Foundation Investigation Report

Watermain Relocation, Station 17+035, QEW Widening from West of Mississauga Road to West of Hurontario Street, Mississauga, Ministry of Transportation, Ontario, GWP 2002-13-00

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the watermain installation at Station 17+035, associated with the widening of the Queen Elizabeth Way (QEW) from west of Mississauga Road to west of Hurontario Street in the City of Mississauga, Ontario (see Drawing 1).

The purpose of the foundation investigation is to explore the subsurface soil, bedrock and groundwater conditions along the alignment of the proposed watermain installation by borehole drilling / bedrock coring, geotechnical / laboratory testing and analytical chemistry laboratory testing on selected soil and bedrock samples.

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

2.0 SITE DESCRIPTION

The proposed watermain installation at Station 17+035 is located approximately 200 m east of the Credit River in the City of Mississauga, Ontario. The proposed watermain will cross under the widened Premium Way from near the connection to Stavebank Road on the north side of the QEW and the QEW, to approximately 38 m north of Pinetree Crescent on the south side of the QEW, extending for an overall length of about 81 m. The QEW and Premium Way are oriented in a northeast-southwest direction which, for the purpose of this report, is referred to as west-east orientation, and Stavebank Road and the proposed crossing are oriented in a northwest-southeast direction.

The QEW is comprised of three eastbound lanes (to Toronto) and three westbound lanes (to Hamilton), while Premium Way, Pinetree Way and Stavebank Road are comprised of one lane in each direction. Residential areas are located along the south side of the QEW and along most of the north side of Premium Way; greenspace and hydro poles / overhead electrical lines occupy the area at the north end of the watermain and greenspace and a pump station occupy the area at the south end of the watermain. The existing ground surface along the alignment of the watermain varies from about Elevation 96.5 m at the north end to about Elevation 94.5 m at the south end.

3.0 INVESTIGATION PROCEDURES

Field work was carried out between February 22 and 27, 2019, during which time a total of three sampled boreholes, designated as Boreholes C4-1, C4-2, C4-3, were advanced along or adjacent to the proposed watermain alignment approximately at the location shown on Drawing 1. This information is supplemented with Boreholes PED-01, PED-05, and NW3-1 which were advanced on August 17 and 18 and between October 16 and 26, 2017 for the adjacent North-South Active Transportation and Noise Barrier Wall bridge.

Field drilling was carried out using a truck-mounted CME 75 drill rig supplied and operated by Geo-Environmental Drilling Inc., of Halton Hills, Ontario, a track-mounted CME 55 drill rig, supplied and operated by Davis Drilling Ltd., of Milton Ontario, and a truck-mounted CME 55 drill rig and a track-mounted CME 850 drill rig, supplied and operated by Aardvark Drilling Inc., of Guelph, Ontario. The boreholes were advanced through the overburden

using 184 mm, 203 mm or 210 mm outside diameter (O.D.) hollow stem augers. Soil samples were obtained at 0.6 m, 0.75 m and 1.5 m intervals of depth, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-11)[1]. Samples of the bedrock were obtained using an 'HQ' size rock core barrel and coring techniques in Boreholes PED-01, PED-05, and NW3-1. The boreholes were advanced to depths between 9.2 m and 25.4 m below existing ground surface, including coring of bedrock for core lengths of 3.0 m, 3.1 m, and 3.6 m in Boreholes PED-05, PED-01 and NW3-1, respectively.

Groundwater conditions and water levels in the open boreholes were observed during and immediately following the drilling operations. A standpipe piezometer was installed in Boreholes C4-1 and C4-3 to permit monitoring of the groundwater level at the borehole locations. The installed piezometers consist of a 50 mm diameter PVC pipe, with a slotted screen sealed. The annulus surrounding the piezometer screen was backfilled with filter sand. The section of borehole below the standpipe piezometer was backfilled with bentonite to the underside of the sand pack level, and the remainder of the borehole above the sand pack was backfilled with bentonite to near the ground surface and topped with cold patch asphalt or sand and gravel to match the adjacent ground surface material. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 Wells (as amended).

Field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits, grain size distribution and organic content) was carried out on selected soil samples. Point load tests in accordance with ASTM D5731-08 *(Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification),* were conducted on selected rock core samples from Boreholes NW3-1 and PED-05.

Selected soil samples were submitted to Maxxam Analytics (Maxxam) of Mississauga, Ontario which is a Standards Council of Canada (SCC) accredited laboratory for chemical analysis of a suite of parameters that indicate corrosivity potential including pH, resistivity, conductivity, chloride content and sulphate content.

The as-drilled borehole locations and the ground surface elevations were obtained using a GPS (Trimble Geo 7X), having an accuracy of 0.1 m in the vertical and 0.1 m in the horizontal. The locations given in the Record of Borehole/Drillhole sheets and shown on Drawing 1 are 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, geographic coordinates, ground surface elevations and drilled depths are summarized below.

[1] ASTM D1586-11 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the soil.

Borehole No.	Location (MTM NAD 83 Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (Latitude)	Easting (Longitude)		
C4-1	4,824,290.3 (43.558498)	295,984.8 (-79.609115)	96.1	11.0
C4-2	4,824,285.8 (43.558457)	296,023.4 (-79.608637)	95.5	9.5
C4-3	4,824,269.8 (43.558313)	296,043.5 (-79.608388)	94.9	9.2
PED-01	4,824,314.1 (43.558703)	295,977.3 (-79.609205)	96.3	25.4 (including 3.1 m of bedrock core)
PED-05	4,824,275.4 (43.558356)	296,047.1 (-79.608341)	94.4	13.7 (including 3.0 m of bedrock core)
NW3-1	4,824,275.8 (43.558358)	295,959.8 (-79.609422)	96.5	15.4 (including 3.6 m of bedrock core)

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The project area is located within the Iroquois Plain physiographic region, as delineated in The Physiography of Southern Ontario (Chapman and Putman, 1984)[2]. The glacial Iroquois Plain stretches along the northern shoreline of Lake Ontario, extending from the Niagara Escarpment in the west to the Scarborough Bluffs in the east. The Iroquois Plain soils consist of glaciolacustrine sediments deposited in Lake Iroquois, primarily sand, silt and gravel, with a shallow cover of till remaining over the bedrock. Bedrock of the Georgian Bay Formation that underlies the study area consists mainly of blue-grey shale, containing siltstone, sandstone and limestone interbeds. Outcrops of this formation are commonly found along water courses on the west side of Toronto and in Mississauga, notably in the Humber River, Mimico Creek, Etobicoke Creek and Credit River valleys.

4.2 Subsurface Conditions

The detailed subsurface soil, bedrock and groundwater conditions as encountered in the boreholes, details of the piezometer installations and water level readings, and the results of the geotechnical laboratory tests carried out on selected soil and bedrock core samples are presented on the Records of Borehole and Drillhole sheets provided in Appendix A. Photographs of the recovered bedrock core samples are presented on Figures A-1 to A-3, in Appendix A. The results of the in-situ field tests (i.e., SPT “N”-values) as presented on the Record of Borehole sheets and in sub-sections of Section 4.2 are uncorrected. Lists on abbreviations and symbols and

[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.)

lithological, geotechnical rock description terminology, field estimation of rock hardness and rock weathering classification are also included in Appendix A to assist in the interpretation of the Record of Borehole and Record of Drillhole sheets. Plots of the grain size distribution and Atterberg limits tests results are presented on Figures B-1 to B-9, provided in Appendix B. The analytical laboratory test report is included in Appendix C and the test results are summarized in Section 4.4.

The stratigraphic boundaries shown on the borehole records and the stratigraphic profile on Drawing 1 are inferred from non-continuous sampling, observations of drilling progress and the results of the 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 and drillhole records governs any interpretation of the site conditions. It should be noted that the interpreted stratigraphy shown on Drawing 1 is a simplification of the subsurface conditions.

In general, the stratigraphy encountered at the various borehole locations typically consists of surficial layers of asphalt / concrete pavement or topsoil underlain by non-cohesive fill underlain by a sandy silt to silty sand deposit, in turn underlain by an interlayered deposit of silt to clayey silt to silty clay. The cohesive deposit is underlain by a cohesive till deposit, underlain by deposits of sand to sand and gravel in one borehole. In places the sandy silt and cohesive till deposits are underlain by a cohesive deposit of residual soil and in the deeper boreholes shale bedrock was encountered. Detailed descriptions of the subsurface conditions are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit.

4.2.1 Asphalt / Concrete Pavement

An approximately 150 mm and 300 mm thick layer of asphalt pavement was encountered at ground surface in Boreholes PED-01 and C4-2, respectively. A 250 mm thick layer of concrete was encountered underlying the asphalt pavement in Borehole C4-2.

4.2.2 Topsoil

An approximately 50 mm and 150 mm thick layer of topsoil was encountered at ground surface in Boreholes PED-05 and NW3-1, respectively.

4.2.3 Fill

Approximately 1.3 m to 5.4 m thick layer of fill comprised of sandy silt to silt and sand to silty sand to sand, trace to some clay, trace organics was encountered at ground surface in Boreholes C4-1 and C4-3 and underlying the asphalt / concrete pavement or topsoil in Boreholes NW3-1, PED-01, PED-05 and C4-2. The surface of the fill layer was encountered between Elevations 96.3 m and 94.3 m, and extends to depths of between 1.5 m and 5.6 m below ground surface (between Elevations 95.0 m and 90.7 m). In Borehole PED-01 from 0.2 m below ground surface (Elevation 96.1 m) to 2.7 m below ground surface (Elevation 93.6 m) the fill was found to be gravelly, and trace rootlets, asphalt fragments and clayey silt pockets were encountered.

The Standard Penetration Test (SPT) “N”-values measured within the fill deposit range from 2 blows to 32 blows per 0.3 m of penetration, indicating a very loose to dense compactness condition. Grain size distribution testing was carried out on six samples of the fill layers and the results are shown on Figure B-1 in Appendix B. The water content measured on twenty samples of the fill ranges from about 2 per cent to about 26 per cent. The organic content measured on one sample of the non-cohesive fill from Borehole PED-05 is 1.2 per cent.

4.2.4 Sandy Silt to Silty Sand

A 2.2 m to 5.7 m thick sandy silt to silt and sand to silty sand deposit was encountered underlying the fill in Boreholes C4-1, C4-3, PED-05 and NW3-1 at depths of between about 1.5 m and 3.7 m below ground surface (between Elevations 95.0m and 91.2 m) and extends to depths of between about 4.2 m and 7.2 m below ground surface (between Elevations 90.2 m and 88.8 m). The SPT “N”-values measured within the sandy silt to silty sand deposit range from 4 blows to 78 blows per 0.3 m of penetration, suggesting a loose to very dense compactness condition.

Grain size distribution testing was carried out on six samples of the sandy silt to silty sand deposit and the results are shown on Figure B-2 in Appendix B. Atterberg limits testing was carried out on two samples of the sandy silt to silty sand deposit and the results indicated that the material is non-plastic. The water content measured on nineteen samples of the sandy silt to silty sand deposit ranges between 6 per cent and 26 per cent.

4.2.5 Clayey Silt to Silty Clay

A 0.1 m to 2.4 m thick deposit of clayey silt to silty clay, trace sand to sandy, trace to some gravel was encountered underlying the silt and sand to silty sand deposit in Boreholes C4-1, PED-05 and NW3-1 underlying the non-cohesive fill in Borehole PED-01 and underlying the silt deposit in Borehole C4-2. The cohesive deposit is interlayered in places with a silt to sandy silt stratum as described in Section 4.2.6. The surface of the deposit was encountered at depths between about 4.3 m and 7.2 m below ground surface (between Elevations 90.9 m and 89.3 m), and the deposit extends to depths between about 4.3 m and 9.3 m below ground surface (between Elevations 90.1 m and 86.8 m).

The SPT “N”-values measured within the cohesive deposit range between 3 blows and 13 blows per 0.3 m of penetration. One in-situ field vane test carried out within the cohesive deposit in Borehole C4-1 measured an undrained shear strength of greater than 95 kPa. The field vane test result together with the SPT “N”-values suggest that the cohesive deposit has a soft to stiff consistency.

Grain size distribution testing was carried out on four samples of the cohesive deposit and the results are shown on Figure B-3 in Appendix B. Atterberg limits testing was carried out on seven samples of the cohesive deposit and measured liquid limits ranging between about 19 per cent and 36 per cent, plastic limits ranging between about 13 per cent and 16 per cent, and corresponding plasticity indices ranging between about 5 per cent and 20 per cent. These results, which are plotted on a plasticity chart on Figure B-4 in Appendix B, indicate that the deposit is comprised of clayey silt of low plasticity to silty clay of medium plasticity. The water content measured on nine samples of the cohesive deposit ranges between 14 per cent and 31 per cent.

4.2.6 Silt to Sandy Silt

A 0.8 m to 3.1 m thick deposit comprised of 0.7 m to 1.6 m thick interlayers of silt, trace to some sand to sandy silt, trace to some clay, trace gravel was encountered underlying the fill material and interlayered with the cohesive deposit in Borehole C4-2, underlying the clayey silt layer in Borehole PED-05, and interlayered with the sandy clayey silt and clayey silt deposit in Borehole C4-1. The surface of the deposit was encountered at depths between about 3.0 m and 6.8 m below ground surface (between Elevations 92.5 m and 89.3 m) and extends to depths between about 4.6 m and 8.5 m below ground surface (between Elevations 90.9 m and 87.0 m). The SPT “N”-values measured within the silt deposit interlayers range from 18 blows to 45 blows per 0.3 m of penetration, suggesting a compact to dense compactness condition.

Grain size distribution testing was carried out on one sample of the sandy silt interlayers and three samples of the silt layer and the results are shown on Figures B-2 and B-5, respectively, in Appendix B. Atterberg limits testing

was carried out on one sample of the silt deposit and one sample of the sandy silt interlayers and the results indicated that the materials are non-plastic. The water content measured on four samples of the silt deposit ranges between 15 per cent and 19 per cent.

4.2.7 Clayey Silt with Sand to Clayey Silt (Till)

A 1.4 m to 4.5 m thick cohesive till deposit was encountered underlying the sandy clayey silt to silty clay deposit in Boreholes C4-1, PED-01, and NW3-1, underlying the sandy silt deposit in Borehole C4-3 and underlying the silt deposit in Borehole PED-05, at depths between 5.6 m and 9.3 m below ground surface (between Elevations 89.1 m and 86.8 m). The till deposit consists of clayey silt with sand to sandy clayey silt to clayey silt, trace to some gravel, and containing shale fragments and cobbles in Borehole C4-1. The cohesive till deposit extends to depths between 8.4 m and 11.7 m below ground surface (between Elevations 86.5 m and 84.6 m). Borehole C4-1 terminated in this cohesive till deposit at a depth of 11.0 m below ground surface (Elevation 85.1 m).

The SPT “N”-values measured within the cohesive till deposit range from 1 blow to 15 blows per 0.3 m of penetration in Boreholes C4-3, PED-05 and NW3-1, suggesting a very soft to stiff consistency, and range from 13 blows to 50 blows per 0.3 m of penetration, and up to 94 blows for 0.23 m of penetration, in Boreholes C4-1 and PED-01, suggesting a stiff to hard consistency.

Grain size distribution testing was carried out on five selected samples of the cohesive till deposit and the results are shown on Figure B-6 in Appendix B. Atterberg limits testing was carried out on six samples of the till deposit and measured liquid limits ranging between about 23 per cent and 29 per cent, plastic limits ranging between about 14 per cent and 22 per cent, and plasticity indices ranging between about 6 per cent and 13 per cent. These results, which are plotted on a plasticity chart on Figure B-7 in Appendix B, indicate that the cohesive till deposit is comprised of clayey silt of low plasticity. The water content measured on twelve samples of the till deposit ranges between about 8 per cent and 31 per cent.

4.2.8 Sand to Sand and Gravel

Underlying the till deposit in Borehole PED-01 a 9.6 m thick deposit of sand, trace to some silt, trace to some clay, trace to some gravel underlain by a 1.0 m thick layer of sand and gravel some silt was encountered at a depth of 11.7 m below ground surface (Elevation 84.6 m) and extends to a depth of about 22.3 m below ground surface (Elevation 74.0 m). Within the deposit of sand, a 0.1 m thick clayey silt lens was encountered at a depth of about 14.0 m below ground surface; and at a depth of approximately 17.8 m below ground surface the deposit was found to be gravelly.

The SPT “N”-values measured within the sand deposit range from 50 blows to 121 blows per 0.3 m of penetration, with one value of 100 blows for 0.13 m of penetration (in the gravelly zone), suggesting a very dense compactness condition. Two SPT “N”-values measured within the sand and gravel layer are both 100 blows per 0.05 m of penetration, suggesting a very dense compactness condition.

Grain size distribution testing was carried out on three samples of the sand deposit and the results are shown on Figure B-8 in Appendix B. The natural water content measured on four samples of the sand deposit ranges between 3 per cent and 8 per cent. The water content measured on one sample of the sand and gravel deposit is 9 per cent.

4.2.9 Clayey Silt (Residual Soil)

A 0.8 m to 2.0 m thick deposit of residual soil deposit consisting of sandy gravelly clayey silt to sandy clayey silt to clayey silt, containing some shale fragments was encountered underlying the cohesive till in Boreholes C4-3,

PED-05 and NW3-1, and underlying the sandy silt interlayer in Borehole C4-2, at depths between about 8.4 m and 10.1 m below ground surface (to between Elevations 87.0 m and 85.7 m). The cohesive residual soil deposit extends to depths between about 9.2 m and 11.8 m below ground surface (to between Elevations 86.0 m and 83.7 m). Residual soil is a heterogeneous mix of fully weathered bedrock that is disintegrated into a soil like material that no longer retains the structure of parent bedrock. The SPT "N"-values measured within the residual soil deposit range from 64 blows per 0.3 m of penetration to 100 blows for 0.08 m of penetration, suggesting a hard consistency.

Atterberg limits testing was carried out on one sample of the residual soil and measured a liquid limit of about 20 per cent, a plastic limit of about 14 per cent, and a plasticity index of about 6 per cent. The result, which is plotted on a plasticity chart on Figure B-9 in Appendix B, indicates that the residual soil deposit is comprised of clayey silt of low plasticity. The water content measured on four samples of the residual soil deposit ranges between about 4 per cent and 11 per cent.

4.2.10 Shale Bedrock

Bedrock was encountered in Boreholes PED-01, PED-05 and NW3-1 and core lengths of 3.1 m, 3.0 m and 3.6 m, respectively, were obtained. Auger refusal was encountered at a depth of 9.5 m below ground surface (Elevation 86.0 m) in Borehole C4-2. The depths to bedrock below ground surface, as inferred from the augering / split spoon sampling and bedrock coring, and the corresponding bedrock surface elevation are summarized below.

Borehole	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Comments
PED-01	22.3	74.0	Bedrock coring for 3.1 m
PED-05	10.7	83.7	Bedrock coring for 3.0 m
NW3-1	11.8	84.7	Bedrock coring for 3.6 m

Based on a review of the bedrock core samples, the bedrock consists of shale of the Georgian Bay Formation. In general, the bedrock core samples are described as slightly weathered to fresh, thinly laminated to medium bedded, very fine to fine grained, faintly porous, very weak to weak, grey, shale, with slightly weathered to fresh, laminated to medium bedded, grey, fine grained, faintly porous, medium strong to very strong limestone interbeds at varying intervals of depth as presented on the drillhole records. Note that no strength testing was carried out on the limestone interbeds so the strength is assumed. The strong limestone layers range in thickness from about 10 mm to 290 mm, with an average thickness of about 61 mm. The rock core samples obtained during the drilling investigation contain less than 5 per cent to up to 55 per cent stronger limestone layers (based on the percentage of limestone in a core run). The details of the bedrock descriptions are presented on the drillhole records and a photograph of the recovered bedrock core samples is presented on Figures A-1 to A-3, in Appendix A. The degree of weathering of the bedrock samples (i.e., fresh to slightly weathered – W1 to W2), and the strength classification of the intact rock mass based on field identification (i.e., very weak to weak – R1 to R2)

are described in accordance with the International Society for Rock Mechanics (ISRM[3]) standard classification system.

The Rock Quality Designation (RQD) measured on the core samples ranges from about 85 per cent to 98 per cent, indicating a rock mass of good to excellent quality as per Table 3.10 of CFEM (2006)[4]. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered range between 92 per cent and 100 per cent and between 90 per cent and 98 per cent, respectively.

Point Load tests were carried out on 12 samples of the shale bedrock, and the results are summarized below Based on the point load tests, in accordance with Table 3.5 in CFEM (2006)[4], the shale bedrock is inferred to be classified as very weak (R1, 1 MPa < UCS < 5 MPa) to weak (R2, 5 MPa < UCS < 25 MPa).

Borehole No.	Sample Depth (m)	Sample Elevation (m)	Orientation	Corrected Axial Is (50 mm) (MPa)
PED-05	11.28	83.12	Axial	0.504
PED-05	11.28	83.12	Diametral	0.452
PED-05	11.83	82.57	Axial	0.753
PED-05	11.83	82.57	Diametral	0.286
PED-05	13.19	81.21	Axial	0.722
PED-05	13.19	81.21	Diametral	0.589
NW3-1	12.41	84.09	Axial	0.560
NW3-1	12.41	84.09	Diametral	0.172
NW3-1	13.20	83.30	Axial	0.418
NW3-1	13.20	83.30	Diametral	0.429
NW3-1	14.54	81.96	Axial	0.434
NW3-1	14.54	81.96	Diametral	0.429

4.2.11 Groundwater Conditions

Details of the water levels observed in the open boreholes at the time of drilling are presented on the Record of Borehole sheets in Appendix A. A standpipe piezometer was installed in each of Boreholes C4-1 and C4-3 to monitor the groundwater level at the borehole locations. The water levels measured in the open boreholes and in

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

[4] Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual (CFEM), 4th Edition. The Canadian Geotechnical Society, BiTech Published Ltd., British Columbia.

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

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
C4-1	96.1	9.4	86.7	February 22, 2019	Upon completion of drilling
		4.7	91.4	February 22, 2019	Piezometer sealed into Sand Fill / Silt and Sand Strata
		3.5	92.6	March 13, 2019	
C4-2	95.5	Dry	-	February 25, 2019	Dry upon completion of drilling
C4-3	94.9	2.7	92.2	February 27, 2019	Upon completion of drilling
		3.4	91.5	February 27, 2019	Piezometer sealed into Silty Sand fill / Silty Sand / Sandy Silt Strata
		2.8	92.1	March 13, 2019	
		3.7	91.2	March 21, 2019	
PED-01	96.3	Dry	-	-	Dry upon completion of soil drilling, prior to rock coring
PED-05	94.4	Dry	-	-	Dry upon completion of soil drilling, prior to rock coring
NW3-1	96.5	4.5	92.0	October 17, 2017	Upon completion of drilling

4.2.12 Analytical Testing Results

As noted in Section 3.0, three soil samples collected were submitted to Maxxam Analytics (Maxxam), a Standards Council of Canada (SCC) accredited laboratory, of Mississauga, Ontario, 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 following table summarizes the results of the testing:

Borehole No.	Borehole NW3-1 Sample 7 Elev. 91.6 m (Silty Sand)	Borehole C4-2 Combined Samples 8 and 9 Elev. 89.5 m (Clayey Silt / Sandy Silt)	Borehole C4-3 Samples 9B, 10A, 10B and 12 Elev. 88.7 m (Sandy Silt / Clayey Silt Till
pH	7.86	7.77	7.77
Resistivity (ohm-cm)	490	1,500	1,000
Electrical Conductivity (umho/cm)	2,040	670	991

Borehole No.	Borehole NW3-1 Sample 7 Elev. 91.6 m (Silty Sand)	Borehole C4-2 Combined Samples 8 and 9 Elev. 89.5 m (Clayey Silt / Sandy Silt)	Borehole C4-3 Samples 9B, 10A, 10B and 12 Elev. 88.7 m (Sandy Silt / Clayey Silt Till
Chlorides (ug/g)	1,000	250	410
Soluble Sulphates (ug/g)	69	130	190

5.0 CLOSURE

This report was prepared by Ms. Alex MacMillan, E.I.T., a geotechnical Engineer-In-Training with Golder and reviewed by Ms. Sandra McGaghran, M.Eng., P.Eng. an Associate and Senior Geotechnical Engineer with Golder. Mr. Jorge M.A. Costa, P.Eng., a MTO Foundations Designated Contact and Senior Consultant with Golder, conducted a technical and quality control review of the report.

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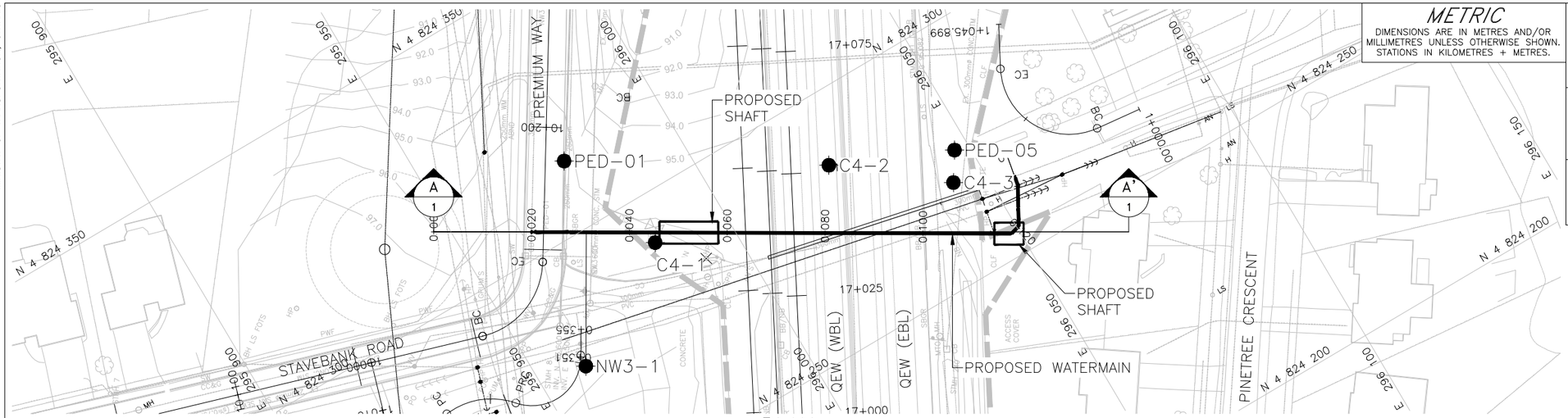
MINISTRY OF TRANSPORTATION, ONTARIO



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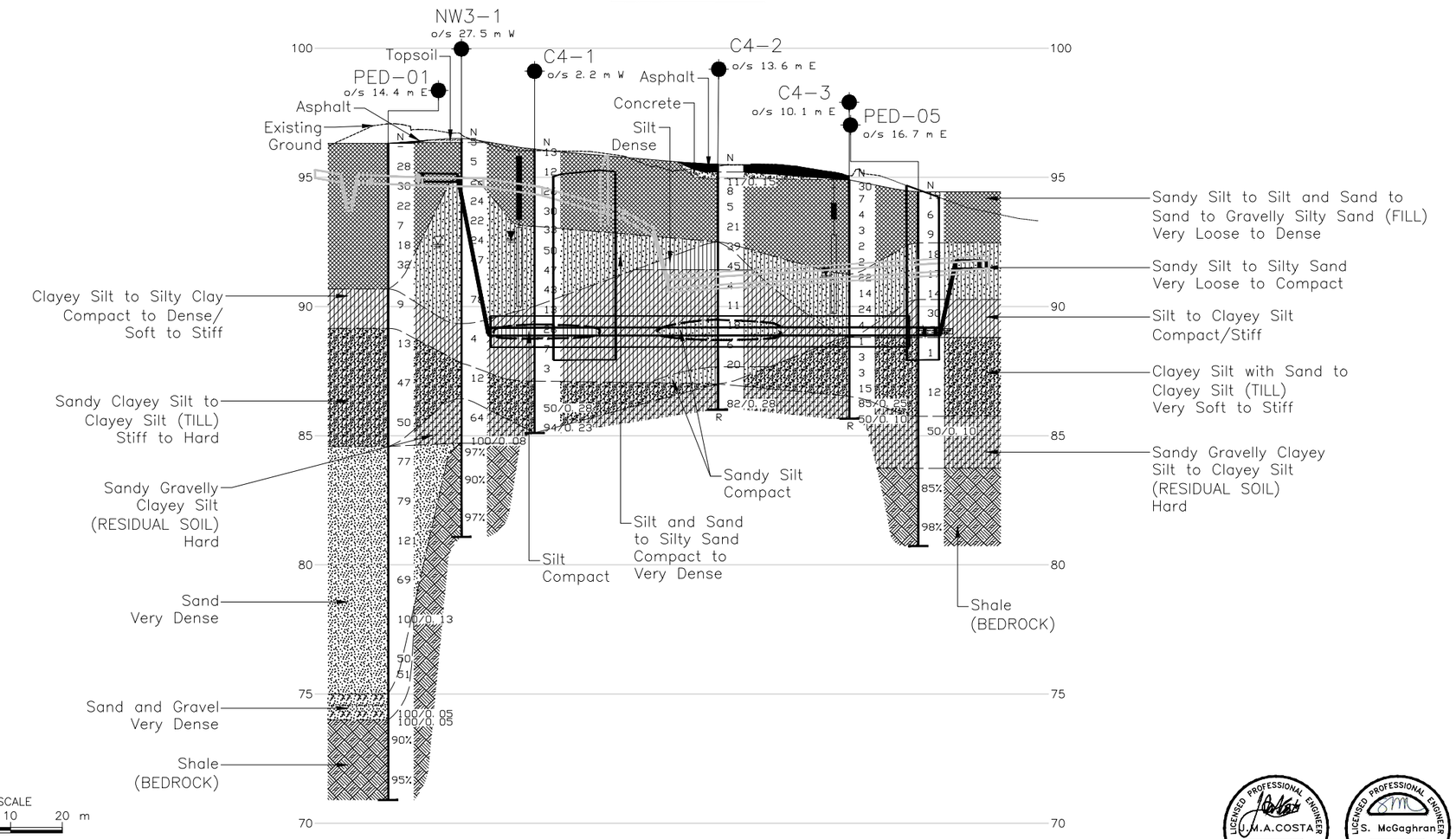
SCALE
10 0 10 20 m



VERTICAL SCALE
10 0 10 20 m

HORIZONTAL SCALE
10 0 10 20 m

A-A' PROFILE A-A' – WATERMAIN – STATION 17+035

METRIC

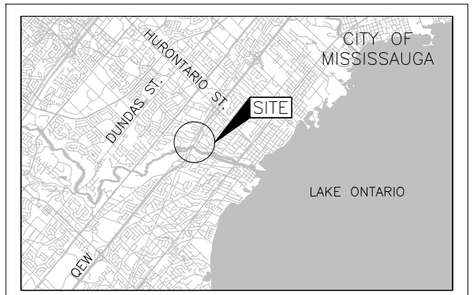
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2002-13-00

SHEET

QEW WIDENING – MISSISSAUGA RD TO HURONTARIO ST
WATERMAIN INSTALLATION STATION 17+035
BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R Refusal
- 100% Rock Quality Designation (RQD)
- WL in piezometer MAR 13 and 21, 2019
- WL upon completion of drilling

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
C4-1	96.1	4824290.3	295984.8
C4-2	95.5	4824285.8	296023.4
C4-3	94.9	4824269.8	296043.5
NW3-1	96.5	4824275.8	295959.8
PED-01	96.3	4824314.1	295977.3
PED-05	94.4	4824275.4	296047.1

NOTES

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

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

REFERENCE

Base plans provided in digital format by MH, drawing file nos. X11609340Base.dwg, X-Final Merged Util.dwg, X-PROP-UTIL.dwg, Existing Property.dwg, 11609340 – QEW Prop Util-Dickson & Lynchmere – C3D 2017.dwg, 11609340 – QEW Prop Util-IndianGroveAve – C3D 2017.dwg, 1160934O – QEW Prop Util-Stavebank Rd – C3D 2017.dwg, 1160934O – QEW Prop Util-Knareswood Dr – C3D 2017.dwg, and x1160934_Align.dwg, received March 25, 2019.

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA Jul. 30, 2019 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER S. McGaghran Jul. 30, 2019 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 30M12-450

HWY. QEW		PROJECT NO. 1662333	DIST. CENTRAL
SUBM'D. AB/EJ	CHKD. DM	DATE: 7/30/2019	SITE: .
DRAWN: DD	CHKD. SMM	APPD. JMAC	DWG. 1

PLOT DATE: July 29, 2019
FILENAME: S:\Clients\MTO\QEW-Credit_River\99_PRO\1662333_MH_PAR\VO_PROD\0023_MM_Relocation_Crossing_A\1662333-0023-BG-0001.dwg

APPENDIX A

Record of Borehole and Drillhole Sheets and Bedrock Core Photographs

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
FoS	factor of safety

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

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

(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 δ
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

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

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

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)
A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

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

(b) Cohesive Soils

Consistency

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

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

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

WEATHERINGS STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

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

FIELD ESTIMATION OF ROCK HARDNESS

Grade	Description	Field Identification	Approx. Range of UCS (MPa)
R0	Extremely Weak Rock	Indented by thumbnail	0.25 - 1
R1	Very Weak Rock	Material can be peeled or shaped with a knife. Crumbles under firm blows from geological hammer.	1 - 5
R2	Weak Rock	Knife cuts material but too hard to shape into triaxial specimens or material can be peeled with a knife with difficulty. Shallow (<5mm) indentations made by firm blows from pick of a geological hammer.	5 - 25
R3	Moderately Strong Rock	Cannot be peeled or scraped with a knife. Hand held specimens can be fractured with single firm blow of geological hammer.	25 - 50
R4	Strong Rock	Hand held specimen requires more than one blow of geological hammer to fracture.	50 - 100
R5	Very Strong Rock	Hand held specimen requires many blows of geological hammer to fracture.	100 - 250
R6	Extremely Strong Rock	Specimen can only be chipped under repeated hammer blows, rings when hit.	> 250

Notes:

1. Hand held specimens should have height approximately 2 times the diameter.
2. Materials having a uniaxial compressive strength of less than approximately 0.5 MPa and cohesionless materials should be classified using soil classification systems.
3. Rocks with a uniaxial compressive strength below 25 MPa (i.e. below R2) are likely to yield highly ambiguous results under point load testing.

Reference:

Brown, 1981. "Suggested Methods for Rock Characterization Testing and Monitoring", International Society for Rock Mechanics.

Hoek, E., Kaiser, P.K., Bawden, W.F., 1995. "Support of Underground Excavations in Hard Rock", Balkema, Rotterdam.

ROCK WEATHERING CLASSIFICATION

Term	Symbol	Description	Discoloration Extent	Fracture Condition	Surface Characteristics
Residual soil	W6	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	Throughout	N/A	Resembles soil
Completely weathered	W5	100% of rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	Throughout	Filled with alteration minerals	Resembles soil
Highly weathered	W4	More than 50% of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.	Throughout	Filled with alteration minerals	Friable and possibly pitted
Moderately weathered	W3	Less than 50% of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones. Visible texture of the host rock still preserved. Surface planes are weathered (oxidized or carbonate filling) even when breaking the “intact rock”.	>20% of fracture spacing on both sides of fracture	Discoloured, may contain thick filling	Partial to complete discoloration, not friable except poorly cemented rocks
Slightly weathered	W2	Discoloration indicates weathering of rock material on discontinuity surfaces (usually oxidized). Less than 5% of rock mass altered.	<20% of fracture spacing on both sides of fracture	Discoloured, may contain thin filling	Partial discoloration
Fresh	W1	No visible sign of rock material weathering.	None	Closed or discoloured	Unchanged

Reference:

Brown, 1981. "Suggested Methods for Rock Characterization Testing and Monitoring", International Society for Rock Mechanics.

GOLDER

RECORD OF BOREHOLE No C4-1

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824290.3; E 295984.8 MTM NAD ZONE 10 (LAT. 43.558498; LONG. -79.609115)

ORIGINATED BY EJ

DIST Central HWY QEW

BOREHOLE TYPE CME 55 83 mm I.D. Hollow Stem Augers

COMPILED BY KN

DATUM Geodetic

DATE February 22, 2019

CHECKED BY SEMP/SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
96.1	GROUND SURFACE						96				
0.0 / 95.7	Silty sand, trace rootlets (FILL) Compact Dark brown Wet		1A 1B	SS	13						
0.4	Sand, some silt, trace clay (FILL) Compact Brown to grey Moist		2	SS	12		95				
			3	SS	26				○		0 81 15 4
			4	SS	30		94				
93.1											
3.0	SILT and SAND, trace to some clay Dense Brown to grey Moist to wet		5	SS	33		93		○		
			6	SS	50		92		○		
			7	SS	47				○		
			8	SS	43		91		○		0 51 43 6
90.0											
6.1 / 89.3	CLAYEY SILT, trace to some sand, trace gravel Stiff Grey		9	SS	13		90		⊢○⊣		1 9 70 20
6.8 / 88.5	Moist SILT, trace to some clay, trace to some sand Compact Grey		10	SS	26		89		○		Non-plastic 0 10 81 9
7.6	Moist Sandy CLAYEY SILT, trace to some gravel Soft to firm Grey Moist		11	SS	7		88		○		
87.1			12	SS	3				⊢○⊣		5 25 40 30
9.0	CLAYEY SILT, some gravel, trace to some sand to sandy, some shale fragments, cobble fragments present (TILL) Hard Grey Dry to moist						87	>95			
			13	SS	50/0.28		86		○		
85.1			14A 14B	SS	94/0.23						
11.0	END OF BOREHOLE										

NOTES:

1. Water level measured within augers at 9.4 m depth below ground surface (Elev. 86.7 m) upon completion of drilling.

2.Borehole caved to 6.1 m depth below ground surface upon removal of Hollow Stem Augers.

3. Water level was measured at 4.7 m depth below ground surface (Elev. 91.4 m) after piezometer installation.

4. Water level measured in piezometer at 3.5 m depth below ground surface (Elev. 92.6 m) on March 13, 2019.

$+^3, \times^3$: Numbers refer to Sensitivity

$\bigcirc^{3\%}$ STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No C4-2

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824285.8; E 296023.4 MTM NAD ZONE 10 (LAT. 43.558457; LONG. -79.608637)

ORIGINATED BY AB

DIST Central HWY QEW

BOREHOLE TYPE CME 75 108 mm I.D. Hollow Stem Augers

COMPILED BY KN

DATUM Geodetic

DATE February 25, 2019

CHECKED BY AC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
95.5	GROUND SURFACE										
0.0 / 95.2	ASPHALT (300 mm)										
	CONCRETE (250 mm)										
0.6	Sand, some silt, trace clay (FILL) Loose to compact Brown Moist		1	SS	11/0.15		95				
			2	SS	8						
			3	SS	5		94		○		0 81 14 5
			4	SS	21		93		○		
92.5											
3.0	SILT, trace to some sand, trace to some clay, trace gravel Dense Grey-brown Moist		5	SS	39		92		○		
			6	SS	45				○		1 12 80 7
90.9							91				
4.6	CLAYEY SILT, some sand to sandy Firm to stiff Grey Wet		7	SS	4				⊖		0 22 49 29
			8	SS	11		90		⊖		1 17 62 20
89.5											
6.0	Sandy SILT, some clay, trace gravel Compact Grey Moist		9	SS	18		89		○	Non-plastic	2 21 63 14
88.7											
6.8	Sandy CLAYEY SILT Firm Grey Moist		10	SS	6				○⊖		
87.7							88				
7.8	Sandy SILT, trace gravel Compact Grey Moist		11A 11B	SS	20				○ ○		
87.0							87				
8.5	CLAYEY SILT, some gravel, trace to some sand (RESIDUAL SOIL) Hard Grey Dry		12	SS	82/0.28						
86.0							86				
9.5	- Auger grinding at 8.5 m - Auger grinding from 9.4 m to 9.5 m END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No C4-3

SHEET 1 OF 1 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
DIST Central HWY QEW
DATUM Geodetic

LOCATION N 4824269.8; E 296043.5 MTM NAD ZONE 10 (LAT. 43.558313; LONG. -79.608388)
BOREHOLE TYPE CME 55, 83 mm I.D. Hollow Stem Augers
DATE February 27, 2019

ORIGINATED BY EJ
COMPILED BY SE
CHECKED BY SEMP/SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.9	GROUND SURFACE								
0.0	Sandy silt, trace organics (FILL) Compact Brown Wet		1A 1B	SS	30				
94.5									
0.4	Silty sand, trace clay, trace organics (FILL) Very loose to loose Brown Moist to wet		2	SS	7		94		
			3	SS	4				
			4	SS	3		93		
			5	SS	2		92		
			6	SS	2				
91.2									
3.7	Silty SAND, trace clay Compact Brown Wet		7	SS	22		91		
			8	SS	14			Non-plastic	0 67 28 5
89.9			9A 9B	SS	24		90	Non-plastic	0 23 71 6
5.0	Sandy SILT, trace to some clay Very loose to compact Brown Wet		10A 10B	SS	4		89		
88.8									
6.1	CLAYEY SILT, some sand, trace to some gravel (TILL) Very soft to stiff Grey Wet		11	SS	1				1 12 46 41
			12	SS	3		88		
			13	SS	3				12 19 47 22
			14A 14B	SS	15		87		
86.5									
8.4	Sandy CLAYEY SILT, some shale fragments (RESIDUAL SOIL) Hard Grey Moist		15	SS	85/0.25		86		
85.7			16	SS	50/0.10				
9.2	END OF BOREHOLE SPLIT-SPOON REFUSAL								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

NOTES:

1. Water level measured inside augers at 2.7 m depth below ground surface (Elev. 92.2 m) upon completion of drilling.

2. Borehole caved to 6.1 m depth below ground surface upon removal of Hollow Stem Augers.

3. Water level measured at 3.4 m depth below ground surface (Elev. 91.5 m) immediately after piezometer installation.

4. Water level measured in piezometer at 2.8 m depth below ground surface (Elev. 92.1 m) on March 13, 2019.

5. Water level measured in piezometer at 3.7 m depth below ground surface (Elev. 91.2 m) on March 21, 2019.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No NW3-1 SHEET 1 OF 2 METRIC

PROJECT 1662333
G.W.P. 2002-13-00
DIST Central HWY QEW
DATUM Geodetic

LOCATION N 4824275.8; E 295959.8 MTM NAD 83 ZONE 10 (LAT. 43.558358; LONG. -79.609422)
BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers
DATE October 16-17, 2017

ORIGINATED BY JL
COMPILED BY MPL
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
96.5	GROUND SURFACE										
0.0	TOPSOIL (150mm)										
0.2	Silty sand, trace clay (FILL) Loose Brown Moist		1	SS	5		96				
			2	SS	5				○		0 74 23 3
95.0							95				
1.5	SILT and SAND to Silty SAND, trace clay, trace gravel Compact to very dense Brown Moist to wet		3	SS	22						
	- Silt pocket at a depth of about 2.6 m		4	SS	24		94		○		0 68 30 2
			5	SS	22				○		
	- Becoming wet at a depth of about 3.7 m		6	SS	24	▽	93		○		
			7	SS	47		92				
							91				
	- Becoming grey at a depth of about 6.3 m		8	SS	78		90		○		5 32 61 2
89.3											
7.2	SILTY CLAY, trace to some sand, trace gravel Soft Grey Wet		9	SS	4		89		○—○		
87.8							88				
8.7	Sandy CLAYEY SILT, trace to some gravel (TILL) Stiff Grey Moist to wet		10	SS	12		87		○		10 29 45 16
86.4							86				
10.1	Sandy gravelly CLAYEY SILT, some shale fragments (RESIDUAL SOIL) Hard Grey Moist to wet - Tricone grinding at a depth of about 10.1 m		11	SS	64				○		
84.7	- Tricone grinding at a depth of about 11.6 m		12	SS	100/0.08		85				
11.8	Shale (BEDROCK) Grey Slightly weathered to fresh		1	RC	REC 100%						RQD = 97%
	Bedrock cored from a depth of 11.8 m to 15.4 m		2	RC	REC 96%		84				RQD = 90%
	For bedrock coring details, refer to Record of Drillhole NW3-01		3	RC	REC 97%		83				RQD = 97%
							82				

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No NW3-1

SHEET 2 OF 2 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4824275.8; E 295959.8 MTM NAD 83 ZONE 10 (LAT. 43.558358; LONG. -79.609422)
ORIGINATED BY JL
DIST Central HWY QEW
BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers
COMPILED BY MPL
DATUM Geodetic
DATE October 16-17, 2017
CHECKED BY SMM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- *CONTINUED FROM PREVIOUS PAGE* ---										
81.1			3	RC	REC 97%						RQD = 97%
15.4	END OF BOREHOLE										

NOTES:

1. Water level measured at a depth of about 4.5 m below ground surface (Elev. 92.0 m) prior to start of rock coring.

2. Water level measured at top of casing (Elev. 96.9 m) following completion of bedrock coring.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

PROJECT: 1662333

RECORD OF DRILLHOLE: NW3-1

SHEET 1 OF 1

LOCATION: N 4824275.8 ;E 295959.8

DRILLING DATE: October 16-17, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850 Track

DRILLING CONTRACTOR: Aardvark Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	ROCK STRENGTH INDEX R4	ROCK STRENGTH INDEX R3	ROCK STRENGTH INDEX R2	ROCK STRENGTH INDEX R1	WEATHERING INDEX W1	WEATHERING INDEX W2	WEATHERING INDEX W3	WEATHERING INDEX W4	WEATHERING INDEX W5	WEATHERING INDEX W6	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole NW3-1		84.70																							
12	HQ Core	Slightly weathered to fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly to slightly porous, weak SHALE (Georgian Bay Formation) with slightly weathered to fresh, thinly bedded, grey, non-porous, medium LIMESTONE interbeds.		11.80	1							BD,PL,SM Sa	1	2													
												BD,PL,RO Cl	1.5	1													
												BD,UN,SM Sa	2	2													
												CO,UN,SM CC, Cl	2	4												R1	
												CO,UN,SM Cl	2	1													PLT(A) = 0.6 MPa PLT(D) = 0.2 MPa
13					2							BD,IR,SM IN, Ga	2	6												R1	
												CO,PL,SM Sa	1	2												R1	
												CO,UN,RO Sa	3	2													
												BD,PL,SM Sa	1	2													
												BD,PL,SM Cl	1	1													PLT(A) = 0.4 MPa PLT(D) = 0.4 MPa
												BD,PL,SM Cl	1	1													
												BD,PL,SM Cl	1	1													
14	HQ Core				3							BD,PL,SM Cl	1	1													
												BD,PL,SM Cl	1	1													
												BD,PL,SM Cl	1	1													PLT(A) = 0.4 MPa PLT(D) = 0.4 MPa
												BD,PL,SM Cl	1	1													
15				81.08																							
		END OF DRILLHOLE		15.42																							
16																											
17																											
18																											
19																											
20																											

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: JC

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GOLDER

RECORD OF BOREHOLE No PED-01 SHEET 1 OF 2 METRIC

PROJECT 1662333
G.W.P. 2002-13-00
DIST Central HWY QEW
DATUM Geodetic
LOCATION N 4824314.1; E 295977.3 MTM NAD 83 ZONE 10 (LAT. 43.558703; LONG. -79.609205) ORIGINATED BY FC
BOREHOLE TYPE CME 55, 203 mm O.D. Hollow Stem Augers, HQ Casing COMPILED BY KN
DATE August 17-18, 2017 CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
96.3	GROUND SURFACE								
0.0	ASPHALT (150 mm)								
0.2	Gravelly silty sand, trace to some clay, trace rootlets, trace silty clay pockets (FILL) Compact to dense Brown Moist		1	AS	-		96		
			2	SS	28				
	- Asphalt fragments from a depth of about 1.7 m to 1.8 m		3	SS	30		95		21 52 21 6
			4A 4B 4C	SS	22		94		
93.6 2.7	- Clayey silt pocket/zone, trace asphalt at a depth of about 2.5 m to 2.7 m Silt and sand, trace clay (FILL) Loose to dense Brown Moist		5	SS	7		93		
	- Wet at a depth of about 3.4 m		6	SS	18				0 37 60 3
			7	SS	32		92		
90.7 5.6	CLAYEY SILT, trace sand, trace gravel Stiff Grey Moist to wet		8	SS	9		91		
89.1 7.2	CLAYEY SILT with SAND to some sand, trace to some gravel (TILL) Stiff to hard Grey Moist to wet		9	SS	13		90		
			10A 10B	SS	47		89		
			11	SS	50		88		11 32 42 15
84.6 11.7	SAND, trace to some silt, trace to some clay, trace to some gravel Very dense Grey Moist to wet		12	SS	77		87		
	- Clayey silt lens from a depth of about 14 m to 14.1 m		13	SS	79		86		3 75 15 7
							85		
							84		
							83		
							82		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30

Continued Next Page

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

GOLDER

PROJECT 1662333

RECORD OF BOREHOLE No PED-01

SHEET 2 OF 2

METRIC

G.W.P. 2002-13-00 LOCATION N 4824314.1; E 295977.3 MTM NAD 83 ZONE 10 (LAT. 43.558703; LONG. -79.609205) ORIGINATED BY FC

DIST Central HWY QEW BOREHOLE TYPE CME 55, 203 mm O.D. Hollow Stem Augers, HQ Casing COMPILED BY KN

DATUM Geodetic DATE August 17-18, 2017 CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND, trace to some silt, trace to some clay, trace to some gravel Very dense Grey Moist to wet		14	SS	121		81	○	○		14 73 10 3
			15A 15B	SS	69		80		○		
	- Gravelly at a depth of about 17.8 m		16	SS	100/0.13		79		○		
			17	SS	50		78				
			18	SS	51		77		○		10 81 7 2
75.0							76				
21.3	SAND and GRAVEL, some silt Very dense Grey Moist to wet		19	SS	100/0.05		75		○		
74.0			20	SS	100/0.05		74				
22.3	Shale (BEDROCK) Grey Bedrock cored from a depth of 22.3 m to 25.4 m For bedrock coring details, refer to Record of Drillhole PED-01		1	RC	REC 92%		73				RQD = 90%
			2	RC	REC 100%		72				RQD = 95%
70.9							71				
25.4	END OF BOREHOLE NOTE: 1. Borehole dry prior to rock coring.										

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT: 1662333

RECORD OF DRILLHOLE: PED-01

SHEET 1 OF 1

LOCATION: N 4824314.1 ;E 295977.3

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Aardvark Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole PED-01		73.99															
23	HQ Core	Slightly weathered, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with slightly weathered to fresh, grey, fine grained, strong to very strong LIMESTONE interbeds		22.32	1							BD,PL,SM Cl	1	1					
												BD,IR,RO Sa	3	2				R1	
												BD,UN,RO Cl	3	1					
												BD,UN,RO Sa	3	2					
												BD,PL,SM Sa	1	2					
24	NQ Rock Core											BD,UN,SM Cl	2	1					
					2							BD,IR,SM Sa	2	2					
25												BD,PL,SM Sa	1	2				R1	
				70.90															
		END OF DRILLHOLE		25.41															
26																			
27																			
28																			
29																			
30																			
31																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: FC
CHECKED: JC

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GOLDER

RECORD OF BOREHOLE No PED-05

SHEET 1 OF 1 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
DIST Central HWY QEW
DATUM Geodetic

LOCATION N 4824275.4; E 296047.1 MTM NAD 83 ZONE 10 (LAT. 43.558356; LONG. -79.608341)
BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing
DATE October 25-26, 2017

ORIGINATED BY JL
COMPILED BY MPL
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.4	GROUND SURFACE										
0.0 / 0.1	TOPSOIL (50mm)										
	Silty Sand, trace clay, trace organics (FILL) Loose to compact Brown Moist		1	SS	19		94				
			2	SS	6				○	OC = 1.2%	0 70 28 2
92.4			3A 3B	SS	9		93		○		
2.0	SILT and SAND, trace clay, trace gravel Compact Brown Moist to wet		4	SS	18		92		○		0 32 67 1
			5	SS	17		91		○		
90.2			6A 6B 6C	SS	14				○		
	CLAYEY SILT Grey Wet						90				
4.3	SILT, trace to some sand, trace clay Compact Grey Moist to wet		7	SS	30				○		0 9 87 4
88.8							89				
5.6	CLAYEY SILT with SAND, trace to some gravel (TILL) Very soft to stiff Grey Moist to wet		8	SS	1		88		○		
			9	SS	12		87		○ ⊢⊣		7 30 48 15
85.7							86				
8.7	Sandy gravelly CLAYEY SILT, some shale fragments (RESIDUAL SOIL) Hard Grey Moist to wet		10	SS	50/0.10		85		○ ⊢⊣		
83.7			1	SC	-		84				
10.7	Shale BEDROCK Grey Bedrock cored from a depth of 10.7 m to 13.7 m For bedrock coring details, refer to Record of Drillhole PED-05		2	RC	REC 100%		83				RQD = 85%
			3	RC	REC 98%		82				RQD = 98%
80.7							81				
13.7	END OF BOREHOLE NOTE: 1. Borehole dry prior to rock coring.										

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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PROJECT: 1662333

RECORD OF DRILLHOLE: PED-05

SHEET 1 OF 1

LOCATION: N 4824275.4 ;E 296047.1

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850 Track

DRILLING CONTRACTOR: Aardvark Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole PED-05		83.72															
11	HQ Casing	Slightly weathered to fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with slightly weathered to fresh, grey, fine grained, strong to very strong LIMESTONE interbeds		10.71	2							BD,UN,RO Cl BD,UN,RO Cl BD,UN,SM Cl BD,UN,SM Cl CO,PL,SM Cl BD,UN,SM Cl CO,UN,SM Cl	3 3 2 2 1 2 2	1 1 1 1 1 1 1	R4 R3 R2 R1	W1 W2 W3 W4 W5 W6			PLT(A) = 0.5 MPa PLT(D) = 0.5 MPa
12	HQ Core											CO,UN,SM Cl	2	1					PLT(A) = 0.8 MPa PLT(D) = 0.3 MPa
												CO,UN,SM Cl CO,UN,SM Cl	2 2	1 1					
13					3							CO,UN,SM Cl	2	1					PLT(A) = 0.7 MPa PLT(D) = 0.6 MPa
				80.72								CO,CU,SM Cl	2	1					
14		END OF DRILLHOLE NOTE: 1. Run No. 1 in overburden soils excluded.		13.71															
15																			
16																			
17																			
18																			
19																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

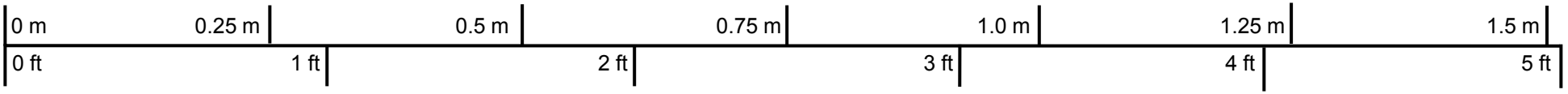
GOLDER

LOGGED: JL
CHECKED: MWK

GTA-RCK 054 S:\CLIENTS\MTO\QEW-CREDIT_RIVER\02_DATA\GINT\QEW-CREDIT_RIVER.GPJ GAL-MISS.GDT 07/29/19

Start of Run No. 1 (22.32 m)

Start of Run No. 2 (23.86 m)



Scale

PROJECT

MTO Assignment 2015-E-0033
Watermain Relocation Station 17+035
Mississauga Road and Hurontario Street

TITLE

Bedrock Core Photograph
Borehole PED-01 (22.32 m to 25.41 m)

GOLDER

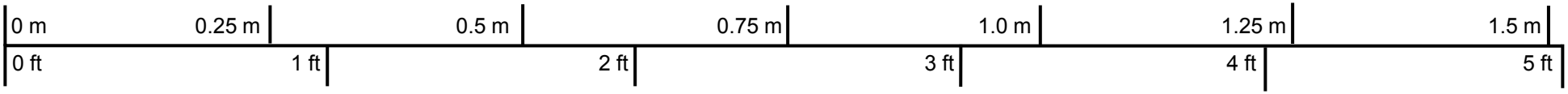
PROJECT No. 1662333			FILE No. ----		
DRAFT	SE	20190321	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE A-1**		
CHECK	SMM	20180329			
REVIEW	JMAC	20190402			

REVISION DATE: August 21, 2018 BY: SE Project: 1662333

Start of Run No. 1 (10.31 m)
(Residual Soil)

Start of Run No. 2 (10.71 m)

Start of Run No. 3 (12.24 m)



Scale

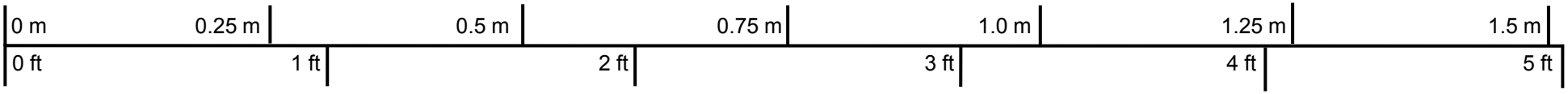
PROJECT	MTO Assignment 2015-E-0033 Watermain Relocation Station 17+035 Mississauga Road and Hurontario Street				
TITLE	Bedrock Core Photograph Borehole PED-05 (10.31 m to 13.71 m)				
GOLDER	PROJECT No. 1662333			FILE No. ----	
	DRAFT	SE	20190321	SCALE AS SHOWN	VER. 1.
	CADD	--		FIGURE A-2	
	CHECK	SMM	20180329		
	REVIEW	JMAC	20190402		

REVISION DATE: August 21, 2018 BY: SE Project: 1662333

Start of Run No. 2 (12.5 m)

Start of Run No. 1 (11.78 m)

Start of Run No. 3 (13.9 m)



Scale

PROJECT

MTO Assignment 2015-E-0033
Watermain Relocation Station 17+035
Mississauga Road and Hurontario Street

TITLE

Bedrock Core Photograph
Borehole NW3-1 (11.78 m to 15.42 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	SE	20190321	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE A-3**		
CHECK	SMM	20180329			
REVIEW	JMAC	20190402			

REVISION DATE: August 21, 2018 BY: SE Project: 1662333

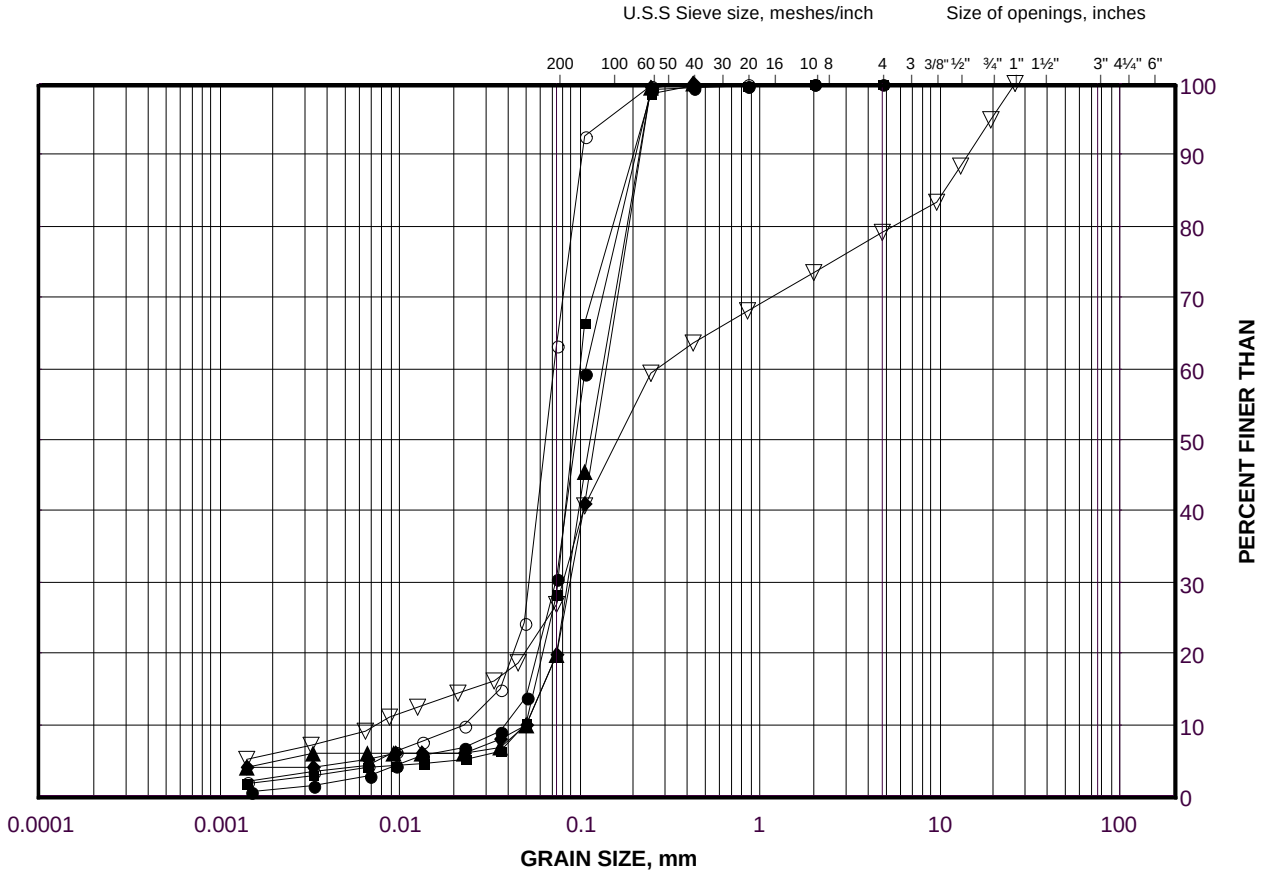
APPENDIX B

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand (Fill)

FIGURE B-1



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	PED-05	2	93.3
■	NW3-1	2	95.4
◆	C4-1	3	94.3
▲	C4-2	3	93.7
▽	PED-01	3	94.5
❍	PED-01	6	92.2

Project Number: 1662333

Checked By: SMM

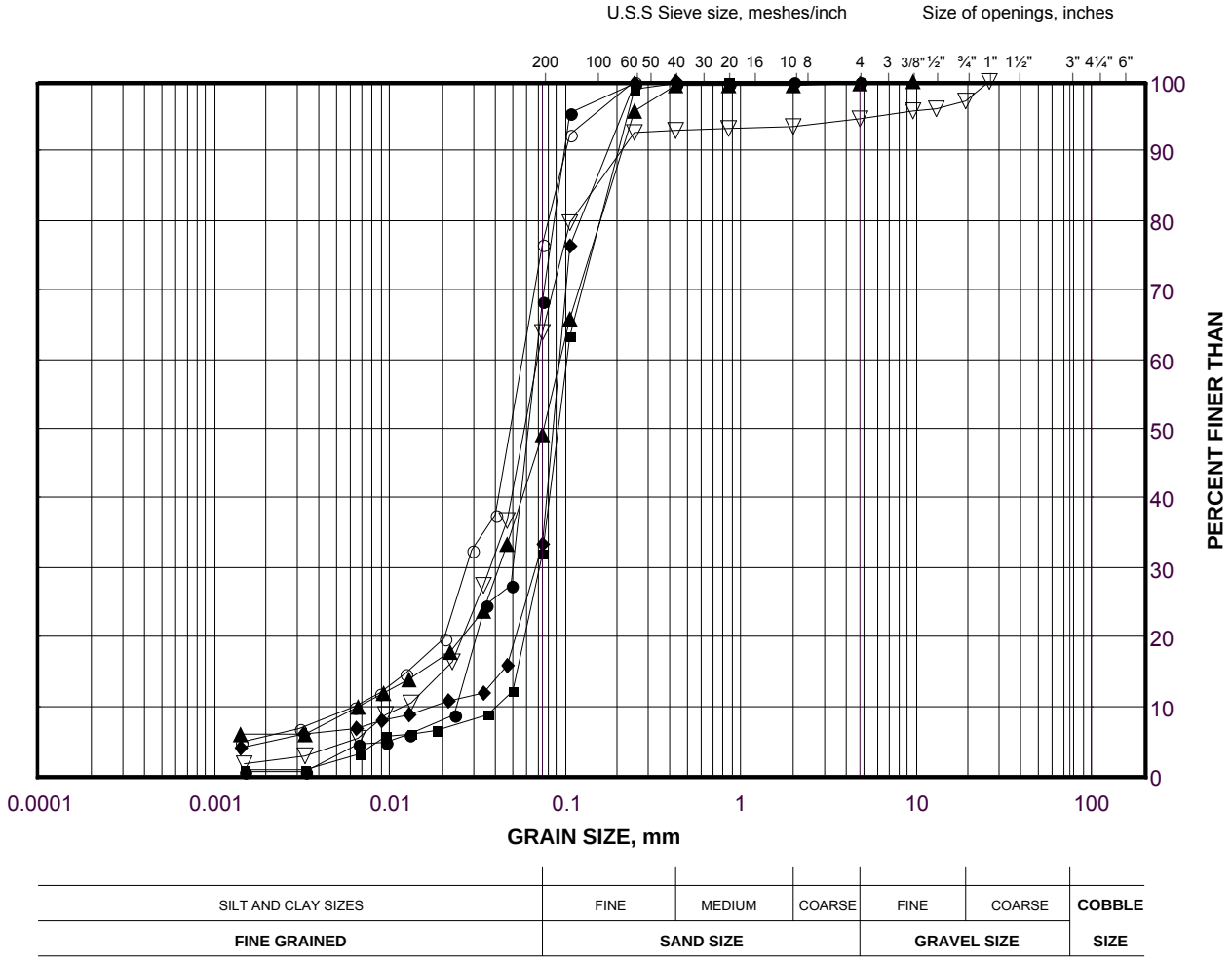
Golder Associates

Date: 04-Apr-19

GRAIN SIZE DISTRIBUTION

Sandy Silt to Silty Sand

FIGURE B-2



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	PED-05	4	91.8
■	NW3-1	4	93.9
◆	C4-3	8	90.3
▲	C4-1	8	90.5
▽	NW3-1	8	90.1
❍	C4-3	9B	89.6

Project Number: 1662333

Checked By: SMM

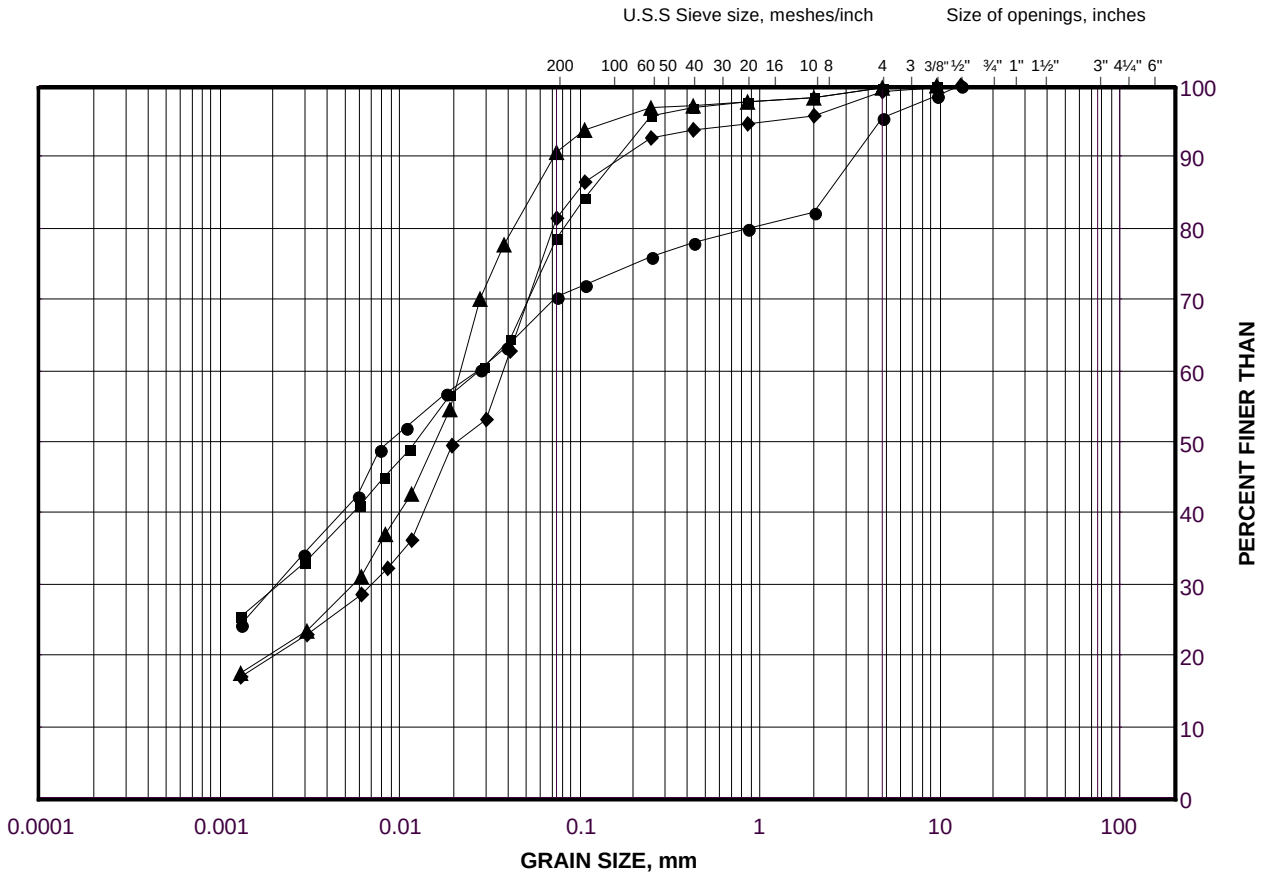
Golder Associates

Date: 04-Apr-19

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt

FIGURE B-3



LEGEND

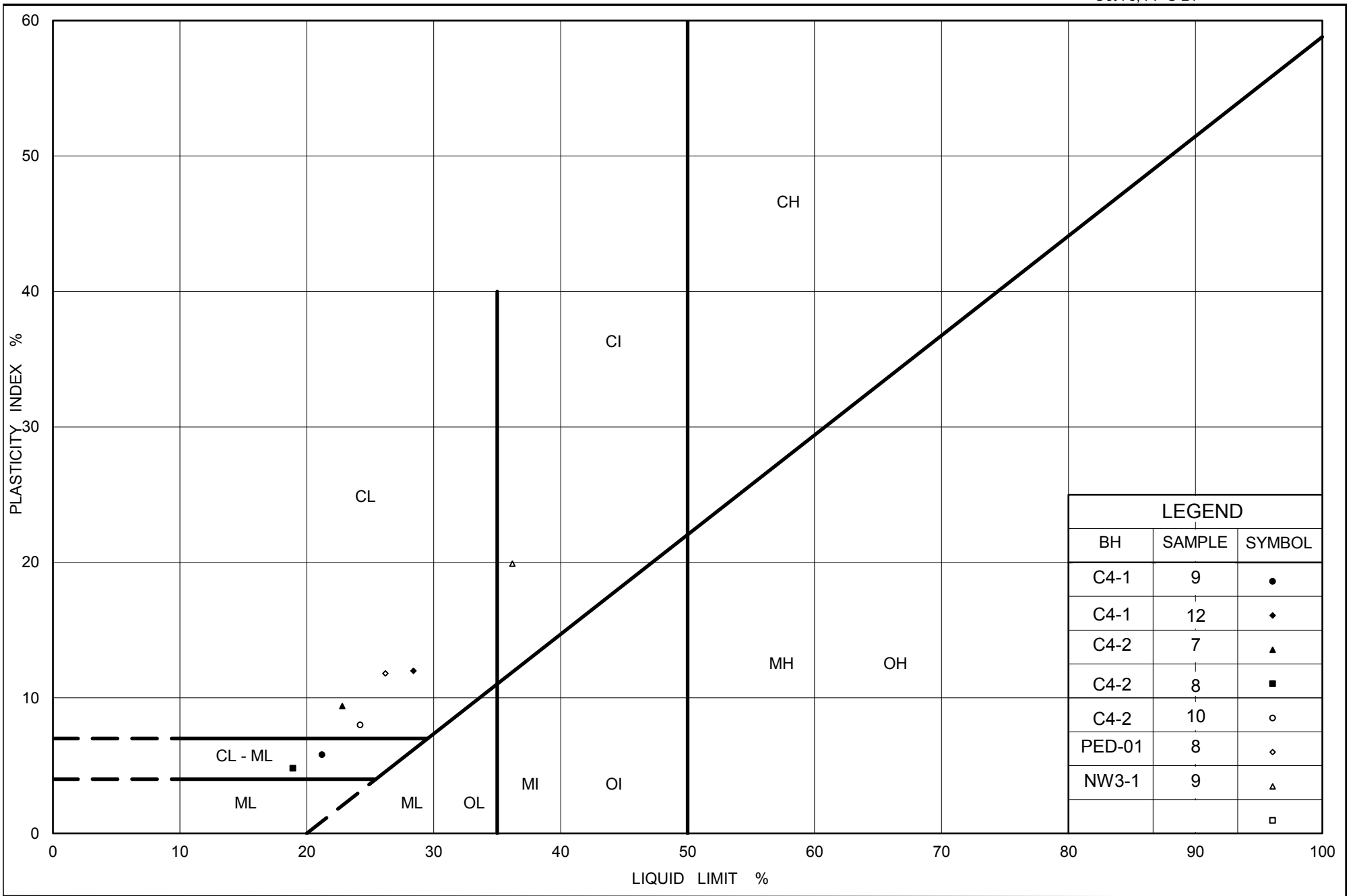
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	C4-1	12	87.4
■	C4-2	7	90.7
◆	C4-2	8	89.9
▲	C4-1	9	89.7

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 28-Mar-19



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay

Figure No. B-4

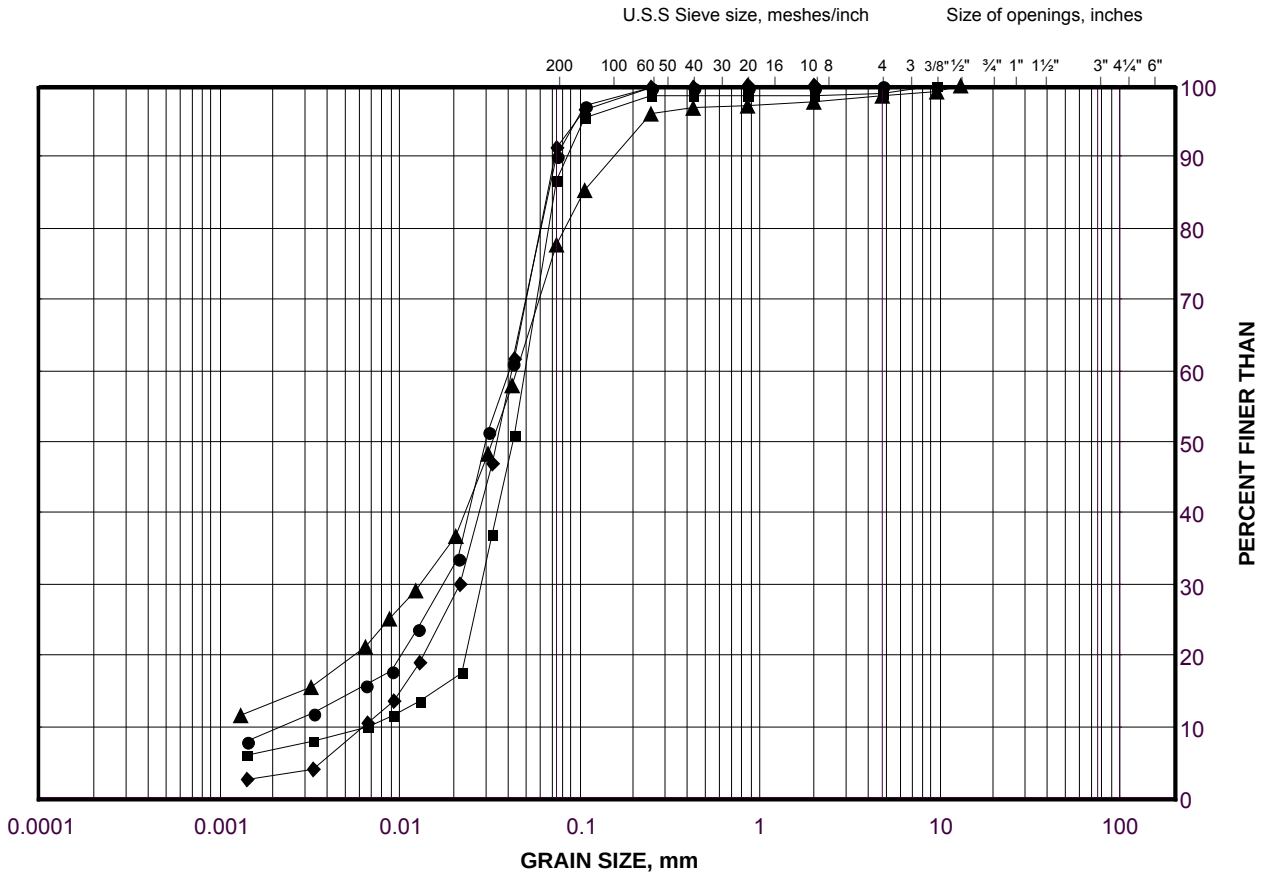
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Silt to Sandy Silt

FIGURE B-5



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	C4-1	10	88.9
■	C4-2	6	91.4
◆	PED-05	7	89.5
▲	C4-2	9	89.1

Project Number: 1662333

Checked By: SMM

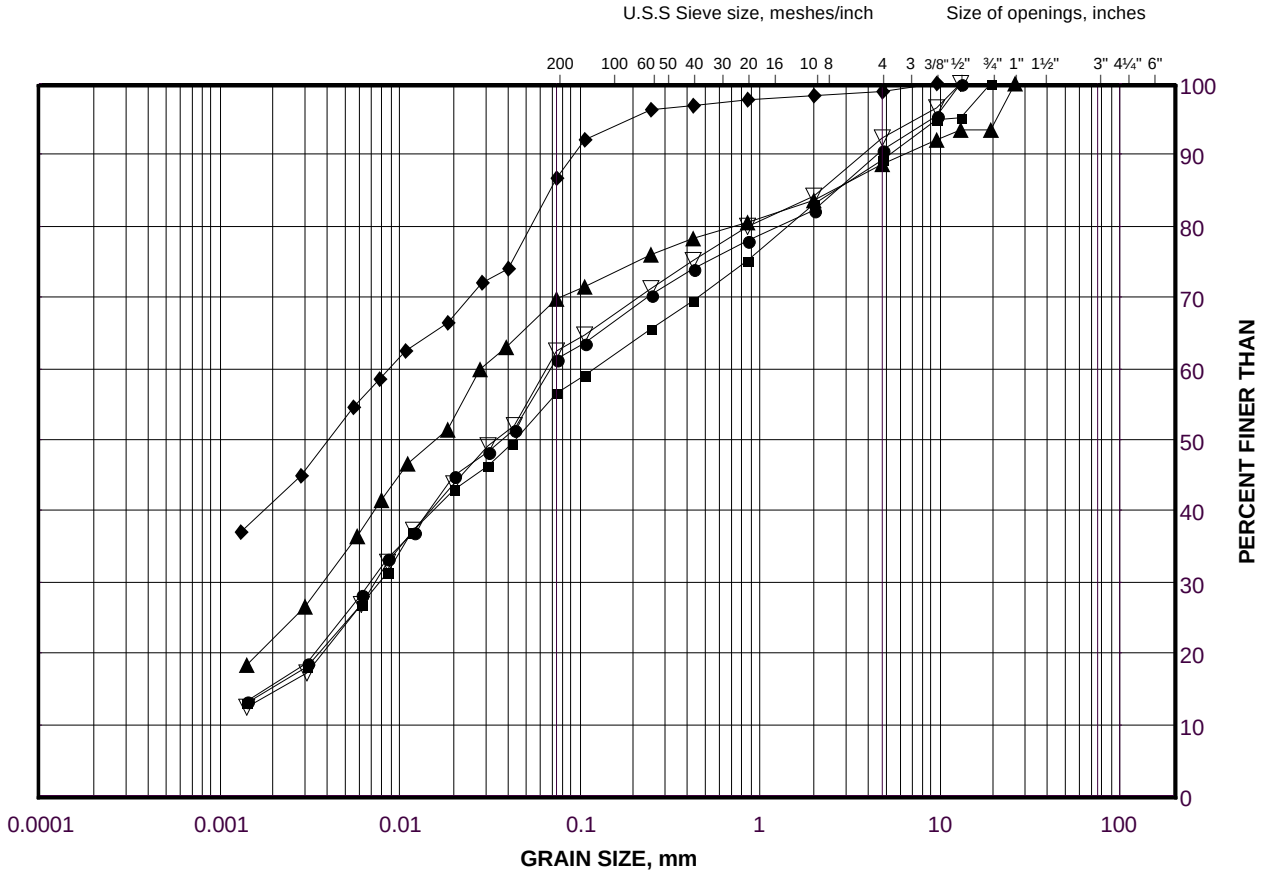
Golder Associates

Date: 04-Apr-19

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand to Clayey Silt (Till)

FIGURE B-6



LEGEND

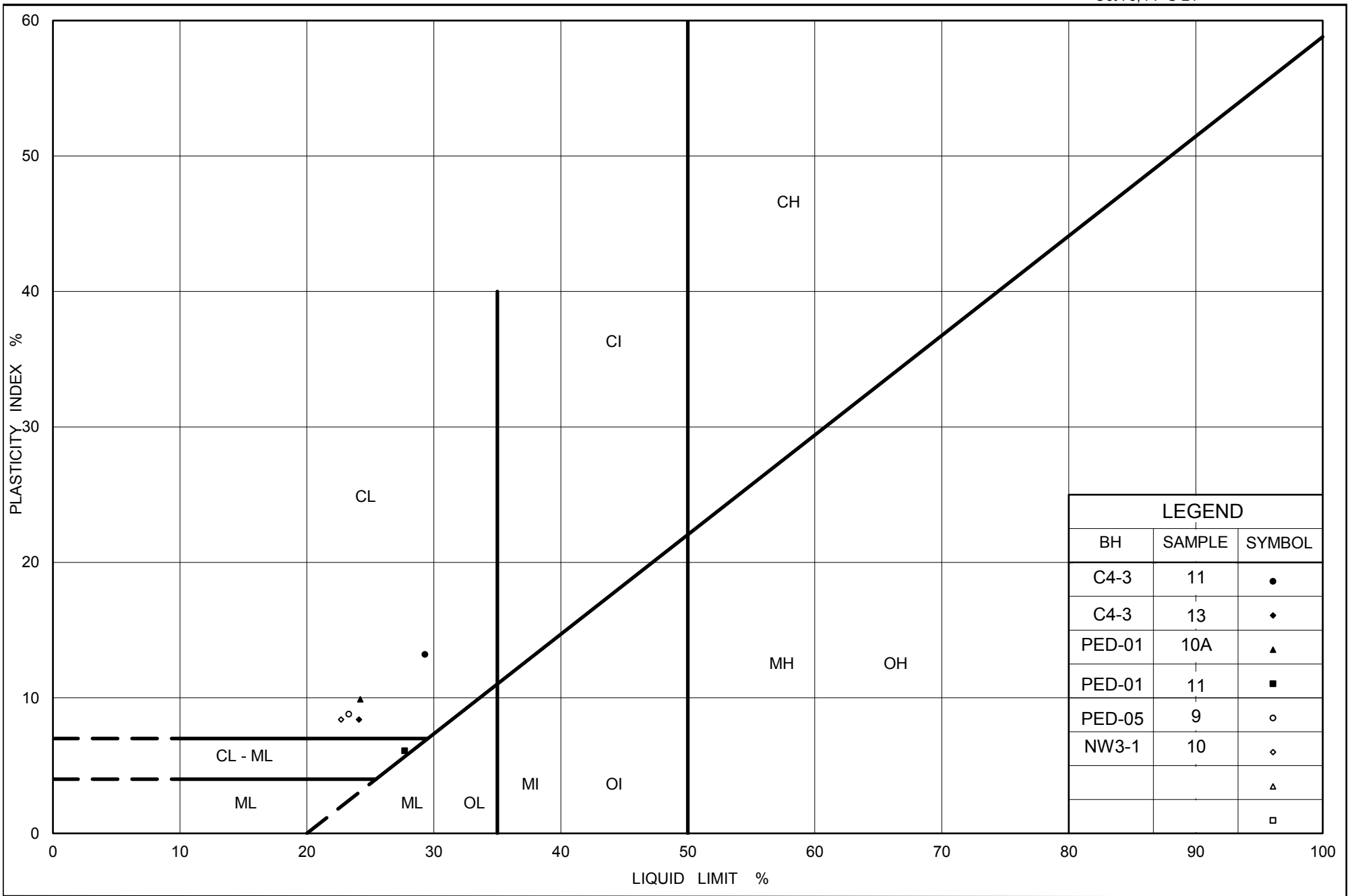
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-1	10	87.0
■	PED-01	10A	86.9
◆	C4-3	11	88.5
▲	C4-3	13	87.3
▽	PED-05	9	86.5

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 28-Mar-19



Ministry of Transportation

Ontario

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

Figure No. B-7

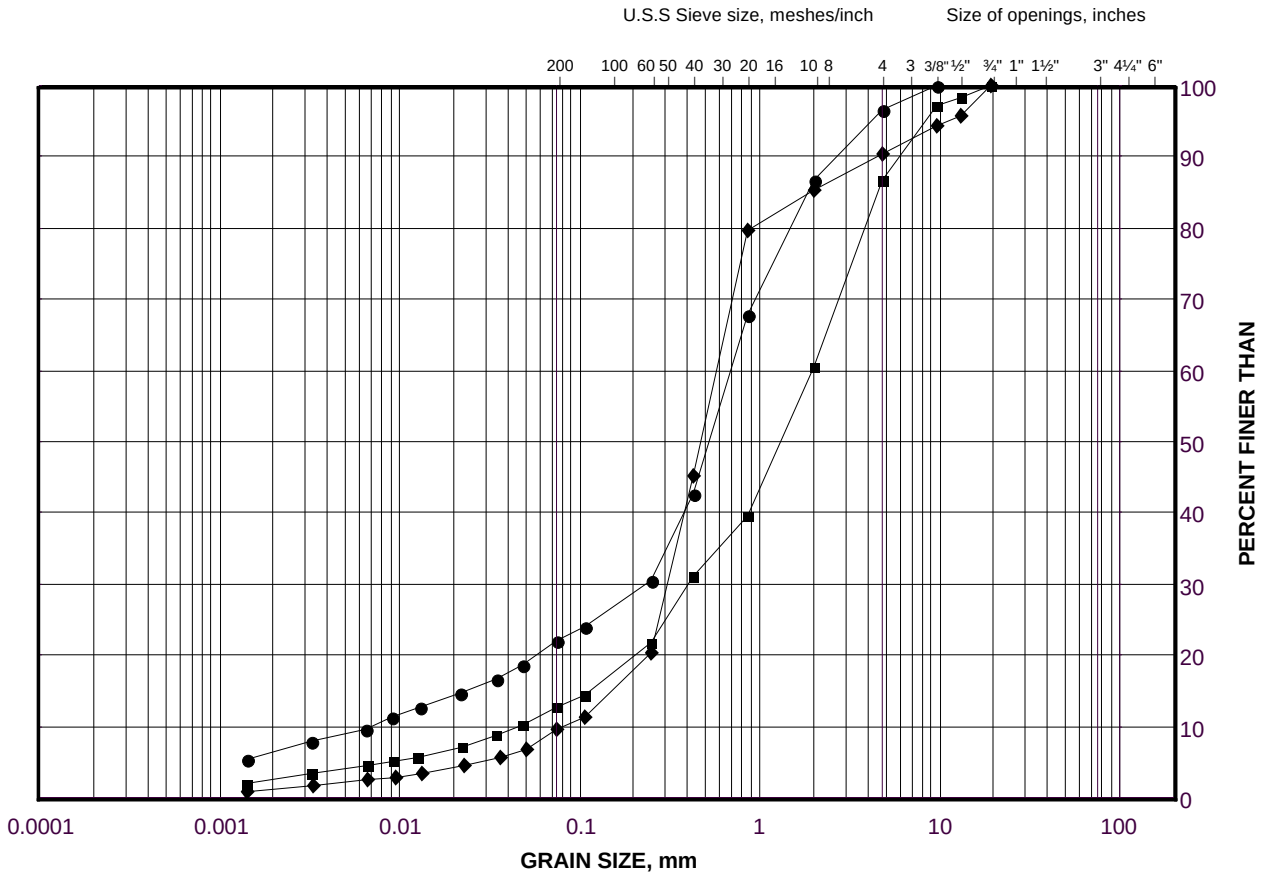
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sand

FIGURE B-8



LEGEND

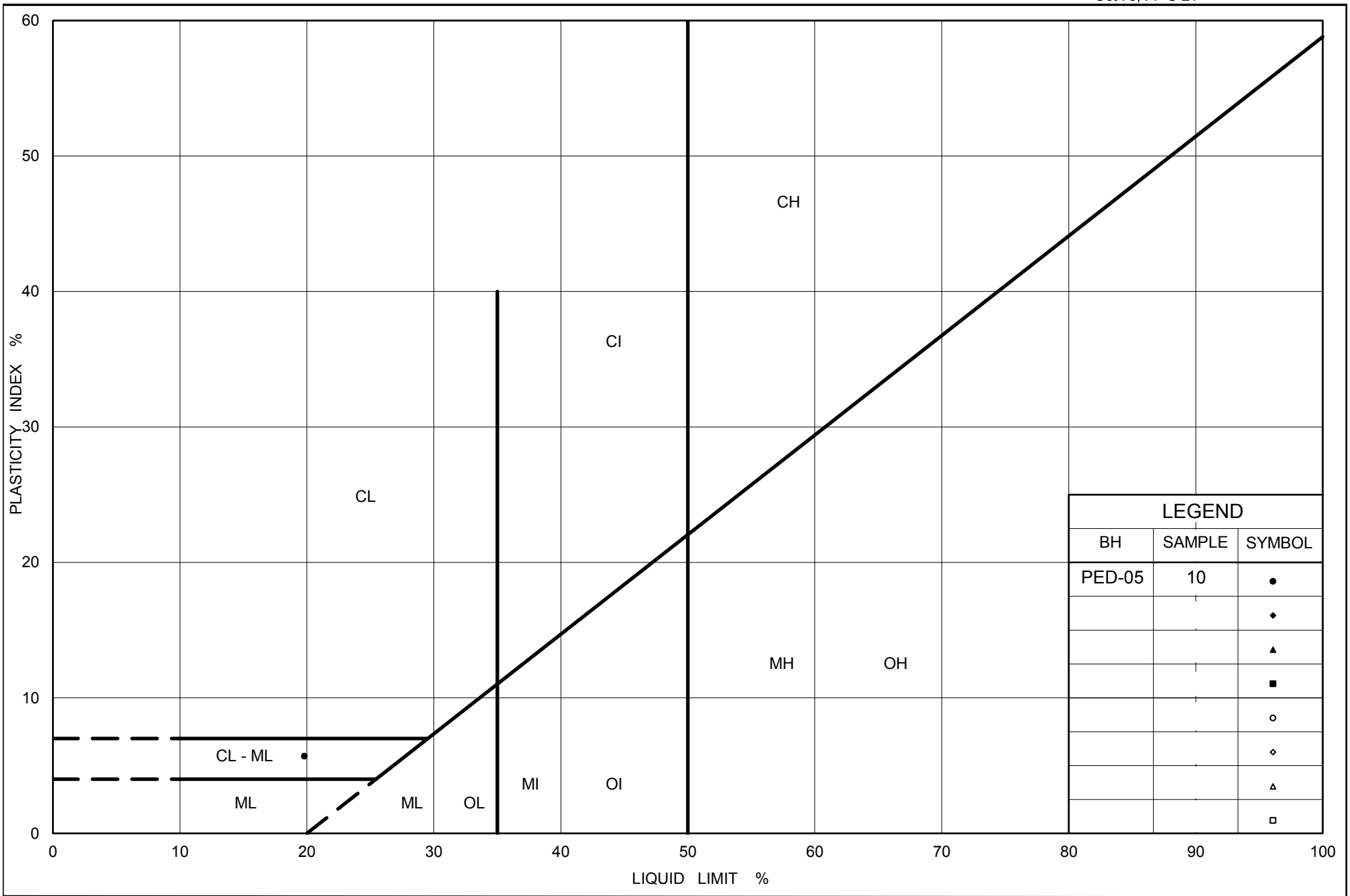
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	PED-01	12	83.8
■	PED-01	14	80.8
◆	PED-01	17	76.2

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 28-Mar-19



Ministry of Transportation

Ontario

PLASTICITY CHART
Sandy Gravelly Clayey Silt (Residual Soil)

Figure No. B-9

Project No. 1662333

Checked By: SMM

APPENDIX C

Analytical Laboratory Test Results

Maxxam
A Bureau Veritas Group Company

Your Project #: 1662333
Your C.O.C. #: 709061-01-01

Attention: David Marmor

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

Report Date: 2019/03/26
Report #: R5644475
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B974455
Received: 2019/03/21, 16:07

Sample Matrix: Rock
Samples Received: 10

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	10	2019/03/25	2019/03/26	CAM SOP-00463	EPA 325.2 m
Conductivity	10	2019/03/25	2019/03/25	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	10	2019/03/25	2019/03/25	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	10	2019/03/22	2019/03/26	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	10	2019/03/25	2019/03/26	CAM SOP-00464	EPA 375.4 m

Remarks:

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

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. 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.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: 1662333
Your C.O.C. #: 709061-01-01

Attention: David Marmor

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

Report Date: 2019/03/26
Report #: R5644475
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B974455
Received: 2019/03/21, 16:07

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829
==========
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B974455
Report Date: 2019/03/26

Golder Associates Ltd
Client Project #: 1662333
Sampler Initials: JP

RESULTS OF ANALYSES OF ROCK

Maxxam ID		JGK384	JGK385	JGK386	JGK387	JGK388	JGK389		
Sampling Date		2019/03/21 01:30	2019/03/21 01:30	2019/03/21 01:30	2019/03/21 01:30	2019/03/21 01:30	2019/03/21 01:30		
COC Number		709061-01-01	709061-01-01	709061-01-01	709061-01-01	709061-01-01	709061-01-01		
	UNITS	1662333 C1-2	1662333 C1-1	1662333 C2-2	1662333 C2-3	1662333 C3-3	1662333 C3-1	RDL	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	2100	1700	2500	2600	3800	3700		6032288
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	32	37	<20	71	<20	<20	20	6035188
Conductivity	umho/cm	469	583	407	391	266	274	2	6035037
Available (CaCl2) pH	pH	8.19	8.02	8.08	8.14	8.19	8.19		6035215
Soluble (20:1) Sulphate (SO4)	ug/g	160	350	190	72	51	35	20	6035189

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		JGK390	JGK391	JGK392	JGK393		
Sampling Date		2019/03/20 04:30	2019/03/20 04:30	2019/03/20 04:30	2019/03/20 04:30		
COC Number		709061-01-01	709061-01-01	709061-01-01	709061-01-01		
	UNITS	1662333 C4-2	1662333 C4-3	1662333 C5-2	1662333 C5-1	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm	1500	1000	1700	3100		6032288
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	250	410	240	<20	20	6035188
Conductivity	umho/cm	670	991	578	323	2	6035037
Available (CaCl2) pH	pH	7.77	7.77	7.85	7.78		6035215
Soluble (20:1) Sulphate (SO4)	ug/g	130	190	130	220	20	6035189

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B974455
Report Date: 2019/03/26

Golder Associates Ltd
Client Project #: 1662333
Sampler Initials: JP

TEST SUMMARY

Maxxam ID: JGK384 **Collected:** 2019/03/21
Sample ID: 1662333 C1-2 **Shipped:**
Matrix: Rock **Received:** 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

Maxxam ID: JGK385 **Collected:** 2019/03/21
Sample ID: 1662333 C1-1 **Shipped:**
Matrix: Rock **Received:** 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

Maxxam ID: JGK386 **Collected:** 2019/03/21
Sample ID: 1662333 C2-2 **Shipped:**
Matrix: Rock **Received:** 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

Maxxam ID: JGK387 **Collected:** 2019/03/21
Sample ID: 1662333 C2-3 **Shipped:**
Matrix: Rock **Received:** 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

Maxxam ID: JGK388 **Collected:** 2019/03/21
Sample ID: 1662333 C3-3 **Shipped:**
Matrix: Rock **Received:** 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas

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Maxxam Job #: B974455
Report Date: 2019/03/26

Golder Associates Ltd
Client Project #: 1662333
Sampler Initials: JP

TEST SUMMARY

Maxxam ID: JGK388
Sample ID: 1662333 C3-3
Matrix: Rock

Collected: 2019/03/21
Shipped:
Received: 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

Maxxam ID: JGK389
Sample ID: 1662333 C3-1
Matrix: Rock

Collected: 2019/03/21
Shipped:
Received: 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

Maxxam ID: JGK390
Sample ID: 1662333 C4-2
Matrix: Rock

Collected: 2019/03/20
Shipped:
Received: 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

Maxxam ID: JGK391
Sample ID: 1662333 C4-3
Matrix: Rock

Collected: 2019/03/20
Shipped:
Received: 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

Maxxam ID: JGK392
Sample ID: 1662333 C5-2
Matrix: Rock

Collected: 2019/03/20
Shipped:
Received: 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

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Maxxam Job #: B974455
Report Date: 2019/03/26

Golder Associates Ltd
Client Project #: 1662333
Sampler Initials: JP

TEST SUMMARY

Maxxam ID: JGK393
Sample ID: 1662333 C5-1
Matrix: Rock

Collected: 2019/03/20
Shipped:
Received: 2019/03/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6035188	2019/03/25	2019/03/26	Deonarine Ramnarine
Conductivity	AT	6035037	2019/03/25	2019/03/25	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6035215	2019/03/25	2019/03/25	Gnana Thomas
Resistivity of Soil		6032288	2019/03/26	2019/03/26	Anastassia Hamanov
Sulphate (20:1 Extract)	KONE/EC	6035189	2019/03/25	2019/03/26	Alina Dobreanu

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Maxxam Job #: B974455
Report Date: 2019/03/26

Golder Associates Ltd
Client Project #: 1662333
Sampler Initials: JP

GENERAL COMMENTS

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

Package 1	-2.0°C

Results relate only to the items tested.

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Maxxam Job #: B974455
Report Date: 2019/03/26

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1662333
Sampler Initials: JP

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
6035037	Conductivity	2019/03/25			102	90 - 110	<2	umho/cm	0.40	10
6035188	Soluble (20:1) Chloride (Cl-)	2019/03/26	108	70 - 130	103	70 - 130	<20	ug/g	NC	35
6035189	Soluble (20:1) Sulphate (SO4)	2019/03/26	115	70 - 130	109	70 - 130	<20	ug/g	3.8	35
6035215	Available (CaCl2) pH	2019/03/25			100	97 - 103			0.39	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).

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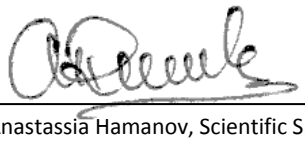
Maxxam Job #: B974455
Report Date: 2019/03/26

Golder Associates Ltd
Client Project #: 1662333
Sampler Initials: JP

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

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CHAIN OF CUSTODY RECORD

Page of

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:	David Marmor	P.O. #:			709061
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	1662333	COC #:	Project Manager:
Tel:	(905) 567-4444 Fax: (905) 567-6561	Tel:	Fax:	Project Name:		C#709061-01-01	Ema Gitej
Email:	AP_CustomerService@golder.com	Email:	David_Marmor@golder.com	Site #:			
				Sampled By:			

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
☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___	☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558. ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☐ PWQO ☐ Other ___	

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

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	ANALYSIS REQUESTED (PLEASE BE SPECIFIC): Corrosivity pkg (Cl, SO4, pH, EC/Resistivity)	# of Bottles	Comments
1		1662333 C1-2	21/3/2019	1:30	Rock		X		
2		1662333 C1-1	21/3/2019	1:30	Rock		X		
3		1662333 C2-2	21/3/2019	1:30	Rock		X		
4		1662333 C2-3	21/3/2019	1:30	Rock		X		
5		1662333 C3-3	21/3/2019	1:30	Rock		X		
6		1662333 C3-1	21/3/2019	1:30	Rock		X		
7		1662333 C4-2	20/3/2019	4:30	Soil		X		
8		1662333 C4-3	20/3/2019	4:30	Soil		X		
9		1662333 C5-2	20/3/2019	4:30	Soil		X		
10		1662333 C5-1	20/3/2019	4:30	Soil		X		

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 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 #)*

21-Mar-19 16:07
Ema Gitej
B974455
URE ENV-1222

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
JANE PETER (Jane)	2019/03/21	3:00pm	[illegible]	19/03/21	16:57	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	-3/-2/-1	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.

* 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

Maxxam
A Bureau Veritas Group Company

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

Attention:David Marmor

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

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

CERTIFICATE OF ANALYSIS

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

Sample Matrix: Soil
Samples Received: 3

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

Remarks:

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

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

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

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.

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

Maxxam
A Bureau Veritas Group Company

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

Attention:David Marmor

Golder Associates Ltd
Mississauga - Standing Offer
6925 Century Ave
Suite 100
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CERTIFICATE OF ANALYSIS

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

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829

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

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

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

RESULTS OF ANALYSES OF SOIL

Maxxam ID		FNR708			FNR708		FNR709	FNR710		
Sampling Date		2017/10/16 16:00			2017/10/16 16:00		2017/10/20 10:00	2017/10/26 13:30		
COC Number		51329			51329		51329	51329		
	UNITS	NW3-01 SA7	RDL	QC Batch	NW3-01 SA7 Lab-Dup	QC Batch	CRB-06 RC-01 6.00-6.05	PED-03 SA8	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm	490		5263307			5000	1300		5263307
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	1000	40	5268736			<20	350	20	5268736
Conductivity	umho/cm	2040	2	5273678			201	762	2	5273678
Available (CaCl2) pH	pH	7.86		5270614	7.93	5270614	8.11	7.73		5270614
Soluble (20:1) Sulphate (SO4)	ug/g	69	20	5268737			30	70	20	5268737

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

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

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

TEST SUMMARY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

GENERAL COMMENTS

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

Package 1	5.3°C

Results relate only to the items tested.

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Maxxam Job #: B7P4571
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QUALITY ASSURANCE REPORT

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

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

N/A = Not Applicable

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

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

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

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

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

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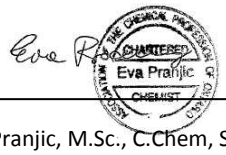
Maxxam Job #: B7P4571
Report Date: 2017/11/21

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

VALIDATION SIGNATURE PAGE

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



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

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Maxxam

6740 Campobello Road, Mississauga, Ontario L5N 2L8 www.maxxam.ca
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CHAIN OF CUSTODY RECORD

51329

Page 1 of 1

INVOICE INFORMATION	REPORT INFORMATION (if differs from invoice)	PROJECT INFORMATION	TURNAROUND TIME (TAT) REQUIRED
Company Name: Golder Associates	Company Name:	Quotation #:	[X] Regular TAT (5-7 days)
Contact Name: David Marmor	Contact Name:	P.O. #: 1662333	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 6925 Century Ave Suite #1000 Mississauga	Address:	Project #: 1662333	Rush TAT (Applicable Surcharge)
		Site Location: QEW/Credit River	[ ] 1 Day (100%)
Phone: 705-792-8203 Fax: 9055676561	Phone: Fax:	Site #:	[ ] 2 Days (50%)
Email: david-marmor@golder.com	Email:	Sampled By: Jeremy Lebow	[ ] 3-4 Days (25%)

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

REGULATION 153 (2011): [ ] Table 1 [ ] Res/Park [ ] Med/Fine; [ ] Table 2 [ ] Ind/Comm [ ] Coarse; [ ] Table 3 [ ] Agri/Other; [ ] Table ___

FOR RSC (PLEASE CIRCLE) YES / NO

OTHER REGULATIONS: [ ] CCME [ ] Sanitary Sewer Bylaw; [ ] MISA [ ] Storm Sewer Bylaw; [ ] PWQO Municipality: ; [ ] Other (Specify): ; [ ] REG 558 (MINIMUM 3 DAY TAT REQUIRED)

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

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

ANALYSIS REQUESTED: FIELD FILTERED (PLEASE CIRCLE) Metals / Hg / CrVI; Standard Corrosivity; pH, Chloride, Sulphate; Conductivity/Resistivity

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	MATRIX	# OF CONT.	Field Filtered	Standard Corrosivity	pH, Chloride, Sulphate	Conductivity/Resistivity
1	NW3-01 Sa 7	17/10/16	4 pm	Soil	1	X			
2	CRB-06 RC-01 6.00-6.05	17/10/20	10 am	Soil/Rock	1	X			
3	PED-03 Sa 8	17/10/26	1:30pm	Soil	1	X			
4									
5									
6									
7									
8									
9									
10									

Rush Confirmation #:

Date Required:

LABORATORY USE ONLY

CUSTODY SEAL (Y/N): Present / Intact

Temperature (°C) on Receipt: 4/4/7

COOLING MEDIA PRESENT (Y/N)

COMMENTS / TAT COMMENTS

13-Nov-17 12:50
Ema Gitej
B7P4571
TSP ENV-980

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME:	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME:	# JARS USED AND NOT SUBMITTED	MAXXAM JOB #
D. Marmor	2017/11/13	1250	Tuvvas Tavounezian	2017/11/13	12:50		

COC-1004 (11/13) - ENV ENG

Maxxam Analytics International Corporation o/a Maxxam Analytics

White: Maxxam ~ Yellow: Client

golder.com