



# Foundation Investigation and Design Report

*Noise Barrier Wall No. 2*

*Bridge Replacement and Interchange Reconfiguration at Highway 11/12 (Old  
Barrie Road), Orillia*

*Ministry of Transportation, Ontario*

*GWP 2129-18-00*

Submitted to:

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# **PART A**

**FOUNDATION INVESTIGATION REPORT**

**NOISE BARRIER WALL NO. 2**

**BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATION AT  
HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA**

**MINISTRY OF TRANSPORTATION, ONTARIO**

**GWP 2129-18-00**

## 1.0 INTRODUCTION

WSP Canada Inc. (WSP, formerly Golder Associates Ltd., amalgamated with WSP in 2023), has been retained by Egis Canada Ltd. (Egis, formerly McIntosh Perry Consulting Engineers Ltd.) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the interchange improvements at the Highway 11 and Highway 12 (Coldwater Road) north junction and at the Highway 11 and Highway 12 (Old Barrie Road) south junction. This report presents the results of the foundation investigation for the proposed noise barrier wall designated as Noise Barrier Wall No. 2 at the Highway 11/12 (Old Barrie Road) interchange.

The purpose of this foundation investigation is to establish the subsurface conditions along the alignment of the proposed noise barrier wall by methods of 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 along the proposed noise barrier wall.

## 2.0 PROJECT AND 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 this report, Highway 11 (in the vicinity of the City of Orillia) is considered oriented in a south-north direction and Highway 12 (Old Barrie Road) is considered oriented in a west-east direction.

### 2.1 Project Description

The overall assignment includes the preparation of two separate contracts. The first contract includes: the replacement of the Coldwater Road Underpass and the reconfiguration/reconstruction of the Highway 11 and Highway 12 (Coldwater Road) interchange. The second contract includes: the replacement of the Old Barrie Road Underpass; the reconfiguration/reconstruction of the Highway 11 and Highway 12 (Old Barrie Road) interchange, including the construction of deep cuts and high fill embankments; construction of two retaining walls; construction of two noise barrier walls (designated as Noise Barrier Wall No. 1 and 2); and construction of a stormwater management pond.

The proposed Noise Barrier Wall No. 2 is located on the north side of Highway 12 (Old Barrie Road) to the east of the Highway 11/12 (Old Barrie Road) interchange, as shown on Drawing 1. The proposed noise barrier wall is about 482 m long.

### 2.2 Site Description

At the location of the proposed Noise Barrier Wall No. 2, Highway 12 (Old Barrie Road) consists of an undivided highway comprised of one lane in each direction. At this location, Highway 12 is constructed in a shallow earth cut. The ground surface is relatively flat and slopes downwards from the western limit at about Elevation 249.5 m, to the eastern limit at about Elevation 241.6 m. The proposed noise barrier wall is situated along the north side of Highway 12, between Highway 12 and residential properties to the north. The vegetation is generally comprised of grasses with areas of dense tree cover, as shown in Photograph 1 and 2 below.





**Photograph 1:** Near eastern limit of the proposed Noise Barrier Wall No. 2 (looking east along Highway 12)



**Photograph 2:** Along the proposed Noise Barrier Wall No. 2 footprint (looking west along Highway 12)

### 3.0 INVESTIGATION PROCEDURES

The field work for the proposed Noise Barrier Wall No. 2 was carried out between April 29 and May 3, 2021, during which time a total of seven boreholes (designated as Boreholes NW2-1 to NW2-7) were advanced in the vicinity of proposed noise barrier wall alignment. The locations of the boreholes are shown in plan on Drawing 1.

The boreholes were advanced using a D-50 track-mounted drill rig, supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced using 210 mm outer diameter, continuous flight hollow stem augers. Soil samples were typically obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in general accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586)<sup>1</sup>

Water levels were observed in the open boreholes during and immediately following the drilling operations. A standpipe piezometer was installed in a selected borehole (Borehole NW-2) to permit monitoring of the groundwater level. The standpipe piezometer consists of a 50 mm outer diameter Schedule 40 PVC pipe, with a slotted screen surrounded with a sand filter pack, sealed at a selected depth within the borehole. The annulus surrounding the pipe above the well screen and sand filter pack was backfilled to the ground surface with bentonite.

All boreholes excluding Borehole NW-2, were backfilled with bentonite upon completion of drilling operations in accordance with Ontario Regulation (O.Reg.) 903 (*Wells*), as amended. Borehole NW-2 is to be decommissioned (as per O.Reg. 903) by the Design-Build Contractor at the time of construction.

Prior to commencement of the field work, WSP arranged for the clearance of underground utilities. The field work was supervised by a member of WSP's engineering staff, who observed the borehole drilling, in-situ testing, and

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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.

soil sampling operations, and logged the boreholes in the field. The soil samples were placed in appropriate containers, labelled, and transported to WSP's Mississauga geotechnical laboratory where the samples underwent further visual and tactile examination and geotechnical laboratory testing.

Geotechnical index testing, such as water content, Atterberg limits, and grain size distribution, was carried out on selected soil samples in accordance with MTO and/or ASTM Standards, as appropriate, and the results of which are presented in Appendix B. In addition, two soil samples were submitted for corrosivity testing, under chain-of-custody procedures, to Bureau Veritas Laboratories (a Standards Council of Canada (SCC) accredited laboratory) of Mississauga, Ontario. The samples were analyzed for a suite of corrosivity parameters which includes conductivity/resistivity, soluble chloride and soluble sulphate concentrations, sulphide concentrations, and pH. The results of the corrosivity testing are presented in Appendix C.

The as-drilled borehole locations and corresponding ground surface elevations were surveyed on-site by Callon Dietz Inc. of London, Ontario. The borehole survey information, including northing/easting coordinates (reference to the NAD83 Canadian Spatial Reference System (CSRS) V6:2010 MTM Zone 10 coordinate system), latitude/longitude coordinates, and corresponding ground surface elevations (referenced to the Canadian Geodetic Vertical Datum (CGVD) 1928:1978), as well as borehole depths are provided on the borehole records in Appendix A and summarized below.

Borehole No.	Coordinates (MTM NAD 83 Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
NW2-1	4,939,037.0 (44.591325)	309,482.6 (-79.441023)	249.5	8.2
NW2-2	4,939,049.1 (44.591434)	309,552.8 (-79.440139)	249.6	7.8
NW2-3	4,939,053.4 (44.591472)	309,622.7 (-79.439259)	249.2	7.7
NW2-4	4,939,058.1 (44.591514)	309,697.7 (-79.438314)	247.7	8.1
NW2-5	4,939,059.7 (44.591528)	309,782.5 (-79.437245)	243.8	8.0
NW2-6	4,939,064.7 (44.591572)	309,850.1 (-79.436394)	241.5	8.2
NW2-7	4,939,068.6 (44.591607)	309,929.0 (-79.435400)	241.6	8.2

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

This section of Highway 12 lies within the Simcoe Lowlands, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984). The Simcoe Lowlands consist of a series of steep sided, flat-floored valleys that were flooded by glacial lake Algonquin. The surficial soils in this area of the Simcoe Lowlands typically comprise glaciolacustrine sediments of very fine to medium-grained sand, silt and minor clay; and fluvial and glaciofluvial



ice-contact sediments of fine to very coarse-grained sand, gravelly sand and gravel with minor amounts of silt, clay and flowtill. Modern alluvial deposits of clay, silt, sand gravel that may contain organics are also present.

## 4.2 Subsurface Conditions

The subsurface soil and groundwater conditions encountered in the boreholes advanced at the site, together with the results of the in-situ and geotechnical/analytical laboratory testing, are presented on the record of boreholes in Appendix A and the details of the laboratory results are presented in Appendices B and C. The results of in-situ tests as presented on the record of boreholes are uncorrected for overburden pressure and energy transfers. The 'N'-values are based on SPT sampling procedures carried out with a standard weight (i.e., 140 lbs), and an automatic hammer.

The stratigraphic boundaries shown on the borehole records and on the profile shown on Drawing 1 have been inferred from observations of drilling progress, generally non-continuous sampling and in-situ testing, and therefore represent transitions between soil types rather than exact planes of geologic change. Further, subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface soils encountered along the noise barrier wall alignment consist of topsoil, underlain by fill which in turn is underlain by a non-cohesive and cohesive glacial till deposit. A silty sand interlayer was encountered within the till deposit at the eastern end of the proposed noise wall alignment. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

### 4.2.1 Topsoil

An approximately 180 mm to 700 mm thick layer of topsoil was encountered at the ground surface in Boreholes NW2-1, NW2-2 and NW2-3.

A water content measured on a sample of the topsoil was about 22%.

### 4.2.2 Fill

An approximately 0.2 m to 0.8 m thick layer of non-cohesive and cohesive fill was encountered in all boreholes. The non-cohesive fill was encountered below the topsoil in Boreholes NW2-1 to NW2-3 and extended to depths ranging from about 0.7 m to 1.4 m below ground surface (i.e., extending to Elevations 248.8 m to 247.8 m). The cohesive fill was encountered at ground surface in Boreholes NW2-4 to NW2-7 and extended to depths ranging from 0.3 m to 0.8 m below ground surface (i.e., extending to Elevations 246.9 m to 240.8 m).

The non-cohesive fill ranges in composition from silty sand to gravelly silty sand and contained crushed rock fragments in Boreholes NW-1 and NW-2. Based on the encountered crushed rock fragments, the fill is inferred to contain cobbles. The cohesive fill ranges in composition from clayey silt and sand to clayey sand-silty sand and contained rootlets in Borehole NW2-4 to NW-7.

The SPT 'N'-values measured within the non-cohesive fill are 13 blows and 38 blows per 0.3 m of penetration, indicating a compact to dense state of compactness. The SPT 'N'-values measured within the cohesive fill range from 2 blows to 11 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency.

Grain size distribution testing was carried out on two samples of the cohesive fill and the results are presented on Figure B1 in Appendix B. An Atterberg limits test was carried out on a sample of the cohesive fill and measured a liquid limit of about 21%, a plastic limit of about 17%, and a plasticity index of about 4%. The Atterberg limits test

results are presented on Figure B2 in Appendix B and indicate that the material is classified as a clayey sand-silty sand or low plasticity.

The water contents measured on two samples of the non-cohesive fill were about 9% and 10% and the water contents measured on five samples of the cohesive fill range from about 12% and 24%.

### 4.2.3 Glacial Till

A glacial till deposit was encountered in all boreholes and extended to the borehole termination depths in all boreholes. In Borehole NW2-7, a silty sand interlayer was encountered within the till deposit (as described in the section below). The glacial till deposit was primarily non-cohesive, except at Boreholes NW2-3, NW2-6 and NW2-7 where cohesive glacial till was also encountered.

The non-cohesive till was encountered below the fill in all boreholes, at depths ranging from about 0.3 m to 1.4 m below ground surface (i.e., at Elevations 248.8 m to 240.8 m). The cohesive till was encountered in Boreholes NW2-3, NW2-6 and NW2-7 at depths ranging from about 3.2 m to 7.1 m below ground surface (i.e., at Elevations 246.0 m to 234.4 m).

The non-cohesive till ranges in composition from silty sand to gravelly silty sand to sandy silty gravel to silty gravel and sand to sandy gravel. The cohesive till ranges in composition from sandy clayey silt-silt, some gravel to clayey silt-silt and sand, trace gravel. The non-cohesive till deposit contains rock fragments in all boreholes, excluding Borehole NW2-7. Auger grinding was also noted during borehole advancement within the non-cohesive till deposit in all boreholes excluding Borehole NW2-7 (as shown on the respective borehole records), which suggests the presence of cobbles, boulders and/or rock fragments.

The SPT 'N'-values measured within the non-cohesive till deposit generally ranges from 17 blows to 94 blows per 0.3 m of penetration, indicating a compact to very dense state of compactness. The SPT 'N'-values measured within the cohesive till deposit range from 14 blows to 69 blows per 0.3 m of penetration, suggesting a stiff to hard consistency. Higher SPT 'N'-values ranging between 50 blows and 99 blows for less than 0.3 m of penetration were also measured within the non-cohesive till deposit and can be likely attributed to cobbles, boulders and/or rock fragments.

Grain size distribution testing was carried out on eleven samples of the non-cohesive till and the results are presented on Figures B3A and B3B in Appendix B. Atterberg limit testing was also carried out on five samples of the non-cohesive till. Three of the five samples were determined to be non-plastic (NP), as shown on the record of boreholes. The remaining two samples measured liquid limits of about 13% and 15%, plastic limits of about 12% and 11%, and plasticity indices of about 1% and 4%. The Atterberg limits test results are presented on Figure B4 in Appendix B and indicate that the samples are classified as a clayey sand-silty sand and silty sand of low plasticity.

Grain size distribution testing was carried out on two samples of the cohesive till and the results are presented on Figure B5 in Appendix B. Atterberg limits testing was also carried out on three samples of the cohesive till and measured liquid limits ranging from about 14% to 18%, plastic limits ranging from about 12% to 9%, and plasticity indices ranging from about 5% to 6%. The Atterberg limit test results are presented on Figure B6 in Appendix B and indicate that the samples are classified as a clayey silt-silt of low plasticity.

The water contents measured on samples of the non-cohesive till range from about 3% to 11% and the water content measured on three samples of the cohesive till range from about 7% to 13%.

#### 4.2.4 Silty Sand (SM)

A non-cohesive deposit of silty sand, trace gravel was encountered within the glacial till deposit in Borehole NW2-7. The silty sand deposit was encountered at a depth of about 2.2 m below ground surface (i.e., at Elevation 239.4 m) and extends to a depth of about 4.0 m below ground surface (i.e., extending to Elevation 237.6 m).

The SPT 'N'-values measured within the silty sand deposit generally were 33 blows and 41 blows per 0.3 m of penetration, indicating a dense state of compactness.

Grain size distribution testing was carried out on a sample of the silty sand deposit and the results are presented on Figure B7 in Appendix B. Atterberg limits testing was carried out on a sample of the silty sand deposit and indicate that the soil is classified as non-plastic ("NP"), as indicated on the borehole record.

The water content measured on a sample of the silty sand deposit is about 20%.

#### 4.3 Groundwater Conditions

In general, the soil samples recovered from the boreholes were moist. The groundwater levels were measured in the open boreholes upon completion of drilling operations. A standpipe piezometer was installed in Borehole NW2-3 to monitor the groundwater level at the site. The groundwater level measurements and standpipe piezometer installation details and are presented below and on the borehole records.

Borehole No.	Piezometer Screen Depth / Elevation (m) [Screened Stratigraphy]	Water Level		Date of Water Level Reading	Remarks
		Depth (m)	Elevation (m)		
NW2-1	No piezometer installation	2.0	247.5	April 30, 2021	Water level measured in open borehole upon completion of drilling
NW2-2	4.0 – 7.9 / 245.6 – 241.7 [Gravelly Silty Sand Till]	5.3	244.3	April 30, 2021 (upon completion of drilling)	--
		5.6	244.0	January 21, 2022	
		6.1	243.5	February 14, 2022	
NW2-3	No piezometer installation	Dry	--	May 1, 2021	Water level measured in open borehole upon completion of drilling
NW2-4	No piezometer installation	6.7	241.0	May 1, 2021	
NW2-5	No piezometer installation	2.9	240.9	May 1, 2021	
NW2-6	No piezometer installation	1.5	240.0	May 3, 2021	
NW2-7	No piezometer installation	2.2	239.4	May 3, 2021	

The groundwater level observations/measurements at this site are subject to seasonal fluctuations and precipitation events; therefore, the groundwater level should be expected to be higher during wet periods or during any period of heavy and/or sustained precipitation.

## 4.4 Analytical Testing

Two soil samples were collected and submitted to Bureau Veritas Laboratories for analysis of parameters used to assess corrosion potential and sulphate attack. A summary of the results is presented in the following table. The Certificates of Analysis are provided in Appendix C.

Borehole No.	Sample No.	Sample Depth [Elevation] (m)	Soil Type	Parameters				
				Chloride (µg/g)	Sulphate (µg/g)	pH	Conductivity (µohm/cm)	Resistivity (ohm-cm)
NW2-2	5	3.0 – 3.7 [246.6 – 245.9]	Gravelly Silty Sand (Till)	72	<20	7.95	235	4,200
NW2-6	2	0.8 – 1.4 [240.7 – 240.1]	Gravelly Silty Sand (Till)	<20	<20	7.72	120	8,300

The sulphide concentration measured in the soil samples recovered from Boreholes NW2-2 and NW2-5 was also analyzed and the results were 1.3 mg/kg and 0.9 mg/kg, respectively.

## 5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Thomas Tingson, and reviewed by Ms. Anastasia Poliacik, P.Eng., a senior geotechnical engineer with WSP. Mr. David Staseff, P.Eng., a senior principal and MTO Principal Foundations Contact with WSP conducted an independent technical and quality review of this report.

## Signature Page

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TT/AMP/DS/al

[https://golderassociates.sharepoint.com/sites/120052/project files/6 deliverables/2. reporting/06 - noise barrier wall 2/5. final/19135676-rpt-rev0-nbw2 hwy 11 obr-final fidr-13\\_feb\\_24.docx](https://golderassociates.sharepoint.com/sites/120052/project%20files/6%20deliverables/2.%20reporting/06%20-%20noise%20barrier%20wall%202/5.%20final/19135676-rpt-rev0-nbw2%20hwy%2011%20obr-final%20fidr-13_feb_24.docx)

# **PART B**

**FOUNDATION DESIGN REPORT**

**NOISE BARRIER WALL NO. 2**

**BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATION AT  
HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA**

**MINISTRY OF TRANSPORTATION, ONTARIO**

**GWP 2129-18-00**



## 6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report (Part B) provides foundation engineering design recommendations for the proposed noise barrier wall (designated as Noise Barrier Wall No. 2) associated with the reconstruction / reconfiguration of the Highway 11/12 (Old Barrie Road) interchange. The discussion and recommendations are based on interpretation and analysis of the factual data obtained from the boreholes and other subsurface explorations advanced during the foundation investigation(s) at this site as described in the Foundation Investigation Report (Part A of this report).

This section of the report (Part B) is intended for the use of the MTO and their procurement-ready designer for this assignment and shall not be relied upon for any other purpose or by any other parties. The discussion, recommendations and geotechnical/foundation aspects of any preliminary design or reference concept design are provided for information purposes only. Where any comments are made on construction, they are provided only to highlight those aspects which could affect the detailed design of the project. The design-build proponent(s) shall make their own interpretations based on the factual data presented in the Foundation Investigation Report (Part A of this report) and supplement with additional information as necessary, to generate and assess foundation alternatives and develop the design of the preferred alternative. The design-build proponent is responsible for all aspects of the detailed design and construction for the preferred alternative.

### 6.1 General

The proposed Noise Barrier Wall No. 2 is located on the north side of Highway 12 (Old Barrie Road) to the east of the Highway 11/12/Old Barrie Road interchange, as shown on Drawing 1. The proposed noise barrier wall is about 482 m long and constructed between Highway 12 and the residential units north of Old Barrie Road.

### 6.2 Design of Noise Barrier Wall Foundations

It is recommended that the noise barrier wall be supported using conventional augered caissons with a diameter of 0.6 m to 0.9 m. Geotechnical parameters for design of the footings/caisson foundations for the proposed noise barrier wall are provided in Table 1 following the text of this report, based on subsurface conditions encountered in the boreholes advanced in the vicinity of the proposed noise barrier wall. The stratigraphy presented in Table 1 (Fill / Soil Stratum) has been simplified from the detailed stratigraphic descriptions presented on the borehole records for the purposes of the noise barrier wall foundation design, and the design values and stations over which they apply has been further simplified in SP 760F01 amending OPSS 760 (Noise Barrier Systems) for the designer fill-in table of design parameters, a copy of which is included in Appendix D.

The geotechnical parameters presented in Table 1 and in SP 760F01 are based on field and laboratory test data as well as empirical correlations (NAVFAC (1986), Bowles (1984) and Kulhawy and Mayne, (1990)) and the analysis was tempered by engineering judgement based on experience in similar soils.

Where both undrained shear strength ( $s_u$ ) and drained parameters (effective cohesion,  $c'$ , and effective friction angle,  $\phi'$ ) have been given in Table 1 for a cohesive deposit, the footing/caisson should be checked for both the total and effective stress conditions, and the greater of the two calculated footing/caisson depths shall govern.

The design of caissons subjected to lateral loads should consider such factors as the relative rigidity of the caisson to the surrounding soil, the fixity condition at the head of the caisson, the structural capacity of the caisson to withstand bending moments, the soil resistance that can be mobilized, the tolerable lateral deflections at the head of the caisson and group effects (if applicable). For a longer, more flexible caisson, the maximum yield moment of

the caisson may be reached prior to mobilization of the lateral geotechnical resistance. For design purposes, both the structural and geotechnical resistances should be evaluated to establish the governing case.

The resistance to lateral loading in front of a single caisson may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction,  $k_h$  (kPa/m), is based on the equations provided below (CFEM, 2023, as referenced in the *Commentary of the CHBDC, 2019*). Additional assessment of the deformation response may be developed and provided in the form of p-y curves if the structural engineers' initial analyses suggest that the values derived from subgrade reaction theory do not adequately characterize the response of the caissons at this site.

For non-cohesive soils:

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

where:  $n_h$  = coefficient related to soil density (kPa/m)  
 $z$  = depth below the top of the caisson (m)  
 $B$  = caisson diameter or width (m)

For cohesive soils:

$$k_h = \frac{67s_u}{B}$$

where:  $s_u$  = undrained shear strength of the soil (kPa)  
 $B$  = caisson diameter or width (m)

The values of  $n_h$  (Terzaghi, 1955 and Reese, 1975) and  $s_u$ , provided in Table 1, shall be incorporated into the calculations of the coefficient of horizontal subgrade reaction ( $k_h$ ) within the fill and native overburden, to be used for the structural analysis of the caissons at this site.

The resistance within the upper 1.7 m below ground surface should be neglected to account for frost action within the depth of frost penetration zone as interpreted from OPSS 3090.101 (*Foundation Frost Penetration Depths for Southern Ontario*). Passive resistance below the depth of frost penetration provided in Table 1 should be reduced by an appropriate factor considering the allowable wall movement in accordance with Figure C6.27 of the *Canadian Highway Bridge Design Code* (CHBDC, 2019).

A consequence factor ( $\Psi$ ) of 1.0 and a geotechnical resistance factor of 0.5 (assuming a “typical” consequence level and a “typical” degree of site understanding as outlined in the 2019 *Canadian Highway Bridge Design Code and its Commentary* (CHBDC, 2019) should be applied to this unfactored lateral resistance to obtain the factored ultimate lateral geotechnical resistance.

## 6.3 Construction Considerations

The footings/caissons for the noise barrier wall should be constructed in accordance with OPSS.PROV 903 (*Deep Foundations*). The noise barrier wall should also be constructed in accordance with OPSS 760 (*Noise Barrier Systems*) and SP 760F01. A copy of SP 760F01 is included in Appendix D with the fill-ins completed for the geotechnical parameters.

### 6.3.1 Control of Soil and Groundwater for Caissons

Caisson construction is anticipated to require auguring / excavation through the existing fill and overburden deposits. Most of the fill and overburden encountered at the proposed noise barrier wall location are classified as

coarse-grained soils and may be water-bearing, particularly at the eastern portion of the alignment (in the vicinity of Borehole NW2-7 where a silty sand deposit was encountered). Wet, non-cohesive soil layers and pockets should be expected to run or flow into the drilled hole during or after auguring for foundations. In accordance with OPSS.PROV 903 (*Deep Foundations*), the contractor is required to maintain sidewall stability through out the excavation of the caisson and concrete placement and therefore use of drilling mud or temporary caisson liners or other appropriate methods will be required.

### 6.3.2 Obstructions

The Design-Build Contractor should be alerted to the potential presence of cobble and boulder obstructions within the existing fill and native soils as noted on the borehole records. The potential presence of cobble and boulder obstructions has been inferred based on the presence of rock fragments within the collected soil samples and several instances of auger grinding and split-spoon refusal. Further, glacially derived till deposits, such as those encountered at this site, should be expected to contain coarse gravel, cobbles and/or boulders. Note that the extent and depth of the cobble and boulder obstructions may vary beyond and between the borehole locations.

The presence of obstructions (i.e., cobbles and/or boulders) may affect excavation operations for caisson construction. The Design-Build Contractor must be prepared with suitable equipment and procedures to remove/penetrate through any obstructions that may be encountered during construction.

## 6.4 Analytical Testing of Construction Materials

The analytical test results 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 concentrations measured on the soil samples is less than 0.002%, which is below the moderate degree of exposure (i.e., below the class S3 exposure limits); suggesting that the effects of sulphate may not need to be considered. However, if the proposed foundations will be exposed to de-icing salt or other chemicals, consideration should also be given by the designer to designing the concrete structure for a “C” type exposure class as defined by CSA A23.1 Table 1.

The pH levels and resistivity analytical test results of the soil samples were also compared to the *MTO Gravity Pipe Design Guidelines* (MTO, 2014) to assess the relative level of corrosion potential on any buried steel elements in contact with the fill/soil. The pH levels measured on the soil samples were about 7.7 and 8.0, suggesting the granular glacial till deposits are basic (i.e., pH levels greater than 7). These pH levels are not considered detrimental to steel durability given that the pH levels are less than 8.5. The resistivity (R) measured on the two samples were about 4,200 ohm cm and 8,300 ohm cm, which indicates that the soil corrosiveness is very low ( $10,000 > R > 6,000$ ) to low ( $6,000 > R > 4,500$ ) as per Table 3.2 of the *MTO Gravity Pipe Design Guideline* (2014). Therefore, corrosion protection may not need to be considered for steel foundation elements in contact with the fill/soil.

These recommendations are provided as guidance only. 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 Ms. Anastasia Poliacik, P.Eng., a senior geotechnical engineer with WSP. Mr. David Staseff, P.Eng., a senior principal and MTO Principal Foundations Contact with WSP conducted an independent technical and quality review of this report.

## Signature Page

**WSP Canada Inc.**



Anastasia Poliacik, P.Eng.  
*Senior Geotechnical Engineer*



David Staseff, P.Eng.  
*Senior Principal, MTO Principal Foundations Contact*

TT/AMP/DS/al

[https://golderassociates.sharepoint.com/sites/120052/project files/6 deliverables/2. reporting/06 - noise barrier wall 2/5. final/19135676-rpt-rev0-nbw2 hwy 11 obr-final fidr-13\\_feb\\_24.docx](https://golderassociates.sharepoint.com/sites/120052/project%20files/6%20deliverables/2.%20reporting/06%20-%20noise%20barrier%20wall%202/5.%20final/19135676-rpt-rev0-nbw2%20hwy%2011%20obr-final%20fidr-13_feb_24.docx)

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- Bowles, J.E. 1984. *Physical and Geotechnical Properties of Soils*, Second Edition, McGraw Hill Book Company, New York.
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- Unified Facilities Criteria, U.S. Navy. 1986. *NAVFAC Design Manual 7.02. Soil Mechanics, Foundation and Earth Structures*. Alexandria, Virginia.
- Ministry of Transportation, Ontario. 2014. *Gravity Pipe Design Guidelines*.

### Ontario Provisional Standard Drawings (OPSD)

OPSD 3090.101 Foundation Frost Penetration Depths for Southern Ontario

### Ontario Provincial Standard Specifications (OPSS)

OPSS 760 Construction Specification for Noise Barrier Systems

OPSS.PROV 903 Construction Specification for Deep Foundations

### Special Provisions

SP 760F01 Amendment to OPSS 760

### Ontario Water Resources Act

Ontario Regulation 903 Wells (as amended)

Tables



Table 1: Geotechnical Design Parameters for Noise Barrier Wall No. 2

Approximate Noise Barrier Wall Location	Relevant Boreholes		Fill / Soil Stratum	Approximate Depth <sup>2</sup> (m)	Design Groundwater Depth <sup>3</sup> (m)	Geotechnical Design Parameters <sup>4</sup>							
						$s_u$ (kPa)	$n_h$ (kPa/m)	$\varphi'$ (°)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_o$ <sup>8</sup>	$K_a$ <sup>8</sup>	$K_p$ <sup>5,6,7,8</sup>
North of Highway 12 (Old Barrie Road)	Western Portion of the wall	NW2-1 to NW2-3	Compact to dense silty sand to gravelly silty sand (fill)	0.0 – 1.4	1.5	--	12,000	30	20	10	0.50	0.33	3.00
			Dense to very dense gravelly silty sand to sandy gravel (till)	1.4 – 3.2		-	20,000	35	21	11	0.43	0.27	3.69
			Stiff to very stiff sandy clayey silt-silt (till)	3.2 – 5.1		100	--	30	21	11	0.50	0.33	3.00
			Compact to very dense silty sand to sandy gravel (till)	1.4 – 8.2		--	20,000	33	21	11	0.46	0.29	3.39
	Middle Portion of the wall	NW2-4 to NW2-6	Soft to stiff clayey silt and sand to clayey sand-silty sand (fill)	0.0 – 0.8	1.5	50	--	28	19	9	0.53	0.36	2.77
			Compact to very dense silty sand to sandy gravel (till)	0.8 – 8.1		--	20,000	33	21	11	0.46	0.29	3.39
	Eastern Portion of the wall	NW2-7	Firm clayey silt and sand (fill)	0.0 – 0.3	1.5	50	--	28	19	9	0.53	0.36	2.77
			Dense to very dense silty sand to sandy silty gravel (till)	0.3 – 2.2		--	20,000	35	21	11	0.43	0.27	3.69
			Dense silty sand	2.2 – 4.0		--	25,000	33	20	10	0.46	0.29	3.39
			Hard clayey silt-silt and sand (till)	4.0 – 8.2		200	--	35	21	11	0.43	0.27	3.69

- NOTES:
1. Refer to Drawing 1 for the approximate location of the proposed noise barrier wall.

2. Depths are given relative to the borehole ground surface elevations; the ground surface elevations at the borehole locations should be compared to the ground surface elevations at the proposed noise barrier wall, and the depths to various soil strata adjusted accordingly.

3. Groundwater elevation is based on measurements in open boreholes and in standpipe piezometers installed at the site. Given the variability in the ground surface elevation along the alignment of the proposed noise barrier wall, a design groundwater elevation is not provided.

4. The geotechnical design parameters are as follows:

$s_u$  = undrained shear strength (kPa)

$n_h$  = coefficient related to soil density (kPa/m)

$\varphi'$  = effective (drained) friction angle (°)

$K_a$  = active earth pressure coefficient

$K_p$  = passive earth pressure coefficient

$K_o$  = earth pressure coefficient at rest

$\gamma$  = bulk unit weight (kN/m<sup>3</sup>)

$\gamma'$  = effective unit weight (below the groundwater level) (kN/m<sup>3</sup>)

5. The passive resistance in the upper 1.7 m should be neglected to account for frost action.

6. Where footings/caissons are to be installed on or near a slope (i.e., sloping downwards from the proposed noise barrier wall), the passive resistance shall be reduced accordingly.

7. The total passive resistance below frost depth may be calculated based on the values of  $K_p$  provided above but reduced by an appropriate factor that considers allowable wall movement in accordance with Figure C6.27 of the *Canadian Highway Bridge Design Code* (CHBDC, 2019) to account for large strains required to mobilize full passive resistance.

8. For cohesive soils (e.g., clayey silt), an assessment for the effective stress, drained ( $\varphi'$ ) and total stress, undrained ( $s_u$ ) cases should be made to establish the more conservative earth pressure condition for design purposes.

Drawings

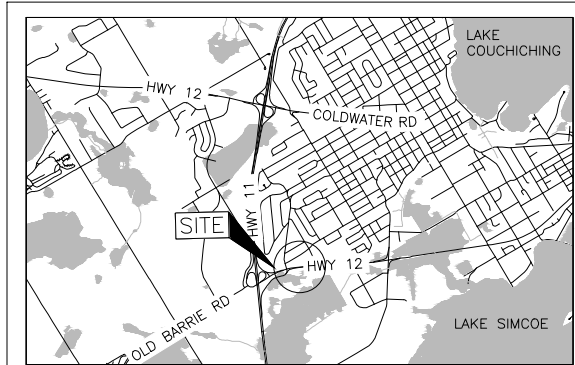


**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No.  
GWP No. 2129-18-00

HIGHWAY 11/12  
NOISE BARRIER WALL NO.2  
BOREHOLE LOCATION PLAN AND  
SOIL STRATA

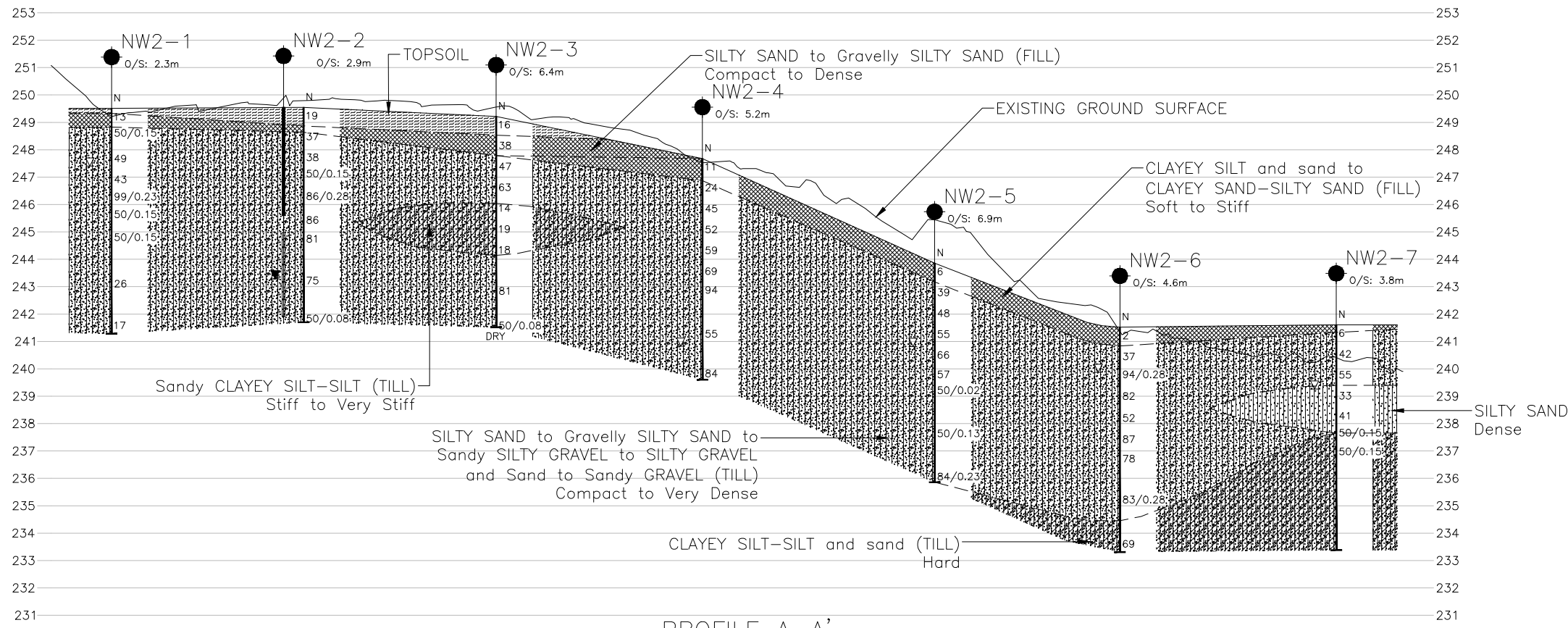
SHEET



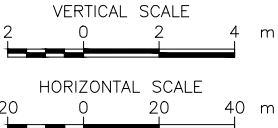
LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer (Feb. 14, 2022)
- WL upon completion of drilling

BOREHOLE CO-ORDINATES (MTM83 ZONE 10)			
No.	ELEVATION	NORTHING	EASTING
NW2-1	249.5	4939037.0	309482.6
NW2-2	249.6	4939049.1	309552.8
NW2-3	249.2	4939053.4	309622.7
NW2-4	247.7	4939058.1	309697.7
NW2-5	243.8	4939059.7	309782.5
NW2-6	241.5	4939064.7	309850.1
NW2-7	241.6	4939068.6	309929.0



PROFILE A-A'



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

**REFERENCE**  
Base plans provided in digital format by McIntosh Perry, drawing file no. x\_197147\_BASE.dwg, received May 19, 2021.  
Noise barrier wall plan provided in digital format by McIntosh Perry, drawing file no. 197147-c2\_hwy011\_dph-ncp-interim.dwg, received November 22, 2023.

NO.	DATE	BY	REVISION
Geocres No. 31D11-001			
HWY. 11 AND 12		PROJECT NO. 19135676	DIST. .
SUBM'D. AMP	CHKD. AMP	DATE: 12/06/2023	SITE: .
DRAWN: DD	CHKD. AMP	APPD. DS	DWG. 1

**APPENDIX A**

# Records of Borehole Sheets

# 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

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

#### (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

Notes: 1  
2

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



PROJECT	19135676	LOCATION	N 4939037; E 309482.6 NAD83 / MTM Zone 10 (LAT. 44.591325; LONG. -79.441023)	Sheet 1 of 1	METRIC
G.W.P.	2129-18-00	BOREHOLE TYPE	210 mm O.D. Continuous Flight Hollow Stem Augers	ORIGINATED BY	MH
DIST	Central HWY 11/12	DATE	Apr 29, 2021 - Apr 30, 2021	COMPILED BY	BL
DATUM	CGVD28 Surface Elevation:249.5 m			CHECKED BY	TZ/AMP

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>						
249.5	TOPSOIL (180 mm)		1A					20	40	60	80	100	20	40	60						
0.0																					
249.3	Gravelly SILTY SAND (SM), containing crushed rock fragments (FILL)		1B	SS	13		249														
0.2	Compact Brown Moist																				
248.8	Gravelly SILTY SAND (SM) to sandy GRAVEL (GW-GM), trace fines (TILL)		2	SS	50/0.15													60	32	8	0
0.7	Compact to very dense Brown Moist to wet																				
	- 0.7 m: Grinding of augers noted (Elevation 248.8 m)																				
	- 1.5 to 2.1 m: Containing crushed rock fragments (between Elevation 248.0 m and Elevation 247.4 m)		3	SS	49		248														
			4	SS	43		247														
			5	SS	99/0.23		246														
	- 3.8 m: Wet below Elevation 245.7 m		6	SS	50/0.15		245														
			7	SS	50/0.15		244														
			8	SS	26		243											22	56	18	4
							242														
			9	SS	17																
241.3	End of Borehole						241														
8.2	Note: 1. Water level measured in open borehole at a depth of about 2.0 m below ground surface (Elevation 247.5 m) upon completion of drilling.						240														

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

METRIC

ORIGINATED BY                      MH

COMPILED BY BL

CHECKED BY TZ/AMP

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT  Y kN/m³	GR	SA	SI	CL	REMARKS	
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL							
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W <sub>p</sub>	W	W <sub>i</sub>							
249.6																						
0.0	TOPSOIL (700 mm)		1	SS	19																	
248.9																						
0.7	Gravelly SILTY SAND (SM), containing crushed rock fragments (FILL)		2A																			
0.9	Brown Moist Gravelly SILTY SAND (SM) to sandy SILTY GRAVEL (GM), containing crushed rock fragments (TILL) Dense to very dense Brown Moist - 1.5 m: Grinding of augers noted (Elevation 248.1 m)		2B	SS	37																	
			3	SS	38														55	30	12	3
			4	SS	50/0.15																	
			5	SS	86/0.28																	
			6	SS	86																	
			7	SS	81																	
			8	SS	75																	
														</								



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

PROJECT	19135676	RECORD OF BOREHOLE	No. NW2-3	Sheet 1 of 1	METRIC
G.W.P.	2129-18-00	LOCATION	N 4939053.4; E 309622.7 NAD83 / MTM Zone 10 (LAT. 44.591472; LONG. -79.439259)	ORIGINATED BY	MH
DIST	Central HWY 11/12	BOREHOLE TYPE	210 mm O.D. Continuous Flight Hollow Stem Augers	COMPILED BY	BL
DATUM	CGVD28 Surface Elevation:249.2 m	DATE	Apr 30, 2021 - May 01, 2021	CHECKED BY	TZ/AMP

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	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>						
249.2								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	NP Nonplastic			Y					
0.0	TOPSOIL (700 mm)		1	SS	16		249	20	40	60	80	100	20	40	60						
248.5																					
0.7	SILTY SAND (SM), trace gravel (FILL) Dense Brown Moist		2	SS	38		248														
247.8																					
1.4	Gravelly SILTY SAND (SM), containing crushed rock fragments (TILL) Dense to very dense Brown Moist  - 1.5 m: Grinding of augers noted (Elevation 247.7 m)		3	SS	47		247														
			4	SS	63																
246.0			5A				246														
3.2	Sandy CLAYEY SILT-SILT (CL-ML), some gravel (TILL) Stiff to very stiff Brown Moist		5B	SS	14																
			6	SS	19		245														
			7A	SS	18																
244.1			7B				244														
5.1	SILTY SAND (SM), some gravel (TILL) Very dense Brown Moist  - 5.2 to 6.1 m: Grinding of augers noted (between Elevation 244.0 m and Elevation 243.1 m)		8	SS	81		243														
							242														
241.5			9	SS	50/0.08																
7.7	End of Borehole Note: 1. Open borehole dry upon completion of drilling.						241														
							240														

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

PROJECT	19135676	RECORD OF BOREHOLE	No. NW2-4	Sheet 1 of 1	METRIC
G.W.P.	2129-18-00	LOCATION	N 4939058.1; E 309697.7 NAD83 / MTM Zone 10 (LAT. 44.591514; LONG. -79.438314)	ORIGINATED BY	MH
DIST	Central	HWY	11/12	BOREHOLE TYPE	210 mm O.D. Continuous Flight Hollow Stem Augers
DATUM	CGVD28 Surface Elevation:247.7 m	DATE	May 01, 2021	COMPILED BY	BL
				CHECKED BY	TZ/AMP

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT  Y  kN/m³	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W <sub>p</sub>	W	W <sub>i</sub>						
													NP Nonplastic								
247.7							20	40	60	80	100	20	40	60							
0.0	CLAYEY SILT (CL) and sand, trace gravel, containing rootlets (FILL) Stiff Brown Moist		1	SS	11												5	41	38	16	
246.9			2A				247														
0.8	Gravelly SILTY SAND (SM) of slight plasticity to Gravelly SILTY SAND (SM) to SILTY GRAVEL and sand (GM/SM), containing crushed rock fragments (TILL) Compact to very dense Brown Moist		2B	SS	24																
			3	SS	45		246										52	35	11	2	
			4A	SS	52		245														
	- 2.7 to 2.9 m: Sandy SILT (ML) stratum (between Elevation 245.0 m and Elevation 244.8 m) - 3.0 m: Grinding of augers noted (Elevation 244.7 m)		4B																		
			5	SS	59		244										25	44	24	7	
			6	SS	69																
			7	SS	94		243										33	50	14	3	
	- 4.9 m: Grinding of augers noted (Elevation 242.8 m)																				
							242														
			8	SS	55		241														
							240														
			9	SS	84																
239.6																					
8.1	End of Borehole Note: 1. Water level measured in open borehole at a depth of about 6.7 m below ground surface (Elevation 241.0 m) upon completion of drilling.						239														
							238														

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

PROJECT	19135676	RECORD OF BOREHOLE	No. NW2-5	Sheet 1 of 1	METRIC
G.W.P.	2129-18-00	LOCATION	N 4939059.7; E 309782.5 NAD83 / MTM Zone 10 (LAT. 44.591528; LONG. -79.437245)	ORIGINATED BY	MH
DIST	Central	HWY	11/12	BOREHOLE TYPE	210 mm O.D. Continuous Flight Hollow Stem Augers
DATUM	CGVD28 Surface Elevation:243.8 m	DATE	May 01, 2021	COMPILED BY	BL
				CHECKED BY	TZ/AMP

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	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>						
243.8								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined													
								20 40 60 80 100					20 40 60								
0.0	CLAYEY SAND-SILTY SAND (SC-SM), some gravel, containing rootlets (FILL) Firm Brown Moist		1A																		
			1B	SS	6																
243.1																					
0.7	SILTY SAND (SM), some gravel to gravelly, containing crushed rock fragments (TILL) Dense to very dense Brown to grey Moist		2	SS	39		243														
			3	SS	48		242														
			4	SS	55		241														
			5A																		
			5B	SS	66																
	- 3.3 to 3.7 m: CLAYEY SAND-SILTY SAND (SC-SM), some gravel (TILL) stratum (between Elevation 240.5 m and Elevation 240.1 m)		6	SS	57		240														
	- 3.8 m: Grey below Elevation 240.0 m		7	SS	50/0.02		239														
			8	SS	50/0.13		238														
			9	SS	84/0.23		236														
235.8																					
8.0	End of Borehole Note: 1. Water level measured in open borehole at a depth of about 2.9 m below ground surface (Elevation 240.9 m) upon completion of drilling.						235														
							234														

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

METRIC

MH

BL

TZ/AMP

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



PROJECT	19135676	RECORD OF BOREHOLE	No. NW2-7	Sheet 1 of 1	METRIC
G.W.P.	2129-18-00	LOCATION	N 4939068.6; E 309929 NAD83 / MTM Zone 10 (LAT. 44.591607; LONG. -79.4354)	ORIGINATED BY	MH
DIST	Central HWY 11/12	BOREHOLE TYPE	210 mm O.D. Continuous Flight Hollow Stem Augers	COMPILED BY	BL
DATUM	CGVD28 Surface Elevation:241.6 m	DATE	May 03, 2021	CHECKED BY	TZ/AMP

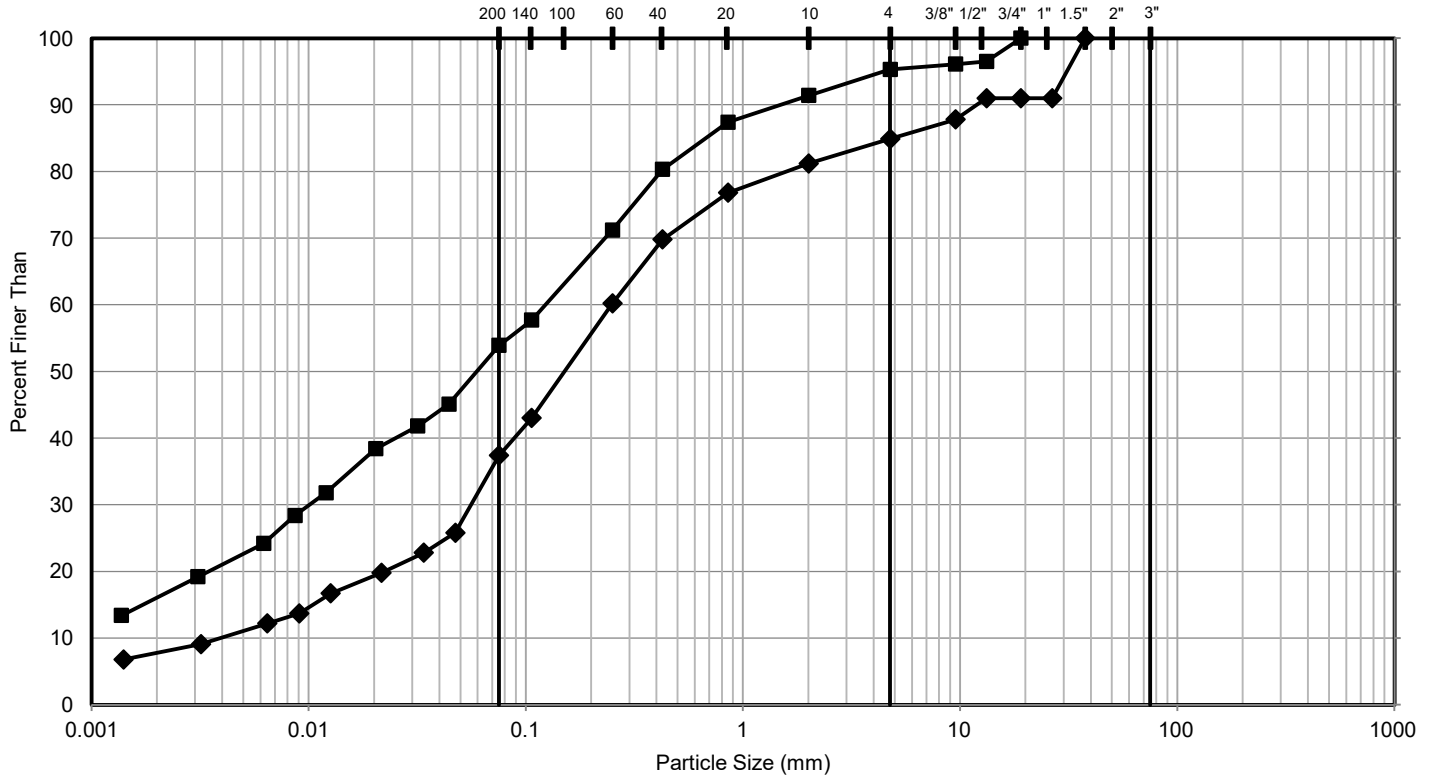
SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT					REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W <sub>p</sub>	NMC W	LL W <sub>L</sub>		GR	SA	SI	CL	
241.6								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined													
0.0 241.3	CLAYEY SILT (CL) and sand, trace gravel, containing rootlets (FILL)		1A	SS	6		241	20	40	60	80	100	20	40	60						
0.3	Firm Brown Moist SILTY SAND (SM), some gravel to sandy SILTY GRAVEL (GM) (TILL) Dense to very dense Brown Moist to wet		1B																		
	- 1.5 m: Wet below Elevation 240.1 m		2	SS	42		240										65	22	11	2	
239.4			3	SS	55																
2.2	SILTY SAND (SM), trace gravel Dense Brown Moist		4	SS	33		239									NP	2	79	16	3	
			5	SS	41		238														
237.6			6A	SS	50/0.15																
4.0	CLAYEY SILT-SILT (CL-ML) and sand, trace gravel (TILL) Hard Grey Moist		6B				237														
			7	SS	50/0.15																
			8	AS			236														
			9	AS			235														
			10	AS			234														
233.4																					
8.2	End of Borehole Note: 1. Water level measured in open borehole at a depth of about 2.2 m below ground surface (Elevation 239.4 m) upon completion of drilling.						233														
							232														

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

**APPENDIX B**

# Geotechnical Laboratory Test Results

# GRAIN SIZE DISTRIBUTION



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

Symbol	Borehole	Sample Number	Depth (m)	Elevation (m)
■	NW2-4	1	0.0 - 0.6	247.7 to 247.1
◆	NW2-6	1B	0.2 - 0.6	241.4 to 240.9

CLIENT

MCINTOSH PERRY /  
MINISTRY OF TRANSPORTATION ONTARIO (MTO)

CONSULTANT



YYYY-MM-DD 2023-11-15

DESIGNED

-

PREPARED

BL

REVIEWED

TZ/TT

APPROVED

CN/AMP

PROJECT

NOISE BARRIER WALL NO. 2  
BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT HIGHWAY  
11/12 (COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA,  
GWP 2129-18-00

TITLE

CLAYEY SILT (CL) and sand to CLAYEY SAND-SILTY SAND (SC-  
SM) (FILL)

PROJECT NO.

19135676

CONTROL

0

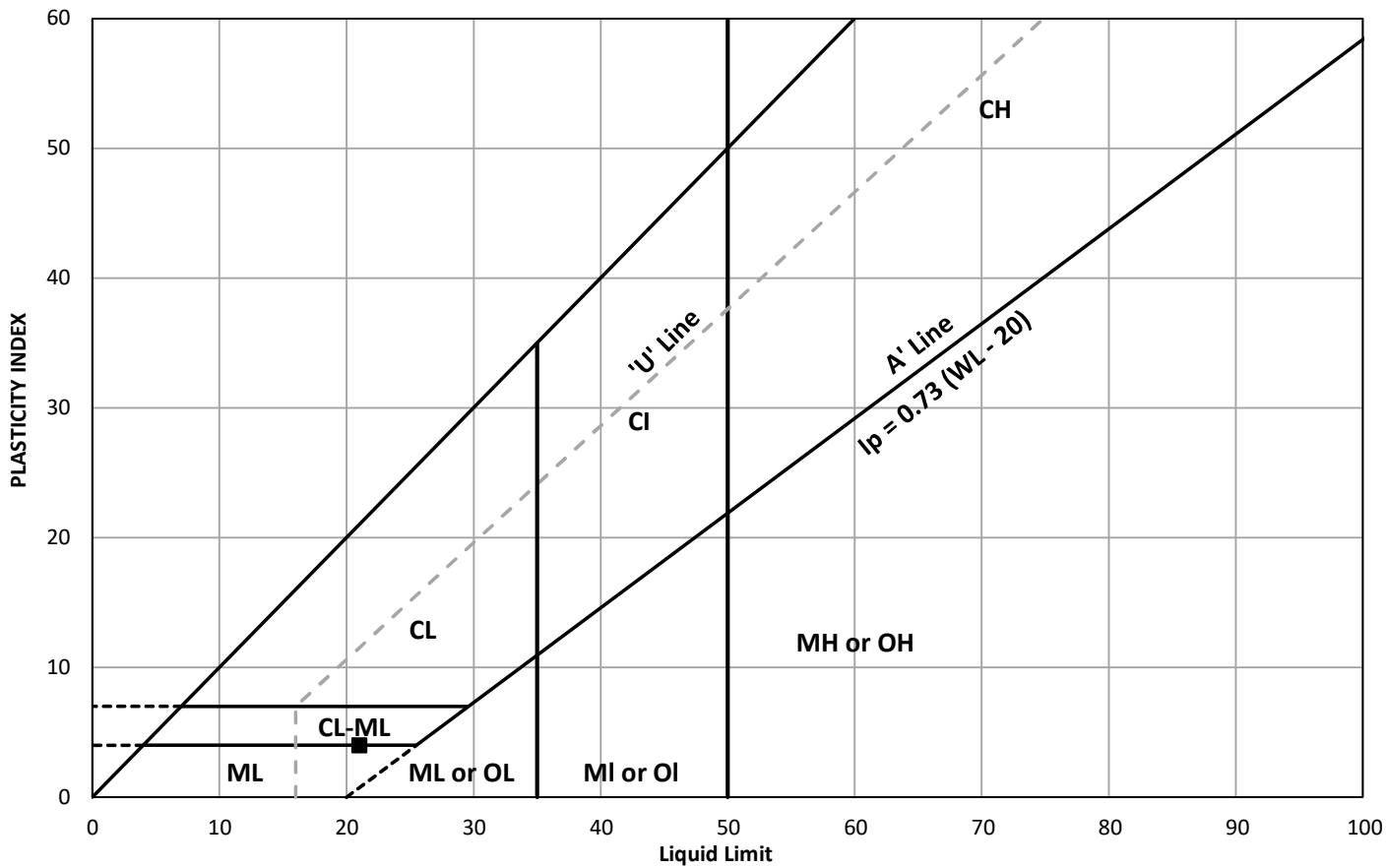
REV.

0

FIGURE

B1

PLASTICITY CHART




	Borehole	Sample / Specimen Number	Elevation (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	NW2-6	1B	241.4 to 240.9	14.5	21	17	4	-0.63

CLIENT

MCINTOSH PERRY /  
MINISTRY OF TRANSPORTATION ONTARIO (MTO)

CONSULTANT



WSP

PROJECT

NOISE BARRIER WALL NO. 2  
BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT HIGHWAY 11/12  
(COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA, GWP 2129-18-00

TITLE

CLAYEY SAND-SILTY SAND (SC-SM) (FILL)

PROJECT NO.

19135676

CONTROL

0

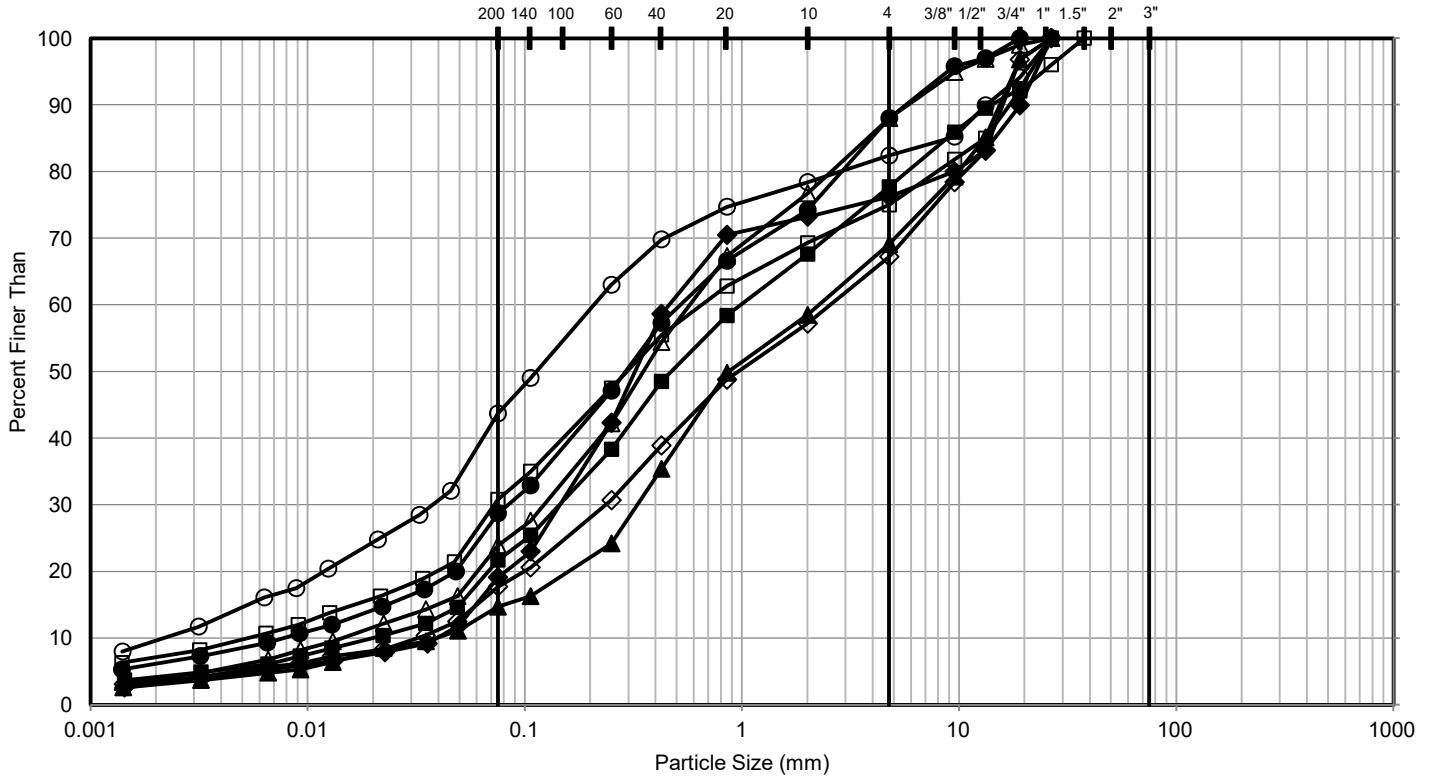
REV.

0

FIGURE

B2

# GRAIN SIZE DISTRIBUTION



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

Symbol	Borehole	Sample Number	Depth (m)	Elevation (m)
■	NW2-1	8	6.1 - 6.7	243.4 to 242.8
◆	NW2-2	7	4.6 - 5.0	245.0 to 244.5
▲	NW2-3	4	2.3 - 2.9	246.9 to 246.3
●	NW2-3	8	6.1 - 6.7	243.1 to 242.6
□	NW2-4	5	3.0 - 3.7	244.6 to 244.0
◇	NW2-4	7	4.6 - 5.0	243.1 to 242.7
△	NW2-5	4	2.3 - 2.9	241.5 to 240.9
○	NW2-5	5B	3.3 - 3.7	240.5 to 240.1

## CLIENT

MCINTOSH PERRY /  
MINISTRY OF TRANSPORTATION ONTARIO (MTO)

## CONSULTANT



YYYY-MM-DD 2023-11-15

DESIGNED -

PREPARED BL

REVIEWED TZ/TT

APPROVED CN/AMP

## PROJECT

NOISE BARRIER WALL NO. 2  
BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT HIGHWAY  
11/12 (COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA,  
GWP 2129-18-00

## TITLE

CLAYEY SAND-SILTY SAND (SC-SM) to SILTY SAND (SM) to  
Gravelly SILTY SAND (SM) (TILL)

PROJECT NO.

19135676

CONTROL

0

REV.

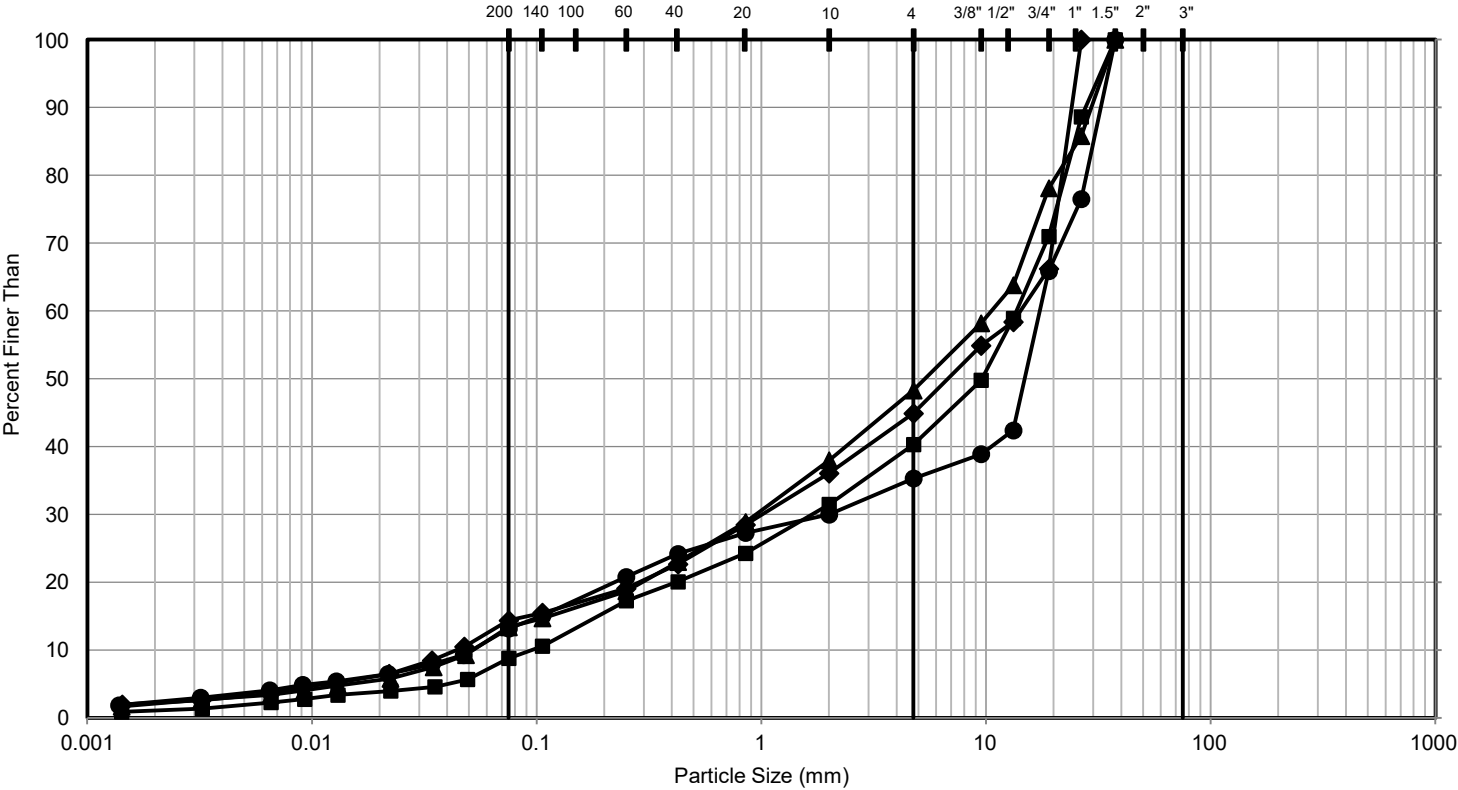
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FIGURE

B3A

PATH: https://wsponline-my.sharepoint.com/personal/anastasia\_poljacik\_wsp\_com/Documents/Desktop/NW2/Appendix B - Geotechnical Laboratory Test Results/Excel working files | FILE NAME: Laboratory Particle Size Distribution MTO\_Figure B3A and B3B.xlsm

GRAIN SIZE DISTRIBUTION



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

Symbol	Borehole	Sample Number	Depth (m)	Elevation (m)
■	NW2-1	2	0.8 - 1.1	248.7 to 248.4
◆	NW2-2	3	1.5 - 2.1	248.0 to 247.4
▲	NW2-4	3	1.5 - 2.1	246.2 to 245.5
●	NW2-7	3	1.5 - 2.1	240.1 to 239.5

CLIENT

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CONSULTANT



YYYY-MM-DD 2023-11-15

DESIGNED -

PREPARED BL

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PROJECT

NOISE BARRIER WALL NO. 2  
BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT HIGHWAY  
11/12 (COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA,  
GWP 2129-18-00

TITLE

Sandy GRAVEL (GW-GM) to SILTY GRAVEL and sand (GM/SM) to  
sandy SILTY GRAVEL (GM) (TILL)

PROJECT NO.

19135676

CONTROL

0

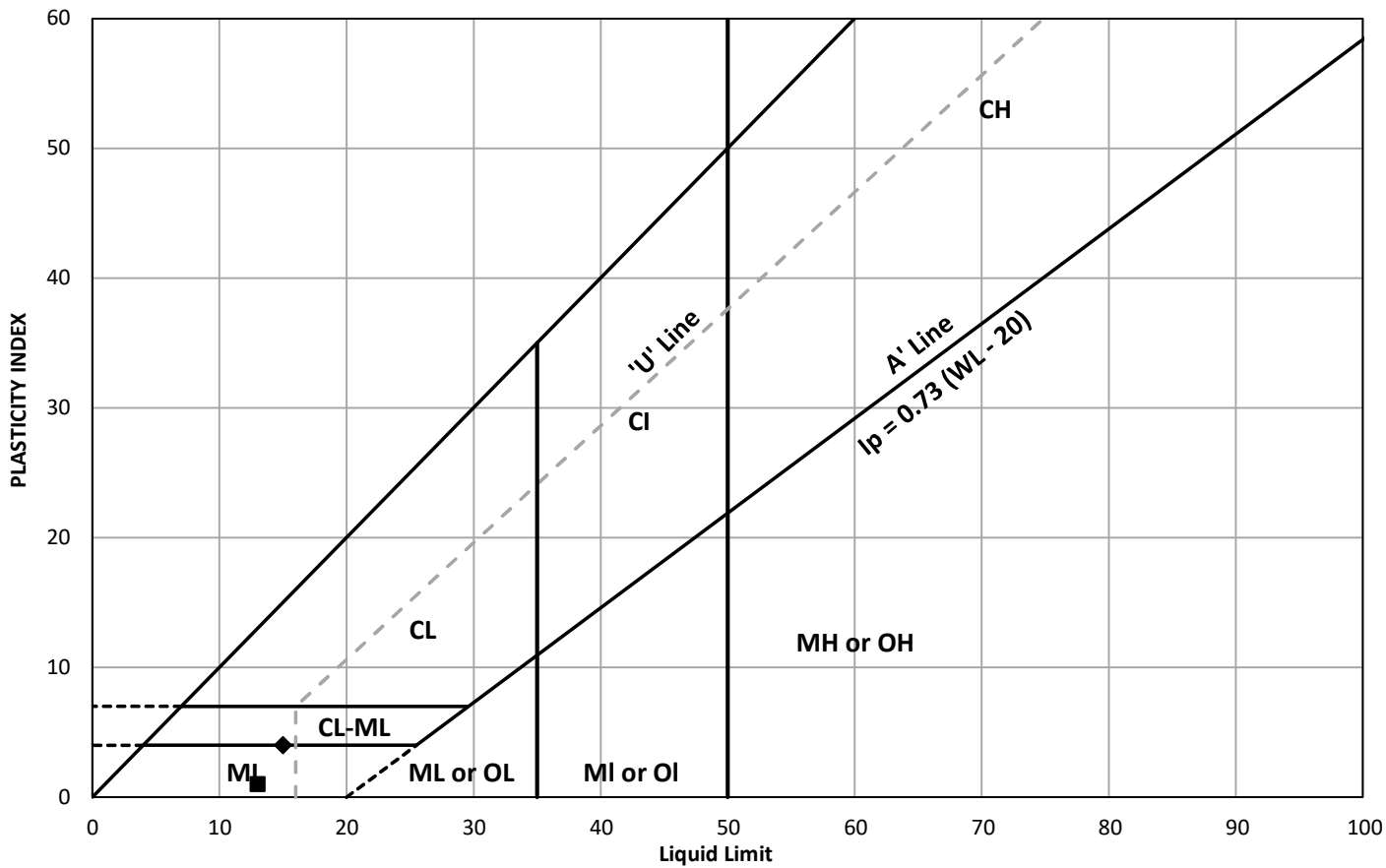
REV.

0

FIGURE

B3B

PLASTICITY CHART

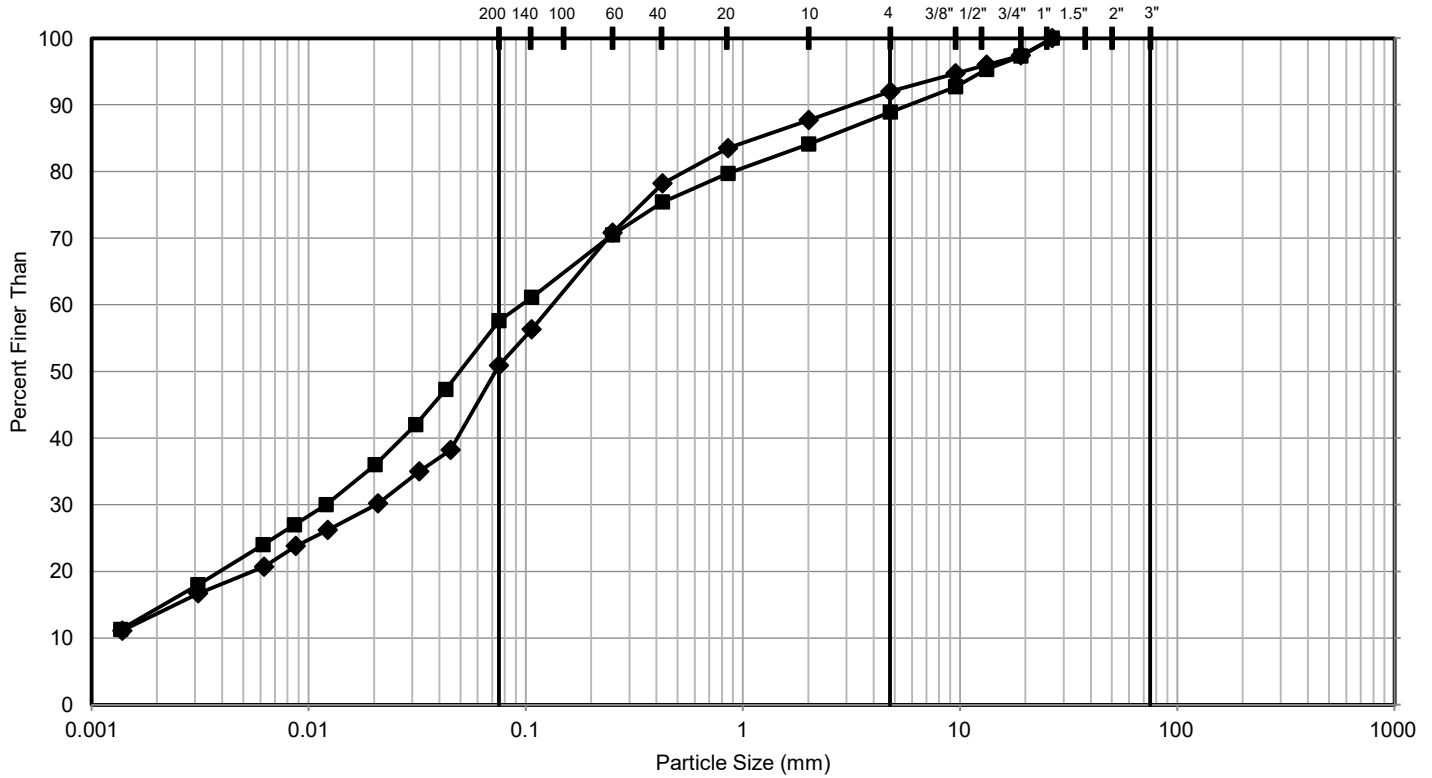


	Borehole	Sample / Specimen Number	Elevation (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	NW2-4	5	244.6 to 244.0	5.1	13	12	1	-6.90
◆	NW2-5	5B	240.5 to 240.1	7.7	15	11	4	-0.83

CLIENT			PROJECT			
MCINTOSH PERRY / MINISTRY OF TRANSPORTATION ONTARIO (MTO)			NOISE BARRIER WALL NO. 2 BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT HIGHWAY 11/12 (COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA, GWP 2129-18-00			
CONSULTANT			TITLE			
			CLAYEY SAND-SILTY SAND (SC-SM) to SILTY SAND (SM) of slight plasticity (TILL)			
			PROJECT NO.	CONTROL	REV.	FIGURE
			0	0	0	B4
			YYYY-MM-DD	2023-11-15		
			DESIGNED	-		
			PREPARED	BL		
			REVIEWED	TZ/TT		
			APPROVED	CN/AMP		



# GRAIN SIZE DISTRIBUTION



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

Symbol	Borehole	Sample Number	Depth (m)	Elevation (m)
■	NW2-3	6	3.8 - 4.4	245.4 to 244.8
◆	NW2-6	9	7.6 - 8.2	233.9 to 233.3

CLIENT

MCINTOSH PERRY /  
MINISTRY OF TRANSPORTATION ONTARIO (MTO)

CONSULTANT



YYYY-MM-DD 2023-11-15

DESIGNED

-

PREPARED

BL

REVIEWED

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PROJECT

NOISE BARRIER WALL NO. 2  
BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT HIGHWAY  
11/12 (COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA,  
GWP 2129-18-00

TITLE

Sandy CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT-SILT (CL-ML)  
and sand (TILL)

PROJECT NO.

19135676

CONTROL

0

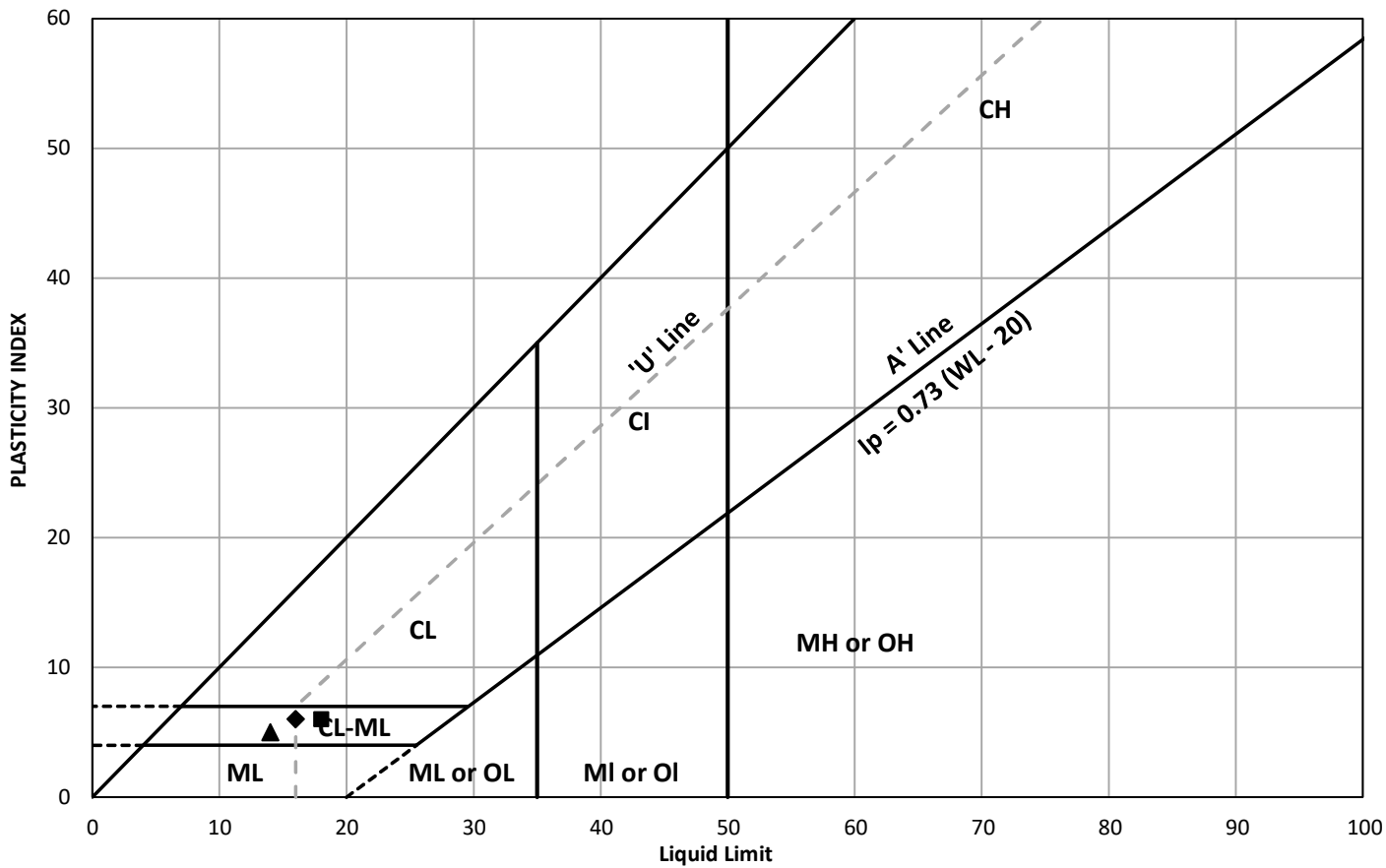
REV.

0

FIGURE

B5

PLASTICITY CHART



	Borehole	Sample / Specimen Number	Elevation (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	NW2-3	6	245.4 to 244.8	13	18	12	6	0.17
◆	NW2-6	9	233.9 to 233.3	7.2	16	10	6	-0.47
▲	NW2-7	8	236.3 to 235.7	9.1	14	9	5	0.02

CLIENT

MCINTOSH PERRY /  
MINISTRY OF TRANSPORTATION ONTARIO (MTO)

CONSULTANT

YYYY-MM-DD

2023-11-15

DESIGNED

-

PREPARED

BL

REVIEWED

TZ/TT

APPROVED

CN/AMP

PROJECT

NOISE BARRIER WALL NO. 2  
BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT HIGHWAY 11/12  
(COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA, GWP 2129-18-00

TITLE

Sandy CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT-SILT (CL-ML) and sand (TILL)

PROJECT NO.

0

CONTROL

0

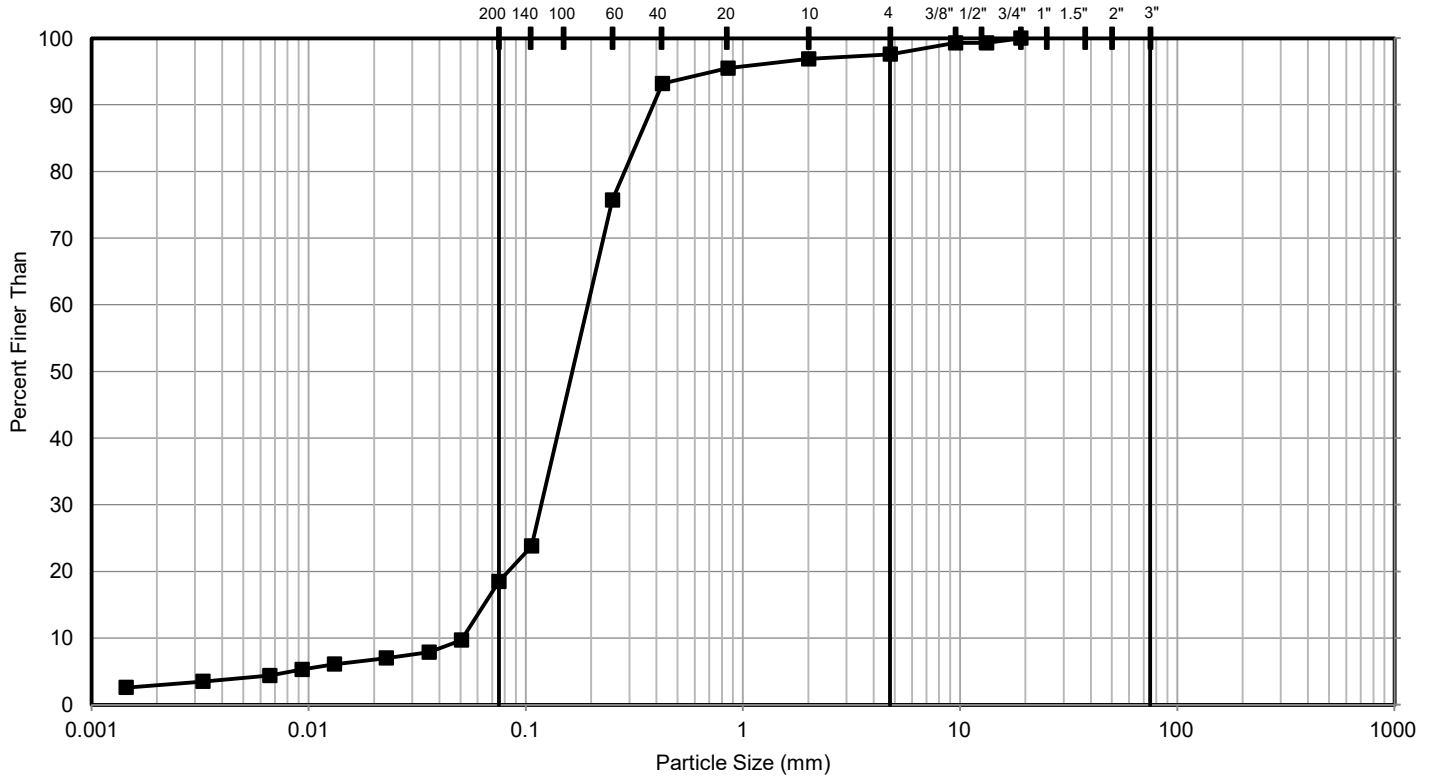
REV.

0

FIGURE

B6

# GRAIN SIZE DISTRIBUTION



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

Symbol	Borehole	Sample Number	Depth (m)	Elevation (m)
■	NW2-7	4	2.3 - 2.9	239.3 to 238.7

CLIENT

MCINTOSH PERRY /  
MINISTRY OF TRANSPORTATION ONTARIO (MTO)

CONSULTANT



YYYY-MM-DD 2023-11-15

DESIGNED

-

PREPARED

BL

REVIEWED

TZ/TT

APPROVED

CN/AMP

PROJECT

NOISE BARRIER WALL NO. 2  
BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT HIGHWAY  
11/12 (COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE ROAD), ORILLIA,  
GWP 2129-18-00

TITLE

SILTY SAND (SM)

PROJECT NO.

19135676

CONTROL

0

REV.

0

FIGURE

B7

**APPENDIX C**

# Analytical Laboratory Test Results



Your Project #: 19135676  
Site Location: HWY11/12, ORILLIA  
Your C.O.C. #: n/a

**Attention: Alysha Kobylinski**

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

**Report Date: 2021/05/13**  
Report #: R6632618  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**BV LABS JOB #: C1C0782**

**Received: 2021/05/05, 15:00**

Sample Matrix: Soil  
# Samples Received: 2

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	2	2021/05/10	2021/05/10	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	2	2021/05/10	2021/05/10	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	2	N/A	2021/05/10	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	2	N/A	2021/05/09	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	2	2021/05/07	2021/05/07	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	2	2021/05/05	2021/05/11	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	2	2021/05/10	2021/05/10	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 via Mississauga

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



Your Project #: 19135676  
Site Location: HWY11/12, ORILLIA  
Your C.O.C. #: n/a

**Attention: Alysha Kobylnski**

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

**Report Date: 2021/05/13**  
Report #: R6632618  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**BV LABS JOB #: C1C0782**

**Received: 2021/05/05, 15:00**

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

Email: emese.gitej@bureauveritas.com

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BUREAU  
VERITAS

BV Labs Job #: C1C0782  
Report Date: 2021/05/13

Golder Associates Ltd  
Client Project #: 19135676  
Site Location: HWY11/12, ORILLIA  
Sampler Initials: MH

### SOIL CORROSIVITY PACKAGE (SOIL)

<b>BV Labs ID</b>		PMM319	PMM320		
<b>Sampling Date</b>		2021/04/30	2021/05/03		
<b>COC Number</b>		n/a	n/a		
	<b>UNITS</b>	<b>NW2-2 SA 5 10'-12'</b>	<b>NW2-6 SA 2 2.5-4.5'</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>					
Resistivity	ohm-cm	4200	8300		7336760
<b>Inorganics</b>					
Soluble (20:1) Chloride (Cl-)	ug/g	72	<20	20	7342971
Conductivity	umho/cm	235	120	2	7343102
Available (CaCl2) pH	pH	7.95	7.72		7339224
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	20	7343008
Sulphide	mg/kg	1.3 (1)	0.9	0.5	7349124
<b>Physical Testing</b>					
Moisture-Subcontracted	%	9.4	8.5	0.30	7350534
RDL = Reportable Detection Limit					
QC Batch = Quality Control Batch					
(1) Analyzed past method specified hold time					



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## TEST SUMMARY

**BV Labs ID:** PMM319  
**Sample ID:** NW2-2 SA 5 10'-12'  
**Matrix:** Soil

**Collected:** 2021/04/30  
**Shipped:**  
**Received:** 2021/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7342971	2021/05/10	2021/05/10	Avneet Kour Sudan
Conductivity	AT	7343102	2021/05/10	2021/05/10	Amanpreet Sappal
Moisture (Subcontracted)	BAL	7350534	N/A	2021/05/10	Margarita Aguilera
Sulphide in Soil	SPEC	7349124	N/A	2021/05/09	Bailey Morrison
pH CaCl2 EXTRACT	AT	7339224	2021/05/07	2021/05/07	Neil Dassanayake
Resistivity of Soil		7336760	2021/05/11	2021/05/11	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7343008	2021/05/10	2021/05/10	Avneet Kour Sudan

**BV Labs ID:** PMM320  
**Sample ID:** NW2-6 SA 2 2.5-4.5'  
**Matrix:** Soil

**Collected:** 2021/05/03  
**Shipped:**  
**Received:** 2021/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7342971	2021/05/10	2021/05/10	Avneet Kour Sudan
Conductivity	AT	7343102	2021/05/10	2021/05/10	Amanpreet Sappal
Moisture (Subcontracted)	BAL	7350534	N/A	2021/05/10	Margarita Aguilera
Sulphide in Soil	SPEC	7349124	N/A	2021/05/09	Bailey Morrison
pH CaCl2 EXTRACT	AT	7339224	2021/05/07	2021/05/07	Neil Dassanayake
Resistivity of Soil		7336760	2021/05/11	2021/05/11	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7343008	2021/05/10	2021/05/10	Avneet Kour Sudan





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### GENERAL COMMENTS

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

Package 1	9.0°C
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Results relate only to the items tested.



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BV Labs Job #: C1C0782

Report Date: 2021/05/13

## QUALITY ASSURANCE REPORT

Golder Associates Ltd

Client Project #: 19135676

Site Location: HWY11/12, ORILLIA

Sampler Initials: MH

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7339224	Available (CaCl <sub>2</sub> ) pH	2021/05/07			100	97 - 103			1.4	N/A
7342971	Soluble (20:1) Chloride (Cl <sup>-</sup> )	2021/05/10	107	70 - 130	110	70 - 130	<20	ug/g	NC	35
7343008	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2021/05/10	NC	70 - 130	110	70 - 130	<20	ug/g	3.2	35
7343102	Conductivity	2021/05/10			103	90 - 110	<2	umho/cm	6.9	10
7349124	Sulphide	2021/05/09	92	75 - 125	82	75 - 125	<0.5	mg/kg	1.6	30
7350534	Moisture-Subcontracted	2021/05/10					<0.30	%		

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).



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Sampler Initials: MH

### VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Brad Newman, B.Sc., C.Chem., Scientific Service Specialist

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

Sandy (Wei) Yuan, M.Sc., QP, Scientific Specialist

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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	
Contact Name:	Canada Accounts Payable	Contact Name:	Alysha Kobylinski	P.O. #/ AFE#:	19135676	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS	
Address:	6925 Century Ave. Suite 100 Mississauga, ON	Address:	6925 Century Ave. Suite 100 Mississauga, ON L5N 7K2	Project #:		Rush TAT (Surcharges will be applied)	
Phone:	905-567-4444 Fax: 905-567-6561	Phone:	647-239-0174 Fax: 905-567-6561	Site Location:	Hwy 11/12, Orillia	<input type="checkbox"/> 1 Day	<input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days
Email:	canadaaccounts payableinvoices@golder.com	Email:	akobylinski@golder.com; 120052@golder.com	Site Location Province:	Ontario	Date Required:	
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY				Sampled By:	MH/ACK	Rush Confirmation #:	
<b>Regulation 153</b>		<b>Other Regulations</b>		<b>Analysis Requested</b>		<b>LABORATORY USE ONLY</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 _____ FOR RSC (PLEASE CIRCLE) Y / N		<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWQO Region _____ <input type="checkbox"/> Other (Specify) _____ <input type="checkbox"/> REG 558 (MIN: 3 DAY TAT REQUIRED) <input type="checkbox"/> REG 406 Table _____		# OF CONTAINERS SUBMITTED FIELD FILTERED (CIRCLE) Metals / kg / cvl Corrosivity pkg (Cl, SO4, pH, EC/Resistivity and Sulphide)		CUSTODY SEAL Y / <input checked="" type="checkbox"/> N Present Intact COOLER TEMPERATURES 9/9/9 COOLING MEDIA PRESENT: Y / <input checked="" type="checkbox"/> 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			
1	NW2-2 SA 5 10'-12'	2021-04-30	PM	SOIL	2	X	
2	NW2-6 SA 2 2.5'-4.5'	2021-05-03	PM	SOIL	2	X	
3							
4							
5							
6							
7							
8							
9							
10							
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)
		2021-05-05		Pm/HSEANGET RODRIG		2021-05-05	15:00

MSA with BV Signed May 18, 2020 Rate from Ema Gitej email dated April 21, 2021 The short Corrosivity pkg which includes (pH, Cl, SO4, EC/Resistivity) is \$46.40/sample Sulphide analyzed at BV Burnaby is \$52.20/sample

05-May-21 15:00  
Ema Gitej  
C1C0782  
ATM ENV-1421

**APPENDIX D**

# Special Provisions

## 5 m NOISE BARRIER SYSTEM

Special Provision No. 760F01

March 2018

### **Amendment to OPSS 760, November 2014**

#### **760.03 DEFINITIONS**

Section 760.03 of OPSS 760 is amended by the deletion of the definitions for **Certificate of Conformance** and **Quality Verification Engineer**.

#### **760.04 DESIGN AND SUBMISSION REQUIREMENTS**

##### **760.04.01 Design Requirements**

##### **760.04.01.01 Footings**

##### **760.04.01.01.01 General**

Clause 760.04.01.01.01 of OPSS 760 is amended by the addition of the following paragraph:

The soil design parameters for the design of footings shall be as specified in Table A:

**Table A – Soil Design Parameters**

<b>Location</b>	<b><math>s_u</math> (kPa)</b>	<b><math>n_h</math> (kPa/m)</b>	<b><math>\phi'</math> (°)</b>	<b><math>\gamma</math> (kN/m<sup>3</sup>)</b>	<b><math>\gamma'</math> (kN/m<sup>3</sup>)</b>	<b><math>K_o</math> <sup>8</sup></b>	<b><math>K_a</math> <sup>8</sup></b>	<b><math>K_p</math> <sup>5,6,7,8</sup></b>
Noise Wall 2 – Western Portion	-	12,000	30	20	10	0.50	0.33	3.00
Noise Wall 2 – Middle Portion	50	--	28	19	9	0.53	0.36	2.77
Noise Wall 2 – Eastern Portion	50	--	28	19	9	0.53	0.36	2.77
<b>Where:</b> $s_u$ = undrained shear strength (kPa) $n_h$ = coefficient related to soil density (kPa/m) $\phi'$ = effective (drained) friction angle (°) $K_a$ = active earth pressure coefficient $K_p$ = passive earth pressure coefficient $K_o$ = earth pressure coefficient at rest $\gamma$ = bulk unit weight (kN/m <sup>3</sup> ) $\gamma'$ = effective unit weight (below the groundwater level) (kN/m <sup>3</sup> )								

Subsection 760.04.01 of OPSS 760 is amended by the addition of the following clauses:

**760.04.01.02                      Wind Load**

The wind load applied for the design of structure shall be: \_\_\_\_\_.

**760.04.01.03                      Acoustics**

The minimum acoustical characteristic of the noise barrier system shall be such that the noise barrier is: \_\_\_\_\_.

**760.04.01.04                      Aesthetics**

The colour and texture for the noise barrier system shall be within the following parameters:

Number of colours adjacent to highway: \_\_\_\_\_

   in the proportion of \_\_\_\_\_

Number of textures: \_\_\_\_\_

   in the proportion of \_\_\_\_\_

Number of colours adjacent to residential property: \_\_\_\_\_

   in the proportion of \_\_\_\_\_

Number of textures: \_\_\_\_\_

   in the proportion of \_\_\_\_\_

Final colour selections shall be determined by the Contract Administrator at the point of manufacture from samples prepared by the manufacturer.

If only one colour and texture are specified, the noise barrier shall be constructed using the colour and texture specified by the Contract Administrator following the award of the Contract. Final colour selection shall be determined at the point of manufacture from samples prepared by the manufacturer.

**760.07                                      CONSTRUCTION**

**760.07.13                              Quality Control**

**760.07.13.01                      Interim Inspection of Footings and Posts**

Clause 760.07.13.01 of OPSS 760 is deleted in its entirety and replaced with the following:

**760.07.13.01                      Inspection before Installation of Noise Barrier Panels**

A Request to Proceed shall be submitted to the Contract Administrator after the construction of the noise barrier footings and posts and prior to the installation of the noise barrier panels

The installation of the noise barrier panels shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

**760.07.13.02                      Certificate of Conformance**

Clause 760.07.13.02 of OPSS 760 is deleted in its entirety and replaced by the following:

**760.07.13.02                      Inspection after Installation of Noise Barrier System**

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the installation of the noise barrier system.



