



## Foundation Investigation Report

*Sign Supports, Highway 48 and Bloomington Road Roundabout (Lat. 44.000847, Long. -79.289013), York Region, Ontario, Ministry of Transportation, Ontario, G.W.P. No. 2086-16-00*

Submitted to:

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## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed sign support foundations associated with the proposed Highway 48 / Bloomington Road Roundabout, between Bloomington and Lemonville, Ontario, under G.W.P. 2086-16-00, at the location shown on the Key Plan on Drawing 1.

The Terms of Reference for the foundation engineering services are outlined in MTO's Work Item Order No. 2016-E-0029-009, dated December 2017, which forms part of the Consultant's Assignment for the Central Region Large Value Retainer under Agreement No. 2016-E-0029-009.

## 2.0 SITE DESCRIPTION

The proposed Steel Column (Breakaway Type) Signs and Trichord Overhead Signs are located within a 500 m radius of the Highway 48 and Bloomington Road intersection, in the Town of Whitchurch-Stouffville. The Steel Column Signs are located on Highway 48 about 350 m and 500 m to the north and south of the intersection. The Trichord Overhead Signs are located on Highway 48 and on Bloomington Road within 150 m of the intersection, on the four approaches (north, south, east and west) to the intersection.

An Esso gas station is located on the southwest corner of the intersection. Residential areas and farmland are located north and southeast of the intersection. The topography of the site is generally flat-lying but rises from south to north, from about Elevation 314 m at the southernmost project limit to about Elevation 340 m at the northernmost project limit.

## 3.0 INVESTIGATION PROCEDURES

The field work for the foundation investigations for the sign supports was carried out between March 4 and 12, 2018, during which time 12 boreholes (designated as Boreholes S1-1, S1-2, S2-1, S2-2, S3-1, S3-2, S4-1, S4-2, and GM-1 to GM-4) were advanced at the locations shown on Drawing 1.

The field borehole investigation was carried out using a CME 75 truck mounted drill rig, supplied and operated by Geo-Environmental Drilling Inc. of Acton, Ontario. The boreholes were advanced through the overburden using 153 mm outside diameter (O.D.) hollow stem augers to depths of 8.2 m below existing ground surface.

Soil samples were obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586)<sup>1</sup>.

The groundwater conditions in the open boreholes were observed during and immediately following the drilling operations. All boreholes were backfilled with bentonite to / near the surface, in accordance with Ontario Regulation 903, Wells (as amended) and two boreholes were sealed at ground surface with cold patch asphalt.

The field work was monitored on a full-time basis by a member of Golder's technical staff who located the boreholes in the field, directed the sampling and in situ testing operations, logged the boreholes and examined the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further visual review and geotechnical laboratory testing on selected samples. The geotechnical laboratory index and classification testing; consisting of natural moisture content, Atterberg limits and grain size distribution was conducted in accordance with MTO and / or ASTM Standards as

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<sup>1</sup> ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

applicable. One soil sample obtained during the field investigation from each of the boreholes, using appropriate sampling protocols, was submitted to a specialist analytical laboratory under chain of custody procedures for testing of conductivity / resistivity, pH chemical analysis of sulphate and chloride content, to assess the potential for the soil to cause deterioration to buried concrete and corrosion to steel.

The borehole locations were marked in the field by Golder personnel relative to existing road features and pre-selected coordinates using a hand-held GPS. The locations given in the Record of Borehole sheets and shown on Drawing 1 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.

Borehole No.	MTM NAD83 (Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude)	Easting (m) (Longitude)		
S1-1	4,873,419.6 (44.000578)	321,578.1 (-79.290794)	326.7	8.2
S1-2	4,873,398.5 (44.000389)	321,567.7 (-79.290924)	327.3	8.2
S2-1	4,873,471.3 (44.001039)	321,817.8 (-79.287803)	325.3	8.2
S2-2	4,873,492.4 (44.001228)	321,815.3 (-79.287834)	324.9	8.2
S3-1	4,873,332.3 (43.999789)	321,756.3 (-79.288574)	323.8	8.2
S3-2	4,873,325.5 (43.999728)	321,728.3 (-79.288923)	324.2	8.2
S4-1	4,873,567.7 (44.001909)	321,710.0 (-79.289144)	329.6	8.2
S4-2	4,873,556.7 (44.001810)	321,683.9 (-79.289470)	329.1	8.2
GM-1	4,872,923.6 (43.996108)	321,824.2 (-79.287740)	314.4	8.2
GM-2	4,873,015.7 (43.996938)	321,805.1 (-79.287976)	316.6	8.2
GM-3	4,873,804.2 (44.004039)	321,653.3 (-79.289844)	337.0	8.2
GM-4	4,873,931.9 (44.005188)	321,629.2 (-79.290140)	340.1	8.2

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

The site is located at the boundary of the Oak Ridges Moraine and South Slope physiographic regions, according to *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)<sup>2</sup>

The Oak Ridges Moraine is hilly, with a knob-and-basin relief typical of end moraines. The hills are mostly composed of sand and gravel, however, some are formed of till which protrudes above the sands. The South Slope is a smooth and drumlinized till plain that has formed as a result of glacial action and deposition of till materials just south of the Oak Ridges Moraine.

### 4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation and the results of the geotechnical laboratory tests carried out on selected soil samples are presented on the Record of Borehole 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 Section 4.2 are uncorrected. The results of the geotechnical laboratory testing on soil samples are also presented in Appendix B. The results of the analytical testing are discussed in Section 4.4 and are provided in Appendix C.

The stratigraphic boundaries shown on the Record of Borehole sheets 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 sheets governs any interpretation of the site conditions.

In general, the stratigraphy encountered at the various borehole locations typically consists of surface layer of asphalt at the locations of boreholes drilled through the pavement, or granular fill, underlain by a cohesive till deposit, in places further underlain by a sand and / or sand and gravel deposits.

Detailed descriptions of the subsurface conditions are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit.

#### 4.2.1 Asphalt

An approximately 127 mm and 152 mm thick layer of asphalt pavement was encountered at ground surface in Boreholes S1-1 and S3-2.

#### 4.2.2 Fill

A 0.7 m to 2.3 m thick layer of fill was encountered underlying the asphalt pavement in Boreholes S1-1 and S3-2, and at ground surface in the remaining ten boreholes. The surface of the fill layer was encountered between Elevations 340.1 m and 314.4 m, and the base of the fill layer was encountered between Elevations 338.9 m and 312.9 m.

The fill is variable in composition but is mainly non-cohesive and is comprised of sandy silt to sand, gravelly sand and sand and gravel. Cobble fragments were noted within the granular fill layer in Borehole GM-2, and grinding of the augers was observed in a Borehole S1-2. A hydrocarbon odour was noted below a depth of 0.7 m in Borehole S1-1 and in all the samples in Borehole S1-2. A 0.5 m and 0.2 m thick layer of cohesive fill

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

was encountered in Boreholes GM-3 and GM-4, respectively, and is comprised of sandy clayey silt to clayey silt with sand containing trace to some gravel. Trace organics or rootlets were encountered in the fill layer in Boreholes S1-1, S2-2, S3-1 and GM-4.

The Standard Penetration Test (SPT) “N”-values measured within the non-cohesive fill deposit range from 8 blows to 50 blows per 0.3 m of penetration, indicating a loose to very dense level of compactness. The SPT “N”-value measured within the cohesive fill is 25 blows per 0.3 m of penetration, suggesting a very stiff consistency. The natural water content measured on selected samples of the non-cohesive fill ranges from about 3 per cent to about 16 per cent.

#### **4.2.3 Clayey Silt to Sandy Clayey Silt**

A 0.6 m to 3.4 m thick deposit of clayey silt to sandy clayey silt was encountered underlying the fill in Boreholes S2-1 and GM-4. In Borehole GM-4 the clayey silt to sandy clayey silt deposit is interlayered with a 0.8 m thick sand deposit and 0.2 m thick organic silt deposit (see below). The surface of the clayey silt to sandy clayey silt deposit was encountered at Elevations 338.9 m and 323.9 m.

The SPT “N”-values measured within the clayey silt to sandy clayey silt deposit range from 7 blows to 44 blows per 0.3 m of penetration, suggesting a firm to hard consistency.

Grain size distribution testing was carried out on one sample of the clayey silt to sandy clayey silt and the result is shown on Figure B-1 in Appendix B. Atterberg limits testing was carried out on one sample of the clayey silt to clayey silt with sand deposit and measured a liquid limit of 23 per cent, a plastic limit of 15 per cent, and a corresponding plasticity index of 8 per cent. The results, which is plotted on a plasticity chart on Figure B-2 in Appendix B, indicates that the deposit consists of clayey silt of low plasticity. The natural water content measured on three selected samples of the clayey silt to sandy clayey silt ranges from about 8 per cent to about 21 per cent.

#### **4.2.4 Organic Silt**

A 0.2 m thick interlayer of organic silt was encountered within the clayey silt to sandy clayey silt deposit in Borehole GM-4. The surface of the organic silt layer was encountered at Elevation 337.9 m.

An organic content test was carried out on one sample of the organic silt layers and measured 6.1 per cent organics. The natural water content measured on one sample of the organic silt is 27 per cent.

#### **4.2.5 Sandy Clayey Silt to Gravelly Clayey Silt with Sand (Till)**

A 2.4 m to 6.4 m thick cohesive till deposit was encountered in all boreholes, except Boreholes S1-1, S1-2 and S4-2. The cohesive till is comprised of sandy clayey silt to clayey silt with sand to gravelly clayey silt with sand. The surface of the cohesive till deposit was encountered between Elevations 336.3 m and 313.0 m. Boreholes S2-1, S2-2, GM-1 and GM-4 were terminated within the cohesive till deposit, penetrating it for a thickness between 0.1 m and 6.0 m. In Boreholes S2-2, GM-1 and GM-2, 0.2 m to 0.6 m thick interlayers of silt and sand, sand, gravelly sand, and sand and gravel were encountered within the cohesive till deposit (see below). Grinding of the augers was observed in Boreholes S3-3 and S3-2. Trace organics were encountered in the cohesive deposit in Boreholes S2-1, S2-2 and S3-1.

The SPT “N”-values measured within the cohesive till range from 4 blows to 50 blows per 0.15 m of penetration, suggesting a firm to hard consistency.

Grain size distribution testing was carried out on 13 samples of the cohesive till and the results are shown on Figures B-3A and B-3B in Appendix B. Atterberg limits testing was carried out on 13 samples of the cohesive till deposit and measured liquid limits between 16 per cent and 24 per cent, plastic limits between 11 per cent and 15 per cent, and plasticity indices between 5 per cent and 11 per cent. These results, which are plotted on



a plasticity chart on Figures B-4A and B-4B in Appendix B, indicate that the cohesive till consists of clayey silt of low plasticity. The natural water content measured on selected samples of the cohesive till range from about 7 per cent to about 20 per cent.

#### **4.2.6 Silt and Sand to Sand**

A 0.1 m to 2.6 m thick silt and sand to sand deposit and interlayers were encountered in Boreholes S1-2, S3-2, and GM-1 to GM-4. The surface of the overall deposit was encountered between Elevations 338.6 m and 308.8 m. Boreholes S3-2, GM-2 and GM-3 and terminated within this deposit, penetrating it for a thickness of 1.0 m to 2.6 m.

The deposit consists of sand containing trace to some silt, trace to some gravel and trace clay in Boreholes S1-2, S3-2 and GM-1 to GM-4, and consists of silt and sand containing trace clay in Borehole GM-2. A hydrocarbon odour was noted in all the samples in Borehole S1-2.

The SPT "N"-values measured within the silt and sand to sand deposit range from 13 blows to 69 blows per 0.3 m of penetration, indicating a compact to very dense level of compactness.

Grain size distribution testing was carried out on six samples of the silt and sand to sand deposit and the results are shown on Figure B-5 in Appendix B. The natural water content measured on selected samples of the silt and sand to sand deposit range from about 2 per cent to about 16 per cent.

#### **4.2.7 Silt**

A 1.0 m thick deposit of silt, some sand, trace clay was encountered interlayered between the clayey silt with sand till deposit and the silty sand till deposit in Borehole S4-1. The surface of the deposit was encountered at Elevation 325.0 m.

A SPT "N"-value measured within the silt deposit was 22 blows per 0.3 m of penetration, indicating a compact level of compactness.

Grain size distribution testing was carried out on one sample of the silt deposit and the results are shown on Figure B-6 in Appendix B. Atterberg limits testing was carried out on one sample of the silt deposit and was non-plastic. The natural water content measured on one selected sample of the silt deposit is about 22 per cent.

#### **4.2.8 Gravelly Sand to Sand and Gravel**

A 0.2 m to 6.0 m thick gravelly sand to sand and gravel deposit was encountered in Borehole S1-1 underlying the till deposit (described below) and in Boreholes S1-2, S2-1, S2-2, S3-1 and S3-2. The surface of the deposit was encountered between Elevations 324.5 m and 317.2 m. Boreholes S1-1 and S3-1 terminated within this deposit, penetrating for thicknesses of 6.0 m and 1.6 m, respectively.

The deposit consists of gravelly sand containing some silt and trace sand in Borehole S2-2, and sand and gravel containing trace to some silt and trace clay in Boreholes S2-1, S3-1 and S3-2. Grinding of the augers was observed in a Boreholes S1-1 and S1-2. A hydrocarbon odour was noted in all the samples in Boreholes S1-1 and S1-2.

The SPT "N"-values measured within the gravelly sand to sand and gravel deposit generally range from 35 blows to 76 blows per 0.3 m of penetration indicating a dense to very dense level of compactness. Split spoon refusal was encountered within the sand and gravel layer in Borehole S1-1, where SPT "N"-values of 14 blows and 25 blows per 0.15 m of penetration were measured and in the gravelly sand layer in Borehole S2-2, where a SPT "N"-value of 50 blows per 0.15 m of penetration was measured.

Grain size distribution testing was carried out on seven samples of the gravelly sand to sand and gravel deposit and the results are shown on Figure B-7 in Appendix B. The natural water content measured on selected samples of the gravelly sand to sand and gravel deposit range from about 1 per cent to about 3 per cent.

#### 4.2.9 Silt and Sand to Gravelly Sand Till

A 0.5 m to 7.4 m thick deposit of silt and sand, silty sand, sand and gravelly sand till was encountered below the fill in Boreholes S1-1 and S4-2, below the sand and gravel deposit in Borehole S1-2, below both the fill and the silt deposit in Borehole S4-1, and as a bottom layer to the clayey silt with sand to sandy clayey silt till in Boreholes S3-1 and S3-2. The surface of the deposit was encountered between Elevations 317.7 m and 328.7 m. Boreholes S1-1, S1-2, S4-1 and S4-2 were terminated within this deposit. Grinding of the augers was observed in a Borehole S4-2. A hydrocarbon odour was noted in all the samples in Boreholes S1-1 and S1-2. A hydrocarbon odour was noted below in all the samples in Boreholes S1-1 and S1-2. Organics were encountered in the till layer in Borehole S1-1.

The SPT “N”-values measured within the non-cohesive till deposit range between 13 and 70 blows per 0.3 m of penetration, indicating a compact to very dense level of compactness.

Grain size distribution testing was carried out on eight samples of the silt and sand to gravelly sand till deposit and the results are shown on Figures B-8A and B8-B in Appendix B. Atterberg limits testing was carried out on three samples of the till deposit and measured liquid limits between 14 per cent and 16 per cent, plastic limits between 10 per cent and 12 per cent, and plasticity indices between 3 per cent and 4 per cent. These results, which are plotted on a plasticity chart on Figure B-9 in Appendix B, indicate that the fines component of the non-cohesive till consists of silt of low plasticity. The natural water content measured on selected samples of the silt and sand to silty sand till deposit range between about 2 per cent and 18 per cent.

### 4.3 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations. All boreholes were dry upon completion of drilling, with the exception of Borehole GM-4, where the water level on completion of drilling was encountered at a depth of 3.8 m below ground surface, corresponding to Elevation 336.3 m. Boreholes S1-1, S1-2 and GM-4 caved to depths of 3.0 m, 2.6 m, and 4.0 m below ground surface on removal of augers.

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.

### 4.4 Analytical Testing Results

Three soil samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. Detailed analytical test results are included in Appendix C and a summary of the results is as follows:

Borehole No. / Sample No.	pH	Resistivity (ohm-cm)	Electrical Conductivity (umho/cm)	Chlorides (ug/g)	Soluble Sulphates (ug/g)
S1-1 / 4	8.11	2,300	432	140	<20
S1-2 / 8	8.17	1,400	714	380	<20
S2-1 / 7	7.28	1,000	958	520	<20
S2-2 / 7	7.47	940	1,070	570	<20

Borehole No. / Sample No.	pH	Resistivity (ohm-cm)	Electrical Conductivity (umho/cm)	Chlorides (ug/g)	Soluble Sulphates (ug/g)
S3-1 / 6	7.93	830	1,210	600	<20
S3-2 / 4	7.84	310	3,190	1,700	180
S4-1 / 4	7.92	1,100	885	380	<20
S4-2 / 7	8.13	4,400	226	31	<20
GM-1 / 6A	7.85	1,000	987	490	37
GM-2 / 6	7.9	2,300	437	170	24
GM-3 / 7A	7.88	670	1,500	850	37
GM-4 / 5	7.77	1,800	568	230	<20

## 5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Nikol Kochmanová, P.Eng., a geotechnical engineer with Golder. Mr. Jorge Costa, P.Eng., a MTO Foundations Designated Contact and Senior Consultant with Golder, conducted a quality control review of the report.

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MTO Foundations Designated Contact, Senior Consultant

MCK/NK/JMAC/rb

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## REFERENCES

Chapman, L.J. and Putnam, D.F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.

### **ASTM International**

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split Barrel Sampling of Soils

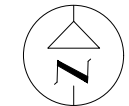
### **Ontario Water Resources Act**

Ontario Regulation 903 Wells (as amended)



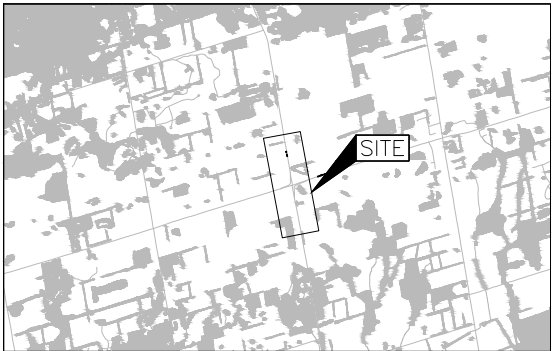
**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No. .  
GWP No. 2086-16-00



HWY 48 AND BLOOMINGTON ROAD  
(LAT. 44.000847, LONG. -79.289013)  
SIGN SUPPORT STRUCTURES  
BOREHOLE LOCATIONS

SHEET



KEY PLAN  
SCALE



LEGEND

● Borehole - Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
GM-1	314.4	4872923.6	321824.2
GM-2	316.6	4873015.7	321805.1
GM-3	337.0	4873804.2	321653.3
GM-4	340.1	4873931.9	321629.2
S1-1	326.7	4873419.6	321578.1
S1-2	327.3	4873398.5	321567.7
S2-1	325.3	4873471.3	321817.8
S2-2	324.9	4873492.4	321815.3
S3-1	323.8	4873332.3	321756.3
S3-2	324.2	4873325.5	321728.3
S4-1	329.6	4873567.7	321710.0
S4-2	329.1	4873556.7	321683.9

NOTES

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

REFERENCE

Base plans provided in digital format by AECOM, drawing file nos. Hwy48 Bloom\_bgd\_PH 150409\_Hwy48N.dwg, Hwy48 Bloom\_bgd\_PH 150410\_Hwy48S.dwg and Hwy48 Bloom\_plan.dwg, received February 15, 2018 and Hwy48 Bloom\_bgd.dwg, received April 12, 2018.



NO.	DATE	BY	REVISION
Geocres No. 30M14-476			
HWY. 48	PROJECT NO. 1671430		DIST. .
SUBM'D. NK	CHKD. NK	DATE: 4/18/2018	SITE: .
DRAWN: DD	CHKD. NK	APPD. JMAC	DWG. 1

**APPENDIX A**

# Record of Borehole 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

#### (a) Index Properties

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

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

w	water content
$w_l$ or LL	liquid limit
$w_p$ or PL	plastic limit
$I_p$ or PI	plasticity index = $(w_l - w_p)$
$w_s$	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

$\tau = c' + \sigma' \tan \phi'$   
shear strength = (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

Compactness	N
Condition	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 <sub>4</sub>	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



PROJECT 1671430		RECORD OF BOREHOLE No S1-1				SHEET 1 OF 1		METRIC									
G.W.P. 2086-16-00		LOCATION N 4873419.6; E 321578.1 MTM NAD 83 ZONE 10 (LAT. 44.000578; LONG. -79.290794)				ORIGINATED BY JS											
DIST Central HWY 48		BOREHOLE TYPE 153 mm O.D., 70 mm I.D. Hollow Stem Augers				COMPILED BY ACM											
DATUM Geodetic		DATE March 12, 2018				CHECKED BY NK											
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									
326.7	GROUND SURFACE																
0.0	ASPHALT (127 mm)		1A	AS	-												
0.1	Sand, trace to some gravel, trace to some silt, trace clay (FILL)		1B														
325.9	Dense Brown Moist		2	SS	45												
0.8	SAND, trace to some gravel, trace to some silt, trace clay, trace organics (TILL)		3	SS	34												
324.5	Dense Brown Moist																
2.2	Hydrocarbon odour noted in all samples		4	SS	79												
	SAND and GRAVEL, trace silt, trace clay, trace gravel (rock fragments)		5	SS	84												
	Very dense Brown Moist		6	SS	61												
	Hydrocarbon odour noted in all samples		7	SS	14/0.15												
	- Auger grinding between depths of about 3.0 m and 3.8 m																
	- Auger grinding between depths of about 4.6 m and 6.1 m																
	- Split spoon refusal at depth of about 4.6 m																
	- Split spoon refusal at depth of about 7.6 m		9	SS	25/0.15												
318.5	END OF BOREHOLE																
8.2	NOTES:																
	1. Borehole caved to a depth of 3.0 m below ground surface on removal of augers.																
	2. Open borehole dry upon completion of drilling.																

PROJECT 1671430		RECORD OF BOREHOLE No S1-2				SHEET 1 OF 1		METRIC									
G.W.P. 2086-16-00		LOCATION N 4873398.5; E 321567.7 MTM NAD 83 ZONE 10 (LAT. 44.000389; LONG. -79.290924)				ORIGINATED BY JS											
DIST Central HWY 48		BOREHOLE TYPE 153 mm O.D., 70 mm I.D. Hollow Stem Augers				COMPILED BY ACM											
DATUM Geodetic		DATE March 12, 2018				CHECKED BY NK											
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									
327.3	GROUND SURFACE																
0.0	Gravelly sand, trace to some silt (FILL)		1	SS	21												
326.6	Compact Brown Moist		2	SS	20												
0.7	Hydrocarbon odour on all samples		3	SS	23												
325.0	Sand, trace to some gravel, trace to some silt, trace clay (FILL)																
2.3	Compact Brown Moist to moist-wet																
	Hydrocarbon odour on all samples																
	- Auger grinding between depths of about 1.5 m and 2.3 m																
323.9	SAND, trace to some gravel, trace to some silt, trace clay		4	SS	28												
	Compact Brown Moist to moist-wet																
323.9	Hydrocarbon odour noted in all samples		5A														
3.4	SAND and GRAVEL, trace to some silt, trace clay		5B	SS	58												47 45 6 2
	Dense to very dense																
	Brown Moist		6	SS	94												
	Hydrocarbon odour on all samples																
	- Auger grinding between depths of about 3.8 m and 4.6 m		7	SS	35												58 37 3 2
321.7																	
5.6	SAND, trace to some gravel below a depth 7.2 m, trace to some silt, trace clay (TILL)																
	Dense to very dense																
	Brown Moist		8	SS	43												
	Hydrocarbon odour on all samples																
319.1			9	SS	54												12 81 6 1
8.2	END OF BOREHOLE																
NOTES:																	
1. Borehole caved to a depth of 2.6 m below ground surface on removal at augers.																	
2. Open borehole dry upon completion of drilling.																	

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

PROJECT 1671430		RECORD OF BOREHOLE No S2-2				SHEET 1 OF 1		METRIC						
G.W.P. 2086-16-00		LOCATION N 4873492.4; E 321815.3 MTM NAD 83 ZONE 10 (LAT. 44.001228; LONG. -79.287834)				ORIGINATED BY JS								
DIST Central HWY 48		BOREHOLE TYPE 153 mm O.D., 70 mm I.D. Hollow Stem Augers				COMPILED BY ACM								
DATUM Geodetic		DATE March 6, 2018				CHECKED BY NK								
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						
324.9	GROUND SURFACE													
0.0	Gravelly sand to sand, trace to some silt, trace to some organics from 0.8 m to 1.2 m (FILL) Compact Brown Moist		1	SS	20									
323.7			2A	SS	14									
1.2	CLAYEY SILT with SAND, trace to some gravel, trace to some organics from 2.3 m to 2.7 m (TILL) Stiff to very stiff Dark brown Moist		2B											
			3A	SS	16									
			3B											
			4A	SS	14									
			4B											
			5	SS	10									
321.0			6A	SS	50/0.15									
3.9	Gravelly SAND, some silt, trace clay Very dense Brown Dry - Split spoon refusal at depth of about 4.0 m		6B											
320.4			7A	SS	45									
4.5	CLAYEY SILT with SAND, trace gravel, trace organics from 4.6 m to 4.9 m (TILL) Hard Brown Moist		7B											
			8	SS	34									
			9	SS	21									
316.7														
8.2	END OF BOREHOLE													
NOTES: 1. Open borehole dry upon completion of drilling.														

PROJECT 1671430		RECORD OF BOREHOLE No S3-1				SHEET 1 OF 1		METRIC									
G.W.P. 2086-16-00		LOCATION N 4873332.3; E 321756.3 MTM NAD 83 ZONE 10 (LAT. 43.999789; LONG. -79.288574)				ORIGINATED BY JS											
DIST Central HWY 48		BOREHOLE TYPE 153 mm O.D., 70 mm I.D. Hollow Stem Augers				COMPILED BY ACM											
DATUM Geodetic		DATE March 6, 2018				CHECKED BY NK											
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									
323.8	GROUND SURFACE																
0.0	Gravelly sand, trace to some silt, trace rootlets (FILL)		1	SS	17												
323.1	Compact Brown Moist		2	SS	8												
0.7	Sand, trace to some silt, some gravel (FILL)		3A	SS	7												
322.3	Loose Brown Moist		3B														
1.5	CLAYEY SILT with SAND, trace to some gravel, trace organics to 1.7 m (TILL)		4	SS	7												
	Firm to very stiff		5	SS	9												
	Light to dark brown		6	SS	10												
	Moist to wet		7A														
	- Organic odour and oxidation stains from depths of about 1.5 m to 2.2 m		7B	SS	27												
	- Auger grinding between depths of about 5.2 m and 6.1 m																
317.7	SILT and SAND, trace to some clay, trace to some gravel (TILL)		8A	SS	17												
6.1	Compact Brown Moist		8B														
317.2	SAND and GRAVEL, trace to some silt, trace clay																
6.6	Very dense Brown-grey Moist		9	SS	76												
	- Auger grinding between depths of about 6.7 m and 7.6 m																
315.6	END OF BOREHOLE																
8.2	NOTES:																
	1. Open borehole dry upon completion of drilling.																

PROJECT 1671430		RECORD OF BOREHOLE No S3-2				SHEET 1 OF 1				METRIC					
G.W.P. 2086-16-00		LOCATION N 4873325.5; E 321728.3 MTM NAD 83 ZONE 10 (LAT. 43.999728; LONG. -79.288923)				ORIGINATED BY JS									
DIST Central HWY 48		BOREHOLE TYPE 153 mm O.D., 70 mm I.D. Hollow Stem Augers				COMPILED BY ACM									
DATUM Geodetic		DATE March 7, 2018				CHECKED BY NK									
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							
324.2	GROUND SURFACE														
0.0	ASPHALT (152 mm)														
0.4	Gravelly sand, trace to some silt (FILL) Brown Moist		1A 1B	AS	-		324								
323.0	Sand, trace to some gravel, trace silt (FILL) Dense Brown Moist		2A 2B	SS	38		323								
1.2	Sandy CLAYEY SILT, trace to some gravel (TILL) Stiff to hard Brown to dark brown Moist - Auger grinding at a depth of about 1.4 m - Sand pockets at a depth of about 3.0 m		3	SS	14		322							3 29 49 19	
			4	SS	20		321								
			5	SS	15		320								
			6	SS	39		319								
319.8	SILT and SAND, trace to some clay, trace gravel (TILL) Dense Brown Moist		7	SS	40		318								
318.6	SAND and GRAVEL, trace to some silt, trace clay Very dense Brown Moist		8	SS	75		317							54 38 6 2	
317.0	SAND, trace to some silt, trace clay Dense Brown Moist		9	SS	42		316							0 94 5 1	
316.0	END OF BOREHOLE														
8.2	NOTE:  1. Open borehole dry upon completion of drilling.														

PROJECT 1671430		RECORD OF BOREHOLE No S4-1				SHEET 1 OF 1		METRIC									
G.W.P. 2086-16-00		LOCATION N 4873567.7; E 321710.0 MTM NAD 83 ZONE 10 (LAT. 44.001909; LONG. -79.289144)				ORIGINATED BY JS											
DIST Central HWY 48		BOREHOLE TYPE 153 mm O.D., 70 mm I.D. Hollow Stem Augers				COMPILED BY ACM											
DATUM Geodetic		DATE March 5, 2018				CHECKED BY NK											
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									
329.6	GROUND SURFACE																
0.0	Sand to gravelly sand, trace silt (FILL) Compact Brown Moist		1A	SS	19												
328.7			1B														
0.9	SILT and SAND, trace to some clay, trace gravel (TILL) Compact Brown Moist		2A	SS	13												
			2B														
			3	SS	14												
327.4																	
2.2	CLAYEY SILT with SAND, trace to some gravel (TILL) Firm to very stiff Brown Moist		4	SS	7												
			5	SS	12												
			6	SS	14												
325.0																	
4.6	SILT, some sand, trace clay Compact Brown Moist		7	SS	22												
324.0																	
5.6	Silty SAND, trace gravel, trace clay (TILL) Dense Brown Dry to moist		8	SS	50												
			9	SS	45												
321.4																	
8.2	END OF BOREHOLE																
	NOTES: 1. Open borehole dry upon completion of drilling.																

GTA-MTO 001 N:\COMMON\K\WALL\NONTARIO PROJECTS\1671430 W09HWY\_48.GPJ GAL-GTA.GDT 04/26/18




GTA-MTO 001 N:\COMMON\K\W\ONTARIO PROJECTS\1671430 W09\HWY\_48.GPJ GAL-GTA.GDT 04/26/18


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



PROJECT		1671430		RECORD OF BOREHOLE No GM-1		SHEET 1 OF 1		METRIC					
G.W.P.		2086-16-00		LOCATION		N 4872923.6; E 321824.2 MTM NAD 83 ZONE 10 (LAT. 43.996108; LONG. -79.287740)		ORIGINATED BY JS					
DIST		Central HWY 48		BOREHOLE TYPE		153 mm O.D., 70 mm I.D. Hollow Stem Augers		COMPILED BY ACM					
DATUM		Geodetic		DATE		March 4, 2018		CHECKED BY NK					
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 (%)			
314.4	GROUND SURFACE												
0.0	Gravelly sand, trace to some silt (FILL)		1A	SS	46								
314.1	Brown to black Moist		1B										
0.3	Sandy silt to silt and sand, trace to some clay, trace gravel (FILL)		2	SS	9								
	Loose to dense Brown Moist												
312.9	Sandy CLAYEY SILT, trace gravel (TILL)		3	SS	19								
1.5	Stiff to very stiff Brown Moist to wet		4	SS	9								
	- Sand seam between depths of about 3.5 m and 3.6 m		5	SS	12								
			6A	SS	20								
310.1	SAND, trace gravel, trace silt Moist		6B										
309.5	SAND and GRAVEL, trace to some silt Very dense Light brown to grey Moist		7A	SS	54								
4.9			7B										
308.8	Gravelly CLAYEY SILT with SAND (TILL)												
5.6	Hard Brown Moist		8	SS	53								
	SAND, trace to some silt, trace gravel, trace clay Very dense Light to dark brown Dry/moist to moist												
			9A	SS	69								
306.3	Sandy CLAYEY SILT (TILL)		9B										
8.2	Light brown Moist		9C										
	END OF BOREHOLE												
NOTES: 1. Open borehole dry upon completion of drilling.													

GTA-MTO 001 N:\COMMON\K\W\IN\ONTARIO PROJECTS\1671430 W09HWY\_48.GPJ GAL-GTA.GDT 04/26/18

PROJECT 1671430		RECORD OF BOREHOLE No GM-2		SHEET 1 OF 1		METRIC																	
G.W.P. 2086-16-00		LOCATION N 4873015.7; E 321805.1 MTM NAD 83 ZONE 10 (LAT. 43.996938; LONG. -79.287976)		ORIGINATED BY JS																			
DIST Central HWY 48		BOREHOLE TYPE 153 mm O.D., 70 mm I.D. Hollow Stem Augers		COMPILED BY ACM																			
DATUM Geodetic		DATE March 4, 2018		CHECKED BY NK																			
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL				
316.6	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> W W <sub>L</sub> 10 20 30			kN/m <sup>3</sup>							
0.0	Gravelly sand, trace to some silt, trace cobbles (FILL)		1A	SS	50		316																
315.9	Dense Brown to black Moist		1B																				
0.7	Clayey silt, some sand to with sand, trace gravel (TILL)		2	SS	4			315															
	Firm to very stiff																						
	Brown Moist to wet		3	SS	8																		
	- Pockets of sand between depths of about 1.5 m and 2.1 m																						
	- Oxidation staining at a depth of about 1.8 m																						
313.8	SILT and SAND, trace clay		4A	SS	28			314															
2.8	Compact		4B																				
313.4	Brown	5A																					
3.2	Moist to wet	5B	SS	13			313																
	Sandy CLAYEY SILT, some gravel																						
	(TILL)																						
	Stiff to very stiff	6	SS	20			312																
	Brown																						
	Moist to dry	7	SS	29																			
311.0							311																
5.6	SAND, some gravel, trace to some silt, trace clay																						
	Dense to very dense	8	SS	45			310																
	Light brown to dark brown																						
	Dry to moist																						
308.4		9	SS	59			309																
8.2	END OF BOREHOLE																						
NOTE:																							
1. Open borehole dry upon completion of drilling.																							

PROJECT 1671430		RECORD OF BOREHOLE No GM-3		SHEET 1 OF 1		METRIC															
G.W.P. 2086-16-00		LOCATION N 4873804.2; E 321653.3 MTM NAD 83 ZONE 10 (LAT. 44.004039; LONG. -79.289844)		ORIGINATED BY JS																	
DIST Central HWY 48		BOREHOLE TYPE 153 mm O.D., 70 mm I.D. Hollow Stem Augers		COMPILED BY ACM																	
DATUM Geodetic		DATE March 5, 2018		CHECKED BY NK																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
337.0	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> — W — W <sub>L</sub> 10 20 30			kN/m <sup>3</sup>					
0.0	Gravelly sand, trace to some silt (FILL)		1A	SS	25																
0.2	Brown Moist		1B																		
336.3	Clayey silt with sand, some gravel (FILL)		2	SS	7		336														
0.7	Very stiff Brown Moist																				
	Sandy CLAYEY SILT to CLAYEY SILT with SAND, trace to some gravel (TILL)		3	SS	19		335														
	Firm to hard Brown Moist		4	SS	12																
	- Rock fragments between depths of about 3.0 m and 4.4 m		5	SS	27		334														
			6	SS	15		333														
			7A																		
			7B	SS	39		332														
331.4	SAND, trace to some gravel, trace to some silt, trace clay						331														
5.6	Dense Brown Moist		8	SS	38																
	- Gravel size rock fragments encountered at a depth of about 6.7 m						330														
			9	SS	40		329														
328.8	END OF BOREHOLE																				
8.2	NOTE: 1. Open borehole dry upon completion of drilling.																				

GTA-MTO 001 N:\COMMON\WALLINONTARIO PROJECTS\1671430 W09HWY\_48.GPJ GAL-GTA.GDT 04/26/18

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

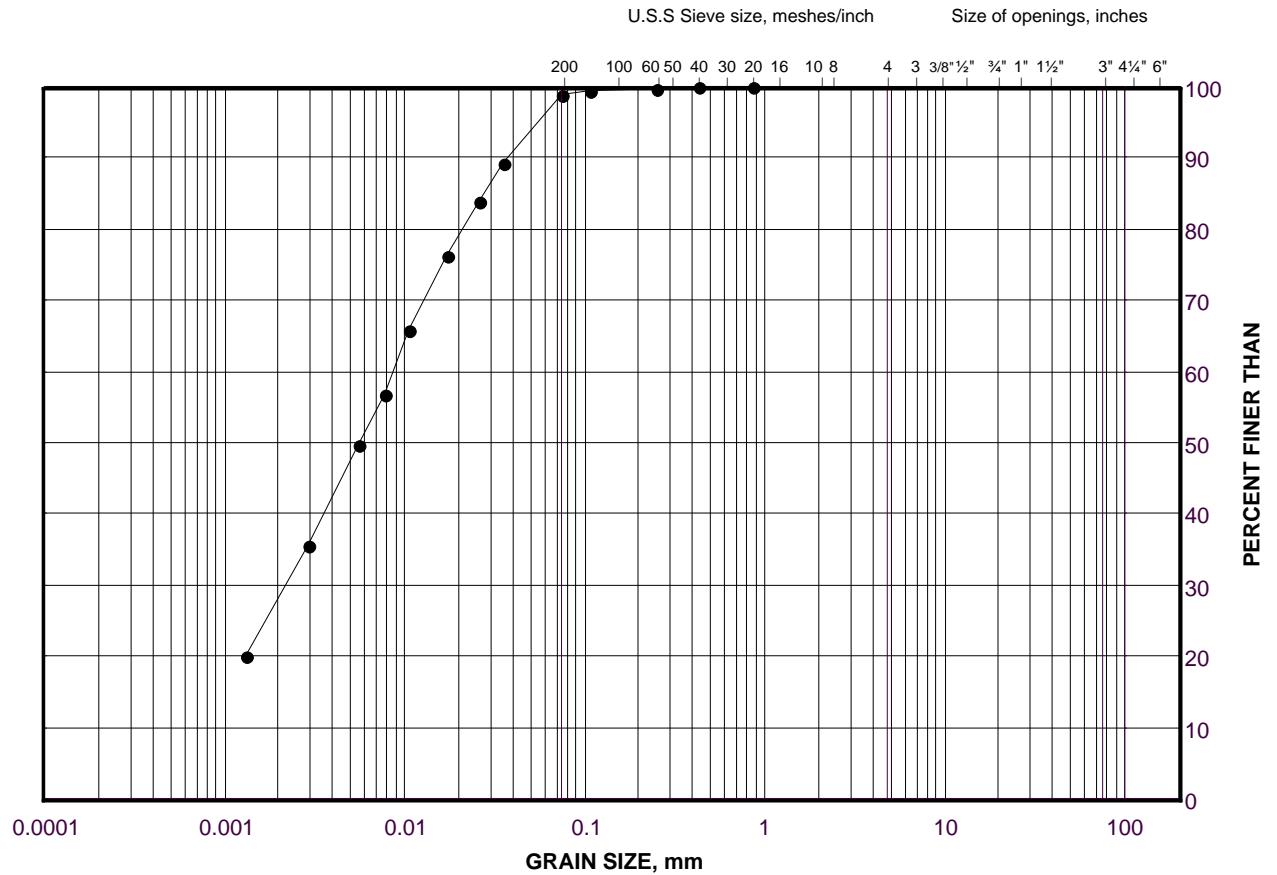
**APPENDIX B**

**Geotechnical Laboratory Test  
Results**

# GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE B-1



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

## LEGEND

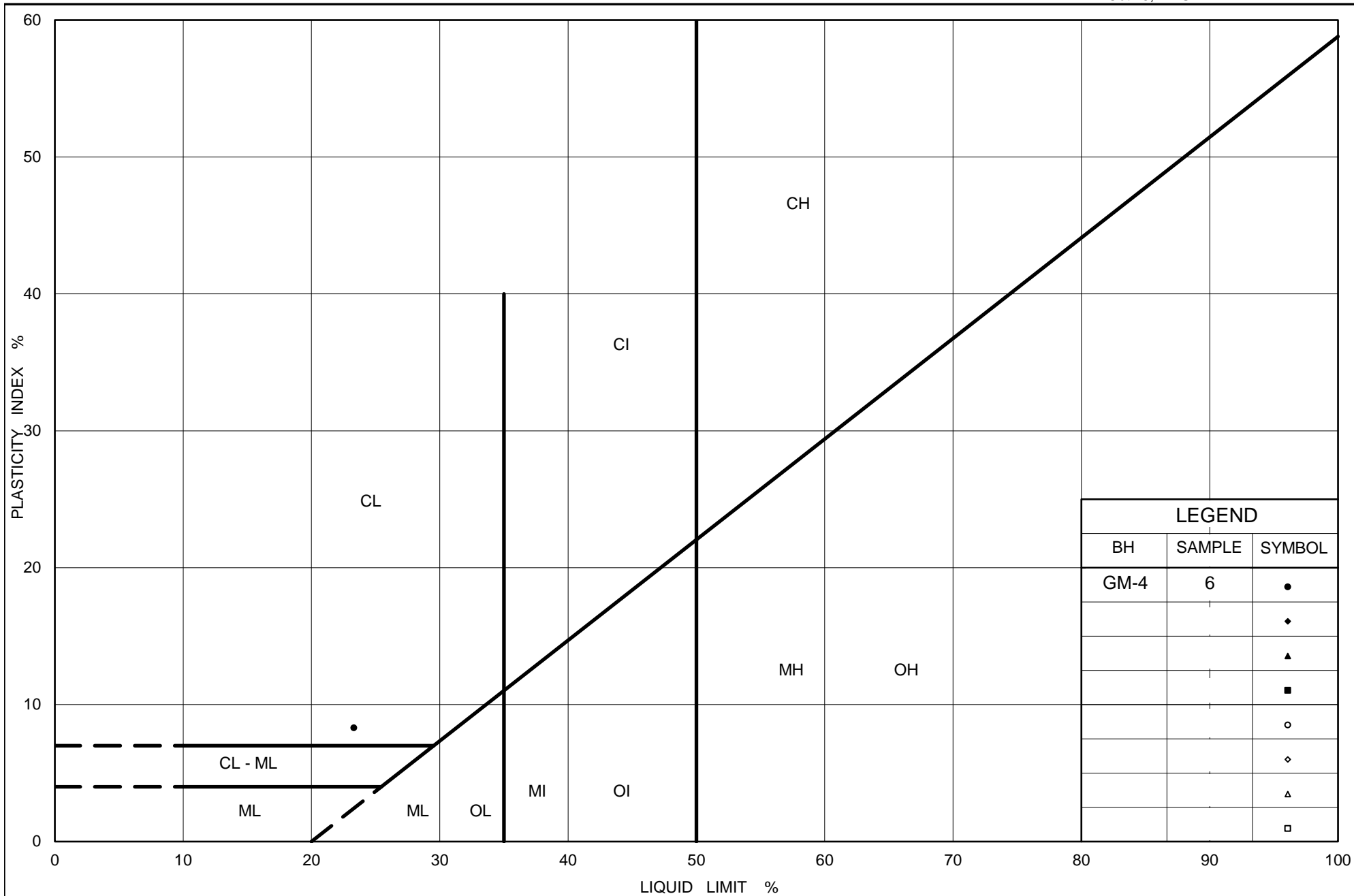
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	GM-4	6	336.0

Project Number: 1671430

Checked By: MCK

**Golder Associates**

Date: 18-Apr-18



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## PLASTICITY CHART

### Clayey Silt

Figure No. B-2

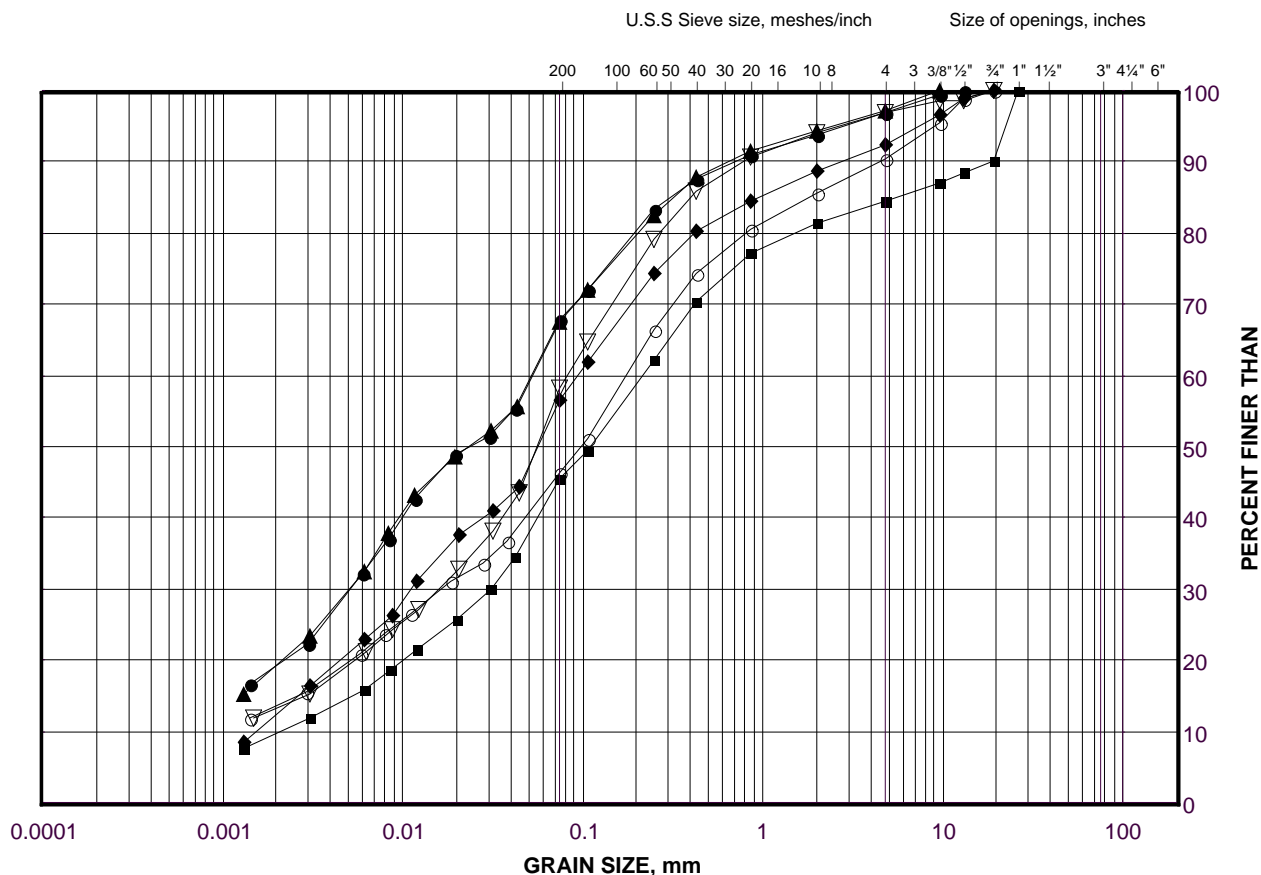
Project No. 1671430

Checked By: MCK

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE B-3A



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S3-2	3	322.4
■	S2-2	3A	323.2
◆	S3-1	5	320.4
▲	S2-1	6	321.2
▽	S2-2	8	318.5
○	S2-1	9	317.4

Project Number: 1671430

Checked By: MCK

**Golder Associates**

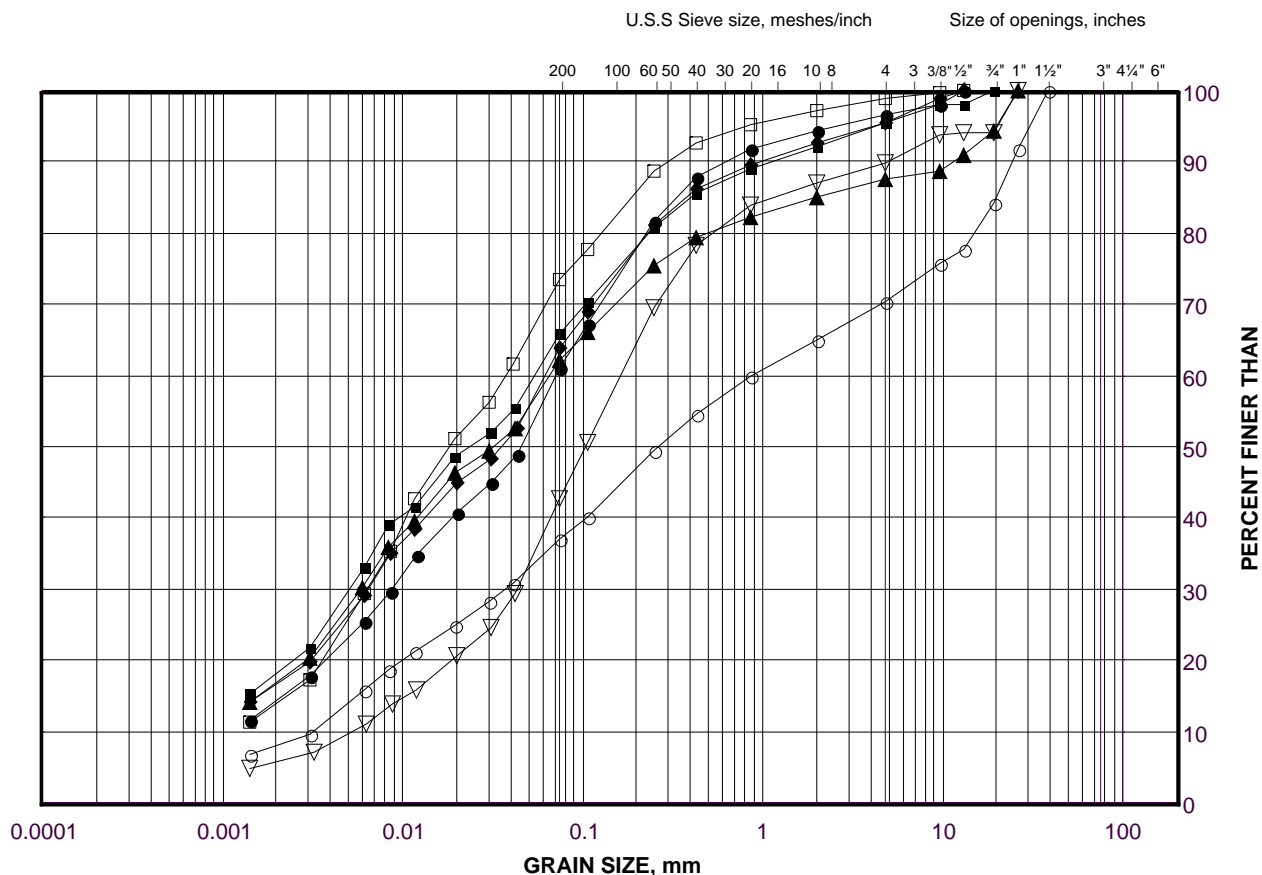
Date: 18-Apr-18



# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Gravelly Clayey Silt with Sand (Till)

FIGURE B-3B



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

## LEGEND

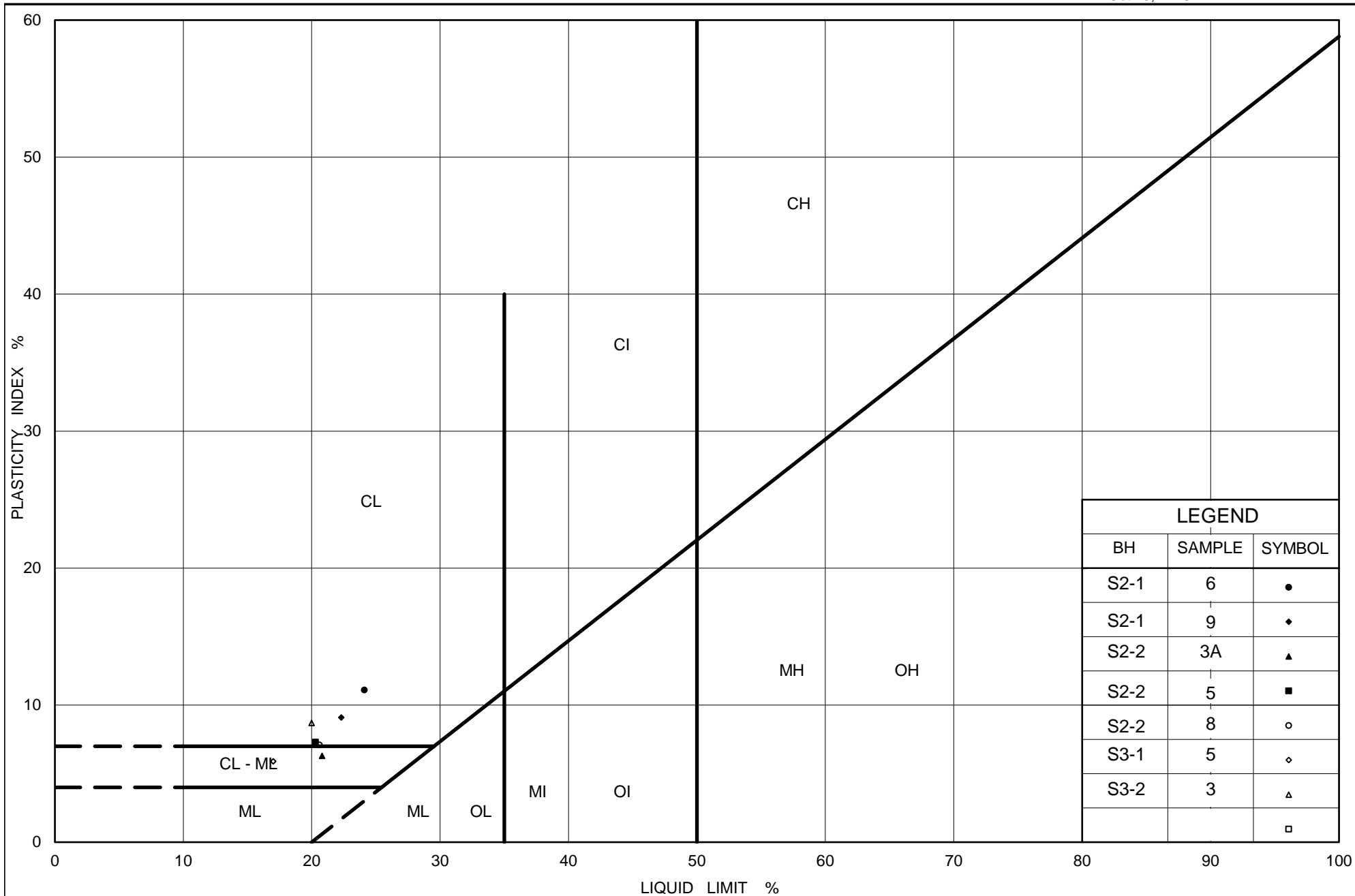
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	GM-2	3	314.8
■	GM-3	4	334.4
◆	GM-1	5	311.0
▲	GM-2	7	311.7
▽	GM-3	7B	332.0
○	GM-1	7B	309.4
□	GM-4	8	333.7

Project Number: 1671430

Checked By: MCK

**Golder Associates**

Date: 25-Apr-18



Ministry of Transportation

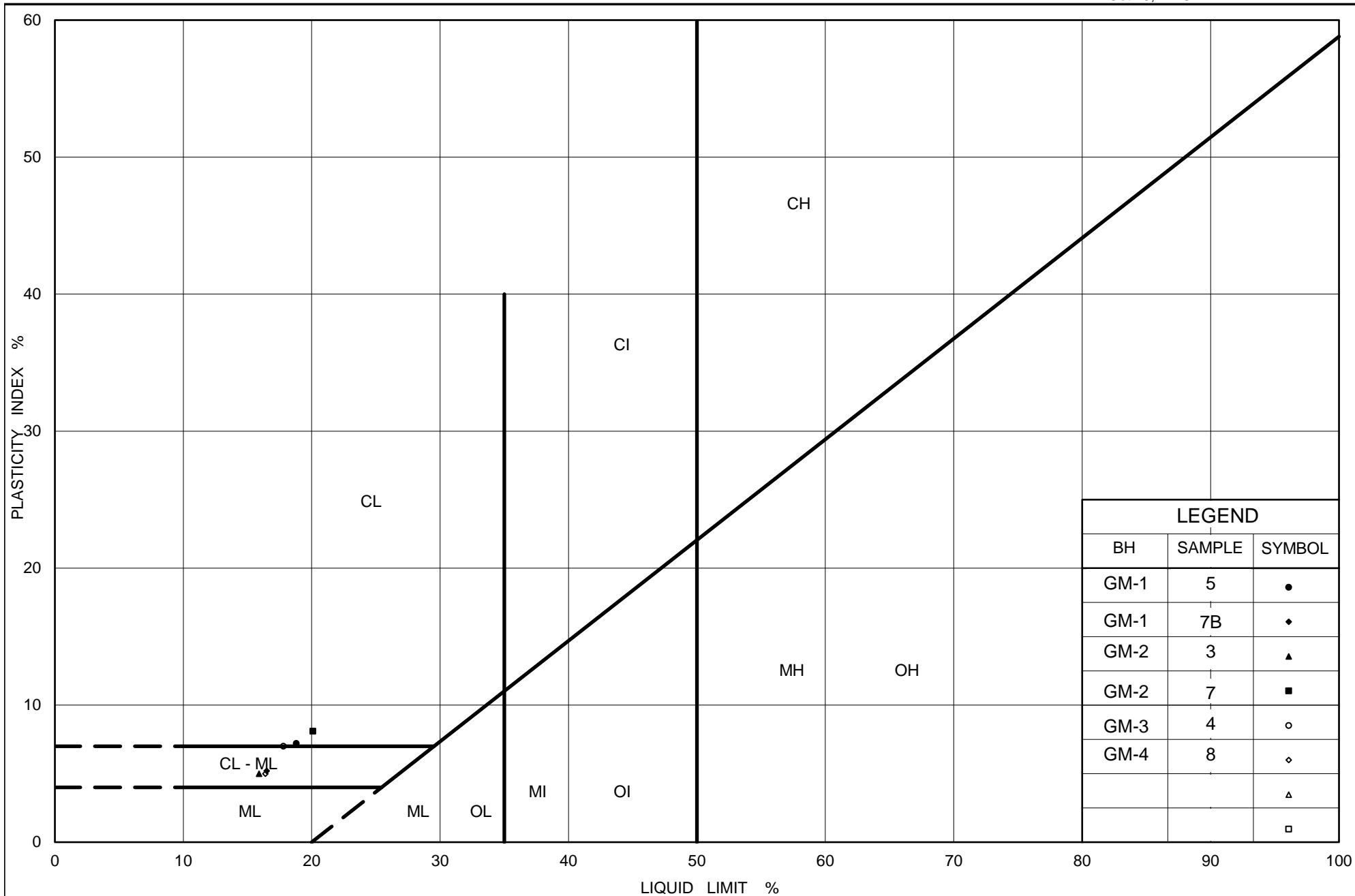
Ontario

# PLASTICITY CHART Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. B-4A

Project No. 1671430

Checked By: MCK



Ministry of Transportation

Ontario

# PLASTICITY CHART Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. B-4B

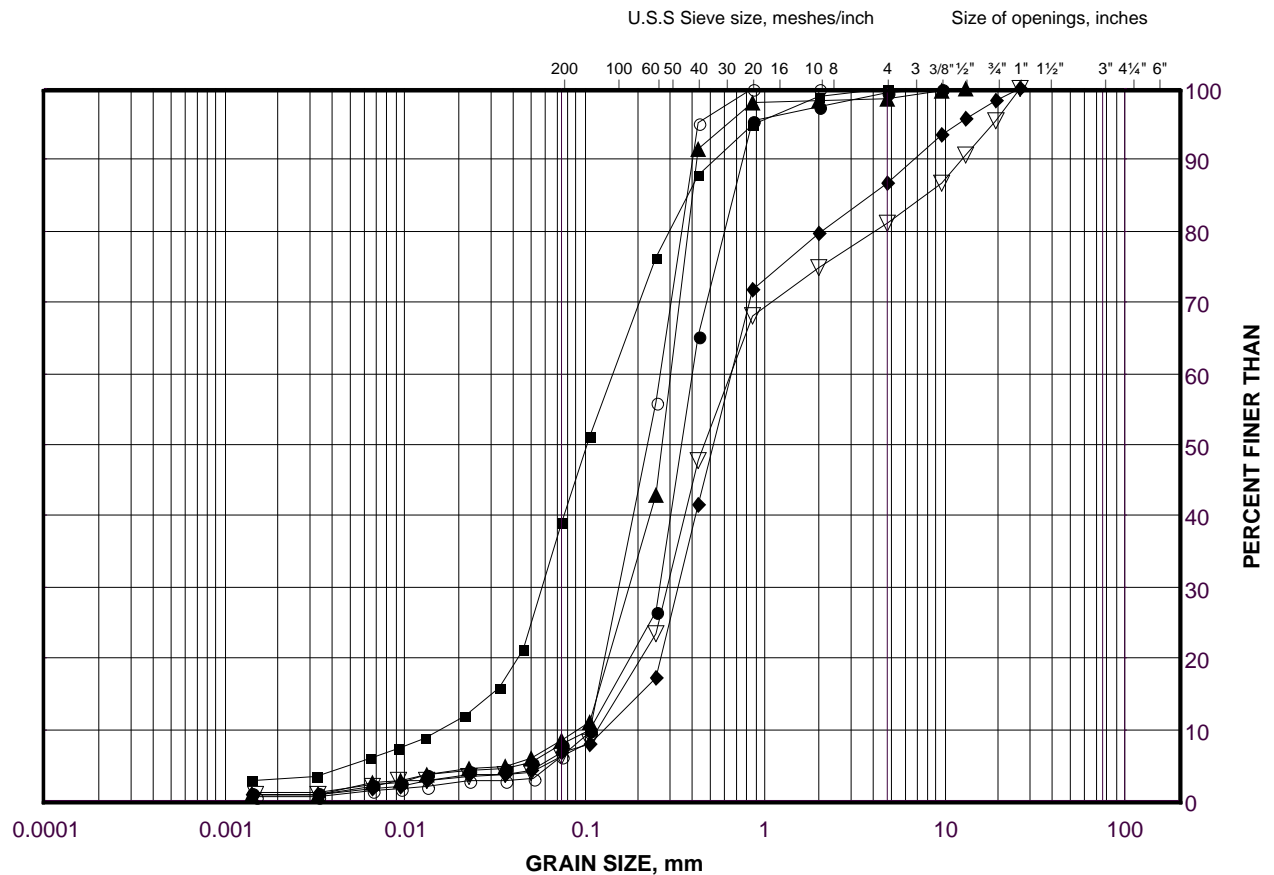
Project No. 1671430

Checked By: MCK

# GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand

FIGURE B-5



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	GM-4	3A	338.4
■	GM-2	5A	313.5
◆	GM-3	8	330.6
▲	GM-1	8	308.0
▽	GM-2	8	310.2
○	S3-2	9	316.3

Project Number: 1671430

Checked By: MCK

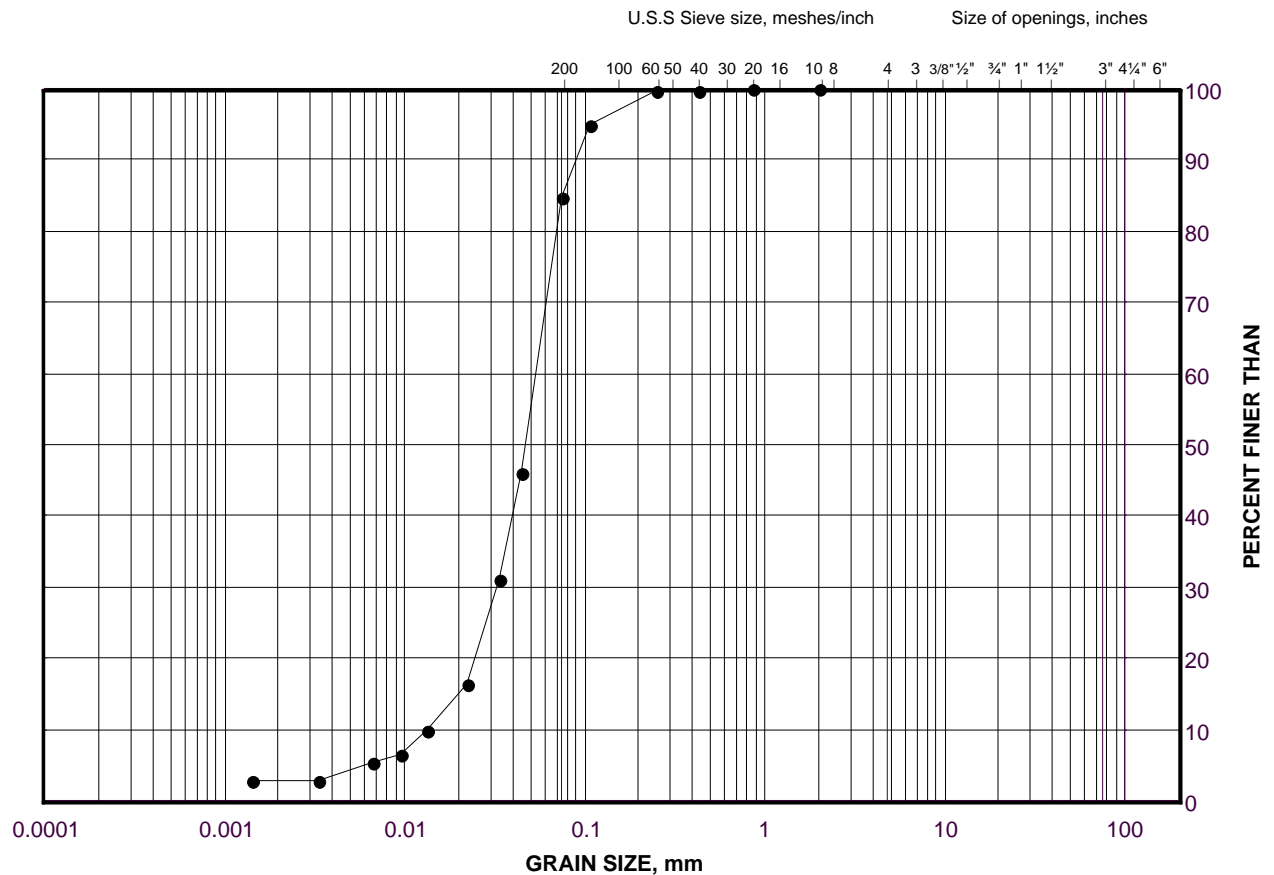
**Golder Associates**

Date: 25-Apr-18

# GRAIN SIZE DISTRIBUTION

Silt

FIGURE B-6



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	S4-1	7	324.7

Project Number: 1671430

Checked By: MCK

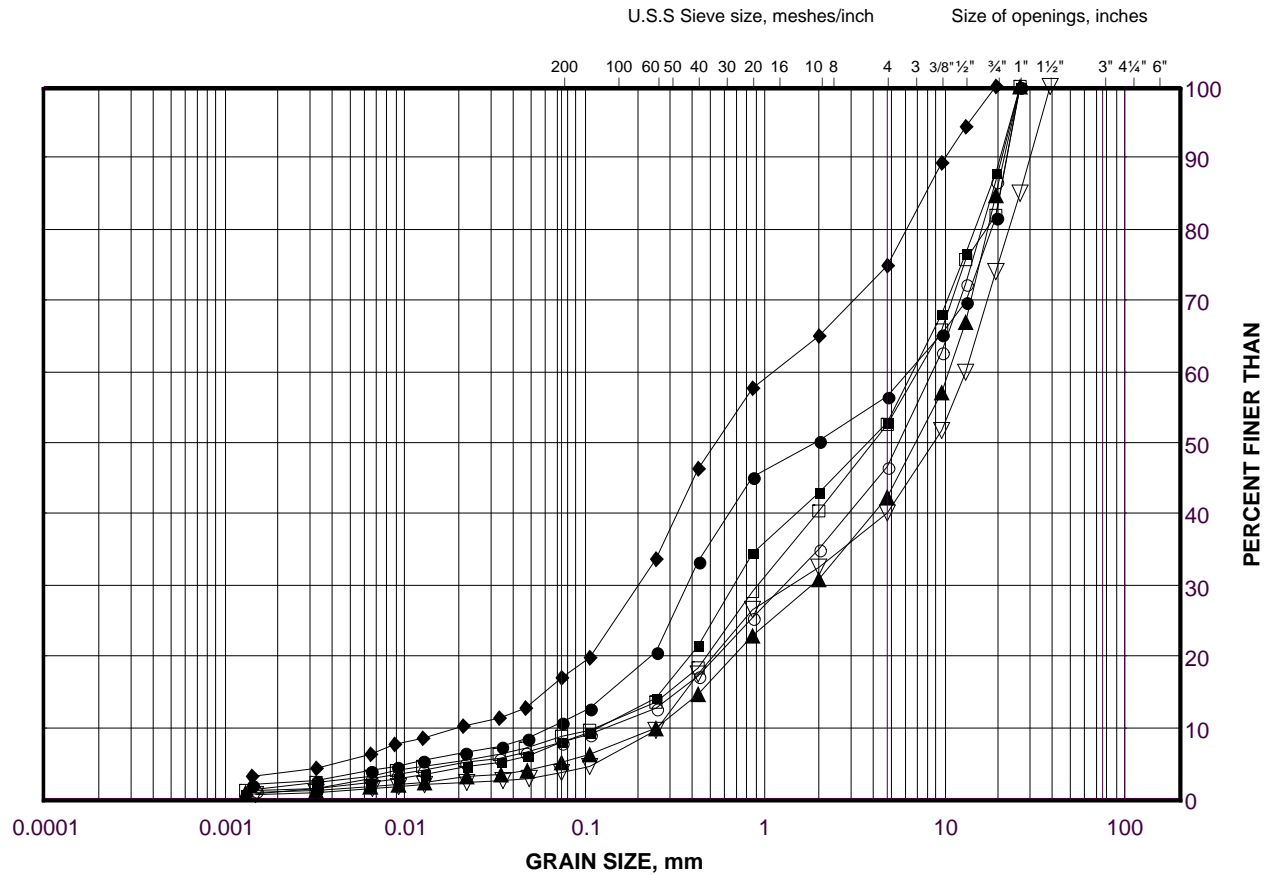
Golder Associates

Date: 18-Apr-18

# GRAIN SIZE DISTRIBUTION

Gravelly Sand to Sand and Gravel

FIGURE B-7



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S2-1	3B	323.2
■	S1-2	5B	323.8
◆	S2-2	6B	320.9
▲	S1-2	7	322.4
▽	S1-1	7	322.0
○	S3-2	8	317.8
□	S3-1	9	315.9

Project Number: 1671430

Checked By: MCK

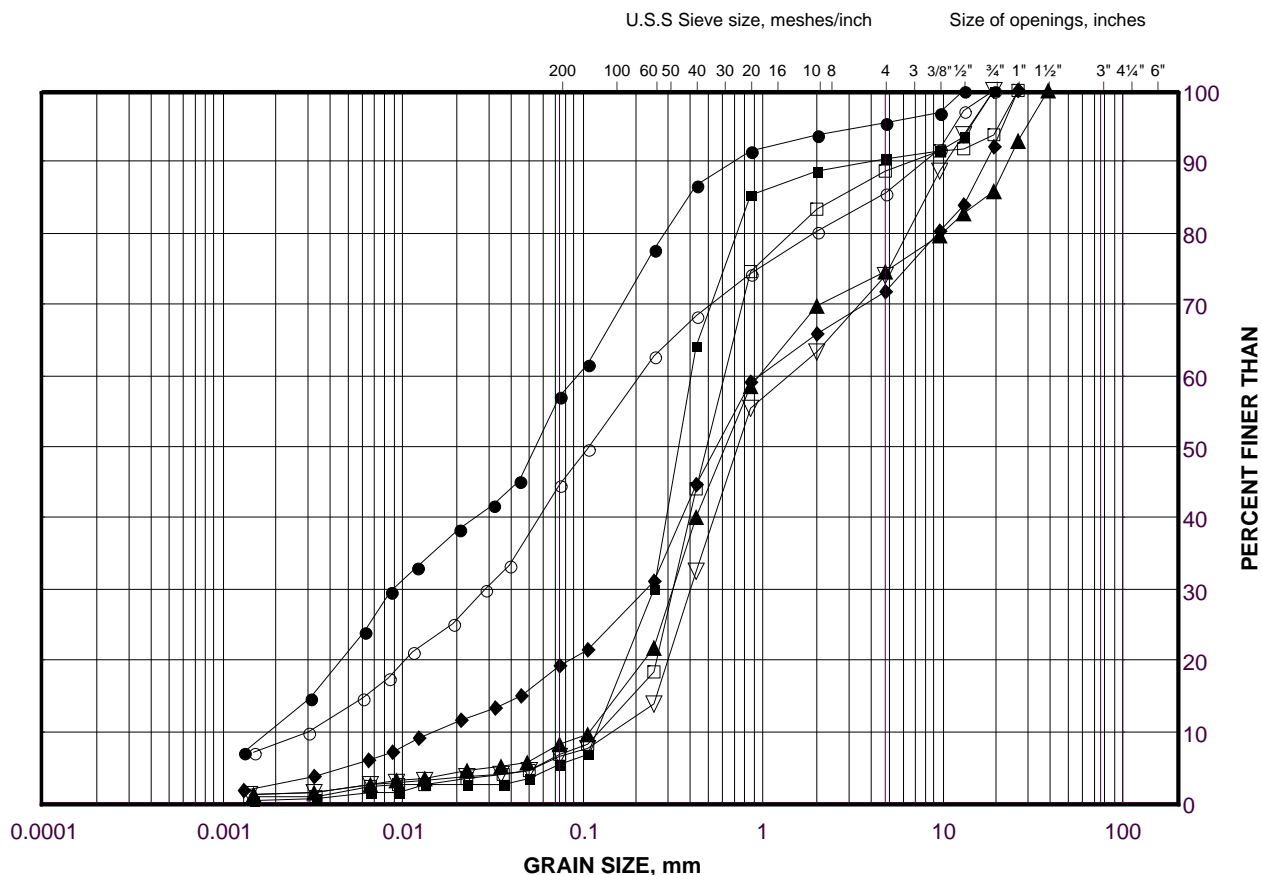
**Golder Associates**

Date: 25-Apr-18

# GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand to Sand (Till)

FIGURE B-8A



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S4-1	3	327.8
■	S1-1	3	324.9
◆	S4-2	4	326.5
▲	S4-2	6	325.0
▽	S4-2	8	322.7
○	S3-1	8A	317.3
□	S1-2	9	319.4

Project Number: 1671430

Checked By: MCK

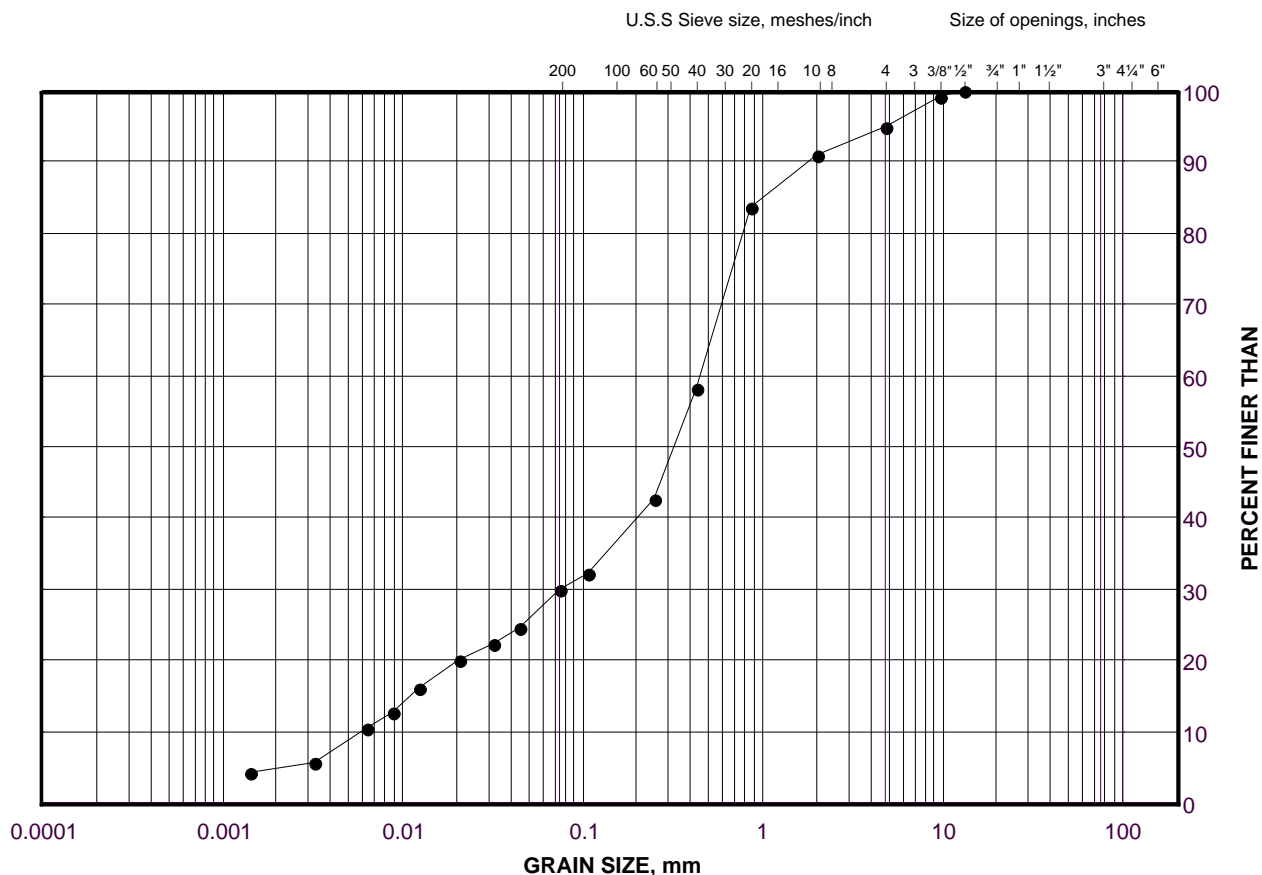
**Golder Associates**

Date: 25-Apr-18

# GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand to Sand (Till)

FIGURE B-8B



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	S4-1	9	321.7

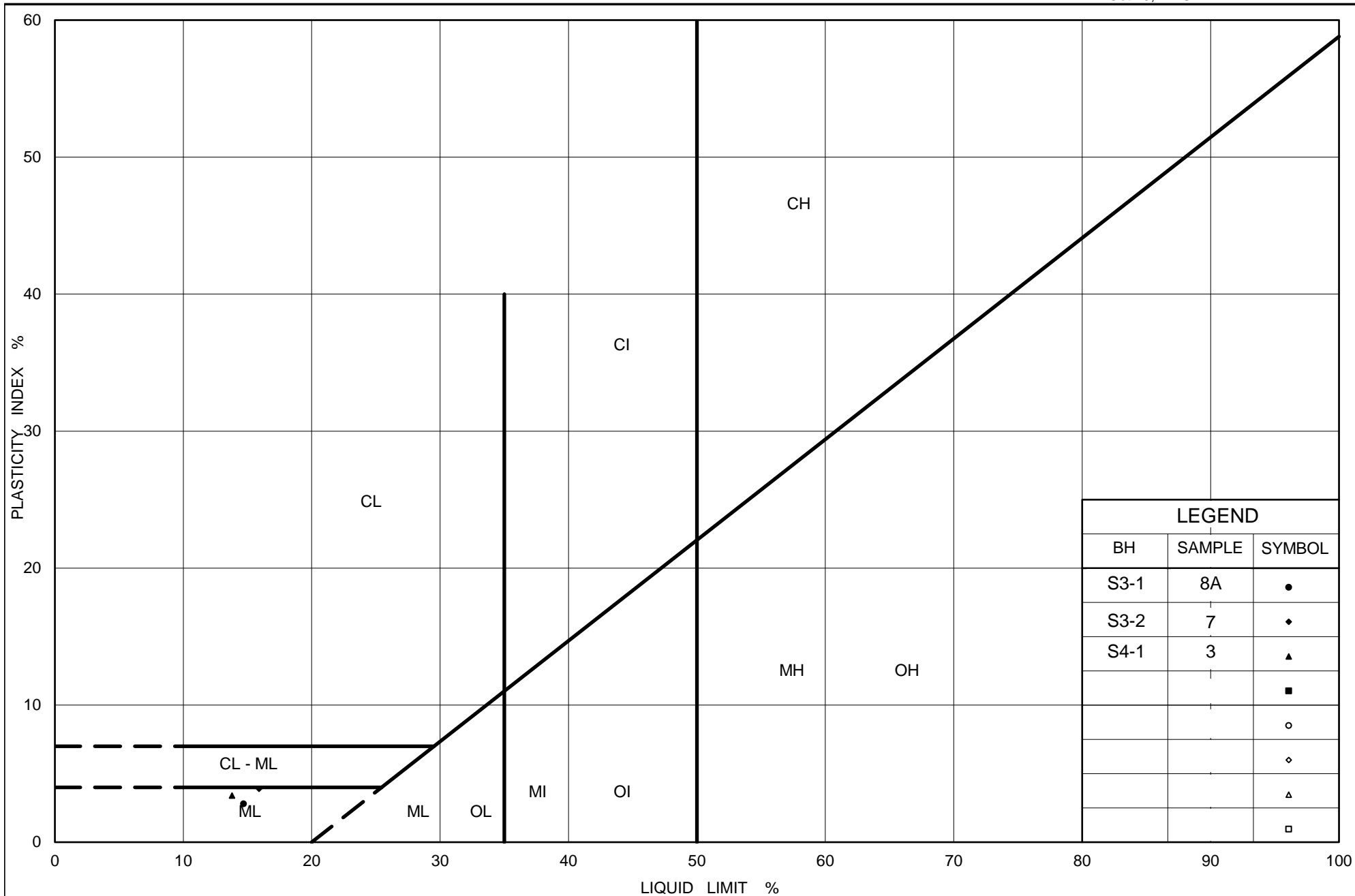
Project Number: 1671430

Checked By: MCK

**Golder Associates**

Date: 25-Apr-18





Ministry of Transportation

Ontario

## PLASTICITY CHART Silt and Sand (Till)

Figure No. B-9

Project No. 1671430

Checked By: MCK

**APPENDIX C**

# Analytical Test Results

Your Project #: 1671430-W09

Site Location: HWY 48

Your C.O.C. #: 105771

**Attention: Nikol Kochmanova**

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

**Report Date: 2018/03/23**

Report #: R5052512

Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B862072**

**Received: 2018/03/20, 12:06**

Sample Matrix: Soil  
# Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	8	N/A	2018/03/22	CAM SOP-00463	EPA 325.2 m
Conductivity	8	N/A	2018/03/22	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	8	2018/03/23	2018/03/23	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	8	2018/03/20	2018/03/22	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	8	N/A	2018/03/22	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 #: 1671430-W09

Site Location: HWY 48

Your C.O.C. #: 105771

**Attention: Nikol Kochmanova**

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

**Report Date: 2018/03/23**

Report #: R5052512

Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B862072**

**Received: 2018/03/20, 12:06**

**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.

### SOIL CORROSIVITY PACKAGE (SOIL)

<b>Maxxam ID</b>		GHG162	GHG163	GHG164	GHG165			GHG165		
<b>Sampling Date</b>		2018/03/12	2018/03/12	2018/03/12	2018/03/06			2018/03/06		
<b>COC Number</b>		105771	105771	105771	105771			105771		
	<b>UNITS</b>	<b>S1-1-SA4</b>	<b>S1-2-SA8</b>	<b>S2-1-SA7</b>	<b>S2-2-SA7</b>	<b>RDL</b>	<b>QC Batch</b>	<b>S2-2-SA7 Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>

<b>Calculated Parameters</b>										
Resistivity	ohm-cm	2300	1400	1000	940		5448848			
<b>Inorganics</b>										
Soluble (20:1) Chloride (Cl)	ug/g	140	380	520	570	20	5450392	550	20	5450392
Conductivity	umho/cm	432	714	958	1070	2	5451899			
Available (CaCl2) pH	pH	8.11	8.17	7.28	7.47		5452126			
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	<20	<20	20	5450427			
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										
Lab-Dup = Laboratory Initiated Duplicate										

<b>Maxxam ID</b>		GHG166		GHG167		GHG168	GHG169		
<b>Sampling Date</b>		2018/03/06		2018/03/07		2018/03/05	2018/03/05		
<b>COC Number</b>		105771		105771		105771	105771		
	<b>UNITS</b>	<b>S3-1-SA6</b>	<b>RDL</b>	<b>S3-2-SA4</b>	<b>RDL</b>	<b>S4-1-SA4</b>	<b>S4-2-SA7</b>	<b>RDL</b>	<b>QC Batch</b>

<b>Calculated Parameters</b>									
Resistivity	ohm-cm	830		310		1100	4400		5448848
<b>Inorganics</b>									
Soluble (20:1) Chloride (Cl)	ug/g	600	20	1700	60	380	31	20	5450392
Conductivity	umho/cm	1210	2	3190	2	885	226	2	5451899
Available (CaCl2) pH	pH	7.93		7.84		7.92	8.13		5452126
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	180	20	<20	<20	20	5450427
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									

## TEST SUMMARY

**Maxxam ID:** GHG162  
**Sample ID:** S1-1-SA4  
**Matrix:** Soil

**Collected:** 2018/03/12  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu
Conductivity	AT	5451899	N/A	2018/03/22	Tahir Anwar
pH CaCl2 EXTRACT	AT	5452126	2018/03/23	2018/03/23	Neil Dassanayake
Resistivity of Soil		5448848	2018/03/22	2018/03/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5450427	N/A	2018/03/22	Alina Dobreanu

**Maxxam ID:** GHG163  
**Sample ID:** S1-2-SA8  
**Matrix:** Soil

**Collected:** 2018/03/12  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu
Conductivity	AT	5451899	N/A	2018/03/22	Tahir Anwar
pH CaCl2 EXTRACT	AT	5452126	2018/03/23	2018/03/23	Neil Dassanayake
Resistivity of Soil		5448848	2018/03/22	2018/03/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5450427	N/A	2018/03/22	Alina Dobreanu

**Maxxam ID:** GHG164  
**Sample ID:** S2-1-SA7  
**Matrix:** Soil

**Collected:** 2018/03/12  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu
Conductivity	AT	5451899	N/A	2018/03/22	Tahir Anwar
pH CaCl2 EXTRACT	AT	5452126	2018/03/23	2018/03/23	Neil Dassanayake
Resistivity of Soil		5448848	2018/03/22	2018/03/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5450427	N/A	2018/03/22	Alina Dobreanu

**Maxxam ID:** GHG165  
**Sample ID:** S2-2-SA7  
**Matrix:** Soil

**Collected:** 2018/03/06  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu
Conductivity	AT	5451899	N/A	2018/03/22	Tahir Anwar
pH CaCl2 EXTRACT	AT	5452126	2018/03/23	2018/03/23	Neil Dassanayake
Resistivity of Soil		5448848	2018/03/22	2018/03/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5450427	N/A	2018/03/22	Alina Dobreanu

**Maxxam ID:** GHG165 Dup  
**Sample ID:** S2-2-SA7  
**Matrix:** Soil

**Collected:** 2018/03/06  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu

## TEST SUMMARY

**Maxxam ID:** GHG166  
**Sample ID:** S3-1-SA6  
**Matrix:** Soil

**Collected:** 2018/03/06  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu
Conductivity	AT	5451899	N/A	2018/03/22	Tahir Anwar
pH CaCl2 EXTRACT	AT	5452126	2018/03/23	2018/03/23	Neil Dassanayake
Resistivity of Soil		5448848	2018/03/22	2018/03/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5450427	N/A	2018/03/22	Alina Dobreanu

**Maxxam ID:** GHG167  
**Sample ID:** S3-2-SA4  
**Matrix:** Soil

**Collected:** 2018/03/07  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu
Conductivity	AT	5451899	N/A	2018/03/22	Tahir Anwar
pH CaCl2 EXTRACT	AT	5452126	2018/03/23	2018/03/23	Neil Dassanayake
Resistivity of Soil		5448848	2018/03/22	2018/03/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5450427	N/A	2018/03/22	Alina Dobreanu

**Maxxam ID:** GHG168  
**Sample ID:** S4-1-SA4  
**Matrix:** Soil

**Collected:** 2018/03/05  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu
Conductivity	AT	5451899	N/A	2018/03/22	Tahir Anwar
pH CaCl2 EXTRACT	AT	5452126	2018/03/23	2018/03/23	Neil Dassanayake
Resistivity of Soil		5448848	2018/03/22	2018/03/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5450427	N/A	2018/03/22	Alina Dobreanu

**Maxxam ID:** GHG169  
**Sample ID:** S4-2-SA7  
**Matrix:** Soil

**Collected:** 2018/03/05  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5450392	N/A	2018/03/22	Alina Dobreanu
Conductivity	AT	5451899	N/A	2018/03/22	Tahir Anwar
pH CaCl2 EXTRACT	AT	5452126	2018/03/23	2018/03/23	Neil Dassanayake
Resistivity of Soil		5448848	2018/03/22	2018/03/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5450427	N/A	2018/03/22	Alina Dobreanu

### GENERAL COMMENTS

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

Package 1	15.0°C
-----------	--------

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



## QUALITY ASSURANCE REPORT

Golder Associates Ltd  
Client Project #: 1671430-W09  
Site Location: HWY 48  
Sampler Initials: JLS

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5450392	Soluble (20:1) Chloride (Cl)	2018/03/22	NC	70 - 130	103	70 - 130	<20	ug/g	2.4	35
5450427	Soluble (20:1) Sulphate (SO4)	2018/03/22	114	70 - 130	102	70 - 130	<20	ug/g	NC	35
5451899	Conductivity	2018/03/22			100	90 - 110	<2	umho/cm	0.35	10
5452126	Available (CaCl2) pH	2018/03/23			99	97 - 103			0.89	N/A

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).



Brad Newman, Scientific Service Specialist

---

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.

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](http://www.maxxam.ca/terms). Sample container, preservation, hold time and packages information can be viewed at <http://www.maxxam.ca/wp-content/uploads/Ontario-COC.pdf>.

Your Project #: 1671430-W09  
Site Location: HWY 48  
Your C.O.C. #: 105770

**Attention: Nikol Kochmanova**

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

**Report Date: 2018/03/26**  
Report #: R5055053  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B862118**

**Received: 2018/03/20, 12:06**

Sample Matrix: Soil  
# Samples Received: 4

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	4	N/A	2018/03/26	CAM SOP-00463	EPA 325.2 m
Conductivity	4	N/A	2018/03/26	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl <sub>2</sub> EXTRACT	4	2018/03/26	2018/03/26	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	4	2018/03/20	2018/03/26	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	4	N/A	2018/03/26	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 #: 1671430-W09

Site Location: HWY 48

Your C.O.C. #: 105770

**Attention: Nikol Kochmanova**

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

**Report Date: 2018/03/26**

Report #: R5055053

Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B862118**

**Received: 2018/03/20, 12:06**

**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.

### SOIL CORROSIVITY PACKAGE (SOIL)

<b>Maxxam ID</b>		GHG334			GHG334			GHG335	GHG336		
<b>Sampling Date</b>		2018/03/04			2018/03/04			2018/03/04	2018/03/05		
<b>COC Number</b>		105770			105770			105770	105770		
	<b>UNITS</b>	<b>GM-1-SA6A</b>	<b>RDL</b>	<b>QC Batch</b>	<b>GM-1-SA6A Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>	<b>GM-2-SA6</b>	<b>GM-3-SA7A</b>	<b>RDL</b>	<b>QC Batch</b>

#### Calculated Parameters

Resistivity	ohm-cm	1000		5448848				2300	670		5448848
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#### Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	490	20	5453941				170	850	20	5453941
Conductivity	umho/cm	987	2	5454237	988	2	5454237	437	1500	2	5454237
Available (CaCl2) pH	pH	7.85		5454347				7.90	7.88		5454347
Soluble (20:1) Sulphate (SO4)	ug/g	37	20	5453942				24	37	20	5453942

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

<b>Maxxam ID</b>		GHG337		
<b>Sampling Date</b>		2018/03/05		
<b>COC Number</b>		105770		
	<b>UNITS</b>	<b>GM-4-SA5</b>	<b>RDL</b>	<b>QC Batch</b>

#### Calculated Parameters

Resistivity	ohm-cm	1800		5448848
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#### Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	230	20	5453941
Conductivity	umho/cm	568	2	5454237
Available (CaCl2) pH	pH	7.77		5454347
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	5453942

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

## TEST SUMMARY

**Maxxam ID:** GHG334  
**Sample ID:** GM-1-SA6A  
**Matrix:** Soil

**Collected:** 2018/03/04  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5453941	N/A	2018/03/26	Deonarine Ramnarine
Conductivity	AT	5454237	N/A	2018/03/26	Tahir Anwar
pH CaCl2 EXTRACT	AT	5454347	2018/03/26	2018/03/26	Surinder Rai
Resistivity of Soil		5448848	2018/03/26	2018/03/26	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5453942	N/A	2018/03/26	Deonarine Ramnarine

**Maxxam ID:** GHG334 Dup  
**Sample ID:** GM-1-SA6A  
**Matrix:** Soil

**Collected:** 2018/03/04  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5454237	N/A	2018/03/26	Tahir Anwar

**Maxxam ID:** GHG335  
**Sample ID:** GM-2-SA6  
**Matrix:** Soil

**Collected:** 2018/03/04  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5453941	N/A	2018/03/26	Deonarine Ramnarine
Conductivity	AT	5454237	N/A	2018/03/26	Tahir Anwar
pH CaCl2 EXTRACT	AT	5454347	2018/03/26	2018/03/26	Surinder Rai
Resistivity of Soil		5448848	2018/03/26	2018/03/26	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5453942	N/A	2018/03/26	Deonarine Ramnarine

**Maxxam ID:** GHG336  
**Sample ID:** GM-3-SA7A  
**Matrix:** Soil

**Collected:** 2018/03/05  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5453941	N/A	2018/03/26	Deonarine Ramnarine
Conductivity	AT	5454237	N/A	2018/03/26	Tahir Anwar
pH CaCl2 EXTRACT	AT	5454347	2018/03/26	2018/03/26	Surinder Rai
Resistivity of Soil		5448848	2018/03/26	2018/03/26	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5453942	N/A	2018/03/26	Deonarine Ramnarine

**Maxxam ID:** GHG337  
**Sample ID:** GM-4-SA5  
**Matrix:** Soil

**Collected:** 2018/03/05  
**Shipped:**  
**Received:** 2018/03/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5453941	N/A	2018/03/26	Deonarine Ramnarine
Conductivity	AT	5454237	N/A	2018/03/26	Tahir Anwar
pH CaCl2 EXTRACT	AT	5454347	2018/03/26	2018/03/26	Surinder Rai
Resistivity of Soil		5448848	2018/03/26	2018/03/26	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5453942	N/A	2018/03/26	Deonarine Ramnarine

### GENERAL COMMENTS

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

Package 1	15.0°C
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**Results relate only to the items tested.**



## QUALITY ASSURANCE REPORT

Golder Associates Ltd  
Client Project #: 1671430-W09  
Site Location: HWY 48  
Sampler Initials: JLS

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5453941	Soluble (20:1) Chloride (Cl)	2018/03/26	NC	70 - 130	105	70 - 130	<20	ug/g	7.9	35
5453942	Soluble (20:1) Sulphate (SO4)	2018/03/26	NC	70 - 130	100	70 - 130	<20	ug/g	3.5	35
5454237	Conductivity	2018/03/26			98	90 - 110	<2	umho/cm	0.099	10
5454347	Available (CaCl2) pH	2018/03/26			100	97 - 103			0.034	N/A

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.

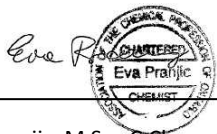
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

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)

### 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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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.

CHAIN OF CUSTODY RECORD

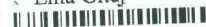
105770

Page 2 of 3

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)		Turnaround Time (TAT) Required								
Company Name: <b>Golder Associates Ltd.</b>		Company Name:		Quotation #:		<input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses								
Contact Name: <b>Nikol Kochmanova</b>		Contact Name:		P.O. #/ AFER:		PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS								
Address: <b>6925 Century Ave #100</b>		Address:		Project #: <b>1671430 - W09</b>		Rush TAT (Surcharges will be applied)								
Address: <b>MISSISSAUGA ON</b>		Address:		Site Location:		<input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days								
Phone: <b>905-567-4444</b>		Phone:		Site #: <b>HWY 48</b>		Date Required:								
Email: <b>Nikol.Kochmanova@golder.com</b>		Email:		Sampled By: <b>JLS</b>		Rush Confirmation #:								
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY														
<b>Regulation 153</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 FOR RSC (PLEASE CIRCLE) Y / N		<b>Other Regulations</b> <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWQO <input type="checkbox"/> Region <input type="checkbox"/> Other (Specify) <input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED)		<b>Analysis Requested</b> FIELD (ENTERED) (CIRCLE) Metals / Hg / CVI BTEX / PHC E1 PHCs P2 - P4 VOCs REG 153 METALS & INORGANICS REG 153 ICPCAS METALS REG 153 METALS (Pb, Cr VI, ICPCAS Metals, HWS - B) <b>CORROSIONITY PACKAGE</b>		<b>LABORATORY USE ONLY</b> CUSTODY SEAL Y / N Present Intact COOLER TEMPERATURES COOLING MEDIA PRESENT: Y / (N)								
Include Criteria on Certificate of Analysis: Y / N														
SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM														
SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH-MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD (ENTERED) (CIRCLE) Metals / Hg / CVI	BTEX / PHC E1	PHCs P2 - P4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPCAS METALS	REG 153 METALS (Pb, Cr VI, ICPCAS Metals, HWS - B)	CORROSIONITY PACKAGE	HOLD - DO NOT ANALYZE	COMMENTS
1 GM-1-SA6A	2018/3/4	PM	SOIL	1								X		
2 GM-2-SA6	2018/3/4	PM	SOIL	1								X		
3 GM-3-SA7A	2018/3/5	AM	SOIL	1								X		
4 GM-4-SA5	2018/3/5	AM	SOIL	1								X		
5														
6														
7														
8														
9														
10														
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)		TIME: (HH-MM)		RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)		TIME: (HH-MM)				
Katie Neo Kili		2018/03/20		12:05 PM		Yorkey/Rizart-Purend		2018/3/20		12:06				

20-Mar-18 12:06

Ema Gitej



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