# Foundation Investigation Report

*Sanitary Sewer Installation at Station 15+850, QEW from West of Mississauga Road to West of Hurontario Street, Mississauga*
*Ministry of Transportation, Ontario, GWP 2002-13-00*

Submitted to:


**Morrison Hershfield Limited**
125 Commerce Valley Drive West, Suite 300
Markham, ON
L3T 7W4


Submitted by:


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

+1 905 567 4444



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**GEOCRES No.: 30M12-448**


**Latitude:** 43.550092, **Longitude:** -79.617350

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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 sanitary sewer installation at Station 15+850 associated with the widening of the Queen Elizabeth Way (QEW) from west of Mississauga Road to west of Hurontario Street in the City of Mississauga, Ontario, as shown on the Key Plan on Drawing 1.

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

The Terms of Reference (TOR) and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated July 2016, and the approved Change Request letters, which 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

The proposed sanitary sewer installation at Station 15+850 is located approximately 10 m west of the intersection of Sheridan Way and Indian Grove Avenue south of the QEW and extends from the grassy area between Mississauga Road and the Mississauga Road E – QEW W On-Ramp southwards to just north of South Sheridan Way, located south of the QEW, in the City of Mississauga, Ontario (see Drawing 1). The QEW is oriented in a northeast-southwest direction which at this location and for the purpose of this report, is referred to as west-east orientation.

The QEW consists of three eastbound lanes (to Toronto) and three westbound lanes (to Hamilton), while South Sheridan Way consists of one lane in each direction. Residential areas are located on the south side of South Sheridan Way and a golf course is located north of Mississauga Road. The existing ground surface along the sanitary sewer alignment varies from about Elevation 100.8 m at the north end of the sanitary sewer alignment, to about Elevation 101.2 m on the pavement surface of the QEW (westbound lanes), to about Elevation 100.5 m at the south end of the alignment.

# 3.0 INVESTIGATION PROCEDURES

Field work for the foundation investigation was carried out between February 25 and March 8, 2019, during which time a total of three sampled boreholes, designated as Boreholes C2-1, C2-2 and C2-3 were advanced along or adjacent to the proposed sanitary sewer alignment approximately at the locations shown on Drawing 1. This information was supplemented with Borehole NW4-5 advanced on July 3, 2018 for the proposed Noise Barrier Wall. In addition, use of the water level information obtained from a standpipe piezometer installed in Borehole C1-4 for the proposed watermain installation at Station 15+825 (located about 25 m west of the proposed sanitary sewer) is included in this report.

Field drilling was carried out using a truck-mounted CME 75 drilling rig supplied and operated by Geo-Environmental Drilling Inc., of Halton Hills, Ontario and a track-mounted CME 55 drilling rig and a truck-mounted CME 75 drilling rig supplied and operated by Davis Drilling Ltd., of Milton Ontario. The boreholes were advanced through the overburden using 70 mm, 83 mm and 108 mm inside diameter (I.D.) hollow stem augers. Soil samples were obtained at 0.60 m, 0.75 m and 1.5 m intervals of depth, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-11)[1]. Samples of the bedrock were obtained using an ‘HQ’ size rock core barrel and wireline coring techniques in Boreholes C2-1, C2-2, C2-3 and NW4-5.

The boreholes were advanced to depths between 7.6 m and 8.9 m below existing ground surface, including coring of bedrock for core lengths of between 3.5 m and 5.6 m in Boreholes C2-1 to C2-3 and NW4-5.

Groundwater conditions and water levels in the open boreholes were observed during and immediately following the drilling operations. A standpipe piezometer was installed in Boreholes C1-4 and C2-1 to permit monitoring of the water level at these borehole locations. The installed piezometers consist of a 50 mm diameter PVC pipe, with a slotted screen. The annulus surrounding the piezometer screens were backfilled with a filter sand pack. The section of borehole below the standpipe piezometers were backfilled with bentonite to the underside of the sand pack level, and the remainder of the borehole above the sand pack was backfilled with bentonite to near the ground surface and topped with cold patch asphalt or sand and gravel to match the adjacent ground surface material. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 Wells (as amended)

Field work was observed by members of Golder’s engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder’s Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the soil 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.

Selected rock core samples were submitted to Geomechanica Inc. of Toronto, Ontario for unconfined compression (UC) testing, assessment of Young’s modulus and bulk density and CERCHAR abrasivity testing. Rock core specimens were also submitted to Western University in London, Ontario for a suite of swell testing, which includes free swell, null swell and semi-confined, with accompanying moisture, salt, and calcite content testing; however, due to the long duration of the test, the results are not available for this reporting stage.

Selected bedrock core samples were submitted to Maxxam Analytics (Maxxam) of Mississauga, Ontario, which is a Standards Council of Canada (SCC) accredited laboratory for chemical analysis of a suite of characteristics including Petroleum Hydrocarbons, CCME F1 and BTEX. Additional bedrock core samples were analyzed by Maxxam for a suite of characteristics that indicate corrosivity potential including; pH, resistivity, conductivity, chloride content and sulphate content.

The as-drilled borehole locations and the ground surface elevations were obtained using a GPS Trimble Geo 7X, having an accuracy of approximately 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) CSRS CBNV6-2010.0 northing and easting coordinates and the ground surface elevations are

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

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) | | |
| C1-4 | 4,823,329.3 (43.549839) | 295,310.9 (-79.617440) | 100.4 | 12.8 (including 9.09 m of bedrock core) |
| C2-1 | 4,823,392.0 (43.550403) | 295,230.5 (-79.618436) | 101.1 | 8.0 (including 4.38 m of bedrock core) |
| C2-2 | 4,823,375.4 (43.550254) | 295,283.7 (-79.617778) | 101.1 | 8.8 (including 4.90 m of bedrock core) |
| C2-3 | 4,823,357.4 (43.550092) | 295,318.2 (-79.617350) | 100.8 | 8.9 (including 5.58 m of bedrock core) |
| NW4-5 | 4,823,340.0 (43.549927) | 295,333.6 (-79.617156) | 100.3 | 7.6 (including 3.51 m of bedrock core) |

# 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

## 4.1 Regional Geology

The project area is located within the Iroquois Plain physiographic region, as delineated in The Physiography of Southern Ontario (Chapman and Putman, 1984)[2]. The glacial Iroquois Plain stretches along the northern shoreline of Lake Ontario, extending from the Niagara Escarpment in the west to the Scarborough Bluffs in the east. The Iroquois Plain soils consist of glaciolacustrine sediments deposited in Lake Iroquois, primarily sand, silt and gravel, with a shallow cover of till remaining over the bedrock.

The Georgian Bay Formation bedrock, which 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

Subsurface soil, bedrock and groundwater conditions as encountered in the boreholes advanced during the geotechnical investigation, the details of the piezometer installations and water level readings, and the results of the geotechnical laboratory tests carried out on selected soil and bedrock samples are presented on the Records of Borehole and Drillhole sheets provided in Appendix A. Photographs of the recovered bedrock core samples are presented on Figures A-1 to A-4, in Appendix A. The results of the in-situ field tests (i.e. SPT "N" values) as presented on the Record of Borehole sheets and in sub-sections of Section 4.2 are uncorrected. Lists on abbreviations and symbols and lithological, geotechnical rock description terminology, field estimation of rock

[2] Chapman, L.J. and Putman, D.F., 1984, The Physiography of Southern Ontario, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.)

hardness and rock weathering classification are also included in Appendix A to assist in the interpretation of the borehole and drillhole records. The results of the geotechnical laboratory testing on the soil and bedrock samples are also presented on Figures B-1 to B-5 in Appendix B. The analytical laboratory test report is included in Appendix C and the test results are summarized in Section 4.2.6.

Stratigraphic boundaries shown on the Record of Borehole sheets and on the stratigraphic profile on Drawing 1 are inferred from non-continuous sampling, observations of drilling progress and the results of the Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations; however, the factual data presented in the borehole and drillhole records governs any interpretation of the site conditions. It should be noted that the interpreted stratigraphy shown on Drawing 1 is a simplification of the subsurface conditions.

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

### 4.2.1 Asphalt / Concrete Pavement

An approximately 100 mm to 150 mm thick layer of asphalt pavement was encountered at ground surface in Boreholes C2-2, C2-3 and NW4-5. A 200 mm and 240 mm thick layer of concrete was encountered underlying the asphalt pavement in Boreholes C2-3 and C2-2, respectively.

### 4.2.2 Fill

An approximately 0.6 m thick layer of fill comprised of clayey silt trace to some sand and some organics was encountered immediately at ground surface in Borehole C2-1 and extended to Elevation 100.5 m. An approximately 0.5 m to 0.9 m thick layer of fill comprised of gravelly sand to silty sand and gravel to sand and gravel was encountered underlying the asphalt / concrete pavement in the Boreholes C2-2, C2-3 and NW4-5 and underlying the fill in Borehole C2-1 at depths of between 0.2 m to 0.6 m (between Elevations 100.8 m and 100.1 m).

The Standard Penetration Test (SPT) “N”-value measured within the clayey silt fill layer was 10 blows per 0.3 m of penetration, suggesting a stiff consistency. The SPT “N”-values measured within the granular fill ranged from 10 blows to 48 blows per 0.3 m of penetration, indicating a compact to dense compactness condition.

Grain size distribution testing was carried out on one sample from the granular fill layers and the results are shown on Figure B-1 in Appendix B.

The water content measured on one sample of the clayey silt fill was about 19 per cent. The water content measured on three samples of the granular fill ranged from about 6 per cent to about 22 per cent.

### 4.2.3 Clayey Silt to Silty Clay

Underlying the fill in Boreholes NW4-5 and C2-2, a 0.8 m and 0.5 m thick cohesive deposit consisting of clayey silt to silty clay, some gravel, trace to some sand, was encountered at depths of 0.7 m and 1.0 m below ground surface (Elevations 99.6 m and 100.1 m), respectively.

The SPT "N"-values measured within the this deposit were 9 blows and 19 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency.

Grain size distribution testing was carried out on one sample of the cohesive deposit and the result is shown on Figure B-2 in Appendix B. Atterberg limits testing was carried out on one sample of the cohesive deposit and had a measured liquid limit of about 40 per cent, plastic limit of about 22 per cent, and a plasticity index of about 18 per cent. These results, which are plotted on a plasticity chart on Figure B-3 in Appendix B, indicate that the cohesive deposit consists of silty clay of medium plasticity.

The water content measured on two samples of the cohesive deposit was 15 per cent and 24 per cent.

### 4.2.4 Shale Bedrock

The upper portion of the bedrock was sampled by split-spoon and the bedrock was confirmed by coring in Boreholes C2-1 to C2-3 and NW4-5. The length of bedrock sampled by split-spooning and by coring and the depths to, and corresponding elevations of, the completely to moderately weathered shale bedrock and the depths to, and corresponding elevations of, the slightly weathered to fresh shale bedrock are summarized below:

| Borehole No. | Completely to Moderately Weathered Bedrock | | Length of Bedrock Sampled by Split-Spoon (m) | Slightly Weathered to Fresh Bedrock | | Length of Bedrock Cored (m) |
|---|---|---|---|---|---|---|
| | Depth (m) | Elevation (m) | | Depth (m) | Elevation (m) | |
| C2-1 | 1.2 – 3.7 | 99.9 – 97.4 | 2.6 | 3.66 – 8.04 | 97.44 – 93.06 | 4.38 |
| C2-2 | 1.5 – 3.9 | 99.6 – 97.2 | 2.4 | 3.94 – 8.84 | 97.16 – 92.26 | 4.90 |
| C2-3 | 1.2 – 3.3 | 99.6 – 97.5 | 2.1 | 3.33 – 8.91 | 97.47 – 91.89 | 5.58 |
| NW4-5 | 1.5 – 3.8 | 98.8 – 96.5 | 2.4 | 3.8 – 7.63 | 96.5 – 92.70 | 3.51 |

#### *Completely to Moderately Weathered Shale*

Completely to moderately weathered shale bedrock was encountered at depths ranging from 1.2 m to 1.5 m below ground surface (Elevations 99.9 m to 98.8 m), inferred based on drilling behavior, observations of drilling cuttings and split-spoon sampling. The thickness of the completely to moderately weathered bedrock is inferred to range from about 2.1 m to 2.5 m.

The SPT "N"-values measured within the inferred completely to moderately weathered shale bedrock range from 21 blows per 0.3 m of penetration to 100 blows for 0.10 m of penetration, suggesting a very stiff to hard consistency and blockages of the sampling equipment by fragments of rock.

Grain size distribution testing was carried out on three samples of the inferred completely to moderately weathered bedrock obtained by split-spoon sampling and the results are shown on Figure B-4 in Appendix B. The split-spoon samples obtained from within the inferred completely to moderately weathered bedrock do not contain larger fragments of rock due to the sampler size and sampling method. Larger fragments or layers of unweathered shale bedrock may be present in-situ. In addition, the percentage of gravel size particles may include shale fragments that either remained intact after or were broken down during sampling and during sample preparation. Therefore, the results of the grain size distribution testing may not be representative of the bulk grain size distribution or behavior of the in-situ or excavated completely to moderately weathered shale bedrock.

Atterberg limits testing was carried out on the finer fractions of four samples of the inferred completely to moderately weathered shale bedrock and measured liquid limits ranging from about 32 per cent to 36 per cent, plastic limits ranging from about 20 per cent to 23 per cent, and plastic indices ranging from about 11 per cent to 15 per cent. These results are plotted on a plasticity chart on Figure B-5 in Appendix B and indicate that the finer fraction of the inferred completely to moderately weathered shale bedrock, when broken down to a soil, consists of a clayey silt of low plasticity to a silty clay of medium plasticity. The water content measured on thirteen samples of the inferred completely to moderately weathered shale bedrock range between approximately 5 per cent and 14 per cent.

### *Moderately Weathered to Fresh Shale*

Based on a review of the recovered bedrock core samples, the bedrock consists of shale of the Georgian Bay Formation. In general, the bedrock core samples are described as moderately weathered to fresh, very thinly laminated to thinly bedded, very fine to fine grained, faintly porous, weak, grey, shale, with slightly weathered to fresh, laminated to medium bedded, grey, very fine grained to fine grained, medium strong to very strong limestone interbeds at varying intervals of depth as presented on the drillhole records. Note that no strength testing was carried out on the limestone interbeds and the strength is based on field identification in accordance with the International Society for Rock Mechanics (ISRM[3]). The strong limestone layers within the slightly weathered to fresh shale range in thickness from about 10 mm to 200 mm, with an average thickness of about 50 mm. The rock core samples obtained during the drilling investigation contain less than 5 per cent to up to 20 per cent stronger limestone layers (based on the percentage of limestone in a core run). Details of the bedrock descriptions are presented on the drillhole records and a photograph of the recovered bedrock core samples is presented on Figures A-1 to A-4 in Appendix A. The degree of weathering of the bedrock core samples (i.e., fresh to moderately weathered – W1 to W3), and the strength classification of the intact rock mass based on field identification (i.e., weak – R2) are described in accordance with the International Society for Rock Mechanics (ISRM[4]) standard classification system.

The Rock Quality Designation (RQD) measured on the core samples ranges from about 46 per cent to 100 per cent, indicating that the slightly weathered to fresh portion of the rock mass consists of poor to excellent quality as per Table 3.10 of CFEM (2006)[5]. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered range between 95 per cent and 100 per cent and between 80 per cent and 100 per cent, respectively.

Unconfined Compression (UC) testing (ASTM D7012)[6] was carried out on four selected core samples of the shale bedrock and the uniaxial compressive strength (UCS), bulk density and Young's moduli of the intact samples are summarised below and the details are presented in the Rock Laboratory Test Results report from Geomechanica in Appendix B. The UCS of intact shale rock specimens ranges from 13 MPa to 23 MPa, with an average of about 18.5 MPa for the slightly weathered to fresh portion of the bedrock formation. Based on the range of laboratory

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

[4] 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.

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

UCS test results, in accordance with Table 3.5 in CFEM (2006)[5], the shale bedrock is classified as weak rock (R2, 5 MPa < UCS < 25 MPa).

| Borehole No. / Sample No.* | Sample Depth (m) | Sample Elevation (m) | UCS (MPa) | Young's Modulus, E at 2.5 MPa (GPa) | Young's Modulus,E at 50% UCS (GPa) | Density ($g/cm^3$) | Rock Type |
|---|---|---|---|---|---|---|---|
| C2-1 / SA-01 | 4.60 - 4.85 | 96.50 - 96.25 | 17.1 | 1.5 | 0.8 | 2.591 | Shale |
| C2-1 / SA-02 | 4.99 - 5.40 | 96.11 - 95.70 | 20.2 | 1.8 | 1.0 | 2.589 | Shale |
| C2-2 / SA-01 | 8.13 - 8.32 | 92.97 - 92.78 | 13.3 | 1.1 | 0.8 | 2.592 | Shale |
| C2-3 / SA-05 | 10.86 - 11.07 | 89.94 - 89.73 | 23.2 | 1.9 | 1.4 | 2.602 | Shale |

NOTE: * The sample numbers listed above and in the table below are related to the samples selected from the rock core and do not correspond to the run number shown on the drillhole sheets.

The results of the CERCHAR abrasivity index (CAI) testing carried out on one selected core sample of the shale bedrock obtained in Borehole C2-2 are presented below and in Appendix B.

| Borehole No. / Sample No. | Sample Depth (m) | Sample Elevation (m) | Mean Wear (mm) | CAI | Standard Deviation of CAI | ISRM Classification |
|---|---|---|---|---|---|---|
| C2-2 / SA-02 | 7.20 - 7.29 | 93.90 - 93.81 | 0.027 | 0.27 | 0.12 | < Very Low |

The swelling potential of the shale bedrock was investigated by conducting a suite of swell tests at Western University (K.Y. Lo Inc.) in London, Ontario. The samples were subjected to either free swell (samples with no applied pressure), semi-confined (confining pressure applied to samples in the direction of the sample axis) or null swell conditions (swelling in the direction of the sample axis was fully restricted and the pressure applied to suppress swelling was measured), in either vertical and horizontal orientations (sample axis perpendicular and along the bedding plane respectively), with accompanying moisture, salt, and calcite content testing.

The tests assessing the swell potential are still underway at the time of this report and will be issued to the MTO under a separate cover.

### 4.2.5 Groundwater Conditions

Details of the water levels observed in the open boreholes at the time of drilling are presented on the Records of Boreholes in Appendix A. A standpipe piezometer was installed in Borehole C2-1 to monitor the groundwater level at the borehole location. In addition, for the proposed watermain installation at Station 15+825 located about 25 m west of the proposed sanitary sewer, a standpipe piezometer was installed in Borehole C1-4. This information is included below to supplement the groundwater information obtained from Borehole C2-1. The water levels measured in the open boreholes and the piezometers are summarized below. It should be noted that the groundwater level in the area is subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year.

| Borehole No. | Ground Surface Elevation (m) | Depth to Water Level (m) | Groundwater Elevation (m) | Date | Comments |
|---|---|---|---|---|---|
| C1-4 | 100.4 | Dry | - | February 2, 2019 | Dry prior to bedrock coring |
| | | 4.6 | 95.8 | March 19, 2019 | Piezometer – sealed into shale bedrock |
| C2-1 | 101.1 | Dry | - | February 26, 2019 | Dry prior to bedrock coring |
| | | 4.7 | 96.4 | March 13, 2019 | Piezometer – sealed into shale bedrock |
| | | 5.7 | 95.4 | March 21, 2019 | |
| C2-2 | 101.1 | Dry | - | February 26, 2019 | Dry prior to bedrock coring |
| C2-3 | 100.8 | Dry | - | March 7, 2019 | Dry prior to bedrock coring |
| NW4-5 | 100.3 | Dry | - | July 3, 2018 | Dry prior to bedrock coring |

### 4.2.6 Analytical Testing Results

Selected specimens of the rock core samples collected from Boreholes C2-2 and C2-3 were submitted to Maxxam Analytics (Maxxam), a Standards Council of Canada (SCC) accredited laboratory, of Mississauga, Ontario for chemical analysis of the following parameters: Petroleum Hydrocarbons, CCME F1 and BTEX.

No evidence of odour or staining was noted during drilling in any of the samples. The Maxxam report is provided in Appendix C. A summary of the parameters analyzed is provided below.

| Borehole No. / Sample No. | Sample Depth (m) | Sample Elevation (m) | Analyzed Parameters |
|---|---|---|---|
| C2-2 / SA-03 | 8.11 - 8.18 | 92.99 - 92.92 | Petroleum Hydrocarbons, CCME F1 and BTEX |
| C2-3 / SA-01 | 4.26 - 4.33 | 96.54 - 96.47 | Petroleum Hydrocarbons, CCME F1 and BTEX |

Two specimens from the bedrock core samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. The Maxxam report is provided in Appendix C and summarized below.

| Borehole No. | Borehole C2-2<br>Run#2<br>Elev. 96.3 m | Borehole C2-3<br>Run#1<br>Elev. 97.0 m |
|---|---|---|
| pH | 8.08 | 8.14 |
| Resistivity (ohm-cm) | 2,500 | 2,600 |
| Electrical Conductivity (umho/cm) | 407 | 391 |
| Chlorides (ug/g) | <20* | 71 |
| Soluble Sulphates (ug/g) | 190 | 72 |

**Notes:**

* Lower than Reportable Detection Limit

## 5.0 CLOSURE

This report was prepared by Ms. Andrea Begin, E.I.T. of the Mississauga Rock Group, and reviewed by Ms. Sandra McGaghran, M.Eng., P.Eng. an Associate and senior geotechnical engineer with Golder. Mr. Paul Dittrich, Ph.D., P.Eng., an MTO Foundations Designated Contact and Principal with Golder, conducted a technical and quality control review of the report.

**Golder Associates Ltd.**

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

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

SP/SMM/JPD/MJT/SJB/rb



https://golderassociates.sharepoint.com/sites/11176g/shared documents/07-reporting/foundations/12 - peel crossing fidr/crossing 2/3 - final/1662333 fir peel crossing 2 2019july30.docx

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

CONT No.
GWP No. 2002–13–00

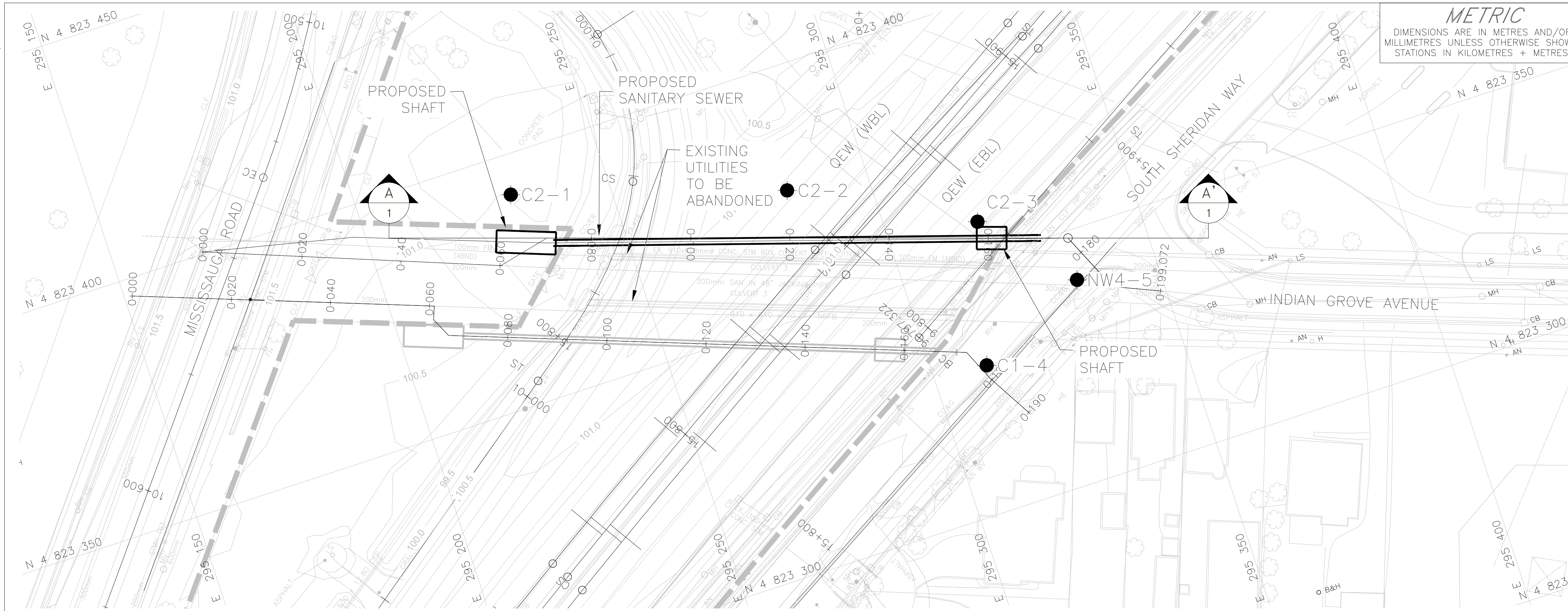
SHEET

QEW WIDENING – MISSISSAUGA RD TO HURONTARIO ST

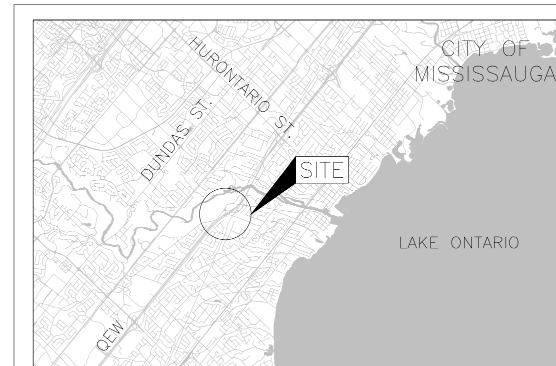
SANITARY SEWER INSTALLATION STATION 15+850

# BOREHOLE LOCATIONS PLAN AND SOIL STRATA

GOLDER




PLAN
SCALE
10 0 10 20 m

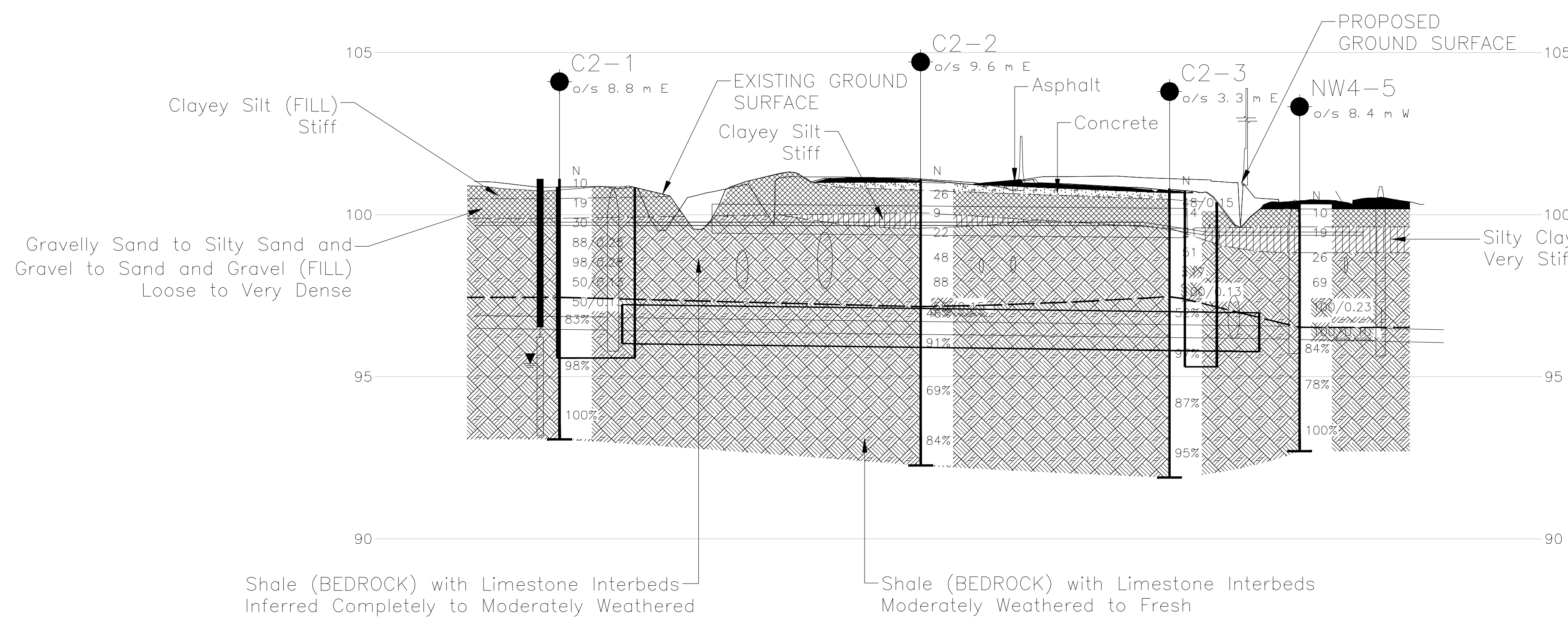



KEY PLAN
SCALE
2 0 2 4 km

## LEGEND

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

| BOREHOLE CO–ORDINATES (MTM NAD 83 ZONE 10) | | | |
|---|---|---|---|
| No. | ELEVATION | NORTHING | EASTING |
| C1–4 | 100.4 | 4823329.3 | 295310.9 |
| C2–1 | 101.1 | 4823392.0 | 295230.5 |
| C2–2 | 101.1 | 4823375.4 | 295283.7 |
| C2–3 | 100.8 | 4823357.4 | 295318.2 |
| NW4–5 | 100.3 | 4823340.0 | 295333.6 |




PROFILE A–A' – SANITARY SEWER – STATION 15+850

VERTICAL SCALE
10 0 10 20 m

HORIZONTAL SCALE
10 0 10 20 m

## NOTES

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

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

## REFERENCE

Base plans provided in digital format by MH, drawing file nos. X11609340Base.dwg, X–Final Merged Util.dwg, X–PROP–UTIL.dwg, Existing Property.dwg, 11609340 – QEW Prop Util–Dickson & Lynchmere – C3D 2017.dwg, 11609340 – QEW Prop Util–Stavebank Rd – C3D 2017.dwg, 11609340 – QEW Prop Util–Knareswood Dr – C3D 2017.dwg, and x1160934_Align.dwg, received March 25, 2019 and 11609340 – QEW Prop Util–IndianGroveAve – C3D 2017.dwg, received June 21, 2019.


| NO. | DATE | BY | REVISION |
|---|---|---|---|

Geocres No. 30M12–448

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

PLOT DATE: July 29, 2019

**APPENDIX A**

# Records of Borehole and Drillhole Sheets and Bedrock Core Photographs

# LIST OF SYMBOLS

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

## I. GENERAL

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

## II. STRESS AND STRAIN

| | |
|---|---|
| $\gamma$ | shear strain |
| $\Delta$ | change in, e.g. in stress: $\Delta\,\sigma$ |
| $\varepsilon$ | linear strain |
| $\varepsilon_v$ | volumetric strain |
| $\eta$ | coefficient of viscosity |
| $\upsilon$ | Poisson's ratio |
| $\sigma$ | total stress |
| $\sigma'$ | effective stress ($\sigma' = \sigma - u$) |
| $\sigma'_{vo}$ | initial effective overburden stress |
| $\sigma_1$, $\sigma_2$, $\sigma_3$ | principal stress (major, intermediate, minor) |
| $\sigma_{oct}$ | mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| $\tau$ | shear stress |
| u | porewater pressure |
| E | modulus of deformation |
| G | shear modulus of deformation |
| K | bulk modulus of compressibility |

## III. SOIL PROPERTIES

### (a) Index Properties

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

* Density symbol is $\rho$. Unit weight symbol is $\gamma$ 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 |
| $C_\alpha$ | secondary compression index |
| $m_v$ | coefficient of volume change |
| $c_v$ | coefficient of consolidation (vertical direction) |
| $c_h$ | coefficient of consolidation (horizontal direction) |
| $T_v$ | time factor (vertical direction) |
| U | degree of consolidation |
| $\sigma'_p$ | pre-consolidation stress |
| OCR | over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$ |

### (d) Shear Strength

| | |
|---|---|
| $\tau_p$, $\tau_r$ | peak and residual shear strength |
| $\phi'$ | effective angle of internal friction |
| $\delta$ | angle of interface friction |
| $\mu$ | coefficient of friction = $\tan\delta$ |
| $c'$ | effective cohesion |
| $c_u$, $s_u$ | undrained shear strength ($\phi = 0$ analysis) |
| p | mean total stress $(\sigma_1 + \sigma_3)/2$ |
| p′ | mean effective stress $(\sigma'_1 + \sigma'_3)/2$ |
| q | $(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$ |
| $q_u$ | compressive strength $(\sigma_1 - \sigma_3)$ |
| $S_t$ | sensitivity |

**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) |
| $\gamma$ | unit weight |

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

## V. MINOR SOIL CONSTITUENTS

| Per cent by Weight | Modifier | Example |
|---|---|---|
| 0 to 5 | Trace | Trace sand |
| 5 to 12 | Trace to Some (or Little) | Trace to some sand |
| 12 to 20 | Some | Some sand |
| 20 to 30 | (ey) or (y) | Sandy |
| over 30 | And (non-cohesive (cohesionless)) or With (cohesive) | Sand and Gravel<br>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 90º angle is horizontal.

**Description and Notes**

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

**Abbreviations**

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

# FIELD ESTIMATION OF ROCK HARDNESS

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

## Notes:

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

## Reference:

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

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

# ROCK WEATHERING CLASSIFICATION

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

# Reference:

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

GOLDER



# RECORD OF BOREHOLE No C1-4

SHEET 1 OF 1 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4823329.3; E 295310.9 MTM NAD ZONE 10 (LAT. 43.549839; LONG. -79.617440)
ORIGINATED BY EJ
DIST Central HWY QEW
BOREHOLE TYPE CME 75, 83 mm I.D. Hollow Stem Augers, HQ Casing
COMPILED BY KN
DATUM Geodetic
DATE February 21, 2019
CHECKED BY SEMP/SMM

| ELEV DEPTH | DESCRIPTION | NUMBER | TYPE | "N" VALUES | ELEVATION SCALE | WATER CONTENT (%) | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|
| 100.4 | GROUND SURFACE | | | | | | |
| 0.0 | ASPHALT (150 mm) | | | | | | |
| 0.2 | Gravelly sand, trace silt (FILL) Very dense Brown to dark brown Moist | 1 | SS | 50/0.10 | 100 | w plotted | |
| 99.8 / 0.6 | CLAYEY SILT, some sand Very stiff Light brown Dry to moist | 2 | SS | 21 | | | |
| 99.2 / 1.2 | Inferred completely to moderately weathered, brown to grey, extremely weak to very weak SHALE (Georgian Bay Formation) | 3 | SS | 50 | 99 | w plotted | 33 23 27 17 |
| | | 4 | SS | 27 | 98 | wP–wL plotted | |
| | | 5 | SS | 49 | | w plotted | 35 10 36 19 |
| | | 6 | SS | 80/0.25 | 97 | | |
| 96.7 / 3.7 | SHALE (BEDROCK) Grey Moderately weathered to 4.0 m depth to slightly weathered to fresh below 4.0 m depth<br>Bedrock cored from a depth of 3.7 m to 12.8 m.<br>For bedrock coring details, refer to Record of Drillhole C1-4. | 7 | SS | 50/0.13 | | | |
| | | 1 | RC | REC 100% | 96 | | RQD = 87% |
| | | 2 | RC | REC 100% | 95 / 94 | | RQD = 86% |
| | | 3 | RC | REC 100% | 93 | | RQD = 100% |
| | | 4 | RC | REC 100% | 92 / 91 | | RQD = 89% |
| | | 5 | RC | REC 100% | 90 | | RQD = 100% |
| | | 6 | RC | REC 100% | 89 / 88 | | RQD = 100% |
| 87.7 / 12.8 | END OF BOREHOLE | | | | | | |

NOTE:

1. Open Borehole dry upon completion of drilling prior to bedrock coring.

2. Water level measured at 4.6 m depth below ground surface (Elev. 95.8 m) in piezometer on March 19, 2019.

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100; PLASTIC LIMIT $W_P$, NATURAL MOISTURE CONTENT W, LIQUID LIMIT $W_L$; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

# RECORD OF DRILLHOLE: C1-4

LOCATION: N 4823329.3 ;E 295310.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: February 21, 2019

DRILL RIG: CME 75 Truck

DRILLING CONTRACTOR: Davis Drilling

DATUM: Geodetic

**Abbreviations:** 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 %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja) | ROCK STRENGTH INDEX (R4 R3 R2 R1) | WEATHERING INDEX (W1 W2 W3 W4 W5 W6) | FEATURES | R0/R1 ZONES | NOTES WATER LEVELS INSTRUMENTATION

Continued from Record of Borehole C1-4 — 96.74

**96.74 / 3.66** — Moderately weathered from 3.66 m to 4.00 m depth, to fresh below 4.00 m depth, very thinly laminated to thinly laminated, grey, fine grained, faintly porous, very weak from 3.66 m to 4.00 m depth, to weak below 4.00 m depth SHALE (Georgian Bay Formation) with slightly weathered to fresh, grey, fine grained, strong to very strong LIMESTONE interbeds

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

| Depth (m, approx.) | Type and Surface Description | Jr | Ja |
|---|---|---|---|
| 4.5 | CO,PL,SM | 1 | 1 |
| 5.0 | CO,IR,SM | 2 | 1 |
| 5.3 | BD,IR,SM | 2 | 1 |
| 5.4 | JN,CU,SM | 2 | 1 |
| 5.8 | JN,IR,SM | 2 | 4 |
| | CC,CL, 1 mm | 1 | 1 |
| | BD,PL,SM | 2 | 1 |
| | BD,UN,SM | 2 | 1 |
| | BD,UN,SM | 2 | 4 |
| | JN,IR,SM | 2 | 1 |
| | CC,CL, 1 mm | | |
| | CO,UN,SM | | |
| 6.5 | CO,UN,SM | 2 | 1 |
| 7.0 | BD,UN,SM | 2 | 1 |
| 8.2 | BD,UN,SM | 1 | 8 |
| | IN,CL, 5 mm | | |
| 9.6 | BD,PL,SM | 1 | 15 |
| | IN,CL, 30 mm | 1.5 | 3 |
| | JN,PL,RO | | |
| | PC,CA, 1 mm | 1 | 1 |
| | BD,PL,SM | | |
| 11.1 | BD,UN,SM | 2 | 1 |
| 11.5 | BD,PL,SM | 1 | 1 |
| 11.9 | BD,PL,SM | 1 | 1 |

Notes / Instrumentation: Bentonite; Sand; Screen; UCS = 11.00 MPa; Sand; UCS = 15.9 MPa; Bentonite

*CONTINUED NEXT PAGE*

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE 1 : 50

GOLDER

LOGGED: EJ

CHECKED: AC

PROJECT: 1662333

# RECORD OF DRILLHOLE: C1-4



LOCATION: N 4823329.3 ;E 295310.9

DRILLING DATE: February 21, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 Truck

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 | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Jr | Ja | ROCK STRENGTH INDEX | WEATHERING INDEX | FEATURES | R0/R1 ZONES | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | | | |
| | | END OF DRILLHOLE | | 87.65<br>12.75 | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | |

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: EJ
CHECKED: AC

# RECORD OF BOREHOLE No C2-1

SHEET 1 OF 1 **METRIC**

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4823392.0; E 295230.5 MTM NAD ZONE 10 (LAT. 43.550403; LONG. -79.618436)

ORIGINATED BY EJ

DIST Central HWY QEW

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

COMPILED BY SE

DATUM Geodetic

DATE February 26, 2019

CHECKED BY SEMP/SMM

SOIL PROFILE | SAMPLES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 | SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED 20 40 60 80 100 | PLASTIC LIMIT $w_P$, NATURAL MOISTURE CONTENT w, LIQUID LIMIT $w_L$ – WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

| ELEV DEPTH | DESCRIPTION | NUMBER | TYPE | "N" VALUES | ELEVATION SCALE | REMARKS (GR SA SI CL) |
|---|---|---|---|---|---|---|
| 101.1 | GROUND SURFACE | | | | | |
| 0.0 | Clayey silt, trace to some sand, some organics (FILL) Stiff Brown Wet | 1 | SS | 10 | 101 | |
| 100.5<br>0.6 | Sand and gravel, trace to some silt, trace clay (FILL) Compact Brown Moist -Styrofoam encountered at 0.6 m | 2 | SS | 19 | 100 | 32 55 10 3 |
| 99.9<br>1.2 | Inferred completely to moderately weathered, brown to grey, extremely weak to weak SHALE (Georgian Bay Formation) | 3 | SS | 30 | | |
| | | 4 | SS | 88/0.25 | 99 | |
| | | 5 | SS | 98/0.28 | | 25 7 46 22 |
| | | 6 | SS | 50/0.13 | 98 | |
| 97.4<br>3.7 | SHALE (BEDROCK) Grey Slightly weathered to fresh<br><br>Bedrock cored from a depth of 3.7 m to 8.0 m.<br><br>For bedrock coring details, refer to Record of Drillhole C2-1. | 7 | SS | 50/0.13 | | |
| | | 1 | RC | REC 100% | 97 | RQD = 83% |
| | | 2 | RC | REC 100% | 96, 95 | RQD = 98% |
| | | 3 | RC | REC 100% | 94 | RQD = 100% |
| 93.1<br>8.0 | END OF BOREHOLE | | | | | |

NOTES:

1. Borehole dry upon completion of soil drilling prior to rock coring.

2. Water level measured at 2.5 m depth below ground surface (Elev. 98.6 m) after piezometer installation.

3. Water level measured at 4.7 m depth below ground surface (Elev. 96.4 m) in piezometer on March 13, 2019.

4. Water level measured at 5.7 m depth below ground surface (Elev. 95.4 m) on March 21, 2019.

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

# RECORD OF DRILLHOLE: C2-1

PROJECT: 1662333
LOCATION: N 4823392.0 ;E 295230.5
INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: February 25, 2019
DRILL RIG: CME 55 Track
DRILLING CONTRACTOR: Davis Drilling Ltd.


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.

| DEPTH SCALE METRES | DESCRIPTION | ELEV. DEPTH (m) | RUN No. | DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION | Jr | Ja | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|---|---|
| | Continued from Record of Borehole C2-1 | 97.44 | | | | | |
| 4 | Slightly weathered to fresh, very thinly to thinly laminated, grey, fine grained, faintly porous, weak, SHALE (Georgian Bay Formation) with slightly weathered to fresh, grey, fine grained, strong to very strong LIMESTONE interbeds | 3.66 | 1 | BD,UN,SM | 2 | 1 | Bentonite |
| | | | | BD,UN,SM | 2 | 1 | UCS = 17.1 MPa |
| 5 | | | | BD,UN,SM | 2 | 1 | Sand |
| | | | 2 | | | | UCS = 20.2 MPa |
| 6 | | | | BD,UN,SM | 2 | 1 | Screen |
| 7 | | | 3 | | | | |
| 8 | | 93.06 | | | | | Sand |
| | END OF DRILLHOLE | 8.04 | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

FEATURES LEGEND

BROKEN CORE    CLAY SEAM    LIMESTONE    LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: EJ
CHECKED: AC

GOLDER

Foundation Design

# RECORD OF BOREHOLE No C2-2

SHEET 1 OF 1

**METRIC**

PROJECT: 1662333

G.W.P.: 2002-13-00

LOCATION: N 4823375.4; E 295283.7 MTM NAD ZONE 10 (LAT. 43.550254; LONG. -79.617778)

ORIGINATED BY: AB

DIST: Central

HWY: QEW

BOREHOLE TYPE: CME 75, 108 mm I.D. Hollow Stem Augers, HQ Casing

COMPILED BY: SE

DATUM: Geodetic

DATE: February 26, 2019

CHECKED BY: SEMP/SMM

## SOIL PROFILE

| ELEV / DEPTH | DESCRIPTION |
|---|---|
| 101.1 | GROUND SURFACE |
| 0.0 | ASPHALT (100 mm) |
| | CONCRETE (240 mm) |
| 0.3 | Silty sand and gravel (FILL)<br>Compact<br>Brown<br>Moist |
| 100.1 / 1.0 | CLAYEY SILT, some gravel, trace to some sand<br>Stiff<br>Brown-grey with oxidation staining<br>Moist |
| 99.6 / 1.5 | Inferred completely to moderately weathered, brown to grey, extremely weak to weak SHALE (Georgian Bay Formation) |
| 97.2 / 3.9 | SHALE (BEDROCK)<br>Grey<br>Slightly weathered to fresh<br><br>Bedrock cored from a depth of 3.9 m to 8.8 m.<br><br>For bedrock coring details, refer to Record of Drillhole C2-2. |
| 92.3 / 8.8 | END OF BOREHOLE<br><br>NOTE:<br><br>1. Borehole dry upon completion of soil drilling prior to rock coring. |

## SAMPLES

| NUMBER | TYPE | "N" VALUES | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|
| 1 | SS | 26 | |
| 2 | SS | 9 | |
| 3 | SS | 22 | |
| 4 | SS | 48 | |
| 5 | SS | 88 | GR 13, SA 10, SI 55, CL 22 |
| 6 | SS | 50/0.15 | |
| 1 | RC | REC 95% | RQD = 46% |
| 2 | RC | REC 100% | RQD = 91% |
| 3 | RC | REC 100% | RQD = 69% |
| 4 | RC | REC 100% | RQD = 84% |

Column headings: SOIL PROFILE (ELEV DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE (101, 100, 99, 98, 97, 96, 95, 94, 93); 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/m[3]; REMARKS & GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

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

# RECORD OF DRILLHOLE: C2-2

PROJECT: 1662333

LOCATION: N 4823375.4 ;E 295283.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 5, 2019

DRILL RIG: CME 75 Truck

DRILLING CONTRACTOR: Geo-Environmental Drilling Inc.

SHEET 1 OF 1

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.

| DEPTH SCALE METRES | DESCRIPTION | ELEV. DEPTH (m) | RUN No. | DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION | Jr | Ja | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|---|---|
| | Continued from Record of Borehole C2-2 | 97.16 | | | | | |
| 4 | Slightly weathered to fresh, thinly bedded, grey, very fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with slightly weathered to fresh, grey, fine grained, strong to very strong LIMESTONE interbeds | 3.94 | 1 | BD,UN,RO PC,CL | 3 | 4 | |
| | | | 2 | BD,IR,RO SA | 3 | 2 | UCS = 13.3 MPa |
| | | | | BD,IR,RO SA | 3 | 2 | |
| | | | | BD,ST,RO SA | 3 | 2 | |
| 5 | | | | BD,IR,RO SA | 3 | 2 | |
| | | | | BD,UN,RO SA | 3 | 2 | |
| | | | | CO,IR,RO SA | 3 | 2 | |
| | | | | BD,UN,RO SA | 3 | 2 | |
| 6 | | | 3 | CO,ST,SM SA | 2 | 2 | |
| | | | | BD,PL,RO PC,CL | 1.5 | 4 | |
| | | | | CO,IR,RO PC,CL | 3 | 4 | |
| 7 | | | | BD,UN,RO CC,CL | 3 | 4 | |
| | | | | CO,CU,SM SO | 2 | 1 | |
| | | | | CO,IR,RO PC,CL | 3 | 4 | |
| | | | 4 | BD,IR,RO PC,CL | 3 | 4 | |
| 8 | | | | BD,UN,RO PC,CL | 3 | 4 | |
| | | | | BD,UN,RO PC,CL | 3 | 4 | |
| | | 92.26 | | | | | |
| 9 | END OF DRILLHOLE | 8.84 | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE 1 : 50

GOLDER

LOGGED: AB

CHECKED: AC

GOLDER



# RECORD OF BOREHOLE No C2-3

SHEET 1 OF 1 **METRIC**

PROJECT 1662333

G.W.P. 2002-13-00

LOCATION N 4823357.4; E 295318.2 MTM NAD ZONE 10 (LAT. 43.550092; LONG. -79.617350)

ORIGINATED BY AB

DIST Central HWY QEW

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

COMPILED BY ACM

DATUM Geodetic

DATE March 7, 2019

CHECKED BY SEMP/SMM

| ELEV DEPTH | DESCRIPTION | NUMBER | TYPE | "N" VALUES | WATER CONTENT (%) | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|
| 100.8 | GROUND SURFACE | | | | | |
| 0.0 | ASPHALT (130 mm) | | | | | |
| | CONCRETE (200 mm) | | | | | |
| 0.3 | Gravelly sand, some silt (FILL) Compact to very dense Brown Dry to moist - Cobbles present at 0.8 m | 1 | SS | 48/0.15 | ~6 | |
| | | 2 | SS | 14 | | |
| 99.6 / 1.2 | Inferred completely to moderately weathered, brown to grey, extremely weak to weak SHALE (Georgian Bay Formation) | 3 | SS | 21 | ~15 | |
| | | 4 | SS | 51 | ~10 (wP ~20, wL ~36) | 10 16 52 22 |
| | | 5 | SS | 117 | | |
| | | 6 | SS | 100/0.13 | | |
| 97.5 / 3.3 | SHALE (BEDROCK) Grey Moderately weathered to fresh<br>Bedrock cored from a depth of 3.3 m to 8.9 m.<br>For bedrock coring details, refer to Record of Drillhole C2-3. | 1 | RC | REC 100% | | RQD = 52% |
| | | 2 | RC | REC 100% | | RQD = 97% |
| | | 3 | RC | REC 100% | | RQD = 87% |
| | | 4 | RC | REC 100% | | RQD = 95% |
| 91.9 / 8.9 | END OF BOREHOLE<br>NOTE:<br>1. Borehole dry upon completion of soil drilling prior to rock coring. | | | | | |

Elevation scale: 100, 99, 98, 97, 96, 95, 94, 93, 92

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

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

PROJECT: 1662333

# RECORD OF DRILLHOLE: C2-3



LOCATION: N 4823357.4 ;E 295318.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 8, 2019

DRILL RIG: CME 75 Truck

DRILLING CONTRACTOR: Geo-Environmental Drilling Inc.

DATUM: Geodetic

Abbreviations: 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 | DESCRIPTION | ELEV. / DEPTH (m) | RUN No. | DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION | Jr | Ja | R0/R1 ZONES | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|---|---|---|
| | Continued from Record of Borehole C2-3 | 97.47 | | | | | | |
| 4 | Moderately weathered, thinly bedded, grey, very fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with slightly weathered to fresh, grey, fine grained, strong to very strong LIMESTONE interbeds | 3.33 | 1 | BD,UN,RO PC,CL | 3 | 4 | R1 | |
| | | | | CO,ST,SM SA | 2 | 2 | R1 | |
| | | | | BD,UN,RO SA | 3 | 2 | | |
| | | | | BD,PL,SM | 1 | 0 | | |
| | | | | BD,IR,RO CC,CL | 3 | 4 | | |
| | | 96.47 | | BD,PL,SM IN,CL, 8 mm | 1 | 0 | | |
| 5 | Slightly weathered to fresh, thinly bedded, grey, very fine grained, faintly porous, weak SHALE (Georgian Bay Formation) with slightly weathered to fresh, grey, fine grained, strong to very strong LIMESTONE interbeds | 4.33 | 2 | BD,PL,RO SA | 1 | 2 | R1 | |
| | | | | BD,PL,SM SA | 3 | 2 | | |
| | | | | CO,CU,RO SA | 3 | 1 | | |
| | | | | CO,PL,RO CC,CL | 15 | 4 | | |
| 6 | | | 3 | CO,CU,RO PC,CL | 3 | 4 | | |
| | | | | BD,CU,RO SA | 3 | 2 | | |
| | | | | CO,ST,RO CC,CL | 3 | 4 | | |
| | | | | BD,PL,RO SA | 15 | 2 | | |
| 7 | | | | | | | | |
| 8 | | | 4 | BD,IR,RO PC,CL | 3 | 4 | | UCS = 23.2 MPa |
| | | 91.89 | | BD,PL,SM PC,CL | 1 | 4 | | |
| 9 | END OF DRILLHOLE | 8.91 | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AB

CHECKED: AC

GOLDER

Foundation Design

# RECORD OF BOREHOLE No NW4-5

SHEET 1 OF 1 **METRIC**

PROJECT 1662333
G.W.P. 2002-13-00
LOCATION N 4823340.0; E 295333.6 MTM NAD 83 ZONE 10 (LAT. 43.549927; LONG. -79.617156)
ORIGINATED BY CC
DIST Central HWY QEW
BOREHOLE TYPE CME 75, 150 mm O.D., Solid Stem Augers
COMPILED BY SE
DATUM Geodetic
DATE July 3, 2018
CHECKED BY SMM

| ELEV DEPTH | DESCRIPTION | NUMBER | TYPE | "N" VALUES | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|
| 100.3 | GROUND SURFACE | | | | |
| 0.0 | ASPHALT (150 mm) | | | | |
| 0.2 | Sand and gravel, some silt (FILL) Compact Brown, mottled red, mottled grey Moist | 1A / 1B | SS | 10 | |
| 99.6 / 0.7 | SILTY CLAY, some gravel, trace to some sand Very stiff Brown to grey Moist | 2 | SS | 19 | 18 6 46 30 |
| 98.8 / 1.5 | Inferred highly to moderately weathered, brown to grey, extremely weak to weak SHALE (Georgian Bay Formation) | 3 | SS | 26 | |
| | | 4 | SS | 69 | |
| | | 5 | SS | 100/0.23 | |
| 96.5 / 3.8 | SHALE (BEDROCK) Grey Slightly weathered to fresh | 6 | SS | 100/0.10 | |
| | Bedrock cored from a depth of 4.1 m to 7.6 m. | 1 | RC | REC 100% | RQD = 84% |
| | For bedrock coring details, refer to Record of Drillhole NW4-5. | 2 | RC | REC 100% | RQD = 78% |
| | | 3 | RC | REC 100% | RQD = 100% |
| 92.7 / 7.6 | END OF BOREHOLE | | | | |

NOTE:

1. Open borehole dry upon completion of drilling.

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (100, 99, 98, 97, 96, 95, 94, 93); 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

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

# RECORD OF DRILLHOLE: NW4-5

PROJECT: 1662333
LOCATION: N 4823340.0 ;E 295333.6
INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: July 3, 2018
DRILL RIG: CME 75
DRILLING CONTRACTOR: Davis 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.

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | ELEV. DEPTH (m) | RUN No. | DISCONTINUITY TYPE AND SURFACE DESCRIPTION | Jr | Ja | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|---|---|---|
| | | Continued from Borehole NW4-5 | 96.21 | | | | | |
| | 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 slightly weathered to fresh, grey, fine grained, strong to very strong LIMESTONE interbeds | 4.12 | 1 | | | | R1 |
| | | | | | BD,PL,SM SO | 1 | 1 | |
| | | | | | BD,UN,SM SO | 2 | 1 | |
| 5 | | | | 2 | BD,PL,SM SO | 1 | 1 | |
| | | | | | BD,PL,SM SO | 1 | 1 | |
| | | | | | BD,PL,SM SO | 1 | 1 | |
| | | | | | BD,PL,SM Sa | 1 | 2 | |
| | | | | | BD,PL,RO PC | 1.5 | 3 | |
| | | | | | BD,UN,SM SO | 2 | 1 | |
| 6 | | | | | BD,PL,SM SO | 1 | 1 | |
| | | | | | BD,PL,SM SO | 1 | 1 | |
| | | | | 3 | BD,CU,SM SO | 2 | 1 | |
| 7 | | | | | BD,PL,SM SO | 1 | 1 | |
| | | | | | BD,CU,SM SO | 2 | 1 | |
| | | | 92.70 | | BD,PL,SM SO | 1 | 1 | |
| | | END OF DRILLHOLE | 7.63 | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |

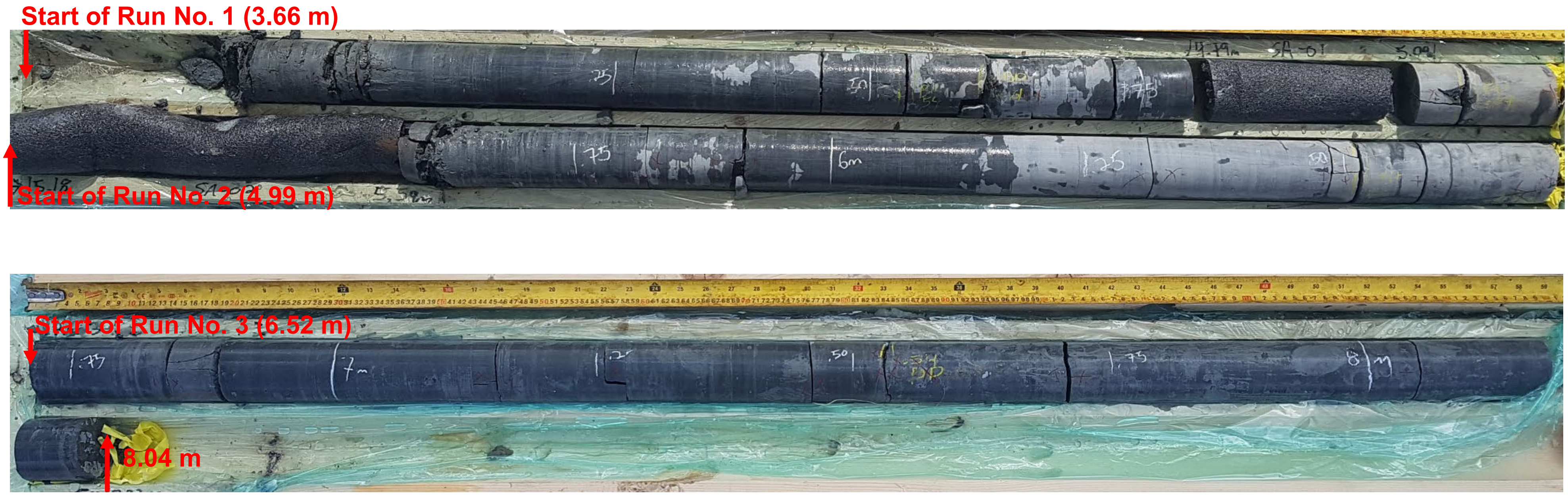
FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: CC
CHECKED: AB



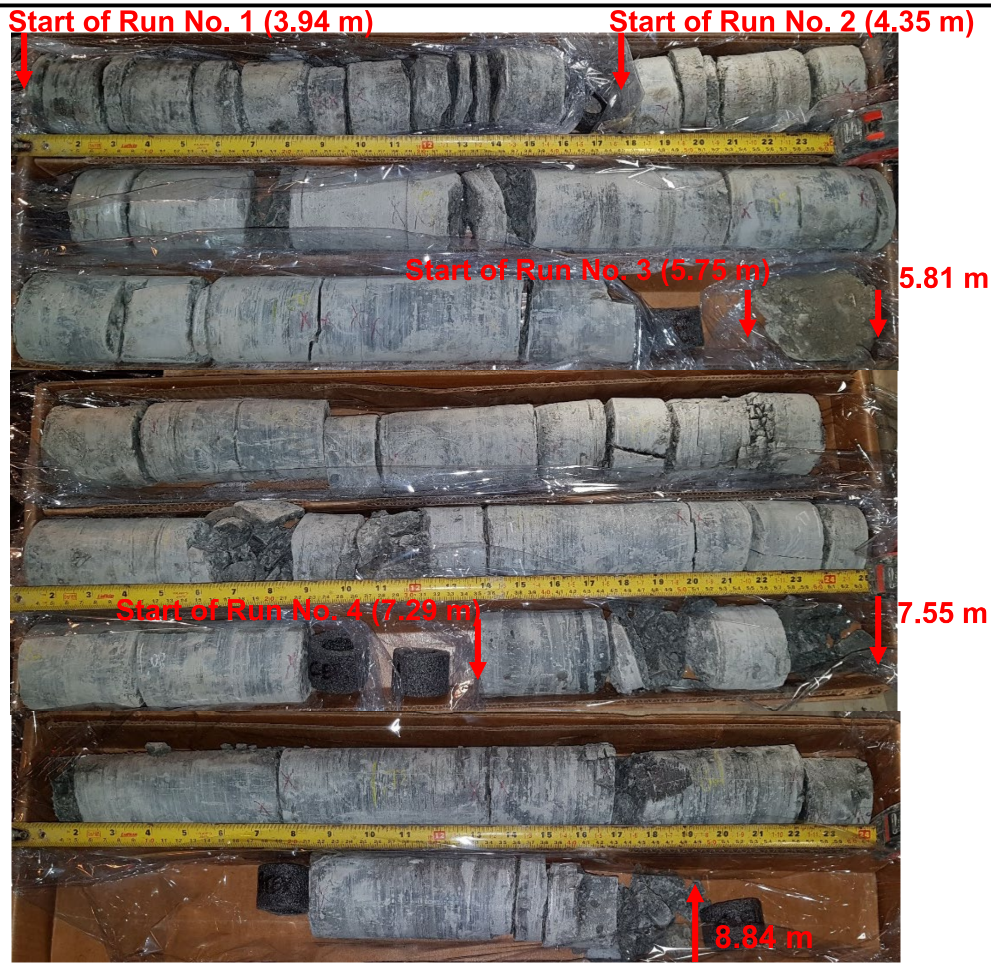

0 m | 0.25 m | 0.5 m | 0.75 m | 1.0 m | 1.25 m | 1.5 m

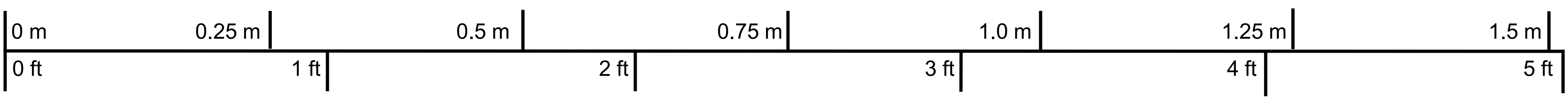
0 ft | 1 ft | 2 ft | 3 ft | 4 ft | 5 ft

Scale

| | | | | | |
|---|---|---|---|---|---|
| PROJECT | **MTO Assignment 2015-E-0033<br>Sanitary Sewer Installation Station 15+850<br>Mississauga Road to Hurontario Street** | | | | |
| TITLE | **Bedrock Core Photograph<br>Borehole C2-1 (3.66 m to 8.04 m)** | | | | |
| GOLDER | PROJECT No. 1662333 | | | FILE No. ---- | |
| | DRAFT | JMP | 20190326 | SCALE AS SHOWN | VER. 1. |
| | CADD | -- | | **FIGURE A-1** | |
| | CHECK | SMM | 20190329 | | |
| | REVIEW | JMAC | 201903-- | | |

REVISION DATE: March 26, 2019 BY: JMP Project: 1662333



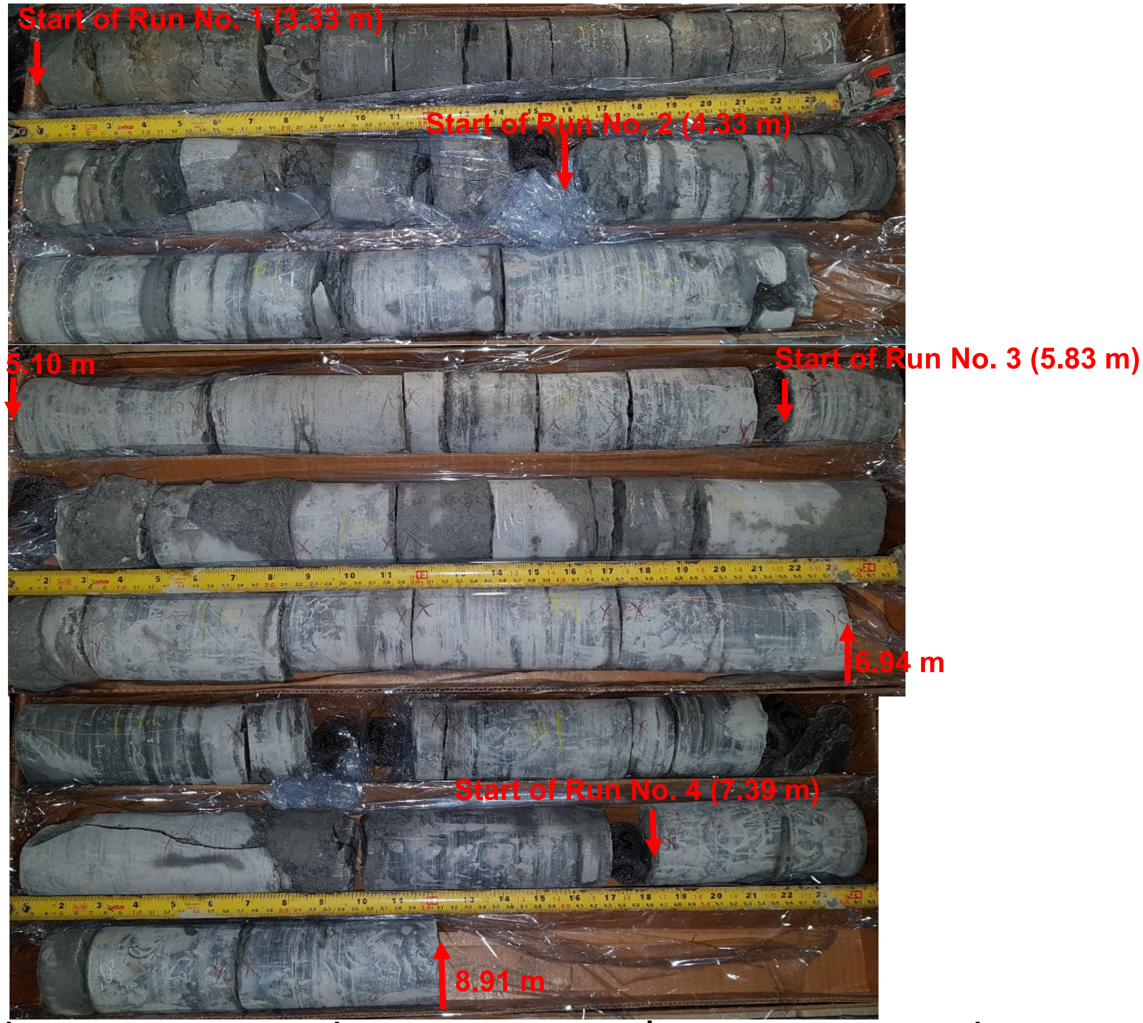

Scale

| | |
|---|---|
| PROJECT | **MTO Assignment 2015-E-0033<br>Sanitary Sewer Installation Station 15+850<br>Mississauga Road to Hurontario Street** |
| TITLE | **Bedrock Core Photograph<br>Borehole C2-2 (3.94 m to 8.84 m)** |

GOLDER

| | | | | | |
|---|---|---|---|---|---|
| PROJECT No. 1662333 | | | FILE No. ---- | | |
| DRAFT | JMP | 20190326 | SCALE | AS SHOWN | VER. 1. |
| CADD | -- | | **FIGURE A-2** | | |
| CHECK | SMM | 20190329 | | | |
| REVIEW | JMAC | 201903-- | | | |

REVISION DATE: March 26, 2019 BY: JMP 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

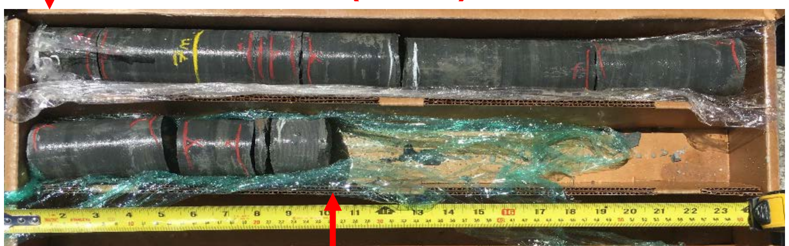
| | | | | | |
|---|---|---|---|---|---|
| PROJECT | MTO Assignment 2015-E-0033<br>Sanitary Sewer Installation Station 15+850<br>Mississauga Road to Hurontario Street | | | | |
| TITLE | Bedrock Core Photograph<br>Borehole C2-3 (3.33 m to 8.91 m) | | | | |
| GOLDER | PROJECT No. 1662333 | | | FILE No. ---- | |
| | DRAFT | JMP | 20190326 | SCALE AS SHOWN | VER. 1. |
| | CADD | -- | | FIGURE A-3 | |
| | CHECK | SMM | 20190329 | | |
| | REVIEW | JMAC | 201903-- | | |

REVISION DATE: March 26, 2019 BY: JMP Project: 1662333

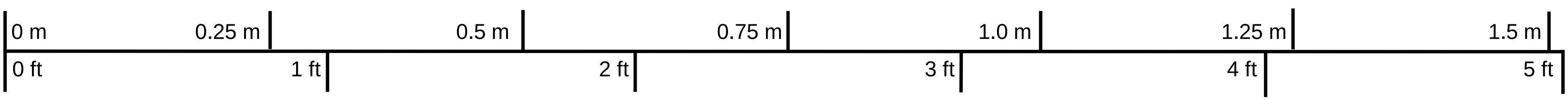
Start of Run No. 1 (4.12 m)

Start of Run No. 2 (4.80 m)

Start of Run No. 3 (6.33 m)



7.63 m




Scale

PROJECT

**MTO Assignment 2015-E-0033**
**Sanitary Sewer Installation Station 15+850**
**Mississauga Road and Hurontario Street**

TITLE

**Bedrock Core Photograph**
**Borehole NW4-5 (4.12 m to 7.63 m)**

GOLDER

| | | | | | |
|---|---|---|---|---|---|
| PROJECT No. 1662333 | | | FILE No. ---- | | |
| DRAFT | SE | 20180821 | SCALE | AS SHOWN | VER. 1. |
| CADD | -- | | **FIGURE A-4** | | |
| CHECK | SMM | 20190329 | | | |
| REVIEW | JMAC | 201903XX | | | |

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

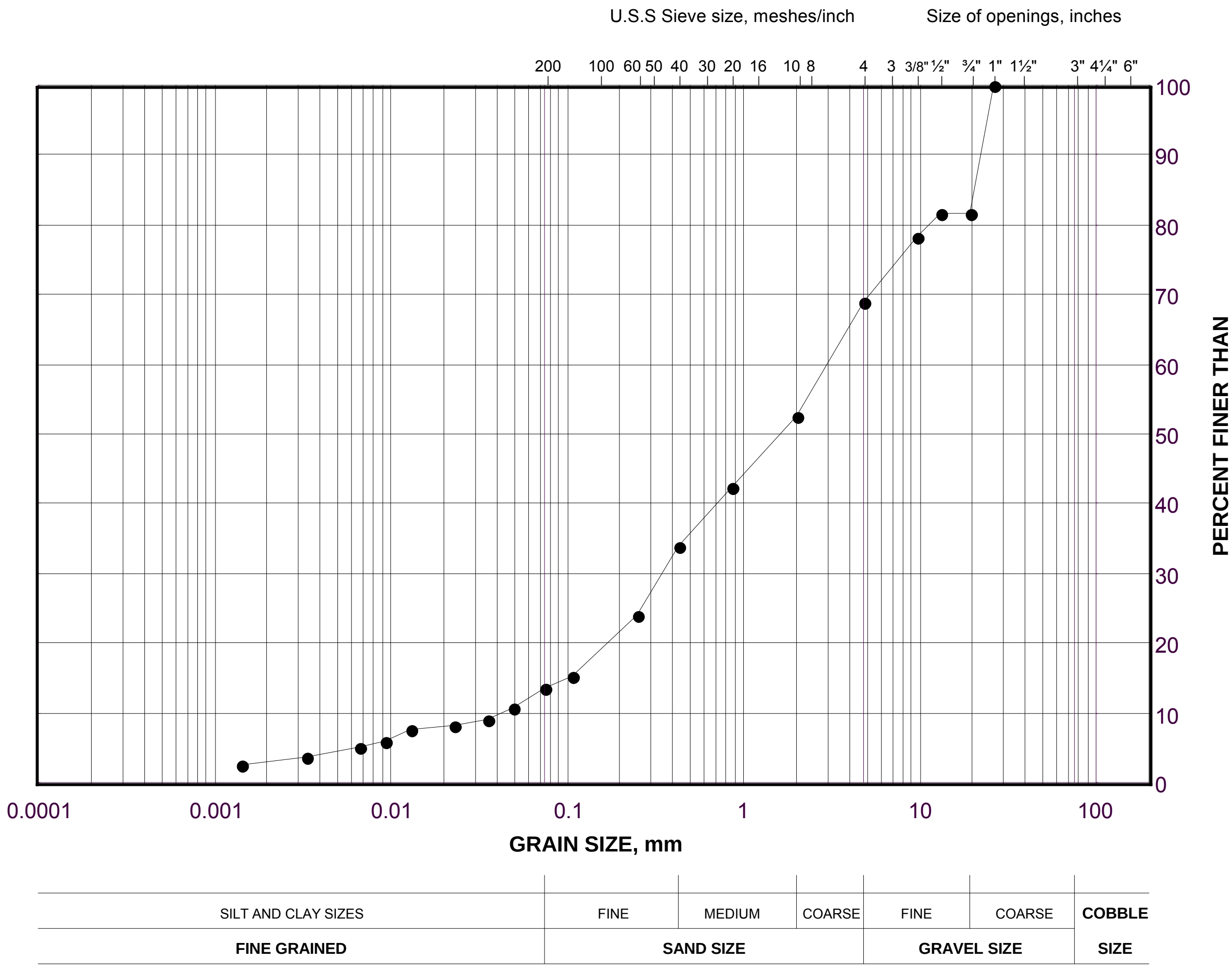
**APPENDIX B**

# Geotechnical Laboratory Test Results (incl. Geomechanica Test Results on Rock)

# GRAIN SIZE DISTRIBUTION

Sand and Gravel (Fill)

FIGURE B-1




## LEGEND

| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|---|---|---|---|
| ● | C2-1 | 2 | 100.2 |

Project Number: 1662333

Checked By: SMM

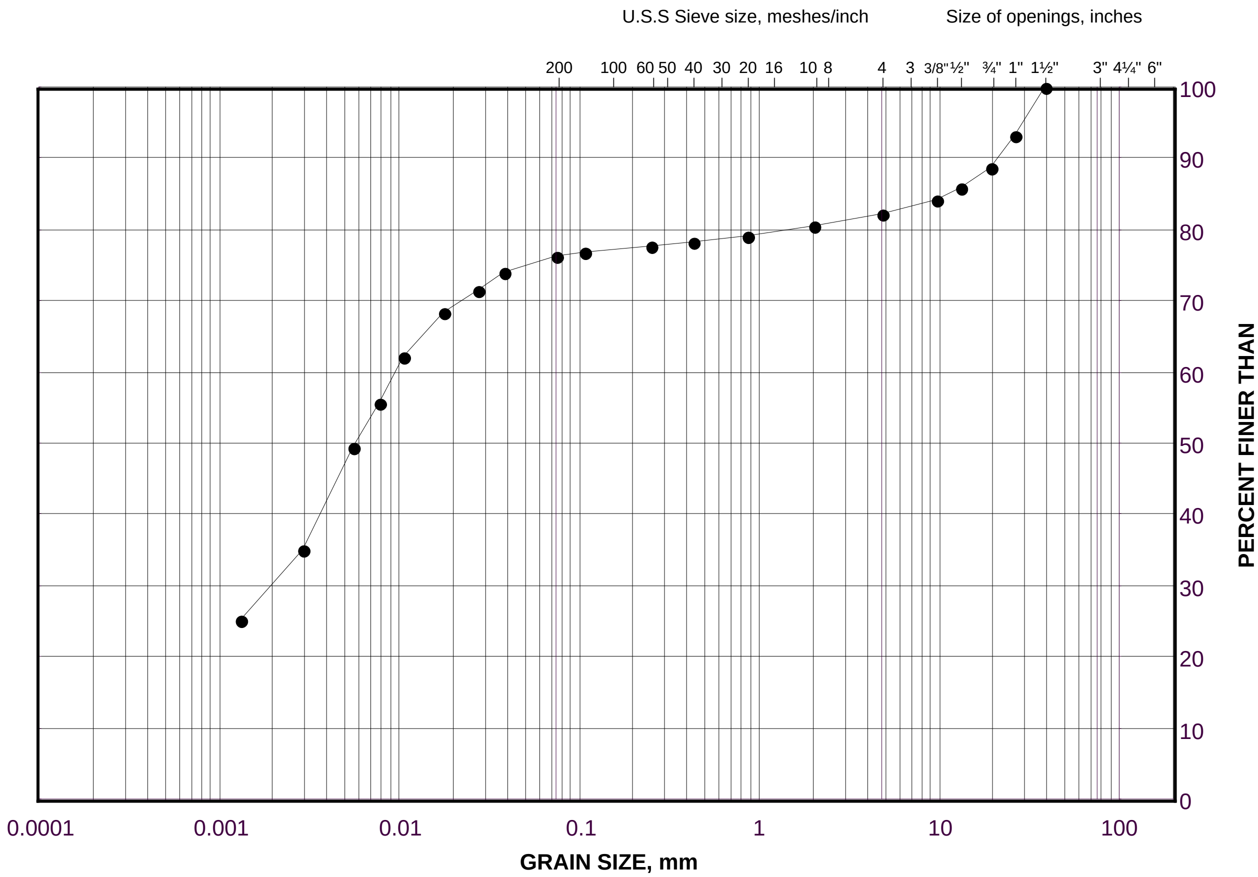
**Golder Associates**

Date: 17-Apr-19

# GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE B-2




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

## LEGEND

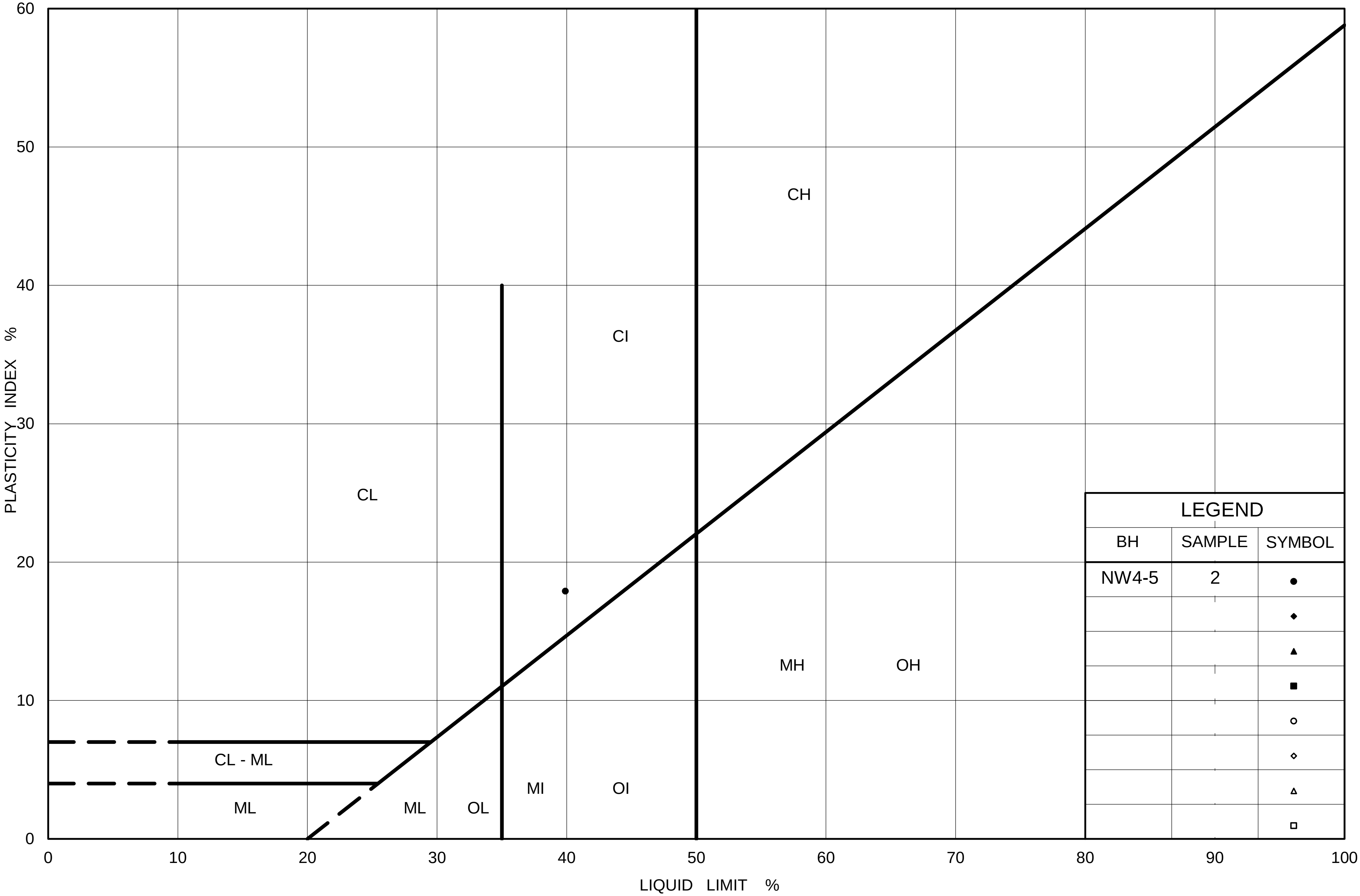
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|---|---|---|---|
| ● | NW4-5 | 2 | 99.3 |

Project Number: 1662333

Checked By: SMM

**Golder Associates**

Date: 17-Apr-19




Ministry of Transportation

Ontario

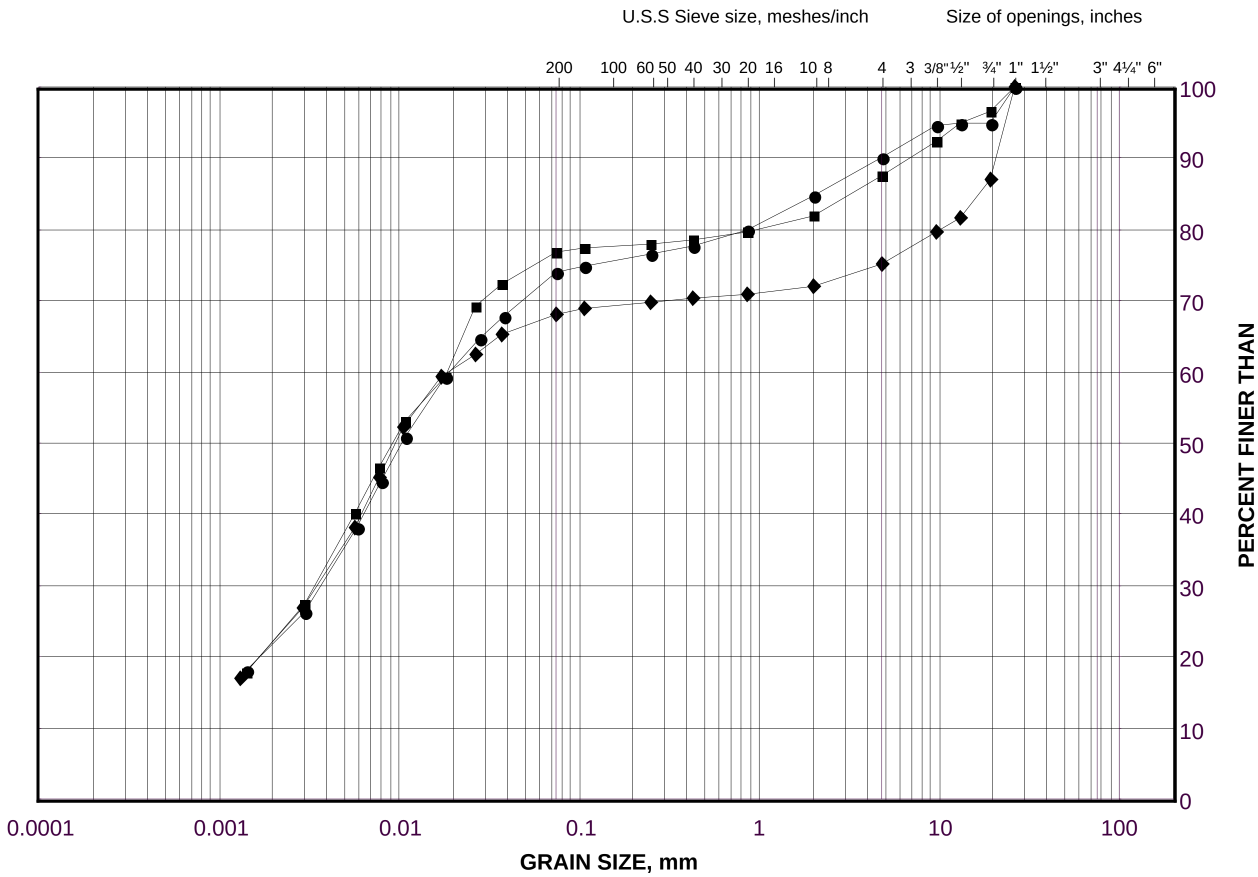
# PLASTICITY CHART
## Silty Clay

Figure No. B-3

Project No. 1662333

Checked By: SMM

| **GRAIN SIZE DISTRIBUTION**<br>Inferred Completely to Moderately Weathered Shale (Bedrock) | FIGURE B-4 |
|---|---|




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

**LEGEND**

| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|---|---|---|---|
| ● | C2-3 | 4 | 98.7 |
| ■ | C2-2 | 5 | 97.9 |
| ◆ | C2-1 | 5 | 98.4 |

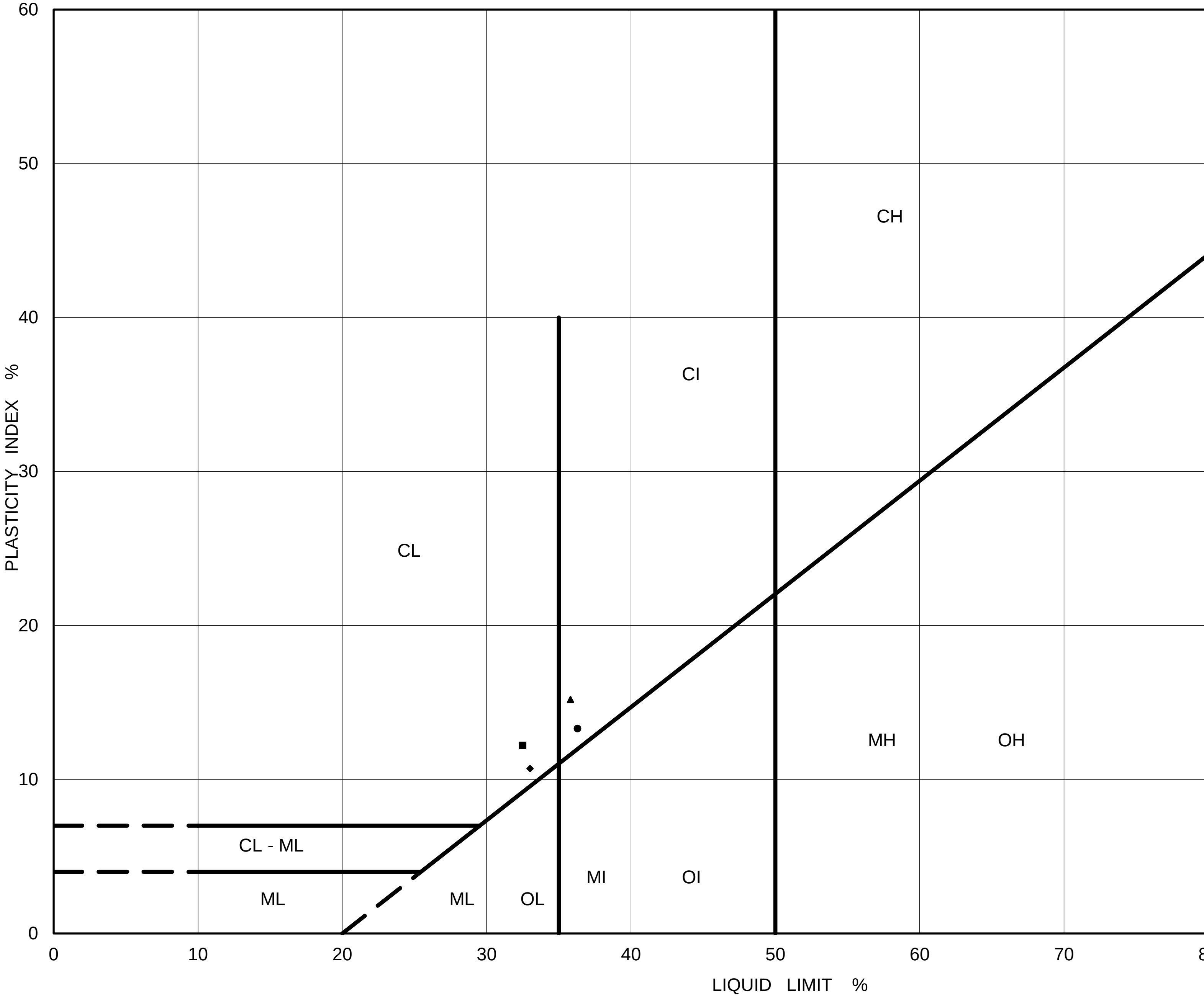
NOTES:

1. The samples of inferred completely to moderately weathered bedrock were obtained by split-spoon sampling, and as such, the particle size(s) are effected by the sampling method and are limited to the size of the sampler. Larger fragments of shale bedrock may be present in-situ.
2. The percentage of gravel size particles may include shale fragments that either remained intact after or were broken during sampling and sample preparation. Therefore, the results of the grain size distribution testing may not be representative of the bulk grain size distribution or behavior of the in-situ or excavated completely to moderately weathered shale bedrock.

Project Number: 1662333

Checked By: SMM **Golder Associates** Date: 17-Apr-19

Oct 75, FF-S-21




| LEGEND | | |
|---|---|---|
| BH | SAMPLE | SYMBOL |
| C2-1 | 5 | ● |
| C2-2 | 5 | ◆ |
| C2-3 | 4 | ▲ |
| NW4-5 | 4 | ■ |
| | | ○ |
| | | ◇ |
| | | △ |
| | | □ |

Ministry of Transportation

Ontario

# PLASTICITY CHART

Inferred Completely to Moderately Weathered Shale (Bedrock)

Figure No. B-5

Project No. 1662333

Checked By: SMM

GEOMECHANICA

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

March 15, 2019

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

Re: UCS, Slake, and CERCHAR testing
(Golder Project No. 1662333)

Dear Mr. Marmor:

On March 8, 2019 and March 12, 2019 eighteen (18) and two (2) HQ-sized core samples were received by Geomechanica Inc. via drop-off by Golder personnel, respectively. These samples were identified as being from boreholes drilled as part of Golder project 1662333. A total of 14 uniaxial compressive strength (UCS) tests, 2 slake durability tests, and 4 CERCHAR tests were performed using these samples.

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

Sincerely,

Bryan Tatone Ph.D., P. Eng.

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

GEOMECHANICA

# Rock Laboratory Testing Results

**A report submitted to:**

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

**Prepared by:**

Bryan Tatone, PhD, PEng

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

**March 15, 2019**
Project number: 1662333

**Abstract**

This document summarizes the results of rock laboratory testing, including the results of Uniaxial Compressive Strength (UCS), Slake durability, and CERCHAR abrasivity testing. The results of each test type are presented in separate sub-sections herein.

**In this document:**

# 1 Uniaxial Compressive Strength Tests

## 1.1 Overview

This section summarizes the results of uniaxial compressive strength (UCS) testing of HQ3-sized specimens. The testing was performed in Geomechanica's rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.150 mm/min and 0.100 mm/min for shale and limestone specimens, respectively (Figure 1). The preparation and testing of each specimen included the following:

1. Unwrapping of the core sample, inspecting it for damage, and re-wrapping it in electrical tape to minimize exposure to moisture during subsequent specimen preparation.
2. Diamond cutting of core sample to obtain cylindrical specimens with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding of specimen to obtain flat (within $\pm0.025$ mm) and parallel end faces (within 0.25°).
4. Placing specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axially loading the specimens to rupture while continuously recording axial force, axial deformation, radial deformation (for select samples) to determine the peak strength (UCS), tangent Young's modulus, and Poisson's ratio (for select samples).

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-08. The side straightness criteria, as checked with a 0.5 mm feeler gauge, was met for all samples and the minimum length:diameter criteria was met for all specimens unless noted otherwise in Table 3. Testing of the specimens followed ASTM D7012-14 with the following exceptions:

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

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

### 1.2 Quantifying Poisson's ratio

To quantify the Poisson's ratio, the radial strain during UCS testing was recorded using a specially designed sensor consisting of a radial spring and non-contact displacement transducer (Figure 2). This sensor was calibrated by axially loading an aluminum cylinder with known elastic modulus and Poisson's ratio and having the same dimensions as the test specimens. By doing so, the output of the non-contact displacement transducer could be calibrated directly to the radial strain of the cylinder. Poisson's ratio was measured over the same range of stresses as the tangent Young's modulus.

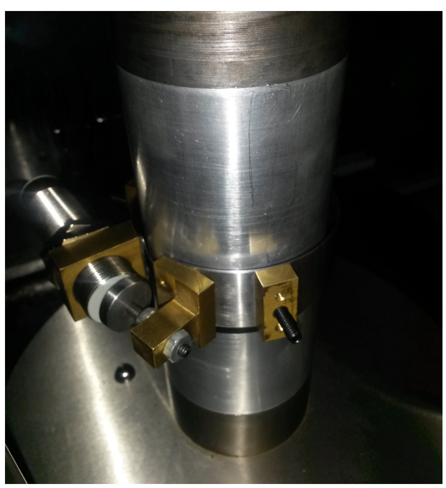


Figure 2: Radial strain sensor comprised of a radial spring and non-contact displacement transducer positioned on the aluminum calibration cylinder.

## 1.3 Results

The results of UCS testing are summarized in Table 1. The corresponding stress-strain curves are presented in Figures 3 - 5. Please note that additional details and measurements for each test specimen are included in the summary spreadsheet that accompanies this report. The Young's modulus, $E$, is the tangent modulus, calculated as the slope of the best-fit line through $\pm 300$ axial strain data points and the Poisson's ratio, $\nu$, is defined as the ratio of the slope of the best-fit line through $\pm 300$ radial strain data points divided by the Young's modulus. For this project, the moduli have been defined at stress levels corresponding to both 50% of the UCS strength and at a stress level of 2.5 MPa (for shale samples only). Definition of the moduli at 50% of the UCS is the conventional approach, however the shale samples tested display non-linear behaviour at this stress level. Therefore, the moduli have also been defined at an alternative stress level where the stress-strain response displays a more linear response.

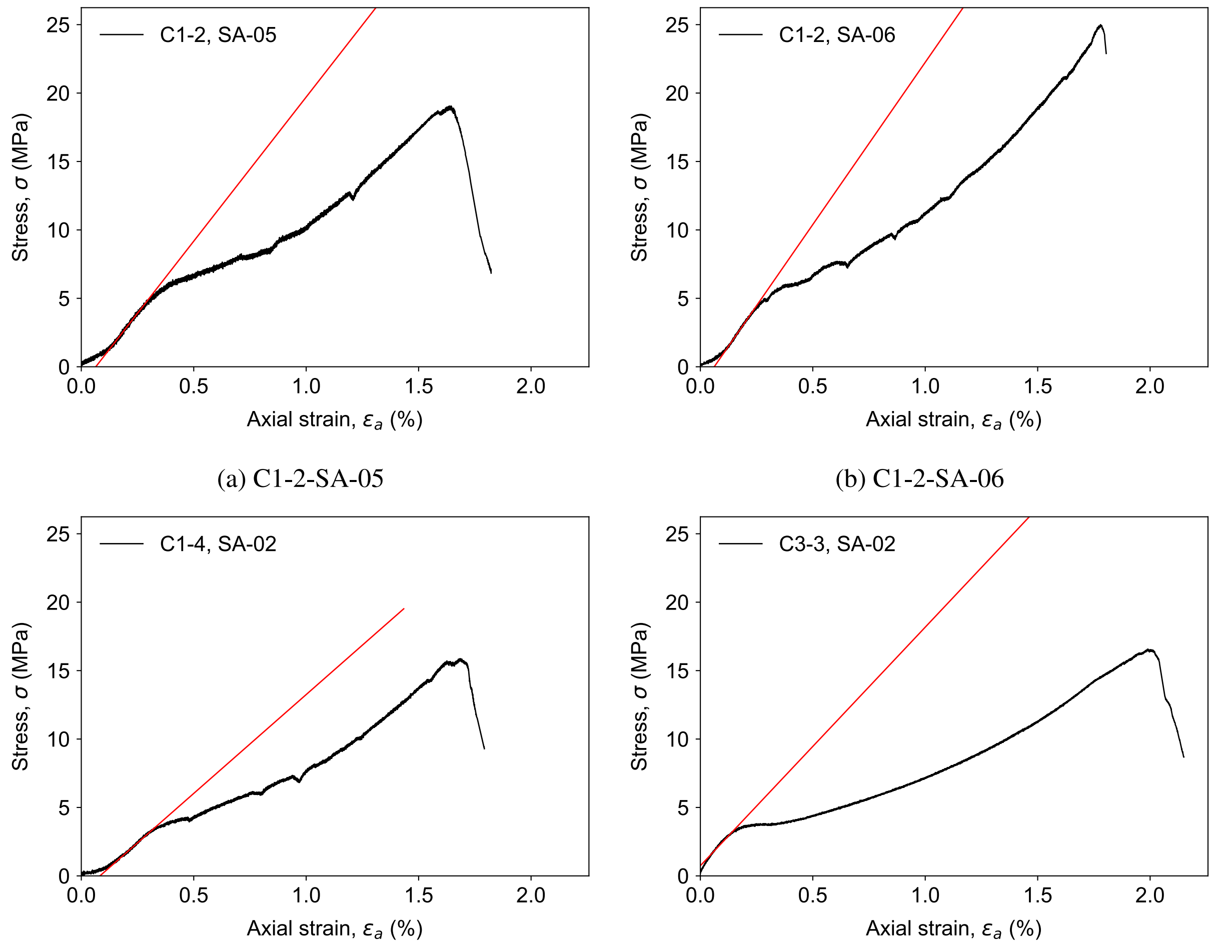
Table 1: Summary of Uniaxial Compression test results.

| Sample | Depth (m) | Bulk density $\rho$ (g/cm$^3$) | UCS (MPa) | Young's modulus $E$ @ 2.5 MPa (GPa) | Poisson's ratio $\nu$ @ 2.5 MPa | Young's modulus $E$ @ 50% UCS (GPa) | Poisson's ratio $\nu$ @ 50% UCS | Lithology | Failure description |
|---|---|---|---|---|---|---|---|---|---|
| C1-2, SA-05 | 8.13 - 8.32 | 2.600 | 19.1 | 2.1 | - | 0.7 | - | Shale | 1, 2 |
| C1-2, SA-06 | 10.86 - 11.07 | 2.602 | 25.0 | 2.4 | - | 1.5 | - | Shale | 3, 2 |
| C1-4, SA-02 | 7.49 - 7.81 | 2.603 | 15.9 | 1.4 | - | 1.0 | - | Shale | 3, 2 |
| C3-3, SA-02 | 6.18 - 6.38 | 2.598 | 16.6 | 1.7 | - | 0.8 | - | Shale | 4, 5 |
| C1-1, SA-02 | 5.25 - 5.55 | 2.607 | 19.3 | 1.8 | 0.54 | 1.0 | 0.06 | Shale | 1, 5 |
| C1-1, SA-03 | 6.79 - 7.13 | 2.602 | 15.2 | 1.4 | 0.12 | 1.0 | 0.15 | Inter-bedded limestone & shale | 1, 2 |
| C1-4, SA-03 | 7.15 - 7.38 | 2.585 | 11.0 | 0.9 | 0.19 | 0.5 | 0.13 | Shale | 6, 1, 2 |
| C2-1, SA-01 | 4.60 - 4.85 | 2.591 | 17.1 | 1.5 | 0.19 | 0.8 | 0.05 | Shale | 3, 5 |
| C2-1, SA-02 | 4.99 - 5.40 | 2.589 | 20.2 | 1.8 | 0.18 | 1.0 | 0.05 | Shale | 1, 3, 5 |
| C2-2, SA-01 | 4.52 - 4.7 | 2.592 | 13.3 | 1.1 | 0.11 | 0.8 | 0.18 | Shale | 1, 5 |
| C3-4, SA-01 | 3.09 - 3.41 | 2.601 | 17.6 | 1.9 | 0.13 | 0.8 | 0.14 | Shale | 1, 5 |
| C3-4, SA-02 | 3.41 - 3.77 | 2.594 | 17.3 | 2.0 | 0.20 | 0.8 | 0.02 | Shale | 4, 5 |
| C2-3, SA-05 | 8.29 - 8.49 | 2.602 | 23.2 | 1.9 | 0.27 | 1.4 | 0.06 | Shale | 4, 2 |
| C1-3, SA-04 | 6.54 - 6.75 | 2.667 | 210.2 | N/A | N/A | 44.4 | 0.25 | Limestone | 7 |

1 Axial splitting failure
2 Specimen emitted saline pore water upon loading
3 Partial hourglass failure
4 Inclined shear band failure
5 Specimen emitted pore water upon loading
6 Localized crushing
7 Hourglass failure

## 1.4 Specimen photographs

Photographs of the UCS specimens before and after testing are presented in the Appendix of this report.



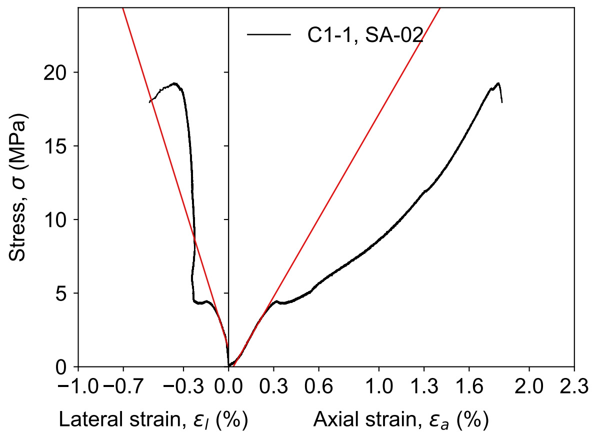

(a) C1-2-SA-05

(b) C1-2-SA-06

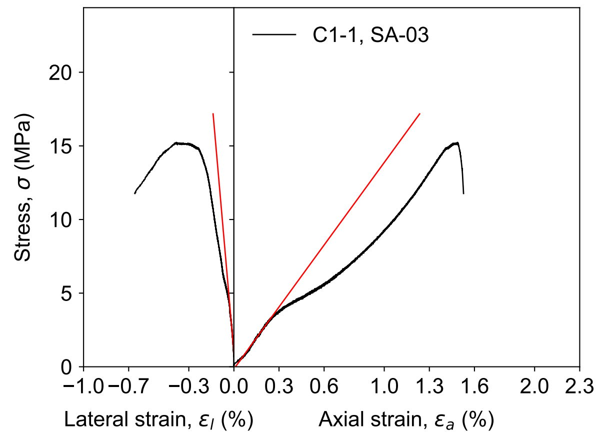
(c) C1-4-SA-02

(d) C3-3-SA-02

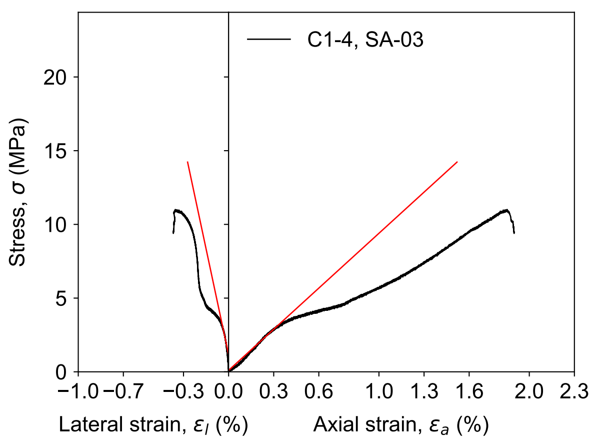
Figure 3: Measured stress-strain curves for specimens without radial strain measurement.



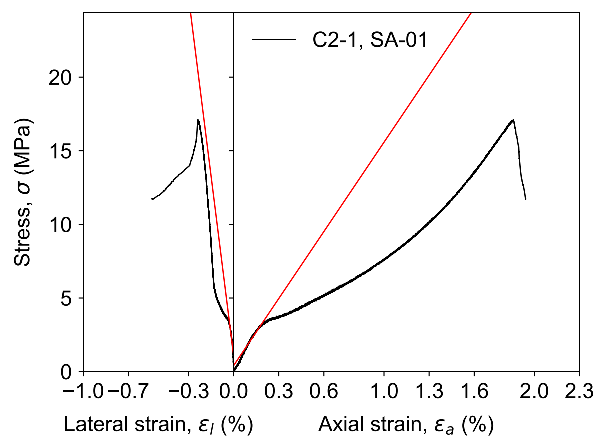

(a) C1-1-SA-02



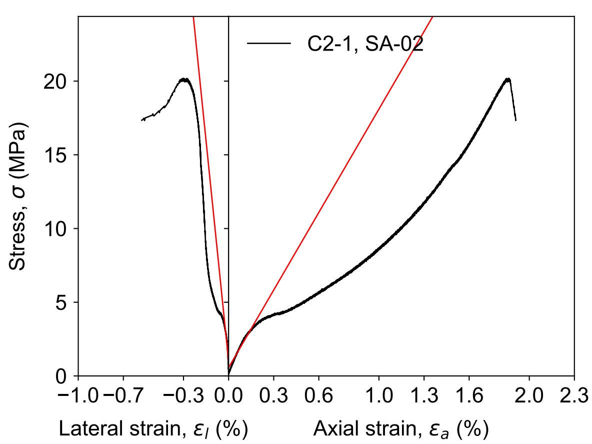

(b) C1-1-SA-03



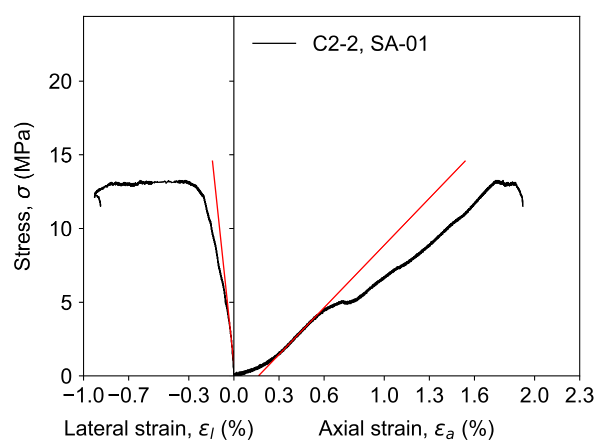

(c) C1-4-SA-03




(d) C2-1-SA-01

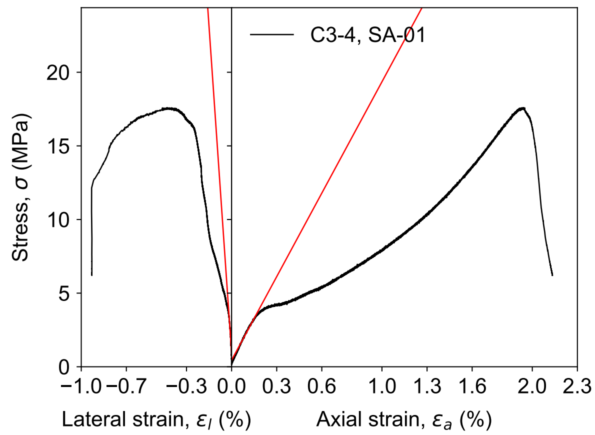



(e) C2-1-SA-02

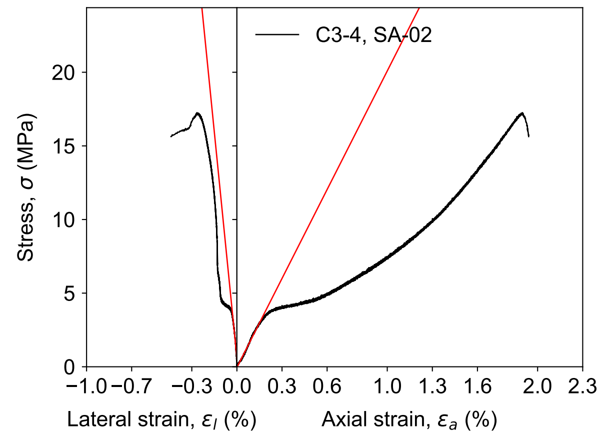



(f) C2-2-SA-01

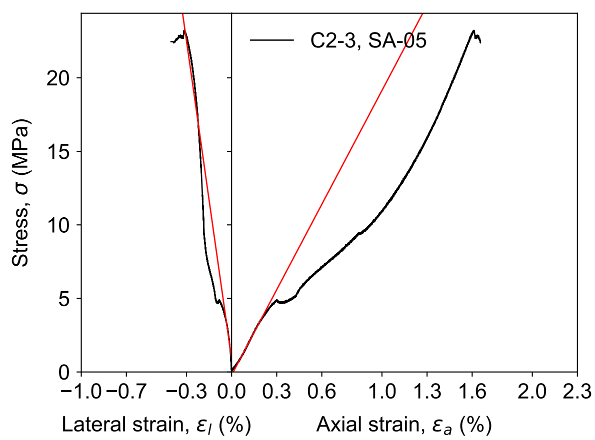
Figure 4: Measured stress-strain curves for specimens with axial and radial strain measurements.



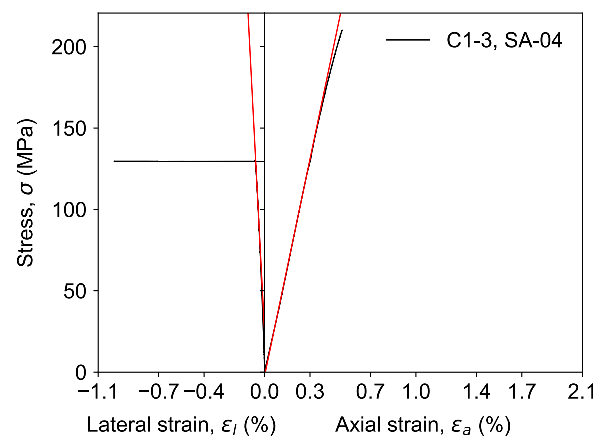

(a) C3-4-SA-01




(b) C3-4-SA-02




(c) C2-3-SA-05




(d) C1-3-SA-04 (limestone)

Figure 5: Measured stress-strain curves for specimens with axial and radial strain measurements (continued).

# 2 Slake Durability

## 2.1 Overview

This section summarizes the results of slake durability testing. The tests were performed using an M&L Testing Equipment Slake Durability apparatus capable of simultaneously performing four slake durability tests (Figure 6). The test was conducted using the following procedure:

1. The core was broken using a hammer and point load testing apparatus into 40-60 g lumps. The sharp edges of the lumps were removed by lightly hammering the edges.
2. Approximately 10 lumps weighing 450-550 g were inserted into the drum and dried in the oven at 110 °C until reaching a constant mass.
3. The drum was removed from the oven and allowed to cool to room temperature, weighed, and subsequently rotated in room temperature distilled water at 20 revolutions per minute for 10 minutes.
4. The drum was returned to the oven to dry for approximately one day and weighed again.
5. Steps 3 and 4 were then repeated for a second cycle.
6. The drum was thoroughly cleaned, dried, and weighed.

The above slake durability testing procedure adhered to ASTM D4644-16.

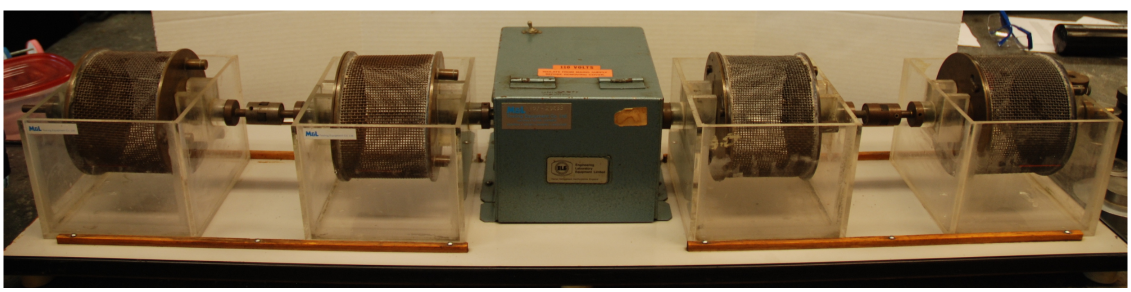


Figure 6: Test setup showing the slake durability apparatus.

## 2.2 Results

The results of the tests are summarized in Table 2. Additional measurements and sample descriptions are provided in the summary spreadsheet that accompanies this report. The slake durability index after one and two cycles was calculated as follows, respectively:

$$I_{d1} = \frac{B - D}{A - D} \times 100\% \quad (1)$$

$$I_{d2} = \frac{C - D}{A - D} \times 100\% \quad (2)$$

where $A$ is the mass of the specimen and drum before the first test cycle, $B$ is the mass of the specimen and drum after oven drying the first cycle, $C$ is the mass of the specimen and drum after oven drying the second cycle and $D$ is the mass of the drum.

Table 2: Summary of slake durability testing results.

| Sample | Depth (m) | Moisture content (%) | Pre-First Cycle, $A$ (g) | Post-First Cycle, $B$ (g) | Post-Second Cycle, $C$ (g) | Mass of Drum, $D$ (g) | Slake Durability Index , (1st Cycle) $I_{d1}$ (%) | Slake Durability Index (2nd Cycle), $I_{d2}$ (%) | Lithology |
|---|---|---|---|---|---|---|---|---|---|
| C1-4, SA-01 | 6.27 - 6.47 | 0.90 | 2378.84 | 2286.94 | 2172.12 | 1897.46 | 80.9 | 57.1 | Grey shale |
| C3-1, SA-01 | 4.50 - 4.69 | 0.82 | 2424.48 | 2365.03 | 2304.42 | 1952.74 | 87.4 | 74.5 | Grey shale |

## 2.3 Specimen Photographs

Photographs of the specimens before testing and after testing are shown in Figure 7.


Figure 7: Photographs of slake durability specimens before and after testing.

# 3 CERCHAR Abrasivity Tests

## 3.1 Overview

This section summarizes the results of CERCHAR abrasivity testing. The tests were performed using a Type-2 CERCHAR apparatus as shown in Figure 8a. The tips of the styluses were sharpened to a conical angle of 90° using the setup shown in Figure 8b. The styluses used to perform the tests are shown in Figure 8c-d (Rockwell hardness 55±1). A static force of 70 N was applied on top of the stylus by using a combination of weights. Details of the testing procedure are as follows:

1. The tips of the five styluses are sharpened using the grinding apparatus (Figure 8b).
2. The styluses are placed under a microscope (60x magnification) and three scaled photos (120° apart) are captured before the test is conducted to ensure the 90° point has been properly formed.
3. The test specimens are obtained by breaking core samples to expose a fresh fracture surface perpendicular to the core axis.
4. The specimen is secured in the cross-slide vise of the testing apparatus and the stylus is carefully lowered on to the surface of the rock.
5. A scratch measuring 10 mm in length is performed over a duration of 10 seconds. This process is repeated with all five styluses on undisturbed parts of the fracture surface (e.g., Figure 9a).
6. Lastly, the worn tips are re-examined under the microscope. From three scaled photos (120° apart), the wear flat, $d$, is measured (e.g., Figure 9c).

The length or the diameter of the wear flat, $d$, was measured from scaled microscope images using the image processing software Fiji (e.g., Figure 9b-c). The mean wear of the tip is calculated by taking the average $d$ of all tests. The CERCHAR-Abrasivity-Index (CAI) of the sample is subsequently calculated by taking the mean wear and multiplying it by 10.

## 3.2 Results

The results of the CERCHAR abrasivity tests are summarized in Table 3. Additional measurements and sample descriptions are provided in the summary spreadsheet that accompanies this report.

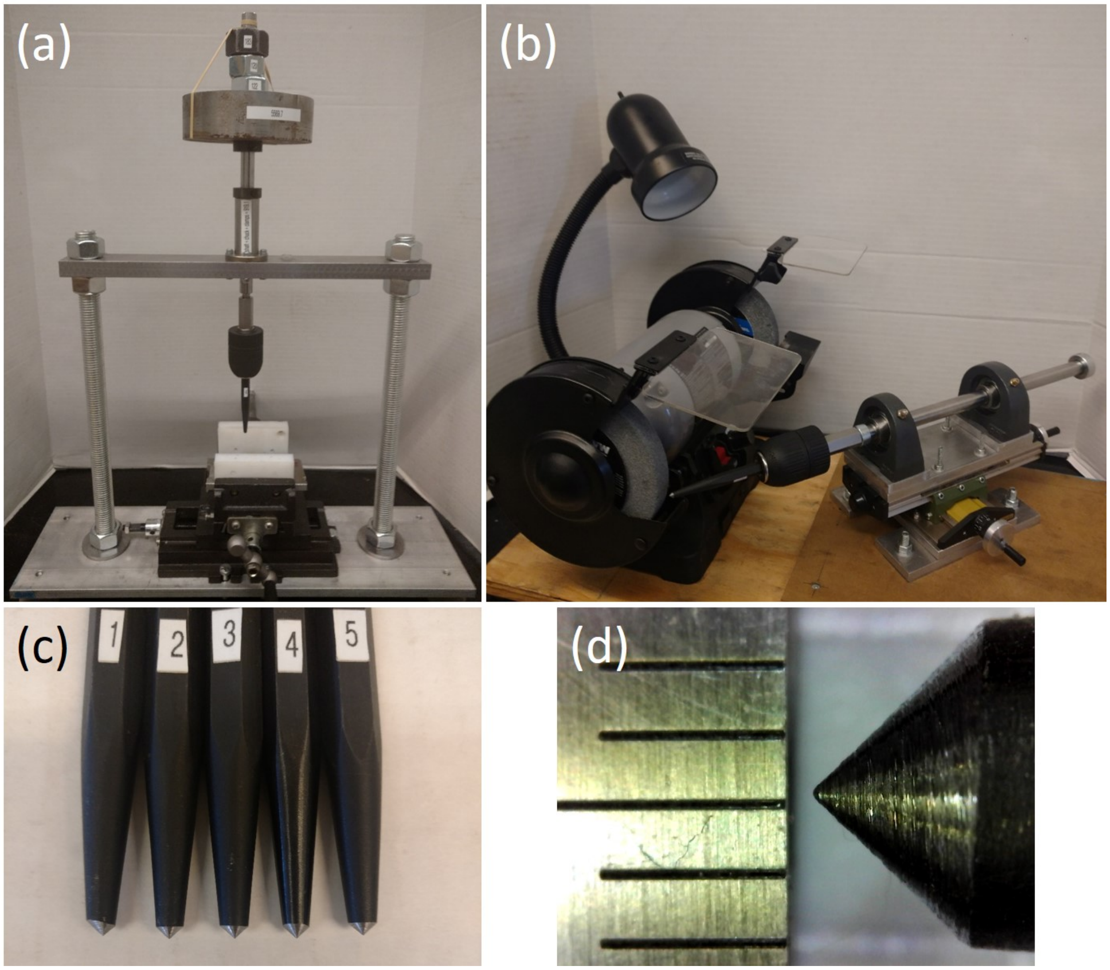



Figure 8: Photos showing (a) the CERCHAR apparatus, (b) tip sharpening setup, (c) the five styluses used to perform the test and (d) a microscope image of one of the stylus tips.

Table 3: Summary of CERCHAR abrasivity test results.

| Sample | Depth (m) | Test 1 Mean (mm) | Test 2 Mean (mm) | Test 3 Mean (mm) | Test 4 Mean (mm) | Test 5 Mean (mm) | Mean Wear (mm) | CAI | Standard Deviation of CAI | ASTM Classification |
|---|---|---|---|---|---|---|---|---|---|---|
| C1-2, SA-02 | 4.78 - 4.91 | 0.019 | 0.022 | 0.035 | 0.024 | 0.026 | 0.025 | 0.25 | 0.06 | < Very Low |
| C2-2, SA-02 | 7.20 - 7.29 | 0.026 | 0.015 | 0.033 | 0.045 | 0.015 | 0.027 | 0.27 | 0.12 | < Very Low |
| C3-2, SA-03 | 7.55 - 7.68 | 0.027 | 0.042 | 0.008 | 0.022 | 0.015 | 0.023 | 0.23 | 0.13 | < Very Low |
| C3-3, SA-04 | 7.03 - 7.18 | 0.015 | 0.025 | 0.060 | 0.032 | 0.033 | 0.033 | 0.33 | 0.17 | < Very Low |

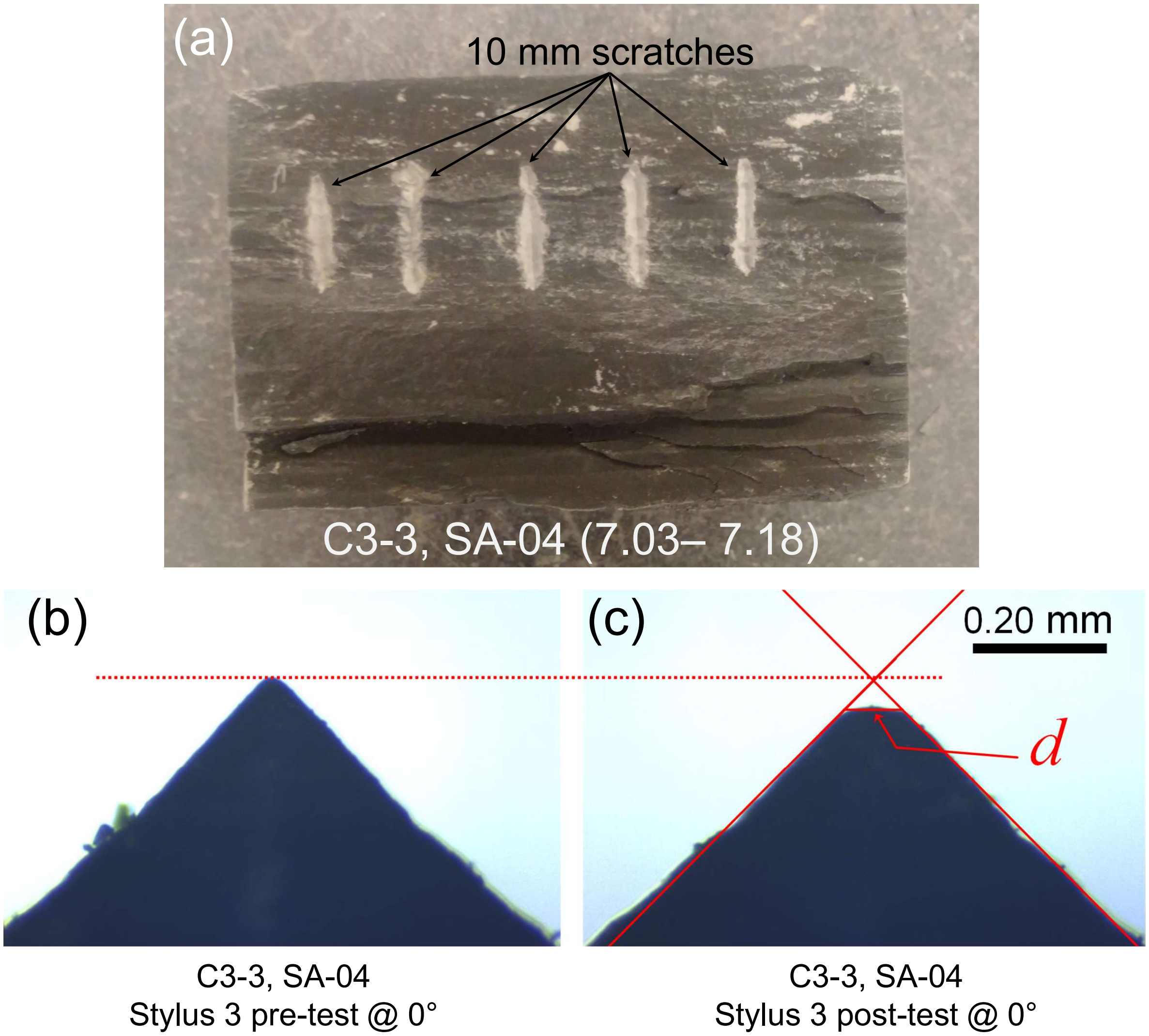



Figure 9: (a) Photograph showing an example of the five 10 mm scratches on a test specimen (b) microscope image of select stylus prior to testing at the noted position; and (c) microscope image of the same stylus at the same position following testing with the wear flat, $d$, denoted.

# Appendices

## A UCS specimen sheets

Tests without radial strain measurement

- C1-2, SA-05
- C1-2, SA-06
- C1-4, SA-02
- C3-3, SA-02

Tests with radial strain measurement

- C1-1, SA-02
- C1-1, SA-03
- C1-4, SA-03
- C2-1, SA-01
- C2-1, SA-02
- C2-2, SA-01
- C3-4, SA-01
- C3-4, SA-02
- C2-3, SA-05
- C1-3, SA-04

## Uniaxial Compression Test

| | | | |
|---|---|---|---|
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
| **Sample** | C1-2, SA-05 | **Depth** | 8.13 - 8.32 |

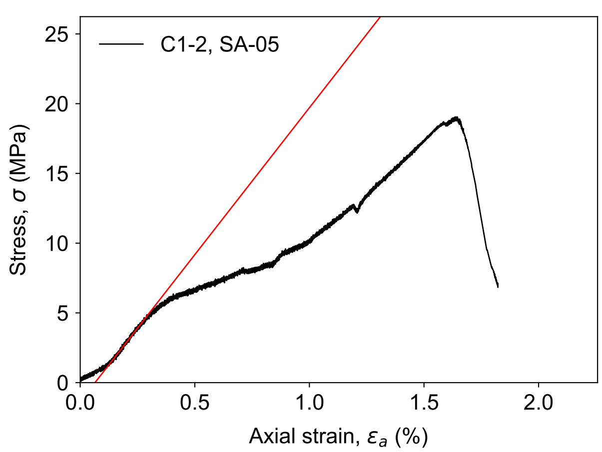
Specimen parameters

| | |
|---|---|
| Diameter (mm) [a] | 62.26 |
| Length (mm) [a] | 121.79 |
| Bulk density $\rho$ (g/cm$^3$) | 2.600 |
| UCS (MPa) | 19.1 |
| Young's modulus $E$ (GPa) [b] | 2.1 |
| Lithology | Shale |
| Failure description [c] | 1, 2 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 13.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure; [2] Specimen emitted saline pore water upon loading;

Prior to testing

After testing




Remarks:

| | | | |
|---|---|---|---|
| **Performed by** | BSAT | **Date** | 2019-03-11 |

**Uniaxial Compression Test**

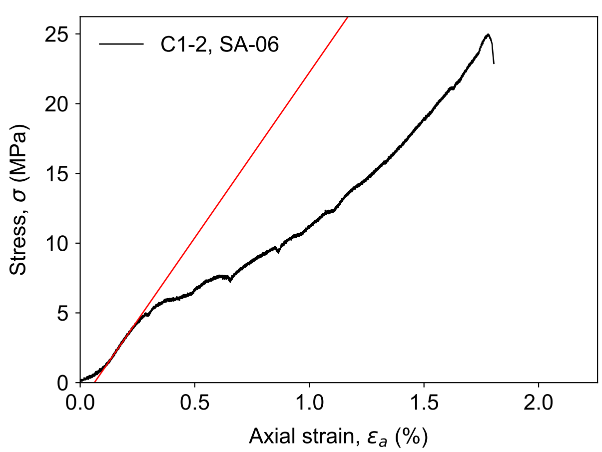
| | | | |
|---|---|---|---|
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
| **Sample** | C1-2, SA-06 | **Depth** | 10.86 - 11.07 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 62.25 |
| Length (mm) [a] | 122.19 |
| Bulk density $\rho$ (g/cm$^3$) | 2.602 |
| UCS (MPa) | 25.0 |
| Young's modulus $E$ (GPa) [b] | 2.4 |
| Lithology | Shale |
| Failure description [c] | 3, 2 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 10.0% of the peak strength.
[c] Failure description: [3] Partial hourglass failure; [2] Specimen emitted saline pore water upon loading;

Prior to testing

After testing




Remarks:

| | | | |
|---|---|---|---|
| **Performed by** | BSAT | **Date** | 2019-03-11 |

**Uniaxial Compression Test**

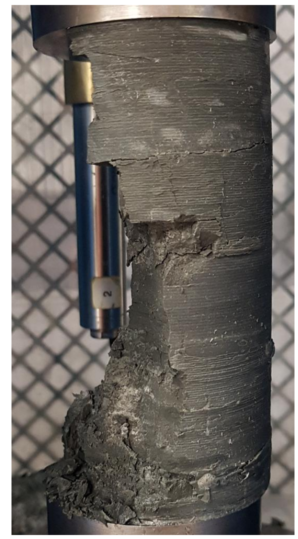
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
|---|---|---|---|
| **Sample** | C1-4, SA-02 | **Depth** | 7.49 - 7.81 |

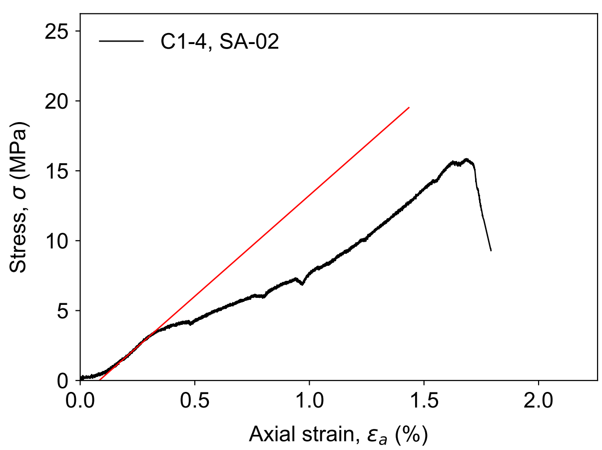
| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.80 |
| Length (mm) [a] | 122.21 |
| Bulk density $\rho$ (g/cm$^3$) | 2.603 |
| UCS (MPa) | 15.9 |
| Young's modulus $E$ (GPa) [b] | 1.4 |
| Lithology | Shale |
| Failure description [c] | 3, 2 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 16.0% of the peak strength.
[c] Failure description: [3] Partial hourglass failure; [2] Specimen emitted saline pore water upon loading;

Prior to testing

After testing






Remarks:

| **Performed by** | BSAT | **Date** | 2019-03-11 |
|---|---|---|---|

## Uniaxial Compression Test

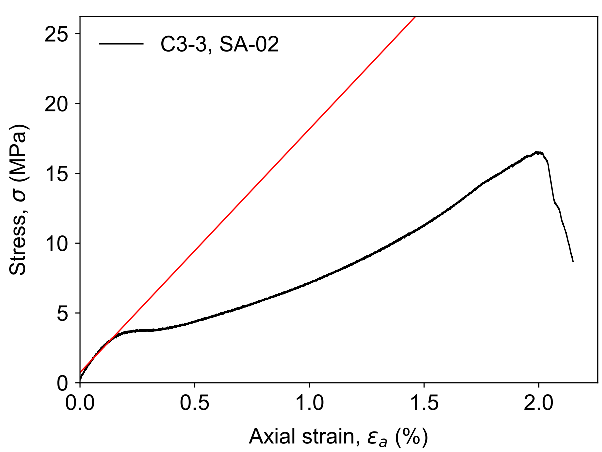
| Client | Golder Associates Ltd. | Project | 1662333 |
|---|---|---|---|
| Sample | C3-3, SA-02 | Depth | 6.18 - 6.38 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 63.02 |
| Length (mm) [a] | 121.86 |
| Bulk density $\rho$ (g/cm$^3$) | 2.598 |
| UCS (MPa) | 16.6 |
| Young's modulus $E$ (GPa) [b] | 1.7 |
| Lithology | Shale |
| Failure description [c] | 4, 5 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 15.0% of the peak strength.
[c] Failure description: [4] Inclined shear band failure; [5] Specimen emitted pore water upon loading;

Prior to testing

After testing




Remarks:

| Performed by | BSAT | Date | 2019-03-11 |
|---|---|---|---|

**Uniaxial Compression Test**

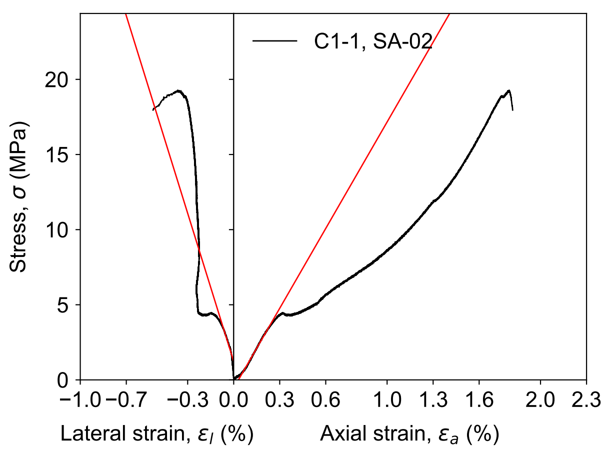
| Client | Golder Associates Ltd. | Project | 1662333 |
|---|---|---|---|
| Sample | C1-1, SA-02 | Depth | 5.25 - 5.55 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.67 |
| Length (mm) [a] | 123.08 |
| Bulk density $\rho$ (g/cm$^3$) | 2.607 |
| UCS (MPa) | 19.3 |
| Young's modulus $E$ (GPa) [b] | 1.8 |
| Poisson's ratio $\nu$ (-) [b] | 0.54 |
| Lithology | Shale |
| Failure description [c] | 1, 5 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 13.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure; [5] Specimen emitted pore water upon loading;

Prior to testing

After testing




Remarks:

| Performed by | BSAT | Date | 2019-03-11 |
|---|---|---|---|

**Uniaxial Compression Test**

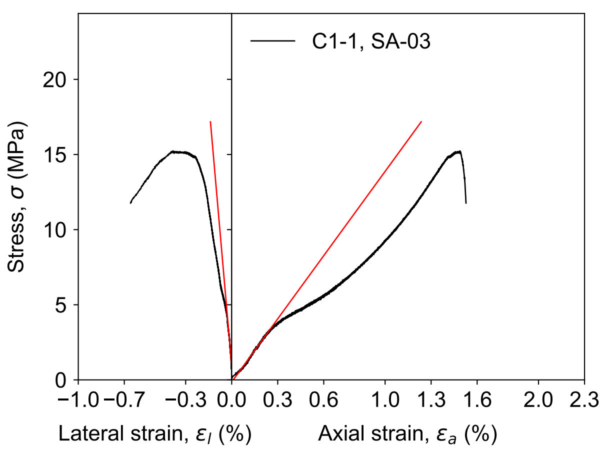
| | | | |
|---|---|---|---|
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
| **Sample** | C1-1, SA-03 | **Depth** | 6.79 - 7.13 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.70 |
| Length (mm) [a] | 119.52 |
| Bulk density $\rho$ (g/cm$^3$) | 2.602 |
| UCS (MPa) | 15.2 |
| Young's modulus $E$ (GPa) [b] | 1.4 |
| Poisson's ratio $\nu$ (-) [b] | 0.12 |
| Lithology | Inter-bedded limestone and s |
| Failure description [c] | 1, 2 |

Prior to testing

After testing

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 16.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure; [2] Specimen emitted saline pore water upon loading;




Remarks:

| | | | |
|---|---|---|---|
| **Performed by** | BSAT | **Date** | 2019-03-11 |

## Uniaxial Compression Test

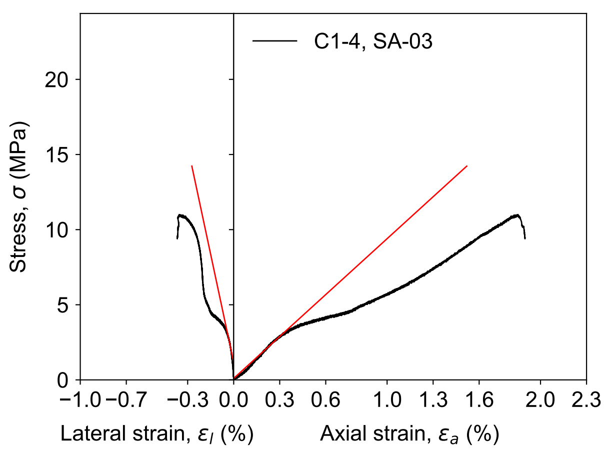
| Client | Golder Associates Ltd. | Project | 1662333 |
|---|---|---|---|
| Sample | C1-4, SA-03 | Depth | 7.15 - 7.38 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.80 |
| Length (mm) [a] | 122.48 |
| Bulk density $\rho$ (g/cm$^3$) | 2.585 |
| UCS (MPa) | 11.0 |
| Young's modulus $E$ (GPa) [b] | 0.9 |
| Poisson's ratio $\nu$ (-) [b] | 0.19 |
| Lithology | Shale |
| Failure description [c] | 6, 1, 2 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through $\pm$300 data points on either side of the point representing 23.0% of the peak strength.
[c] Failure description: [6] Localized crushing; [1] Axial splitting failure; [2] Specimen emitted saline pore water upon loading;

Prior to testing

After testing




Remarks:

| Performed by | BSAT | Date | 2019-03-11 |
|---|---|---|---|

## Uniaxial Compression Test

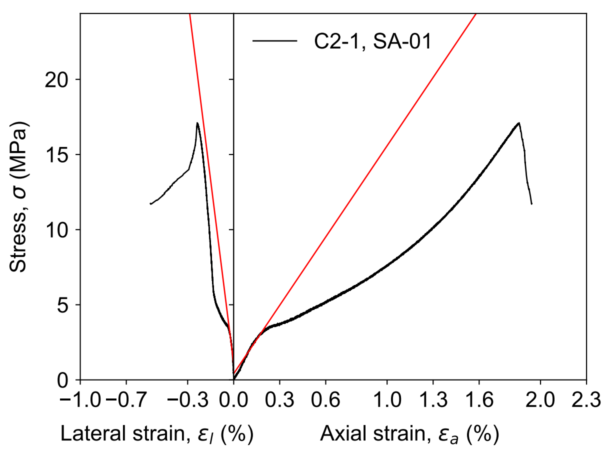
| | | | |
|---|---|---|---|
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
| **Sample** | C2-1, SA-01 | **Depth** | 4.60 - 4.85 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.65 |
| Length (mm) [a] | 122.77 |
| Bulk density $\rho$ (g/cm$^3$) | 2.591 |
| UCS (MPa) | 17.1 |
| Young's modulus $E$ (GPa) [b] | 1.5 |
| Poisson's ratio $\nu$ (-) [b] | 0.19 |
| Lithology | Shale |
| Failure description [c] | 3, 5 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 15.0% of the peak strength.
[c] Failure description: [3] Partial hourglass failure; [5] Specimen emitted pore water upon loading;

Prior to testing

After testing




Remarks:

| | | | |
|---|---|---|---|
| **Performed by** | BSAT | **Date** | 2019-03-11 |

## Uniaxial Compression Test

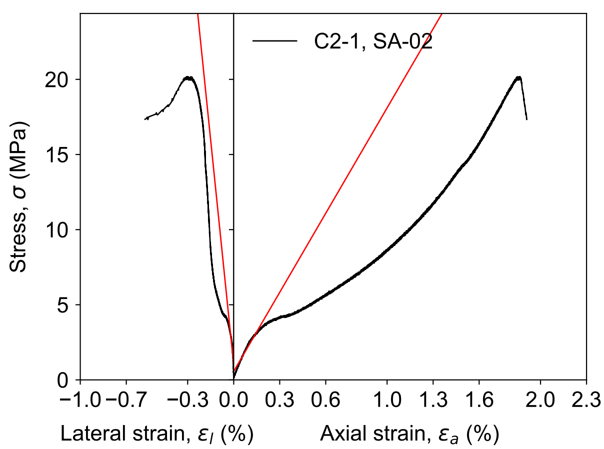
| | | | |
|---|---|---|---|
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
| **Sample** | C2-1, SA-02 | **Depth** | 4.99 - 5.40 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.73 |
| Length (mm) [a] | 122.55 |
| Bulk density $\rho$ (g/cm$^3$) | 2.589 |
| UCS (MPa) | 20.2 |
| Young's modulus $E$ (GPa) [b] | 1.8 |
| Poisson's ratio $\nu$ (-) [b] | 0.18 |
| Lithology | Shale |
| Failure description [c] | 1, 3, 5 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 12.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure; [3] Partial hourglass failure; [5] Specimen emitted pore water upon loading;

Prior to testing

After testing




Remarks:

| | | | |
|---|---|---|---|
| **Performed by** | BSAT | **Date** | 2019-03-12 |

**Uniaxial Compression Test**

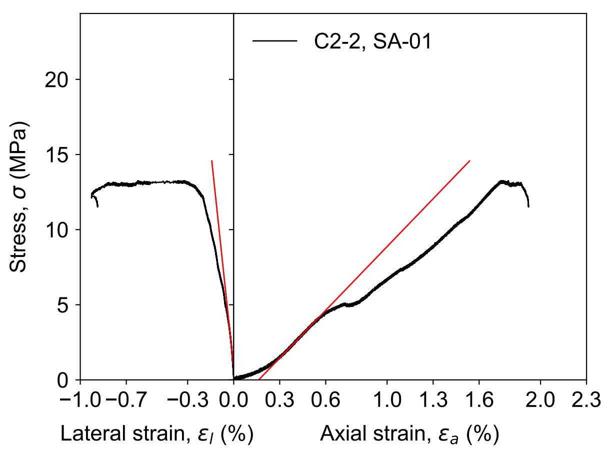
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
|---|---|---|---|
| **Sample** | C2-2, SA-01 | **Depth** | 4.52 - 4.7 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 61.78 |
| Length (mm) [a] | 122.04 |
| Bulk density $\rho$ (g/cm$^3$) | 2.592 |
| UCS (MPa) | 13.3 |
| Young's modulus $E$ (GPa) [b] | 1.1 |
| Poisson's ratio $\nu$ (-) [b] | 0.11 |
| Lithology | Shale |
| Failure description [c] | 1, 5 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 19.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure; [5] Specimen emitted pore water upon loading;

Prior to testing

After testing




Remarks:

| **Performed by** | BSAT | **Date** | 2019-03-12 |
|---|---|---|---|

**Uniaxial Compression Test**

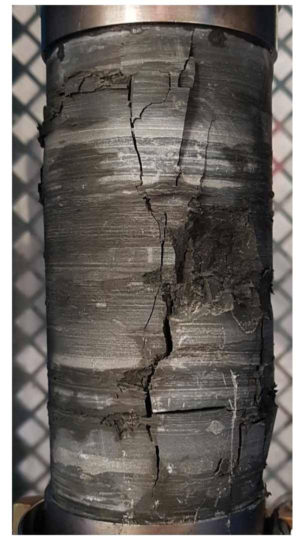
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
|---|---|---|---|
| **Sample** | C3-4, SA-01 | **Depth** | 3.09 - 3.41 |

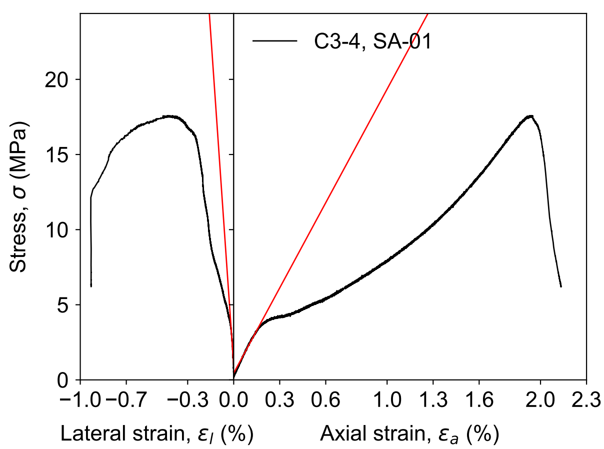
| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.65 |
| Length (mm) [a] | 121.72 |
| Bulk density $\rho$ (g/cm$^3$) | 2.601 |
| UCS (MPa) | 17.6 |
| Young's modulus $E$ (GPa) [b] | 1.9 |
| Poisson's ratio $\nu$ (-) [b] | 0.13 |
| Lithology | Shale |
| Failure description [c] | 1, 5 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 14.0% of the peak strength.
[c] Failure description: [1] Axial splitting failure; [5] Specimen emitted pore water upon loading;

Prior to testing

After testing






Remarks:

| **Performed by** | BSAT | **Date** | 2019-03-13 |
|---|---|---|---|

## Uniaxial Compression Test

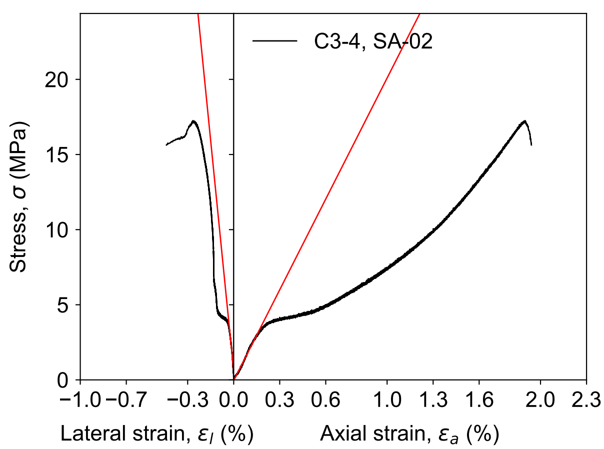
| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
|---|---|---|---|
| **Sample** | C3-4, SA-02 | **Depth** | 3.41 - 3.77 |

| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 60.76 |
| Length (mm) [a] | 122.84 |
| Bulk density $\rho$ (g/cm$^3$) | 2.594 |
| UCS (MPa) | 17.3 |
| Young's modulus $E$ (GPa) [b] | 2.0 |
| Poisson's ratio $\nu$ (-) [b] | 0.20 |
| Lithology | Shale |
| Failure description [c] | 4, 5 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 14.0% of the peak strength.
[c] Failure description: [4] Inclined shear band failure; [5] Specimen emitted pore water upon loading;

Prior to testing

After testing




Remarks:

| **Performed by** | BSAT | **Date** | 2019-03-13 |
|---|---|---|---|

Uniaxial Compression Test

| Client | Golder Associates Ltd. | Project | 1662333 |
|---|---|---|---|
| Sample | C2-3, SA-05 | Depth | 8.29 - 8.49 |

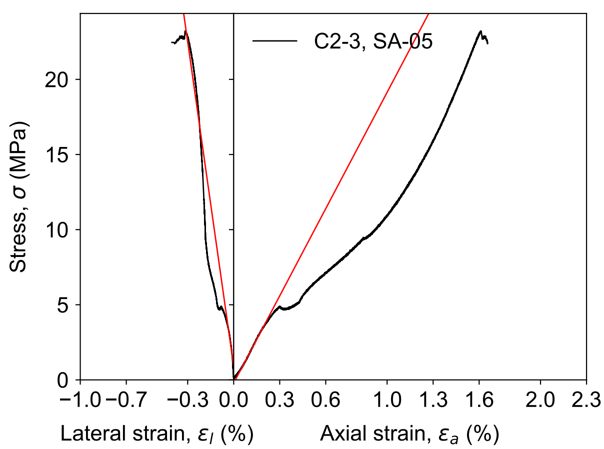
Specimen parameters

| | |
|---|---|
| Diameter (mm) [a] | 62.29 |
| Length (mm) [a] | 124.74 |
| Bulk density $\rho$ (g/cm$^3$) | 2.602 |
| UCS (MPa) | 23.2 |
| Young's modulus $E$ (GPa) [b] | 1.9 |
| Poisson's ratio $\nu$ (-) [b] | 0.27 |
| Lithology | Shale |
| Failure description [c] | 4, 2 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 11.0% of the peak strength.
[c] Failure description: [4] Inclined shear band failure; [2] Specimen emitted saline pore water upon loading;

Prior to testing

After testing




Remarks:

| Performed by | BSAT | Date | 2019-03-13 |
|---|---|---|---|

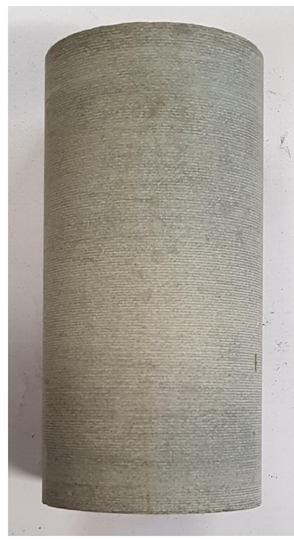
**Uniaxial Compression Test**

| **Client** | Golder Associates Ltd. | **Project** | 1662333 |
|---|---|---|---|
| **Sample** | C1-3, SA-04 | **Depth** | 6.54 - 6.75 |

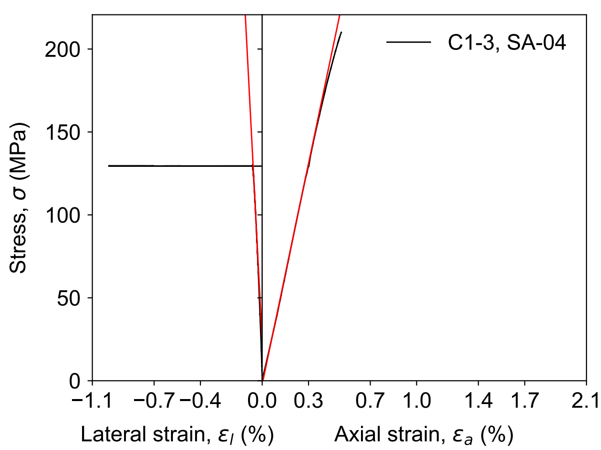
| Specimen parameters | |
|---|---|
| Diameter (mm) [a] | 62.34 |
| Length (mm) [a] | 125.90 |
| Bulk density $\rho$ (g/cm$^3$) | 2.667 |
| UCS (MPa) | 210.2 |
| Young's modulus $E$ (GPa) [b] | 44.4 |
| Poisson's ratio $\nu$ (-) [b] | 0.25 |
| Lithology | Limestone |
| Failure description [c] | 7 |

[a] Additional specimen measurement/details provides in accompanying summary spreadsheet.
[b] Tangent modulus, calculated as the slope of the best fit line through ±300 data points on either side of the point representing 50.0% of the peak strength.
[c] Failure description: [7] Hourglass failure;

Prior to testing



After testing




Remarks: Removed radial strain sensor prior to rupture to avoid possible damage.

| **Performed by** | BSAT | **Date** | 2019-03-14 |
|---|---|---|---|

**APPENDIX C**

# Analytical Laboratory Test Results (Maxxam Analytics)

Maxxam
A Bureau Veritas Group Company

Your C.O.C. #: 125152

**Attention: David Marmor**

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

**Report Date: 2019/03/12**
Report #: R5625381
Version: 1 - Final

# CERTIFICATE OF ANALYSIS

**MAXXAM JOB #: B958559**
**Received: 2019/03/06, 15:01**

Sample Matrix: Soil
# Samples Received: 2

| Analyses | Quantity | Date Extracted | Date Analyzed | Laboratory Method | Reference |
|---|---|---|---|---|---|
| Petroleum Hydro. CCME F1 & BTEX in Soil (1) | 2 | N/A | 2019/03/08 | CAM SOP-00315 | CCME PHC-CWS m |
| Moisture | 2 | N/A | 2019/03/06 | CAM SOP-00445 | Carter 2nd ed 51.2 m |

**Remarks:**

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

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) No lab extraction date is given for F1BTEX & VOC samples that are field preserved with methanol. Extraction date is the date sampled unless otherwise stated.

Maxxam
A Bureau Veritas Group Company

Your C.O.C. #: 125152

**Attention: David Marmor**

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

**Report Date: 2019/03/12**
Report #: R5625381
Version: 1 - Final

# CERTIFICATE OF ANALYSIS

**MAXXAM JOB #: B958559**
**Received: 2019/03/06, 15:01**

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
A Bureau Veritas Group Company

Maxxam Job #: B958559
Report Date: 2019/03/12

Golder Associates Ltd
Sampler Initials: AM

## RESULTS OF ANALYSES OF SOIL

| **Maxxam ID** | | JDC559 | JDC560 | | |
|---|---|---|---|---|---|
| **Sampling Date** | | 2019/03/05 15:15 | 2019/03/01 14:40 | | |
| **COC Number** | | 125152 | 125152 | | |
| | **UNITS** | **BHC2-2 SA-03** | **BHC3-2 SA-01** | **RDL** | **QC Batch** |
| **Inorganics** | | | | | |
| Moisture | % | 5.0 | 6.4 | 1.0 | 6006016 |

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch



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

Maxxam Job #: B958559
Report Date: 2019/03/12

Golder Associates Ltd
Sampler Initials: AM

## PETROLEUM HYDROCARBONS (CCME)

| **Maxxam ID** | | JDC559 | JDC560 | | |
|---|---|---|---|---|---|
| **Sampling Date** | | 2019/03/05 15:15 | 2019/03/01 14:40 | | |
| **COC Number** | | 125152 | 125152 | | |
| | **UNITS** | **BHC2-2 SA-03** | **BHC3-2 SA-01** | **RDL** | **QC Batch** |
| **BTEX & F1 Hydrocarbons** | | | | | |
| Benzene | ug/g | 0.21 | <0.020 | 0.020 | 6008322 |
| Toluene | ug/g | 0.072 | <0.020 | 0.020 | 6008322 |
| Ethylbenzene | ug/g | <0.020 | <0.020 | 0.020 | 6008322 |
| o-Xylene | ug/g | <0.020 | <0.020 | 0.020 | 6008322 |
| p+m-Xylene | ug/g | <0.040 | <0.040 | 0.040 | 6008322 |
| Total Xylenes | ug/g | <0.040 | <0.040 | 0.040 | 6008322 |
| F1 (C6-C10) | ug/g | <10 | <10 | 10 | 6008322 |
| F1 (C6-C10) - BTEX | ug/g | <10 | <10 | 10 | 6008322 |
| **Surrogate Recovery (%)** | | | | | |
| 1,4-Difluorobenzene | % | 100 | 102 | | 6008322 |
| 4-Bromofluorobenzene | % | 98 | 98 | | 6008322 |
| D10-Ethylbenzene | % | 96 | 92 | | 6008322 |
| D4-1,2-Dichloroethane | % | 101 | 102 | | 6008322 |

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch


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

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B958559
Report Date: 2019/03/12

Golder Associates Ltd
Sampler Initials: AM

## TEST SUMMARY

**Maxxam ID:** JDC559
**Sample ID:** BHC2-2 SA-03
**Matrix:** Soil

**Collected:** 2019/03/05
**Shipped:**
**Received:** 2019/03/06

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|---|---|---|---|---|---|
| Petroleum Hydro. CCME F1 & BTEX in Soil | HSGC/MSFD | 6008322 | N/A | 2019/03/08 | Ravinder Gaidhu |
| Moisture | BAL | 6006016 | N/A | 2019/03/06 | Min Yang |

**Maxxam ID:** JDC560
**Sample ID:** BHC3-2 SA-01
**Matrix:** Soil

**Collected:** 2019/03/01
**Shipped:**
**Received:** 2019/03/06

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|---|---|---|---|---|---|
| Petroleum Hydro. CCME F1 & BTEX in Soil | HSGC/MSFD | 6008322 | N/A | 2019/03/08 | Ravinder Gaidhu |
| Moisture | BAL | 6006016 | N/A | 2019/03/06 | Min Yang |


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

## GENERAL COMMENTS

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

| | |
|---|---|
| Package 1 | 3.7°C |

Rock sample submitted, sample has been crushed and preserved at the lab prior to analysis as per client request.

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



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

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B958559
Report Date: 2019/03/12

# QUALITY ASSURANCE REPORT

Golder Associates Ltd
Sampler Initials: AM

| | | | Matrix Spike | | SPIKED BLANK | | Method Blank | | RPD | |
|---|---|---|---|---|---|---|---|---|---|---|
| QC Batch | Parameter | Date | % Recovery | QC Limits | % Recovery | QC Limits | Value | UNITS | Value (%) | QC Limits |
| 6008322 | 1,4-Difluorobenzene | 2019/03/08 | 100 | 60 - 140 | 101 | 60 - 140 | 101 | % | | |
| 6008322 | 4-Bromofluorobenzene | 2019/03/08 | 99 | 60 - 140 | 99 | 60 - 140 | 98 | % | | |
| 6008322 | D10-Ethylbenzene | 2019/03/08 | 91 | 60 - 140 | 82 | 60 - 140 | 84 | % | | |
| 6008322 | D4-1,2-Dichloroethane | 2019/03/08 | 100 | 60 - 140 | 101 | 60 - 140 | 100 | % | | |
| 6006016 | Moisture | 2019/03/06 | | | | | | | 3.4 | 20 |
| 6008322 | Benzene | 2019/03/08 | 83 | 60 - 140 | 83 | 60 - 140 | <0.020 | ug/g | | |
| 6008322 | Ethylbenzene | 2019/03/08 | 88 | 60 - 140 | 87 | 60 - 140 | <0.020 | ug/g | | |
| 6008322 | F1 (C6-C10) - BTEX | 2019/03/08 | | | | | <10 | ug/g | NC | 30 |
| 6008322 | F1 (C6-C10) | 2019/03/08 | 94 | 60 - 140 | 89 | 80 - 120 | <10 | ug/g | NC | 30 |
| 6008322 | o-Xylene | 2019/03/08 | 89 | 60 - 140 | 87 | 60 - 140 | <0.020 | ug/g | | |
| 6008322 | p+m-Xylene | 2019/03/08 | 89 | 60 - 140 | 87 | 60 - 140 | <0.040 | ug/g | | |
| 6008322 | Toluene | 2019/03/08 | 91 | 60 - 140 | 90 | 60 - 140 | <0.020 | ug/g | | |
| 6008322 | Total Xylenes | 2019/03/08 | | | | | <0.040 | ug/g | | |

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.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

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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## VALIDATION SIGNATURE PAGE

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

Anastassia Hamanov, Scientific Specialist

---

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



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6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/4

# CHAIN OF CUSTODY RECORD 125152

Page 1 of 1

| Invoice Information | | Report Information (if differs from invoice) | | Project Information (where applicable) | | Turnaround Time (TAT) Required |
|---|---|---|---|---|---|---|
| Company Name: | Golder Associates | Company Name: | | Quotation #: | | [X] Regular TAT (5-7 days) Most analyses |
| Contact Name: | David Marmor | Contact Name: | | P.O. #/ AFE#: | | PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS |
| Address: | 6925 Century Avenue Site #lab Mississauga, ON L5N 7K2 | Address: | | Project #: | | Rush TAT (Surcharges will be applied) |
| | | | | Site Location: | | [ ] 1 Day [ ] 2 Day [ ] 3-4 Days |
| Phone: | 905-567-4444 Fax: 905-567-6561 | Phone: | Fax: | Site #: | | |
| Email: | dmarmor@golder.com | Email: | | Site Location Province: | | Date Required: |
| | | | | Sampled By: | | 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**: [ ] Table 1 [ ] Res/Park [ ] Med/ Fine; [ ] Table 2 [ ] Ind/Comm [ ] Coarse; [ ] Table 3 [ ] Agri/ Other; [ ] Table ____

FOR RSC (PLEASE CIRCLE) Y / N

**Other Regulations**: [ ] CCME [ ] Sanitary Sewer Bylaw; [ ] MISA [ ] Storm Sewer Bylaw; [ ] PWQO Region ____; [ ] Other (Specify) ____; [ ] 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

**LABORATORY USE ONLY**: CUSTODY SEAL Y / (N) — Present / Intact; COOLER TEMPERATURES: 2 / 8 / 1; COOLING MEDIA PRESENT: (Y) / N

| | 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) | | | | | | | | HOLD- DO NOT ANALYZE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BHC2-2 SA-03 | 2019/03/05 | 03:15 | Rock | 1 Jar 2 vials | | X | | | | | | | | | | | | | | |
| 2 | BH C3-2 SA-01 | 2019/03/01 | 02:40 | Rock | 1 Jar 2 vials | | X | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | |
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| 9 | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | |

| RELINQUISHED BY: (Signature/Print) | DATE: (YYYY/MM/DD) | TIME: (HH:MM) | RECEIVED BY: (Signature/Print) | DATE: (YYYY/MM/DD) | TIME: (HH:MM) |
|---|---|---|---|---|---|
| Alex MacMillan | 2019/03/06 | 15:00 | [signature] | 2019/03/06 | 1501 |
| | | | | | |

06-Mar-19 15:01
Ema Gitej
B958559
KVG env-1302

*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 w... Sample container, preservation, hold time and packages information can be viewed at http://maxxam.ca/wp-content/uploads/Ontario-COC.pdf.*

COC-1004 (01/19) White: Maxxam ~ Yellow: Client

Maxxam
A Bureau Veritas Group Company

Your C.O.C. #: 705774-01-01

**Attention: David Marmor**

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

**Report Date: 2019/03/15**
Report #: R5630057
Version: 1 - Final

# CERTIFICATE OF ANALYSIS

**MAXXAM JOB #: B963042**
**Received: 2019/03/11, 17:34**

Sample Matrix: ROCK
# Samples Received: 3

| Analyses | Quantity | Date Extracted | Date Analyzed | Laboratory Method | Reference |
|---|---|---|---|---|---|
| Petroleum Hydro. CCME F1 & BTEX in Soil (1) | 3 | N/A | 2019/03/13 | CAM SOP-00315 | CCME PHC-CWS m |
| Moisture | 3 | N/A | 2019/03/12 | CAM SOP-00445 | Carter 2nd ed 51.2 m |

**Remarks:**

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

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) No lab extraction date is given for F1BTEX & VOC samples that are field preserved with methanol. Extraction date is the date sampled unless otherwise stated.


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Maxxam
A Bureau Veritas Group Company

Your C.O.C. #: 705774-01-01

**Attention: David Marmor**

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

**Report Date: 2019/03/15**
Report #: R5630057
Version: 1 - Final

# CERTIFICATE OF ANALYSIS

**MAXXAM JOB #: B963042**
**Received: 2019/03/11, 17:34**

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 #: B963042
Report Date: 2019/03/15

Golder Associates Ltd
Sampler Initials: AM

## RESULTS OF ANALYSES OF ROCK

| **Maxxam ID** | | JEB073 | JEB074 | JEB075 | | |
|---|---|---|---|---|---|---|
| **Sampling Date** | | 2019/03/07 14:00 | 2019/03/09 | 2019/03/09 14:55 | | |
| **COC Number** | | 705774-01-01 | 705774-01-01 | 705774-01-01 | | |
| | **UNITS** | **BHC1-2** | **BHC1-3** | **BHC2-3** | **RDL** | **QC Batch** |
| **Inorganics** | | | | | | |
| Moisture | % | 3.8 | 4.8 | 4.2 | 1.0 | 6013966 |

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch



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Maxxam Job #: B963042
Report Date: 2019/03/15

Golder Associates Ltd
Sampler Initials: AM

## PETROLEUM HYDROCARBONS (CCME)

| **Maxxam ID** | | JEB073 | | JEB074 | | JEB075 | | |
|---|---|---|---|---|---|---|---|---|
| **Sampling Date** | | 2019/03/07 14:00 | | 2019/03/09 | | 2019/03/09 14:55 | | |
| **COC Number** | | 705774-01-01 | | 705774-01-01 | | 705774-01-01 | | |
| | **UNITS** | **BHC1-2** | **RDL** | **BHC1-3** | **RDL** | **BHC2-3** | **RDL** | **QC Batch** |
| **BTEX & F1 Hydrocarbons** | | | | | | | | |
| Benzene | ug/g | 0.15 | 0.020 | 0.11 | 0.060 | 0.18 | 0.020 | 6016584 |
| Toluene | ug/g | 0.030 | 0.020 | <0.060 | 0.060 | <0.020 | 0.020 | 6016584 |
| Ethylbenzene | ug/g | <0.020 | 0.020 | <0.060 | 0.060 | <0.020 | 0.020 | 6016584 |
| o-Xylene | ug/g | <0.020 | 0.020 | <0.060 | 0.060 | <0.020 | 0.020 | 6016584 |
| p+m-Xylene | ug/g | <0.040 | 0.040 | <0.12 | 0.12 | <0.040 | 0.040 | 6016584 |
| Total Xylenes | ug/g | <0.040 | 0.040 | <0.12 | 0.12 | <0.040 | 0.040 | 6016584 |
| F1 (C6-C10) | ug/g | <10 | 10 | <30 | 30 | <10 | 10 | 6016584 |
| F1 (C6-C10) - BTEX | ug/g | <10 | 10 | <30 | 30 | <10 | 10 | 6016584 |
| **Surrogate Recovery (%)** | | | | | | | | |
| 1,4-Difluorobenzene | % | 101 | | 101 | | 100 | | 6016584 |
| 4-Bromofluorobenzene | % | 105 | | 103 | | 103 | | 6016584 |
| D10-Ethylbenzene | % | 105 | | 123 | | 107 | | 6016584 |
| D4-1,2-Dichloroethane | % | 91 | | 90 | | 91 | | 6016584 |

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch



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# TEST SUMMARY

**Maxxam ID:** JEB073
**Sample ID:** BHC1-2
**Matrix:** ROCK

**Collected:** 2019/03/07
**Shipped:**
**Received:** 2019/03/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|---|---|---|---|---|---|
| Petroleum Hydro. CCME F1 & BTEX in Soil | HSGC/MSFD | 6016584 | N/A | 2019/03/13 | Joe Paino |
| Moisture | BAL | 6013966 | N/A | 2019/03/12 | Min Yang |

**Maxxam ID:** JEB074
**Sample ID:** BHC1-3
**Matrix:** ROCK

**Collected:** 2019/03/09
**Shipped:**
**Received:** 2019/03/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|---|---|---|---|---|---|
| Petroleum Hydro. CCME F1 & BTEX in Soil | HSGC/MSFD | 6016584 | N/A | 2019/03/13 | Joe Paino |
| Moisture | BAL | 6013966 | N/A | 2019/03/12 | Min Yang |

**Maxxam ID:** JEB075
**Sample ID:** BHC2-3
**Matrix:** ROCK

**Collected:** 2019/03/09
**Shipped:**
**Received:** 2019/03/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|---|---|---|---|---|---|
| Petroleum Hydro. CCME F1 & BTEX in Soil | HSGC/MSFD | 6016584 | N/A | 2019/03/13 | Joe Paino |
| Moisture | BAL | 6013966 | N/A | 2019/03/12 | Min Yang |



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## GENERAL COMMENTS

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

| | |
|---|---|
| Package 1 | 3.3°C |

Sample JEB074 [BHC1-3] : F1/BTEX Analysis: Detection limits were adjusted for sample weight.

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


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Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B963042
Report Date: 2019/03/15

## QUALITY ASSURANCE REPORT

Golder Associates Ltd
Sampler Initials: AM

| | | | Matrix Spike | | SPIKED BLANK | | Method Blank | | RPD | |
|---|---|---|---|---|---|---|---|---|---|---|
| QC Batch | Parameter | Date | % Recovery | QC Limits | % Recovery | QC Limits | Value | UNITS | Value (%) | QC Limits |
| 6016584 | 1,4-Difluorobenzene | 2019/03/13 | 99 | 60 - 140 | 99 | 60 - 140 | 101 | % | | |
| 6016584 | 4-Bromofluorobenzene | 2019/03/13 | 104 | 60 - 140 | 105 | 60 - 140 | 103 | % | | |
| 6016584 | D10-Ethylbenzene | 2019/03/13 | 98 | 60 - 140 | 98 | 60 - 140 | 95 | % | | |
| 6016584 | D4-1,2-Dichloroethane | 2019/03/13 | 91 | 60 - 140 | 93 | 60 - 140 | 93 | % | | |
| 6013966 | Moisture | 2019/03/12 | | | | | | | 5.5 | 20 |
| 6016584 | Benzene | 2019/03/13 | 74 | 60 - 140 | 87 | 60 - 140 | <0.020 | ug/g | 0.62 | 50 |
| 6016584 | Ethylbenzene | 2019/03/13 | 76 | 60 - 140 | 97 | 60 - 140 | <0.020 | ug/g | 0.81 | 50 |
| 6016584 | F1 (C6-C10) - BTEX | 2019/03/13 | | | | | <10 | ug/g | NC | 30 |
| 6016584 | F1 (C6-C10) | 2019/03/13 | 127 | 60 - 140 | 109 | 80 - 120 | <10 | ug/g | NC | 30 |
| 6016584 | o-Xylene | 2019/03/13 | 81 | 60 - 140 | 94 | 60 - 140 | <0.020 | ug/g | 2.4 | 50 |
| 6016584 | p+m-Xylene | 2019/03/13 | 78 | 60 - 140 | 104 | 60 - 140 | <0.040 | ug/g | 0.43 | 50 |
| 6016584 | Toluene | 2019/03/13 | 83 | 60 - 140 | 95 | 60 - 140 | <0.020 | ug/g | 8.5 | 50 |
| 6016584 | Total Xylenes | 2019/03/13 | | | | | <0.040 | ug/g | 0.47 | 50 |

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.

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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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## VALIDATION SIGNATURE PAGE

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

Anastassia Hamanov, Scientific Specialist

---

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# CHAIN OF CUSTODY RECORD

Page 1 of 1

| INVOICE TO: | | REPORT TO: | | PROJECT INFORMATION: | | Laboratory Use Only: | |
|---|---|---|---|---|---|---|---|
| Company Name: | #1326 Golder Associates Ltd | Company Name: | | Quotation #: | B80683 | Maxxam Job #: | Bottle Order #: 705774 |
| Attention: | Accounts Payable | Attention: | David Marmor | P.O. #: | | | |
| Address: | 6925 Century Ave Suite 100 Mississauga ON L5N 7K2 | Address: | | Project: | | COC #: C#705774-01-01 | Project Manager: Ema Gitej |
| Tel: | (905) 567-4444 Fax: (905) 567-6561 | Tel: | Fax: | Project Name: | | | |
| Email: | AP_CustomerService@golder.com | Email: | David_Marmor@golder.com | Site #: | | | |
| | | | | Sampled By: | | | |

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

| Regulation 153 (2011) | Other Regulations | Special Instructions |
|---|---|---|
| ☐ Table 1 ☐ Res/Park ☐ Medium/Fine<br>☐ Table 2 ☐ Ind/Comm ☐ Coarse<br>☐ Table 3 ☐ Agri/Other ☐ For RSC<br>☐ Table ___ | ☐ CCME ☐ Sanitary Sewer Bylaw<br>☐ Reg 558 ☐ Storm Sewer Bylaw<br>☐ MISA Municipality ___<br>☐ PWQO<br>☐ 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 | Matrix | Field Filtered (please circle): Metals / Hg / Cr VI | Petroleum Hydro. CCME F1 & BTEX | | | | | | | | | # of Bottles | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BHC1-2 | | 2019/03/07 | 02:00 | Rock | | X | | | | | | | | | 3 | |
| 2 | BHC1-3 | | 2019/03/09 | AM | Rock | | X | | | | | | | | | 3 | |
| 3 | BHC2-3 | | 2019/03/09 | 02:55 | Rock | | X | | | | | | | | | 3 | |
| 4 | ↳ a little bit of methanol spilled before sample taken | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | 11-Mar-19 17:34 |
| 8 | | | | | | | | | | | | | | | | | Ema Gitej |
| 9 | | | | | | | | | | | | | | | | | B963042 |
| 10 | | | | | | | | | | | | | | | | | THP ENV-1335 |

| * RELINQUISHED BY: (Signature/Print) | Date: (YY/MM/DD) | Time | RECEIVED BY: (Signature/Print) | Date: (YY/MM/DD) | Time | # jars used and not submitted | Time Sensitive | Temperature (°C) on Recei | Custody Seal | Yes | No |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alex MacMillan | 19/03/11 | 17:33 | Ronald Walker | 2019/03/11 | 17:34 | | | 3 4 3 | Present | | X |
| | | | | | | | | | Intact | | X |

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

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

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

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

White: Maxxam Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Maxxam
A Bureau Veritas Group Company

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

**Attention: David Marmor**

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

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

# CERTIFICATE OF ANALYSIS

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

Sample Matrix: Rock
# Samples Received: 10

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

**Remarks:**

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

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.
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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Maxxam
A Bureau Veritas Group Company

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

**Attention: David Marmor**

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

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

# CERTIFICATE OF ANALYSIS

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

Encryption Key

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

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

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

## RESULTS OF ANALYSES OF ROCK

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

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch


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Maxxam
A Bureau Veritas Group Company

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

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

## TEST SUMMARY

**Maxxam ID:** JGK384
**Sample ID:** 1662333 C1-2
**Matrix:** Rock

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

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

**Maxxam ID:** JGK385
**Sample ID:** 1662333 C1-1
**Matrix:** Rock

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

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

**Maxxam ID:** JGK386
**Sample ID:** 1662333 C2-2
**Matrix:** Rock

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

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

**Maxxam ID:** JGK387
**Sample ID:** 1662333 C2-3
**Matrix:** Rock

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

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

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

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

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



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## TEST SUMMARY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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


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Maxxam
A Bureau Veritas Group Company

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

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

## TEST SUMMARY

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

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

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


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## GENERAL COMMENTS

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

| | |
|---|---|
| Package 1 | -2.0°C |

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



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## QUALITY ASSURANCE REPORT



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

N/A = Not Applicable

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

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

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

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

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



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## VALIDATION SIGNATURE PAGE

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

Anastassia Hamanov, Scientific Specialist





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**CHAIN OF CUSTODY RECORD**

Page of

| INVOICE TO: | | REPORT TO: | | PROJECT INFORMATION: | | Laboratory Use Only: | |
|---|---|---|---|---|---|---|---|
| Company Name: | #1326 Golder Associates Ltd | Company Name: | | Quotation #: | B80683 | Maxxam Job #: | Bottle Order #: 709061 |
| Attention: | Accounts Payable | Attention: | David Marmor | P.O. #: | | | |
| Address: | 6925 Century Ave Suite 100 Mississauga ON L5N 7K2 | Address: | | Project: | 1662333 | COC #: C#709061-01-01 | Project Manager: Ema Gitej |
| Tel: | (905) 567-4444 Fax: (905) 567-6561 | Tel: | Fax: | Project Name: | | | |
| Email: | AP_CustomerService@golder.com | Email: | David_Marmor@golder.com | Site #: | | | |
| | | | | Sampled By: | | | |

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

**Regulation 153 (2011)**: Table 1 / Table 2 / Table 3 / Table __; Res/Park / Ind/Comm / Agri/Other; Medium/Fine / Coarse / For RSC

**Other Regulations**: CCME / Reg 558 / MISA / PWQO / Other; Sanitary Sewer Bylaw / Storm Sewer Bylaw / Municipality

**Special Instructions**

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

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

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

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

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

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

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

| * RELINQUISHED BY: (Signature/Print) | Date: (YY/MM/DD) | Time | RECEIVED BY: (Signature/Print) | Date: (YY/MM/DD) | Time | # jars used and not submitted |
|---|---|---|---|---|---|---|
| JANE PETER (Jane) | 2019/03/21 | 3:00pm | | 2019/03/21 | 16:07 | |

| Laboratory Use Only | | | |
|---|---|---|---|
| Time Sensitive | Temperature (°C) on Recei: 3/-4/-1 | Custody Seal | Yes / No |
| | | Present | ✓ |
| | | Intact | ✓ |

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

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

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

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

White: Maxxam Yellow: Client

golder.com