Foundation Investigation Report

Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street, Mississauga

Ministry of Transportation, Ontario, GWP 2002-13-0

Submitted to:

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GEOCRES NO.: 30M12-441
Stavebank Creek Culvert
Latitude: 43.558913 **Longitude**: -79.608430
Kenollie Creek Culvert
Latitude: 43.562222 **Longitude**:-79.60604

Distribution List

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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 two culvert replacements and temporary protection systems at Stavebank Creek (approximately Station 17+100) and Kenollie Creek (approximately Station 17+500). This investigation is associated with the widening of the Queen Elizabeth Way (QEW) and interchanges improvements in the City of Mississauga, Ontario. The general areas of the site investigations are shown on the Key Plan on Drawings 1 and 2.

The purpose of this investigation is to establish the subsurface soil, bedrock and groundwater conditions at the existing and proposed culverts, by borehole drilling / bedrock coring and geotechnical / analytical laboratory testing on selected soil and rock 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 forms part of the Consultant's Assignment Number (Number 2015-E-0033) for this project. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated February 3, 2017.

2.0 SITE DESCRIPTION

The existing Stavebank Creek and Kenollie Creek Culverts are located approximately 200 m and 650 m east, respectively, of the Credit River in the City of Mississauga, Ontario. The QEW and Premium Way are oriented in a northeast-southwest direction which for the purpose of this report implied as west-east orientation, and the existing culverts are oriented in a northwest-southeast direction, from north of Premium Way to south of the QEW. The creeks' flow direction is essentially northwest to southeast. The QEW consists of three eastbound lanes (Toronto) and three westbound (Hamilton) lanes, while Premium Way consists of one lane in each direction.

The culverts cross under both the QEW and Premium Way, which parallels the northside of the QEW. The existing Stavebank Creek Culvert is approximately 109 m long and is comprised of two longitudinally separate 30 m long and 79 m long concrete boxes1.8 m wide by 1.2 m high. The existing Kenollie Creek Culvert is comprised of one longitudinally continuous concrete box section approximately 70 m long and is 3 m wide by 1.2 m high. Site Photographs 1 to 8 are appended to this report.

Both the existing Stavebank Creek Culvert and Kenollie Creek Culvert and highway embankment in the vicinity of the existing culverts appear to be performing appropriately, from a geotechnical perspective. No settlement or cracking of either culvert is apparent from the field reconnaissance completed as part of the investigation. The nearby embankment side slopes are heavily vegetated with grasses, low shrubs and small diameter trees, there is no apparent seepage on the face and adjacent platform between the QEW and the local streets or at the toes of the embankment and there are no signs of sloughing or erosion.

There are residential areas located north and south of the culvert sites, along the north side of the Premium Way north of the QEW, and along both sides of Pinetree Way south of the QEW. The existing ground surface along the Stavebank Creek Culvert at Station 17+100 varies from about Elevations 95 m to 87 m along its alignment; and at the Kenollie Creek Culvert at Station 17+500 the ground surface varies from about Elevations 95 m to 89 m along its alignment.

3.0 INVESTIGATION PROCEDURES

The field work for the foundation investigation was carried out in a number of separate periods / phases from September 13 to December 21, 2018, during which time a total of thirteen boreholes were advanced:

- Boreholes S1 to S7 were advanced near the location of the existing Stavebank Creek Culvert; and
- Boreholes K1 to K6 were advanced near the location of the existing Kenollie Creek Culvert.

These boreholes are supplemented with nine boreholes drilled between August 23, 2017 and August 9, 2018 for other immediately adjacent structures, such as noise barrier walls and the North-South AT Pedestrian bridge:

- Boreholes NW3-2, NW3-2A, NW3-3, PED-02, PED-03, PED-03A and PED-03B were advanced in the vicinity of Stavebank Creek Culvert; and,
- Boreholes NRW3-6 and NRW7-3 were advanced in the vicinity of Kenollie Creek Culvert.

The locations of the boreholes advanced at the Stavebank Creek Culvert site and the Kenollie Creek Culvert site are shown on Drawings 1 and 2, respectively.

Boreholes S1 and S7 were advanced using a Portable Tripod rig and a manual hammer drive system supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. Boreholes S2 to S6 and K1 to K6 were advanced by a CME-55 track-mounted drill rig supplied and operated by Geo-Environmental Drilling Inc. of Halton Hills, a CME-55 truck-mounted drill rig supplied and operated by Tri-Phase Environmental Inc. of Mississauga, a CME-75 truck-mounted drill and a CME-55 track-mounted drill rig supplied and operated by Davis Drilling Ltd. of Milton, and a CME-55 truck-mounted drill rig supplied and operated by Aardvark Drilling Inc. of Guelph, Ontario. The supplemental boreholes at adjacent structures were advanced by a CME-55 truck mounted and a CME-850 truck-mounted drill rig supplied and operated by Aardvark Drilling Inc. of Guelph, Ontario.

The boreholes were advanced through the overburden using 203 mm outer diameter hollow stem augers, with the exception of Boreholes NW3-2A, and PED-03B, which were advanced using a 156 mm Tricone with drilling mud. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedures outlined in ASTM D1586-08[1].

The groundwater conditions and water levels in the open boreholes were observed during and immediately following drilling operations. A standpipe piezometer was installed in Boreholes S3, PED-03A at the Stavebank Creek Culvert site and in Borehole K2 at the Kenollie Creek Culvert site to permit monitoring of the groundwater level at the borehole locations. The standpipe piezometers consist of a 50 mm diameter PVC pipe with a slotted screen sealed at a selected depth within the borehole. The borehole 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).

[1] ASTM D1586-08a – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the soil.

The field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services including both public and, where applicable, private locates, observed the drilling, sampling and in-situ testing operations, logged the boreholes, and examined the soil 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 geotechnical laboratory testing. All of the geotechnical laboratory tests were carried out in accordance with 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. Unconfined compression (uniaxial) strength (UCS), Young's modulus, bulk density, was carried out on selected specimens of the bedrock core.

Six selected soil samples and one selected rock core sample were submitted, under chain-of-custody procedures, to Maxxam Analytics of Mississauga, Ontario (a Standards Council of Canada (SCC) accredited laboratory) for corrosivity testing. The soil samples and rock core samples were analyzed for a suite of parameters, including conductivity, resistivity, soluble chloride concentration, soluble sulphate concentration and pH.

The borehole locations and ground surface elevations were measured using a GPS unit (Trimble XH 3.5G), having an accuracy of 0.1 m in the vertical and horizontal directions, with the exception of Borehole S7 which had a vertical accuracy of 1.9 m and a horizontal accuracy of 0.7 m due to heavy tree cover in the area. The as-drilled locations of Boreholes S2, S4 to S6, PED-02, K3 to K6 and NRW7-3, were referenced to site features and then plotted on the borehole location drawing to obtain the coordinates of the locations; and the ground surface elevations were obtained by plotting the coordinates on the digital terrain model and interpreting the elevation. The locations provided on the borehole records and shown on Drawings 1 and 2 are positioned relative to MTM NAD 83 (Zone 10) coordinates system, and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and drilled depths are summarized below.

Borehole No.	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
Stavebank Creek Culvert				
S1	4,824,356.1 (43.559090)	295,982.6 (-79.609144)	91.7	3.4
S2	4,824,357.2 (43.559092)	296,001.4 (-79.608907)	94.9	17.4
S3	4,824,337.3 (43.558912)	296,021.0 (-79.608665)	90.0	16.6
S4	4,824,336.4 (43.558913)	296,040.2 (-79.608430)	95.2	18.4
S5	4,824,341.1 (43.558955)	296,053.5 (-79.608265)	95.3	16.9
S6	4,824,318.8 (43.558755)	296,059.4 (-79.608192)	95.2	14.8

Borehole No.	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
S7	4,824,321.2 (43.558768)	296,076.9 (-79.607973)	90.1	4.6
NW3-02	4,824,342.4 (43.558958)	295,994.3 (-79.608996)	95.3	12.3
NW3-02A	4,824344.2 (43.558975)	295,993.8 (-79.609002)	95.3	27.6
NW3-03	4,824,329.2 (43.558840)	296,002.3 (-79.608895)	90.6	8.1
PED-02	4,824,321.8 (43.558773)	296,032.3 (-79.608524)	95.2	16.7
PED-03	4,824,305.3 (43.558625)	296,063.0 (-79.608144)	93.7	13.8
PED-03A	4,824,308.4 (43.558653)	296,062.1 (-79.608155)	94.1	6.1
PED-03B	4,824,309.6 (43.558664)	296,062.8 (-79.608146)	94.1	17.8 (including 3.0 m of bedrock core)
Kenollie Creek Culvert				
K1	4,824,728.9 (43.562439)	296,200.2 (-79.606453)	90.1	5.1 (including 3.8 m of bedrock core)
K2	4,824,716.6 (43.562329)	296216.3 (-79.606253)	93.2	9.4 (including 3.1 m of bedrock core)
K3	4,824,703.7 (43.562222)	296,236.7 (-79.606004)	95.0	14.1 (including 3.4 m of bedrock core)
K4	4,824,692.4 (43.562120)	296,229.9 (-79.606087)	95.0	13.9 (including 3.0 m of bedrock core)
K5	4,824,683.3 (43.562038)	296,242.1 (-79.605937)	95.0	13.5
K5A	4,824,681.0 (43.562017)	296,241.1 (-79.605949)	95.0	16.5 (including 3.7 m of bedrock core)
K6	4,824,688.5 (43.562085)	296,254.9 (-79.605778)	94.9	15.0 (including 0.7 m of bedrock core)
NRW3-6	4,824,701.8 (43.562195)	296,220.4 (-79.606203)	92.9	11.4 (including 3.9 m of bedrock core)
NRW7-3	4,824,696.6	296,259.1	94.9	12.3

Borehole No.	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
	(43.562158)	(-79.605727)		

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Region 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 sands, silts and gravels, with a shallow cover of till remaining over the bedrock.

The 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 advanced during the current investigation, the details of the piezometer installations and the summary results of the geotechnical laboratory testing are presented on the Records of Borehole and Drillhole sheets provided in Appendix A for Stavebank Creek Culvert and Appendix B for Kenollie Creek Culvert. Lists on abbreviations and symbols and lithological, geotechnical rock description terminology, field estimation of rock hardness and rock weathering classification are also included in Appendix A and B to assist in the interpretation of the borehole and drillhole records. Plots of the grain size distribution and Atterberg limits tests results are presented on Figures A-1 to A-10D, provided in Appendix A for Stavebank Creek Culvert and on Figures B-1A to B-8, provided in Appendix B for Kenollie Creek Culvert. 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. Photographs of the bedrock core samples recovered from the boreholes at the Stavebank Creek Culvert site and the Kenollie Creek Culvert site are presented on Figures A-11 and A-12 and on Figures B-9 to B-15, included in Appendix A and B, respectively. The results of the laboratory tests carried out on selected bedrock core samples and the analytical laboratory test reports are contained in Appendices C and D, respectively for both Stavebank Creek Culverts and Kenollie Creek Culverts.

The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations; however, the factual data presented in the Records

[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.)

of Borehole and Drillhole sheets governs any interpretation of the site conditions. It should be noted that the interpreted stratigraphy shown on Drawings 1 and 2 is a simplification of the subsurface conditions.

4.2.1 Stavebank Creek Culvert

In general, the subsurface conditions at the proposed culvert consist of a layer of topsoil, asphalt or concrete, underlain by fill material consisting of clayey silt, silt and sand, and sand and gravel. The fill is underlain by native clayey silt with sand to silt and sand, sand and gravel deposits, and a glacial till deposit consisting of clayey silt, some sand to with sand, some gravel to with gravel. Shale bedrock was encountered underlying the native soil deposits in one borehole.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1.1 Asphalt

A layer of asphalt was encountered in Boreholes S2, S5, S6, NW3-2 and PED-02 at ground surface and ranges in thickness from about 100 mm to 300 mm.

4.2.1.2 Concrete

A layer of concrete was encountered in Borehole S4 at ground surface and has a thickness of 450 mm.

4.2.1.3 Topsoil

Topsoil was encountered in Boreholes S3, S7 and PED-03 at ground surface and the thickness of the layer ranges from about 200 mm to 300 mm.

4.2.1.4 Fill

A 1.2 m to 6.0 m thick fill material, comprised predominately of non-cohesive soil, with cohesive soil in places, was encountered in all boreholes at the Stavebank Creek Culvert site, from ground surface or underlying the asphalt, concrete or topsoil surface layer. In boreholes advanced through Premium Way and the QEW, a thin layer of sand and gravel was encountered underlying the asphalt and/or concrete pavement. The non-cohesive fill generally consists of silt and sand to silty sand with the exception of Borehole S2 advanced through Premium Way where the fill is variable in composition and is interlayered, as described below. The depth and elevation of the top and bottom of the fill material and the corresponding thickness and soil type are summarized below.

Borehole No.	Top of Layer (below ground/pavement surface)		Bottom of Layer		Thickness (m)	Fill Soil Type
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)		
S1	0.0	91.7	0.6	91.1	0.6	Clayey Silt with Sand
	0.6	91.1	1.2	90.5	0.6	Silty Sand
S2	0.2	94.7	0.3	94.6	0.1	Sand and Gravel
	0.3	94.6	0.7	94.2	0.4	Sandy Silt
	0.7	94.2	0.9	94.0	0.2	Gravelly Sand

Borehole No.	Top of Layer (below ground/pavement surface)		Bottom of Layer		Thickness (m)	Fill Soil Type
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)		
	0.9	94.0	3.7	91.2	2.8	Gravelly Clayey Silt with Sand
	3.7	91.2	4.5	90.4	0.8	Sand
	4.5	90.4	5.6	89.3	1.1	Silty Sand
S3	0.2	89.8	2.7	87.3	2.5	Silt and Sand
S4	0.5	94.7	1.5	93.7	1.0	Sand and Gravel
	1.5	93.7	5.6	89.6	4.1	Silt and Sand
S5	0.3	95.0	5.6	89.7	5.3	Silt and Sand
S6	0.2	95.0	0.7	94.5	0.5	Sand and Gravel
	0.7	94.5	5.6	89.6	4.9	Silt and Sand
S7	0.3	89.8	2.3	87.8	2.0	Silt and Sand
NW3-2	0.2	95.1	2.6	92.7	2.4	Silty Sand
	2.6	92.7	3.7	91.6	1.1	Sandy Clayey Silt
	3.7	91.6	5.3	90.0	1.6	Sand and Gravel
	5.3	90.0	7.8	87.5	2.5	Silty Sand
NW3-3	0.0	90.6	1.5	89.2	1.5	Silty Sand
PED-02	0.1	95.1	3.7	91.5	3.6	Silty Sand to Sand
PED-03	0.2	93.5	6.2	87.6	6.0	Silt and Sand to Silty Sand

The SPT “N”-values measured within the layers of sand and gravel fill range from 8 blows to 34 blows per 0.3 m of penetration, indicating a loose to dense compactness condition. The SPT “N”-values measured within the sandy silt to sand fill layers range from 1 blow to 39 blows per 0.3 m of penetration, indicating a very loose to dense compactness condition. The SPT “N”-values measured within the clayey silt to gravelly clayey silt to clayey silt with sand fill range from 3 blows to 29 blows per 0.3 m of penetration, suggesting a soft to very stiff consistency.

A grain size distribution test was carried out on one sample of the sand and gravel fill and the result is shown on Figure A-1 in Appendix A. The water content measured on a sample of the sand and gravel fill is 10 per cent.

Grain size distribution tests were carried out on thirteen samples of the sandy silt to sand fill layers and the results are shown on Figures A-2A and A-2B in Appendix A. The sandy silt and sand fill contain some asphalt fragments, concrete chips, and in Borehole NW3-3 a hydrocarbon odour was noted at a depth of about 0.8 m below ground

surface. In Boreholes S5 and S2 the augers were grinding within the non-cohesive fill material at depths of 0.3 m to 0.6 m and from 1.5 m to 2.7 m, respectively. The water content measured on samples of the silt and sand fill ranges between about 3 per cent and 38 per cent.

A grain size distribution test was carried out on one sample of the cohesive fill material and the result is shown on Figure A-3 in Appendix A. Atterberg limits tests were carried out on three samples of the cohesive fill layers and measured liquid limits ranging from about 19 per cent to 24 per cent, plastic limits ranging from about 14 per cent to 15 per cent and plasticity indices ranging from about 6 per cent to 10 per cent. The results of the Atterberg limits tests are plotted on the plasticity chart on Figure A-4 in Appendix A and indicate that the cohesive fill material consists of clayey silt of low plasticity. The water content measured on samples of the clayey silt with sand fill ranges between about 12 per cent and 16 per cent.

4.2.1.5 Sand and Gravel to Gravel

A deposit of sand and gravel to gravel, trace sand, trace clay was encountered in Borehole S1 underlying a silty sand layer (see Section 4.2.1.6 for discussion), and in Borehole PED-02 underlying the non-cohesive fill material. The surface of the deposit was encountered at depths of 2.7 m and 3.7 m below ground surface (Elevations 89.0 m and 91.5 m), respectively, and extends to a depth of 6.5 m below ground surface (Elevation 88.7 m) in Borehole PED-02. Borehole S1 terminated in the sand and gravel deposit at a depth of 3.4 m below ground surface (Elevation 88.3 m).

The SPT “N”-values measured within the sand and gravel deposit range from 5 blows to 35 blows per 0.3 m of penetration with an “N”-value of 100 blows per 0.05 m of penetration at the bottom of Borehole S1, indicating a generally loose to dense compactness condition and an inferred obstruction (cobble or boulder) at the bottom of Borehole S1.

Grain size distribution tests were carried out on two samples of the sand and gravel deposit and the results are shown on Figure A-5 in Appendix A. The water content measured on two samples of the sand and gravel deposit is about 13 per cent and 22 per cent.

4.2.1.6 Silt to Silt and Sand to Sand

Boreholes S1, S2, S4 to S6, and PED-02, penetrated a deposit consisting of silt to silt and sand to silty sand to sand, trace to some gravel was encountered underlying the fill material in all boreholes, except in Borehole PED-02 where it was encountered underlying the sand and gravel layer. The surface of the deposit was encountered at depths of between about 1.2 m and 6.5 m (between Elevations 90.5 m and 88.7 m) below ground surface, and ranges in thickness from about 0.5 m to 3.1 m.

A lower layer of this deposit (silt, silty sand, sand and gravel) was also encountered underlying the till deposit in Boreholes S2 and NW3-2A and interlayered within the till deposit in PED-03B. The surface of the deposit was encountered at depths of about 14.6 m, 20.3 m and 11.6 m below ground surface (at Elevations 80.3 m, 75.0 m and 82.5 m), respectively, and its thickness is about 1.1 m in the Borehole PED-03B. Borehole S2 terminated within the silty sand deposit at a depth of 17.4 m below ground surface (Elevation 77.5 m), after penetrating about 2.8 m into the deposit. Borehole NW3-2A terminated within the sand and gravel deposit at a depth of 27.6 m (Elevation 67.7 m), after penetrating about 7.3 m into the deposit.

The SPT “N”-values measured within the silt and sand to sand deposit range from 0 blows (weight of hammer) to 16 blows per 0.3 m of penetration, indicating that the deposit has a very loose to compact compactness condition. The SPT “N”-values measured within the non-cohesive interlayers within the till deposit (silt, silty sand) range from

35 blows to 54 blows per 0.3 m of penetration, indicating a dense to very dense compactness condition of the interlayers.

Grain size distribution tests were carried out on three samples of the silty sand layer of the deposit and the results are shown on Figure A-6 in Appendix A. Two organic content tests were completed on samples of the silt and sand to sand layer of the deposit from Borehole S5 and the results are 1.5 per cent and 2.2 per cent. The water content measured on samples of the silt to silt and sand deposit ranges between about 7 per cent and 28 per cent.

4.2.1.7 Clayey Silt with Sand

In Borehole S7 a deposit of clayey silt with sand, trace gravel was encountered underlying the silt and sand fill. The surface of the deposit was encountered at a depth of about 2.3 m below ground surface (Elevation 87.8 m) and the deposit is 0.4 m thick.

An SPT “N”-value measured within the clayey silt with sand deposit is 7 blows per 0.3 m of penetration, suggesting that the clayey silt with sand deposit has a firm consistency.

One grain size distribution test was carried out on the clayey silt with sand deposit and the result is shown on Figure A-7 in Appendix A. One Atterberg limits test was carried out on this same sample and measured a liquid limit of about 22 per cent, a plastic limit of about 16 per cent and a plasticity index was about 6 per cent. The result of the Atterberg limits test is plotted on the plasticity chart on Figure A-8 in Appendix A and indicates that the deposit consists clayey silt to silt of low plasticity. The water content measured on one sample of the clayey silt with sand deposit was about 24 per cent.

4.2.1.8 Clayey silt to Clayey Silt with Sand and Gravel (Till)

In all boreholes except S1 an interlayered till deposit consisting of clayey silt, some sand to sandy clayey silt to clayey silt with sand, some gravel to gravelly clayey silt to clayey silt with sand and gravel to sandy gravelly clayey silt, was encountered underlying the silt and sand deposit or underlying the silt and sand fill. Within the till deposit non-cohesive layers of silt and sand to gravelly silt and sand to gravelly sand, trace to some clay, were encountered. The surface of the till deposit was encountered at depths of between about 1.5 m and 8.7 m below ground surface (between Elevations 89.2 m and 86.6 m), and the thickness of the deposit ranges from about 1.6 m to 13.9 m.

Limestone fragments were encountered underlying the till at the bottom of Borehole S7 at a depth of 4.3 m below ground surface (Elevation 85.8 m), inferred to be a cobble/ boulder size slab. The till deposit in Borehole PED-03 was cored from a depth of about 10.7 m to 13.8 m below ground surface (Elevation 83.0 to 79.9 m) as a result of split-spoon refusal and encountered a 0.5 m thick limestone slab at a depth of 12.1 m below ground surface (Elevation 81.6 m), underlain by a 0.3 m thick zone of gravel and cobbles at a depth of 12.9 m below ground surface (Elevation 80.8 m). A photograph of the soil core is presented on Figure A-11in Appendix A.

The SPT “N”-values measured within the cohesive till deposit generally range from 4 blows to 99 blows per 0.3 m of penetration with “N”-values up to 131 blows per 0.08 m of penetration, suggesting a firm to hard consistency; and the SPT “N”-values measured within the non-cohesive till deposit generally range from 17 blows to 46 blows per 0.3 m of penetration, with “N”-values up to 100 blows for 0.08 m of penetration, indicating a compact to very dense compactness condition.

Grain size distribution tests were carried out on twenty-three samples of the till deposit and the results are shown on Figures A-9A to A-9E in Appendix A. Atterberg limits tests were carried out on twenty-two samples of the till deposit and measured liquid limits ranging from about 18 per cent to 30 per cent, plastic limits ranging from about

13 per cent to 17 per cent and plasticity indices ranging from about 5 per cent to 13 per cent for the cohesive till layers; and liquid limits ranging from about 16 per cent to 19 per cent, plastic limits ranging from about 13 per cent to 16 per cent and plasticity indices ranging from about 3 per cent to 4 per cent for the non-cohesive till layers. The results of the Atterberg limits test are plotted on the plasticity charts on Figures A-10A to A-10D in Appendix A and indicate the till deposit consists of clayey silt layers of low plasticity and silt to silty sand of slight plasticity. The water content measured on samples of the cohesive and non-cohesive portions of the till deposit ranges between about 6 per cent and 21 per cent.

4.2.1.9 Sandy Gravelly Clayey Silt (Residual Soil)

A 0.6 m thick layer of residual soil comprised of sandy gravelly clayey silt, containing some shale fragments was encountered underlying the cohesive till layer in Borehole PED-02 at a depth of about 16.1 m below ground surface (Elevation 79.1 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"-value measured within the residual soil deposit at the bedrock contact is 100 blows per 0.13 m of penetration. The water content measured on a sample of the residual soil is 15 per cent.

4.2.1.10 Shale Bedrock

Shale bedrock was encountered in Boreholes PED-02 and was cored in PED-03B. In Borehole PED-02 shale was encountered at a depth of 16.7 m below ground surface (Elevation 78.5 m) and is inferred by a 0.1 m split-spoon sample. In Borehole PED-03B shale was encountered at a depth of 14.8 m below ground surface (Elevation 79.3 m), and 3 m of rock were cored (from 14.8 m to 17.8 m below ground surface).

Based on a review of the bedrock core samples the bedrock consists of shale of the Georgian Bay Formation. In general, the bedrock samples are described as slightly weathered to fresh, laminated to thinly bedded, fine grained, non-porous, very weak, grey shale, with slightly weathered to fresh, laminated, grey, fine grained, non-porous, medium strong limestone interbeds at varying intervals of depth.

The strong limestone layers range in thickness from about 10 mm to 400 mm, with an average thickness of about 20 mm. The stronger layers generally make up about 10 per cent by thickness of the rock encountered during the investigation. The details of the bedrock descriptions are presented on the Record of Drillhole PED-03B sheet and a photograph of the recovered bedrock core samples is presented on Figure A-12 in Appendix A. The degree of weathering of the bedrock samples (i.e. fresh to completely weathered – W1 to W5), and the strength classification of the intact rock mass based on field identification (i.e. very weak to strong – R1 to R4) 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 obtained from Borehole PED-03B ranges from about 38 per cent to 78 per cent, indicating a rock mass of poor to good quality, as per Table 3.10 of CFEM (2006)[4]. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are 100 per cent and between 13 per cent and 43 per cent, respectively.

[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.

An Unconfined Compression (UC) test (ASTM D7012)[5] was carried out on a selected core sample of the shale bedrock and the uniaxial compressive strength (UCS), bulk density and tangent Young's modulus of the intact sample are summarised below and the details are presented on the Rock Laboratory Test Results report from Geomechanica in Appendix C.

Borehole No.	Sample Depth Interval (m)	Sample Elevation Interval (m)	Uniaxial Compressive Strength (UCS) (MPa)	Bulk Density (g/cm^3)	Tangent Young's Modulus (GPa)
PED-03B	16.0 – 16.3	78.1 – 77.8	6.7	2.57	0.29

Based on the laboratory UCS, in accordance with Table 3.5 in CFEM (2006)[4], the shale bedrock of the core sample tested is classified as weak (R2, 5 MPa < UCS < 25 MPa).

4.2.1.11 Groundwater Conditions

The overburden samples obtained from the borehole investigations were generally moist to wet. The depth to the water level observed in the boreholes upon completion of drilling (and prior to rock coring (where applicable)) is presented below.

Borehole	Upon Completion of Drilling		Comment
	Water Level Depth (m)	Water Level Elevation (m)	
S1	0.7	91.0	Upon completion of drilling.
S2	Dry	--	
S3	15.9	74.1	
S4	6.1	89.1	
S5	7.0	88.3	
S6	11.9	83.3	
S7	--	--	Water used during borehole advancement
NW3-2	Dry	--	Upon completion of drilling
NW3-2A	3.4	91.9	
NW3-3	Dry	--	
PED-02	1.1*	94.1	Prior to start drilling on Dec 6, 2017
PED-03	Dry	--	Upon completion of drilling

[5] ASTM D7012 – Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Borehole	Upon Completion of Drilling		Comment
	Water Level Depth (m)	Water Level Elevation (m)	
PED-03A	Dry	--	Upon completion of drilling
PED-03B	Dry	--	Upon completion of overburden drilling and prior to rock coring.

Notes:
* Water level not considered to be representative due to the introduction of water to advance the drilling.

The water levels recorded in the standpipe piezometers installed during the current investigation are presented below.

Borehole	Stratum Well Sealed Into	Water Level Depth (m)	Water Elevation (m)	Date of Piezometer Reading
S3	Fill/Silty Clay Till	0.8	89.2	November 6, 2018
PED-03A	Silt and Sand to Silty Sand Fill	Dry	-	October 10, 2017
		4.3	89.8	November 14, 2017
		4.4	89.7	November 21, 2017
		4.1	90.0	November 6, 2018
		4.4	89.7	November 28, 2018

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

4.2.1.12 Analytical Testing Results

Four soil samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. The following summarizes the results of the testing:

Parameter	Borehole S2 (SA #9 – Till)	Borehole S4 (SA #9A – Silt and Sand)	Borehole S5 (SA #9 – Silt and Sand)	Borehole S6 (SA #9 – Till)
pH	7.77	7.62	7.04	7.19
Resistivity (ohm-cm)	1500	720	680	840
Electrical Conductivity (umho/cm)	661	1390	1480	1190
Chlorides (ug/g)	37	600	760	630
Soluble Sulphates (ug/g)	550	260	<20*	<20*

Notes:
* Lower than Reportable Detection Limit

4.2.2 Kenollie Creek Culvert

In general, the subsurface conditions at the proposed culvert consist of a layer of topsoil or asphalt and/ or concrete underlain at most borehole locations by fill varying in composition from sand and gravel to gravelly sand in places, underlain by sandy silt to silt and silty sand to sand. The fill deposits are underlain by interlayered deposits of clayey silt with sand, sand to silty sand, and clayey silt with sand, which are in turn underlain by a till deposit consisting of clayey silt to sandy clayey silt and/ or silty sand, which is underlain by residual soil consisting of clayey silt, in places, underlain by shale bedrock. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.2.1 Asphalt

A layer of asphalt pavement was encountered in Boreholes K2, K3, K4, K5 and K6 at ground surface and ranges in thickness from about 150 mm to 200 mm.

4.2.2.2 Concrete

A layer of concrete was encountered in Boreholes K5 and K6 underlying the asphalt pavement and in Borehole NRW7-3 at ground surface, and ranges in thickness from 300 mm to 430 mm.

4.2.2.3 Topsoil

A layer of topsoil was encountered in Borehole K1 at ground surface and has a thickness of 0.8 m. The water content measured on one sample of the topsoil is about 55 per cent.

4.2.2.4 Fill

A 0.4 m to 0.6 m thick layer of gravelly sand to sand and gravel fill was encountered underlying the asphalt or concrete in Boreholes K3, K4 and NRW7-3. The granular fill was encountered in Boreholes K3 and K4 at a depth of 0.2 m below ground surface (Elevation 94.8 m), concrete in Borehole NRW7-3 at a depth of 0.4 m below ground surface (Elevation 94.5 m).

In all boreholes, with the exception of Borehole K1, non-cohesive fill material consisting of sandy silt to silt and sand to silty sand, trace clay was generally encountered underlying the gravelly sand / sand and gravel fill, asphalt, and/ or concrete, or at ground surface at Borehole NRW3-6. The sandy silt to silty sand fill contains asphalt debris, wood chips, and 0.1 m of black organic silt. The surface of the deposit was encountered at depths ranging between about 0.0 m and 1.0 m below ground surface (between Elevations 94.5 m and 92.9 m), and the thickness of the overall fill material ranges from about 3.6 m to 5.1 m.

The SPT “N”-values measured within the gravelly sand / sand and gravel fill range from 25 blows to 49 blows per 0.3 m of penetration, indicating a compact to dense compactness condition. The SPT “N”-values measured within the sandy silt to silty sand fill range from 0 blows (weight of hammer) to 36 blows per 0.3 m of penetration, indicating a very loose to dense compactness condition.

Grain size distribution tests were carried out on eleven samples of the non-cohesive fill material and the results are shown on Figures B-1A and B-1B in Appendix B. An organic content test was completed on a sample of silty sand fill from Borehole K6 and the result is 1.2 per cent. Atterberg limits tests were carried out on two samples of the silt and sand to silty sand fill and indicate the material to be non-plastic.

The water content measured on samples of the silt and sand to silty sand fill ranges between about 4 per cent and 33 per cent. The water content measured on one sample of the sand and gravel fill is about 12 per cent.

4.2.2.5 Clayey Silt to Clayey Silt with Sand

A deposit of clayey silt, some sand to clayey silt with sand, some gravel was encountered below the non-cohesive fill deposit in Boreholes K4, K5, K6 and NRW7-3. The surface of the clayey silt deposit was encountered at a depth of about 4.9 m and 5.6 m below ground surface (between Elevations 90.1 m and 89.3 m), and the thickness of the deposit ranges from about 1.6 m to 4.6 m.

The SPT “N”-values measured within the clayey silt with sand deposit range from 6 blows to 48 blows per 0.3 m of penetration, suggesting a firm to hard consistency.

Grain size distribution tests were carried out on four samples of the clayey silt with sand and the results are shown on Figure B-2 in Appendix B. An organic content test was completed on a sample of the clayey silt with sand material underlying the fill deposit in Borehole K5 and the result is 3.2 per cent.

Atterberg limits tests were carried out on six samples of the clayey silt with sand deposit and measured liquid limits ranging from about 17 per cent to 27 per cent, plastic limits ranging from about 12 per cent to 20 per cent and plasticity indices ranging from about 5 per cent to 11 per cent. The results of the Atterberg limits test are plotted on the plasticity chart on Figure B-3 in Appendix B and indicate that the deposit consists of clayey silt of low plasticity.

The water content measured on samples of the clayey silt with sand deposit ranges between about 11 per cent and 26 per cent.

4.2.2.6 Silty Sand to Sand

A deposit of silty sand to sand, trace to some gravel was encountered below the clayey silt with sand deposit in Boreholes K4, K5, K6 and NRW7-3. The surface of the silty sand to sand deposit was encountered at depths about 7.2 m and 10.2 m below ground surface (between Elevations 87.8 m and 84.8 m), and the deposit ranges in thickness from about 2.6 m to 4.5 m.

The SPT “N”-values measured within the silty sand to sand deposit range from 16 blows and 53 blows per 0.3 m of penetration, with two “N”-values of 100 blows for 0.13 m of penetration, indicating a compact to very dense compactness condition.

Grain size distribution tests were carried out on three samples of the silty sand to sand deposit and the results are shown on Figure B-4 in Appendix B.

The water content measured on samples of the silty sand to sand deposit ranges between about 11 per cent and 21 per cent.

4.2.2.7 Till

A till deposit comprised of clayey silt to clayey silt with sand, trace gravel to with gravel and an interlayer of silty sand till was encountered below the silt and sand fill deposit in Boreholes K3 and NRW3-6, and below the sand deposit in Boreholes K4 and K6. The surface of the till deposit was encountered at depths between about 3.6 m and 11.7 m below ground surface (Elevations 89.4 m to 83.2 m), and the thickness of the deposit ranges from about 0.6 m to 4.4 m.

Two SPT “N”-values measured within the cohesive till deposit are 4 blows and 17 blows per 0.3 m of penetration and with “N”-values up to 100 blows for 0.10 m of penetration, suggesting that the cohesive till deposit has a firm to hard consistency. One SPT “N”-value measured within the silty sand till interlayer is 32 blows per 0.3 m of penetration, indicating a dense compactness condition.

Grain size distribution tests were carried out on three samples of the till deposit and the results are shown on Figure B-5 in Appendix B.

Atterberg limits tests were carried out on three samples of the till deposit and measured liquid limits ranging from about 15 per cent to 25 per cent, plastic limits ranging from about 12 per cent to 16 per cent and plasticity indices ranging from about 3 per cent to 9 per cent. The results of the Atterberg limits test are plotted on the plasticity chart on Figure B-6 in Appendix B and indicate the till consists of silt of slight plasticity to clayey silt of low plasticity. The water content measured on samples of the till deposit ranges between about 11 per cent and 22 per cent.

4.2.2.8 Sandy Clayey Silt to Clayey Silt (Residual Soil)

A deposit of residual soil comprised of clayey silt, some sand to sandy to clayey silt, trace gravel to with gravel, some shale fragments was encountered underlying the topsoil in Borehole K1, underlying the silty sand fill in Borehole K2, underlying the till deposit in Borehole NRW3-6, and underlying the silty sand layer in Borehole NRW7-3. The surface of the residual soil deposit was encountered at depths between about 0.8 m and 10.8 m below ground surface (between Elevations 89.3 m and 84.1 m), and the thickness of the deposit ranges from about 0.3 m to 1.5 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 generally range from 16 blows and 43 blows per 0.3 m of penetration, with “N”-values of 50 blows for 0.25 m and to 100 blows for 0.08 m of penetration at the interface with the overlying silty sand layer and underlying shale bedrock, respectively, suggesting a very stiff to hard consistency.

Grain size distribution tests were carried out on two samples of the residual soil deposit and the results are shown on Figure B-7 in Appendix B.

Atterberg limits tests were carried out on two samples of the residual soil deposit and measured liquid limits of about 30 per cent and 34 per cent, plastic limits of about 20 per cent and 21 per cent, and plasticity indices of about 10 per cent and 13 per cent. The results of the Atterberg limits test are plotted on the plasticity chart on Figure B-8 in Appendix B and indicate the residual soil consists of clayey silt of low plasticity.

The water content measured on samples of the residual soil deposit ranges between about 7 per cent and 19 per cent.

4.2.2.9 Shale Bedrock

Bedrock was encountered and core samples were recovered in all boreholes with the exception of Borehole NRW7-3, where the presence of bedrock is inferred by refusal to further split-spoon advancement. The depths to bedrock or refusal below ground surface, the corresponding bedrock surface elevation or refusal elevation and the cored depths are summarized below.

Borehole	Depth to Bedrock Surface / Refusal (m)	Bedrock Surface / Refusal Elevation (m)	Comments
K1	1.1	89.0	Bedrock cored 3.8 m
K2	5.3	87.9	Bedrock cored 3.1 m

Borehole	Depth to Bedrock Surface / Refusal (m)	Bedrock Surface / Refusal Elevation (m)	Comments
K3	10.0	85.0	Bedrock cored 3.4 m
K4	10.8	84.2	Bedrock cored 3.0 m
K5 / K5A	13.4 / 12.8	81.6 / 82.2	Bedrock cored 3.7 m
K6	12.3	82.6	Bedrock cored 0.7 m[1]
NRW3-6	6.2	86.7	Bedrock cored 3.9 m
NRW7-3	12.3	82.6	Refusal to split-spoon advancement

In general, the bedrock surface as encountered along the alignment of the proposed culvert replacement slopes downwards from north-west to south-east.

Based on a review of the bedrock core samples the bedrock consists of shale of the Georgian Bay Formation. In general, the bedrock samples are described as slightly weathered, thinly bedded, fine grained, faintly porous, weak, grey shale, with medium strong to strong limestone interbeds at varying intervals of depth. It is also considered that the shale bedrock is completely to highly weathered in the upper 0.1 m to 1.5 m, based on the encountered resistance to auger advancement and penetration by the split-spoon.

The strong limestone layers range in thickness from 10 mm to 90 mm, with an average thickness of about 20 mm. The stronger layers generally make up about 5 per cent by thickness of the rock encountered during the investigation. The details of the bedrock descriptions are presented on the Record of Drillhole sheets and the photographs of the recovered bedrock core are shown on Figures B-9 to B-15 in Appendix B. The degree of weathering of the bedrock samples (i.e. fresh to completely weathered – W1 to W5), and the strength classification of the intact rock mass based on field identification (i.e. very weak to strong – R1 to R4) 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 obtained from the current investigation ranges from about 28 per cent to 100 per cent with two short runs (less than 0.1 m) measuring an RQD of 0 per cent, indicating a rock mass of poor to excellent quality, and generally an RQD greater than 62 per cent below the upper weathered zone, indicating fair 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 are between 54 per cent and 100 per cent and between 3 per cent and 99 per cent, respectively, with very small TCR and SCR values measured in highly weathered zone and short core runs.

Unconfined Compression (UC) tests (ASTM D7012)[5] were carried out on selected core samples of the shale bedrock and one sample of the interbedded limestone and the uniaxial compressive strength (UCS), bulk density and tangent Young's modulus of the intact samples are summarised below, and the details are presented on the Rock Laboratory Test Results report from Geomechanica in Appendix C. The core sample from Borehole K1 consisted of shale with limestone inclusions, whereas the core sample from Boreholes K2 and K3 consisted of slightly weathered shale.

Borehole No./ Run	Sample Depth Interval (m)	Sample Elevation Interval (m)	Uniaxial Compressive Strength (UCS) (MPa)	Bulk Density (g/cm^3)	Tangent Young's Modulus (GPa)
K1/ Run #2	3.1 – 3.3	87.0 – 86.8	6.4	2.58	0.9
K2/ Run #2	8.1 – 8.2	85.1 – 85.0	13.0	2.55	1.5
K3/ Run #2	11.9 – 12.1	83.1 – 82.9	18.2	2.58	2.3

Based on the laboratory UCS, in accordance with Table 3.5 in CFEM (2006)[4], the shale bedrock is generally classified as weak (R2, 5 MPa < UCS < 25 MPa).

4.2.2.10 Groundwater Conditions

The overburden samples obtained from the borehole investigations were generally moist to wet. The depths and elevation of the water level observed in the boreholes upon completion of drilling and prior to rock coring is presented below.

Borehole	Upon Completion of Drilling		Comment
	Water Level Depth (m)	Water Elevation (m)	
K1	1.2	88.9	Upon completion of overburden drilling and prior to rock coring.
K2	5.2	88.0	
K3	9.8	85.2	
K4	7.3	87.7	
K5	2.4	92.6	Water used during soil drilling.
K6	12.3	82.6	
NRW3-6	5.2	87.7	
NRW7-3	6.4	88.5	Upon completion of soil drilling

The water level recorded in the standpipe piezometer installed in one borehole of the current investigation are presented below.

Borehole	Stratum Well Sealed Into	Water Level Depth (m)	Water Elevation (m)	Date of Piezometer Reading
K2	Fill / Residual Soil / Bedrock	2.1	91.1	December 17, 2018

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

4.2.2.11 Analytical Testing Results

As noted in Section 3.0, one sample of crushed and homogenized shale bedrock core from Borehole K1 and two samples of fill (from Boreholes K3 and K6) were submitted for analysis of parameters used to assess the potential corrosivity of the site soil and bedrock to steel and concrete. The following summarizes the results of the testing:

Parameter	Borehole K1 (Run #1 Shale)	Borehole K3 (SA#7 FILL)	Borehole K6 (SA#5 FILL)
pH	7.73	7.10	7.65
Resistivity (ohm-cm)	2700	810	640
Electrical Conductivity (umho/cm)	372	1230	1550
Chlorides (ug/g)	53	600	830
Soluble Sulphates (ug/g)	97	210	46

5.0 CLOSURE

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

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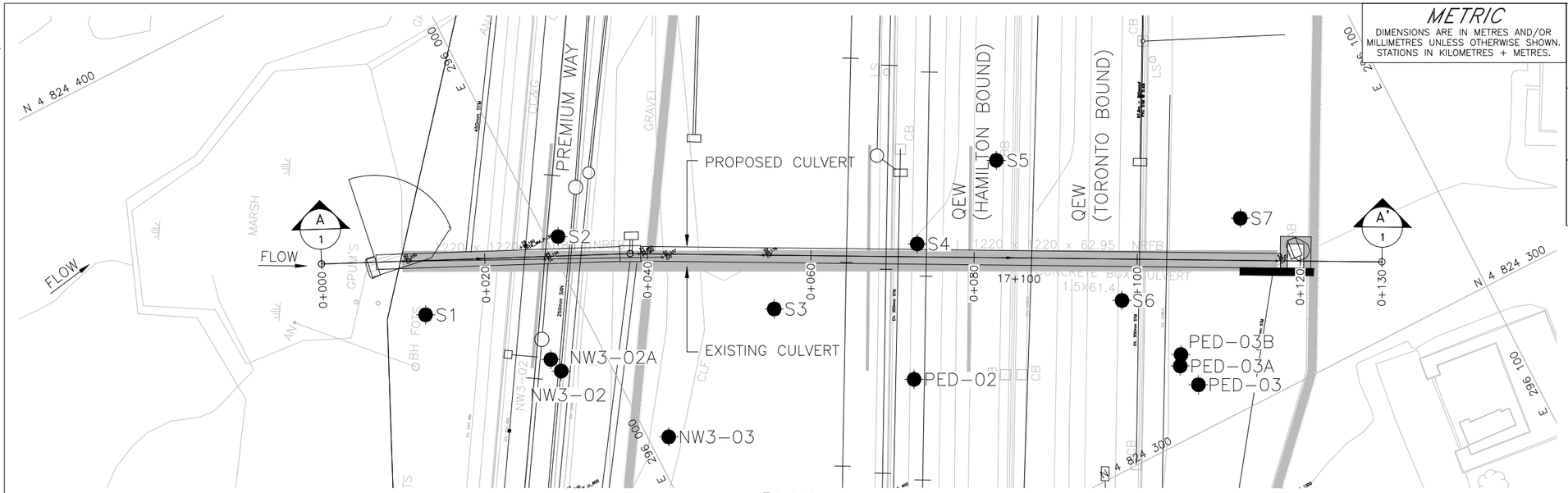
AM/SMM/JMAC/rb

https://golderassociates.sharepoint.com/sites/11176g/shared documents/07-reporting/foundations/11 - culverts/3 - final/1662333 fir stavebank kenollie culverts 2019apr30.docx

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
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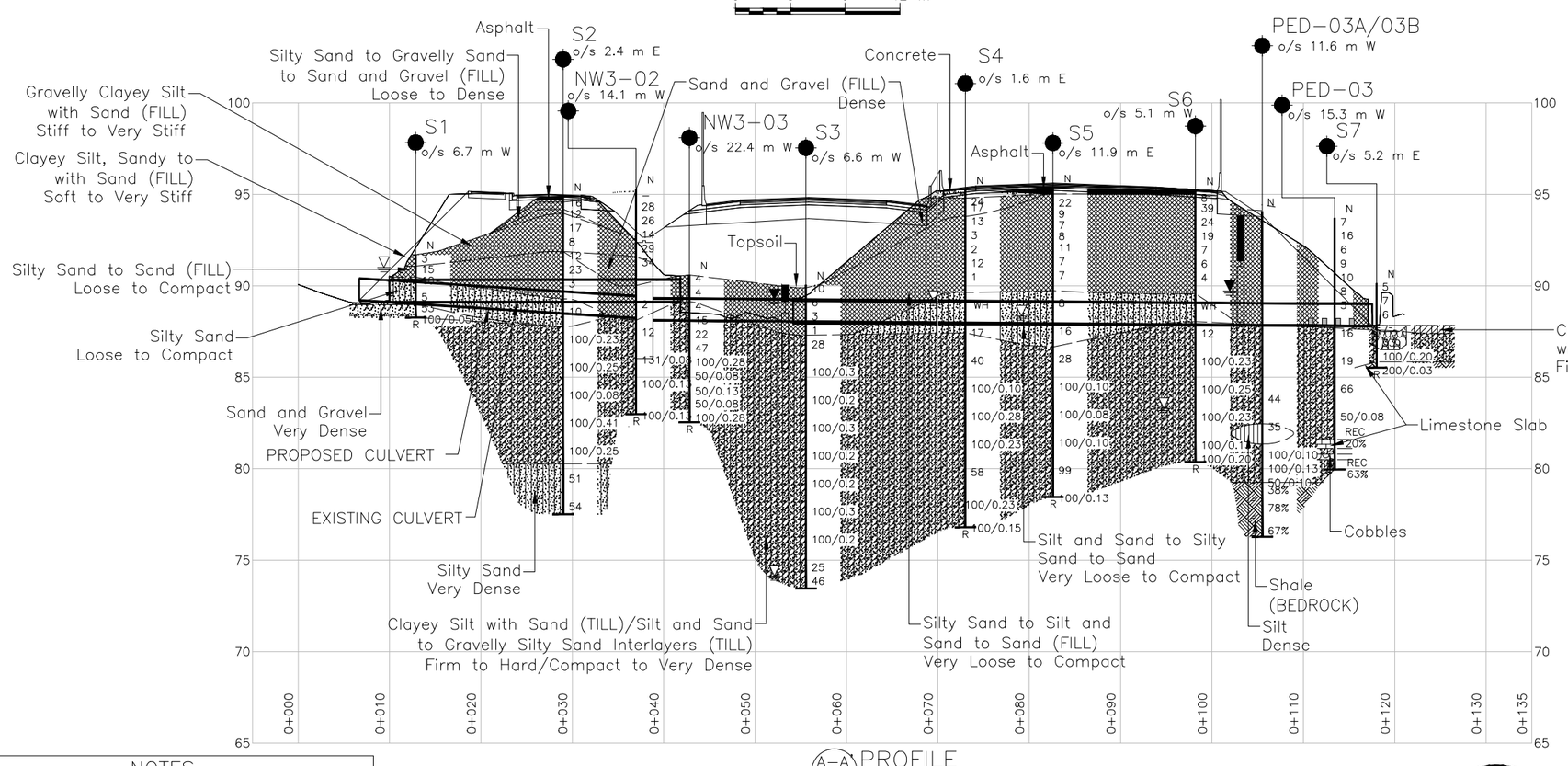


A-A PROFILE
(A 1)
SCALE HORIZONTAL 6 0 6 12 m
SCALE VERTICAL 3 0 3 6 m

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.

METRIC

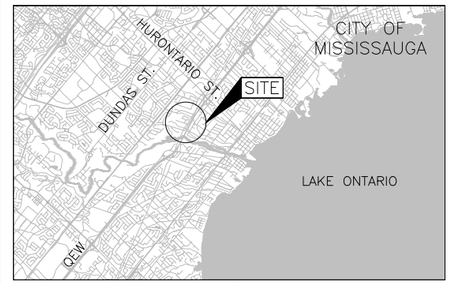
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. 2019-2016
GWP No. 2002-13-00

SHEET

QEW WIDENING-MISISSAUGA RD TO HURONTARIO ST
STAVEBANK CREEK CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- WL in piezometer, measured on NOV 28, 2017 or NOV 6, 2018
- WL upon completion of drilling
- R — Split-spoon Refusal
- REC/% — Recovery

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
S7	90.1	4824321.2	296076.9
S6	95.2	4824318.8	296059.4
S5	95.3	4824341.1	296053.5
S4	95.2	4824336.4	296040.2
S3	90.0	4824337.3	296021.0
S2	94.9	4824357.2	296001.4
S1	91.7	4824356.1	295982.6
PED-03B	94.1	4824309.6	296062.8
PED-03A	94.1	4824308.4	296062.1
PED-03	93.7	4824305.3	296063.0
PED-02	95.2	4824321.8	296032.3
NW3-03	90.6	4824329.2	296002.3
NW3-02A	95.3	4824344.2	295993.8
NW3-02	95.3	4824342.4	295994.3

REFERENCE

Base plans provided in digital format by Morrison Hershfield, drawing file no. X11609340Base.dwg, received April 12, 2018.
Culverts plan provided in digital format by Morrison Hershfield, drawing file no. Culverts-and-Protection.dwg, received August 28, 2018.
General arrangement plan provided by Morrison Hershfield, drawing file 11609340 – QEW Culvert – C3D 2017.dwg, received January 11, 2019.

NO.	DATE	BY	REVISION
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Geocres No.: 30M12-441

HWY. QEW		PROJECT NO. 1662333	DIST. CENTRAL
SUBM'D. ACM	CHKD. DM	DATE: 02/15/2019	SITE: .
DRAWN: DD	CHKD. SMM	APPD. JMAC	DWG. 1

LICENSED PROFESSIONAL ENGINEER J.M.A. COSTA Feb. 15, 2019 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER S. McGaghran Feb. 15, 2019 PROVINCE OF ONTARIO

PLOT DATE: February 15, 2019
FILENAME: S:\Clients\MTO\QEW-Credit_River\09_PROJ\1662333_MR_PMP\40_PROD\0013_Stavebank_Culvert\1662333-0013-BC-0001.dwg

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

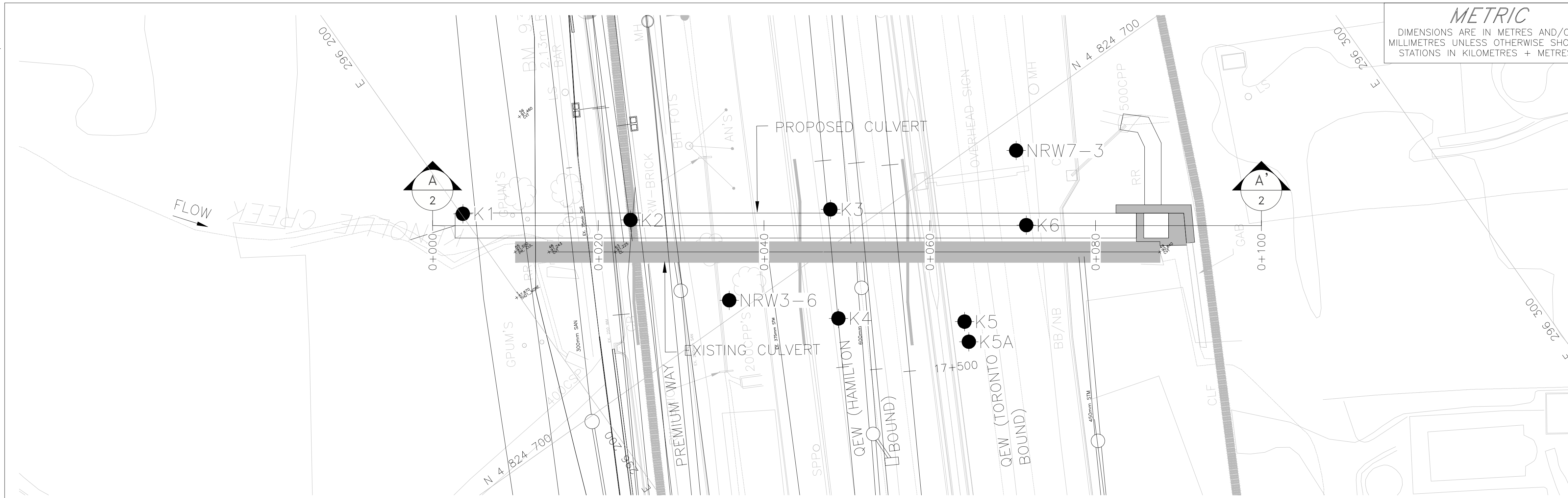
CONT No. 2019–2016
GWP No. 2002–13–00

SHEET

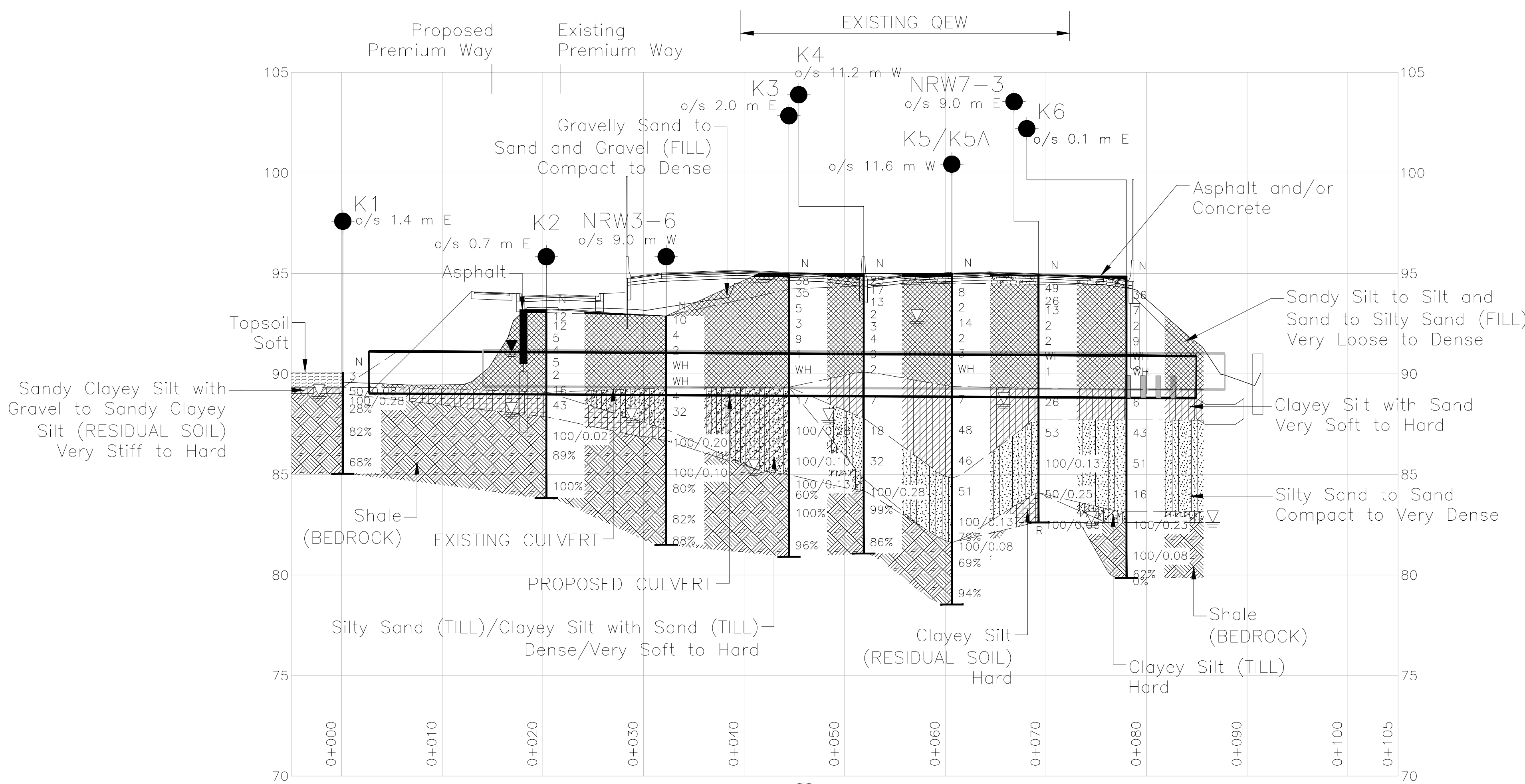
QEW WIDENING MISSISSAUGA RD TO HURONTARIO ST
KENOLLIE CREEK CULVERT

BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER



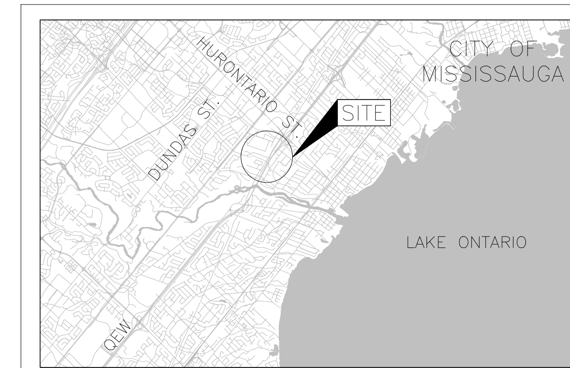
PLAN
SCALE
6 0 6 12 m



A–A PROFILE

SCALE HORIZONTAL
6 0 6 12 m

SCALE VERTICAL
3 0 3 6 m



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

●	Borehole – Current Investigation
▮	Seal
▯	Piezometer
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
100%	Rock Quality Designation (RQD)
▼	WL in piezometer, measured on DEC 17, 2018
▽	WL upon completion of drilling
R	Split-Spoon Refusal

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
K1	90.1	4824728.9	296200.2
K2	93.2	4824716.6	296216.3
K3	95.0	4824703.7	296236.7
K4	95.0	4824692.4	296229.9
K5	95.0	4824683.3	296242.1
K5A	95.0	4824681.0	296241.1
K6	94.9	4824688.5	296254.9
NRW3–6	92.9	4824701.8	296220.4
NRW7–3	94.9	4824696.6	296259.1

NOTES

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

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

REFERENCE

Base plans provided in digital format by Morrison Hershfield, drawing file no. X11609340Base.dwg, received April 12, 2018.
Culverts plan provided in digital format by Morrison Hershfield, drawing file no. Culverts–and–Protection.dwg, received August 28, 2018,
General arrangement plan provided by Morrison Hershfield, drawing file 11609340 – QEW Culvert – C3D 2017.dwg, received January 11, 2019.

NO.	DATE	BY	REVISION

Geocres No. **30M12-441**

HWY. QEW	PROJECT NO. 1662333	DIST. CENTRAL
SUBM'D. ACM / CHKD. DM	DATE: 02/15/2019	SITE:
DRAWN: DD / CHKD. SMM	APPD. JMAC	DWG. 2

PLOT DATE: February 19, 2019
FILENAME: S:\Clients\MTO\QEW-Credit_River\99_PROJ\1662333_MH_PAP\40_PROD\0019_Kenollie_Culvert\1662333-0019-BG-0001.dwg

CREATED: April 8, 2019 8 BY: DPM Project: 1662333

PROJECT
Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street

TITLE
Looking East toward Borehole S1 and Inlet of Proposed Stavebank Culvert

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	DPM	08/04/19	SCALE	AS SHOWN	VER. 1.
CADD	--		**Photograph 1**		
CHECK	SMM				
REVIEW	JMAC				

PROJECT

Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street

TITLE

Looking West at Borehole S2 on Stavebank Road

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	DPM	08/04/19	SCALE	AS SHOWN	VER. 1.
CADD	--		**Photograph 2**		
CHECK	SMM				
REVIEW	JMAC				

CREATED: April 8, 2019 8 BY: DPM Project: 1662333

PROJECT

Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street

TITLE

Looking East towards Borehole S3 between Stavebank Road and the QEW

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	DPM	08/04/19	SCALE	AS SHOWN	VER. 1.
CADD	--		**Photograph 3**		
CHECK	SMM				
REVIEW	JMAC				

CREATED: April 8, 2019 8 BY: DPM Project: 1662333

PROJECT

Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street

TITLE

Looking West towards Borehole S4, Located in QEW Erie-Bound Lanes

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	DPM	08/04/19	SCALE	AS SHOWN	VER. 1.
CADD	--		**Photograph 4**		
CHECK	SMM				
REVIEW	JMAC				

CREATED: April 8, 2019 8 BY: DPM Project: 1662333

PROJECT

Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street

TITLE

Looking South-East towards Borehole S7 at Outlet of Proposed Stavebank Culvert

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	DPM	08/04/19	SCALE	AS SHOWN	VER. 1.
CADD	--		**Photograph 5**		
CHECK	SMM				
REVIEW	JMAC				

CREATED: April 8, 2019 8 BY: DPM Project: 1662333

PROJECT

Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street

TITLE

Looking West towards Borehole K1 at Inlet of Proposed Kenolie Culvert

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	DPM	08/04/19	SCALE	AS SHOWN	VER. 1.
CADD	--		**Photograph 6**		
CHECK	SMM				
REVIEW	JMAC				

CREATED: April 8, 2019 8 BY: DPM Project: 1662333

PROJECT

Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street

TITLE

Looking East towards Borehole K2 from Premium Way

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	DPM	08/04/19	SCALE	AS SHOWN	VER. 1.
CADD	--		**Photograph 7**		
CHECK	SMM				
REVIEW	JMAC				

CREATED: April 8, 2019 8 BY: DPM Project: 1662333

PROJECT

Stavebank Creek Culvert and Kenollie Creek Culvert Replacements, QEW Widening from West of Mississauga Road to West of Hurontario Street

TITLE

Looking South towards Borehole K3 from QEW Erie-Bound Lanes

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	DPM	08/04/19	SCALE	AS SHOWN	VER. 1.
CADD	--		**Photograph 8**		
CHECK	SMM				
REVIEW	JMAC				

CREATED: April 8, 2019 8 BY: DPM Project: 1662333

APPENDIX A

Record of Borehole and Drillhole Sheets, Bedrock Core Photographs and Geotechnical Laboratory Results for Stavebank Creek Culvert

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
σ_1, σ_2, σ_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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan 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^{o} 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 S1

SHEET 1 OF 1 **METRIC**

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

LOCATION N 4824356.1; E 295982.6 MTM NAD 83 ZONE 10 (LAT. 43.559090; LONG. -79.609144)
BOREHOLE TYPE Portable Tripod - NW Casing and Wash Boring
DATE December 19, 2018

ORIGINATED BY ACM
COMPILED BY SK
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
91.7	GROUND SURFACE										
0.0	Clayey silt with sand (FILL) Soft Brown		1	SS	3						
91.1	Moist					▽	91				
0.6	Silty sand, some gravel (FILL) Compact Brown		2	SS	15				○		
90.5	Moist										
1.2	Silty SAND, some gravel, trace clay Loose to compact Grey-brown Wet		3	SS	10		90		○		18 53 25 4
			4	SS	5						
89.0							89				
2.7	SAND and GRAVEL, trace to some silt, trace clay Very dense Grey		5	SS	53				○		35 57 6 2
88.3	Wet		6	SS	100/0.05						
3.4	END OF BOREHOLE										

NOTES:

1. Water level measured at a depth of about 0.7 m below ground surface (Elev. 91.0 m) upon completion of drilling.

2. Flowing sands encountered between a depth of about 2.4 m to 3.4 m.

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

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

GTA-MTO 001 S:\CLIENTS\MTO\QEW-CREDIT_RIVER\02_DATA\GINT\QEW-CREDIT_RIVER.GPJ GAL-GTA.GDT 2/13/19

GOLDER

RECORD OF BOREHOLE No S2

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824357.2; E 296001.4 MTM NAD 83 ZONE 10 (LAT. 43.559092; LONG. -79.608907) ORIGINATED BY ACM

DIST Central HWY QEW BOREHOLE TYPE CME 75, 210 mm O.D. Hollow Stem Augers COMPILED BY JMP

DATUM Geodetic DATE September 13, 2018 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
94.9 / 0.0	GROUND SURFACE ASPHALT (150 mm)								
94.2 / 0.9	Sand and gravel, some silt (FILL) Brown Moist		1A 1B	SS	16		94		
	Sandy silt, trace organics, some wood fragments (FILL) Compact Brown Moist		2A 2B	SS	12				
	Gravelly sand, trace silt (FILL) Grey Moist		3	SS	17		93		
	Gravelly clayey silt with sand (FILL) Stiff to very stiff Grey-brown Moist		4	SS	8		92		
91.2 / 3.7	- Auger grinding from 1.5 m to 2.7 m Sand, some silt, some gravel, trace clay, asphalt pieces (FILL) Compact Brown-grey, contains oxidation staining		5	SS	12				21 49 21 9
90.4 / 4.5	Moist Silty sand, trace to some clay (FILL) Loose Brown to grey		6A 6B	SS	23		91		19 61 15 5
	Wet		7	SS	3		90		
89.3 / 5.6	Silty SAND, trace to some clay Loose Brown to grey Wet		8	SS	10		89		0 72 22 6
87.8 / 7.1	Sandy CLAYEY SILT, some gravel to gravelly (TILL) Hard Grey Moist		9	SS	100/0.23		88		
			10	SS	100/0.25		87		
	- Auger grinding from 9.8 m to 10.1 m		11	SS	100/0.08		86		
	- Auger grinding from 11.0 m to 11.6 m		12	SS	100/0.41		85		
	- Auger grinding at 13.4 m		13	SS	100/0.25		84		20 29 42 9
80.3 / 14.6	Silty SAND						83		
							82		
							81		
							80		

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

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No S2

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824357.2; E 296001.4 MTM NAD 83 ZONE 10 (LAT. 43.559092; LONG. -79.608907) ORIGINATED BY ACM

DIST Central HWY QEW BOREHOLE TYPE CME 75, 210 mm O.D. Hollow Stem Augers COMPILED BY JMP

DATUM Geodetic DATE September 13, 2018 CHECKED BY SMM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Silty SAND, some gravel, trace to some clay Very dense Grey Moist		14	SS	51		79				
77.5			15	SS	54		78		○		13 55 25 7
17.4	END OF BOREHOLE NOTE: 1. Borehole dry upon completion of drilling.										

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

GOLDER

RECORD OF BOREHOLE No S3

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824337.3; E 296021.0 MTM NAD 83 ZONE 10 (LAT. 43.558912; LONG. -79.608665)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 108 mm I.D., Hollow Stem Augers

COMPILED BY JMP

DATUM Geodetic

DATE October 9, 2018

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
90.0	GROUND SURFACE								
0.0	TOPSOIL (150 mm)		1A						
0.2	Silt and sand, trace to some clay, trace to some gravel, wood pieces, organic odour (FILL) Very loose to compact Brown and black Moist to wet - Some gravel from 0.2 m to 0.6 m		1B	SS	10				
			2	SS	6		89		
			3	SS	3		88		6 43 43 8
87.3			4A	SS	1				
2.7	CLAYEY SILT with SAND, some gravel (TILL) Very stiff to hard Grey Moist - Auger grinding from 3.4 m to 3.7 m		4B				87		
			5	SS	28		86		19 32 36 13
			6	SS	100/0.3		85		
84.6									
5.4	SILT and SAND, some gravel (TILL) Very dense Grey Moist - Auger grinding from 7.0 m to 7.3 m		7	SS	100/0.2		84		17 42 35 6
82.8							83		
7.2	Gravelly silty SAND (TILL) Very dense Grey Moist		8	SS	100/0.3		82		
81.3									
8.7	CLAYEY SILT with SAND (TILL) Hard Grey Moist		9	SS	100/0.2		81		
			10	SS	100/0.2		80		0 77 17 6
	- Auger grinding from 11.3 m to 11.4 m						79		
			11	SS	100/0.3		78		
			12	SS	100/0.2		77		
	- Oxidation staining at 13.9 m - Auger grinding from 14.0 m to 14.3 m						76		
75.3									
14.7	Gravelly SAND (TILL)								

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

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No S3

SHEET 2 OF 2 **METRIC**

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

LOCATION N 4824337.3; E 296021.0 MTM NAD 83 ZONE 10 (LAT. 43.558912; LONG. -79.608665)
BOREHOLE TYPE CME 55, 108 mm I.D., Hollow Stem Augers
DATE October 9, 2018

ORIGINATED BY ACM
COMPILED BY JMP
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 ---										
	Gravelly SAND, trace to some silt, trace clay (TILL) Compact to dense Grey Wet		13	SS	25		74		○		20 72 6 2
73.4			14	SS	46						
16.6	END OF BOREHOLE										

NOTES:

1. Water level measured at a depth of 15.9 m below ground surface (Elev. 74.1 m) upon completion of drilling.

2. Groundwater level measurements in piezometer:

Date	Depth (m)	Elev. (m)
06/11/18	0.8	89.2

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

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

GOLDER

RECORD OF BOREHOLE No S4

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824336.4; E 296040.2 MTM NAD 83 ZONE 10 (LAT. 43.558913; LONG. -79.608430) ORIGINATED BY ACM

DIST Central HWY QEW BOREHOLE TYPE CME 55, 108 mm I.D., Hollow Stem Augers COMPILED BY JMP

DATUM Geodetic DATE September 16, 2018 CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
95.2	GROUND SURFACE						
0.0	CONCRETE (450 mm)						95
94.7							
0.5	Sand and gravel, trace to some silt (FILL) Compact Brown Moist		1	SS	24		
			2	SS	17		94
93.7							
1.5	Silt and sand, trace clay (FILL) Very loose to compact Brown Moist to wet at a depth of 5.0 m		3	SS	13		
	- Trace to some gravel from 2.3 m to 2.9 m		4	SS	3		93
			5	SS	2		92
			6	SS	12		91
			7	SS	1		
89.6							90
5.6	SILT and SAND Very loose Grey Wet		8	SS	WH	▽	89
	- Silty seam at a depth of 6.6 m, 1 mm thick						
87.4	- Trace clay layer between 7.6 m to 7.8 m		9A 9B	SS	17		88
7.8	SILT and SAND, some gravel, trace to some clay (TILL) Compact to very dense Grey Moist to wet						87
			10	SS	40		86
			11	SS	100/0.10		85
83.7							84
11.5	Gravelly CLAYEY SILT with SAND (TILL) Hard Grey Moist		12	SS	100/0.28		83
	- Auger grinding from 12.8 m to 13.4 m						
			13	SS	100/0.23		82
							81

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
	0	65	33	2
	16	42	37	5
	19	43	27	11

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

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GOLDER

RECORD OF BOREHOLE No S4

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824336.4; E 296040.2 MTM NAD 83 ZONE 10 (LAT. 43.558913; LONG. -79.608430)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 108 mm I.D., Hollow Stem Augers

COMPILED BY JMP

DATUM Geodetic

DATE September 16, 2018

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 ---										
	Gravelly CLAYEY SILT with SAND (TILL) Hard Grey Moist		14	SS	58		80				
							79				
			15	SS	100/0.23				○ —		29 45 19 7
	- Auger grinding from 17.4 m to 17.7 m						78				
76.8			16	SS	100/0.15		77				
18.4	END OF BOREHOLE										

NOTES:

1. Water level recorded at a depth of about 6.1 m below ground surface (Elev. 89.1 m) upon completion of drilling.

2. Borehole caved to a depth of about 6.1 m upon removal of augers.

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

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

GOLDER

RECORD OF BOREHOLE No S5

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824341.1; E 296053.5 MTM NAD 83 ZONE 10 (LAT. 43.558955; LONG. -79.608265)

ORIGINATED BY SK

DIST Central HWY QEW

BOREHOLE TYPE CME 75, 184 mm O.D., Hollow Stem Augers

COMPILED BY JMP

DATUM Geodetic

DATE November 23, 2018

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
95.3	GROUND SURFACE										
0.0 / 95.0	ASPHALT (300 mm)						95				
0.3	Silt and sand, trace clay (FILL) Loose to compact Brown Moist		1	SS	22						
	- Auger grinding from 0.3 m to 0.6 m		2	SS	9		94		○		
			3	SS	7						
	- Some oxidation staining at 2.4 m to 3.1 m		4	SS	8		93		○		0 58 41 1
			5	SS	11						
			6	SS	7		92		○		
			7	SS	7						
89.7							91				
5.6	SILT and SAND to SAND, some organics, some wood pieces, trace clay Loose to compact Grey Moist		8	SS	8	▽	90		○		Org = 1.5%
			9	SS	16		89		○		Org = 2.2%
86.6							88				
8.7	CLAYEY SILT with SAND, some gravel (TILL) Very stiff to hard Grey Moist		10	SS	28		87		○ ⊢		18 34 38 10
	- Auger grinding at 10.4 m		11	SS	100/0.10		86				
83.6							85				
11.7	SILT and SAND, some gravel, trace to some clay, trace organics (TILL) Very dense Grey Moist		12	SS	100/0.08		84		○ ⊢		18 30 45 7
82.0							83				
13.3	CLAYEY SILT with SAND, some gravel, shale fragments (TILL) Hard Grey Moist		13	SS	100/0.10		82				
							81				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

PROJECT 1662333

RECORD OF BOREHOLE No S5

SHEET 2 OF 2

METRIC

G.W.P. 2002-13-00 LOCATION N 4824341.1; E 296053.5 MTM NAD 83 ZONE 10 (LAT. 43.558955; LONG. -79.608265) ORIGINATED BY SK

DIST Central HWY QEW BOREHOLE TYPE CME 75, 184 mm O.D., Hollow Stem Augers COMPILED BY JMP

DATUM Geodetic DATE November 23, 2018 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 ---										
	CLAYEY SILT with SAND, some gravel, shale fragments (TILL) Hard Grey Moist		14	SS	99		80		○ ⊢		15 55 23 7
78.4	- Oxidation staining at 16.8 m		15	SS	100/0.13		79				
16.9	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of 7.6 m below ground surface upon completion of drilling.

2. Water level measured in caved borehole at a depth of 7.0 m below ground surface (Elev 88.3 m) upon completion of drilling.

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

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GOLDER

RECORD OF BOREHOLE No S6

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824318.8; E 296059.4 MTM NAD 83 ZONE 10 (LAT. 43.558755; LONG. -79.608192)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 108 mm I.D., Hollow Stem Augers

COMPILED BY JMP

DATUM Geodetic

DATE October 2, 2018

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
95.2	GROUND SURFACE								
0.0	ASPHALT (200 mm)								
0.2	Sand and gravel (FILL) Very dense Brown		1	SS	8				
94.5									
0.7	Moist Silt and sand, trace clay, trace gravel (FILL) Loose to dense Brown Moist		2	SS	39				
			3	SS	24				
			4	SS	19				2 63 31 4
			5	SS	7				
			6	SS	6				
			7	SS	4				0 56 41 3
89.6									
5.6	Silty SAND, trace to some clay, some gravel Very loose Brown to grey at 6.3 m Wet		8	SS	WH				
88.0									
7.2	CLAYEY SILT with SAND, trace gravel (TILL) Stiff to hard Grey Moist - Sand pocket at 7.9 m and 10.8 m		9	SS	12				4 33 46 17
			10	SS	100/0.23				
			11	SS	100/0.25				
83.6									
11.6	SILT and SAND, trace to some clay, trace gravel (TILL) Hard Grey Moist		12	SS	100/0.23	▽			2 30 58 10
81.8									
13.4	CLAYEY SILT with SAND with GRAVEL, containing shale fragments (TILL) Hard Grey Moist to wet - Auger grinding from 13.4 m to 14.5 m		13	SS	100/0.13				
			14	SS	100/0.20				44 36 16 4
80.4									
14.8	- Auger bouncing at 14.5 m								

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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

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

PROJECT 1662333

RECORD OF BOREHOLE No S6

SHEET 2 OF 2

METRIC

G.W.P. 2002-13-00 LOCATION N 4824318.8; E 296059.4 MTM NAD 83 ZONE 10 (LAT. 43.558755; LONG. -79.608192) ORIGINATED BY ACM

DIST Central HWY QEW BOREHOLE TYPE CME 55, 108 mm I.D., Hollow Stem Augers COMPILED BY JMP

DATUM Geodetic DATE October 2, 2018 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, ● 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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE NOTES: 1. Water level measured at a depth of 11.9 m (Elev. 83.3 m) below ground surface upon completion of drilling.										

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

GOLDER

RECORD OF BOREHOLE No S7

SHEET 1 OF 1 **METRIC**

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824321.2; E 296076.9 MTM NAD 83 ZONE 10 (LAT. 43.558768; LONG. -79.607973) ORIGINATED BY ACM

DIST Central HWY QEW BOREHOLE TYPE Portable Tripod - NW Casing and Wash Boring COMPILED BY SK

DATUM Geodetic DATE December 20-21, 2018 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
90.1	GROUND SURFACE										
0.0 / 89.8	TOPSOIL		1A	SS	5		90				
0.3	Silt and sand, trace to some gravel, trace clay (FILL) Loose Brown with oxidation staining Moist to wet at 8.7 m		1B								
			2	SS	7		89				7 56 34 3
	- 0.03 m concrete piece at 1.5 m		3	SS	6						
87.8							88				
2.3 / 87.4	CLAYEY SILT with SAND, trace gravel Firm Grey Wet		4A	SS	7						4 43 37 16
2.7	- Oxidation staining from 2.7 m to 3.7 m		4B								
			5	SS	33		87				3 33 44 20
	CLAYEY SILT with SAND, trace gravel (TILL) Hard Brown-grey to grey Moist		6	SS	100/0.20						
85.8 / 85.5	LIMESTONE		7	SS	200/0.03		86				
4.6	END OF BOREHOLE SPLIT-SPOON REFUSAL										

NOTES:

1. Water level not taken due to water added during drilling.

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

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GOLDER

RECORD OF BOREHOLE No NW3-2

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824342.4; E 295994.3 MTM NAD 83 ZONE 10 (LAT. 43.558958; LONG. -79.608996)

ORIGINATED BY FC

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 203 mm O.D. Hollow Stem Augers

COMPILED BY KN

DATUM Geodetic

DATE August 23, 2017

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
95.3 / 0.0	GROUND SURFACE ASPHALT (150 mm)							
0.2	Silty sand, some gravel to gravelly, trace to some clay (FILL) Compact Brown Moist	1	AS	-				
		2	SS	28				
	- Asphalt fragments at a depth of about 1.8 m	3	SS	26	16	58	20	6
92.7 / 2.6	Sandy clayey silt, trace to some gravel (FILL) Stiff to very stiff Brown to grey, mottled Moist	4A 4B	SS	14				
		5	SS	29				
91.6 / 3.7	Sand and gravel, some silt, trace clay (FILL) Dense Grey to brown Moist to wet - Trace asphalt fragments at a depth of about 4.0 m	6	SS	34	43	41	12	4
90.0 / 5.3	Silty sand, trace clay, trace gravel, trace organics, trace asphalt fragments (FILL) Very loose Brown Moist to wet	7	SS	2	1	70	26	3
87.5 / 7.8	- 100 mm silty sand, organic layer and pieces of wood at a depth of 7.6 m CLAYEY SILT with SAND, some gravel (TILL) Stiff to hard Grey Moist to wet - Trace organics from a depth of about 8.5 m	8	SS	12				
		9	SS	131/0.08	12	38	38	12
		10	SS	100/0.13				
83.0 / 12.3	END OF BOREHOLE NOTE: 1. Borehole dry prior to tricone drilling below a depth of 3.4 m and introduction of wash water.	11	SS	100/0.13				

GROUND WATER CONDITIONS

ELEVATION SCALE: 95, 94, 93, 92, 91, 90, 89, 88, 87, 86, 85, 84, 83

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

98.69

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

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

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

GTA-MTO 001 S:\CLIENTS\MTO\QEW-CREDIT_RIVER\02_DATA\GINT\QEW-CREDIT_RIVER.GPJ GAL-GTA.GDT 2/13/19

GOLDER

RECORD OF BOREHOLE No NW3-2A

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824344.2; E 295993.8 MTM NAD 83 ZONE 10 (LAT. 43.558975; LONG. -79.609002) ORIGINATED BY FC

DIST Central HWY QEW BOREHOLE TYPE CME 850, 156 mm Tricone with Drilling Mud COMPILED BY KN

DATUM Geodetic DATE November 20-21, 2017 CHECKED BY MWK

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
95.3	GROUND SURFACE						95				
0.0							94				
							93				
						▽	92				
							91				
							90				
	Refer to Record of Borehole NW3-2 for soil profile details. Borehole NW3-2A locates about 2 m NE of Borehole NW3-2.						89				
							88				
							87				
							86				
							85				
							84				
83.1							83				
12.2	CLAYEY SILT with SAND, some gravel (TILL) Hard Grey Moist to wet		1	SS	100/0.10		82				
			2	SS	100/0.28		81				
			3	SS	92						
			4	SS	77						

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No NW3-2A

SHEET 2 OF 2 **METRIC**

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

LOCATION N 4824344.2; E 295993.8 MTM NAD 83 ZONE 10 (LAT. 43.558975; LONG. -79.609002)
BOREHOLE TYPE CME 850, 156 mm Tricone with Drilling Mud
DATE November 20-21, 2017

ORIGINATED BY FC
COMPILED BY KN
CHECKED BY MWK

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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT with SAND, some gravel (TILL) Hard Grey Moist to wet		5	SS	72		80				18 64 14 4
			6	SS	85		79				
77.5							78				
17.8	Gravelly CLAYEY SILT with SAND (TILL) Hard Grey Wet		7	SS	97		77				26 57 14 3
75.0			8	SS	73		76				
20.3	Silty SAND, trace to some clay, trace gravel Grey Moist to wet						75				
73.7			9A 9B	SS	46		74				1 70 24 5
21.6	SILT, some sand, trace clay Dense Grey										
73.1	Wet		10A 10B	SS	100/0.18		73				
22.2	- Clayey silt pocket at a depth of about 21.9 m SAND and GRAVEL, trace to some silt, trace clay Very dense Grey Moist to wet		11	SS	70		72				
			12	SS	100/0.28		71				
			13	SS	100/0.28		70				37 44 16 3
67.7			14	SS	100/0.05		69				
27.6	END OF BOREHOLE NOTES: 1. Water level measured at a depth of about 3.4 m below ground surface (Elev. 91.9 m) on November 21, 2017 before start of drilling when the borehole was at a depth of about 23.5 m, after the introduction of drilling mud/water during borehole drilling operations on Nov 20, 2017.						68				

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

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

GOLDER

RECORD OF BOREHOLE No NW3-3

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824329.2; E 296002.3 MTM NAD 83 ZONE 10 (LAT. 43.558840; LONG. -79.608895) ORIGINATED BY ACM

DIST Central HWY QEW BOREHOLE TYPE CME 55, 114 mm I.D., Hollow Stem Augers COMPILED BY SK

DATUM Geodetic DATE August 9, 2018 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
90.6	GROUND SURFACE										
0.0	Silty sand, some gravel, trace to some clay, trace organics (FILL) Very loose Dark brown Moist to wet below 0.7 m - Hydrocarbon odour at 0.8 m		1	SS	4		90				
			2	SS	4						18 49 27 6
89.2							89				
1.5	CLAYEY SILT with SAND, trace to some gravel (TILL) Soft to stiff Grey-brown to grey at 3.7 m with oxidation staining Moist		3	SS	4						
			4	SS	15		88				8 31 44 17
87.2			5	SS	22						
3.4	SILT and SAND, some gravel, trace to some clay (TILL) Compact to very dense Grey Moist - Auger grinding from 3.4 m to 3.8 m		6	SS	47		87				
			7	SS	100/0.28		86				
			8	SS	50/0.08						
	- Auger grinding from 6.1 m to 6.9 m - Limestone layer between depths of 6.2 m and 6.3 m		9A 9B	SS	50/0.13		85				
			10	SS	50/0.08		84				
			11	SS	100/0.28		83				
82.5											
8.1	END OF BOREHOLE										

NOTES:

1. Open borehole dry upon completion of drilling.

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

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GOLDER

RECORD OF BOREHOLE No PED-02

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824321.8; E 296032.3 MTM NAD 83 ZONE 10 (LAT. 43.558773; LONG. -79.608524)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 75, 203 mm O.D. Hollow Stem Augers, HQ Casing

COMPILED BY DH

DATUM Geodetic

DATE December 4-6 2017

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
95.2	GROUND SURFACE						
0.0	ASPHALT (100 mm)						
0.1	Silt sand to sand, some gravel to gravelly sand, some silt, trace clay, some asphalt fragments (FILL) Loose to Compact Brown Moist		1	AS	-		
			2	SS	25	▽	
			3	SS	14		19 56 22 3
			4	SS	12		
			5	SS	9		
91.5							
3.7	SAND and GRAVEL to GRAVEL trace sand, trace fines Loose Grey Moist to wet		6	SS	5		
			7	SS	7		66 32 (2)
			8	SS	7		
88.7							
6.5	SILT and SAND to Silty SAND Brown						
88.2	Moist to wet						
7.0	CLAYEY SILT, some sand to with SAND, trace to some gravel (TILL) Very stiff to hard Grey Moist to wet		9	SS	20		6 27 45 22
	- SAND to SILTY SAND pockets/zones						
	- Contains some shale fragments throughout		10	SS	100/0.08		
			11	SS	100/0.10		
			12	SS	100/0.03		
			13	SS	100/0.25		

ELEVATION SCALE: 95, 94, 93, 92, 91, 90, 89, 88, 87, 86, 85, 84, 83, 82, 81

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

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

○ $^{3\%}$ STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No PED-02

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824321.8; E 296032.3 MTM NAD 83 ZONE 10 (LAT. 43.558773; LONG. -79.608524) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 75, 203 mm O.D. Hollow Stem Augers, HQ Casing COMPILED BY DH

DATUM Geodetic DATE December 4-6 2017 CHECKED BY MWK

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 ---		14	SS	100/0.28		80		○ w_P — ○ w — ○ w_L		17 51 24 8
79.1											
16.1	Sandy gravelly CLAYEY SILT, some shale fragments (RESIDUAL SOIL) Very dense Grey Moist to wet						79				
78.5			15	SS	100/0.13				○		
16.7	SHALE (BEDROCK) Grey										
	END OF BOREHOLE SPLIT-SPOON REFUSAL										

NOTES:

1. Borehole dry to 3.0 m depth prior to tricone drilling.

2. Water level measured at a depth of about 1.9 m below ground surface (Elev. 93.3 m) on December 5, 2017 before start of drilling when the borehole was at a depth of about 10.5 m.

3. Water level measured at a depth of about 1.1 m below ground surface (Elev. 94.1 m) on December 6, 2017 before start of drilling when the borehole was at a depth of about 16.6 m.

4. The water level measurement is not considered to be representative of the groundwater level due to the introduction of drilling mud/water during borehole drilling operations.

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

GOLDER

RECORD OF BOREHOLE No PED-03

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824305.3; E 296063.0 MTM NAD 83 ZONE 10 (LAT. 43.558625; LONG. -79.608144)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing

COMPILED BY DPM

DATUM Geodetic

DATE October 26-27, 2017

CHECKED BY MWK

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
93.7	GROUND SURFACE										
0.0	TOPSOIL (200mm)										
0.2	Silt and sand to silty sand, trace clay, trace organics (FILL) Very loose to compact Brown Moist		1	SS	7		93				
			2	SS	16		92		○		
			3	SS	6				○		0 66 31 3
			4	SS	9		91		○		
			5	SS	10						
	- Becoming grey at a depth of about 3.5 m - Auger grinding at a depth of about 3.7 m - PHC odour between depths of about 3.8 m and 6.1 m - Becoming black at a depth of about 4.1 m - Some asphalt fragments at a depth of about 4.1 m - Becoming wet at a depth of about 4.6 m - Some gravel at a depth of about 4.6 m		6	SS	8		90		○		14 57 27 2
			7	SS	3		89				
87.6							88				
6.2	Sandy CLAYEY SILT, trace to some gravel to gravelly (TILL) Very stiff to hard Brown and grey Moist to wet - Mottled grey at a depth of about 7.2 m		8	SS	16		87		○		18 26 41 15
			9	SS	19		86		○		
			10	SS	66		85		○		
			11	SS	50/0.08		84				
			1	SC	REC 20%		83				RQD = 0%
	- Limestone slab cored from a depth of about 12.1 m to 12.6 m - Red- grey below a depth of about 12.2 m - Cobbles and gravel from a depth of about 12.9 m to 13.2 m		2	SC	REC 63%		82				RQD = 0%
80.0							81				
13.8	END OF BOREHOLE NOTE: 1. Borehole dry prior to rock coring.						80				

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

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

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GOLDER

RECORD OF BOREHOLE No PED-03A

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824308.4; E 296062.1 MTM NAD 83 ZONE 10 (LAT. 43.558653; LONG. -79.608155) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing COMPILED BY DPM

DATUM Geodetic DATE October 27, 2017 CHECKED BY MWK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ	GR SA SI CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%) 10 20 30	kN/m³	
94.1	GROUND SURFACE							20 40 60 80 100			
0.0	Refer to Record of Borehole PED-03 for soil profile details						94 93 92 91 90 89				
88.0											
6.1	END OF BOREHOLE										

NOTES:

1. Groundwater level measurements in piezometer:

Date	Depth (m)	Elev. (m)
27/10/17	DRY	
14/11/17	4.3	89.8
21/11/17	4.4	89.7
28/11/18	4.4	89.7
06/11/18	4.1	90.0

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

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

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GOLDER

PROJECT 1662333

RECORD OF BOREHOLE No PED-03B

SHEET 1 OF 2

METRIC

G.W.P. 2002-13-00 LOCATION N 4824309.6; E 296062.8 MTM NAD 83 ZONE 10 (LAT. 43.558664; LONG. -79.608146) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 850, 156 mm Tricone with Drilling Mud COMPILED BY KN

DATUM Geodetic DATE November 15-16, 2017 CHECKED BY MWK

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
94.1	GROUND SURFACE										
0.0	Refer to Record of Borehole PED-03 for soil stratigraphy between ground surface and a depth of about 10.1 m						93 92 91 90 89 88 87 86 85				
84.0											
10.1	Sandy gravelly CLAYEY SILT (TILL) Hard Grey Moist to wet		1	SS	44		84				
82.5											
11.6	SILT, some clay, some sand Dense Grey Moist to wet		2	SS	35		83 82		○		
81.4											
12.7	Gravelly CLAYEY SILT with SAND (TILL) Hard Red/grey Moist to wet		3	SS	100/0.10		81		○—○		24 48 21 7
			4	SS	100/0.13		80		○		
79.3			5	SS	50/0.10						
14.8			1	RC							RQD = 38%

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No PED-03B

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824309.6; E 296062.8 MTM NAD 83 ZONE 10 (LAT. 43.558664; LONG. -79.608146) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 850, 156 mm Tricone with Drilling Mud COMPILED BY KN

DATUM Geodetic DATE November 15-16, 2017 CHECKED BY MWK

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 ---										
	Shale BEDROCK Grey		1	RC	REC 96%						RQD = 38%
	Bedrock cored from a depth of 14.8 m to 17.8 m For bedrock coring details, refer to Record of Drillhole PED-03B		2	RC	REC 100%		78				RQD = 78%
			3	RC	REC 100%		77				RQD = 67%
76.3											
17.8	END OF BOREHOLE NOTE: 1. Borehole dry prior to tricone drilling.										

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: PED-03B

SHEET 1 OF 1

LOCATION: N 4824309.6 ;E 296062.8

DRILLING DATE: November 15-16, 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	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole PED-03		79.26															
15	NW Casing	Slightly weathered to fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		14.80	1							BD,CU,SM CL	2	1					R0
												BD,UN,RO CL	3	1					
												BD,UN,RO CL	3	1					R1
												,,	1.5	1					R1
												BD,PL,RO CL	3	1					
												BD,UN,RO CL	3	1					
16	NQ Rock Core				2							BD,UN,RO SO							UC = 6.7 MPa
												JN,UN,RO CL	3	1					
												BD,UN,RO CL	3	1					
												BD,UN,RO CL	3	1					
17												,,							
					3							BD,IR,RO CL	3	1					R1
												BD,PL,RO CL	1.5	1					
												BD,UN,RO CL	3	1					
												,,							R1
				76.29								BD,UN,RO CL	3	1					
		END OF DRILLHOLE		17.77								BD,UN,RO CL							
18																			
19																			
20																			
21																			
22																			
23																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: SMM

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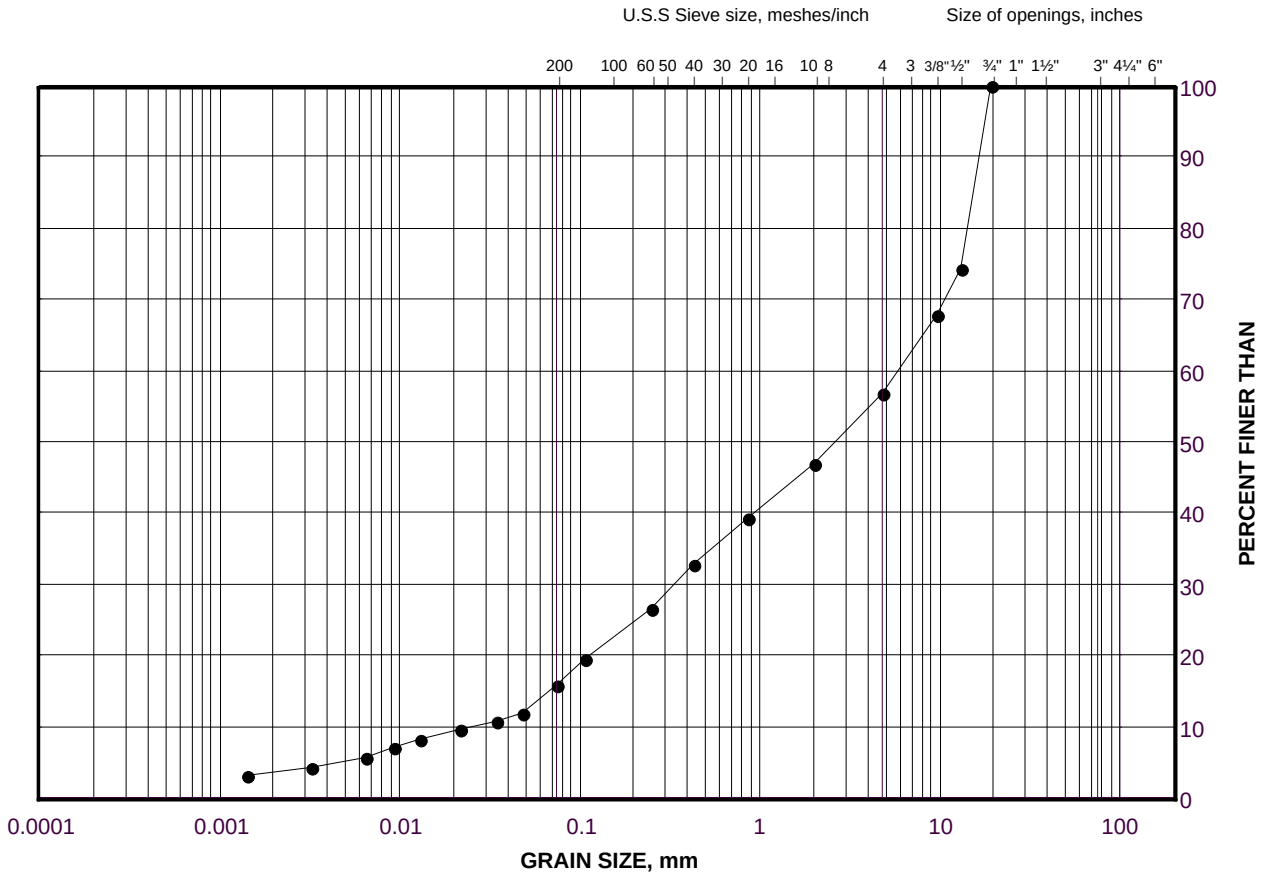
GRAIN SIZE DISTRIBUTION

Sand and Gravel (Fill)

FIGURE A-1



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-2	6	91.2

Project Number: 1662333

Checked By: SMM

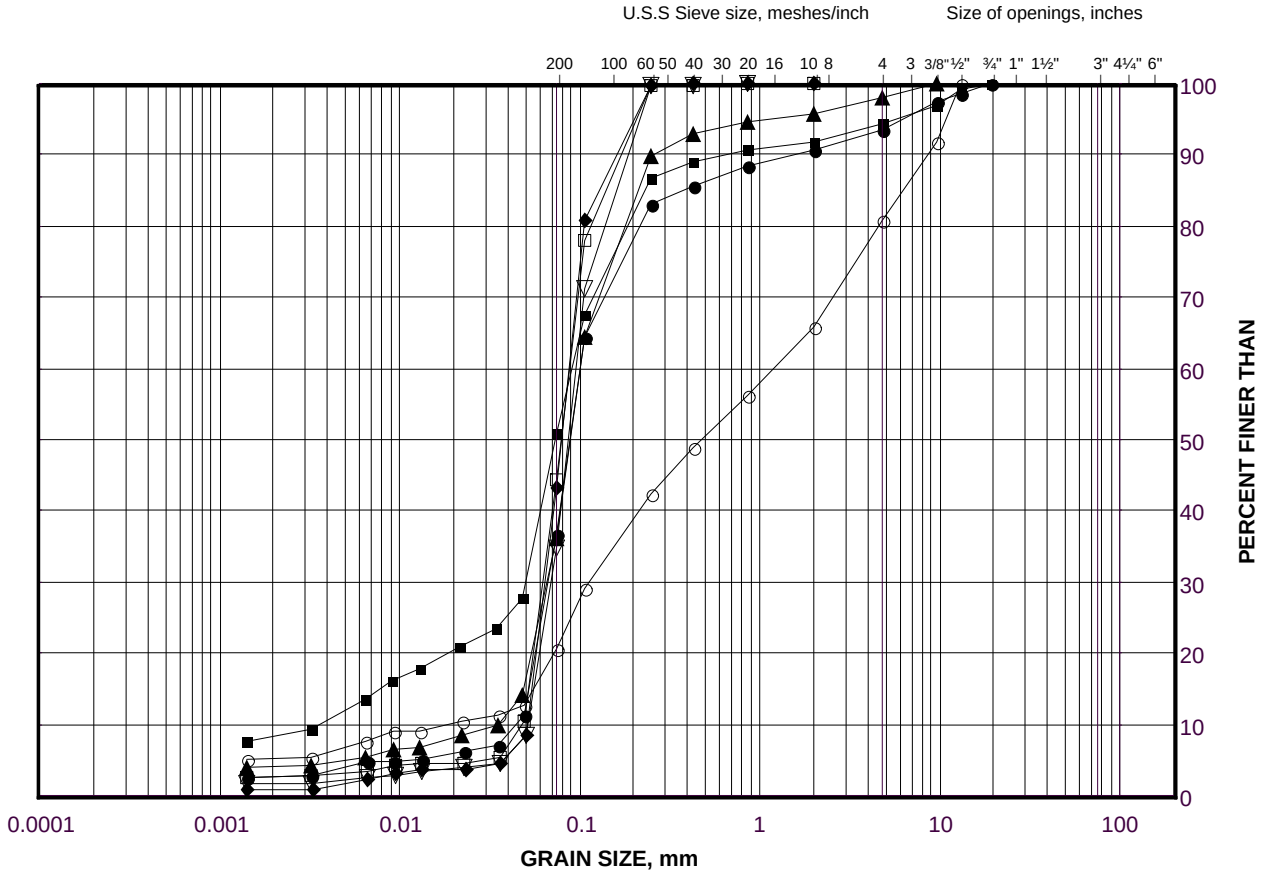
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand (Fill)

FIGURE A-2A



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S7	2	89.1
■	S3	3	88.2
◆	S5	4	92.6
▲	S6	4	92.6
▽	S4	5	91.8
❍	S2	6A	90.9
□	S6	7	90.3

Project Number: 1662333

Checked By: SMM

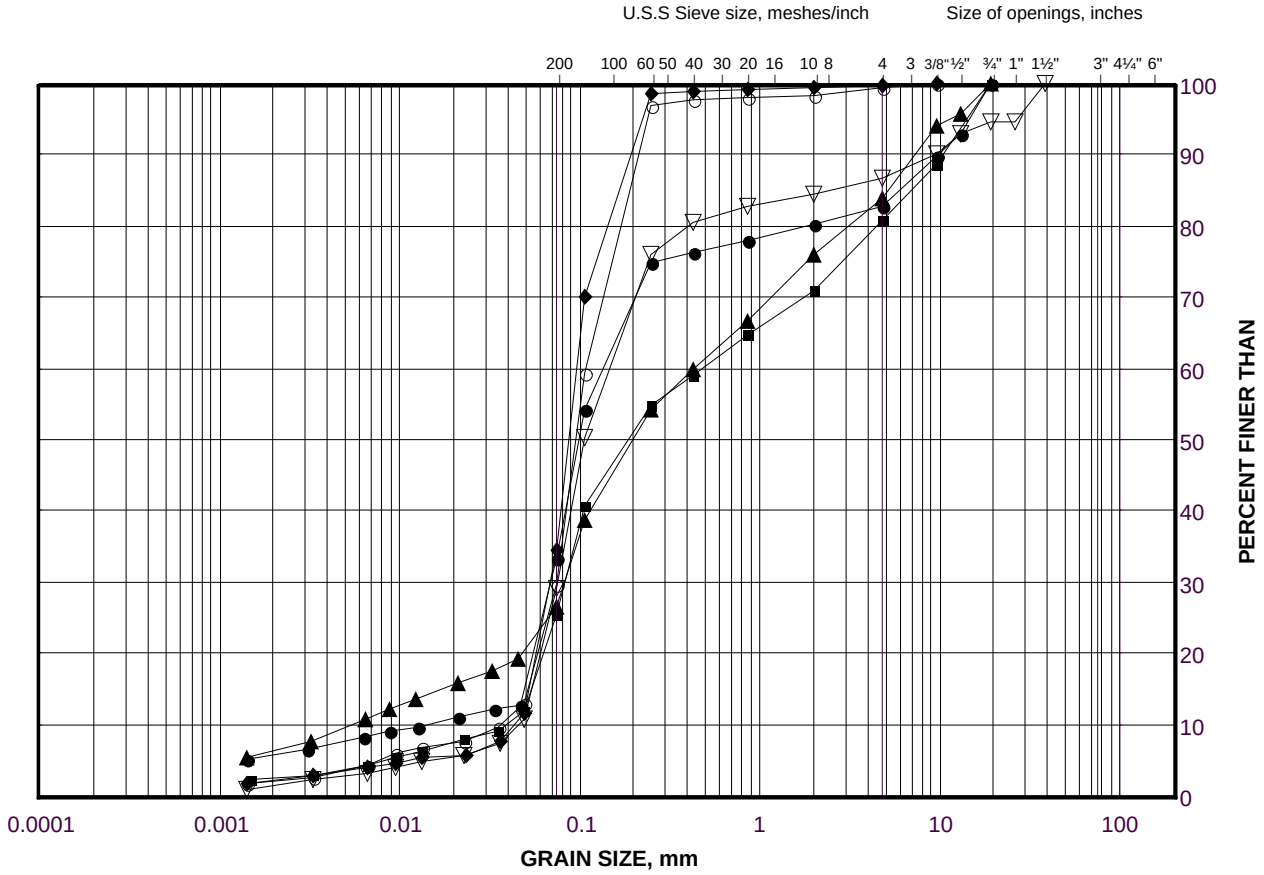
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand to Sand (Fill)

FIGURE A-2B



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW3-3	2	89.5
■	PED-02	3	93.4
◆	PED-03	3	91.9
▲	NW3-2	3	93.4
▽	PED-03	6	89.6
❍	NW3-2	7	88.9

Project Number: 1662333

Checked By: SMM

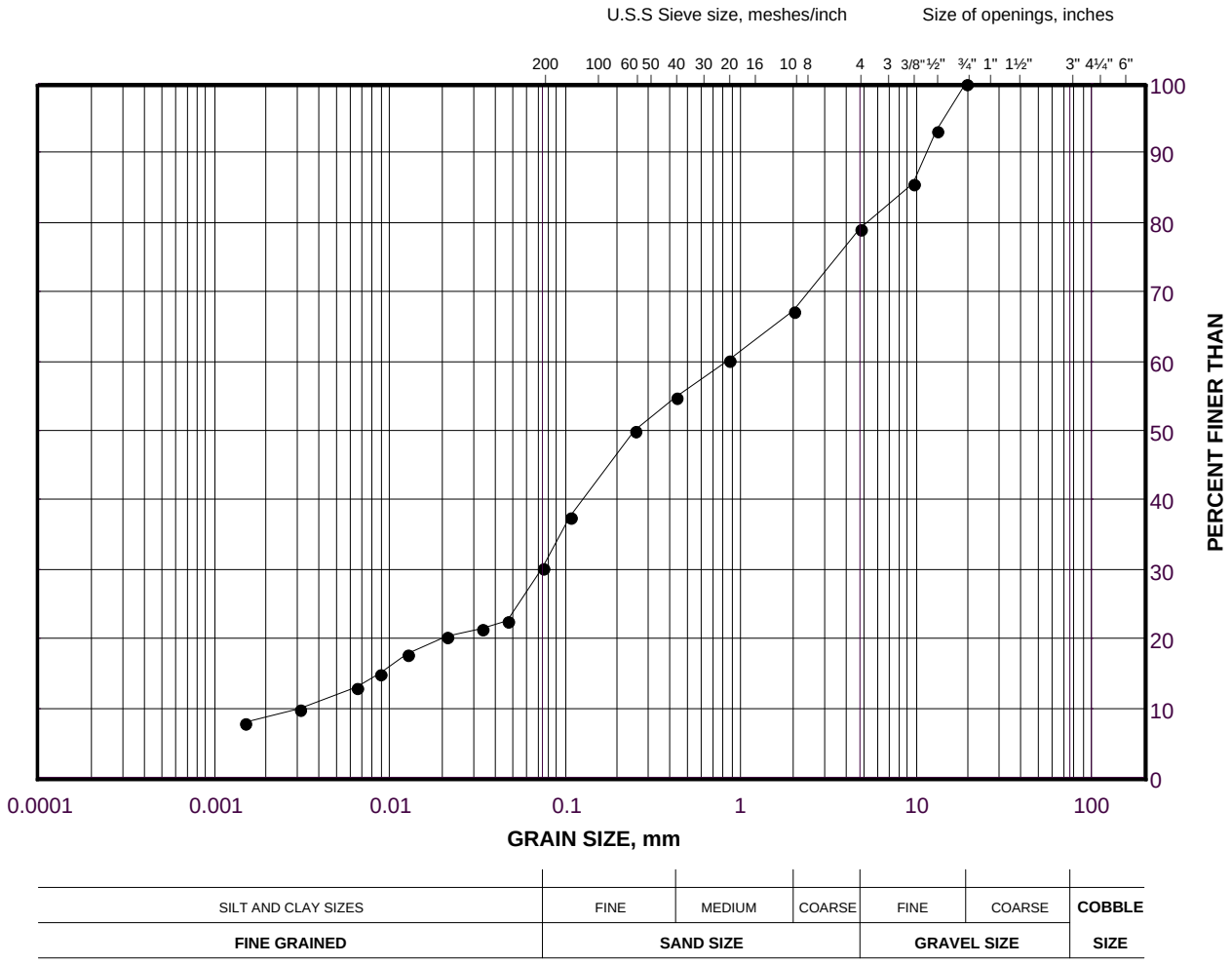
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Gravelly Clayey Silt with Sand (Fill)

FIGURE A-3



LEGEND

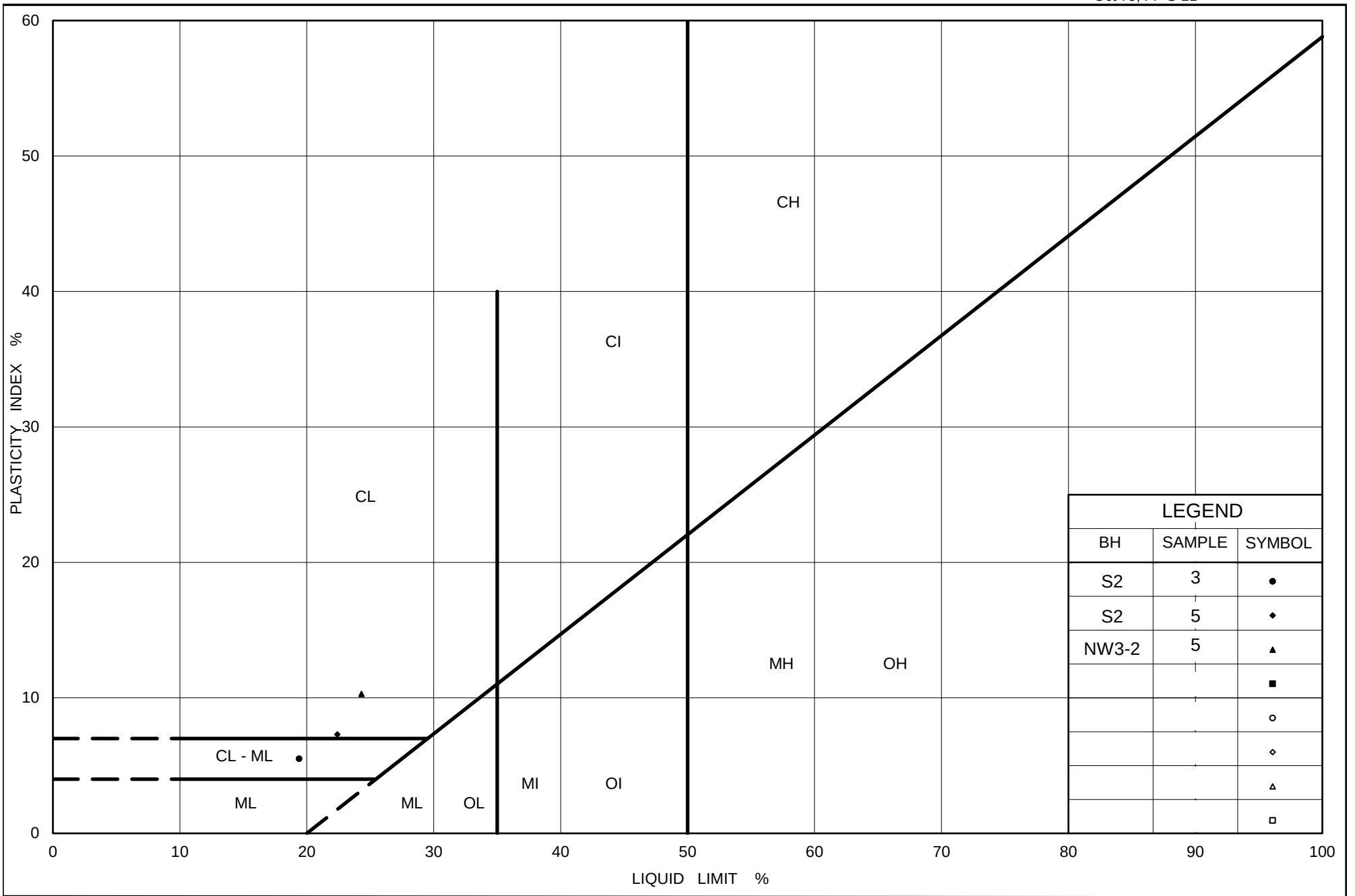
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S2	5	91.5

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 05-Feb-19



Ministry of Transportation

Ontario

PLASTICITY CHART
Gravelly Clayey Silt with Sand to Clayey Silt with Sand (Fill)

Figure No. A-4

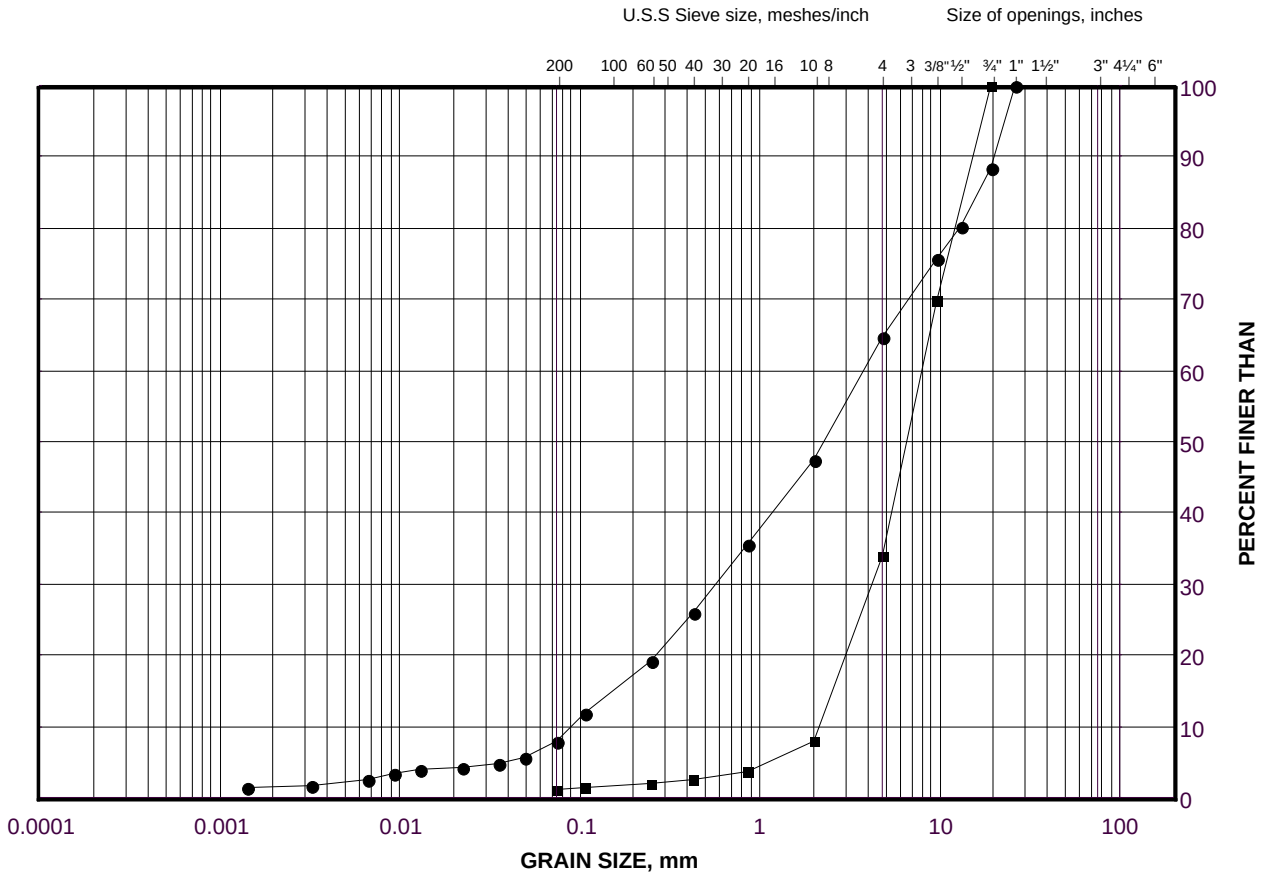
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sand and Gravel

FIGURE A-5



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S1	5	88.7
■	PED-02	7	90.5

Project Number: 1662333

Checked By: SMM

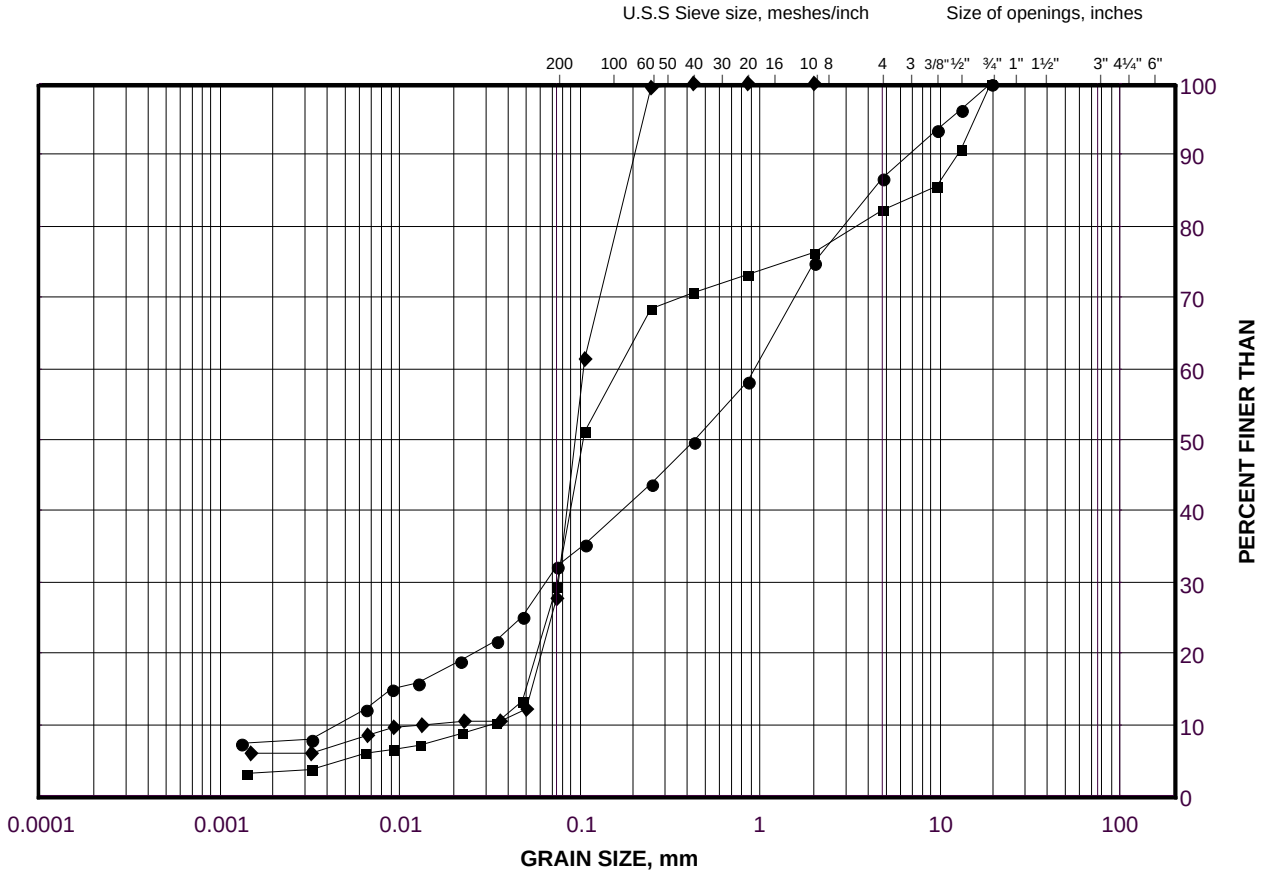
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Silty Sand

FIGURE A-6



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S2	15	77.8
■	S1	3	90.2
◆	S2	8	88.5

Project Number: 1662333

Checked By: SMM

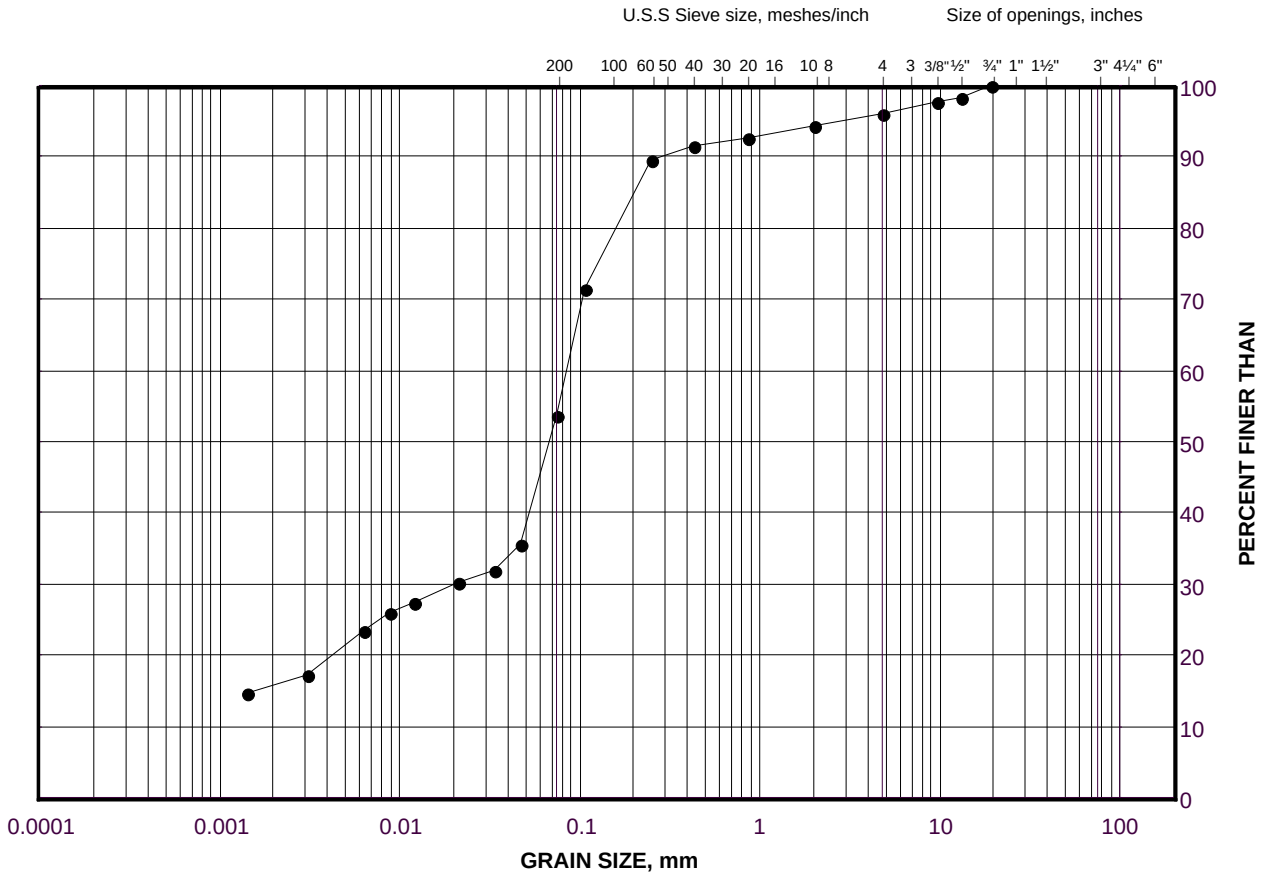
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand

FIGURE A-7



LEGEND

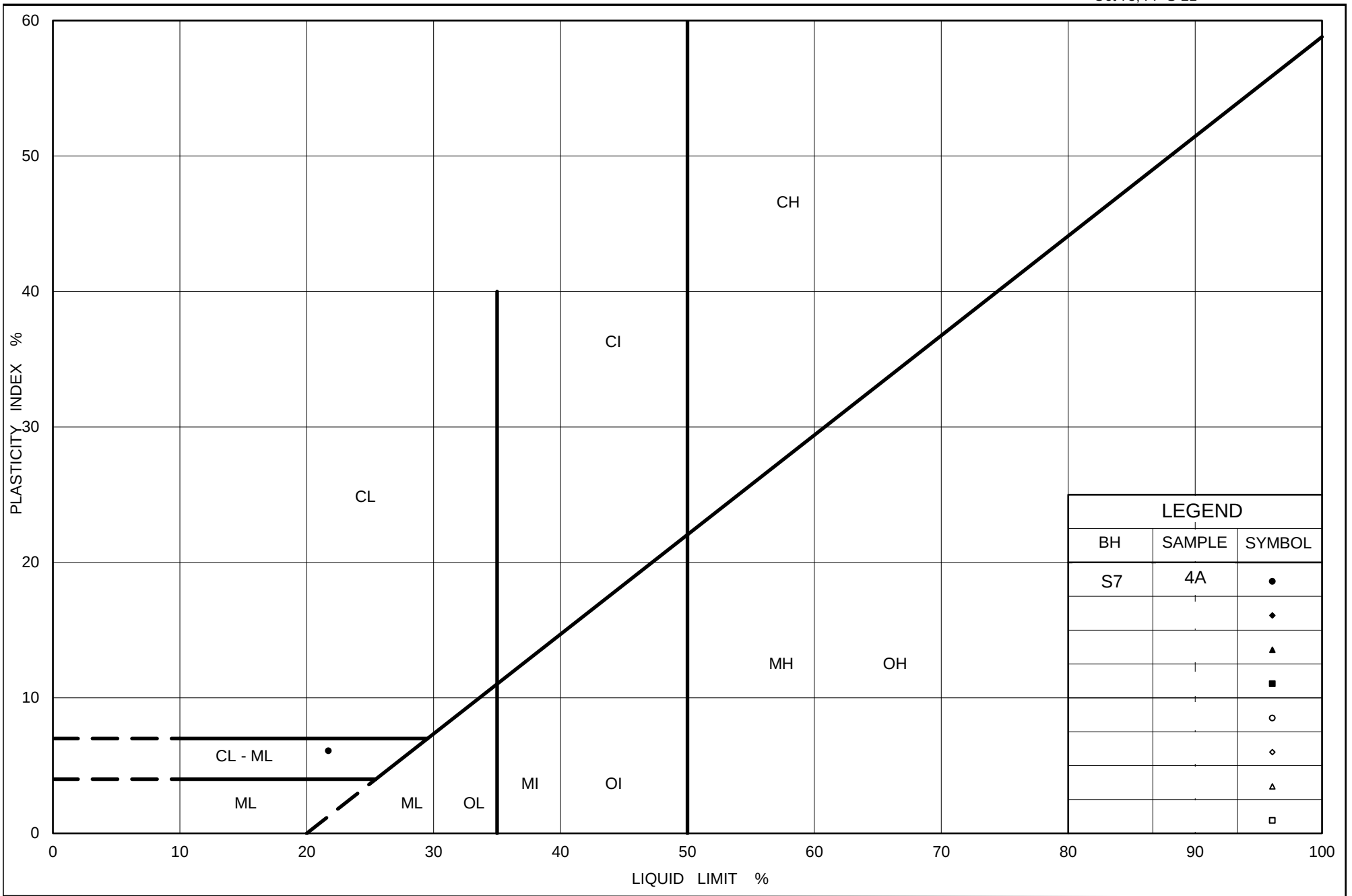
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S7	4A	87.6

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 05-Feb-19



Ministry of Transportation

Ontario

PLASTICITY CHART

Clayey Silt with Sand

Figure No. A-8

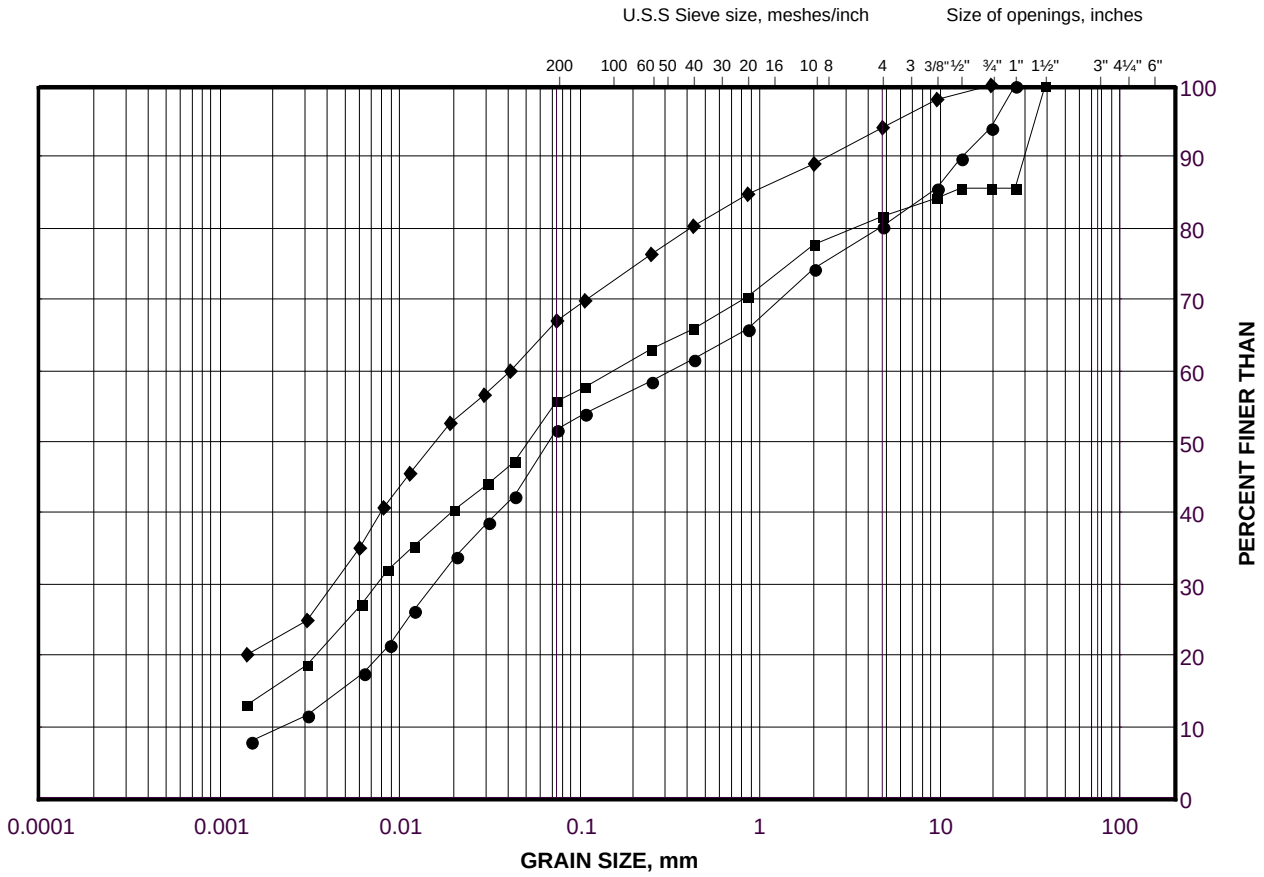
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Till)

FIGURE A-9A



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S2	12	82.6
■	PED-03	8	87.3
◆	PED-02	9	87.5

Project Number: 1662333

Checked By: SMM

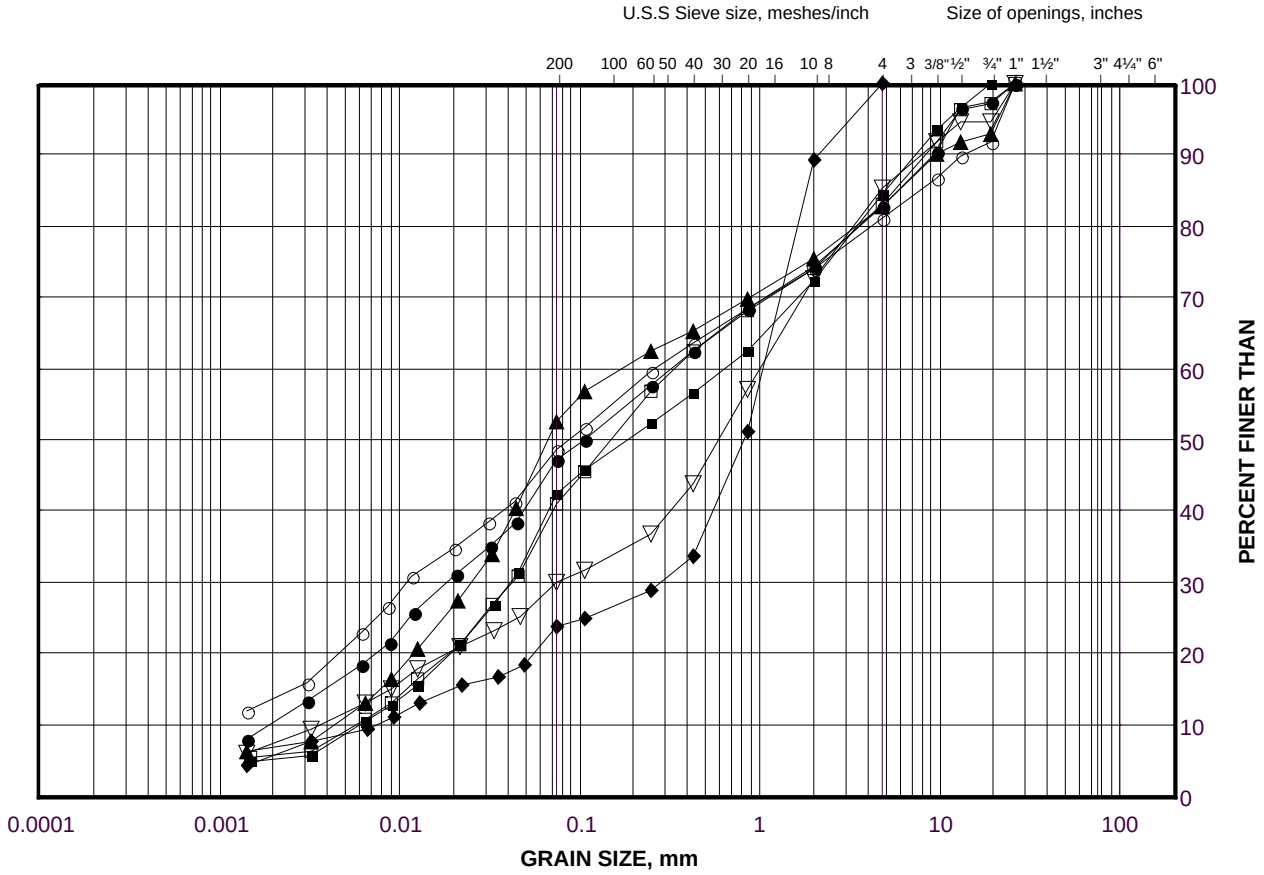
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Silt and Sand to Clayey Silt with Sand (Till)

FIGURE A-9B



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S5	10	85.9
■	S4	10	85.8
◆	S3	10	79.1
▲	S5	12	83.1
▽	S5	14	79.8
❍	S3	5	86.7
□	S3	7	83.8

Project Number: 1662333

Checked By: SMM

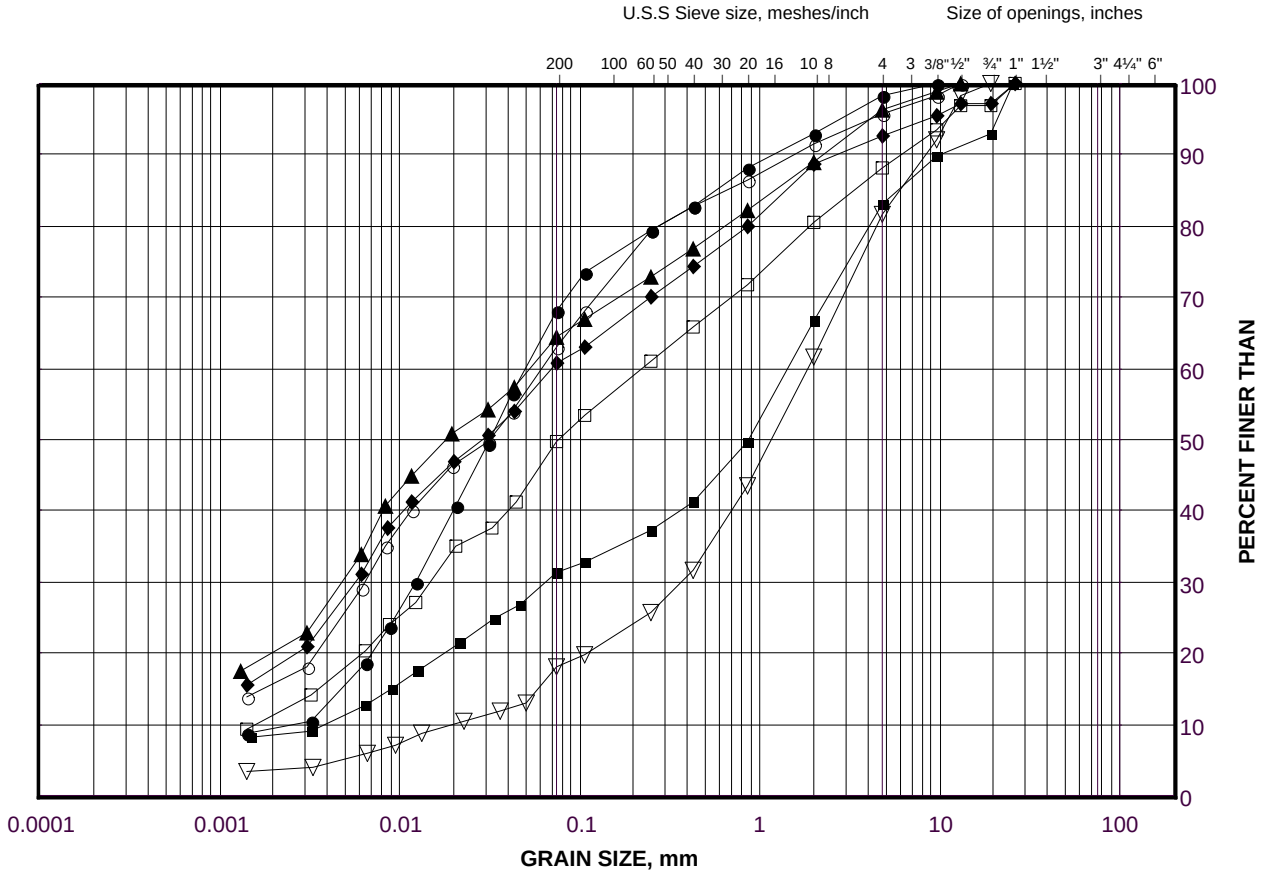
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Silt and Sand to Clayey Silt with Sand (Till)

FIGURE A-9C



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S6	12	82.7
■	PED-02	14	80.0
◆	NW3-3	4	88.0
▲	S7	5	86.8
▽	NW3-2A	5	79.8
❍	S6	9	87.3
□	NW3-2	9	85.9

Project Number: 1662333

Checked By: SMM

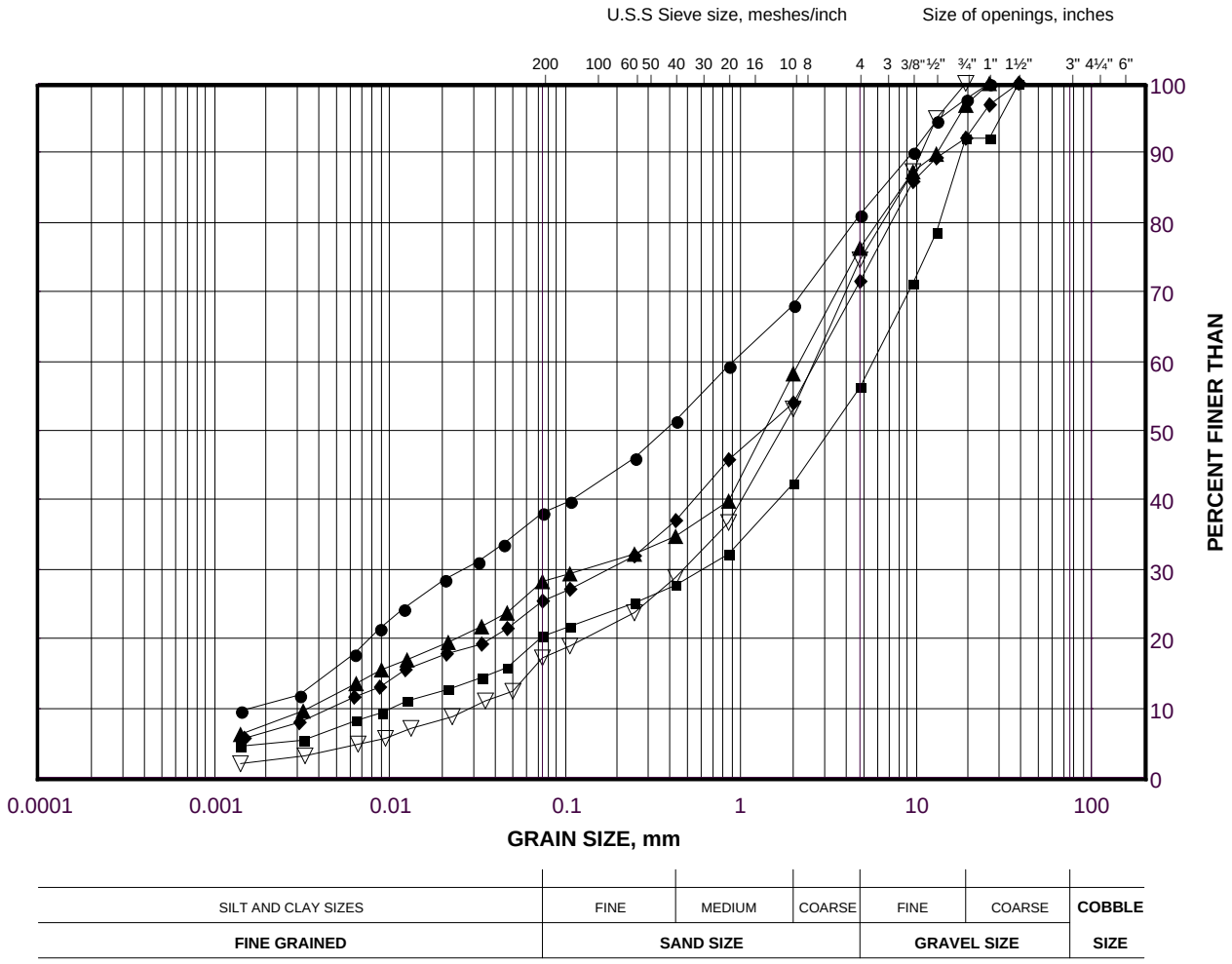
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand, Gravelly to with Gravel (Till)

FIGURE A-9D



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S4	12	82.9
■	S6	14	80.6
◆	S4	15	78.3
▲	PED-03B	3	80.9
▽	NW3-2A	7	76.7

Project Number: 1662333

Checked By: SMM

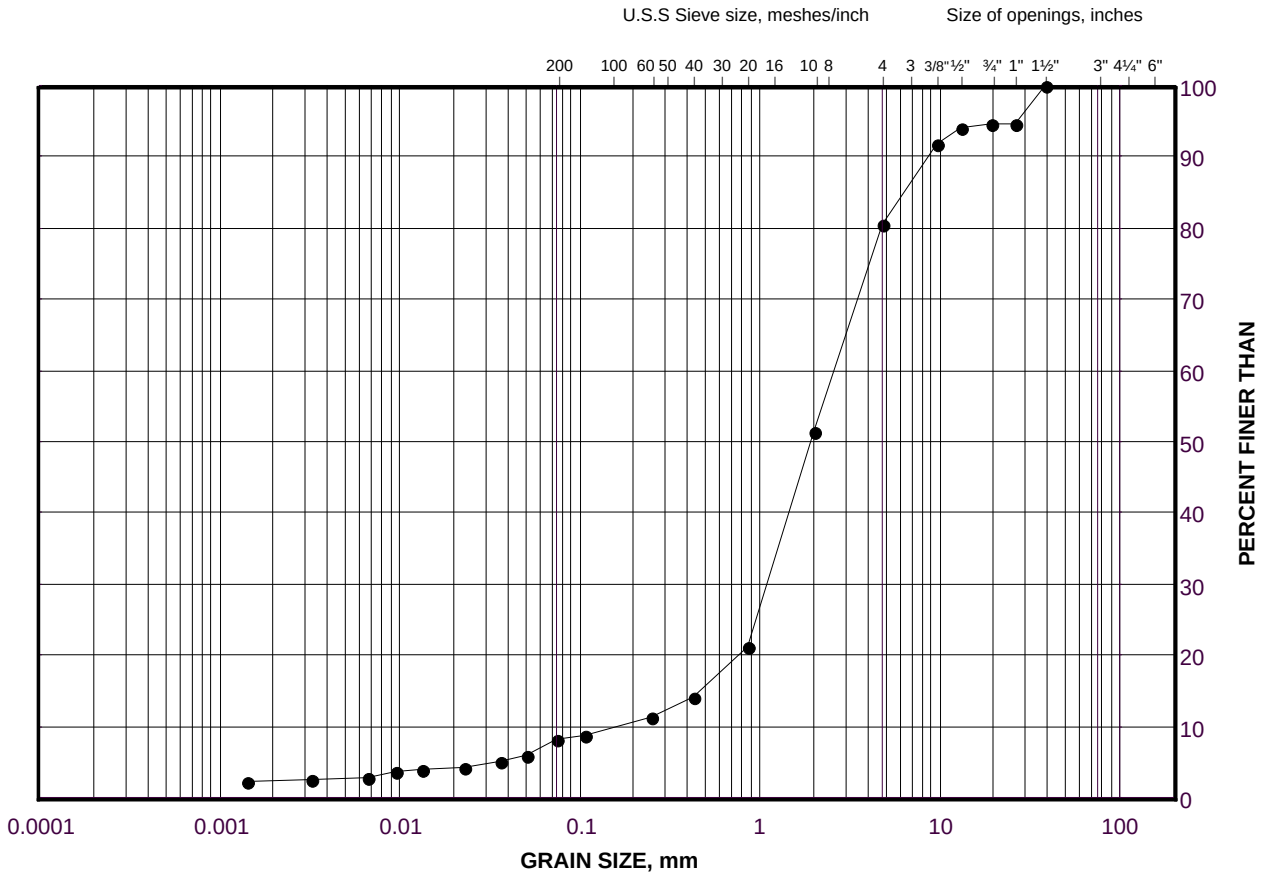
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Gravelly Sand (Till)

FIGURE A-9E



LEGEND

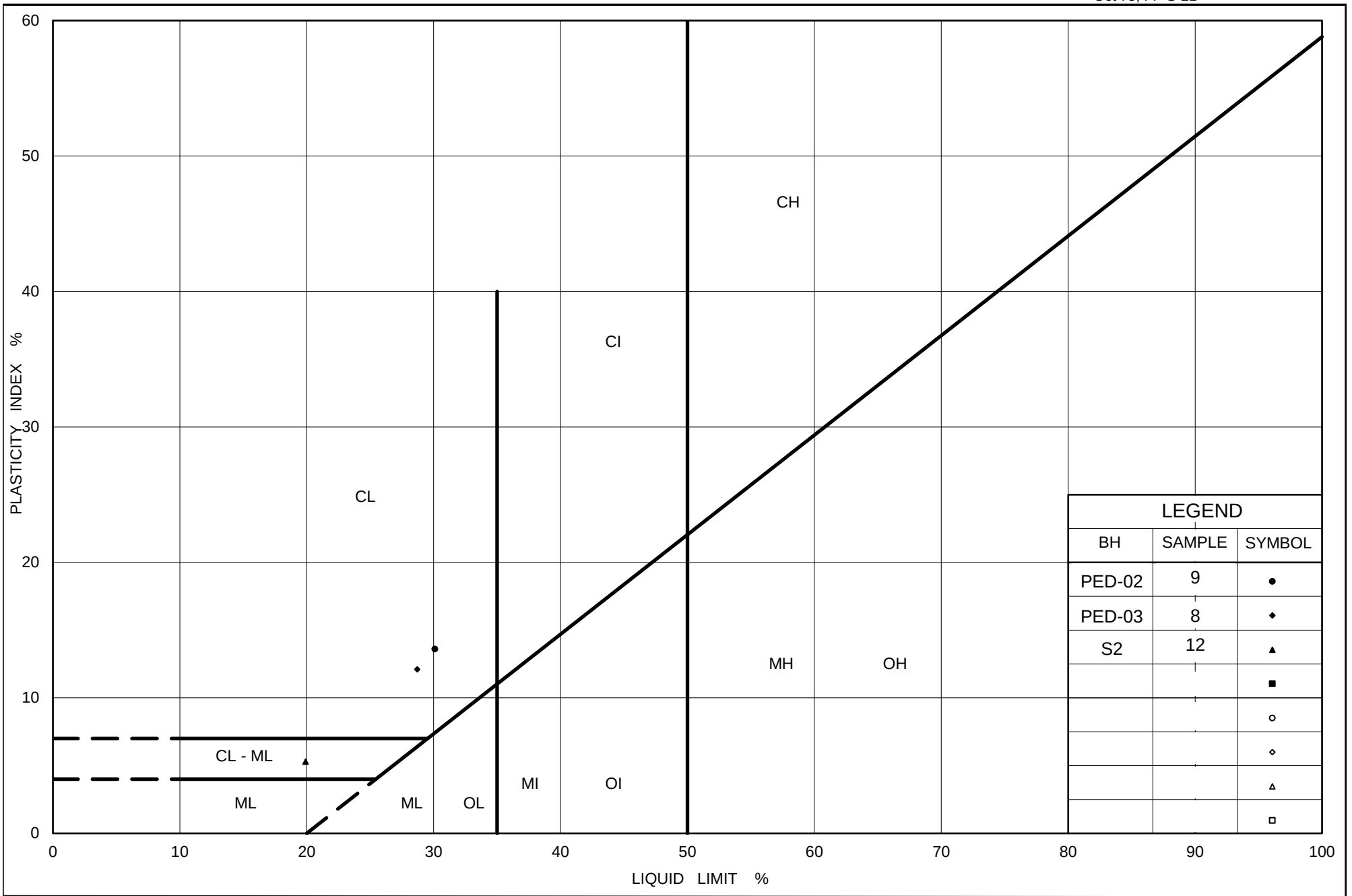
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	S3	13	74.5

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 05-Feb-19



Ministry of Transportation

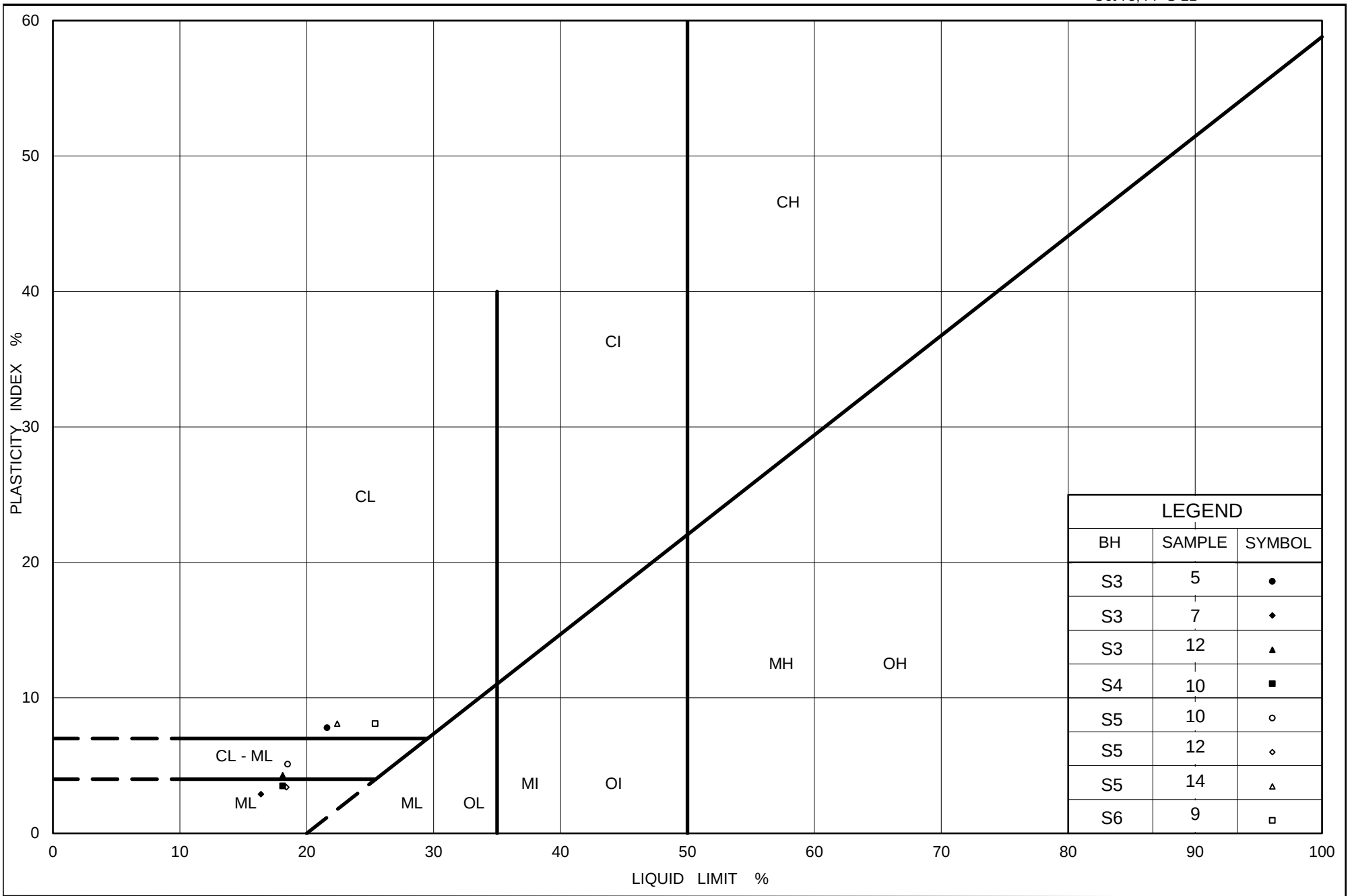
Ontario

PLASTICITY CHART
Sandy Clayey Silt (Till)

Figure No. A-10A

Project No. 1662333

Checked By: SMM



Ministry of Transportation

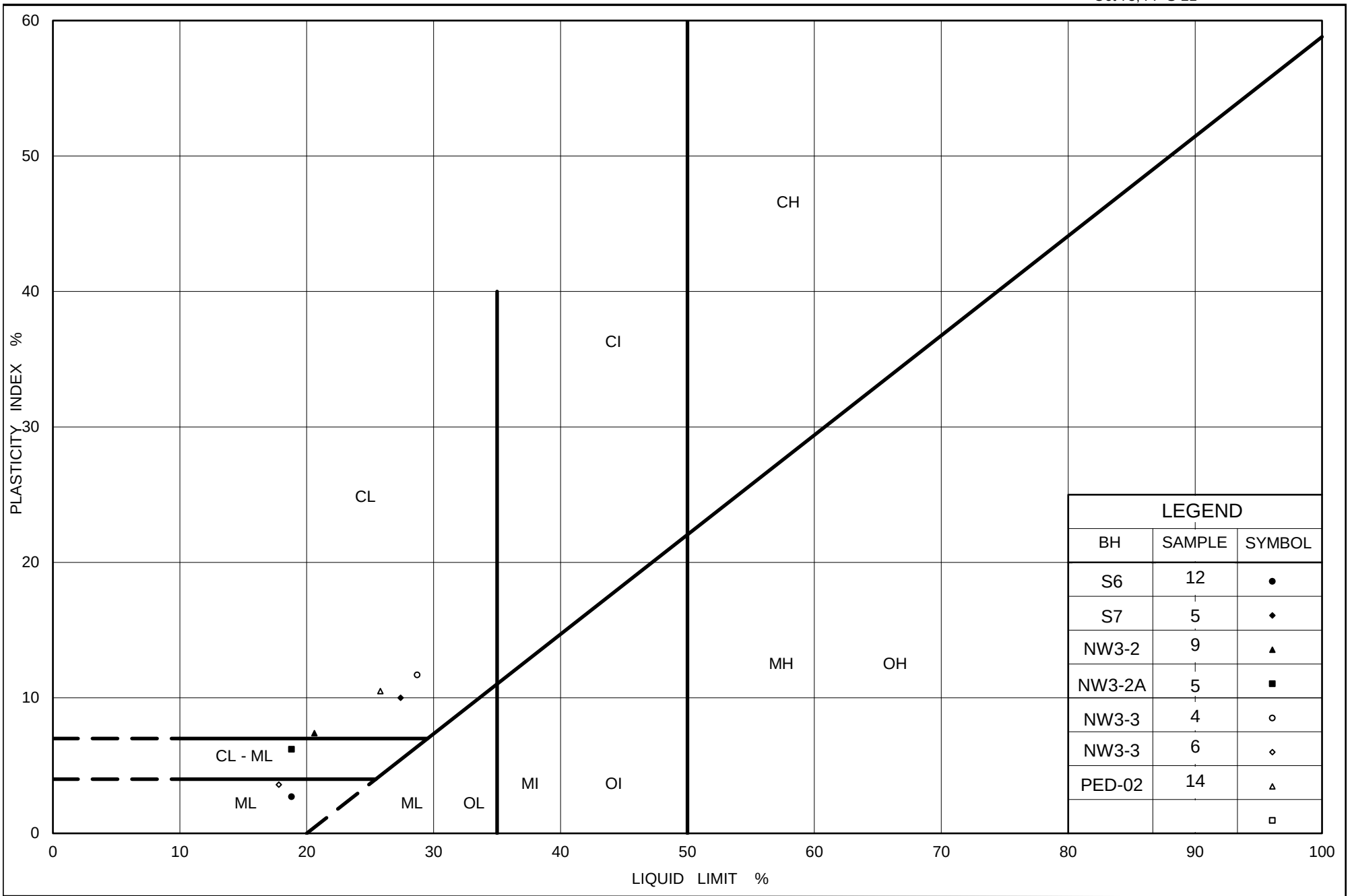
Ontario

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

Figure No. A-10B

Project No. 1662333

Checked By: SMM



Ministry of Transportation

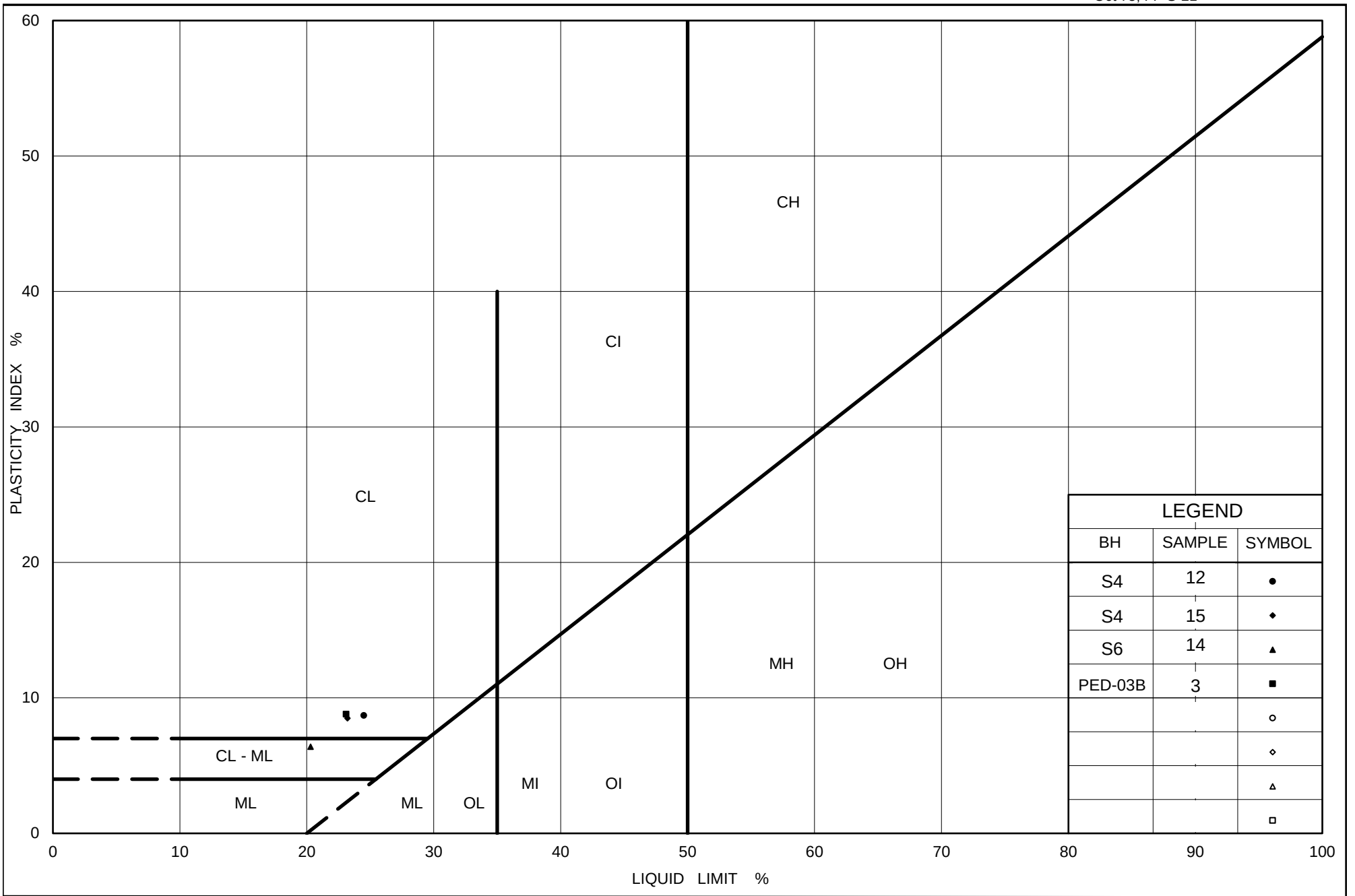
Ontario

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

Figure No. A-10C

Project No. 1662333

Checked By: SMM



Ministry of Transportation

Ontario

PLASTICITY CHART

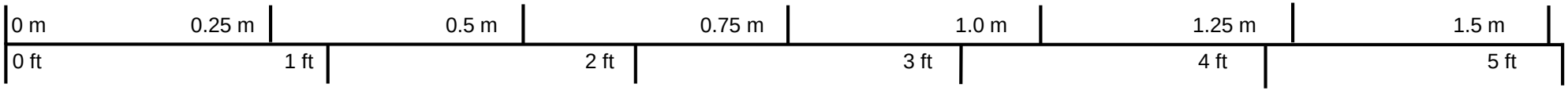
Clayey Silt with Sand, Gravelly to with Gravel (Till)

Figure No. A-10D

Project No. 1662333

Checked By: SMM

Start of Run No. 1 (10.72 m) Start of Run No. 2 (12.23 m)



Scale

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

TITLE: **Core Photograph**
Borehole PED-03 (10.72 m to 13.75 m)

GOLDER

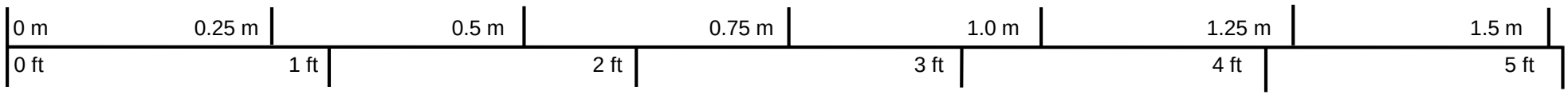
PROJECT No. 1662333			FILE No. ----		
DRAFT	KMG	Feb 2019	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	SMM	Apr 2019	**FIGURE A-11**		
REVIEW	JMAC	Apr 2019			

REVISION DATE: March 7, 2018 BY: JIL Project: 1662333

Start of Run No. 1 (14.80 m)

Start of Run No. 2 (15.27 m)

Start of Run No. 3 (16.75 m)



Scale

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

TITLE: **Bedrock Core Photograph**
Borehole PED-03B (14.80 m to 17.77 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	KMG	Feb 2019	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE A-12**		
CHECK	SMM	Apr 2019			
REVIEW	JMAC	Apr 2019			

REVISION DATE: March 7, 2018 BY: JIL Project: 1662333

APPENDIX B

Record of Borehole and Drillhole Sheets, Bedrock Core Photographs and Geotechnical Laboratory Results for Kenollie Creek Culvert

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
σ_1, σ_2, σ_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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan 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^{o} 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 K1

SHEET 1 OF 1 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4824728.9; E 296200.2 MTM NAD 83 ZONE 10 (LAT. 43.562439; LONG. -79.606453)
ORIGINATED BY ACM
DIST Central HWY QEW
BOREHOLE TYPE CME 75, 114 mm I.D., Hollow Stem Augers
COMPILED BY DM
DATUM Geodetic
DATE November 29, 2018
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
90.1	GROUND SURFACE										
0.0 / 89.3	TOPSOIL Soft Brown Moist		1	SS	3		90		54.7		
89.0 / 1.1	CLAYEY SILT, some sand, some gravel, some shale fragments (RESIDUAL SOIL) Hard Grey Wet		2A 2B	SS	50/0.08	▽	89				20 19 47 14
			3	SS	100/0.28						
			1	RC	REC 54%						RQD = 28%
	SHALE (BEDROCK) Grey Bedrock cored from a depth of 1.3 m to 5.1 m For bedrock coring details, refer to Record of Drillhole K1 - Auger grinding from 1.1 m to 1.2 m		2	RC	REC 100%		88 87				RQD = 82%
85.0			3	RC	REC 100%		86				RQD = 68%
5.1	END OF BOREHOLE NOTES: 1. Water level measured at a depth of 1.2 m below ground surface (Elev 88.9 m) upon completion of soil drilling, prior to bedrock coring.						85				

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

GTA-MTO 001 S:\CLIENTS\MTO\QEW-CREDIT_RIVER\02_DATA\GINT\QEW-CREDIT_RIVER.GPJ GAL-GTA.GDT 2/13/19

PROJECT: 1662333

RECORD OF DRILLHOLE: K1

SHEET 1 OF 1

LOCATION: N 4824728.9 ;E 296200.2

DRILLING DATE: November 29, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Geo-Environmental 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 Record of Borehole K1		88.85															
2		Slightly weathered, thinly bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with medium strong to strong limestone interbeds		1.25	1							CO,PL,RO CC, CL CO,PL,RO SA							
3					2							CO,CU,RO PC, CL BD,PL,SM CO,CU,RO PC, CL							UCS = 6.4 MPa E = 0.9 GPa e = 2.6 g/cm^3
4					3							CO,CU,SM IN, CL BD,CU,SM PC, CL							
5				85.00								CO,CU,RO PC, CL CO,CU,RO IN, CL JN,PL,RO IN, CL CO,CU,SM CC, CL BD,CU,SM PC, CL							
		END OF DRILLHOLE		5.10															

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: ACM

CHECKED: DPM

GTA-RCK 054 S:\CLIENTS\MTO\QEW-CREDIT_RIVER\02_DATA\GINT\QEW-CREDIT_RIVER.GPJ GAL-MISS.GDT 2/13/19

GOLDER

RECORD OF BOREHOLE No K2

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824716.6; E 296216.3 MTM NAD 83 ZONE 10 (LAT. 43.562329; LONG. -79.606253)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 75, 210 mm O.D., Hollow Stem Augers

COMPILED BY JMP

DATUM Geodetic

DATE September 14, 2018

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 / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.2	GROUND SURFACE										
0.0	ASPHALT (150 mm)										
0.2	Silty sand, trace to some gravel, trace clay (FILL) Very loose to compact Brown Moist to wet - Asphalt fragments encountered at 1.1 m		1	SS	12		93				
			2	SS	12						
			3	SS	5		92		○		16 55 26 3
			4	SS	4	▼	91				
			5	SS	5						
			6	SS	2		90		○		1 68 29 2
	- Wood chips present from 3.7 m to 4.1 m depth		7A	SS	16				○		
89.1			7B				89				
4.1	Sandy CLAYEY SILT with GRAVEL, some shale fragments (RESIDUAL SOIL) Very stiff to hard Grey Moist		8	SS	43				○ —		31 26 33 10
87.9							88				
5.3	SHALE (BEDROCK) Grey Bedrock cored from a depth of 6.3 m to 9.4 m For bedrock coring details, refer to Record of Drillhole K2		9	SS	100/0.02		87				
			1	RC	REC 100%		86				RQD = 89%
			2	RC	REC 100%		85				RQD = 100%
83.8							84				
9.4	END OF BOREHOLE NOTES: 1. Water level measured at a depth of 5.2 m below ground surface (Elev 88.0 m) upon completion of soil drilling, prior to bedrock coring. 2. Water level measured in piezometer at a depth of 2.1 m below ground surface (Elev. 91.1 m) on December 17, 2018.										

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

PROJECT: 1662333

RECORD OF DRILLHOLE: K2

SHEET 1 OF 1

LOCATION: N 4824716.6 ;E 296216.3

DRILLING DATE: September 14, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Davis 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 Record of Borehole K2		86.88															
7		Slightly weathered, thinly bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation), with medium strong to strong limestone / siltstone interbeds		6.30	1							BD,UN,SM PC, CL CO,PL,SM PC, CL CO,UN,SM PC, CL BD,UN,SM PC, CL CO,UN,SM SA, CL CO,PL,SM PC, CL			R4 R3 R2 R1	W1 W2 W3 W4 W5 W6			
8					2							CO,UN,SM SA, CL CO,PL,SM SA, CL BD,PL,SM IN, CL, IO							UCS = 13.0 MPa E = 1.5 GPa e = 2.6 g/cm^3
9				83.81								BD,UN,SM SA, CL							
		END OF DRILLHOLE		9.37															
10																			
11																			
12																			
13																			
14																			
15																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: ACM
CHECKED: JP

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GOLDER

RECORD OF BOREHOLE No K3

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824703.7; E 296236.7 MTM NAD 83 ZONE 10 (LAT. 43.562222; LONG. -79.606004)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 108 mm I.D., Hollow Stem Augers

COMPILED BY JMP

DATUM Geodetic

DATE September 17, 2018

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
95.0	GROUND SURFACE										
0.0	ASPHALT (150 mm)										
0.2	Sand and gravel (FILL) Dense Brown		1A	SS	38						
94.2	Moist		1B				94				
0.8	Silty sand, trace clay (FILL) Very loose to dense Brown, oxidation staining from 3.1 m to 3.7 m Moist to wet below 3.8 m		2	SS	35						
			3	SS	5		93				
			4	SS	3		92				
			5	SS	9						0 72 26 2
			6	SS	1		91				
			7	SS	WH		90				0 78 20 2
89.4											
5.6	Sandy CLAYEY SILT with GRAVEL (TILL) Very stiff to hard Grey Moist to wet - Auger grinding from 6.4 m to 6.6 m		8	SS	17		89				34 29 29 8
			9	SS	100/0.28		88				
	- Trace shale fragments from 9.1 m to 10.0 m - Auger grinding at 9.4 m to 9.8 m		10	SS	100/0.10	▽	87				
85.0							86				
10.0	SHALE (BEDROCK) Grey Bedrock cored from a depth of 10.7 m to 14.1 m For bedrock coring details, refer to Record of Drillhole K3		1	RC	REC 60%		85				RQD = 60%
			2	RC	REC 100%		84				RQD = 100%
			3	RC	REC 100%		83				RQD = 96%
80.9							82				
14.1	END OF BOREHOLE						81				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No K3

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824703.7; E 296236.7 MTM NAD 83 ZONE 10 (LAT. 43.562222; LONG. -79.606004)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 108 mm I.D., Hollow Stem Augers

COMPILED BY JMP

DATUM Geodetic

DATE September 17, 2018

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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	NOTES: 1. Water level measured at a depth of 9.8 m below ground surface (Elev. 85.2 m) upon completion of soil drilling, prior to bedrock coring.										

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

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

PROJECT: 1662333

RECORD OF DRILLHOLE: K3

SHEET 1 OF 1

LOCATION: N 4824703.7 ;E 296236.7

DRILLING DATE: September 17, 2018

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 Record of Borehole K3		84.24															
11		Slightly weathered, thinly bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with medium strong to strong limestone interbeds		10.72	1							BD,PL,SM SA							
												BD,UN,SM							
12					2							BD,PL,SM							UCS = 18.2 MPa E = 2.3 GPa e = 2.6 g/cm^3
												BD,PL,SM PC							
13												BD,PL,SM SA							
					3							BD,UN,SM SA BD,UN,SM SA							
14				80.89								CO,UN,SM							
		END OF DRILLHOLE		14.07															
15																			
16																			
17																			
18																			
19																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: ACM

CHECKED: JP

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GOLDER

RECORD OF BOREHOLE No K4

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824692.4; E 296229.9 MTM NAD 83 ZONE 10 (LAT. 43.562120; LONG. -79.606087)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 210 mm O.D. Hollow Stem Auger

COMPILED BY JMP

DATUM Geodetic

DATE September 18, 2018

CHECKED BY SMM

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
95.0	GROUND SURFACE										
0.0	ASPHALT (150 mm)										
0.2	Sand and gravel, trace silt (FILL) Compact Brown Moist		1	SS	25						
94.4 0.6	Silt and sand, trace clay (FILL) Very loose to compact Brown Moist becoming wet below a depth of 3.8 m		2	SS	17		94				
			3	SS	13						
			4	SS	2		93		○		0 62 37 1
	- Oxidation staining at 2.7 m		5	SS	3						
			6	SS	4		92		○		
			7	SS	WH		91		○		
90.1			8A 8B 8C	SS	2				○		
4.9	CLAYEY SILT, some sand to with sand, some gravel Very soft to firm Grey to brown, oxidation staining present Moist to wet						90		○		0 55 35 10
			9A 9B	SS	7		89		○		
87.8						▽	88				
7.2	SAND, some silt, trace clay Compact to dense Brown Wet		10	SS	18		87				
			11	SS	32		86		○		0 79 17 4
84.8							85				
10.2	CLAYEY SILT, some sand, some gravel (TILL) Hard Grey Moist		12A 12B	SS	100/0.28		84				
84.2 10.8	SHALE (BEDROCK) Grey Bedrock cored from a depth of 10.9 m to 13.9 m For bedrock coring details, refer to Record of Drillhole K4		1	RC	REC 99%		83				RQD = 99%
			2	RC	REC 100%		82				RQD = 86%
81.1											
13.9	END OF BOREHOLE										

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No K4

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824692.4; E 296229.9 MTM NAD 83 ZONE 10 (LAT. 43.562120; LONG. -79.606087)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 210 mm O.D. Hollow Stem Auger

COMPILED BY JMP

DATUM Geodetic

DATE September 18, 2018

CHECKED BY SMM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	NOTES: 1. Water level recorded at a depth of about 7.3 m below ground surface (Elev. 87.7 m) upon completion of soil drilling, prior to bedrock coring										

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

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

PROJECT: 1662333

RECORD OF DRILLHOLE: K4

SHEET 1 OF 1

LOCATION: N 4824692.4 ;E 296229.9

DRILLING DATE: September 18, 2018

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	Jr	Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Record of Borehole K4		84.12															
11		Slightly weathered, thinly bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation), with medium strong to strong limestone / siltstone interbeds		10.85	1							BD,UN,SM SA			R4 R3 R2 R1	W1 W2 W3 W4 W5 W6			
12												BD,UN,SM SA							
13												BD,UN,SM IN, CL							
14					2							BD,PL,SM SA							
		END OF DRILLHOLE		81.05 13.92															
15																			
16																			
17																			
18																			
19																			

FEATURES LEGEND

BROKEN CORE CLAY SEAM LIMESTONE LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: ACM

CHECKED: JP

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GOLDER

RECORD OF BOREHOLE No K5

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824683.3; E 296242.1 MTM NAD 83 ZONE 10 (LAT. 43.562038; LONG. -79.605937) ORIGINATED BY SK

DIST Central HWY QEW BOREHOLE TYPE CME 75, 180 mm O.D., Hollow Stem Augers COMPILED BY DM

DATUM Geodetic DATE November 30, 2018 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
95.0	GROUND SURFACE										
0.0	ASPHALT (300 mm)										
94.5	CONCRETE (300 mm)										
0.5	Silt and sand, trace clay (FILL) Very loose to compact Brown Moist to wet		1	SS	8		94				
			2	SS	2		93		○		
			3	SS	14	▽					
			4	SS	2		92		○	NP	0 59 39 2
			5	SS	3		91				
	- Brown to grey at 4.7 m		6	SS	WH		90		○		
89.4											
5.6	CLAYEY SILT with SAND, trace to some gravel Firm to hard Grey Moist to wet		7	SS	7		89		⊢○⊣	Org = 3.2%	13 32 39 16
	- Auger grinding at 7.0 m						88				
	- Auger grinding from 7.9 m to 8.2 m and from 8.7 m to 9.0 m		8	SS	48		87				
			9	SS	46		86		⊢d⊣		10 61 25 4
84.8											
10.2	Silty SAND, trace to some gravel, trace clay Very dense Grey Wet		10	SS	51		85				
			11	SS	100/0.13		84		○		
82.2											
12.8	SHALE (BEDROCK) Grey - Auger grinding at 13.1 m						83				
81.5			12	SS	100/0.08		82				
13.5	END OF BOREHOLE SPLIT-SPOON REFUSAL										

Continued Next Page

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

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

GOLDER

RECORD OF BOREHOLE No K5

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824683.3; E 296242.1 MTM NAD 83 ZONE 10 (LAT. 43.562038; LONG. -79.605937) ORIGINATED BY SK

DIST Central HWY QEW BOREHOLE TYPE CME 75, 180 mm O.D., Hollow Stem Augers COMPILED BY DM

DATUM Geodetic DATE November 30, 2018 CHECKED BY SMM

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

NOTES:

1. Borehole caved to a depth of 6.4 m below ground surface (Elev. 88.6 m) upon removal of Hollow Stem Augers.

2. Water level measured at a depth of 2.4 m below ground surface (Elev. 92.6 m) upon removal of Hollow Stem Augers, but water was added during drilling.

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

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

GOLDER

RECORD OF BOREHOLE No K5A

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824683.3; E 296242.1 MTM NAD 83 ZONE 10 (LAT. 43.562017; LONG. -79.605949) ORIGINATED BY SK

DIST Central HWY QEW BOREHOLE TYPE CME 75, 180 mm O.D., Hollow Stem Augers COMPILED BY DM

DATUM Geodetic DATE November 30, 2018 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
95.0	GROUND SURFACE										
0.0	Refer to Record of Borehole K5 for stratigraphy						94				
							93				
							92				
							91				
							90				
							89				
							88				
							87				
							86				
							85				
							84				
							83				
82.2											
12.8	SHALE (BEDROCK) Grey Bedrock cored from a depth of 12.8 m to 16.5 m For bedrock coring details, refer to Record of Drillhole K5A		1	RC	REC 100%		82				RQD = 79%
			2	RC	REC 95%		81				RQD = 69%

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No K5A

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824683.3; E 296242.1 MTM NAD 83 ZONE 10 (LAT. 43.562017; LONG. -79.605949) ORIGINATED BY SK

DIST Central HWY QEW BOREHOLE TYPE CME 75, 180 mm O.D., Hollow Stem Augers COMPILED BY DM

DATUM Geodetic DATE November 30, 2018 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 ---										
	SHALE (BEDROCK) Grey Bedrock cored from a depth of 12.8 m to 16.5 m For bedrock coring details, refer to Record of Drillhole K5A		3	RC	REC 100%		79				RQD = 94%
78.5 16.5	END OF BOREHOLE SPLIT-SPOON REFUSAL NOTES: 1. Borehole K5A was cored about 2 m west of Borehole K5.										

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

PROJECT: 1662333

RECORD OF DRILLHOLE: K5A

SHEET 1 OF 1

LOCATION: N 4824683.3 ;E 296242.1

DRILLING DATE: November 30, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Davis 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	R3	R2	R1	WEATHERING INDEX: W1	W2	W3	W4	W5	W6	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Record of Borehole K5		82.17																							
13		Slightly weathered, thinly bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with medium strong to strong limestone interbeds		12.83	1							JN,PL,SM SA															
												JN,PL,PL SA															
												JN,PL,PL SA															
14					2							JN,PL,PL SA															
												JN,PL,PL SA															
15					3							JN,UN,PL SA															
16				78.51								JN,PL,PL SO															
		END OF DRILLHOLE		16.49																							
17																											
18																											
19																											
20																											
21																											

FEATURES LEGEND

BROKEN CORE; CLAY SEAM; LIMESTONE; LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SK

CHECKED: KF

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GOLDER

RECORD OF BOREHOLE No K6

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824688.5; E 296254.9 MTM NAD 83 ZONE 10 (LAT. 43.562085; LONG. -79.605778)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 38 mm, Solid Stem Augers

COMPILED BY JMP

DATUM Geodetic

DATE November 11, 2018

CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.9	GROUND SURFACE							
0.0	ASPHALT (150 mm)							
94.4	CONCRETE							
0.5	Silt and sand, trace clay (FILL) Compact to very loose Brown with oxidation staining Moist to wet - Trace to some gravel from 0.8 m to 1.4 m		1	SS	36			
			2	SS	7			
			3	SS	2			
			4	SS	9			0 61 37 2
91.2								
3.7	Silty sand, trace clay (FILL) Very Loose Brown Wet		5	SS	WH			Non-Plastic
	- Oxidation staining from 4.6 m to 6.1 m		6	SS	WH		Org = 1.2%	0 78 20 2
89.3								
5.6	CLAYEY SILT with SAND Firm Brown to grey Wet to moist		7	SS	6			
87.7								
7.2	SAND, some silt, trace clay Very dense to compact Grey Wet		8	SS	43			
			9	SS	51			
			10	SS	16			0 79 18 3
83.2								
11.7	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist		11A 11B	SS	100/0.23	▽		
82.6								
12.3	SHALE (BEDROCK) Grey							
	Bedrock cored from a depth of 14.3 m to 15.0 m							
	For bedrock coring details, refer to Record of Drillhole K6		12	SS	100/0.08			
			1	RC	REC 62%			RQD = 62%
79.9					REC			

Continued Next Page

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

ELEVATION SCALE: 94 93 92 91 90 89 88 87 86 85 84 83 82 81 80

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No K6

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824688.5; E 296254.9 MTM NAD 83 ZONE 10 (LAT. 43.562085; LONG. -79.605778) ORIGINATED BY ACM

DIST Central HWY QEW BOREHOLE TYPE CME 55, 38 mm, Solid Stem Augers COMPILED BY JMP

DATUM Geodetic DATE November 11, 2018 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 ● 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
15.0	END OF BOREHOLE		2	RC	100%						RQD = 0%
	NOTES:										
	1. Water level measured at a depth of 12.3 m below ground surface (Elev. 82.6 m) prior to rock coring.										

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

PROJECT: 1662333

RECORD OF DRILLHOLE: K6

SHEET 1 OF 1

LOCATION: N 4824688.5 ;E 296254.9

DRILLING DATE: November 11, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Triphase 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 % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA: B Angle (0 90 180 270)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	ROCK STRENGTH INDEX (R4 R3 R2 R1)	WEATHERING INDEX (W1 W2 W3 W4 W5 W6)	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Record of Borehole K6		80.52															
		Slightly weathered, thinly bedded, grey, fined grained, faintly porous, weak SHALE (Georgian Bay Formation)		14.33	1														
15		END OF DRILLHOLE		79.83 / 15.02	2														
16																			
17																			
18																			
19																			
20																			
21																			
22																			
23																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: ACM

CHECKED: DPM

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GOLDER

RECORD OF BOREHOLE No NRW3-6

SHEET 1 OF 1 **METRIC**

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

LOCATION N 4824701.8; E 296220.4 MTM NAD 83 ZONE 10 (LAT. 43.562195; LONG. -79.606203)
BOREHOLE TYPE CME 75, 85 mm I.D., 190 mm O.D., Hollow Stem Augers
DATE June 22, 2018

ORIGINATED BY CC
COMPILED BY ACM
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
92.9	GROUND SURFACE										
0.0	Sandy silt, some gravel, rootlets, trace organics (FILL) Compact Brown		1	SS	10						
92.2 / 0.7	Dry										
	Silt and sand, trace clay, trace rootlets (FILL) Very Loose Brown, grey below 2.2 m depth Moist to wet below 2.3 m depth		2	SS	4		92				
			3	SS	2		91				
			4	SS	WH		90				0 52 44 4
89.3			5A 5B	SS	WH						
3.6	CLAYEY SILT with SAND, trace to some gravel (TILL) Very soft Brown to grey with oxidation staining		6	SS	4		89				10 35 42 13
88.4 / 4.5	Moist										
	Silty SAND, some gravel, trace to some clay (TILL) Dense Grey Wet		7	SS	32	▽	88				16 56 22 6
87.3 / 5.6	- Augers grinding from 5.2 m to 7.6 m										
	CLAYEY SILT, some sand, some shale fragments (RESIDUAL		8A 8B	SS	100/0.20						
86.7 / 6.2	SOIL) Grey Wet						86				
	Inferred completely to moderately weathered, brown to grey, extremely weak to weak SHALE (Georgian Bay Formation)										
85.4 / 7.5	SHALE (BEDROCK) Grey		1	RC	REC						RQD = 0%
	Bedrock cored from a depth of 7.5 m to 11.4 m		2	RC	REC 94%		85				RQD = 80%
	For bedrock coring details, refer to Record of Drillhole NRW3-6		3	RC	REC 96%		84				RQD = 82%
			4	RC	REC 100%		83				RQD = 88%
81.5							82				
11.4	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of 6.7 m below ground surface upon completion of soil drilling prior to rock coring.

2. Water level measured at a depth of about 5.2 m below ground surface (Elev. 87.7 m) prior to rock coring.

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

PROJECT: 1662333

RECORD OF DRILLHOLE: NRW3-6

SHEET 1 OF 1

LOCATION: N 4824701.8 ;E 296220.4

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Davis 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	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole NRW3-6		85.39															
8		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		7.47	1							BD,PL,SM Sa	1	2					
												BD,UN,SM Sa	2	2					
9					2							CO,UN,RO Sa	3	2					
												BD,PL,SM PC	1	3					R1
												BD,CU,SM PC	2	3					
												BD,IR,RO Sa	3	2					
10					3							BD,PL,SM CI	1	1					
												CO,PL,RO CI	5	1					
												BD,IR,RO IN, CI	3	6					
												BD,UN,Ro CI	3	1					
												BD,UN,SM PC	2	3					
11					4							BD,UN,SM CI	2	1					
												BD,UN,SM CC, CI	2	4					
												CO,UN,RO CI	3	1					
				81.48								BD,CU,SM SO	2	1					
		END OF DRILLHOLE		11.38															
12																			
13																			
14																			
15																			
16																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED:

CHECKED:

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GOLDER

RECORD OF BOREHOLE No NRW7-3

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824696.6; E 296259.1 MTM NAD 83 ZONE 10 (LAT. 43.562158; LONG. -79.605727)

ORIGINATED BY ACM

DIST Central HWY QEW

BOREHOLE TYPE CME 114 mm O.D. Hollow Stem Auger

COMPILED BY SK

DATUM Geodetic

DATE July 15, 2018

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 / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.9	GROUND SURFACE										
0.0 / 94.5	CONCRETE (430 mm)										
0.4 / 93.9	Gravelly sand, trace to some silt (FILL) Dense Brown Wet		1	SS	49		94				
1.0	Silt and sand, trace clay (FILL) Very loose to compact Brown Moist to wet below 3.6 m		2	SS	26						
			3	SS	13		93				
	- 0.1 m of black organic silt present at 2.4 m		4	SS	2				○		0 67 31 2
			5	SS	2		92		○		
			6	SS	WH		91		○		0 64 34 2
89.3			7	SS	1		90		○		
5.6	CLAYEY SILT with SAND, some gravel Very stiff Grey Wet		8	SS	26	▽	89		⊢○⊣		17 40 31 12
87.7	- Auger grinding from 6.7 m to 7.0 m						88				
7.2	Silty SAND, trace to some clay, trace gravel Very dense Grey Wet - Auger grinding from 7.6 m to 8.2 m and from 9.1 m to 12.2 m		9	SS	53		87		○		2 70 21 7
			10	SS	100/0.13		86		○		
84.1			11A 11B	SS	50/0.25		85		○		
10.8	CLAYEY SILT, some sand, some shale fragments below 11.6 m (RESIDUAL SOIL) Hard Grey Moist						84		○		
82.6			12	SS	100/0.08		83		○		
12.3	END OF BOREHOLE SPLIT-SPOON REFUSAL										

NOTES:

1. Borehole caved to a depth of 4.3 m below ground surface upon removal of hollow stem augers.

2. Water level measured at a depth of 6.4 m below ground surface (Elev. 88.5 m) within hollow stem augers upon completion of soil drilling.

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

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

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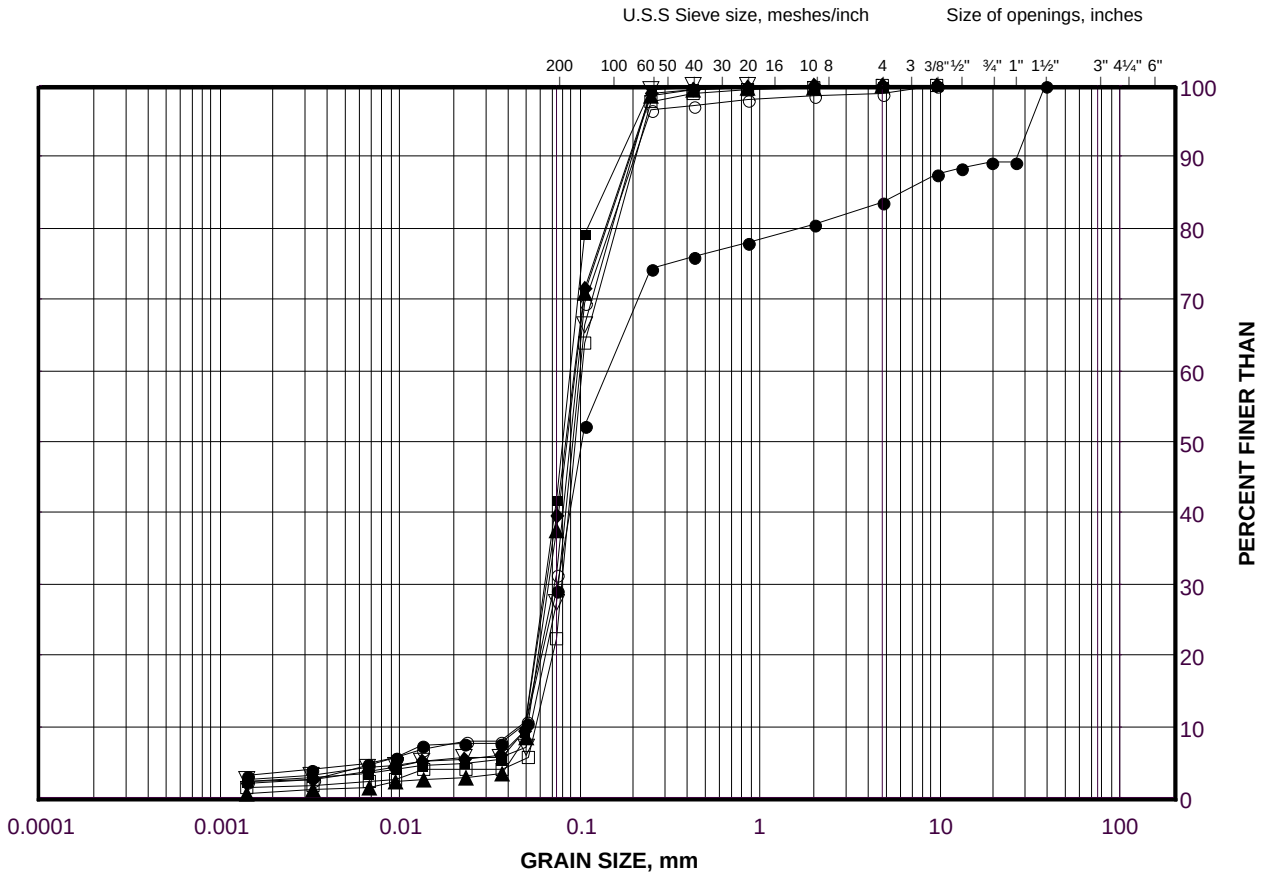
GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand (Fill)

FIGURE B-1A



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	K2	3	91.7
■	K5	4	91.6
◆	K6	4	91.5
▲	K4	4	92.9
▽	K3	5	91.6
❍	K2	6	89.8
□	K3	7	90.1

Project Number: 1662333

Checked By: SMM

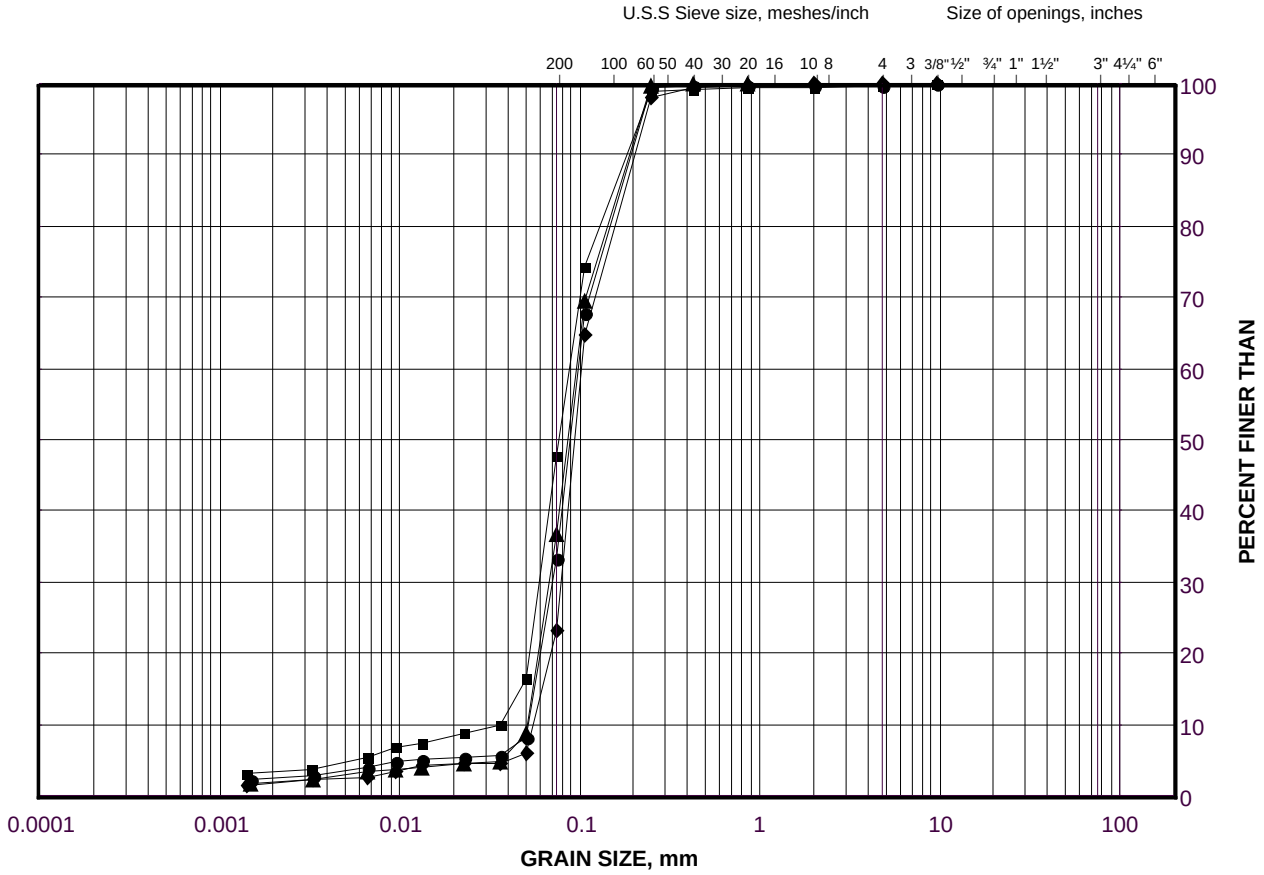
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand (Fill)

FIGURE B-1B



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NRW7-3	4	92.3
■	NRW3-6	4	90.3
◆	K6	6	90.0
▲	NRW7-3	6	90.8

Project Number: 1662333

Checked By: SMM

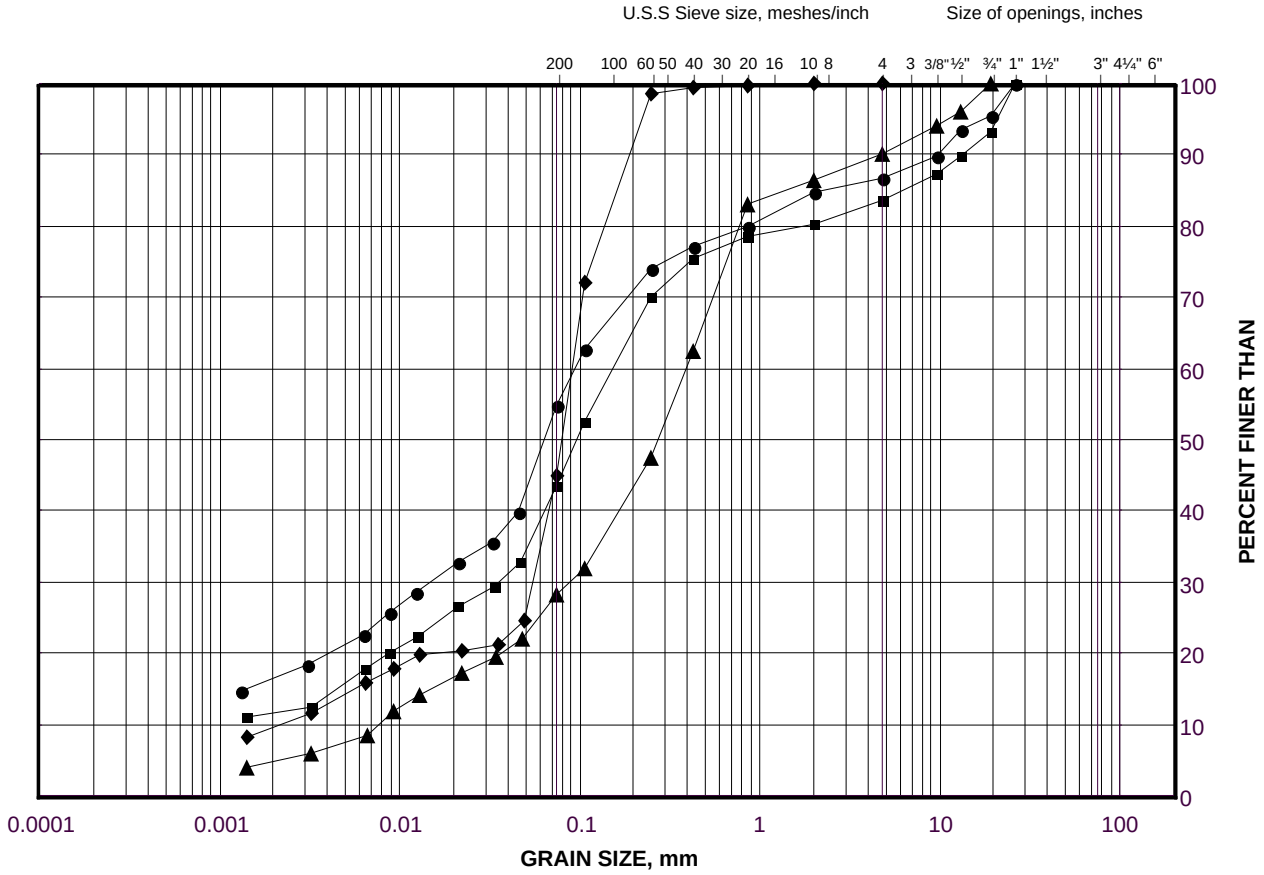
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand

FIGURE B-2



LEGEND

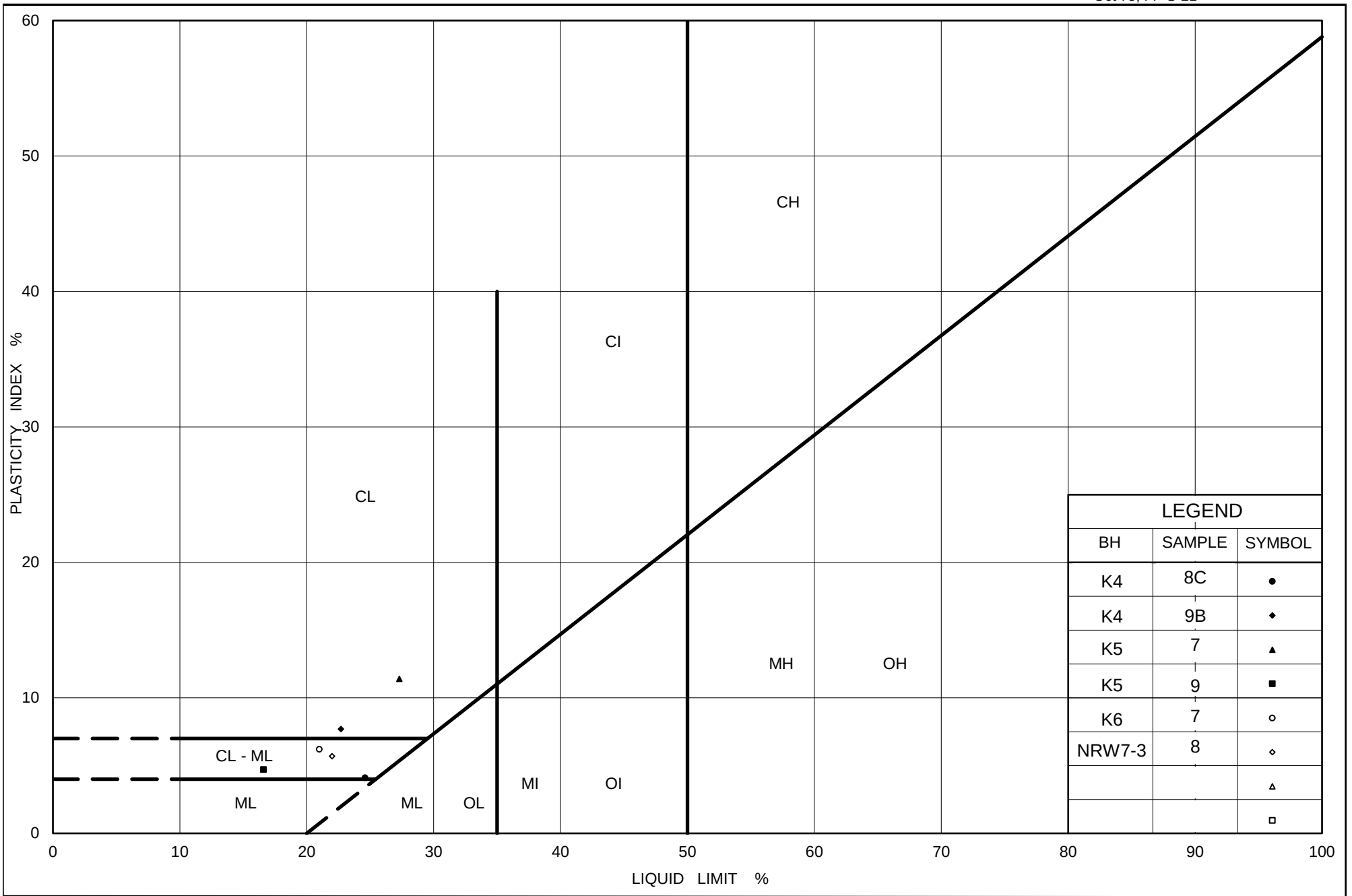
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	K5	7	88.6
■	NRW7-3	8	88.5
◆	K4	8C	89.9
▲	K5	9	85.6

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 05-Feb-19



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt with Sand

Figure No. B-3

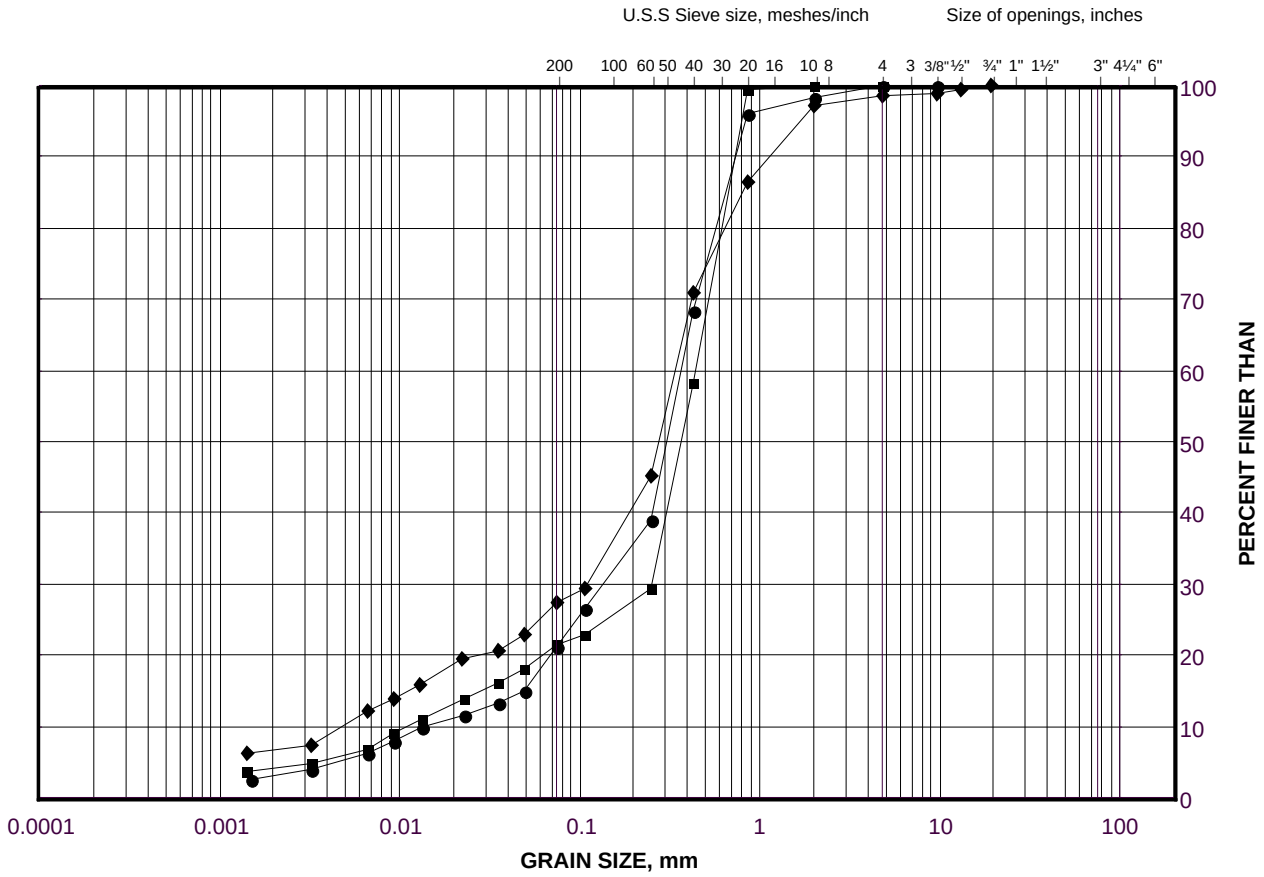
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand

FIGURE B-4



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	K6	10	83.9
■	K4	11	85.6
◆	NRW7-3	9	86.9

Project Number: 1662333

Checked By: SMM

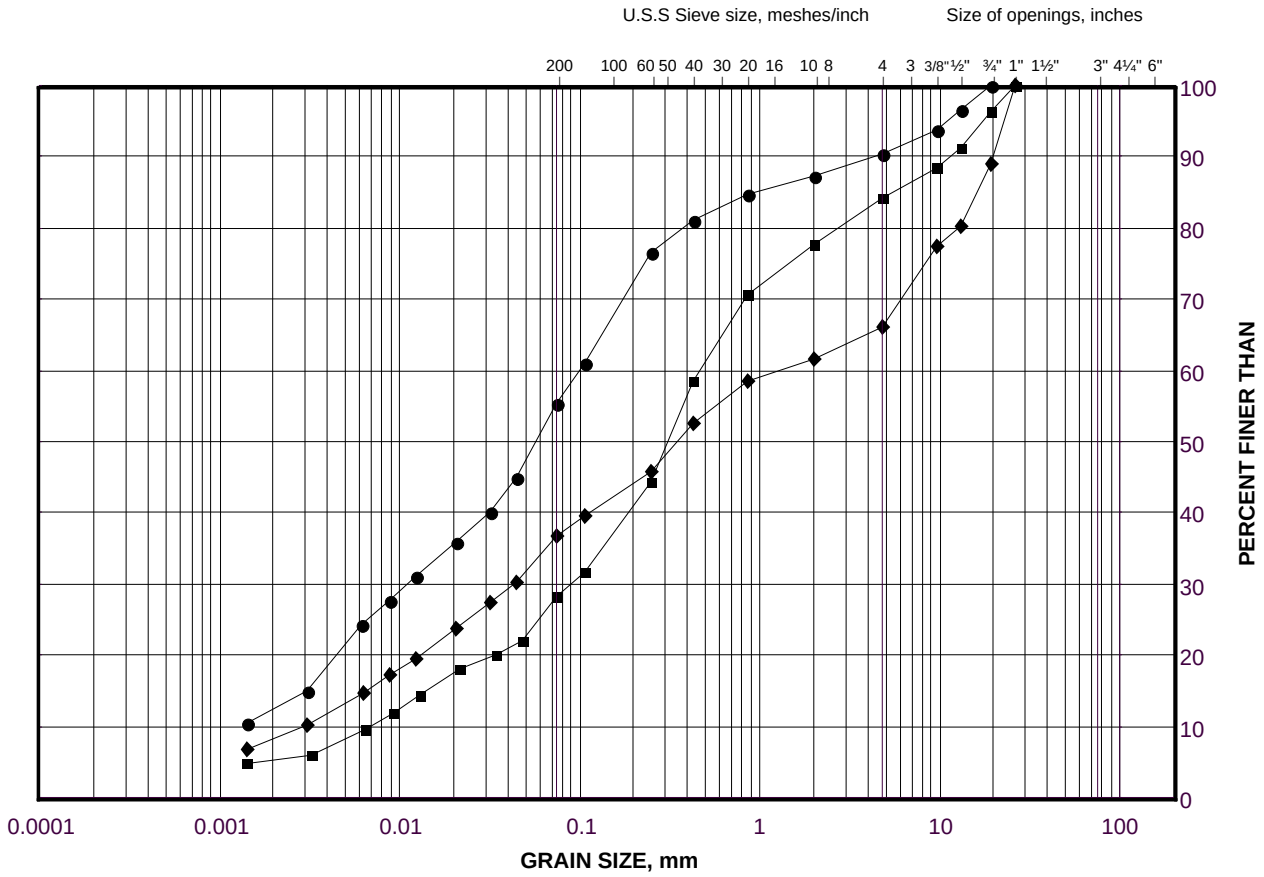
Golder Associates

Date: 05-Feb-19

GRAIN SIZE DISTRIBUTION

Silty Sand / Sandy Clayey Silt with Gravel / Clayey Silt with Sand (Till)

FIGURE B-5



LEGEND

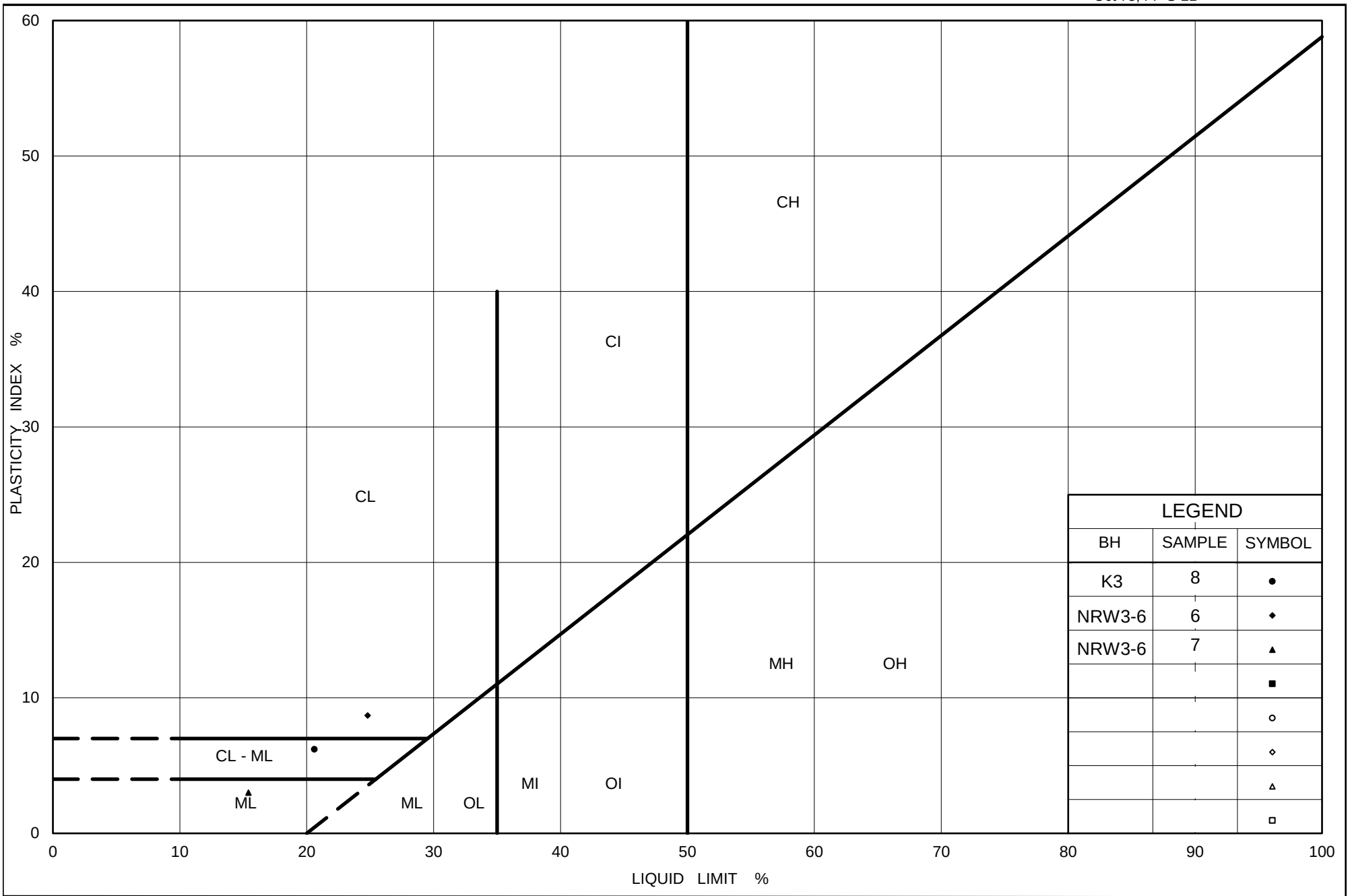
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NRW3-6	6	88.8
■	NRW3-6	7	88.0
◆	K3	8	88.6

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 05-Feb-19



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty Sand to Sandy Clayey Silt with Gravel / Clayey Silt with Sand (Till)

Figure No. B-6

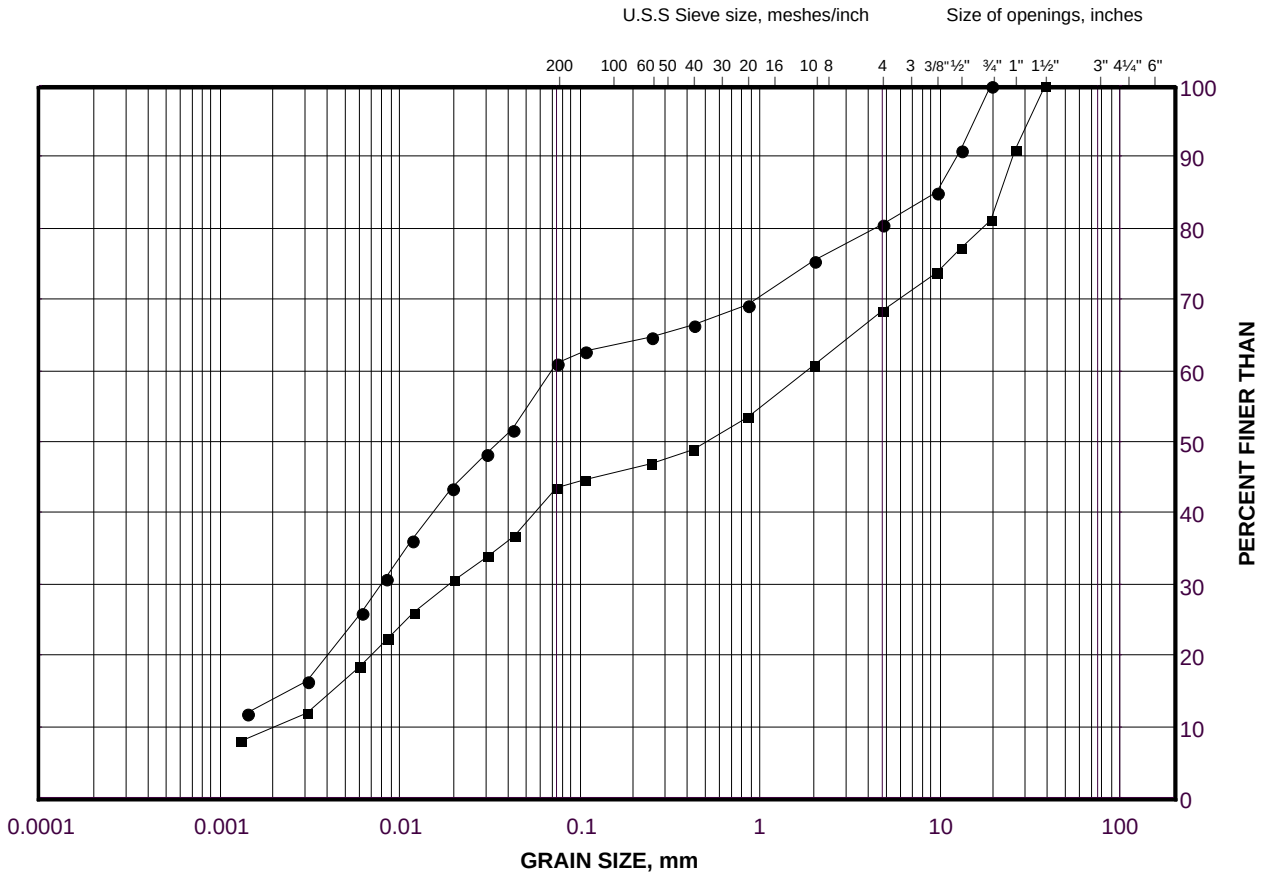
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt with Gravel / Clayey Silt (Residual Soil)

FIGURE B-7



LEGEND

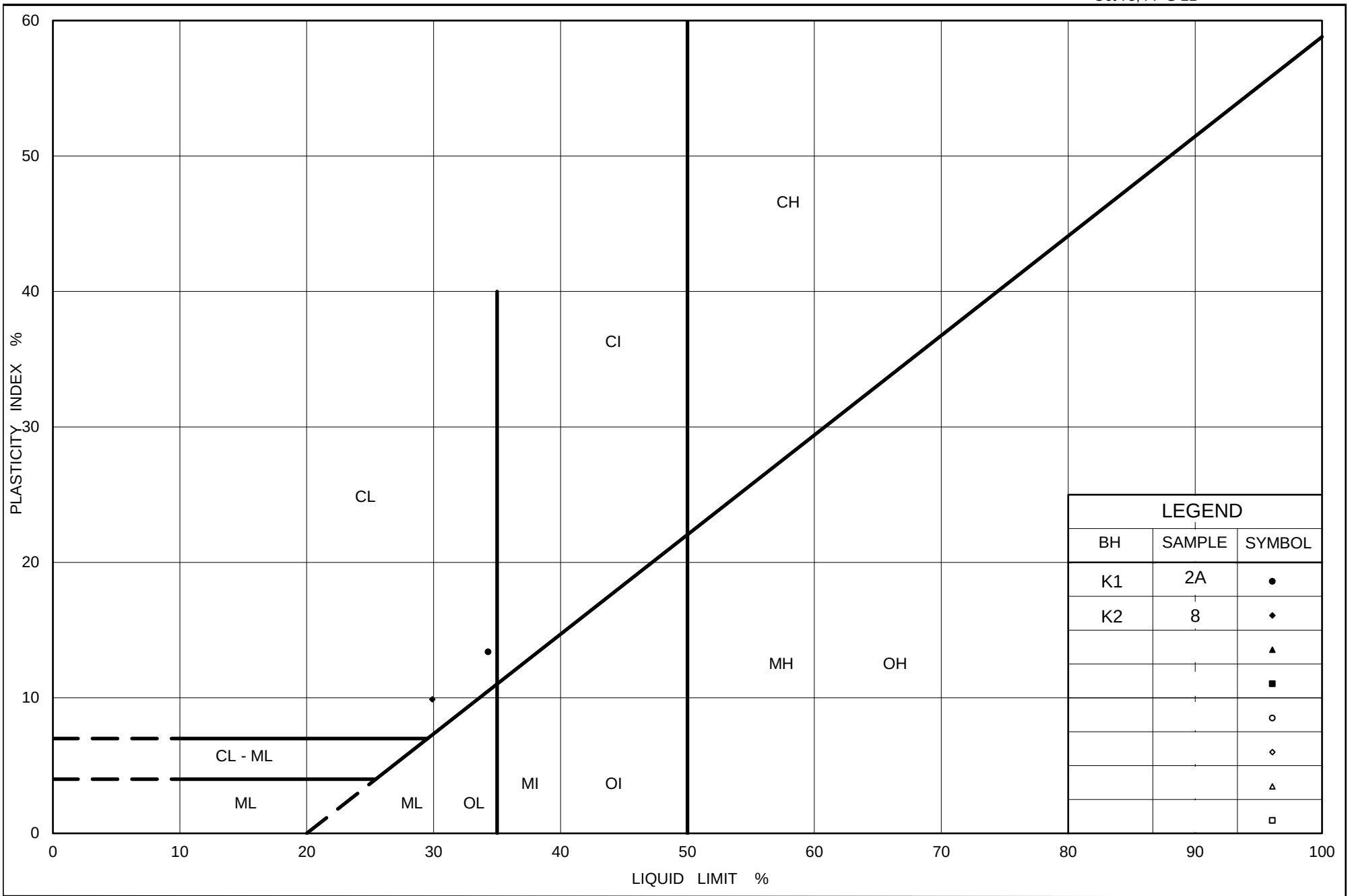
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	K1	2A	89.1
■	K2	8	88.3

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 05-Feb-19



Ministry of Transportation

Ontario

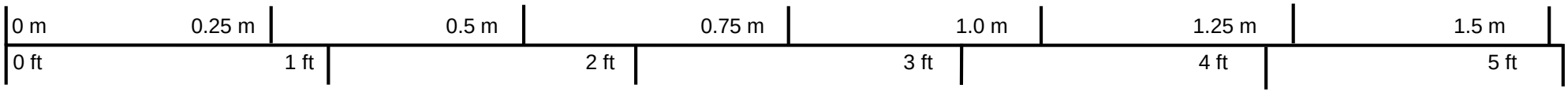
PLASTICITY CHART

Sandy Clayey Silt with Gravel / Clayey Silt (Residual Soil)

Figure No. B-8

Project No. 1662333

Checked By: SMM



Scale

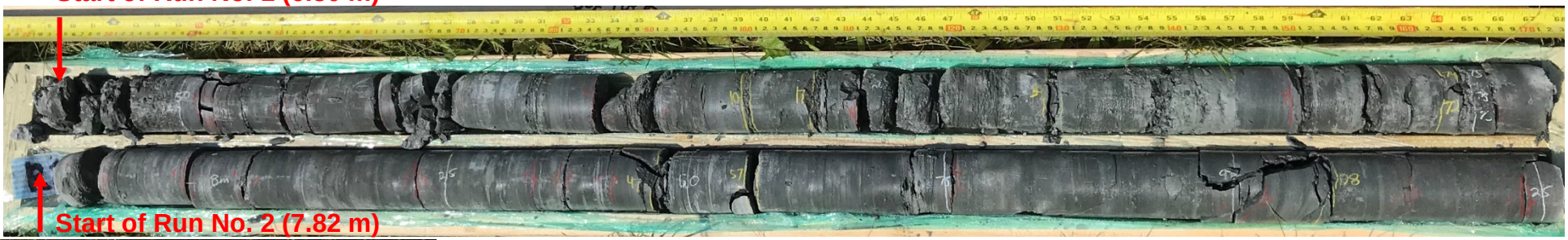
REVISION DATE: March 7, 2018 BY: JIL Project: 1662333

PROJECT	**MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street**
TITLE	**Bedrock Core Photograph Borehole K1 (1.25 m to 5.05 m)**

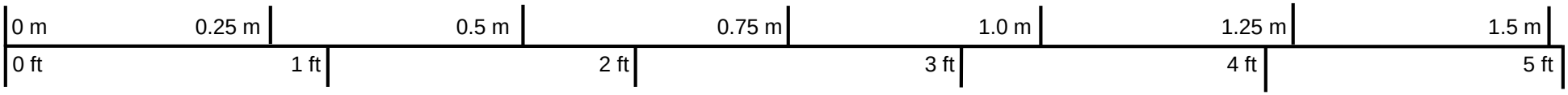
GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	KMG	Jan 2019	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-9**		
CHECK	SMM	Apr 2019			
REVIEW	JMAC	Apr 2019			

Start of Run No. 1 (6.30 m)



Start of Run No. 2 (7.82 m)



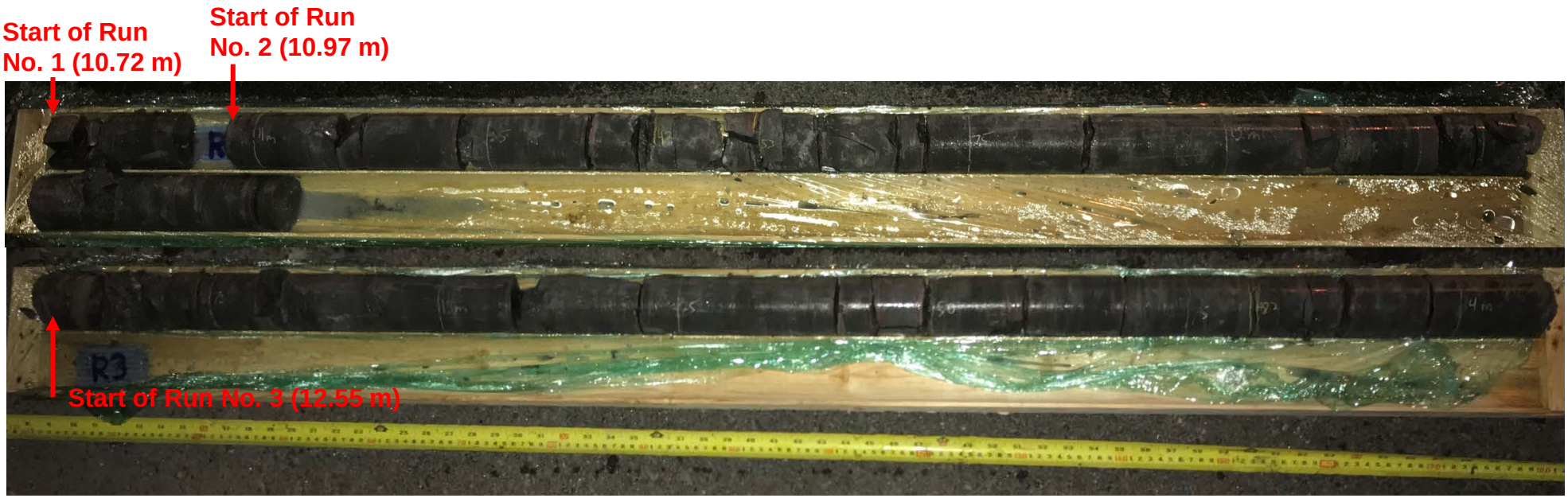
Scale

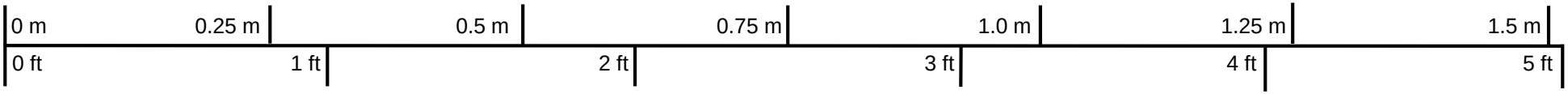
REVISION DATE: March 7, 2018 BY: JIL Project: 1662333

PROJECT	**MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street**
TITLE	**Bedrock Core Photograph Borehole K2 (6.30 m to 9.37 m)**

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	KMG	Jan 2019	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-10**		
CHECK	SMM	Apr 2019			
REVIEW	JMAC	Apr/2019			





Scale

PROJECT

MTO Assignment 2015-E-0033
QEW Widening Between
Mississauga Road and Hurontario Street

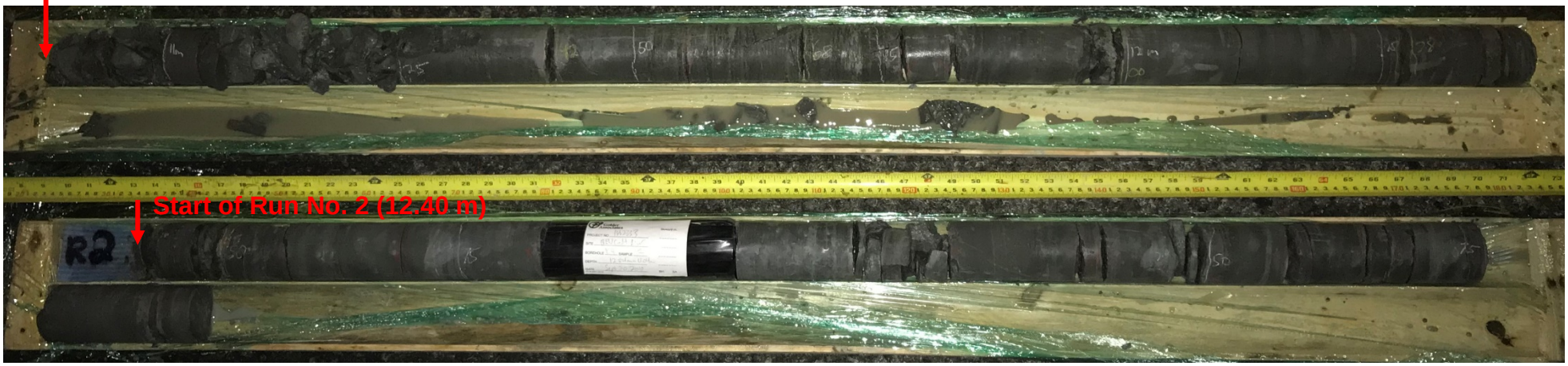
TITLE

Bedrock Core Photograph
Borehole K3 (10.72 m to 14.07 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	KMG	Jan 2019	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	SMM	Apr 2019	**FIGURE B-11**		
REVIEW	JMAC	Apr 2019			

REVISION DATE: March 7, 2018 BY: JIL Project: 1662333



0 m | 0.25 m | 0.5 m | 0.75 m | 1.0 m | 1.25 m | 1.5 m

0 ft | 1 ft | 2 ft | 3 ft | 4 ft | 5 ft

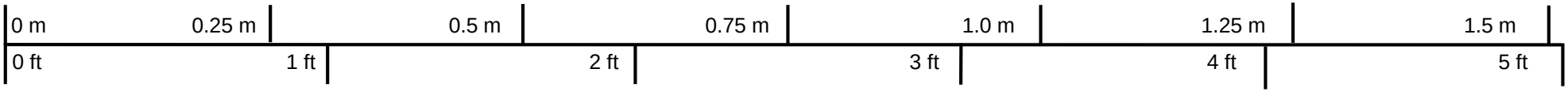
Scale

REVISION DATE: March 7, 2018 BY: JIL Project: 1662333

PROJECT	**MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street**
TITLE	**Bedrock Core Photograph Borehole K4 (10.85 m to 13.92 m)**

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	KMG	Jan 2019	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-12**		
CHECK	SMM	Apr 2019			
REVIEW	JMAC	Apr 2019			



Scale

PROJECT

MTO Assignment 2015-E-0033
QEW Widening Between
Mississauga Road and Hurontario Street

TITLE

Bedrock Core Photograph
Borehole K5 (12.83 m to 16.49 m)

GOLDER

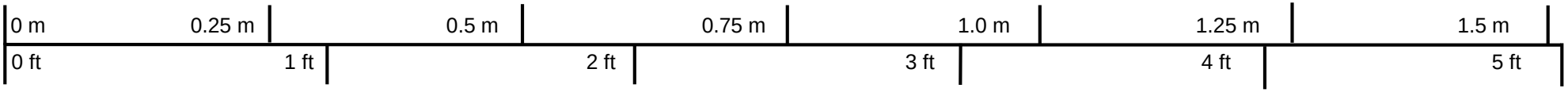
PROJECT No. 1662333			FILE No. ----		
DRAFT	KMG	Jan 2019	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	SMM	xx/xx/2019			
REVIEW	JMAC	xx/xx/2019			

FIGURE B-13

REVISION DATE: March 7, 2018 BY: JIL Project: 1662333

Start of Run No. 1 (14.33 m)

Start of Run No. 2 (14.94 m)



Scale

REVISION DATE: March 7, 2018 BY: JIL Project: 1662333

PROJECT

MTO Assignment 2015-E-0033
QEW Widening Between
Mississauga Road and Hurontario Street

TITLE

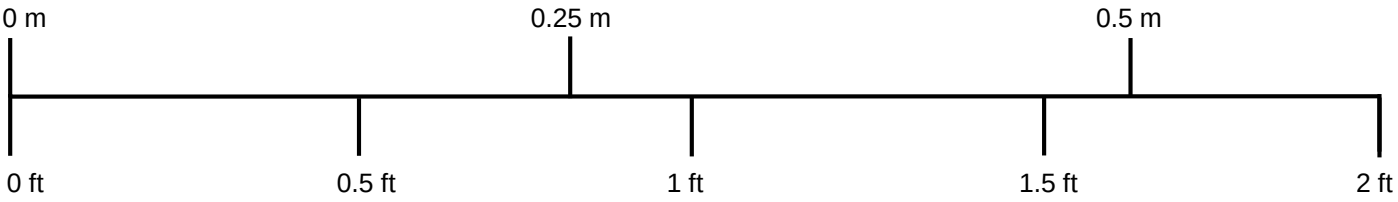
Bedrock Core Photograph
Borehole K6 (14.33 m to 15.02 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	KMG	Jan 2019	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	SMM	Apr 2019	**FIGURE B-14**		
REVIEW	JMAC	Apr 2019			

Borehole NRW3-6

Scale



REVISION DATE: Februrary 13, 2019 BY: Project: 1662333

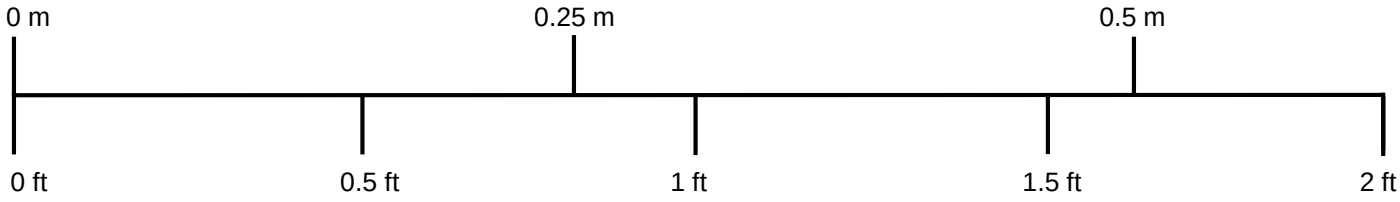
PROJECT	**MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW between Mississauga Road and Hurontario Street**
TITLE	**Bedrock Core Photograph Borehole NRW3-6 (7.47 m to 10.30)**

GOLDER

PROJECT No. 1662333			FILE No. ----		
DESIGN	JMP	Feb 2019	SCALE	AS SHOWN.	VER. 1
CADD	-- --				
CHECK	SMM	Apr 2019	**FIGURE B-15**		
REVIEW	JMAC	Apr 2019			

Borehole NRW3-6

Scale



REVISION DATE: February 13, 2019 BY: Project: 1662333

PROJECT	**MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW between Mississauga Road and Hurontario Street**				
TITLE	**Bedrock Core Photograph Borehole NRW3-6 (10.30 m to 11.38)**				
GOLDER	PROJECT No. 1662333			FILE No. ----	
	DRAFT	JMP	Feb 2019	SCALE AS SHOWN.	VER. 1
	CADD	-- --			
	CHECK	SMM	Apr 2019	**FIGURE B-15**	
	REVIEW	JMAC	Apr 2019		

APPENDIX C

Geomechanica Rock Testing Results

GEOMECHANICA

Geomechanica Inc.
Suite 900 – 390 Bay St.
Toronto Ontario
Canada M5H 2Y2

December 20, 2018

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

Re: UCS + E testing
(Golder Project No. 1662333-8006)

Dear Mr. Marmor:

On Decmeber 6, 2018 three HQ-sized core samples were received by Geomechanica Inc. via drop-off by Golder personnel. These samples were identified as being from boreholes drilled as part of Golder project 1662333-8006. A total of 3 uniaxial compressive strength (UCS) specimens were prepared and tested from these samples.

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

Sincerely,

Bryan Tatone Ph.D., P. Eng.

Geomechanica Inc.
Tel: (647) 478-9767
Email: bryan.tatone@geomechanica.com

GEOMECHANICA

Rock Laboratory Testing Results

A report submitted to:

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

Prepared by:

Bryan Tatone, PhD, PEng

Omid Mahabadi, PhD, PEng
Geomechanica Inc.
#900-390 Bay St.
Toronto ON
M5H 2Y2 Canada
Tel: +1-647-478-9767
lab@geomechanica.com

December 20, 2018
Project number: 1662333-8006

Abstract

This document summarizes the results of rock laboratory testing, including the result of 3 uniaxial compressive strength (UCS) tests. The uniaxial compressive strength (UCS) and tangent Young's modulus along with photographs of samples before and after testing are presented herein.

In this document:

1 Uniaxial Compressive Strength Tests

1.1 Overview

This section summarizes the results of uniaxial compressive strength testing. The testing was performed in Geomechanica's rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.150 mm/min (Figure 1). The preparation and testing of each UCS specimen included the following:

1. Unwrapping of the core sample, inspecting it for damage, and re-wrapping it in electrical tape to minimize exposure to moisture during subsequent specimen preparation.
2. Diamond cutting of core sample to obtain a cylindrical specimen with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding of specimen to obtain flat (within ± 0.025 mm) and parallel end faces (within 0.25°).
4. Placement of the specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axially loading the specimens to rupture while continuously recording axial force and axial deformationto determine the peak strength (UCS) and tangent Young's modulus.

Figure 1: Forney loading frame setup for uniaxial compression testing.

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-08. The side straightness criteria, as checked with a feeler gauge, was met for all samples and the minimum length:diameter criteria was met for all specimens unless noted otherwise in Table 1. Testing of the specimens followed ASTM D7012-14 with the following exceptions:

- Rather than a spherical seat diameter equal to 1 to 2 times the specimen diameter, the setup used here employed a 25.4 mm diameter high precision ball bearing and seat. Despite the smaller diameter, this seat could move freely to accommodate small angular rotations in any direction, as needed, and therefore did not appreciably influence the results.
- The tests presented herein included the measurement of the UCS and Young's (elastic) modulus, but not the Poisson's ratio. This represents a hybrid between Methods C and D of ASTM D7012-14.

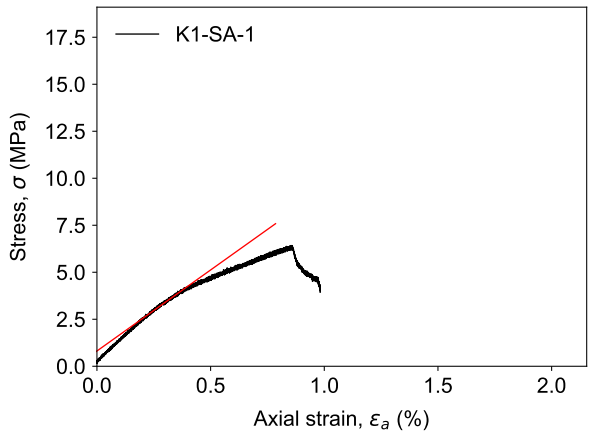
1.2 Results

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

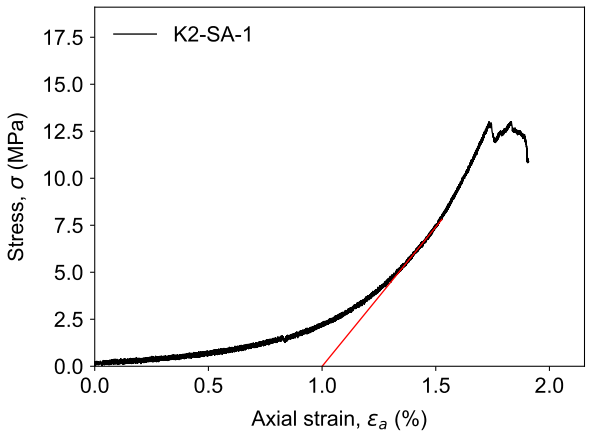
Table 1: Summary of Uniaxial Compression test results.

Sample	Depth (m)	Bulk density ρ (g/cm^3)	UCS (MPa)	Young's modulus E (GPa)	Lithology	Failure description
K1-SA-1	3.14 - 3.28	2.576	6.4	0.9	Georgian Bay Formation - shale with limestone inclusions	1
K2-SA-1	8.05 - 8.22	2.550	13.0	1.5	Georgian Bay Formation - weathered shale	1
K3-SA-1	11.87 - 12.06	2.576	18.2	2.3	Georgian Bay Formation - very weathered shale	1
	Average	2.567	12.5	1.6		
	Standard deviation	0.012	4.8	0.6		

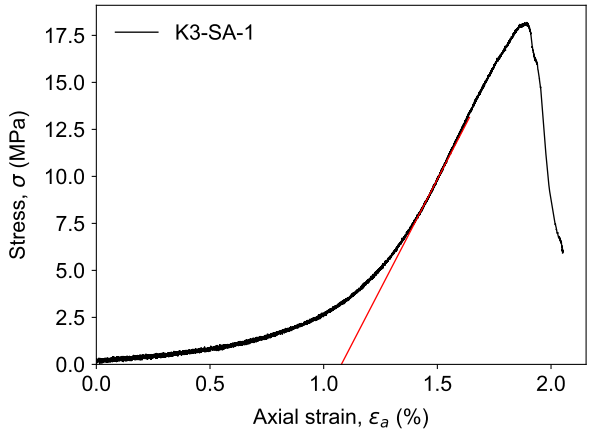
[1] Axial splitting failure



(a) K1-SA-1



(b) K2-SA-1



(c) K3-SA-1

Figure 2: Measured stress-strain curves.

1.3 Specimen photographs

Photographs of the specimens prior to and after testing are presented in the Appendix of this report.

Appendices

Specimen sheets

- K1-SA-1
- K2-SA-1
- K3-SA-1

GEOMECHANICA

Uniaxial Compression Test

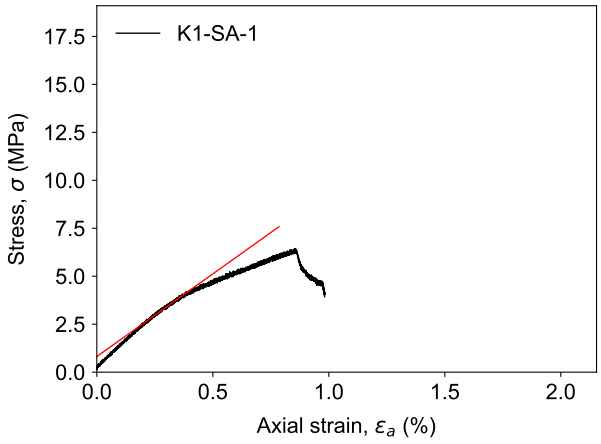
Client	Golder Associates Ltd.	**Project**	1662333-8006
Sample	K1-SA-1	**Depth**	3.14 - 3.28

Specimen parameters	
Diameter (mm) [a]	63.07
Length (mm) [a]	136.54
Bulk density ρ (g/cm^3)	2.576
UCS (MPa)	6.4
Young's modulus E (GPa) [b]	0.9
Lithology	Georgian Bay Formation - shale with limestone inclusions
Failure description [c]	1

Prior to testing

After testing

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 50.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure;



Remarks:

Performed by	BSAT	**Date**	2018-12-19

GEOMECHANICA

Uniaxial Compression Test

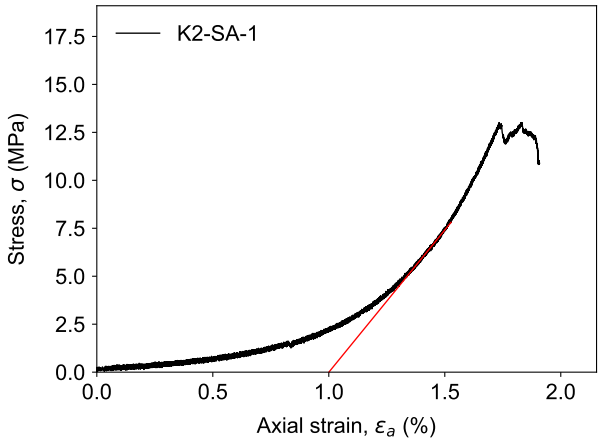
Client	Golder Associates Ltd.	**Project**	1662333-8006
Sample	K2-SA-1	**Depth**	8.05 - 8.22

Specimen parameters	
Diameter (mm) [a]	60.20
Length (mm) [a]	127.31
Bulk density ρ (g/cm^3)	2.550
UCS (MPa)	13.0
Young's modulus E (GPa) [b]	1.5
Lithology	Georgian Bay Formation - weathered shale
Failure description [c]	1

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through $\pm$300 data points on either side of the point representing 50.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure;

Prior to testing

After testing



Remarks:

Performed by	BSAT	**Date**	2018-12-19

GEOMECHANICA

Uniaxial Compression Test

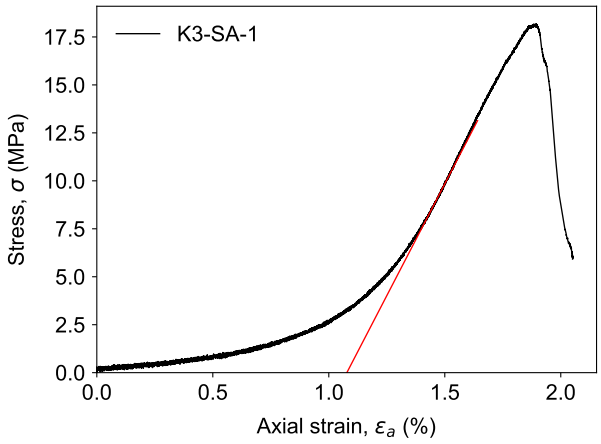
Client	Golder Associates Ltd.	**Project**	1662333-8006
Sample	K3-SA-1	**Depth**	11.87 - 12.06

Specimen parameters	
Diameter (mm) [a]	60.19
Length (mm) [a]	123.03
Bulk density ρ (g/cm^3)	2.576
UCS (MPa)	18.2
Young's modulus E (GPa) [b]	2.3
Lithology	Georgian Bay Formation - very weathered shale
Failure description [c]	1

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 50.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure;

Prior to testing

After testing



Remarks:

Performed by	BSAT	**Date**	2018-12-19

Geomechanica Inc.
Suite 900 – 390 Bay St.
Toronto Ontario
Canada M5H 2Y2

January 03, 2018

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

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

Dear Mr. Marmor:

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

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

Sincerely,

Giovanni Grasselli Ph.D., P. Eng.

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

GEOMECHANICA

Rock Laboratory Testing Results

A report submitted to:

David Marmor

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

Prepared by:

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

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

January 3, 2018
Project number: 1662333

Abstract

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

In this document:

1 Overview

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

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

Figure 1: UCS Test setup.

2 Results

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

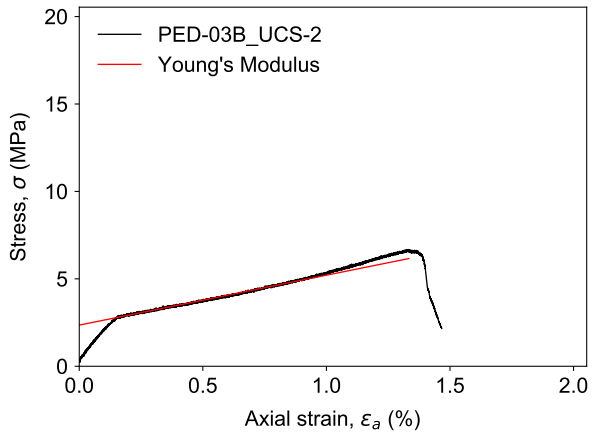
Table 1: Summary of laboratory test results.

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

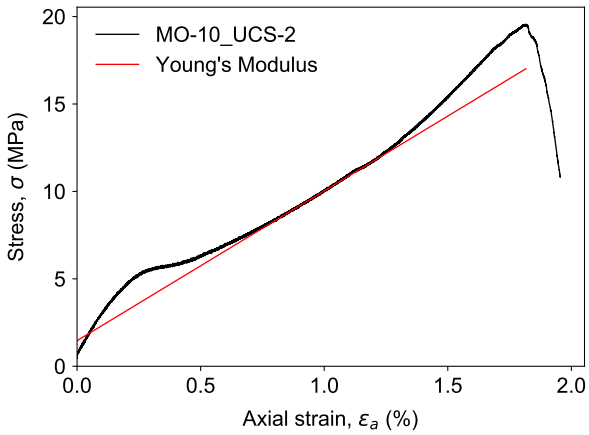
[1] Specimen emitted fresh pore water upon loading
[2] Length:diameter ratio $<$ 2:1
[3] Contains limestone layers

2.1 Specimen photographs

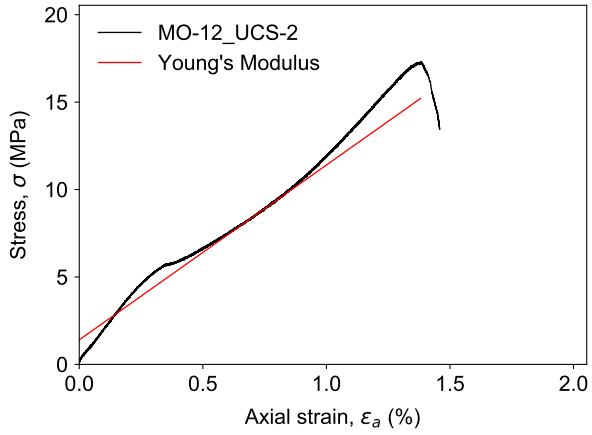
Photographs of the specimens before and after testing are presented in Figure 3.



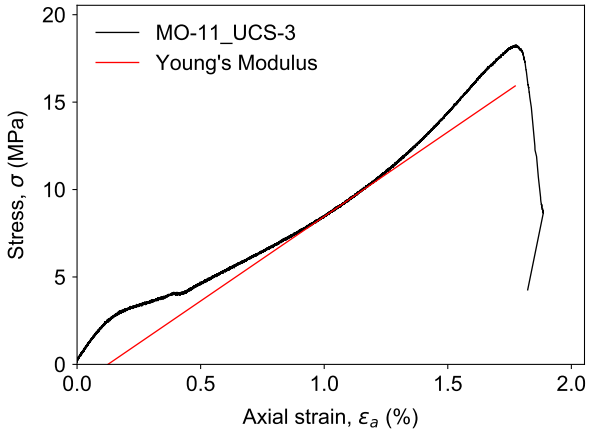
(a) PED-03B, UCS-2



(b) MO-10, UCS-2



(c) MO-12, UCS-2



(d) MO-11, UCS-3

Figure 2: Measured stress-strain curves.

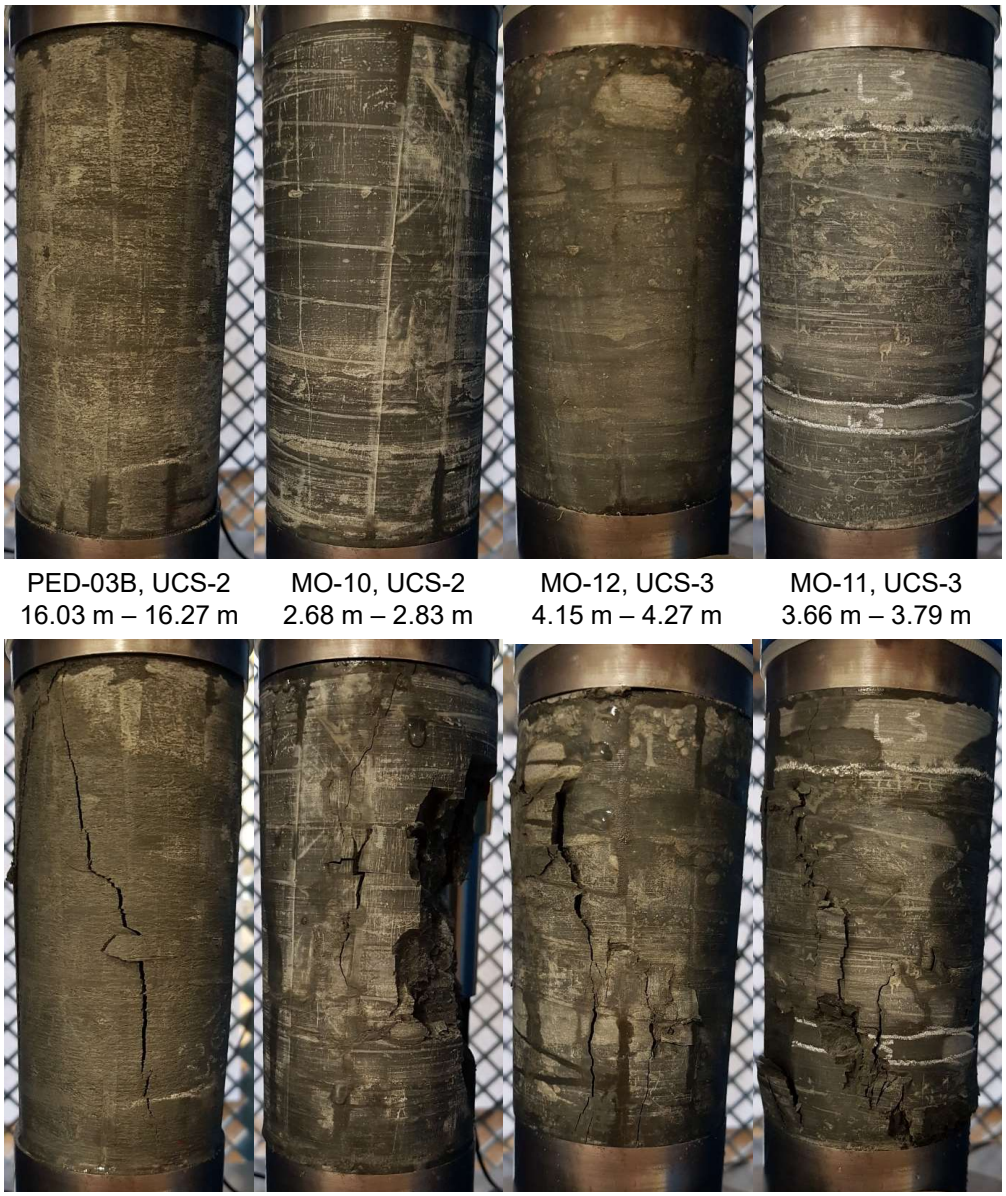


Figure 3: Photographs of specimens prior to testing.

APPENDIX D

Analytical Test Reports (Maxxam Analytics)

Maxxam
A Bureau Veritas Group Company

Your Project #: 1662333
Site Location: QEW/CREDIT RIVER
Your C.O.C. #: 641804-09-01

Attention: Jane Peter

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

Report Date: 2018/12/12
Report #: R5522742
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8W6758
Received: 2018/12/06, 12:29

Sample Matrix: ROCK
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	1	N/A	2018/12/12	CAM SOP-00463	EPA 325.2 m
Conductivity	1	N/A	2018/12/12	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	1	2018/12/12	2018/12/12	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	1	2018/12/11	2018/12/12	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	1	N/A	2018/12/12	CAM SOP-00464	EPA 375.4 m

Sample Matrix: Soil
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	4	N/A	2018/12/12	CAM SOP-00463	EPA 325.2 m
Conductivity	4	N/A	2018/12/12	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	4	2018/12/12	2018/12/12	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	4	2018/12/11	2018/12/12	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	4	N/A	2018/12/12	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.

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. #: 641804-09-01

Attention: Jane Peter

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

Report Date: 2018/12/12
Report #: R5522742
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8W6758
Received: 2018/12/06, 12:29

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

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.

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Maxxam Job #: B8W6758
Report Date: 2018/12/12

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

SOIL CORROSIVITY PACKAGE (ROCK)

Maxxam ID		IMF969		
Sampling Date		2018/12/06 11:45		
COC Number		641804-09-01		
	UNITS	**1.75M TO 1.83M K1-CORROSIVITY #1**	**RDL**	**QC Batch**
Calculated Parameters				
Resistivity	ohm-cm	2700		5882461
Inorganics				
Soluble (20:1) Chloride (Cl-)	ug/g	53	20	5883825
Conductivity	umho/cm	372	2	5883994
Available (CaCl2) pH	pH	7.73		5883840
Soluble (20:1) Sulphate (SO4)	ug/g	97	20	5883826

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B8W6758
Report Date: 2018/12/12

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

SOIL CORROSIVITY PACKAGE (SOIL)

Maxxam ID		IMF965	IMF966	IMF967	IMF968		
Sampling Date		2018/12/04 16:30	2018/12/04 16:30	2018/12/04 16:30	2018/12/04 16:30		
COC Number		641804-09-01	641804-09-01	641804-09-01	641804-09-01		
	UNITS	15'-17' K3-SS7	25'-25'8'' S4-SS9A	25'-26'6'' S2-SS9	25'-27' S5-SS9	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm	810	720	1500	680		5882461
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	600	600	37	760	20	5883825
Conductivity	umho/cm	1230	1390	661	1480	2	5883994
Available (CaCl2) pH	pH	7.10	7.62	7.77	7.04		5883840
Soluble (20:1) Sulphate (SO4)	ug/g	210	260	550	<20	20	5883826

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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 Job #: B8W6758
Report Date: 2018/12/12

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

TEST SUMMARY

Maxxam ID: IMF965
Sample ID: 15'-17' K3-SS7
Matrix: Soil

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

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883825	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5883994	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5883840	2018/12/12	2018/12/12	Gnana Thomas
Resistivity of Soil		5882461	2018/12/12	2018/12/12	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5883826	N/A	2018/12/12	Deonarine Ramnarine

Maxxam ID: IMF966
Sample ID: 25'-25'8'' S4-SS9A
Matrix: Soil

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

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883825	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5883994	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5883840	2018/12/12	2018/12/12	Gnana Thomas
Resistivity of Soil		5882461	2018/12/12	2018/12/12	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5883826	N/A	2018/12/12	Deonarine Ramnarine

Maxxam ID: IMF967
Sample ID: 25'-26'6'' S2-SS9
Matrix: Soil

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

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883825	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5883994	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5883840	2018/12/12	2018/12/12	Gnana Thomas
Resistivity of Soil		5882461	2018/12/12	2018/12/12	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5883826	N/A	2018/12/12	Deonarine Ramnarine

Maxxam ID: IMF968
Sample ID: 25'-27' S5-SS9
Matrix: Soil

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

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883825	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5883994	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5883840	2018/12/12	2018/12/12	Gnana Thomas
Resistivity of Soil		5882461	2018/12/12	2018/12/12	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5883826	N/A	2018/12/12	Deonarine Ramnarine

Maxxam ID: IMF969
Sample ID: 1.75M TO 1.83M K1-CORROSIVITY #1
Matrix: ROCK

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

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5883825	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5883994	N/A	2018/12/12	Kazzandra Adeva

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Maxxam Job #: B8W6758
Report Date: 2018/12/12

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

TEST SUMMARY

Maxxam ID: IMF969
Sample ID: 1.75M TO 1.83M K1-CORROSIVITY #1
Matrix: ROCK

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

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5883840	2018/12/12	2018/12/12	Gnana Thomas
Resistivity of Soil		5882461	2018/12/12	2018/12/12	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5883826	N/A	2018/12/12	Deonarine Ramnarine

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Maxxam Job #: B8W6758
Report Date: 2018/12/12

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

GENERAL COMMENTS

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

Package 1	5.3°C

Sample IMF969 [1.75M TO 1.83M K1-CORROSIVITY #1] : Sample analyzed for Corrosivity package to include Chloride, Sulphate, pH and Conductivity as per client request.

Results relate only to the items tested.

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Maxxam Job #: B8W6758
Report Date: 2018/12/12

QUALITY ASSURANCE REPORT

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

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5883825	Soluble (20:1) Chloride (Cl-)	2018/12/12	NC	70 - 130	102	70 - 130	<20	ug/g	1.9	35
5883826	Soluble (20:1) Sulphate (SO4)	2018/12/12	NC	70 - 130	103	70 - 130	<20	ug/g	24	35
5883840	Available (CaCl2) pH	2018/12/12			101	97 - 103			1.3	N/A
5883994	Conductivity	2018/12/12			103	90 - 110	<2	umho/cm	0.65	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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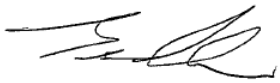
Maxxam Job #: B8W6758
Report Date: 2018/12/12

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

VALIDATION SIGNATURE PAGE

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



Brad Newman, Scientific Service Specialist

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IMMEDIATE

Maxxam Analytics International Corporation o/a Maxxam Analytics
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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:	GOLDER ASSOCIATES	Quotation #:	B70916	Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:	JANE PETER	P.O. #:			641804
Address:	6925 Century Ave Suite 100	Address:	6925 CENTURY AVE	Project:	1662333	COC #:	Project Manager:
	Mississauga ON L5N 7K2		MISSISSAUGA, ON, L5N7K2	Project Name:	QEW/ Credit River	C#641804-09-01	Ema Gitej
Tel:	(905) 567-4444 x Fax: (905) 567-6561 x	Tel:	(613) 9299467 Fax:	Site #:			
Email:	AP_CustomerService@golder.com	Email:	Jane-peter@golder.com	Sampled By:	JMP		

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 ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ______ ☐ PWQO ☐ Other ______

Special Instructions

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

ANALYSIS REQUESTED (PLEASE BE SPECIFIC): Field Filtered (please circle): Metals / Hg / Cr VI; CORROSIVITY (STANDARD PACKAGE)

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 #)*

	Sample Barcode Label / Depth:	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered	Corrosivity (Standard Package)	# of Bottles	Comments
1	15'–17'	K3-SS7	04/12/18	4:30pm	SS		X	1	
2	25'–25'8"	S4-SS9A	04/12/18	4:30pm	SS		X	1	
3	25'–26'6"	S2-SS9	04/12/18	4:30pm	SS		X	1	
4	25'–27'	S5-SS9	04/12/18	4:30pm	SS		X	1	06-Dec-18 12:29
5	1.75 m to 1.83 m	K1- Corrosivity #7	06/12/18	11:45am	ROCK				Ema Gitej B8W6758
6									URE ENV-1116
7									
8									
9									
10									

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only		
JANE PETER / Jane	18/12/05		K.V. KAITLYN VANGELDER	2018/12/06	12:29		Time Sensitive	Temperature (°C) on Recei 8/3/5	Custody Seal Present Intact: Yes / No ✓

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

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

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

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

White: Maxxam Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Maxxam
A Bureau Veritas Group Company

Your Project #: 1662333
Site#: K6
Site Location: QEW-CREDIT RIVER
Your C.O.C. #: 641804-07-01

Attention: Jane Peter

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

Report Date: 2018/12/07
Report #: R5516071
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8V9829
Received: 2018/11/29, 18:29

Sample Matrix: Soil
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	2	N/A	2018/12/06	CAM SOP-00463	EPA 325.2 m
Conductivity	2	N/A	2018/12/06	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	2	2018/12/06	2018/12/06	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	2	2018/12/01	2018/12/07	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	2	N/A	2018/12/06	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.

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Maxxam
A Bureau Veritas Group Company

Your Project #: 1662333
Site#: K6
Site Location: QEW-CREDIT RIVER
Your C.O.C. #: 641804-07-01

Attention: Jane Peter

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

Report Date: 2018/12/07
Report #: R5516071
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8V9829
Received: 2018/11/29, 18:29

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 Job #: B8V9829
Report Date: 2018/12/07

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW-CREDIT RIVER
Sampler Initials: JMP

RESULTS OF ANALYSES OF SOIL

Maxxam ID		IKS868			IKS868			IKS869		
Sampling Date		2018/11/28 07:24			2018/11/28 07:24			2018/11/28 07:24		
COC Number		641804-07-01			641804-07-01			641804-07-01		
	UNITS	K6-SS5	RDL	QC Batch	K6-SS5 Lab-Dup	RDL	QC Batch	S6-SS9	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm	640		5867074				840		5867074
Inorganics										
Soluble (20:1) Chloride (Cl-)	ug/g	830	20	5874021	790	20	5874021	630	20	5874021
Conductivity	umho/cm	1550	2	5874376				1190	2	5874376
Available (CaCl2) pH	pH	7.65		5873908				7.19		5873908
Soluble (20:1) Sulphate (SO4)	ug/g	46	20	5874022	30	20	5874022	<20	20	5874022

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

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 Job #: B8V9829
Report Date: 2018/12/07

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW-CREDIT RIVER
Sampler Initials: JMP

TEST SUMMARY

Maxxam ID: IKS868
Sample ID: K6-SS5
Matrix: Soil

Collected: 2018/11/28
Shipped:
Received: 2018/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5874021	N/A	2018/12/06	Alina Dobreanu
Conductivity	AT	5874376	N/A	2018/12/06	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5873908	2018/12/06	2018/12/06	Gnana Thomas
Resistivity of Soil		5867074	2018/12/07	2018/12/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5874022	N/A	2018/12/06	Alina Dobreanu

Maxxam ID: IKS868 Dup
Sample ID: K6-SS5
Matrix: Soil

Collected: 2018/11/28
Shipped:
Received: 2018/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5874021	N/A	2018/12/06	Alina Dobreanu
Sulphate (20:1 Extract)	KONE/EC	5874022	N/A	2018/12/06	Alina Dobreanu

Maxxam ID: IKS869
Sample ID: S6-SS9
Matrix: Soil

Collected: 2018/11/28
Shipped:
Received: 2018/11/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5874021	N/A	2018/12/06	Alina Dobreanu
Conductivity	AT	5874376	N/A	2018/12/06	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5873908	2018/12/06	2018/12/06	Gnana Thomas
Resistivity of Soil		5867074	2018/12/07	2018/12/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5874022	N/A	2018/12/06	Alina Dobreanu

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Maxxam Job #: B8V9829
Report Date: 2018/12/07

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW-CREDIT RIVER
Sampler Initials: JMP

GENERAL COMMENTS

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

Package 1	3.0°C

Results relate only to the items tested.

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Maxxam Job #: B8V9829
Report Date: 2018/12/07

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW-CREDIT RIVER
Sampler Initials: JMP

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5873908	Available (CaCl2) pH	2018/12/06			100	97 - 103			0.98	N/A
5874021	Soluble (20:1) Chloride (Cl-)	2018/12/06	NC	70 - 130	102	70 - 130	<20	ug/g	5.0	35
5874022	Soluble (20:1) Sulphate (SO4)	2018/12/06	NC	70 - 130	109	70 - 130	<20	ug/g	NC	35
5874376	Conductivity	2018/12/06			104	90 - 110	<2	umho/cm	0.44	10

N/A = Not Applicable

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

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

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

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

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

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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Golder Associates Ltd
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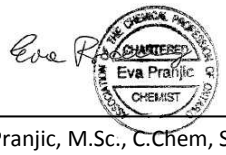
Site Location: QEW-CREDIT RIVER
Sampler Initials: JMP

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

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

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CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#1326 Golder Associates Ltd	Company Name:	GOLDER ASSOCIATES	Quotation #:	B70916	Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:	JANE PETER	P.O. #:			641804
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:	6925 CENTURY AVE MISSISSAUGA ON, L5N7K2	Project:	QEW - Credit River	COC #:	Project Manager:
Tel:	(905) 567-4444 x Fax: (905) 567-6561 x	Tel:	(613) 929 9167 Fax:	Project Name:	1662333	C#641804-07-01	Ema Gitej
Email:	AP_CustomerService@golder.com	Email:	Jane_peter@golder.com	Site #:	KG		
				Sampled By:	JMP		

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 O. Reg.	

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

Field Filtered (please circle): Metals / Hg / Cr VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

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 #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Corrosivity	# of Bottles	Comments
1	KG-SS5	KG-SS5	08 Nov 2018	7:24	SS	X	1	
2	SG-SS9	SG-SS9	"	"	SS	X	1	limited samples
3								
4								
5								
6								
7								
8								
9								
10								

CAUTION
Reason: Matrix Unclear

29-Nov-18 18:29
Ema Gitej
B8V9829
CA2 SRFumeHood

* 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	18/11/28	7:24pm	KATELYN VANGUNSTEREN.	2018/11/29	18:29	

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	2/4/3	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 Analytics International Corporation o/a Maxxam Analytics

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