



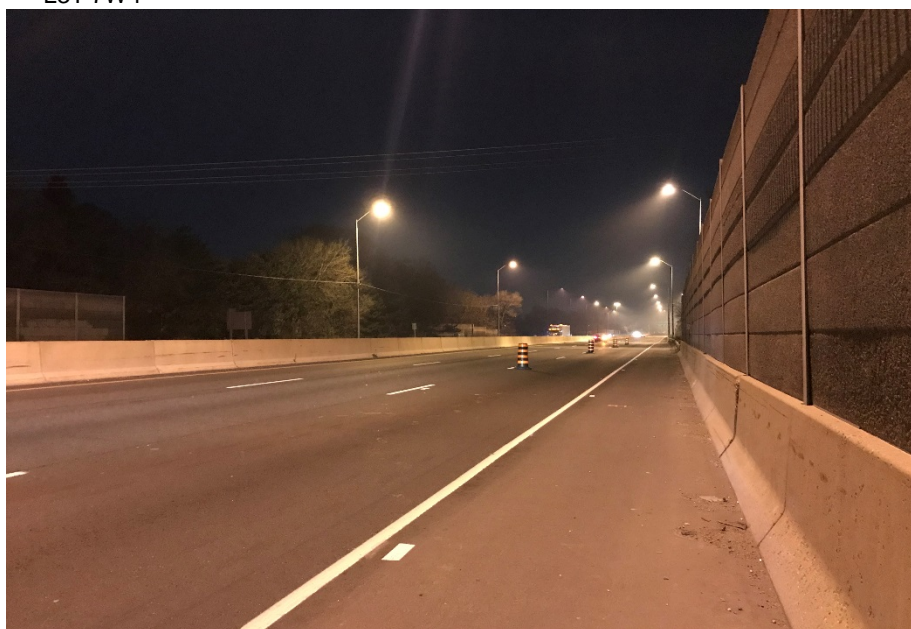
April 25, 2018

## FOUNDATION INVESTIGATION REPORT

### NORTH-SOUTH ACTIVE TRANSPORT CROSSING STRUCTURE OVER QEW QEW WIDENING FROM WEST OF MISSISSAUGA ROAD TO WEST OF HURONTARIO STREET CITY OF MISSISSAUGA MINISTRY OF TRANSPORTATION, ONTARIO ASSIGNMENT NO. 2015-E-0033, GWP 2002-13-00

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REPORT



## Table of Contents

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION.....</b>	<b>1</b>
<b>3.0 INVESTIGATION PROCEDURES .....</b>	<b>1</b>
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS .....</b>	<b>3</b>
4.1 Regional Geology .....	3
4.2 Subsurface Conditions.....	4
4.2.1 Asphalt.....	4
4.2.2 Topsoil .....	4
4.2.3 Non-Cohesive Fill.....	4
4.2.4 Cohesive Fill .....	5
4.2.5 Silty Sand to Silt and Sand to Sand .....	5
4.2.6 Clayey Silt to Silty Clay .....	5
4.2.7 Clayey Silt to Clayey Silt with Sand (Till) .....	6
4.2.8 Silt.....	6
4.2.9 Sand and Gravel to Gravel.....	6
4.2.10 Residual Soil .....	7
4.2.11 Bedrock.....	7
4.2.12 Groundwater Conditions .....	9
4.2.13 Analytical Testing Results.....	10
<b>5.0 CLOSURE .....</b>	<b>10</b>

### DRAWINGS

Drawing 1	Borehole Locations
Drawing 2	Soil Strata
Drawing 3	Soil Strata

### APPENDICES

#### Appendix A Record of Boreholes Sheets

Lists of Symbols and Abbreviations

Lithological and Geotechnical Rock Description Terminology

Record of Boreholes PED-01 to PED-05, PED-03A, PED-03B, NW3-01, NW3-02, NW3-02A

Record of Drillholes PED-01, PED-03B, PED-04, PED-05, NW3-01



**Appendix B**

**Laboratory Test Results, Bedrock Core Photographs – Current Investigation**

Figure B1A	Grain Size Distribution - Silt and Sand to Gravelly Silty Sand (Fill)
Figure B1B	Grain Size Distribution - Silty Sand to Sand and Gravel (Fill)
Figure B2	Plasticity Chart - Clayey Silt (Fill)
Figure B3	Grain Size Distribution - Silty Sand to Sand
Figure B3B	Grain Size Distribution - Silt and Sand
Figure B4	Grain Size Distribution - Sandy Clayey Silt
Figure B5	Plasticity Chart - Clayey Silt to Silty Clay
Figure B6A/B6B	Grain Size Distribution - Clayey Silt (Till)
Figure B7A/B7B	Plasticity Chart - Clayey Silt (Till)
Figure B8	Grain Size Distribution - Silt
Figure B9	Plasticity Chart - Silt
Figure B10	Grain Size Distribution - Sand and Gravel
Figure B11	Plasticity Chart - Clayey Silt (Residual Soil)
Figure B12	Bedrock Core Photographs – Boreholes PED-01 and NW3-01
Figure B13	Bedrock Core Photographs – Boreholes PED-03B to PED-05

Rock Laboratory Testing Results Reports dated January 3, 2018 – Geomechanica Inc.

Certificates of Analysis – Chemical Test Results



## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the widening of the Queen Elizabeth Way (QEW) from west of Mississauga Road to west of Hurontario Street in the City of Mississauga, in the Regional Municipality of Peel, Ontario.

The purpose of this investigation is to establish the subsurface soil and bedrock conditions at the location of the proposed North-South Active Transport Crossing (pedestrian bridge) structure crossing the Queen Elisabeth way by borehole drilling, rock coring and laboratory testing on selected soil and rock core samples.

The Terms of Reference (TOR) and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated July 2016, which forms part of the Consultant's Assignment Number (Number 2015-E-0033) for this project. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated February 3, 2017.

## **2.0 SITE DESCRIPTION**

The proposed pedestrian bridge will span across the QEW, joining the ends of Stavebank Road approximately 800 m northeast of the Mississauga Road and QEW Interchange in the City of Mississauga (refer to Key Plan on Drawing 1). The QEW alignment in the project area is oriented generally in a southwest-northeast direction; for the purposes of this report, the direction of east-west along the QEW has been assumed.

Land use is primarily residential in the vicinity of the proposed pedestrian bridge. The current grade of the QEW at the proposed bridge is at about Elevation 95.2 m and the existing ground surface in the area surrounding the pedestrian bridge is at between about Elevations 93 m to 95 m, generally sloping downward toward the Credit River which is located about 250 m west of the proposed bridge location.

## **3.0 INVESTIGATION PROCEDURES**

The field work for this foundation investigation was carried out between August 17 and December 4, 2017 during which time seven sampled boreholes (designated as Boreholes PED-01 to PED-05, NW3-01 and NW3-02) were advanced in the area of the structure, at the locations shown on Drawing 1. Additional boreholes were advanced in the vicinity of boreholes PED-03 and NW3-02 (i.e. Boreholes PED-03B and NW3-02A) to extend the boreholes to a greater depth as the original boreholes were terminated at a shallower depth due to time constraints; an additional borehole (i.e. Borehole PED-03A) was advanced in the vicinity of Borehole PED-03 to install a standpipe piezometer to allow for monitoring of the groundwater level at that location. The Record of Borehole/Drillhole sheets are presented in Appendix A.

The field borehole investigation was carried out using truck-mounted CME 75 and CME 55 drill rigs and a track-mounted CME 850 drill rig, supplied and operated by Aardvark Drilling Inc. of Guelph, Ontario. The boreholes were advanced through the overburden using 203 mm or 210 mm outside diameter (O.D.) hollow stem augers, HQ casing, or 156 mm diameter tricone drill bit as indicated on the Record of Borehole sheets. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm outer diameter (O.D.) split-spoon sampler driven



by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-08)<sup>1</sup>. In the boreholes where bedrock was encountered, samples of the bedrock were obtained using an 'HQ' size rock core barrel and coring techniques.

The primary boreholes were advanced to depths of between about 10.8 m and 27.6 m below existing ground surface, including coring of bedrock for core lengths between 3.0 m and 3.6 m in some of the boreholes; and the standpipe piezometer borehole was advanced to a depth of 6.1 m below ground surface.

The water levels in the open boreholes and field moisture content of the recovered soil samples were observed during the drilling operations and are noted on the borehole records in Appendix A. A piezometer was installed in Borehole PED-03A to monitor the groundwater level at the site. The piezometer consists of 50 mm diameter PVC pipe, with a slotted screen sealed at a select depth within the fill deposit. The borehole and annulus surrounding the piezometer pipe above the screen sand pack was backfilled to the ground surface with bentonite pellets. Piezometer installation details and water level readings are described on the Record of Borehole sheets presented following the text of the report. The remaining boreholes were backfilled to ground surface with Bentonite pellets/grout in accordance with Ontario Regulation 903 (as amended).

The field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and bedrock core samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples. A uniaxial unconfined compression (UCS) strength test, Young's modulus and core density determination were carried out on a selected specimen of the bedrock core samples by Geomechanica Inc., on behalf of Golder. The results of the laboratory testing are included in Appendix B.

Selected soil samples were submitted to Maxxam Analytics (Maxxam), a Standards Council of Canada (SCC) accredited laboratory in Mississauga, Ontario for chemical analysis. The soil samples were analyzed for a suite of corrosivity parameters, including conductivity, resistivity, soluble chloride, soluble sulphate and pH. The results of the chemical analyses are presented in Appendix B and discussed in Section 4.2.13.

The as-drilled borehole locations and the ground surface elevations were obtained using a GPS (Trimble XH 3.5G), having an accuracy of 0.1 m in the vertical and 0.1 m in the horizontal directions. The locations given in the Record of Borehole/Drillhole sheets and shown on Drawing 1 to 3 are positioned relative to MTM NAD 83 (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and drilled depths are summarized below.

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<sup>1</sup> ASTM D1586-08a – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the soil.



**FOUNDATION REPORT – NORTH-SOUTH ACTIVE TRANSPORT  
CROSSING STRUCTURE  
GWP 2002-13-00**

Borehole No.	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (Latitude, °)	Easting (Longitude, °)		
PED-01	4,824,314.1 (43.558703)	295,977.3 (-79.609205)	96.3	25.4*
PED-02	4,824,321.8 (43.558773)	296,032.3 (-79.608524)	95.2	16.7
PED-03	4,824,305.3 (43.558625)	296,063.0 (-79.608144)	93.7	13.8
PED-03A	4,824,308.4 (43.558653)	296,062.1 (-79.608155)	94.1	6.1
PED-03B	4,824,309.6 (43.558664)	296,062.8 (-79.608146)	94.1	17.8*
PED-04	4,824,288.0 (43.558469)	296,068.1 (-79.608081)	93.0	13.5*
PED-05	4,824,275.4 (43.558356)	296,047.1 (-79.608341)	94.4	13.7*
NW3-01	4,824,275.8 (43.558358)	295,959.8 (-79.609422)	96.5	15.4*
NW3-02	4,824,342.4 (43.558958)	295,994.3 (-79.608996)	95.3	10.8
NW3-02A	4,824,344.2 (43.558975)	295,993.8 (-79.609002)	95.3	27.6

\* includes bedrock core between 3.0 m and 3.6 m length

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

The project area is located within the Iroquois Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putman, 1984)<sup>2</sup>.

The glacial Iroquois Plain stretches along the northern shoreline of Lake Ontario, extending from the Niagara Escarpment in the west to the Scarborough Bluffs in the east. The Iroquois Plain soils consist of glaciolacustrine sediments deposited in Lake Iroquois, primarily sands, silts and gravels, with a shallow cover of till remaining over the bedrock.

Bedrock of the Georgian Bay Formation underlies the study area and consists mainly of blue-grey shale, containing siltstone, sandstone and limestone interbeds. Outcrops of this formation are commonly found along water courses on the west side of Toronto and in Mississauga, notably in the Humber River, Mimico Creek, Etobicoke Creek and Credit River valleys.

<sup>2</sup> Chapman, L.J. and Putman, D.F., 1984, *The Physiography of Southern Ontario*, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.)





## **4.2 Subsurface Conditions**

The detailed subsurface soil, bedrock and groundwater conditions as encountered in the boreholes advanced during the foundation investigation and the results of the laboratory tests carried out on selected soil and bedrock core samples are presented on the Record of Borehole and Drillhole sheets provided in Appendix A. The results of the in situ field tests (i.e. SPT “N” values) as presented on the Record of Borehole sheets and in sub sections of Section 4.2 are uncorrected. The geotechnical laboratory testing plots are contained in Appendix B.

The stratigraphic boundaries shown on the Record of Borehole sheets and on the stratigraphic profiles on Drawings 2 and 3 are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations; however, the factual data presented in the record of Borehole and Drillhole sheets governs any interpretation of the site conditions. It should be noted that the interpreted stratigraphy shown on Drawings 2 and 3 is a simplification of the subsurface conditions.

In general, the subsurface conditions in the area of the proposed pedestrian bridge consist of a layer of asphalt or topsoil underlain by a deposit of granular fill associated with the construction of the existing QEW highway and Premium Way. The fill is underlain by deposits of silt and sand, underlain by deposits of clayey silt to silty clay in some locations. The fill deposits and near surface native deposits are underlain by a deposit of clayey silt till, which is underlain in some locations by deposits of silty sand to sand and gravel or residual soil. The native deposits are underlain by shale bedrock.

A detailed description of the subsurface conditions encountered in the boreholes from the foundation investigations are provided in the following sections.

### **4.2.1 Asphalt**

Boreholes NW3-02 and PED-01 were advanced within the travelled lanes of Premium Way and encountered a 150 mm thick layer of asphalt. Borehole PED-02 was advanced through the QEW shoulder and encountered a 100 mm thick layer of asphalt.

### **4.2.2 Topsoil**

Boreholes NW3-01 and PED-3 to PED-05 were advanced outside of the QEW and Premium Way roadway surfaces and encountered a topsoil layer between 50 mm and 200 mm thick at the ground surface.

### **4.2.3 Non-Cohesive Fill**

A 1.3 m to 7.0 m thick layer of non-cohesive fill was encountered underlying the asphalt or topsoil in all the boreholes advanced at the site. The fill is variable in composition and generally consists of silt and sand to silty sand to sand to sand and gravel containing trace amounts of clay, organics and rootlets, asphalt fragments and silty clay to clayey silt pockets at some borehole locations. Auger grinding on possible cobbles and/or boulders was observed in Borehole PED-03 as noted on the Record of Borehole sheet. A 1.1 m thick deposit of sandy clayey silt fill (described below) was encountered within the non-cohesive fill in Borehole NW3-02. The surface of the fill deposit was encountered between about Elevations 96.3 m and 92.8 m and extends to depths of between about 1.5 m and 7.2 m below ground surface.

The SPT “N” values measured within the non-cohesive fill range from 2 blows to 34 blows per 0.3 m of penetration, indicating that the fill layer has a loose to dense relative density.



Grain size distribution tests were carried out on ten samples of the non-cohesive fill material and the results are shown on Figures B1A and B1B in Appendix B. The water content measured on twenty five samples of the non-cohesive fill ranges between about 1 per cent and 28 per cent. The organic content measured on one sample of the non-cohesive fill from Borehole PED-05 is 1.2 per cent.

#### **4.2.4 Cohesive Fill**

In Borehole NW3-02, a 1.1 m thick cohesive fill deposit consisting of sandy clayey silt containing trace to some gravel, was encountered within the non-cohesive fill deposit at a depth of 2.6 m below ground surface (Elevation 92.7 m).

Two SPT “N” values measured within the cohesive deposit are 14 blows and 29 blows per 0.3 m of penetration, suggesting that the cohesive fill deposit has a stiff to very stiff consistency.

An Atterberg limits test carried out on one sample of the deposit measured a liquid limit of 24 per cent, a plastic limit of 13 per cent, and a plasticity index of 11 per cent; the result of the Atterberg limit test is shown on Figure B2 in Appendix B and indicates that the deposit consists of clayey silt of low plasticity.

The natural water content measured on two samples of the cohesive deposit are 11 per cent and 16 per cent.

#### **4.2.5 Silty Sand to Silt and Sand to Sand**

A 0.5 m to 9.6 m thick deposit of silty sand to silt and sand to sand some silt was encountered underlying the fill in Boreholes NW3-01 and PED-05, underlying the sand and gravel to gravel deposits in Borehole PED-02 (described below) and underlying the clayey silt till (described below) in Boreholes NW3-02A and PED-01. The surface of the deposit was encountered between 1.5 m and 20.3 m below ground surface (Elevations 95.0 m to 75.0 m) and the deposit extends to depths between 4.2 m and 21.6 m below ground surface.

The SPT “N” values measured within the sand deposit range between 17 blows per 0.3 m of penetration and 121 blows for 0.13 m of penetration, and one value of 100 blows for 0.13 m of penetration, indicating that the silt and sand to silty sand to sand deposit has a compact to very dense relative density.

The results of seven grain size distribution tests carried out on selected samples of the deposit are shown on Figures B3A and B3B in Appendix B.

The natural water content measured on four samples of the sand deposit are between 18 per cent and 23 per cent.

#### **4.2.6 Clayey Silt to Silty Clay**

A 0.2 m to 1.9 m thick cohesive deposit ranging in composition from sandy clayey silt to clayey silt to silty clay containing trace to some sand and trace to some gravel, was encountered underlying the fill In Borehole PED-01, underlying the silt and sand deposits in Boreholes NW3-01 and PED-05 and underlying the silt deposit in PED-04 at depths between 3.7 m and 7.2 m below ground surface (between Elevations 90.7 m and 89.3 m).

The SPT “N” values measured within the cohesive deposit range between 4 blows and 9 blows per 0.3 m of penetration, suggesting that the cohesive deposit has a firm to stiff consistency.

A grain size distribution test was carried out on a selected sample of the sandy clayey silt deposit from Borehole PED-04 and the result is shown on Figure B4 in Appendix B. Atterberg limits tests were carried out on three samples of this deposit and measured liquid limits between 24 per cent and 36 per cent, plastic limits between 14 per cent and 16 per cent, and plasticity indices between 9 per cent and 20 per cent. The results of the Atterberg





Limits tests are shown on Figure B5 in Appendix B and indicate that the deposit is a clayey silt of low plasticity to silty clay of medium plasticity.

The natural water content measured on four samples of the cohesive deposit are between 20 per cent and 32 per cent.

#### **4.2.7 Clayey Silt to Clayey Silt with Sand (Till)**

In all of the boreholes at this site a 1.4 m to 13.1 m thick cohesive till deposit ranging in composition from clayey silt to clayey silt with sand, trace gravel to gravelly, was encountered underlying the fill, silt and sand, and cohesive deposits (where present) at depths between 5.6 m and 8.7 m below ground surface (between Elevations 89.1 m and 87.4 m). Grinding of the augers on possible cobbles and/or boulders was observed during drilling at Borehole PED-03 at a depth of about 12.9 m below ground surface, as noted on the Record of Borehole sheet.

The SPT “N” values measured within the cohesive till deposit range between 1 blow per 0.3 m of penetration and 100 blows for 0.03 m of penetration, and up to about 131 blows per 0.08 m of penetration, suggesting that the cohesive till deposit has a very soft to hard (but generally hard) consistency.

The results of eleven grain size distribution tests carried out on selected samples of the cohesive till deposit are shown on Figures B6A and B6B in Appendix B. Atterberg limits tests were carried out on eleven samples of this deposit and measured liquid limits between 19 per cent and 30 per cent, plastic limits between 13 per cent and 22 per cent, and plasticity indices between 6 per cent and 14 per cent. These results, which are plotted on a plasticity chart on Figures B7A and B7B in Appendix B indicate that the till deposit consists of clayey silt of low plasticity.

The natural water content measured on samples of the cohesive till deposit range from 7 per cent to 99 per cent.

#### **4.2.8 Silt**

A 0.6 m to 1.5 m thick silt deposit or pockets, containing trace to some sand and trace to some clay was encountered underlying the silty sand deposit in Borehole NW3-02A, underlying the fill deposit in Borehole PED-04, underlying the clayey silt deposit in Borehole PED-05 and interlayered within the clayey silt till deposit in Borehole PED-03B at depths between 2.2 m and 21.9 m below ground surface (between Elevations 90.8 m and 73.7 m).

The SPT “N” values measured within the silt deposit range between 7 blows and 46 blows per 0.3 m of penetration and up to 100 blows for 0.18 m of penetration in places, suggesting that the deposit has a loose to dense/very dense relative density.

The results of grain size distribution tests carried out on two samples of the silt deposit are shown on Figure B8 in Appendix B. Atterberg limits tests were carried out on two samples of this deposit and measured liquid limits of 19 per cent, plastic limits of 16 per cent and 17 per cent, and plasticity indices of 2 per cent and 3 per cent. These results, which are plotted on a plasticity chart on Figure B9 in Appendix B indicate that the deposit consists of silt of slight plasticity.

The natural water content measured on four samples of the sand deposit are between 18 per cent and 23 per cent.

#### **4.2.9 Sand and Gravel to Gravel**

A 1.0 m to 5.4 m thick deposit of sand and gravel to gravel was encountered underlying the fill in Borehole PED-02, underlying the sand deposit in Borehole PED-01 and underlying the silt deposit in Borehole NW3-02A. The surface of the deposit was encountered at depths between 3.7 m and 22.2 m below ground surface (Elevations



91.5 m to 73.1 m) and the deposit extends to depths between 6.5 m and 22.3 m below ground surface in the boreholes where it was fully penetrated; Borehole NW3-02A was terminated within this deposit at a depth of 27.6 m below ground surface (Elevation 67.7 m).

The SPT “N” values measured within the sand and gravel to gravel deposit range between 5 blows and 70 blows per 0.3 m of penetration and up to 100 blows for 0.05 m of penetration in places, indicating that the deposit has a loose to very dense relative density.

The results of two grain size distribution tests carried out on selected samples of the deposit are shown on Figure B10 in Appendix B.

The natural water content measured on samples of the sand and gravel to gravel deposit are between 7 per cent and 22 per cent.

#### **4.2.10 Residual Soil**

Underlying the clayey silt till deposit in Boreholes NW3-01, PED-02, PED-04 and PED-05, a 0.6 m to 2.0 m thick deposit of residual soil was encountered at depths between 8.7 m and 16.1 m below ground surface (between Elevations 86.4 m to 79.1 m).

The SPT “N” values measured within the residual soil deposit range between 54 blows per 0.3 m of penetration and 100 blows for 0.05 m of penetration, suggesting a hard consistency.

The deposit consists of sandy, gravelly, clayey silt and contains trace shale fragments, derived from weathering of the underlying shale bedrock. An Atterberg limits test was carried out on a select sample of the residual soil deposit and measured a liquid limit of 20 per cent, a plastic limit of 14 per cent and a corresponding plasticity index of 6 per cent. This result, which is plotted on a plasticity chart on Figure B11 in Appendix B, indicates that the residual soil deposit can be classified as a clayey silt of low plasticity.

The water content measured on three samples of the residual soil deposit is between 7 per cent and 16 per cent.

#### **4.2.11 Bedrock**

Bedrock was encountered and core samples were recovered in Boreholes NW3-01, PED-04, PED-05, PED-01 and PED-03B and the bedrock surface was inferred from split-spoon sampling in Borehole PED-02. The depths to bedrock below ground surface, and the corresponding bedrock surface elevation are summarized below.

<b>Foundation Element</b>	<b>Borehole</b>	<b>Depth to Bedrock Surface (m)</b>	<b>Bedrock Surface Elevation (m)</b>	<b>Comments</b>
North Ramp Abutment and Pier 1	NW3-01	11.8	84.7	Bedrock Cored
North Ramp Pier 2 to 4	PED-01	22.3	74.0	Bedrock Cored
North Ramp Pier 5 and 6	NW3-02 / NW3-02A	--	--	Not encountered
Center Pier	PED-02	16.7	78.5	Split Spoon Sample
South Ramp Pier 9 and 17	PED-03 / PED-03B	14.8	79.3	Bedrock Cored



**FOUNDATION REPORT – NORTH-SOUTH ACTIVE TRANSPORT  
CROSSING STRUCTURE  
GWP 2002-13-00**

Foundation Element	Borehole	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Comments
South Ramp Pier 11, 12, 15 and 16	PED-04	10.4	82.6	Bedrock Cored
South Ramp Pier 10 and 13	PED-05	10.7	83.7	Bedrock Cored

In general, the bedrock surface as encountered or inferred in the area of the proposed pedestrian bridge structure slopes down toward the north and east.

Based on a review of the bedrock core samples the bedrock consists of shale of the Georgian Bay Formation. In general, the bedrock samples are described as slightly weathered to fresh, thinly laminated to medium bedded, fine grained, slightly porous to non-porous, very weak to weak, grey, with medium strong limestone interbeds at varying intervals, as presented on the Record of Drillhole sheets in Appendix A, and shown on the photographs of the recovered core samples on Figures B12 and B13 in Appendix B. The degree of weathering of the bedrock samples (i.e. fresh to moderately weathered – W1 to W3), and the strength classification of the intact rock mass based on field identification (i.e. strong to very strong – R4 to R5) are described in accordance with the International Society for Rock Mechanics (ISRM)<sup>3</sup> standard classification system.

The Rock Quality Designation (RQD) measured on the core samples range from about 38 per cent to 100 per cent, indicating a rock mass of poor to excellent quality as per Table 3.10 of CFEM (2006)<sup>4</sup>. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are between 55 per cent and 100 per cent and between 0 per cent and 100 per cent, respectively.

An Unconfined Compression (UC) test (ASTM D7012)<sup>5</sup> was carried out on a selected core sample of the shale bedrock obtained in Borehole PED-03B and measured a compressive strength of about 6.7 MPa, as presented on the Rock Laboratory test Result reports from Geomechanica in Appendix B. The Young's modulus is 290 MPa and the bulk density is 2.57 g/cm<sup>3</sup>.

Point Load tests were carried out on 18 samples of the shale bedrock, and the results are summarized below:

Borehole No.	Sample Depth (m)	Sample Elevation (m)	Orientation	Axial Is (50 mm) (MPa)	Approximate Unconfined Compressive Strength (MPa) <sup>1</sup>
PED-04	10.77	82.22	Axial	0.461	7
PED-04	10.77	82.22	Diametral	0.314	5
PED-04	11.47	81.52	Axial	0.430	6
PED-04	11.47	81.52	Diametral	0.434	6

<sup>3</sup> International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

<sup>4</sup> Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual (CFEM), 4<sup>th</sup> Edition. The Canadian Geotechnical Society, BiTech Published Ltd., British Columbia.

<sup>5</sup> ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens



**FOUNDATION REPORT – NORTH-SOUTH ACTIVE TRANSPORT  
CROSSING STRUCTURE  
GWP 2002-13-00**

Borehole No.	Sample Depth (m)	Sample Elevation (m)	Orientation	Axial Is (50 mm) (MPa)	Approximate Unconfined Compressive Strength (MPa) <sup>1</sup>
PED-04	12.41	80.58	Axial	0.584	9
PED-04	12.41	80.58	Diametral	0.189	3
PED-05	11.28	83.15	Axial	0.504	7
PED-05	11.28	83.15	Diametral	0.452	7
PED-05	11.83	82.60	Axial	0.753	11
PED-05	11.83	82.60	Diametral	0.286	4
PED-05	13.19	81.24	Axial	0.722	11
PED-05	13.19	81.24	Diametral	0.589	9
NW3-01	12.41	84.09	Axial	0.560	8
NW3-01	12.41	84.09	Diametral	0.172	3
NW3-01	13.20	83.30	Axial	0.418	6
NW3-01	13.20	83.30	Diametral	0.429	6
NW3-01	14.54	81.96	Axial	0.434	6
NW3-01	14.54	81.96	Diametral	0.429	6

The estimated uniaxial compressive strength (UCS) values for each sample tested for point load strength are based on a relationship between  $Is_{50}$  and UCS which is given by a correlation factor (C) in accordance with ASTM D5731-08 (*Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification*), which may vary depending on the size of the core sample and the strength of the rock. For this site, the UCS values are based on an estimated average correlation factor (C) of 14.8 calculated from the average  $Is_{50}$  compared to the result of the UCS test.

Based on the laboratory UCS and point load tests, in accordance with Table 3.5 in CFEM (2006)<sup>4</sup>, the shale bedrock is classified as very weak (R1, 1 MPa < UCS < 5 MPa) to weak (R2, 5 MPa < UCS < 25 MPa).

#### 4.2.12 Groundwater Conditions

The overburden samples obtained from the borehole investigations were generally moist to wet. The depths to the water level observed in the two boreholes upon completion of drilling and prior to rock coring varied between about 3.4 m and 4.5 m below ground surface (at about Elevations 91.9 m and 92.0 m, respectively) to dry at depths of up to 22.3 m below ground surface (Elevation 74.0 m). A standpipe piezometer was installed in Borehole PED-03A to monitor the groundwater level at the site. Details of the piezometer installation are shown on the Record of Borehole sheet in Appendix A. A summary of the water levels recorded in the piezometer is presented below.

Borehole	Stratum Sealed Into	Water Level Depth (m)	Water Elevation (m)	Date
PED-03A	Sand and silt to silty sand (FILL)	Dry	--	Oct. 27, 2017 (on completion)
		4.3	89.8	Nov. 14, 2017
		4.4	89.7	Nov. 21, 2017
		4.4	89.7	Nov. 28, 2017



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CROSSING STRUCTURE  
GWP 2002-13-00**

It should be noted that the groundwater level in the area is subject to seasonal fluctuations and precipitation events, and should be expected to be higher during wet periods of the year.

#### **4.2.13 Analytical Testing Results**

As discussed in Section 3.0, five soil samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil and bedrock to steel and concrete. Detailed analytical test results are included in Appendix C and the following table summarizes the results of the testing:

Parameter	Borehole NW3-01 Sample 7 (Elev. 91.6 m)	Borehole PED-03 Sample 8 (Elev. 87.3 m)	Borehole PED-02 Sample 13 (Elev. 81.5 m)	Borehole NW3-02A Sample 12 (Elev. 70.6 m)	Borehole NW3-02A Sample 2 (Elev. 82.0 m)
pH	7.86	7.73	7.84	7.93	7.70
Resistivity (ohm-cm)	490	1300	1900	3500	2000
Electrical Conductivity (umho/cm)	2040	762	522	284	494
Chlorides (ug/g)	1000	350	210	38	78
Soluble Sulphates (ug/g)	69	70	95	120	330

## **5.0 CLOSURE**

This report was prepared by Mr. Matthew Kelly, P.Eng., a geotechnical engineer with Golder. Mr. Jorge Costa, P.Eng., a Designated MTO Foundations Contact for Golder and Senior Consultant conducted a technical and quality control review of the report.

### **GOLDER ASSOCIATES LTD.**



Matthew Kelly, P. Eng.  
Geotechnical Engineer

MWK/JMAC/sm



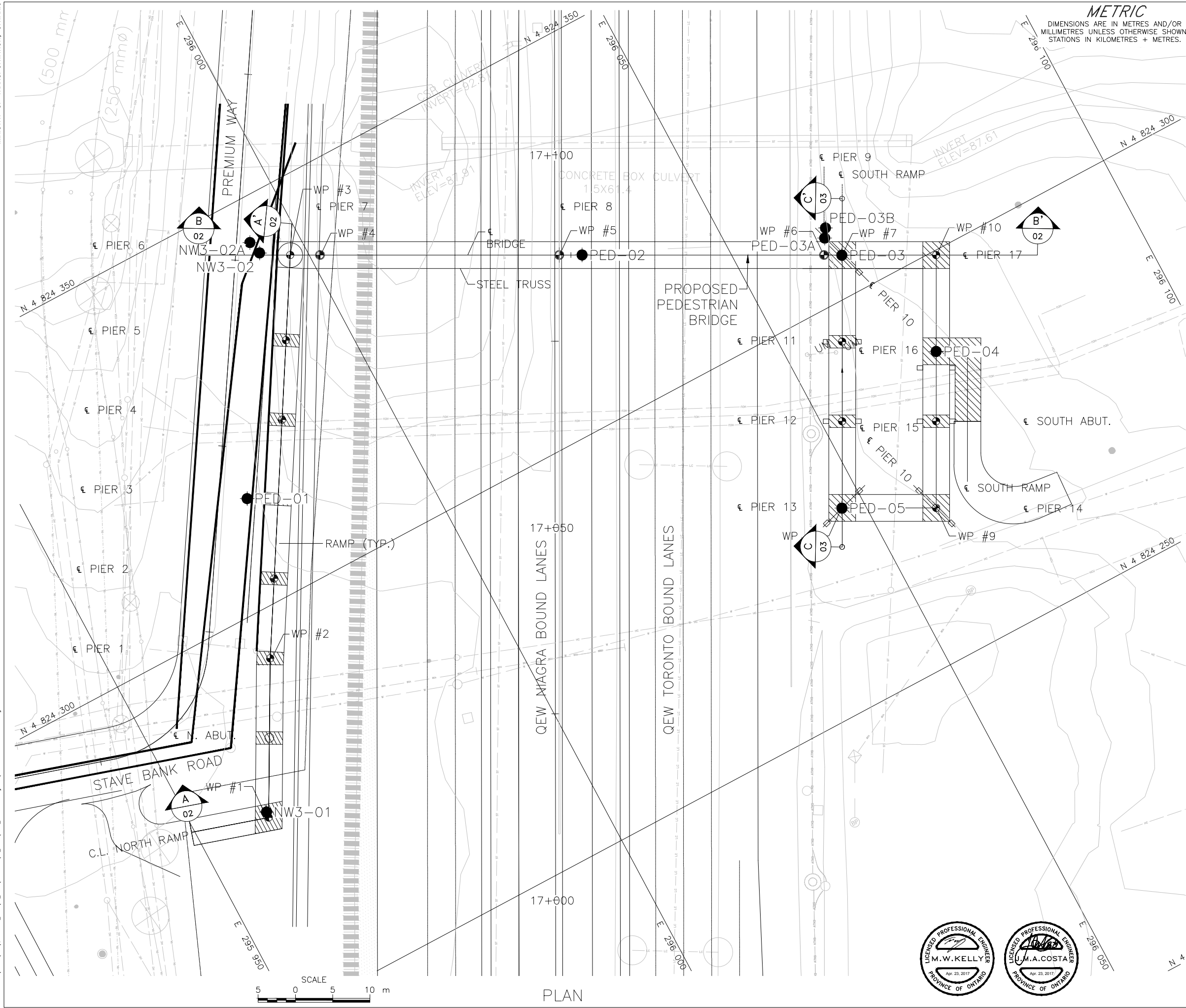
Jorge M. A. Costa, P.Eng.  
Designated MTO Foundations Contact, Senior Consultant

[https://golderassociates.sharepoint.com/sites/11176g/shared documents/07-reporting/foundations/pedestrian bridge - at crossing/final/1662333 18apr20 fidr - ped bridge.docx](https://golderassociates.sharepoint.com/sites/11176g/shared%20documents/07-reporting/foundations/pedestrian%20bridge%20-%20at%20crossing/final/1662333%2018apr20%20fidr%20-%20ped%20bridge.docx)



# **DRAWINGS**



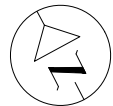


**METRIC**

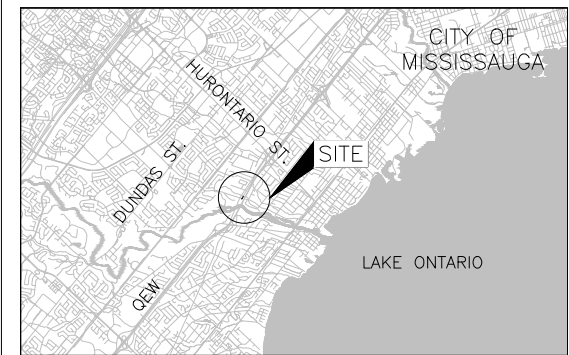
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No.  
GWP No.2002-13-00

QEW NORTH - SOUTH ACTIVE  
TRANSPORT CROSSING STRUCTURE  
BOREHOLE LOCATIONS



SHEET



KEY PLAN

SCALE

2 0 2 4 km



LEGEND

● Borehole - Current Investigation

BOREHOLE CO-ORDINATES

No.	ELEVATION (m)	NORTHING	EASTING
NW3-01	96.5	4824275.8	295959.8
NW3-02	95.3	4824342.4	295994.3
NW3-02A	95.3	4824344.2	295993.8
PED-01	96.3	4824314.1	295977.3
PED-02	95.2	4824321.8	296032.3
PED-03	93.7	4824305.3	296063.0
PED-03A	94.1	4824308.4	296062.1
PED-03B	94.1	4824309.6	296062.8
PED-04	93.0	4824288.0	296068.1
PED-05	94.4	4824275.4	296047.1

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.

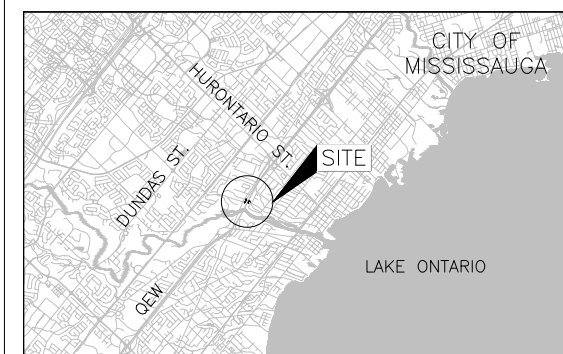
REFERENCE

Base plans provided in digital format by Morrison Hershfield, drawing file P7733-117404-8, dated April 27, 2017, received April 27, 2016.

NO.	DATE	BY	REVISION

Geocres No. 30M12-415	PROJECT NO. 1662333	DIST. CENTRAL
HWY. QEW	CHKD. MWK	DATE: 4/23/2018
SUBM'D.	CHKD. GDS	APPD. JMAC
DRAWN: SMD	CHKD. GDS	DWG. 1





## LEGEND

- Borehole - Current Investigation
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated  
(Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- R Refusal
- WL in piezometer, measured on Nov. 28, 2017
- WL upon completion of drilling

## BOREHOLE CO-ORDINATES

No.	ELEVATION (m)	NORTHING	EASTING
NW3-01	96.5	4824275.8	295959.8
NW3-02	95.3	4824342.4	295994.3
NW3-02A	95.3	4824344.2	295993.8
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PED-03	93.7	4824305.3	296063.0
PED-03A	94.1	4824308.4	296062.1
PED-03B	94.1	4824309.6	296062.8

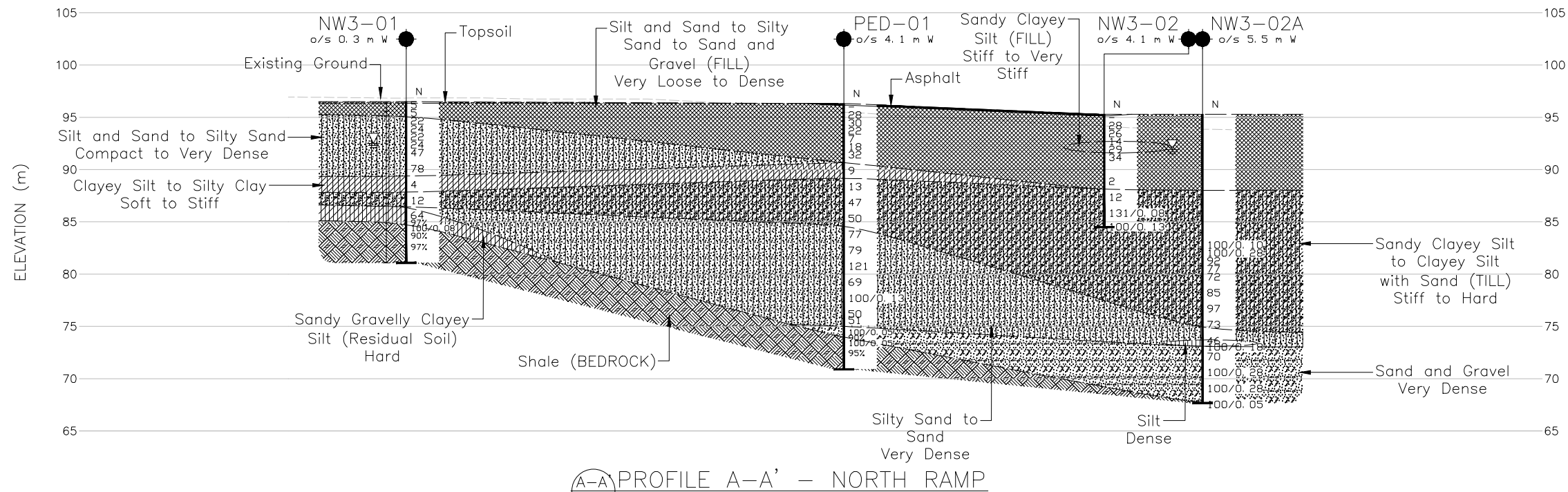
## NOTES

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.

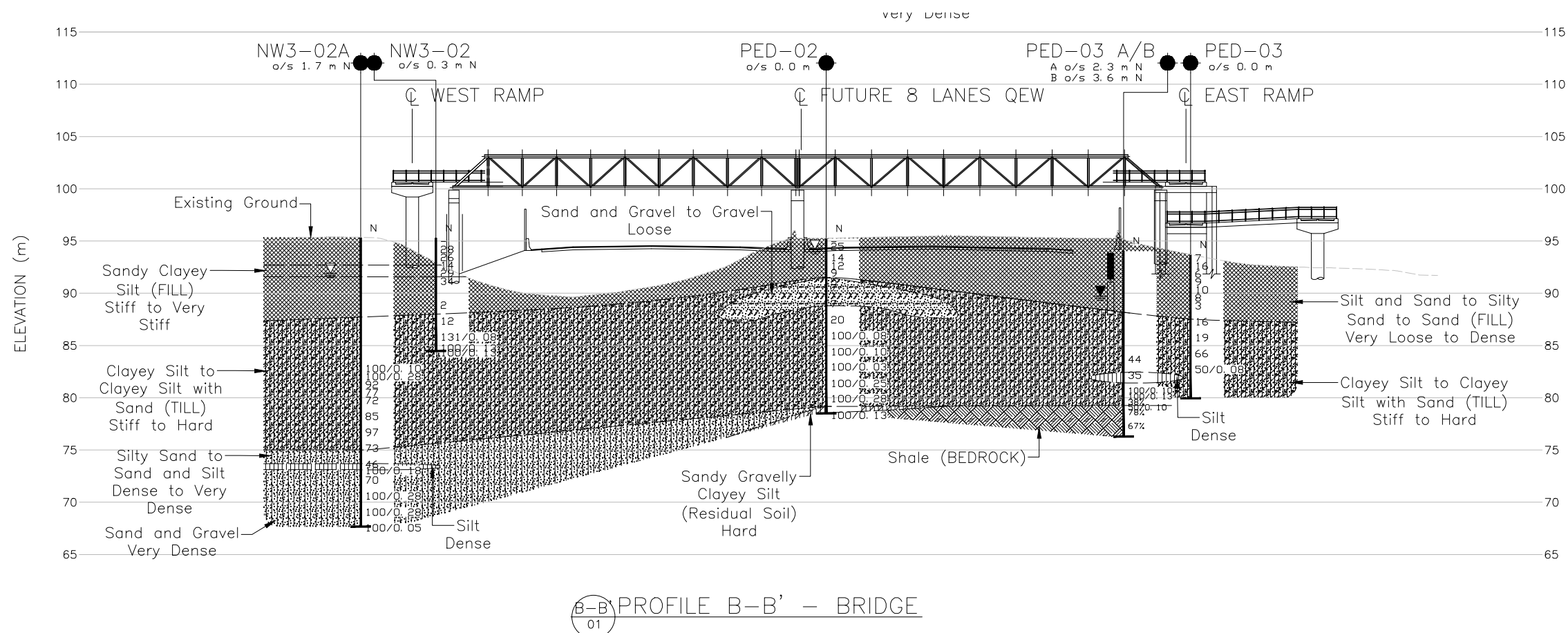
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

## REFERENCE

Base plans provided in digital format by Morrison Hershfield, drawing file P7733-117404-8, dated April 27, 2017, received April 27, 2016.



A-A' PROFILE A-A' - NORTH RAMP



B-B' PROFILE B-B' - BRIDGE



NO.	DATE	BY	REVISION

Geocres No. 30M12-415

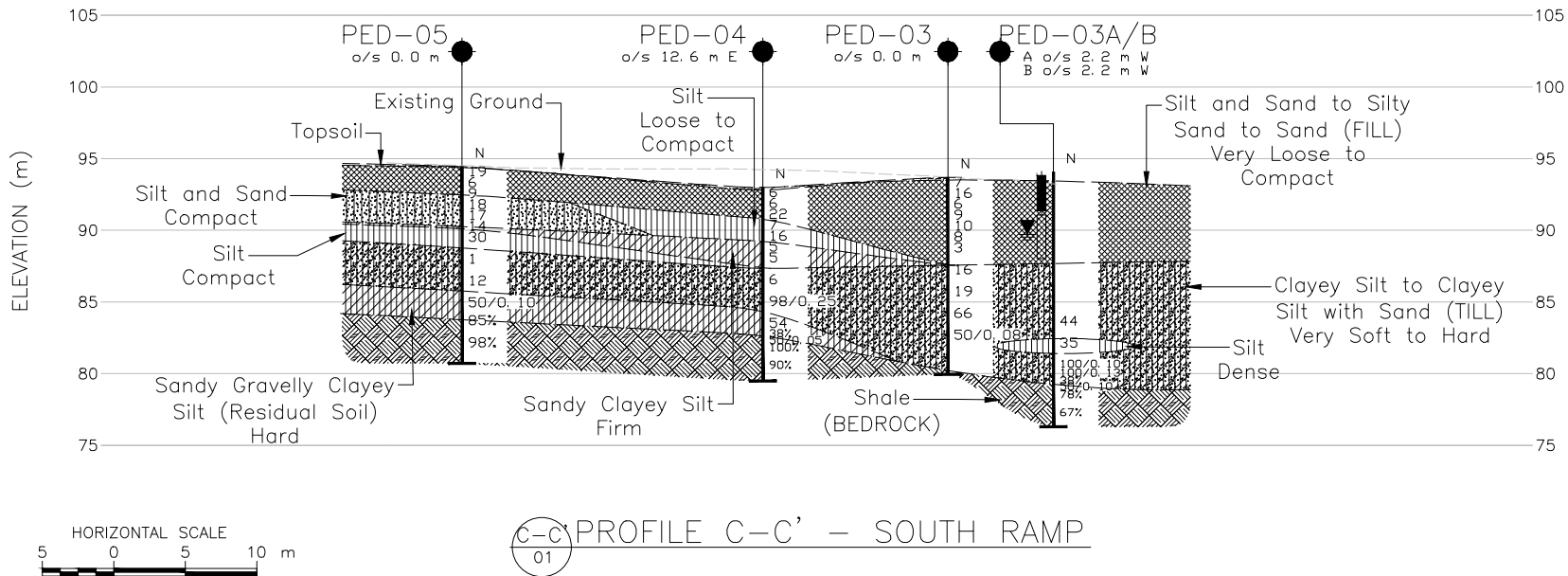
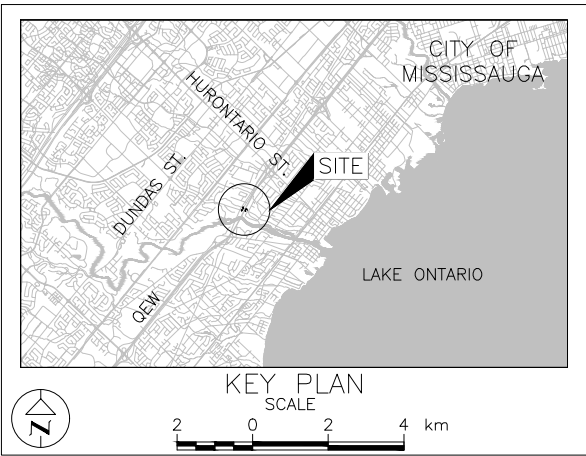
HWY. QEW	PROJECT NO. 1662333	DIST. CENTRAL
SUBM'D.	CHKD. MWK	DATE: 4/23/2018
DRAWN: SMD	CHKD. GDS	APPD. JMAC
		DWG. 2

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

CONT No.  
GWP No.2002-13-00

QEW NORTH – SOUTH ACTIVE  
TRANSPORT CROSSING STRUCTURE  
SOIL STRATA

SHEET



LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- R Refusal
- WL in piezometer, measured on Nov. 28, 2017

BOREHOLE CO-ORDINATES			
No.	ELEVATION (m)	NORTHING	EASTING
PED-03	93.7	4824305.3	296063.0
PED-03A	94.1	4824308.4	296062.1
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PED-04	93.0	4824288.0	296068.1
PED-05	94.4	4824275.4	296047.1

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NO.	DATE	BY	REVISION
Geocres No. 30M12-415			
HWY.	QEW	PROJECT NO.	1662333
SUBM'D.	CHKD. MWK	DATE:	4/23/2018
DRAWN: SMD	CHKD. GDS	APPD. JMAC	DWG. 3





# APPENDIX A

## Record of Borehole and Record of Drillhole Sheets



## LIST OF SYMBOLS

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

<b>(a)</b>	<b>Index Properties</b>
$\rho(\gamma)$	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 = $(w_l - w_p)$
$w_s$	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
$C_\alpha$	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
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	coefficient of friction = $\tan \delta$
$c'$	effective cohesion
$c_u, s_u$	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	$(\sigma_1 - \sigma_3)/2$ 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  $\gamma = \rho g$  (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1  
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

### I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

### II. 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.) drive open sampler for a distance of 300 mm (12 in.)

#### Dynamic Cone Penetration Resistance; $N_d$ :

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

#### Piezo-Cone Penetration Test (CPT)

A 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 (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

### III. SOIL DESCRIPTION

#### (a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

#### (b) Cohesive Soils Consistency

	$C_u, S_u$	
	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

### IV. SOIL TESTS

w	water content
$w_p$	plastic limit
$w_l$	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
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
$SO_4$	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
$\gamma$	unit weight

**Note:** 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

### V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand





## LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

### WEATHERINGS STATE

**Fresh:** no visible sign of weathering

**Faintly weathered:** weathering limited to the surface of major discontinuities.

**Slightly weathered:** penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

**Moderately weathered:** weathering extends throughout the rock mass but the rock material is not friable.

**Highly weathered:** weathering extends throughout rock mass and the rock material is partly friable.

**Completely weathered:** rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

### BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

### JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

### GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: \* Grains greater than 60 microns diameter are visible to the naked eye.

### CORE CONDITION

#### Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

#### Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

#### Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

### DISCONTINUITY DATA

#### Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

#### Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

#### Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

#### Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

PROJECT 1662333		RECORD OF BOREHOLE No NW3-01					SHEET 1 OF 2		METRIC				
G.W.P. 2002-13-00		LOCATION N 4824275.8; E 295959.8 MTM NAD 83 ZONE 10 (LAT. 43.558358; LONG. -79.609422)					ORIGINATED BY JL						
DIST Central HWY QEW		BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing					COMPILED BY MPL						
DATUM Geodetic		DATE October 16-17, 2017					CHECKED BY SMM						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT $w_p$			NATURAL MOISTURE CONTENT $w$
96.5	GROUND SURFACE												
0.0	TOPSOIL (150mm)												
0.2	Silty sand, trace clay (FILL) Loose Brown Moist		1	SS	5		96						0 72 26 2
			2	SS	5								
95.0							95						
1.5	SILT and SAND to SILTY SAND, trace clay, trace gravel Compact to very dense Brown Moist to wet		3	SS	22								
	- Silt pocket at a depth of about 2.6 m		4	SS	24		94						0 68 31 1
			5	SS	22								
	- Becoming wet at a depth of about 3.7 m		6	SS	24		93						
			7	SS	47		92						
							91						
	- Becoming grey at a depth of about 6.3 m		8	SS	78		90						5 32 61 2
89.3													
7.2	SILTY CLAY, trace to some sand, trace gravel Soft Grey Wet		9	SS	4		89						
							88						
87.8													
8.7	Sandy CLAYEY SILT, trace to some gravel (TILL) Stiff Grey Moist to wet		10	SS	12		87						10 29 45 16
							86						
86.4													
10.1	Sandy gravelly CLAYEY SILT, some shale fragments (RESIDUAL SOIL) Hard Grey Moist to wet - Tricone grinding at a depth of about 10.1 m		11	SS	64		85						
	- Tricone grinding at a depth of about 11.6 m		12	SS	100/0.00								
84.7													
11.8	Shale BEDROCK		1	RC	REC 100%		84						RQD = 97%
	Bedrock cored from a depth of 11.8 m to 15.4 m		2	RC	REC 96%		83						RQD = 90%
	For bedrock coring details, refer to Record of Drillhole NW3-01		3	RC	REC 97%		82						RQD = 97%

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\TOQEW-CREDIT\_RIVER\02\_DATA\INTOQEW-CREDIT\_RIVER.GPJ GAL-GTA.GDT 23/4/18

PROJECT		1662333		RECORD OF BOREHOLE		No NW3-01		SHEET 2 OF 2		METRIC							
G.W.P.		2002-13-00		LOCATION		N 4824275.8; E 295959.8 MTM NAD 83 ZONE 10 (LAT. 43.558358; LONG. -79.609422)		ORIGINATED BY		JL							
DIST		Central HWY QEW		BOREHOLE TYPE		CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing		COMPILED BY		MPL							
DATUM		Geodetic		DATE		October 16-17, 2017		CHECKED BY		SMM							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---																
81.1			3	RC	REC 97%												RQD = 97%
15.4	END OF BOREHOLE  NOTES: 1. Water level measured at a depth of about 4.5 m (Elev. 92.0 m) below ground surface prior to start of rock coring.  2. Water level measured at top of casing (Elev. 96.9 m) following completion of ro																

GTA-MTO 001 S:\CLIENTS\MTQEW-CREDIT\_RIVER02\_DATA\INTQEW-CREDIT\_RIVER.GPJ GAL-GTA.GDT 23/4/18

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Aardvark Drilling

[illegible]

## FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50



# GOLDER

LOGGED: JL

CHECKED: JC

GTARCK 054 S:\CLIENTS\MTQEW-CREDIT RIVER\02 DATA\GIN\QEW-CREDIT RIVER.GPJ GAL-MISS.GDT 23/4/18

PROJECT		RECORD OF BOREHOLE				No NW3-02		SHEET 1 OF 1		METRIC			
G.W.P.		2002-13-00		LOCATION		N 4824342.4; E 295994.3 MTM NAD 83 ZONE 10 (LAT. 43.558958; LONG. -79.608996)		ORIGINATED BY		FC			
DIST		Central		HWY		QEW		BOREHOLE TYPE		CME 55, 203 mm O.D. Hollow Stem Augers			
COMPILED BY		KN		DATE		August 23, 2017		CHECKED BY		MWK			
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa		WATER CONTENT (%)		γ		GR SA SI CL	
95.3	GROUND SURFACE					20 40 60 80 100		10 20 30		kN/m³			
0.0	ASPHALT (150 mm)					20 40 60 80 100		10 20 30					
0.2	Silty sand, some gravel to gravelly, trace to some clay (FILL) Compact Brown Moist		1	AS	-	20 40 60 80 100		10 20 30					
			2	SS	28	20 40 60 80 100		10 20 30					
	- Asphalt fragments at a depth of about 1.8 m		3	SS	26	20 40 60 80 100		10 20 30				16 58 20 6	
92.7			4A	SS	14	20 40 60 80 100		10 20 30					
2.6	Sandy clayey silt, trace to some gravel (FILL) Stiff to very stiff Brown to grey, mottled Moist		4B	SS	14	20 40 60 80 100		10 20 30					
			5	SS	29	20 40 60 80 100		10 20 30					
91.6			6	SS	34	20 40 60 80 100		10 20 30				43 41 12 4	
3.7	Sand and gravel, some silt, trace clay (FILL) Dense Grey to brown Moist to wet - Trace asphalt fragments at a depth of about 4.0 m					20 40 60 80 100		10 20 30					
90.0			7	SS	2	20 40 60 80 100		10 20 30				1 70 26 3	
5.3	Silty sand, trace clay, trace gravel, trace organics, trace asphalt fragments (FILL) Very loose Brown Moist to wet					20 40 60 80 100		10 20 30					
			8	SS	12	20 40 60 80 100		10 20 30					
88.1			9	SS	131/0.08	20 40 60 80 100		10 20 30				12 38 38 12	
7.2	CLAYEY SILT with SAND, some gravel (TILL) Stiff to hard Grey Moist to wet  - Trace organics from a depth of about 8.5 m		10	SS	100/0.13	20 40 60 80 100		10 20 30					
			11	SS	100/0.13	20 40 60 80 100		10 20 30					
84.5						20 40 60 80 100		10 20 30					
10.8	END OF BOREHOLE					20 40 60 80 100		10 20 30					
	NOTE:  1. Borehole dry prior to tricone drilling.					20 40 60 80 100		10 20 30					



GTA-MTO 001 S:\CLIENTS\MTO\QEW-CREDIT\_RIVER\02\_DATA\GIN\QEW-CREDIT\_RIVER.GPJ GAL-GTA.GDT 23/4/18

Continued Next Page

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



PROJECT 1662333		RECORD OF BOREHOLE No NW3-02A				SHEET 2 OF 3		METRIC					
G.W.P. 2002-13-00		LOCATION N 4824344.2; E 295993.8 MTM NAD 83 ZONE 10 (LAT. 43.558975; LONG. -79.609002)				ORIGINATED BY FC							
DIST Central HWY QEW		BOREHOLE TYPE CME 850, 156 mm Tricone with Drilling Mud				COMPILED BY KN							
DATUM Geodetic		DATE November 20-21, 2017				CHECKED BY MWK							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W <sub>p</sub>	W		
--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100						
	CLAYEY SILT with SAND, some gravel to gravelly (TILL) Hard Grey Moist to wet		5	SS	72								18 64 14 4
			6	SS	85								
			7	SS	97								26 57 14 3
75.0			8	SS	73								
20.3	Silty SAND, trace to some clay, trace gravel Grey Moist to wet												
73.7			9A	SS	46								1 70 24 5
21.6	SILT, some sand, trace clay Dense Grey Wet		9B	SS	46								
73.1			10A	SS	100/0.18								
22.2	- Clayey silt pocket at a depth of about 21.9 m SAND and GRAVEL, trace to some silt, trace clay Very dense Grey Moist to wet		10B	SS	100/0.18								
			11	SS	70								
			12	SS	100/0.28								
			13	SS	100/0.28								37 44 16 3
67.7			14	SS	100/0.05								
27.6	END OF BOREHOLE												

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\MTQEW-CREDIT\_RIVER\02\_DATA\GINTQEW-CREDIT\_RIVER.GPJ GAL-GTA.GDT 23/4/18



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

GTA-MTO 001 S:\CLIENTS\IMTO\QEW-CREDIT RIVER\02 DATA\GINT\QEW-CREDIT RIVER.GPJ GAL-GTA.GDT 23/4/18

PROJECT 1662333		RECORD OF BOREHOLE No PED-01				SHEET 1 OF 2		METRIC	
G.W.P. 2002-13-00		LOCATION N 4824314.1; E 295977.3 MTM NAD 83 ZONE 10 (LAT. 43.558703; LONG. -79.609205)				ORIGINATED BY FC			
DIST Central HWY QEW		BOREHOLE TYPE CME 55, 203 mm O.D. Hollow Stem Augers, HQ Casing				COMPILED BY KN			
DATUM Geodetic		DATE August 17-18, 2017				CHECKED BY SMM			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
96.3	GROUND SURFACE							20 40 60 80 100							
0.0	ASPHALT (150 mm)							○ UNCONFINED + FIELD VANE							
0.2	Gravelly silty sand, trace to some clay, trace rootlets, trace silty clay pockets (FILL) Compact to dense Brown Moist		1	AS	-		96	● QUICK TRIAXIAL × REMOULDED							
			2	SS	28										
							95								
	- Asphalt fragments from a depth of about 1.7 m to 1.8 m		3	SS	30										
							94								
93.6	- Clayey silt pocket/zone, trace asphalt at a depth of about 2.5 m to 2.7 m		4A	SS	22										
2.7	Silt and sand, trace clay (FILL) Loose to dense Brown Moist - Wet at a depth of about 3.4 m		4B												
			4C												
			5	SS	7		93								
			6	SS	18		92								
			7	SS	32										
							91								
90.7	CLAYEY SILT, trace sand, trace gravel Stiff Grey Moist to wet														
5.6			8	SS	9		90								
89.1	CLAYEY SILT with SAND to some sand, trace to some gravel (TILL) Stiff to hard Grey Moist to wet						89								
7.2			9	SS	13										
							88								
			10A	SS	47		87								
			10B												
							86								
			11	SS	50		85								
84.6	SAND, trace to some silt, trace to some clay, trace to some gravel Very dense Grey Moist to wet						84								
11.7			12	SS	77										
							83								
	- Clayey silt lens from a depth of about 14 m to 14.1 m		13	SS	79		82								

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

GTA-MTO 001 S:\CLIENTS\MTQEW-CREDIT\_RIVER\02\_DATA\INTQEW-CREDIT\_RIVER.GPJ GAL-GTA.GDT 23/4/18

PROJECT 1662333		RECORD OF BOREHOLE No PED-01				SHEET 2 OF 2		METRIC								
G.W.P. 2002-13-00		LOCATION N 4824314.1; E 295977.3 MTM NAD 83 ZONE 10 (LAT. 43.558703; LONG. -79.609205)				ORIGINATED BY FC										
DIST Central HWY QEW		BOREHOLE TYPE CME 55, 203 mm O.D. Hollow Stem Augers, HQ Casing				COMPILED BY KN										
DATUM Geodetic		DATE August 17-18, 2017				CHECKED BY SMM										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
							20	40	60	80	100	10	20	30		
81	SAND, trace to some silt, trace to some clay, trace to some gravel Very dense Grey Moist to wet		14	SS	121							○				14 73 10 3
80																
79			15A 15B	SS	69							○				
78	- Gravelly at a depth of about 17.8 m		16	SS	100/0.13							○				
77																
76			17 18	SS	50 51							○				10 81 7 2
75																
74	SAND and GRAVEL, some silt Very dense Grey Moist to wet		19 20	SS	100/0.05 100/0.05							○				
73	Shale BEDROCK Grey		1	RC	REC 92%											RQD = 90%
72	Bedrock cored from a depth of 22.3 m to 25.4 m  For bedrock coring details, refer to Record of Drillhole PED-01		2	RC	REC 100%											RQD = 95%
71	END OF BOREHOLE															
25.4	NOTE:  1. Borehole dry prior to rock coring.															

PROJECT: 1662333

**RECORD OF DRILLHOLE: PED-01**

SHEET 1 OF 1

LOCATION: N 4824314.1 ; E 295977.3

DRILLING DATE: August 17-18, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Aardvark Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break BR - Broken Rock <b>NOTE:</b> For additional abbreviations refer to list of abbreviations & symbols.																FEATURES	RQ/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
						RECOVERY		R.Q.D. %	FRACT. INDEX PER Meter	DISCONTINUITY DATA						ROCK STRENGTH INDEX		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
						TOTAL CORE %	SOLID CORE %			B Angle		DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION		Jr	Ja	R4	R3	R2	R1	W1				W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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		Continued from Borehole PED-01		73.99																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

## FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: FC

CHECKED: JC

GTA-RCK 054 S:\CLIENTS\MTQ\QEW-CREDIT\_RIVER\GPJ GAL-MISS.GDT 23/4/18

S:\CLIENTS\MTO\QEW-CREDIT\_RIVER\02 DATA\GIN\QEW-CREDIT\_RIVER.GPJ GAL-GTA.GDT 23/4/18

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



PROJECT		RECORD OF BOREHOLE				No PED-02		SHEET 2 OF 2		METRIC							
G.W.P. 2002-13-00		LOCATION				N 4824321.8; E 296032.3 MTM NAD 83 ZONE 10 (LAT. 43.558773; LONG. -79.608524)				ORIGINATED BY JL							
DIST Central HWY QEW		BOREHOLE TYPE				CME 75, 203 mm O.D. Hollow Stem Augers, HQ Casing				COMPILED BY DH							
DATUM Geodetic		DATE				December 4, 2017				CHECKED BY MWK							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
79.1			14	SS	100/0.28		80										17 51 24 8
16.1	Sandy gravelly CLAYEY SILT, some shale fragments (RESIDUAL SOIL)						79										
78.5	Very dense																
16.7	Grey Moist to wet SHALE (BEDROCK) Grey END OF BOREHOLE		15	SS	100/0.13												
NOTES: 1. Borehole dry to 3.0 m depth prior to tricone drilling. 2. Water level measured at a depth of about 1.9 m below ground surface (Elev. 93.3 m) on December 5, 2017 before start of drilling when the borehole was at a depth of about 10.5 m. 3. Water level measured at a depth of about 1.1 m below ground surface (Elev. 94.1 m) on December 6, 2017 before start of drilling when the borehole was at a depth of about 16.6 m. 4. The water level measurement is not considered to be representative of the groundwater level due to the introduction of drilling mud/water during borehole drilling operations.																	

GTA-MTO 001 S:\CLIENTS\MTQEW-CREDIT\_RIVER02\_DATA\INTQEW-CREDIT\_RIVER.GPJ GAL-GTA.GDT 23/4/18



STA-MTO 001 S:\CLIENTS\MTO\QEW-CREDIT RIVER\02 DATA\GINT\QEW-CREDIT RIVER.GPJ GAL-GTA.GDT 23/4/18

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

GTA-MTO 001 S:\CLIENTS\IMTO\QEW-CREDIT RIVER\02 DATA\INT\QEW-CREDIT RIVER.GPJ GAL-GTA.GDT 23/4/18


+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



GTA-MTO 001 S:\CLIENTS\MTO\QEW-CREDIT\_RIVER\02\_DATA\GIN\QEW-CREDIT\_RIVER.GPJ GAL-GTA.GDT 23/4/18

Continued Next Page

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

PROJECT 1662333		RECORD OF BOREHOLE No PED-03B				SHEET 2 OF 2		METRIC									
G.W.P. 2002-13-00		LOCATION N 4824309.6; E 296062.8 MTM NAD 83 ZONE 10 (LAT. 43.558664; LONG. -79.608146)				ORIGINATED BY JL											
DIST Central HWY QEW		BOREHOLE TYPE CME 850, 156 mm Tricone with Drilling Mud				COMPILED BY KN											
DATUM Geodetic		DATE November 15-16, 2017				CHECKED BY MWK											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100						
	Shale BEDROCK Grey		1	RC	REC 100%												RQD = 38%
	Bedrock cored from a depth of 14.8 m to 17.8 m For bedrock coring details, refer to Record of Drillhole PED-03B		2	RC	REC 100%	78											RQD = 78%
			3	RC	REC 100%	77											RQD = 67%
76.3 17.8	END OF BOREHOLE  NOTE: 1. Borehole dry prior to tricone drilling.																

DATUM: Geodetic

DRILL RIG: CME 850 Track

DRILLING CONTRACTOR: Aardvark Drilling

[illegible]

## FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50



# GOLDER

LOGGED: JL

CHECKED:

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

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Aardvark Drilling

[illegible]



PROJECT 1662333		RECORD OF BOREHOLE No PED-05				SHEET 1 OF 1		METRIC				
G.W.P. 2002-13-00		LOCATION N 4824275.4; E 296047.1 MTM NAD 83 ZONE 10 (LAT. 43.558356; LONG. -79.608341)				ORIGINATED BY JL						
DIST Central HWY QEW		BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing				COMPILED BY MPL						
DATUM Geodetic		DATE October 25-26, 2017				CHECKED BY MWK						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
94.4	GROUND SURFACE											
94.4	TOPSOIL (50mm)		1	SS	19							
	Silty Sand, trace clay, trace organics (FILL)											
	Loose to compact		2	SS	6							
	Brown											
	Moist											
92.4			3A									
			3B	SS	9							
2.0	SILT and SAND, trace clay, trace gravel											
	Compact		4	SS	18							
	Brown											
	Moist to wet											
			5	SS	17							
90.2			6A									
			6B	SS	14							
			6C									
4.3	CLAYEY SILT											
	Grey											
	Wet											
	SILT, trace to some sand, trace clay		7	SS	30							
	Compact											
	Grey											
	Moist to wet											
88.8												
5.6	CLAYEY SILT with SAND, trace to some gravel (TILL)		8	SS	1							
	Very soft to stiff											
	Grey											
	Moist to wet											
			9	SS	12							
85.7												
8.7	Sandy gravelly CLAYEY SILT, some shale fragments (RESIDUAL SOIL)		10	SS	50/0.10							
	Hard											
	Grey											
	Moist to wet											
83.7												
10.7	Shale BEDROCK		2	SC	REC 100%							
	Grey											
	Bedrock cored from a depth of 10.7 m to 13.7 m											
	For bedrock coring details, refer to Record of Drillhole PED-05		3	SC	REC 98%							
80.7												
13.7	END OF BOREHOLE											
	NOTE:											
	1. Borehole dry prior to rock coring.											

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Aardvark Drilling

[illegible]

## FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50



# GOLDER

LOGGED: JL

CHECKED: MWK

GTARCK 054 S:\CLIENTS\MTQEW-CREDIT RIVER\02 DATA\GIN\QEW-CREDIT RIVER.GPJ GAL-MISS.GDT 23/4/18

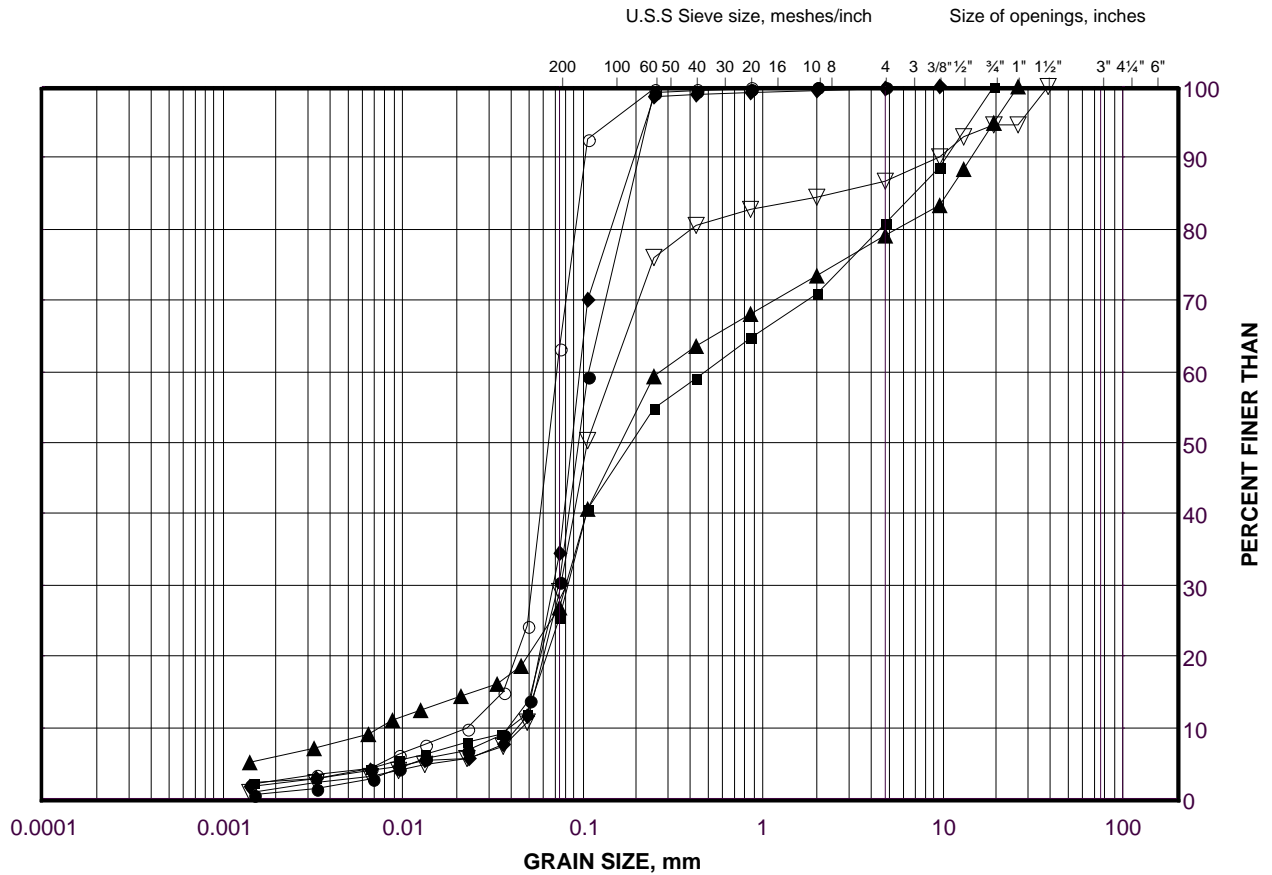
# APPENDIX B

## Laboratory testing

# GRAIN SIZE DISTRIBUTION

Silt and Sand to Gravelly Silty Sand (Fill)

FIGURE B1A



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	PED-05	2	93.3
■	PED-02	3	93.4
◆	PED-03	3	91.9
▲	PED-01	3	94.5
▽	PED-03	6	89.6
○	PED-01	6	92.2

Project Number: 1662333

Checked By: MWK

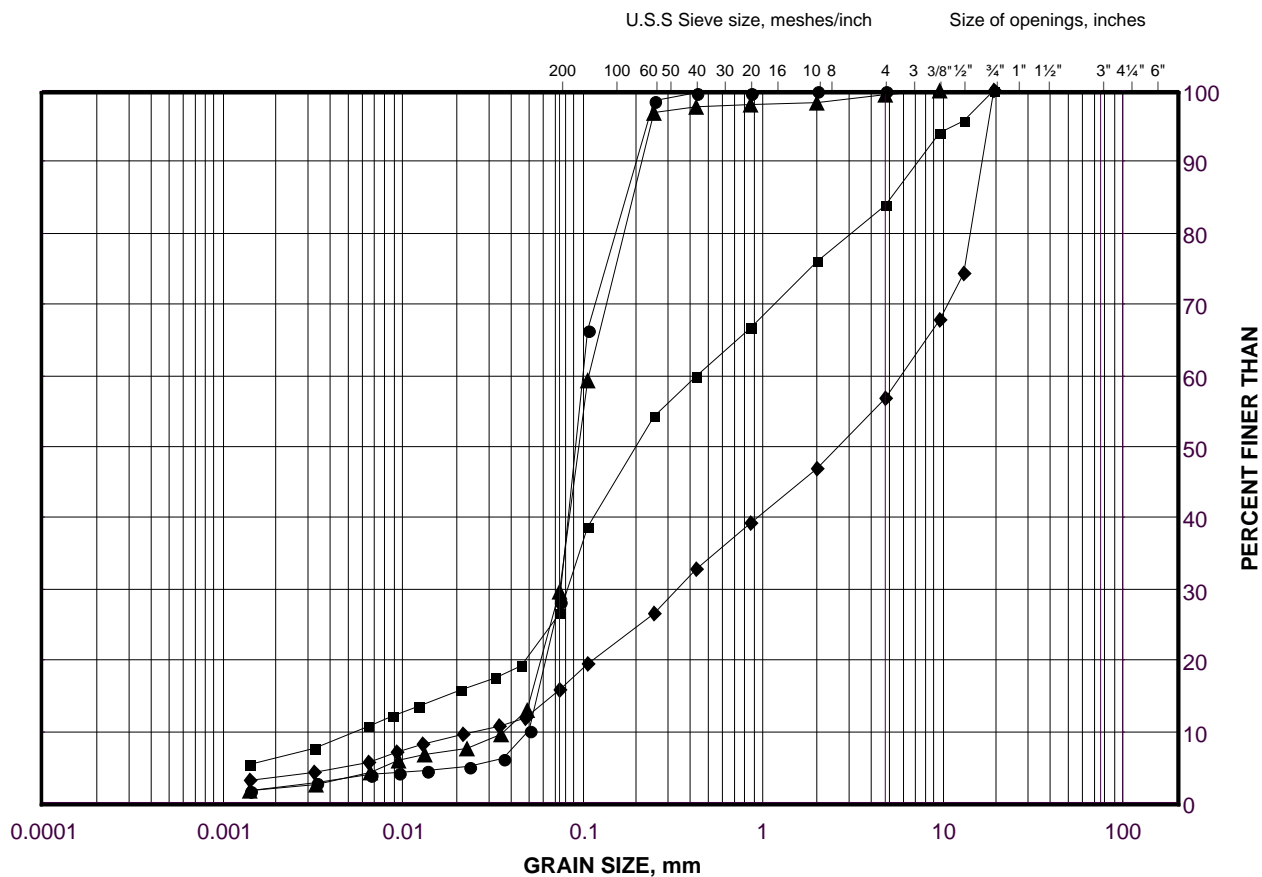
**Golder Associates**

Date: 17-Jan-18

# GRAIN SIZE DISTRIBUTION

Silty Sand to Sand and Gravel (Fill)

FIGURE B1B



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		

## LEGEND

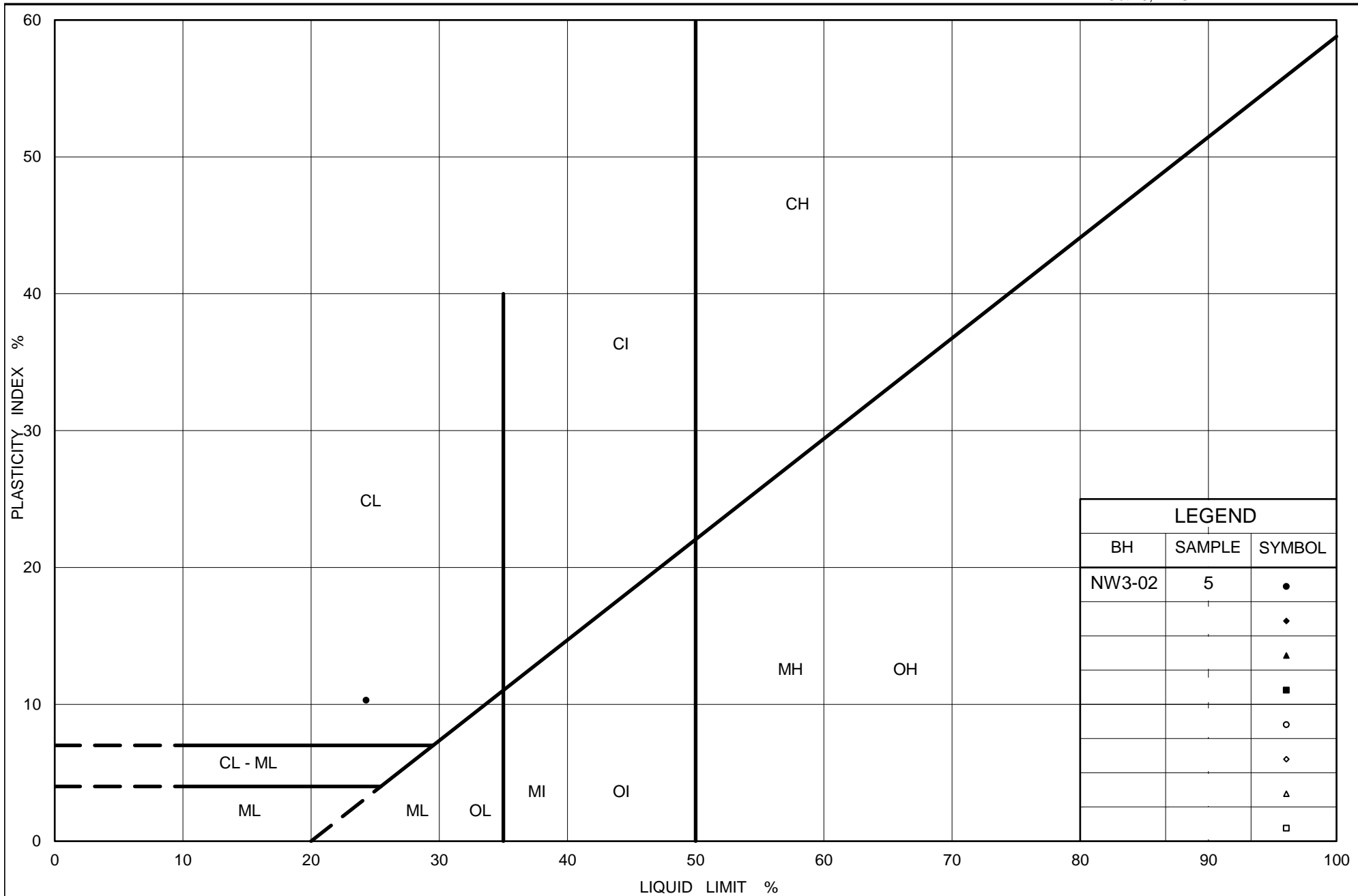
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-01	2	95.4
■	NW3-02	3	93.5
◆	NW3-02	6	91.2
▲	NW3-02	7	88.9

Project Number: 1662333

Checked By: MWK

**Golder Associates**

Date: 22-Jan-18



Ministry of Transportation

Ontario

## PLASTICITY CHART

### Clayey Silt (Fill)

Figure No. B2

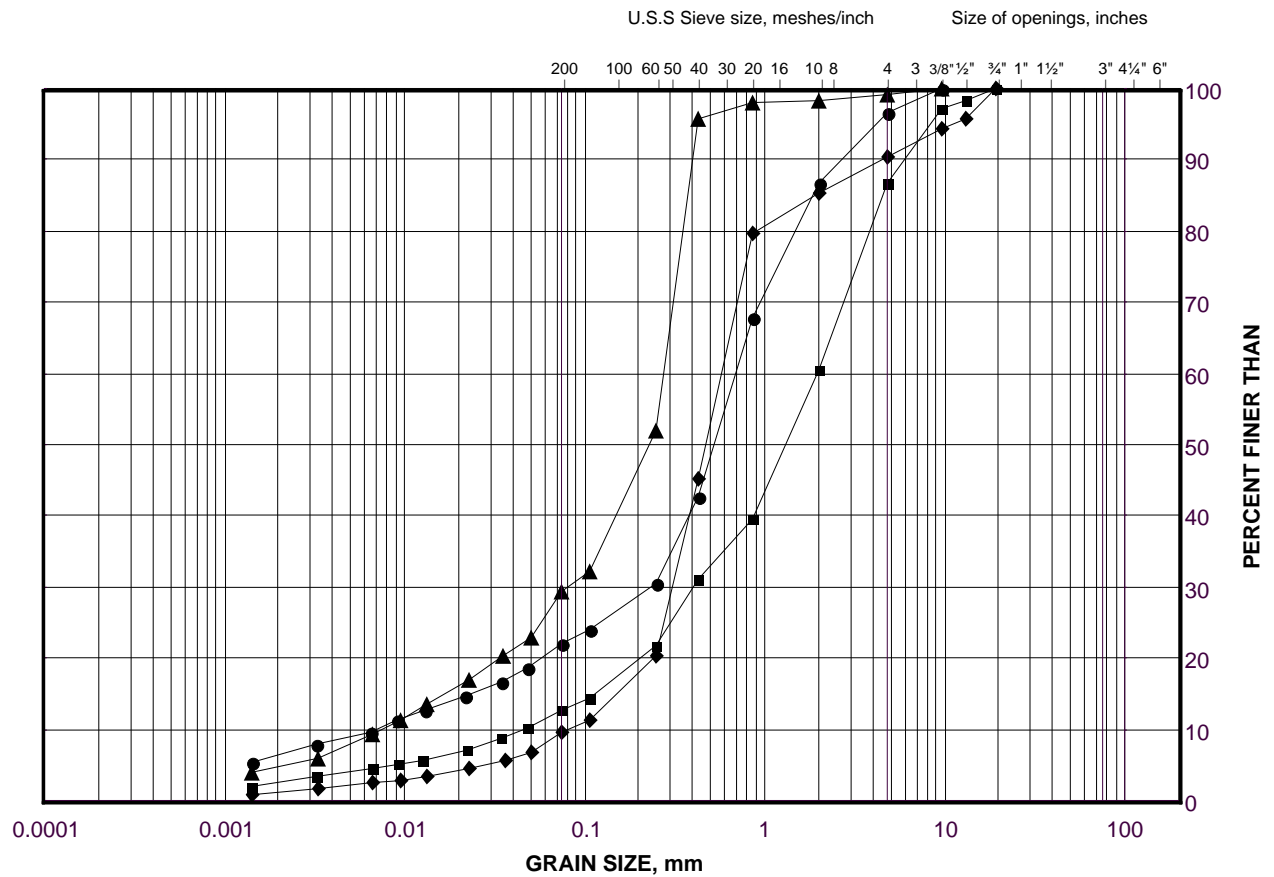
Project No. 1662333

Checked By: GDS

# GRAIN SIZE DISTRIBUTION

Silty Sand to Sand

FIGURE B3A



## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	PED-01	12	83.8
■	PED-01	14	80.8
◆	PED-01	17	76.2
▲	NW3-02A	9A	73.8

Project Number: 1662333

Checked By: MWK

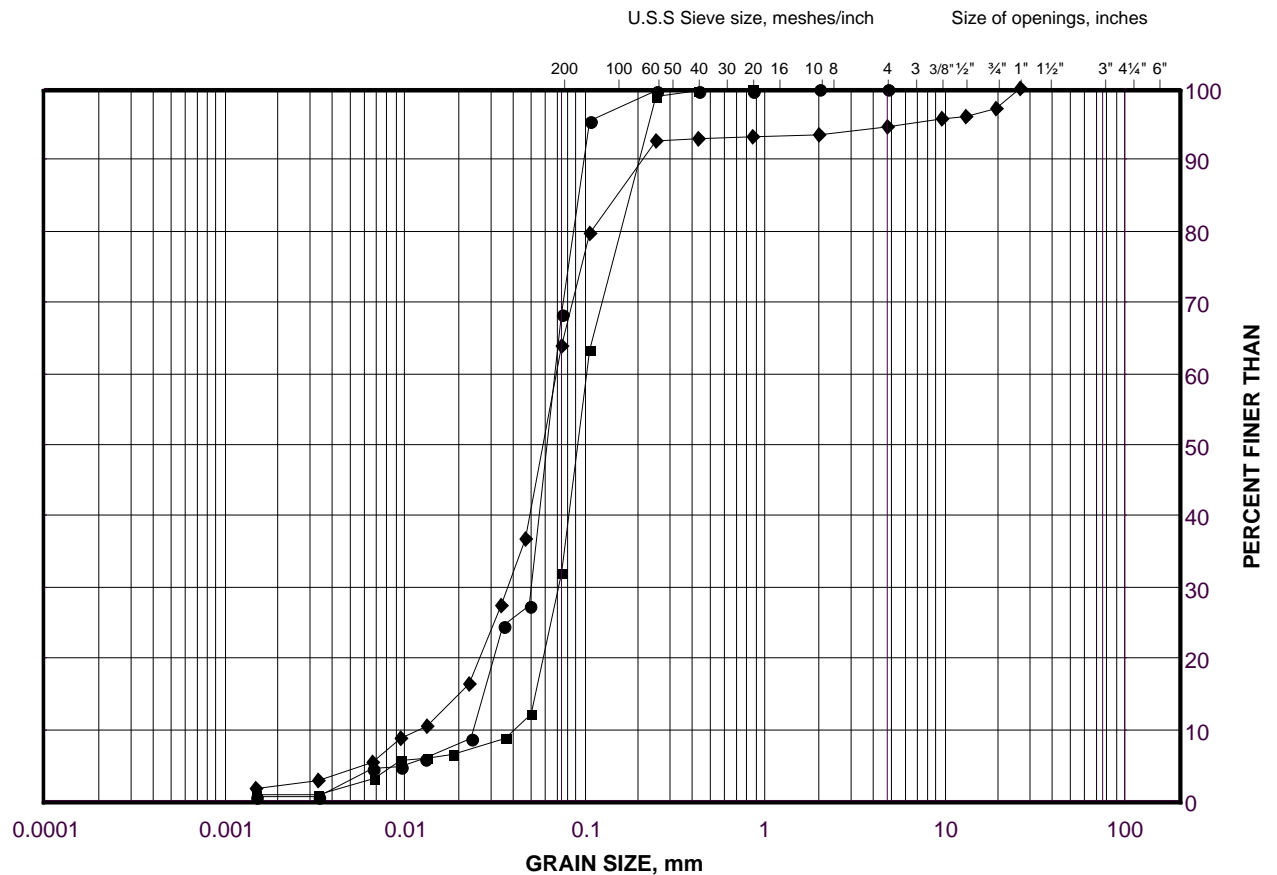
**Golder Associates**

Date: 30-Jan-18

# GRAIN SIZE DISTRIBUTION

Silt and Sand

FIGURE B3B

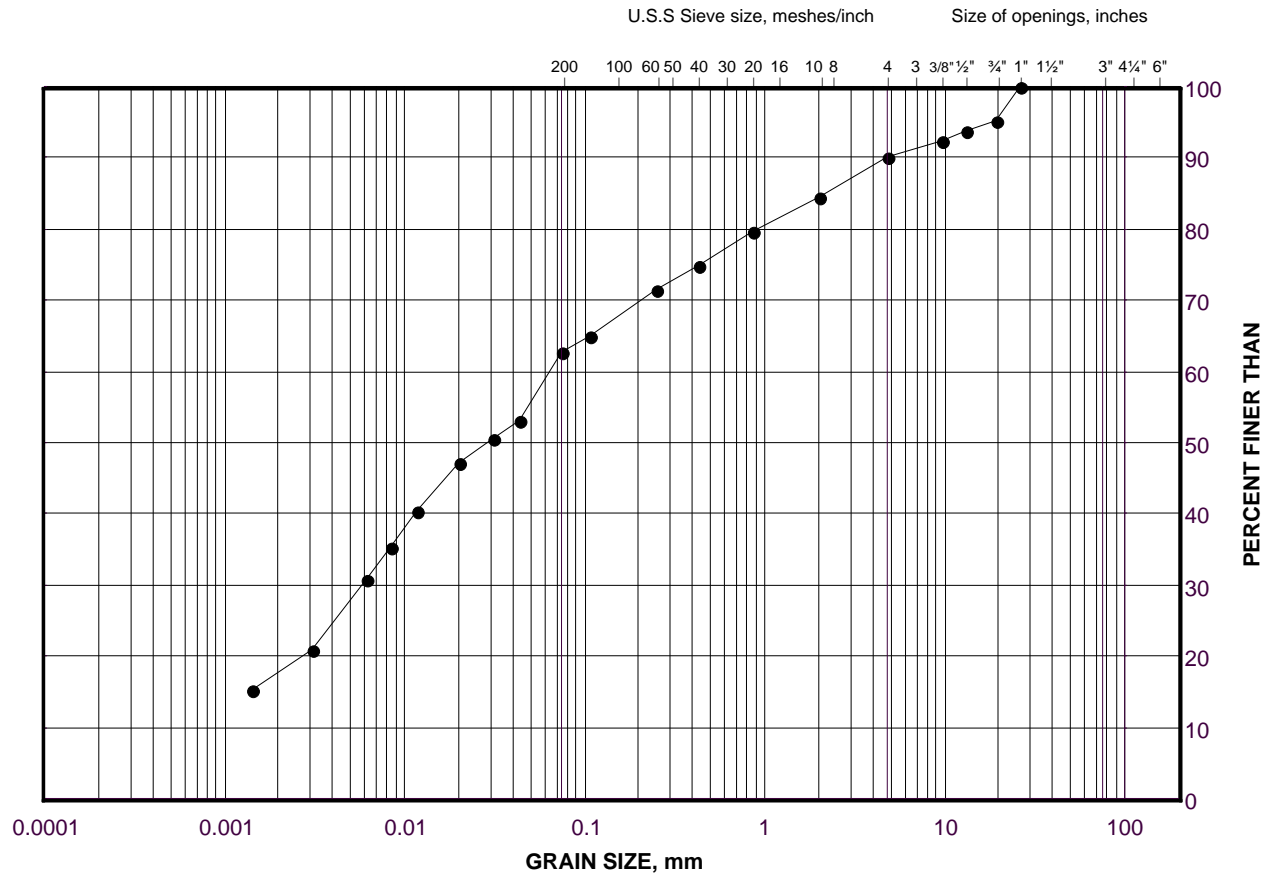




# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt

FIGURE B4



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

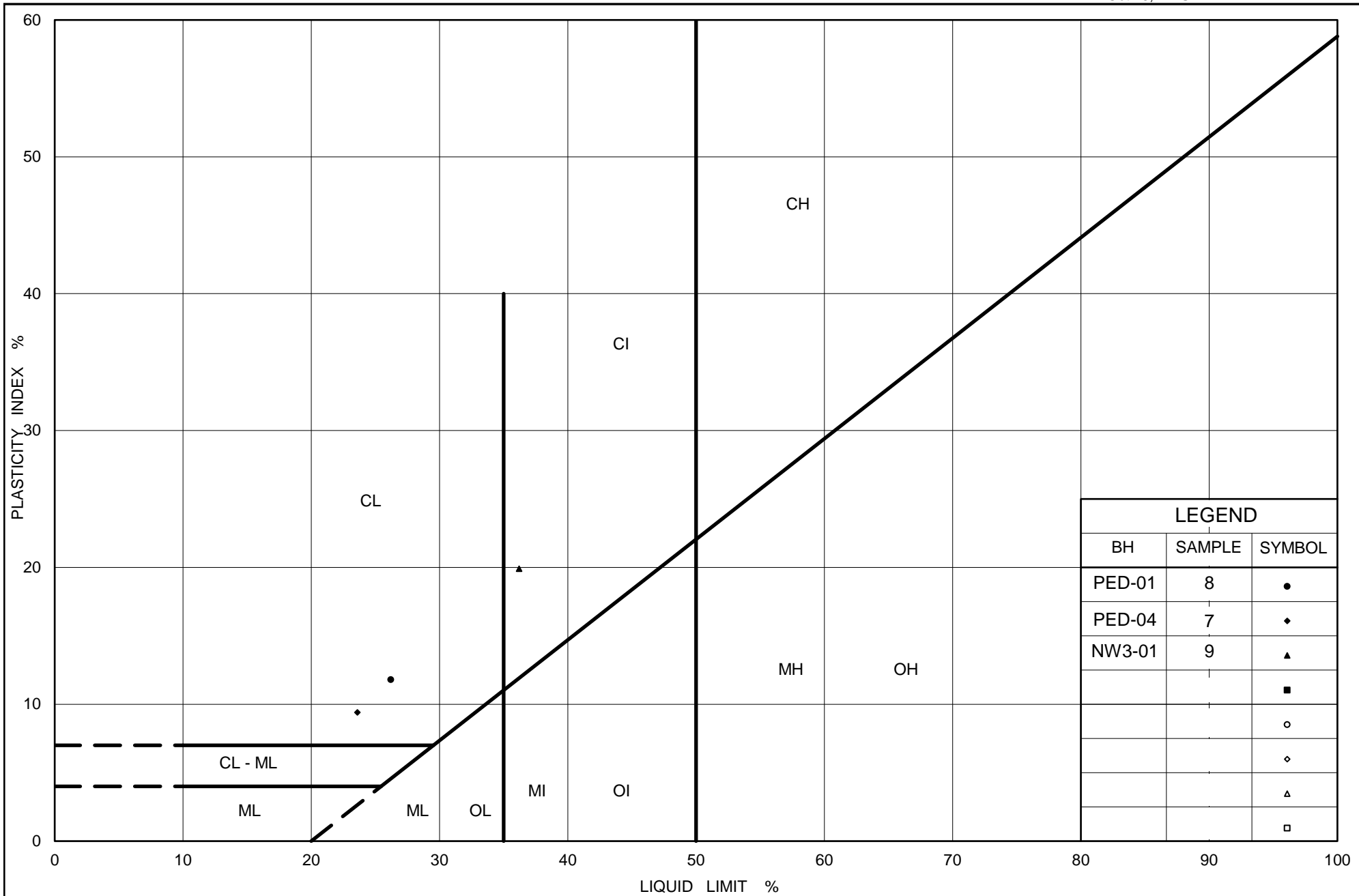
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	PED-04	7	88.1

Project Number: 1662333

Checked By: GDS

**Golder Associates**

Date: 22-Jan-18



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# PLASTICITY CHART Clayey Silt to Silty Clay

Figure No. B5

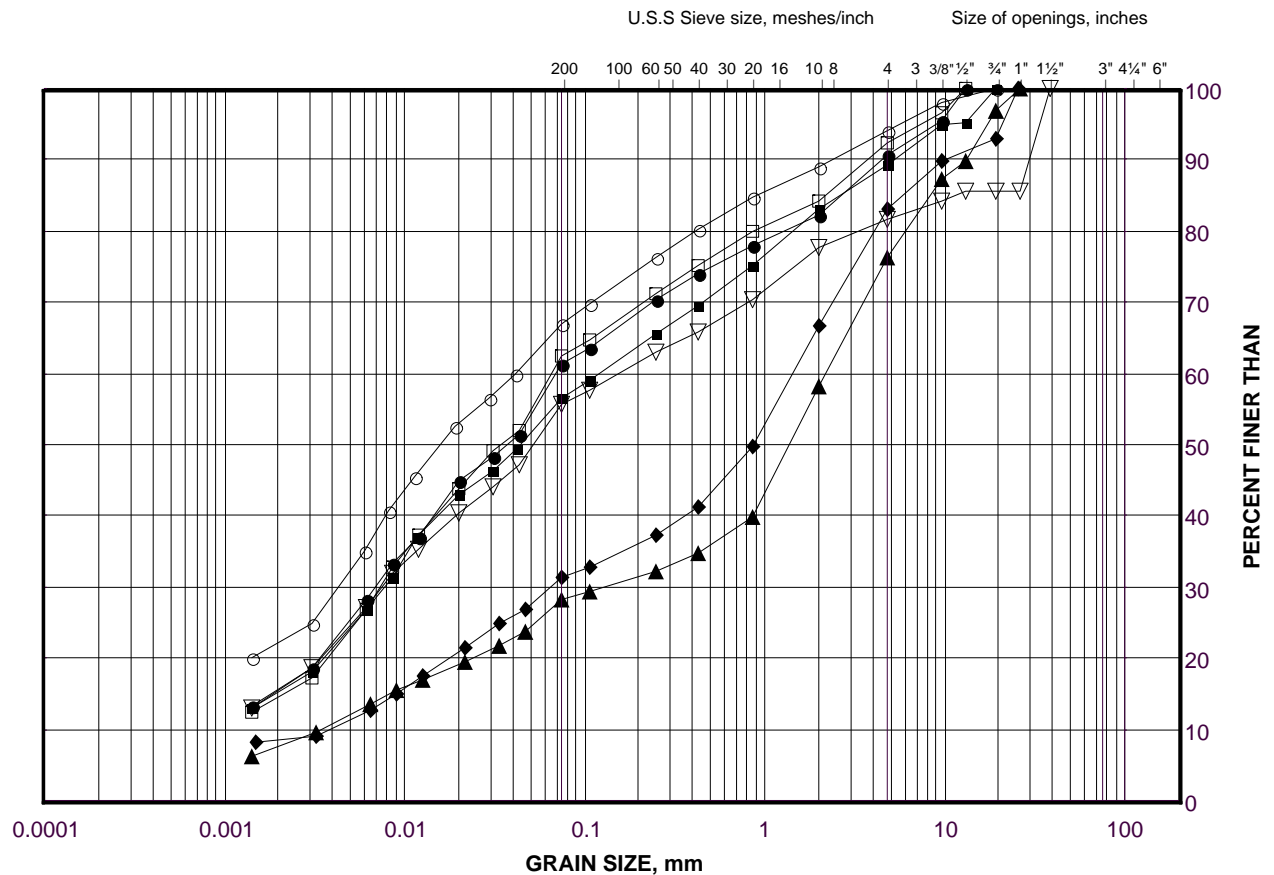
Project No. 1662333

Checked By: GDS

# GRAIN SIZE DISTRIBUTION

Clayey Silt (Till)

FIGURE B6A



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-01	10	87.1
■	PED-01	10A	86.9
◆	PED-02	14	80.0
▲	PED-03B	3	80.8
▽	PED-03	8	87.3
○	PED-02	9	87.4
□	PED-05	9	86.5

Project Number: 1662333

Checked By:           MWK          

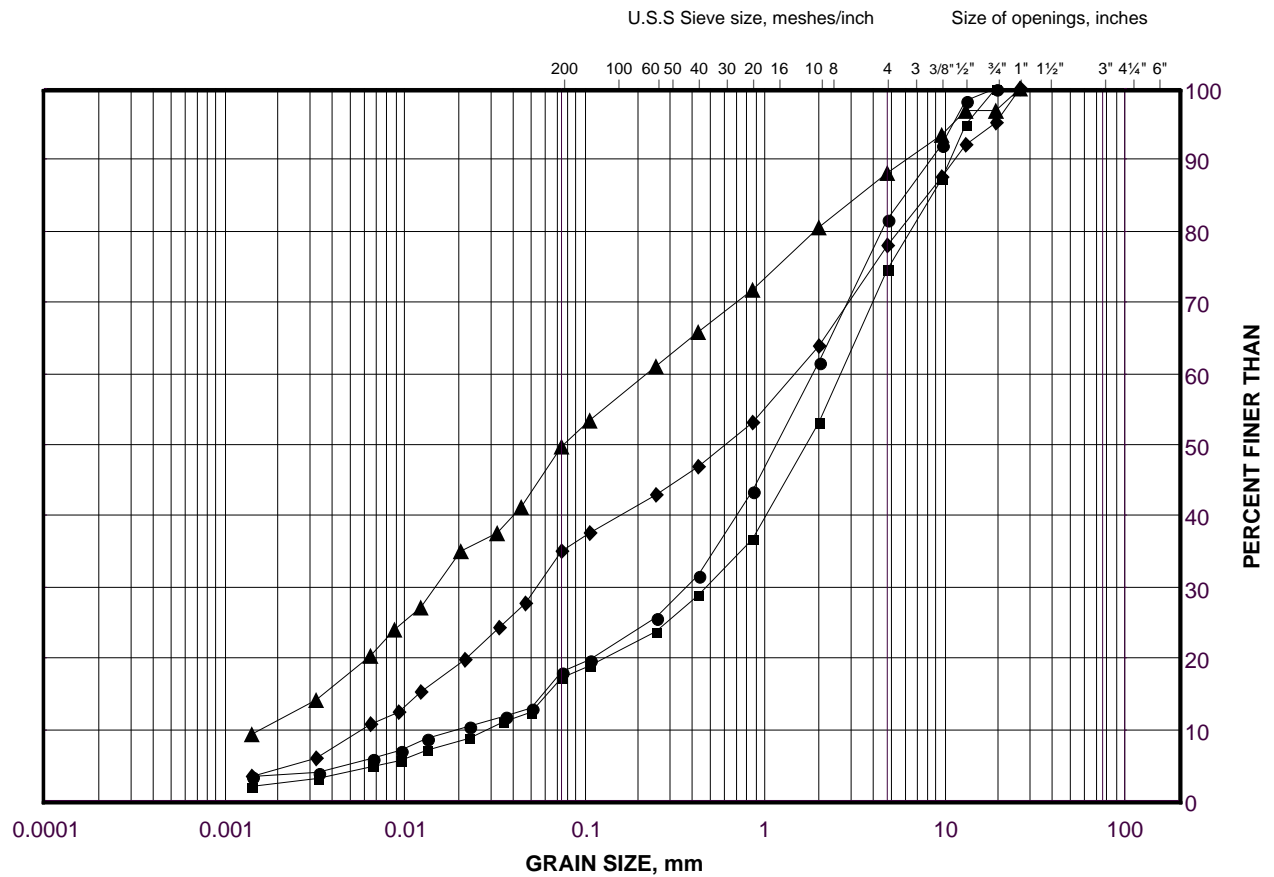
**Golder Associates**

Date: 30-Jan-18

# GRAIN SIZE DISTRIBUTION

Clayey Silt (Till)

FIGURE B6B



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

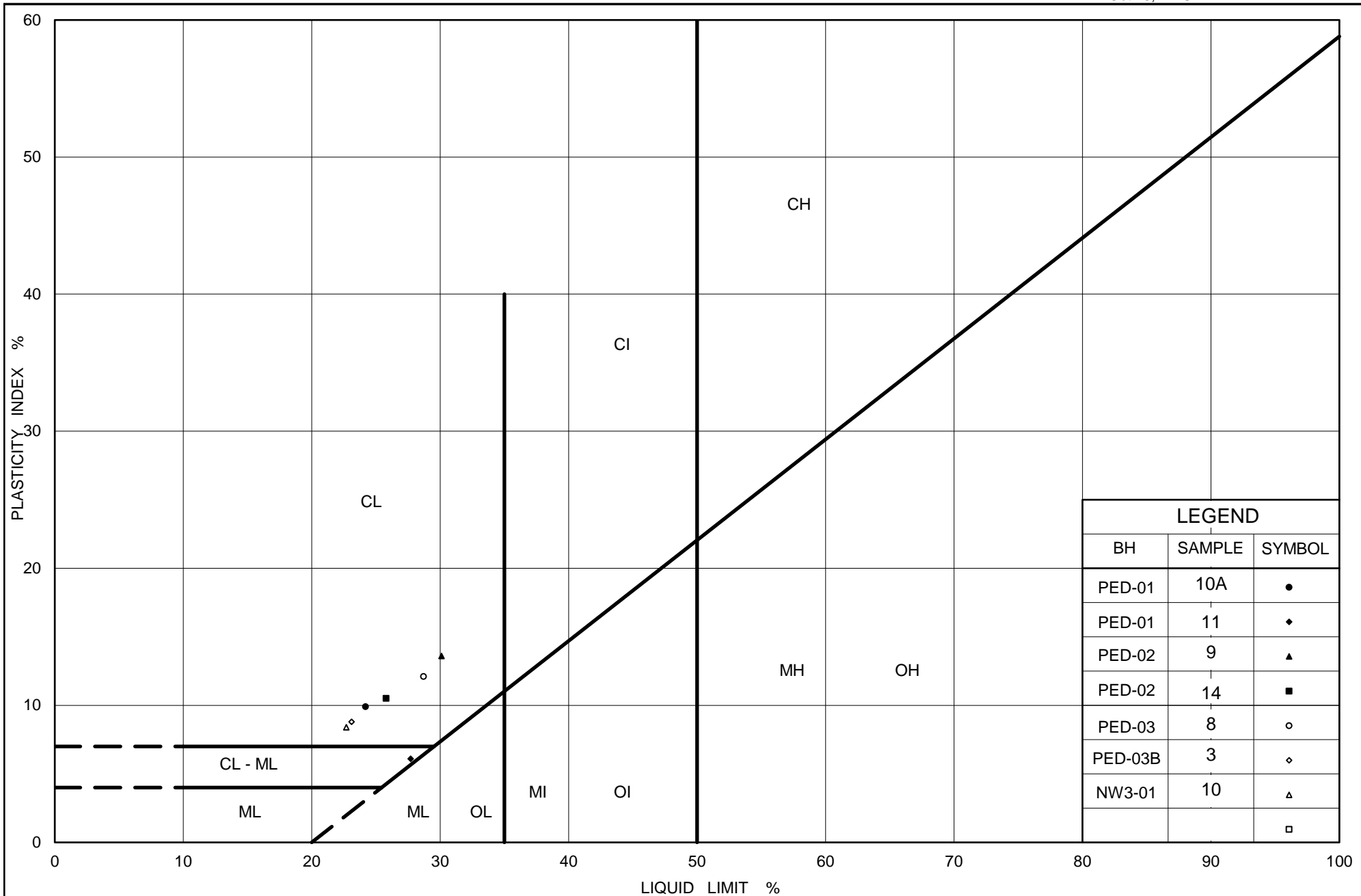
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-02A	5	79.8
■	NW3-02A	7	76.7
◆	PED-04	9	85.1
▲	NW3-02	9	85.9

Project Number: 1662333

Checked By: GDS

**Golder Associates**

Date: 22-Jan-18



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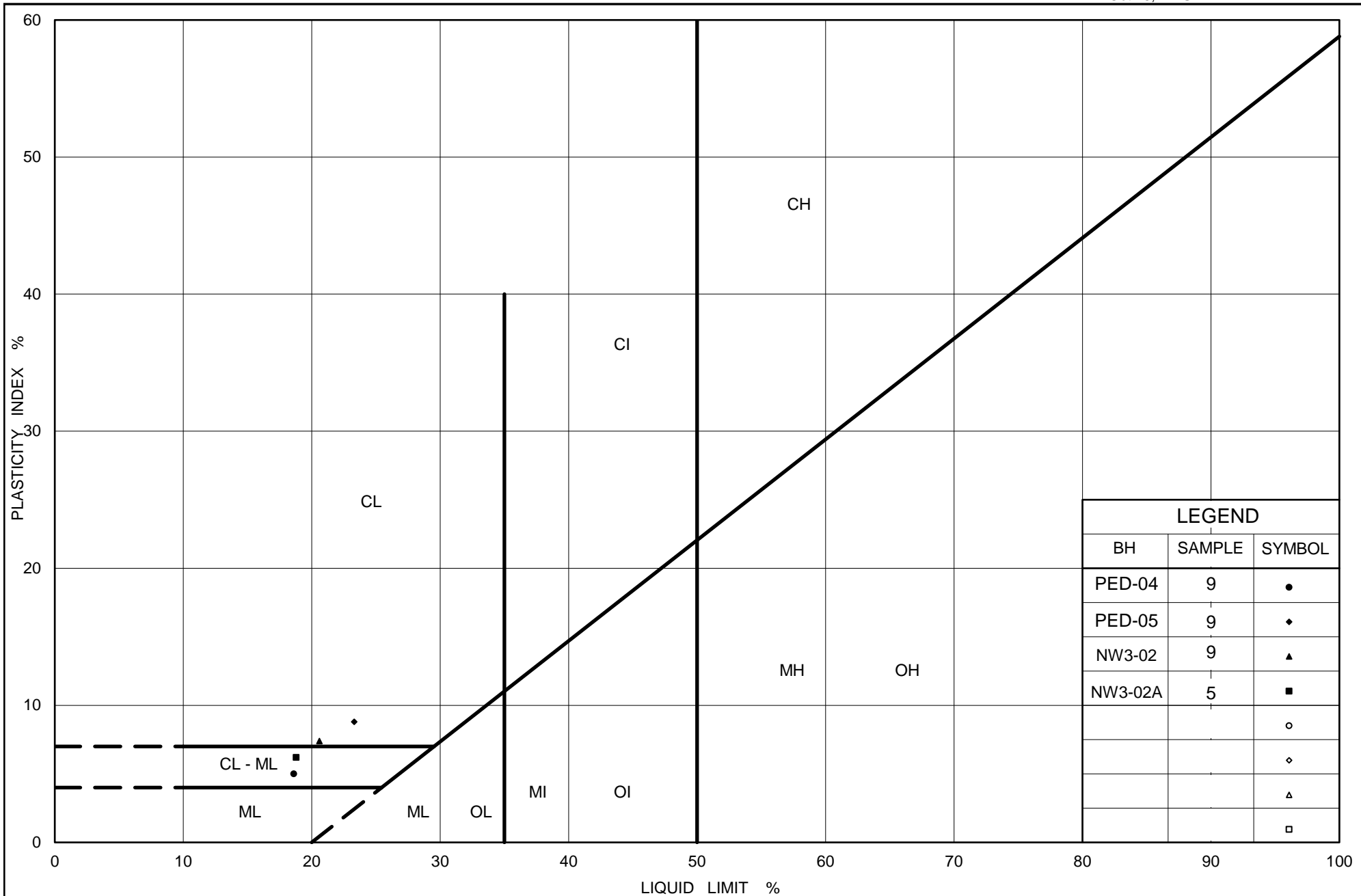
## PLASTICITY CHART

### Clayey Silt (Till)

Figure No. B7A

Project No. 1662333

Checked By: GDS



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## PLASTICITY CHART

### Clayey Silt (Till)

Figure No. B7B

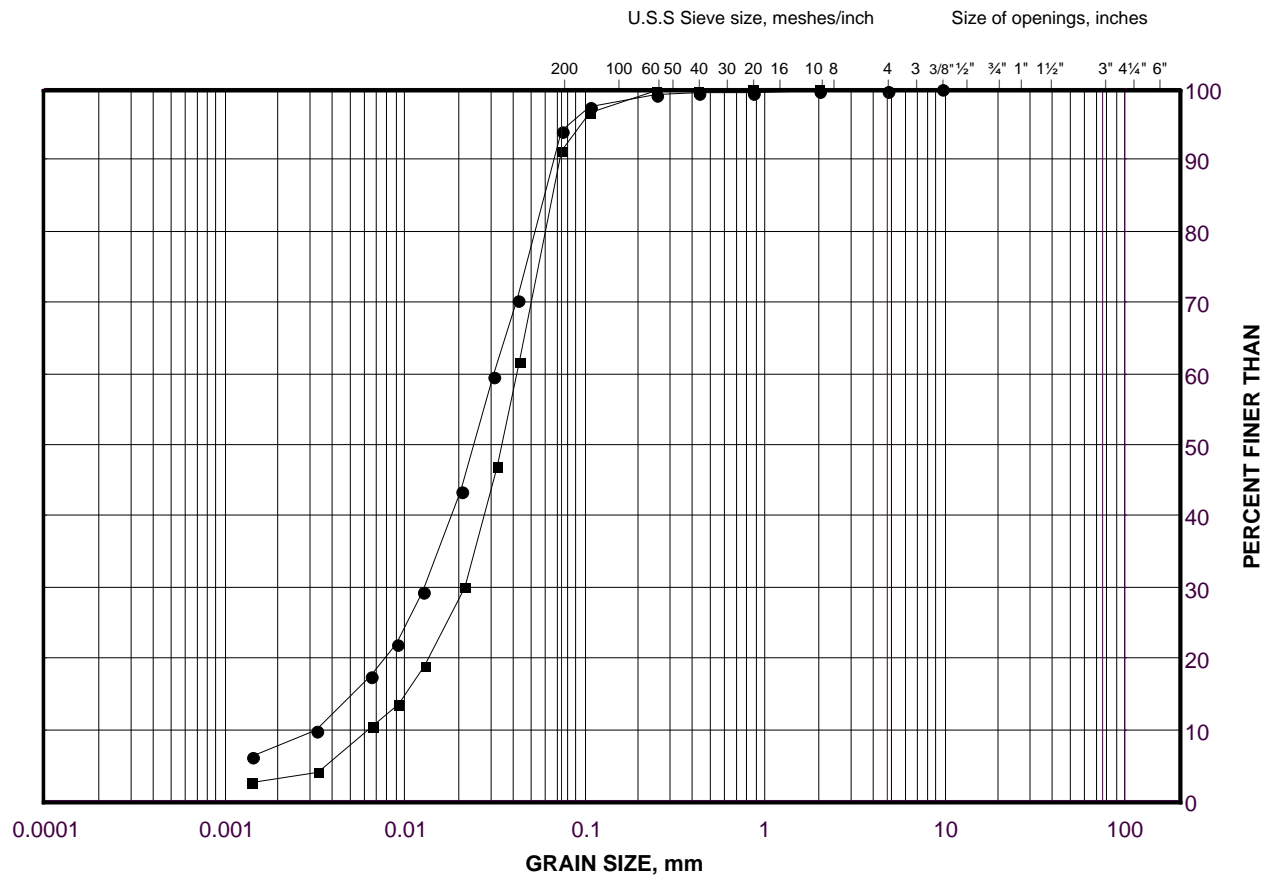
Project No. 1662333

Checked By: GDS

# GRAIN SIZE DISTRIBUTION

Silt

FIGURE B8



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

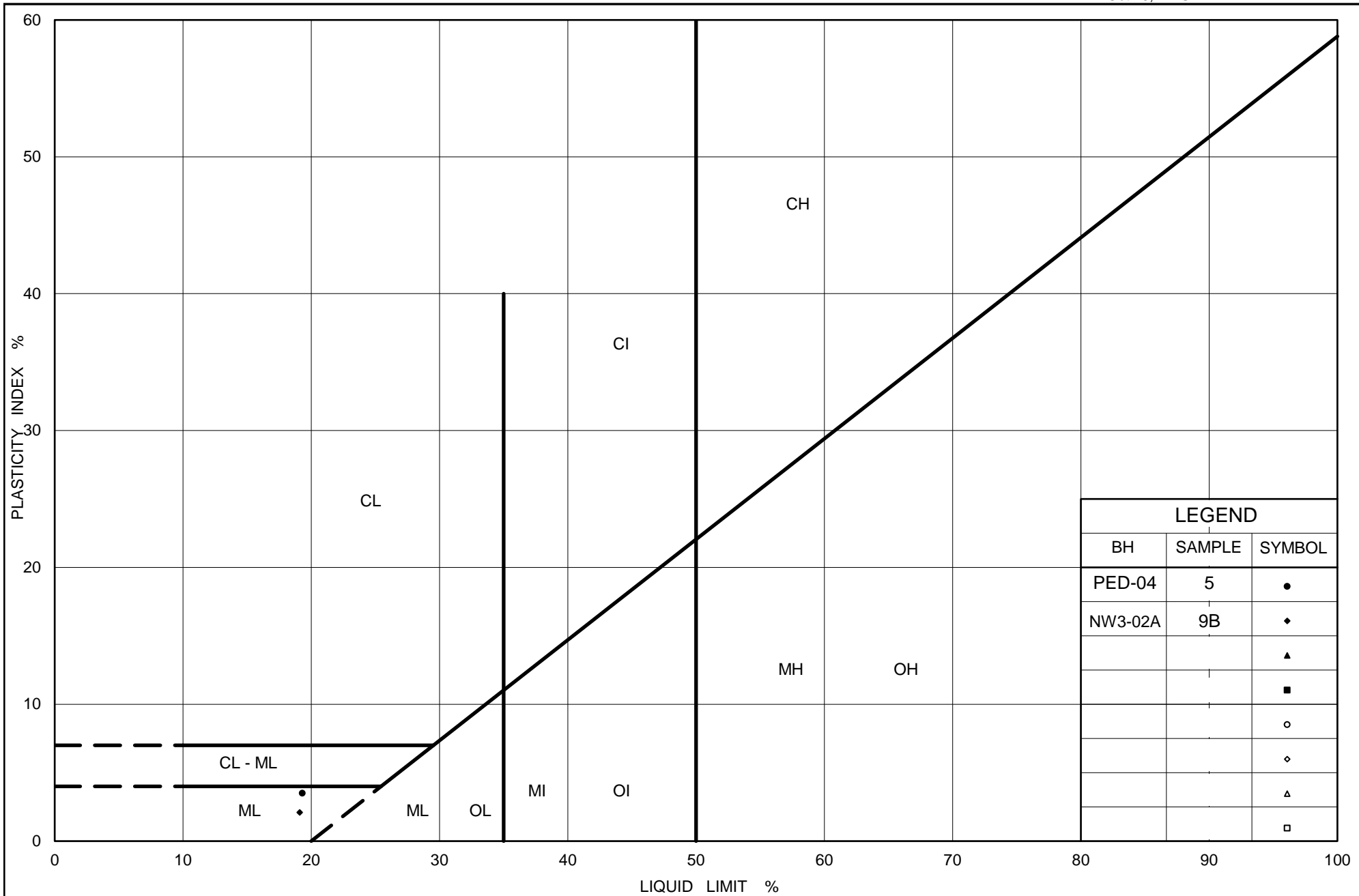
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	PED-04	5	89.6
■	PED-05	7	89.5

Project Number: 1662333

Checked By: GDS

**Golder Associates**

Date: 19-Jan-18



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# PLASTICITY CHART Silt

Figure No. B9

Project No. 1662333

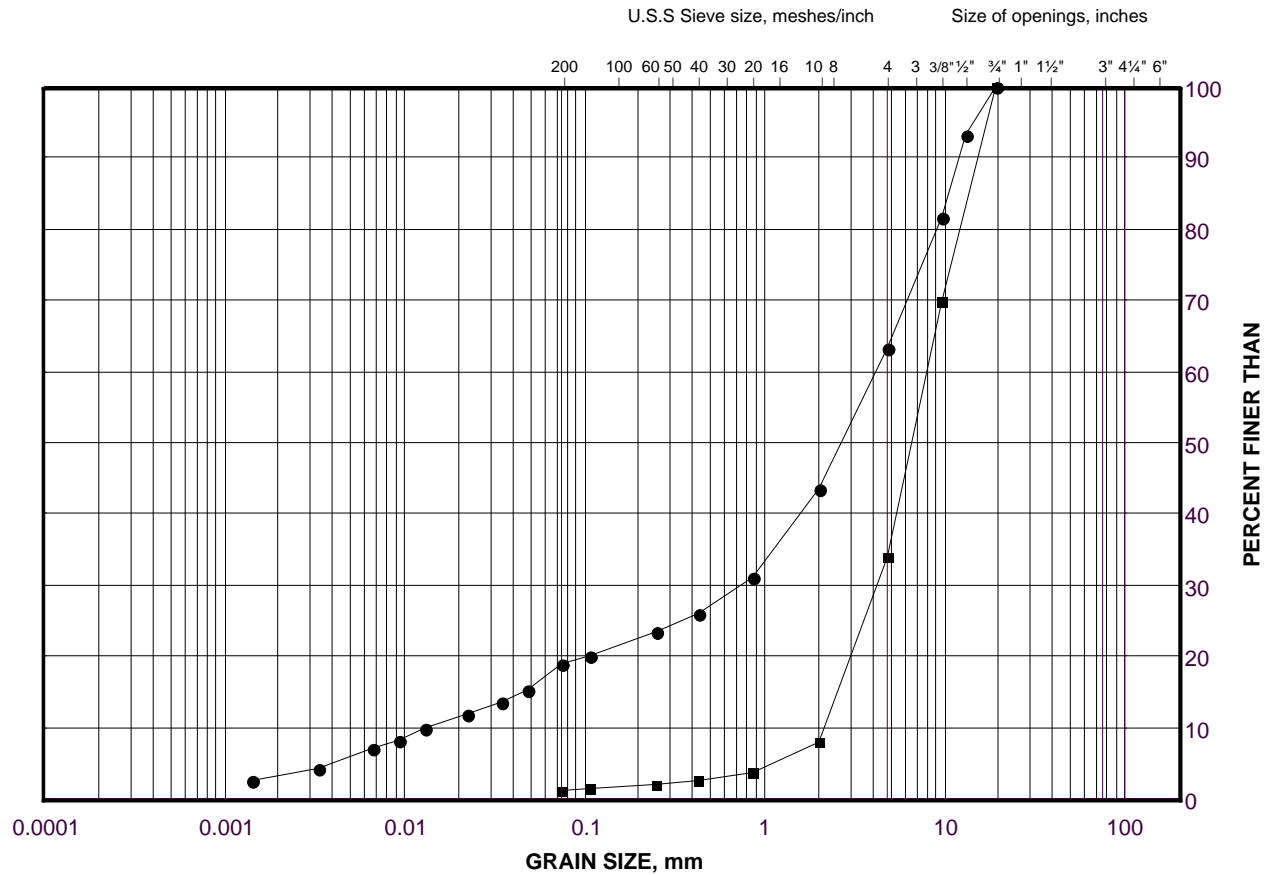
Checked By: GDS



# GRAIN SIZE DISTRIBUTION

Sand and Gravel

FIGURE B10



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

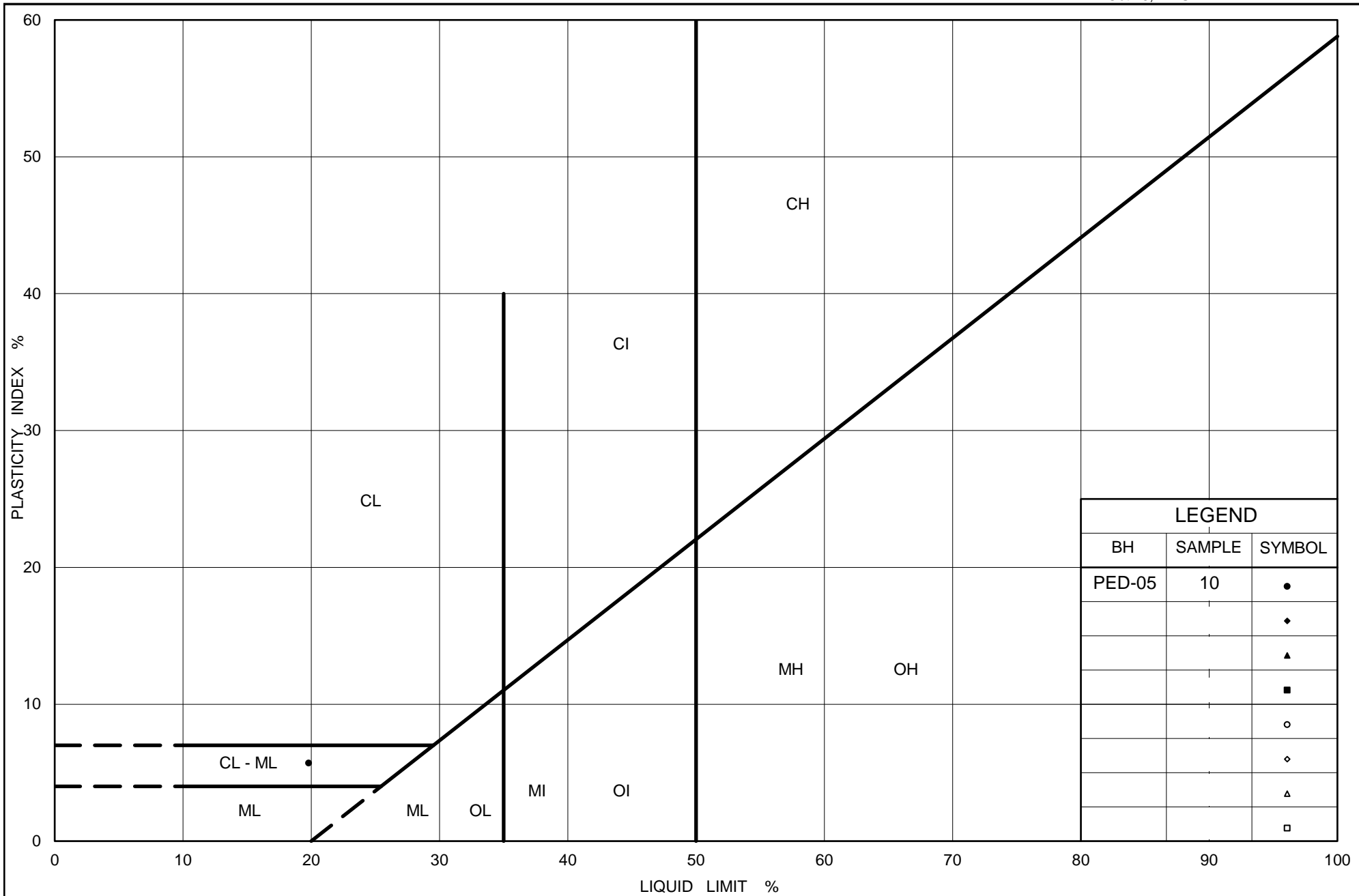
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-02A	13	69.2
■	PED-02	7	90.6

Project Number: 1662333

Checked By: GDS

**Golder Associates**

Date: 22-Jan-18



Ministry of Transportation

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# PLASTICITY CHART Clayey Silt (Residual Soil)

Figure No. B11

Project No. 1662333

Checked By: GDS

## PED-01



22.32 m – 25.41 m

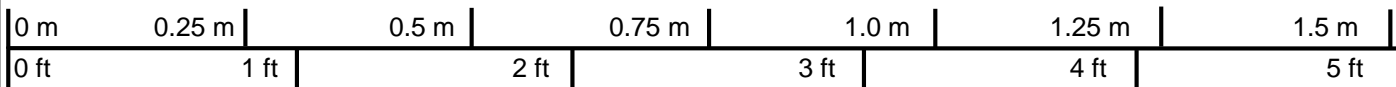
## Borehole NW3-01



11.78 m – 13.90 m



13.90 m – 15.42 m



Scale

PROJECT MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW Between Mississauga Road and Hurontario Street

TITLE

## Bedrock Core Photographs Boreholes PED-01 and NW3-01



PROJECT No. 1662333		FILE No. ----	
DESIGN	MWK		REV.
CADD	--		
CHECK	GDS		
REVIEW	JMAC		

**FIGURE B12**

### Borehole PED-03B



14.80 m – 17.77 m

### Borehole PED-04



10.41 m – 13.50 m

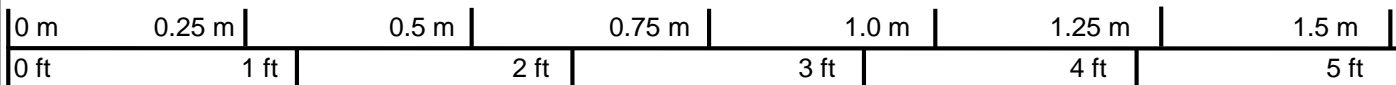
### Borehole PED-05



10.71 m – 13.36 m



13.36 m – 13.71 m



Scale

PROJECT MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW Between Mississauga Road and Hurontario Street

TITLE **Bedrock Core Photographs  
Boreholes PED-03B to PED-05**



PROJECT No. 1662333		FILE No. ----	
DESIGN	MWK		REV.
CADD	--		
CHECK	GDS		
REVIEW	JMAC		

**FIGURE B13**

January 03, 2018

Mr. David Marmor  
Golder Associates Ltd.  
6925 Century Avenue, Suite #100  
Mississauga, Ontario  
Canada L5N 7K2

Re: UCS + E testing  
(Golder Project No. 166233)

Dear Mr. Marmor:

On November 25, 2017 one (1) HQ-sized core sample was received by Geomechanica Inc. via drop-off by Golder personnel. On December 22, 2017 an additional three (3) HQ-sized core samples were received by Geomechanica Inc. via drop-off by Golder personnel. These samples were identified as being from boreholes drilled as part of Golder project 166233 (denoted as QEW South Ped. Bridge and QEW and Mississauga Road UCS samples). A uniaxial compressive strength (UCS) specimen was prepared and tested from each of these samples (4 tests total).

Details regarding the steps of specimen preparation and testing along with the test results and specimen photographs before and after testing are presented in the accompanying laboratory report.

Sincerely,



Giovanni Grasselli Ph.D., P. Eng.

Geomechanica Inc.  
Tel: (647) 478-9767  
Email: [giovanni.grasselli@geomechanica.com](mailto:giovanni.grasselli@geomechanica.com)

# Rock Laboratory Testing Results

**A report submitted to:**

David Marmor  
Golder Associates Ltd.  
6925 Century Avenue, Suite #100  
Mississauga, Ontario  
Canada L5N 7K2

**Prepared by:**

Bryan Tatone, PhD  
Omid Mahabadi, PhD  
Giovanni Grasselli, PhD, PEng

Geomechanica Inc  
#900-390 Bay St  
Toronto ON  
M5H 2Y2 Canada  
Tel: +1-647-478-9767  
info@geomechanica.com

**January 3, 2018**

Project number: 1662333

**Abstract**

This document summarizes the results of 4 uniaxial compression tests on HQ-sized core samples for Golder Project 1662333. Results including uniaxial compressive strength (UCS) and Young's modulus along with photographs of samples before and after testing are presented.

**In this document:**

1	Overview	1
2	Results	2

## 1 Overview

This report summarizes the results of 4 uniaxial compression tests on HQ-sized core samples for Golder Project 1662333. The tests were performed in Geomechanica's laboratory in Oakville, Ontario, Canada using a 1.3 MN capacity Forney compression testing machine (Figure 1). The specimens were loaded with a nearly constant axial displacement rate of 0.150 mm/min. The specimen preparation and testing procedure included the following:

1. Unwrapping of the core samples, inspecting them for damage, and re-wrapping them in electrical tape to minimize disturbance during subsequent specimen preparation.
2. Diamond cutting of core samples to obtain cylindrical specimens with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Surface grinding of specimens to obtain flat (within  $\pm 0.025$  mm) and parallel end faces (within  $0.25^\circ$ ).
4. Placing each specimen into the loading frame, applying a 0.5-1.0 kN axial load, removing the electrical tape, and subsequently increasing the axial load gradually to cause rupture while continuously recording axial force and axial deformation to determine peak strength (UCS) and (tangent) Young's modulus.



Figure 1: UCS Test setup.



## 2 Results

The results of the tests are summarized in Table 1. The corresponding stress-strain curves for the uniaxial compression tests are presented in Figure 2. Young's modulus is the tangent modulus, calculated as the slope of the best fit line through  $\pm 300$  data points on either side of the point representing 50.0% of the peak strength.

Table 1: Summary of laboratory test results.

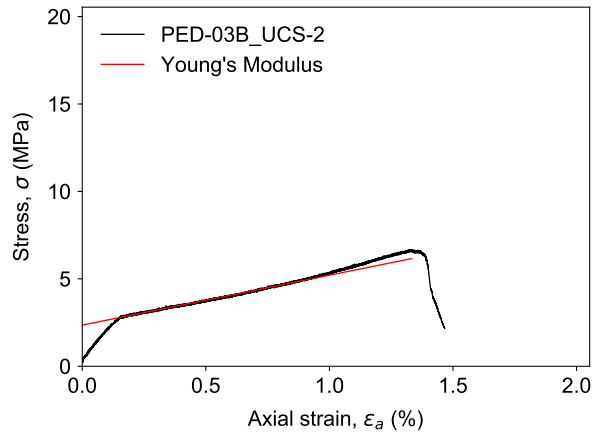
Sample	Depth (m)	Bulk density $\rho$ (g/cm <sup>3</sup> )	UCS (MPa)	Young's Modulus $E$ (GPa)	Notes
PED-03B, UCS-2	16.03 - 16.27	2.57	6.7	0.29	1
MO-10, UCS-2	2.68 - 2.83	2.60	19.6	0.86	1
MO-12, UCS-2	4.15 - 4.27	2.60	17.3	1.00	1,2
MO-11, UCS-3	3.66 - 3.79	2.59	18.3	0.97	1,2,3 - 2 layers 8 - 20 mm thick
Mean		2.59	15.5	0.8	
Standard Deviation		0.02	5.1	0.3	

<sup>1</sup> Specimen emitted fresh pore water upon loading  
<sup>2</sup> Length:diameter ratio < 2:1  
<sup>3</sup> Contains limestone layers

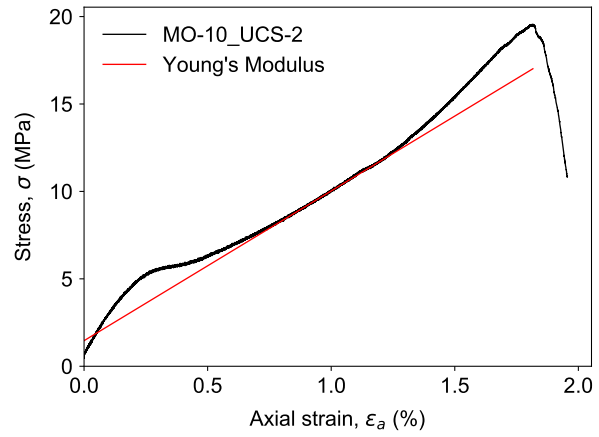
### 2.1 Specimen photographs

Photographs of the specimens before and after testing are presented in Figure 3.

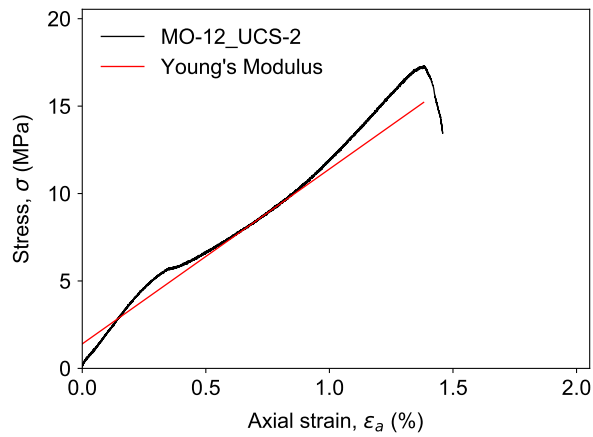




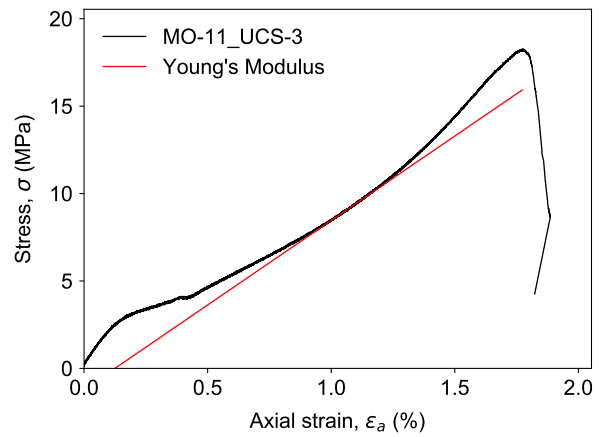
(a) PED-03B, UCS-2



(b) MO-10, UCS-2



(c) MO-12, UCS-2



(d) MO-11, UCS-3

Figure 2: Measured stress-strain curves.

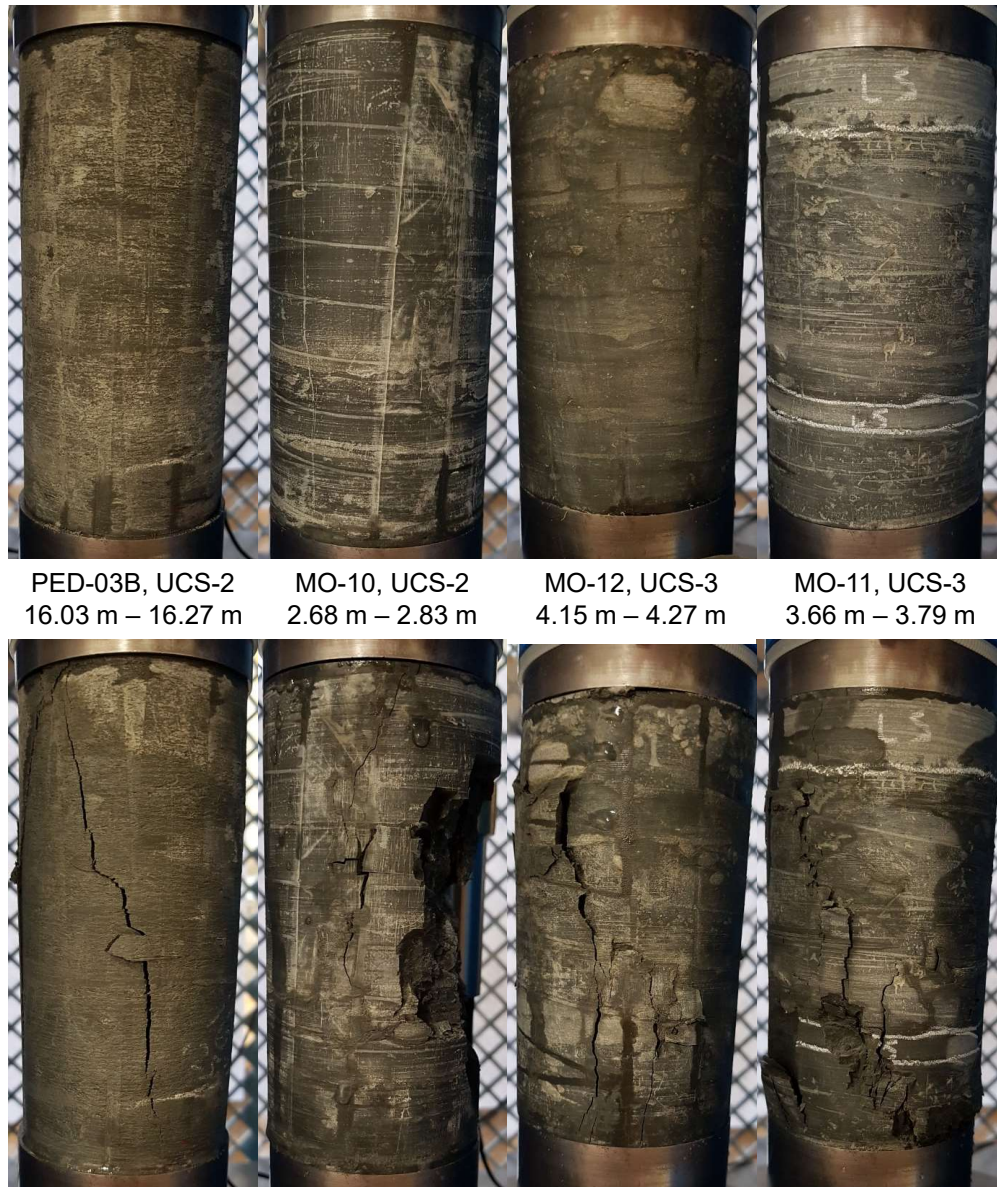


Figure 3: Photographs of specimens prior to testing.

Your Project #: 1662333  
Site Location: QEW/CREDIT RIVER  
Your C.O.C. #: 51329

**Attention:David Marmor**

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

**Report Date: 2017/11/21**  
Report #: R4869236  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B7P4571**

**Received: 2017/11/13, 12:50**

Sample Matrix: Soil  
# Samples Received: 3

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	3	N/A	2017/11/17	CAM SOP-00463	EPA 325.2 m
Conductivity	3	N/A	2017/11/20	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	3	2017/11/17	2017/11/17	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2017/11/13	2017/11/20	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	3	N/A	2017/11/17	CAM SOP-00464	EPA 375.4 m

**Remarks:**

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam 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.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam 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 Maxxam, unless otherwise agreed in writing.

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.

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.

Your Project #: 1662333  
Site Location: QEW/CREDIT RIVER  
Your C.O.C. #: 51329

**Attention:David Marmor**

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

**Report Date: 2017/11/21**  
Report #: R4869236  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B7P4571**  
**Received: 2017/11/13, 12:50**

Encryption Key

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

Ema Gitej, Senior Project Manager

Email: EGitej@maxxam.ca

Phone# (905)817-5829

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B7P4571  
Report Date: 2017/11/21

Golder Associates Ltd  
Client Project #: 1662333  
Site Location: QEW/CREDIT RIVER  
Sampler Initials: JC

### RESULTS OF ANALYSES OF SOIL

Maxxam ID		FNR708			FNR708		FNR709	FNR710		
Sampling Date		2017/10/16 16:00			2017/10/16 16:00		2017/10/20 10:00	2017/10/26 13:30		
COC Number		51329			51329		51329	51329		
	UNITS	NW3-01 SA7	RDL	QC Batch	NW3-01 SA7 Lab-Dup	QC Batch	CRB-06 RC-01 6.00-6.05	PED-03 SA8	RDL	QC Batch

#### Calculated Parameters

Resistivity	ohm-cm	490		5263307			5000	1300		5263307
-------------	--------	-----	--	---------	--	--	------	------	--	---------

#### Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	1000	40	5268736			<20	350	20	5268736
Conductivity	umho/cm	2040	2	5273678			201	762	2	5273678
Available (CaCl2) pH	pH	7.86		5270614	7.93	5270614	8.11	7.73		5270614
Soluble (20:1) Sulphate (SO4)	ug/g	69	20	5268737			30	70	20	5268737

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Maxxam Job #: B7P4571  
Report Date: 2017/11/21

Golder Associates Ltd  
Client Project #: 1662333  
Site Location: QEW/CREDIT RIVER  
Sampler Initials: JC

## TEST SUMMARY

**Maxxam ID:** FNR708  
**Sample ID:** NW3-01 SA7  
**Matrix:** Soil

**Collected:** 2017/10/16  
**Shipped:**  
**Received:** 2017/11/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5268736	N/A	2017/11/17	Deonarine Ramnarine
Conductivity	AT	5273678	N/A	2017/11/20	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5270614	2017/11/17	2017/11/17	Tahir Anwar
Resistivity of Soil		5263307	2017/11/20	2017/11/20	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5268737	N/A	2017/11/17	Deonarine Ramnarine

**Maxxam ID:** FNR708 Dup  
**Sample ID:** NW3-01 SA7  
**Matrix:** Soil

**Collected:** 2017/10/16  
**Shipped:**  
**Received:** 2017/11/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5270614	2017/11/17	2017/11/17	Tahir Anwar

**Maxxam ID:** FNR709  
**Sample ID:** CRB-06 RC-01 6.00-6.05  
**Matrix:** Soil

**Collected:** 2017/10/20  
**Shipped:**  
**Received:** 2017/11/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5268736	N/A	2017/11/17	Deonarine Ramnarine
Conductivity	AT	5273678	N/A	2017/11/20	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5270614	2017/11/17	2017/11/17	Tahir Anwar
Resistivity of Soil		5263307	2017/11/20	2017/11/20	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5268737	N/A	2017/11/17	Deonarine Ramnarine

**Maxxam ID:** FNR710  
**Sample ID:** PED-03 SA8  
**Matrix:** Soil

**Collected:** 2017/10/26  
**Shipped:**  
**Received:** 2017/11/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5268736	N/A	2017/11/17	Deonarine Ramnarine
Conductivity	AT	5273678	N/A	2017/11/20	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5270614	2017/11/17	2017/11/17	Tahir Anwar
Resistivity of Soil		5263307	2017/11/20	2017/11/20	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5268737	N/A	2017/11/17	Deonarine Ramnarine

### GENERAL COMMENTS

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

Package 1	5.3°C
-----------	-------

**Results relate only to the items tested.**

## QUALITY ASSURANCE REPORT

Golder Associates Ltd  
Client Project #: 1662333  
Site Location: QEW/CREDIT RIVER  
Sampler Initials: JC

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5268736	Soluble (20:1) Chloride (Cl)	2017/11/17	NC	70 - 130	103	70 - 130	<20	ug/g	14	35
5268737	Soluble (20:1) Sulphate (SO4)	2017/11/17	NC	70 - 130	107	70 - 130	<20	ug/g	13	35
5270614	Available (CaCl2) pH	2017/11/17			99	97 - 103			0.85	N/A
5273678	Conductivity	2017/11/20			100	90 - 110	<2	umho/cm	0	10

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)

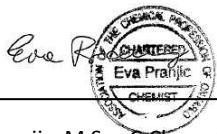


Maxxam Job #: B7P4571  
Report Date: 2017/11/21

Golder Associates Ltd  
Client Project #: 1662333  
Site Location: QEW/CREDIT RIVER  
Sampler Initials: JC

### VALIDATION SIGNATURE PAGE

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



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

---

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6740 Campobello Road, Mississauga, Ontario L5N 2L8 www.maxxam.ca  
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266

# CHAIN OF CUSTODY RECORD

51329

Page 1 of 1

INVOICE INFORMATION		REPORT INFORMATION (if differs from invoice)		PROJECT INFORMATION		TURNAROUND TIME (TAT) REQUIRED	
Company Name: <u>Golden Associates</u>	Company Name:	Quotation #:	<input checked="" type="checkbox"/> Regular TAT (5-7 days)		PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS  Rush TAT (Applicable Surcharge) <input type="checkbox"/> 1 Day (100%) <input type="checkbox"/> 2 Days (50%) <input type="checkbox"/> 3-4 Days (25%)		
Contact Name: <u>David Marmor</u>	Contact Name:	P.O. #:					
Address: <u>6925 Century Ave</u> <u>Suite #1000 Mississauga</u>	Address:	Project #:					
Phone: <u>905-792-8203</u> Fax: <u>905-567-6561</u>	Phone:	Site Location: <u>BEW/Agrocredit River</u>	Site #:				
Email: <u>david-marmor@golden.com</u>	Email:	Sampled By: <u>Jeremy Lebow</u>					
<b>MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY</b>				<b>ANALYSIS REQUESTED</b>		<b>Rush Confirmation #:</b>	
<b>REGULATION 153 (2011)</b>		<b>OTHER REGULATIONS</b>		<b>LABORATORY USE ONLY</b>  CUSTODY SEAL (Y/N) Present: <input checked="" type="checkbox"/> Intact: <input checked="" type="checkbox"/> COOLING MEDIA PRESENT (Y/N) <input checked="" type="checkbox"/>  Temperature (°C) on Receipt: <u>4/17</u>		<b>COMMENTS / TAT COMMENTS</b>	
<input 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 4	<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWQO Municipality: <input type="checkbox"/> Other (Specify): <input type="checkbox"/> REG.558 (MINIMUM 3 DAY TAT REQUIRED)						
FOR RSC (PLEASE CIRCLE) YES / NO							
Include Criteria on Certificate of Analysis (Y/N)? <u>N</u>							
SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM							
SAMPLE IDENTIFICATION		DATE SAMPLED	TIME SAMPLED	MATRIX	# OF CONT.		
1 <u>NW3-01 Sa 7</u>		<u>17/10/16</u>	<u>4 pm</u>	<u>Soil</u>	<u>1</u>		
2 <u>CRB-06 RC-01 6.00-6.05</u>		<u>17/10/20</u>	<u>10 am</u>	<u>Soil/Rock</u>	<u>1</u>		
3 <u>PED-03 Sa 8</u>		<u>17/10/26</u>	<u>1:30 pm</u>	<u>Soil</u>	<u>1</u>		
4							
5							
6							
7							
8							
9							
10							
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME:	RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME:
<u>[Signature]</u>		<u>2017/11/13</u>	<u>12:50</u>	<u>Toussaint Tsimon</u>		<u>2017/11/13</u>	<u>12:50</u>
# JARS USED AND NOT SUBMITTED		MAXXAM JOB #					

COC-1004 (11/13) - ENV. ENG.

Maxxam Analytics International Corporation o/a Maxxam Analytics

White: Maxxam - Yellow: Client

Your Project #: 1662333  
Your C.O.C. #: 628368-03-01

**Attention:Darcy Hansen**

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

**Report Date: 2017/12/22**  
Report #: R4919587  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B7S6098**

**Received: 2017/12/18, 12:10**

Sample Matrix: Soil  
# Samples Received: 3

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	3	N/A	2017/12/20	CAM SOP-00463	EPA 325.2 m
Conductivity	3	N/A	2017/12/20	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	3	2017/12/20	2017/12/20	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2017/12/18	2017/12/20	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	3	N/A	2017/12/20	CAM SOP-00464	EPA 375.4 m

**Remarks:**

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam 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.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam 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 Maxxam, unless otherwise agreed in writing.

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.

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.

Your Project #: 1662333  
Your C.O.C. #: 628368-03-01

**Attention:Darcy Hansen**

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

**Report Date: 2017/12/22**  
Report #: R4919587  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B7S6098**  
**Received: 2017/12/18, 12:10**

Encryption Key

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

Ema Gitej, Senior Project Manager

Email: EGitej@maxxam.ca

Phone# (905)817-5829

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

### RESULTS OF ANALYSES OF SOIL

Maxxam ID		FUA858	FUA859	FUA860		
Sampling Date		2017/12/06	2017/11/21	2017/11/17		
COC Number		628368-03-01	628368-03-01	628368-03-01		
	UNITS	PED-02 SA13	NW3-02A SA12	NW3-02A SA2	RDL	QC Batch
<b>Calculated Parameters</b>						
Resistivity	ohm-cm	1900	3500	2000		5321386
<b>Inorganics</b>						
Soluble (20:1) Chloride (Cl)	ug/g	210	38	78	20	5322621
Conductivity	umho/cm	522	284	494	2	5324617
Available (CaCl2) pH	pH	7.84	7.93	7.70		5324560
Soluble (20:1) Sulphate (SO4)	ug/g	95	120	330	20	5324793
RDL = Reportable Detection Limit						
QC Batch = Quality Control Batch						

## TEST SUMMARY

**Maxxam ID:** FUA858  
**Sample ID:** PED-02 SA13  
**Matrix:** Soil

**Collected:** 2017/12/06  
**Shipped:**  
**Received:** 2017/12/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5322621	N/A	2017/12/20	Alina Dobreanu
Conductivity	AT	5324617	N/A	2017/12/20	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5324560	2017/12/20	2017/12/20	Tahir Anwar
Resistivity of Soil		5321386	2017/12/20	2017/12/20	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5324793	N/A	2017/12/20	Alina Dobreanu

**Maxxam ID:** FUA859  
**Sample ID:** NW3-02A SA12  
**Matrix:** Soil

**Collected:** 2017/11/21  
**Shipped:**  
**Received:** 2017/12/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5322621	N/A	2017/12/20	Alina Dobreanu
Conductivity	AT	5324617	N/A	2017/12/20	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5324560	2017/12/20	2017/12/20	Tahir Anwar
Resistivity of Soil		5321386	2017/12/20	2017/12/20	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5324793	N/A	2017/12/20	Alina Dobreanu

**Maxxam ID:** FUA860  
**Sample ID:** NW3-02A SA2  
**Matrix:** Soil

**Collected:** 2017/11/17  
**Shipped:**  
**Received:** 2017/12/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5322621	N/A	2017/12/20	Alina Dobreanu
Conductivity	AT	5324617	N/A	2017/12/20	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5324560	2017/12/20	2017/12/20	Tahir Anwar
Resistivity of Soil		5321386	2017/12/20	2017/12/20	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5324793	N/A	2017/12/20	Alina Dobreanu

### GENERAL COMMENTS

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

Package 1	2.3°C
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Sample FUA860 [NW3-02A SA2] : SO4 Analysis: Analysis was performed past the recommended sample holding time. This may increase the variability associated with these results.

**Results relate only to the items tested.**

## QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5322621	Soluble (20:1) Chloride (Cl)	2017/12/20	NC	70 - 130	106	70 - 130	<20	ug/g	21	35
5324560	Available (CaCl <sub>2</sub> ) pH	2017/12/20			99	97 - 103			0.19	N/A
5324617	Conductivity	2017/12/20			100	90 - 110	<2	umho/cm	0.20	10
5324793	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2017/12/20	NC	70 - 130	107	70 - 130	<20	ug/g	NC	35

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).



### VALIDATION SIGNATURE PAGE

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

*Cristina Carriere*

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Cristina Carriere, Scientific Service Specialist

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



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# CHAIN OF CUSTODY RECORD

Page 1 of 2

<b>INVOICE TO:</b>		<b>REPORT TO:</b>		<b>PROJECT INFORMATION:</b>		<b>Laboratory Use Only:</b>	
Company Name: #1326 Golder Associates Ltd	Company Name: Darcy Hansen	Quotation #: B20916	Maxxam Job #:	Bottle Order #:			
Attention: Accounts Payable	Attention: Darcy Hansen	P.O. #: 1071122	628368				
Address: 6925 Century Ave Suite 100	Address:	Project: 1667333					
Mississauga ON L5N 7K2		Project Name:			COC #:		Project Manager:
Tel: (905) 567-4444 x Fax: (905) 567-6561 x	Tel: (905) 567-4444 x2064 Fax:	Site #:			C#628368-03-01		Ema Gitej
Email: AP_CustomerService@golder.com	Email: Darcy_Hansen@golder.com	Sampled By:					

<b>MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY</b>					<b>ANALYSIS REQUESTED (PLEASE BE SPECIFIC)</b>										<b>Turnaround Time (TAT) Required:</b>	
															<b>Please provide advance notice for rush projects</b>	
<b>Regulation 153 (2011)</b>					<b>Other Regulations</b>					<b>Special Instructions</b>					<b>Regular (Standard) TAT:</b>	
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/Fine					<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw										<b>(will be applied if Rush TAT is not specified):</b>	
<input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse					<input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw										<b>Standard TAT = 5-7 Working days for most tests.</b>	
<input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC					<input type="checkbox"/> MISA Municipality										<b>Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are &gt; 5 days - contact your Project Manager for details.</b>	
<input type="checkbox"/> Table					<input type="checkbox"/> PWGO										<b>Job Specific Rush TAT (if applies to entire submission)</b>	
					<input type="checkbox"/> Other										<b>Date Required:</b> Time Required: <input type="checkbox"/>	
<b>* Include Criteria on Certificate of Analysis (Y/N)?</b>															<b>Rush Confirmation Number:</b> (call lab for #)	
															<b># of Bottles</b>	
															<b>Comments</b>	
1 PED-02 SA13 2017/12/6 SOIL					Field Filtered (please circle): Metals / Hg / Cr / VI					Chloride & SO4 (20:1 extract)					1	
2 NW3-02A SA12 2017/11/21 SOIL										Conductivity/Resistivity					1	
3 NW3-02A SA2 2017/11/17 SOIL										pH CaCl2 EXTRACT					1	
4										Sulphide (Maxxam BC)						
5																
6																
7																
8																
9																
10																

<b>* RELINQUISHED BY: (Signature/Print)</b>		<b>Date: (YY/MM/DD)</b>		<b>Time</b>		<b>RECEIVED BY: (Signature/Print)</b>		<b>Date: (YY/MM/DD)</b>		<b>Time</b>		<b># jars used and not submitted</b>		<b>Laboratory Use Only</b>	
Darcy Hansen		17/12/18		9am		G. Givon		2018/12/18		12:10				Time Sensitive	
														Temperature (°C) of Recl	
														Custody Seal Present Intact	
														Yes No	

\* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

\* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

\*\* SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

White: Maxxa Yellow: Client

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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