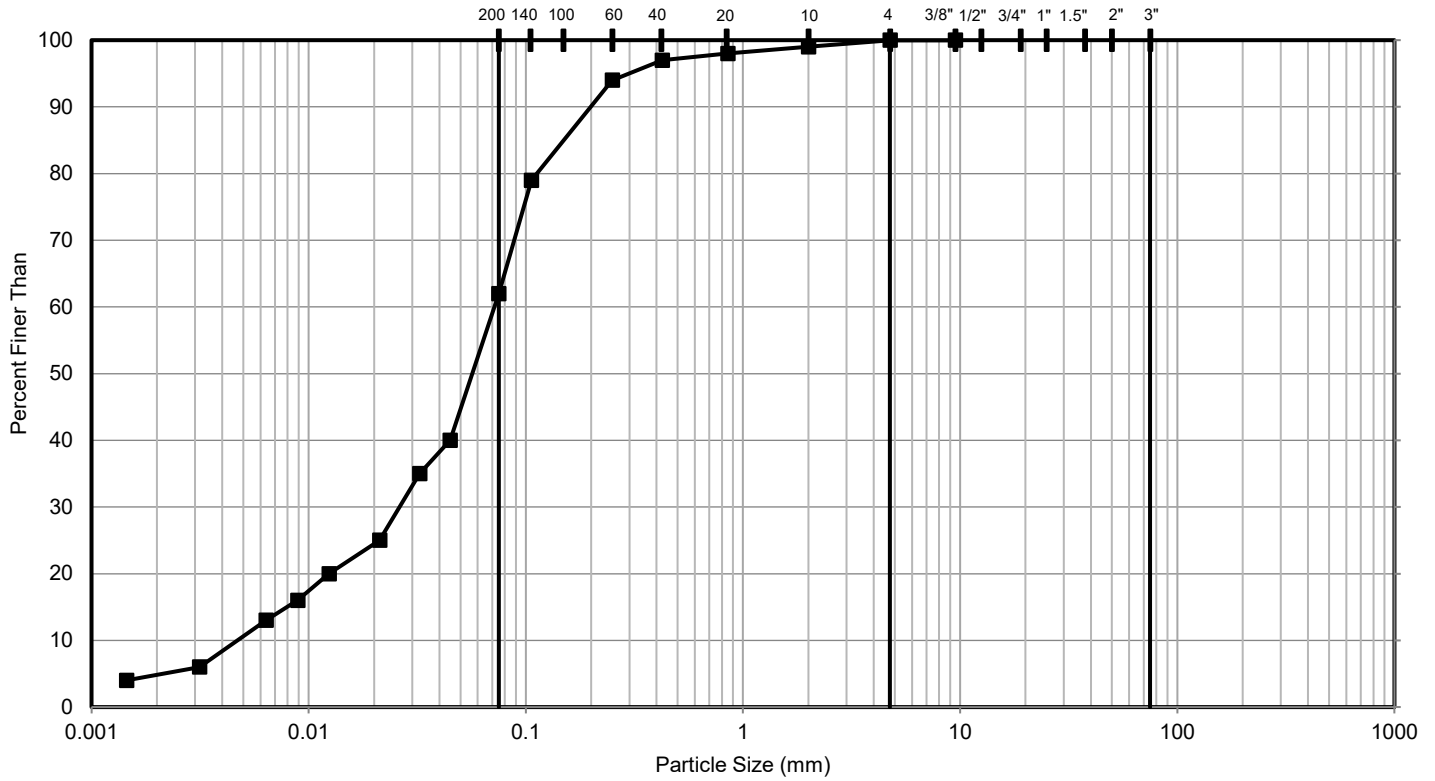
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FIGURE

B-3

PATH: https://goldrassociates.sharepoint.com/sites/140379/Project Files/6 Deliverables/2. PreDraft/Appendix B - Geotech Lab/Working Files | FILE NAME: 21451904\_Laboratory Particle Size Distribution MTO.xlsm

## GRAIN SIZE DISTRIBUTION - ORGANIC SILT (OL)



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	OHS 2	7	4.6 - 5.2	73.8 to 73.2

CLIENT

WSP Canada Inc. / MTO

CONSULTANT



YYYY-MM-DD 2023-02-23

DESIGNED AM

PREPARED AM

REVIEWED MH

APPROVED DAM

PROJECT

QEW BURLINGTON SKYWAY SOUTHBOUND LANE  
OVERHEAD SIGN RELOCATION

TITLE

GRAIN SIZE DISTRIBUTION  
ORGANIC SILT (OL)

PROJECT NO.

21451904

CONTROL

0

REV.

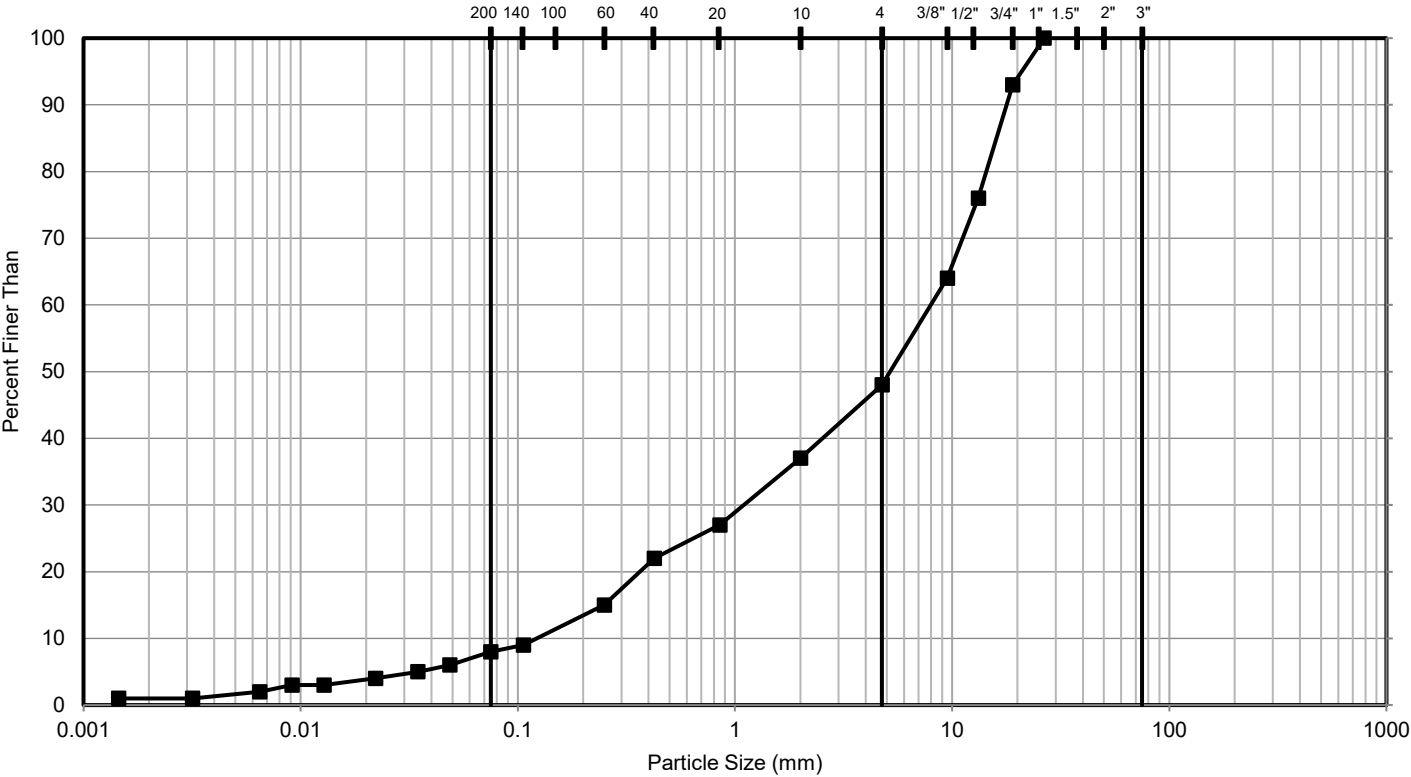
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FIGURE

B-4




GRAIN SIZE DISTRIBUTION - GRAVEL (GW-GM)



FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	OHS 1	10	9.1 - 9.8	68.9 to 68.3

CLIENT		PROJECT	
WSP Canada Inc. / MTO		QEW BURLINGTON SKYWAY SOUTHBOUND LANE OVERHEAD SIGN RELOCATION	
CONSULTANT	YYYY-MM-DD	2023-02-23	
	DESIGNED	AM	
	PREPARED	AM	
	REVIEWED	MH	
	APPROVED	DAM	
		TITLE	
		GRAIN SIZE DISTRIBUTION GRAVEL (GW-GM)	
PROJECT NO.		CONTROL	REV.
21451904		0	0
		FIGURE	
		B-5	

**APPENDIX C**

# Analytical Laboratory Test Results



Your Project #: 21451904  
Site Location: BURLINGTON SKYWAY (QEW), BURLINGTON,  
ON  
Your C.O.C. #: n/a

**Attention: Mark Henderson**

Golder Associates Ltd  
6925 Century Ave  
Suite 100  
Mississauga, ON  
CANADA L5N 7K2

**Report Date: 2022/12/21**  
Report #: R7440179  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**BUREAU VERITAS JOB #: C2AF587**

**Received: 2022/12/13, 14:12**

Sample Matrix: Soil  
# Samples Received: 2

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	2	2022/12/19	2022/12/19	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	2	2022/12/19	2022/12/19	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	2	N/A	2022/12/21	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	2	N/A	2022/12/19	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	2	2022/12/20	2022/12/20	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	2	2022/12/13	2022/12/19	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	2	2022/12/19	2022/12/19	CAM SOP-00464	EPA 375.4 m

**Remarks:**

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

\* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Bureau Veritas Calgary (19th), 4000 19th Street NE, Calgary, AB, T2E 6P8

(2) Offsite analysis requires that subcontracted moisture be reported.



Your Project #: 21451904  
Site Location: BURLINGTON SKYWAY (QEW), BURLINGTON,  
ON  
Your C.O.C. #: n/a

**Attention: Mark Henderson**

Golder Associates Ltd  
6925 Century Ave  
Suite 100  
Mississauga, ON  
CANADA L5N 7K2

**Report Date: 2022/12/21**  
Report #: R7440179  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**BUREAU VERITAS JOB #: C2AF587**

**Received: 2022/12/13, 14:12**

**Encryption Key**

Please direct all questions regarding this Certificate of Analysis to:

Ankita Bhalla, Project Manager

Email: Ankita.Bhalla@bureauveritas.com

Phone# (905) 817-5700

=====

This report has been generated and distributed using a secure automated process.

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.

**SOIL CORROSIVITY PACKAGE (SOIL)**

<b>Bureau Veritas ID</b>		U00529			U00529		
<b>Sampling Date</b>		2022/12/11			2022/12/11		
<b>COC Number</b>		n/a			n/a		
	<b>UNITS</b>	<b>OHS-1 SA04 7'6"-9'6"</b>	<b>RDL</b>	<b>QC Batch</b>	<b>OHS-1 SA04 7'6"-9'6" Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>

**Calculated Parameters**

Resistivity	ohm-cm	700		8400535			
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**Inorganics**

Soluble (20:1) Chloride (Cl-)	ug/g	830	20	8411202			
Conductivity	umho/cm	1430	2	8411083			
Available (CaCl2) pH	pH	7.41		8413343			
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	8411217	<20	20	8411217
Sulphide	mg/kg	13.1 (1)	0.5	8417625			

**Physical Testing**

Moisture-Subcontracted	%	27	0.30	8417599			
------------------------	---	----	------	---------	--	--	--

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

(1) Sample contained greater than 10% headspace at time of extraction.

<b>Bureau Veritas ID</b>		U00530			U00530		
<b>Sampling Date</b>		2022/12/12			2022/12/12		
<b>COC Number</b>		n/a			n/a		
	<b>UNITS</b>	<b>OHS-2 SA04 7'6"-9'6"</b>	<b>RDL</b>	<b>QC Batch</b>	<b>OHS-2 SA04 7'6"-9'6" Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>

**Calculated Parameters**

Resistivity	ohm-cm	1200		8400535			
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**Inorganics**

Soluble (20:1) Chloride (Cl-)	ug/g	470	20	8411202	430	20	8411202
Conductivity	umho/cm	817	2	8411083			
Available (CaCl2) pH	pH	7.44		8413339			
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	8411217			
Sulphide	mg/kg	3.3 (1)	0.5	8417625			

**Physical Testing**

Moisture-Subcontracted	%	22	0.30	8417599			
------------------------	---	----	------	---------	--	--	--

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

(1) Sample contained greater than 10% headspace at time of extraction.



## TEST SUMMARY

**Bureau Veritas ID:** U00529  
**Sample ID:** OHS-1 SA04 7'6"-9'6"  
**Matrix:** Soil

**Collected:** 2022/12/11  
**Shipped:**  
**Received:** 2022/12/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	8411202	2022/12/19	2022/12/19	Samuel Law
Conductivity	AT	8411083	2022/12/19	2022/12/19	Gurpartee K AUR
Moisture (Subcontracted)	BAL	8417599	N/A	2022/12/21	Richard Ly
Sulphide in Soil	SPEC	8417625	N/A	2022/12/19	Bailey Morrison
pH CaCl <sub>2</sub> EXTRACT	AT	8413343	2022/12/20	2022/12/20	Taslina Aktar
Resistivity of Soil		8400535	2022/12/19	2022/12/19	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	8411217	2022/12/19	2022/12/19	Samuel Law

**Bureau Veritas ID:** U00529 Dup  
**Sample ID:** OHS-1 SA04 7'6"-9'6"  
**Matrix:** Soil

**Collected:** 2022/12/11  
**Shipped:**  
**Received:** 2022/12/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	8411217	2022/12/19	2022/12/19	Samuel Law

**Bureau Veritas ID:** U00530  
**Sample ID:** OHS-2 SA04 7'6"-9'6"  
**Matrix:** Soil

**Collected:** 2022/12/12  
**Shipped:**  
**Received:** 2022/12/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	8411202	2022/12/19	2022/12/19	Samuel Law
Conductivity	AT	8411083	2022/12/19	2022/12/19	Gurpartee K AUR
Moisture (Subcontracted)	BAL	8417599	N/A	2022/12/21	Richard Ly
Sulphide in Soil	SPEC	8417625	N/A	2022/12/19	Bailey Morrison
pH CaCl <sub>2</sub> EXTRACT	AT	8413339	2022/12/20	2022/12/20	Taslina Aktar
Resistivity of Soil		8400535	2022/12/19	2022/12/19	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	8411217	2022/12/19	2022/12/19	Samuel Law

**Bureau Veritas ID:** U00530 Dup  
**Sample ID:** OHS-2 SA04 7'6"-9'6"  
**Matrix:** Soil

**Collected:** 2022/12/12  
**Shipped:**  
**Received:** 2022/12/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	8411202	2022/12/19	2022/12/19	Samuel Law



BUREAU  
VERITAS

Bureau Veritas Job #: C2AF587

Report Date: 2022/12/21

Golder Associates Ltd

Client Project #: 21451904

Site Location: BURLINGTON SKYWAY (QEW), BURLINGTON,  
ON

Sampler Initials: AM

### GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	6.3°C
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**Results relate only to the items tested.**



**BUREAU  
VERITAS**

Bureau Veritas Job #: C2AF587

Report Date: 2022/12/21

## QUALITY ASSURANCE REPORT

Golder Associates Ltd

Client Project #: 21451904

BURLINGTON SKYWAY (QEW), BURLINGTON,

Site Location: ON

Sampler Initials: AM

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8411083	Conductivity	2022/12/19			104	90 - 110	<2	umho/cm	1.6	10
8411202	Soluble (20:1) Chloride (Cl-)	2022/12/19	NC	70 - 130	104	70 - 130	<20	ug/g	10	35
8411217	Soluble (20:1) Sulphate (SO4)	2022/12/19	134 (1)	70 - 130	108	70 - 130	<20	ug/g	NC	35
8413339	Available (CaCl2) pH	2022/12/20			100	97 - 103			0.80	N/A
8413343	Available (CaCl2) pH	2022/12/20			100	97 - 103			0.56	N/A
8417599	Moisture-Subcontracted	2022/12/21					<0.30	%	2.4	20
8417625	Sulphide	2022/12/19	118	75 - 125	118	75 - 125	<0.5	mg/kg	16	30

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.





BUREAU  
VERITAS

Bureau Veritas Job #: C2AF587

Report Date: 2022/12/21

Golder Associates Ltd

Client Project #: 21451904

Site Location: BURLINGTON SKYWAY (QEW), BURLINGTON,  
ON

Sampler Initials: AM

### VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

Ewa Pranjić, M.Sc., C.Chem, Scientific Specialist

Sandy Yuan, M.Sc., QP, Scientific Specialist

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6740 Campobello Road, Mississauga, Ontario L5N 2L8  
 Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266  
 CAM FCD-01191/6

## WORK ORDER CHAIN OF CUSTODY RECORD

Page 1 of 1

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)		Turnaround Time (TAT) Required																				
Company Name: <b>Golder Associates Ltd.</b>	Company Name: <b>Golder Associates Ltd.</b>	Quotation #:	<input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses		<input type="checkbox"/> PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS																					
Contact Name: <b>Canada Accounts Payable</b>	Contact Name: <b>Mark Henderson</b>	P.O. #/ AFE#:			<b>Rush TAT (Surcharges will be applied)</b>																					
Address: <b>6925 Century Ave. Suite 100</b>	Address: <b>6925 Century Ave. Suite 100</b>	Project #:	<b>21451904</b>		<input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days																					
<b>Mississauga, ON</b>	<b>Mississauga, ON L5N 7K2</b>	Site Location:	<b>Burlington Skyway (QEW), Burlington, ON</b>																							
Phone: <b>905-567-4444</b> Fax: <b>905-567-6561</b>	Phone: <b>(647) 233-7791</b> Fax:	Site #:			<b>Date Required:</b>																					
Email: <b>canadaaccounts payableinvoices@golder.com</b>	Email: <b>mark.henderson@wsp.com</b>	Site Location Province: <b>Burlington Ontario</b>			<b>Rush Confirmation #:</b>																					
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS CHAIN OF CUSTODY				Sampled By: _____ AM																						
<b>Regulation 153</b> <input checked="" type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/ Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/ Other <input type="checkbox"/> Table _____ <b>FOR RSC (PLEASE CIRCLE) Y / N</b>		<b>Other Regulations</b> <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWLU <input type="checkbox"/> Region _____ <input type="checkbox"/> Other (Specify) _____ <input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED) <input type="checkbox"/> REG 406 Table _____		<b>Analysis Requested</b> <div style="display: flex; justify-content: space-between;"> <div>           # OF CONTAINERS SUBMITTED            FIELD FILTERED (CIRCLE) Metals / Hg / CrVI            BTX/ PHC F1            PHC F2 - F4            VOCs            REG 153 METALS &amp; INORGANICS            REG 153 ICNMS METALS            REG 153 METALS (Hg, Cr VI, ICNMS Metals, HWS - B)            Corrosivity Package (+ Sulphide)         </div> <div>           HOLD- DO NOT ANALYZE         </div> </div>				<b>LABORATORY USE ONLY</b> <table border="1"> <tr> <th colspan="2">CUSTODY SEAL Y / N</th> <th rowspan="2">COOLER TEMPERATURES</th> </tr> <tr> <td>Present</td> <td>Intact</td> </tr> <tr> <td><i>M</i></td> <td><i>N</i></td> <td><i>61617</i></td> </tr> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="3">COOLING MEDIA PRESENT: Y / N</td> </tr> <tr> <td colspan="3">COMMENTS</td> </tr> </table>		CUSTODY SEAL Y / N		COOLER TEMPERATURES	Present	Intact	<i>M</i>	<i>N</i>	<i>61617</i>				COOLING MEDIA PRESENT: Y / N			COMMENTS		
CUSTODY SEAL Y / N		COOLER TEMPERATURES																								
Present	Intact																									
<i>M</i>	<i>N</i>	<i>61617</i>																								
COOLING MEDIA PRESENT: Y / N																										
COMMENTS																										
Include Criteria on Certificate of Analysis: Y / N SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS																										
SAMPLE IDENTIFICATION		DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTX/ PHC F1	PHC F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICNMS METALS	REG 153 METALS (Hg, Cr VI, ICNMS Metals, HWS - B)	Corrosivity Package (+ Sulphide)	HOLD- DO NOT ANALYZE	COMMENTS											
1	OHS-1 SA04 7'6"-9'6"	2022-12-11	PM	SOIL	2								X		2 Jars, no redox.											
2	OHS-2 SA04 7'6"-9'6"	2022-12-12	AM	SOIL	2								X		2 Jars, no redox.											
3																										
4																										
5																										
6																										
7																										
8																										
9																										
10																										

MSA with BV Signed May 18, 2020.  
 Golder standing offer rates in email from Julie Clement dated Sept 20, 2021.  
 Corrosivity package including chloride, conductivity, resistivity, pH, sulphate, sulphide is \$98.60/sample.

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)
Ankaren Mahes <i>[Signature]</i>	2022-12-13	15:00	<i>[Signature]</i>	2022-12-13	15:12

13-Dec-22 14:12  
 Ankita Bhalla  
  
**C2AF587**

**APPENDIX D**

# Notice to Contractor

## **Existing Subgrade Conditions**

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### **Notice to Contractor**

---

The Contractor is alerted to the presence of methane gas within the subgrade soils at this site. Methane forms an explosive mixture with air and is a potential hazard for excavation and construction work. Changes in groundwater pressure, which may be caused by dewatering or seepage into excavations, can also lead to migration/release of gaseous or dissolved methane. Appropriate construction procedures, equipment, and precautions will be required during installation of the sign support foundations to manage the presence of natural gas pockets.

Water-bearing non-cohesive soils, as encountered in Boreholes OHS-1 and OHS-2, should be expected to run or flow into the drillholes during caisson installation. Appropriate equipment and procedures, such as use of casings and/or water/drilling fluid to maintain a positive head of pressure within the drilled hole, will be required to minimize ground loss and/or to control base disturbance / basal heave due to groundwater pressures / seepage. Further, the placement of concrete by tremie methods will be required where wet conditions exist.



[golder.com](http://golder.com)