FOUNDATION INVESTIGATION REPORT

Queen Elizabeth Way (QEW) - Credit River Bridge, Structure Site No. 24-203, QEW Widening from West of Mississauga Road to West of Hurontario Street, Mississauga, Ministry of Transportation, Ontario, GWP 2002-13-00

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed twinning of the existing bridge carrying the Hamilton bound traffic on the Queen Elizabeth Way (QEW) over the Credit River in support of the widening of the QEW from west of Mississauga Road to west of Hurontario Street in the City of Mississauga, in the Regional Municipality of Peel, Ontario.

The purpose of this investigation is to establish the subsurface soil and bedrock conditions at the proposed bridge structure location, including the associated approach embankments, by borehole drilling, rock coring, packer testing and laboratory testing on selected soil and rock core samples.

The Terms of Reference (TOR) and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated July 2016, and the approved Change Request letter dated September 6, 2017, which forms part of the Consultant's Assignment Number (2015-E-0033) for this project. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated February 3, 2017.

2.0 SITE DESCRIPTION

At this site the QEW is generally oriented in a northeast-southwest direction; for the purpose of this report the QEW is described as being in an east-west orientation. The existing QEW Credit River Bridge is located approximately 400 m east of the QEW-Mississauga Road Interchange and approximately 1.4 km west of the QEW - Hurontario Street Interchange and crosses the Credit River Valley over the floodplain and river channel.

The existing bridge is an approximately 256 m long and 29 m wide, seven-span spandrel arch structure, with concrete arches at the piers, supporting six lanes of traffic. The Credit River Valley is about 19 m below the surrounding plateau. The ground surface at the base of the floodplain is at about Elevation 76 m, while the surface of the Credit River, as provided by MH, is at about Elevation 75 m (Sept. 1986). The ground surface at the east and west plateau at the top of the valley (and on the highway near the abutments) is at about Elevation 95 m. The existing bridge is supported on two abutments and six piers all supported on shallow foundations. The east and west abutment are atop the valley plateau and the founding elevation of the supporting footings range from about Elevation 88.9 m to 87.5 m. The piers are located on the valley slopes, within the flood plain and within the Credit River itself, and the founding elevation of the supporting footings range from Elevations 84.5 m (at Pier 6, located on the west valley slope) to 68.2 m.

The east slope of the valley is vegetated with tall grass, shrubs and trees and descends to meet the east bank of the Credit River at an overall slope of about 3.5 Horizontal to 1 Vertical (3.5H:1V) but there are locally steeper sections. Rip-rap erosion protection is present on the on the surface of the east slope and east bank of the river, in some areas. The slope configuration may have been modified by fill placement on the existing valley slope. The east plateau is relatively heavily vegetated and relatively flat. Residential dwellings, now demolished and removed, existed within the footprint of the proposed bridge at the east plateau.

At the west side of the valley, a construction access road was constructed in 2006 and it is understood that the access road alignment was cut through the shale bedrock and shotcrete was applied to the exposed rock faces. The access road splits into an upper access road (which leads to the under-bridge maintenance deck) and a lower access road (which extends down to the base of the valley). The upper access road runs parallel to the west

abutment and the surface of the road is at about Elevation 89 m. Above the upper access road, shotcrete was applied to the rock face. The downslope side of the upper access road is supported by a concrete block retaining wall which protects the lower access road. The access road(s) were cut through the west valley slope and constructed to provide access to the underside of the existing bridge and the valley floor. The west valley slopes (between the abutment and access roads) descend near vertically to meet the flood plain of the Credit River Valley. The west plateau is relatively flat but less densely vegetated than the east plateau, consisting mainly of tall grass and some shrubs.

The proposed bridge will be located immediately to the north of the existing bridge. The land use at the east and west plateau of the valley, north of the proposed bridge is residential. A Hydro One Right-of-Way, containing high voltage transmission lines and local utility owned transmission lines, is located within the footprint of the proposed bridge and crosses the Credit River Valley just north of the existing bridge. Additionally, two buried oil pipelines, owned by Trans-Northern Pipeline Inc. are located immediately to the north of the existing bridge and within the footprint of the proposed bridge.

3.0 INVESTIGATION PROCEDURES

The following Sections 3.1 and 3.2 outline the investigations carried out by others (previous) and by Golder (current) that are relevant to the proposed new bridge structure foundation design, respectively. Section 3.3 describes the available subsurface investigation information that may also be relevant to the design of temporary works, such as foundations to support falsework.

3.1 Previous Investigations

From September to November 2010, a foundation investigation for the west access road was carried out by Thurber Engineering Ltd. (Thurber) during which time a total of seven boreholes were drilled in two phases, designated as Boreholes 10-01 to 10-05, 10-03A and 10-03B. The results of the Thurber investigation are contained in their report titled,

- "Foundation Investigation and Design Report, Construction Access Road for Bridge Rehabilitation, QEW Bridge over Credit River, Mississauga, Ontario" File No. 19-92-92-174, dated April 8, 2011 (GEOCRES 30M12-324). Borehole 10-02 was advanced about 7 m north of the west abutment.

In May and June 2011, a preliminary foundation investigation for the new Credit River Bridge was carried out by Thurber, during which time a total of two boreholes, designated as Boreholes 11-01 and 11-02, were advanced at the proposed west abutment and east pier, respectively. The results of the Thurber investigation are contained in their report titled,

- "Foundation Investigation and Design Report, Preliminary Design and Environmental Assessment, QEW Bridge Twinning Over Credit River, Mississauga, Ontario" File No. 19-1351-174, dated May 18, 2012 (GEOCRES 30M12-341).

While the above noted Thurber reports do not reference the coordinate system of the borehole locations, it is inferred that they are referenced to the MTM NAD 83 (Zone 10) coordinate system based on the plotted position relative to that reference system. The locations of the Thurber boreholes (i.e. 10-02, 11-01, and 11-02) that are relevant to the subsurface conditions at or near the proposed new structure foundation units are summarized in the table below along with the geographic coordinates, ground surface elevations (in Geodetic Datum), and the drilled depths based

on the Thurber borehole records. These borehole locations are also shown in plan on Drawing 1 and the borehole records and the summary of the relevant laboratory testing results from the Thurber investigation are presented in Appendix A.

Borehole No.	Location (MTM NAD 83, Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (Latitude, °)	Easting (Longitude, °)		
10-02	4,823,966.3 (43.555579)	295,798.0 (-79.611422)	94.4	24.4*
11-01	4,823,959.1 (43.555514)	295,814.8 (-79.611214)	94.6	7.1*
11-02	4,824,026.4 (43.556210)	295,840.4 (-79.610898)	75.7	8.4*

* Includes bedrock coring lengths of 19.8 m (10-02), 3.5 m (11-01), and 2.1 m (11-02).

3.2 Current Investigation

The field work for the current foundation investigation was carried out between October 10 and October 23, 2017, between January 26 and February 16, 2018 and between July 5 and July 10, 2018, during which time fourteen boreholes, designated as Boreholes CRB-1 to CRB-8, CRB-2A, CRB-2B, CRB-3A, CRB-3C, CRB-5A and NW6-1 were advanced near or within the footprint of the foundation, as follows:

Foundation Element	Nearest Relevant Boreholes
West Approach	CRB-1
West Abutment	CRB-2, CRB-2A and CRB-2B
West Pier	CRB-3, CRB-3A and CRB-3C
East Pier	CRB-4, CRB-5 and CRB-5A
East Abutment	CRB-6 and CRB-7
East Approach	CRB-8
East Retaining Wall	CRB-7, NW6-1

The locations of the boreholes are shown on Drawing 1 and the Records of Boreholes and Drillholes are provided in Appendix B. Lists of abbreviations and symbols and lithological and geotechnical rock description terminology are also provided in Appendix B to assist in the interpretation of the borehole and drillhole records.

The field borehole investigation was carried out using a track-mounted CME 850 drill rig, supplied and operated by Aardvark Drilling Inc., of Guelph, Ontario, a track-mounted CME 55 drill rig, supplied and operated by Geo-Environmental Drilling Inc., of Acton, Ontario, and using portable drilling equipment supplied and operated by OGS Drilling Inc. of Almonte, Ontario. The boreholes were advanced through the overburden using 210 mm and 159 mm outer-diameter hollow-stem augers and ‘HQ’ casing (in the boreholes advanced by a drill rig) and continuous

split-spoon sampling, wash-boring, and 57 mm thin-walled casing (in the boreholes advanced by the portable drilling equipment, Boreholes CRB-2A and CRB-3C). In the boreholes where continuous sampling was not carried out, 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, or cathead/safety hammer (for Boreholes CRB-2A, CRB-2B and CRB-3C), in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-08)[1]. Field vane shear tests were completed using a MTO standard "N"-sized vane and calibrated torque wrench to obtain an estimate of undrained and remolded shear strengths in selected cohesive soil deposits in accordance with ASTM D2573-15[2]. Core samples of the bedrock in all boreholes located at the proposed bridge abutments and piers were obtained using an 'HQ' size rock core barrel, or 57 mm outer diameter thin-walled core barrel (Boreholes CRB-2A and CRB-3C), and coring techniques.

All boreholes were advanced to sampler refusal and bedrock was confirmed by either split-spoon sampling or bedrock coring. The boreholes were advanced to depths ranging from about 3.3 m to 17.2 m below existing ground surface, including coring of bedrock for core lengths of between 7.5 m and 9.6 m in select boreholes. Photographs of the recovered bedrock core samples are provided in Appendix B.

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 CRB-2, CRB-3A, CRB-5A and CRB-6 to permit monitoring of the groundwater level at these 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 sand and the remainder of the borehole was then backfilled with bentonite to or to near the ground surface. Details of the piezometer installation and water level readings are presented on the borehole records in Appendix B. Boreholes located at proposed abutments and piers were backfilled with a bentonite cement grout while boreholes at the approach embankments were backfilled with bentonite upon completion in accordance with Ontario Regulation 903, Wells (as amended).

The field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services both public and private, observed the drilling, sampling and in-situ testing operations, logged the boreholes, and examined and cared for the soil and bedrock core samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. The results of the laboratory testing for the current investigation are included in Appendix C. Unconfined compression (UC) tests (including assessment of Young's modulus, Poisson's ratio, and core density) were carried out on selected specimens of the bedrock core samples by Geomechanica Inc. on behalf of Golder. The results of the laboratory testing on the rock core samples from the current investigation are included in Appendix C.

Selected bedrock core samples were submitted to Maxxam, a Standards Council of Canada (SCC) accredited laboratory of Mississauga, Ontario for chemical analysis. The samples of bedrock core, specifically collected from Boreholes CRB-2, CRB-3A, CRB-5, CRB-6 advanced at the west abutment and pier and east abutment and pier, respectively, were crushed and homogenized by Maxxam prior to testing, and analyzed for a suite of corrosivity

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

[2] ASTM D2573 – Standard Test Method for Field Vane Shear test in Saturated Fine Grained Soils

parameters, including conductivity, resistivity, soluble chloride, soluble sulphate and pH. The results of the chemical analyses are presented in Appendix C.

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

Borehole No.	Location (MTM NAD 83, Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (Latitude, °)	Easting (Longitude, °)		
CRB-1	4,823,940.2 (43.555344)	295811.1 (-79.611250)	94.9	3.3
CRB-2	4,823,949.7 (43.555430)	295,828.3 (-79.611047)	95.6	12.8 (incl. 9.6 m rock core)
CRB-2A	4,823,960.1 (43.555523)	295,808.0 (-79.611298)	94.5	9.0 (incl. 7.9 m rock core)
CRB-2B	4,823,955.2 (43.555479)	295,818.7 (-79.611165)	94.7	12.7 (incl. 1.5 m soil core and 9.1 m rock core)
CRB-3	4,824,016.8 (43.556034)	295,862.2 (-79.610628)	75.9	15.3 (incl. 8.1 m rock core)
CRB-3A	4,824,025.6 (43.556113)	295,844.6 (-79.610847)	75.7	15.8 (incl. 8.8 m rock core)
CRB-3C	4,824,028.3 (43.556138)	295,837.7 (-79.610932)	75.3	14.1 (incl. 7.7 m rock core)
CRB-4	4,824,135.1 (43.557099)	295,902.0 (-79.610138)	79.1	15.3 (incl. 8.1 m rock core)
CRB-5	4,824,128.9 (43.557044)	295,914.2 (-79.609986)	79.2	15.5 (incl. 8.3 m rock core)
CRB-5A	4,824,130.9 (43.557062)	295,910.6 (-79.610032)	79.3	17.2 (incl. 9.5 m rock core)
CRB-6	4,824,196.7 (43.557650)	295,929.5 (-79.609801)	91.7	13.3 (incl. 8.2 m rock core)
CRB-7	4,824,189.6 (43.557590)	295,951.1 (-79.609531)	94.7	16.0 (incl. 7.5 m rock core)
CRB-8	4,824,211.5 (43.557788)	295,953.7 (-79.609499)	94.7	8.5

Borehole No.	Location (MTM NAD 83, Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (Latitude, °)	Easting (Longitude, °)		
NW6-1	4,824,163.1 (43.557371)	295,975.2 (-79.609278)	95.3	7.5

3.2.1 Packer Testing

In-situ hydrogeological testing, in general accordance with the procedures defined in ASTM D4630, was conducted at one depth interval in Boreholes CRB-3 and CRB-3A (at the west pier) and in Boreholes CRB-4 and CBR-5 (at the east pier), using a dual pneumatic packer setup connection to an on-surface nitrogen tank through an inflation line. Upon completion of drilling, the packer assembly was lowered into the borehole to isolate a select depth interval within the bedrock and a constant pressure head test was performed. The test results were then used to evaluate the hydraulic conductivity within the isolated packer interval. A pressure gauge data logger, manufactured by In Situ Inc., was used to monitor water pressure responses in the isolated interval during the tests. Flow rates and test pressures in the isolated interval were recorded during the constant pressure head tests as well as being recorded by the data logger. The water pressure profiles obtained were used to calculate estimates of hydraulic conductivity using standard steady-state analysis methods.

3.2.2 Televiewer

The original borehole program consisted of advancing two boreholes at the west abutment; however, following review of the bedrock core information that included zones of lost core it was recommended that an additional borehole be advanced at about the mid-line of the abutment and that geophysics be carried out. Borehole CRB-2B was advanced for this purpose at the location shown on Drawing 1. The borehole was advanced on July 5, 2018 and upon completion of coring the borehole was flushed with water and left overnight to allow for any suspended sediment to settle prior to carrying out the televiewer testing on the next day (July 6, 2018). The following geophysical methods were carried out along the length of the cored borehole and the results of these methods are plotted on the Geophysical Record of Borehole CRB-2B in Appendix B:

- **Mechanical Caliper:** This measurement records the borehole diameter as indicated by the average deflection of three spring-loaded arms pressed against the wall of the borehole. Abrupt shifts to larger diameter (kicks) can indicate the locations where fractures intersect the borehole wall. However, the thickness of the caliper arms and the mechanical enlargement of fractures that can occur during drilling result in an approximate, qualitative relation between fracture aperture and the size of the caliper deflection.
- **Acoustic Televiewer:** This measurement produces an image of the pattern of reflection of an ultrasonic pulse from a source that scans the borehole wall as the logging probe is slowly pulled upwards. The televiewer probe also records telemetry so that the azimuth of the scan and the deviation of the borehole can be measured during logging. The reflection is uniformly bright wherever the borehole wall is solid and smooth. The reflected pulses are scattered wherever a fracture or other irregular opening intersects the borehole wall. Planar features such as fractures produce a linear feature in the borehole image such that the strike and dip of the feature can be estimated.
- **Optical Televiewer:** This measurement produces a continuous oriented 360° image of the borehole wall using an optical imaging system as the logging probe is slowly pulled upwards. The televiewer probe is magnetically

orientated so that the azimuth of the scan and the deviation of the borehole can be measured during logging. As noted above the borehole was flushed with water the day prior to carrying out the optical televiewer test; however, when carrying out the test the water inside the borehole, below an Elevation of 86.4 m was cloudy and the optical televiewer could only collect data above this elevation.

3.3 Investigations for Support of Falsework Design

Several boreholes have been advanced in the vicinity of the proposed Credit River bridge as part of the overall project by Golder that may provide subsurface information relevant to the design of temporary works and/or the falsework supporting the bridge during construction. These include boreholes for the temporary East Access Road (Borehole AR-2), for the East-to-West Active Transportation (Boreholes EW-1 and EW-2), as well as specifically for the falsework support between the proposed west abutment and west pier (Borehole FW-1).

In addition, boreholes 10-03A, 10-03B and 10-04 drilled by Thurber (2011) per the reference in Section 3.1 (GEOCRES 30M12-324) also provide information on the subsurface conditions that may be relevant to the falsework design.

MTO has also provided records of boreholes advanced on behalf of others in the vicinity of the proposed bridge including BH3 (drilled by Stantec Consulting Limited for Trans-Northern Pipeline Inc.) and BH17-2 (drilled by Golder, in a separate investigation, for Alectra Utilities Corporation).

The reference for the above noted reports are listed as follows:

- "Draft Foundation Investigation and Design Report, Temporary East Access Road, East of the Credit River, QEW Widening from West of Mississauga Road to West of Hurontario Street, City of Mississauga Ministry of Transportation, Ontario" G.W.P. 2002-13-00, dated January 15, 2019, prepared by Golder Associates Ltd. (GEOCRES to be assigned). Report for Borehole AR-2.
- "Draft Foundation Investigation and Design Report, East-West Active Transport Bridge Along Credit River Bridge, QEW Widening from West of Mississauga Road to West of Hurontario Street Ministry of Transportation, Ontario" GWP 2002-13-00, dated January 21, 2019, prepared by Golder Associates Ltd. (GEOCRES to be assigned). Report for Boreholes EW-1 and EW-2.
- "Foundation Investigation and Design Report, Construction Access Road for Bridge Rehabilitation, QEW Bridge over Credit River, Mississauga, Ontario" File No. 19-92-92-174, dated April 8, 2011, prepared by Thurber Engineering Ltd. (GEOCRES 30M12-324). Report for Boreholes 10-03A, 10-03B and 10-04.
- "Geotechnical Investigation, Proposed Pipeline Installations, Crossings of Credit River Project No. 160950937 Queen Elizabeth Way & Credit River Mississauga, ON" Document No. TAJ-C-GEO-002, dated December 18, 2018, prepared by Stantec Consulting Ltd. Report for Borehole BH3.
- "Draft Geotechnical Investigation Report, Proposed Electrical Transmission Line Monopoles at Credit River and QEW" dated September 5, 2018, Report No. 1789831, prepared by Golder Associates Ltd. Report for Borehole 17-2.

The borehole records for each of these boreholes are included in Appendix A. The locations of each borehole are shown in plan on Drawing 1. Selected boreholes are included in the profile on Drawing 1. Bedrock core photos,

and the results of geotechnical laboratory testing conducted on samples from Borehole FW-1 are included Appendix A

These boreholes are provided for the contractor's information and use as he may deem appropriate for design of temporary works (including falsework). The majority of these boreholes (i.e. Boreholes AR-2, EW-1, EW-2, FW-1, 10-03A, 10-03B, and 10-4) are publicly available in the MTO GEOCRES system; however, some of the boreholes (i.e. Boreholes BH3 and BH17-2) were advanced by or on the behalf of others for purposes other than MTO works and cannot be relied upon.

The locations, geographic coordinates, ground surface elevations and drilled depths for each of the boreholes noted above are summarized in the table below.

Borehole No.	Location (MTM NAD 83, Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (Latitude, °)	Easting (Longitude, °)		
AR-2	4,824,172.2 (43.557434)	295,921.4 (-79.609899)	88.4	11.6 (incl. 7.0 m rock core)
EW-1	4,823,955.5 (43.555482)	295,849.5 (-79.610784)	88.5	11.2 (incl. 6.3 m rock core)
EW-2	4,824,156.8 (43.557295)	295,956.2 (-79.609467)	89.1	9.7 (incl. 6.7 m rock core)
FW-1	4,823,994.8 (43.555836)	295,856.0 (-79.610704)	76.1	10.5 (incl. 3.5 m rock core)
10-03A	4,823,979.03 (43.555694)	295,865.10 (-79.610591)	76.2	4.3
10-03B	4,823,983.23 (43.555732)	295,856.15 (-79.610703)	76.3	4.0
10-04	4,824,005.69 (43.555934)	295,823.89 (-79.611102)	76.3	3.7
BH3	4,824,021.6 (43.556077)	295,864.5 (-79.610600)	75.8	30.9 (incl. 23.4 m rock core)
BH17-2	4,824,182.6 (43.557527)	295,900.9 (-79.610151)	89.2	17.1 (incl. 11.0 m rock core)

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The project area is located within the Iroquois Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putman, 1984)[3].

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 are presented on the Records of Borehole and Drillhole sheets provided in Appendix B and the results of the laboratory tests carried out on selected soil and bedrock core samples are provided in Appendix C. The subsurface conditions as encountered in the relevant boreholes advanced during the previous investigation, along with the results of the laboratory testing, are included in Appendix A. The results of the in-situ field tests (i.e. SPT “N” values and field vane undrained shear strengths) as presented on the Record of Borehole sheets and in sub-sections of Section 4.2 are uncorrected.

The stratigraphic boundaries shown on the borehole records and on the stratigraphic profiles on Drawings 1 and 2 are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests and in-situ field vane 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 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.

In general, the subsurface conditions in the area of the proposed bridge vary from the west plateau, to the west and east bank of the river, to the east plateau. On the west plateau, at the proposed location of the west abutment, the subsurface conditions generally consist of topsoil, overlying fill of various gradations, which in turn overlies silty clay to clayey silt (till) soil. The overburden soil is underlain by weathered shale bedrock at relatively shallow depths, between 1.1 m and 3.6 m below ground surface.

In the area of the west bank and flood plain, at the proposed location of the west pier, the subsurface conditions consist of fill and/or clayey silt to silty clay with organics underlain by sand and gravel and clayey silt (residual soil) at some locations. Weathered shale bedrock underlies the sand and gravel or clayey silt (residual soil) at depths ranging from 6.1 m to 6.3 m below ground surface. In the area of the east bank of the river and flood plain, at the proposed location of the east pier, the subsurface conditions consist of fill underlain by either clayey silt or silty

[3] 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.)

sand, which in-turn is underlain by organic soils. Silty sand containing organics (shells and wood fragments) and clayey silt pockets underlie the organic soils at some locations. Weathered shale bedrock was encountered underlying the overburden soils at depths ranging from 7.0 m to 7.2 m below ground surface.

On the east plateau, at the location of the proposed east abutment and retaining wall, the subsurface conditions generally consist of fill overlying mixed soils of silt to sandy silt/silty sand to clayey silt. Clayey silt (residual) soil was encountered overlying the weathered shale bedrock, which was encountered at depths ranging from 4.8 m to 8.1 m below ground surface.

A more detailed description of the subsurface conditions encountered in the boreholes from the previous and current investigations at and/or in the immediate vicinity of the proposed foundation units for the new bridge and retaining wall are provided in the following sections.

4.2.1 Asphalt and Concrete

Approximately 150 mm of apshalt underlain by approximately 150 mm of concrete was encountered in Borehole NW6-1 at ground surface.

4.2.2 Topsoil

Topsoil was encountered in Boreholes CRB-2, CRB-2A, CRB-2B (west abutment) and CRB-7, and CRB-8 (east abutment and east approach) at ground surface and ranged in thickness from about 80 mm to 200 mm.

4.2.3 Fill

Fill was encountered in all boreholes except Boreholes CRB-3A and CRB-3C, which were advanced near the west bank of the Credit River at the west abutment. The fill was generally encountered below the topsoil and concrete, or at the ground surface and is variable in composition ranging from non-cohesive to cohesive soils.

Non-cohesive fill consisting of silt and sand to silty sand to gravelly sand was encountered in Boreholes CRB-2, CRB-3, CRB-5 to CRB-8 and NW6-1 and the thickness generally ranges from about 0.7 m to 2.7 m, with the exception of Borehole CRB-7 where the non-cohesive fill extended to a depth of 4.5 m below ground surface.

The cohesive fill ranges from sandy clayey silt, to clayey silt and was encountered in Boreholes CRB-1 to CRB-5, CRB-2A, CRB-2B, CRB-5A underlying the topsoil/non-cohesive fill or at ground surface and the thickness ranges from 0.5 m to 1.7 m, where encountered with the exception of Boreholes CRB-4 and CRB-5A, where the cohesive fill extends to depths of 3.7 m and 4.0 m below ground surface, respectively.

It is noted that in the vicinity of the east pier the ground surface is currently covered with rip-rap and other cobble and boulder sized rock.

The SPT “N” values measured within the non-cohesive fill generally range from 3 blows to 60 blows per 0.3 m of penetration, indicating that the fill layer has a very loose to very dense compactness condition. One SPT “N” value of 54 blows per 0.3 m of penetration was recorded in Borehole CRB-7, but it is in inferred that the value may be affected by the split-spoon penetrating pieces of brick/brick fragments. The SPT “N” values measured within the cohesive fill generally range from 6 blows to 31 blows per 0.3 m of penetration, suggesting that the cohesive fill layers have a firm to hard consistency.

Grain size distribution tests were carried out on four samples of the non-cohesive fill material and the results are shown on Figure C-1 in Appendix C. The non-cohesive fill contains trace gravel to gravelly, trace clay and brick fragments. The presence or organic material including wood fragments and rootlets were noted within the non-

cohesive fill at boreholes located at the proposed west abutment (Borehole CRB-2) and at the proposed east pier (Boreholes CRB-5 and CRB-5A). The water content measured on samples of the non-cohesive fill range between about 4 per cent and 25 per cent.

Grain size distribution tests were carried out on three samples of the cohesive fill material and the results are shown on Figure C-2 in Appendix C. The cohesive fill contains shale, limestone and brick fragments, pieces of wood, organics and rootlets. Atterberg limits tests were carried out on three samples of the cohesive fill and measured liquid limits ranging from about 23 per cent to 28 per cent, plastic limits ranging from about 14 per cent to 20 per cent and plasticity indices ranging from about 8 per cent to 11 per cent. The results of the Atterberg limits test are plotted on the plasticity chart on Figure C-3 in Appendix C and indicate the cohesive deposit consists of low plasticity clayey silt. The water content measured on samples of the cohesive fill range between about 8 per cent and 42 per cent.

4.2.4 Clayey Silt with Sand to Silty Clay

In all boreholes with the exception of Boreholes CRB-2 (west abutment), CRB-5 and CRB-5A (east pier), CRB-7 (east abutment) and NW6-1 (east retaining wall), a cohesive deposit ranging in variability from silty clay, to clayey silt with sand, to sandy clayey silt, to silty clay was generally encountered underlying the fill materials, but was located at ground surface (in Boreholes CRB-3A and CRB-3C on the west bank of the river), and underlying the native sand and silt deposit (in Borehole CRB-8 at the east approach) at thicknesses ranging from 0.1 m to 2.7 m. The surface of the deposit was encountered at ground surface in Boreholes CRB-3A and CRB-3C and at depths ranging from about 0.7 m to 6.4 m below ground surface in the other boreholes.

The SPT “N” values measured within the cohesive deposit range from 0 blows (weight of hammer) to 14 blows per 0.3 m of penetration. Two in-situ field vane tests carried out within the cohesive deposit in Borehole CRB-3A (west pier) measured undrained shear strengths of about 22 kPa and 58 kPa. The calculated sensitivities were about 1.5 and 3.2. The field vane test results together with the SPT “N” values indicate that the cohesive deposit has a very soft to stiff consistency.

Grain size distribution test were carried out on eight selected samples of the cohesive deposit and the results are presented on Figure C-4A and C-4B in Appendix C. The cohesive deposit was noted to contain organics and rootlets. Cobbles were encountered within this cohesive deposit in Borehole CRB-3C, while advancing the wash boring casing at depths of 1.2 m and 2.4 m below ground surface. Atterberg limits tests were carried out on seven samples of this deposit and measured liquid limits ranging from about 23 per cent to 42 per cent, plastic limits ranging from about 14 per cent to 25 per cent, and plasticity indices ranging from about 9 per cent to 21 per cent. These laboratory results are plotted on the plasticity chart on Figure C-5 in Appendix C and confirm that the cohesive deposit is comprised of clayey silt (with sand) of low plasticity to silty clay of intermediate plasticity.

The natural water content measured on thirteen samples of the cohesive deposit ranges from about 14 per cent to 42 per cent.

4.2.5 Silt to Silt and Sand to Sand

In Boreholes CRB-5 and CRB-5A (east pier), CRB-7 and CRB-8 (east abutment/approach) and NW6-1 (East Retaining Wall) an approximately 0.5 m to 4.9 m thick granular deposit that varies in composition from silt to silt and sand to sand was encountered underlying the fill. This deposit contains a layer of organic clayey silt in Boreholes CRB-5 and CRB-5A (at the east pier). The depth and elevation of the top and bottom of this granular deposit and the corresponding thickness and soil type are summarized below.

Foundation Unit	Borehole No.	Top of Layer		Bottom of Layer		Thickness (m)	Soil Type
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)		
East Pier	CRB-5A	4.0	75.3	4.5	74.8	0.5	Silty Sand
		6.4	72.9	7.2	72.1	0.8	
	CRB-5	2.4	76.8	4.7	74.5	2.3	Silty Sand to Silt and Sand
		5.7	73.5	7.2	72.0	1.5	Silty Sand
East abutment and Approach	CRB-7	4.5	90.2	6.5	88.2	2.0	Sandy Silt
	CRB-8	1.5	93.3	3.7	91.0	2.2	Sand
		3.7	91.0	6.4	88.3	2.7	Silt
East Retaining Wall	NW6-1	3.0	92.3	5.3	90.0	2.3	Silty Sand
		5.3	90.0	7.3	88.0	2.0	Silt

In Boreholes CRB-5A and CRB-5 (east pier), the SPT “N” values measured within the granular deposit generally range from zero (weight of rods) to 7 blows per 0.3 m of penetration, indicating a very loose to loose compactness condition. In Boreholes CRB-7 and CRB-8, advanced at the east abutment and approach, the SPT “N” values measured within the granular deposit generally range from 17 blows to 67 blows per 0.3 m of penetration, indicating a compact to very dense compactness condition. In Borehole NW6-1, advanced at the south side of the existing QEW east of the credit river, the SPT “N” values measured within the granular deposit generally range from 3 blows to 41 blows per 0.3 m of penetration, indicating a very loose to dense compactness condition.

Grain size distribution tests were carried out on eight selected samples of the granular deposit and the results are presented on Figure C-6A and Figure C-6B in Appendix C. In Boreholes CRB-5A and CRB-5, advanced at the east pier, the granular deposit contains rootlets, shell fragments and pieces of wood. The organic content measured on a sample of this deposit was about 1 per cent. Atterberg limits tests were carried out on two samples of the silt to sandy silt deposit; one test result indicates the soil to be non-plastic and the results of the second test measured a liquid limit of about 19 per cent, a plastic limit of about 16 per cent, and a plastic index of about 3 per cent. These test results are plotted on the plasticity chart on Figure C-7 in Appendix C and confirm that the granular deposit is comprised of silt of slight plasticity to non-plastic. The water content measured on thirteen samples the silty sand to sandy silt deposit ranges from about 15 per cent to 28 per cent.

4.2.6 Sand and Gravel

In Boreholes CRB-3, CRB-3A and CRB-3C (advanced at the west side of the Credit River), a deposit of sand and gravel was encountered underlying the cohesive deposits. The surface of the sand and gravel deposit was encountered at depths of between about 2.6 m and 3.0 m below ground surface (between Elevations between 73.1 m and 72.7 m) and ranges in thickness from about 2.6 m to 3.6 m.

The SPT “N” values measured within the sand and gravel deposit generally range from 14 blows to 55 blows per 0.3 m of penetration, indicating a compact to very dense compactness condition. One SPT “N” value of 72 blows for 100 mm of penetration was measured in Borehole CRB-3C, which is inferred to be due to the presence of cobbles at the sampling depth.

Five grain size distribution tests were carried out on selected samples of the sand and gravel deposit and the results are shown on Figure C-8 in Appendix C. The sand and gravel contain some silt, trace to some clay and shell fragments were noted within the deposit in Borehole CRB-3. A clayey silt pocket was encountered within the granular deposit in Borehole CRB-3A at a depth of 4.7 m below ground surface and clayey silt layers/pockets were encountered within samples SS6 and SS8 in Borehole CRB-3C, between depths of 3.5 m and 4.7 m below ground surface.

Atterberg limits tests were carried out on the clayey silt layers/pockets from two samples of this deposit from Borehole CRB-3C and measured liquid limits of 23 per cent and 25 per cent, plastic limits of 16 per cent and 17 per cent, and plasticity indices of 6 per cent and 9 per cent. These results are plotted on the plasticity chart on Figure C-9 in Appendix C and confirm that these pockets are clayey silt of low plasticity.

The water content measured on eight samples of the sand and gravel deposit ranges between 12 per cent and 14 per cent.

4.2.7 Organic Clayey Silt with Sand

In Boreholes CRB-4, CRB-5 and CRB-5A (east pier), a deposit of organic clayey silt with to some sand, was encountered at depths of between about 4.5 m and 6.2 m (between Elevations 74.8 m and 73.0 m) below ground surface and ranges in thickness from about 0.8 m to 1.9 m.

The SPT “N” values measured within the organic deposit range from 1 blow to 7 blows per 0.3 m of penetration, suggesting a very soft to firm consistency.

Three grain size distribution tests were carried out on selected samples of the organic clayey silt deposit and the results are shown on Figure C-10 in Appendix C. The organic soil contains trace gravel, sand lenses and pockets of cohesive clayey silt as well as wood and shell fragments. Atterberg limits tests were carried out on three samples of this deposit and measured liquid limits ranging from about 38 per cent to 46 per cent, plastic limits ranging from about 26 per cent to 35 per cent, and plasticity indices ranging from about 6 per cent to 17 per cent. These results are plotted on the plasticity chart on Figure C-11 in Appendix C and indicate that the deposit consists of organic clayey silt of intermediate plasticity.

Organic content tests completed on two samples from this deposit measured 5.5 per cent and 7.1 per cent. The water content measured on samples from the organic deposit ranged from 27 per cent to 47 per cent.

4.2.8 Clayey Silt (Till)

In Borehole CRB-2 (west abutment), in Borehole CRB-7 (east abutment) and in Borehole NW6-1 (east retaining wall) a deposit of clayey silt to clayey silt with sand (till) was encountered underlying the fill and just above the bedrock in Borehole CRB-2; underlying the fill and sandy silt deposit and overlying residual soil and bedrock in Borehole CRB-7; and underlying the silt deposit in Borehole NW6-1 The surface of the clayey silt till was encountered at depths of 2.6 m, 6.5 m, and 7.3 m (Elevations 93.0 m, 88.2 m and 88.0 m) and has a thickness of 0.6 m and 1.3 m at these borehole locations. Borehole NW6-1 terminated in this till deposit at a depth of 7.5 m below ground surface (Elevation 87.8 m).

The SPT “N” values measured within the clayey silt till deposit are 10 blows per 0.3 m of penetration and 50 blows for 150 mm of penetration, suggesting a stiff to hard consistency.

The deposit consists of clayey silt with sand to some sand, trace to some gravel. Two grain size distribution tests were carried out on selected samples of the cohesive till deposit = and the results are shown on Figure C-12 in Appendix C. Atterberg limits tests were carried out on three samples of this cohesive till deposit and measured liquid limits of about 23 per cent to 26 per cent, plastic limits of about 14 per cent to 15 per cent, and plasticity indices of about 9 per cent to 11 per cent. These results are plotted on the plasticity chart on Figure C-13 in Appendix C and indicate that the cohesive till deposit consists of clayey silt of low plasticity.

The natural water content measured on three samples of the clayey silt till are about 14 per cent.

4.2.9 Residual Soil

In Boreholes CRB-2B (west abutment), CRB-3 (west pier), and CRB-6, CRB-7 and CRB-8 (east abutment/approach), a deposit of residual soil was encountered, immediately overlying the bedrock. The surface of the residual soil deposit was encountered at depths of between about 1.4 m and 7.8 m (between about Elevations 93.3 m and 70.3 m) and ranges in thickness from about 0.3 m to 2.2 m. Residual soil represents a heterogeneous mix of severely weathered rock where, in some zones it is indistinguishable from sedimentary materials, while in other zones it retains a degree of the original parent bedrock structure and strength. While advancing Borehole CRB-2B auger refusal was encountered at a depth of 2.1 m (Elevation 92.6 m) below ground surface and the borehole was advanced beyond this depth by HQ coring. At the top of the 1.5 m long core run a 0.25 m thick layer of limestone was encountered; this is possibly a boulder or a limestone layer within the residual soil.

The SPT “N” values measured within the residual soil deposit range from 61 blows per 0.3 m of penetration to 150 mm of penetration, suggesting a hard consistency. The deposit is described as a clayey silt to a sandy clayey silt and contains shale fragments, derived from weathering of the underlying shale bedrock.

Grain size distribution tests were carried out on one selected sample of the clayey silt residual soil deposit and the results are shown on Figure C-14 in Appendix C, although it is noted that the SPT sample tested could not contain larger fragments of rock on account of the sampler size and, within residual soils in general, larger fragments of unweathered rock must be expected. Atterberg limits test were carried out on two samples of this deposit and measured liquid limits of about 23 per cent and 24 per cent, plastic limits of about 15 per cent and 16 per cent, and plasticity indices of about 7 per cent and 8 per cent. These results are plotted on the plasticity chart on Figure C-15 in Appendix C and indicate that the residual soil consists of clayey silt of low plasticity.

The natural water content measured on four samples of the clayey silt residual soil deposit range between 9 per cent and 12 per cent.

4.2.10 Bedrock

Bedrock was encountered and core samples were recovered in all boreholes advanced during the current investigation for this bridge with the exception of Boreholes CRB-1 (west approach) and CRB-8 (east approach), where the bedrock surface was inferred from auguring and/or split-spoon sampling, and with the exception of Borehole NW6-1 where the borehole was terminated prior to encountering refusal. Bedrock was also encountered and cored in Boreholes 10-02, 11-01 and 11-02, advanced during the previous (2010 and 2011) foundation investigations, by others. The depths to bedrock or refusal below ground surface, and the corresponding bedrock surface elevation or refusal elevation, and the cored depth are summarized below.

Foundation Element / Approach	Borehole	Depth to Bedrock Surface /Refusal (m)	Bedrock Surface / Refusal Elevation (m)	Comments
West Approach	CRB-1	1.7	93.2	Augering and split-spoon sampling; 1.6 m penetration
West Abutment	CRB-2	3.2	92.4	Bedrock cored 9.6 m
	11-01[1]	3.3	91.3	0.3 m auger penetration; bedrock cored 3.5 m
	CRB-2A	1.1	93.4	Bedrock cored 7.9 m
	10-02[2]	3.2	91.2	1.4 m augering penetration and split-spoon sampling; bedrock cored 19.7 m
	CRB-2B	3.6	91.1	Soil cored 1.5 m, from Elevation 92.6 to 91.1 m; Bedrock cored 9.1 m
West Pier	CRB-3	6.3	69.6	0.8 m split-spoon penetration; bedrock cored 8.1 m
	CRB-3A	6.1	69.6	0.9 m split-spoon penetration; bedrock cored 8.8 m
	11-02[1]	6.3	69.4	Bedrock cored 2.1 m
	CRB-3C	6.2	69.1	0.2 m split-spoon penetration; bedrock cored 7.7 m
East Pier	CRB-4	7.0	72.1	0.2 m split-spoon penetration; bedrock cored 8.1 m
	CRB-5	7.2	72.0	Bedrock bored 8.3 m
	CRB-5A	7.2	72.1	0.5 m split-spoon penetration; bedrock cored 9.5 m
East Abutment	CRB-6	4.8	86.9	0.3 m split-spoon penetration; bedrock cored 8.2 m
	CRB-7	8.1	86.6	0.4 m split-spoon penetration; bedrock cored 7.5 m
East Approach	CRB-8	8.1	86.7	Split-spoon sampling; 0.4 m penetration

Note:

1. Thurber Engineering Ltd. File No. 19-1351-174, dated May 18, 2012 (GEOCRES 30M12-341).
2. Thurber Engineering Ltd. File No. 19-92-92-174, dated April 8, 2011 (GEOCRES 30M12-324)

In general, the bedrock surface as encountered or inferred in the area of the proposed bridge replacement slopes relatively steeply downwards towards the Credit River, on either side of the valley. At the locations of the boreholes drilled within the west and east river valley, and at the east valley plateau, the bedrock surface appears to be relatively flat. At the west valley plateau, the shallow bedrock surface appears to undulate across the proposed west abutment foundation unit. The bedrock surface at the west abutment as presented on the borehole records and on Drawing 2 indicates that the bedrock surface is generally at between about Elevation 92.4 m and 91.1 m; however, it was encountered at a higher elevation (93.4 m) at Borehole CRB-2A, advanced at the north end of the proposed abutment. It is likely that the upper portion of the bedrock is highly to completely weathered and the difference in elevation is a result of different interpretation of the contact between the residual soil and the highly to completely weathered bedrock.

Based on a review of the bedrock core samples from the current investigation and descriptions of the bedrock from the previous investigation, the bedrock consists of shale of the Georgian Bay Formation. In general, the bedrock samples are described as completely to moderately weathered to slightly weathered to fresh, thinly laminated to medium bedded, fine grained, non-porous to faintly porous, very weak to weak, grey shale, with strong limestone interbeds at varying intervals of depth. The strong limestone layers range in thickness from about 5 mm to as much as 510 mm, with an average thickness of about 50 mm. The stronger layers can comprise up to about 25 per cent by thickness of the rock encountered during the investigation, but generally make up between about 5 per cent to 19 per cent by thickness. The details of the bedrock descriptions are presented in the borehole records from the previous investigation in Appendix A, and on the Record of Drillhole sheets and photographs of the recovered bedrock core samples on Figures B-1 to B-11 from the current investigation 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)[4] standard classification system. The surface and upper portion of the shale bedrock, generally had higher degrees of weathering, (completely to highly weathered) as shown on the Record of Drillhole sheets.

The Rock Quality Designation (RQD) measured on the core samples obtained from the current investigation ranges from about 0 per cent to 100 per cent, indicating a rock mass of very poor to excellent quality, but below the completely to highly weathered upper zone, the RQD is generally greater than 54 per cent, indicating fair to excellent quality of the bedrock at depth, as per Table 3.10 of CFEM (2006)[5]. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are between 11 per cent and 100 per cent and between 0 per cent and 100 per cent, respectively. Similar to RQD, both TCR and SCR increase below the upper completely to highly weathered zone of the shale bedrock. The Thurber report (GEOCRES No. 30M12-341) indicates that the RQD in Borehole 11-01 (west abutment) was practically zero over the depth of the cored borehole (between Elevation 91.0 m and 87.5 m), but Thurber notes that the low RQD values may be a result of the coring equipment used in the tri-pod setup. At the west abutment, 0.5 m and 0.3 m zones of lost core were noted when logging the core samples retrieved from Boreholes CRB-2 and CRB-2A at Elevations of 86.0 m and 88.4 m, respectively. In addition, between Elevation 89.1 m and 88.1 m the RQD was about 40 per cent. However, as discussed in Section 3.2.2, an acoustic

[4] 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.

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

and optical televiewer test was carried out and based on these results a “soft” zone having a thickness of about 0.1 m was identified at about Elevation 86.1 m.

Unconfined Compression (UC) tests (ASTM D7012)[6] 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.

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)
CRB-2	7.8 – 7.9	87.8 to 87.7	11.2	2.58	0.83
CRB-2	11.4 – 11.5	84.2 – 84.1	13.0	2.61	2.19
CRB-2A	4.3 – 4.5	90.2 – 90.0	18.2	2.59	0.75
CRB-2A	4.9 – 5.1	89.6 – 89.4	17.1	2.60	0.76
CRB-2B	6.9 – 7.1	87.8 – 87.6	12.1	2.59	0.59
CRB-2B	9.1 – 9.25	85.6 – 85.4	15.5	2.60	0.63
CRB-3	11.4 – 11.7	64.5 – 64.2	9.4	2.61	2.10
CRB-3A[1]	10.2 – 10.3	65.5 – 65.4	8.9	2.60	0.48
CRB-3A	13.0 - 13.3	62.7 – 62.4	16.9	2.62	0.67
CRB-3C[2]	7.9 – 8.0	67.4 – 67.3	114.1	2.61	22.91
CRB-4	13.6 – 13.8	65.5 – 65.3	18.6	2.61	0.84
CRB-5	13.7 – 13.9	65.5 – 65.3	15.5	2.61	0.61
CRB-5A	12.4 – 12.6	66.9 - 66.7	14.2	2.60	0.96
CRB-5A	15.3 – 15.6	64.0 – 63.7	22.7	2.64	0.93
CRB-6	6.1 - 6.2	85.6 – 85.5	14.6	2.17	0.63
CRB-7	9.2 - 9.4	85.5 – 85.3	15.5	2.59	0.65
CRB-7	12.1 – 12.4	82.6 – 82.3	7.4	2.59	1.28

Note: [1]Specimen included two 5 mm to 10 mm thick interbedded limestone layers.
[2]Specimen consists of limestone.

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

Thirty-two axial and thirty-four diametral Point Load Tests (PLTs) were carried out on sixty-six samples of the shale bedrock, and the results are summarized in Table C1 in Appendix C.

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) and the limestone interlayers are classified as very strong (R5, 100 MPa < UCS < 250 MPa).

4.2.11 Groundwater Conditions

The overburden samples obtained from the borehole investigations were generally moist to wet. Boreholes CRB-1, CRB-2, CRB-2A, CRB-2B, CRB-6 and CRB-7 were observed to be dry upon completion of drilling operations (and prior to start of rock coring operations, where relevant). The depths to the water level observed in the boreholes upon completion of drilling and prior to rock coring is presented below.

Foundation Unit	Borehole	Water Level Depth (m)	Water Elevation (m)	Comment
West Approach	CRB-1	Dry	Dry	Upon completion of drilling.
West Abutment	CRB-2	Dry	Dry	Upon completion of overburden drilling and prior to rock coring.
	CRB-2A	Dry	Dry	
	CRB-2B	Dry	Dry	
West Pier	CRB-3	2.7	73.2	
	CRB-3A	0.9	74.8	
	CRB-3C	0.7	74.6	
East Pier	CRB-4	3.8	75.4	
	CRB-5	4.3	74.9	
	CRB-5A	3.6	75.7	
East Abutment	CRB-6	Dry	Dry	
	CRB-7	Dry	Dry	
East Approach	CRB-8	1.5	93.2	Upon completion of drilling.
East Retaining Wall	NW6-1	6.3	89.0	Upon completion of drilling.

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

Foundation Unit	Borehole	Stratum Well Sealed Into	Water Level Depth (m)	Water Elevation (m)	Date of Piezometer Reading
West Abutment	CRB-2	Fill/Clayey Silt Till	2.6	93.0	March 12, 2018
			2.6	93.0	April 30, 2018
			2.5	93.1	November 6, 2018
West Pier	CRB-3A	Sand and Gravel	1.0	74.7	March 12, 2018
			0.7	75.0	April 30, 2018
East Pier	CRB-5A	Silty Sand/Organic Clayey Silt	1.6	77.7	March 12, 2018
			4.0	75.3	April 30, 2018
			4.6	74.7	November 6, 2018
East Abutment	CRB-6	Shale Bedrock	5.6	86.1	November 12, 2017
			5.0	86.7	March 12, 2018
			4.9	86.8	April 30, 2018
			4.9	86.8	November 6, 2018

The water levels recorded in the standpipe piezometers during the previous (2010 and 2011) foundation investigation, are presented below. Additional water levels were measured in the standpipe piezometers in Boreholes 11-01 and 11-02, as part of this current investigation and are also presented in the table below.

Borehole	Stratum Well Sealed Into	Water Level Depth (m)	Water Elevation (m)	Date of Piezometer Reading
10-02	Silty Clay / Shale bedrock	Dry	Dry	December 17, 2018
	Shale bedrock	8.5	85.9	October 4, 2010
		8.5	85.9	October 5, 2010
		8.7	85.7	October 12, 2010
		9.3	85.1	December 17, 2018
11-01	Shale bedrock	3.2	91.4	September 30, 2011
		Dry	Dry	February 12, 2018

Borehole	Stratum Well Sealed Into	Water Level Depth (m)	Water Elevation (m)	Date of Piezometer Reading
		Dry	Dry	March 12, 2018
		Dry	Dry	April 30, 2018
11-02	Sand / Shale bedrock	0.7	75.0	June 8, 2011
		1.5	74.2	October 4, 2011
		0.0	75.7	February 12, 2018
		0.8	74.9	March 12, 2018
		0.9	74.8	April 30, 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.

4.2.11.1 Packer Test Results

As described in Section 3.2.1 packer testing was carried out during the borehole drilling program in selected boreholes at the piers. The following summarizes the hydraulic conductivity based on the results of the testing:

Borehole	Depth (Elevation)		Estimated Hydraulic Conductivity (m/s)
	From (m)	To (m)	
CRB-3	8.2 (67.7)	11.5 (64.4)	3.7×10^{-7}
CRB-3A	7.6 (68.1)	9.2 (66.5)	7.2×10^{-8}
CRB-4	9.5 (69.6)	11.7 (67.4)	8.3×10^{-7}
CRB-5	9.7 (69.5)	12.0 (67.2)	6.2×10^{-7}

4.2.12 Analytical Testing Results

As discussed in Section 3.2, four samples of crushed and homogenized shale bedrock core were submitted for analysis of parameters used to assess the potential corrosivity of the site bedrock to steel and concrete. The following summarizes the results of the testing:

Parameter	Borehole CRB-2	Borehole CRB-3A	Borehole CRB-5	Borehole CRB-6
pH	8.09	8.07	8.08	8.11
Resistivity (ohm-cm)	3,800	3,100	1,700	5,000
Electrical Conductivity (umho/cm)	263	321	582	201
Chlorides (ug/g)	<20	44	46	<20
Soluble Sulphates (ug/g)	56	49	160	30

5.0 CLOSURE

This report was prepared by Mr. David Marmor, E.I.T., a geotechnical engineer-in-training with Golder. Ms. Sandra McGaghran, M.Eng., P.Eng. a senior geotechnical engineer and Associate conducted a technical review of the report and Mr. Paul Dittrich, Ph.D., P.Eng., a MTO Foundations Designated Contact and Principal of Golder conducted a quality control review of the report.

Golder Associates Ltd.

David Marmor, E.I.T.
Geotechnical Engineer in Training

Sandra McGaghran, M.Eng., P.Eng.
Associate, Senior Geotechnical Engineer

J. Paul Dittrich, Ph.D., P.Eng.
Principal, MTO Foundations Designated Contact

DM/SMM/JPD/rb

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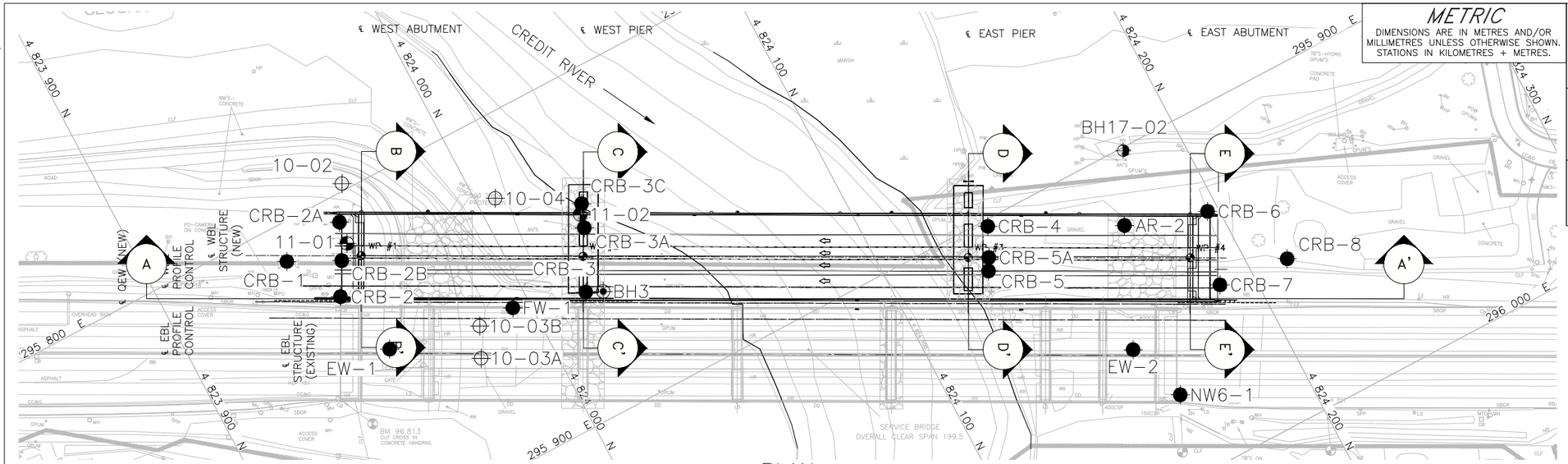
https://golderassociates.sharepoint.com/sites/11176g/shared documents/07-reporting/foundations/5 - credit river bridge/4 - final/1662333 fir credit river bridge 2019feb12.docx

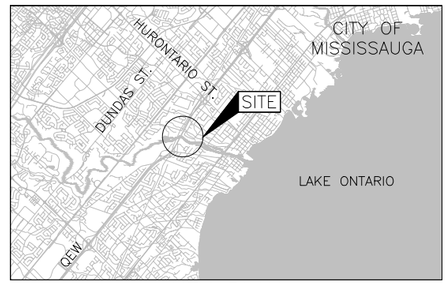
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE

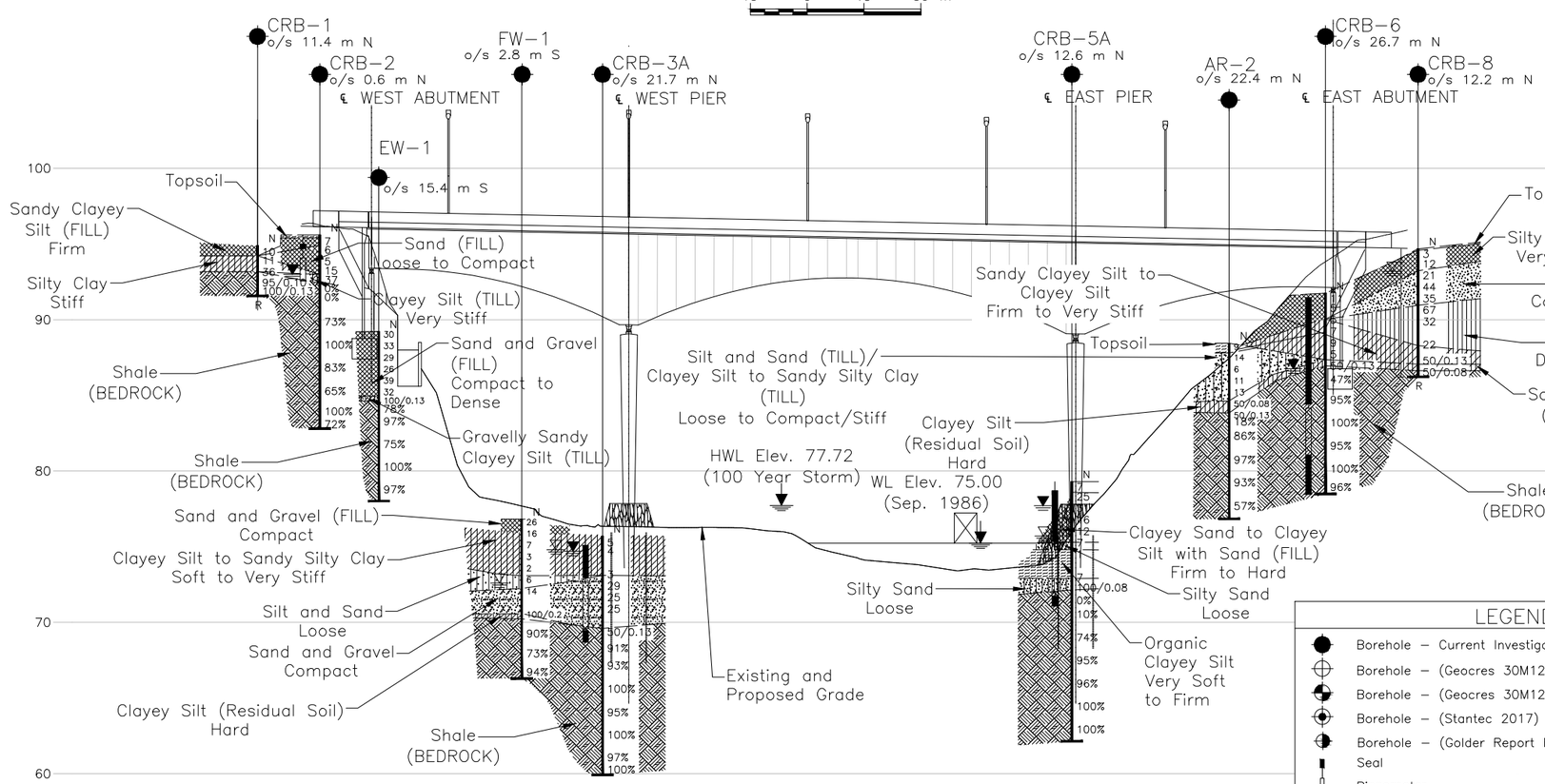
15 0 15 30 m



KEY PLAN

SCALE

2 0 2 4 km



PROFILE A–A'

HORIZONTAL SCALE

15 0 15 30 m

VERTICAL SCALE

3.75 0 3.75 7.5 m

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
QEW – CREDIT RIVER BRIDGE

BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER

BOREHOLE CO–ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
10–02	94.4	4823966.3	295798.0
10–03A	76.2	4823979.0	295865.1
10–03B	76.3	4823983.2	295856.2
10–04	76.3	4824005.7	295823.9
11–01	94.6	4823959.1	295814.8
11–02	75.7	4824026.4	295840.4
AR–2	88.4	4824172.2	295921.4
BH17–02	89.2	4824182.6	295900.9
CRB–1	94.9	4823940.2	295811.1
CRB–2	95.6	4823949.7	295828.3
CRB–2A	94.5	4823960.1	295808.0
CRB–2B	94.7	4823955.2	295818.7
CRB–3	75.9	4824016.8	295862.2
CRB–3A	75.7	4824025.6	295844.6
CRB–3C	75.3	4824028.3	295837.7
CRB–4	79.1	4824135.1	295902.0
CRB–5	79.2	4824128.9	295914.2
CRB–5A	79.3	4824130.9	295910.6
CRB–6	91.7	4824196.7	295929.5
CRB–7	94.7	4824189.6	295951.1
CRB–8	94.7	4824211.5	295953.7
EW–1	87.7	4823955.5	295849.5
EW–2	89.1	4824156.8	295956.2
FW–1	76.1	4823994.8	295856.0
NW6–1	95.3	4824163.1	295975.2

LEGEND

- Borehole – Current Investigation
- Borehole – (Geocres 30M12–324)
- Borehole – (Geocres 30M12–341)
- Borehole – (Stantec 2017)
- Borehole – (Golder Report No. 1789831)
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R Split–Spoon Refusal
- 100% Rock Quality Designation (RQD)
- WL in piezometer, measured on November 6, 2018
- WL upon completion of drilling

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.
General Arrangement plan and profile provided in digital format by Morrison Hershfield, drawing file no. 01.GENERAL ARRANGEMENT (for Golder).dwg, received April, 13, 2018 and 01.GENERAL ARRANGEMENT.dwg, received January 29, 2019.

LICENSED PROFESSIONAL ENGINEER J.P. DITTRICK Feb. 05, 2019 PROVINCE OF ONTARIO

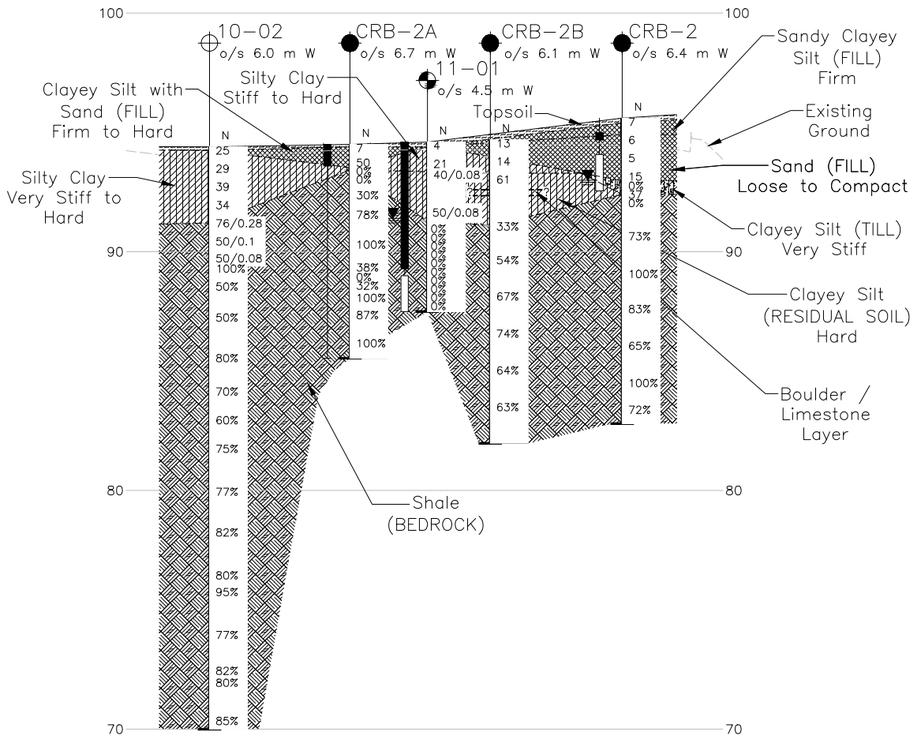
LICENSED PROFESSIONAL ENGINEER S. McGaghran Feb. 05, 2019 PROVINCE OF ONTARIO

Geocres No. 30M12–426

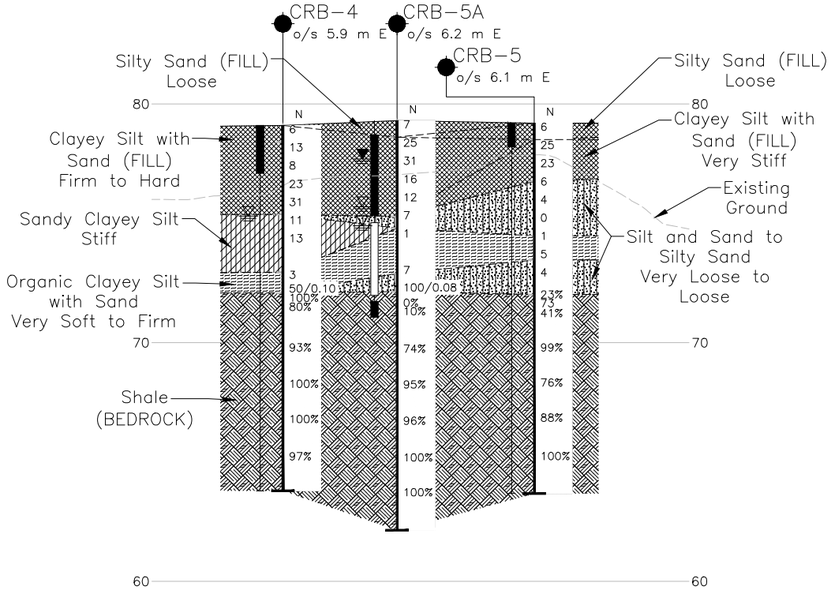
HWY. QEW	PROJECT NO. 1662333		DIST. CENTRAL
SUBM'D. JIL	CHKD. DM	DATE: 2/5/2019	SITE: 24–203
DRAWN: DD/TB	CHKD. SMM	APPD. JPD	DWG. 1

PLOT DATE: February 11, 2019
FILENAME: S:\Clients\MTO\QEW-Credit_River\99_PROJ\1662333_MH_P&P\40_PROD\0001_Credit_River_Bridge_Twin\1662333-0001-BD-0001.dwg

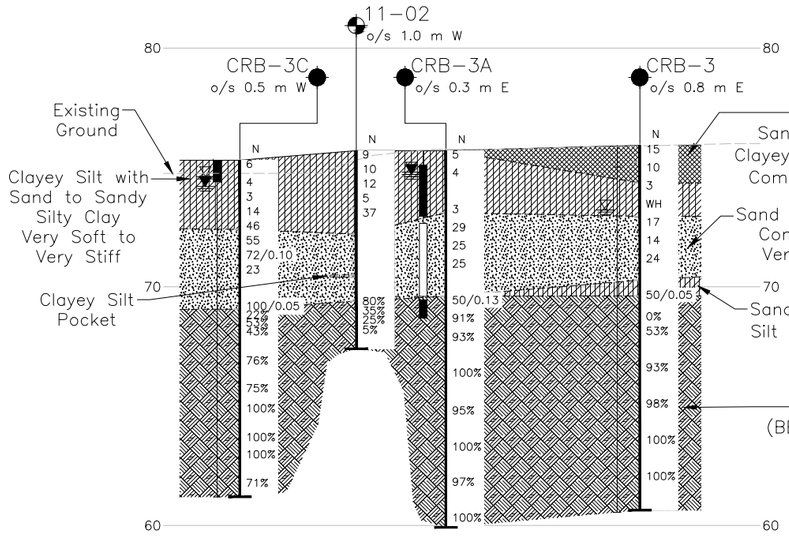
MINISTRY OF TRANSPORTATION, ONTARIO



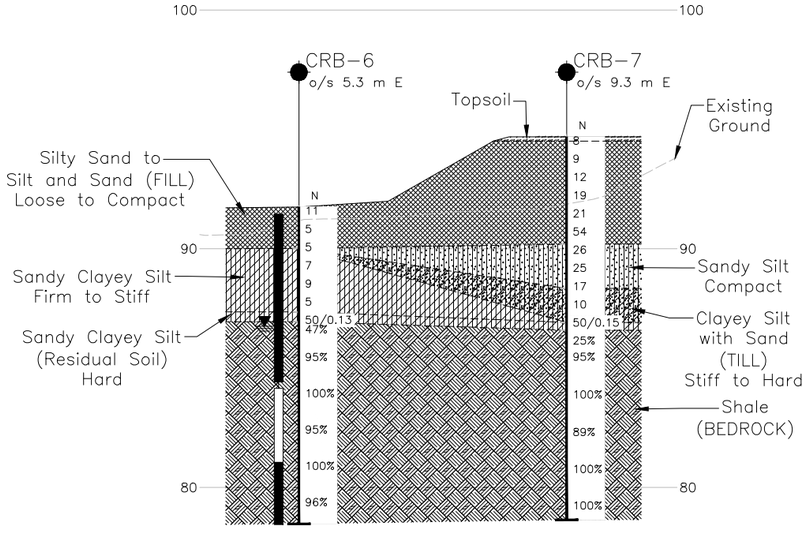
SECTION B-B' WEST ABUTMENT



SECTION D-D' EAST PIER



SECTION C-C' WEST PIER



SECTION E-E' EAST ABUTMENT

SCALE HORIZONTAL
5 0 5 10 m

VERTICAL SCALE
2.5 0 2.5 5 m

METRIC

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

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

QEW WIDENING - MISSISSAUGA RD TO HURONTARIO ST
QEW - CREDIT RIVER BRIDGE

SOIL STRATA

SHEET

GOLDER

LEGEND

- Borehole - Current Investigation
- Borehole - (Geocres 30M12-341)
- Borehole - (Geocres 30M12-324)
- 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 November 6, 2018
- WL upon completion of drilling

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
10-02	94.4	4823966.3	295798.0
11-01	94.6	4823959.1	295814.8
11-02	75.7	4824026.4	295840.4
CRB-2	95.6	4823949.7	295828.3
CRB-2A	94.5	4823960.1	295808.0
CRB-2B	94.7	4823955.2	295818.7
CRB-3	75.9	4824016.8	295862.2
CRB-3A	75.7	4824025.6	295844.6
CRB-3C	75.3	4824028.3	295837.7
CRB-4	79.1	4824135.1	295902.0
CRB-5	79.2	4824128.9	295914.2
CRB-5A	79.3	4824130.9	295910.6
CRB-6	91.7	4824196.7	295929.5
CRB-7	94.7	4824189.6	295951.1

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.

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LICENSED PROFESSIONAL ENGINEER J.P. DITTRICH Jan. 04, 2019 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER S. McGaghran Jan. 04, 2019 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 30M12-426

HWY. QEW	PROJECT NO. 1662333		DIST. CENTRAL
SUBM'D. JIL	CHKD. DM	DATE: 1/4/2019	SITE: 24-203
DRAWN: DD/TB	CHKD. SMM	APPD. JPD	DWG. 2

PLOT DATE: February 6, 2019
FILENAME: S:\Clients\MTO\QEW-Credit_River\09_PROJ\1662333_MR_PAP\40_PROD\0001_Credit_River_Bridge_Twin\1662333-0001-BD-0002.dwg

APPENDIX A

Previous By Others and Relevant Borehole and Drillhole Records, Bedrock Core Photographs Geotechnical Laboratory Test Results and Analytical Test Results

Draft Geotechnical Investigation Report, Proposed Electrical Transmission Line Monopoles at Credit River and QEW" dated September 5, 2018, Report No. 1789831, prepared by Golder Associates Ltd.

Borehole 17-2

PROJECT: 1789831

RECORD OF BOREHOLE: BH17-2

SHEET 1 OF 2

LOCATION: SEE FIGURE 1

BORING DATE: June 25 and 26, 2018

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

DRILL RIG: MARL-MT5

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕; Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		89.19									GR SA SI CL
0	Power Auger	FILL - (SM) CLAYEY SILTY SAND, some gravel, trace organics		0.00 / 88.89	1A								
		FILL - (SW/GW) SAND and GRAVEL; dark brown to grey; moist, compact		0.30	1B	SS	16						
1					2	SS	25						
		FILL - (SM) SILTY SAND; brown; moist, non-cohesive, compact		87.67 / 1.52	3	SS	14						
2		(Cl) SILTY CLAY, trace sand; varved, brown; w<PL, firm to very stiff		87.06 / 2.13	4	SS	8						
3	153 mm O.D. Solid Stem Auger				5	SS	19					MH	
4					6A								
				84.34	6B	SS	50/ 0.08						
5		SHALE (BEDROCK); grey		4.85									▽
6					7	SS	50/ 0.02						
	HQ Core	- Bedrock cored from a depth of 6.1 m to 17.1 m. - For bedrock coring details, refer to record of Drillhole BH17-2.			1	RC							RQD = 0%
7													
					2	RC							RQD = 0%
8													
9					3	RC							RQD = 48%
10					4	RC							
		CONTINUED NEXT PAGE											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SM/BC

CHECKED: AK

GTA-BHS 005 S:\CLIENTS\ALECTRA_UTILITIES_INC\HYDRO_POLES_QEW-CREDIT_RIVER\02_DATA\GINT\HYDRO_POLES_QEW.GPJ GAL-MIS.GDT 8/7/18

PROJECT: 1789831

RECORD OF BOREHOLE: BH17-2

SHEET 2 OF 2

LOCATION: SEE FIGURE 1

BORING DATE: June 25 and 26, 2018

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

DRILL RIG: MARL-MT5

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		--- CONTINUED FROM PREVIOUS PAGE ---									GR SA SI CL
10	HQ Core	SHALE (BEDROCK); grey			4	RC					RQD = 64%
11											UC = 21.4 MPa
12					5	RC					RQD = 55%
13					6	RC					RQD = 72%
14											
15					7	RC					RQD = 78%
16											
17				72.09	8	RC					RQD = 99%
		END OF HOLE NOTES: 1. Water level was measured to be at a depth of 5.2 m below ground surface in open borehole prior to rock coring.		17.10							
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SM/BC

CHECKED: AK

GTA-BHS 005 S:\CLIENTS\ALECTRA_UTILITIES_INC\HYDRO_POLES_QEW-CREDIT_RIVER\02_DATA\GINT\HYDRO_POLES_QEW.GPJ GAL-MIS.GDT 8/7/18

PROJECT: 1789831

RECORD OF DRILLHOLE: BH17-2

SHEET 1 OF 2

LOCATION: SEE FIGURE 1

DRILLING DATE: June 25 and 26, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: MARL-MT5

DRILLING CONTRACTOR: Drilltech

JN - Joint, FLT - Fault, SH - 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, VR - Very 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.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. COUNT PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole 17-2		83.09																
7	HQ CORE	Highly weathered, thinly bedded, grey, fine grained, very weak, SHALE (Georgian Bay Formation) with LIMESTONE interbeds		6.10	1															
8				81.09	2															
		Moderately weathered, thinly bedded, grey, fine grained, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		8.10	3															
9																				
10					4															
11																				UC = 21.4 MPa
12					5															
13																				
14					6															
15					7															
				73.44																
16				15.75	8															
		CONTINUED NEXT PAGE																		

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SM/BC

CHECKED: AK

GTA-RCK 018 S:\CLIENTS\ALECTRA_UTILITIES_INC\HYDRO_POLES_QEW-CREDIT_RIVER\02_DATA\GINT\HYDRO_POLES_QEW.GPJ GAL-MISS.GDT 8/7/18

PROJECT: 1789831

RECORD OF DRILLHOLE: BH17-2

SHEET 2 OF 2

LOCATION: SEE FIGURE 1

DRILLING DATE: June 25 and 26, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: MARL-MT5

DRILLING CONTRACTOR: Drilltech

JN - Joint, FLT - Fault, SH - 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, VR - Very 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.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. COUNT PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		--- CONTINUED FROM PREVIOUS PAGE ---																		
17	HQ CORE	Slightly weathered to fresh, thinly bedded, grey, fine grained, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		72.09	8															
		END OF BOREHOLE		17.10																
18																				
19																				
20																				
21																				
22																				
23																				
24																				
25																				
26																				

DEPTH SCALE

1 : 50

GOLDER

LOGGED: SM/BC

CHECKED: AK

GTA-RCK 018 S:\CLIENTS\ALECTRA_UTILITIES_INC\HYDRO_POLES_QEW-CREDIT_RIVER\02_DATA\GINT\HYDRO_POLES_QEW.GPJ GAL-MISS.GDT 8/7/18

PROJECT

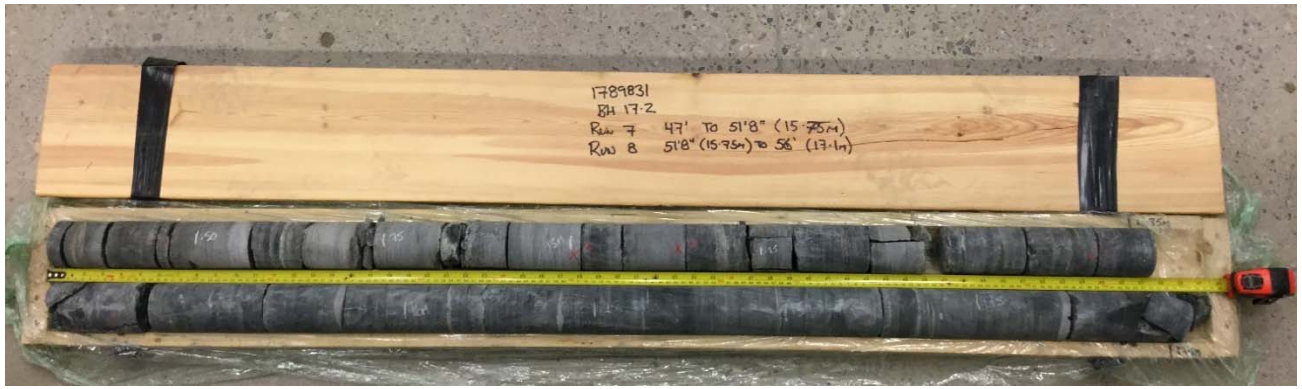
Proposed Electrical Transmission Line Monopoles at Credit River and QEW

TITLE

Bedrock Core Photograph
Borehole BH17-2 (6.1 m to 12.1 m)

GOLDER

PROJECT No. 1789831			FILE No.	----
DRAFT	SM	20180801	SCALE	AS SHOWN
CADD	--			
CHECK	AK	20180801		**FIGURE**
REVIEW	--			



PROJECT

Proposed Electrical Transmission Line Monopoles at Credit River and QEW

TITLE

Bedrock Core Photograph
Borehole BH17-2 (12.1 m to 17.1 m)

GOLDER

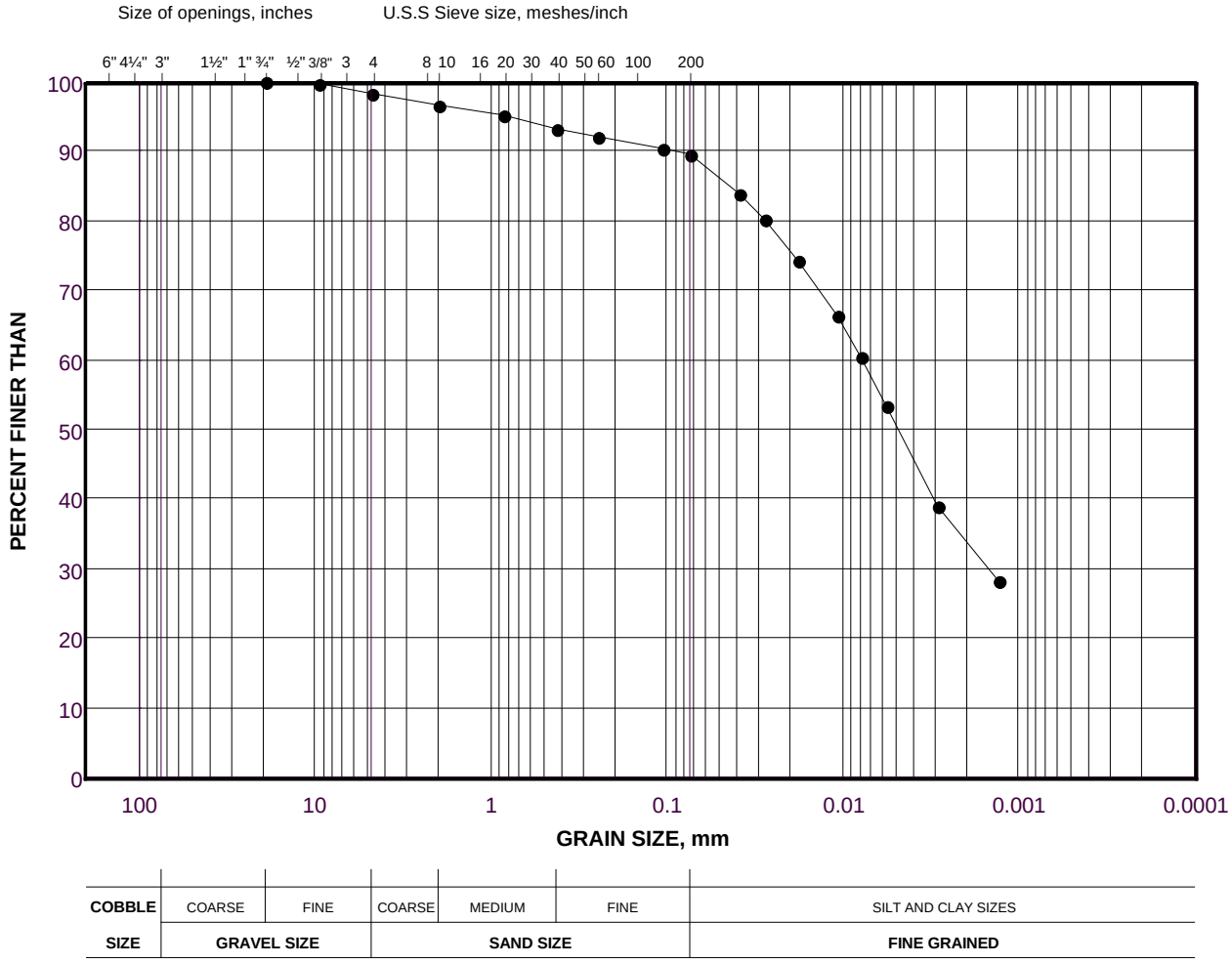
PROJECT No. 1789831			FILE No.	----
DRAFT	SM	20180801	SCALE	AS SHOWN
CADD	--			
CHECK	AK	20180801		
REVIEW	--			

FIGURE

GRAIN SIZE DISTRIBUTION

(CI) SILTY CLAY

FIGURE



LEGEND

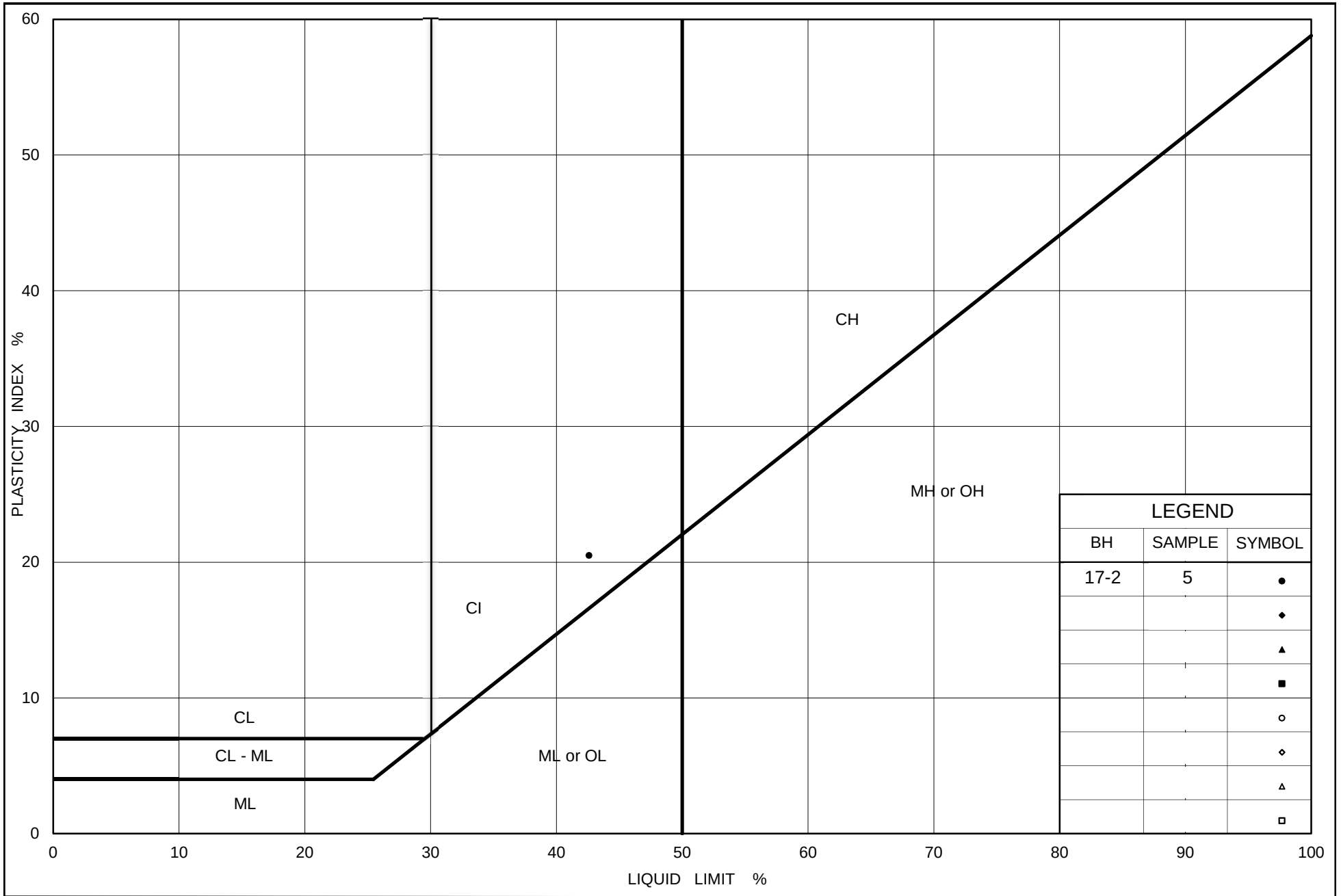
SYMBOL	Borehole	SAMPLE
●	17-2	5

Project Number: 1789831

Checked By: AK

Golder Associates

Date: 19-Jul-18



GOLDER

PLASTICITY CHART
(CI) - SILTY CLAY

Figure No.

Project No. 1789831

Checked By: AK

Maxxam
A Bureau Veritas Group Company

Your Project #: 1789831
Site Location: QEW/CREDIT RIVER
Your C.O.C. #: 112658

Attention: Jeff Tolton

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

Report Date: 2018/07/17
Report #: R5299625
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8G6725
Received: 2018/07/05, 15:33

Sample Matrix: Soil
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	1	N/A	2018/07/10	CAM SOP-00463	EPA 325.2 m
Conductivity	1	N/A	2018/07/11	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	1	2018/07/12	2018/07/12	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	1	2018/07/05	2018/07/11	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	1	N/A	2018/07/09	CAM SOP-00464	EPA 375.4 m

Remarks:

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

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

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

Your Project #: 1789831
Site Location: QEW/CREDIT RIVER
Your C.O.C. #: 112658

Attention: Jeff Tolton

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

Report Date: 2018/07/17
Report #: R5299625
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8G6725
Received: 2018/07/05, 15:33

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 #: B8G6725
Report Date: 2018/07/17

Golder Associates Ltd
Client Project #: 1789831
Site Location: QEW/CREDIT RIVER
Sampler Initials: BC

RESULTS OF ANALYSES OF SOIL

Maxxam ID			HDH112			HDH112		
Sampling Date			2018/06/25			2018/06/25		
COC Number			112658			112658		
	UNITS	Criteria	BH17-2 SA4-5	RDL	QC Batch	BH17-2 SA4-5 Lab-Dup	RDL	QC Batch
Calculated Parameters								
Resistivity	ohm-cm	-	4500		5615167			
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	-	<20	20	5618714			
Conductivity	umho/cm	**470**	224	2	5621364	222	2	5621364
Available (CaCl2) pH	pH	-	7.54		5624965			
Soluble (20:1) Sulphate (SO4)	ug/g	-	70	20	5618691			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
Criteria: Ontario Reg. 153/04 (Amended April 15, 2011)
Table 1: Full Depth Background Site Condition Standards
Soil - Agricultural or Other Property Use

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Maxxam Job #: B8G6725
Report Date: 2018/07/17

Golder Associates Ltd
Client Project #: 1789831
Site Location: QEW/CREDIT RIVER
Sampler Initials: BC

TEST SUMMARY

Maxxam ID: HDH112
Sample ID: BH17-2 SA4-5
Matrix: Soil

Collected: 2018/06/25
Shipped:
Received: 2018/07/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5618714	N/A	2018/07/10	Deonarine Ramnarine
Conductivity	AT	5621364	N/A	2018/07/11	Tahir Anwar
pH CaCl2 EXTRACT	AT	5624965	2018/07/12	2018/07/12	Gnana Thomas
Resistivity of Soil		5615167	2018/07/11	2018/07/11	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5618691	N/A	2018/07/09	Deonarine Ramnarine

Maxxam ID: HDH112 Dup
Sample ID: BH17-2 SA4-5
Matrix: Soil

Collected: 2018/06/25
Shipped:
Received: 2018/07/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5621364	N/A	2018/07/11	Tahir Anwar

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 #: B8G6725
Report Date: 2018/07/17

Golder Associates Ltd
Client Project #: 1789831
Site Location: QEW/CREDIT RIVER
Sampler Initials: BC

GENERAL COMMENTS

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

Package 1	10.0°C

Results relate only to the items tested.

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Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B8G6725
Report Date: 2018/07/17

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1789831
Site Location: QEW/CREDIT RIVER
Sampler Initials: BC

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5618691	Soluble (20:1) Sulphate (SO4)	2018/07/09	NC	70 - 130	99	70 - 130	<20	ug/g	9.3	35
5618714	Soluble (20:1) Chloride (Cl-)	2018/07/10	105	70 - 130	102	70 - 130	<20	ug/g	NC	35
5621364	Conductivity	2018/07/11			101	90 - 110	<2	umho/cm	0.89	10
5624965	Available (CaCl2) pH	2018/07/12			101	97 - 103			0.0019	N/A

N/A = Not Applicable

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

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

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

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

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

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

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Maxxam Job #: B8G6725
Report Date: 2018/07/17

Golder Associates Ltd
Client Project #: 1789831
Site Location: QEW/CREDIT RIVER
Sampler Initials: BC

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

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6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-81[illegible] Toll Free: 800-563-6266
CAM FCD-01191/3

For: Ema Gitej

CHAIN OF CUSTODY RECORD 112858

Page ____ of ____

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: Golder Associates	Company Name: Golder Associates	Quotation #:	[X] Regular TAT (5-7 days) Most analyses
Contact Name: Erti Mansaku	Contact Name: Erti Mansaku / Jeff Tolton	P.O. #/ AFE#:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 6925 Century Avenue,	Address:	Project #: 1789831	Rush TAT (Surcharges will be applied)
Phone: Fax:	Phone: Fax:	Site Location: QEW / Credit River	[ ] 1 Day [ ] 2 Days [ ] 3-4 Days
Email: erti_mansaku@golder.com	Email: jeff_tolton@golder.com	Site #:	Date Required:
		Sampled By: Brad Crowe	Rush Confirmation #:

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

Regulation 153	Other Regulations
[X] Table 1 [ ] Res/Park [X] Med/ Fine	[ ] CCME [ ] Sanitary Sewer Bylaw
[ ] Table 2 [ ] Ind/Comm [ ] Coarse	[ ] MISA [ ] Storm Sewer Bylaw
[ ] Table 3 [X] Agri/ Other	[ ] PWQO Region
[ ] Table ____	[ ] Other (Specify)
FOR RSC (PLEASE CIRCLE) Y / (N)	[ ] REG 558 (MIN. 3 DAY TAT REQUIRED)

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

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

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTEX / PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)	corrositivity package						HOLD - DO NOT ANALYZE
1	BH17-2 SA 4-5	Jun 25, 2018	PM	SOIL									X						
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

05-Jul-18 15:33
Ema Gitej
B8G6725
GK1 ENV-676

LABORATORY USE ONLY

CUSTODY SEAL Y / N		COOLER TEMPERATURES
Present	Intact	
		10 10 10

COOLING MEDIA PRESENT: Y / (N)

COMMENTS

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
Erti Mansaku	2018/07/05	PM		2018/07/05	15:33	

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White: Maxxam - Yellow: Client

COC-1004 (03/17)

Current Investigation - Boreholes Advanced for Other Structures

Boreholes AR-2, FW-1, EW-1 and EW-2

GOLDER

RECORD OF BOREHOLE No AR-2

SHEET 1 OF 1 **METRIC**

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824172.2; E 295921.4 MTM NAD 83 ZONE 10 (LAT. 43.557434; LONG. -79.609899) ORIGINATED BY ACM

DIST Central HWY QEW BOREHOLE TYPE CME 75, 114 mm I.D. Hollow Stem Augers, HQ Casing COMPILED BY CC

DATUM Geodetic DATE July 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
88.4	GROUND SURFACE										
0.0 / 87.8	TOPSOIL (600 mm)		1	SS	9		88				
0.6 / 87.3	CLAYEY SILT, some sand, some gravel, trace rootlets, shale fragments (TILL)		2A 2B	SS	14						
1.1	Stiff Brown to grey Moist						87				
86.2	SILT and SAND, trace to some clay, trace to some gravel, clayey silt pockets, shale fragments (TILL)		3	SS	6						6 56 31 7
2.2	Loose to compact Brown Moist		4	SS	11		86				
84.6	Sandy SILTY CLAY, trace to some gravel, trace shale fragments (TILL) Stiff Brown grey with oxidation staining Moist		5	SS	13		85				7 22 44 27
3.8	CLAYEY SILT, some sand, some shale fragments (RESIDUAL SOIL)		6	SS	50/0.08						
83.8	Hard Brown grey Moist		7	SS	50/0.13		84				
4.6	SHALE (BEDROCK) Grey Bedrock cored from a depth of 4.6 m to 11.6 m For bedrock coring details, refer to Record of Drillhole AR-2		1	RC	REC 100%						RQD = 18%
			2	RC	REC 100%		83				RQD = 86%
			3	RC	REC 100%		82				RQD = 97%
			4	RC	REC 100%		81				RQD = 93%
			5	RC	REC 100%		80				RQD = 57%
76.8							79				
11.6	END OF BOREHOLE NOTES: 1. Borehole dry prior to rock coring.						78				
							77				

$+^3$, $\times^3$: 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 1/9/19

PROJECT: 1662333

RECORD OF DRILLHOLE: AR-2

SHEET 1 OF 1

LOCATION: N 4824172.2 ;E 295921.4

DRILLING DATE: July 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	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole AR-2		83.87															
5	HQ Core	Moderately to slightly weathered, thinly laminated to medium bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		4.57	1							BD,UN,SM CC, Cl BD,UN,SM CC, Cl BD,PL,SM CC, Cl BD,UN,SM SA, He BD,UN,SM PC, Cl BD,UN,RO SA BD,UN,SM CC, Cl BD,PL,SM SA, He BD,UN,SM CC, Cl BD,UN,RO CC, Cl	2 2 1 2 2 3 2 1 2 3	4 4 4 2 3 2 4 2 4 4	R4 R3 R2 R1	W1 W2 W3 W4 W5 W6		R1 R1	
6					2							BD,PL,RO PC, Cl	1.5	3					UCS = 9.1 MPa
7																			
8					3							BD,UN,SM CL	2	1					
9					4							BD,UN,SM CC, Cl	2	4					UCS = 11.5 MPa
10												BD,CU,SM PC, Cl	2	3					
11					5							BD,UN,SM CC, Cl JN,PL,SM CC, Cl BD,PL,SM CC, Cl BD,PL,SM SA, Co	2 1 1 1	4 4 4 2					
				76.84															
12		END OF DRILLHOLE		11.60															
13																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

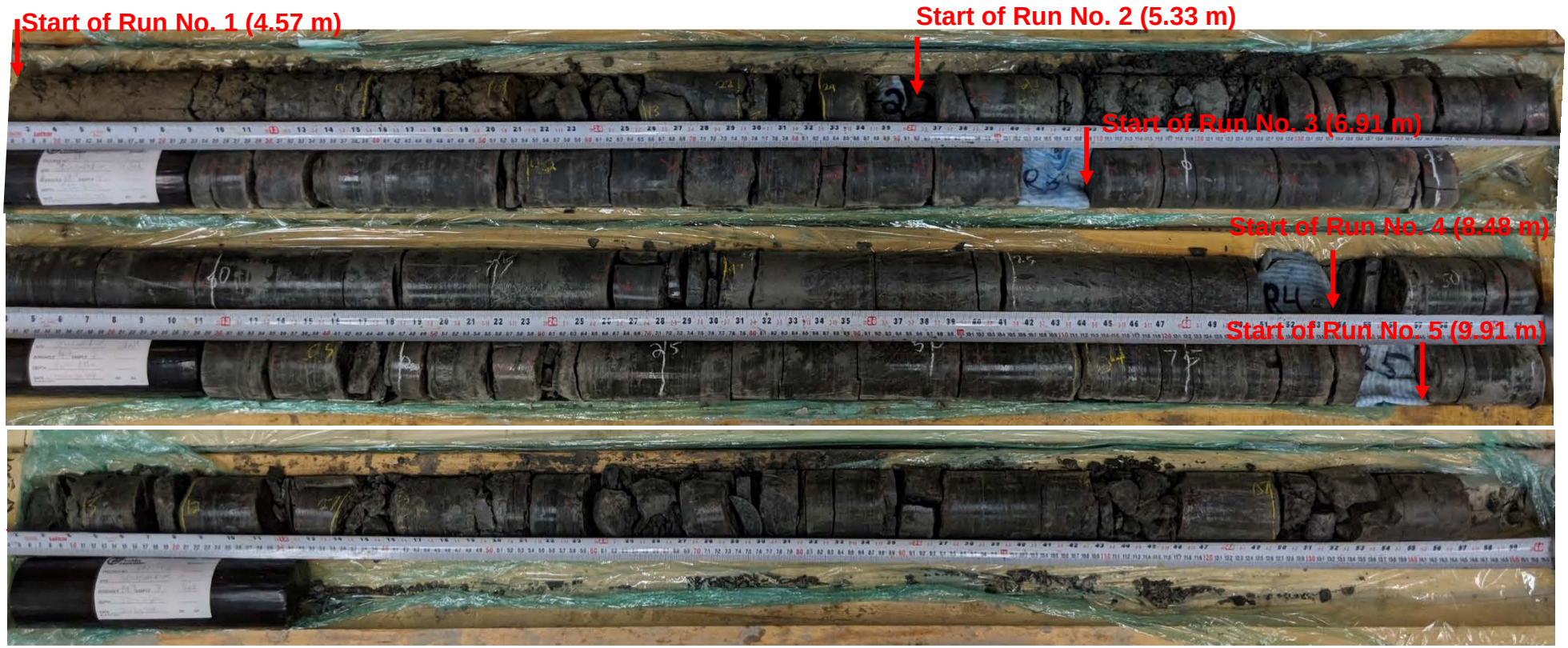
1 : 50

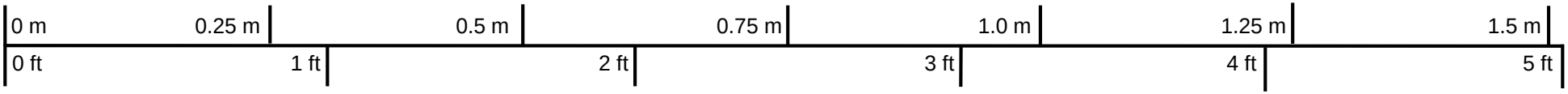
GOLDER

LOGGED: ACM

CHECKED: AB

GTA-RCK 054 S:\CLIENTS\MTO\CEW-CREDIT_RIVER\02_DATA\GINT\CEW-CREDIT_RIVER.GPJ GAL-MISS.GDT 1/9/19





Scale

PROJECT

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

TITLE

Bedrock Core Photograph
Borehole AR-2 (4.57 m to 11.60 m)

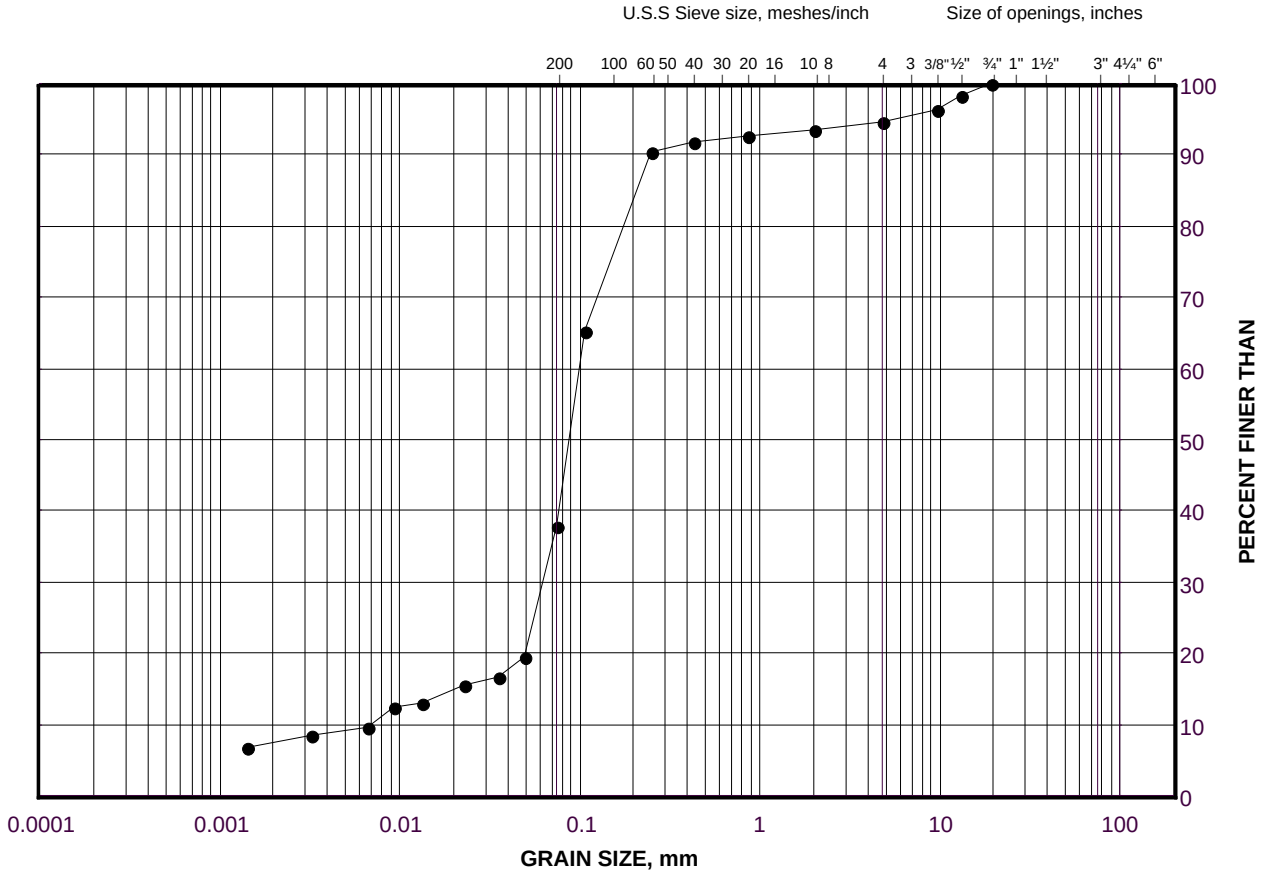
GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	SE	20180821	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE**		
CHECK	SMM	20181116			
REVIEW	JMAC	20181116			

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

GRAIN SIZE DISTRIBUTION
Silt and Sand (Till)

FIGURE



LEGEND

SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	AR-2	3	1.52 - 2.13

Project Number: 1662333

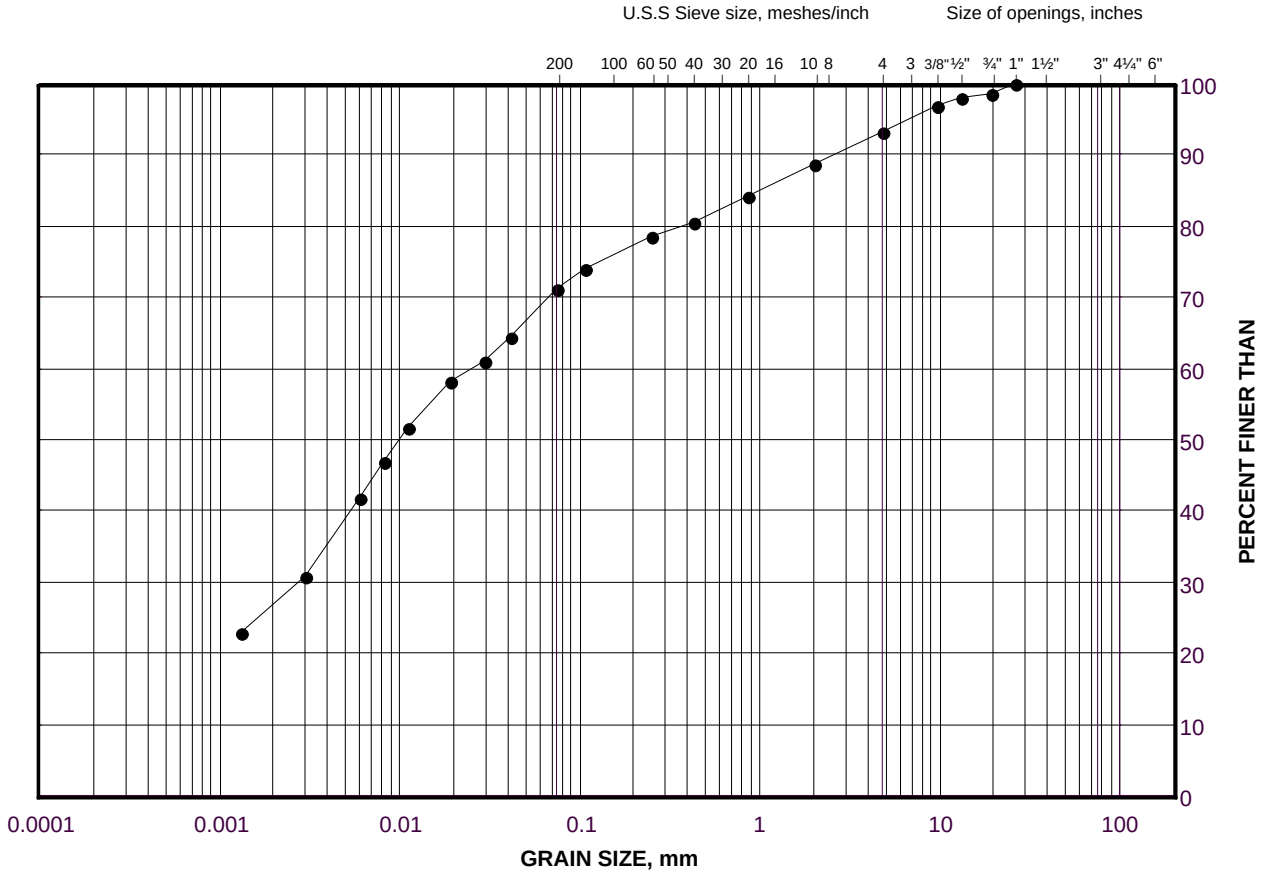
Checked By: SMM

Golder Associates

Date: 09-Aug-18

GRAIN SIZE DISTRIBUTION
Sandy Silty Clay (Till)

FIGURE



LEGEND

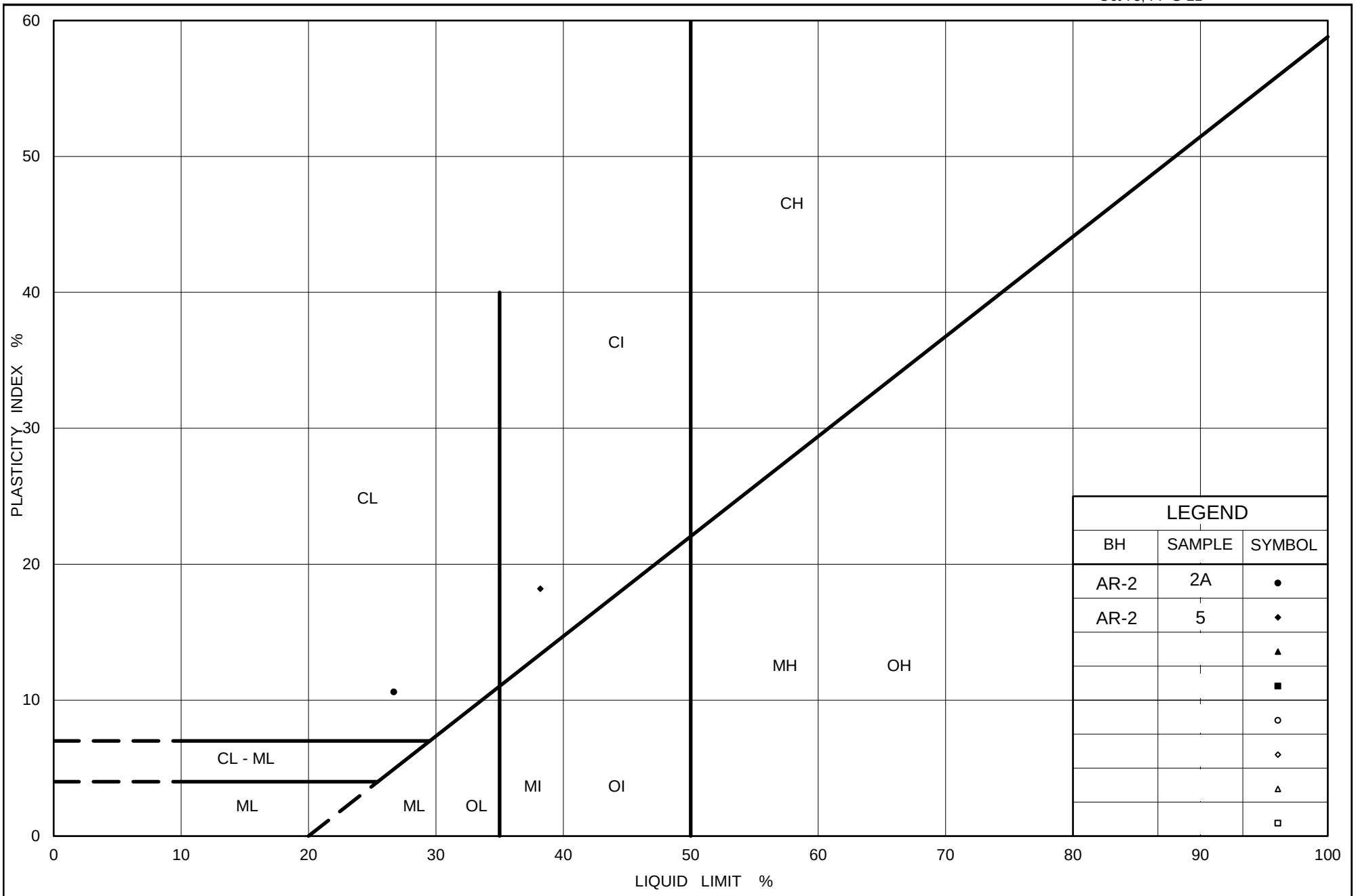
SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	AR-2	5	3.05 - 3.66

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 09-Aug-18



Ministry of Transportation

Ontario

PLASTICITY CHART
Sandy Clayey Silt (Till) to Silty Clay (Till)

Figure No.

Project No. 1662333

Checked By: SMM

GOLDER

RECORD OF BOREHOLE No FW-1

SHEET 1 OF 1 **METRIC**

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

LOCATION N 4823994.8; E 295856.0 MTM NAD 83 ZONE 10 (LAT. 43.555836; LONG. -79.610704)
BOREHOLE TYPE CME 55, 114 mm O.D., Hollow Stem Augers
DATE October 10, 2018

ORIGINATED BY ACM
COMPILED BY JMP
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
76.1	GROUND SURFACE								
0.0 / 75.4	Sand and gravel, some silt (FILL) Compact Brown Moist		1	SS	26		76		
0.7 / 73.1	CLAYEY SILT, interbedded with SILT and SAND, some clay, trace gravel Soft to very stiff Grey-brown to dark brown Moist		2A 2B	SS	16		75		
			3	SS	7		74		1 31 53 15
			4	SS	3		73		
3.1 / 72.4	CLAYEY SILT, some sand, some shell fragments, trace organics Soft Grey-brown Moist		5	SS	2	▽			
3.7 / 71.5	SILT and SAND, some gravel, trace to some clay, some shell fragments Loose Dark brown Wet		6	SS	6		72		12 47 33 8
4.6 / 69.9	SAND and GRAVEL, trace to some silt, trace clay, some shell fragments from 6.1 m to 6.2 m Compact Dark brown to grey Wet		7	SS	14		71		49 39 10 2
69.5	CLAYEY SILT, some gravel, some shale fragments		8A 8B 8C	SS	100/0.2		70		
6.6 / 65.6	(RESIDUAL SOIL) Hard Grey Moist SHALE (BEDROCK) Grey Bedrock cored from a depth of 7.0 m to 10.5 m For bedrock coring details, refer to Record of Drillhole FW-1		1	RC	REC 90%		69		RQD = 90%
			2	RC	REC 91%		68 67		RQD = 73%
			3	RC	REC 100%		66		RQD = 94%
10.5	END OF BOREHOLE NOTES: 1. Water level measured at 3.5 m (Elev. 72.6 m) below ground surface upon completion of drilling.								

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

$+^3, \times^3$: 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 19-1-4

PROJECT: 1662333

RECORD OF DRILLHOLE: FW-1

SHEET 1 OF 1

LOCATION: N 4823994.8 ;E 295856.0

DRILLING DATE: October 10, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

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	Jr	Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Record of Borehole FW-1		69.09															
8		Moderate to slighly weathered, thinly bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with limestone interbeds.		7.01	1							CO,UN,SM SA BD,PL,SM PC, CL BD,UN,SM PC, CL			R4 R3 R2 R1	W1 W2 W3 W4 W5 W6			
9					2							CO,UN,SM CN, CL CO,UN,SM CN, CL CO,UN,SM CN, CL BD,PL,SM PC, CL CO,UN,SM CN, CL BD,UN,SM CN, CL BD,UN,SM CN, CL CO,UN,SM CC, CL							
10				65.58	3							CO,UN,SM CN, CL CO,PL,SM CC, CL CO,UN,SM PC, CL BD,UN,SM CC, CL CO,UN,SM SA							
		END OF DRILLHOLE		10.52															

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: ACM

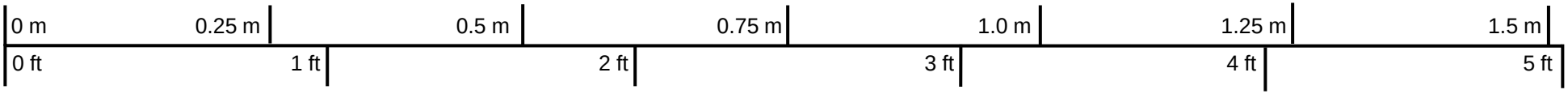
CHECKED: SK

GTA-RCK 054 S:\CLIENTS\MTO\QEW-CREDIT_RIVER\02_DATA\GINT\QEW-CREDIT_RIVER.GPJ GAL-MISS.GDT 19-1-4

Start of Run No. 1 (7.01 m)

Start of Run No. 2 (8.08 m)

Start of Run No. 3 (9.65 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 FW-1 (7.01 m to 10.52 m)

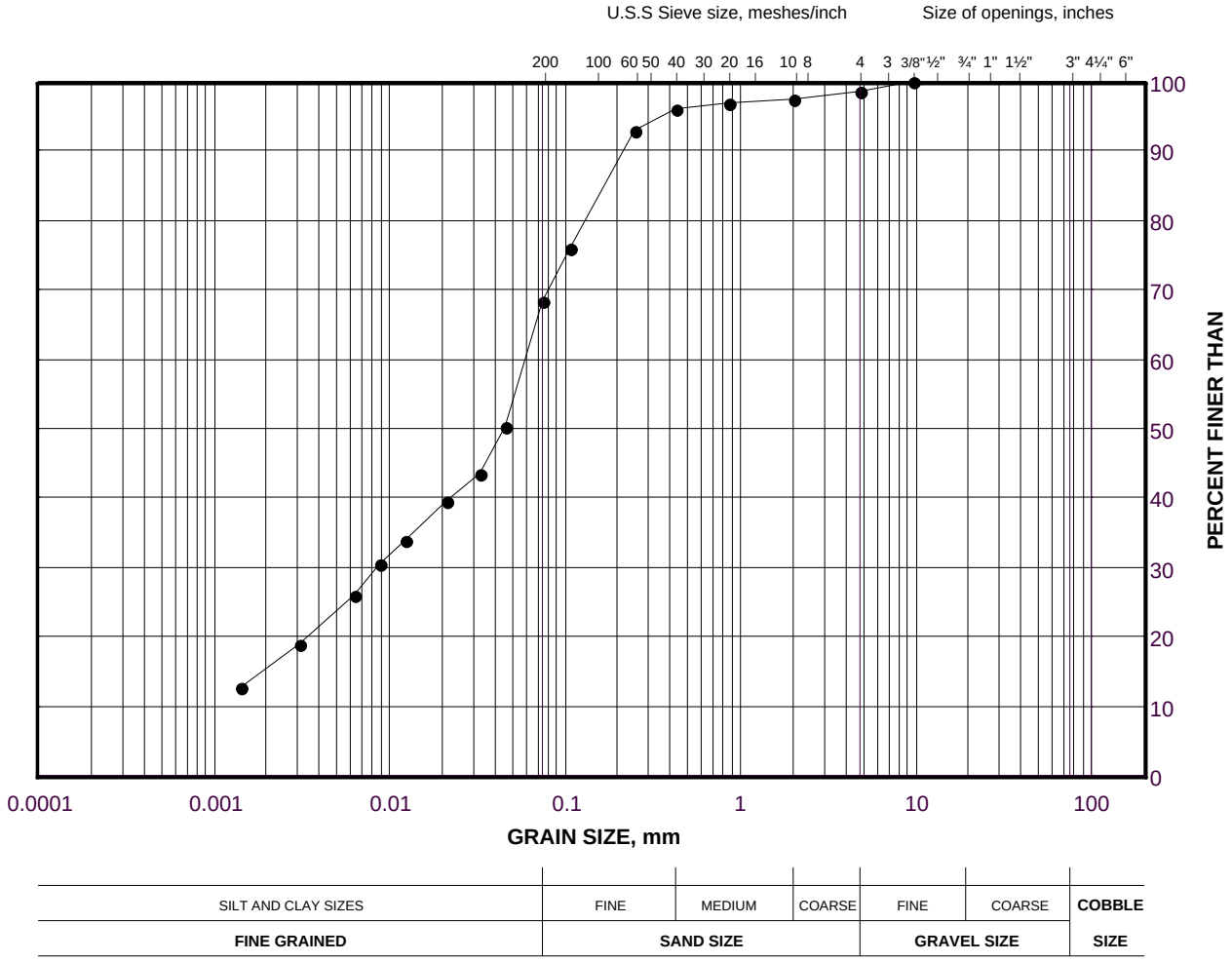
GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	ACM	Jan. 2019	SCALE	AS SHOWN	VER. 1.
CADD	--		FIGURE		
CHECK					
REVIEW					

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

GRAIN SIZE DISTRIBUTION
Clayey Silt

FIGURE



LEGEND

SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	FW-1	3	1.52 - 2.13

Project Number: 1662333

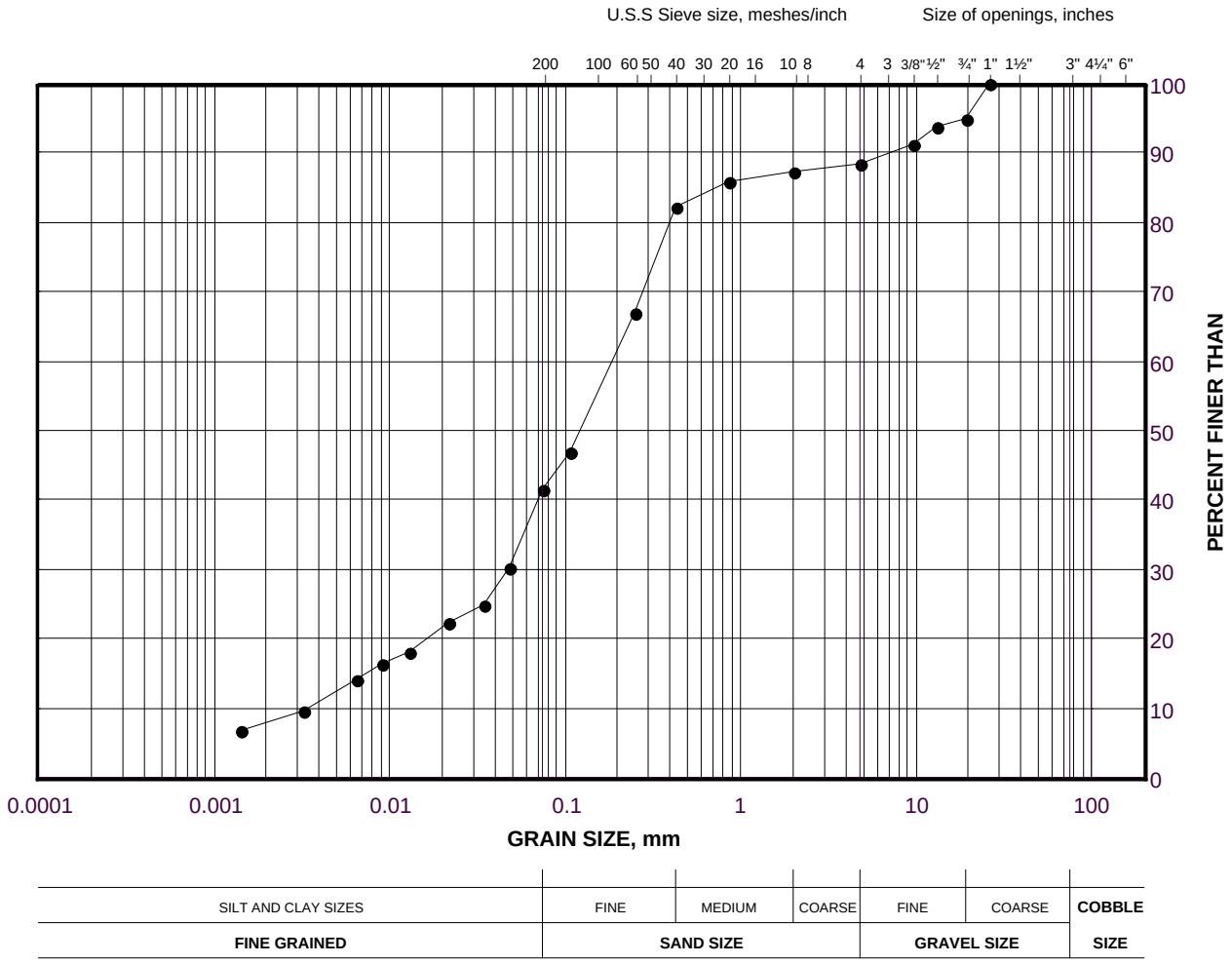
Checked By: SMM

Golder Associates

Date: 09-Nov-18

GRAIN SIZE DISTRIBUTION
Silt and Sand

FIGURE



LEGEND

SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	FW-1	6	3.81 - 4.42

Project Number: 1662333

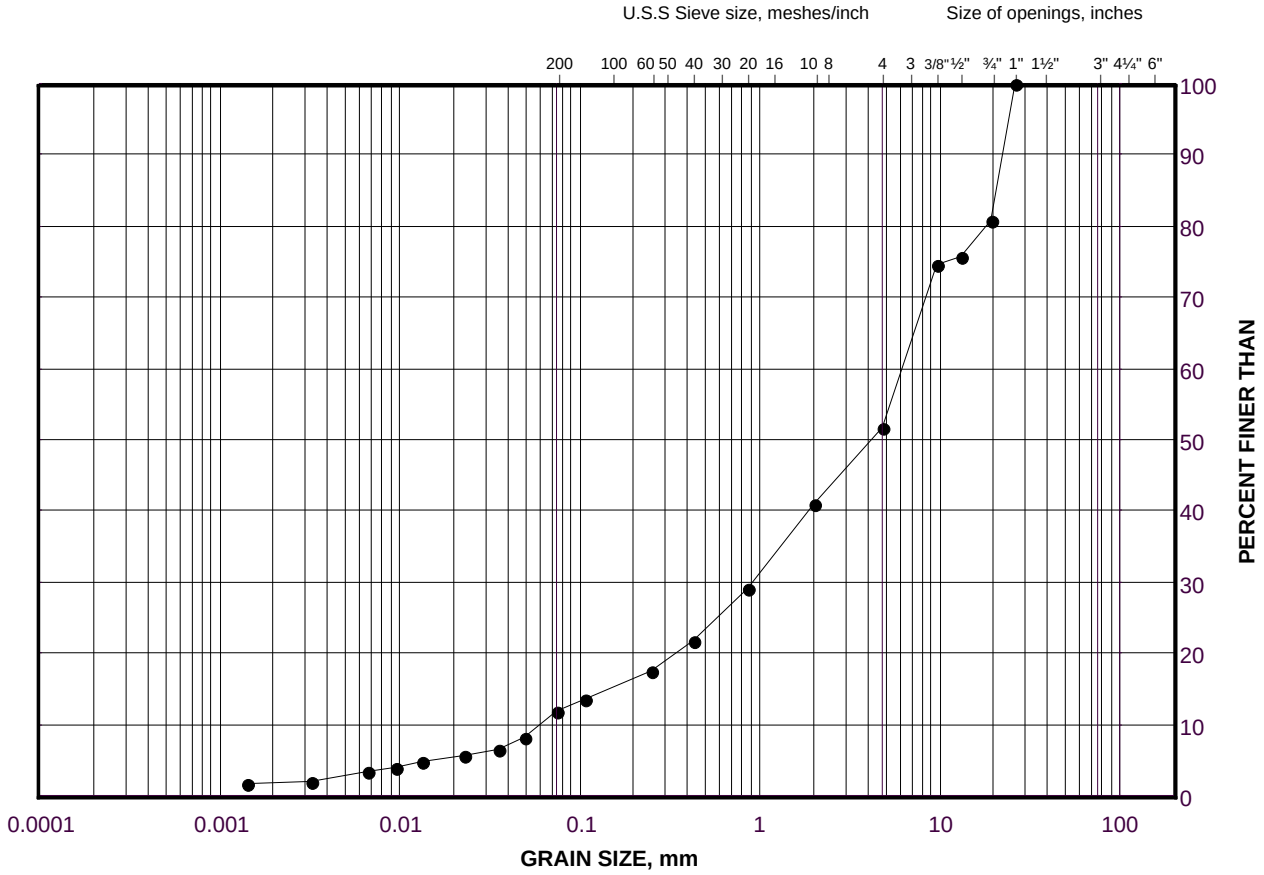
Checked By: SMM

Golder Associates

Date: 09-Nov-18

GRAIN SIZE DISTRIBUTION
Sand and Gravel

FIGURE



LEGEND

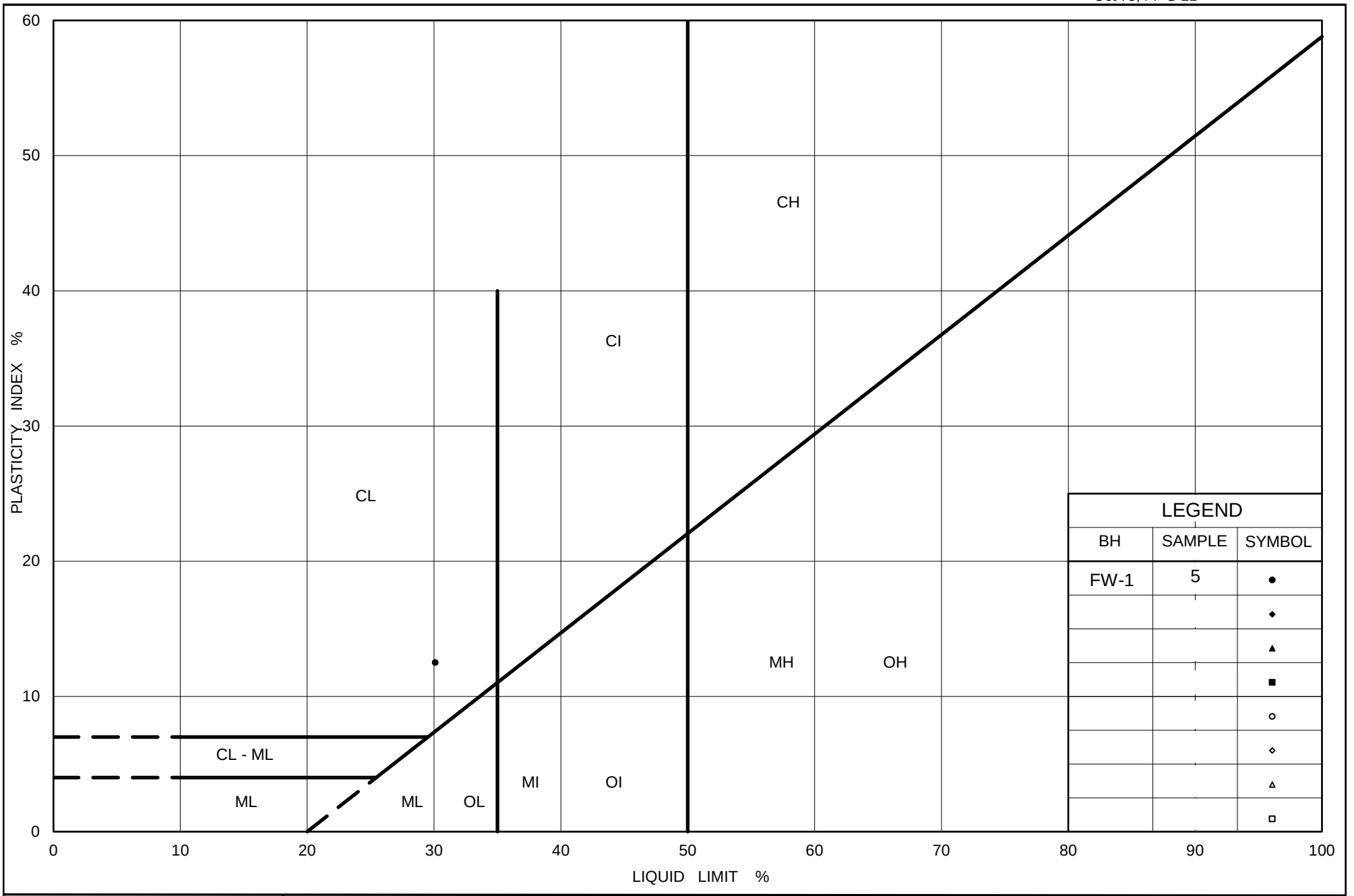
SYMBOL	Borehole	SAMPLE	DEPTH(m)
●	FW-1	7	4.57 - 5.18

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 09-Nov-18



Ministry of Transportation

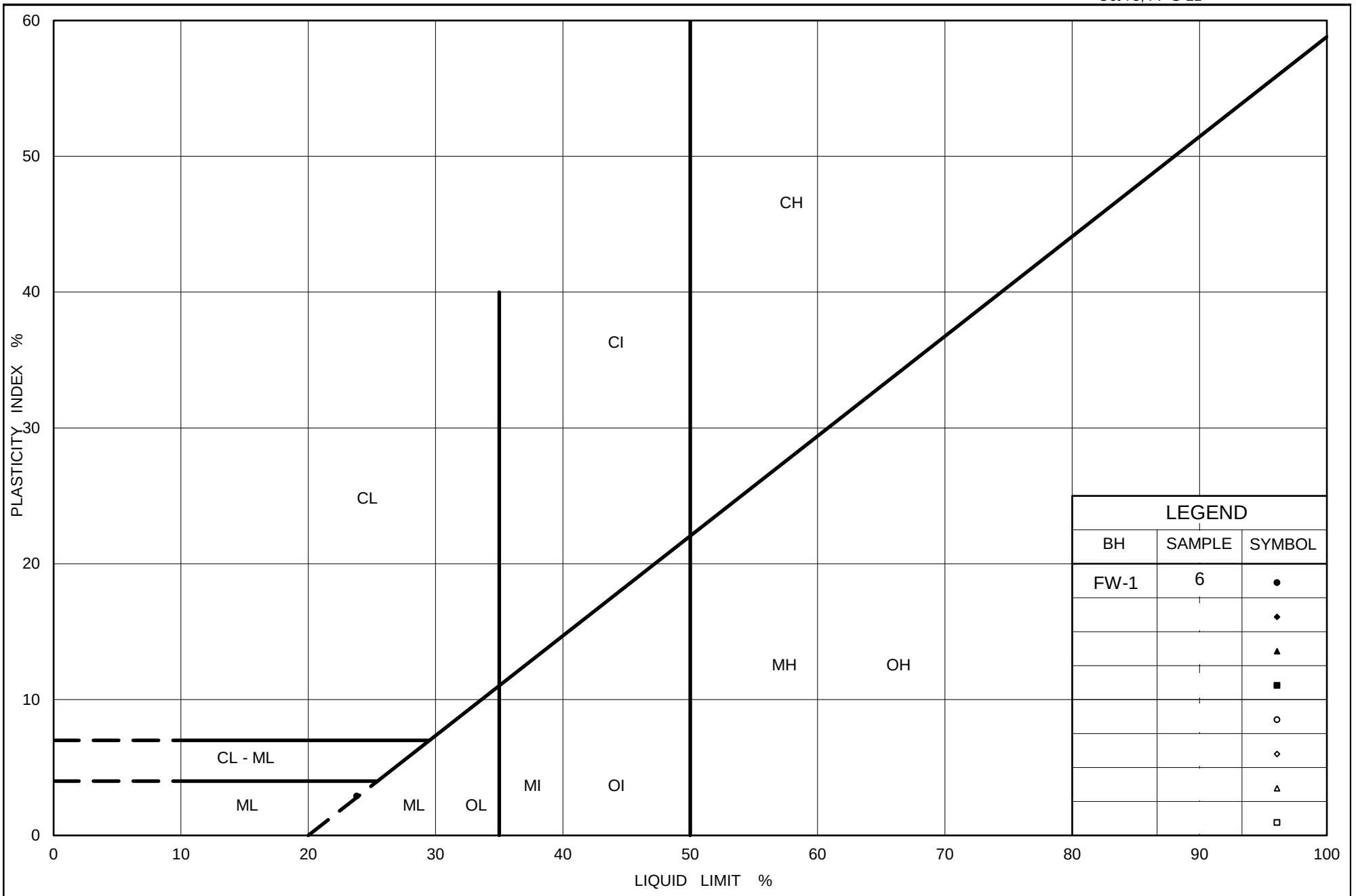
Ontario

PLASTICITY CHART
Clayey Silt

Figure No.

Project No. 1662333

Checked By: SMM



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt and Sand

Figure No.

Project No. 1662333

Checked By: SMM

GOLDER

RECORD OF BOREHOLE No EW-1

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4823955.5; E 295849.5 MTM NAD 83 ZONE 10 (LAT. 43.555482; LONG. -79.610784)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 159 mm O.D., Hollow Stem Augers, HQ Casing

COMPILED BY KN

DATUM Geodetic

DATE May 1, 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
88.5	GROUND SURFACE										
0.0	Sand and gravel, some silt, trace clay (FILL) Compact to dense Grey to grey-brown Dry		1	SS	30		88				
			2	SS	33				○		37 46 15 2
	- Geotextile grid fragments recovered in split-spoon sample SA#3 at 1.8 m depth and SA#4 at 2.7 m depth		3	SS	29		87				
			4	SS	26		86		○		32 50 16 2
			5	SS	39				○		
84.2			6	SS	32		85		○		
83.9	Gravelly Sandy CLAYEY SILT (TILL) Grey to brown Moist to wet		7	SS	100/0.13		84				
4.6	SHALE (BEDROCK) Grey		1	RC	REC 100%						RQD = 78%
	Bedrock cored from a depth of 4.9 m to 11.2 m For bedrock coring details, refer to Record of Drillhole EW-1		2	RC	REC 100%		83				RQD = 97%
			3	RC	REC 100%		82				RQD = 75%
			4	RC	REC 100%		81				RQD = 100%
			5	RC	REC 100%		80				RQD = 97%
77.3							79				
11.2	END OF BOREHOLE NOTES: 1. Borehole dry prior to rock coring. 2. Borehole backfilled with bentonite cement grout to 3.0 m depth, and bentonite (Hole Plug) to ground surface.						78				

$+^3, \times^3$: 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 11/15/18

PROJECT: 1662333

RECORD OF DRILLHOLE: EW-1

SHEET 1 OF 1

LOCATION: N 4823955.5 ;E 295849.5

DRILLING DATE: May 1, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Geo-Environmental Drilling Inc.

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 EW-1		83.60															
5	HQ Core	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		4.90	1							BD,UN,SM CL	2	1					
												CO,UN,SM CL	2	1					
6					2							CO,UN,SM CL	2	1					
												BD,UN,SM PC, Cl	2	3					
												CO,UN,SM SA, Cl	2	2					
7					3							CO,UN,SM CC, Cl	2	4				R1	
												JN,PL,SM CL	1	1				R0	
												CO,UN,SM CL	2	2					
												BD,UN,SM SA, Cl	2	4					UCS=156.8 MPa (Limestone)
												BD,UN,SM CC, Cl	1	1					
												JN,PL,SM CL	1	1					
8												JN,UN,SM CL	2	1					
												BD,UN,SM IN, Cl	2	6					
												BD,UN,SM CL	2	1					
												BD,UN,SM CL	2	1					
					4							CO,UN,SM SA, Cl	2	2					
												BD,UN,SM PC, Cl	2	3					
9												JN,UN,SM CL	2	1					
												JN,UN,SM CL	2	1					
10					5							BD,UN,SM SA, Cl	2	2					
												BD,UN,SM SA, Cl	2	2					
												BD,UN,SM SO, Cl	2	1					
11												BD,UN,SM PC, Cl	2	3					
												BD,UN,SM IN, Cl	2	6					
		END OF DRILLHOLE		77.31 11.19															
12																			
13																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: AKV

GTA-RCK 054 S:\CLIENTS\MTO\CEW-CREDIT_RIVER\02_DATA\GINT\CEW-CREDIT_RIVER.GPJ GAL-MISS.GDT 11/15/18

Start of Run No. 1 (4.90 m)

Start of Run No. 2 (5.17 m)

Start of Run No. 3 (6.69 m)

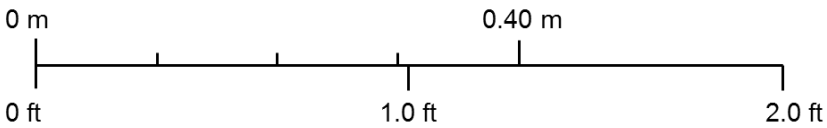
Box 1: 4.90 m to 8.19 m

Start of Run No. 4 (8.19 m)

Start of Run No. 5 (9.67 m)

End of Borehole (11.19 m)

Box 2: 8.19 m to 11.19 m



Scale

PROJECT

EAST-WEST ACTIVE TRANSPORT PEDESTRIAN BRIDGE ALONG CREDIT RIVER BRIDGE

TITLE

Bedrock Core Photographs
Borehole EW-1 (4.90 m to 11.19 m)

GOLDER

PROJECT No. 1 2333			FILE No. ----		
DRAFT	SK	20180628	SCALE	NTS	VER. 1.
CADD	--		**FIGURE**		
CHECK	SMM				
REVIEW	MAC	20181108			

REVISION DATE: January 23, 2018 BY: DCB Project: 1530382

GOLDER

RECORD OF BOREHOLE No EW-2

SHEET 1 OF 1 **METRIC**

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

LOCATION N 4824156.8; E 295956.2 MTM NAD 83 ZONE 10 (LAT. 43.557295; LONG. -79.609467)
BOREHOLE TYPE CME 55, 159 mm O.D., Hollow Stem Augers, HQ Casing
DATE May 2, 2018

ORIGINATED BY JL
COMPILED BY KN
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
89.1	GROUND SURFACE										
0.0	Sandy clayey silt, trace gravel (FILL) Stiff Brown Dry		1	SS	13						
88.4											
0.9	Sand and gravel, trace to some silt, trace clay (FILL) Brown Moist		2A	SS	9						36 50 12 2
			2B								
	Gravelly CLAYEY SILT with SAND (TILL) Stiff to very stiff		3A	SS	17						
86.9			3B								24 38 26 12
2.2	Brown Moist		4	SS	100/0.28						
	SHALE (BEDROCK), with limestone interbeds Grey		5	SS	100/0.20						
	Bedrock cored from a depth of 3.0 m to 9.7 m		1	RC	REC 100%		88				RQD = 84%
	For bedrock coring details, refer to Record of Drillhole EW-2		2	RC	REC 100%		85				RQD = 31%
			3	RC	REC 100%		84				RQD = 78%
			4	RC	REC 100%		82				RQD = 93%
			5	RC	REC 100%		80				RQD = 100%
79.4											
9.7	END OF BOREHOLE										

NOTES:

1. Borehole dry prior to rock coring.

2. Borehole backfilled with bentonite cement grout to 1.5 m depth, and bentonite (Hole Plug) to ground surface.

$+^3, \times^3$: 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 11/15/18

PROJECT: 1662333

RECORD OF DRILLHOLE: EW-2

SHEET 1 OF 1

LOCATION: N 4824156.8 ;E 295956.2

DRILLING DATE: May 2, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Geo-Environmental Drilling Inc.

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	WEATH-ERING INDEX: W1	W2	W3	W4	W5	W6	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Record of Borehole EW-2		86.07																						
3		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		3.00	1							BD,UN,SM SA, CI	2	2													R0
												BD,UN,SM IN, CI	2	6													
												BD,UN,SM SA, CI	2	2													
												BD,UN,SM SO, CI	2	1													
												BD,UN,SM SA, CI	2	2													
4					2							BD,UN,SM PC, CI	2	3													
												CO,UN,SM SA, CI	2	2													
												CO,UN,SM CL	2	1													
												JN,CU,SM CL	2	1													
												CO,CU,SM SO, CI	2	1													
5																											UCS=16.1 MPa
												BD,UN,SM SO, CI	2	1													
												CO,UN,SM PC, CI	2	3													
												BD,UN,SM CL	2	1													
												BD,UN,SM CL	2	1													
												BD,UN,SM CL	2	1													
												BD,UN,SM CL	2	1													
												CO,UN,SM SO, CI	2	2													
												JN,UN,SM SA, CI	1	1													
6	HQ Core				3							JN,PL,SM CL															
												CO,UN,SM CL	2	1													R0
												BD,UN,SM SO, CI	2	1													
												BD,UN,SM SA, CI	2	2													
7					4							BD,UN,SM PC, CI	2	3													
												BD,UN,SM PC, CI	2	3													
8												BD,UN,SM PC, CI	2	3													
9					5							CO,PL,SM PC, CI	1	3													
												BD,UN,SM SA, CI	2	2													
				79.42																						
		END OF DRILLHOLE		9.65																						
10																											
11																											
12																											

FEATURES LEGEND

BROKEN CORE; CLAY SEAM; LIMESTONE; LOST CORE

DEPTH SCALE

1 : 50

GOLDER

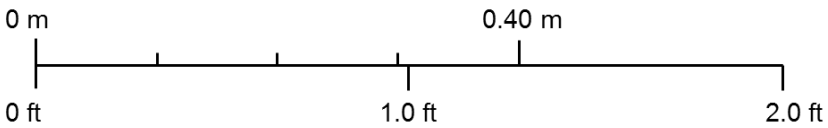
LOGGED: JL

CHECKED: AKV

GTA-RCK 054 S:\CLIENTS\MTO\CEW-CREDIT_RIVER\02_DATA\GINT\CEW-CREDIT_RIVER.GPJ GAL-MISS.GDT 11/15/18

Box 1: 3.00 m to 6.66 m

Box 2: 6.66 m to 9.65 m



Scale

PROJECT

EAST-WEST ACTIVE TRANSPORT PEDESTRIAN BRIDGE ALONG CREDIT BRIDGE

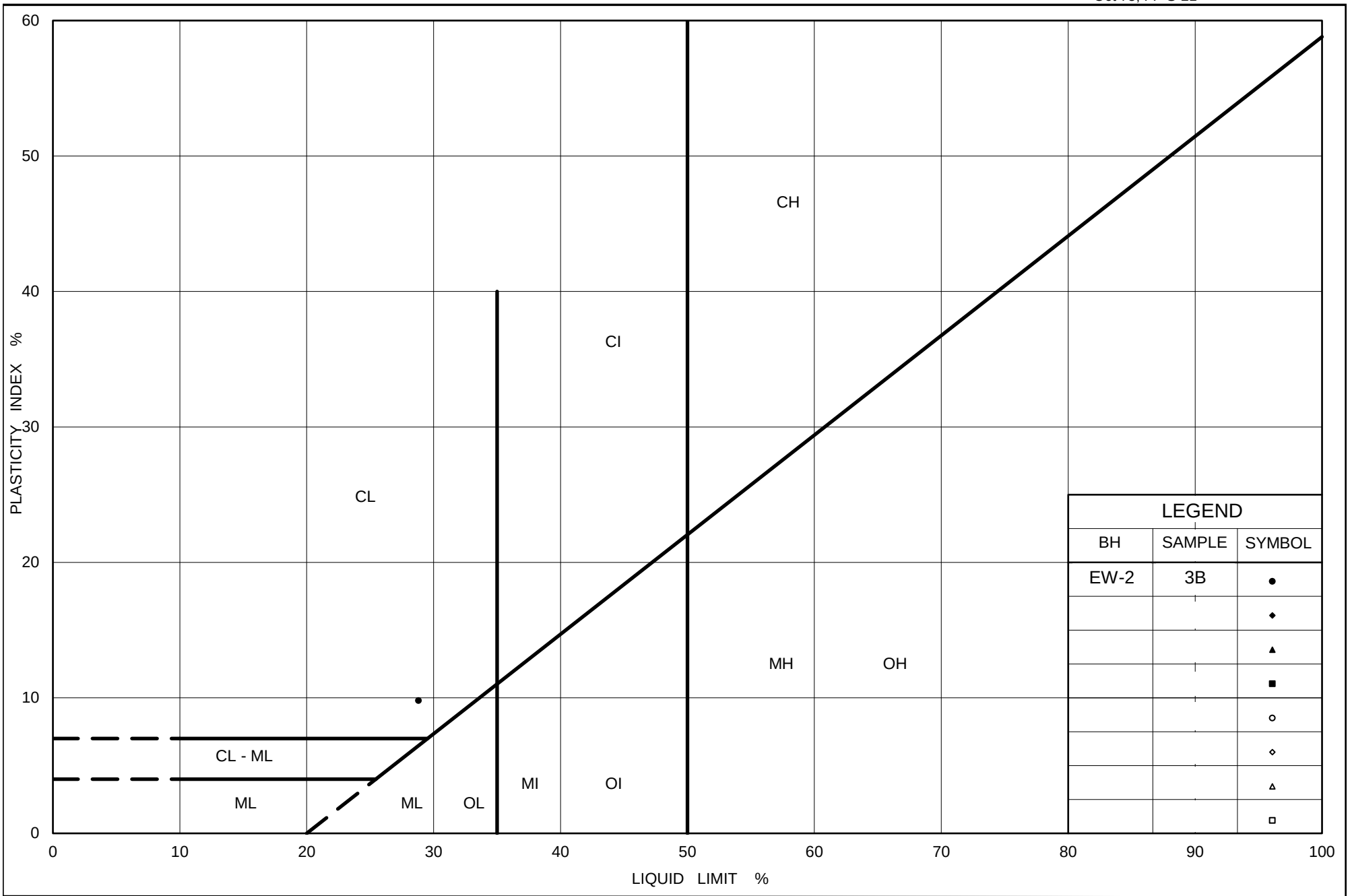
TITLE

Bedrock Core Photographs
Borehole EW-2 (3.00 m to 9.65 m)

GOLDER

PROJECT No. 1 2333			FILE No. ----		
DRAFT	SK	20180628	SCALE	NTS	VER. 1.
CADD	--		**FIGURE**		
CHECK	SMM				
REVIEW	JMAC	20181108			

REVISION DATE: January 23, 2018 BY: DCB Project: 1530382



Ministry of Transportation

Ontario

PLASTICITY CHART
Gravelly CLAYEY SILT with Sand (TILL)

Figure No.

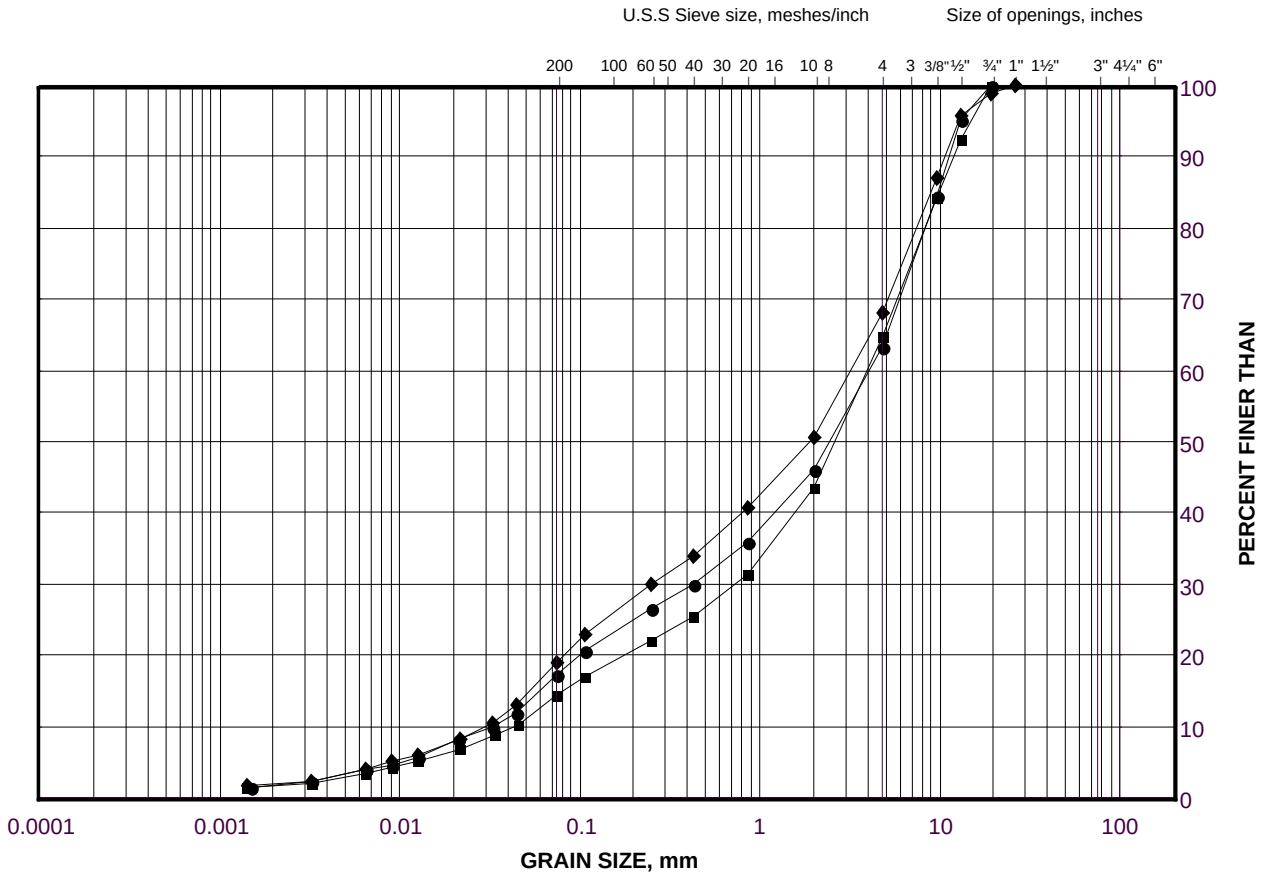
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sand and Gravel (FILL)

FIGURE



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	EW-1	2	87.5
■	EW-2	2A	88.2
◆	EW-1	4	85.9

Project Number: 1662333

Checked By: SMM

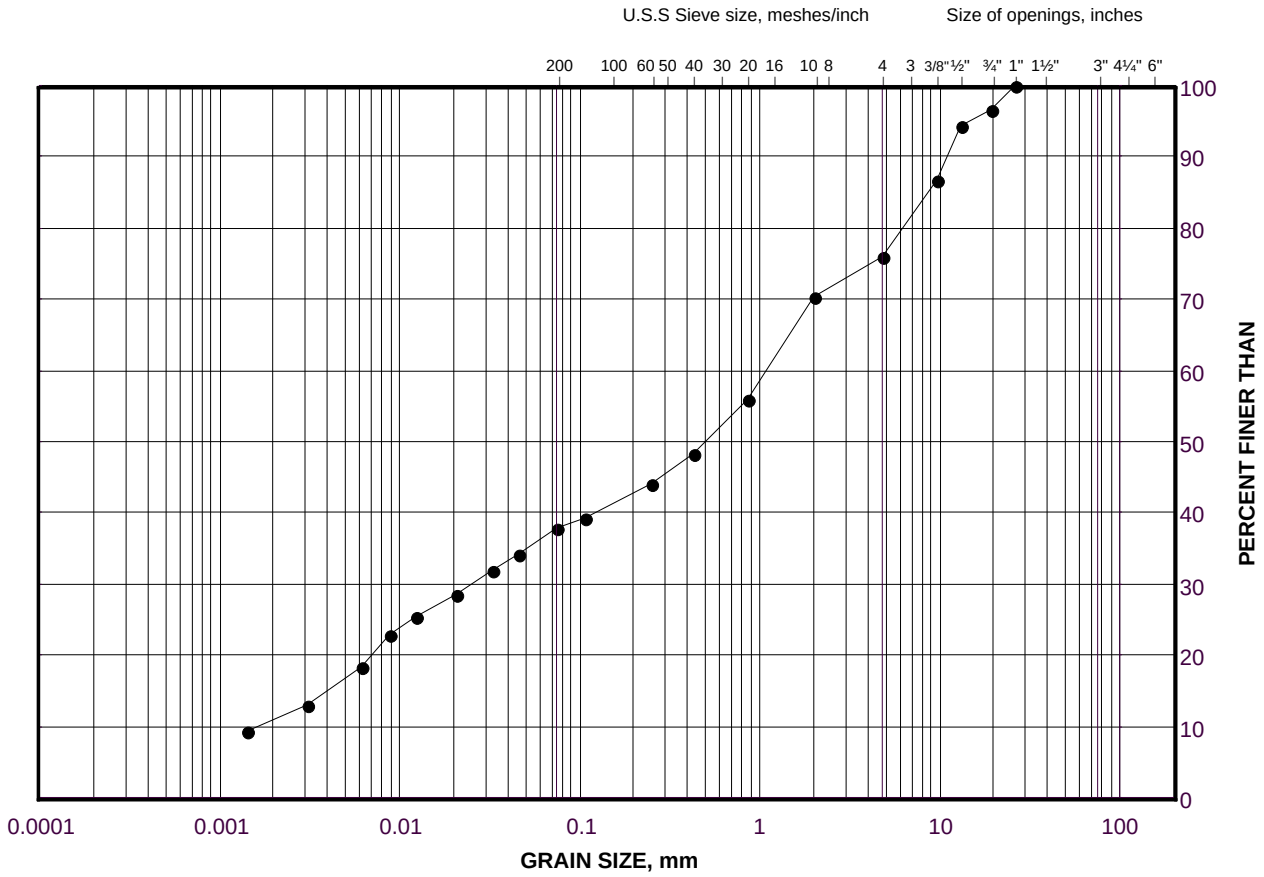
Golder Associates

Date: 25-Jun-18

GRAIN SIZE DISTRIBUTION

Gravelly Clayey Silt with Sand (TILL)

FIGURE



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	EW-2	3B	87.1

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 25-Jun-18

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

June 05, 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)

Dear Mr. Marmor:

On May 22, 2018 two (2) 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. A uniaxial compressive strength (UCS) specimen was prepared and tested from each of these samples (2 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,

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
info@geomechanica.com

June 5, 2018
Project number: 1662333

Abstract

This document summarizes the results of rock laboratory testing of 2 uniaxial compression tests. Results, including uniaxial compressive strength (UCS) and Young's modulus along with photographs of samples before and after testing are presented. Additional specimen information is included in an accompaning summary spreadsheet.

In this document:

Disclaimer: This report was prepared by Geomechanica Inc. for Golder Associates Ltd.. The material herein reflects Geomechanica Inc.'s best judgment given the information available at the time of preparation. Any use which a third party makes of this report, any reliance on or decision to be made based on it, are the responsibility of such third parties. Geomechanica Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

1 Uniaxial Compressive Strength (UCS) testing

This report summarizes the results of 2 uniaxial compression tests. 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 0.15 mm/min for shale and inter-bedded limestone/shale and 0.075 mm/min for limestone samples (Figure 1).

The specimen preparation and testing procedure 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 samples to obtain cylindrical specimens with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding of specimens 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. Axial loading to rupture while continuously recording axial force and axial deformation to determine the peak strength (UCS) and (tangent) Young's modulus (E).

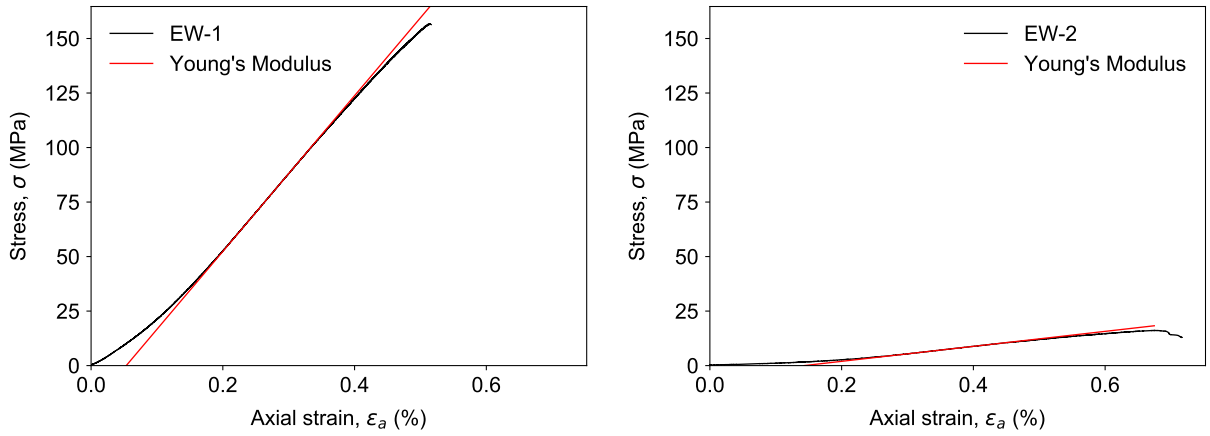
Figure 1: UCS test setup.

1.1 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 ±300 data points on either side of the point representing 50.0% of the peak strength. Additional specimen information is included in the accompaning summary spreadsheet.

Table 1: Summary of laboratory test results.

Sample	Depth (m)	Lithology description	Bulk density ρ (g/cm^3)	UCS (MPa)	Young's Modulus E (GPa)	Failure description
EW-1	7.26 - 7.43	Limestone	2.66	156.8	35.7	Axial splitting
EW-2	4.89 - 5.09	Inter-bedded shale & limestone	2.62	16.1	3.4	Axial splitting



(a) EW-1 - Limestone

(b) EW-2 - Inter-bedded shale/limestone

Figure 2: Measured stress-strain curves.

1.2 Specimen photographs

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

Figure 3: Photographs of specimens before and after testing.

Maxxam
A Bureau Veritas Group Company

Your Project #: 1662333
Site Location: QEW/CREDIT
Your C.O.C. #: 655260-05-01

Attention: Sandra McGaghran

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

Report Date: 2018/05/30
Report #: R5183725
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8C0582
Received: 2018/05/22, 19:45

Sample Matrix: ROCK
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	2	N/A	2018/05/29	CAM SOP-00463	EPA 325.2 m
Conductivity	2	N/A	2018/05/29	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	2	2018/05/29	2018/05/29	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	2	2018/05/23	2018/05/29	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	2	N/A	2018/05/29	CAM SOP-00464	EPA 375.4 m

Remarks:

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

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: 1662333
Site Location: QEW/CREDIT
Your C.O.C. #: 655260-05-01

Attention: Sandra McGaghran

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

Report Date: 2018/05/30
Report #: R5183725
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CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8C0582
Received: 2018/05/22, 19:45

Encryption Key

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

==========

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

Maxxam Job #: B8C0582
Report Date: 2018/05/30

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

RESULTS OF ANALYSES OF ROCK

Maxxam ID		GTG829	GTG830			GTG830		
Sampling Date		2018/05/01	2018/05/02			2018/05/02		
COC Number		655260-05-01	655260-05-01			655260-05-01		
	UNITS	EW1-R3-7.20 TO 7.26	EW2-R1-3.38 TO 3.51	RDL	QC Batch	EW2-R1-3.38 TO 3.51 Lab-Dup	RDL	QC Batch
Calculated Parameters								
Resistivity	ohm-cm	1800	1300		5543388			
Inorganics								
Soluble (20:1) Chloride (Cl)	ug/g	110	130	20	5550731			
Conductivity	umho/cm	561	794	2	5552520	870	2	5552520
Available (CaCl2) pH	pH	8.28	8.00		5552937			
Soluble (20:1) Sulphate (SO4)	ug/g	250	630	20	5550732	630	20	5550732

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 #: B8C0582
Report Date: 2018/05/30

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

TEST SUMMARY

Maxxam ID: GTG829
Sample ID: EW1-R3-7.20 TO 7.26
Matrix: ROCK

Collected: 2018/05/01
Shipped:
Received: 2018/05/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5550731	N/A	2018/05/29	Deonarine Ramnarine
Conductivity	AT	5552520	N/A	2018/05/29	Tahir Anwar
pH CaCl2 EXTRACT	AT	5552937	2018/05/29	2018/05/29	Gnana Thomas
Resistivity of Soil		5543388	2018/05/29	2018/05/29	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5550732	N/A	2018/05/29	Alina Dobreanu

Maxxam ID: GTG830
Sample ID: EW2-R1-3.38 TO 3.51
Matrix: ROCK

Collected: 2018/05/02
Shipped:
Received: 2018/05/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5550731	N/A	2018/05/29	Deonarine Ramnarine
Conductivity	AT	5552520	N/A	2018/05/29	Tahir Anwar
pH CaCl2 EXTRACT	AT	5552937	2018/05/29	2018/05/29	Gnana Thomas
Resistivity of Soil		5543388	2018/05/29	2018/05/29	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5550732	N/A	2018/05/29	Alina Dobreanu

Maxxam ID: GTG830 Dup
Sample ID: EW2-R1-3.38 TO 3.51
Matrix: ROCK

Collected: 2018/05/02
Shipped:
Received: 2018/05/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5552520	N/A	2018/05/29	Tahir Anwar
Sulphate (20:1 Extract)	KONE/EC	5550732	N/A	2018/05/29	Alina Dobreanu

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 #: B8C0582
Report Date: 2018/05/30

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

GENERAL COMMENTS

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

Package 1	8.7°C

Results relate only to the items tested.

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Maxxam Job #: B8C0582
Report Date: 2018/05/30

QUALITY ASSURANCE REPORT

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

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5550731	Soluble (20:1) Chloride (Cl)	2018/05/29	NC	70 - 130	108	70 - 130	<20	ug/g	3.1	35
5550732	Soluble (20:1) Sulphate (SO4)	2018/05/29	NC	70 - 130	99	70 - 130	<20	ug/g	0.89	35
5552520	Conductivity	2018/05/29			100	90 - 110	<2	umho/cm	9.2	10
5552937	Available (CaCl2) pH	2018/05/29			100	97 - 103			0.39	N/A

N/A = Not Applicable

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

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

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

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

NC (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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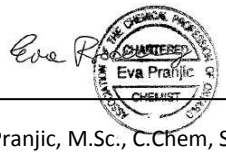
Maxxam Job #: B8C0582
Report Date: 2018/05/30

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

VALIDATION SIGNATURE PAGE

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



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

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

CHAIN OF CUSTODY RECORD

Page 1 of 1

IMMEDIATE

REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name: #1326 Golder Associates Ltd	Company Name: Golder Associates	Quotation #: B80683		Maxxam Job #:	Bottle Order #: 655260
Attention: Accounts Payable	Attention: Sandra Megaghran	P.O. #:			
Address: 6925 Century Ave Suite 100	Address:	Project: ~~1674130 WO#9~~ 16623333			
Mississauga ON L5N 7K2		Project Name: QEW / CREDIT		COC #: C#655260-05-01	Project Manager: Ema Gitej
Tel: (905) 567-4444 x Fax: (905) 567-6561 x	Tel: Fax:	Site #:			
Email: AP_CustomerService@golder.com	Email: Sandra_Megaghran@golder.com	Sampled By: JL			

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	☐ CCME ☐ Sanitary Sewer Bylaw	
☐ Table 2 ☐ Ind/Comm ☐ Coarse	☐ Reg 558 ☐ Storm Sewer Bylaw	
☐ Table 3 ☐ Agr/Other ☐ For RSC	☐ MISA Municipality	
☐ Table ___	☐ PWQO	
	☐ Other	

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

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~~ Date	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Standard Corrosivity pkg (No Sulphide and Redox Potential)	# of Bottles	Comments
1		EW1-R3-7.20 to 7.26	2018/05/01	ROCK			X	1	Sample in Bag
2		EW2-R1-3.38 to 3.51	2018/05/02	ROCK			X	1	Sample in Bag
3									
4									
5									
6									
7									
8									
9									
10									

22-May-18 19:45
Ema Gitej
B8C0582
GK1 ENV-632

RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Kate Mc	18/05/22	7:45 PM	[illegible]	180522	19:45	

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal Present	Yes	No
	7/10/9	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

Geotechnical Investigation, Proposed Pipeline Installations, Crossings of Credit River Pro ect No. 1 0950937 Queen Eli abeth Way Credit River Mississauga, ON" Document No. TA -C-GEO-002, dated December 18, 2018, prepared by Stantec Consulting Ltd.

Record of Borehole BH3

Stantec

RECORD OF BOREHOLE No BH3

1 OF 4

METRIC

PROJECT # 160950937 PROJECT ESA Drilling Credit River & QEW

W.P. LOCATION Credit River and QEW, Mississauga, ON N: 4 823 506 E: 612 222 ORIGINATED BY RB

DIST HWY BOREHOLE TYPE ollow Stem Auger COMPILED BY DR

DATUM Geodetic DATE November 13, 2017 CHECKED BY JJB

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 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
75.8	Grass										
	Sandy CLAY (CL) Brown Very soft to soft - moist to wet		1	SS	4		75				
			2	SS	4						
			3	SS	3		74		42		
73.5											
2.3	Grey - wet		4	SS	0		73				1 30 48 21
72.8											
3.0	Silty Gravel with Sand (GM) Grey Compact - trace clay - wet		5	SS	14		72				
			6	SS	16						
			7	SS	29		71				
			8	SS	16		70				40 37 14 9
			9	SS	14		69				
68.6											
7.2	Inferred BEDROCK (Georgian Bay Formation) Grey - highly to completely weathered shale (soil-like consistency)		1	HQ	100/ 100/		68				TCR=89% SCR=56% RQD=0%
67.8											
8.0	SHALE with limestone interbedding (Georgian Bay Formation) Dark grey shale with light grey limestone interbedding - very poor quality - moderately weathered - occassional clay seams up to 25mm		2	HQ	100/		67				TCR=95% SCR=86% RQD=19%
65.8							66				

Continued Next Page

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

STN13-ONTARIO MTO STANTEC 160950937.GPJ STANTEC_MARKHAM_DATA_TEMPLATE_2015-05-20.GDT 1/30/19

Stantec

RECORD OF BOREHOLE No BH3

2 OF 4 **METRIC**

PROJECT # 160950937 PROJECT ESA Drilling Credit River & QEW

W.P. LOCATION Credit River and QEW, Mississauga, ON N: 4 823 506 E: 612 222 ORIGINATED BY RB

DIST HWY BOREHOLE TYPE ollow Stem Auger COMPILED BY DR

DATUM Geodetic DATE November 13, 2017 CHECKED BY JJB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ✖ FIELD VANE ● QUICK TRIAXIAL × LAB VANE 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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
10.0	SHALE with limestone interbedding (Georgian Bay Formation) Dark grey shale with light grey limestone interbedding - poor to good quality - freshly to moderately weathered - occassional clay seams up to 25mm		3	HQ	100/		65				TCR=100% SCR=91% RQD=48%
			4	HQ	100/		64				TCR=99% SCR=96% RQD=84%
			5	HQ	100/		63				TCR=98% SCR=98% RQD=80%
			6	HQ	100/		62				
			7	HQ	100/		61				TCR=95% SCR=82% RQD=57%
			8	HQ	100/		60				TCR=99% SCR=93% RQD=25%
			9	HQ	100/		59				TCR=93% SCR=78% RQD=49%
55.8							58				TCR=99% SCR=98% RQD=77%
							57				
							56				

Continued Next Page

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

STN13-ONTARIO MTO STANTEC 160950937.GPJ STANTEC_MARKHAM_DATA_TEMPLATE_2015-05-20.GDT 1/30/19

Stantec

RECORD OF BOREHOLE No BH3

3 OF 4

METRIC

PROJECT # 160950937 PROJECT ESA Drilling Credit River & QEW

W.P. LOCATION Credit River and QEW, Mississauga, ON N: 4 823 506 E: 612 222 ORIGINATED BY RB

DIST HWY BOREHOLE TYPE ollow Stem Auger COMPILED BY DR

DATUM Geodetic DATE November 13, 2017 CHECKED BY JJB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ✖ FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
20.0	SHALE with limestone interbedding (Georgian Bay Formation) Dark grey shale with light grey limestone interbedding - very poor to excellent quality - freshly to slightly weathered - occassional clay seams										
			10	HQ	100/		55				TCR=98% SCR=97% RQD=82%
			11	HQ	100/		54				TCR=100% SCR=98% RQD=21%
			12	HQ	100/		53				TCR=100% SCR=100% RQD=91%
			13	HQ	100/		52				TCR=100% SCR=95% RQD=68%
			14	HQ	100/		51				TCR=100% SCR=100% RQD=93%
			15	HQ	100/		50				TCR=100% SCR=100% RQD=94%
							49				
							48				
							47				
45.8							46				

Continued Next Page

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

STN13-ONTARIO MTO STANTEC 160950937.GPJ STANTEC_MARKHAM_DATA_TEMPLATE_2015-05-20.GDT 1/30/19

Stantec

RECORD OF BOREHOLE No BH3

4 OF 4 **METRIC**

PROJECT # 160950937 PROJECT ESA Drilling Credit River & QEW

W.P. LOCATION Credit River and QEW, Mississauga, ON N: 4 823 506 E: 612 222 ORIGINATED BY RB

DIST HWY BOREHOLE TYPE ollow Stem Auger COMPILED BY DR

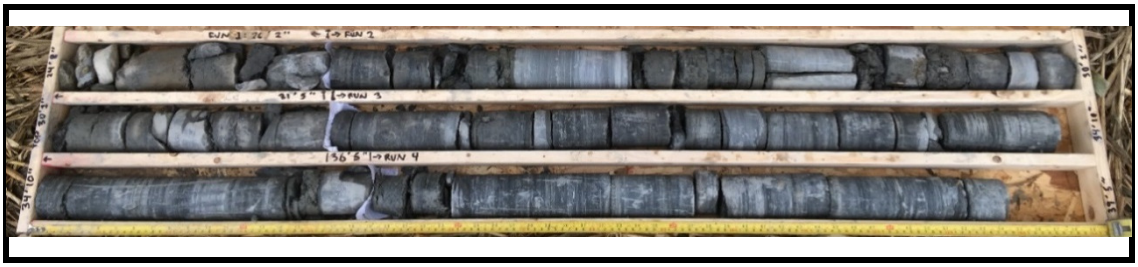
DATUM Geodetic DATE November 13, 2017 CHECKED BY JJB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
30.0	SHALE with limestone interbedding (Georgian Bay Formation) Dark grey shale with light grey limestone interbedding - good quality - freshly weathered		16	HQ	100/		45				TCR=99% SCR=96% RQD=77%
44.9											
30.9	END OF BOREHOLE at approximately 30.9 m below existing grade. Groundwater level not measured in open borehole due to the introduction of water for rock coring.										

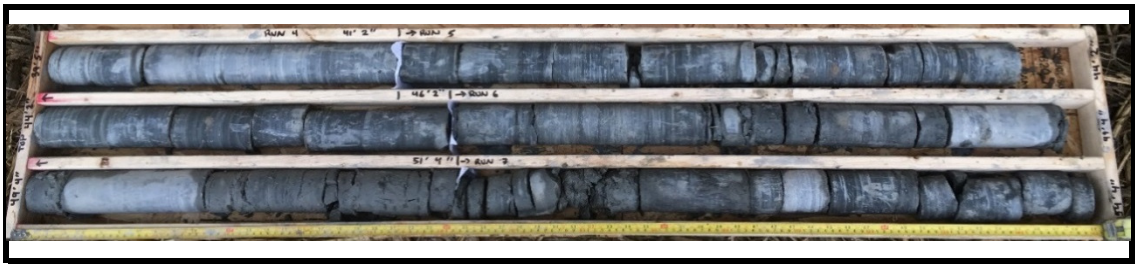
✖³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

STN13-ONTARIO MTO STANTEC 160950937.GPJ STANTEC_MARKHAM_DATA_TEMPLATE_2015-05-20.GDT 1/30/19

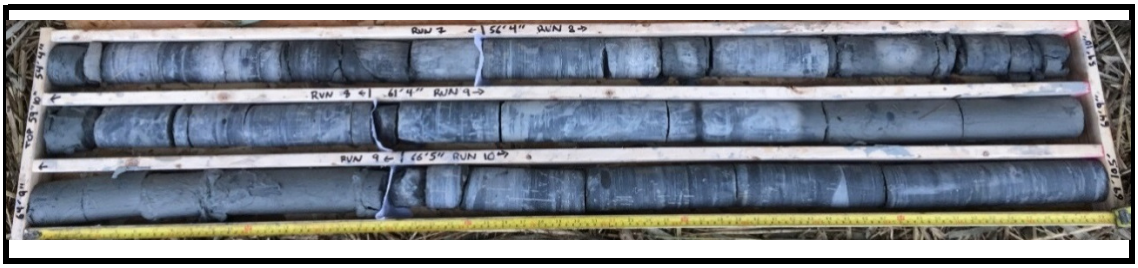
Project:	ESA Drilling Credit River & QEW			
Project Number:	160950937			
Location:	Mississauga, ON			
Borehole:	BH3	**Depth (m):**	7.52 - 30.94	



7.52m	RUN 1	RUN 2	9.17m
9.17m	RUN 2	RUN 3	10.62m
10.62m	RUN 3	RUN 4	12.01m

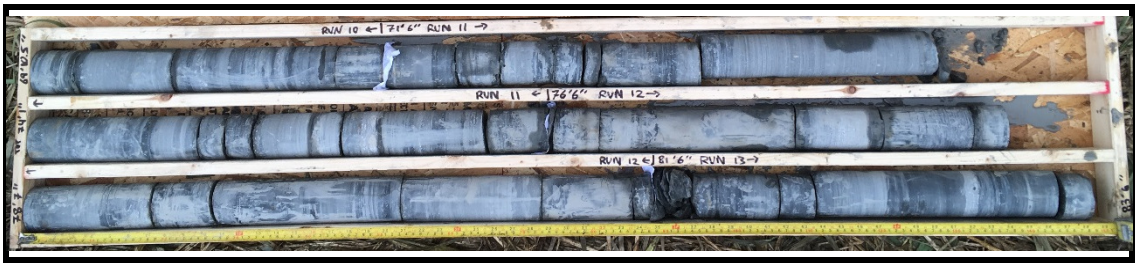


12.01m	RUN 4	RUN 5	13.46m
13.46m	RUN 5	RUN 6	15.04m
15.04m	RUN 6	RUN 7	16.56m

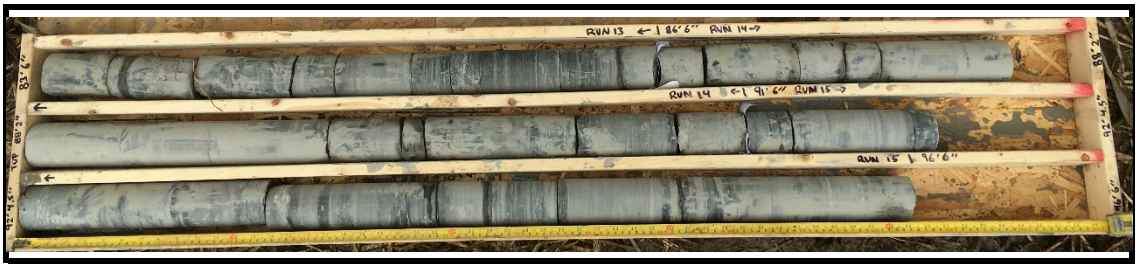


16.56m	RUN 7	RUN 8	18.24m
18.24m	RUN 8	RUN 9	19.74m
19.74m	RUN 9	RUN 10	21.30m

Project:	ESA Drilling Credit River & QEW			
Project Number:	160950937			
Location:	Mississauga, ON			
Borehole:	BH3	**Depth (m):**	7.52 - 30.94	

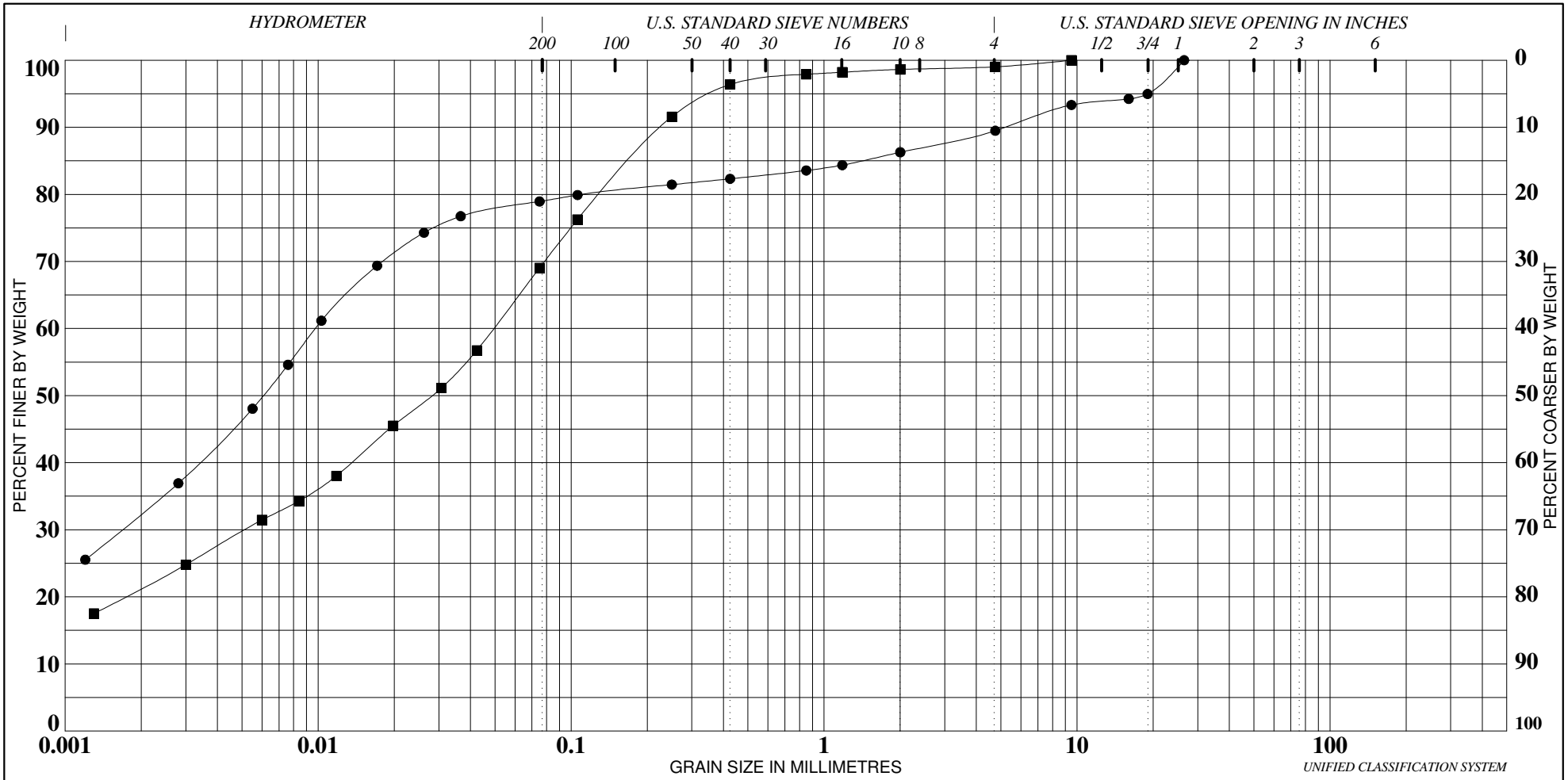


21.30m	RUN 10 → RUN 11	22.58m
22.58m	RUN 11 → RUN 12	23.95m
23.95m	RUN 12 → RUN 13	25.45m



25.45m	RUN 13 → RUN 14	26.87m
26.87m	RUN 14 → RUN 15	28.16m
28.16	RUN 15 →	29.42m

29.42m	RUN 16 →	30.94m



SILT & CLAY		SAND			GRAVEL		COBBLES	BLDs
CLAY	SILT	fine	medium	coarse	fine	coarse		

Sample	Depth (m)	Description	W%	W_L	W_P	I_P	%Gravel	%Sand	%Silt	%Clay
● BH2	1.1	Clay with gravel (CL)	12	37	22	15	11	10	47	32
■ BH3	2.6	Sandy CLAY (CL)	31	32	18	14	1	30	48	21

Stantec

Project: ESA Drilling Credit River & QEW

Location: Credit River and QEW, Mississauga, ON

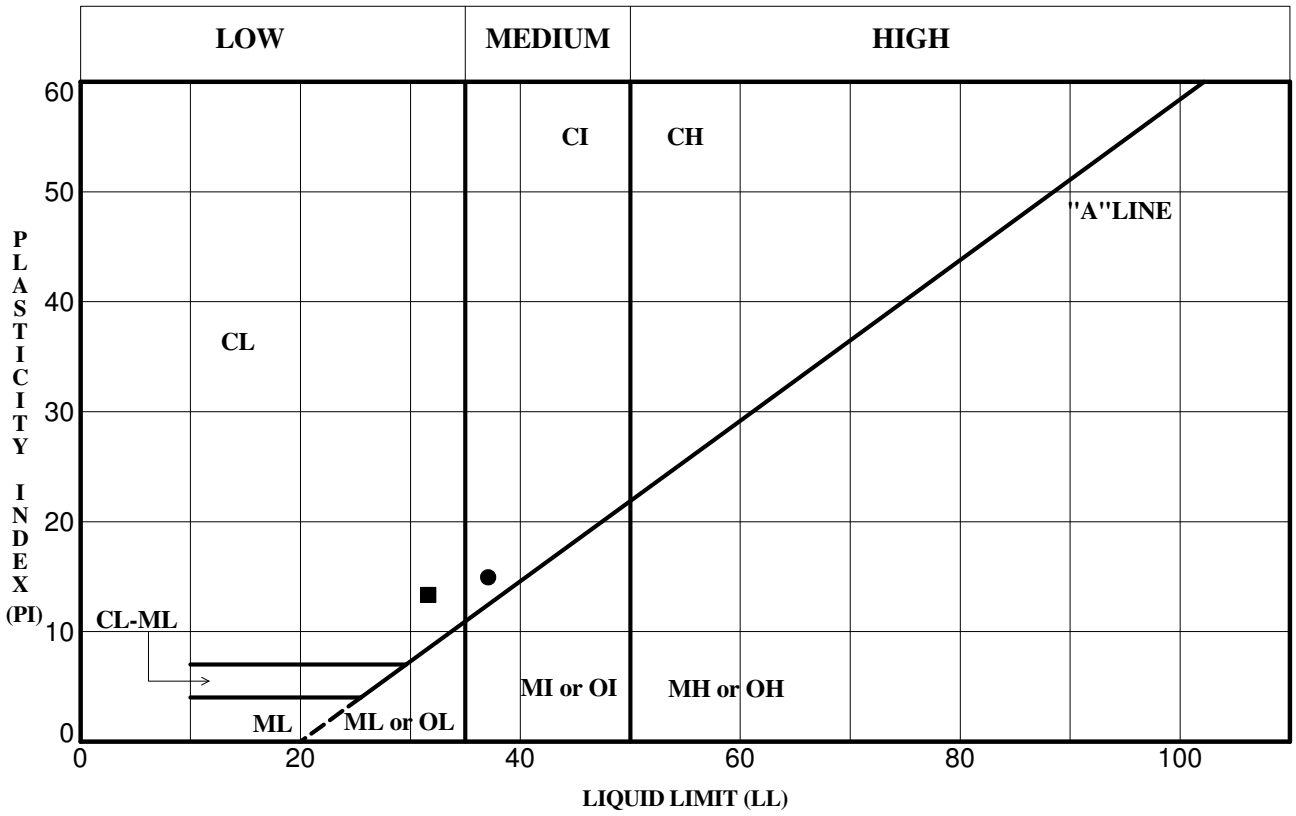
Project No.: 160950937

GRADATION CURVE (ASTM D422)

Figure: 1

Remarks:

PLASTICITY CHART



	Specimen	Depth (m)	LL	PL	PI	Fines	W%	Classification
●	BH2	1.1	37	22	15	79	12	Clay with gravel (CL)
■	BH3	2.6	32	18	14	69	31	Sandy CLAY (CL)

Stantec

Project: ESA Drilling Credit River & QEW

Location: Credit River and QEW, Mississauga, ON

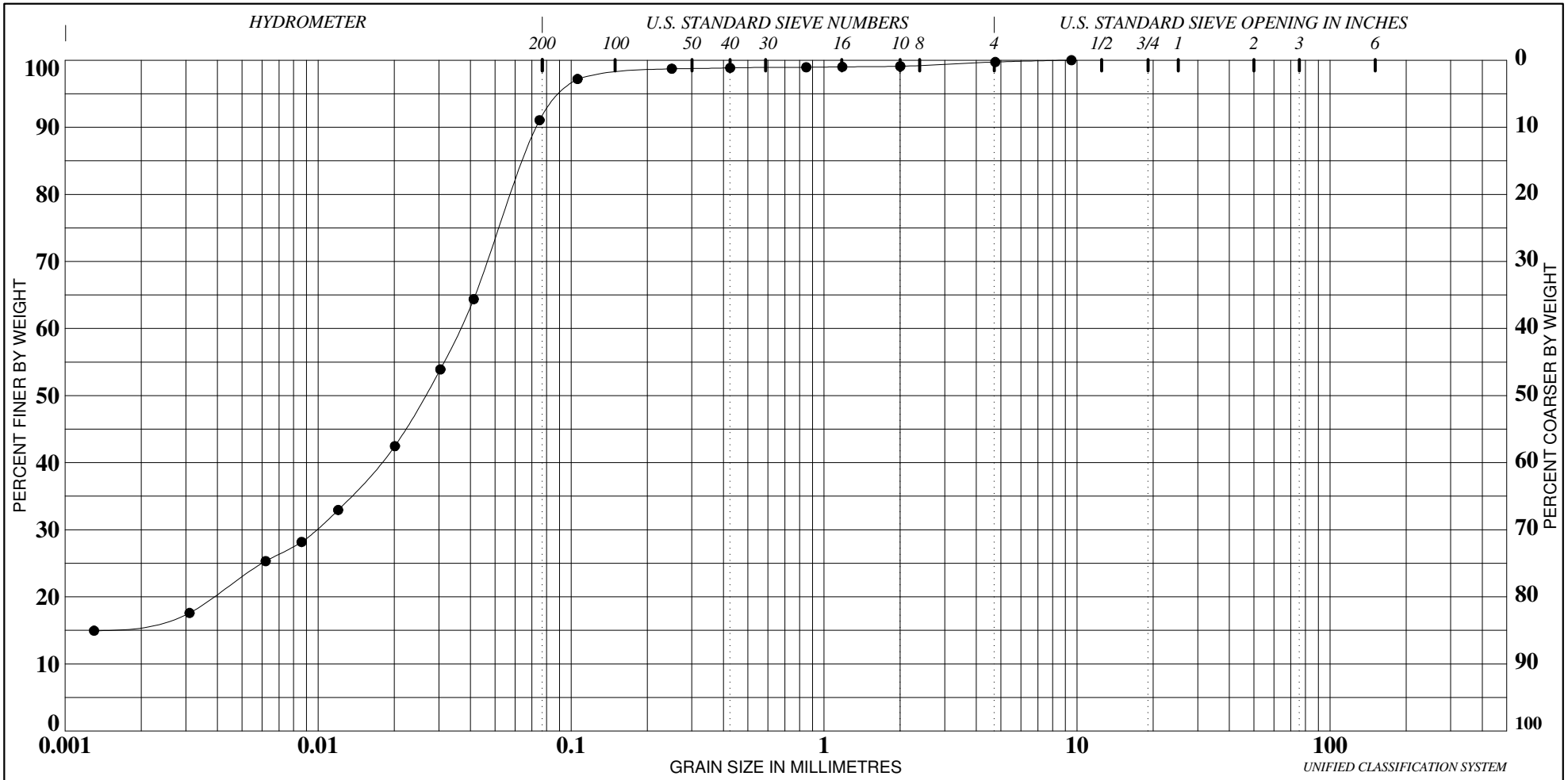
Project No.: 160950937

ATTERBERG LIMITS
(ASTM D4318)

Figure: 2

Remarks:

STN13-ATTERBERG MTO 160950937 MTO.GPJ MM.GDT 5/11/18



SILT & CLAY		SAND			GRAVEL		COBBLES	BLDs
CLAY	SILT	fine	medium	coarse	fine	coarse		

Sample	Depth (m)	Description	W%	W_L	W_P	I_P	%Gravel	%Sand	%Silt	%Clay
● BH4	3.4	SILT (ML)	16				0	9	75	16

Stantec

Project: ESA Drilling Credit River & QEW

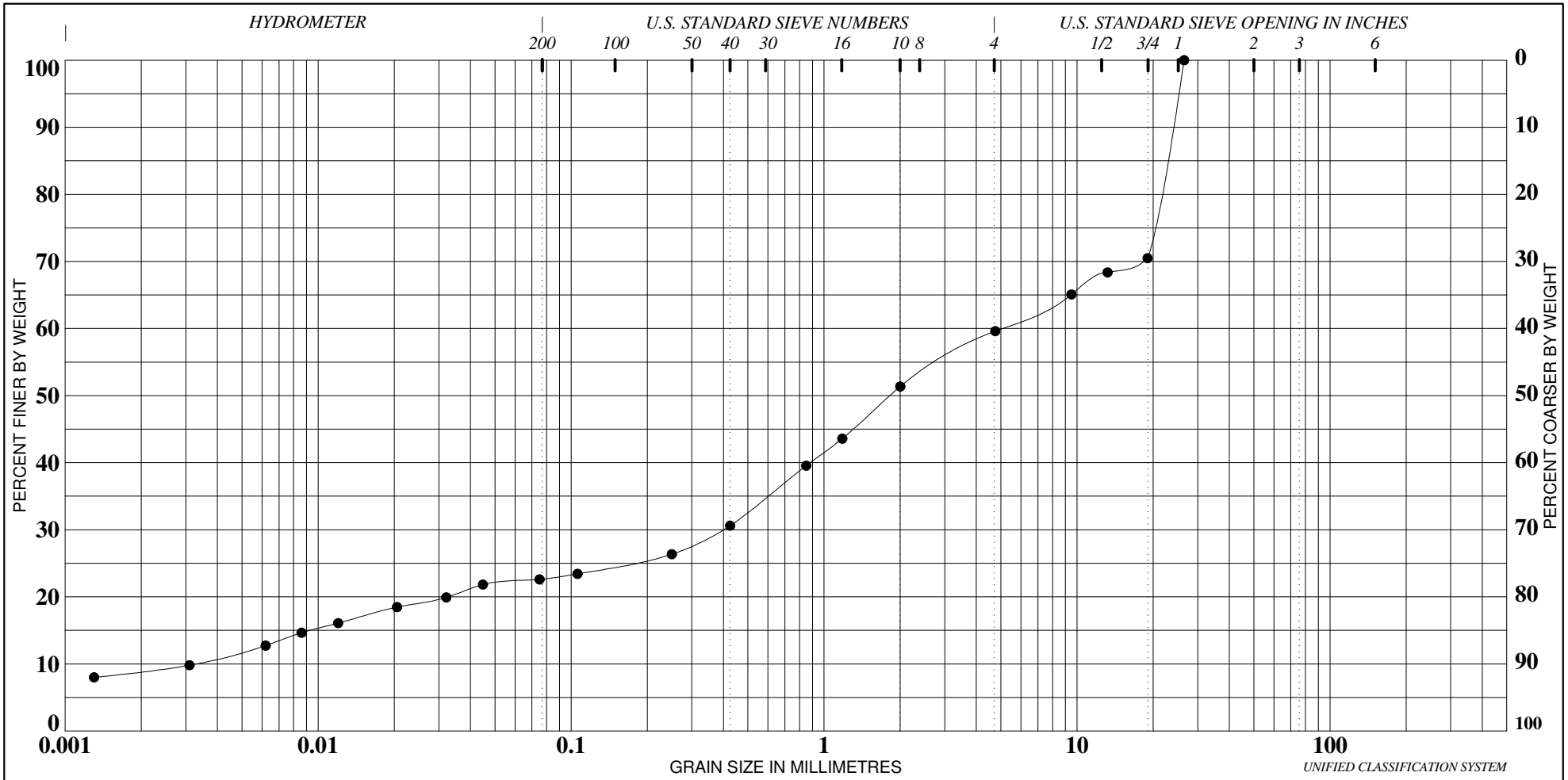
Location: Credit River and QEW, Mississauga, ON

Project No.: 160950937

GRADATION CURVE (ASTM D422)

Figure: 3

Remarks:



SILT & CLAY		SAND			GRAVEL		COBBLES	BLDs
CLAY	SILT	fine	medium	coarse	fine	coarse		

Sample	Depth (m)	Description	W%	W_L	W_P	I_P	%Gravel	%Sand	%Silt	%Clay
● BH3	5.6	Silty Gravel with Sand (GM)	13				40	37	14	9

Stantec

Project: ESA Drilling Credit River & QEW

Location: Credit River and QEW, Mississauga, ON

Project No.: 160950937

GRADATION CURVE (ASTM D422)

Figure: 4

Remarks:

Foundation Investigation and Design Report, Preliminary Design and Environmental Assessment, QEW Bridge Twinning Over Credit River, Mississauga, Ontario" File No. 19-1351-174, dated May 18, 2012 (GEOCRES 30M12-341)

Boreholes 11-01 and 11-02

Foundation Investigation and Design Report, Construction Access Road for Bridge Rehabilitation, QEW Bridge over Credit River, Mississauga, Ontario" File No. 19-92-92-174, dated April 8, 2011, prepared by Thurber Engineering Ltd. (GEOCRES 30M12-324).

Boreholes 10-03A, 10-03B and 10-04.

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[1] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS Split Spoon Sample WS Wash Sample AS Auger (Grab) Sample
TW Thin Wall Shelby Tube Sample TP Thin Wall Piston Sample
PH Sampler Advanced by Hydraulic Pressure PM Sampler Advanced by Manual Pressure
WH Sampler Advanced by Self Static Weight RC Rock Core SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

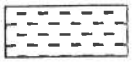
EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

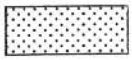
Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS

CLAYSTONE



SILTSTONE



SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	**Approximate Uniaxial Compressive Strength (MPa)**	**(psi)**	**Field Estimation of Hardness***
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 11-01 1 OF 1 METRIC

W.P. W.O. 08-20008 LOCATION N 4 823 959.1 E 295 814.8 QEW Bridge at Credit River ORIGINATED BY SLD

HWY QEW BOREHOLE TYPE Tripod (Hilti) - Wash Boring and Coring COMPILED BY AN

DATUM Geodetic DATE 2011.05.30 - 2011.06.02 CHECKED BY SKP

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.6											
0.0	**TOPSOIL**, with roots and organics:										
0.2	(200mm)		1	SS	4				○		
	Silty **CLAY**, trace sand Very Stiff Grey Moist						94				
			2	SS	21				⊢●		2 15 49 34
	trace shale fragments		3	SS	40/ 0.075				○		
			1	RUN			93				
			2	RUN							
			3	RUN							
			4	RUN			92				
			5	RUN							
			4	SS	50/ 0.075				○		
91.3							▼				
3.3	**SHALE**, weathered, grey										
91.0							91				
3.6	END OF SPT SAMPLING TO 3.6m AND START CORING. FOR ROCK DETAILS PLEASE REFER TO 11-01R. Piezometer installation consists of 38mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.30/11 3.2 91.4										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 1174.GPJ 5/18/12

RECORD OF BOREHOLE 11-01R

PROJECT : QEW Mississauga Rd. Overpass
LOCATION : Mississauga, ON
STARTED : May 30, 2011
COMPLETED : June 2, 2011

INCLINATION: Vertical AZIMUTH:

Project No. W.O. 08-20008

SHEET 1 OF 1
DATUM Geodetic

FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN
F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED
SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR
FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED

DEPTH SCALE (metres)	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 3 m	DISCONTINUITY DATA DIP wrt Core Axis	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	25 Unconfined 50 Compressive Strength 75 (MPa)	FIELD/LABORATORY TESTING RESULTS
				91.0												
	RUN	**SHALE**, slightly to moderately weathered, fine grained, thinly bedded, grey, with limestone interbeds		3.6	1		100									
4	RUN				2		100									
	RUN	20mm clay seam at 3.7m 30mm clay seam at 3.76m			3		90									
	RUN	10mm clay seams at 3.8m, 3.9m, 4.0m and 4.2m			4		100									
	RUN	Frequent clay seams (20mm to 100mm) from 4.3m to 5.0m 350mm clay seam at 5.0m 200mm rubble zone at 5.4m			5		100									
	RUN	Clay seams (25mm to 75mm) at 5.5m, 5.6m, 5.7m, 5.9m, 6.0m			6		100									
6	RUN				7		100									
	RUN	Clay seams (25mm to 75mm) at 6.2m, 6.3m, 6.4m, 6.6m, 6.7m and 6.8m			8		100									
	RUN				9		100									
	RUN				10		100									
		END OF BOREHOLE AT 7.1m.		87.5 7.1												
8																
10																
12																

FIELD/LABORATORY TESTING RESULTS
- ● Point Load Test Diametral
- ▲ Point Load Test Axial
- ◙ Laboratory UCS Test

Bentonite Seal
89.24
Sand
88.94
Slotted Screen
87.44

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL (date)

▼ DEEP/DUAL INSTALLATION
WATER LEVEL (date)

LOGGED : SLD
CHECKED : SKP

ROCKM 1174.GPJ 5/17/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 11-02 1 OF 1 METRIC

W.P. W.O. 08-20008 LOCATION N 4 824 026.4 E 295 840.4 QEW Bridge at Credit River ORIGINATED BY SLD/ES

HWY QEW BOREHOLE TYPE Tripod (Hilti) - Wash Boring and Coring COMPILED BY AN

DATUM Geodetic DATE 2011.06.07 - 2011.06.09 CHECKED BY SKP

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 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.7 / 0.0	Clayey **SILT**, some sand, trace gravel, trace shale fragments Stiff to Very Stiff Brown Moist		1	SS	9*		75		o		
			2	SS	10*				o		0 27 55 18
			3	SS	12*	▼	74		o		
73.3 / 2.4	Frequent obstructions, inferred as cobbles and boulders		4	SS	5*				o		
			5	SS	37*		73		o		
72.2 / 3.5	**SAND**, trace to some gravel Brown						72				
71.9 / 3.8	Frequent obstructions, inferred as cobbles and boulders										
71.1 / 4.6							71				
70.5 / 5.2	Clayey **SILT**, some sand, trace gravel										
70.4 / 5.3	Frequent obstructions, inferred as cobbles and boulders Shale fragements						70				
69.4 / 6.3	END OF SAMPLING AT 6.3m AND START CORING. FOR ROCK DETAILS PLEASE REFER TO 11-02R. Piezometer installation consists of 31mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun.08/11 0.7 75.0 Oct.04/11 1.5 74.2										

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

$15 \oplus \frac{20}{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 1174.GPJ 5/18/12

RECORD OF BOREHOLE 11-02R

PROJECT : QEW Mississauga Rd. Overpass
LOCATION : Mississauga, ON
STARTED : June 7, 2011
COMPLETED : June 9, 2011

INCLINATION: Vertical AZIMUTH:

Project No. W.O. 08-20008

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR / % RETURN / FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER .3 m	DISCONTINUITY DATA: DIP wrt Core Axis	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	Unconfined Compressive Strength (MPa)	FIELD/LABORATORY TESTING RESULTS
				69.4												
8	NQ Coring RUN RUN RUN RUN	**SHALE**, highly weathered, fine grained, thinly bedded, with strong limestone interbeds 75mm clay seam at 6.5m 50mm sand seam at 6.7m Limestone interbed (up to 25mm thick) at 6.5m 125mm sand seam at 6.7m 50mm sand seam at 6.9m 50mm clay seam at 6.8m 50mm clay seam at 7.0m 50mm sand and gravel layer at 7.1m		6.3 67.3	1 2 3 4	0.006 0.008 0.01 0.008	10 0 0 0									Slotted Screen 68.42 Bentonite 67.36
10		END OF BOREHOLE AT 8.3m. NOTE: SAND BLEW BACK UP THE HOLE AT 7.0m.		8.4												
12																
14																
16																

FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN
F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED
SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR
FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED

FIELD/LABORATORY TESTING RESULTS
- ● Point Load Test Diametral
- ▲ Point Load Test Axial
- ■ Laboratory UCS Test

GROUNDWATER ELEVATIONS

▽ SHALLOW/SINGLE INSTALLATION
WATER LEVEL (date)

▼ DEEP/DUAL INSTALLATION
WATER LEVEL (date)

LOGGED : SLD
CHECKED : SKP

ROCKM 1174.GPJ 5/17/12

Appendix B

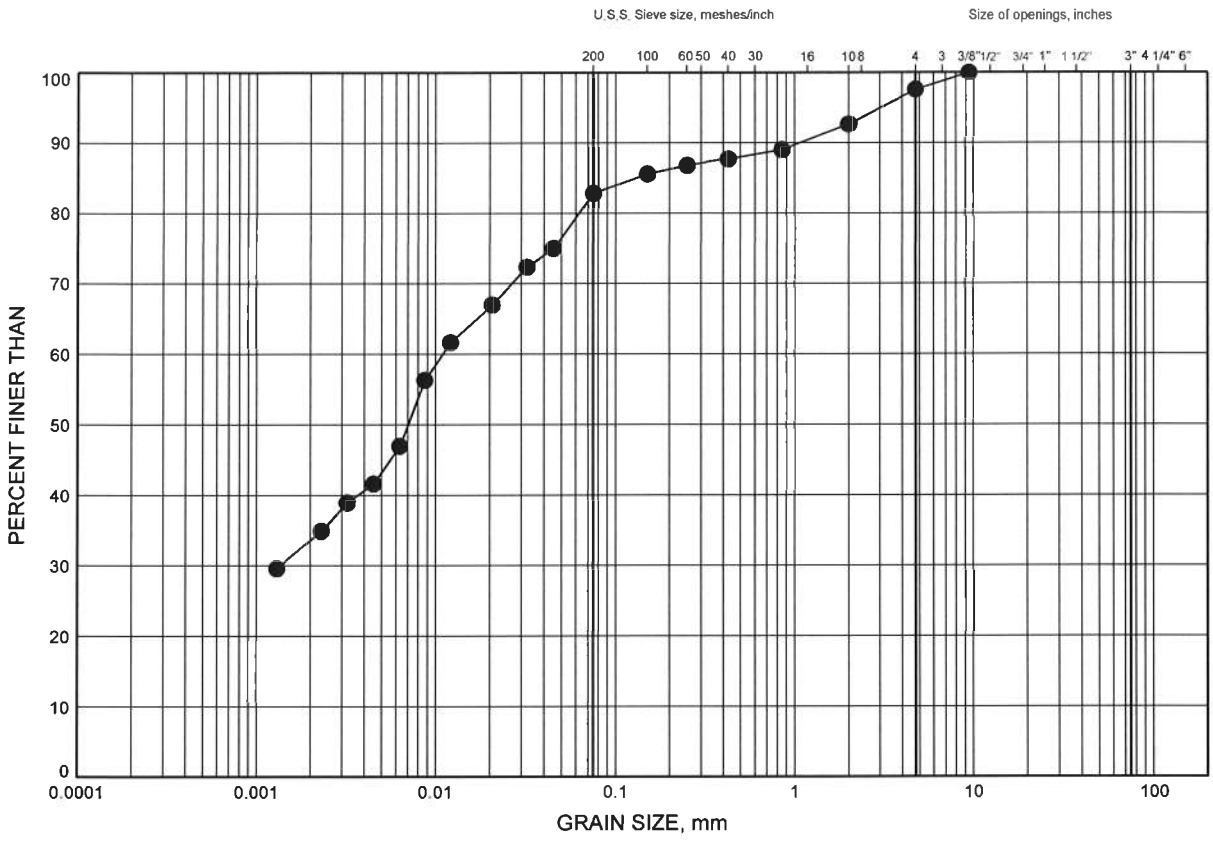
Laboratory Test Results

QEW Bridge at Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	11-01	1.07	93.50

Date May 2012

W.P.# W.O. 08-20008

THURBER

Prep'd MFA

Chkd. SKP

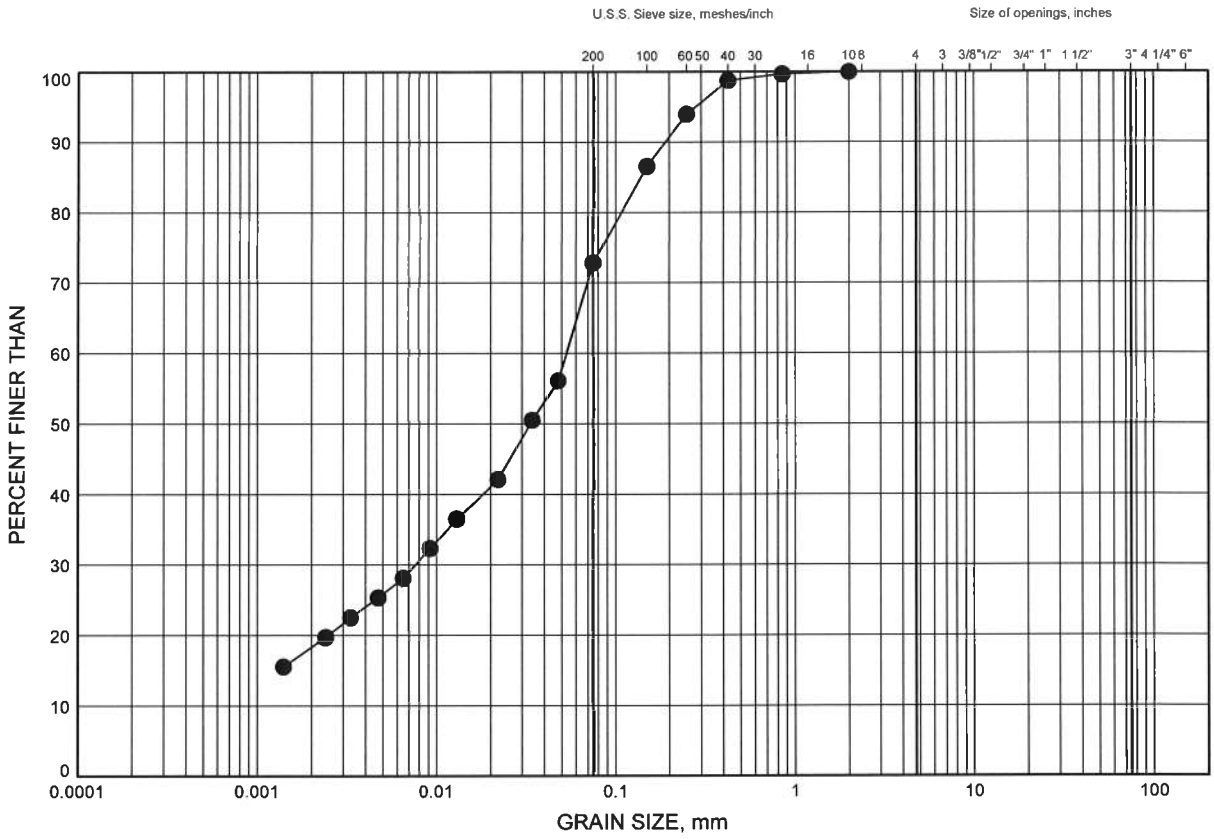
GRAIN SIZE DISTRIBUTION - THURBER 1174.GPJ 5/17/12

QEW Bridge at Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B2

CLAYEY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	11-02	0.91	74.83

Date May 2012

W.P.# W.O. 08-20008

THURBER

Prep'd MFA

Chkd. SKP

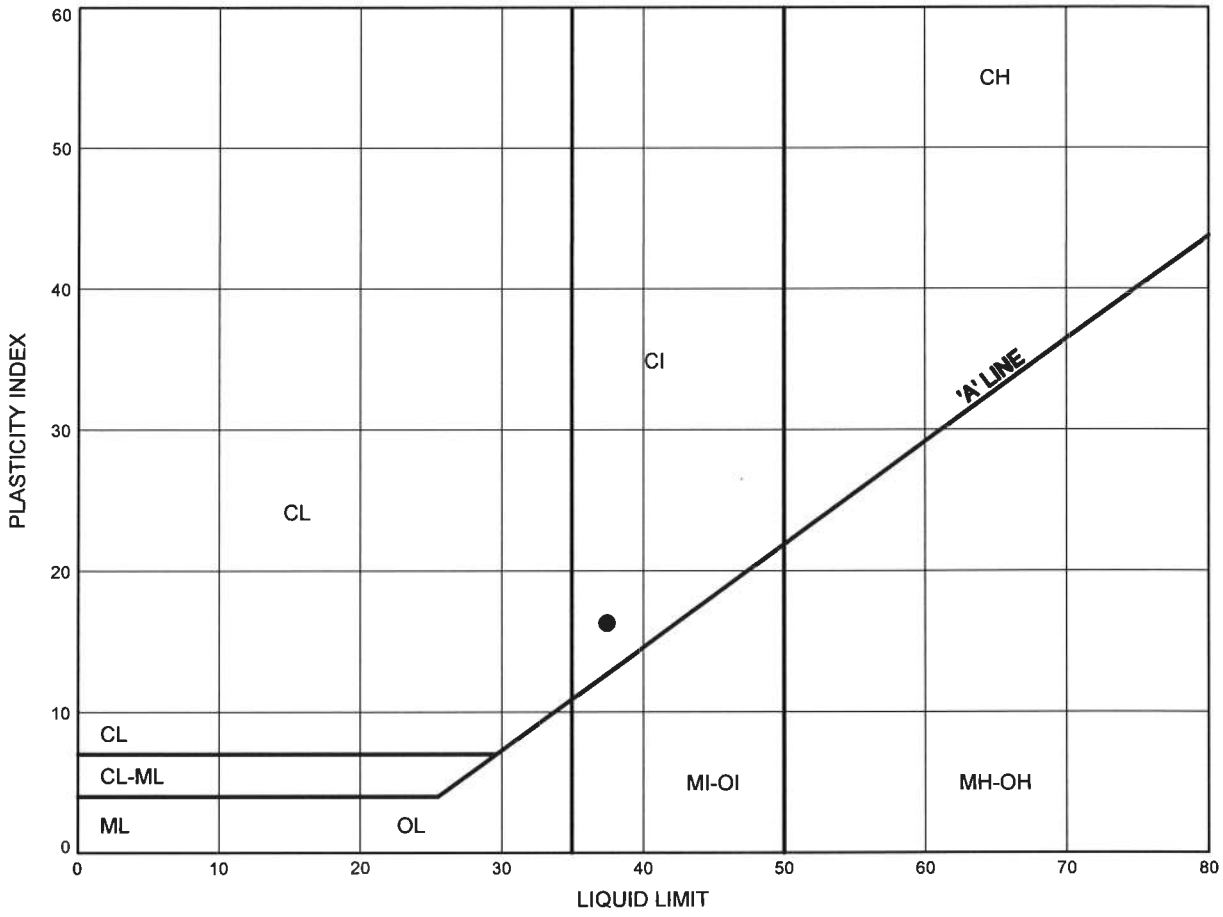
GRAIN SIZE DISTRIBUTION - THURBER 1174.GPJ 5/17/12

QEW Bridge at Credit River

ATTERBERG LIMITS TEST RESULTS

FIGURE B3

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	11-01	1.07	93.50

Date May 2012

W.P.# W.O. 08-20008

THURBER

Prep'd MFA

Chkd. SKP

THURBALT 1174.GPJ 5/17/12

TABLE 2 - Point Load and Unconfined Compressive Strength Test Results
Credit River Access Road

Run	Depth (m)	UCS (MPa)	Rock Type	Test
Borehole		**10-01**		
2	3.4	0.7	Shale	
2	3.6	0.6	Shale	
2	3.9	2.7	Shale	
2	4.4	3.4	Shale	
3	4.7	10.7	Shale	
3	5.1	3.0	Shale	
3	5.4	0.7	Shale	
3	5.7	6.8	Shale	
3	5.8	3.4	Shale	
3	6.2	3.4	Shale	
4	6.5	2.0	Shale	
4	6.9	0.7	Shale	
4	7.3	0.7	Shale	
4	7.6	4.8	Shale	
5	7.9	0.7	Shale	
5	8.3	2.7	Shale	
5	8.7	5.4	Shale	
5	8.9	2.9	Shale	
5	9.2	2.0	Shale	
6	9.6	9.4	Shale	
6	10.0	1.3	Shale	
6	10.2	6.8	Shale	
6	10.7	1.4	Shale	
7	11.0	4.8	Shale	
7	11.6	0.7	Shale	
7	11.7	3.4	Shale	
7	12.2	49.6	Limestone	
Borehole		**10-02**		
1	4.4	0.5	Shale	
1	4.4	0.5	Shale	
2	5.0	0.7	Shale	
2	5.0	0.5	Shale	
2	5.7	0.5	Shale	
2	6.0	0.5	Shale	
2	6.0	8.9	Shale	
3	6.4	1.7	Shale	
3	6.4	3.1	Shale	
3	6.9	4.1	Shale	
3	7.4	0.7	Shale	
3	7.4	8.6	Shale	

Total Rock Core

Rock Type	Shale	Limestone
Average (MPa)	3.3	49.6
Minimum (MPa)	0.6	
Maximum (MPa)	10.7	

Run #	Average (MPa)
2	1.9
3	4.7
4	2.0
5	2.8
6	4.7
7	14.6

Total Rock Core

Rock Type	Shale	Limestone	Shale/Limestone
Average (MPa)	4.2	109.5	26.6
Minimum (MPa)	0.5	95.2	5.1
Maximum (MPa)	13.8	120.4	48.1

Run #	Average (Mpa)
2	2.2
3	3.6
4	2.8
5	1.9
6	5.0
7	19.7

TABLE 2 - Point Load and Unconfined Compressive Strength Test Results
Credit River Access Road

Run	Depth (m)	UCS (MPa)	Rock Type	Test
4	7.8	0.7	Shale	
4	7.8	4.5	Shale	
4	8.7	1.7	Shale	
4	8.7	4.4	Shale	
5	9.5	0.7	Shale	
5	9.5	5.4	Shale	
5	10.1	0.5	Shale	
5	10.1	3.2	Shale	
5	10.5	0.5	Shale	
5	10.5	1.4	Shale	
6	11.0	0.5	Shale	
6	11.0	13.8	Shale	
6	11.8	0.7	Shale	
6	11.8	7.6	Shale	
6	12.4	2.6	Shale	
7	12.5	1.7	Shale	
7	12.5	6.5	Shale	
7	12.9	112.9	Limestone	
7	13.2	1.7	Shale	
7	13.2	4.1	Shale	
7	13.6	10.7	Shale	UC
7	13.7	0.7	Shale	
8	14.0	0.7	Shale	
8	14.0	8.5	Shale	
8	14.8	1.7	Shale	
8	14.8	9.5	Shale	
8	15.1	3.4	Shale	
8	15.1	13.0	Shale	
9	15.5	0.7	Shale	
9	15.5	2.6	Shale	
9	16.0	0.7	Shale	
9	16.0	1.5	Shale	
9	16.4	120.4	Limestone	
10	17.0	0.7	Shale	
10	17.0	3.9	Shale	
10	17.6	0.7	Shale	
10	17.6	2.5	Shale	
10	18.0	0.7	Shale	
10	18.0	3.8	Shale	
11	18.6	10.1	Shale	
11	18.6	12.9	Shale	

8	6.1
9	25.2
10	2.0
11	6.6
12	20.0
13	3.3
14	7.2
15	9.2

TABLE 2 - Point Load and Unconfined Compressive Strength Test Results
Credit River Access Road

Run	Depth (m)	UCS (MPa)	Rock Type	Test
11	19.1	0.7	Shale	
11	19.1	7.3	Shale	
11	19.3	11.9	Shale	UC
11	19.6	0.7	Shale	
11	19.6	2.7	Shale	
12	19.9	3.4	Shale	
12	19.9	11.5	Shale	
12	20.3	1.7	Shale	
12	20.3	7.2	Shale	
12	21.0	95.2	Limestone	
12	21.1	1.7	Shale	
12	21.1	6.3	Shale	
12	21.3	5.1	Shale/Lime	
12	21.3	48.1	Shale/Lime	
13	21.9	0.7	Shale	
13	21.9	5.9	Shale	
14	22.4	5.0	Shale	
14	22.4	9.4	Shale	
15	23.0	5.1	Shale	
15	23.0	8.7	Shale	
15	23.9	6.7	Shale	
15	23.9	12.4	Shale	
15	24.3	13.4	Shale	
Borehole		**10-05**		
1	3.2	1.4	Shale	
2	3.5	0.9	Shale	
2	4.0	0.8	Shale	
2	4.2	1.1	Shale	
2	4.8	4.1	Shale	
3	5.0	0.7	Shale	
3	5.3	8.4	Shale	
3	5.6	1.5	Shale	
3	6.0	1.3	Shale	
3	6.3	1.3	Shale	
4	6.4	1.3	Shale	
4	6.7	8.5	Shale	
4	7.1	2.7	Shale	
4	7.4	10.8	Shale	UC
4	7.5	2.0	Shale	
4	7.8	2.0	Shale/Lime	
5	8.1	1.4	Shale	

Total Rock Core

Rock Type	Shale	Limestone	Shale/Limestone
Average (MPa)	3.0	73.1	3.7
Minimum (MPa)	0.7	27.9	2.0
Maximum (MPa)	10.8	200.5	5.4

Run #	Average (Mpa)
1	1.4
2	1.7
3	2.6
4	4.6
5	9.6
6	3.8
7	7.7
8	4.7
9	61.2

TABLE 2 - Point Load and Unconfined Compressive Strength Test Results
Credit River Access Road

Run	Depth (m)	UCS (MPa)	Rock Type	Test
5	8.5	1.4	Shale	
5	8.9	0.7	Shale	
5	9.0	35.0	Limestone	
6	9.4	3.4	Shale	
6	9.8	0.7	Shale	
6	10.0	2.9	Shale	
6	10.3	5.4	Shale	
6	10.7	6.8	Shale	
7	11.0	2.0	Shale	
7	11.3	27.9	Limestone	
7	11.6	1.3	Shale	
7	11.9	0.7	Shale	
7	12.2	6.8	Shale	
8	12.5	4.7	Shale	
8	13.0	2.7	Shale	
8	13.5	5.9	Shale	
8	13.7	5.4	Shale/Lime	
9	14.1	37.7	Limestone	
9	14.4	200.5	Limestone	
9	14.6	64.3	Limestone	
9	15.0	1.3	Shale	
9	15.2	2.0	Shale	

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RECORD OF BOREHOLE No 10-02 1 OF 1 METRIC

W.P. 2186-07-00 LOCATION QEW - Credit River Access Road (N 4 823 966.28 E 295 797.95) ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Hollow Stem Augers/HQ Rock Coring COMPILED BY AN

DATUM Geodetic DATE 2010.09.30 - 2010.09.30 CHECKED BY SKP

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.4											
0.0	TOPSOIL: (150mm)										
0.2	Silty CLAY, with sand, trace gravel, roots and rootlets Very Stiff to Hard Brown Moist		1	SS	25		94		○		3 59 22 16
			2	SS	29		93		○		
	With shale fragments		3	SS	39				○		3 16 46 35
			4	SS	34		92		○		1 26 47 26
91.2											
3.2	SHALE, weathered Grey Moist		5	SS	76/ 0.275		91		○		
			6	SS	50/ 0.100				○		
89.7			7	SS	50/ 0.075		90		○		
4.6	END OF SPT SAMPLING AT 4.6m. START CORING AT 4.6m. FOR ROCK DETAILS PLEASE REFER TO 10-02R.										

Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.

SHALLOW PIEZOMETER
WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Oct.04/10	Dry	-
Oct.05/10	Dry	-
Oct.12/10	Dry	-
Dec.17/10	Dry	-

DEEP PIEZOMETER
WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Oct.04/10	8.5	85.9
Oct.05/10	8.5	85.9
Oct.12/10	8.7	85.7
Dec.17/10	9.3	85.1

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 9292.GPJ 1/7/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 10-03A 1 OF 1 METRIC

W.P. 2186-07-00 LOCATION QEW - Credit River Access Road (N 4 823 979.03 E 295 865.10) ORIGINATED BY GA

HWY QEW BOREHOLE TYPE Tri-pod COMPILED BY AN

DATUM Geodetic DATE 2010.11.04 - 2010.11.04 CHECKED BY SKP

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.2											
0.0 / 75.6	Clayey SILT, with sand, trace gravel, trace shale fragments Very Stiff Brown/Grey Dry		1	SS	17		76				0 44 36 20
0.6 / 75.0	Frequent shale fragments, trace silt and sand		2	SS	24						
1.2 / 73.5	Clayey SILT, with sand, trace gravel Stiff to Firm Grey Wet		3	SS	14	▽	75				3 33 47 17
			4	SS	8		74				
			5	SS	10						1 38 46 15
2.7 / 72.6	PEAT, amorphous, occasional rootlets Firm Brown Moist		6	SS	4		73				
3.7 / 72.0	SHALE, weathered Grey Moist		7	SS	35		72				
4.3	END OF BOREHOLE AT 4.3m UPON SPLIT SPOON SAMPLER REFUSAL. BOREHOLE OPEN TO 4.3m AND WATER LEVEL AT 1.5m. BOREHOLE BACKDFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 10-03B 1 OF 1 METRIC

W.P. 2186-07-00 LOCATION QEW - Credit River Access Road (N 4 823 983.23 E 295 856.15) ORIGINATED BY GA

HWY QEW BOREHOLE TYPE Tri-pod COMPILED BY AN

DATUM Geodetic DATE 2010.10.04 - 2010.11.04 CHECKED BY SKP

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: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.3											
0.0 / 75.7	Clayey SILT, with sand, trace gravel Very Stiff Brown Dry		1	SS	21		76		o		
0.6 / 75.0	Frequent shale fragments		2	SS	28				o		
1.3 / 73.9	Clayey SILT, with sand Stiff Grey Moist		3	SS	14		75		o		0 36 46 18
			4	SS	11	▽			o		
2.4 / 73.2	PEAT, amorphous, occasional rootlets Firm to Stiff Brown		5	SS	7		74		o 87		
3.0 / 72.6	Moist Clayey SILT, some clay, mixed with organics Stiff		6	SS	10		73		o		0 25 57 18
3.7 / 72.3	SHALE, weathered Grey		7	SS	50/						
4.0	Wet END OF BOREHOLE AT 4.0m UPON SPLIT SPOON SAMPLER REFUSAL. BOREHOLE OPEN TO 4.0m AND WATER LEVEL AT 2.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.150				o		

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 10-04 1 OF 1 METRIC

W.P. 2186-07-00 LOCATION QEW - Credit River Access Road (N 4 824 005.69 E 295 823.89) ORIGINATED BY GA

HWY QEW BOREHOLE TYPE Tri-pod COMPILED BY AN

DATUM Geodetic DATE 2010.11.05 - 2010.11.05 CHECKED BY SKP

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 × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.3											
0.0 / 0.0	TOPSOIL: (50mm)										
	Clayey SILT, some sand, trace gravel Stiff to Very Stiff Brown to Grey Dry to Wet		1	SS	17		76				
			2	SS	19						2 30 46 22
			3	SS	12		75				
			4	SS	8						
			5	SS	10		74				0 23 59 18
72.8			6	SS	26		73				
72.5 / 72.7	SHALE, weathered		7	SS	50/ 0.025						
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN TO 3.7m AND WATER LEVEL AT 0.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

15 (20 / 10) 5 (%) STRAIN AT FAILURE

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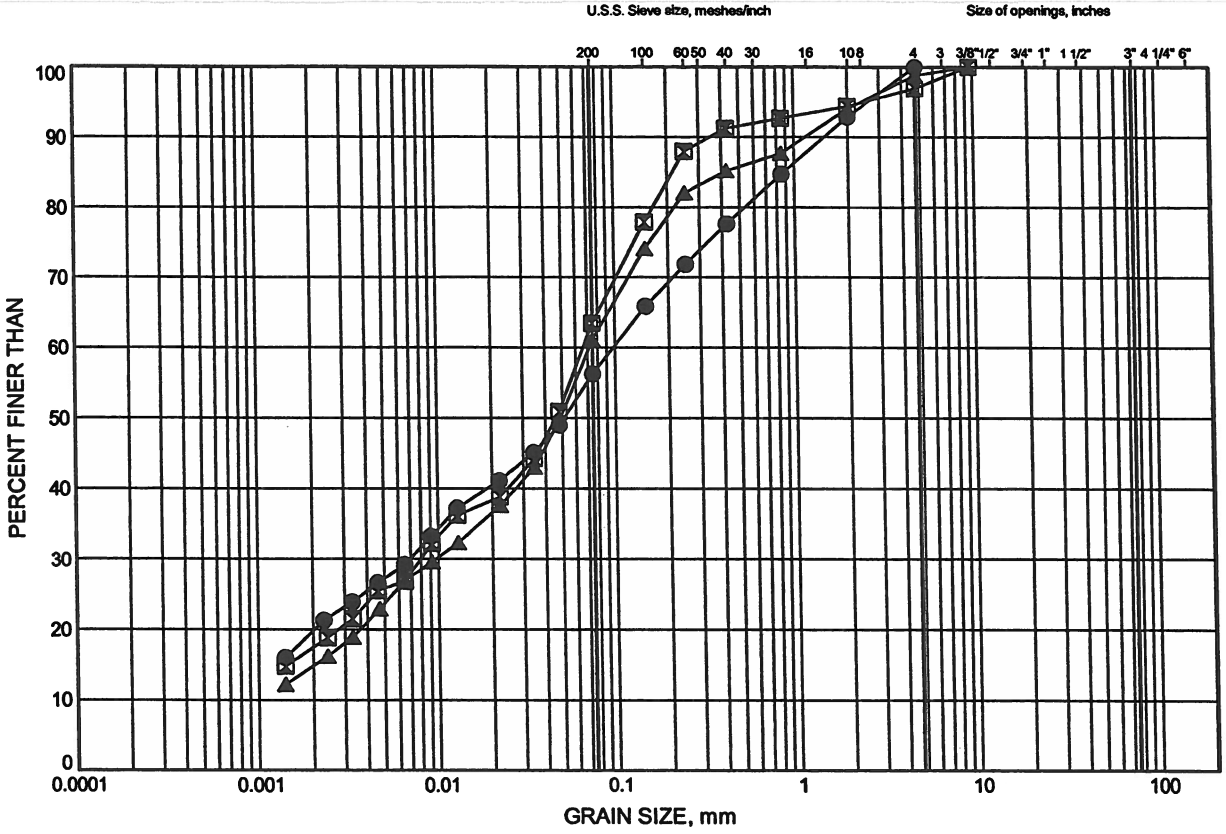
QEW - Credit River Access Road

GRAIN SIZE DISTRIBUTION

FIGURE B1

CLAYEY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-03A	0.30	75.92
⊠	10-03A	1.52	74.70
▲	10-03A	2.74	73.48

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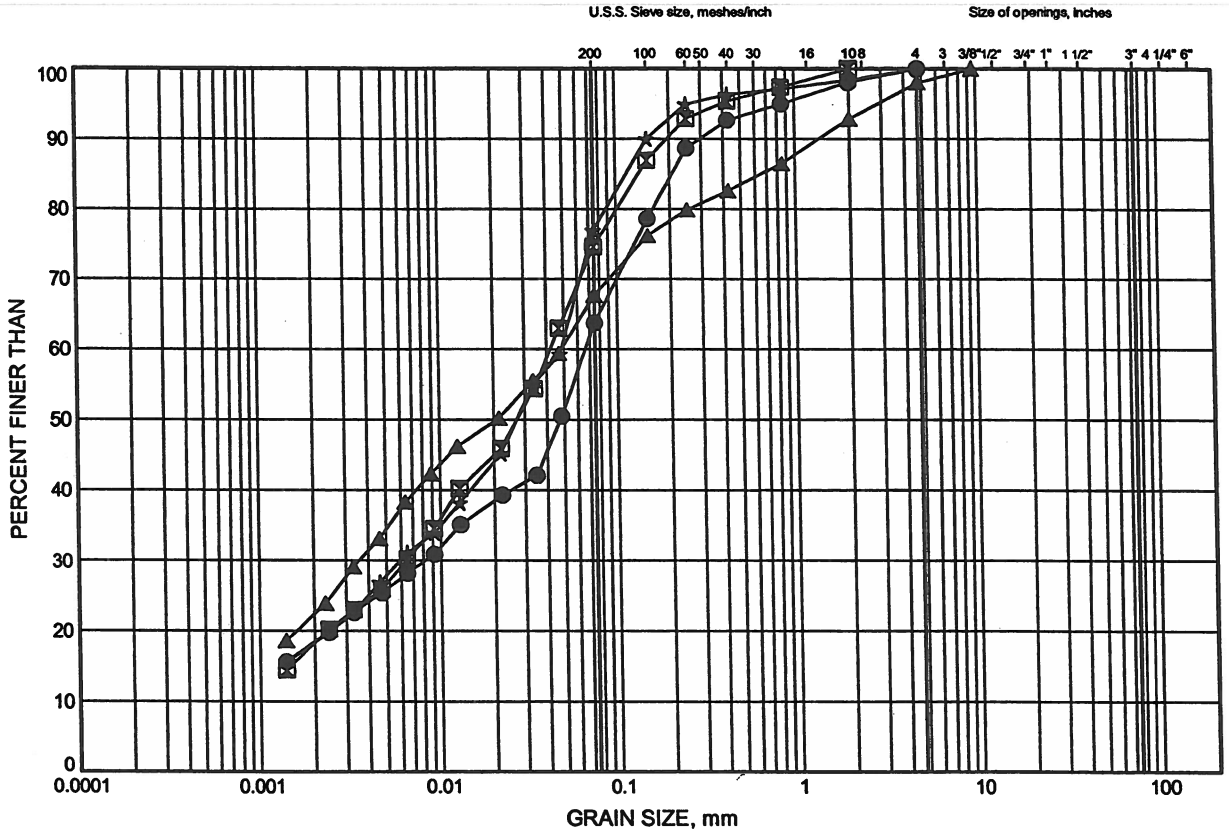
GRAIN SIZE DISTRIBUTION - THURBER 9292.GPJ 1/7/11

QEW - Credit River Access Road

GRAIN SIZE DISTRIBUTION

FIGURE B2

CLAYEY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-03B	1.52	74.77
⊠	10-03B	3.35	72.94
▲	10-04	0.91	75.43
★	10-04	2.74	73.60

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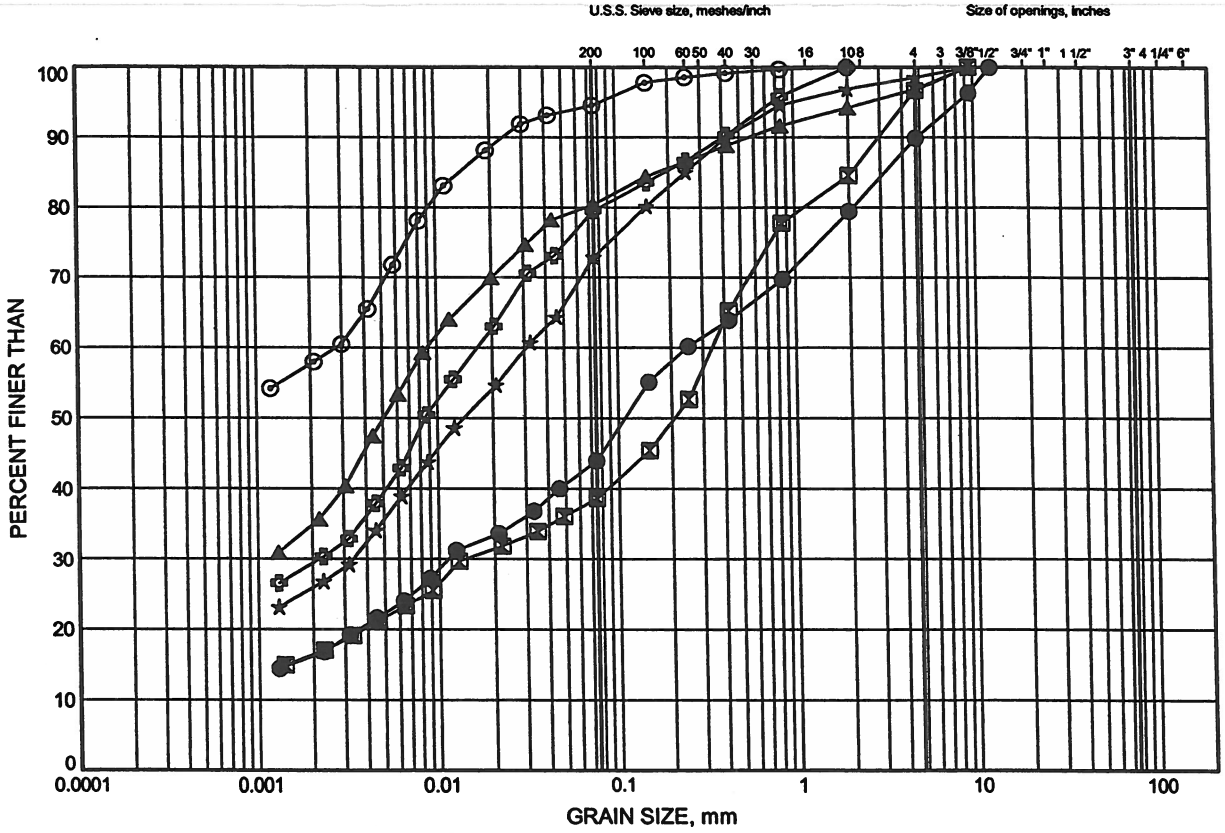
QEW - Credit River Access Road

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-01	0.30	95.88
⊠	10-02	0.30	94.09
▲	10-02	1.83	92.56
★	10-02	2.59	91.80
⊙	10-05	0.91	94.33
✿	10-05	1.83	93.41

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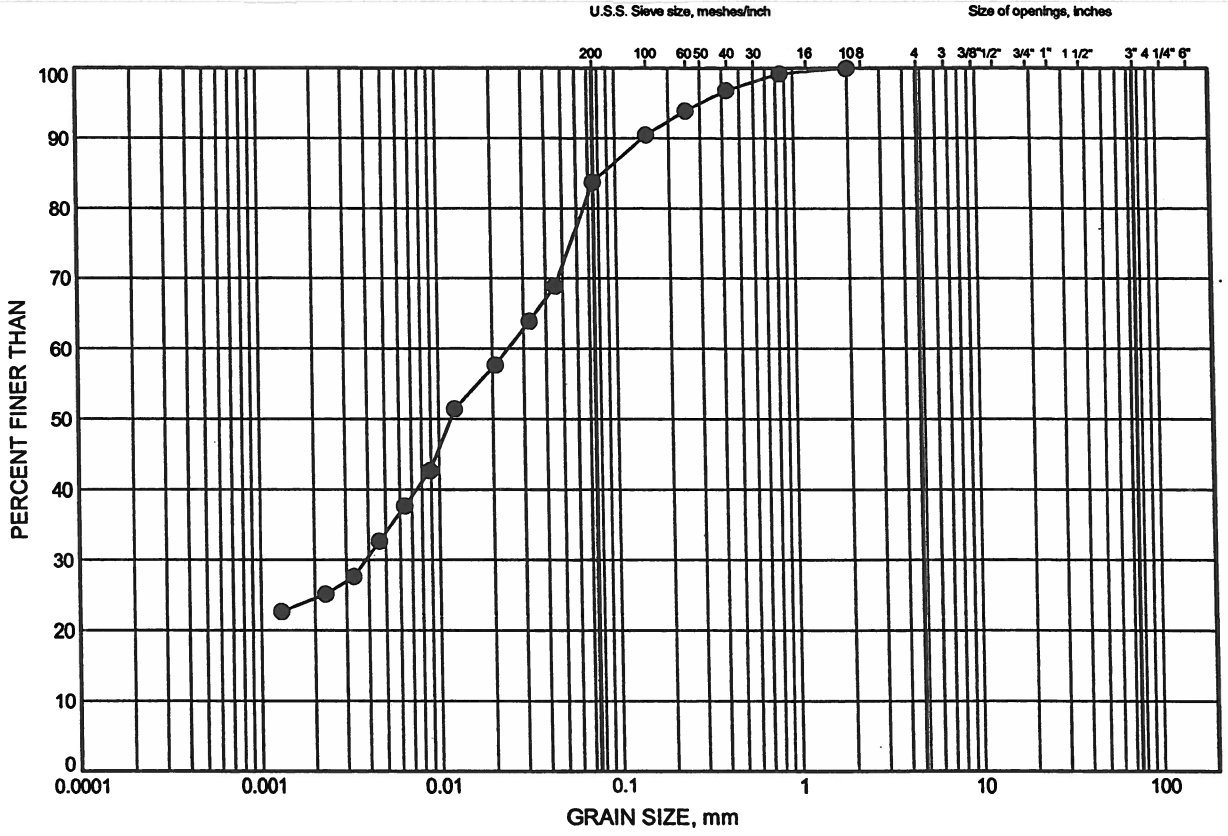
QEW - Credit River Access Road

GRAIN SIZE DISTRIBUTION

FIGURE B4

WEATHERED SHALE



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-01	1.83	94.35

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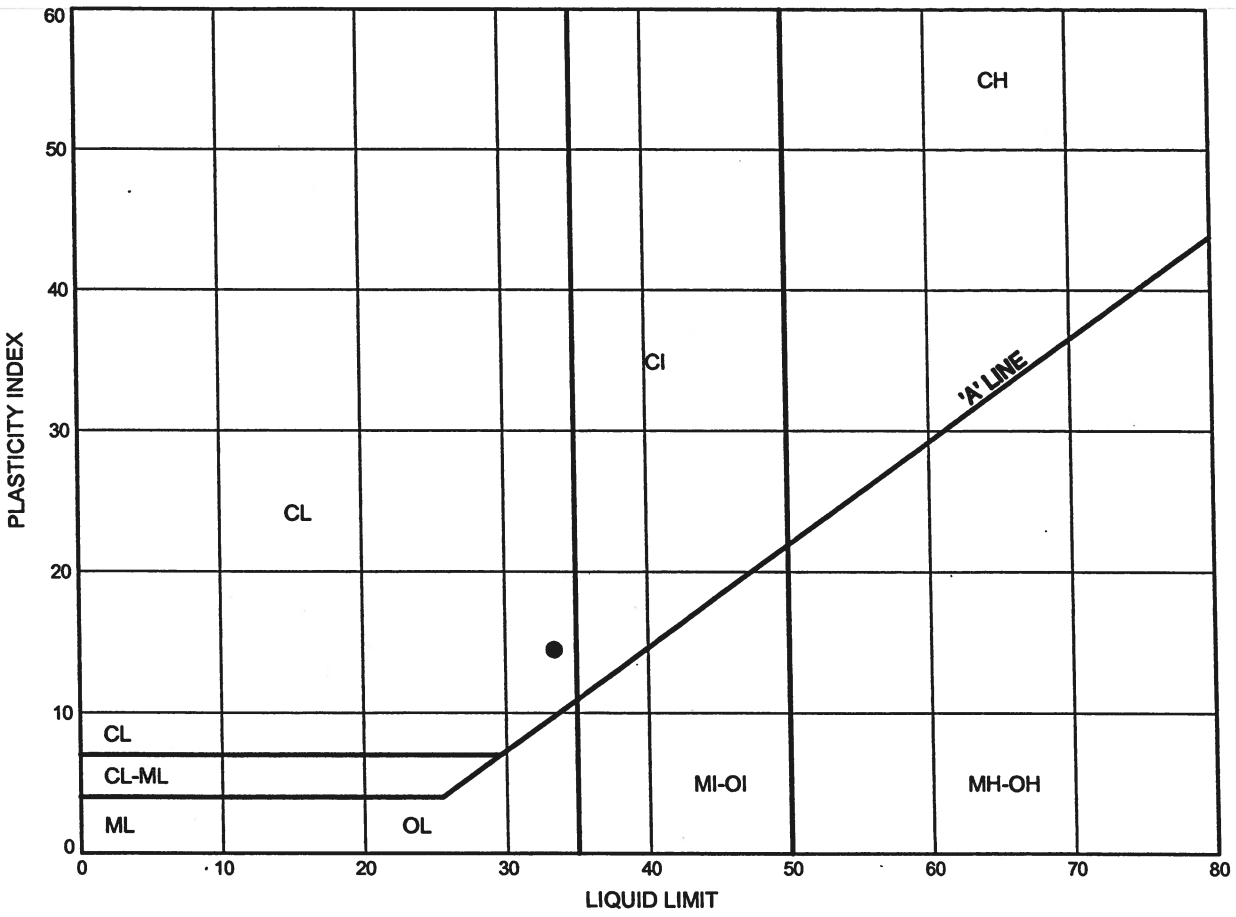
GRAIN SIZE DISTRIBUTION - THURBER 9292.GPJ 1/7/11

QEW - Credit River Access Road

ATTERBERG LIMITS TEST RESULTS

FIGURE B5

CLAYEY SILT



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	10-03A	0.30	75.92

Date January 2011

Project 2186-07-00

THURBER

Prep'd AN

Chkd. SKP

THURBALT 9292.GPJ 1/7/11

APPENDIX B

Current Investigation – Borehole Records, Drillhole Records and Bedrock Core Photographs

LIST OF SYMBOLS

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

I. GENERAL

π	3.1416
ln x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
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		

GOLDER

RECORD OF BOREHOLE No CRB-1

SHEET 1 OF 1 **METRIC**

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4823940.2; E 295811.1 MTM NAD 83 ZONE 10 (LAT. 43.555344; LONG. -79.611250) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 55, 210 mm O.D., 108 mm I.D. Hollow Stem Augers (Auto Hammer) COMPILED BY KN

DATUM Geodetic DATE February 7, 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
94.9	GROUND SURFACE										
0.0	Sandy clayey silt, some gravel, contains rootlets / organics (FILL) Stiff		1	SS	10						
94.2	Brown										
0.7	Dry to moist										
	SILTY CLAY some sand, trace gravel Stiff		2A 2B	SS	11		94				4 15 49 32
	Mottled brown to grey										
93.2	Moist		3A								
1.7	SHALE (BEDROCK) Grey		3B	SS	36		93				
			4	SS	95/0.10						
							92				
91.6			5	SS	100/0.13						
3.3	END OF BOREHOLE - SPLIT-SPOON REFUSAL										

NOTE:

1. Borehole dry upon completion of drilling.

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

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GOLDER

RECORD OF BOREHOLE No CRB-2

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4823949.7; E 295828.3 MTM NAD 83 ZONE 10 (LAT. 43.555430; LONG. -79.611047)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 210 mm O.D., 108 mm I.D. Hollow Stem Augers (Auto Hammer)

COMPILED BY KN

DATUM Geodetic

DATE February 6, 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
95.6	GROUND SURFACE										
0.0	TOPSOIL (200 mm)										
0.2	Sandy clayey silt, some gravel (FILL)		1	SS	7		95				
94.9	Firm										
0.7	Grey Moist										
	Sand, some silt, trace to some gravel, trace clay, contains rootlets / organics (FILL) Loose to compact Brown to grey Moist, becoming wet at a depth of about 2.3 m		2	SS	6						6 12 47 35
			3	SS	5		94		○		10 67 19 4
93.0			4A 4B	SS	15	▼					
2.6	CLAYEY SILT, some sand, some gravel (TILL)						93				
92.4	Very stiff Grey		5A	RC	REC 37.5%						RQD = 0%
3.2	Moist to wet		5B	SS	37						
	SHALE (BEDROCK) Grey Bedrock cored from a depth of 3.2 m to 12.8 m For bedrock coring details, refer to Record of Drillhole CRB-2		2	RC	REC 23%		92				RQD = 2%
			3	RC	REC 100%		91				RQD = 73%
			4	RC	REC 100%		90				RQD = 100%
			5	RC	REC 100%		89				RQD = 83%
			6	RC	REC 71%		88				RQD = 65%
			7	RC	REC 100%		87				RQD = 100%
82.8			8	RC	REC 100%		86				RQD = 72%
12.8							85				
							84				
							83				

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

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

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GOLDER

PROJECT 1662333

RECORD OF BOREHOLE No CRB-2

SHEET 2 OF 2

METRIC

G.W.P. 2002-13-00 LOCATION N 4823949.7; E 295828.3 MTM NAD 83 ZONE 10 (LAT. 43.555430; LONG. -79.611047) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 55, 210 mm O.D., 108 mm I.D. Hollow Stem Augers (Auto Hammer) COMPILED BY KN

DATUM Geodetic DATE February 6, 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 / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	w_P w w_L 10 20 30	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE										
	NOTES: 1. Borehole dry upon completion of drilling. 3. Groundwater level measurements in piezometer: Date Depth (m) Elev. (m) 12/03/18 2.6 93.0 30/04/18 2.6 93.0 06/11/18 2.5 93.1										

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-2

SHEET 1 OF 2

LOCATION: N 4823949.7 ;E 295828.3

DRILLING DATE: February 6, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

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 Borehole CRB-2		92.56															
	NQ Rock Core	Completely weathered, thinly laminated to medium bedded, brown to grey, very fine to fine grained, faintly porous, extremely weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		3.04	1														
4					2														
				90.65															
5		Slightly weathered to fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, very weak to weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		4.95	3							BD,UN,SM CL	2	1					
												BD,UN,SM CL	2	1					
												BD,UN,SM CL	2	1					
												BD,UN,SM CL	2	1					
												BD,UN,SM CL	2	1					
												JN,PL,SM CL	1	1					
6												BD,UN,SM PC, CI	2	3					
												CO,UN,SM PC, CI	2	3					
												CO,UN,SM PC, CI	2	3					
												BD,UN,SM PC, CI	2	3					
7					4														
																			UC = 11.2 MPa
8												BD,UN,SM PC, CI	2	3					
																			PLT(D) = 0.04
																			PLT(A) = 0.82
					5														
9												CO,CU,SM PC, CI	2	3					
												CO,UN,SM PC, CI	2	3					
												BD,UN,SM PC, CI	2	3					
												BD,UN,SM PC, CI	2	3					
												CO,ST,SM IN, CI	2	6					
10					6														
																			PLT(D) = 0.19
												BD,UN,SM CL	2	1					
												CO,UN,SM CL	2	1					
												CO,UN,SM PC, CI	2	3					
11																			
												BD,UN,SM PC, CI	2	3					
					7							BD,UN,SM IN, CI	2	6					UC = 13.0 MPa
																			PLT(A) = 0.33
												BD,UN,SM CL	2	1					
12												CO,CU,SM CL	2	1					
		CONTINUED NEXT PAGE																	

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: AB

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-2

SHEET 2 OF 2

LOCATION: N 4823949.7 ;E 295828.3

DRILLING DATE: February 6, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

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 PREVIOUS PAGE ---																	
	NQ Rock Core	Slightly weathered to fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, very weak to weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds			7														PLT(D) = 0.10 PLT(A) = 0.24
					8							BD,UN,SM CC, Cl CO,CU,SM PC, Cl CO,UN,SM PC, Cl	2 2 2	4 3 3					
				82.80								CO,UN,SM IN, Cl	2	6					
		END OF DRILLHOLE		12.80															

13 14 15 16 17 18 19 20 21

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: AB

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GOLDER

RECORD OF BOREHOLE No CRB-2A

SHEET 1 OF 1 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4823960.1; E 295808.0 MTM NAD 83 ZONE 10 (LAT. 43.555523; LONG. -79.611298)
ORIGINATED BY JL
DIST Central HWY QEW
BOREHOLE TYPE 64 mm O.D. 51 mm I.D. Continuous Split Spoon Sampling (Cathead/Safety Hammer)
COMPILED BY KN
DATUM Geodetic
DATE January 28, 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
94.5	GROUND SURFACE										
0.0	TOPSOIL (100 mm)										
0.1	Clayey silt, sandy to with sand, contains organics / rootlets, oxidation staining, trace gravel (FILL) Firm to hard Brown to grey to black Moist		1	SS	7		94		42		
93.5			2A 2B 2C	SS	50						0 4 65 31
1.1	SILTY CLAY, trace sand Hard Mottled brown to grey Dry		1	RC	REC 100%						RQD = 0%
			2	RC	REC 86%		93				RQD = 0%
	SHALE (BEDROCK) Grey		3	RC	REC 100%	▼	92				RQD = 30%
	Bedrock cored from a depth of 1.1 m to 9.0 m For bedrock coring details, refer to Record of Drillhole CRB-2A		4	RC	REC 100%		91				RQD = 78%
			5	RC	REC 100%		90				RQD = 100%
			6	RC	REC 100%		89				RQD = 38%
			7	RC	REC 100%						RQD = 42%
			8	RC	REC 54%						RQD = 32%
			9	RC	REC 100%		88				RQD = 100%
			10	RC	REC 100%		87				RQD = 89%
			11	RC	REC 100%		86				RQD = 100%
85.5											
9.0	END OF BOREHOLE										

NOTE:

1. Borehole dry prior to rock coring.

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

PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-2A

SHEET 1 OF 1

LOCATION: N 4823960.1 ;E 295808.0

DRILLING DATE: January 28, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable/Tripod

DRILLING CONTRACTOR: OGS 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 CRB-2A		93.38															
2	NQ Rock Core	Highly weathered to moderately weathered, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, very weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		1.12	1														
					2							BD,UN,SM CL CO,UN,SM CL JN,PL,SM SA CO,PL,SM CL	2 2 1 1 2 2	1 1 1 1 2 3	R4 R3 R2 R1	W1 W2 W3 W4 W5 W6			
				92.37															
3		Slightly weathered to fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, very weak to weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		2.13	3							BD,UN,SM CL BD,UN,SM PC, CI CO,UN,RO CL JN,PL,SM PC, CI CO,UN,SM PC, CI BD,UN,SM CL BD,UN,SM PC, CI BD,UN,SM CL	3 3 2 2 2 2 2 2	1 3 2 2 1 3 3 1				R0 R0
4					4							JN,PL,SM PC, CI BD,UN,SM PC, CI CO,UN,SM CL CO,UN,SM CL CO,UN,SM CC, CI CO,UN,SM PC, CI BD,UN,SM CC, CI CO,UN,SM CC, CI JN,PL,SM CC, CI BD,UN,SM PC, CI JN,PL,SM CL BD,UN,SM CC, CI BD,UN,SM IN, CI JN,IR,SM PC, CI BD,UN,SM CC, CI	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	4 4 3 1 1 4 6 3 4 4				
5					5							BD,UN,SM PC, CI	2	3					UC = 18.2 MPa PLT(D) = 0.18 MPa UC = 17.1 MPa
6					6							CO,UN,SM CC, CI CO,UN,SM IN, CI	2 2	4 6					
7					7							BD,UN,SM CC, CI BD,UN,SM IN, CI	2 2	6 6					
8					8							CO,UN,SM IN, CI BD,UN,SM CC, CI BD,UN,SM CC, CI BD,UN,SM CC, CI BD,UN,SM IN, CI	2 2 2 2 2	4 4 4 6					PLT(D) = 0.28 MPa PLT(A) = 0.40 MPa
9					9														
10					10							BD,UN,SM CC, CI	2	4					PLT(A) = 0.37 MPa
					11														PLT(D) = 0.44 MPa PLT(A) = 0.13 MPa
				85.54								JN,IR,SM SA	2	2					
		END OF DRILLHOLE		8.96															

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: MPL

GTA-RCK 054 S:\CLIENTS\MTO\CEW-CREDIT_RIVER\02_DATA\GINT\CEW-CREDIT_RIVER.GPJ GAL-MISS.GDT 2/12/19

GOLDER

RECORD OF BOREHOLE No CRB-2B

SHEET 1 OF 1 **METRIC**

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

LOCATION N 4823955.2; E 295818.7 MTM NAD 83 ZONE 10 (LAT. 43.555479; LONG. -79.611166)
BOREHOLE TYPE CME 55, 210 mm O.D., 108 mm I.D. Hollow Stem Augers (Auto Hammer)
DATE July 5, 2018

ORIGINATED BY SK
COMPILED BY
CHECKED BY

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
	GROUND SURFACE										
0.0	TOPSOIL (150 mm)		1A								
0.2	Sandy clayey silt, some gravel (FILL) Stiff Brown Moist		1B	SS	13				○		
0.7	SILTY CLAY, some sand, trace to some gravel Stiff Brown Moist		2	SS	14				○ — 42		6 13 46 35
1.4	CLAYEY SILT, some sand, some gravel, some shale fragments (RESIDUAL SOIL) Hard Brown Moist - Auger grinding at 1.5 m depth - A 0.3 m thick boulder / limestone layer at 2.1		3	SS	61				○		
2.4											
3.6	SHALE (BEDROCK) Bedrock cored from a depth of 2.0 m to 12.7 m For bedrock coring details, refer to Record of Drillhole CRB-2B		1	RC	REC 100%						RQD = 33%
			2	RC	REC 97%						RQD = 55%
			3	RC	REC 100%						RQD = 67%
			4	RC	REC 100%						RQD = 74%
			5	RC	REC 100%						RQD = 64%
			6	RC	REC 100%						RQD = 63%
12.7	END OF BOREHOLE NOTE: 1. Borehole dry prior to rock coring.										

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-2B

LOCATION: N 4823955.2 ;E 295818.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: July 5, 2018

DRILL RIG: CME 55 Track

DRILLING CONTRACTOR: Geo-Environmental Drilling

DATUM: Geodetic

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.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | RECOVERY (TOTAL CORE % 80 60 40 20; 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; DIP w.r.t. CORE AXIS 0 30 60 90; 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 Borehole CRB-2B

Depth 3.64 m: Slightly weathered to fresh, thinly laminated to medium bedded, very fine to fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds

Depth scale: 4, 5, 6, 7, 8, 9, 10, 11, 12

Runs: 1, 2, 3, 4, 5, 6

Discontinuity type and surface description (top to bottom):

BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM IN
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM IN
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM CC
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM CC
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM IN
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM SO
BD,PL,SM SO
BD,CU,SM SO
BD,PL,SM SA
BD,PL,SM CC
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM SA
BD,CU,SM SA
BD,UN,SM SA
BD,UN,SM SO
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,CU,SM SA
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM IN
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SO
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA
BD,UN,SM SO
BD,UN,SM SO
BD,PL,SM PC
BD,UN,SM SA
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM PC
BD,PL,SM SA
BD,PL,SM SA
BD,PL,SM SA

Notes:

UCS = 12.1 MPa
E = 0.59 MPa

UCS = 15.5 MPa
E = 0.63 MPa

CONTINUED NEXT PAGE

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED:
CHECKED:

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-2B

SHEET 2 OF 2

LOCATION: N 4823955.2 ;E 295818.7

DRILLING DATE: July 5, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

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 % (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 PREVIOUS PAGE ---																	
												BD,PL,SM PC							
		END OF BOREHOLE		12.72															
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			

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 CRB-3

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824016.8; E 295862.2 MTM NAD 83 ZONE 10 (LAT. 43.556034; LONG. -79.610628)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing (Auto Hammer)

COMPILED BY MPL

DATUM Geodetic

DATE October 10-13, 2017

CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.9	GROUND SURFACE								
0.0 / 75.2	Silty sand, some gravel (FILL) Compact Brown to grey Moist to wet		1	SS	15				
0.7 / 74.3	Sandy clayey silt, trace gravel (FILL) Stiff Brown Moist to wet		2	SS	10				
1.6 / 72.9	CLAYEY SILT with SAND, trace gravel, contains organics Soft to very soft Brown to black Moist to wet		3	SS	3				
			4	SS	WH	▽		OC = 1.7%	1 41 46 12
3.0 / 70.3	SAND and GRAVEL, trace to some silt, trace clay Compact Brown to grey Wet - Shell fragments from a depth of about 3.8 m to a depth of 5.2 m		5	SS	17				50 35 13 2
			6	SS	14				
			7	SS	24				42 48 (10)
5.6 / 69.6	Sandy CLAYEY SILT, contains shale fragments (RESIDUAL SOIL) Hard Brown Moist		8A 8B	SS	50/0.05				
6.3	SHALE (BEDROCK) Grey								
	Bedrock cored from a depth of 7.2 m to 15.3 m		1	RC	REC 11%				RQD = 0%
	For bedrock coring details, refer to Record of Drillhole CRB-3		2	RC	REC 100%				RQD = 53%
			3	RC	REC 98%				RQD = 93%
			4	RC	REC 100%				RQD = 98%
			5	RC	REC 100%				RQD = 100%
			6	RC	REC 100%				RQD = 100%

ELEVATION SCALE: 75, 74, 73, 72, 71, 70, 69, 68, 67, 66, 65, 64, 63, 62, 61

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

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GOLDER

RECORD OF BOREHOLE No CRB-3

SHEET 2 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824016.8; E 295862.2 MTM NAD 83 ZONE 10 (LAT. 43.556034; LONG. -79.610628)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing (Auto Hammer)

COMPILED BY MPL

DATUM Geodetic

DATE October 10-13, 2017

CHECKED BY SMM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● 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 ---										
60.6	SHALE (BEDROCK)		6	RC							RQD = 100%
15.3	END OF BOREHOLE										
	NOTE:										
	1. Water level measured at a depth of about 2.7 m (Elev. 73.2 m) below ground surface prior to rock coring.										

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

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-3

SHEET 1 OF 1

LOCATION: N 4824016.8 ;E 295862.2

DRILLING DATE: October 10-13, 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 CRB-3		68.76															
	HQ Core	Completely weathered, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, extremely weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		7.16	1														
				68.15															
		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		7.77	2							CO,UN,RO CL CO,PL,SM CL	3 1	1 1				R1	
8												BD,PL,RO IN, Si, Sa BD,IR,RO CL BD,PL,RO IN, Si, Sa BD,PL,RO CL BD,PL,RO CL BD,PL,SM PC, Cl BD,IR,RO CL BD,IR,RO CL BD,IR,RO CL CO,IR,RO CL BD,IR,RO CC, Cl BD,PL,SM IN, Cl BD,PL,RO PC, Cl BD,PL,RO PC, Cl	1.5 3 1.5 1.5 1 3 3 3 3 1 1.5 1.5	6 1 6 1 3 1 1 1 4 6 3 3				R1	
9																		R1 R1	PLT(A) = 0.30 MPa PLT(D) = 0.09 MPa
10					3							BD,PL,SM PC, Cl BD,IR,RO PC, Cl BD,PL,SM CL	1 3 1	3 3 1				R1 R1	
11					4														PLT(A) = 0.68 MPa PLT(D) = 0.22 MPa PLT(A) = 0.26 MPa PLT(D) = 0.85 MPa UC = 9.4 MPa
12												CO,PL,SM CL CO,PL,RO CL	1 1.5	1 1				R1	
13					5							BD,CU,SM PC, Cl BD,PL,SM CL BD,CU,SM CL BD,PL,SM PC, Cl	2 1 2 1	3 1 1 3					
14					6							BD,UN,SM CL	2	1					
15												BD,UN,SM SA BD,PL,RO PC, Cl	2 1.5	2 3				R1	
				60.64								BD,PL,SM SA	1	2				R1 R1	
		END OF DRILLHOLE		15.28															
16																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: ML

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GOLDER

RECORD OF BOREHOLE No CRB-3A

SHEET 1 OF 2 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4824025.6; E 295844.6 MTM NAD 83 ZONE 10 (LAT. 43.556113; LONG. -79.610847)
ORIGINATED BY JL
DIST Central HWY QEW
BOREHOLE TYPE CME 55, 210 mm O.D., 108 mm I.D. Hollow Stem Augers (Auto Hammer)
COMPILED BY KN
DATUM Geodetic
DATE February 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
75.7	GROUND SURFACE								
0.0	Sandy SILTY CLAY, contains rootlets / organics Soft to stiff Brown Moist, becoming wet at a depth of about 2.3 m		1	SS	5		75		0 27 57 16
			2	SS	4				
73.1			3A 3B	SS	3		74	OC= 3.1%	
2.6	SAND and GRAVEL, some silt, trace clay Compact Brown to grey Wet		4	SS	29		73		
			5	SS	25		72		
	- Clayey silt pocket encountered at a depth of about 4.7 m below ground surface		6	SS	25		71		43 39 14 4
69.6							70		
6.1	SHALE (BEDROCK) Grey Bedrock cored from a depth of 7.0 m to 15.8 m For bedrock coring details, refer to Record of Drillhole CRB-3A		7	SS	50/0.13		69		
			1	RC	REC 100%		68		RQD = 85%
			2	RC	REC 100%		67		RQD = 67%
			3	RC	REC 100%		66		RQD = 89%
			4	RC	REC 98%		65		RQD = 83%
			5	RC	REC 100%		64		RQD = 99%
			6	RC	REC 100%		63		RQD = 90%
							62		
							61		

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

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

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

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Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No CRB-3A

SHEET 2 OF 2 **METRIC**

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

LOCATION N 4824025.6; E 295844.6 MTM NAD 83 ZONE 10 (LAT. 43.556113; LONG. -79.610847)
BOREHOLE TYPE CME 55, 210 mm O.D., 108 mm I.D. Hollow Stem Augers (Auto Hammer)
DATE February 9, 2018

ORIGINATED BY JL
COMPILED BY KN
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 ---										
	SHALE (BEDROCK) Grey		6	RC	REC 100%						RQD = 90%
59.9			7	RC	REC 100%		60				RQD = 93%
15.8	END OF BOREHOLE										

NOTES:

1. Water level measured at a depth of about 0.9 m below ground surface prior to rock coring.

2. Water level measured in standpipe piezometer:

Date	Depth (m)	Elev. (m)
12/03/18	1.0	74.7
30/04/18	0.7	75.0
06/11/18	1.5	74.2

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

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-3A

SHEET 1 OF 1

LOCATION: N 4824025.6 ;E 295844.6

DRILLING DATE: February 9, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

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	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 Borehole CRB-3A		68.69																						
	HQ Core	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		7.01	1							BD,UN,SM PC, CI BD,UN,SM CC, CI BD,UN,SM PC, CI	2 2 2	3 4 3													PLT(D) = 0.62 PLT(A) = 0.46
8					2							CO,PL,SM CL CO,UN,SM SA, CI BD,UN,SM PC, CI	1 2 2	1 2 3													R1 R0 R1
												BD,UN,SM CL	2	1												
9												CO,UN,SM CL BD,UN,SM SA, CI CO,UN,SM CL	2 2 2	1 2 1												
												BD,UN,SM SA, CI	2	2												
		Fresh, thinly to medium bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds										BD,UN,SM CL CO,PL,SM PC, CI	2 1	1 3												
												CO,UN,SM CL CO,UN,SM PC, CI	2 2	1 3												
10					3							BD,UN,SM CL	2	1												
												BD,PL,SM CL	1	1												UC = 8.9 MPa PLT(D) = 0.06 PLT(A) = 1.35
																										R1
																										R1
11												CO,UN,SM CL	2	1												R0
					4																					
																										R0
12																										
												BD,UN,SM SA, CI	2	2												
												JN,CU,SM PC, CI	2	3												
13												CO,UN,SM CL	2	1												
					5																					UC = 16.9 MPa
												BD,UN,SM CL	2	1												PLT(A) = 0.78 PLT(D) = 0.36
14																										
												CO,UN,SM SA, CI	2	2												
					6							BD,UN,SM PC, CI BD,UN,SM PC, CI	2 2	3 3												R1 R1
15												CO,UN,SM CC, CI	2	4												
					7							CO,UN,SM CL BD,UN,SM CL	2 2	1 1												
				59.92								CO,UN,SM CL	2	1												
		END OF DRILLHOLE		15.78								BD,UN,SM CL	2	1												
16																										

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: DM

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GOLDER

RECORD OF BOREHOLE No CRB-3C

SHEET 1 OF 2 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4824028.3; E 295837.7 MTM NAD 83 ZONE 10 (LAT. 43.556138; LONG. -79.610932)
ORIGINATED BY JL
DIST Central HWY QEW
BOREHOLE TYPE Cont. Split Spoon & 73 mm O.D., 60 mm I.D., Washbore Casing (Cathead/Safety Hammer)
COMPILED BY MPL
DATUM Geodetic
DATE January 26, 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
75.3	GROUND SURFACE										
0.0	CLAYEY SILT with SAND, some gravel, contains organics / rootlets Soft to stiff Brown to grey Wet		1	SS	6	▽	75		41		
			2	SS	4						
	- Cobble encountered at 1.2 m depth		3	SS	3		74			OC= 2.4%	13 35 41 11
			4	SS	14		73				
72.7	- Cobble encountered at 2.4 m depth										
2.6	SAND and GRAVEL to SAND, some gravel, some silt, trace to some clay, contains cobbles Compact to very dense Brown and grey to grey Wet		5	SS	46						
			6	SS	55		72				40 36 18 6
	- Clayey silt pockets / layers encountered in samples SS6 and SS8		7	SS	72/0.10						
			8	SS	23		71				15 57 20 8
69.1											
6.2	SHALE (BEDROCK) Grey		~~9~~	~~SS~~	~~100/0.05~~		69				
			1	RC	REC 67%						RQD = 22%
	Bedrock cored from a depth of 6.4 m to 14.1 m		2	RC	REC 100%						RQD = 53%
	For bedrock coring details, refer to Record of Drillhole CRB-3C		3	RC	REC 100%		68				RQD = 43%
			4	RC	REC 91%		67				RQD = 76%
			5	RC	REC 100%		66				RQD = 75%
			6	RC	REC 100%		65				RQD = 100%
			7	RC	REC 100%		64				RQD = 100%
			8	RC	REC 100%		63				RQD = 100%
			9	RC	REC 100%		62				RQD = 71%
61.2											
14.1	END OF BOREHOLE										

Continued Next Page

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

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GOLDER

RECORD OF BOREHOLE No CRB-3C

SHEET 2 OF 2 **METRIC**

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824028.3; E 295837.7 MTM NAD 83 ZONE 10 (LAT. 43.556138; LONG. -79.610932) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE Cont. Split Spoon & 73 mm O.D., 60 mm I.D., Washbore Casing (Cathead/Safety Hammer) COMPILED BY MPL

DATUM Geodetic DATE January 26, 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 / WATER CONTENT (%)	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	10 20 30		
	NOTES:										
	1. Water level measured at ground surface (Elev. 75.3 m) at start of shift on January 25, 2018										
	2. Water level measured at a depth of 0.7 m below ground surface (Elev. 74.6 m) prior to rock coring on January 26, 2018										

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-3C

SHEET 1 OF 1

LOCATION: N 4824028.3 ;E 295837.7

DRILLING DATE: January 26, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable/Tripod

DRILLING CONTRACTOR: OGS 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 CRB-3C		68.87															
7	NQ Rock Core	Slightly weathered to fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, very weak to weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		6.43	1							BD,UN,SM CL	2	1					
				68.60								CO,UN,SM PC, CI	2	3					
				6.70	2							BD,UN,SM CC, CI	2	4					
												BD,UN,SM IN, CI	2	10					
												BD,UN,SM IN, CI	2	1					
												CO,UN,SM CL	2	1					
												CO,UN,SM CL	2	1					
												CO,UN,SM CL	3	3					
												JN,IR,RO PC, CI	2	3					
					3							CO,UN,SM PC, CI	2	1					
												CO,UN,SM CL	2	3					
												JN,UN,SM CL	1	3					
8												CO,UN,SM PC, CI	2	4					UC = 114.1 MPa
												CO,PL,SM PC, CI	3	3					
												CO,UN,SM CC, CI	1	3					
												CO,UN,RO PC, CI	2	3					
												CO,PL,SM PC, CI	2	3					
												JN,UN,SM CL	1.5	3					
												CO,PL,SM PC, CI	1.5	3					
												CO,UN,SM PC, CI							
												CO,UN,SM PC, CI							
					4							JN,UN,SM PC, CI	2	3					
												JN,PL,RO PC, CI							
												CO,PL,RO PC, CI							
												CO,IR,SM PC, CI							
9												CO,UN,SM PC, CI	2	3					PLT(D) = 0.25 MPa PLT(A) = 0.28 MPa
												CO,UN,SM CL	2	1					
												BD,UN,SM CL	2	1					
10					5							BD,UN,SM CL	2	1					
												CO,UN,SM CL	2	1					
												CO,UN,SM PC, CI	2	3					
												CO,UN,SM CL	1	3					
												CO,UN,SM PC, CI	2	3					
												BD,UN,SM CL	2	1					
11					6							CO,UN,SM CL	2	1					PLT(D) = 0.24 MPa PLT(A) = 0.60 MPa
					7														
12																			
					8														
13																			PLT(D) = 0.28 MPa PLT(A) = 0.58 MPa
					9							CO,UN,SM CL	2	1					
												CO,UN,SM CL	2	1					
												JN,UN,SM CL	2	1					
14				61.20								JN,UN,SM CL	2	1					
		END OF DRILLHOLE		14.10															
15																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: AB

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GOLDER

RECORD OF BOREHOLE No CRB-4

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824135.1; E 295902.0 MTM NAD 83 ZONE 10 (LAT. 43.557099; LONG. -79.610138)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 159 mm O.D., 70 mm I.D. Hollow Stem Augers (Auto Hammer)

COMPILED BY KN

DATUM Geodetic

DATE February 16, 2018

CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
79.1	GROUND SURFACE						
0.0	Clayey silt with sand, trace to some gravel, contains rootlets, contains shale fragments (FILL) Firm to hard Brown, becoming grey at 3.1 m Moist		1	SS	6		
			2	SS	13		
			3	SS	8		
			4	SS	23		7 41 37 15
			5	SS	31		
75.4						▽	
3.7	Sandy CLAYEY SILT, some gravel, contains shale fragments Stiff Moist, becoming wet at 4.6 m		6	SS	11		14 27 42 17
			7	SS	13		
73.0							
6.2	ORGANIC CLAYEY SILT with SAND, trace gravel, contains sand lenses Soft Brown Wet		8	SS	3		2 32 56 10
72.1							
7.0	SHALE (BEDROCK) Grey		1	RC	REC 100%		RQD = 0%
	Bedrock cored from a depth of 7.2 m to 15.3 m		9	SS	50/0.10		
	For bedrock coring details, refer to Record of Drillhole CRB-4		2	RC	REC 87%		RQD = 53%
			3	RC	REC 97%		RQD = 77%
			4	RC	REC 100%		RQD = 79%
			5	RC	REC 100%		RQD = 86%
			6	RC	REC 100%		RQD = 97%

ELEVATION SCALE: 79, 78, 77, 76, 75, 74, 73, 72, 71, 70, 69, 68, 67, 66, 65

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

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

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GOLDER

PROJECT 1662333

RECORD OF BOREHOLE No CRB-4

SHEET 2 OF 2

METRIC

G.W.P. 2002-13-00 LOCATION N 4824135.1; E 295902.0 MTM NAD 83 ZONE 10 (LAT. 43.557099; LONG. -79.610138) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 55, 159 mm O.D., 70 mm I.D. Hollow Stem Augers (Auto Hammer) COMPILED BY KN

DATUM Geodetic DATE February 16, 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 ---										
63.8	SHALE (BEDROCK)		6	RC			64				RQD = 97%
15.3	END OF BOREHOLE										
	NOTES:										
	1. Water level encountered during drilling at a depth of about 4.6 m (Elev. 74.5 m) below ground surface.										
	2. Water level measured in open borehole at a depth of about 3.8 m (Elev. 75.4 m) below ground surface prior to rock coring.										

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-4

SHEET 1 OF 1

LOCATION: N 4824135.1 ;E 295902.0

DRILLING DATE: February 16, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

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: R4	ROCK STRENGTH INDEX: R3	ROCK STRENGTH INDEX: R2	ROCK STRENGTH INDEX: R1	WEATHERING INDEX: W1	WEATHERING INDEX: W2	WEATHERING INDEX: W3	WEATHERING INDEX: W4	WEATHERING INDEX: W5	WEATHERING INDEX: W6	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole CRB-4		71.88																							
		Completely weathered, thinly laminated to medium bedded, brown-grey, very fine to fine grained, faintly porous, extremely weak SHALE (Georgian Bay Formation)		7.22 / 71.58	1																						
		Moderately weathered to fresh, thinly to medium bedded, brown-grey, fine grained, faintly porous, very weak to weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		7.52	2							BD,UN,SM SA, Cl BD,UN,SM SA, Cl	2 2	2 2													R0 R1 R0 R1 R0 R1 R0
8																											
9				69.80																							PLT(D) = 0.04 MPa PLT(A) = 1.02 MPa PLT(A) = 2.14 MPa
		Fresh, thinly to medium bedded, grey, fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		9.30	3							JN,PL,SM CL CO,UN,SM IN, Cl JN,CU,SM CL BD,UN,SM PC, Cl BD,UN,SM IN, Cl	1 2 2 2 2	1 6 1 3 6													
10																											
11	HQ Core				4							CO,UN,SM SA, Cl JN,CU,SM CL CO,UN,SM IN, Cl BD,UN,SM PC, Cl CO,UN,SM PC, Cl BD,UN,SM IN, Cl CO,UN,SM CL	2 2 2 2 2 2 2	2 1 6 3 3 6 1													
12												BD,UN,SM CL	2	1													
13					5							CO,PL,SM CL CO,PL,SM CL CO,UN,SM SA, Cl CO,UN,SM CL	1 1 2 2	1 1 2 1													PLT(D) = 0.89 MPa UC = 15.5 MPa
14																											PLT(D) = 0.08 MPa
15					6							BD,UN,SM IN, Cl	2	6													PLT(A) = 0.23 MPa
				63.79																							
		END OF DRILLHOLE		15.31																							
16																											

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: DM

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GOLDER

RECORD OF BOREHOLE No CRB-5

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824128.9; E 295914.2 MTM NAD 83 ZONE 10 (LAT. 43.557044; LONG. -79.609986)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 203 mm O.D., 108 mm I.D. Hollow Stem Augers (Auto Hammer)

COMPILED BY KN

DATUM Geodetic

DATE February 13, 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
79.2	GROUND SURFACE										
0.0	Silty sand, some gravel, contains rootlets (FILL) Loose Brown		1	SS	6		79				
78.5 / 0.7	Wet Clayey silt with sand, trace to some gravel, contains rootlets / organics. contains clayey silt pockets and shale fragments (FILL) Very stiff Brown and grey Moist/frozen		2	SS	25		78				
			3	SS	23		77				
76.8 / 2.4	Silty SAND to SILT and SAND, trace gravel, trace clay, trace organics, contains clayey silt pockets and rootlets Very loose to loose Brown to grey Moist to wet		4A 4B	SS	6		76				
			5	SS	4		75			OC= 1.1%	5 60 29 6
			6	SS	WH	▽					
74.5 / 4.7	ORGANIC CLAYEY SILT with SAND, trace gravel Very soft to firm Brown Moist		7A 7B	SS	1		74				
73.5 / 5.7	Silty SAND, trace to some gravel, trace clay, contains clayey silt pockets, contains wood fragments Loose Grey Wet		8A 8B	SS	5				46	OC= 7.1%	1 41 50 8
			9	SS	4		73				8 68 20 4
72.0			10A								
7.2	SHALE (BEDROCK) Grey Bedrock cored from a depth of 7.2 m to 15.5 m For bedrock coring details, refer to Record of Drillhole CRB-5		10B 1	SS RC	73 REC 53%		72				RQD = 0%
			2	RC	REC 51%		71				RQD = 13%
			3	RC	REC 100%		70				RQD = 99%
			4	RC	REC 100%		69				RQD = 73%
			5	RC	REC 97%		68				RQD = 78%
			6	RC	REC 100%		67				RQD = 99%
							66				
							65				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No CRB-5

SHEET 2 OF 2 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4824128.9; E 295914.2 MTM NAD 83 ZONE 10 (LAT. 43.557044; LONG. -79.609986)
ORIGINATED BY JL
DIST Central HWY QEW
BOREHOLE TYPE CME 55, 203 mm O.D., 108 mm I.D. Hollow Stem Augers (Auto Hammer)
COMPILED BY KN
DATUM Geodetic
DATE February 13, 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 (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
63.7	SHALE (BEDROCK) Grey		6	RC	REC 100%		64				RQD = 99%
15.5	END OF BOREHOLE NOTES: 1. Water level encountered during drilling at a depth of about 3.7 m (Elev. 75.5 m)below ground surface. 2. Water level measured in open borehole at a depth of about 4.3 m (Elev. 74.9 m) below ground surface prior to rock coring.										

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-5

SHEET 1 OF 1

LOCATION: N 4824128.9 ;E 295914.2

DRILLING DATE: February 13, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

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	Jr	Ja	ROCK STRENGTH INDEX: R4	R3	R2	R1	WEATH-ERING INDEX: W1	W2	W3	W4	W5	W6	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole CRB-5		72.02																						
		Highly weathered, thinly laminated to medium bedded, brown to grey, very fine to fine grained, faintly porous, very weak SHALE (Georgian Bay Formation)		7.18	1							BD,UN,SM CC, CI BD,UN,SM CC, CI	2 2	4 4												R0
		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		71.38 7.82	2							BD,UN,RO PC, CI BD,UN,RO PC, CI	3 3	3 3												R1
8																										PLT(D) = 0.76 MPa PLT(A) = 0.37 MPa
9				69.80								JN,UN,SM SA, CI CO,UN,SM PC, CI	2 2	2 3												
		Slightly weathered to fresh, thinly to medium bedded, grey, fine grained, faintly porous, very weak to weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		9.40	3							JN,PL,SM SA, CI	1	2												PLT(A) = 1.45 MPa R1 R1
10																										R1
																										R1
11	HQ Core																									
					4							CO,UN,SM CL CO,UN,SM SA, CI JN,IR,SM SA, CI	2 2 2	1 2 2												
12												CO,CU,SM PC, CI JN,IR,SM SA, CI CO,UN,SM CC, CI CO,UN,SM CC, CI	2 2 2 2	3 2 4 4												
												BD,UN,SM CC, CI BD,UN,SM CC, CI	2 2	4 4												
					5							BD,UN,SM CL BD,UN,SM CL JN,PL,SM SA, CI CO,UN,SM CC, CI BD,UN,SM IN, CI CO,CU,SM SA, CI JN,IR,SM SA, CI CO,UN,SM SA, CI	2 2 1 2 2 2 2 2	1 1 2 4 6 2 2 2												R0 R1
13																										PLT(D) = 0.07 MPa
																										UC = 18.6 MPa
14												BD,UN,SM IN, CI	2	6												
					6																					PLT(D) = 0.52 MPa PLT(A) = 0.27 MPa
15				63.68																						
		END OF DRILLHOLE		15.52																						
16																										

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: DM

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GOLDER

RECORD OF BOREHOLE No CRB-5A

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824130.9; E 295910.6 MTM NAD 83 ZONE 10 (LAT. 43.557062; LONG. -79.610032)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 55, 159 mm O.D., 70 mm I.D. Hollow Stem Augers (Auto Hammer)

COMPILED BY KN

DATUM Geodetic

DATE February 15 and 16, 2018

CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
79.3	GROUND SURFACE				
0.0	Clayey silt with sand, trace to some gravel, contains organics / rootlets, contains wood fragments. contains shale fragments with limestone (FILL) Firm to hard Brown to grey Moist to wet	1	SS	7	
		2	SS	25	
		3	SS	31	11 45 34 10
		4	SS	16	
		5	SS	12	
75.3					
4.0	Silty SAND, trace rootlets and wood fragments Loose Brown Wet	6A 6B	SS	7	
74.8					
4.5	ORGANIC CLAYEY SILT, some sand, contains sand lenses, wood fragments and shell fragments Very soft to firm Brown Moist to wet	7	SS	1	OC= 5.5% 0 20 62 18
72.9		8A 8B	SS	7	0 71 24 5
6.4	Silty SAND, trace clay, contains shell fragments and rootlets Loose Grey Wet				
72.1					
7.2	SHALE (BEDROCK) Grey	9	SS	100/0.08	
	Bedrock cored from a depth of 7.7 m to 17.2 m	1	RC	REC 100%	RQD = 0%
	For bedrock coring details, refer to Record of Drillhole CRB-5A	2	RC	REC 13%	RQD = 4%
		3	RC	REC 100%	RQD = 69%
		4	RC	REC 100%	RQD = 81%
		5	RC	REC 100%	RQD = 95%
		6	RC	REC 100%	RQD = 95%

ELEVATION SCALE: 79, 78, 77, 76, 75, 74, 73, 72, 71, 70, 69, 68, 67, 66, 65

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

Continued Next Page

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

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

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GOLDER

PROJECT 1662333

RECORD OF BOREHOLE No CRB-5A

SHEET 2 OF 2

METRIC

G.W.P. 2002-13-00 LOCATION N 4824130.9; E 295910.6 MTM NAD 83 ZONE 10 (LAT. 43.557062; LONG. -79.610032) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 55, 159 mm O.D., 70 mm I.D. Hollow Stem Augers (Auto Hammer) COMPILED BY KN

DATUM Geodetic DATE February 15 and 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 ---										
	SHALE (BEDROCK) Grey Bedrock cored from a depth of 7.7 m to 17.2 m For bedrock coring details, refer to Record of Drillhole CRB-5A		6	RC	REC 100%		64				RQD = 95%
			7	RC	REC 100%		63				RQD = 100%
62.1 17.2	END OF BOREHOLE										

NOTES:

1. Water level encountered during drilling at a depth of about 4.0 m (Elev. 75.3 m) below ground surface.

2. Water level measured in open borehole at a depth of about 3.6 m (Elev. 75.7 m) below ground surface prior to rock coring.

3. Groundwater level measurements in piezometer:

Date	Depth (m)	Elev. (m)
12/03/18	1.6	77.7
30/04/18	4.0	75.3
06/11/18	4.6	74.7

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

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-5A

SHEET 1 OF 2

LOCATION: N 4824130.9 ;E 295910.6

DRILLING DATE: February 15 and 16, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

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: R4	ROCK STRENGTH INDEX: R3	ROCK STRENGTH INDEX: R2	ROCK STRENGTH INDEX: R1	WEATHERING INDEX: W1	WEATHERING INDEX: W2	WEATHERING INDEX: W3	WEATHERING INDEX: W4	WEATHERING INDEX: W5	WEATHERING INDEX: W6	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole CRB-5A		71.58																							
8	HQ Core	Completely to highly weathered, thinly laminated to medium bedded, brown to grey, very fine to fine grained, faintly porous, extremely weak SHALE (Georgian Bay Formation)		7.72	1																						
					2							JN,UN,SM SA	2	2													
9				69.75																							
		Fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		9.55																							
10					3							CO,UN,SM SA, CI	2	2													
												JN,PL,SM CC, CI	2	4													
												JN,PL,SM CL	1	1													
												CO,UN,SM PC, CI	2	3													PLT(D) = 0.56 PLT(A) = 0.42
												CO,UN,SM IN, CI	2	6													
												BD,UN,SM CL	2	1													
11					4							JN,CU,SM CL	2	1													
												CO,UN,SM SA, CI	2	2													
												CO,UN,SM SA, CI	2	2													
												CO,UN,SM IN, CI	2	6													
												CO,UN,SM IN, CI	2	6													
												CO,UN,SM IN, CI	2	6													
												JN,PL,SM CL	1	2													
												JN,UN,SM SA, CI	2	2													
12												CO,UN,SM IN, CI	2	6													
												CO,UN,SM PC, CI	2	3													
												BD,UN,SM PC, CI	2	3													
																											UC = 14.2 MPa
13					5							CO,CU,SM SA, CI	2	2													
												JN,UN,SM CL	2	1													
												CO,UN,SM CL	2	1													
												BD,UN,SM IN, CI	2	6													
14																											PLT(D) = 0.43 PLT(A) = 0.07
												CO,UN,SM SA, CI	2	2													
15					6							CO,UN,SM SA, CI	2	2													
												CO,UN,SM CL	2	1													
																											UC = 22.7 MPa
16					7							BD,UN,SM SA, CI	2	2													
		CONTINUED NEXT PAGE																									

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: DM

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-5A

SHEET 2 OF 2

LOCATION: N 4824130.9 ;E 295910.6

DRILLING DATE: February 15 and 16, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track

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	Jr	Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																	
17	HQ Core				7														PLT(D) = 0.82 PLT(A) = 0.24
		END OF DRILLHOLE		62.14 17.16															
18																			
19																			
20																			
21																			
22																			
23																			
24																			
25																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: DM

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GOLDER

RECORD OF BOREHOLE No CRB-6

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824196.7; E 295929.5 MTM NAD 83 ZONE 10 (LAT. 43.557650; LONG. -79.609801)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing (Auto Hammer)

COMPILED BY MPL

DATUM Geodetic

DATE October 18-20, 2017

CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
91.7	GROUND SURFACE										
0.0	Silty sand, trace to some gravel, trace clay, contains brick fragments (FILL) Loose to compact Brown Moist		1	SS	11		91				
			2	SS	5				○		7 67 24 2
90.0											
1.7	Sandy CLAYEY SILT, trace to some gravel Firm to stiff brown Moist to wet - Mottled brown-grey below a depth of about 2.3 m		3A 3B	SS	5		90		○		
			4	SS	7		89		○		
			5	SS	9		88		○		
	- Becoming gravelly at a depth of about 3.7 m - Auger grinding at a depth of about 3.7 m		6	SS	5				○		10 26 44 20
87.3											
4.4	Sandy CLAYEY SILT, some shale fragments (RESIDUAL SOIL) Hard Grey Moist		7	SS	50/0.13		87		○		
86.9											
4.8	SHALE (BEDROCK) Grey		1	RC	REC 86%		86				RQD = 47%
	Bedrock cored from a depth of 5.1 m to 13.3 m For bedrock coring details, refer to Record of Drillhole CRB-6		2	RC	REC 100%		85				RQD = 95%
			3	RC	REC 100%		84				RQD = 100%
			4	RC	REC 100%		82				RQD = 95%
			5	RC	REC 100%		80				RQD = 100%
			6	RC	REC 96%		79				RQD = 96%
78.4											
13.3	END OF BOREHOLE										

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

PROJECT 1662333

RECORD OF BOREHOLE No CRB-6

SHEET 2 OF 2

METRIC

G.W.P. 2002-13-00 LOCATION N 4824196.7; E 295929.5 MTM NAD 83 ZONE 10 (LAT. 43.557650; LONG. -79.609801) ORIGINATED BY JL

DIST Central HWY QEW BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing (Auto Hammer) COMPILED BY MPL

DATUM Geodetic DATE October 18-20, 2017 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 / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100 ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L 10 20 30	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										

NOTES:

1. Borehole dry prior to rock coring.

2. Water level measured in standpipe piezometer:

Date	Depth (m)	Elev. (m)
12/11/17	5.6	86.1
12/03/18	5.0	86.7
30/04/18	4.9	86.8
06/11/18	4.9	86.8

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-6

SHEET 1 OF 1

LOCATION: N 4824196.7 ;E 295929.5

DRILLING DATE: October 18-20, 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 CRB-6		86.63															
	HQ Casing	Moderately weathered to fresh, thinly laminated to medium bedded, grey, very fine to fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with LIMESTONE interbeds		5.12															
				86.25															
				5.50	1							BD,PL,SM CL	1	1				R1	
												BD,PL,RO SA	1.5	2					
												CO,UN,RO CL	3	1				R1	
6												CO,UN,RO CL	3	1					PLT(A) = 0.70 MPa PLT(D) = 0.44 MPa UCS = 14.6 MPa
		Moderately weathered to fresh, thinly laminated to medium bedded, grey, fine grained, slightly porous, weak SHALE (Georgian Bay Formation) with slightly weathered to fresh, thinly bedded, grey, fine grained, non-porous, medium strong, LIMESTONE interbeds.																	
					2							BD,PL,SM CL	1	1				R1	
												BD,PL,SM CL	1	1					
												BD,PL,SM CL	1	1					
												CO,UN,RO PC, Cl	3	3				R1	
7												CO,PL,SM SA	1	2					
												CO,UN,SM CL	2	1					PLT(A) = 0.65 MPa PLT(D) = 0.51 MPa
8												BD,UN,SM CL	2	1					
					3							CO,UN,RO CL	3	1					
9	HQ Core											BD,PL,SM CL	1	1					PLT(A) = 0.61 MPa PLT(D) = 0.15 MPa
												CO,PL,SM PC, Cl	1	3					
												BD,PL,SM CL	1	1					
10					4							BD,PL,SM CL	1	1					
11												BD,PL,SM CL	1	1					
					5														
12												BD,PL,SM CL	1	1					
					6							CO,UN,SM PC, Cl	2	3					
13												BD,IR,RO CL	3	1					
				78.48															
		END OF DRILLHOLE		13.27															
14																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: MPL

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GOLDER

RECORD OF BOREHOLE No CRB-7

SHEET 1 OF 2

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824189.6; E 295951.1 MTM NAD 83 ZONE 10 (LAT. 43.557590; LONG. -79.609531)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing (Auto Hammer)

COMPILED BY MPL

DATUM Geodetic

DATE October 23, 2017

CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.7	GROUND SURFACE										
0.0	TOPSOIL (180mm)										
0.2	Silt and sand, trace gravel, trace clay (FILL) Loose to compact Brown Moist		1	SS	8		94				
			2	SS	9				○		
			3	SS	12		93		○		3 62 33 2
	- Becoming wet at a depth of about 2.6 m		4	SS	19		92				
			5	SS	21				○		
	- Brick fragments at a depth of about 4.0 m		6A 6B	SS	54		91		○		
90.2											
4.5	Sandy SILT, trace clay Compact Brown Wet - Clayey silt layer between 4.6 m to 4.7 m - Becoming grey at a depth of about 4.9 m		7	SS	26		90		○		
			8	SS	25		89		○		NP 0 22 75 3
88.2	- Clayey silt layer between 6.4 m and 6.5 m		9A 9B 9C	SS	17				○		
6.5	CLAYEY SILT with SAND, trace gravel (TILL) Stiff to hard Grey Moist		10	SS	10		88		○		4 30 47 19
86.9											
86.6	Sandy CLAYEY SILT, containing shale fragments (RESIDUAL		11	SS	50/0.15		87		○		
8.1	SOIL) Hard Grey Moist										
	SHALE (BEDROCK) Grey Bedrock cored from a depth of 8.5 m to 16.0 m		1	RC	REC 79%		86				RQD = 25%
	For bedrock coring details, refer to Record of Drillhole CRB-7		2	RC	REC 100%		85				RQD = 95%
			3	RC	REC 100%		84				RQD = 100%
			4	RC	REC 100%		83				RQD = 89%
			5	RC	REC 100%		82				RQD = 100%
							81				
							80				RQD = 100%

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No CRB-7

SHEET 2 OF 2 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4824189.6; E 295951.1 MTM NAD 83 ZONE 10 (LAT. 43.557590; LONG. -79.609531)
ORIGINATED BY JL
DIST Central HWY QEW
BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers, HQ Casing (Auto Hammer)
COMPILED BY MPL
DATUM Geodetic
DATE October 23, 2017
CHECKED BY SMM

SOIL PROFILE 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 + 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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SHALE (BEDROCK) Grey		5	RC	REC 100%						RQD = 100%
78.7			6	RC	REC 100%		79				RQD = 100%
16.0	END OF BOREHOLE NOTE: 1. Borehole dry prior to rock coring.										

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

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PROJECT: 1662333

RECORD OF DRILLHOLE: CRB-7

SHEET 1 OF 1

LOCATION: N 4824189.6 ;E 295951.1

DRILLING DATE: October 23, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850 Track

DRILLING CONTRACTOR: Aardvark Drilling

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

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	ROCK STRENGTH INDEX: R4	R3	R2	R1	WEATHERING INDEX: W1	W2	W3	W4	W5	W6	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole CRB-7		86.16																						
9	HQ Core	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		8.53	1							BD,PL,SM SO, Cl	1	1													PLT(A) = 0.47 MPa PLT(D) = 0.26 MPa
				85.48																						
		Slightly weathered to fresh, thinly bedded, grey, fine grained, non-porous, weak to medium strong, SHALE (Georgian Bay Formation) with slightly weathered to fresh, thinly bedded, grey, fine grained, non-porous, medium strong, LIMESTONE interbeds.		9.21								BD,PL,SM CL	1	1													UC = 15.5 MPa PLT(A) = 0.56 MPa PLT(D) = 0.42 MPa
10					2							BD,UN,RO PC, Cl BD,UN,RO PC, Cl BD,PL,RO CL BD,UN,RO CL	3 3 1.5 3	3 3 1 1													
												CO,UN,RO CC, Cl	3	4													
11					3							CO,UN,SM CL	2	1													
												CO,UN,SM CL	2	1													
												BD,UN,RO SA	3	2													
												CO,UN,SM PC, Cl	2	3													
12																											PLT(A) = 0.85 MPa PLT(D) = 0.32 MPa UC = 7.4 MPa
					4							CO,PL,SM CL	1	1													
												BD,UN,RO PC, Cl	3	3													
												BD,UN,RO CL	3	1													
13												BD,UN,RO PC, Cl	3	3													
												BD,UN,RO PC, Cl	3	3													
												BD,UN,RO PC, Cl	3	3													
												BD,UN,RO PC, Cl	3	3													
14					5							CO,UN,RO PC, Cl	3	3													
												CO,UN,RO PC, Cl	3	3													
15												CO,PL,SM CL	1	1													
					6																						
16				78.65																						
		END OF DRILLHOLE		16.04																						
17																											

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: MPL

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GOLDER

RECORD OF BOREHOLE No CRB-8

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4824211.5; E 295953.7 MTM NAD 83 ZONE 10 (LAT. 43.557788; LONG. -79.609499)

ORIGINATED BY JL

DIST Central HWY QEW

BOREHOLE TYPE CME 850, 210 mm O.D. Hollow Stem Augers (Auto Hammer)

COMPILED BY MPL

DATUM Geodetic

DATE October 17, 2017

CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.7	GROUND SURFACE										
0.0 / 0.1	TOPSOIL (80 mm)										
	Sand, some silt, trace clay (FILL) Very loose to compact Brown Moist		1	SS	3						
			2	SS	12		94		○		
93.3						▽					
1.5	SAND, some silt, trace clay Compact to dense Brown Moist		3	SS	21		93		○		
			4	SS	44		92		○		0 84 14 2
	- Becoming wet below a depth of about 3.1 m - Clayey silt pockets at a depth of about 3.1 m		5	SS	35				○		
91.0							91				
3.7	SILT, trace to some sand, trace to some clay Slight plasticity Dense to very dense Grey Wet		6	SS	67				○		
			7	SS	32		90		⊕		0 7 85 8
	- Becoming grey and brown at a depth of about 5.6 m						89				
88.3			8A / 8B	SS	22				○		
6.4	CLAYEY SILT, some sand Very stiff Grey Wet						88				
87.1											
7.6	Sandy CLAYEY SILT with shale fragments (RESIDUAL SOIL) Hard Grey Moist		9A	SS	50/0.13		87		○ ⊕		31 27 34 8
86.7 / 8.1			9B								
86.2			10	SS	50/0.08						
8.5	- Auger grinding at a depth of about 7.6 m SHALE (BEDROCK) Grey END OF BOREHOLE - SPLIT-SPOON REFUSAL										

NOTE:

1. Water level measured at a depth of about 1.5 m (Elev. 93.2 m) below ground surface upon completion of drilling.

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

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

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GOLDER

RECORD OF BOREHOLE No NW6-1

SHEET 1 OF 1

METRIC

PROJECT 1662333

G.W.P. 2002-13-00 LOCATION N 4824163.1; E 295975.2 MTM NAD 83 ZONE 10 (LAT. 43.557371; LONG. -79.609278) ORIGINATED BY ACM

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

DATUM Geodetic DATE July 10, 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
95.3	GROUND SURFACE										
0.0	ASPHALT (150 mm)										
	CONCRETE (150 mm)										
0.3	Gravelly sand, some fines (FILL) Compact to very dense Brown Moist		1	SS	60		95				21 60 (19)
			2	SS	47		94				
			3	SS	40				○		
			4	SS	10		93		○		
92.3											
3.0	Silty SAND, trace to some clay Very loose to dense Brown Moist		5	SS	4		92		○		
			6	SS	3				○		1 67 25 7
			7	SS	34		91		○		
90.0											
5.3	SILT, trace to some sand, trace to some clay Dense Brown to grey below 6.6 m Moist		8	SS	32		90		○		0 8 80 12
			9	SS	41	▽	89		○		
			10A	SS	35						
88.0			10B				88		d		3 22 50 25
7.5	Sandy CLAYEY SILT, trace gravel (TILL) Hard Grey Moist										
	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of 6.4 m below ground surface upon removal of hollow stem augers.

2. Water level measured at a depth of 6.3 m (Elev. 89.0 m) below ground surface upon completion of soil drilling.

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

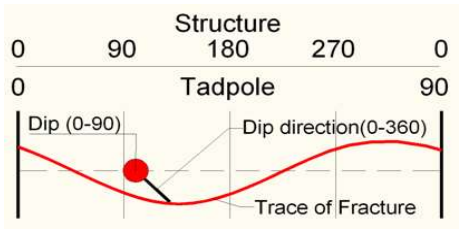
GTA-MTO 001 S:\CLIENTS\MTO\QEW-CREDIT_RIVER\02_DATA\GINT\QEW-CREDIT_RIVER.GPJ GAL-GTA.GDT 02/06/19

GOLDER

GEOPHYSICAL RECORD OF BOREHOLE: CRB-2B

Project Number: 1662333
Client: Morrison Hershfield Ltd.
Date: July 2018

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	2.5 m bgs	**Location:**	QEW Credit River
Easting:	295,818.7 m E	**Drilled Depth:**	13 m bgs	**Water Level:**	8.2 m bgs	**Log Date:**	6-Jul-18
Northing:	4,823,955.2 m N	**Borehole Diameter:**	97 mm	**Borehole Inclination:**	0 deg, Vertical		
Elevation:	94.7 m asl	**Casing Diameter:**	100 mm	**Borehole Azimuth:**	N/A	**Logged By:**	AR



Partially Open Joint / Fracture

Filled Fracture / Joint

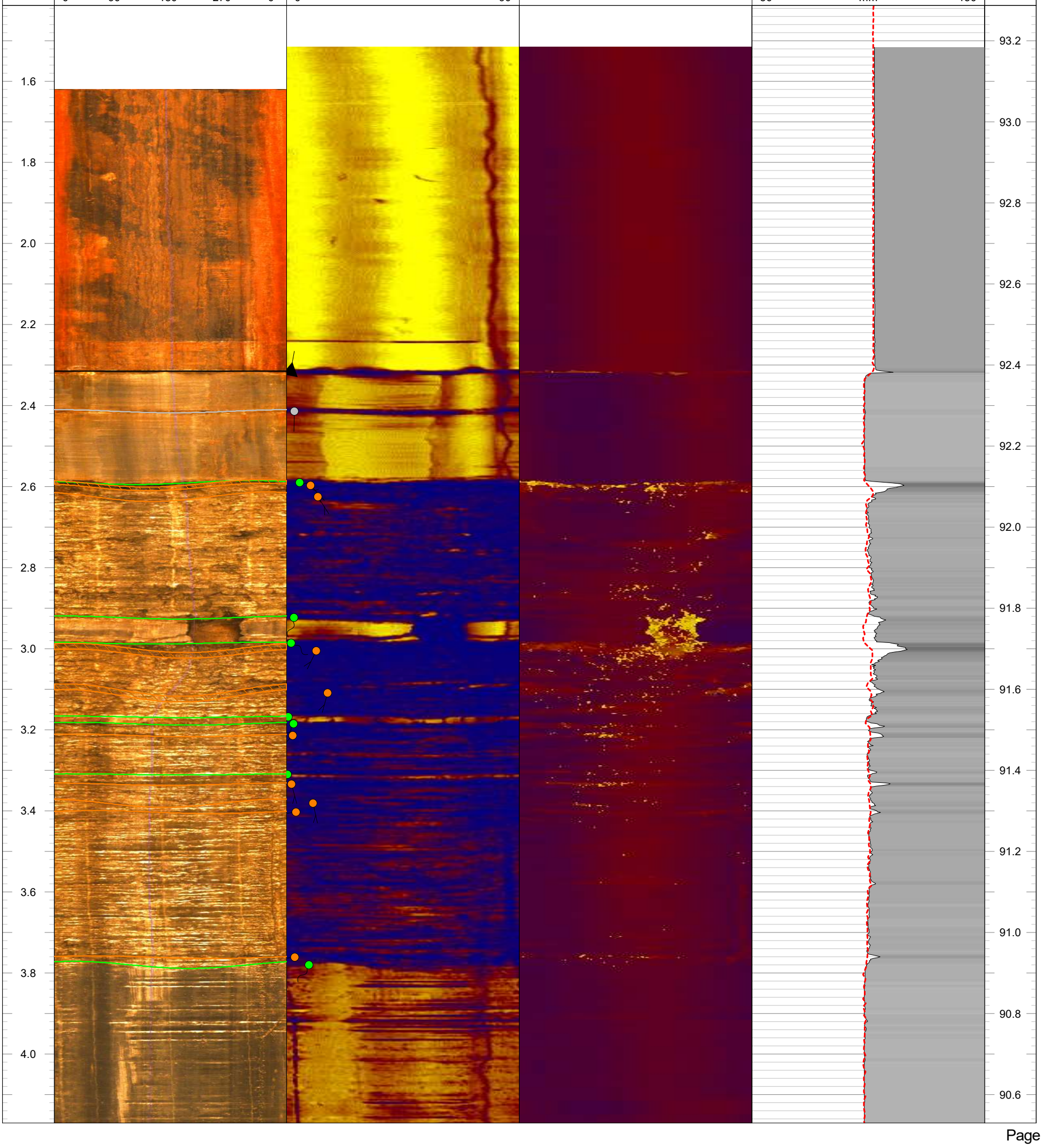
Bedding / Banding / Foliation

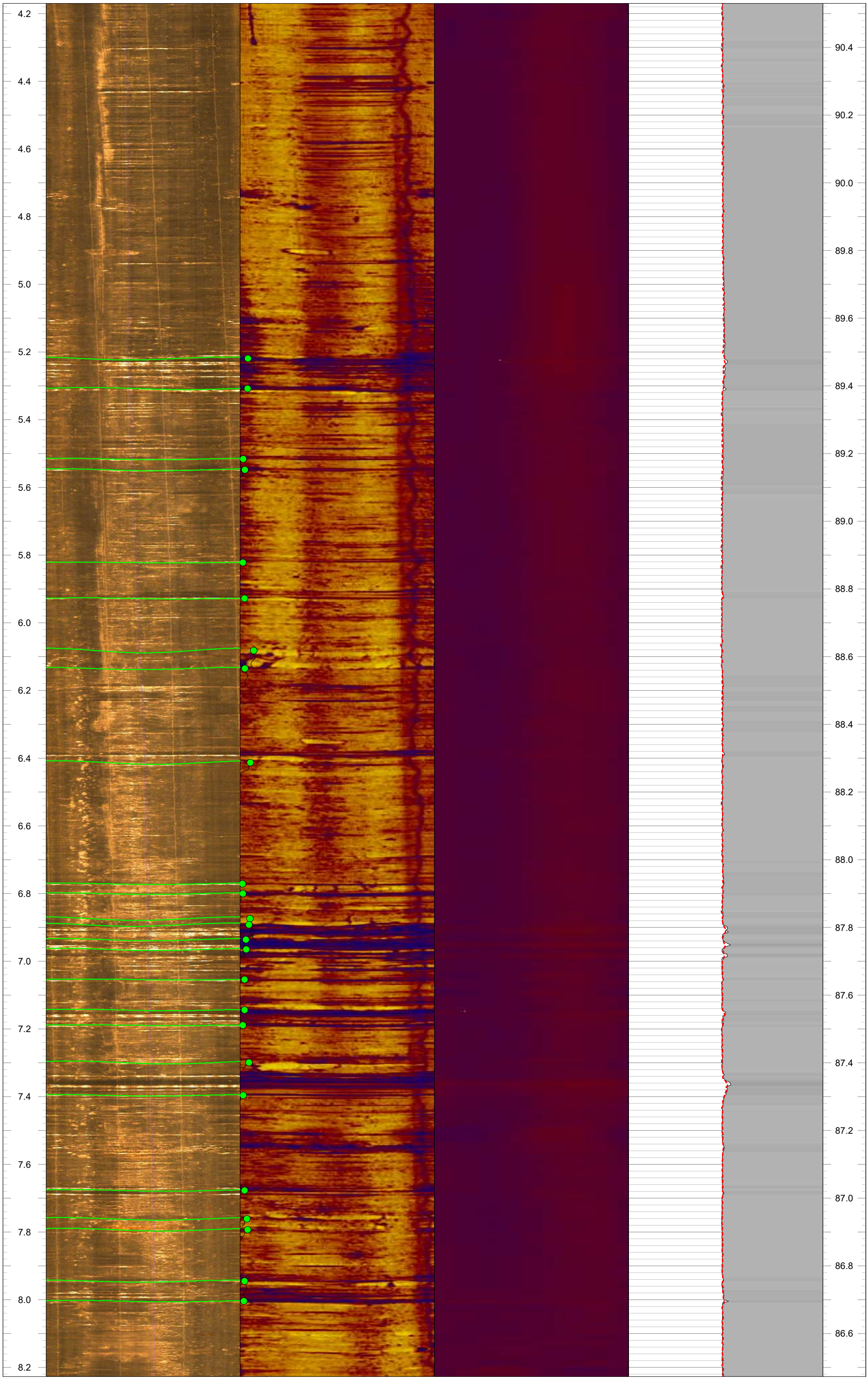
Casing

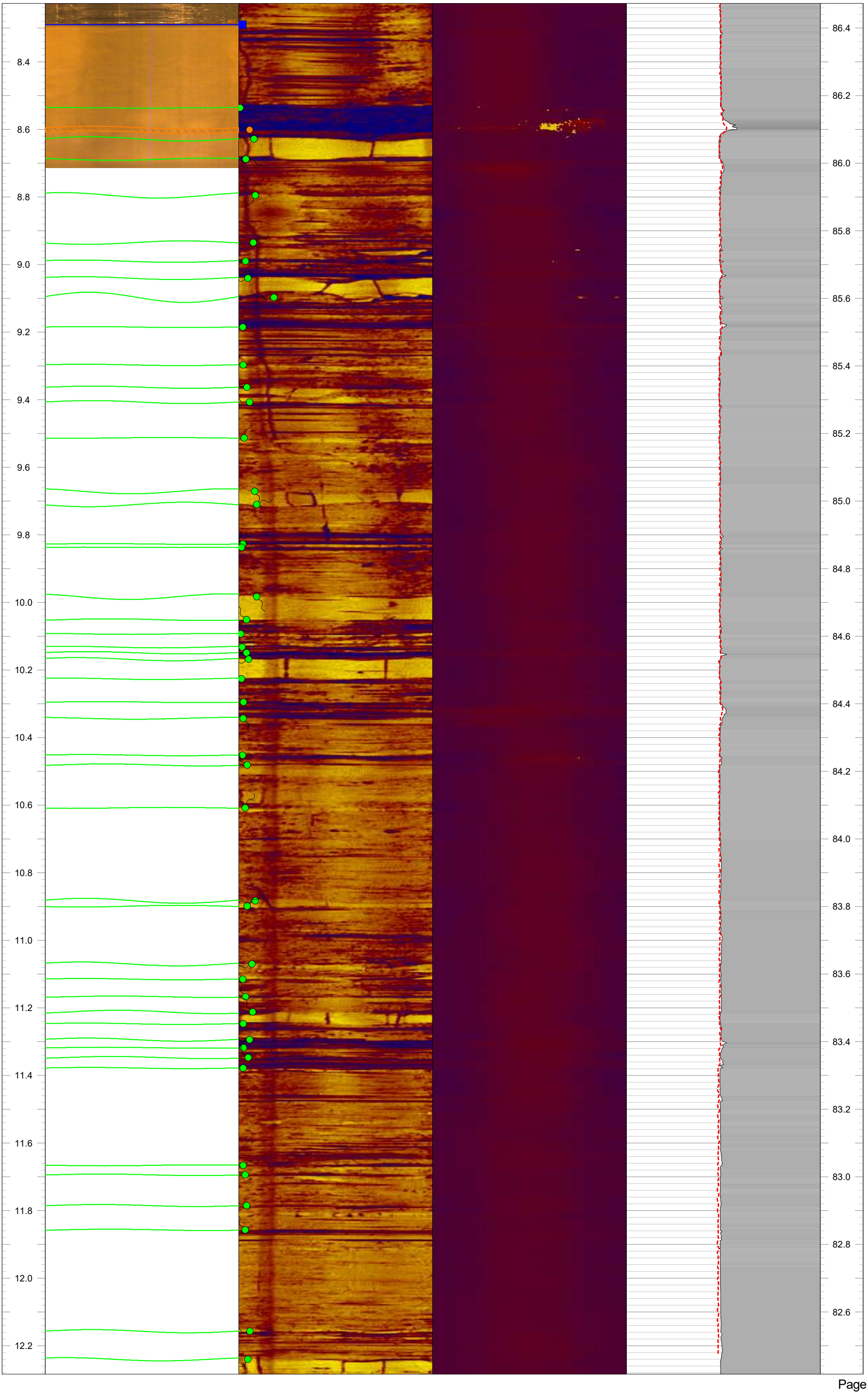
Water Table

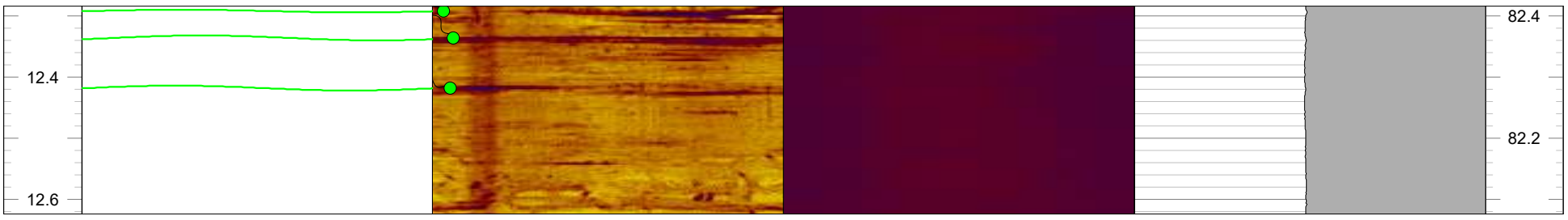
Notes:

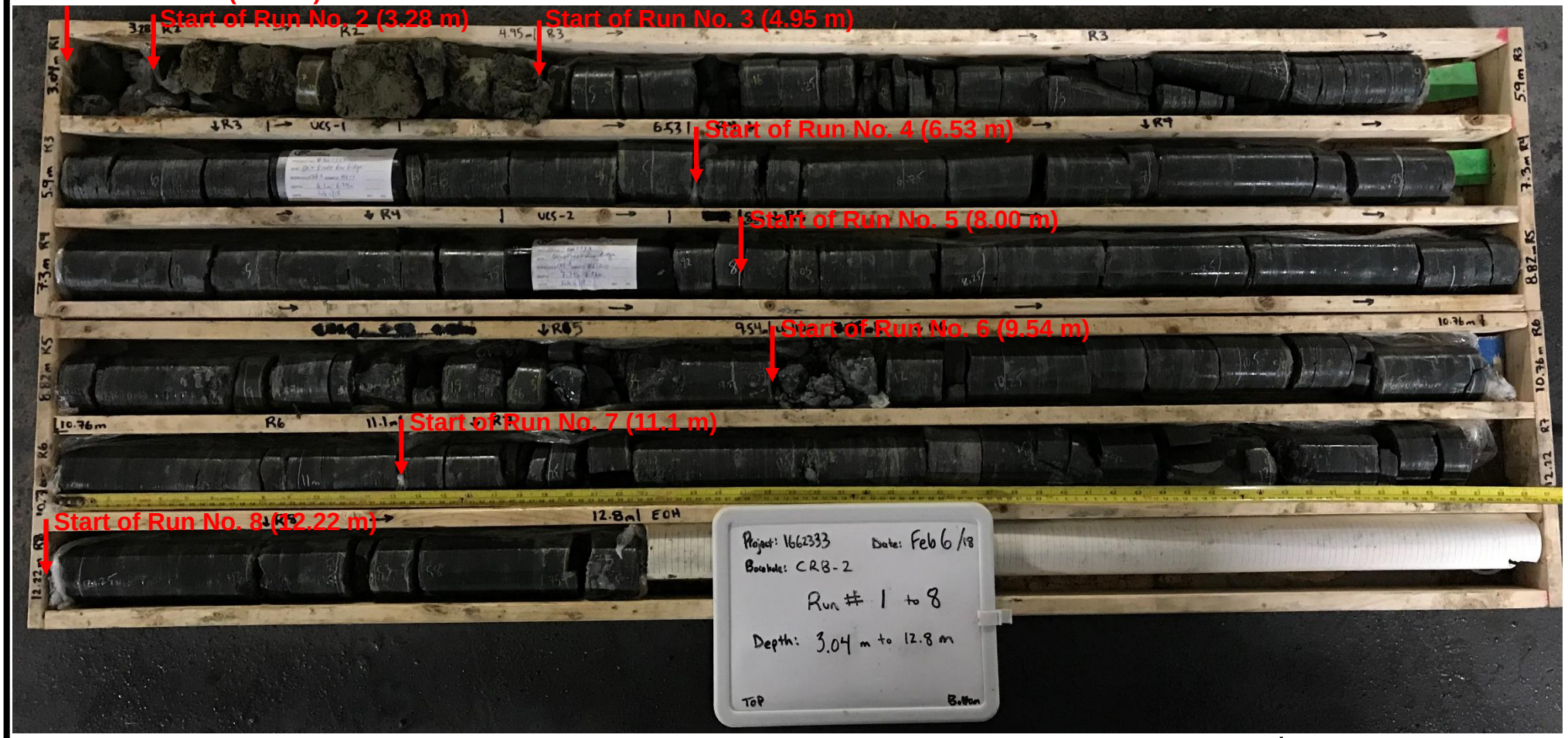
Depth	Optical Image MN	Acoustic Amplitude MN	Acoustic Travel Time MN	Acoustic Caliper	Elevation
	0° 90° 180° 270° 0°	0° 90° 180° 270° 0°	0° 90° 180° 270° 0°	50 mm 150	
1m:10m	Structure	Tadpoles TD&DD		Caliper	m asl
	0° 90° 180° 270° 0°	0 90		50 mm 150	




4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
90.4
90.2
90.0
89.8
89.6
89.4
89.2
89.0
88.8
88.6
88.4
88.2
88.0
87.8
87.6
87.4
87.2
87.0
86.8
86.6


8.4
8.6
8.8
9.0
9.2
9.4
9.6
9.8
10.0
10.2
10.4
10.6
10.8
11.0
11.2
11.4
11.6
11.8
12.0
12.2
86.4
86.2
86.0
85.8
85.6
85.4
85.2
85.0
84.8
84.6
84.4
84.2
84.0
83.8
83.6
83.4
83.2
83.0
82.8
82.6


12.4
12.6
82.4
82.2



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

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

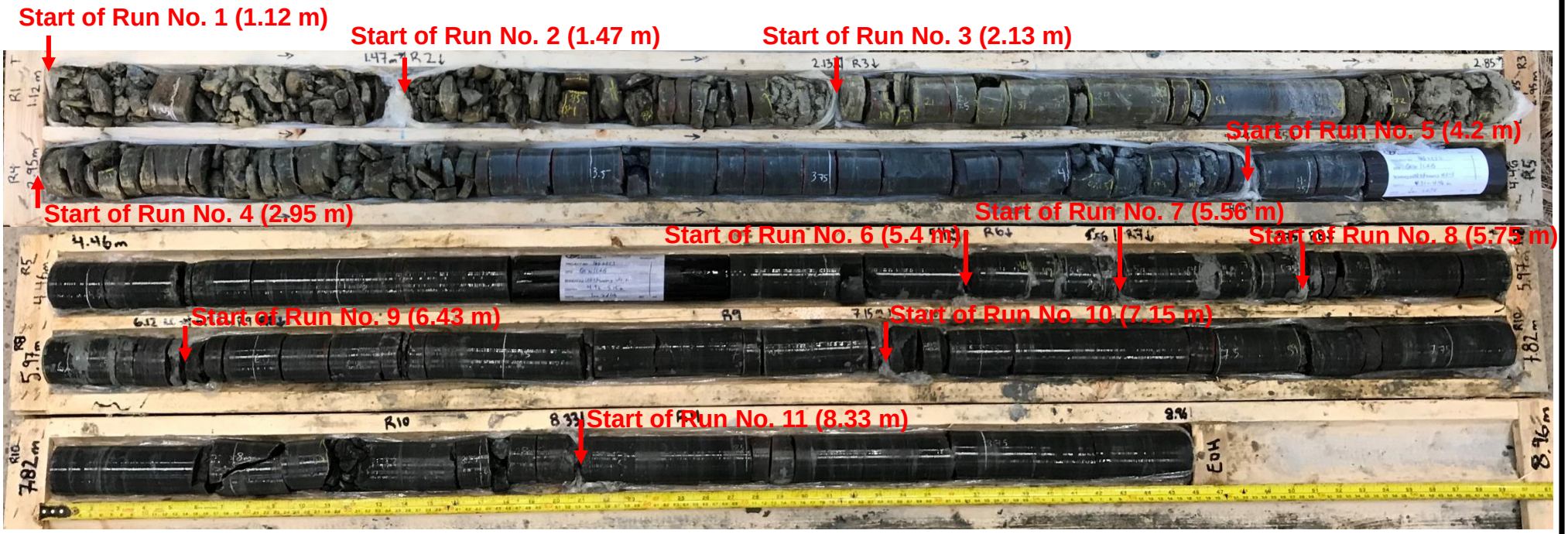
TITLE
Bedrock Core Photograph
Borehole CRB-2 (3.04 m to 12.8 m)

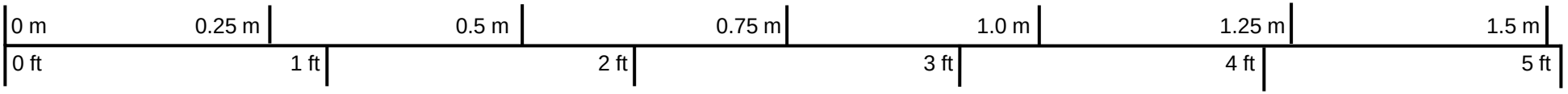
GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018			
REVIEW	SMM	June 2018			

FIGURE B-1

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





Scale

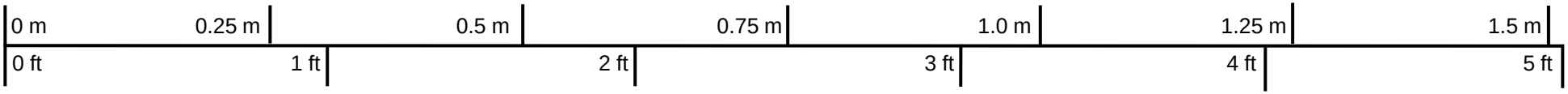
PROJECT
MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW Between Mississauga Road and Hurontario Street

TITLE
Bedrock Core Photograph
Borehole CRB-2A (1.12 m to 8.96 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018	**FIGURE B-2**		
REVIEW	SMM	June 2018			

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



Scale

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

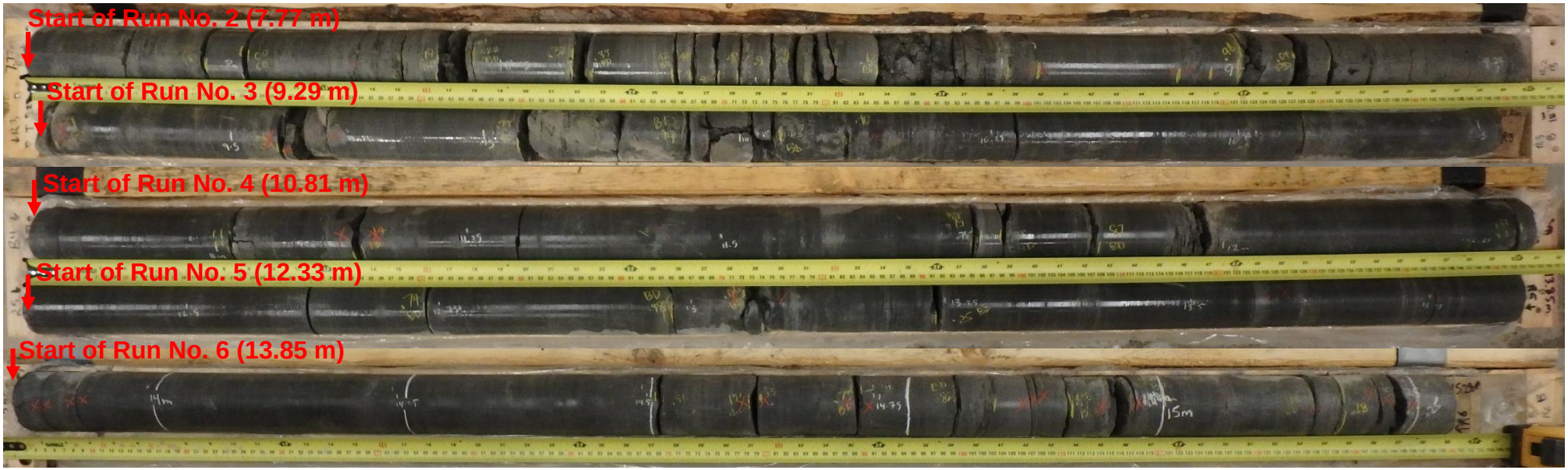
TITLE
Bedrock Core Photograph
Borehole CRB-2B (3.64 m to 12.72 m)

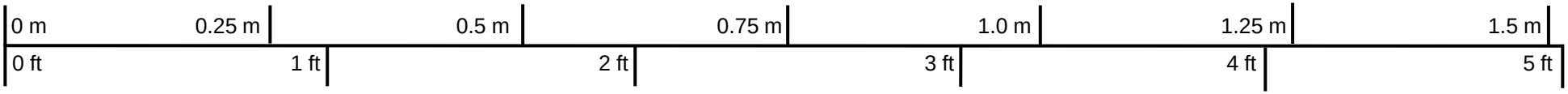
GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	SK	July 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK					
REVIEW					

FIGURE B-3

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





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 CRB-3 (7.77 m to 15.28 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018			
REVIEW	SMM	June 2018			

FIGURE B-4

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

PROJECT

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

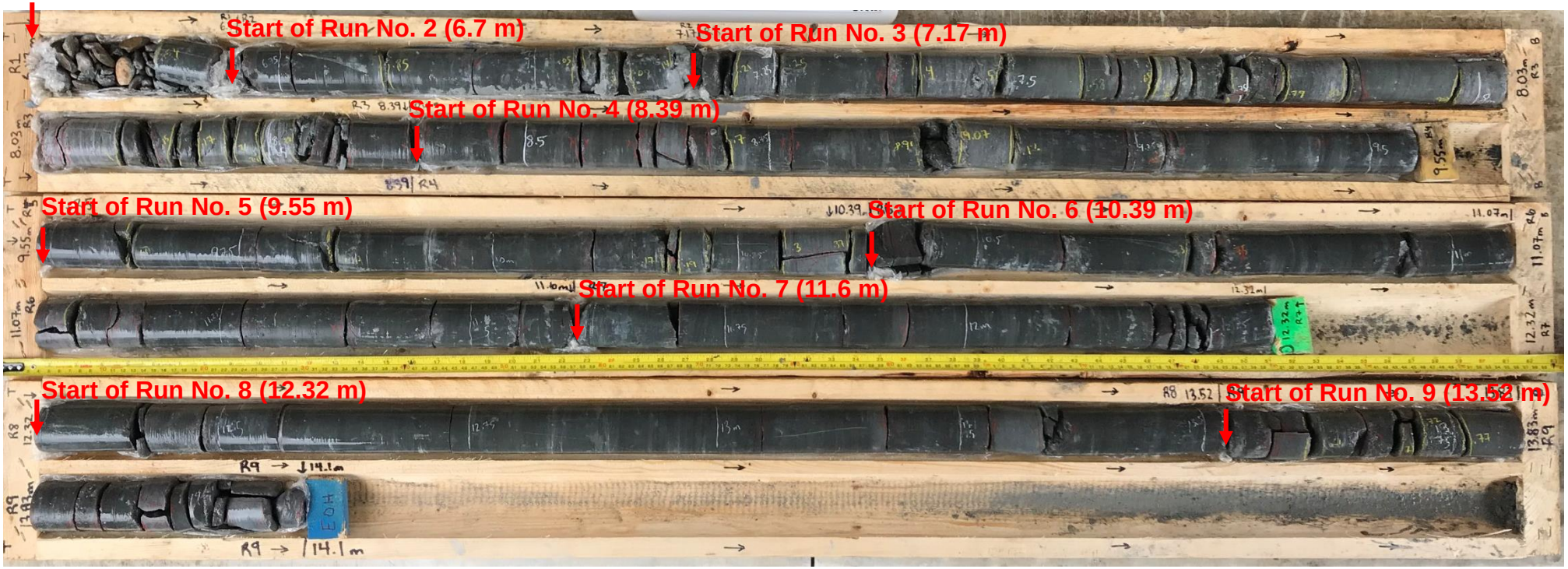
TITLE

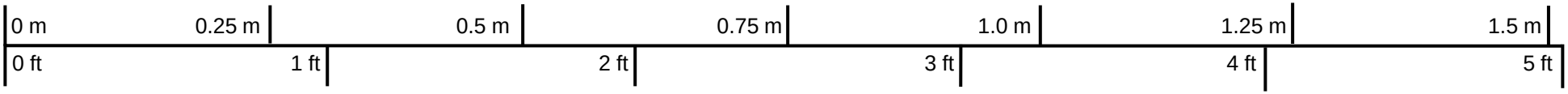
Bedrock Core Photograph
Borehole CRB-3A (7.01 m to 15.78 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018	**FIGURE B-5**		
REVIEW	SMM	June 2018			

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





Scale

PROJECT

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

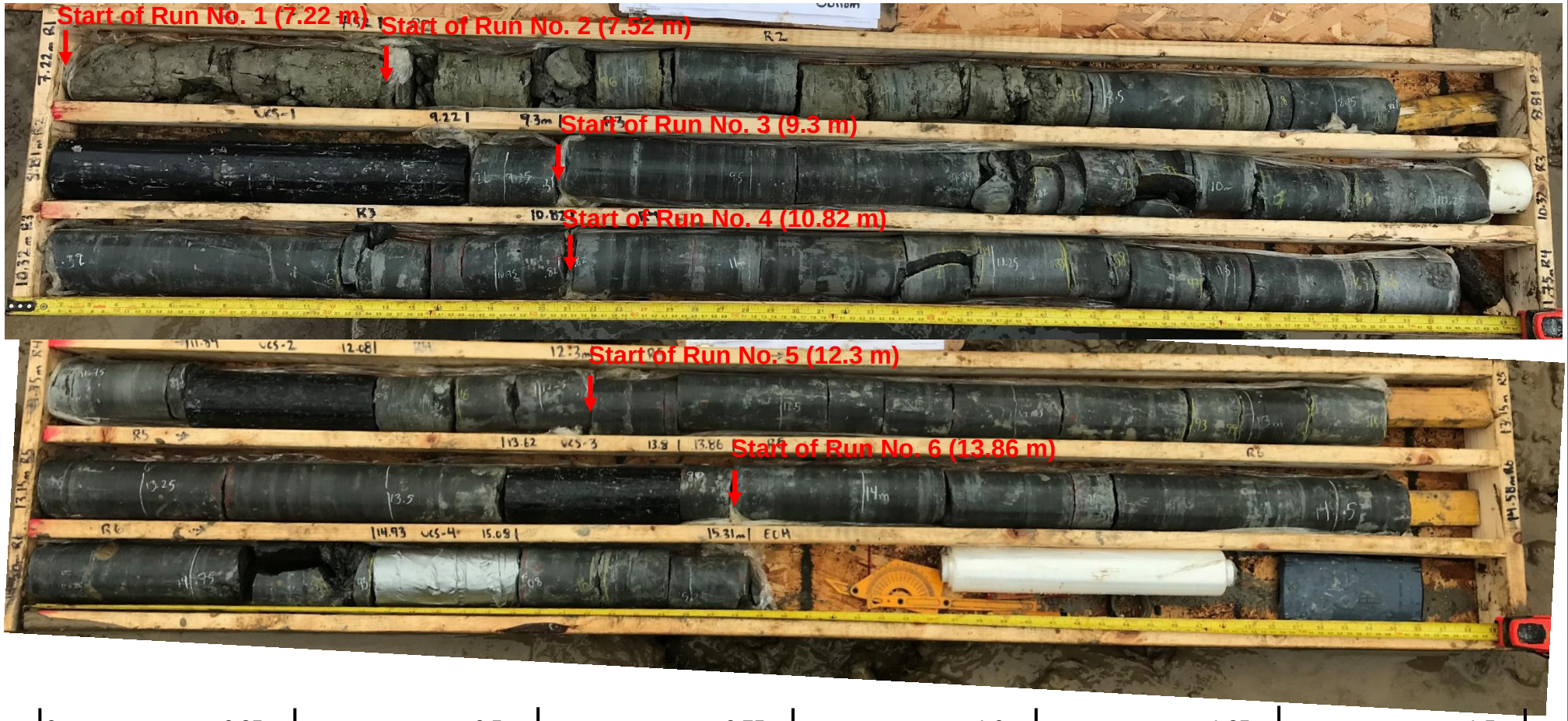
TITLE

Bedrock Core Photograph
Borehole CRB-3C (6.43 m to 14.1 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018	**FIGURE B-6**		
REVIEW	SMM	June 2018			

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

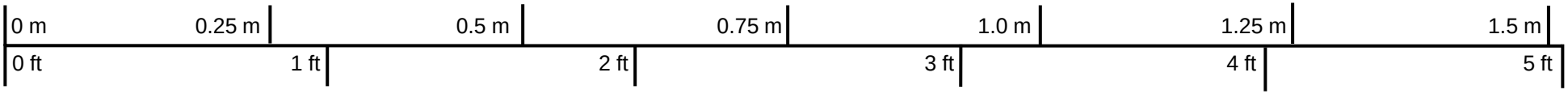
PROJECT
MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW Between Mississauga Road and Hurontario Street

TITLE
Bedrock Core Photograph
Borehole CRB-4 (7.22 m to 15.31 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018	**FIGURE B-7**		
REVIEW	SMM	June 2018			

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



Scale

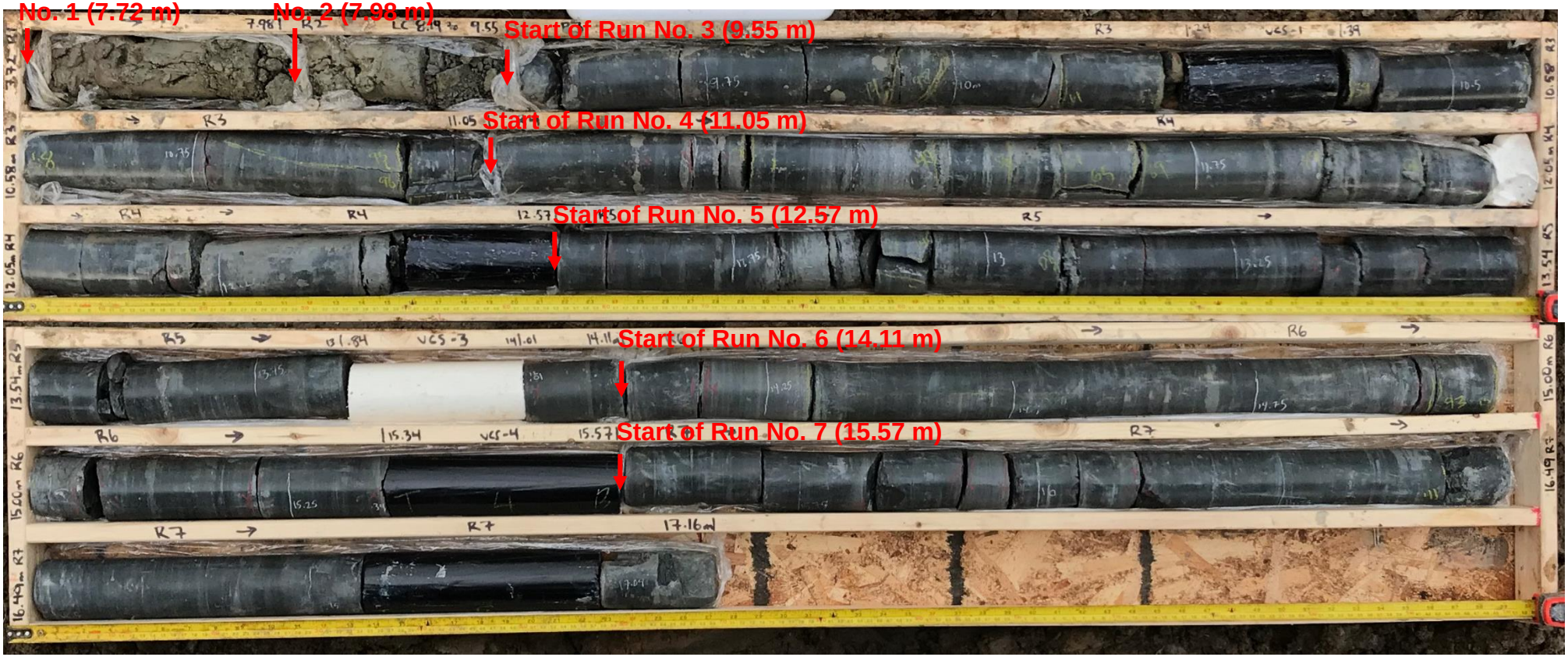
PROJECT
MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW Between Mississauga Road and Hurontario Street

TITLE
Bedrock Core Photograph
Borehole CRB-5 (7.18 m to 15.52 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018	**FIGURE B-8**		
REVIEW	SMM	June 2018			

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

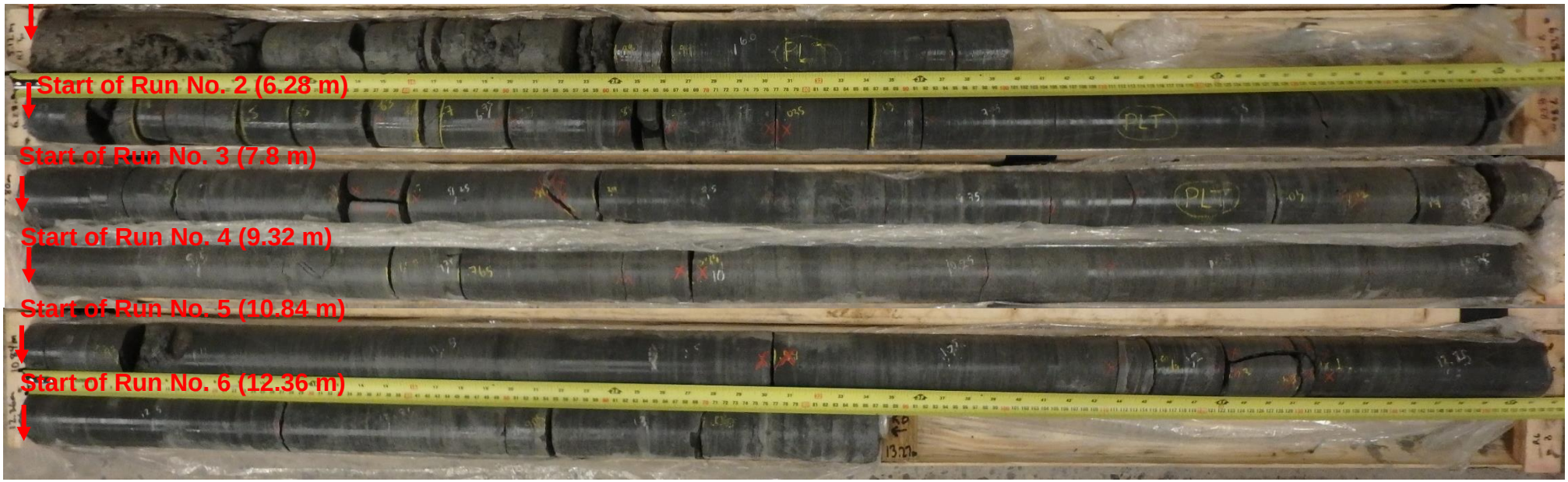
PROJECT
MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW Between Mississauga Road and Hurontario Street

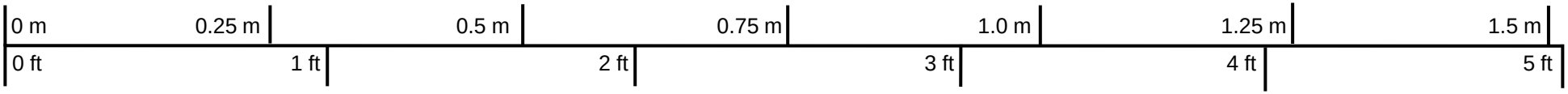
TITLE
Bedrock Core Photograph
Borehole CRB-5A (7.72 m to 17.16 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018	**FIGURE B-9**		
REVIEW	SMM	June 2018			

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





Scale

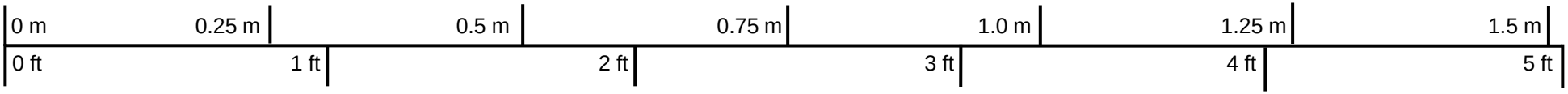
PROJECT
MTO Assignment 2015-E-0033: Detail Design for the widening/rehab/realignment of QEW Between Mississauga Road and Hurontario Street

TITLE
Bedrock Core Photograph
Borehole CRB-6 (5.12 m to 13.27 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-10**		
CHECK	DM	June 2018			
REVIEW	SMM	June 2018			

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



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 CRB-7 (8.53 m to 16.04 m)

GOLDER

PROJECT No. 1662333			FILE No. ----		
DRAFT	JIL	Mar 2018	SCALE	AS SHOWN	VER. 1.
CADD	--				
CHECK	DM	June 2018	**FIGURE B-11**		
REVIEW	SMM	June 2018			

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

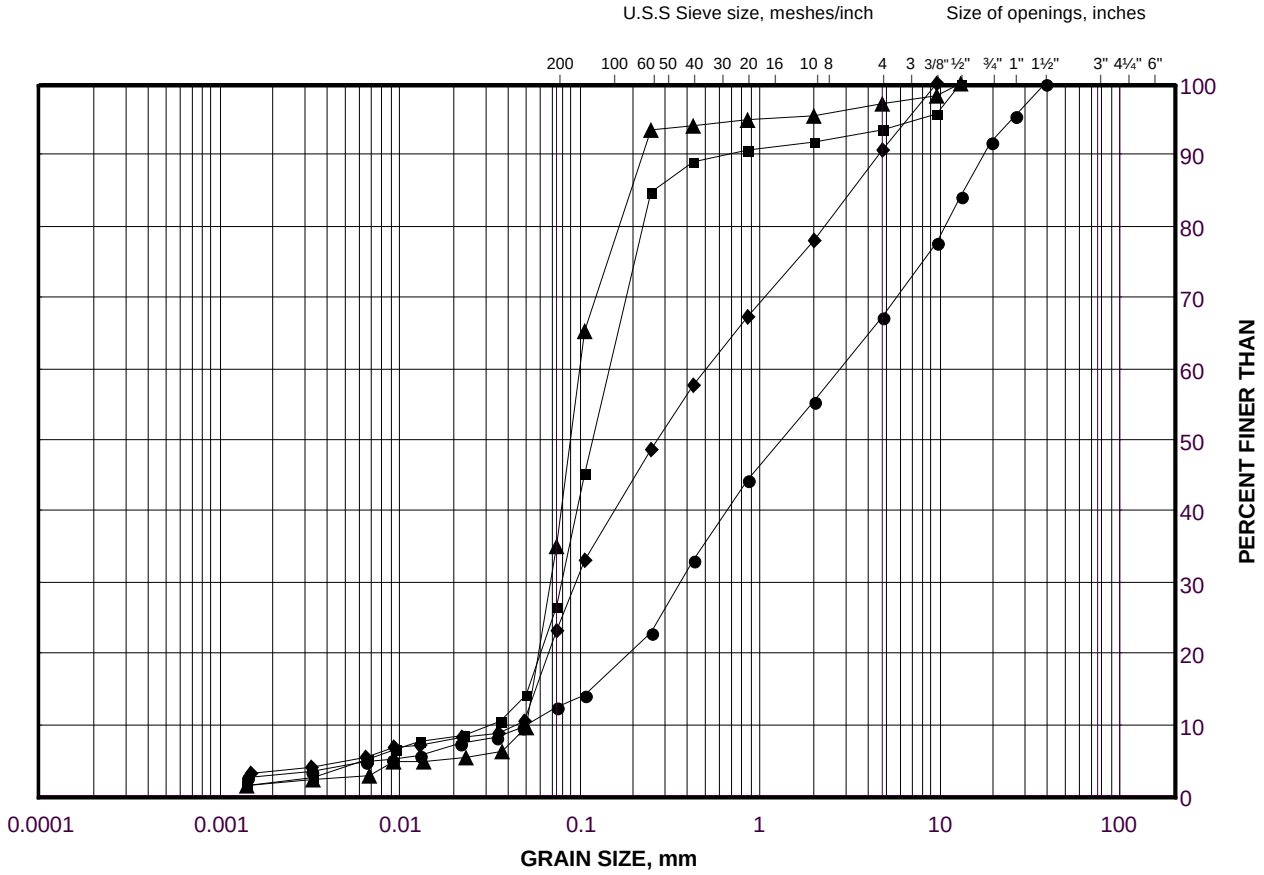
APPENDIX C

Geotechnical Laboratory Test Results and Analytical Test Results

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand to Gravelly Sand (Fill)

FIGURE C-1



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW6-1	1	94.8
■	CRB-6	2	90.6
◆	CRB-2	3	93.8
▲	CRB-7	3	92.9

Project Number: 1662333

Checked By: _____

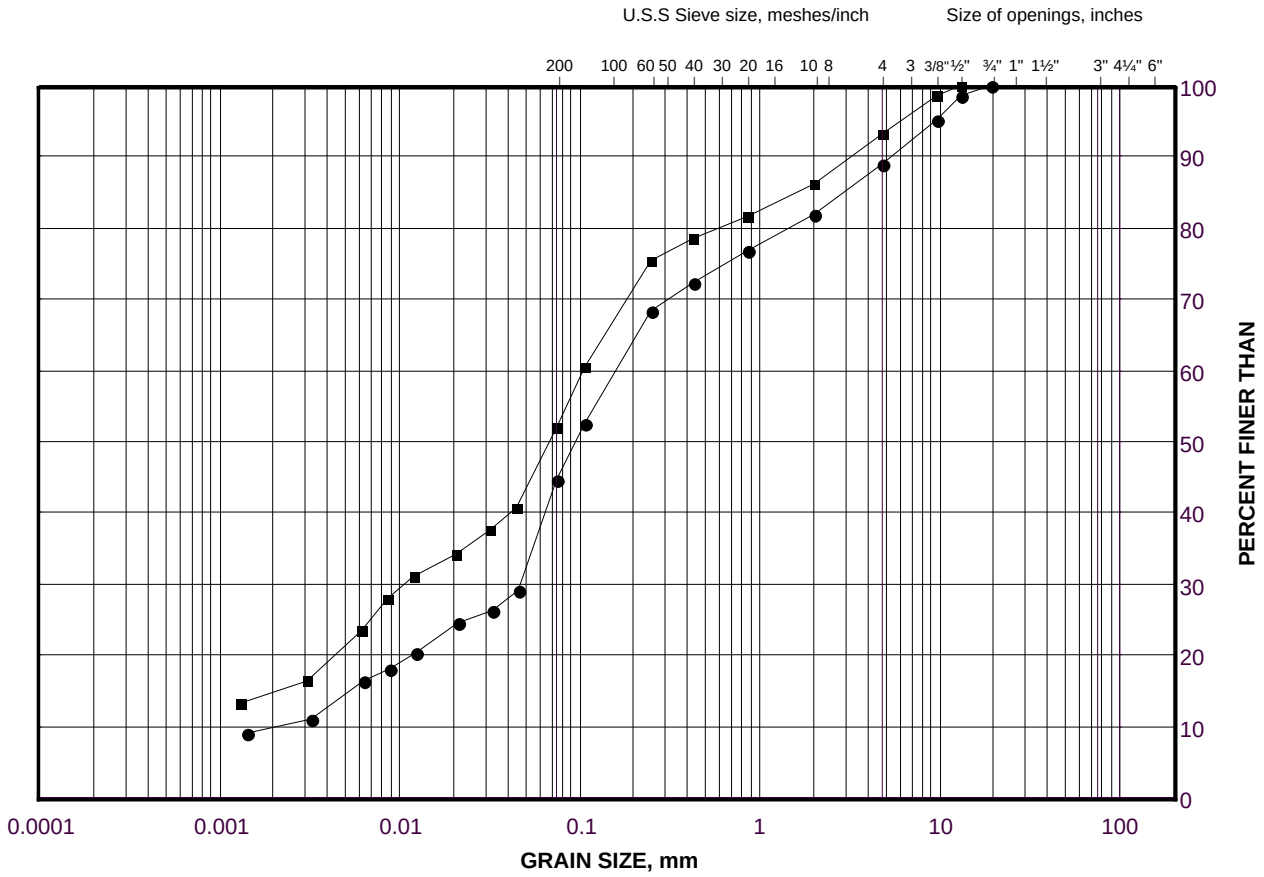
Golder Associates

Date: 01-Feb-19

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand (Fill)

FIGURE C-2



LEGEND

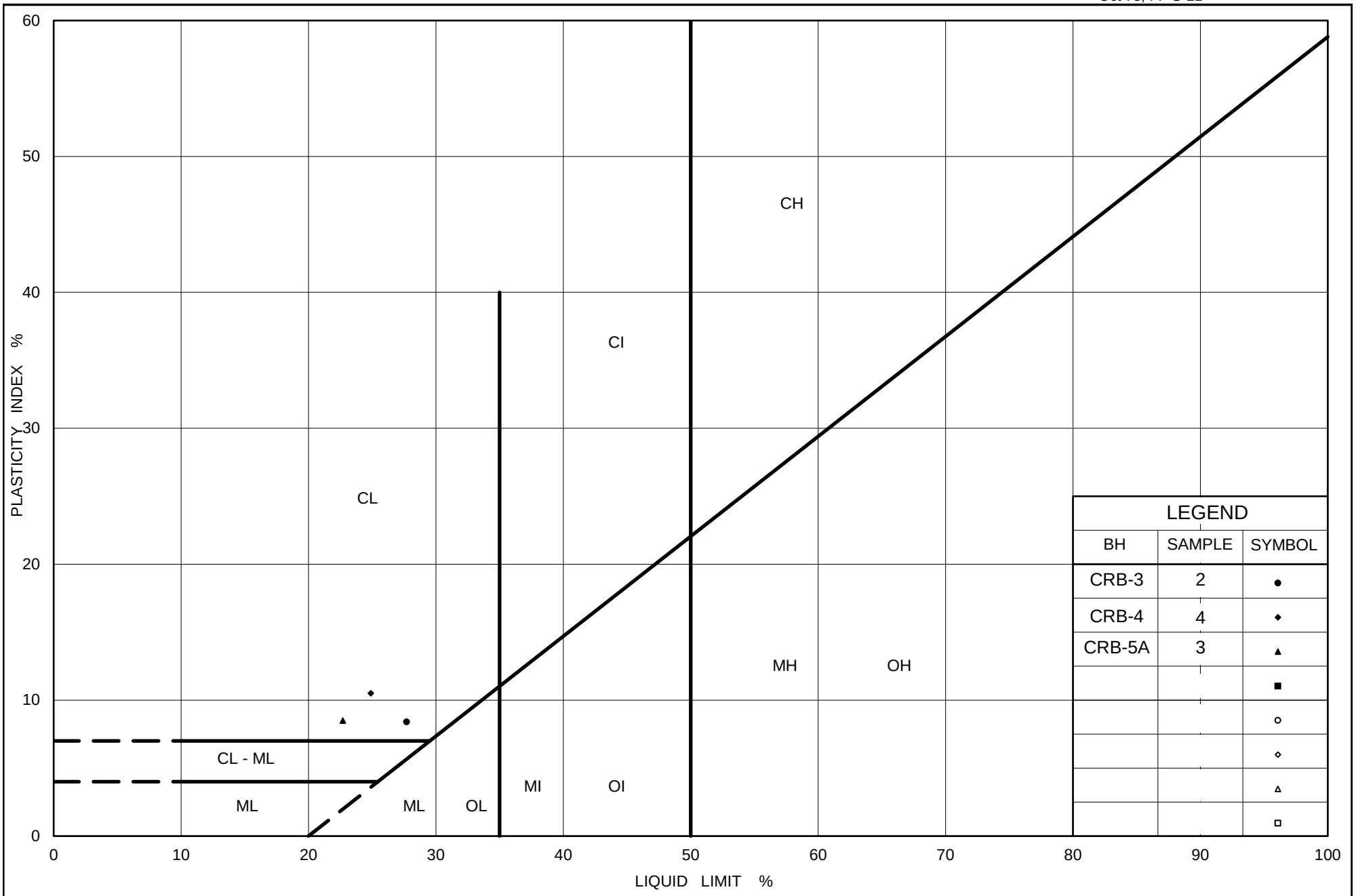
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-5A	3	77.5
■	CRB-4	4	76.5

Project Number: 1662333

Checked By: _____

Golder Associates

Date: 24-May-18



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

Figure No. C-3

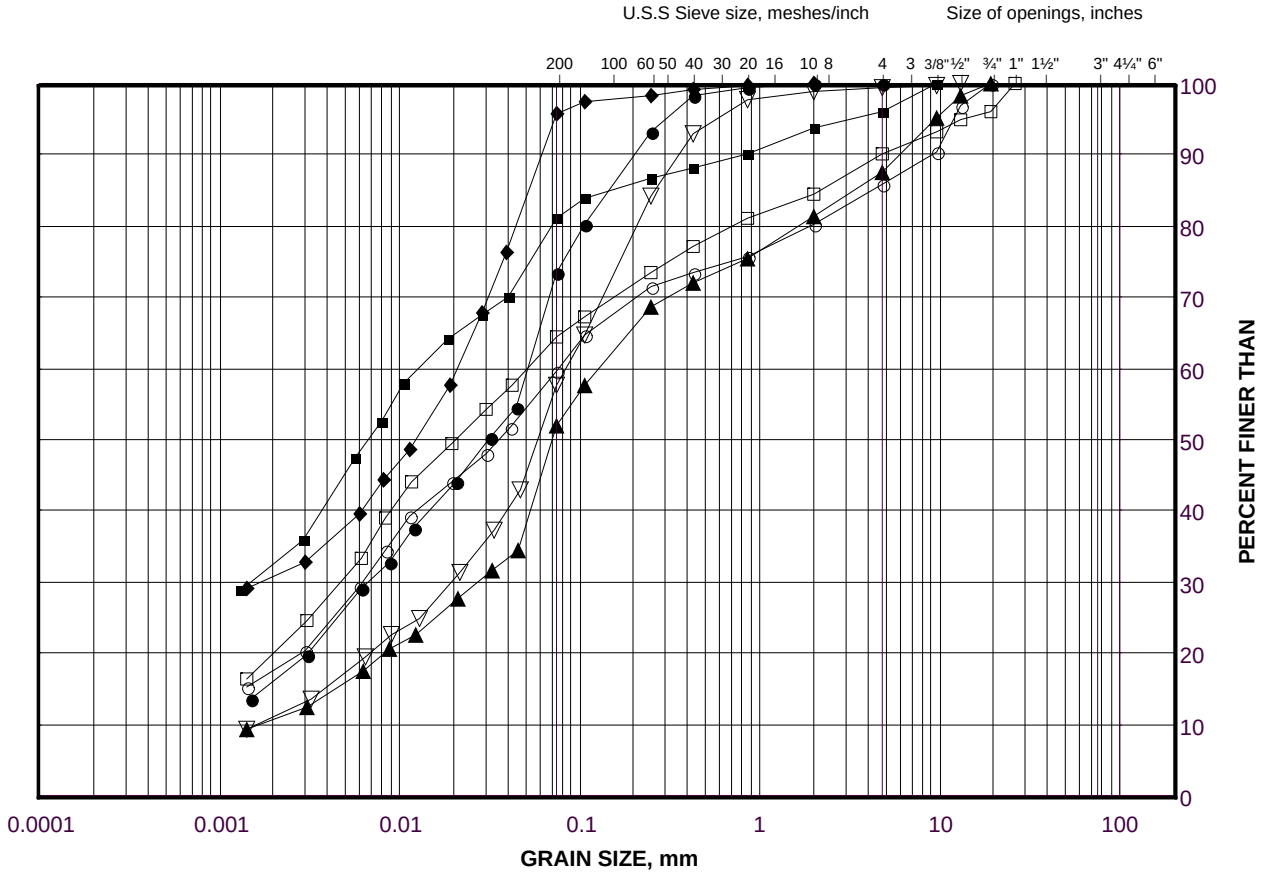
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand to Silty Clay

FIGURE C-4A



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-3A	1	75.4
■	CRB-1	2A	94.0
◆	CRB-2A	2B	93.3
▲	CRB-3C	3	73.6
▽	CRB-3	4	73.3
❍	CRB-4	6	75.0
□	CRB-6	6	87.6

Project Number: 1662333

Checked By: SMM

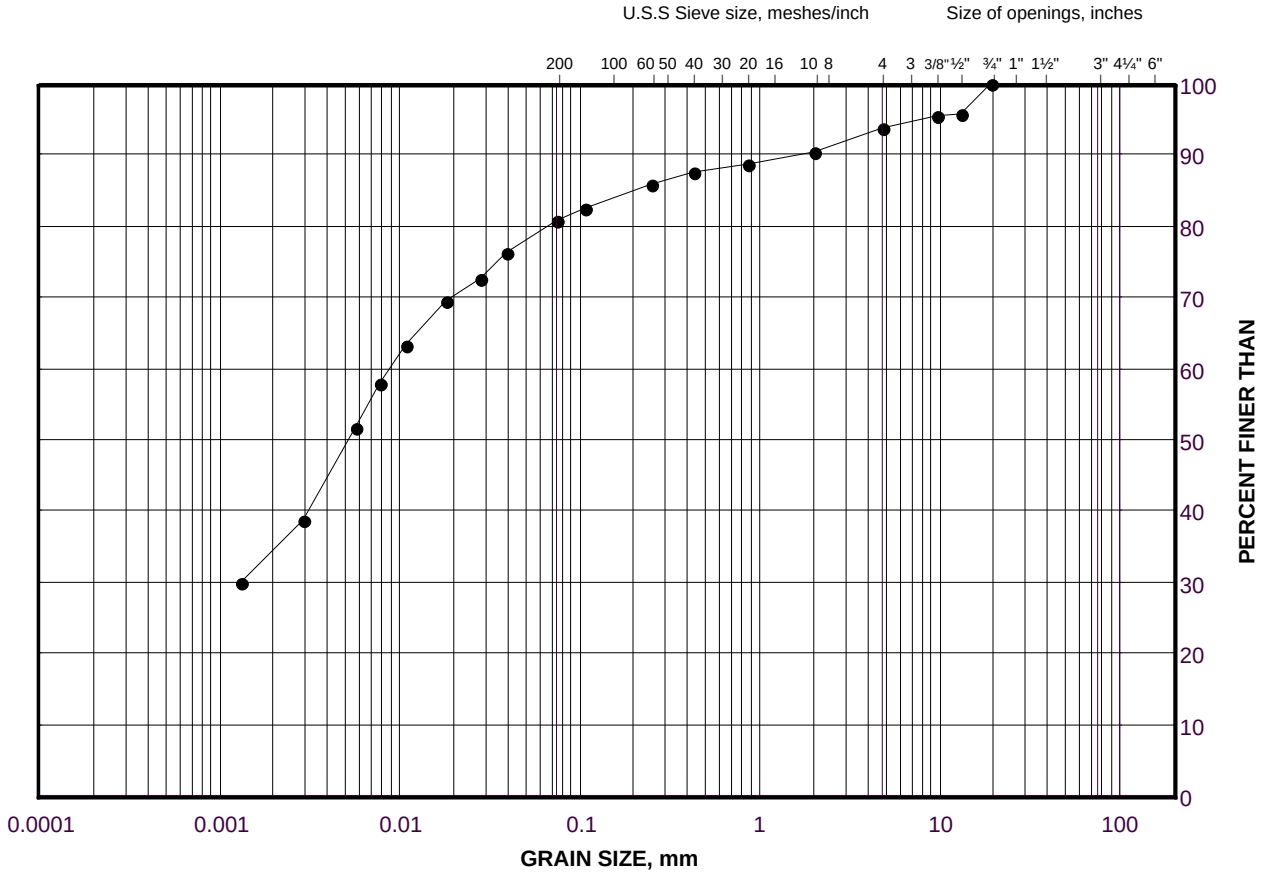
Golder Associates

Date: 24-May-18

GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE C-4B



LEGEND

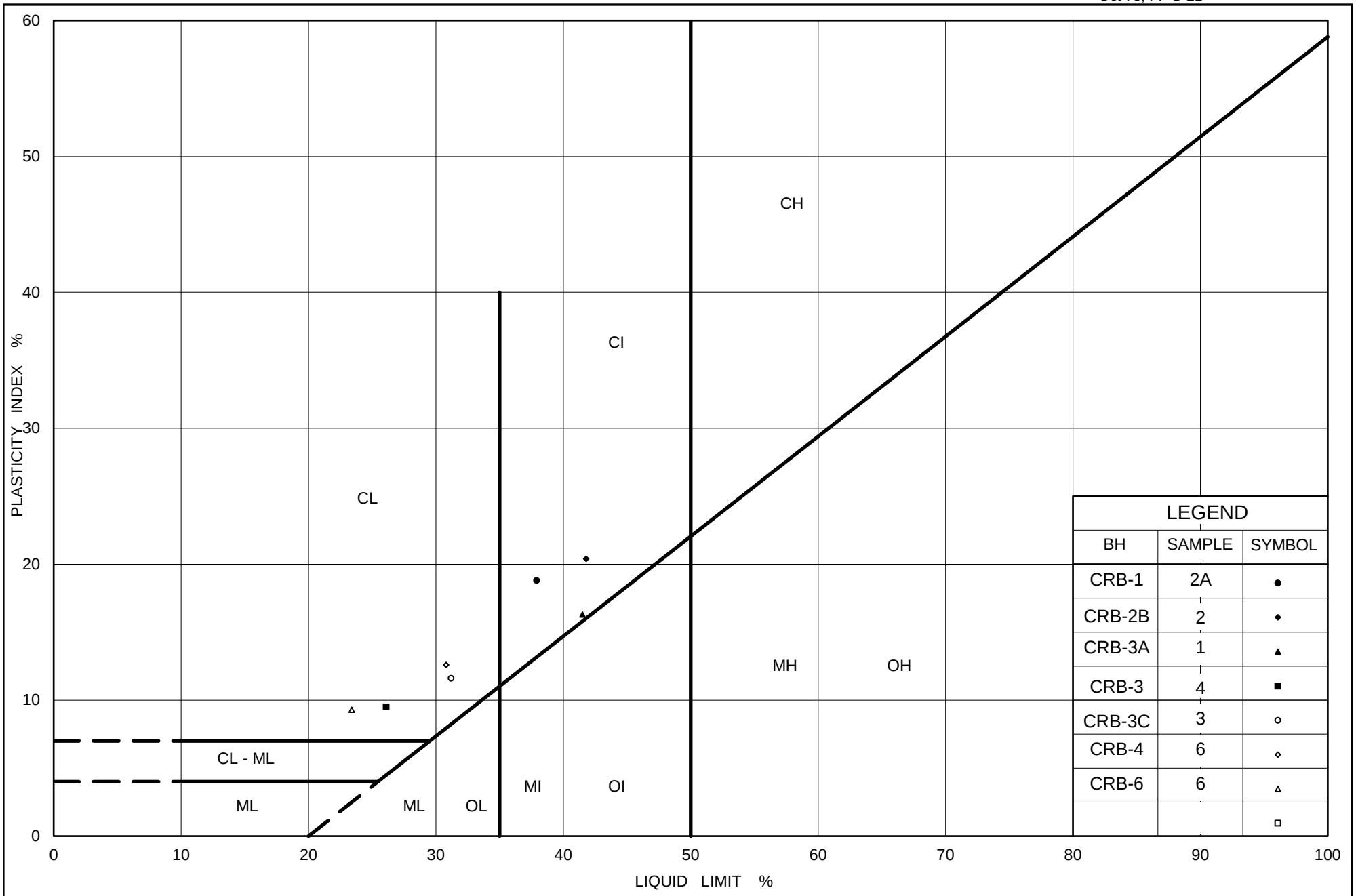
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-2B	2	93.6

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 24-Aug-18



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Ontario

PLASTICITY CHART
Clayey Silt with Sand to Silty Clay

Figure No. C-5

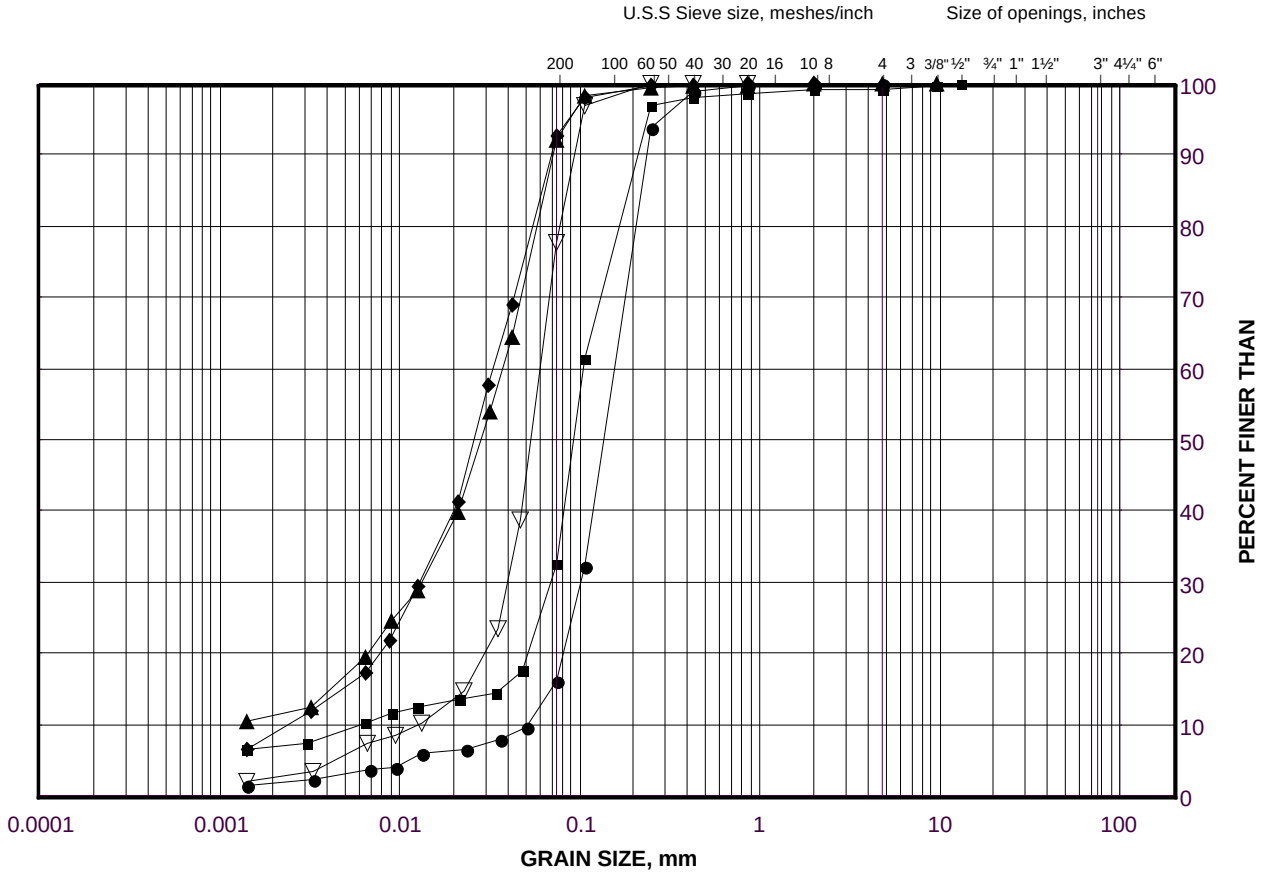
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Silt to Silty Sand to Sand

FIGURE C-6A



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-8	4	92.1
■	NW6-1	6	91.2
◆	CRB-8	7	89.8
▲	NW6-1	8	89.4
▽	CRB-7	8	89.1

Project Number: 1662333

Checked By: _____

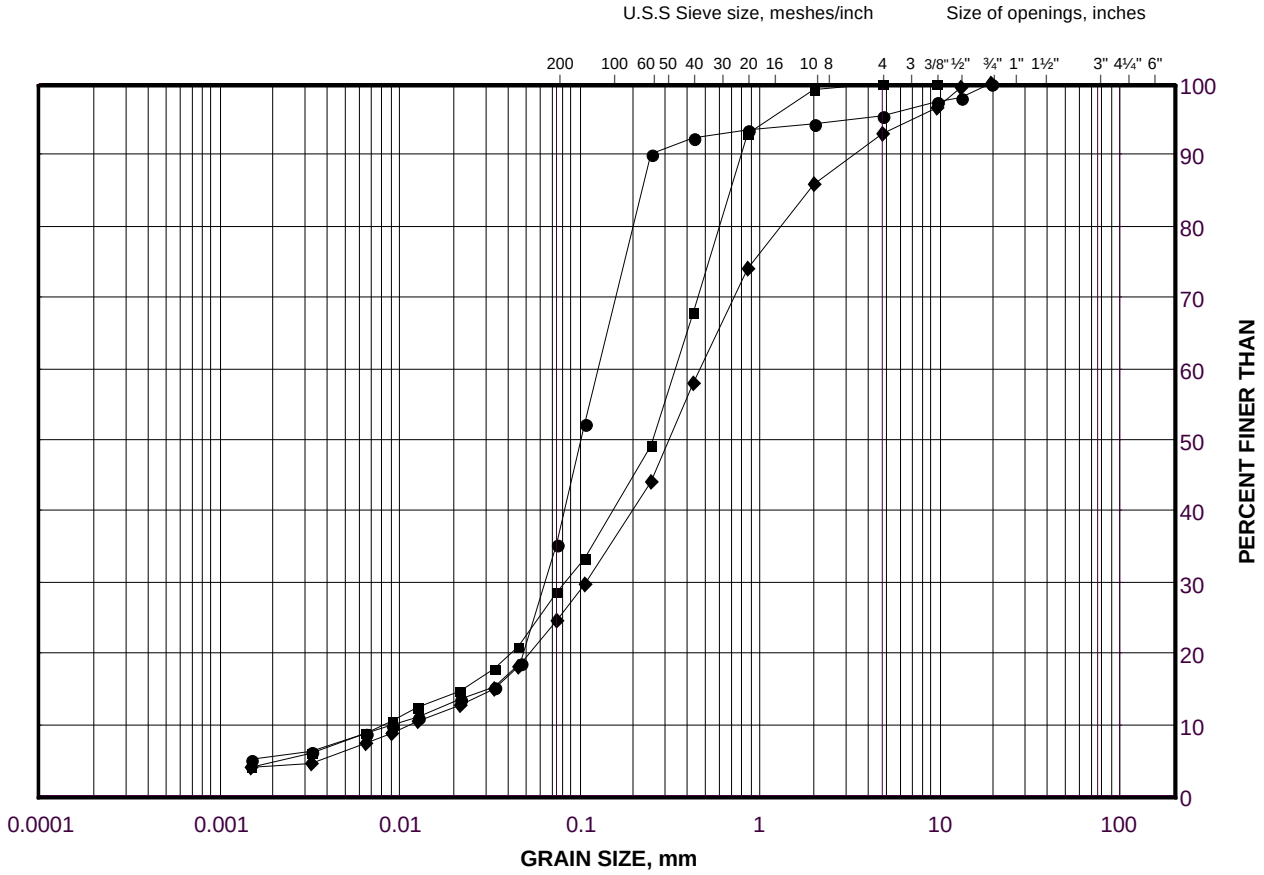
Golder Associates

Date: 01-Feb-19

GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand

FIGURE C-6B



LEGEND

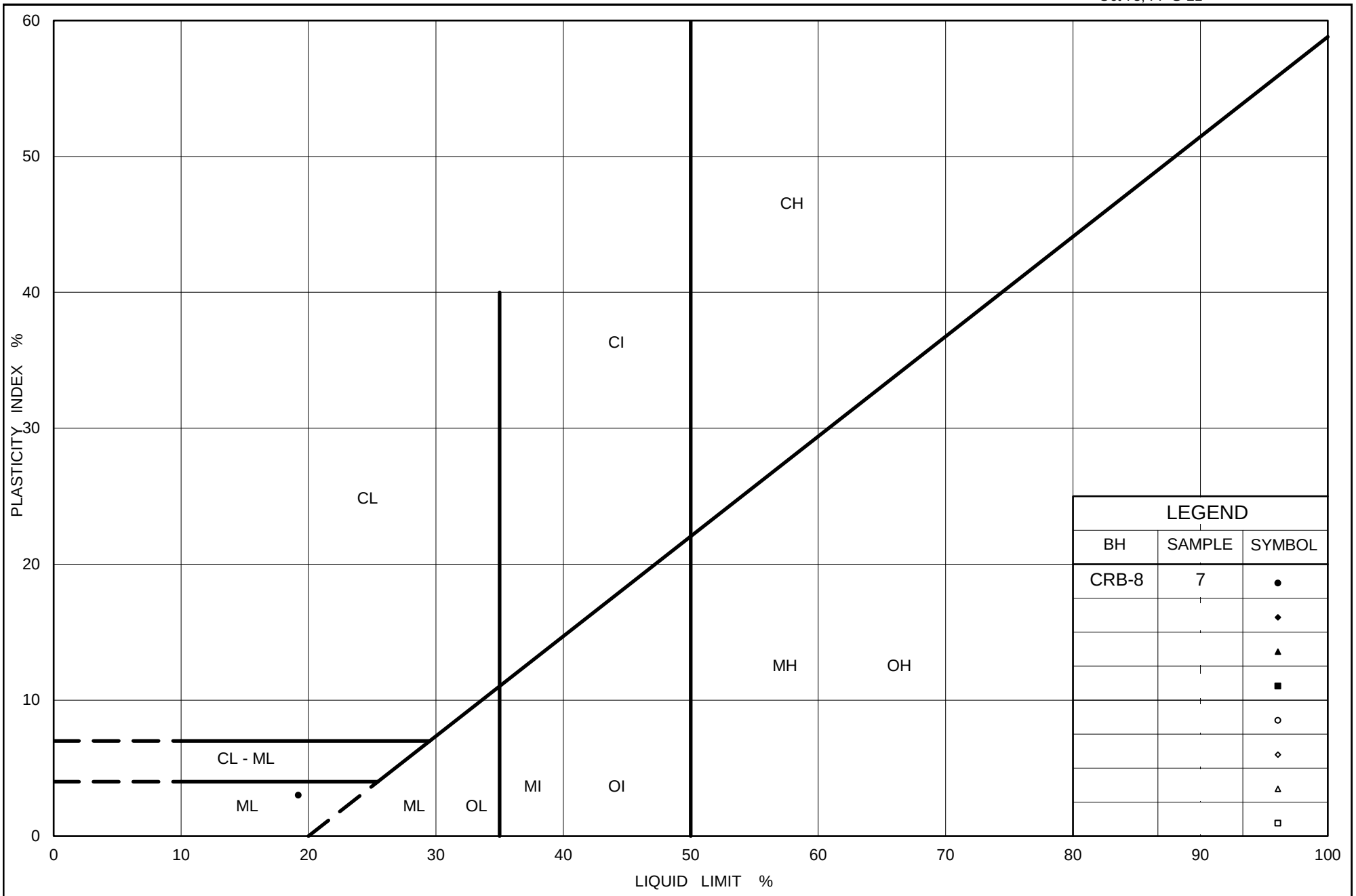
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-5	6	75.1
■	CRB-5A	8B	72.9
◆	CRB-5	9	72.8

Project Number: 1662333

Checked By: _____

Golder Associates

Date: 01-Feb-19



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PLASTICITY CHART
Silt (Slight Plasticity)

Figure No. C-7

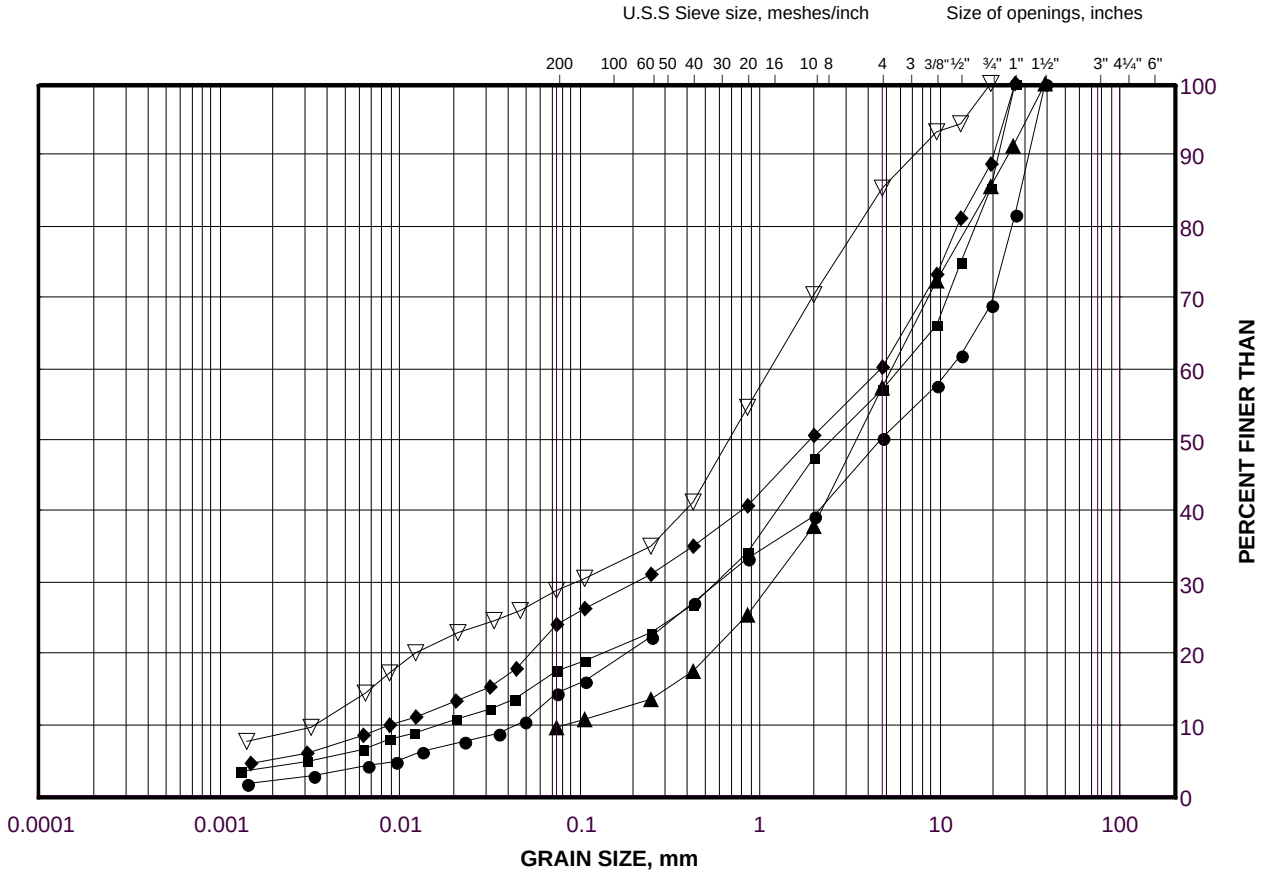
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sand and Gravel to Sand

FIGURE C-8



LEGEND

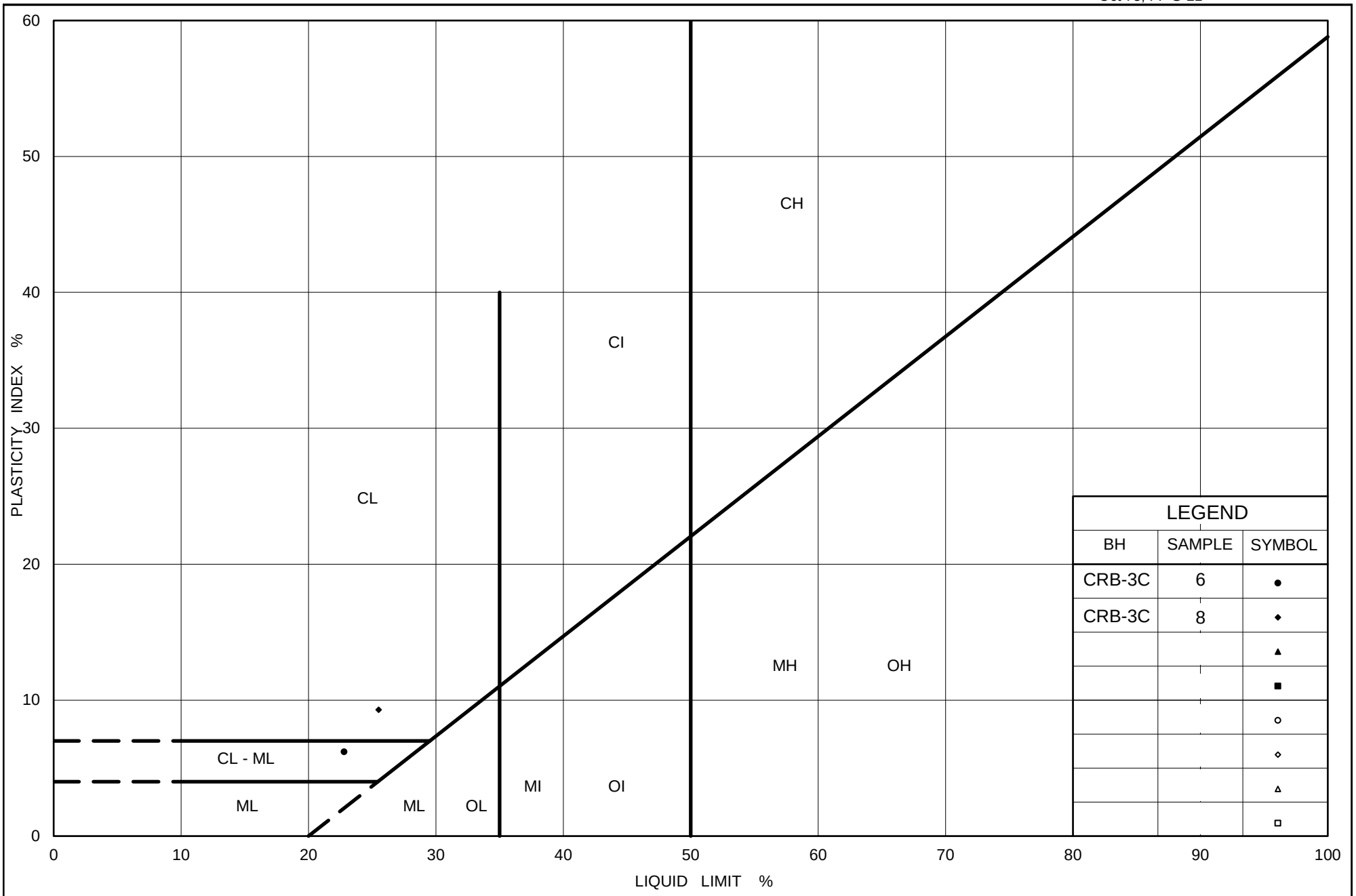
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-3	5	72.6
■	CRB-3A	6	70.8
◆	CBR-3C	6	71.8
▲	CRB-3	7	71.1
▽	CRB-3C	8	70.6

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 24-May-18



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PLASTICITY CHART
Clayey Silt (Pockets)

Figure No. C-9

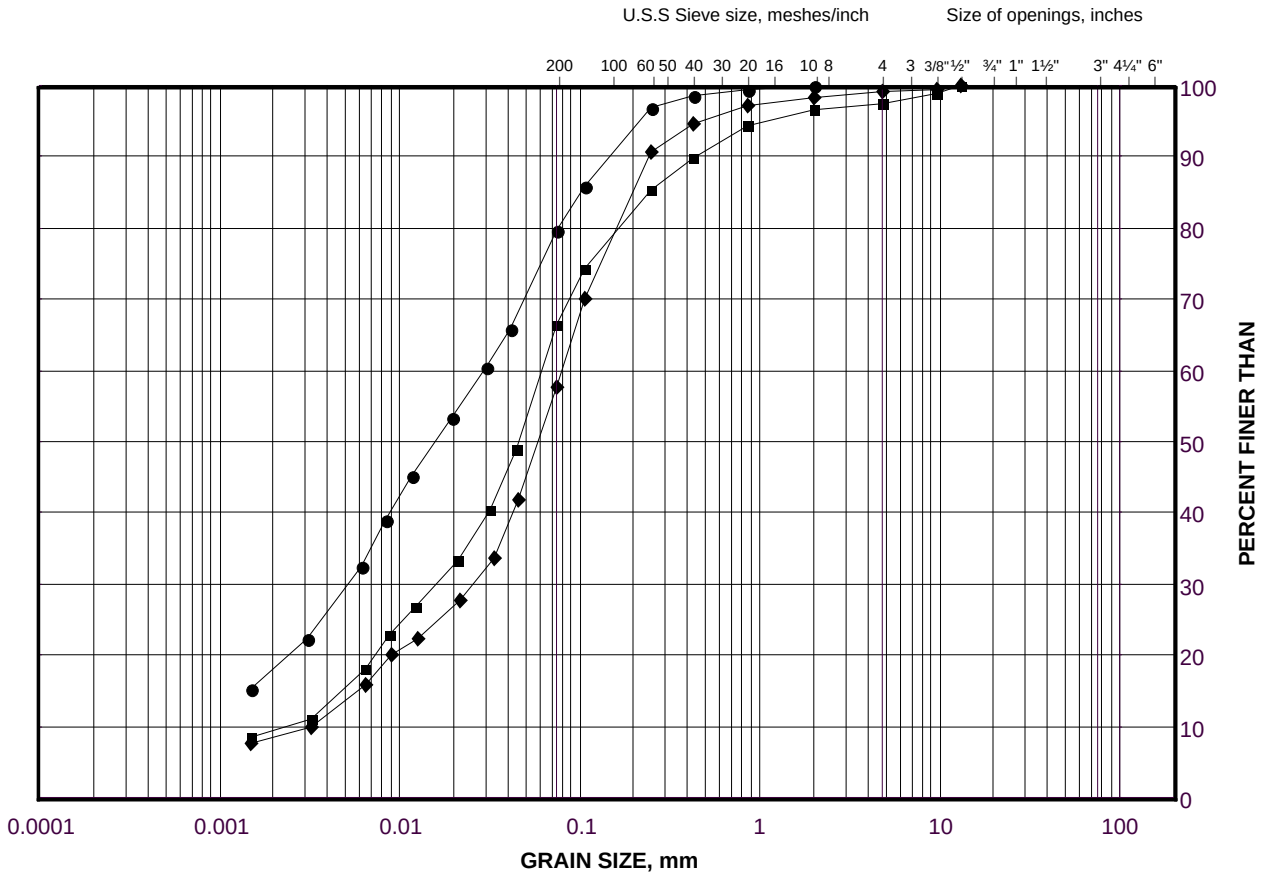
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Organic Clayey Silt to Organic Clayey Silt with Sand

FIGURE C-10



LEGEND

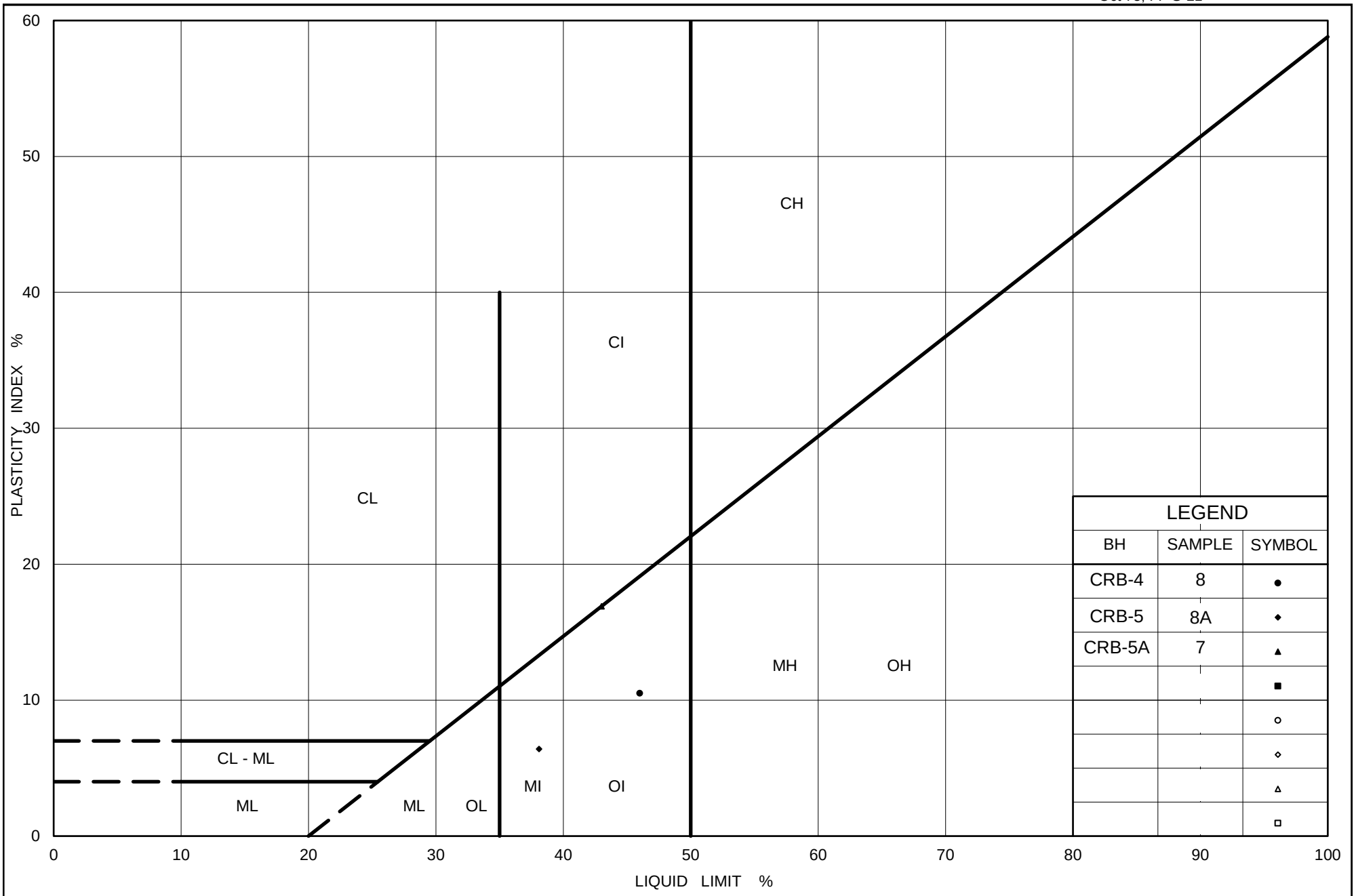
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-5A	7	74.4
■	CRB-4	8	72.7
◆	CRB-5	8A	73.7

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 23-May-18



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Ontario

PLASTICITY CHART
Organic Clayey Silt

Figure No. C-11

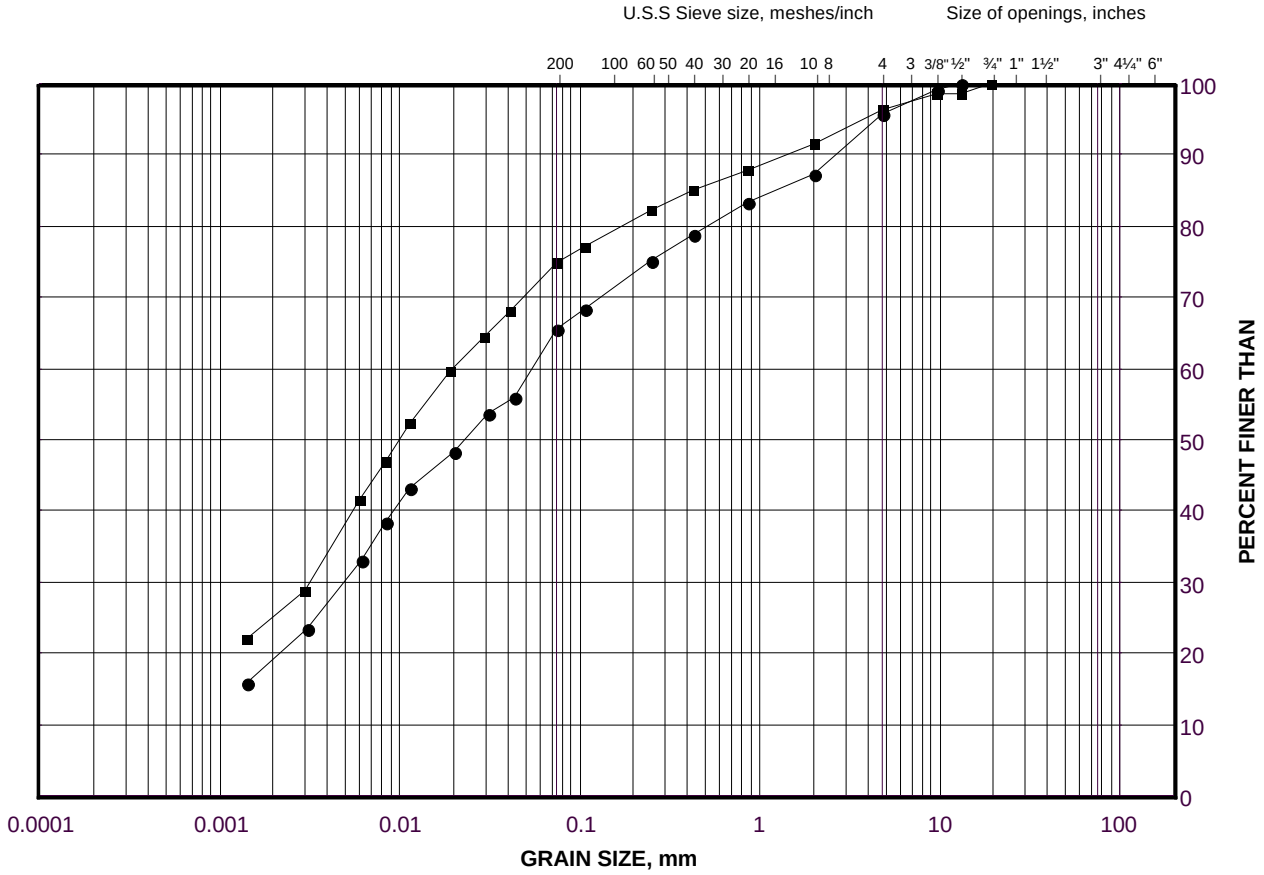
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE C-12



LEGEND

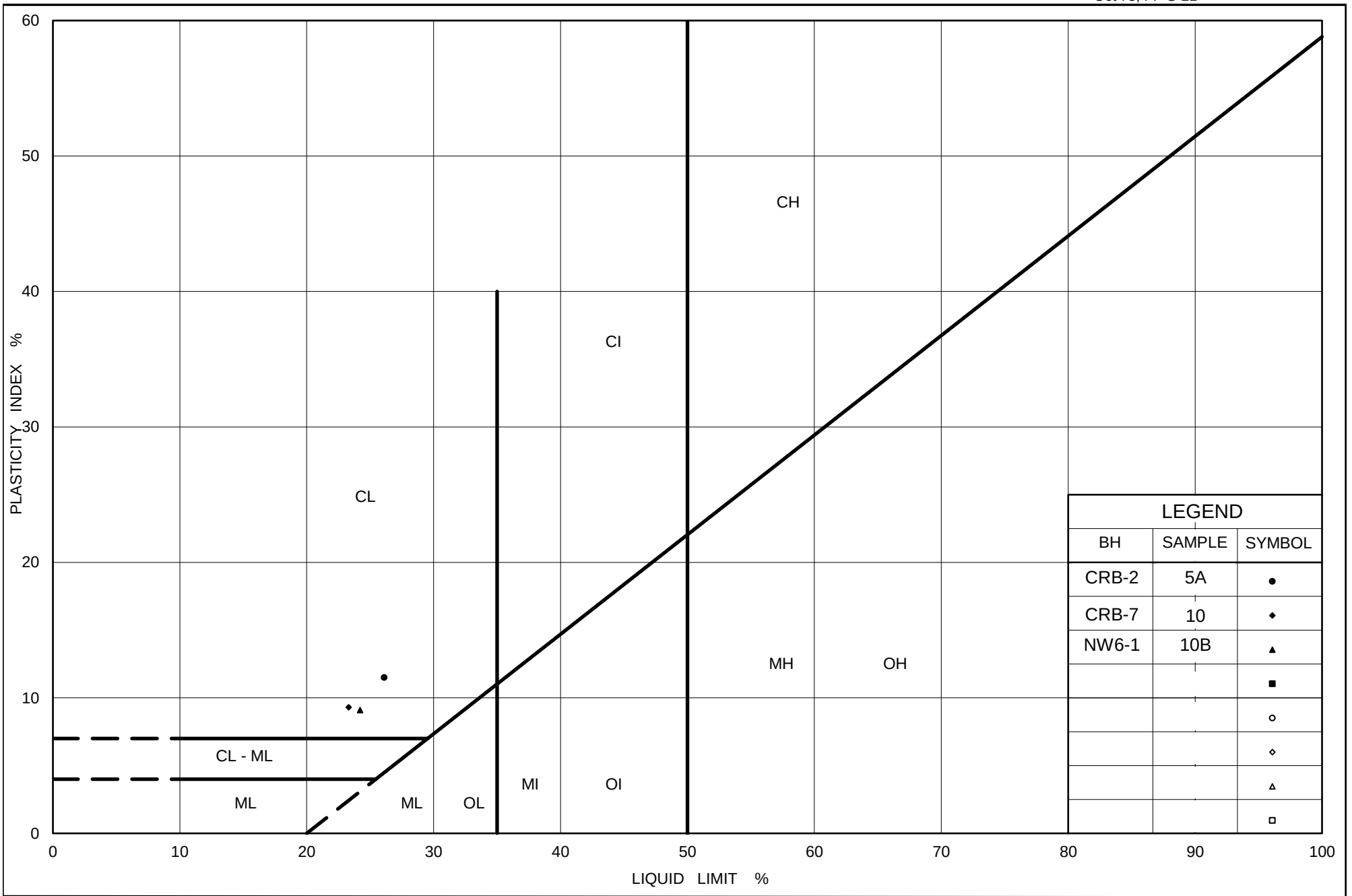
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-7	10	87.5
■	NW6-1	10B	87.9

Project Number: 1662333

Checked By: _____

Golder Associates

Date: 01-Feb-19



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PLASTICITY CHART

Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. C-13

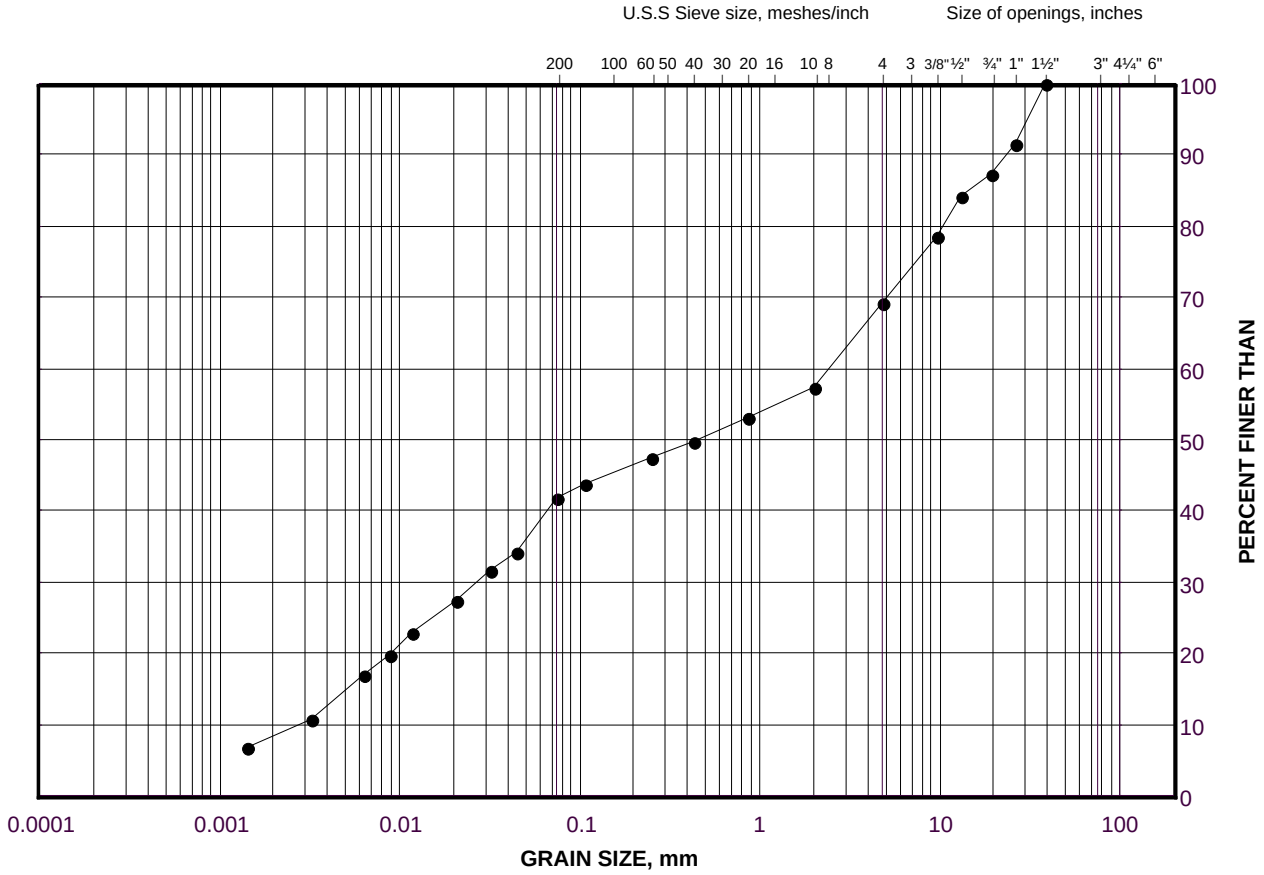
Project No. 1662333

Checked By:

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Residual Soil)

FIGURE C-14



LEGEND

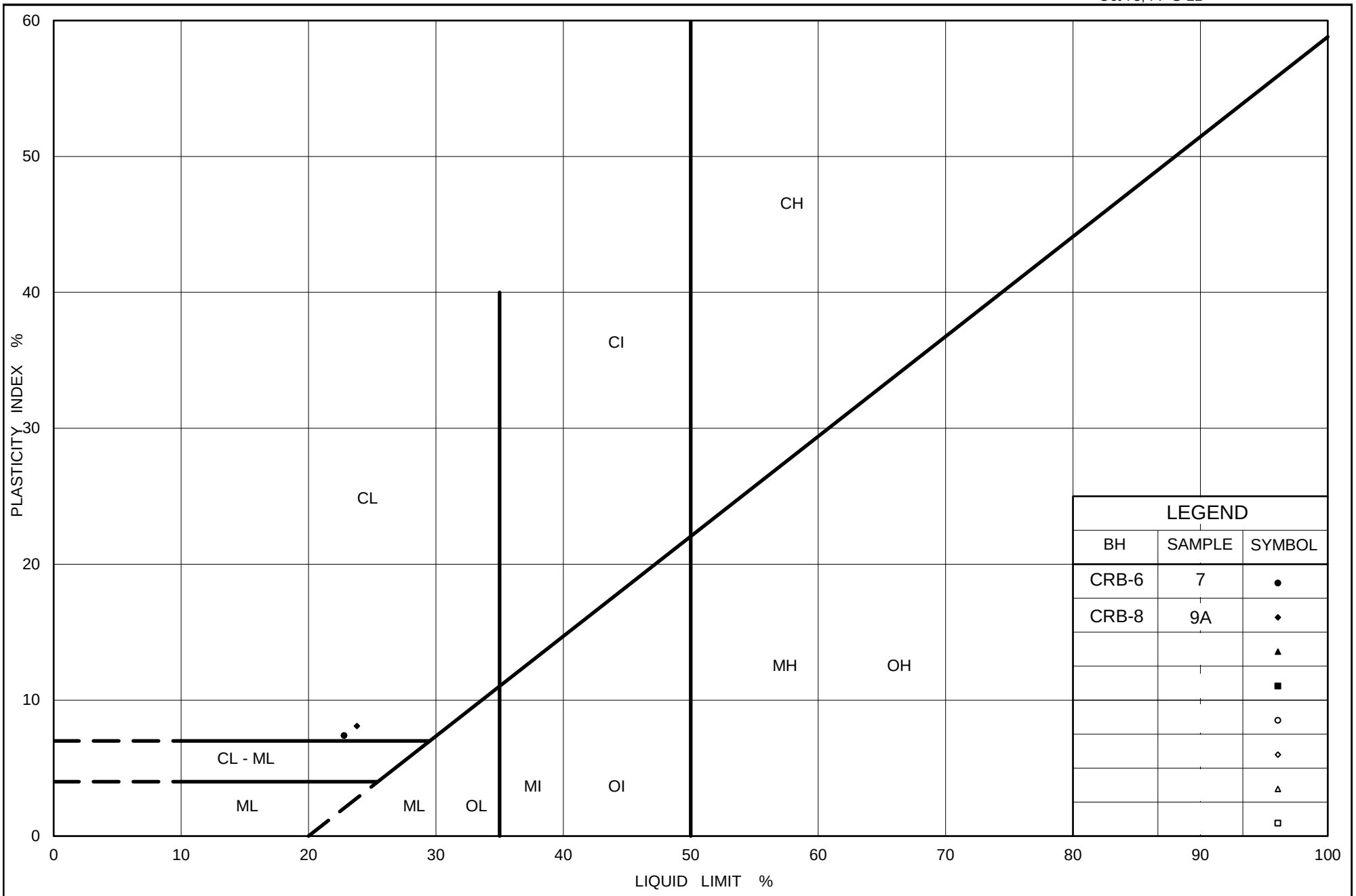
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CRB-8	9A	86.9

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 24-May-18



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PLASTICITY CHART
Sandy Clayey Silt (Residual Soil)

Figure No. C-15

Project No. 1662333

Checked By: SMM

Table C1: Summary of Point Load Test Results

Borehole No.	Sample Depth (m)	Sample Elevation (m)	Orientation	Corrected Is (50 mm) (MPa)
CRB-2	8.47	87.13	Diametral	0.04
CRB-2	8.5	87.10	Axial	0.82
CRB-2	10.48	85.12	Diametral	0.19
CRB-2	11.61	83.99	Axial	0.33
CRB-2	12.22	83.38	Diametral	0.10
CRB-2	12.26	83.34	Axial	0.24
CRB-2A	7.07	87.43	Axial	0.37
CRB-2A	7.5	87.00	Diametral	0.44
CRB-2A	7.55	86.95	Axial	0.13
CRB-2A	4.81	89.69	Diametral	0.18
CRB-2A	5.82	88.68	Diametral	0.28
CRB-2A	5.87	88.63	Axial	0.40
CRB-2B	7.27	87.43	Diametral	0.44
CRB-2B	7.89	86.81	Diametral	0.15
CRB-2B	8.00	86.70	Axial	0.46
CRB-2B	9.49	85.21	Diametral	0.06
CRB-2B	10.27	84.43	Diametral	0.50
CRB-2B	10.27	84.43	Axial	0.33
CRB-3	9.2	66.70	Axial	0.30
CRB-3	9.2	66.70	Diametral	0.09
CRB-3	10.47	65.43	Axial	0.68
CRB-3	10.47	65.43	Diametral	0.22

Borehole No.	Sample Depth (m)	Sample Elevation (m)	Orientation	Corrected Is (50 mm) (MPa)
CRB-3	11.27	64.63	Axial	0.26
CRB-3	11.27	64.63	Diametral	0.85
CRB-3A	7.85	67.85	Diametral	0.62
CRB-3A	7.85	67.85	Axial	0.46
CRB-3A	10.33	65.37	Diametral	0.06
CRB-3A	10.41	65.29	Axial	1.35
CRB-3A	13.4	62.30	Diametral	0.36
CRB-3A	13.36	62.34	Axial	0.78
CRB-3C	9.12	66.18	Diametral	0.25
CRB-3C	9.24	66.06	Axial	0.28
CRB-3C	11.38	63.92	Diametral	0.24
CRB-3C	11.42	63.88	Axial	0.60
CRB-3C	13.18	62.12	Diametral	0.28
CRB-3C	13.9	61.40	Axial	0.58
CRB-4	13.5	65.60	Diametral	0.89
CRB-4	9.22	69.88	Diametral	0.04
CRB-4	9.22	69.88	Axial	1.02
CRB-4	9.28	69.82	Axial	2.14
CRB-4	14.93	64.17	Diametral	0.08
CRB-4	14.93	64.17	Axial	0.23
CRB-5	8.95	70.25	Diametral	0.76
CRB-5	9.03	70.17	Axial	0.37
CRB-5	14.48	64.72	Diametral	0.52

Borehole No.	Sample Depth (m)	Sample Elevation (m)	Orientation	Corrected Is (50 mm) (MPa)
CRB-5	14.51	64.69	Axial	0.27
CRB-5	13.31	65.89	Diametral	0.07
CRB-5	9.53	69.67	Axial	1.45
CRB-5A	10.24	69.06	Diametral	0.56
CRB-5A	10.29	69.01	Axial	0.42
CRB-5A	13.84	65.46	Diametral	0.43
CRB-5A	13.89	65.41	Axial	0.07
CRB-5A	16.8	62.50	Diametral	0.82
CRB-5A	17	62.30	Axial	0.24
CRB-6	6.03	85.67	Axial	0.70
CRB-6	6.03	85.67	Diametral	0.44
CRB-6	7.34	84.36	Axial	0.65
CRB-6	7.34	84.36	Diametral	0.51
CRB-6	9.03	82.67	Axial	0.61
CRB-6	9.03	82.67	Diametral	0.15
CRB-7	9.06	85.64	Axial	0.47
CRB-7	9.06	85.64	Diametral	0.26
CRB-7	9.46	85.24	Axial	0.56
CRB-7	9.46	85.24	Diametral	0.42
CRB-7	12.04	82.66	Axial	0.85
CRB-7	12.04	82.66	Diametral	0.32

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

November 22, 2017

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 3, 2017 four (4) HQ-sized core samples were received by Geomechanica Inc. via courier. These samples were identified as being from boreholes drilled as part of Golder project 166233 (denoted as QEW/Credit River 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
#300-90 Adelaide St W
Toronto ON
M5H 3V9 Canada
Tel: +1-647-478-9767
info@geomechanica.com

November 22, 2017
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:

Disclaimer: This report was prepared by Geomechanica Inc. for Golder Associates Ltd.. The material herein reflects Geomechanica Inc.'s best judgment given the information available at the time of preparation. Any use which a third party makes of this report, any reliance on or decision to be made based on it, are the responsibility of such third parties. Geomechanica Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

1 Overview

This report summarizes the results of laboratory testing 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. The Young's modulus is the tangent modulus, calculated as the slope of the best fit line through ± 300 data points on either side of the point representing 50% of the peak strength.

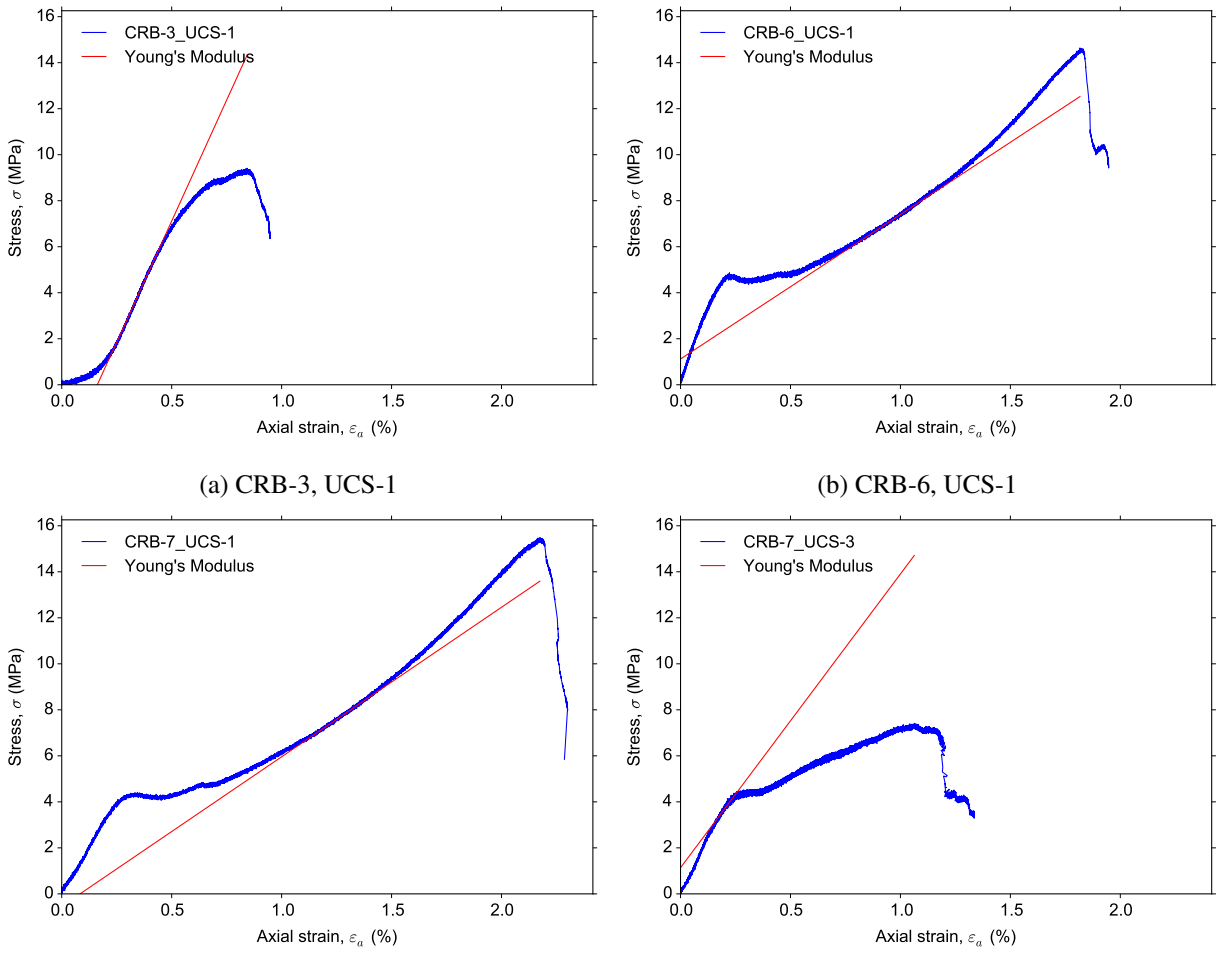
Table 1: Summary of laboratory test results.

Sample	Depth (m)	Bulk density ρ (g/cm^3)	UCS (MPa)	Young's Modulus E (GPa)	Notes
CRB-3, UCS-1	11.44 - 11.66	2.61	9.4	2.10	[1]
CRB-6, UCS-1	6.06 - 6.17	2.17	14.6	0.63	[1,2]
CRB-7, UCS-1	9.21 - 9.369	2.59	15.5	0.65	[1,2]
CRB-7, UCS-3	12.11 - 12.36	2.59	7.4	1.28	
Mean		2.49	11.7	1.2	
Standard Deviation		0.18	3.4	0.6	

[1] Specimen emitted fresh pore water upon loading
[2] length:diameter ratio $< 2{:}1$.

2.1 Specimen photographs

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



(a) CRB-3, UCS-1

(b) CRB-6, UCS-1

(c) CRB-7, UCS-1

(d) CRB-7, UCS-3

Figure 2: Measured stress-strain curves.

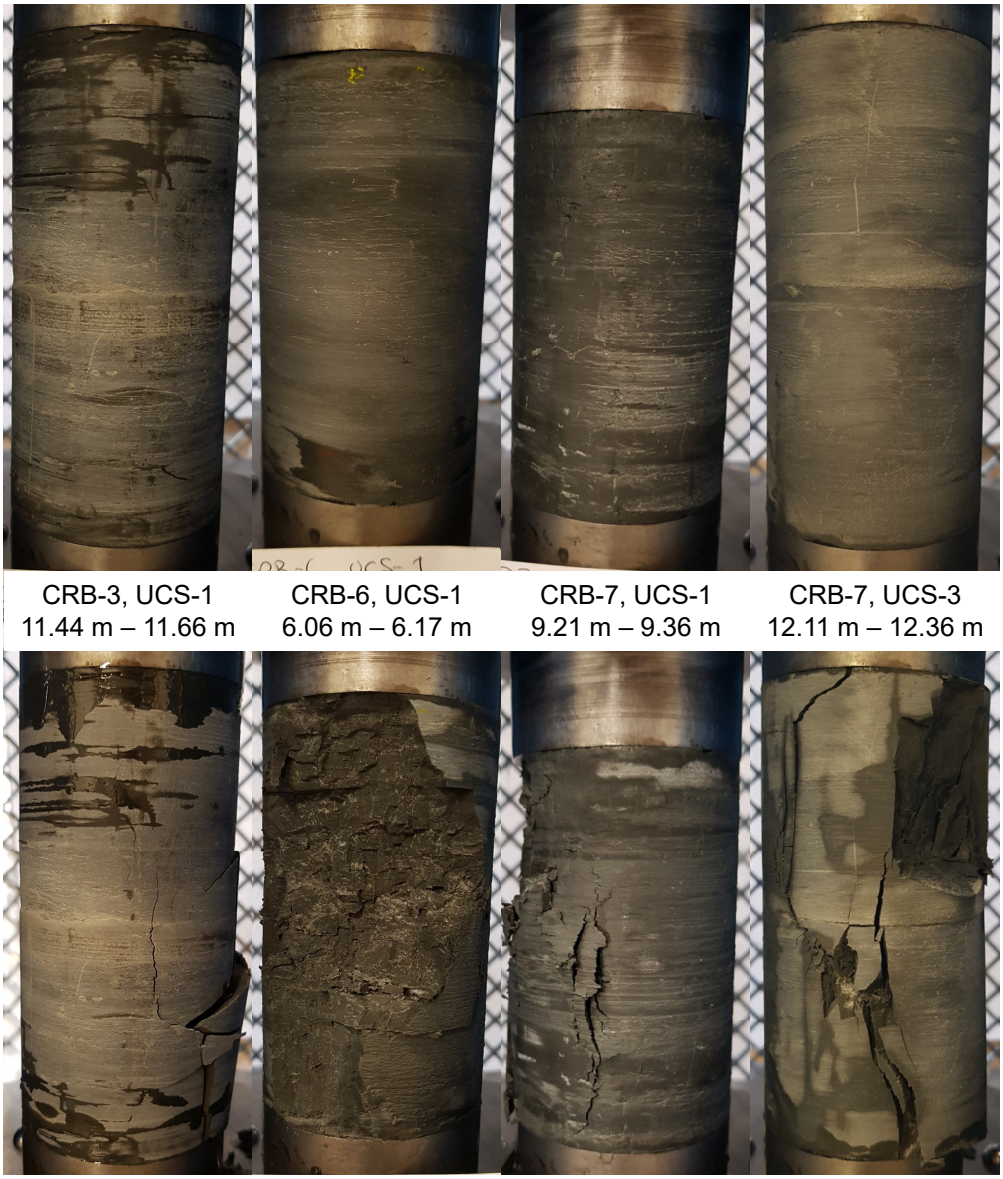


Figure 3: Photographs of specimens prior to testing.

GEOMECHANICA

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

April 09, 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)

Dear Mr. Marmor:

On March 27, 2018 three (3) NQ-sized and eight (8) 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. A uniaxial compressive strength (UCS) specimen was prepared and tested from each of these samples (11 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,

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:

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Geomechanica Inc
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April 9, 2018
Project number: 1662333

Abstract

This document summarizes the results of 11 uniaxial compression tests on a combination of NQ and HQ core samples. Results, including uniaxial compressive strength (UCS) and Young's modulus, along with photographs of test specimens before and after testing are presented.

In this document:

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1 Overview

This report summarizes the results of 11 uniaxial compression tests. 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 axial loading at a constant displacement rate to rupture while continuously recording axial force and axial deformation to determine the peak strength (UCS) and (tangent) Young's modulus (E).

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 1 to Figure 2. The Young's modulus is the 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.

Table 1: Summary of laboratory test results.

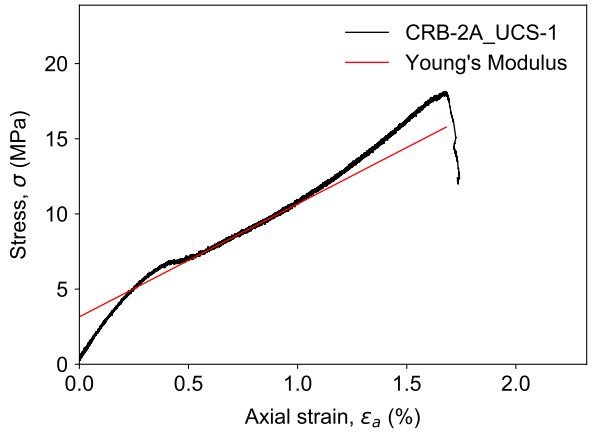
Sample	Rock type	Depth (m)	Bulk density ρ (g/cm^3)	UCS (MPa)	Young's Modulus E (GPa)	Notes
CRB-2A, UCS-1	Shale	4.31 - 4.46	2.59	18.2	0.75	1, 2
CRB-2A, UCS-2	Shale	4.92 - 5.15	2.60	17.1	0.76	1
CRB-3C, UCS-3	Limestone	7.87 - 7.98	2.61	114.1	22.91	2, 3
CRB-2, UCS-2	Shale	7.75 - 7.92	2.58	11.2	0.83	1
CRB-2, UCS-3	Shale	11.37 - 11.52	2.61	13.0	2.19	3
CRB-3A, UCS-3	Shale	10.19 - 10.33	2.60	8.9	0.48	1, 4 - 2 limestone layers 5-10 mm thick
CRB-3A, UCS-5	Shale	12.99 - 13.28	2.62	16.9	0.67	1
CRB-4, UCS-3	Shale	13.62 - 13.80	2.61	18.6	0.84	1
CRB-5, UCS-2	Shale	13.68 - 13.95	2.61	15.5	0.61	1
CRB-5A, UCS-2	Shale	12.43 - 12.57	2.60	14.2	0.96	1
CRB-5A, UCS-4	Shale	15.34 - 15.57	2.64	22.7	0.93	1

[1] Upon loading specimen emitted pore water

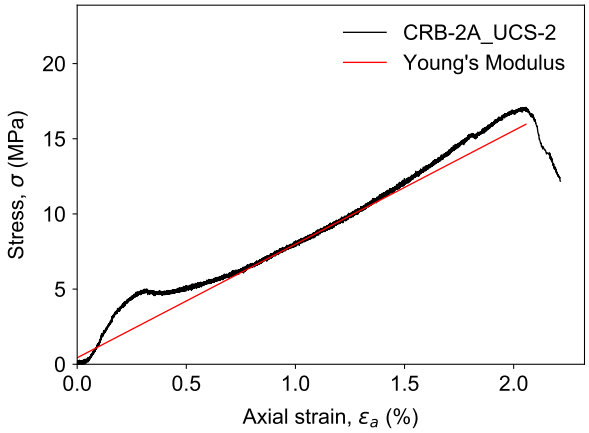
[2] Irregular diameter > 0.5 mm

[3] Length:Diameter ratio less than 2

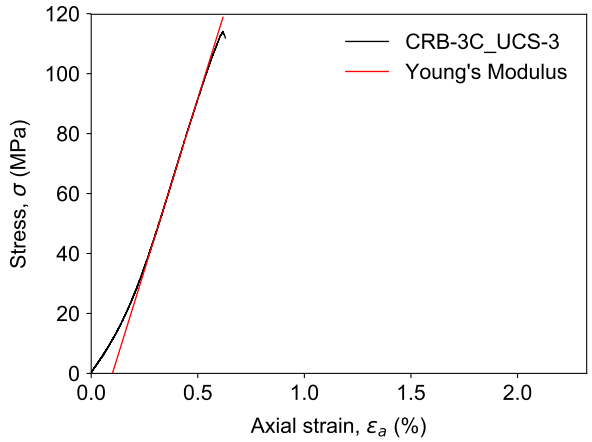
[4] Inter-bedded limestone and shale



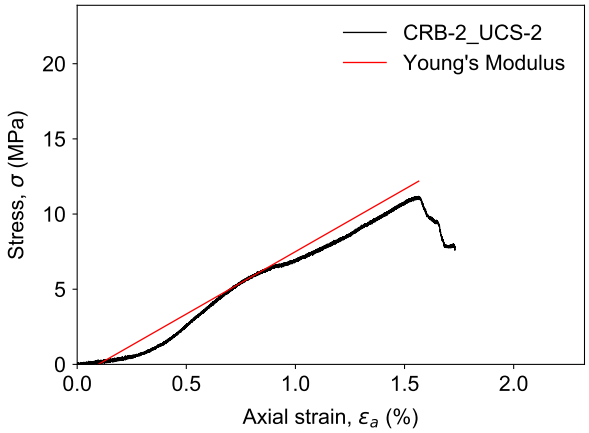
(a) CRB-2A, UCS-1



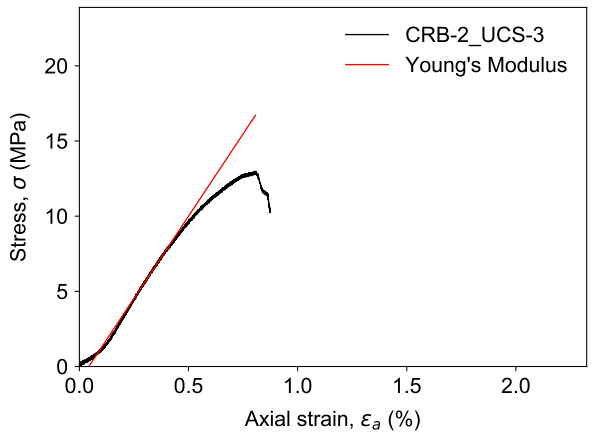
(b) CRB-2A, UCS-2



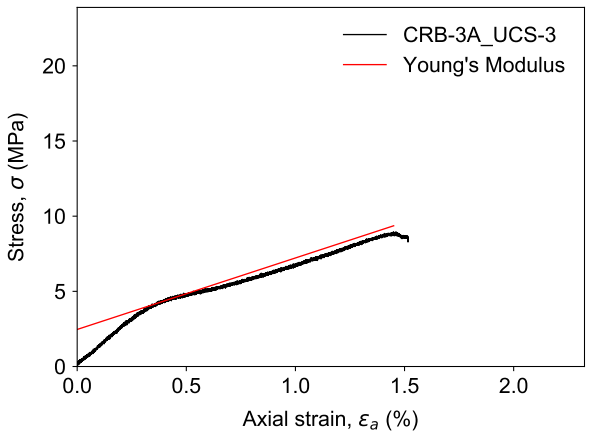
(c) CRB-3C, UCS-3



(d) CRB-2, UCS-2

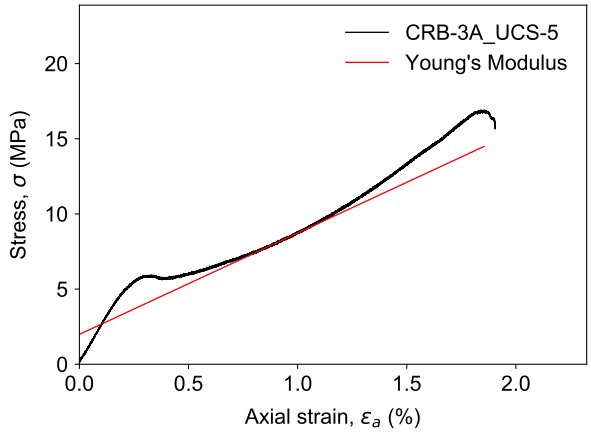


(e) CRB-2, UCS-3

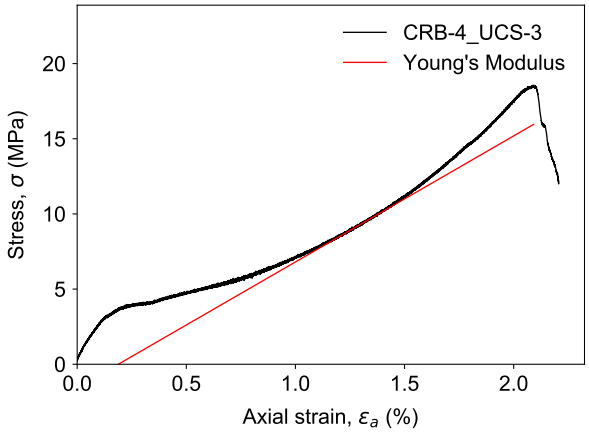


(f) CRB-3A, UCS-3

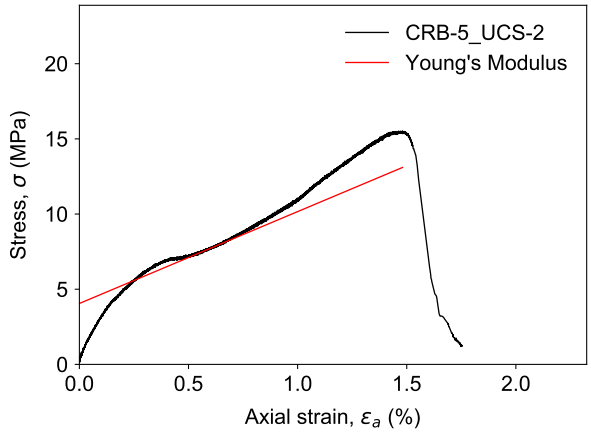
Figure 1: Measured stress-strain curves.



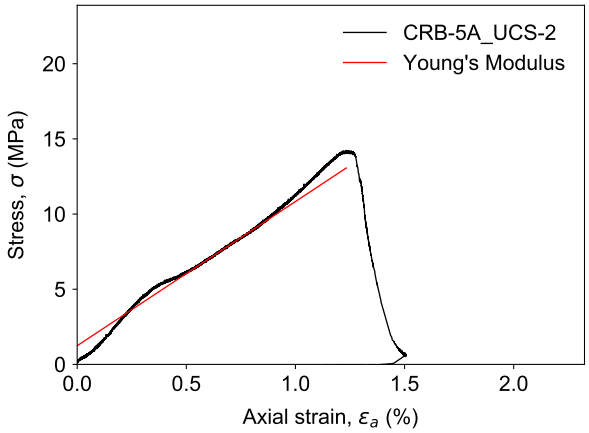
(a) CRB-3A, UCS-5



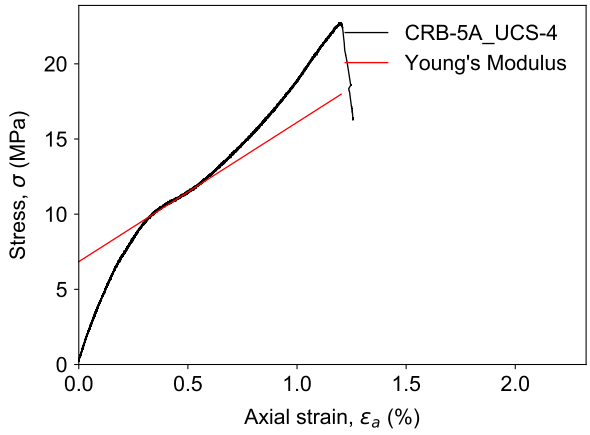
(b) CRB-4, UCS-3



(c) CRB-5, UCS-2



(d) CRB-5A, UCS-2



(e) CRB-5A, UCS-4

Figure 2: Measured stress-strain curves.

2.1 Specimen photographs

Photographs of the specimens before and after testing are presented in Figure 3 and Figure 4

Figure 3: Photographs of specimens prior to testing.

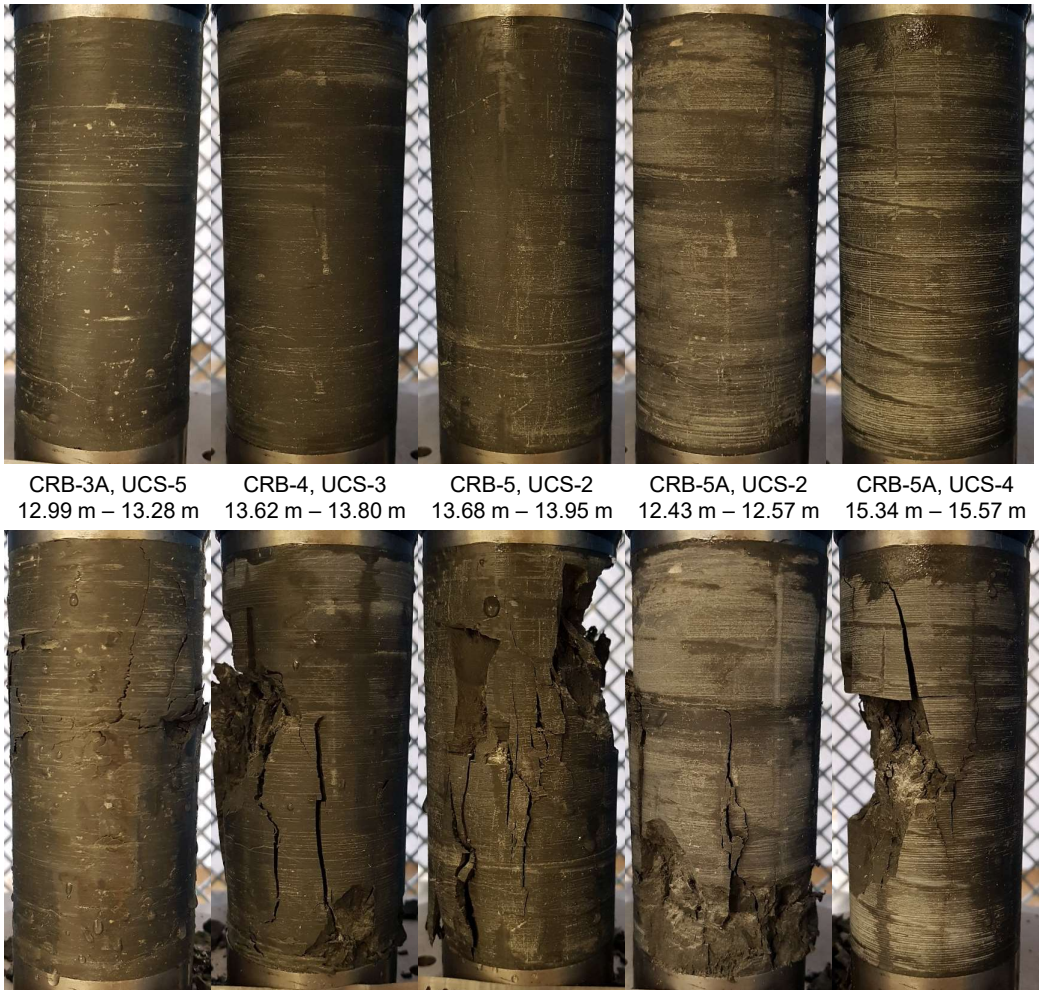


Figure 4: Photographs of failed specimens after testing.

Geomechanica Inc.
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July 26, 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)

Dear Mr. Marmor:

On July 18, 2018 two (2) HQ3-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. A uniaxial compressive strength (UCS) specimen was prepared and tested from each of these samples (2 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,

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
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Prepared by:

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Omid Mahabadi, PhD, PEng

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July 26, 2018
Project number: 1662333

Abstract

This document summarizes the results of rock laboratory testing of 2 uniaxial compressive strength (UCS) tests. Results, including uniaxial compressive strength (UCS) and Young's modulus along with photographs of samples before and after testing are presented. Additional specimen information is included in an accompaning summary spreadsheet.

In this document:

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1 Uniaxial Compressive Strength (UCS) testing

This report summarizes the results of 2 uniaxial compressive strength (UCS) tests. 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 0.15 mm/min (Figure 1). This displacement rate was selected to target specimen failure to occur within 2 - 15 minutes.

The specimen preparation and testing procedure 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 samples to obtain cylindrical specimens with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding of specimens 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. Axial loading to rupture while continuously recording axial force and axial deformation to determine the peak strength (UCS) and (tangent) Young's modulus (E).

Figure 1: UCS test setup.

1.1 Results

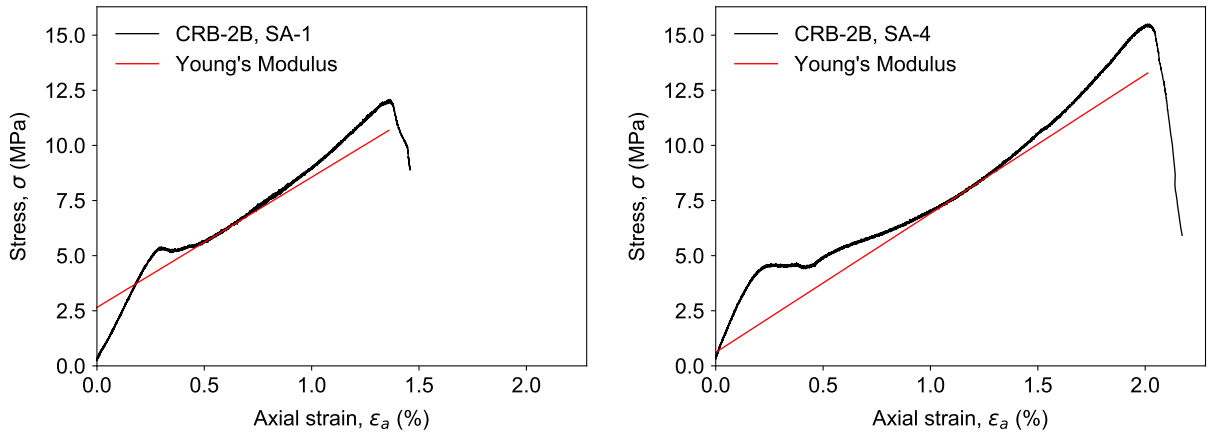
The results of the tests are summarized in Table 1. The corresponding stress-strain curves for the uniaxial compression tests are presented in Figure 2. Young's modulus is the tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing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

Table 1: Summary of laboratory test results.

Sample	Depth (m)	Lithology description	Bulk density ρ (g/cm^3)	UCS (MPa)	Young's Modulus E (GPa)	Failure description
CRB-2B-SA-1	6.89 - 7.06	Shale	2.593	12.1	0.59	Diffuse axial splitting[1, 2]
CRB-2B-SA-4	9.10 - 9.25	Shale	2.601	15.5	0.63	Inclined shear band[1, 2]

[1] Specimen side straightness (i.e., diameter) varied up to 0.6 mm

[2] Specimen emitted pore water upon loading



(a) CRB-2B, SA-1

(b) CRB-2B, SA-4

Figure 2: Measured stress-strain curves.

1.2 Specimen photographs

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

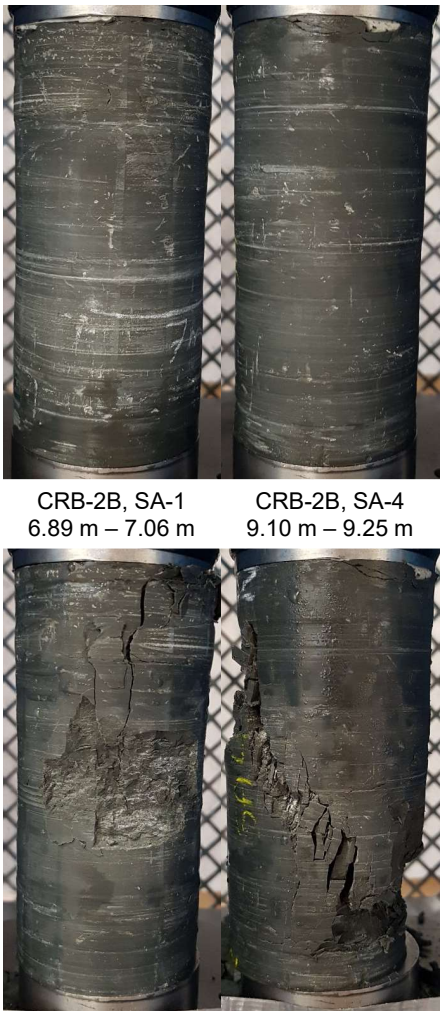


Figure 3: Photographs of specimens before and after testing.

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

Attention:David Marmor

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

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

CERTIFICATE OF ANALYSIS

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

Sample Matrix: Soil
Samples Received: 3

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

Remarks:

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

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

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

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

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

Attention:David Marmor

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

Report Date: 2017/11/21
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CERTIFICATE OF ANALYSIS

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

Encryption Key

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

==========

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

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

RESULTS OF ANALYSES OF SOIL

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

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

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

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

TEST SUMMARY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

GENERAL COMMENTS

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

Package 1	5.3°C

Results relate only to the items tested.

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Report Date: 2017/11/21

QUALITY ASSURANCE REPORT

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

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

N/A = Not Applicable

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

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

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

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

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

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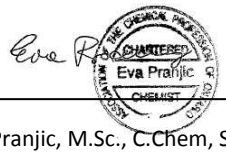
Report Date: 2017/11/21

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

VALIDATION SIGNATURE PAGE

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



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

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Maxxam

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Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266

CHAIN OF CUSTODY RECORD

51329

Page 1 of 1

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

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

REGULATION 153 (2011)			OTHER REGULATIONS	
[ ] Table 1	[ ] Res/Park	[ ] Med/Fine	[ ] CCME	[ ] Sanitary Sewer Bylaw
[ ] Table 2	[ ] Ind/Comm	[ ] Coarse	[ ] MISA	[ ] Storm Sewer Bylaw
[ ] Table 3	[ ] Agri/Other		[ ] PWQO	Municipality:
[ ] Table			[ ] Other (Specify):	
FOR RSC (PLEASE CIRCLE) YES / NO			[ ] REG 558 (MINIMUM 3 DAY TAT REQUIRED)	

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

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

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

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

Rush Confirmation #:

Date Required:

LABORATORY USE ONLY

CUSTODY SEAL (Y/N)	Temperature (°C) on Receipt
Present	4/4/7
Intact	
COOLING MEDIA PRESENT (Y / N)	

COMMENTS / TAT COMMENTS

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

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

COC-1004 (11/13) - ENV ENG

Maxxam Analytics International Corporation o/a Maxxam Analytics

White: Maxxam - Yellow: Client

Maxxam
A Bureau Veritas Group Company

Your Project #: 1662333
Site Location: QEW/CRB
Your C.O.C. #: 35606

Attention: David Marmor

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

Report Date: 2018/04/26
Report #: R5092302
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B886277
Received: 2018/04/17, 14:35

Sample Matrix: Soil
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	3	N/A	2018/04/22	CAM SOP-00463	EPA 325.2 m
Conductivity	3	N/A	2018/04/19	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	3	2018/04/20	2018/04/20	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2018/04/17	2018/04/19	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	3	N/A	2018/04/20	CAM SOP-00464	EPA 375.4 m

Remarks:

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

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: 1662333
Site Location: QEW/CRB
Your C.O.C. #: 35606

Attention: David Marmor

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

Report Date: 2018/04/26
Report #: R5092302
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B886277
Received: 2018/04/17, 14:35

Encryption Key

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

==========

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

Maxxam Job #: B886277
Report Date: 2018/04/26

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW/CRB
Sampler Initials: JL

SOIL CORROSIVITY PACKAGE (SOIL)

Maxxam ID		GLY689	GLY690	GLY691		
Sampling Date		2018/02/14 15:00	2018/02/09 14:00	2018/02/06 12:00		
COC Number		35606	35606	35606		
	UNITS	CRB_5_13.31-13.41	CRB_3A_11.10-11.28	CRB_2_6.10-6.24	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	1700	3100	3800		5488254
Inorganics						
Soluble (20:1) Chloride (Cl)	ug/g	46	44	<20	20	5493401
Conductivity	umho/cm	582	321	263	2	5491303
Available (CaCl2) pH	pH	8.08	8.07	8.09		5492017
Soluble (20:1) Sulphate (SO4)	ug/g	160	49	56	20	5493410

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		GLY691		
Sampling Date		2018/02/06 12:00		
COC Number		35606		
	UNITS	CRB_2_6.10-6.24 Lab-Dup	RDL	QC Batch
Inorganics				
Soluble (20:1) Chloride (Cl)	ug/g	<20	20	5493401
Soluble (20:1) Sulphate (SO4)	ug/g	58	20	5493410

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

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Maxxam Job #: B886277
Report Date: 2018/04/26

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW/CRB
Sampler Initials: JL

TEST SUMMARY

Maxxam ID: GLY689
Sample ID: CRB_5_13.31-13.41
Matrix: Soil

Collected: 2018/02/14
Shipped:
Received: 2018/04/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5493401	N/A	2018/04/22	Deonarine Ramnarine
Conductivity	AT	5491303	N/A	2018/04/19	Tahir Anwar
pH CaCl2 EXTRACT	AT	5492017	2018/04/20	2018/04/20	Gnana Thomas
Resistivity of Soil		5488254	2018/04/19	2018/04/19	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5493410	N/A	2018/04/20	Alina Dobreanu

Maxxam ID: GLY690
Sample ID: CRB_3A_11.10-11.28
Matrix: Soil

Collected: 2018/02/09
Shipped:
Received: 2018/04/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5493401	N/A	2018/04/22	Deonarine Ramnarine
Conductivity	AT	5491303	N/A	2018/04/19	Tahir Anwar
pH CaCl2 EXTRACT	AT	5492017	2018/04/20	2018/04/20	Gnana Thomas
Resistivity of Soil		5488254	2018/04/19	2018/04/19	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5493410	N/A	2018/04/20	Alina Dobreanu

Maxxam ID: GLY691
Sample ID: CRB_2_6.10-6.24
Matrix: Soil

Collected: 2018/02/06
Shipped:
Received: 2018/04/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5493401	N/A	2018/04/22	Deonarine Ramnarine
Conductivity	AT	5491303	N/A	2018/04/19	Tahir Anwar
pH CaCl2 EXTRACT	AT	5492017	2018/04/20	2018/04/20	Gnana Thomas
Resistivity of Soil		5488254	2018/04/19	2018/04/19	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5493410	N/A	2018/04/20	Alina Dobreanu

Maxxam ID: GLY691 Dup
Sample ID: CRB_2_6.10-6.24
Matrix: Soil

Collected: 2018/02/06
Shipped:
Received: 2018/04/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5493401	N/A	2018/04/22	Deonarine Ramnarine
Sulphate (20:1 Extract)	KONE/EC	5493410	N/A	2018/04/20	Alina Dobreanu

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Maxxam Job #: B886277
Report Date: 2018/04/26

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW/CRB
Sampler Initials: JL

GENERAL COMMENTS

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

Package 1	8.7°C

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW/CRB
Sampler Initials: JL

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5491303	Conductivity	2018/04/19			101	90 - 110	<2	umho/cm	0.69	10
5492017	Available (CaCl2) pH	2018/04/20			99	97 - 103			0.37	N/A
5493401	Soluble (20:1) Chloride (Cl)	2018/04/22	116	70 - 130	106	70 - 130	<20	ug/g	NC	35
5493410	Soluble (20:1) Sulphate (SO4)	2018/04/20	NC	70 - 130	101	70 - 130	<20	ug/g	3.1	35

N/A = Not Applicable

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

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

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

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

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

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

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Maxxam Job #: B886277
Report Date: 2018/04/26

Golder Associates Ltd
Client Project #: 1662333
Site Location: QEW/CRB
Sampler Initials: JL

VALIDATION SIGNATURE PAGE

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

Cristina Carriere

Cristina Carriere, Scientific Service Specialist

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CHAIN OF CUSTODY RECORD

35606

Page 1 of 1

INVOICE INFORMATION	REPORT INFORMATION (if differs from invoice)	PROJECT INFORMATION	MAXXAM JOB NUMBER
Company Name: Golder Associates	Company Name:	Quotation #:	
Contact Name: David Marmar	Contact Name:	P.O. #:	CHAIN OF CUSTODY #
Address: 6925 Century ave. #100 Mississauga, ON, L5N7K2	Address:	Project #: 1662333	00
Phone: 905-567-4444 Fax:	Phone: Fax:	Project Name: QEW/CRB	
Email: david_marmar@golder.com	Email:	Location:	
		Sampled By: Jeremy Lebow	

REGULATORY CRITERIA

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form.

- ☐ MISA
- ☐ PWQO
- ☐ Reg. 558
- Reg. 153: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table 6
- ☐ Residential / Parkland ☐ Industrial / Commercial ☐ Medium / Fine ☐ Coarse
- Sewer Use: ☐ Sanitary ☐ Storm
- Municipality:
- Reg. 153: ☐ 2004 ☐ 2011
- Other (specify):

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

ANALYSIS REQUESTED (Please be specific)

TURNAROUND TIME (TAT) REQUIRED

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS.

Regular (Standard) TAT: ☐ 5 to 7 Working Days

Rush TAT: Rush Confirmation #: (call Lab for #)

☐ 1 day ☐ 2 days ☐ 3 days

DATE Required:

TIME Required:

Please note that TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

	Sample Identification	Date Sampled	Time Sampled	Matrix (GW, SW, Soil, etc.)	Regulated Drinking Water? (Y / N)	Metals Field Filtered? (Y / N)	Corrosivity	# of Cont.	COMMENTS / TAT COMMENTS
1	CRB_5_13.31-13.41	Feb.14/18	3:00	rock			X	1	
2	CRB-3A_11.10-11.28	Feb9/18	2:00	rock			X	1	
3	CRB_2_6.10-6.24	Feb.6/18	12:00	rock			X	1	
4									
5									
6									
7									
8									
9									
10									
11									
12									

17-Apr-18 14:35
Ema Gitej
B886277
URE ENV-2012

RELINQUISHED BY (Signature/Print)	RECEIVED BY (Signature/Print)	Date	Time	# JARS USED AND NOT SUBMITTED	Laboratory Use Only
Andrea Begin	Parsey / Parsey K. Parsey	2018/04/17	14:35		Temperature (°C) on Receipt 8/10/8

***MANDATORY SECTIONS IN GREY MUST BE FILLED OUT. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.**

COC-1004 (03/10) - ENV. ENG. Maxxam Analytics International Corporation o/a Maxxam Analytics White: Maxxam Yellow: Mail Pink: Client

golder.com