



Foundation Investigation and Design Report

*Overhead Sign Supports, Highway 401 Westbound Core and Collector Lanes,
Neilson Road to Warden Avenue, City of Toronto, Ontario,
Ministry of Transportation, Ontario, G.W.P. No. 2162-11-00*

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PART A

FOUNDATION INVESTIGATION REPORT
OVERHEAD SIGN SUPPORTS
HIGHWAY 401 WESTBOUND CORE AND COLLECTOR LANES,
NEILSON ROAD TO WARDEN AVENUE, CITY OF TORONTO, ONTARIO
MTO G.W.P. 2162-11-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by WSP on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the rehabilitation and operational improvements of the Highway 401 westbound (WB) core and collector lanes, from Neilson Road to Warden Avenue in the City of Toronto, Ontario (GWP 2162-11-00).

This report addresses the foundation investigation carried out for the proposed overhead sign supports for the section of Highway 401 extending from about Kennedy Road to about 900 m east of Markham Road, as shown on the key plan on Drawings 1 and 2. This report was developed based on information from the 2018 (current) investigation, supplemented with information from a 1966 (previous) foundation investigation completed by others, reported as follows:

- **MTO GEOCRES No. 30M14-74:** Report titled “Foundation Investigation Report for the Proposed Extension of Hwy. #401 and Midland Ave. Crossing, Metropolitan Toronto, District #6, W.J. 66-F-87 - W.P. 260-61”, by DHO, Foundation Section, Materials and Testing Division, dated January 4, 1967;

The results of the 1966 investigation are also summarized in the following report:

- **MTO GEOCRES No. 30M14-340:** “Preliminary Foundation Investigation and Design Report, Retaining Walls, Highway 401 Rehabilitation from Warden Avenue to Brock Road, Toronto, Ontario, W.O. 07-20012,” by Golder Associates Ltd., dated April, 2012.

The Terms of Reference and Scope of Work for the foundation engineering services are outlined in MTO’s Request for Proposal, dated November 21, 2016, which forms part of the Consultant Agreement (No. 2016-E-0009) 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 July 10, 2017.

2.0 SITE DESCRIPTION

Based on the general arrangement drawings for the proposed overhead sign supports (OHS) provided by WSP on September 12, 2018, a description of each proposed OHS is summarized below, and the locations of the proposed OHS are shown on Drawings 1 and 2.

Overhead Sign (Reference Borehole)	Approximate Station	Site Description
OHS No. 1 (CN-01/01A)	Sta. 23+316	Located about 400 m east of the Kennedy Road underpass structure spanning across the WB Collector Lanes and Kennedy Road underpass E-N/S ramp. Existing highway grade in the vicinity of the OHS is at about Elevation 174.0 m
OHS No. 2 (OH-4)	Sta. 23+616	Located about 150 m west of the Midland Ave. overpass in the lanes connecting the WB collector and WB core. Existing highway grade in the vicinity of the OHS is at about Elevation 172.6 m
OHS No. 3 (74-16, 74-17)	Sta. 23+893	Located about 125 m east of the Midland Ave. overpass in the WB collector lanes. Existing highway grade in the vicinity of the OHS is at about Elevation 173.8 m

Overhead Sign (Reference Borehole)	Approximate Station	Site Description
OHS No. 4 (OH-5)	Sta. 23+930, Core Sta. 13+940	Located about 150 m east of the Midland Ave. overpass in the WB core lanes. Existing highway grade in the vicinity of the OHS is at about Elevation 173.8 m
OHS No. 5 (OH-7)	Sta. 24+073	Located about 300 m east of the Midland Ave. overpass in the WB collector lanes. Existing highway grade in the vicinity of the OHS is at about Elevation 175.0 m
OHS No. 6 (OH-9)	Sta. 24+230, Core Sta. 14+240	Located about 450 m east of the Midland Ave. overpass in the WB core lanes. Existing highway grade in the vicinity of the OHS is at about Elevation 174.8 m
VMS No. 1 (OH-10)	Sta. 24+692	Located about 100 m east of the Brimley Rd. underpass in the WB collector Lanes. Existing highway grade in the vicinity of the VMS is at about Elevation 171.9 m
VMS No. 3 (OH-14)	Core Sta. 15+690	Located about 250 m east of the McCowan Road underpass structure in the WB core Lanes. Existing highway grade in the vicinity of the VMS is at about Elevation 160.0 m
OHS No. 7 (OH-16)	Sta. 25+747	Located about 325 m east of the McCowan Road underpass structure spanning across the WB collector Lanes and McCowan Road underpass E-N/S ramp. Existing highway grade in the vicinity of the OHS is at about Elevation 159.2 m
OHS No. 8 (OH-19)	Sta. 26+345	Located about 950 m east of the McCowan Road underpass structure in the WB collector Lanes. Existing highway grade in the vicinity of the OHS is at about Elevation 162.2 m
VMS No. 2 (OH-27)	Sta. 26+996	Located about 50 m west of the Markham Rd. overpass in the WB collector Lanes. Existing highway grade in the vicinity of the VMS is at about Elevation 165.1 m
OHS No. 9 (OH-22)	Markham E-N/S Ramp Sta. 27+200	Located on the Hwy 401/Markham Road E-N/S ramp. Existing ramp grade in the vicinity of the OHS is at about Elevation 161.2 m
OHS No. 10 (OH-24)	Sta. 27+483	Located about 200 m east of the Progress Ave. underpass spanning across the WB collector lanes and Markham Road E-N/S ramp. Existing highway grade in the vicinity of the OHS is at about Elevation 160.0 m
OHS No. 11 (OH-26)	Sta. 27+910	Located about 200 m east of the Progress Ave. underpass in the WB collector Lanes. Existing highway grade in the vicinity of the OHS is at about Elevation 155.2 m

3.0 INVESTIGATION PROCEDURES

3.1 1966 Investigation

A total of 15 boreholes were advanced as part of a 1966 investigation (GEOCRE No. 30M14-74) along a retaining wall extending easterly from Midland Avenue. Two of the previously advanced boreholes, Boreholes 16 and 17, are in the general vicinity of OHS No. 3 and have been used in this report to supplement the information obtained from the current investigation. The previous investigation boreholes used in this report have been renumbered to show the MTO GEOCRE reference number followed by the original borehole designation. For example, the boreholes from MTO GEOCRE Report No. 30M14-74 have been renumbered as 74-X, where X is the original borehole number.

The locations of the boreholes are summarized below and shown on Drawing 1. These borehole locations have been developed based on plotting the station and offset as shown on the 1966 borehole records and drawings, adjusted based on the site features shown on the drawings and converted to MTM NAD83 (Zone 10) coordinates. The borehole records from the 1966 investigation, including the summary results of the groundwater conditions and results of the geotechnical laboratory testing are presented in Appendix A and a summary of the borehole locations, ground surface elevation referenced to Geodetic datum and drilled depths are presented below.

Borehole No.	MTM NAD 83 (Zone 10)		Borehole Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
74-16	4,848,679.9	323,027.0	173.0	9.6
74-17	4,848,688.6	323,055.0	175.1	6.6

The Standard Penetration Test (SPT) "N"-values presented on the borehole records of the 1966 investigation were obtained using a manual hammer.

3.2 2018 Investigation

The current foundation investigation was carried out between March 5 and 13, April 11 and 13, and November 25 and December 4, 2018, during which time thirteen boreholes (designated as Boreholes CN-01, OH-4, OH-5, OH-7, OH-9, OH-10, OH-14, OH-16, OH-19, OH-22, OH-24, OH-26 and OH-27) were advanced in close proximity to the proposed OHS at the locations shown on Drawings 1 and 2.

The borehole investigation was carried out using CME-55 and CME-75 truck-mounted drill rigs supplied and operated by Geo-Environmental Drilling Inc. of Acton, Ontario. The boreholes were advanced through the overburden using 152 mm or 165 mm outer diameter hollow stem augers, to depths ranging between 7.8 m and 8.2 m below ground surface, except for Borehole CN-01/01A, which was advanced at the CN Rail overpass to a depth of 50.9 m below 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)¹.

Groundwater conditions in the open boreholes were observed during and immediately following the drilling operations and are noted on the Record of Borehole logs in Appendix B. All boreholes were abandoned upon completion in accordance with Ontario Regulation 903 (as amended).

Field work was monitored on a full-time basis by a member of Golder's technical staff who located the borehole in the field, directed the sampling and in situ testing operations, logged the borehole 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. Geotechnical laboratory index and classification testing, consisting of natural moisture contents, Atterberg limits and grain size distributions, was conducted on selected samples in accordance with MTO and / or ASTM Standards as applicable. One sample from each of the OH- series boreholes, obtained using appropriate sampling protocols, was submitted to a specialist accredited analytical laboratory under chain of custody procedures for testing of conductivity / resistivity, pH and 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 laid out in the field by Golder personnel relative to existing road features and pre-selected coordinates using a hand-held global positioning system (GPS) unit with an accuracy of 1 m in the horizontal and vertical directions. The borehole locations were then measured relative to existing site features and the ground surface (pavement) elevation at the borehole locations was established from the digital terrain model for the project provided to us by WSP. The location given on the borehole records and shown on Drawings 1 and 2 is positioned relative to MTM NAD 83 (Zone 10) CSRS CBNV6-2010.0 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, including both MTM NAD 83 and geographic coordinates, ground surface elevation and drilled depth are summarized below.

Borehole No.	MTM NAD83 (Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude °)	Easting (m) (Longitude °)		
CN-01/01A	4,848,486.8 (43.776139)	322,498.0 (-79.280151)	174.0	50.9
OH-4	4,848,581.7 (43.776980)	322,778.7 (-79.276620)	172.5	8.2
OH-5	4,848,676.2 (43.777800)	323,084.5 (-79.272840)	173.8	8.2
OH-7	4,848,714.4 (43.778170)	323,219.5 (-79.271180)	175.0	7.9
OH-9	4,848,746.6 (43.778455)	323,401.1 (-79.268922)	174.8	7.8

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

Borehole No.	MTM NAD83 (Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude °)	Easting (m) (Longitude °)		
OH-10	4,848,897.6 (43.779804)	323,813.9 (-79.263789)	171.9	7.9
OH-14	4,849,144.3 (43.781997)	324,774.6 (-79.251845)	160.0	8.2
OH-16	4,849,179.6 (43.782315)	324,833.5 (-79.251111)	159.2	8.0
OH-19	4,849,336.0 (43.783708)	325,402.2 (-79.244040)	162.2	8.1
OH-22	4,849,720.3 (43.787145)	326,187.9 (-79.234263)	161.2	8.2
OH-24	4,849,741.8 (43.787330)	326,453.7 (-79.230960)	160.0	8.2
OH-26	4,849,952.0 (43.789211)	326,831.3 (-79.226260)	155.2	8.2
OH-27	4,849,554.1 (43.785653)	326,035.6 (-79.236162)	165.1	8.2

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located within the physiographic region known as the South Slope, according to *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)².

The South Slope region is comprised of calcareous clay till with lacustrine clay and silt reworked by glaciers, with numerous scattered drumlins and deep valley cuts caused by streams flowing towards Lake Ontario. The surface topography slopes gradually and uniformly southwards towards Lake Ontario. The overburden within the majority of the South Slope area is underlain by shale bedrock of the Queenston and Georgian Bay Formations which contain limestone interlayers.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the borehole advanced during the 2018 investigation, including the results of the geotechnical laboratory tests carried out on selected soil samples are presented on the borehole records provided in Appendix B. The results of the in-situ field tests (i.e., SPT “N”-values) as presented on the borehole records and in Section 4.2 are uncorrected. The SPT “N”-values from the 2018 investigation are based on use of an automatic hammer and the values are reported with no adjustment in

² 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.)

this report, although it is recognized that SPT “N”-values obtained using a manual hammer (as is the case for the 1966 investigation) are frequently higher than those obtained using an automatic hammer. Plot of the results of the geotechnical laboratory testing from the current investigation are shown on Figures C-1 to C-15, inclusive, presented in Appendix C. The results of the analytical testing are provided in Appendix D.

The stratigraphic boundaries shown on the borehole records for the two investigations 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 borehole records governs any interpretation of the site conditions.

A summary description of the subsurface conditions encountered in the boreholes advanced in the immediate vicinity of each of the proposed overhead sign locations is provided in the following subsections, and include the test results for the following parameters:

N = SPT ‘N’-value

w = natural moisture content (%)

w_p = plastic limit (%)

w_l = liquid limit (%)

PI = plasticity index (%)

References to combined sieve and hydrometer analyses (MH) and Atterberg limits testing (AL) are noted in the Laboratory Testing Results column.

4.2.1 Overhead Sign 1 – Station 23+316

Borehole CN-01/01A was advanced in the left lane of the Highway 401 westbound collector lanes near the proposed location of Overhead Sign 1 as shown on Drawing 1.

In general, the subsurface conditions encountered in Borehole CN-01/01A consist of asphalt pavement underlain by layers of non-cohesive fill (pavement structure) and layers of clayey silt with sand fill, underlain by a deposit of clayey silt, which is turn underlain by a deposit of silt. A description of the soil layers and deposits, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer* (Note 1)	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.15	174.0	N/A	N/A
Gravelly Sand (Fill)	0.6	173.8	22	N/A
			Compact	
Sandy Clayey Silt (Fill)	0.2	173.2	N/A	N/A
Sand and Gravel (Fill)	0.5	173.0	51	N/A
			Very Dense	

Deposit/Layer* (Note 1)	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Clayey Silt with Sand (Fill)	7.1	172.5	2 – 30	w = 11% - 17% w _L = 19% w _p = 13% PI = 7% 1 AL (Fig. C-1) 1 MH (Fig. C-2)
			Soft to Very Stiff	
Clayey Silt	1.6	165.4	7	w = 20% w _L = 24% w _p = 17% PI = 7% 1 AL (Fig. C-4)
			Firm	
Silt	3.0	163.8	42 and 114	w = 8% - 14% w _L = 18% w _p = 15% PI = 3% 1 AL (Fig. C-8) 1 MH (Fig. C-9)
			Dense to Very Dense	

* Note 1: Borehole CN-01/01A was advanced to a total depth of 50.9 m, however, only the subsurface conditions to 13.2 m depth are summarized above, and a complete summary of soil conditions are presented in the borehole record included in Appendix B, and are described in the associated Foundation Investigation Report for the CN Rail Overpass structure (Golder 2019, GEOCRETS No. 30M14-489).

4.2.2 Overhead Sign 2 – Station 23+616

Borehole OH-4 was advanced in the left lane of the Highway 401 westbound collector lanes near the proposed location of Overhead Sign 2 as shown on Drawing 1.

In general, the subsurface conditions encountered in OH-4 consist of asphalt pavement underlain by layers of gravelly sand fill, sandy clayey silt fill, and clayey silt with sand fill. A description of the soil layers, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.15	172.5	N/A	N/A
Gravelly Sand (Fill)	0.3	172.3	N/A	N/A
Sandy Clayey Silt (Fill)	1.7	172.0	8 – 9	w = 11%
			Stiff	

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Clayey Silt with Sand (Fill)	> 6.0	170.3	10 – 35	w = 9% - 15% wl = 16% - 19% wp = 12% PI = 4% - 7% 2 AL (Fig. C-1) 2 MH (Fig. C-2)
			Stiff to Hard	

4.2.3 Overhead Sign 3 – Station 23+893; Overhead Sign 4 – Station 23+930, (Core Station 13+940)

Boreholes 74-16 and 74-17 from the 1966 investigation and Borehole OH-5 were advanced in the right shoulder and the left lane of the Highway 401 westbound collector lanes, respectively, approximately 35 m east of the proposed location of Overhead Sign 3 and adjacent to the location of Overhead Sign 4 as shown on Drawing 1.

Borehole records from the 1966 investigation indicate that the subsurface conditions in Boreholes 74-16 and 74-17 generally consist of very dense silty sand to sandy silt with traces of clay. In general, the subsurface conditions encountered in Borehole OH-5 consist of asphalt pavement underlain by layers of gravelly sand fill, sandy clayey silt fill and silty sand fill, underlain by clayey silt with sand till. A description of the soil layers and deposits, results of SPT testing carried out in Borehole OH-5 and the geotechnical laboratory test results are provided below.

Deposit/Layer in Borehole OH-5	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.15	173.8	N/A	N/A
Gravelly Sand (Fill)	0.3	173.6	N/A	N/A
Sandy Clayey Silt (Fill)	1.7	173.3	25 – 31	w = 7% - 9%
			Very stiff to Hard	
Silty Sand (Fill)	0.2	171.6	N/A	N/A
Clayey Silt with Sand (Till)	> 5.8	171.4	25 – 37	w = 8% - 10% wl = 17% wp = 10% - 11% PI = 6% - 7% 2 AL (Fig. C-10) 2 MH (Fig. C-11)
			Very stiff to Hard	

4.2.4 Overhead Sign 5 – Station 24+073

Borehole OH-7 was advanced in the left lane of the Highway 401 westbound collector lanes near the proposed location of Overhead Sign 5 as shown on Drawing 1.

In general, the subsurface conditions encountered in Borehole OH-7 consist of asphalt pavement underlain by layers of gravelly sand fill and sandy clayey silt fill, underlain by deposits of silt to sandy silt, sand and sandy clayey silt till. A description of the soil layers and deposits, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.1	175.0	N/A	N/A
Gravelly Sand (Fill)	0.4	174.9	N/A	N/A
Sandy Clayey Silt (Fill)	1.3	174.5	24 – 35	w = 15%
			Very stiff to Hard	
Silt	3.8	173.2	21 – 57	w = 14% - 20% wl = 14% wp = 13% PI = 1% 2 AL (1-NP, 1- Fig. C-8) 2 MH (Fig. C-9)
			Compact to very Dense	
Sand	0.6	169.4	N/A	N/A
Sandy Clayey Silt (Till)	> 1.7	168.8	62 and 50 blows for 0.15 m of penetration	w = 15%
			Hard	

4.2.5 Overhead Sign 6 – Station 24+230 (Core Station 14+240)

Borehole OH-9 was advanced in the left lane of the Highway 401 westbound core lanes at the proposed location of Overhead Sign 6 as shown on Drawing 1.

In general, the subsurface conditions encountered in Borehole OH-9 consist of asphalt pavement underlain by layers of gravelly sand fill and silt and sand fill, underlain by a till deposit comprised of sandy clayey silt to clayey silt with sand. A description of the soil layers and deposits, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.18	174.8	N/A	N/A
Gravelly Sand (Fill)	0.4	174.6	N/A	N/A
Silt and Sand (Fill)	1.8	174.2	6 – 17	w = 17% wl = 15% wp = 13% PI = 2% 1 AL (Fig. C-1) 1 MH (Fig. C-3)
			Loose to Compact	
Sandy Clayey Silt to Clayey Silt with Sand (Till)	> 5.4	172.4	9 – 40 and 55 blows for 0.15 m of penetration	w = 11% - 13% wl = 17% - 19% wp = 11% - 12% PI = 6% - 7% 2 AL (Fig. C-10) 2 MH (Fig. C-11)
			Stiff to Hard	

4.2.6 Variable Message Sign 1 – Station 24+692

Borehole OH-10 was advanced in the right lane of the Highway 401 westbound collector lanes at the proposed location of Variable Message Sign 1 as shown on Drawing 1.

In general, the subsurface conditions encountered in Borehole OH-10 consist of asphalt and concrete pavement underlain by a layer of sandy silt fill, in turn underlain with a deposit of sandy silt to silt and sand. A description of the soil layer and deposit, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt/Concrete	0.04/0.24	171.9	N/A	N/A
Sandy Silt (Fill)	0.8	171.6	Compact	N/A
Silt and Sand to Sandy Silt (Fill)	> 6.8	170.8	39 - 76 and 100 blows for 0.23 m of penetration	w = 7% - 12% 3 MH (Fig. C-12A and C-12B)
			Dense to very dense	

4.2.7 Variable Message Sign 3 (Core Station 15+690)

Borehole OH-14 was advanced in the left lane of the Highway 401 westbound collector lanes (Station 25+680) near the proposed location of Variable Message Sign 3 as shown on Drawing 2.

In general, the subsurface conditions encountered in OH-14 consist of asphalt pavement underlain by layers of gravelly sand fill and clayey silt with sand fill, in turn underlain by deposits of silty clay and silt and sand till. A description of the soil layers and deposits, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.17	160.0	N/A	N/A
Gravelly Sand (Fill)	0.4	159.8	N/A	N/A
Clayey Silt with Sand (Fill)	1.6	159.4	16	w = 12% wl = 23% wp = 13% PI = 10% 1 AL (Fig. C-1) 1 MH (Fig. C-2)
			Very stiff	
Silty Clay	2.3	157.8	6 – 11	w = 11% - 23% wl = 36% wp = 16% PI = 20% 1 AL (Fig. C-6) 1 MH (Fig. C-7)
			Firm to Stiff	
Silt and Sand (Till)	> 3.7	155.5	12 – 46	w = 7% - 18% 1 MH (Fig. C-13)
			Compact to dense	

4.2.8 Overhead Sign 7 – Station 25+747

Borehole OH-16 was advanced in the right lane of the Highway 401 westbound McCowan Road E-N/S ramp near the proposed location of Overhead Sign 7 as shown on Drawing 2.

In general, the subsurface conditions encountered in Borehole OH-16 consist of asphalt and concrete pavement underlain by a layer of clayey silt with sand fill, underlain by silt and sand till. A description of the soil layer and deposit, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt/Concrete	0.04 / 0.20	159.2	N/A	N/A
Clayey Silt with Sand (Fill)	2.8	159.0	5 – 12	w = 16% wl = 19% wp = 12% PI = 7% 1 AL (Fig. C-1) 1 MH (Fig. C-2)
			Firm to Stiff	
Silt and Sand (Till)	> 5.0	156.2	14 – 38 and 100 blows for 0.25 m of penetration	w = 8% - 9% 2 MH (Fig. C-13)
			Compact to Very dense	

4.2.9 Overhead Sign 8 – Station 26+345

Borehole OH-19 was advanced in the left lane of the Highway 401 westbound collector lanes at the proposed location of Overhead Sign 8 as shown on Drawing 2.

In general, the subsurface conditions encountered in Borehole OH-19 consist of asphalt pavement underlain by layers of sand and gravel fill and sandy silt fill, in turn underlain by deposits of clayey silt with sand, silt and sand till, and clayey silt. A description of the soil layers and deposits, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.14	162.2	N/A	N/A
Sand and Gravel (Fill)	0.4	162.1	N/A	N/A
Sandy Silt (Fill)	1.7	161.7	18 – 25	w = 10%
			Compact	
Clayey Silt with Sand	0.8	160.0	5	w = 17% wl = 18% wp = 14% PI = 4% 1 AL (Fig. C-14) 1 MH (Fig. C-15)
			Firm	

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Silt and Sand (Till)	2.6	159.2	17 – 62	w = 8% - 9% 1 MH (Fig. C-13)
			Compact to Very dense	
Clayey Silt	> 2.5	156.6	68 and 100 blows for 0.28 m of penetration	w = 14% wl = 21% wp = 15% PI = 6% 1 AL (Fig. C-4) 1 MH (Fig. C-5)
			Hard	

4.2.10 Variable Message Sign 2 – Station 26+996

Borehole OH-27 was advanced in the right lane of the Highway 401 westbound collector and Markham Road S-W ramp at the proposed location of Variable Message Sign 2 as shown on Drawing 2.

In general, the subsurface conditions encountered in Borehole OH-27 consist of asphalt and concrete pavement underlain by layers of silty sand fill, clayey silt with sand fill and silt and sand fill, in turn underlain by a silt and sand deposit. A description of the soil layers and deposit, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt / Concrete	0.05 / 0.25	165.1	N/A	N/A
Silt and Sand (Fill)	2.4	164.8	11 – 32	w = 8% 1 MH (Fig. C-3)
			Compact to dense	
Clayey Silt with Sand (Fill)	0.3	162.4	N/A	N/A
Silt and Sand (Fill)	2.5	162.0	7 – 17	w = 9% - 15% 1 MH (Fig. C-3)
			Loose to Compact	
Silt and Sand	> 2.6	159.5	16 - 47	w = 9% 1 MH (Fig. C-12B)
			Compact to dense	

4.2.11 Overhead Sign 9 –Station 27+200

Borehole OH-22 was advanced in the right lane of the Highway 401 westbound to Markham Road E-N/S ramp near the proposed location of Overhead Sign 9 as shown on Drawing 2.

In general, the subsurface conditions encountered in Borehole OH-22 consist of asphalt pavement underlain by layers of sand and gravel fill and sandy silty clay fill, in turn underlain by deposits of silt and sand and silty sand to sand. A description of the soil layers and deposits, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.14	161.2	N/A	N/A
Sand and Gravel (Fill)	0.5	161.1	N/A	N/A
Sandy Silty Clay (Fill)	0.9	160.6	11	N/A
			Stiff	
Silt and Sand	2.2	159.7	20 – 55	w = 9% 1 MH (Fig. C-12A)
			Compact to Very dense	
Silty Sand to Sand	> 4.5	157.5	60 – 80	w = 6% - 14% 2 MH (Fig. C-12B)
			Very dense	

4.2.12 Overhead Sign 10 – Station 27+483

Borehole OH-24 was advanced in the right lane of the Highway 401 westbound collector lanes at the proposed location of Overhead Sign 10 as shown on Drawing 2.

In general, the subsurface conditions encountered in Borehole OH-24 consist of asphalt pavement underlain by a layer of sandy silt fill, in turn underlain by deposits of silt and sand to sandy silt, and sand. A description of the soil layers and deposits, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.17	160.0	N/A	N/A
Sandy Silt (Fill)	1.3	159.8	54	N/A
			Very dense	
Sandy Silt to Silt and Sand	4.1	158.6	50 – 118	w = 9% - 12% 2 MH (Fig. C-12A)
			Very dense	
Sand	> 2.6	154.4	46 and 65	w = 19% 1 MH (Fig. C-12B)
			Dense to Very dense	

4.2.13 Overhead Sign 11 – Station 27+910

Borehole OH-26 was advanced in the right lane of the Highway 401 westbound collector lanes near the proposed location of Overhead Sign 11 as shown on Drawing 2.

In general, the subsurface conditions encountered in Borehole OH-26 consist of asphalt pavement underlain by a layer of silt and sand fill, in turn underlain by a deposit of silt and sand. A description of the soil layer and deposit, results of SPT testing carried out in the borehole and the geotechnical laboratory test results are provided below.

Deposit/Layer	Deposit/Layer Thickness (m)	Surface Elevation (m)	N Values (blows per 0.3 m)	Laboratory Testing Results
			Consistency or Compactness	
Asphalt	0.15	155.2	N/A	N/A
Silt and Sand (Fill)	1.2	155.0	21	w = 9%
			Compact	
Silt and Sand	> 6.8	153.8	11 – 25	w = 8% - 10% 3 MH (Fig. C-12A and C-12B)
			Compact	

4.3 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations during the 2018 and 1966 investigations, as summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)	Date	Comments
CN-01	174.0	N/A	-	Mar. 13, 2018	Not recorded prior to the introduction of drilling fluid
OH-4	172.5	Dry to 8.2	-	Apr. 12, 2018	Open Borehole
OH-5	173.8	Dry to 8.2	-	Apr. 12, 2018	Open Borehole
OH-7	175.0	3.7	171.3	Apr. 11, 2018	Open Borehole
OH-9	174.8	Dry to 7.8	-	Apr. 13, 2018	Open Borehole
OH-10	171.9	Dry to 7.9	-	Nov. 29, 2018	Open Borehole
OH-14	160.0	Dry to 8.2	-	Dec. 4, 2018	Open Borehole
OH-16	159.2	2.9	156.3	Nov. 30, 2018	Open Borehole
OH-19	162.2	Dry to 8.1	-	Nov. 30, 2018	Open Borehole
OH-22	161.2	5.7	155.5	Nov. 29, 2018	Open Borehole
OH-24	160.0	5.5	154.5	Nov. 26, 2018	Open Borehole
OH-26	155.2	Dry to 8.2	-	Nov. 26, 2018	Open Borehole
OH-27	165.1	Dry to 8.2	-	Nov. 28, 2018	Open Borehole
74-16	173.0	-	-	Nov. 7, 1966	Not noted
74-17	175.1	-	-	Nov. 8, 1966	Not noted

As these water levels were measured immediately after completion of drilling, they may not represent the stabilized groundwater level at the site, nor the current level in the case of the 1966 data. The groundwater level will be subject to seasonal fluctuations and should be expected to be higher during the spring season or during and following periods of heavy precipitation.

4.4 Analytical Testing Results

Thirteen soil samples were submitted to an accredited analytical laboratory 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 D and the test results are summarized below.

Borehole No. / Sample No.	pH	Resistivity (ohm-cm)	Electrical Conductivity (umho/cm)	Chlorides (ug/g)	Soluble Sulphates (ug/g)
CN-01/01A	8.34	2,900	343	120	92
OH-4 / 4	8.01	1,300	764	220	370
OH-5 / 7	8.14	1,000	974	490	29
OH-7 / 5	7.99	710	1,410	680	280
OH-9 / 5	8.16	1,400	733	330	<20*
OH-10 / 3	8.06	620	1,610	820	56
OH-14 / 3	7.86	670	1,480	810	22
OH-16 / 4	7.98	1,400	714	170	350
OH-19 / 4	7.88	930	1,080	550	40
OH-22 / 3	8.04	990	1,010	510	67
OH-24 / 5	7.84	1,100	870	400	190
OH-26 / 4	7.85	3,400	291	49	100
OH-27 / 3	7.85	480	2,090	1,100	48

* Reportable Detection Limit

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Eric Naylor, EIT, and reviewed by Mr. Matthew Kelly, P.Eng., a geotechnical engineer with Golder. Mr. Jorge M.A. Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant of Golder, conducted an independent technical and quality control review of the report.

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PART B

FOUNDATION DESIGN REPORT
OVERHEAD SIGN SUPPORTS
HIGHWAY 401 WESTBOUND CORE AND COLLECTOR LANES,
NEILSON ROAD TO WARDEN AVENUE, CITY OF TORONTO, ONTARIO
MTO G.W.P. 2162-11-00

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides detail foundation recommendations for the design of the overhead sign (OHS) supports as part of the rehabilitation and operational improvements of the Highway 401 westbound core and collector lanes, from Neilson Road to Warden Avenue in the City of Toronto, Ontario. These recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the 2018 subsurface investigation at this site, supplemented with data from the 1966 investigation. The discussion and recommendations presented are intended to provide the designer with sufficient information to assess the feasible foundation alternatives and carry out the design of the OHS supports. The foundation investigation report, discussions and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO), and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. The contractor must make their own interpretation based on the factual data in the Foundation Investigation (Part A) of this report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required in the Contract Documents. Those requiring information on the aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling, and the like.

6.2 Correlation of Automatic and Manual Hammer for SPT “N” Values

The results of the 2018 foundation investigation generally demonstrate that lower Standard Penetration Test (SPT) “N”-values are measured in the non-cohesive soil strata than encountered in the boreholes from the 1966 investigation (GEOCREC No. 30M14-74). The differences are considered due to the use of an automated hammer with higher efficiency in the 2018 investigation as compared to a manually operated hammer (i.e., rope cathead) that was used in the 1966 investigation. The 2018 SPT “N”-values correlate reasonably well with the 1966 data when corrected to a 60% efficiency of hammer energy transfer, as suggested in CFEM (2006). The foundation options and recommendations presented below are based on the normalized “N₆₀”-values, where applicable.

6.3 Design of Sign Support Foundations

Caisson foundations for sign supports should be designed in accordance with the requirements in MTO's *Sign Support Manual* (MTO, 2015). The *Sign Support Manual* includes standard caisson foundation designs for each sign type as follows:

- **Cantilever Signs:** Cantilever Static Sign Supports, Division 3 and Standard Drawings SS118-3, SS118-4 and SS118-5.
- **Trichord Overhead Signs:** Tri-Chord Static Sign Supports, including those for Variable Message Signs, Division 4 and Division 8, respectively, and Standard Drawings SS118-3, SS118-4, SS118-5, and SS118-6.
- **Monotube Signs:** Overhead Monotube Sign Supports, Division 7 and Standard Drawing SS118-40, SS118-41 and SS118-42.

6.3.1 Cantilever and Trichord Overhead Signs

In the standard caisson foundation design for cantilever and trichord (including variable message) overhead signs, the caisson is extended 5 m to 6.5 m below the design frost depth which can be taken as 1.2 m as interpreted from OPSD 3090.101 (Foundation Frost Penetration Depths for Southern Ontario) resulting in a total length of 6.2 to 7.7

m below final grade depending on the sign class and corresponding caisson diameter. The standard sign foundation designs presented in the MTO's Sign Support Manual have been developed based on the minimum soil conditions given below.

- **Case 1 (Non-Cohesive Soils):** Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower third of the portion of the caisson below the design frost depth.
- **Case 2 (Cohesive Soils):** Soft clay with an undrained shear strength of 25 kPa surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and "soft" clay with an undrained shear strength of 50 kPa surrounding the lower third of the portion of the caisson below the design frost depth.

The standard foundation design provided in MTO's *Sign Support Manual* does not apply to sites where extensive poor fill materials or materials looser or softer than those of Case 1 or Case 2 are present. The standard foundation design is also not applicable where bedrock is encountered within the standard foundation depth. For such subsurface conditions, a site-specific design is required.

Based on the review of the borehole information, the subsurface conditions at the proposed sign locations have been compared to the standard design requirements to assess whether a standard or site-specific design is required. The requirement for either a standard or site-specific design is summarized in Table 1, following the text of this report, along with geotechnical parameters for design.

6.3.2 Monotube Signs

In the standard caisson foundation design for monotube signs, the caisson is 3 m long, and is placed 75 mm to 200 mm above ground surface for safety reasons. The standard sign foundation designs presented in the MTO's Sign Support Manual have been developed based on the minimum soil conditions given below.

- **Case 1 (Non-Cohesive Soils):** With a minimum angle of internal friction of 30 degrees surrounding the caisson.
- **Case 2 (Cohesive Soils):** With a minimum undrained shear strength of 50 kPa surrounding the caisson.

The standard foundation design provided in MTO's *Sign Support Manual* does not apply to sites where extensive poor fill materials or materials looser or softer than those of Case 1 or Case 2 are present. The standard foundation design is also not applicable where bedrock is encountered within the standard foundation depth. For such subsurface conditions, a site-specific design is required.

Based on the review of the borehole information, the subsurface conditions at the proposed sign locations have been compared to the standard design requirements to assess whether a standard or site-specific design is required. The requirement for either a standard or site-specific design is summarized in Table 1, following the text of this report, along with geotechnical parameters to be used for design.

6.3.3 Site-Specific Caisson Foundation Design in Soil

A site-specific caisson foundation design may be carried out by the structural engineer to optimize the standard foundation design using the geotechnical design parameters given in Table 1 following the text of this report. In the design of the sign foundations, the passive resistance within the upper 1.2 m below ground surface should be neglected to account for frost action. The unfactored lateral resistance should be calculated assuming an equivalent

width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to this unfactored lateral resistance to obtain the factored lateral geotechnical resistance at Ultimate Limit Status (ULS).

The current General Arrangement drawings indicate that the OHS foundations will be constructed in areas of relatively flat ground (except for the north foundation element for OHS 1), and all boreholes penetrated interlayers of non-cohesive and cohesive soils of variable thickness and variable compactness condition/consistency. Therefore, it is recommended that the entire fill soil column be taken as equivalent to one-half (1/2) of its thickness for caisson length design below the depth of frost penetration. In cases where the OHS foundations are located on the highway embankment side slope or within about 2 caisson foundation diameters of the crest of the slope in the direction of loading, there will be unbalanced earth pressures around the foundation due to it being located within sloping ground (assumed 2H:1V embankment). For this case, the passive earth pressure coefficient (K_p 2:1), calculated in accordance with Figure C6.18 of the Canadian Highway Bridge Design Code and its Commentary (CHBDC (2014)), to be used in the foundation design is also included in Table 1, attached.

6.4 Corrosion Assessment and Protection

The results of analytical testing on a soil samples from each of the OH series boreholes advanced near the OHS locations are summarized in Section 4.4 and the analytical laboratory test report is included in Appendix D. The analytical test results were compared to CSA A23.1 Table 3 (*Additional requirements for concrete subjected to sulphate attack*) for potential sulphate attack on concrete. The sulphate concentration measured in the tested samples (ranging between <0.002% and 0.037%) is below the exposure class of S-3 (Moderate) and is considered negligible according to MTO Gravity Pipe Design Guidelines (2014). Therefore, when the designer is selecting the exposure class for the structure, the effects of sulphates may not need to be considered.

The analytical test results of the soil samples were also compared to the MTO Gravity Pipe Design Guidelines (2014) for the potential attack on buried steel and the pH is not considered detrimental to the steel durability. The resistivity measured in the tested soil samples (ranging between 400 ohm-cm and 3,400 ohm-cm) indicate “moderate corrosiveness” to “severe corrosiveness” potential. Based on the results of the samples tested and given that the structure will be exposed to de-icing salt, consideration should be given by the designer to designing for a “C” type exposure class as defined by CSA A23.1 Table 1.

It is ultimately up to the structural designer to determine the appropriate exposure class and to ensure that all aspects of CSA A23.1 Section 4.1.1 “Durability Requirements” are followed.

6.5 Construction Considerations

6.5.1 Control of Soil and Groundwater

The water-bearing cohesionless soils at this site should be expected to run or flow into the caisson hole during or after drilling of the caisson foundations for the overhead signs. Therefore, appropriate equipment and procedures will be required to minimize ground loss during drilling and concrete placement. This could include the use of temporary or permanent caisson liners, and/or the use of drilling mud. Foundations for the overhead sign supports should be constructed consistent with OPSS.PROV 915 (Sign Support Structures). It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn the Contractor of this condition; such an NSSP is provided in Appendix E.

6.5.2 Obstructions

While cobbles and/or boulders were not encountered in the boreholes advanced during the investigations at the proposed overhead sign locations, they are inferred present due to the presence of glacially derived soil in the

majority of boreholes. It is recommended that a Notice to Contractor be included in the Contract Documents to warn the Contractor of the possible presence of cobbles and/or boulders within the overburden soils and an example is presented in Appendix E.

7.0 CLOSURE

This Foundation Design Report was prepared by Mr. Eric Naylor, EIT, and reviewed by Mr. Matthew Kelly, P.Eng., a geotechnical engineer with Golder. Mr. Jorge M.A. Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant of Golder, conducted an independent technical and quality control review of the report.

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

Ontario Provisional Standard Drawing:

OPSD 3090.101 Foundation, Frost Penetration Depths for Southern Ontario

Ontario Provincial Standard Specification:

OPSS.PROV 915 Construction Specification for Sign Support Structures

Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)

Ministry of Transportation, Ontario

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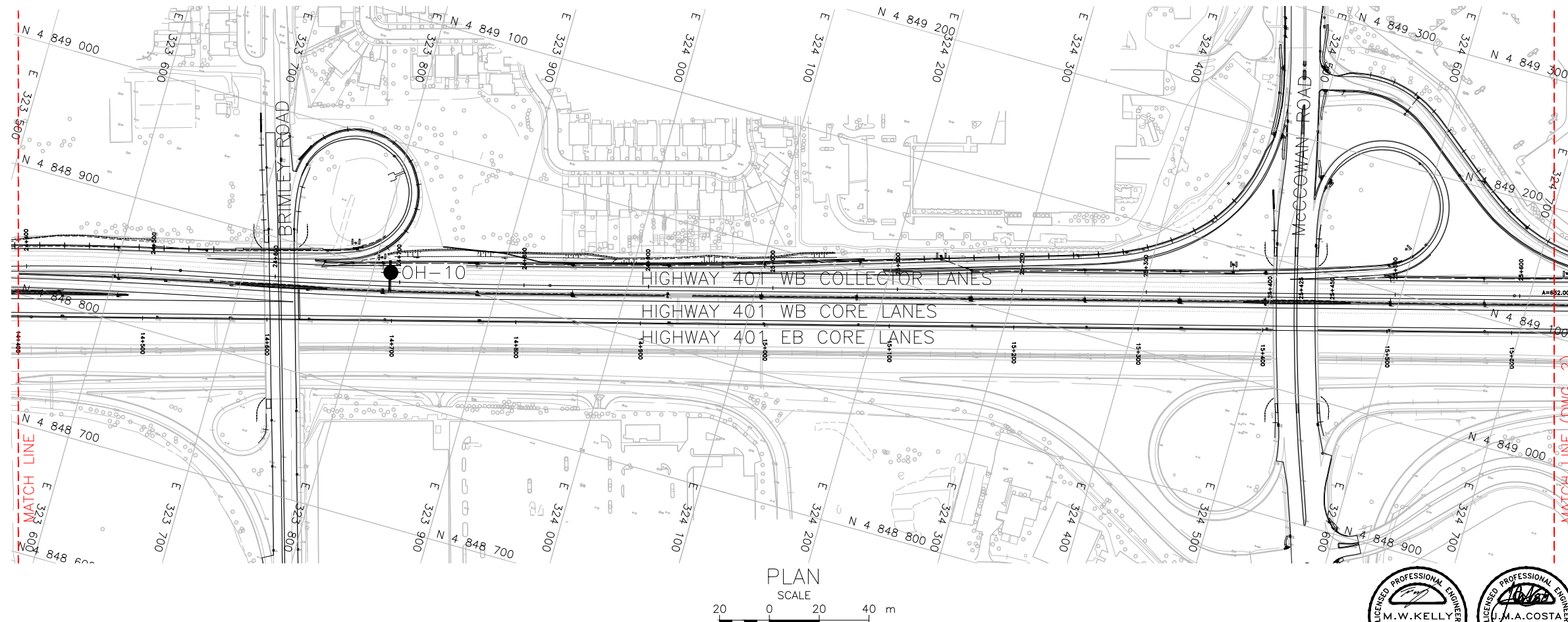
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TABLE 1
GEOTECHNICAL DESIGN PARAMETERS FOR OVERHEAD SIGN FOUNDATIONS

Overhead Sign ID (Location)	Reference Borehole (Station)	Ground Surface Elevation at Reference Borehole (m)	Estimated Ground Surface Elevation at OHS Location (m)	Standard or Site-Specific Foundation Design	Stratum	Depth Relative to Proposed Ground Surface (m) ¹	Elevation (m)	Groundwater Elevation (m)	Design Parameters ^{2,3}					
									S _u (kPa)	Φ'	γ (kN/m ³)	γ' (kN/m ³)	K _p	K _p 2:1
OHS No. 1 (Sta. 23+316)	CN-01/01A (23+317)	174.0	174.0	Site Specific	Compact to very dense Gravelly sand to sand and gravel - Fill	0.0-1.5	174.0-172.5	-	--	28	19	9	2.8	1.0
					Very soft to Firm Clayey silt with sand - Fill	1.5-8.6	172.5-165.4		15	26	19	9	2.6	N/A ⁴
					Firm Clayey silt	8.6 - 10.2	165.4-163.8		35	28	20	10	2.8	1.0
					Dense to very Dense Silt	10.2 - 13.2	163.8 - 160.8		--	32	20	10	3.3	1.2
OHS No. 2 (Sta. 23+616)	OH-4 (23+616)	172.5	172.5	Standard	Gravelly Sand - Fill	0 - 0.5	172.5 - 172.0	-	--	28	19	9	2.8	1.0
					Stiff sandy clayey silt - Fill	0.5 - 2.2	172.0 - 170.3		75	28	19	9	2.8	1.0
					Stiff to hard clayey silt with sand - Fill	2.2 - 8.2	170.3 - 164.3		75	28	19	9	2.8	1.0
					Gravelly Sand - Fill	0.0 - 0.5	173.8 - 173.3		--	28	19	9	2.8	1.0
OHS No. 3 (Sta. 23+893)	OH-5 (23+930) 74-16, 74-17	173.8	173.8	Standard	Very stiff to hard sandy clayey silt - Fill	0.5 - 2.2	173.3 - 171.6	-	100	28	19	9	2.8	1.0
					Compact Silty sand - Fill	2.2 - 2.4	171.6 - 171.4		--	28	19	9	2.8	1.0
					Very stiff to hard clayey silt with sand - Till in OH-5, Very dense sandy silt, trace clay in 74-16, 74-17	2.4 - 8.2	171.4 - 165.6		100	30	21	11	3.0	1.1
					Gravelly Sand - Fill	0.0 - 0.5	173.8 - 173.3		--	28	19	9	2.8	1.0
OHS No. 4 (Sta. 23+930, Core Sta. 13+940)	OH-5 (23+930)	173.8	173.8	Standard	Very stiff to hard sandy clayey silt - Fill	0.5 - 2.2	173.3 - 171.6	-	100	28	19	9	2.8	1.0
					Compact Silty sand - Fill	2.2 - 2.4	171.6 - 171.4		--	28	19	9	2.8	1.0
					Very stiff to hard clayey silt with sand - Till	2.4 - 8.2	171.4 - 165.6		100	32	21	11	3.3	1.2
					Gravelly Sand - Fill	0.0 - 0.5	175.0 - 174.5	171.3	--	28	19	9	2.8	1.0
OHS No. 5 (Sta. 24+073)	OH-7 (24+073)	175.0	175.0	Standard	Stiff to hard sandy clayey silt - Fill	0.5 - 1.8	174.5 - 173.2		75	28	19	9	2.8	1.0
					Compact to very dense Silt to sandy silt	1.8 - 5.6	173.2 - 169.4		--	30	20	10	3.0	1.1
					Very dense sand	5.6 - 6.2	169.4 - 168.8		--	32	20	10	3.3	1.2
					Hard sandy clayey silt - Till	6.2 - 7.9	168.8 - 167.1		200	32	21	11	3.3	1.2
VMS No. 1 (Sta. 24+692)	OH-10 (24+692)	171.9	171.9	Standard	Compact sandy silt - Fill	0.0 - 1.1	171.9 - 170.8	-	--	28	19	9	2.8	1.0
					Compact to very dense silt and sand to sandy silt	1.1 - 7.9	170.8 - 164.0		--	30	20	10	3.0	1.1
VMS No. 3 (Core Sta. 15+690)	OH-14 (Core 15+690)	160.0	160.0	Standard	Sand and gravel - Fill	0.0 - 0.6	160.0 - 159.4	-	--	28	19	9	2.8	1.0
					Very stiff clayey silt with sand - Fill	0.6 - 2.2	159.4 - 157.8		100	28	19	9	2.8	1.0
					Firm silty clay	2.2 - 4.5	157.8 - 155.5		50	28	19	9	2.8	1.0
					Compact to dense silt and sand - Till	4.5 - 8.2	155.5 - 151.8		--	32	21	11	3.3	1.2
OHS No. 6 (Sta. 24+230, Core Sta. 14+240)	OH-9 (24+230)	174.8	174.8	Standard	Gravelly Sand - Fill	0.0 - 0.6	174.8 - 174.2	-	--	28	19	9	2.8	1.0
					Loose to compact silt and sand - Fill	0.6 - 2.4	174.2 - 172.4		--	28	19	9	2.8	1.0
					Stiff to hard sandy clayey silt to clayey silt with sand - Till	2.4 - 7.8	172.4 - 167.1		75	32	21	11	3.3	1.2
					Firm to stiff clayey silt with sand - Fill	0.0 - 3.0	159.2 - 156.2	156.3	35	26	19	9	2.6	N/A ⁴
OHS No. 7 (Sta. 25+747)	OH-16 (25+747)	159.2	159.2	Site-Specific	Compact to very dense silt and sand - Till	3.0 - 8.0	156.2 - 151.2		--	32	19	9	3.3	1.2
					Sand and gravel - Fill	0.0 - 0.5	162.2 - 161.7	-	--	28	19	9	2.8	1.0
OHS No. 8 (Sta. 26+345)	OH-19 (26+345)	162.2	162.2	Standard	Compact Sandy silt - Fill	0.5 - 2.2	161.7 - 160.0		--	28	19	9	2.8	1.0
					Firm Clayey silt with sand	2.2 - 3.0	160.0 - 159.2		50	30	20	10	3.0	1.1
					Compact to very dense silt and sand - Till	3.0 - 5.6	159.2 - 156.6		--	32	21	11	3.3	1.2
					Hard Clayey Silt	5.6 - 8.1	156.6 - 154.1		--	32	20	10	3.3	1.2
					Compact to dense silt and sand - Fill	0.0 - 2.7	165.1 - 162.4		--	28	19	9	2.8	1.0
VMS No. 2 (Sta. 26+996)	OH-27 (26+996)	165.1	165.1	Standard	Stiff clayey silt with sand - Fill	2.7 - 3.1	162.4 - 162.0	-	75	28	19	9	2.8	1.0
					Loose to compact silt and sand - Fill	3.1 - 5.6	162.0 - 159.5		--	28	19	9	2.8	1.0
					Compact to dense silt and sand	5.6 - 8.2	159.5 - 156.9		--	30	20	10	3.0	1.1
					Sand and gravel - Fill	0.0 - 0.6	161.2 - 160.6		--	28	19	9	2.8	1.0
OHS No. 9 (Markham E-N/S Ramp)	OH-22 (Markham E-N/S Ramp, 27+200)	161.2	161.2	Standard	Stiff sandy silty clay - Fill	0.6 - 1.5	160.6 - 159.7	155.5	75	28	19	9	2.8	1.0
					Compact to very dense silt and sand	1.5 - 3.7	159.7 - 157.5		--	30	20	10	3.0	1.1
					Very Dense silty sand to sand	3.7 - 8.2	157.5 - 153.0		--	32	20	10	3.3	1.2
					Very dense sandy silt - Fill	0.0 - 1.5	160.0 - 158.5		--	28	19	9	2.8	1.0
OHS No. 10 (Sta. 27+483)	OH-24 (27+483)	160.0	160.0	Standard	Very dense sandy silt to silt and sand	1.5 - 5.6	158.5 - 154.4	154.5	--	30	20	10	3.0	1.1
					Dense to very dense sand	5.6 - 8.2	154.4 - 151.8		--	32	20	10	3.3	1.2
					Compact silt and sand - Fill	0.0 - 1.4	155.2 - 153.8	-	--	28	19	9	2.8	1.0
OHS No. 11 (Sta. 27+910)	OH-26 (27+910)	155.2	155.2	Standard	Compact silt and sand	1.4 - 8.2	153.8 - 147.0		--	28	20	10	2.8	1.0

NOTES:

- Depths are given at the existing borehole location or proposed sign support locations relative to the estimated proposed ground surface following construction, including any median grade raises or regrading. Although S_u, Φ' and K_p parameters are given for the full depth of the soil, the passive resistance in the upper 1.2 m should be neglected in the design to account for frost action.
- Design parameters:
 - S_u = undrained shear strength (kPa);
 - Φ' = effective friction angle (degrees);
 - γ = bulk unit weight (kN/m³);
 - γ' = effective unit weight below the groundwater level (kN/m³);
 - K_p = passive earth pressure coefficient; and
 - K_p 2:1 = passive earth pressure coefficient for 2H:1V sloping ground surface.
- Where both undrained shear strength and effective friction angle parameters have been provided for fill materials, the structural assessment should be completed for both cohesive soil and cohesionless soil cases, and the selected design should be based on the more conservative approach.
- Value not defined as the 2H:1V inclination (i.e. 26.6 degrees) is greater than the friction angle. Design should ignore depth of foundation above the point where the slope is within 3 caisson diameters.



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

SHEET





GOLDER



KEY PLAN
SCALE



1.5 0 1.5 3 km

 Borehole — Current Investigation
 Borehole — 1966 Investigation
 (GEOCRETS 30M14-74)

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)			
No.	ELEVATION	NORTHING	EASTING
74-16	173.0	4848679.9	323027.0
74-17	175.1	4848688.6	323055.0
CN-01/01A	174.0	4848486.8	322498.0
OH-4	172.5	4848581.7	322778.7
OH-5	173.8	4848676.2	323084.5
OH-7	175.0	4848714.4	323219.5
OH-9	174.8	4848746.6	323401.1
OH-10	171.9	4848897.6	323813.9

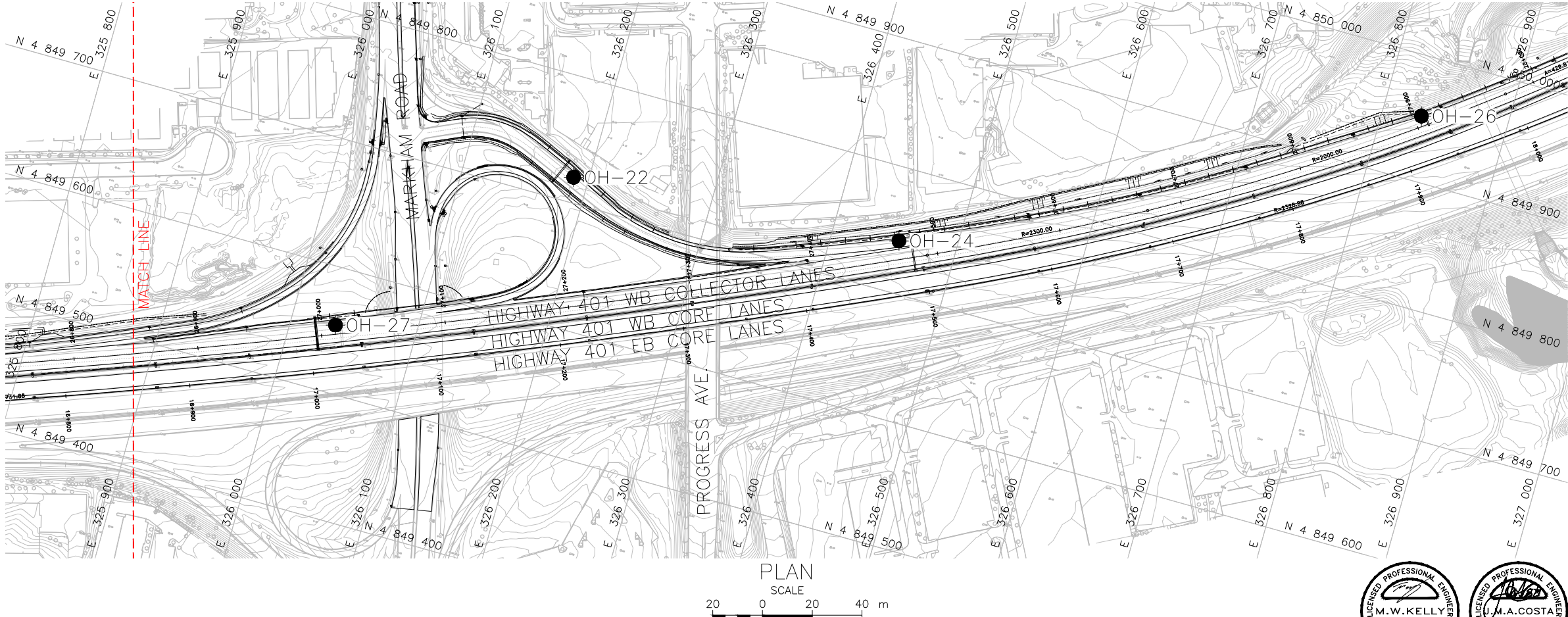
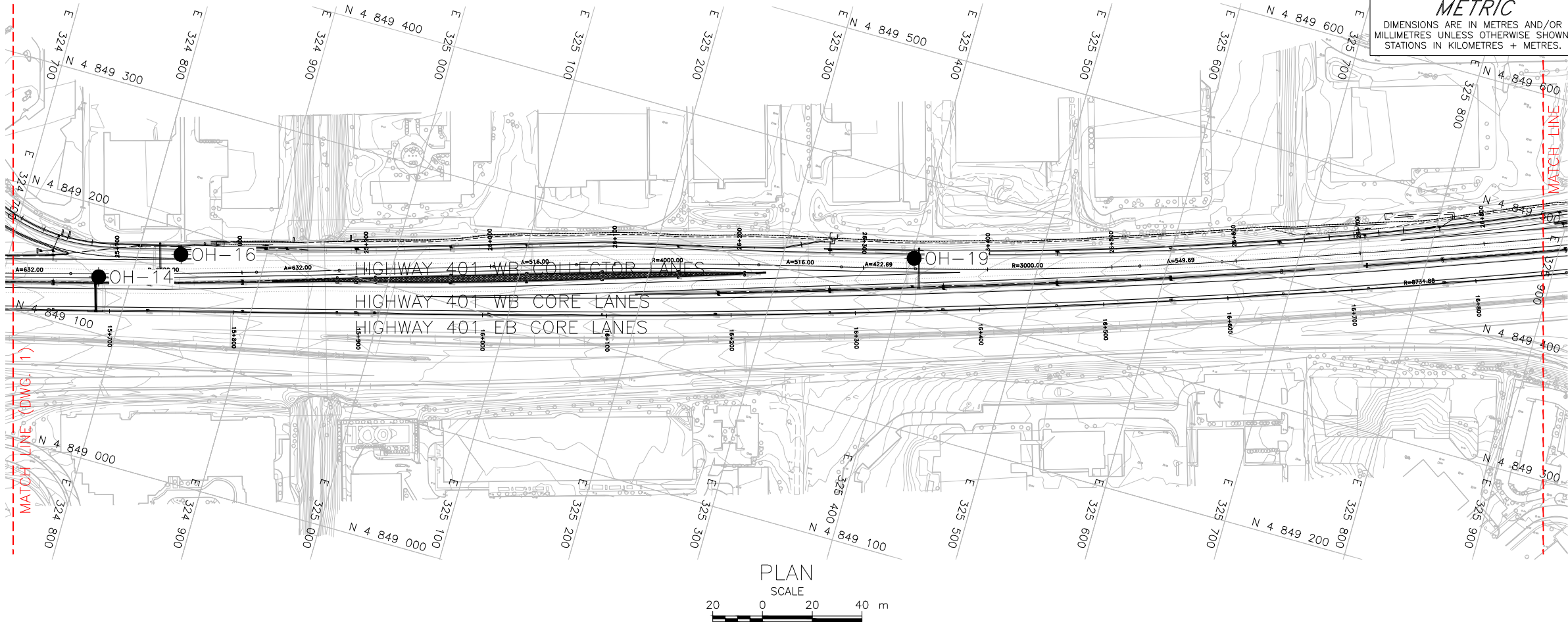
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

Base plan provided in digital format by WSP, drawings files no. H17M-1449-00_XA01.dwg, no.H17M-1449-00_XB01.dwg and H17M-1449-00_XY01.dwg, received October 26, 2017.
Design Layout provided in digital format by WSP, drawing file no. H17M-1449-00_XN01.dwg, received February 13, 2019.
Existing ground provided in digital format by WSP, drawing file no. Contours Sept. 12, 2019.dwg, received September 12, 2018.

-
NO.	DATE	BY	REVISION		
Geocres No. 30M14-502					
HWY. 401		PROJECT NO. 1669995		DIST. .	
SUBM'D. NK		CHKD. NK	DATE: 03/19/2019	SITE:	
DRAWN: DD		CHKD. MWK	APPD. JMAC	DWG. 1	





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

CONT No.
GWP No. 2162-11-00

OVERHEAD SIGN SUPPORTS
HIGHWAY 401 WESTBOUND CORE AND COLLECTORS

BOREHOLE LOCATIONS

SHEET



KEY PLAN
SCALE
1.5 0 1.5 3 km

LEGEND

Borehole – Current Investigation

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)			
No.	ELEVATION	NORTHING	EASTING
OH-14	160.0	4849144.3	324774.6
OH-16	159.2	4849179.6	324833.5
OH-19	162.2	4849336.0	325402.2
OH-22	161.2	4849720.3	326187.9
OH-24	160.0	4849741.8	326453.7
OH-26	155.2	4849952.0	326831.3
OH-27	165.1	4849554.1	326035.6

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 plan provided in digital format by WSP, drawings files no. H17M-01449-00_XA01.dwg, No.H17M-01449-00_XB01.dwg and H17M-01449-00_XY01.dwg, received October 26, 2017.
Design Layout provided in digital format by WSP, drawing file no. H17M-01449-00_XND01.dwg, received February 13, 2019.
Existing ground provided in digital format by WSP, drawing file no. Contours Sept. 12, 2019.dwg, received September 12, 2018.



NO.	DATE	BY	REVISION
Geocres No. 30M14-502			
HWY. 401	PROJECT No. 1669995		DIST. .
SUBM'D. NK	CHKD. NK	DATE: 03/19/2019	SITE: .
DRAWN: DD	CHKD. MWK	APPD. JMAC	DWG. 2

APPENDIX A

**Borehole Records from 1966
Investigation (GEOCRES No.
30M14-74)**

OFFICE REPORT ON SOIL EXPLORATION

BH 74-16

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 16

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 374 + 33; 137' Lt. of C ORIGINATED BY AKB
 W.P. 260-61 BORING DATE November 7, 1966 COMPILED BY AKB
 DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY AKB

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WP	W	WL		
(W) 172.0	567.6	GROUND LEVEL														
	0.0															
			1	SS	105											
			2	SS	136	560										
			3	SS	130											
			4	SS	100/5"											
			5	SS	100/6"	550										
			6	SS	100/4"											
						540										
163.4	536.1		7	SS	100/5"											
9.6	31.5	End of Borehole														

Gr. 3%
 Sa. 52%
 Si. & Cl. 45%

Gr. 5%
 Sa. 40%
 Si. 41%
 Cl. 14%

BH 74-17

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 66-F-87

LOCATION Sta. 375 + 28; 137' Lt. of C

FOUNDATION SECTION

ORIGINATED BY A.K.B.

W.P. 260-61

BCRING DATE November 8, 1966

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Washboring, BX Casing

CHECKED BY

[illegible]

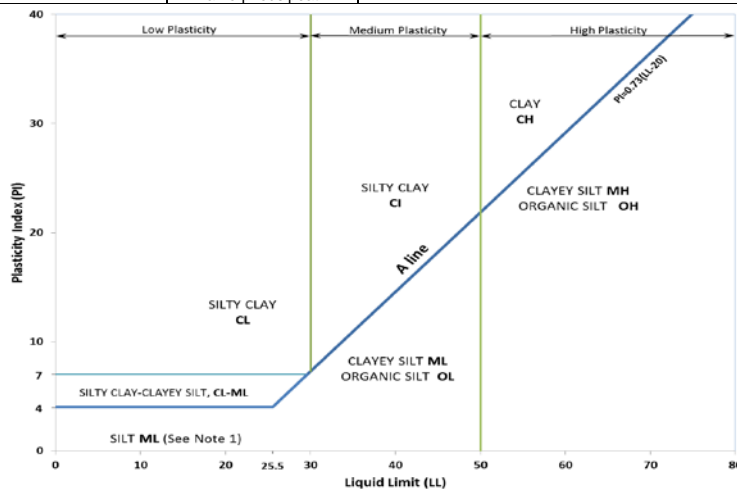
APPENDIX B

**Borehole Records from 2018
Investigation**

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$		$Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$			Organic Content	USCS Group Symbol	Group Name			
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4		≤1 or ≥3			≤30%	GP	GRAVEL			
				Well Graded	≥4		1 to 3				GW	GRAVEL			
			Gravels with >12% fines (by mass)	Below A Line	n/a						GM	SILTY GRAVEL			
				Above A Line	n/a						GC	CLAYEY GRAVEL			
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3			SP		SAND				
				Well Graded	≥6	1 to 3			SW		SAND				
			Sands with >12% fines (by mass)	Below A Line	n/a						SM	SILTY SAND			
				Above A Line	n/a						SC	CLAYEY SAND			
			Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name	
							Dilatancy	Dry Strength	Shine Test		Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or Pl and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT				
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT				
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT				
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT				
		None		Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT					
		CLAYS (Pl and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30%	CL	SILTY CLAY				
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium	(see Note 2)	CI	SILTY CLAY				
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY				
		HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT		
				Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT		



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor “trace organics” for soils with between 5% and 30% organic content include the prefix “organic” before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between “clean” and “dirty” sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (i.e., SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

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

SOIL TESTS

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

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

NON-COHESIVE (COHESIONLESS) SOILS

Compactness²

Term	SPT 'N' (blows/0.3m) ¹
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

- SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
- Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

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

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

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

I. GENERAL

π	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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	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
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	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
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	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 ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

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

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

PROJECT		RECORD OF BOREHOLE No CN-01/01A				SHEET 1 OF 4		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4848486.8; E 322498.0 MTM NAD 83 ZONE 10 (LAT. 43.776139; LONG. -79.280151)		ORIGINATED BY		AB					
DIST		Central HWY 401		BOREHOLE TYPE		CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers		COMPILED BY		KAW					
DATUM		Geodetic		DATE		March 5 to 13, 2018		CHECKED BY		NK					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × REMOULDED</div><div>20406080100</div></div>			<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div><div>w_p w w_L</div><div>WATER CONTENT (%)</div><div>102030</div></div>					
174.0	GROUND SURFACE														
0.0	ASPHALT (152 mm)														
0.2	Gravelly sand, some silt (FILL)		1	SS	22										
173.2	Compact Brown Moist														
1.0	Sandy clayey silt, trace gravel (FILL)		2A	SS	51		173								
172.5	Grey to brown Moist		2B												
1.5	Sand and gravel, some silt (FILL)		3	SS	30		172								
	Very dense Brown Moist														
	Clayey silt with sand, trace gravel (FILL)		4	SS	5		171								
	Very soft to hard Grey to brown Moist to wet														
			5	SS	3		170								
			6	SS	3										
			7	SS	3		169								
			8	SS	2		168								
			9	SS	2		167								
			10	SS	21		166								
165.4															
8.6	CLAYEY SILT, some sand, trace gravel, trace organics						165								
	Firm Dark grey Moist		11	SS	7										
163.8							164								
10.2	SILT, some sand, trace to some clay, trace gravel														
	Dense to very dense Grey to brown Moist		12	SS	42		163								
							162								
			13	SS	114		161								
160.8															
13.2	SILT, some sand to SAND, some silt, trace gravel, trace clay						160								
	Compact to very dense Grey Moist to wet		14	SS	22										

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

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PROJECT <u>1669995</u>		RECORD OF BOREHOLE No CN-01/01A		SHEET 2 OF 4	METRIC
G.W.P. <u>2162-11-00</u>	LOCATION <u>N 4848486.8; E 322498.0 MTM NAD 83 ZONE 10 (LAT. 43.776139; LONG. -79.280151)</u>	ORIGINATED BY <u>AB</u>			
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers</u>	COMPILED BY <u>KAW</u>			
DATUM <u>Geodetic</u>	DATE <u>March 5 to 13, 2018</u>	CHECKED BY <u>NK</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL	
					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)											
	--- CONTINUED FROM PREVIOUS PAGE ---																				
	SILT, some sand to SAND, some silt, trace gravel, trace clay Compact to very dense Grey Moist to wet		15	SS	41		158							○				0	13	81	6
							157														
							156														
			16A 16B	SS	41		155														
							154														
							153														
	- Grinding on inferred cobble at a depth of approximately 20.7 m		17	SS	140		152														
							151														
							150														
			18	SS	47		149							○				0	79	19	2
							148														
							147														
146.2 27.8	Gravelly SAND, trace silt Very dense Grey-brown Wet		19A 19B	SS	58		146														
144.6 29.4	CLAYEY SILT, trace sand		20A 20B	SS	115		145														

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PROJECT		RECORD OF BOREHOLE				No CN-01/01A		SHEET 3 OF 4		METRIC					
G.W.P. 2162-11-00		LOCATION				N 4848486.8; E 322498.0 MTM NAD 83 ZONE 10 (LAT. 43.776139; LONG. -79.280151)				ORIGINATED BY AB					
DIST Central HWY 401		BOREHOLE TYPE				CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers				COMPILED BY KAW					
DATUM Geodetic		DATE				March 5 to 13, 2018				CHECKED BY NK					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> W_p W W_L </div>	<div style="display: flex; justify-content: space-between;"> 10 20 30 </div>		
	CLAYEY SILT, trace sand Very stiff to hard Grey Wet		21	SS	41		143							0 1 71 28	
							142								
							141								
			22	SS	30		140								
							139								
							138								
			23/1	SS	22		137							0 1 75 24	
							136								
							135								
			2	SS	25		134								
							133								
132.5							132								
41.5	CLAYEY SILT, some sand to sandy, trace to some gravel (TILL) Very stiff Grey Wet		3	SS	24		131								
							130								

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

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PROJECT		RECORD OF BOREHOLE				No CN-01/01A		SHEET 4 OF 4		METRIC							
G.W.P. 2162-11-00		LOCATION				N 4848486.8; E 322498.0 MTM NAD 83 ZONE 10 (LAT. 43.776139; LONG. -79.280151)				ORIGINATED BY AB							
DIST Central HWY 401		BOREHOLE TYPE				CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers				COMPILED BY KAW							
DATUM Geodetic		DATE				March 5 to 13, 2018				CHECKED BY NK							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---																
	CLAYEY SILT, some sand to sandy, trace to some gravel (TILL) Very stiff Grey Wet		4	SS	22		128									9 17 38 36	
							127										
							126										
	- 0.1 m thick gravelly sand layer at a depth of approximately 48.8 m		5	SS	15		125										
	- 0.1 m thick gravelly sand layer at a depth of approximately 49.3 m																
	- Grinding on inferred cobble at a depth of approximately 49.7 m																
	- Grinding on inferred cobble at a depth of approximately 50.3 m		6	SS	25		124									1 23 47 29	
123.1 50.9	END OF BOREHOLE																
	NOTES: 1. Borehole CN-01 was terminated at a depth of 37.2 m. A second borehole (CN-01A) was advanced approximately 1.5 m east of Borehole CN-01. Borehole CN-01A was advanced to a depth of 37.2 m with no sampling, after which sampling was conducted to a termination depth of 50.9 m. This Record of Borehole combines Boreholes CN-01 and CN-01A. 2. No water level reading taken upon completion of drilling due to the addition of water/drill mud.																

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PROJECT		1669995		RECORD OF BOREHOLE No OH-4				SHEET 1 OF 1		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4848581.7; E 322778.7 MTM NAD 83 ZONE 10 (LAT. 43.776980; LONG. -79.276620)				ORIGINATED BY JS							
DIST		Central HWY 401		BOREHOLE TYPE		CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers				COMPILED BY KAW							
DATUM		Geodetic		DATE		April 12, 2018				CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
172.5	GROUND SURFACE																
0.0	ASPHALT (152 mm)																
172.0	Gravelly sand, trace to some silt (FILL) Brown Moist		1	AS	-												
0.5	Sandy clayey silt, trace gravel (FILL) Firm to stiff Brown Moist		2A	SS	9												
			2B														
			3	SS	8												
170.3	Clayey silt with sand, trace gravel (FILL) Stiff to hard Brown Moist - Material grey between depths of approximately 3.0 m and 5.3 m		4	SS	35												
2.2			5	SS	18												
			6	SS	10												
			7	SS	10												
			8	SS	21												
			9	SS	24												
164.3	END OF BOREHOLE																
8.2	NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole caved to a depth of approximately 6.0 m upon removal of augers.																

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PROJECT 1669995		RECORD OF BOREHOLE No OH-5		SHEET 1 OF 1		METRIC									
G.W.P. 2162-11-00		LOCATION N 4848676.2; E 323084.5 MTM NAD 83 ZONE 10 (LAT. 43.777800; LONG. -79.272840)		ORIGINATED BY JS											
DIST Central HWY 401		BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers		COMPILED BY KAW											
DATUM Geodetic		DATE April 12, 2018		CHECKED BY											
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	
173.8	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		W _p — W — W _L 10 20 30		kN/m ³			
0.0	ASPHALT (152 mm)														
173.3	Gravelly sand, trace to some silt (FILL) Brown Moist		1	AS	-		173								
0.5	Sandy clayey silt, trace gravel (FILL) Very stiff to hard Brown Moist		2	SS	31		172								
171.6	Silty sand, trace to some clay (FILL) Dense Brown Moist to wet		3	SS	25		171							7 37 42 14	
2.4	CLAYEY SILT with SAND, trace to some gravel (TILL) Very stiff to hard Brown Moist		4A	SS	37		170								
			4B	SS			169								
			5A	SS	25		168								
			5B	SS			167							8 37 42 13	
			6	SS	27		166								
			7	SS	26										
			8	SS	28										
			9	SS	32										
165.6	- Material grey below depth of approximately 7.7 m														
8.2	END OF BOREHOLE														
NOTES:															
1. Open borehole dry upon completion of drilling.															
2. Borehole caved to a depth of approximately 5.2 m upon removal of augers.															

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PROJECT		1669995		RECORD OF BOREHOLE No OH-7				SHEET 1 OF 1		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4848714.4; E 323219.5 MTM NAD 83 ZONE 10 (LAT. 43.778170; LONG. -79.271180)		ORIGINATED BY		JS							
DIST		Central HWY 401		BOREHOLE TYPE		CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers		COMPILED BY		KAW							
DATUM		Geodetic		DATE		April 11, 2018		CHECKED BY									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
175.0	GROUND SURFACE																
0.0	ASPHALT (127 mm)																
174.5	Gravelly sand, trace to some silt (FILL)		1	AS	-												
0.5	Brown Moist																
	Sandy clayey silt, trace gravel (FILL)		2	SS	35												
	Very stiff to hard																
	Light brown to brown Moist																
173.2			3A	SS	24												
1.8	SILT, some sand to Sandy SILT, trace to some clay, trace gravel		3B														
	Compact to very dense																
	Brown		4	SS	48												
	Moist to wet below 3.0 m																
			5	SS	21												
			6	SS	37												
			7	SS	57												
169.4																	
5.6	SAND, trace silt																
	Brown																
	Wet		8A														
168.8			8B	SS	62/0.30												
6.2	Sandy CLAYEY SILT, trace gravel (TILL)																
	Hard																
	Grey																
	Wet																
	- Split spoon refusal on inferred gravel/cobble at a depth of approximately 6.7 m																
167.1			9	SS	50/0.15												
7.9	- Split spoon refusal on inferred gravel/cobble at a depth of approximately 7.9 m																
	END OF BOREHOLE																
NOTES: 1. Water level measured inside casing to a depth of 4.6 m below ground surface. Water level measured at a depth of 3.7 m (Elev. 171.3 m) in open borehole upon removal of augers.																	



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

PROJECT		1669995		RECORD OF BOREHOLE No OH-10				SHEET 1 OF 1		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4848897.6; E 323813.9 MTM NAD 83 ZONE 10 (LAT. 43.779804; LONG. -79.263789)				ORIGINATED BY		KN					
DIST		Central HWY 401		BOREHOLE TYPE		CME 55 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers				COMPILED BY		EN					
DATUM		Geodetic		DATE		November 29, 2018				CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
171.9	GROUND SURFACE																
0.0	ASPHALT (38 mm)																
0.3	CONCRETE (238 mm)																
170.8	Sandy silt, trace some gravel, trace clay (FILL) Compact Brown Moist		1	SS	13												
1.1	Sandy SILT to SILT and SAND, trace to some clay, trace clayey silt pockets between 3.1 m and 3.7 m depth Compact to very dense Brown becoming grey below 5.6 m Moist		2	SS	39												7 42 39 12
			3	SS	49												
			4	SS	66												
			5	SS	76												10 27 50 13
			6	SS	100/0.23												
			7	SS	100/0.23												
164.0	END OF BOREHOLE		8	SS	100/0.29												0 33 60 7
7.9	NOTE: 1. Open borehole dry during and on completion of drilling and removal of augers.																

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PROJECT 1669995		RECORD OF BOREHOLE No OH-14				SHEET 1 OF 1		METRIC								
G.W.P. 2162-11-00		LOCATION N 4849144.3; E 324774.6 MTM NAD 83 ZONE 10 (LAT. 43.781997; LONG. -79.251845)				ORIGINATED BY KN										
DIST Central HWY 401		BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers				COMPILED BY EN										
DATUM Geodetic		DATE December 3 to 4, 2018				CHECKED BY										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
160.0	GROUND SURFACE															
0.0	ASPHALT (170 mm)															
0.2	Sand and gravel (FILL)															
159.4	Grey Moist															
0.6	Clayey silt with sand, trace gravel (FILL) Very stiff Grey-brown Moist		1	SS	16											
			2	SS	16											
157.8																
2.2	SILTY CLAY, trace sand Firm to stiff Brown to grey below 3.7 m Moist to moist-wet		3	SS	11											
			4	SS	11											
			5	SS	6											
155.5																
4.5	SILT and SAND, some clay, trace to some gravel (TILL) Compact to dense Grey Moist		6	SS	12											
			7	SS	28											
151.8			8	SS	46											
8.2	END OF BOREHOLE															
	NOTES: 1. Open borehole dry on completion of drilling. 2. Borehole caved to 6.6 m upon removal of augers.															

PROJECT		1669995		RECORD OF BOREHOLE No OH-16				SHEET 1 OF 1		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4849179.6; E 324833.5 MTM NAD 83 ZONE 10 (LAT. 43.782315; LONG. -79.251111)		ORIGINATED BY		KN							
DIST		Central HWY 401		BOREHOLE TYPE		CME 55 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers		COMPILED BY		EN							
DATUM		Geodetic		DATE		November 30, 2018		CHECKED BY									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
159.2	GROUND SURFACE																
0.0	ASPHALT (40 mm)																
0.2	CONCRETE (200 mm)																
	Clayey silt with sand, trace to some gravel, trace clayey silt pockets (FILL) Firm to stiff Grey Moist - Becoming brown below 1.5 m. - Trace organics and rootlets between 1.5 m and 2.1 m.		1	SS	12												
			2	SS	5												
			3	SS	6												
156.2																	
3.0	SILT and SAND, trace to some gravel, trace to some clay (TILL) Compact to very dense Grey Moist		4	SS	30												
			5	SS	14												
			6	SS	26												
			7	SS	38												
151.2			8	SS	100/0.25												
8.0	END OF BOREHOLE																
	NOTES: 1. Water level in open borehole at a depth of 2.9 m below ground surface (Elev. 156.3 m) on completion of drilling. 2. Borehole caved to 7.1 m below ground surface on removal of augers.																

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PROJECT		1669995		RECORD OF BOREHOLE No OH-19				SHEET 1 OF 1		METRIC			
G.W.P.		2162-11-00		LOCATION		N 4849336.0; E 325402.2 MTM NAD 83 ZONE 10 (LAT. 43.783708; LONG. -79.244040)				ORIGINATED BY			
DIST		Central HWY 401		BOREHOLE TYPE		CME 55 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers				COMPILED BY			
DATUM		Geodetic		DATE		November 30, 2018				CHECKED BY			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)		
162.2	GROUND SURFACE												
0.0	ASPHALT (140 mm)												
161.7	Sand and gravel (FILL)												
0.5	Brown-grey Moist												
	Sandy silt, trace to some gravel, trace organics and rootlets below 2.0 m (FILL)		1	SS	25								
	Compact Brown-grey Moist		2A 2B	SS	18								
160.0	CLAYEY SILT with SAND, trace gravel												
2.2	Firm Grey Wet		3	SS	5								5 50 35 10
159.2	SILT and SAND, some gravel trace to some clay (TILL)												
3.0	Compact to very dense Grey-brown becoming brown below 3.7 m Moist		4	SS	17								
			5	SS	62								13 37 42 8
			6	SS	51								
156.6	CLAYEY SILT, trace sand												
5.6	Hard Grey Dry		7	SS	68								0 3 76 21
154.1	END OF BOREHOLE		8	SS	100/0.28								
8.1	NOTE: 1. Open borehole dry on removal of augers. 2. Borehole caved to 7.2 m on removal of augers.												

PROJECT		1669995		RECORD OF BOREHOLE No OH-22				SHEET 1 OF 1		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4849720.3; E 326187.9 MTM NAD 83 ZONE 10 (LAT. 43.787145; LONG. -79.234263)		ORIGINATED BY		KN							
DIST		Central HWY 401		BOREHOLE TYPE		CME 55 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers		COMPILED BY		EN							
DATUM		Geodetic		DATE		November 29, 2018		CHECKED BY									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
161.2	GROUND SURFACE																
0.0	ASPHALT (140 mm)																
0.1	Sand and gravel (FILL)																
160.6	Grey																
0.6	Sandy silty clay, some gravel (FILL)																
159.7	Stiff Brown, oxidation staining Moist		1	SS	11												
1.5	SILT and SAND, trace to some clay, trace gravel																
	Compact to very dense Brown to grey below 3.0 m Moist		2	SS	20												
			3	SS	41												3 40 50 7
			4	SS	55												
157.5	Silty SAND to SAND, some silt, trace gravel, trace clay																
	Very dense Brown to grey below 5.6 m Moist to wet below 5.6 m		5	SS	61												0 83 14 3
			6	SS	80												
			7	SS	80												3 67 27 3
			8	SS	60												
153.0	END OF BOREHOLE																
8.2	NOTES:																
	1. Water level in open borehole at a depth of 5.7 m below ground surface (Elev. 155.5 m) on completion of drilling.																
	2. Borehole caved to a depth of 6.3 m below ground surface upon removal of augers.																

GTA-MTO 001 S:\CLIENTS\MTOWHY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 03/08/19

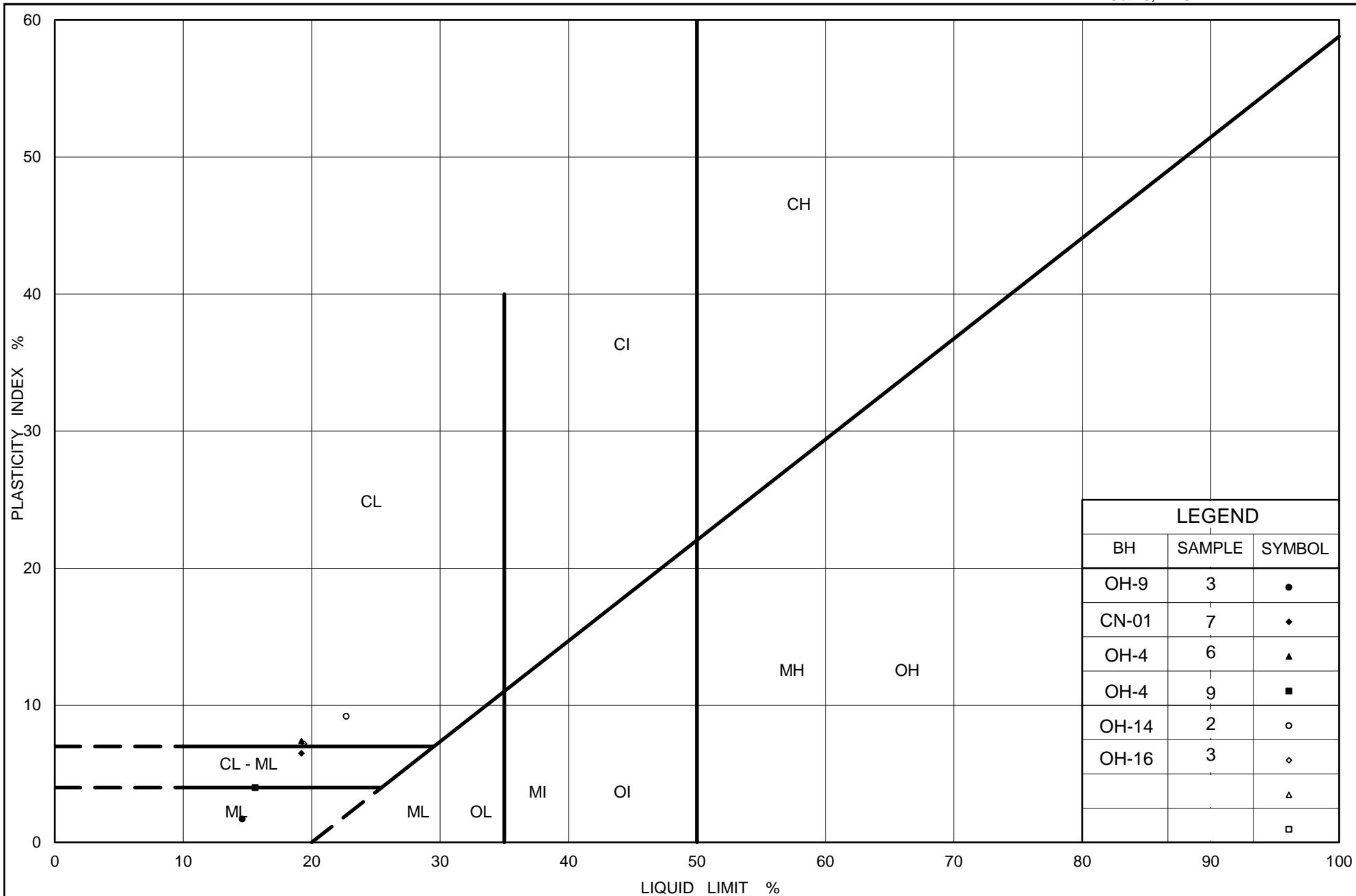
PROJECT		1669995		RECORD OF BOREHOLE No OH-24				SHEET 1 OF 1		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4849741.8; E 326453.7 MTM NAD 83 ZONE 10 (LAT. 43.787330; LONG. -79.230960)				ORIGINATED BY							
DIST		Central HWY 401		BOREHOLE TYPE		CME 55 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers				COMPILED BY							
DATUM		Geodetic		DATE		November 25-26, 2018				CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
160.0	GROUND SURFACE																
0.0	ASPHALT (170 mm)																
0.2	Sandy silt, trace gravel (FILL) Very dense Brown Moist		1	SS	54												
158.5																	
1.5	Sandy SILT to SILT and SAND, trace to some gravel, trace to some clay Very dense Brown to grey at 2.4 m Moist to wet at 3.0 m		2	SS	61												
			3	SS	82												
			4A 4B	SS	50												12 33 48 7
	- Sand lens between depth of 3.6 m and 3.7 m.		5	SS	53												5 26 62 7
			6	SS	118												
154.4																	
5.6	SAND, trace to some silt, trace clay Dense to very dense Brown Wet		7	SS	65												
			8	SS	46												0 91 7 2
151.8																	
8.2	END OF BOREHOLE																
	NOTE: 1. Water level in open borehole at a depth of 5.5 m below ground surface (Elev. 154.5 m) upon completion of drilling.																

PROJECT		1669995		RECORD OF BOREHOLE No OH-26				SHEET 1 OF 1		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4849952.0; E 326831.3 MTM NAD 83 ZONE 10 (LAT. 43.789211; LONG. -79.226260)				ORIGINATED BY		EN					
DIST		Central HWY 401		BOREHOLE TYPE		CME 55 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers				COMPILED BY		EN					
DATUM		Geodetic		DATE		November 25-26, 2018				CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
155.2	GROUND SURFACE						20	40	60	80	100						
0.0	ASPHALT (150 mm)																
0.2	Silt and sand, trace gravel (FILL) Compact Brown Moist		1	SS	21												
153.8																	
1.4	SILT and SAND, some clay, trace to some gravel Compact Brown-grey becoming brown below 3.7 m Moist		2	SS	24												
			3	SS	12											4	40 43 13
			4	SS	14												
			5	SS	11											6	39 41 14
			6	SS	15												
			7	SS	11												
			8	SS	25											7	38 42 13
147.0	END OF BOREHOLE																
8.2	NOTE: 1. Open borehole dry on completion of drilling.																

PROJECT		1669995		RECORD OF BOREHOLE No OH-27				SHEET 1 OF 1		METRIC							
G.W.P.		2162-11-00		LOCATION		N 4849554.1; E 326035.6 MTM NAD 83 ZONE 10 (LAT. 43.785653; LONG. -79.236162)		ORIGINATED BY		KN							
DIST		Central HWY 401		BOREHOLE TYPE		CME 55 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers		COMPILED BY		EN							
DATUM		Geodetic		DATE		November 28, 2018		CHECKED BY									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
165.1	GROUND SURFACE																
0.0	ASPHALT (50 mm)																
0.3	CONCRETE (250 mm)																
	Silt and sand, trace to some gravel, trace to some clay (FILL) Compact to dense Brown to grey Moist to wet		1	SS	22												
			2	SS	32												
162.4	Clayey silt with sand (FILL) Grey Moist		3	SS	11												
162.0																	
3.1	Silt and sand, trace to some gravel, trace clay (FILL) Loose to compact Grey to brown below 3.7 m Moist to wet below 3.7 m		4	SS	7												
			5	SS	17												
	- Trace organics and rootlets between depth of 4.9 m and 5.6 m		6A 6B	SS	9												
159.5																	
5.6	SILT and SAND, trace to some gravel, trace to some clay Compact to dense Brown to grey below 7.2 m Moist		7	SS	16												
156.9			8	SS	47												
8.2	END OF BOREHOLE																
NOTES:																	
1. Open borehole dry on completion of drilling.																	

APPENDIX C

Geotechnical Laboratory Test Results



Ministry of Transportation

Ontario

PLASTICITY CHART Silt and Sand to Clayey Silt with Sand - Fill

Figure No. C-1

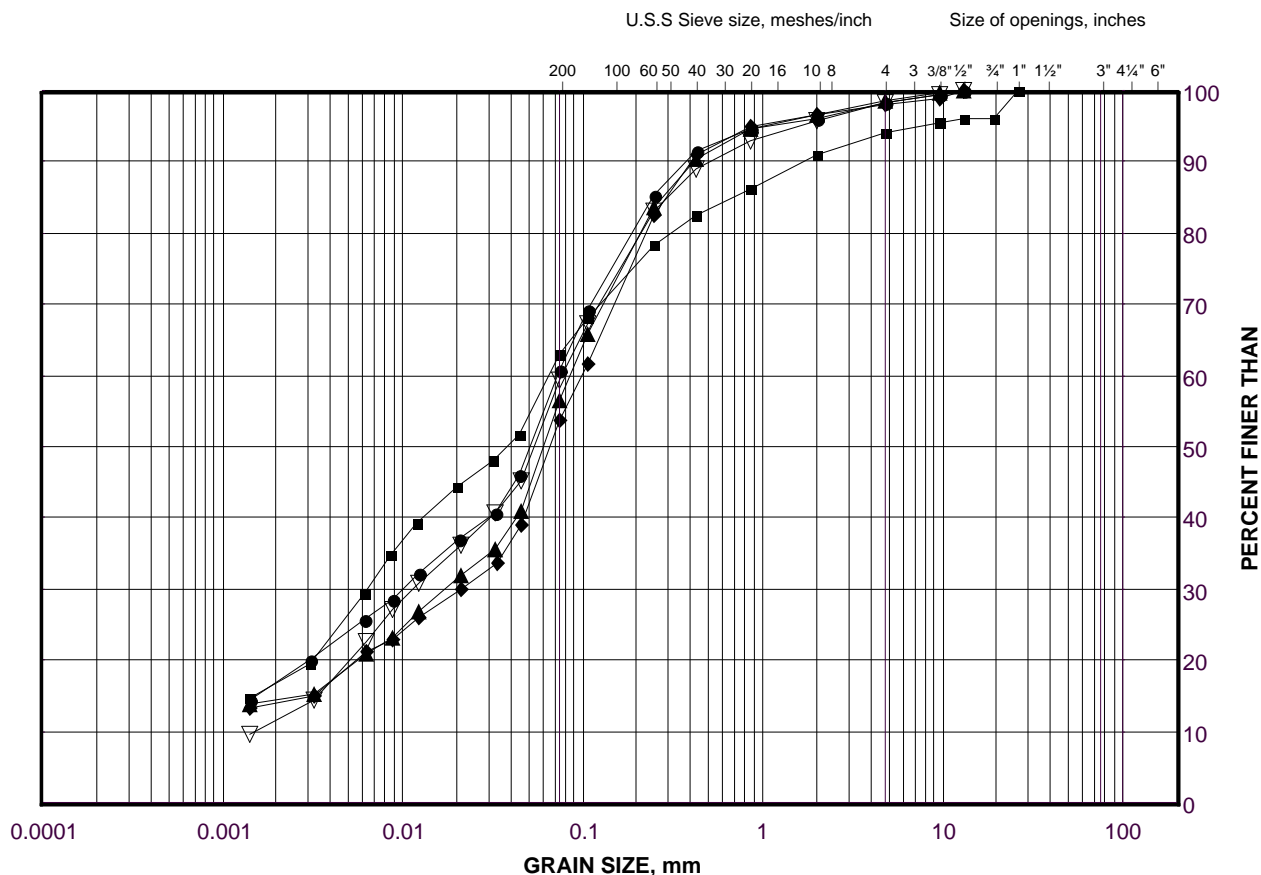
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Silt and Sand to Clayey Silt with Sand - Fill

FIGURE C-2



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	OH-14	2	158.2
■	OH-16	3	156.6
◆	OH-4	6	168.5
▲	CN-01	7	169.1
▽	OH-4	9	164.7

Project Number: 1669995

Checked By: MWK

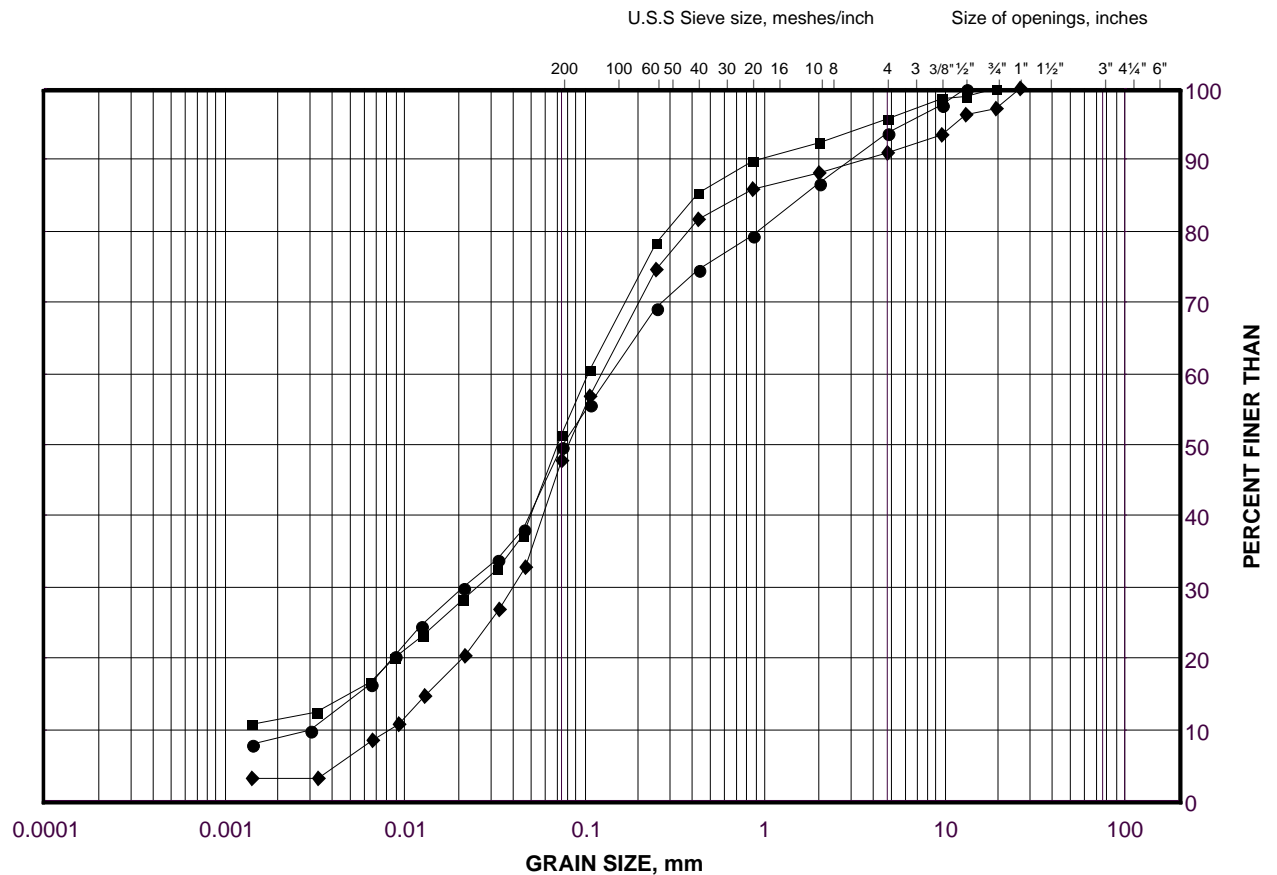
Golder Associates

Date: 08-Mar-19

GRAIN SIZE DISTRIBUTION

Silt and Sand - Fill

FIGURE C-3



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

LEGEND

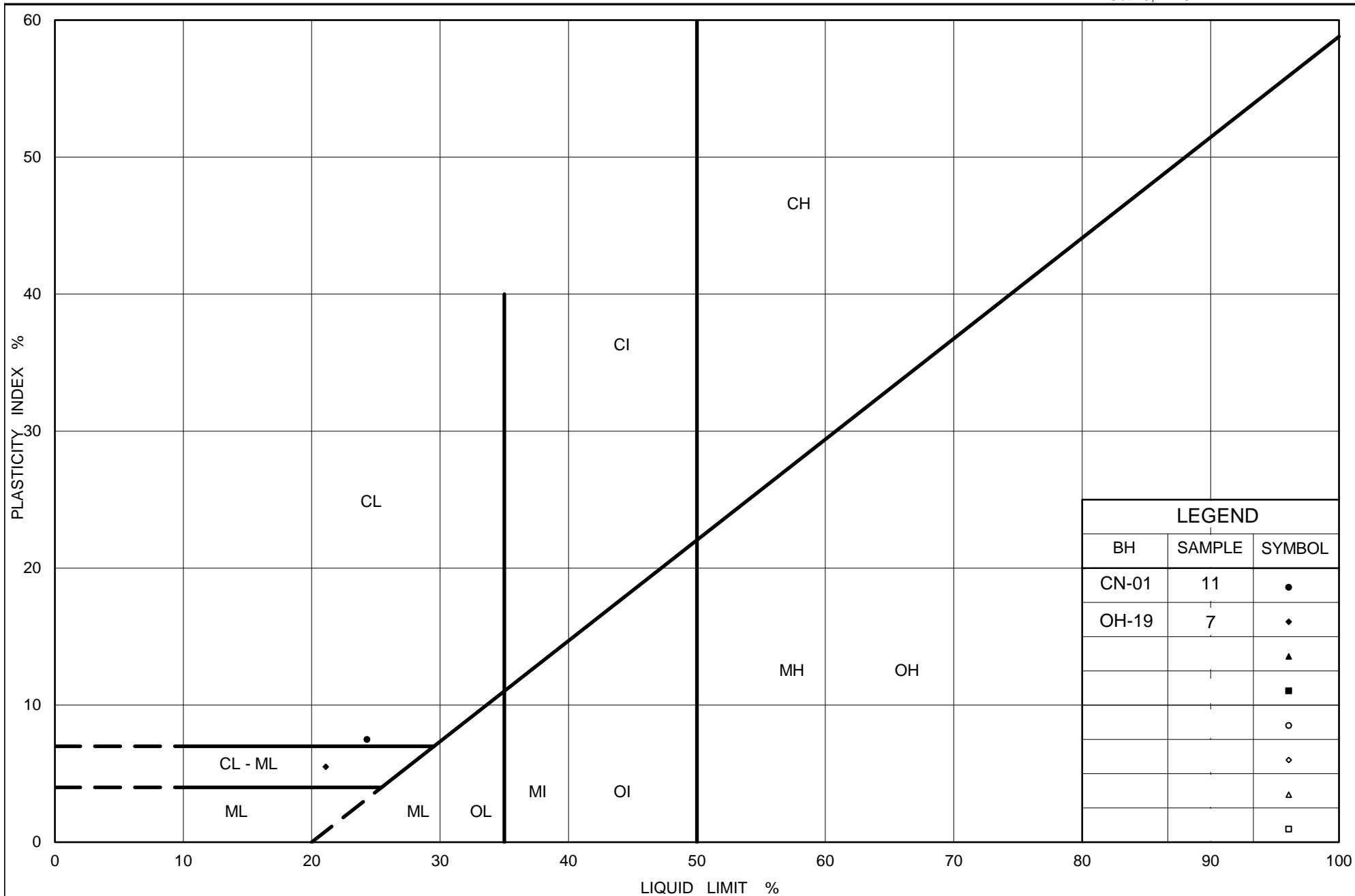
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	OH-27	2	163.3
■	OH-9	3	173
◆	OH-27	5	161

Project Number: 1669995

Checked By: MWK

Golder Associates

Date: 08-Mar-19



LEGEND		
BH	SAMPLE	SYMBOL
CN-01	11	●
OH-19	7	◆
		▲
		■
		○
		◇
		△
		□



Ministry of Transportation

Ontario

PLASTICITY CHART

Clayey Silt

Figure No. C-4

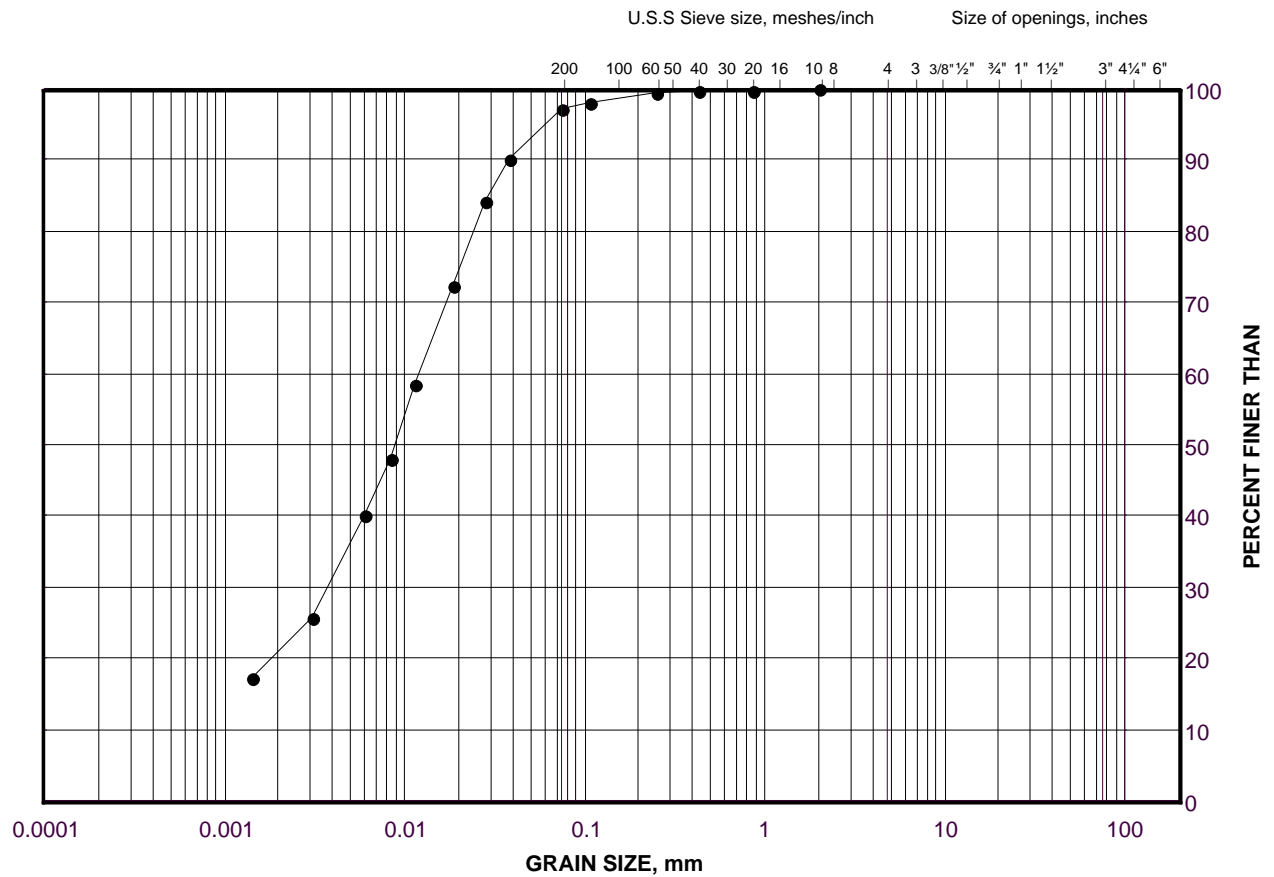
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE C-5



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

LEGEND

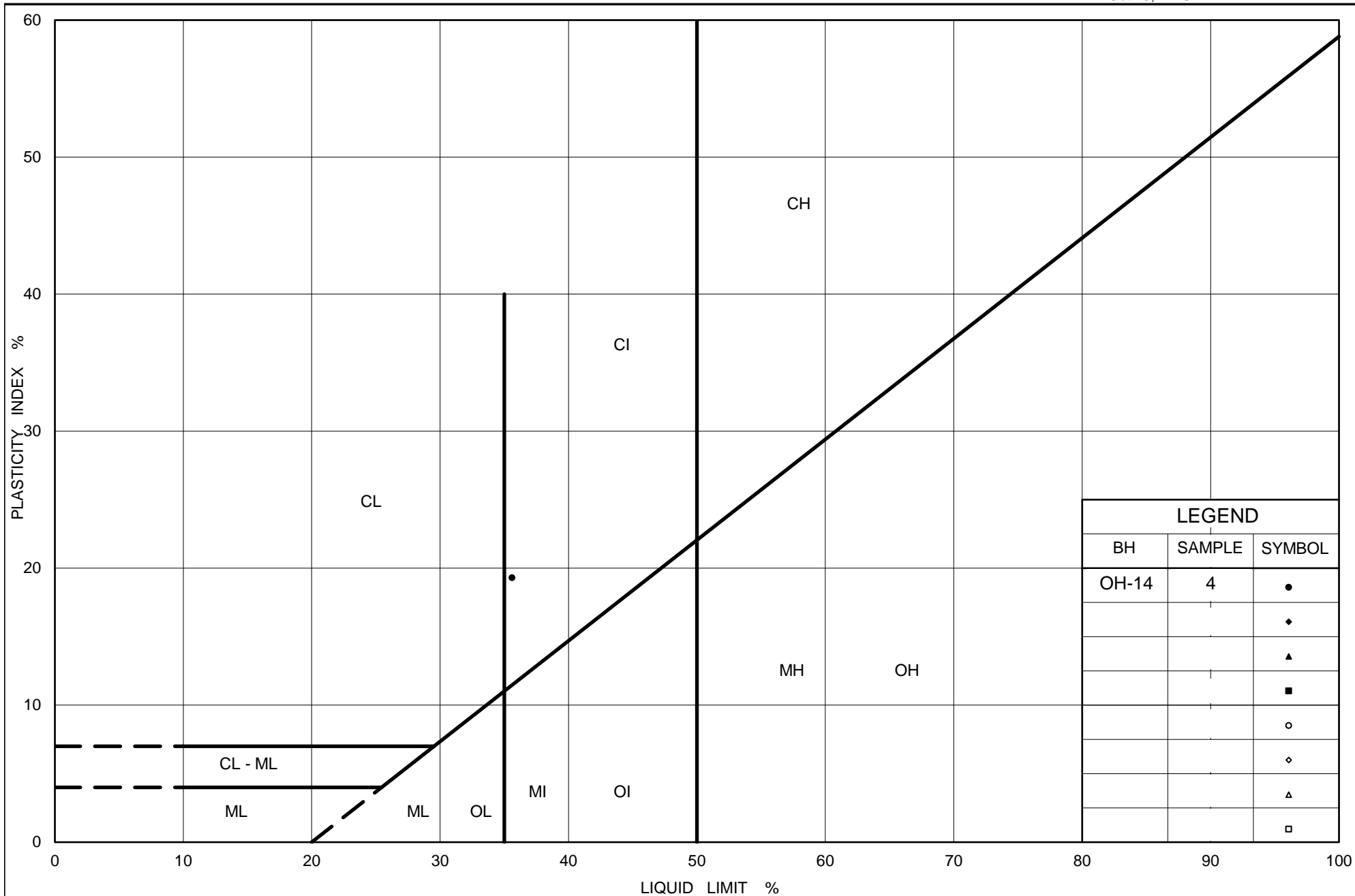
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	OH-19	7	155.8

Project Number: 1669995

Checked By: MWK

Golder Associates

Date: 08-Mar-19



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty Clay

Figure No. C-6

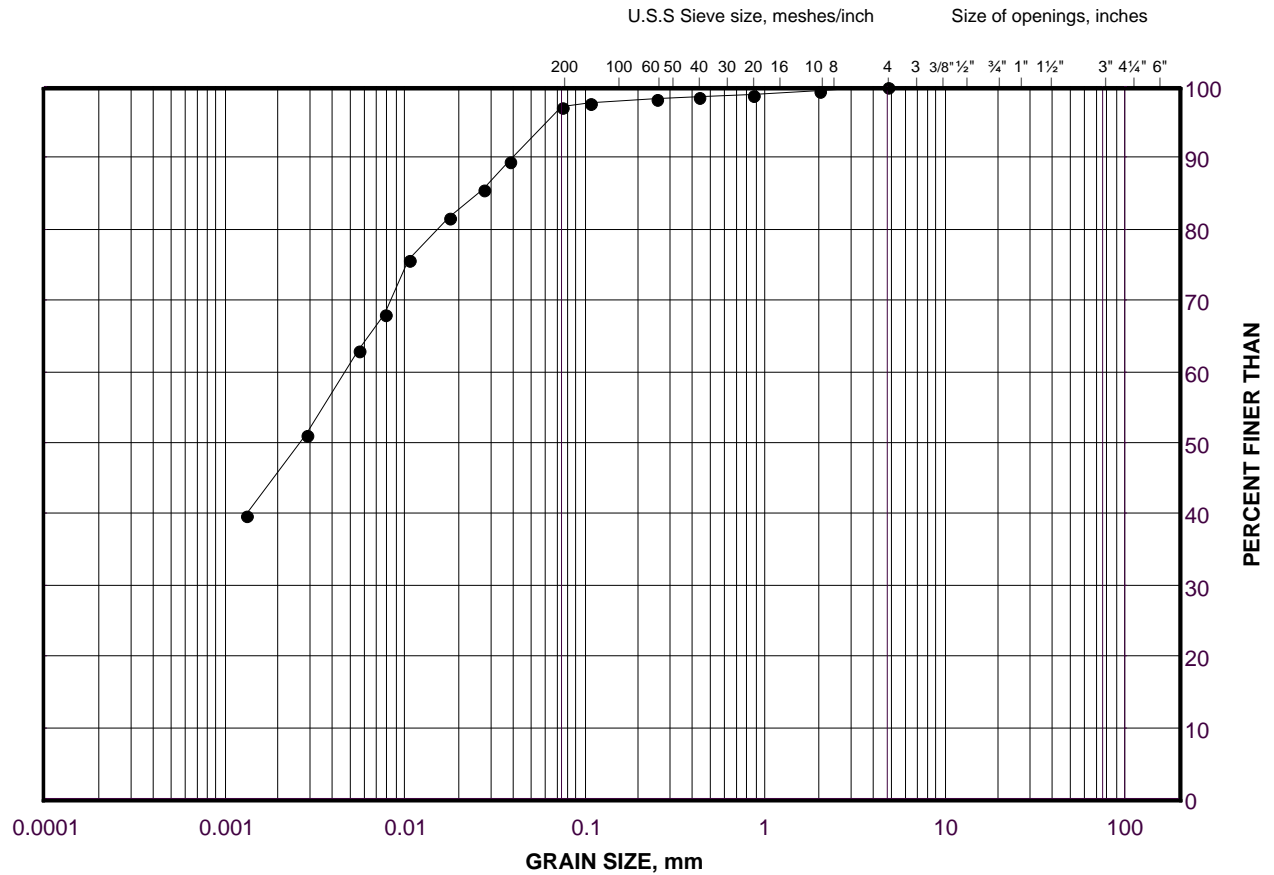
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE C-7



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

LEGEND

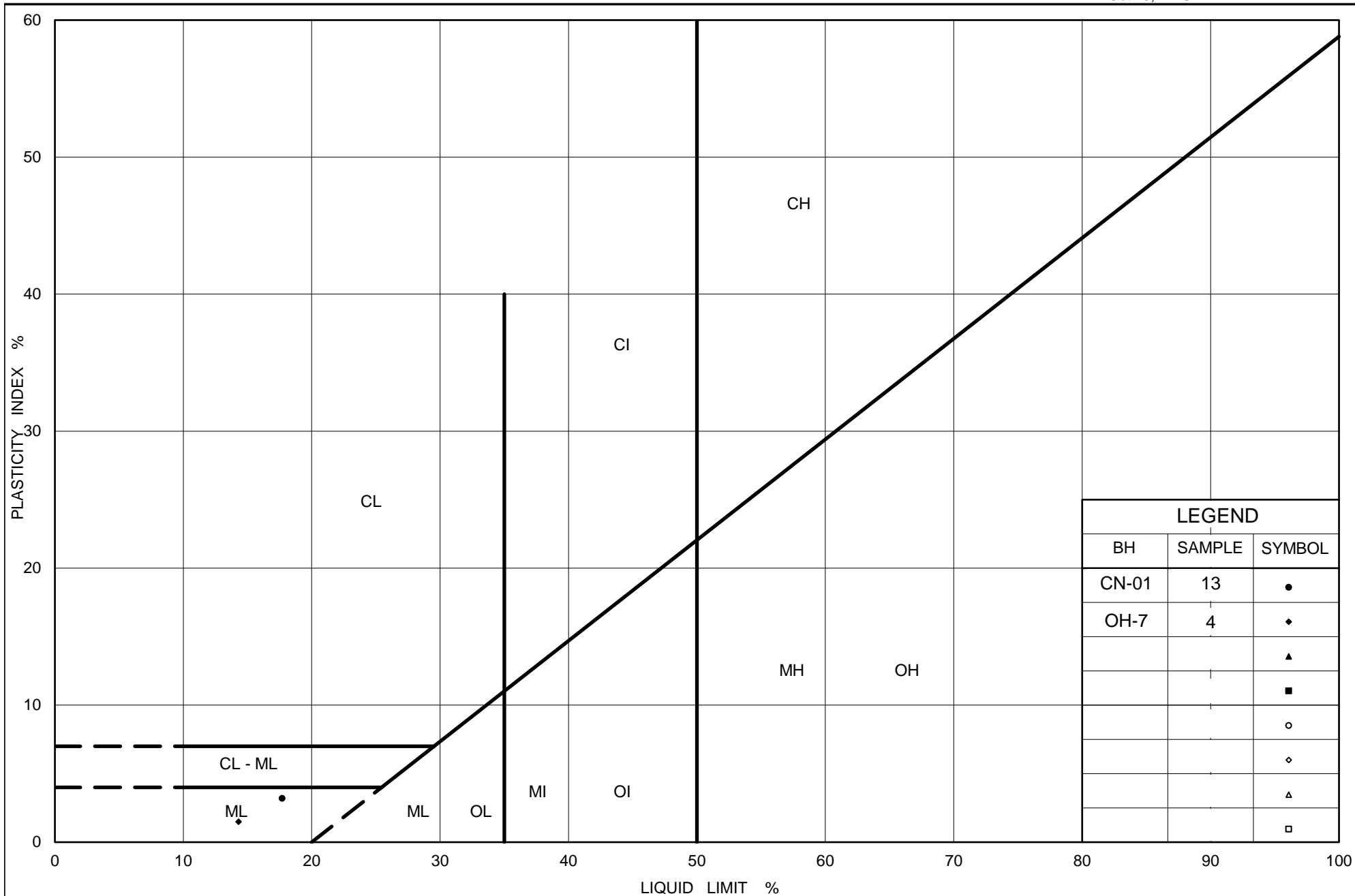
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	OH-14	4	156.6

Project Number: 1669995

Checked By: MWK

Golder Associates

Date: 08-Mar-19



Ministry of Transportation

Ontario

PLASTICITY CHART

Silt

Figure No. C-8

Project No. 1669995

Checked By: MWK

Silt

U.S.S Sieve size, meshes/inch

Size of openings, inches

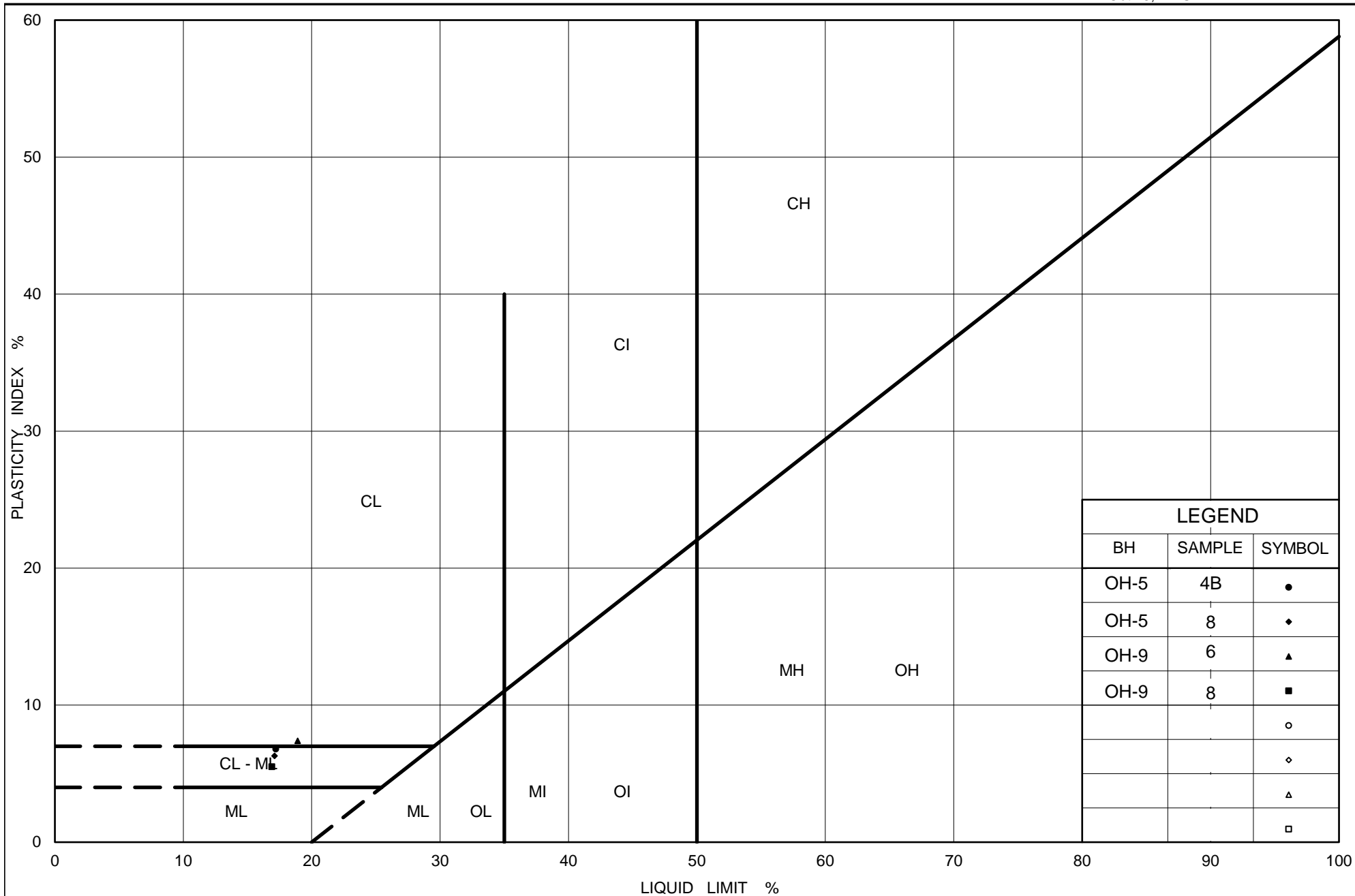
PERCENT FINER THAN

GRAIN SIZE, mm

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

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN-01	13	161.7
■	OH-7	4	172.4
◆	OH-7	7	170.1

Date: 08-Mar-19



Ministry of Transportation

Ontario

PLASTICITY CHART Sandy Clayey Silt to Clayey Silt with Sand - Till

Figure No. C-10

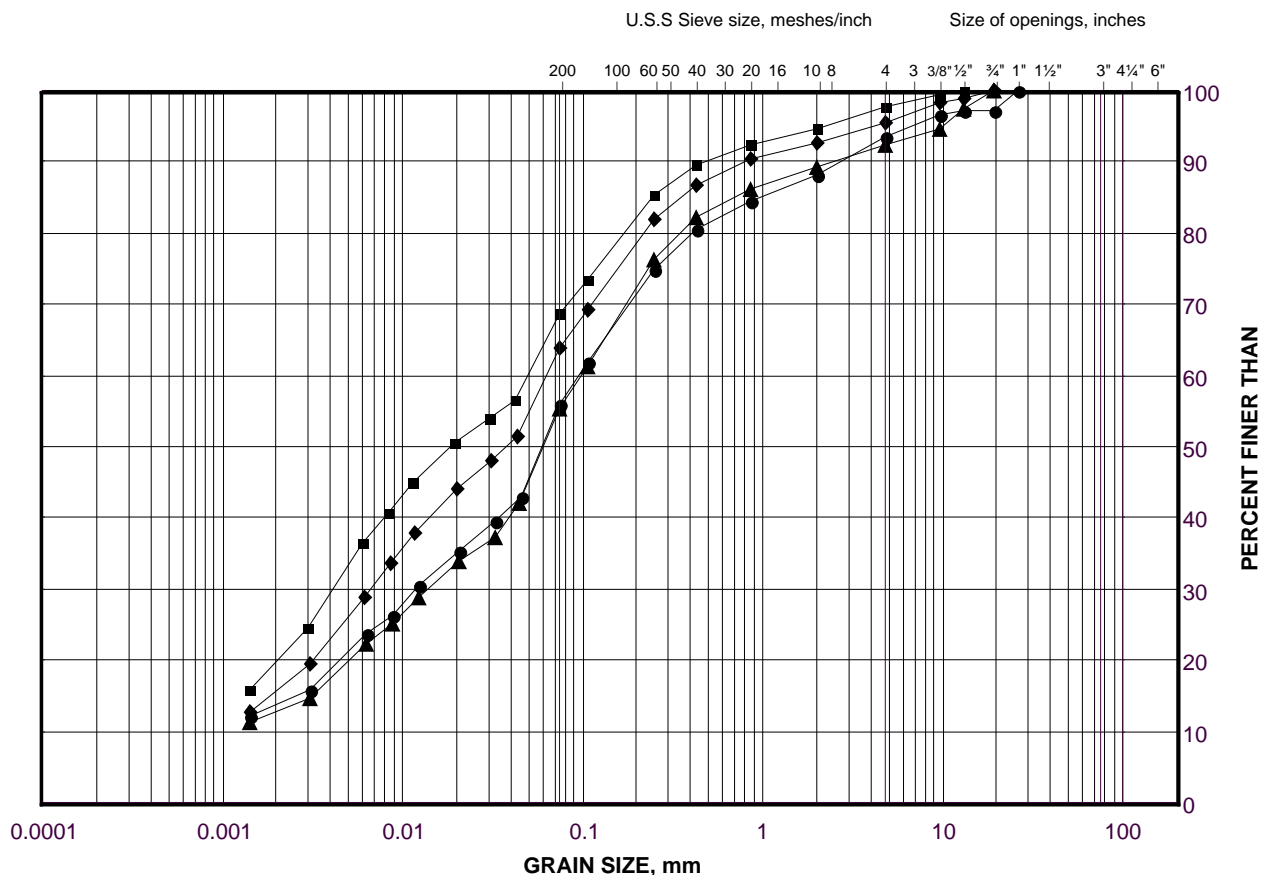
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand - Till

FIGURE C-11



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	OH-5	4B	171.1
■	OH-9	6	170.7
◆	OH-9	8	168.4
▲	OH-5	8	167.4

Project Number: 1669995

Checked By: MWK

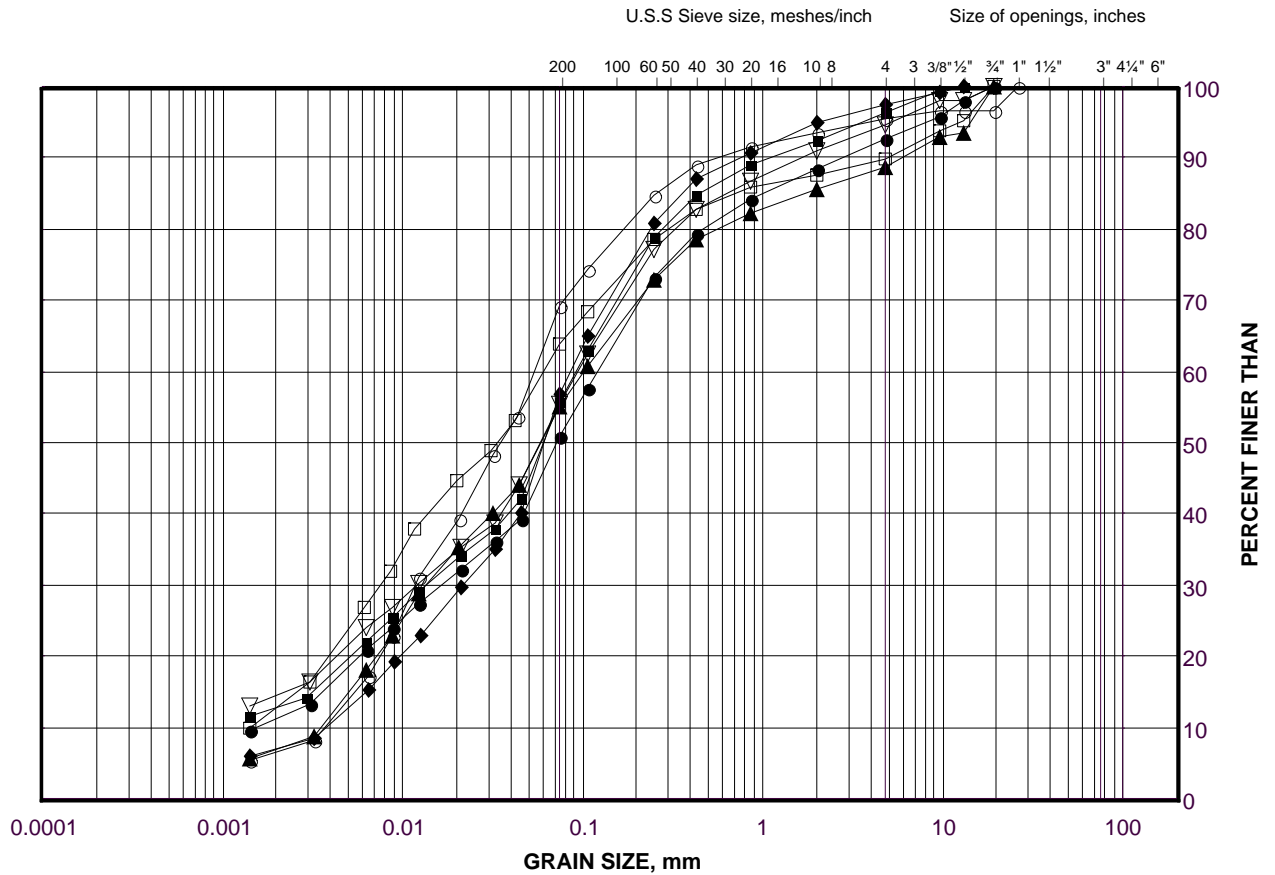
Golder Associates

Date: 08-Mar-19

GRAIN SIZE DISTRIBUTION

Sandy Silt to Silt and Sand

FIGURE C-12A



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	OH-10	2	170.1
■	OH-26	3	152.6
◆	OH-22	3	158.6
▲	OH-24	4A	157.7
▽	OH-26	5	151.1
○	OH-24	5	155.9
□	OH-10	5	167.8

Project Number: 1669995

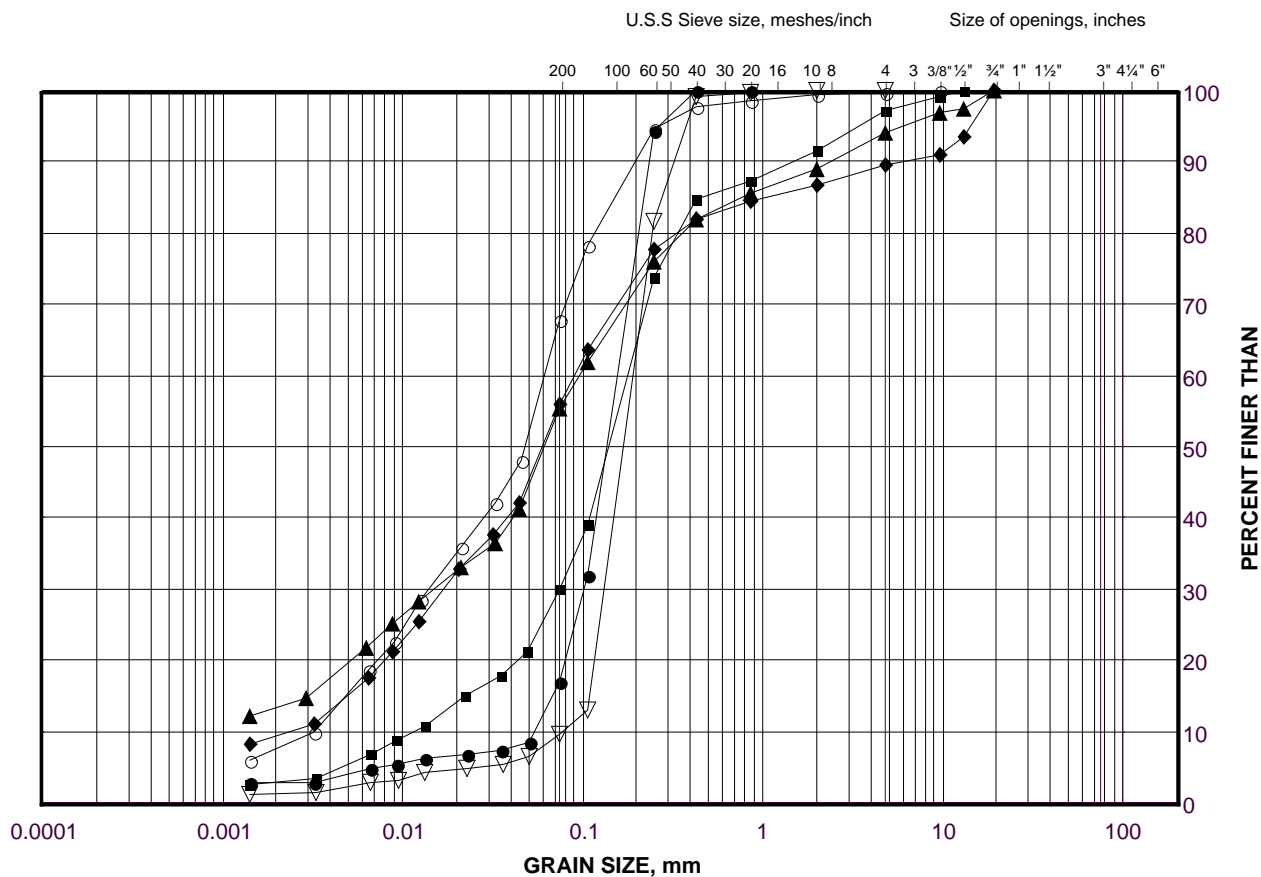
Checked By: MWK

Golder Associates

Date: 08-Mar-19

Silt and Sand to Sand

FIGURE C-12B



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	OH-22	5	157.1
■	OH-22	7	154.8
◆	OH-27	8	157.2
▲	OH-26	8	147.3
▽	OH-24	8	152.1
○	OH-10	8	164.1

Project Number: 1669995

Checked By: MWK

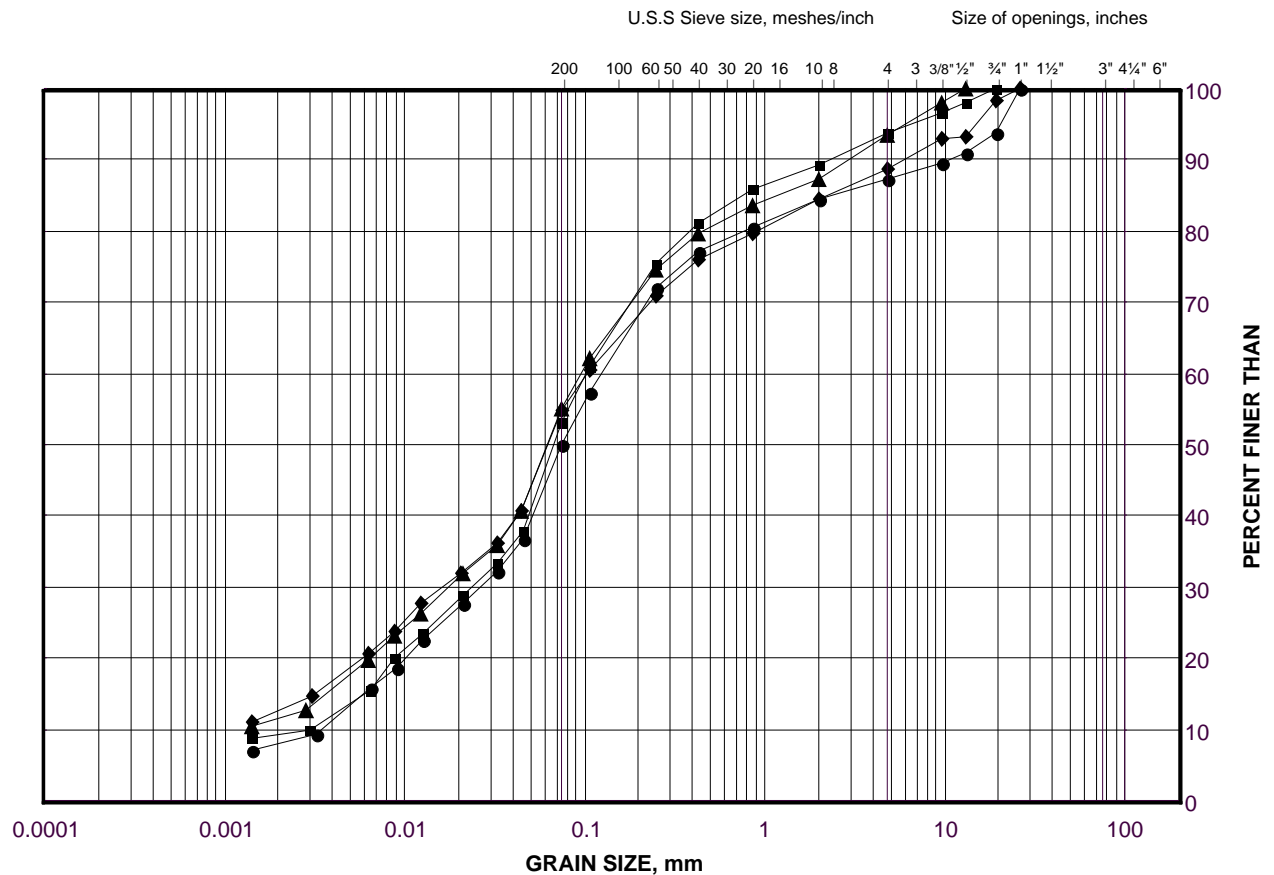
Golder Associates

Date: 08-Mar-19

GRAIN SIZE DISTRIBUTION

Silt and Sand - Till

FIGURE C-13



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

LEGEND

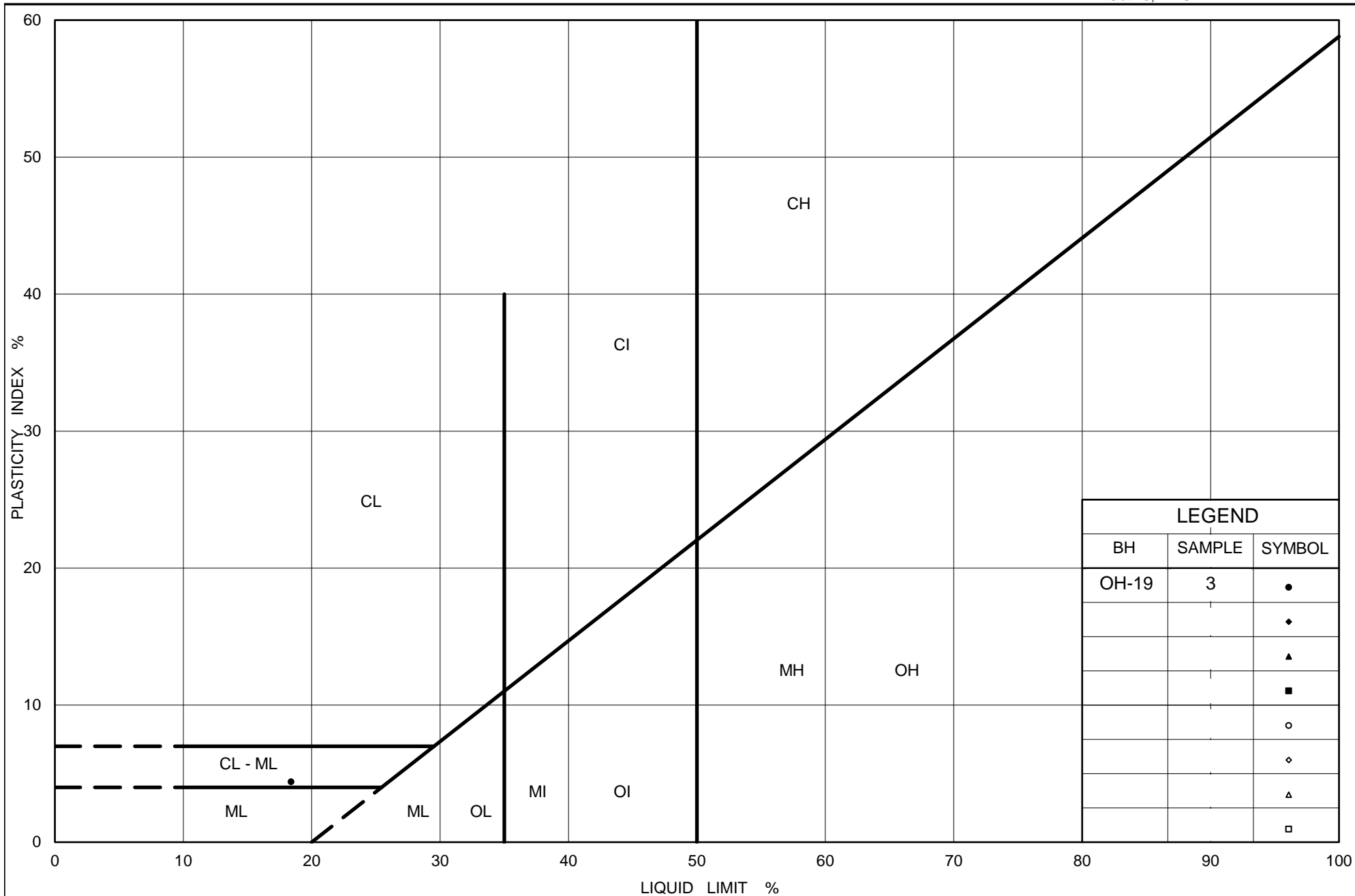
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	OH-19	5	158.1
■	OH-16	5	155.1
◆	OH-16	7	152.8
▲	OH-14	8	152.1

Project Number: 1669995

Checked By: MWK

Golder Associates

Date: 08-Mar-19



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt with Sand

Figure No. C-14

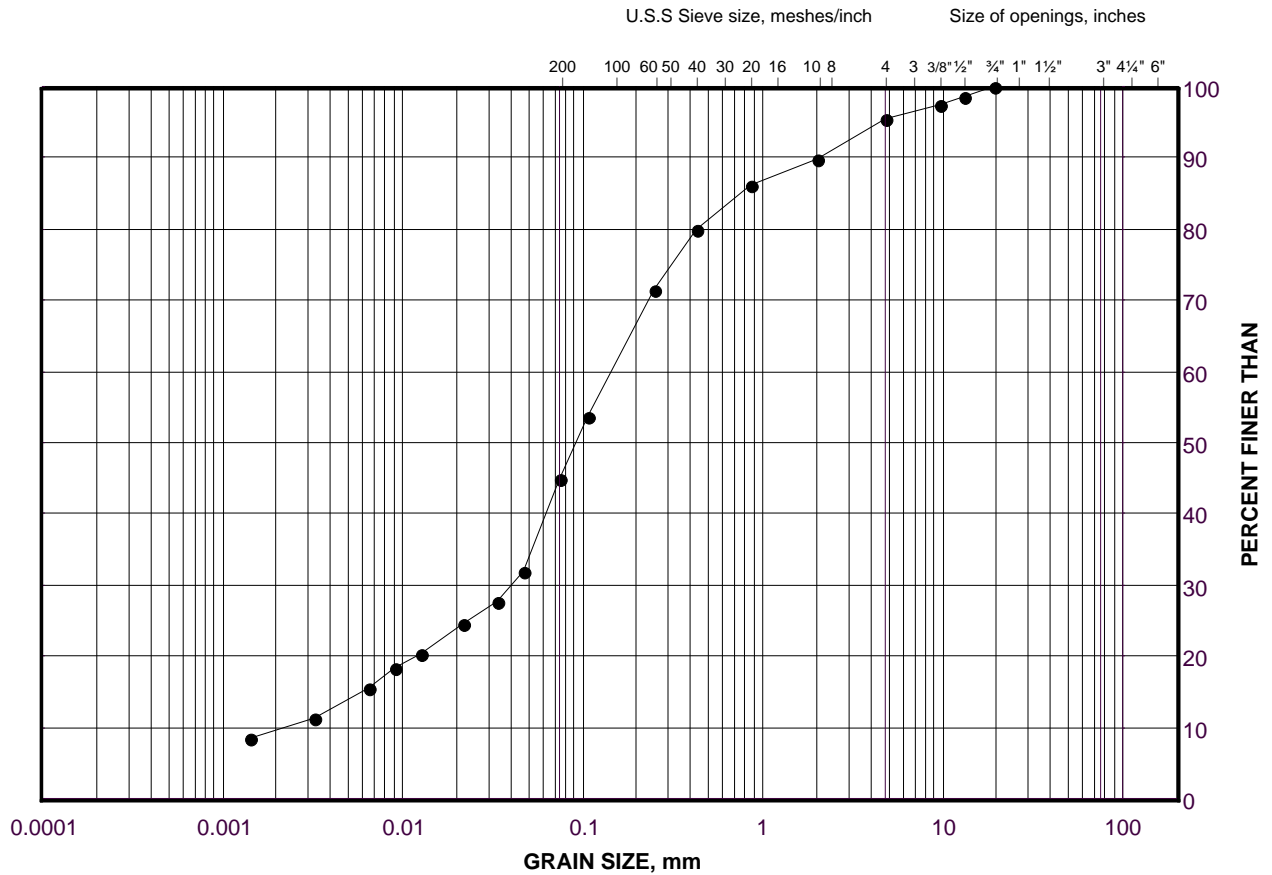
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand

FIGURE C-15



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	OH-19	3	159.6

Project Number: 1669995

Checked By: MWK

Golder Associates

Date: 08-Mar-19

APPENDIX D

Analytical Laboratory Test Results

Your Project #: 1669995
Site Location: 401W

Attention: Nikol Kochmanova

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

Your C.O.C. #: 668025-02-01, 668025-03-01, 668025-04-01, 668025-05-01

Report Date: 2018/06/08
Report #: R5226716
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8D5245

Received: 2018/06/05, 16:46

Sample Matrix: Soil
Samples Received: 31

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	31	N/A	2018/06/08	CAM SOP-00463	EPA 325.2 m
Conductivity	20	N/A	2018/06/07	CAM SOP-00414	OMOE E3530 v1 m
Conductivity	11	N/A	2018/06/08	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl ₂ EXTRACT	20	2018/06/07	2018/06/07	CAM SOP-00413	EPA 9045 D m
pH CaCl ₂ EXTRACT	11	2018/06/08	2018/06/08	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	20	2018/06/06	2018/06/07	CAM SOP-00414	SM 23 2510 m
Resistivity of Soil	11	2018/06/06	2018/06/08	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	31	N/A	2018/06/08	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 #: 1669995
Site Location: 401W

Attention: Nikol Kochmanova

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

Your C.O.C. #: 668025-02-01, 668025-03-01, 668025-04-01, 668025-05-01

Report Date: 2018/06/08
Report #: R5226716
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8D5245

Received: 2018/06/05, 16:46

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		GWL599	GWL600	GWL601		GWL601		
Sampling Date		2018/02/14	2018/04/09	2018/02/28		2018/02/28		
COC Number		668025-02-01	668025-02-01	668025-02-01		668025-02-01		
	UNITS	BR-03 SA#14	RW-02 SA#9	MR-01 SA#10	QC Batch	MR-01 SA#10 Lab-Dup	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	680	6300	1400	5567331			
-------------	--------	-----	------	------	---------	--	--	--

Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	730	<20	390	5569372	420	20	5569372
Conductivity	umho/cm	1480	160	718	5568916	708	2	5568916
Available (CaCl2) pH	pH	8.02	8.28	8.08	5568601			
Soluble (20:1) Sulphate (SO4)	ug/g	270	68	50	5569377	51	20	5569377

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		GWL602		GWL603		GWL604		GWL605		
Sampling Date		2018/04/11		2018/04/12		2018/03/19		2018/03/21		
COC Number		668025-02-01		668025-02-01		668025-02-01		668025-02-01		
	UNITS	OH-7 SA#5	QC Batch	OH-4 SA#4	RDL	MRU-01 SA#4	RDL	BRU-01 SA#6	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	710	5567331	1300		330		990		5567331
-------------	--------	-----	---------	------	--	-----	--	-----	--	---------

Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	680	5569369	220	20	1700	60	620	20	5569369
Conductivity	umho/cm	1410	5570740	764	2	3050	2	1010	2	5570740
Available (CaCl2) pH	pH	7.99	5568601	8.01		8.07		8.07		5569005
Soluble (20:1) Sulphate (SO4)	ug/g	280	5569370	370	20	<20	20	<20	20	5569370

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL606			GWL606			GWL607	GWL608		
Sampling Date		2018/03/14			2018/03/14			2018/03/22	2018/04/05		
COC Number		668025-02-01			668025-02-01			668025-02-01	668025-02-01		
	UNITS	CN-02 SA#23B	RDL	QC Batch	CN-02 SA#23B Lab-Dup	RDL	QC Batch	KR-01 SA#9	NW1-04 SA#6	RDL	QC Batch

Calculated Parameters											
Resistivity	ohm-cm	3200		5567331				940	2000		5567331
Inorganics											
Soluble (20:1) Chloride (Cl)	ug/g	<20	20	5569369				580	230	20	5569372
Conductivity	umho/cm	312	2	5570740	314	2	5570740	1070	508	2	5568916
Available (CaCl2) pH	pH	8.12		5568601				8.01	8.26		5568601
Soluble (20:1) Sulphate (SO4)	ug/g	200	20	5569370				<20	<20	20	5569377
RDL = Reportable Detection Limit											
QC Batch = Quality Control Batch											
Lab-Dup = Laboratory Initiated Duplicate											

Maxxam ID		GWL609	GWL610	GWL611	GWL612	GWL613	GWL614		
Sampling Date		2018/02/25	2018/04/11	2018/02/26	2018/04/11	2018/04/06	2018/04/10		
COC Number		668025-03-01	668025-03-01	668025-03-01	668025-03-01	668025-03-01	668025-03-01		
	UNITS	KR-03S SA#10	NW-05 SA#7B	MA-01 SA#11	NW-04 SA#4	NW-03S SA#7	NW-08 SA#7	RDL	QC Batch

Calculated Parameters									
Resistivity	ohm-cm	2300	620	1300	1000	1600	1300		5567331
Inorganics									
Soluble (20:1) Chloride (Cl)	ug/g	210	820	280	510	340	350	20	5569372
Conductivity	umho/cm	437	1620	797	979	643	778	2	5568916
Available (CaCl2) pH	pH	8.21	8.11	8.09	8.16	8.08	8.13		5568601
Soluble (20:1) Sulphate (SO4)	ug/g	<20	24	310	<20	23	77	20	5569377
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL615		GWL616		GWL617		GWL618		
Sampling Date		2018/04/10		2018/03/25		2018/03/28		2018/03/26		
COC Number		668025-03-01		668025-03-01		668025-03-01		668025-03-01		
	UNITS	NW-07 SA#5A	QC Batch	NBP1-3 SA#6	QC Batch	RW-01 SA#3	QC Batch	NW1-02 SA#3	RDL	QC Batch

Calculated Parameters										
Resistivity	ohm-cm	610	5567331	1600	5567331	1300	5567331	2300		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	810	5569372	320	5569369	370	5569372	170	20	5569372
Conductivity	umho/cm	1630	5568916	627	5568916	743	5568916	429	2	5570740
Available (CaCl2) pH	pH	8.10	5568601	8.00	5568601	8.07	5568601	8.13		5568601
Soluble (20:1) Sulphate (SO4)	ug/g	<20	5569377	<20	5569370	<20	5569377	<20	20	5569377
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										

Maxxam ID		GWL618		GWL619		GWL620		GWL621		
Sampling Date		2018/03/26		2018/03/26		2018/04/09		2018/03/06		
COC Number		668025-03-01		668025-04-01		668025-04-01		668025-04-01		
	UNITS	NW1-02 SA#3 Lab-Dup	QC Batch	NW1-01 SA#4	QC Batch	NBP1-01 SA#9	QC Batch	CN-01 SA#20A	RDL	QC Batch

Calculated Parameters										
Resistivity	ohm-cm			4200	5567331	1200	5567331	2900		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g			78	5569372	460	5569369	120	20	5569372
Conductivity	umho/cm			238	5568916	835	5570740	343	2	5568916
Available (CaCl2) pH	pH	8.09	5568601	8.24	5568601	8.13	5569005	8.34		5568601
Soluble (20:1) Sulphate (SO4)	ug/g			<20	5569377	<20	5569370	92	20	5569377
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										
Lab-Dup = Laboratory Initiated Duplicate										

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL622		GWL623		GWL624		
Sampling Date		2018/02/25		2018/04/12		2018/04/13		
COC Number		668025-04-01		668025-04-01		668025-04-01		
	UNITS	CP-01 SA#12	QC Batch	OH-5 SA#7	QC Batch	OH-9 SA#5	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	1500	5567331	1000	5567331	1400		5567331
Inorganics								
Soluble (20:1) Chloride (Cl)	ug/g	340	5569369	490	5569372	330	20	5569369
Conductivity	umho/cm	649	5570740	974	5568916	733	2	5570740
Available (CaCl2) pH	pH	8.10	5569005	8.14	5568601	8.16		5569005
Soluble (20:1) Sulphate (SO4)	ug/g	<20	5569370	29	5569377	<20	20	5569370
RDL = Reportable Detection Limit								
QC Batch = Quality Control Batch								

Maxxam ID		GWL624			GWL625			GWL626		
Sampling Date		2018/04/13			2018/05/29			2018/04/12		
COC Number		668025-04-01			668025-04-01			668025-04-01		
	UNITS	OH-9 SA#5	RDL	QC Batch	NB-02 SA#4	RDL	QC Batch	OH-01 SA#7	RDL	QC Batch

Calculated Parameters										
Resistivity	ohm-cm				870		5567331	300		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	330	20	5569369	670	20	5569372	1700	60	5569369
Conductivity	umho/cm				1150	2	5568916	3300	2	5570740
Available (CaCl2) pH	pH				8.24		5569005	7.47		5569005
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	5569370	62	20	5569377	250	20	5569370
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										
Lab-Dup = Laboratory Initiated Duplicate										

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL627			GWL628			GWL629		
Sampling Date		2018/05/09			2018/05/07			2018/05/30		
COC Number		668025-04-01			668025-04-01			668025-05-01		
	UNITS	KR-02 SA#3	RDL	QC Batch	MR-02 SA#7	RDL	QC Batch	BR-01 SA#4	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm	470		5567331	760		5567331	400		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	1100	40	5569369	670	20	5569372	1300	60	5569369
Conductivity	umho/cm	2140	2	5568916	1310	2	5568916	2490	2	5570740
Available (CaCl2) pH	pH	8.24		5569005	8.08		5569005	8.04		5569005
Soluble (20:1) Sulphate (SO4)	ug/g	26	20	5569370	70	20	5569377	130	20	5569370
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										

TEST SUMMARY

Maxxam ID: GWL599
Sample ID: BR-03 SA#14
Matrix: Soil

Collected: 2018/02/14
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL600
Sample ID: RW-02 SA#9
Matrix: Soil

Collected: 2018/04/09
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL601
Sample ID: MR-01 SA#10
Matrix: Soil

Collected: 2018/02/28
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL601 Dup
Sample ID: MR-01 SA#10
Matrix: Soil

Collected: 2018/02/28
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL602
Sample ID: OH-7 SA#5
Matrix: Soil

Collected: 2018/04/11
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas

TEST SUMMARY

Maxxam ID: GWL602
Sample ID: OH-7 SA#5
Matrix: Soil

Collected: 2018/04/11
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL603
Sample ID: OH-4 SA#4
Matrix: Soil

Collected: 2018/04/12
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL604
Sample ID: MRU-01 SA#4
Matrix: Soil

Collected: 2018/03/19
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL605
Sample ID: BRU-01 SA#6
Matrix: Soil

Collected: 2018/03/21
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL606
Sample ID: CN-02 SA#23B
Matrix: Soil

Collected: 2018/03/14
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk

TEST SUMMARY

Maxxam ID: GWL606
Sample ID: CN-02 SA#23B
Matrix: Soil

Collected: 2018/03/14
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL606 Dup
Sample ID: CN-02 SA#23B
Matrix: Soil

Collected: 2018/03/14
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar

Maxxam ID: GWL607
Sample ID: KR-01 SA#9
Matrix: Soil

Collected: 2018/03/22
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL608
Sample ID: NW1-04 SA#6
Matrix: Soil

Collected: 2018/04/05
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL609
Sample ID: KR-03S SA#10
Matrix: Soil

Collected: 2018/02/25
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

TEST SUMMARY

Maxxam ID: GWL610
Sample ID: NW-05 SA#7B
Matrix: Soil

Collected: 2018/04/11
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL611
Sample ID: MA-01 SA#11
Matrix: Soil

Collected: 2018/02/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL612
Sample ID: NW-04 SA#4
Matrix: Soil

Collected: 2018/04/11
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL613
Sample ID: NW-03S SA#7
Matrix: Soil

Collected: 2018/04/06
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL614
Sample ID: NW-08 SA#7
Matrix: Soil

Collected: 2018/04/10
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine

TEST SUMMARY

Maxxam ID: GWL614
Sample ID: NW-08 SA#7
Matrix: Soil

Collected: 2018/04/10
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL615
Sample ID: NW-07 SA#5A
Matrix: Soil

Collected: 2018/04/10
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL616
Sample ID: NBP1-3 SA#6
Matrix: Soil

Collected: 2018/03/25
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL617
Sample ID: RW-01 SA#3
Matrix: Soil

Collected: 2018/03/28
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL618
Sample ID: NW1-02 SA#3
Matrix: Soil

Collected: 2018/03/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar

TEST SUMMARY

Maxxam ID: GWL618
Sample ID: NW1-02 SA#3
Matrix: Soil

Collected: 2018/03/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL618 Dup
Sample ID: NW1-02 SA#3
Matrix: Soil

Collected: 2018/03/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas

Maxxam ID: GWL619
Sample ID: NW1-01 SA#4
Matrix: Soil

Collected: 2018/03/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL620
Sample ID: NBP1-01 SA#9
Matrix: Soil

Collected: 2018/04/09
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL621
Sample ID: CN-01 SA#20A
Matrix: Soil

Collected: 2018/03/06
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

TEST SUMMARY

Maxxam ID: GWL622
Sample ID: CP-01 SA#12
Matrix: Soil

Collected: 2018/02/25
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL623
Sample ID: OH-5 SA#7
Matrix: Soil

Collected: 2018/04/12
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL624
Sample ID: OH-9 SA#5
Matrix: Soil

Collected: 2018/04/13
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL624 Dup
Sample ID: OH-9 SA#5
Matrix: Soil

Collected: 2018/04/13
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL625
Sample ID: NB-02 SA#4
Matrix: Soil

Collected: 2018/05/29
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk

TEST SUMMARY

Maxxam ID: GWL625
Sample ID: NB-02 SA#4
Matrix: Soil

Collected: 2018/05/29
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL626
Sample ID: OH-01 SA#7
Matrix: Soil

Collected: 2018/04/12
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL627
Sample ID: KR-02 SA#3
Matrix: Soil

Collected: 2018/05/09
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL628
Sample ID: MR-02 SA#7
Matrix: Soil

Collected: 2018/05/07
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL629
Sample ID: BR-01 SA#4
Matrix: Soil

Collected: 2018/05/30
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

GENERAL COMMENTS

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

Package 1	20.0°C
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Most samples have been received and analyzed past the recommended hold time of 30 days as per client request.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5568601	Available (CaCl ₂) pH	2018/06/07			100	97 - 103			0.50	N/A
5568916	Conductivity	2018/06/07			98	90 - 110	<2	umho/cm	1.4	10
5569005	Available (CaCl ₂) pH	2018/06/08			101	97 - 103			0.13	N/A
5569369	Soluble (20:1) Chloride (Cl)	2018/06/08	NC	70 - 130	108	70 - 130	<20	ug/g	0.23	35
5569370	Soluble (20:1) Sulphate (SO ₄)	2018/06/08	114	70 - 130	107	70 - 130	<20	ug/g	NC	35
5569372	Soluble (20:1) Chloride (Cl)	2018/06/08	NC	70 - 130	107	70 - 130	<20	ug/g	7.2	35
5569377	Soluble (20:1) Sulphate (SO ₄)	2018/06/08	NC	70 - 130	102	70 - 130	<20	ug/g	2.5	35
5570740	Conductivity	2018/06/08			98	90 - 110	<2	umho/cm	0.64	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)

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

Cristina Carriere, 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.



Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campbell Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name: #1326 Golder Associates Ltd		Company Name: Nikol Kochmanova		Quotation #: B80683		Maxxam Job #:	
Attention: Accounts Payable		Attention:		P.O. #:		Bottle Order #:	
Address: 6925 Century Ave Suite 100		Address:		Project: 1669995		668025	
Mississauga ON L5N 7K2				Project Name: 401W		COC #:	
Tel: (905) 567-4444 Fax: (905) 567-6561		Tel: (905) 567-6100 Ext: 1459 Fax:		Site #:		Project Manager:	
Email: AP_CustomerService@golder.com		Email: Nikol_Kochmanova@golder.com		Sampled By:		Erna Gitej	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)		Other Regulations		Special Instructions	
<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		
<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		
<input type="checkbox"/> Table 3	<input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC	<input type="checkbox"/> MISA	Municipality		
<input type="checkbox"/> Table		<input type="checkbox"/> PWQO			
		<input type="checkbox"/> Other			

Include Criteria on Certificate of Analysis (Y/N)?						Field	M	Corrosivity, Reactivity/ Potential	Rush Confirmation Number: _____ (call lab for #)	
Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	# of Bottles				Comments	
1	BR-03 SA#14	Feb 14/18	AM	SOIL		X				
2	RW-02 SA#9	Apr 9/18	AM	SOIL		X				
3	MR-01 SA#10	Feb 28/18	AM	SOIL		X				
4	OH-7 SA#5	Apr 11/18	AM	SOIL		X				
5	OH-4 SA#4	Apr 12/18	AM	SOIL		X				
6	MEU-01 SA#4	Mar 19/18	AM	SOIL		X				
7	BRU-d SA#6	Mar 21/18	AM	SOIL		X				
8	CN-02 SA#23B	Mar 14/18	AM	SOIL		X				
9	KR-01 SA#9	Mar 22/18	AM	SOIL		X				
10	NWL-04 SA#6	Apr 5/18	AM	SOIL		X				

05-Jun-18 16:46
Ema Gitej
B8D5245
GK1
ENV-1309

* RELINQUISHED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		RECEIVED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		# jars used and not submitted		Laboratory Use Only									
Alex Maitland de la Roche		18/06/05		16:45		Alex Maitland de la Roche		18/06/05		16:46				Time Sensitive		Temperature (°C) on Receipt		Custody Seal		Yes		No	
														20/20/20		Present							
																		Intact					

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* 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.

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

White: Maxxa Yellow: Client



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CHAIN OF CUSTODY RECORD



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Page 1/1

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name: #1326 Golder Associates Ltd	Company Name: Nikol Kochmanova	Quotation #: B80683	Maxxam Job #:	Bottle Order #:			
Attention: Accounts Payable	Attention:	P.O. #:					
Address: 6925 Century Ave Suite 100	Address:	Project: 1669995					
Mississauga ON L5N 7K2		Project Name: 401W					
Tel: (905) 567-4444 Fax: (905) 567-6561	Tel: (905) 567-6100 Ext: 1459 Fax:	Site #:			COC #:		Project Manager:
Email: AP_CustomerService@golder.com	Email: Nikol_Kochmanova@golder.com	Sampled By:			C#668025-03-01		Ema Gitej

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY				ANALYSIS REQUESTED (PLEASE BE SPECIFIC)										Turnaround Time (TAT) Required: Please provide advance notice for rush projects									
Regulation 153 (2011)		Other Regulations		Special Instructions		Field Filtered (please circle): Metals / Hg / Cr VI		Corrosivity pH (CL, SO4, pH) Reactivity/EC - no Sulphide and Redox (Potential)												Regular (Standard) TAT: (will be applied if Rush TAT is not specified): Standard TAT = 5-7 Working days for most tests. Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details. Job Specific Rush TAT (if applies to entire submission) Date Required: Time Required: Rush Confirmation Number: (call lab for #)			
<input type="checkbox"/> Table 1 <input type="checkbox"/> Table 2 <input type="checkbox"/> Table 3 <input type="checkbox"/> Table	<input type="checkbox"/> Res/Park <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Agri/Other	<input type="checkbox"/> Medium/Fine <input type="checkbox"/> Coarse <input type="checkbox"/> For RSC	<input type="checkbox"/> CCME <input type="checkbox"/> Reg 558 <input type="checkbox"/> MISA <input type="checkbox"/> PWQO <input type="checkbox"/> Other	<input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> Municipality																			
Include Criteria on Certificate of Analysis (Y/N)?																							
Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix											# of Bottles	Comments							
1	KR-03 SA#10	Feb 25/18	AM	SOIL																			
2	NW-05 SA#7B	Apr 11/18	AM	SOIL																			
3	MA-01 SA#11	Feb 26/18	AM	SOIL																			
4	NW-04 SA#4	Apr 11/18	AM	SOIL																			
5	NW-03 SA#7	Apr 6/18	AM	SOIL																			
6	NW-08 SA#7	Apr 10/18	AM	SOIL																			
7	NW-07 SA#5A	Apr 10/18	AM	SOIL																			
8	NBP1-3 SA#6	Mar 25/18	AM	SOIL																			
9	RW-01 SA#3	Mar 28/18	AM	SOIL																			
10	NWL02 SA#3	Mar 26/18	AM	SOIL																			
* RELINQUISHED BY: (Signature/Print)		Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)		Date: (YY/MM/DD)	Time	# jars used and not submitted		Laboratory Use Only													
See page 1				See page one						Time Sensitive		Temperature, (°C) on Reel		Custody Seal		Yes	No						
														Present									
														Intact									
* 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.														White: Maxxa Yellow: Client									
* 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.																							

CHAIN OF CUSTODY RECORD

3 of 4
Page 11

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#1326 Golder Associates Ltd	Company Name:		Quotation #:	B80683	Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:	Nikol Kochmanova	P.O. #:			
Address:	6925 Century Ave Suite 100	Address:		Project:	1669995		668025
	Mississauga ON L5N 7K2			Project Name:	401W	COC #:	Project Manager:
Tel:	(905) 567-4444 Fax: (905) 567-6561	Tel:	(905) 567-6100 Ext: 1459 Fax:	Site #:			Erna Gitej
Email:	AP_CustomerService@golder.com	Email:	Nikol_Kochmanova@golder.com	Sampled By:		C#668025-04-01	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)			Other Regulations		Special Instructions
<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	
<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	
<input type="checkbox"/> Table 3	<input type="checkbox"/> Agri/Other	<input type="checkbox"/> For RSC	<input type="checkbox"/> MISA	Municipality _____	
<input type="checkbox"/> Table _____			<input type="checkbox"/> PWQO		
			<input type="checkbox"/> Other _____		

Include Criteria on Certificate of Analysis (Y/N)?

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix
1		NW1-01 SA#4	Mar 26/18	AM	SOIL
2		NBP1-H SA#9	Apr 9/18	AM	SOIL
3		CN-01 SA#20A	Mar 6/18	AM	SOIL
4		CP-01 SA#12	Feb 25/18	AM	SOIL
5		OH-5 SA#7	Apr 12/18	AM	SOIL
6		OH-1 SA#5	Apr 13/18	AM	SOIL
7		NB-02 SA#4	May 29/18	AM	SOIL
8		OH-1 SA#7	Apr 12/18	AM	SOIL
9		KR-02 SA#3	May 9/18	AM	SOIL
10		MR-02 SA#7	May 7/18	AM	SOIL

Field Filtered (please circle):

Corrosivity pkg (Cl, SO₄, pH, Resistivity/EC - no Sulphide and Redox Potential)

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

This image shows a full page of blank graph paper. The grid consists of thin black lines forming squares across the entire page. There are no margins, text, or other markings on the paper.

Turnaround Time (TAT) Required:

Please provide advance notice for rush projects

Regular (Standard) TAT:

(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such
days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)	
---	--

Date Required: _____ Time Required: _____ ☐
Rush Confirmation Number: _____

# of Bottles	Comments
--------------	----------

[illegible]

* 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.

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

SAMPLES MUST BE KEPT COOL ($< 10^{\circ}\text{C}$) FROM TIME OF SAMPLING
UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:			
Company Name: #1326 Golder Associates Ltd		Company Name: Nikol Kochmanova		Quotation #: B80683		Maxxam Job #:			
Attention: Accounts Payable		Attention: Nikol Kochmanova		P.O. #:		Bottle Order #:			
Address: 6925 Century Ave Suite 100		Address:		Project: 1669995		668025			
Mississauga ON L5N 7K2				Project Name:		COC #:			
Tel: (905) 567-4444		Tel: (905) 567-6100 Ext: 1459		Site #:		Project Manager:			
Fax: (905) 567-6561		Fax:		Sampled By:		Ema Gitej			
Email: AP_CustomerService@golder.com		Email: Nikol_Kochmanova@golder.com				C#668025-05-01			
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY				ANALYSIS REQUESTED (PLEASE BE SPECIFIC)				Turnaround Time (TAT) Required:	
Regulation 153 (2011)				Other Regulations				Special Instructions	
<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					
<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					
<input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC				<input type="checkbox"/> MISA Municipality					
<input type="checkbox"/> Table				<input type="checkbox"/> PWQO					
<input type="checkbox"/> Other				<input type="checkbox"/>					
Include Criteria on Certificate of Analysis (Y/N)?				Field Filtered (please circle):				Regular (Standard) TAT:	
Sample Barcode Label				Sample (Location) Identification				Date Required:	
Date Sampled				Time Sampled				Time Required:	
Matrix				Metals / Hg / Cr / VI				Rush Confirmation Number:	
				Conductivity, pH, Cl, SO4, pH, Resistivity/EC - no Surphide and Redox Potential				(call lab for #)	
1				BR-d SA#4				May 30/18 AM SOIL	
2									
3									
4									
5									
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* RELINQUISHED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		RECEIVED BY: (Signature/Print)		Date: (YY/MM/DD)	
Time		Time		Time		Time		Time	
See page 1						See page one			
# jars used and not submitted		Laboratory Use Only		Time Sensitive		Temperature (°C) on Recei		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.						White: Maxxa Yellow: Client			
* 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.						SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM			
** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.									

Your Project #: 1669995
Site Location: 401WB
Your C.O.C. #: 700485-05-01

Attention: Nikol Kochmanova

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

Report Date: 2019/01/23
Report #: R5568145
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B915658

Received: 2019/01/18, 10:35

Sample Matrix: Soil
Samples Received: 8

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	8	N/A	2019/01/23	CAM SOP-00463	EPA 325.2 m
Conductivity	8	N/A	2019/01/22	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl ₂ EXTRACT	6	2019/01/22	2019/01/22	CAM SOP-00413	EPA 9045 D m
pH CaCl ₂ EXTRACT	2	2019/01/23	2019/01/23	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	8	2019/01/19	2019/01/22	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	8	N/A	2019/01/23	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. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

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. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

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

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

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

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

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

Your Project #: 1669995
Site Location: 401WB
Your C.O.C. #: 700485-05-01

Attention: Nikol Kochmanova

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

Report Date: 2019/01/23
Report #: R5568145
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B915658
Received: 2019/01/18, 10:35

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		IUD552		IUD553		IUD554		IUD555		
Sampling Date		2018/11/29		2018/12/03		2018/11/30		2018/11/30		
COC Number		700485-05-01		700485-05-01		700485-05-01		700485-05-01		
	UNITS	OH10 SA3	QC Batch	OH14 SA3	QC Batch	OH16 SA4	QC Batch	OH19 SA4	RDL	QC Batch

Calculated Parameters										
Resistivity	ohm-cm	620	5936840	670	5936840	1400	5936840	930		5936840
Inorganics										
Soluble (20:1) Chloride (Cl-)	ug/g	820	5940294	810	5940294	170	5940294	550	20	5940294
Conductivity	umho/cm	1610	5940019	1480	5940019	714	5940019	1080	2	5940019
Available (CaCl2) pH	pH	8.06	5939667	7.86	5939652	7.98	5941762	7.88		5939667
Soluble (20:1) Sulphate (SO4)	ug/g	56	5940279	22	5940279	350	5940279	40	20	5940279
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										

Maxxam ID		IUD556		IUD557			IUD557		
Sampling Date		2018/11/29		2018/11/25			2018/11/25		
COC Number		700485-05-01		700485-05-01			700485-05-01		
	UNITS	OH22 SA3	QC Batch	OH24 SA5	RDL	QC Batch	OH24 SA5 Lab-Dup	RDL	QC Batch

Calculated Parameters									
Resistivity	ohm-cm	990	5936840	1100		5936840			
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	510	5940294	400	20	5940294			
Conductivity	umho/cm	1010	5940019	870	2	5940019	876	2	5940019
Available (CaCl2) pH	pH	8.04	5941762	7.84		5939667			
Soluble (20:1) Sulphate (SO4)	ug/g	67	5940279	190	20	5940279			
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									
Lab-Dup = Laboratory Initiated Duplicate									

RESULTS OF ANALYSES OF SOIL

Maxxam ID		IUD558		IUD559		
Sampling Date		2018/11/25		2018/11/28		
COC Number		700485-05-01		700485-05-01		
	UNITS	OH26 SA4	RDL	OH27 SA3	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	3400		480		5936840
Inorganics						
Soluble (20:1) Chloride (Cl-)	ug/g	49	20	1100	40	5940294
Conductivity	umho/cm	291	2	2090	2	5940019
Available (CaCl2) pH	pH	7.85		7.85		5939662
Soluble (20:1) Sulphate (SO4)	ug/g	100	20	48	20	5940279
RDL = Reportable Detection Limit						
QC Batch = Quality Control Batch						

TEST SUMMARY

Maxxam ID: IUD552
Sample ID: OH10 SA3
Matrix: Soil

Collected: 2018/11/29
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5939667	2019/01/22	2019/01/22	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

Maxxam ID: IUD553
Sample ID: OH14 SA3
Matrix: Soil

Collected: 2018/12/03
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5939652	2019/01/22	2019/01/22	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

Maxxam ID: IUD554
Sample ID: OH16 SA4
Matrix: Soil

Collected: 2018/11/30
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5941762	2019/01/23	2019/01/23	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

Maxxam ID: IUD555
Sample ID: OH19 SA4
Matrix: Soil

Collected: 2018/11/30
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5939667	2019/01/22	2019/01/22	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

Maxxam ID: IUD556
Sample ID: OH22 SA3
Matrix: Soil

Collected: 2018/11/29
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva

TEST SUMMARY

Maxxam ID: IUD556
Sample ID: OH22 SA3
Matrix: Soil

Collected: 2018/11/29
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5941762	2019/01/23	2019/01/23	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

Maxxam ID: IUD557
Sample ID: OH24 SA5
Matrix: Soil

Collected: 2018/11/25
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5939667	2019/01/22	2019/01/22	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

Maxxam ID: IUD557 Dup
Sample ID: OH24 SA5
Matrix: Soil

Collected: 2018/11/25
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva

Maxxam ID: IUD558
Sample ID: OH26 SA4
Matrix: Soil

Collected: 2018/11/25
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5939662	2019/01/22	2019/01/22	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

Maxxam ID: IUD559
Sample ID: OH27 SA3
Matrix: Soil

Collected: 2018/11/28
Shipped:
Received: 2019/01/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5940294	N/A	2019/01/23	Deonarine Ramnarine
Conductivity	AT	5940019	N/A	2019/01/22	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5939662	2019/01/22	2019/01/22	Gnana Thomas
Resistivity of Soil		5936840	2019/01/22	2019/01/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5940279	N/A	2019/01/23	Deonarine Ramnarine

GENERAL COMMENTS

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

Package 1	9.0°C
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pH, Chloride, Sulphate, Conductivity/Resistivity: Sample submitted and analyzed past the recommended sample hold time. This may increase the variability associated with these results.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401WB
Sampler Initials: KN

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5939652	Available (CaCl ₂) pH	2019/01/22			100	97 - 103			0.64	N/A
5939662	Available (CaCl ₂) pH	2019/01/22			100	97 - 103			0.12	N/A
5939667	Available (CaCl ₂) pH	2019/01/22			100	97 - 103			0.12	N/A
5940019	Conductivity	2019/01/22			103	90 - 110	<2	umho/cm	0.68	10
5940279	Soluble (20:1) Sulphate (SO ₄)	2019/01/23	117	70 - 130	108	70 - 130	<20	ug/g	NC	35
5940294	Soluble (20:1) Chloride (Cl ⁻)	2019/01/23	112	70 - 130	103	70 - 130	<20	ug/g	NC	35
5941762	Available (CaCl ₂) pH	2019/01/23			100	97 - 103			0.44	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 (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).



Anastassia Hamanov, Scientific 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.

Page 4 of 4

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#1326 Golder Associates Ltd	Company Name:	Nikol Koshmanova	Quotation #:	B80683	Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:		P.O. #:	1609995		
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	401 WB		700485
Tel:	(905) 567-4444	Tel:		Project Name:		COC #:	Project Manager:
Fax:	(905) 567-6561	Fax:		Site #:	KN/EN		Erna Gitej
Email:	AP_CustomerService@golder.com	Email:	nikol.koshmanova@golder.com	Sampled By:		C8700485/05-01	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE
SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)						Other Regulations							Special Instructions							
<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		<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		<input type="checkbox"/> Table 3	<input type="checkbox"/> Agri/Other	<input type="checkbox"/> For RSC	<input type="checkbox"/> MISA	Municipality _____	<input type="checkbox"/> PWQO		<input type="checkbox"/> Other _____	
Include Criteria on Certificate of Analysis (Y/N)? _____																				
	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix															
1		OH10 SA3	Nov 29, '18	PM	Soil															
2		OH14 SA3	Dec 3, '18																	
3		OH16 SA4	Nov 30, '18																	
4		OH19 SA4	Nov 30, '18																	
5		OH22 SA3	Nov 29, '18																	
6		OH24 SAS	Nov 25, '18																	
7		OH26 SA4	Nov 25, '18																	
8		OH27 SA3	Nov 28, '18																	
9																				
10																				

Regular (Standard) TAT:
 (will be applied if Rush TAT is not specified)
 Standard TAT = 5-7 Working days for most tests.
 Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
 Date Required: _____ Time Required: _____
 Rush Confirmation Number: _____ (call lab for #)

of Bottles

Comments

18-Jan-19 10:35
 Ema Gitej

B915658

 CA2 ENV-835

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only				
Eric Miller Eric Naylor	19/01/18	10:50 AM	[Signature]	19/01/18	10:35		Time Sensitive	Temperature (°C) on Receipt 10/5/21	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/MP-CONTENT/UPLOADS/ONTARIO-COC.PDF](http://MAXXAM.CA/MP-CONTENT/UPLOADS/ONTARIO-COC.PDF)

SAMPLES MUST BE KEPT COOL ($< 10^{\circ}\text{C}$) FROM TIME OF SAMPLING
UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client

APPENDIX E

Non-Standard Special Provisions

BOULDERS/OBSTRUCTIONS DURING EXCAVATION FOR OVERHEAD SIGN SUPPORT FOUNDATIONS – Item No.

Special Provision

The soils at the site are glacially-derived and should be expected to contain cobbles and boulders. Appropriate equipment and procedures will be required to penetrate obstructions (cobbles and boulders) that are encountered during excavation/drilling for overhead sign support foundations.

Basis of Payment

Payment at the contract price for the above tender item shall include full compensation for all labour and materials to complete the work.

END OF SECTION

**CONTROL OF OVERBURDEN SOILS DURING EXCAVATION FOR OVERHEAD SIGN
SUPPORT FOUNDATIONS - Item No.**

Special Provision

Where OPSS 903 is called up by OPSS 915, OPSS 903 is amended by the following. Where conflict occurs, this NSSP shall take precedence.

The Contractor shall construct sign support foundations in conformance with the design and at the locations indicated in the Contract Documents.

The Contractor shall construct the sign support foundations against undisturbed bases and sides of excavations. The bases of caisson excavations shall be cleaned of loosened and/or softened materials prior to pouring concrete for the foundation. The construction methods and techniques shall be the responsibility of the Contractor, but consideration could be given to using temporary liners or tremie concreting techniques where conditions warrant.

The Contractor is advised that excavations for the Overhead Sign Support will be advanced through granular fill materials (where present), various interlayers of granular and native material through/into cohesive soils which may contain lenses or layers of potentially saturated cohesionless soils. The granular soils could slough (if dry) or flow (if water-bearing) into unsupported auger holes during caissons installation. Appropriate construction procedures and equipment will be required to minimize ground loss during drilling, caisson installation and concrete placement.

Basis of Payment

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

END OF SECTION



golder.com