



October 11, 2018

## FOUNDATION INVESTIGATION REPORT

**STRUCTURAL BUNDLE - 11 STRUCTURES ON HIGHWAYS 129, 532 AND 556**

**HIGHWAY 532 - DAM CREEK CULVERTS REPLACEMENT, 0.15 KM NORTH OF HIGHWAY 556 (SITE NO. 38S-040C)**

**LAT. 46.751027° ; LONG. -84.067082°**

**HODGINS TOWNSHIP, ALGOMA DISTRICT, ONTARIO**

**MINISTRY OF TRANSPORTATION, ONTARIO**

**GWP 5378-11-00 ; WP 5261-13-01**

**Submitted to:**

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REPORT





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## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of the replacement of twin culverts on Highway 532 (Site No. 38S-040C) in the Hodgins Township, Algoma District, Ontario.

The purpose of the field investigation is to establish the subsurface conditions at the location of the proposed replacement culverts by methods of borehole drilling, in-situ testing and laboratory testing on selected soil samples.

This report summarizes the factual results of field and laboratory work (including field investigation procedures, borehole stratigraphy, and geotechnical and analytical laboratory test results) as well as a description of the interpreted soil and groundwater conditions at the Dam Creek culverts site.

The Terms of Reference and Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal dated May 2016 (Agreement No. 5016-E-0029) as well as change request letter dated April 24, 2018 which was approved by MTO on June 11, 2018 (Change Order No. CO-5016-E-0029-001). Golder's proposal for foundation engineering services is contained in Section 17.8 of AECOM's Technical Proposal for this assignment.

## 2.0 PROJECT AND SITE DESCRIPTION

### 2.1 Project Description

The existing twin culverts at the site convey the Dam Creek under Highway 532 in an east to west direction. The culverts were constructed in 1983, but there are no records of the culverts being rehabilitated since that time. It is understood that the existing culverts underwent a structural assessment in 2015 and were identified as being in poor structural condition with significant deterioration of several elements, including the culvert barrels and the structural steel coatings. The culverts are to be replaced with either a new single reinforced concrete box culvert or new twin Structural Plate Corrugated Steel Pipe (SPCSP) culverts.

### 2.2 Site Description

The site of the proposed twin culverts replacement is located about 0.15 km north of Highway 556 in the Hodgins Township, Algoma District, Ontario.

As noted above, the site consists of two culverts as follows:

- **Southern Culvert at about Station 13+096:** a Structural Plate Corrugated Steel Pipe (SPCSP) culvert with an approximately 2.40 m diameter and measuring about 18.5 m in length. It is understood that this is a secondary/overflow culvert that conveys Dam Creek under Highway 532 when the water level in the creek is high.
- **Northern Culvert at about Station 13+102:** a Structural Plate Corrugated Steel Pipe Arch (SPCSPA) culvert with an approximately 4.68 m span and 3.05 m rise and measuring about 18.9 m in length. This is the primary culvert that conveys Dam Creek under Highway 532.

The culverts are shown on Drawing 1 and on Photographs 1 to 3 (on the following page).

The Dam Creek at the location of the culverts is between approximately 10 m and 15 m wide and flows in a westerly direction. The downstream end of the Dam Creek flows into the Goulais River about 375 m southwest of the culverts.





Highway 532 at the location of the culverts consists of an approximately 5 m high earth fill embankment and carries one lane of traffic in each direction. The travelled portion of the highway consists of an asphalt surface which is at approximately Elevation 196 m in the vicinity of the existing culverts.



**Photograph 1:** Twin culverts at the Dam Creek site with Highway 532 above the culverts (looking southeast at the outlets)



**Photograph 2:** Outlet of the northern SPCSPA culvert on the west side of Highway 532 (looking southeast)



**Photograph 3:** Outlet of the southern SPCSP culvert on the west side of Highway 532 (looking east through the culvert)

An entrance to a residential dwelling and to a sand and gravel pit, owned by the Ontario Ministry of Transportation and Communications (as posted on a sign near the entrance to the pit), are located on the west side of Highway 532, approximately 50 m south and 60 m north of the existing culverts, respectively. Overhead electrical transmission lines run along the highway on the east side of Highway 532 (i.e., immediately east of the inlets). The overhead lines also cross the highway about 20 m north of the northern culvert.

The topography of the area in the immediate vicinity of the culverts is relatively flat to undulating, particularly on the west side of Highway 532, given that the site is located within the Goulais River valley. However, the natural ground surface rises significantly further east and west of the culverts. The presence of a ski resort near Searchmont, located about 3.5 km north of the site, is an indicator of the high relief and rugged topography. The natural ground surface in the immediate vicinity of the inlets and outlets of the existing culverts varies between about Elevations 191 m and 195 m. The site is vegetated with grasses and shrubs, as well as deciduous and coniferous trees.

### **3.0 FIELD INVESTIGATION PROCEDURES**

The fieldwork at the site of the culverts was carried out over eight days between August 15 and September 7, 2017, during which time six boreholes (designated as Boreholes DCC-01 to DCC-06) were advanced near the existing culverts. Boreholes DCC-01 to DCC-04 were advanced near the inlets and outlets of the existing culverts. These four boreholes were advanced in the creek in areas where: i) access was not restricted; ii) the drilling platform could be safely tied-off; iii) the creek bed was not covered with large cobbles/boulders, and; iv) the current in the creek was not too fast. Boreholes DCC-05 and DCC-06 were advanced through the Highway 532 embankment on the northbound lane (south of the southern culvert) and southbound lane (north of the northern



culvert), respectively. During a subsequent 2018 field investigation, approved as part of the change request, one borehole (designated as Borehole DCC-07) was advanced through the Highway 532 embankment on August 10, 2018. Borehole DCC-07 was advanced at the site to collect Shelby tube samples of the thick cohesive deposit encountered during the 2017 investigation in order to carry out laboratory consolidation testing on specimens of the cohesive samples. The test results were evaluated in order to confirm the geotechnical soil parameters estimated for the cohesive deposit.

The subsurface soil conditions encountered in the boreholes are shown in detail on the Records of Boreholes in Appendix A. Lists of abbreviations and symbols are also provided in Appendix A to assist in the interpretation of the borehole records. The locations of the as-drilled boreholes are shown in plan on Drawing 1.

The boreholes were advanced using portable drilling equipment and a drill rig. Boreholes DCC-01 to DCC-04 were advanced using portable drilling equipment set up on a drilling platform in the Dam Creek near the inlets and outlets of the culverts. The portable drilling equipment was supplied and operated by Ohlmann Geotechnical Services (OGS) Inc. of Almonte, Ontario. These four boreholes were advanced through the overburden using 'BW' casing with wash boring techniques. Boreholes DCC-05 to DCC-07 were advanced using a CME-75 truck-mounted drill rig supplied and operated by Landcore Drilling Inc. of Chelmsford, Ontario. Boreholes DCC-05 and DCC-06 were advanced through the upper portion of the embankment fill using 152 mm outer diameter, continuous flight, solid-stem augers and the remainder of the boreholes were advanced using 'NW' casing with wash boring techniques; while Borehole DCC-07 was advanced using 210 mm outer diameter, continuous flight, hollow-stem augers.

In the four boreholes advanced near the inlets and outlets of the culverts, the soil samples were generally obtained continuously immediately below the creek bed followed by sampling at intervals of depth of about 1.5 m; while in the two boreholes advanced on Highway 532 (i.e., Boreholes DCC-05 and DCC-06), the soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m. All soil samples were collected using a 50 mm outer diameter split-spoon sampler driven by a manual hammer (within Boreholes DCC-01 to DCC-04 advanced using the portable drilling equipment) or an automatic hammer (within Boreholes DCC-05 and DCC-06 advanced using the truck-mounted drill rig) in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*). Field vane shear tests were carried out in the cohesive soils for assessment of undrained shear strengths (ASTM D2573, *Standard Test Method for Field Vane Shear Strength Test in Cohesive Soil*) using MTO Standard 'N'-size vanes in the boreholes advanced using the drill rig and 'B'-size vanes in the smaller diameter boreholes advanced by portable equipment. Dynamic Cone Penetration Tests (DCPTs) were also carried out in Boreholes DCC-01 to DCC-06 following the soil sampling operation. In Borehole DCC-07, SPT was not carried out and three Shelby tube samples were collected in accordance with ASTM D1587, *Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes*.

The boreholes, including the DCPTs, were advanced to depths ranging between about 18.3 m and 21.9 m below existing ground or water surface.

All six boreholes were backfilled upon completion of drilling in accordance with Ontario Regulation 903 (Wells) (as amended).

Prior to commencement of field work, Golder arranged for the clearance of underground utilities/services. The field work was observed on a full-time basis by a member of Golder's engineering staff who monitored the drilling and sampling operations, and logged the boreholes in the field. The soil samples were transported to Golder's



Mississauga geotechnical laboratory where the samples underwent further visual/tactile examination and geotechnical laboratory testing.

Geotechnical index testing (i.e., water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. In addition, two (2) one-dimensional consolidation (i.e., Oedometer) tests were carried out on select specimens of the cohesive samples. The results of the geotechnical laboratory testing are summarized on the borehole records in Appendix A and the results of the geotechnical laboratory testing are provided in Appendix B. All of the laboratory tests were carried out in accordance with MTO Laboratory and/or ASTM Standards, as appropriate.

Two soil samples were also collected from Boreholes DCC-01 (advanced near the outlet of the southern culvert) and DCC-04 (advanced near the inlet of the northern culvert) for corrosivity testing. The selected soil samples were submitted, under chain-of-custody procedures, to Maxxam Analytics of Mississauga, Ontario (a Standards Council of Canada accredited laboratory) for analysis of a suite of corrosivity parameters including pH, sulphate, sulphide, chloride and resistivity/conductivity.

Temporary benchmarks were established and surveyed near the existing Dam Creek culverts by Callon Dietz Inc. prior to the drilling crews mobilizing to site. Upon completion of drilling operations, borehole offsets and corresponding ground surface elevation differences were recorded and tied-in to the surveyed benchmark locations to determine the as-drilled borehole locations and ground surface elevations. The borehole survey information, including northing and easting coordinates (presented in the MTM NAD83 Zone 13 and latitude/longitude coordinate systems) and the ground surface elevations (referenced to Geodetic datum), are provided on the borehole records in Appendix A, presented on Drawing 1, and summarized below.

Borehole No.	Approximate Location	Coordinates (MTM NAD83 Zone 13)		Ground / Water <sup>1</sup> Surface Elevation	Borehole Depth <sup>4</sup>
		Northing (Latitude)	Easting (Longitude)		
DCC-01	Outlet of southern culvert; west of Highway 532	5179049.1 m (46.750998°)	299655.7 m (-84.067337°)	191.5 m <sup>2</sup>	19.1 m <sup>5</sup>
DCC-02	Outlet of northern culvert; west of Highway 532	5179057.6 m (46.751074°)	299662.8 m (-84.067245°)	191.3 m <sup>2</sup>	19.2 m <sup>5</sup>
DCC-03	Inlet of southern culvert; east of Highway 532	5179041.7 m (46.750931°)	299689.5 m (-84.066895°)	191.9 m <sup>2</sup>	18.7 m <sup>5</sup>
DCC-04	Inlet of northern culvert; east of Highway 532	5179050.0 m (46.751006°)	299693.3 m (-84.066846°)	191.8 m <sup>2</sup>	18.3 m <sup>5</sup>
DCC-05	Northbound lane of Highway 532; south of southern culvert	5179038.8 m (46.750905°)	299673.0 m (-84.067112°)	196.3 m <sup>3</sup>	21.9 m
DCC-06	Southbound lane of Highway 532; north of northern culvert	5179063.3 m (46.751126°)	299675.1 m (-84.067084°)	196.0 m <sup>3</sup>	21.6 m
DCC-07	Southbound lane of Highway 532; north of northern culvert	5179057.0 m (46.751061°)	299672.7 m (-84.067111°)	196.1 m <sup>3</sup>	12.8 m

Notes:

1. Water surface refers to the top of the water in the Dam Creek at the time of the investigation.
2. Boreholes DCC-01 to DCC-04 were advanced using portable drilling equipment set up on a drilling platform in the Dam Creek near the inlets and outlets of the culverts.
3. Boreholes DCC-05 to DCC-07 were advanced using a truck-mounted drill rig through the Highway 532 embankment.
4. The borehole depth includes the DCPT carried out at the bottom of each open borehole.





Borehole No.	Approximate Location	Coordinates (MTM NAD83 Zone 13)		Ground / Water <sup>1</sup> Surface Elevation	Borehole Depth <sup>4</sup>
		Northing (Latitude)	Easting (Longitude)		

5. The termination depth of Boreholes DCC-01 to DCC-04 was measured from the water surface in the Dam Creek. The water depth in the creek at the time of drilling was measured at about 0.8 m, 0.9 m, 0.4 m and 0.6 m in the respective boreholes.

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain (NOEGTS)<sup>1</sup> mapping, the Dam Creek culverts site is located within a valley train consisting primarily of gravelly and sandy soils which “are mainly confined to the larger river valleys and usually occur as flat, terraced landforms” (McQuay, 1980). The granular deposits are variable in thickness and are generally underlain by varved silt and clay to glacial till and bedrock. The valley train is bordered by bedrock knobs.

Based on geological mapping developed by the Ontario Ministry of Northern Development and Mines (MNDM)<sup>2</sup>, the site is underlain by bedrock from the gneissic tonalite suite of rocks comprised of tonalite to granodiorite (foliated to gneissic) with minor supracrustal inclusions.

### 4.2 Overview of Local Subsurface Conditions

The subsurface soil and groundwater conditions encountered in the boreholes advanced at this site, together with the results of the in-situ and geotechnical/analytical laboratory testing, are presented on the borehole records (provided in Appendix A) and the laboratory test figures/sheets (provided in Appendices B and C). The results of the in-situ field tests (i.e., SPT ‘N’-values and field vane undrained shear strengths) as presented on the borehole records are uncorrected, and the ‘N’-values are based on SPT sampling procedures carried out with a manual hammer at the locations of Boreholes DCC-01 to DCC-04 and an automatic hammer at the locations of Boreholes DCC-05 and DCC-06. Borehole DCC-07 was advanced at the site to collect Shelby tube samples and SPT was not carried out.

The stratigraphic boundaries shown on the borehole records and on the soil strata profiles (i.e., Drawings 1 and 2) are inferred from observations of drilling progress, generally non-continuous sampling, and in-situ testing and therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions encountered at the Dam Creek culverts site consist of embankment fill (associated with Highway 532) or water (associated with the Dam Creek) underlain by an extensive deposit of varved silt to clayey silt and silty clay. In places, deposits of cobbles and boulders are present on the creek bed and a thin deposit of gravelly sand to gravel or clayey silt with sand or silty clay is found immediately below the creek bed.

<sup>1</sup> Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41KNE, Study Number 91.

<sup>2</sup> Ontario Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2544.



Detailed descriptions of the subsurface conditions encountered in the boreholes at this site are provided in the following subsections.

#### **4.2.1 Water**

Water was encountered above the creek bed in Boreholes DCC-01 to DCC-04 which were advanced in the Dam Creek near the inlets and outlets of the existing culverts. The water surface elevation and water depth at each borehole location is summarized below.

<b>Borehole Designation</b>	<b>Approximate Location</b>	<b>Water Surface Elevation</b>	<b>Approximate Water Depth</b>
DCC-01	About 9.4 m west of outlet of southern culvert	191.5 m	0.8 m
DCC-02	About 4.7 m west of outlet of northern culvert	191.3 m	0.9 m
DCC-03	About 6.7 m east of inlet of southern culvert	191.9 m	0.4 m
DCC-04	About 7.8 m east of inlet of northern culvert	191.8 m	0.6 m

As noted above, cobbles and boulders were observed on/above the creek bed near the inlets and outlets of culverts, especially at the smaller southern culvert (refer to Photograph 4 below).



**Photograph 4:** Cobbles and boulders at the outlet of the southern SPCSP culvert (looking west from top of Highway 532)

#### **4.2.2 Asphalt**

An approximately 40 mm thick layer of asphalt was encountered in Boreholes DCC-05 and DCC-06 which were advanced through the Highway 532 embankment on the northbound lane (south of the southern culvert) and southbound lane (north of the northern culvert), respectively. The top of the asphalt layer is at about Elevation 196.3 m and Elevation 196.0 m in the respective boreholes.





#### **4.2.3 Silty Sand to Gravelly Sand to Sand and Gravel (Fill) / Sandy Clayey Silt (Fill) / Sandy Organic Silt (Fill)**

An approximately 5.6 m thick layer of fill associated with the Highway 532 embankment was encountered below the asphalt in Boreholes DCC-05 and DCC-06. The fill is predominantly non-cohesive and is comprised of silty sand, some gravel, trace clay to gravelly sand, trace to some silt, trace clay to sand and gravel, trace to some silt, trace clay. However, an approximately 0.2 m thick layer of sandy organic silt and an approximately 0.6 m thick layer of sandy clayey silt, trace gravel was encountered interlayered within the non-cohesive fill at depths of about 2 m (corresponding to Elevation 194.3 m) and 0.8 m (corresponding to Elevation 195.2 m) below the existing ground surface in Boreholes DCC-05 and DCC-06, respectively. Clayey silt seams were encountered within the silty sand portion of the fill in Borehole DCC-05 between depths of about 3 m and 4.5 m below existing ground surface. Wood fragments and organics were encountered near the bottom portion of the embankment (i.e., at a depth of about 4.9 m below existing ground surface) in Borehole DCC-06. It is further noted that auger grinding was noted in Borehole DCC-06 between depths of about 2.7 m and 4.6 m below existing ground surface due to inferred cobbles. Difficulty with auger advancement was also encountered in the same borehole at a depth of about 5.2 m below existing ground surface due to presence of gravel and inferred cobbles.

The SPT 'N'-values measured within the non-cohesive portion of the fill range from 2 blows to 51 blows per 0.3 m of penetration, indicating a very loose to dense state of compactness. The lower SPT "N"-values (i.e., 8 blows or less) were encountered generally in the bottom half of the fill in Borehole DCC-05 and the very bottom of the fill in Borehole DCC-06. The SPT 'N'-value measured within the cohesive fill (i.e., the sandy clayey silt) is 20 blows per 0.3 m of penetration, suggesting a very stiff consistency.

The water content measured on eight samples of the non-cohesive fill ranges between approximately 3% and 17%. The water content measured on a sample of the sandy organic silt fill and the sandy clayey silt fill is approximately 30% and 16%, respectively.

The results of a grain size distribution test carried out on a sample recovered from the sandy clayey silt fill are shown on Figure B1 in Appendix B. An Atterberg limits test carried out on a sample of the cohesive fill measured a liquid limit of about 22%, a plastic limit of about 16%, and a corresponding plasticity index of about 6%. The results of this Atterberg limits test are shown on the plasticity chart on Figure B2 in Appendix B, and indicate that the material is classified as a clayey silt of low plasticity.

The results of a grain size distribution test carried out on a sample recovered from the sandy organic silt fill are shown on Figure B3 in Appendix B. An Atterberg limits test carried out on a sample of this fill layer measured a liquid limit of about 34%, a plastic limit of about 29%, and a corresponding plasticity index of about 5%. The results of this Atterberg limits test are shown on the plasticity chart on Figure B4 in Appendix B, and indicate that the fines portion of the material is classified as an organic silt.

The results of grain size distribution tests carried out on two samples recovered from the silty sand fill and gravelly sand fill are shown on Figures B5 and B6, respectively, in Appendix B. An Atterberg limits test was also carried out on a sample of the silty sand fill deposit, but the results indicate that the material is non-plastic.

#### **4.2.4 Gravelly Sand to Gravel**

An approximately 1.2 m thick granular deposit comprised of gravelly sand, trace silt to gravel, some sand, trace silt, trace organics was encountered at the creek bed in Borehole DCC-03. The top of this deposit is at about Elevation 191.5 m.



The SPT 'N'-values measured within this granular deposit are 3 blows and 6 blows per 0.3 m of penetration, indicating a very loose and loose state of compactness.

The water content measured on a sample of the gravelly sand portion of the granular deposit is approximately 20%.

#### 4.2.5 Clayey Silt with Sand to Silty Clay

A cohesive deposit of clayey silt with sand, some gravel to silty clay, some gravel, trace to some sand was encountered at the creek bed in Boreholes DCC-01 and DCC-04, respectively. In Borehole DCC-01 the deposit was encountered at about Elevation 190.7 m and is approximately 0.7 m thick. In Borehole DCC-04 the deposit was encountered at about Elevation 191.2 m and is approximately 0.6 m thick.

The SPT 'N'-values measured within the clayey silt with sand to silty clay deposit are 7 blows and 2 blows per 0.3 m of penetration, respectively, suggesting a firm and very soft to soft consistency.

The water contents measured on two samples of this deposit are about 39% and 42%.

The results of a grain size distribution test carried out on a sample of the clayey silt with sand portion of the cohesive deposit recovered from Borehole DCC-01 are shown on Figure B7 in Appendix B. The results of a grain size distribution test carried out on a sample of the silty clay portion of the cohesive deposit recovered from Borehole DCC-04 are shown on Figure B8 in Appendix B. An Atterberg limits test carried out on the sample recovered from Borehole DCC-04 measured a liquid limit of about 39%, a plastic limit of about 20%, and a corresponding plasticity index of about 19%. The results of this Atterberg limits test are shown on the plasticity chart on Figure B9 in Appendix B, and indicate that the material is classified as a silty clay of intermediate plasticity.

#### 4.2.6 Varved Silt to Clayey Silt and Silty Clay

An extensive varved deposit comprised of silt to clayey silt laminae and silty clay laminae was encountered below the clayey silt with sand deposit in Borehole DCC-01, at the creek bed in Borehole DCC-02, below the gravelly sand deposit in Borehole DCC-03, below the silty clay deposit in Borehole DCC-04, and below the embankment fill in Boreholes DCC-05 and DCC-06. The two types of laminae are shown on Photograph 4 (below).



**Photograph 5:** Silt to clayey silt laminae (light grey colour) and silty clay laminae (dark grey colour)



Additional photographs of the laminae (obtained from the three Shelby tube samples) are shown on Figure B10 in Appendix B. The top of the varved deposit ranges between about Elevations 190.7 m and 190.0 m. All six boreholes were terminated within this deposit between about Elevations 181.7 m and 180.2 m. The thickness of the sampled portion of the varved silt to clayey silt and silty clay deposit ranges from approximately 8.6 m to 10.3 m. DCPTs were also carried out at the bottom of each open borehole (i.e., below the last collected soil sample). The DCPTs were terminated at elevations ranging between about 174.4 m and 172.1 m. The blow counts at these elevations generally range between 25 blows and 100 blows per 0.3 m of penetration.

The SPT 'N'-values measured within the varved clayey deposit range between 1 blow and 8 blows per 0.3 m of penetration. In-situ vane tests carried out within this deposit measured undrained shear strength ranging from about 29 kPa to greater than 96 kPa. The measured (uncorrected) undrained shear strengths below the Highway 532 embankment are greater than 96 kPa, and generally range between about 52 kPa and 92 kPa near the inlets and outlets of the culverts. The sensitivity (defined as the quotient between the undisturbed shear strength and the remoulded shear strength) ranges between about 2 and 11, but typically varies from 2 to 5. The higher sensitivities (i.e., greater than 6) were recorded in Boreholes DCC-03 and DCC-04. The in-situ field vanes tests results indicate that the varved deposit has a predominantly stiff to very stiff consistency. However, given the presence of generally stronger/stiffer silt to clayey silt laminae, the measured undrained shear strengths may not be representative of the operative shear strength of the varved deposit or of the weaker silty clay laminae. In fact, the undrained shear strength of 29 kPa measured at the bottom of Borehole DCC-01, suggesting a firm consistency, may be more representative of the strength of the silty clay laminae.

The water content measured on 29 samples of this deposit ranges between about 40% and 49%.

The results of grain size distribution tests carried out on three samples of the silty clay laminae from the varved deposit are shown on Figure B11 in Appendix B. Atterberg limits tests were carried out on 19 samples of the clayey silt laminae and silty clay laminae of the varved deposit. The tests measured liquid limits between about 34% and 41%, plastic limits between about 20% and 24%, and plasticity indices between about 13% and 21%. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B12 in Appendix B, and indicate that the laminae are classified as clayey silt of low plasticity and silty clay of intermediate plasticity. The results also suggest that the laminae consist predominantly of silty clay, but this may not be a true representation of the overall varved deposit. The results can be attributed to the difficulty in separating the two types of laminae in a laboratory environment. The silt to clayey silt laminae, which were identified in the field and the laboratory based on tactile examination, may have been mixed with portions of the more plastic laminae, yielding Atterberg limits indicative of a cohesive material of intermediate plasticity.

Laboratory consolidation tests were also carried out on two specimens of the varved cohesive deposit obtained from the Shelby tube samples recovered from Borehole DCC-07. The preconsolidation stress was estimated for each specimen from the respective void ratio versus logarithmic pressure plot and from total work versus pressure plot. Details of the test results are shown on Figures B13 and B14 in Appendix B and the test results are summarized below.



Borehole/ Sample No.	Sample Depth (Elevation)	$\gamma$ (kN/m <sup>3</sup> ) (G <sub>s</sub> )	$\sigma'_{vo}$ (kPa)	$\sigma'_p$ (kPa)	$\sigma'_{vo} - \sigma'_p$ (kPa)	OCR	C <sub>c</sub>	C <sub>r</sub>	e <sub>o</sub>	c <sub>v</sub> <sup>1</sup> (cm <sup>2</sup> /s)
DCC-07 SA 1	6.4 m (189.7 m)	17.1 (2.75)	125	450	325	3.6	0.91	0.042	1.34	1.2 x 10 <sup>-2</sup>
DCC-07 SA 2	9.4 m (186.7 m)	17.1 (2.71)	145	490	345	3.3	0.72	0.038	2.56	1.3 x 10 <sup>-2</sup>

Note:

1. The coefficient of consolidation is based on a stress range between the existing in-situ effective overburden stress and the stress increase due to an up to about 5.5 m high embankment widening. The final stress is estimated to be less than the preconsolidation stress and within the over-consolidated stress range.

where:  $\gamma$  is the bulk unit weight in kN/m<sup>3</sup>

G<sub>s</sub> is the specific gravity

$\sigma'_{vo}$  is the effective overburden stress in kPa

$\sigma'_p$  is the preconsolidation stress in kPa

OCR is the overconsolidation ratio

C<sub>c</sub> is the compression index

C<sub>r</sub> is the recompression index

e<sub>o</sub> is the initial void ratio

c<sub>v</sub> is the coefficient of consolidation in cm<sup>2</sup>/s

### 4.3 Groundwater Conditions

Given the presence of the Dam Creek, the groundwater level is anticipated to be at or near the creek surface. The water level in Boreholes DCC-05 and DCC-06 (advanced from the top of the Highway 532 embankment) was not recorded due to introduction of drilling water at depths of about 4.6 m and 5.2 m below the asphalt surface, respectively, to accommodate wash boring techniques. However, above these depths, the boreholes were advanced using solid stem augers and the embankment fill was observed to be moist and no signs of water seepage were recorded.

The water level surveyed at the surface of the Dam Creek during the field investigation is summarized below.

Borehole Designation	Approximate Location	Water Surface Elevation	Date
DCC-01	About 9.4 m west of outlet of southern culvert	191.5 m	August 23, 2017
DCC-02	About 4.7 m west of outlet of northern culvert	191.3 m	August 16, 2017
DCC-03	About 6.7 m east of inlet of southern culvert	191.9 m	August 25, 2017
DCC-04	About 7.8 m east of inlet of northern culvert	191.8 m	August 26, 2017

The water level in the creek and the degree of saturation of the embankment fill (or the potential presence of a perched water table within the fill) is subject to seasonal fluctuations and precipitation events. Water levels in the creek and within the fill are expected to be higher during wet seasons and sustained periods of precipitation.

### 4.4 Analytical Testing of Soil

Two soil samples were selected from Boreholes DCC-01 (advanced near the outlet of the southern culvert) and DCC-04 (advanced near the inlet of the northern culvert) and submitted to Maxxam Analytics Ontario for corrosivity testing. The analytical laboratory test results are provided on the Certificates of Analysis presented in Appendix C, and summarized below.



Borehole Designation	Sample No.	Average Approx. Sample Depth <sup>2</sup> (m)	Average Approx. Sample Elevation (m)	Material Type	Resistivity (ohm-cm)	Conductivity (μohm/cm)	pH	Chloride (Cl) Content (ppm or μg/g)	Sulphate (SO <sub>4</sub> ) Content (ppm or μg/g)
DCC-01 <sup>1</sup>	SA 2	1.1	189.6	Varved Silt to Clayey Silt and Silty Clay	2,200	450	8.2	190	<20 <sup>3</sup>
DCC-04 <sup>1</sup>	SA 2	0.9	190.3		5,100	198	8.0	<20 <sup>3</sup>	39

Notes:

1. It is noted that corrosivity test results associated with soil samples recovered from boreholes that were advanced at other sites associated with this project are also presented on the Certificates of Analysis.
2. Sample depth measured from the bottom of the creek bed.
3. The sulphate and chloride concentrations measured on samples recovered from Boreholes DCC-01 and DCC-04, respectively, are below the reportable detection limit of 20 μg/g.

It is noted that the sulphide concentration measured on soil samples recovered from Boreholes DCC-01 and DCC-04 was also analyzed and is approximately 0.68 μg/g and 0.92 μg/g, respectively.

## 5.0 CLOSURE

The field work for this investigation was supervised by Ms. Alysha Kobylinski, B.A.Sc. and Ms. Amelia Jewison, B.A.Sc. The Foundation Investigation Report was prepared by Mr. Tomasz Zalucki, P.Eng., a geotechnical engineer with Golder. Mr. Paul Dittrich, P.Eng., a Principal and MTO Foundations Designated Contact for Golder, conducted an independent quality control review of the report.





## Report Signature Page

**GOLDER ASSOCIATES LTD.**



Tomasz Zalucki, P.Eng.  
Geotechnical Engineer



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

TZ/JPD/tz/rb

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[https://golderassociates.sharepoint.com/sites/14262g/deliverables/04-final fidr/dam creek culvert/1670846-07a-rpt-rev0-dam creek culverts final fir-20181011.docx](https://golderassociates.sharepoint.com/sites/14262g/deliverables/04-final%20fidr/dam%20creek%20culvert/1670846-07a-rpt-rev0-dam%20creek%20culverts%20final%20fir-20181011.docx)



## REFERENCES

McQuay, D.F. 1980. Sault Ste. Marie Area (NTS 41K/NE), District of Algoma; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 91, 21p. Accompanied by Maps 5012 and 5013, Scale 1:100000.

Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41KNE, Study Number 91.

Ontario Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2544.

### **ASTM International:**

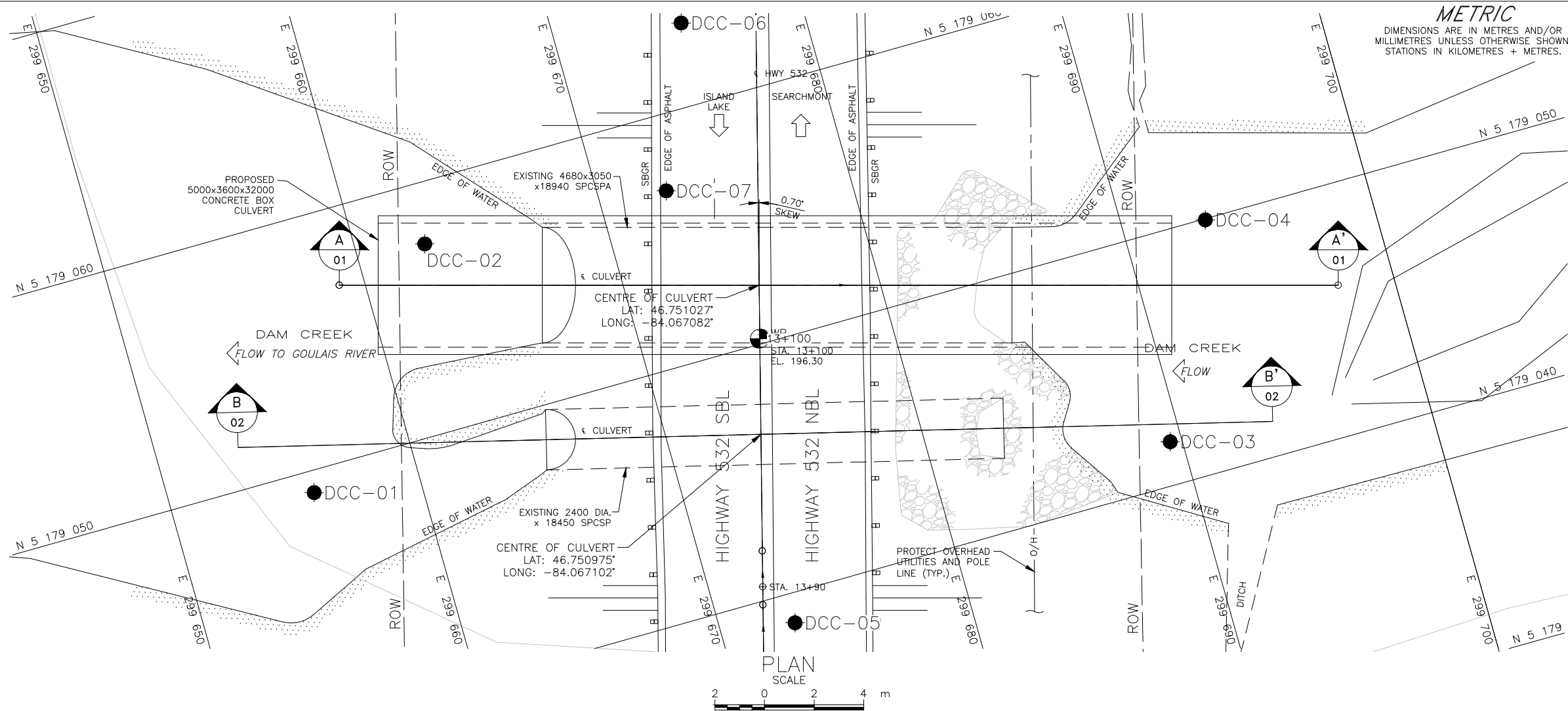
- |            |  |
|------------|--|
| ASTM D1586 | Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils      |
| ASTM D1587 | Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes. |
| ASTM D2573 | Standard Test Method for Field Vane Shear Strength Test in Cohesive Soil                         |

### **Ontario Regulations:**

R.R.O 1990, Regulation 903      Wells, under Ontario Water Resources Act, R.S.O. 1990, c. O.40



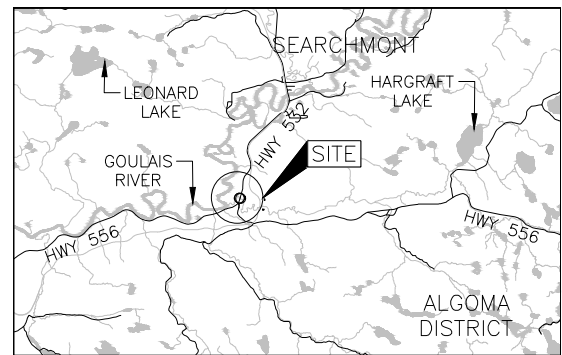
# DRAWINGS



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

CONT No.  
WP No.5261-13-01

HIGHWAY 532  
DAM CREEK CULVERTS  
BOREHOLE LOCATIONS AND  
SOIL STRATA



LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 13)

No.	ELEVATION	NORTHING	EASTING
DCC-01	191.5	5179049.1	299655.7
DCC-02	191.3	5179057.6	299662.8
DCC-03	191.9	5179041.7	299689.5
DCC-04	191.8	5179050.0	299693.3
DCC-05	196.3	5179038.8	299673.0
DCC-06	196.0	5179063.3	299675.1
DCC-07	196.1	5179057.0	299672.7



NOTES

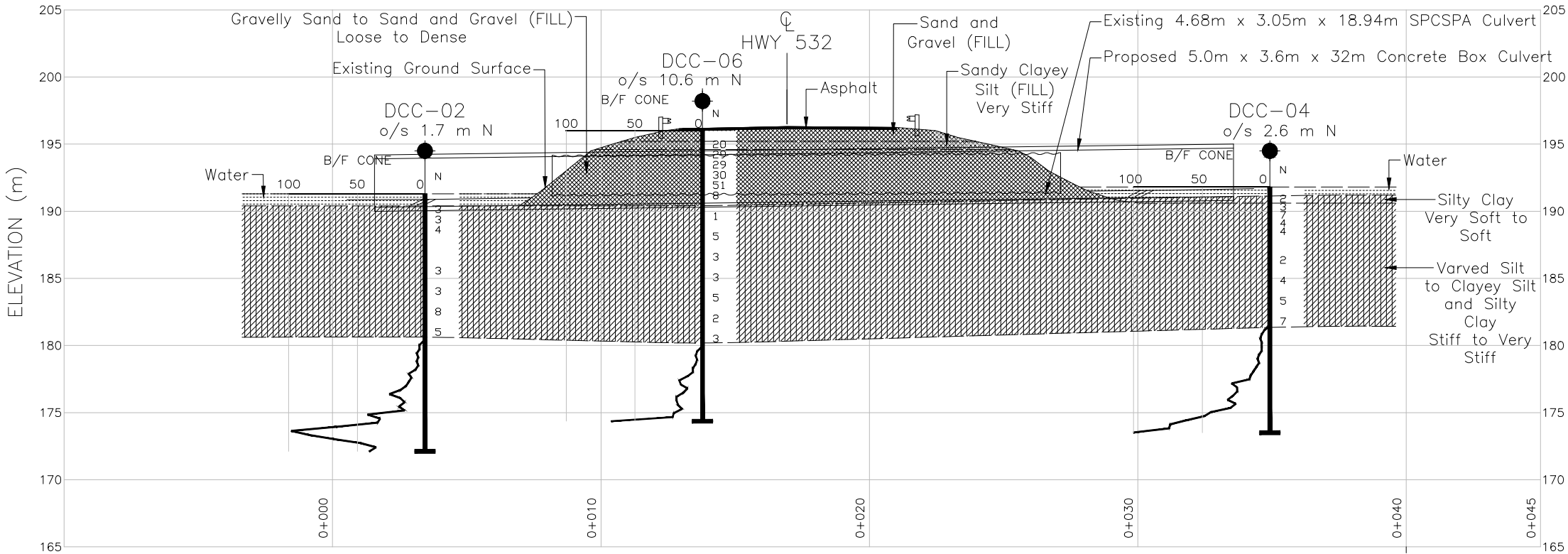
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 client, drawing file nos. 60546679-P90 GEOTECH.dwg, dated March, 2018, received March 19, 2018.

NO.	DATE	BY	REVISION
Geocres No. 41K-107			
HWY. 532	PROJECT NO. 1670846		DIST. ALGOMA
SUBM'D. TZ	CHKD. TZ	DATE: 9/28/2018	SITE: 38S-040C
DRAWN: SMD	CHKD. JPD	APPD. JPD	DWG. 01



HORIZONTAL SCALE  
2 0 2 4 m

A-A  
01  
CULVERT PROFILE

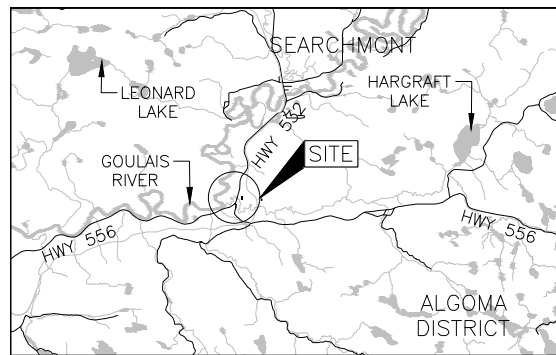
VERTICAL SCALE  
4 0 4 8 m

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

CONT No.  
WP No.5261-13-01

HIGHWAY 532  
DAM CREEK CULVERTS  
SOIL STRATA

SHEET



KEY PLAN  
SCALE  
2 0 2 4 km

LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 13)

No.	ELEVATION	NORTHING	EASTING
DCC-01	191.5	5179049.1	299655.7
DCC-03	191.9	5179041.7	299689.5
DCC-05	196.3	5179038.8	299673.0



NOTES

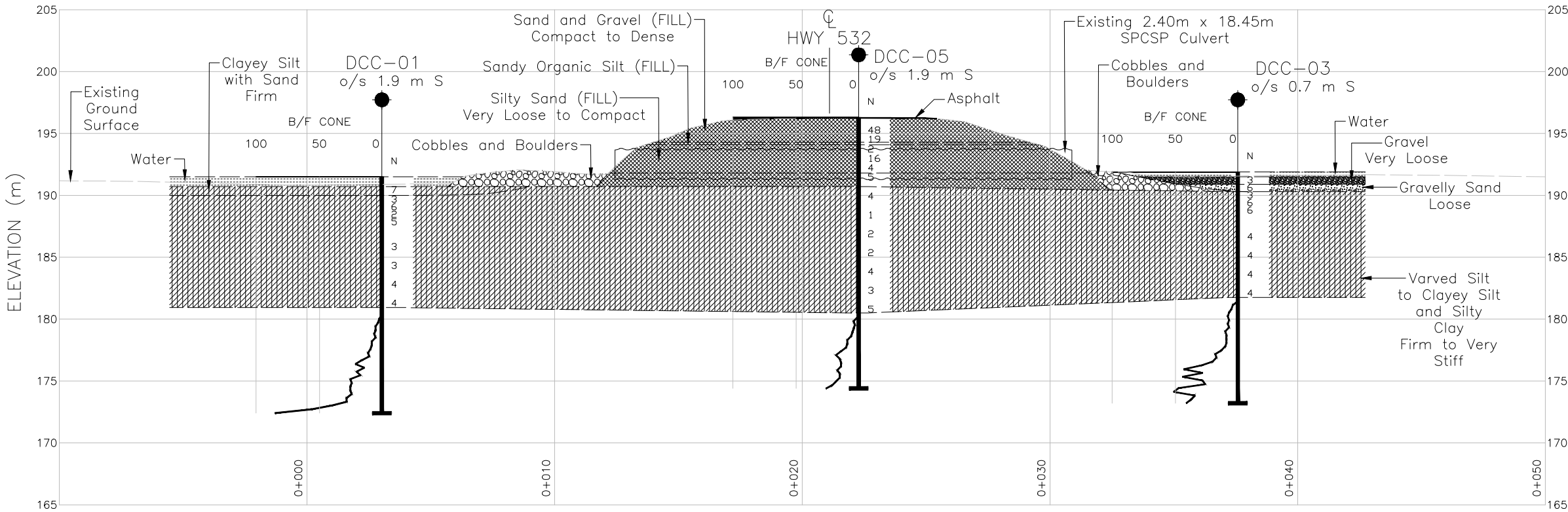
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 client, drawing file nos. Dam Creek\_Existing Culvert Section.dwg, dated March, 2018, received March 19, 2018.

NO.	DATE	BY	REVISION
Geocres No. 41K-107			
HWY. 532		PROJECT NO. 1670846	
SUBM'D. TZ		DIST. ALGOMA	
DRAWN: SMD		DATE: 9/28/2018	
		SITE: 38S-040C	
		DWG. 02	



HORIZONTAL SCALE  
2 0 2 4 m

B-B CULVERT PROFILE  
01

VERTICAL SCALE  
4 0 4 8 m





# APPENDIX A

## Records of Borehole Sheets



## 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
$\nu$	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

<b>(a)</b>	<b>Index Properties</b>
$\rho(\gamma)$	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

### (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

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

Notes: 1  
2

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

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



## 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, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> 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

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	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 <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
$D_R$	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 <sub>4</sub>	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 Silty Clay with sand / Clayey Silt with sand

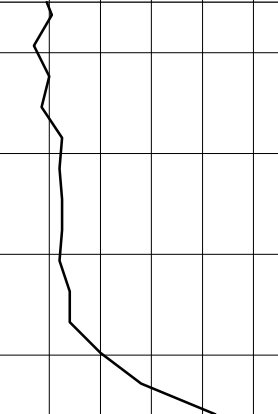
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G.W.P. 5261-13-01		LOCATION N 5179049.1; E 299655.7 MTM NAD 83 ZONE 13 (LAT. 46.750998; LONG. -84.067337)		ORIGINATED BY AJ			
DIST ALGOMA HWY 556		BOREHOLE TYPE Portable Equipment - Wash Boring; BW Casing		COMPILED BY AK			
DATUM Geodetic		DATE August 23, 2017		CHECKED BY TZ			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
191.5 0.0	WATER SURFACE WATER													
190.7 0.8	CLAYEY SILT with SAND, some gravel Firm Grey Wet		1	SS	7									12 46 32 10
190.0 1.5	Varved SILT to CLAYEY SILT and SILTY CLAY, trace sand Firm to stiff Grey Wet		2	SS	3									
			3	SS	6									
			4	SS	2									
			5	SS	5									
			6	SS	3									
			7	SS	3									
			8	SS	4									
			9	SS	4									
180.9 10.6	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTOS\SAULT\_STE\_MARIE\GPJ GAL-GTA.GDT 28/9/18

PROJECT <u>1670846</u>		<b>RECORD OF BOREHOLE No DCC-01</b>				SHEET 2 OF 2		<b>METRIC</b>												
G.W.P. <u>5261-13-01</u>		LOCATION <u>N 5179049.1; E 299655.7 MTM NAD 83 ZONE 13 (LAT. 46.750998; LONG. -84.067337)</u>				ORIGINATED BY <u>AJ</u>														
DIST <u>ALGOMA</u> HWY <u>556</u>		BOREHOLE TYPE <u>Portable Equipment - Wash Boring; BW Casing</u>				COMPILED BY <u>AK</u>														
DATUM <u>Geodetic</u>		DATE <u>August 23, 2017</u>				CHECKED BY <u>TZ</u>														
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa												
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED</span> <span>+ FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between;"> <span>● QUICK TRIAXIAL</span> <span>× REMOULDED</span> </div>													
172.4	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)					176														
175						175														
174						174														
173						173														
19.1	END OF DCPT  NOTE:  1. Borehole DCC-01 advanced in Dam Creek near the outlet (west side of Highway 532) of the existing southern culvert.																			

GTA-MTO 001 S:\CLIENTS\MTOS\SAULT\_STE\_MARIE\02\_DATA\GINT\SAULT\_STE\_MARIE.GPJ GAL-GTA.GDT 28/9/18

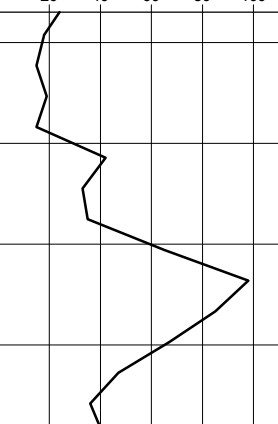


PROJECT		1670846		<b>RECORD OF BOREHOLE No DCC-02</b>		SHEET 1 OF 2		<b>METRIC</b>					
G.W.P.		5261-13-01		LOCATION		N 5179057.6; E 299662.8 MTM NAD 83 ZONE 13 (LAT. 46.751074; LONG. -84.067245)		ORIGINATED BY					
DIST		ALGOMA HWY 556		BOREHOLE TYPE		Portable Equipment - Wash Boring; BW Casing		COMPILED BY					
DATUM		Geodetic		DATE		August 15 and 16, 2017		CHECKED BY					
TZ													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	W <sub>p</sub> W W <sub>L</sub>			
191.3 0.0	WATER SURFACE WATER						191						
190.4 0.9	Varved SILT to CLAYEY SILT and SILTY CLAY, trace sand Stiff Grey Wet		1	SS	3		190						
			2	SS	3								
			3	SS	4		189						
							188						
							187						
			4	SS	3		186						
							185						
			5	SS	3		184						
							183						
			6	SS	8		182						
							181						
180.6 10.7	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)		7	SS	5		180						
							179						
							178						
							177						

Continued Next Page

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

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PROJECT		1670846		<b>RECORD OF BOREHOLE No DCC-02</b>				SHEET 2 OF 2		<b>METRIC</b>				
G.W.P.		5261-13-01		LOCATION		N 5179057.6; E 299662.8 MTM NAD 83 ZONE 13 (LAT. 46.751074; LONG. -84.067245)				ORIGINATED BY		AK		
DIST		ALGOMA HWY 556		BOREHOLE TYPE		Portable Equipment - Wash Boring; BW Casing				COMPILED BY		AK		
DATUM		Geodetic		DATE		August 15 and 16, 2017				CHECKED BY		TZ		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	--- CONTINUED FROM PREVIOUS PAGE ---							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		WATER CONTENT (%)				
	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)						176							
172.1	END OF DCPT						173							
19.2	NOTES:  1. Borehole DCC-02 advanced in Dam Creek near the outlet (west side of Highway 532) of the existing northern culvert.  2. Samples 1 to 3 were collected with a split-spoon sampler driven by a 50 lbs manual hammer. SPT N- values shown here have been adjusted to reflect values that would be obtained with a standard weight hammer.													

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

PROJECT 1670846		RECORD OF BOREHOLE No DCC-03				SHEET 2 OF 2		METRIC					
G.W.P. 5261-13-01		LOCATION N 5179041.7; E 299689.5 MTM NAD 83 ZONE 13 (LAT. 46.750931; LONG. -84.066895)				ORIGINATED BY AJ							
DIST ALGOMA HWY 556		BOREHOLE TYPE Portable Equipment - Wash Boring; BW Casing				COMPILED BY AK							
DATUM Geodetic		DATE August 25, 2017				CHECKED BY TZ							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	20 40 60					
173.2	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)					176							
						175							
						174							
18.7	END OF DCPT  NOTE: 1. Borehole DCC-03 advanced in Dam Creek near inlet (east side of Highway 532) of the existing southern culvert.												

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<b>PROJECT</b> 1670846		<b>RECORD OF BOREHOLE No DCC-04</b>		SHEET 1 OF 2		<b>METRIC</b>	
G.W.P. 5261-13-01		LOCATION N 5179050.0; E 299693.3 MTM NAD 83 ZONE 13 (LAT. 46.751006; LONG. -84.066846)		ORIGINATED BY AJ			
DIST ALGOMA HWY 556		BOREHOLE TYPE Portable Equipment - Wash Boring; BW Casing		COMPILED BY AK			
DATUM Geodetic		DATE August 26, 2017		CHECKED BY TZ			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
191.8	WATER SURFACE													
0.0	WATER													
191.2														
0.6	SILTY CLAY, some gravel, trace to some sand Very soft to soft Grey Wet		1	SS	2		191							13 11 50 26
190.6			2	SS	3									
1.2	Varved SILT to CLAYEY SILT and SILTY CLAY, trace to some gravel, trace to some sand Stiff Grey Wet		3	SS	7		190							
			4	SS	4		189							12 11 50 27
			5	SS	4									
							188							
			6	SS	2		187							
							186							
			7	SS	4		185							
							184							
			8	SS	5		183							
			9	SS	7		182							
181.4														
10.4	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)						181							
							180							
							179							
							178							
							177							

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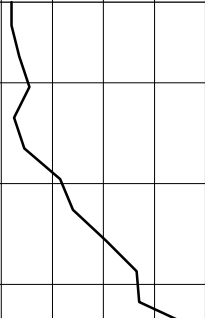
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

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PROJECT <u>1670846</u>		<b>RECORD OF BOREHOLE No DCC-04</b>				SHEET 2 OF 2		<b>METRIC</b>	
G.W.P. <u>5261-13-01</u>		LOCATION <u>N 5179050.0; E 299693.3 MTM NAD 83 ZONE 13 (LAT. 46.751006; LONG. -84.066846)</u>				ORIGINATED BY <u>AJ</u>			
DIST <u>ALGOMA</u> HWY <u>556</u>		BOREHOLE TYPE <u>Portable Equipment - Wash Boring; BW Casing</u>				COMPILED BY <u>AK</u>			
DATUM <u>Geodetic</u>		DATE <u>August 26, 2017</u>				CHECKED BY <u>TZ</u>			

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W <sub>p</sub>	W		
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between; border-bottom: 1px solid black; margin-bottom: 5px;"> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between; border-bottom: 1px solid black; margin-bottom: 5px;"> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> <span>○ UNCONFINED</span> <span>+ FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> <span>● QUICK TRIAXIAL</span> <span>× REMOULDED</span> </div>						
173.5	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)					176							
18.3	END OF DCPT					175							
	NOTE:  1. Borehole DCC-04 advanced on Dam Creek near the inlet (east side of Highway 532) of the existing northern culvert.					174							


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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

PROJECT		RECORD OF BOREHOLE				No DCC-05		SHEET 2 OF 2		METRIC						
G.W.P. 5261-13-01		LOCATION		N 5179038.8; E 299673.0 MTM NAD 83 ZONE 13 (LAT. 46.750905; LONG. -84.067112)				ORIGINATED BY AJ								
DIST ALGOMA HWY 556		BOREHOLE TYPE		152mm O.D. Solid Stem Augers; Wash Boring; NW Casing				COMPILED BY AK								
DATUM Geodetic		DATE		September 6, 2017				CHECKED BY TZ								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100			W <sub>p</sub>	W
180.5	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)		13	SS	5		181									
15.8								180								
								179								
								178								
								177								
							176									
							175									
174.4	END OF DCPT															
21.9	NOTES:  1. Borehole DCC-05 was advanced on the northbound lane of Highway 532 to the south of the existing culverts.  2. Drilling water introduced into borehole at a depth of about 4.6 m below ground surface as part of wash boring method to advance the borehole. Consequently, the water level was not recorded in the open borehole upon completion of drilling.															

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

PROJECT		1670846		<b>RECORD OF BOREHOLE No DCC-06</b>				SHEET 2 OF 2		<b>METRIC</b>			
G.W.P.		5261-13-01		LOCATION		N 5179063.3; E 299675.1 MTM NAD 83 ZONE 13 (LAT. 46.751126; LONG. -84.067084)				ORIGINATED BY		AJ	
DIST		ALGOMA HWY 556		BOREHOLE TYPE		152mm O.D. Solid Stem Augers; Wash Boring; NW Casing				COMPILED BY		AK	
DATUM		Geodetic		DATE		September 6 and 7, 2017				CHECKED BY		TZ	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)		
180.2	END OF BOREHOLE		13	SS	3		180						
15.9	Dynamic Core Penetration Test (DCPT)						179						
							178						
							177						
							176						
							175						
174.4	END OF DCPT												
21.6	NOTES:												
	1. Borehole DCC-06 was advanced on the southbound lane of Highway 532 to north of the existing culverts.												
	2. Drilling water introduced into borehole at a depth of about 5.2 m below ground surface as part of wash boring method to advance the borehole. Consequently, the water level was not recorded in the open borehole upon completion of drilling.												





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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

PROJECT <u>1670846</u>		<b>RECORD OF BOREHOLE No DCC-07</b>		SHEET 2 OF 2		<b>METRIC</b>	
G.W.P. <u>5261-13-01</u>		LOCATION <u>N 5179057.0; E 299672.7 MTM NAD 83 ZONE 13 (LAT. 46.751061; LONG. -84.067111)</u>		ORIGINATED BY <u>LS</u>			
DIST <u>ALGOMA</u> HWY <u>556</u>		BOREHOLE TYPE <u>210 mm O.D. Continuous Flight, Hollow Stem Augers</u>		COMPILED BY <u>TZ</u>			
DATUM <u>Geodetic</u>		DATE <u>August 10, 2018</u>		CHECKED BY <u>TZ</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>						
	2. The stratigraphic profile was inferred based on adjacent sampled boreholes, observations of soil cuttings generated during borehole advancement, and extruded Shelby tube samples.																				

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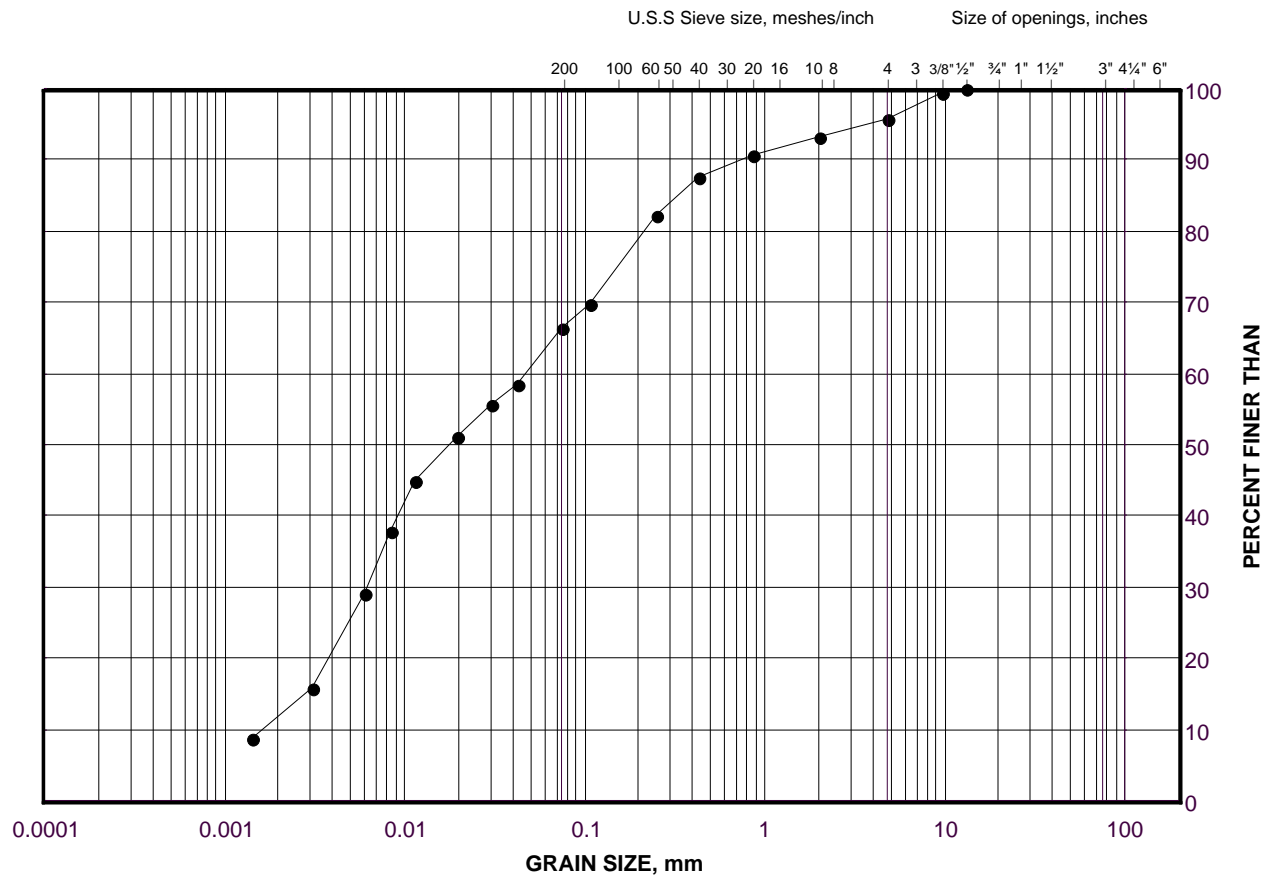
# APPENDIX B

## Geotechnical Laboratory Test Results

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Fill)

FIGURE B1



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

## LEGEND

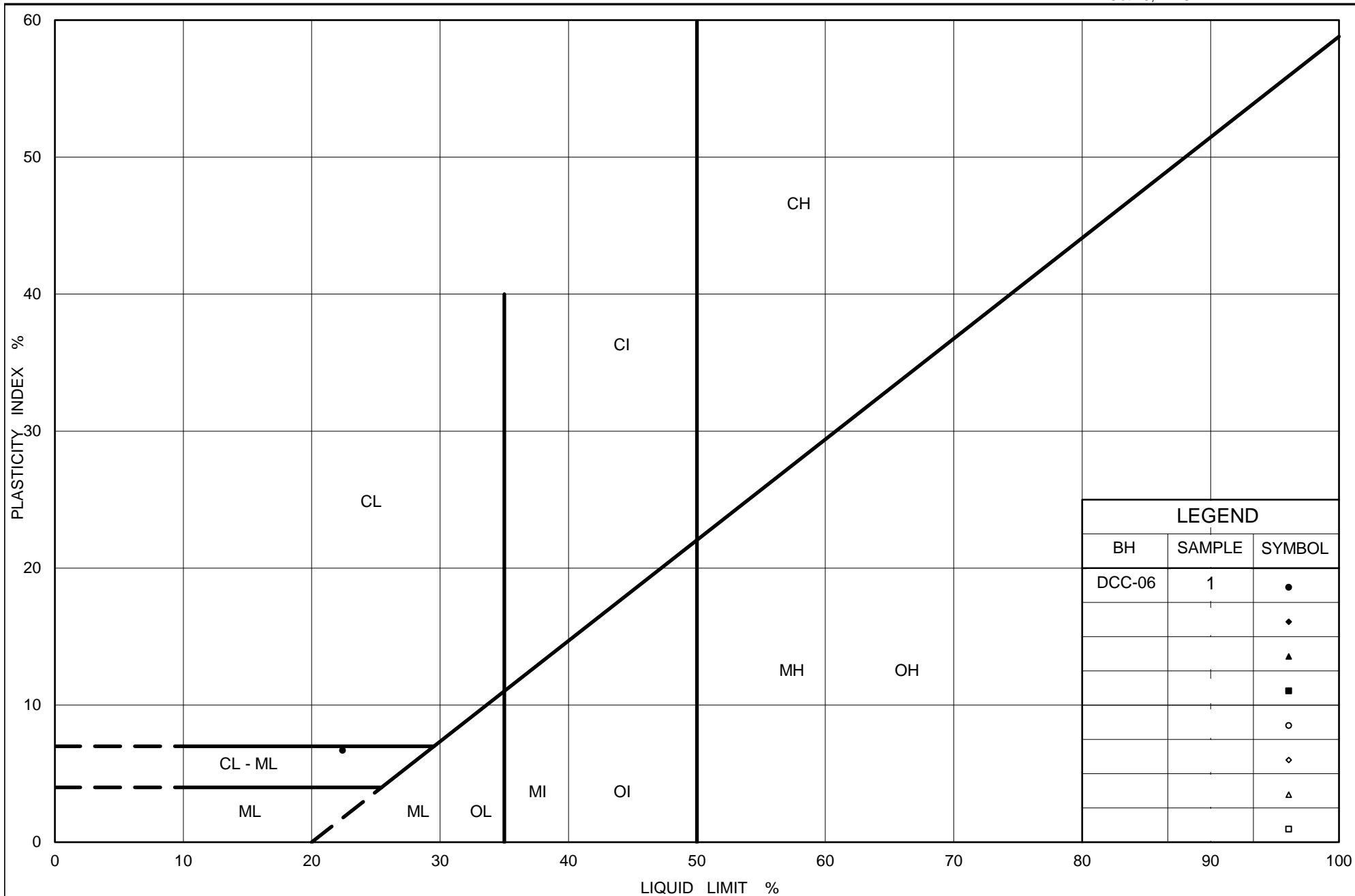
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	DCC-06	1	194.9

Project Number: 1670846

Checked By: TZ

**Golder Associates**

Date: 27-Mar-18



Ministry of Transportation

Ontario

## PLASTICITY CHART

### Sandy Clayey Silt (Fill)

Figure No. B2

Project No. 1670846

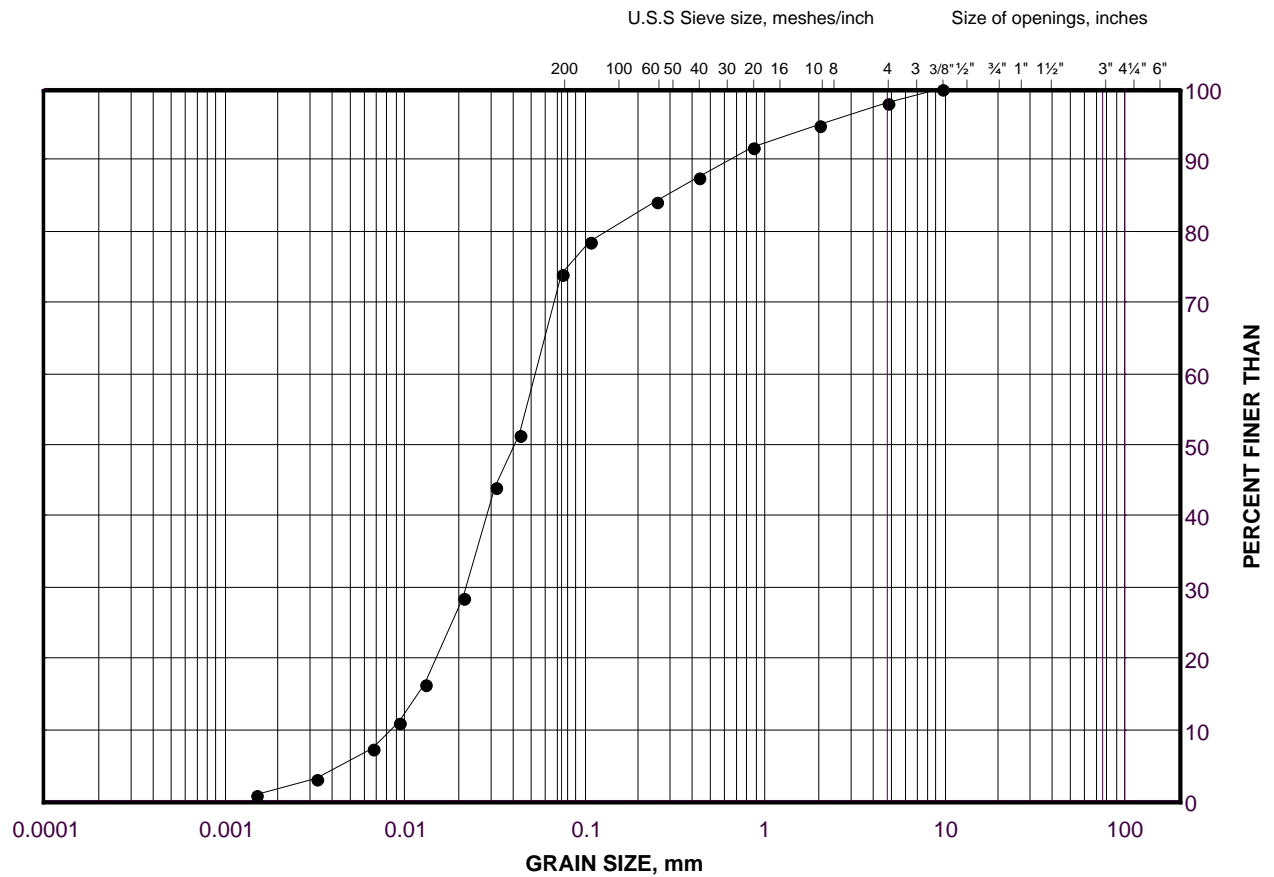
Checked By: TZ



# GRAIN SIZE DISTRIBUTION

Sandy Organic Silt (Fill)

FIGURE B3



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

## LEGEND

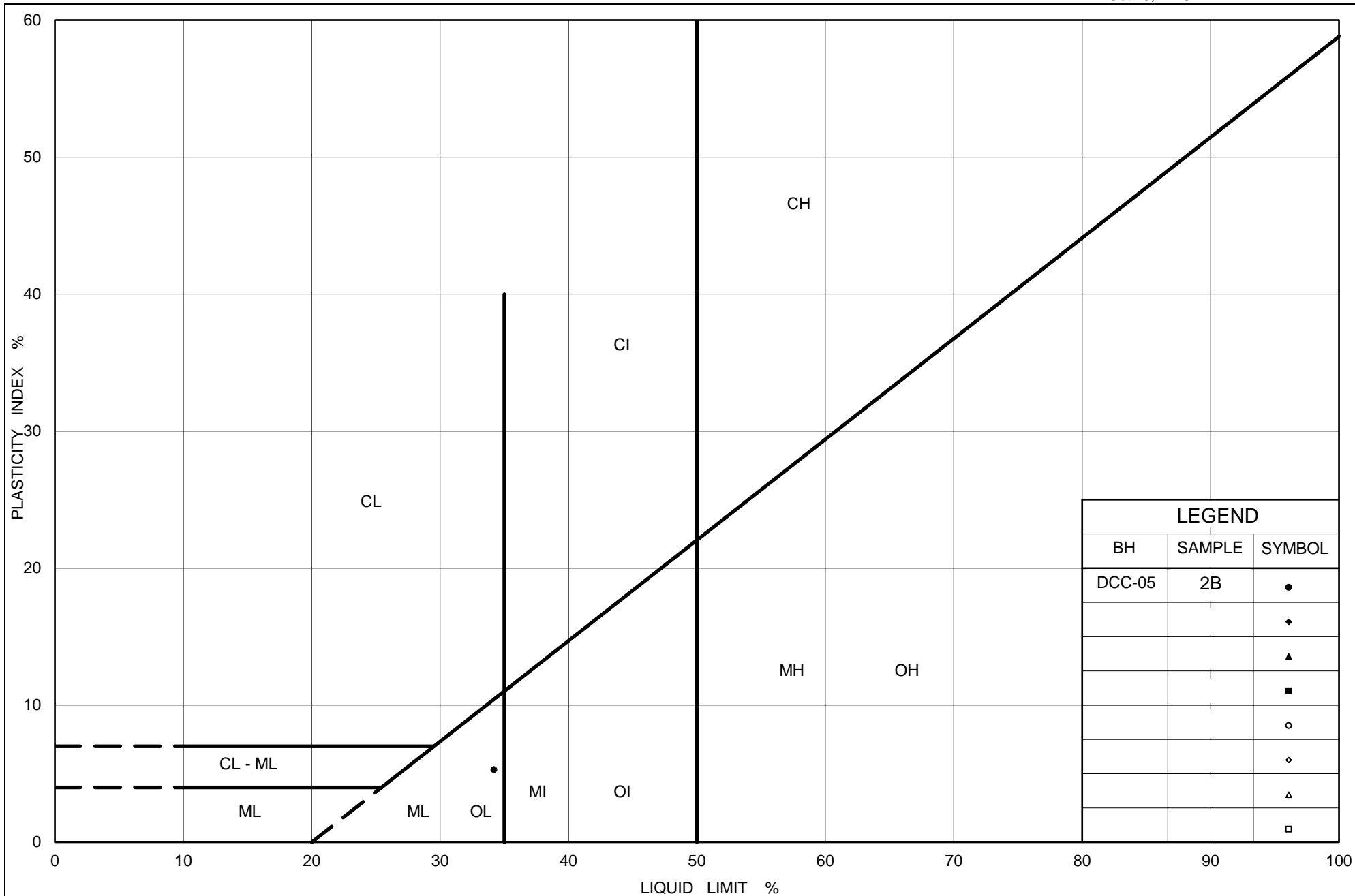
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	DCC-05	2B	194.2

Project Number: 1670846

Checked By: TZ

**Golder Associates**

Date: 27-Mar-18



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# PLASTICITY CHART Organic Silt (Fines Portion) (Fill)

Figure No. B4

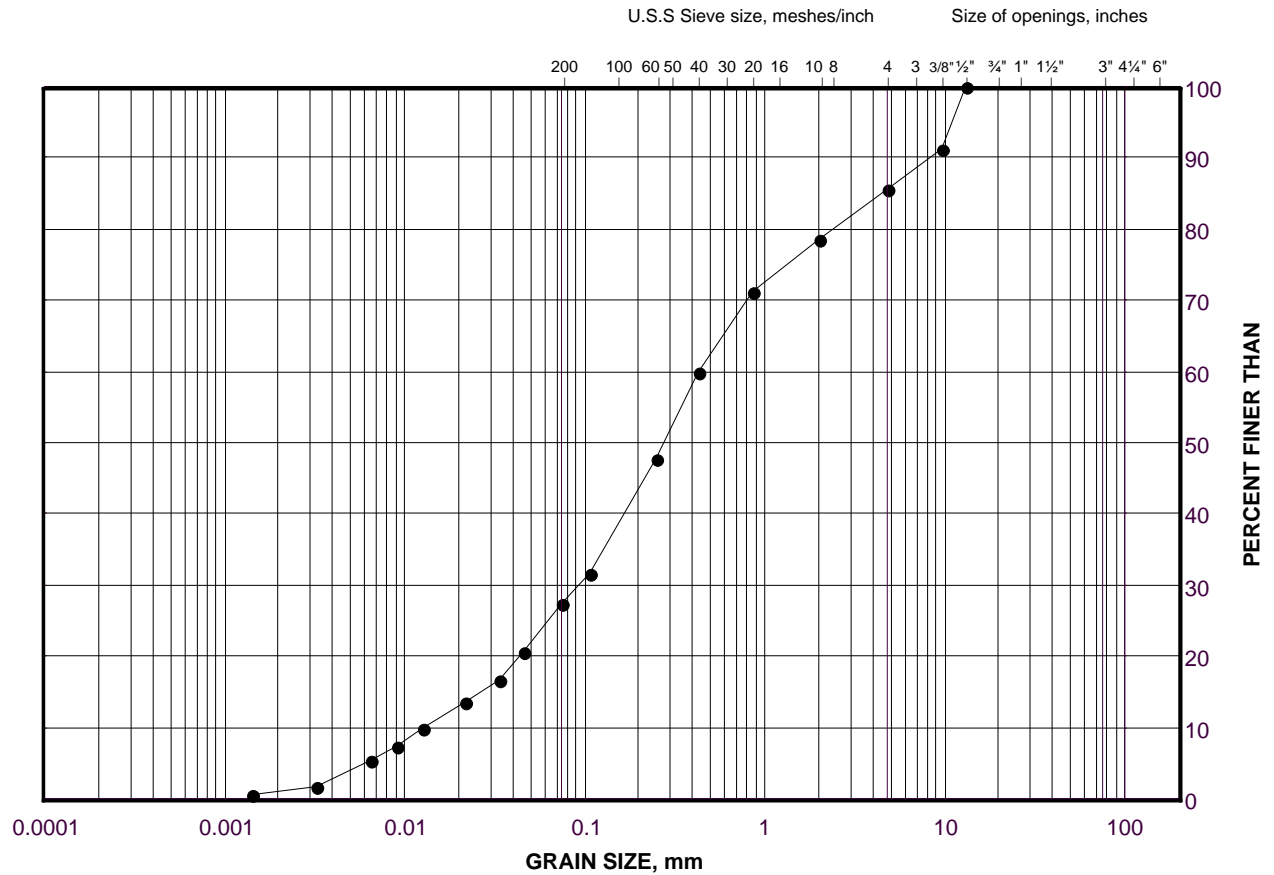
Project No. 1670846

Checked By: TZ

# GRAIN SIZE DISTRIBUTION

Silty Sand (Fill)

FIGURE B5



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	DCC-05	4	192.9

Project Number: 1670846

Checked By: TZ

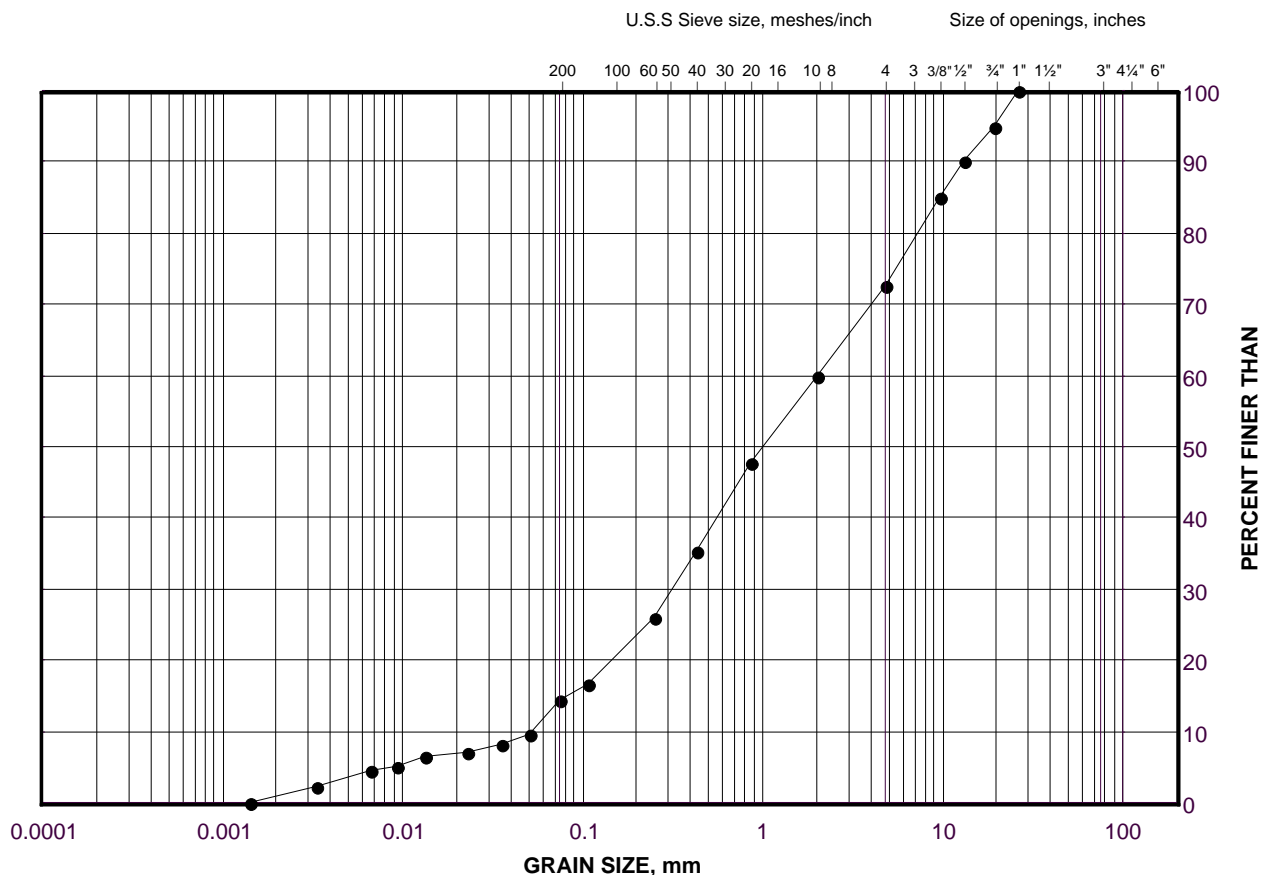
**Golder Associates**

Date: 27-Mar-18

# GRAIN SIZE DISTRIBUTION

Gravelly Sand (Fill)

FIGURE B6



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	DCC-06	4	192.7

Project Number: 1670846

Checked By: TZ

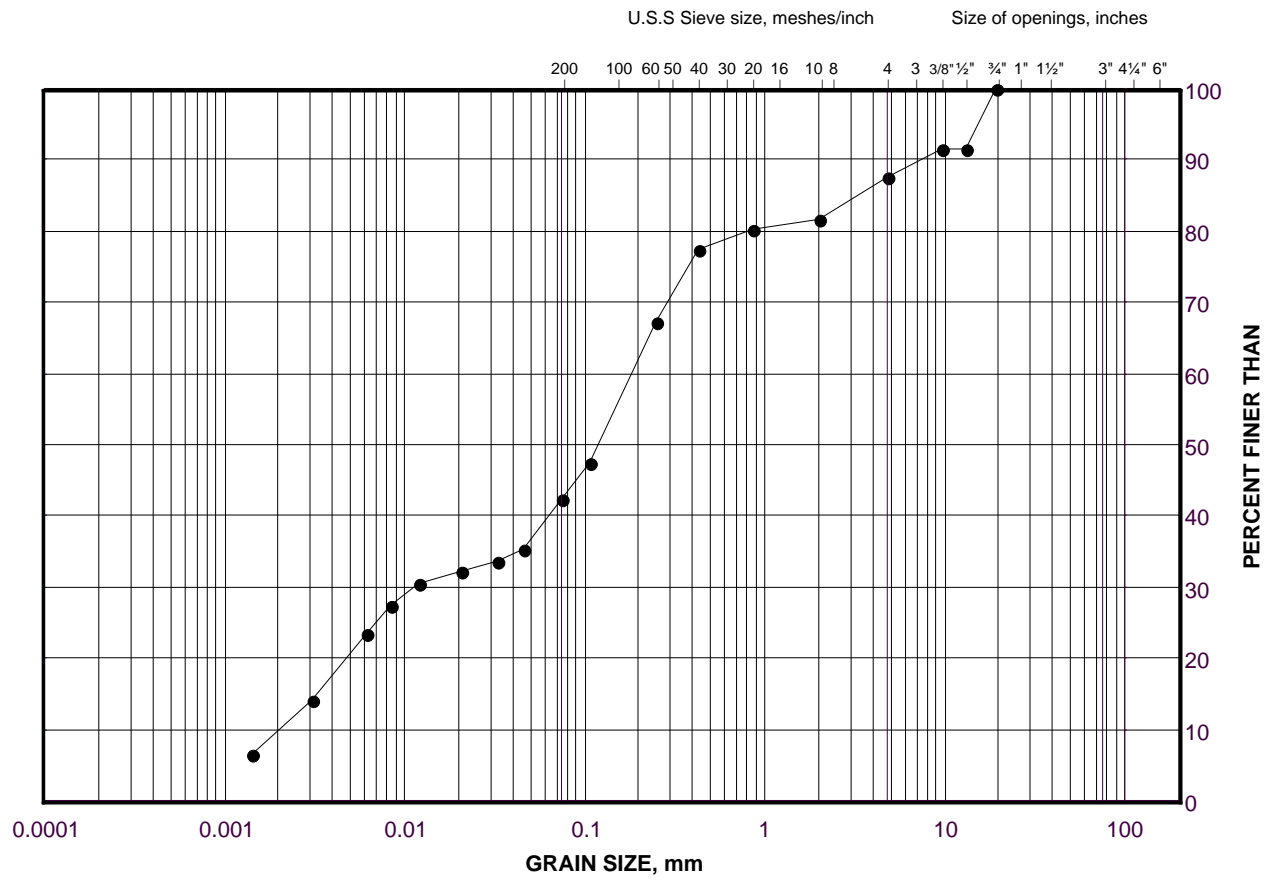
**Golder Associates**

Date: 27-Mar-18

# GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand

FIGURE B7



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	DCC-01	1	190.4

Project Number: 1670846

Checked By: TZ

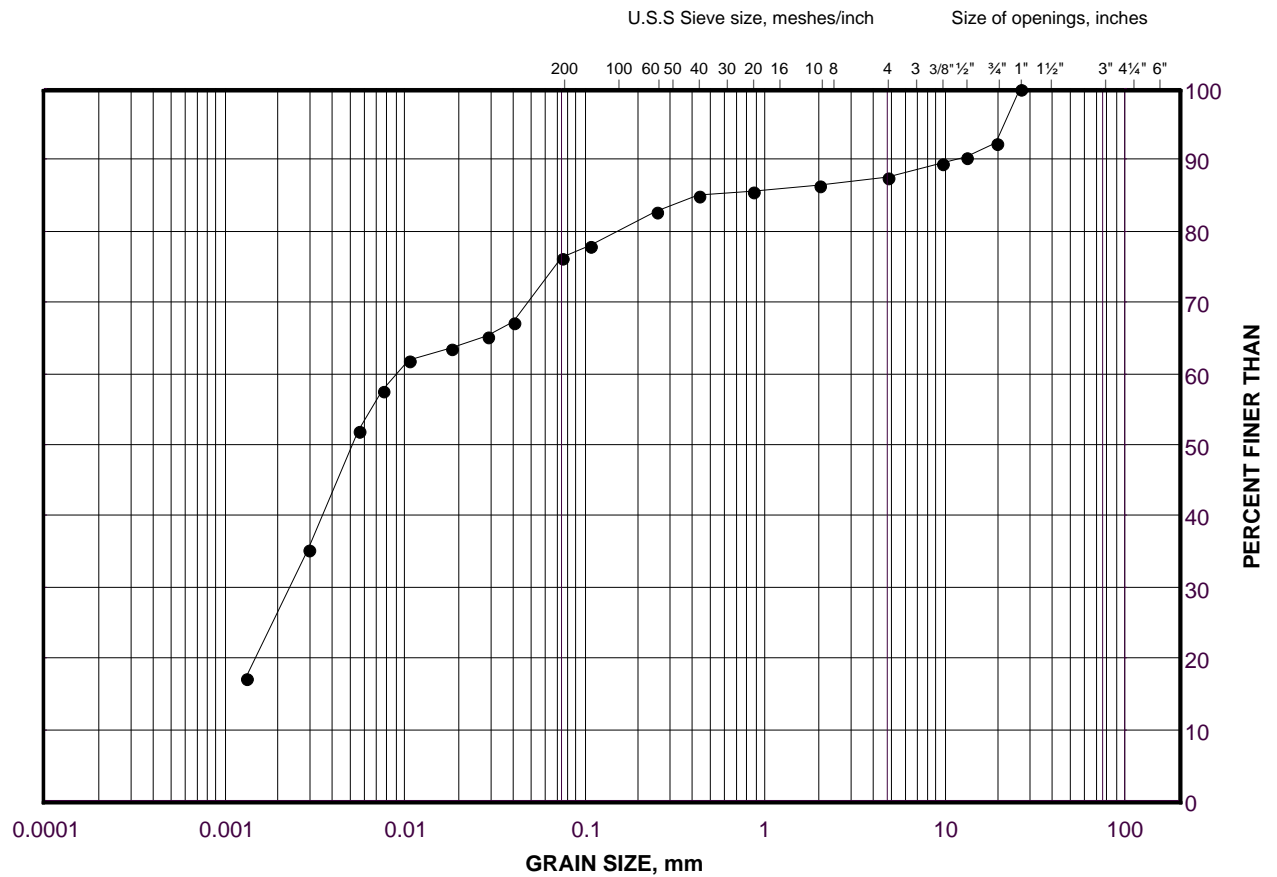
**Golder Associates**

Date: 27-Mar-18

# GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE B8



## LEGEND

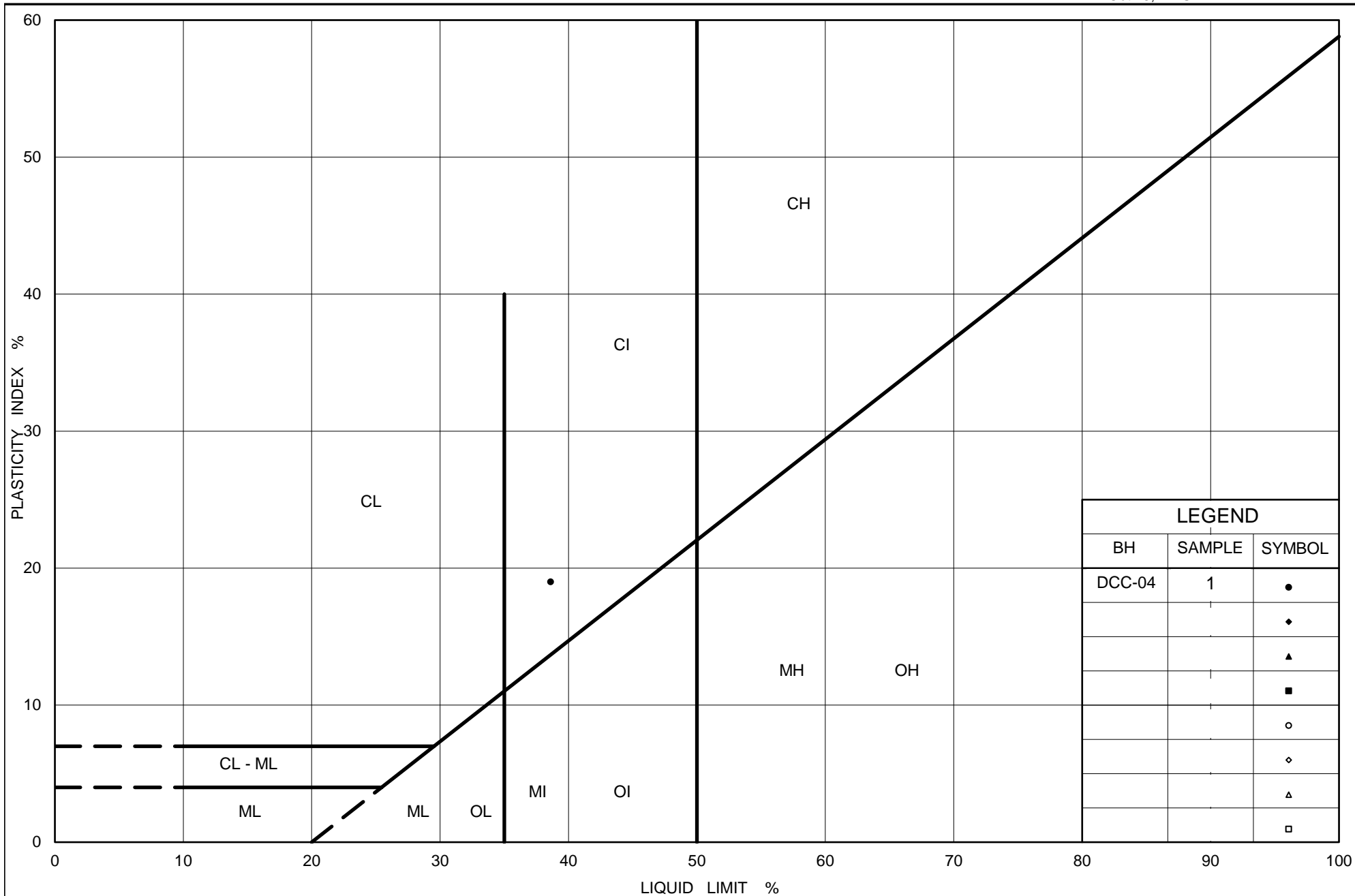
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
•	DCC-04	1	190.9

Project Number: 1670846

Checked By: \_\_\_\_\_

**Golder Associates**

Date: 13-Apr-18



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## PLASTICITY CHART Silty Clay

Figure No. B9

Project No. 1670846

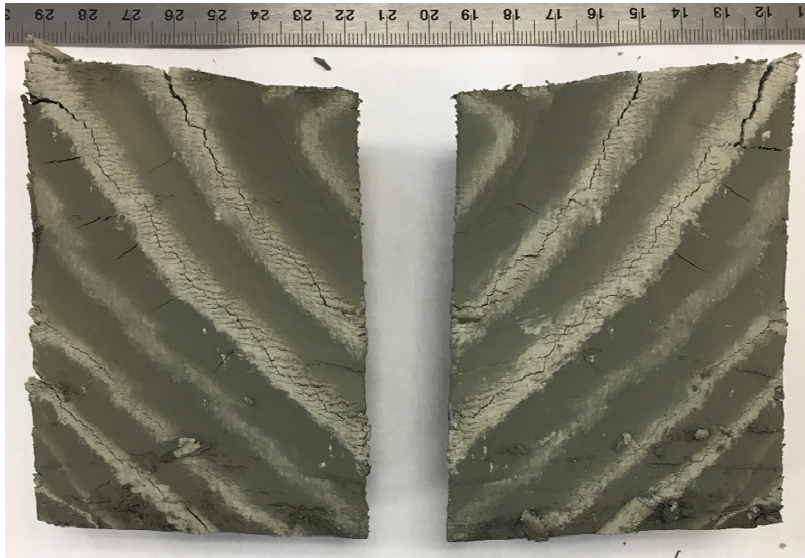
Checked By: TZ



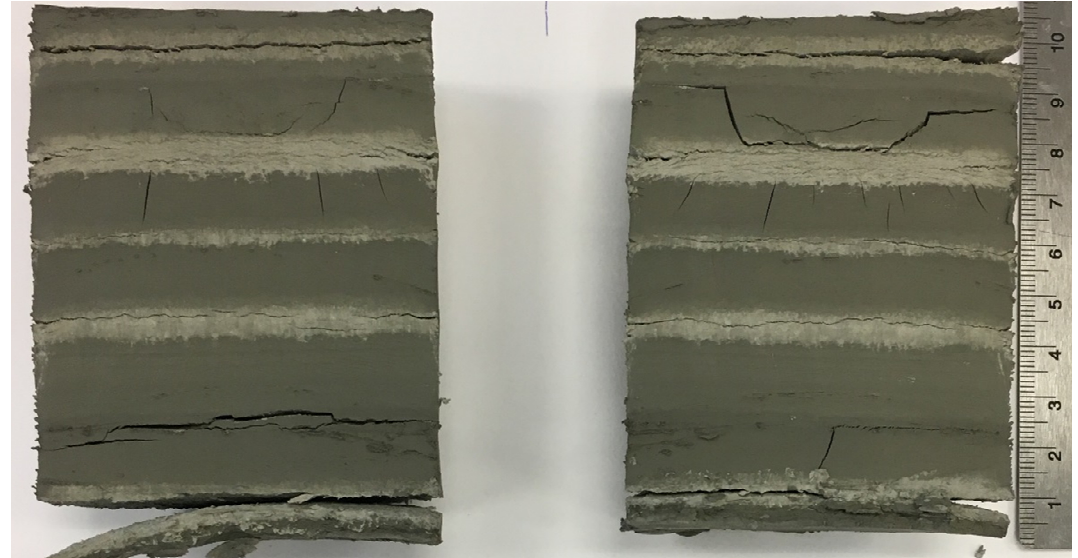


## Varved Clayey Silt and Silty Clay

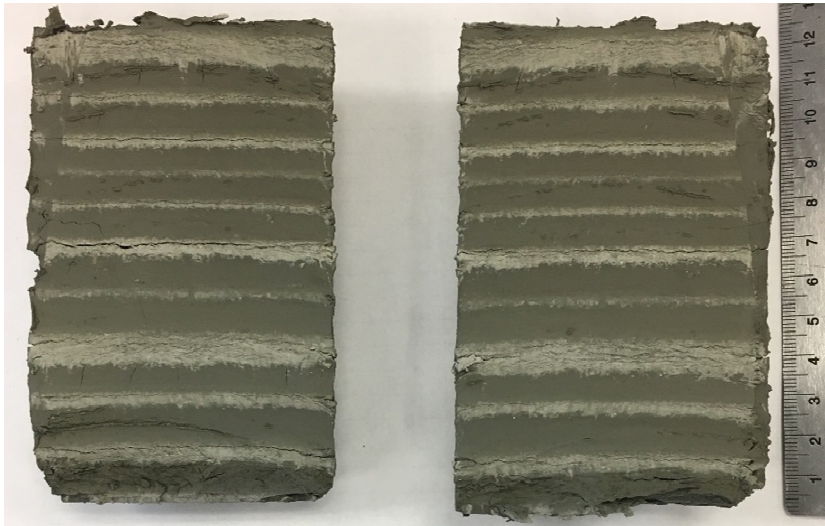
## Figure B10



**Photograph 1:** Soil sample from Borehole DCC-07 Sample 1



**Photograph 3:** Soil sample from Borehole DCC-07 Sample 3



**Photograph 2:** Soil sample from Borehole DCC-07 Sample 2

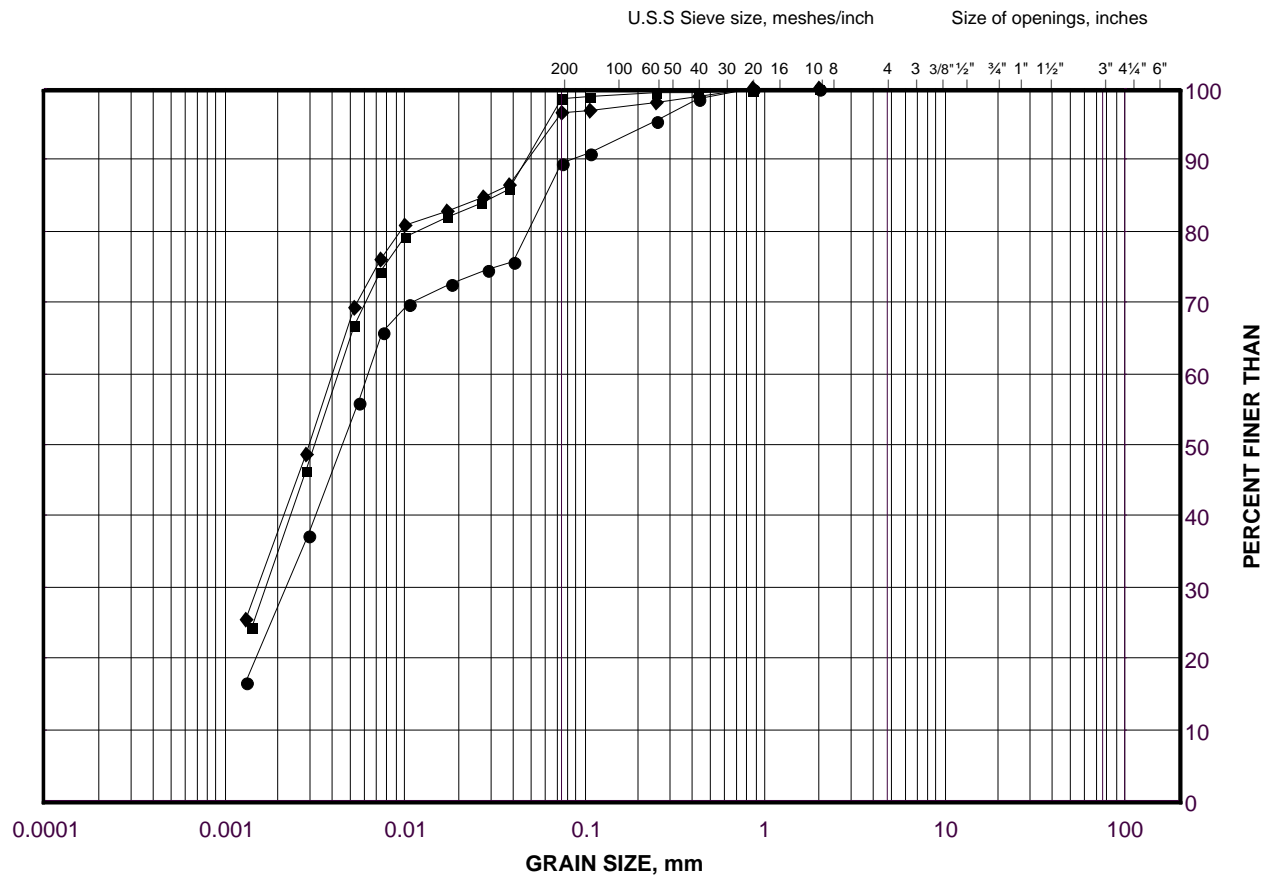
### Notes:

1. The dark laminae represent silty clay of intermediate plasticity, while the lighter laminae represent clayey silt of low plasticity and/or silt.
2. The soil samples were extracted from Shelby tubes and partially dried to illustrate the distinctions between the various laminae.
3. The laminae seen in Sample 1 are oriented approximately 50 degrees from the horizontal axis.

# GRAIN SIZE DISTRIBUTION

Silty Clay Laminae

FIGURE B11



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

## LEGEND

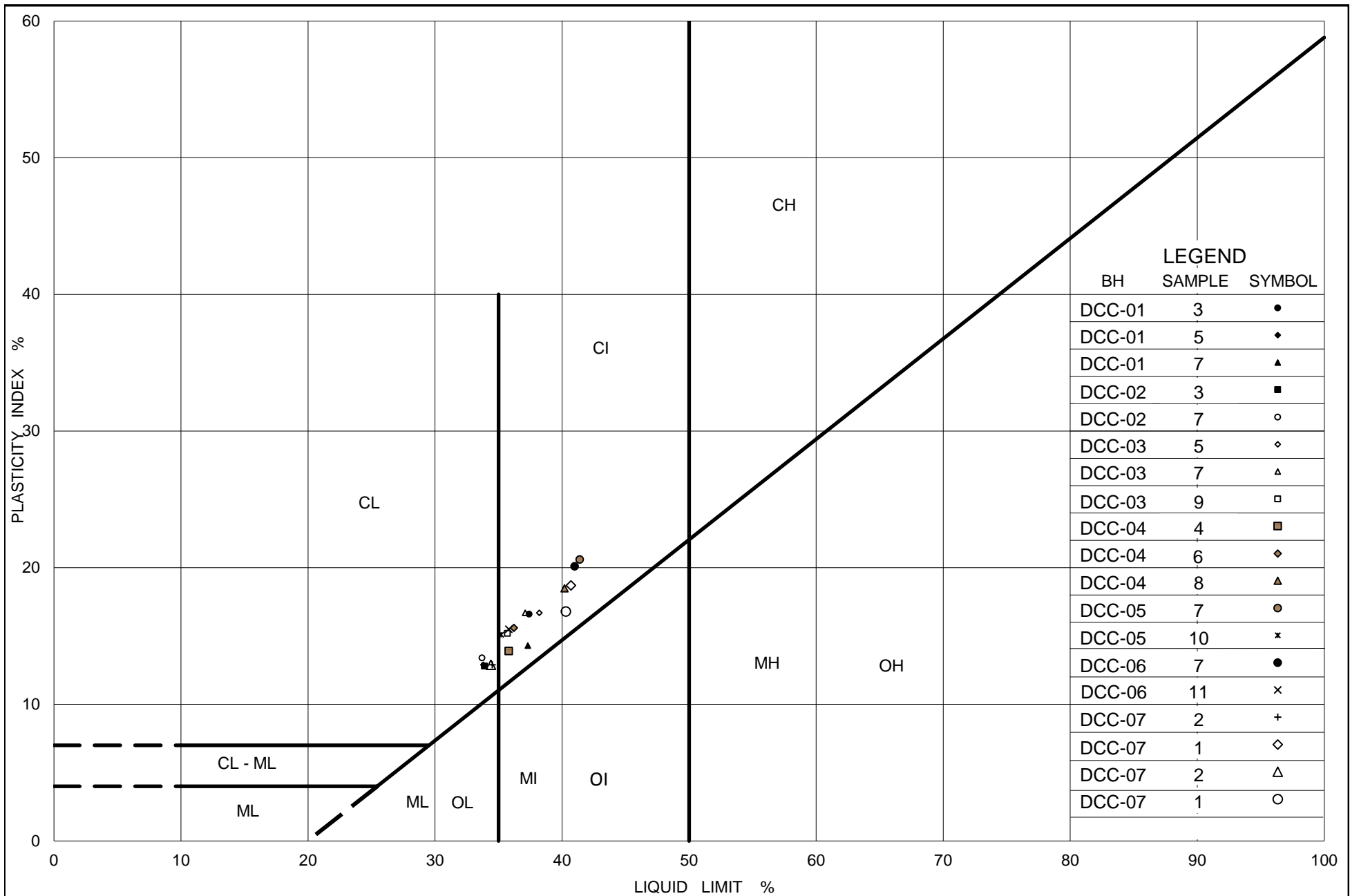
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	DCC-03	5	188.8
■	DCC-05	7	189.9
◆	DCC-06	7	189.6

Project Number: 1670846

Checked By: \_\_\_\_\_

**Golder Associates**

Date: 13-Apr-18



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## PLASTICITY CHART

### Clayey Silt Laminae and Silty Clay Laminae

Figure No. B12

Project No. 1670846

Checked By: TZ

**CONSOLIDATION TEST SUMMARY**  
**ASTM D2435/D2435M**

**FIGURE B13**  
**(1 of 4)**

**SAMPLE IDENTIFICATION**

Project Number	1670846	Sample Number	1
Borehole Number	DCC-07	Sample Depth, m	6.4

**TEST CONDITIONS**

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	08/21/2018		
Date Completed	09/04/2018		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	17.07
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	11.51
Area, cm <sup>2</sup>	31.65	Specific Gravity, assumed	2.75
Volume, cm <sup>3</sup>	80.29	Solids Height, cm	1.083
Water Content, %	48.38	Volume of Solids, cm <sup>3</sup>	34.26
Wet Mass, g	139.80	Volume of Voids, cm <sup>3</sup>	46.03
Dry Mass, g	94.22	Degree of Saturation, %	99.0

**TEST COMPUTATIONS**

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	c <sub>v</sub> cm <sup>2</sup> /s	m <sub>v</sub> m <sup>2</sup> /kN	k cm/s
0.00	2.537	1.344	2.537				
6.01	2.538	1.344	2.537				
10.64	2.536	1.342	2.537	60	2.27E-02	1.62E-04	3.60E-07
20.68	2.534	1.340	2.535	38	3.58E-02	8.24E-05	2.90E-07
40.08	2.526	1.333	2.530	90	1.51E-02	1.67E-04	2.46E-07
78.73	2.515	1.323	2.520	101	1.33E-02	1.09E-04	1.43E-07
155.86	2.493	1.303	2.504	98	1.36E-02	1.13E-04	1.50E-07
310.57	2.459	1.272	2.476	118	1.10E-02	8.48E-05	9.16E-08
620.30	2.338	1.159	2.399	109	1.12E-02	1.55E-04	1.70E-07
1239.82	2.058	0.901	2.198	392	2.61E-03	1.78E-04	4.55E-08
2477.58	1.907	0.761	1.983	265	3.14E-03	4.83E-05	1.49E-08
618.88	1.930	0.782	1.918				
155.86	1.962	0.812	1.946				
39.89	1.999	0.846	1.980				
10.72	2.032	0.877	2.015				

Notes:  
k calculated using cv based on t<sub>90</sub> values.  
Specimen swelled under 6.01 kPa.

**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.93	Unit Weight, kN/m <sup>3</sup>	19.96
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	15.13
Area, cm <sup>2</sup>	31.65	Specific Gravity, assumed	2.75
Volume, cm <sup>3</sup>	61.07	Solids Height, cm	1.083
Water Content, %	31.91	Volume of Solids, cm <sup>3</sup>	34.26
Wet Mass, g	124.29	Volume of Voids, cm <sup>3</sup>	26.81
Dry Mass, g	94.22		

Prepared By: LH

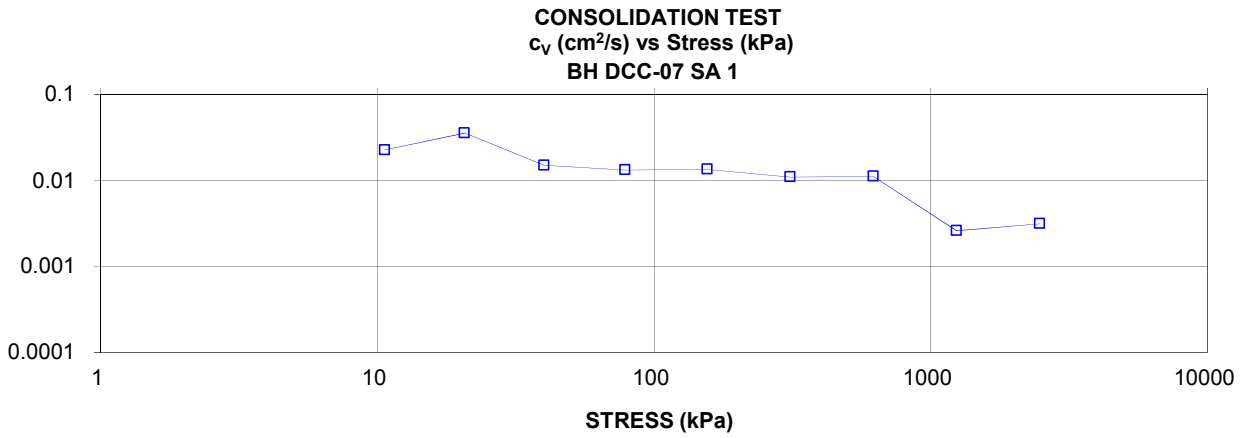
**Golder Associates Ltd.**

Checked By: TZ

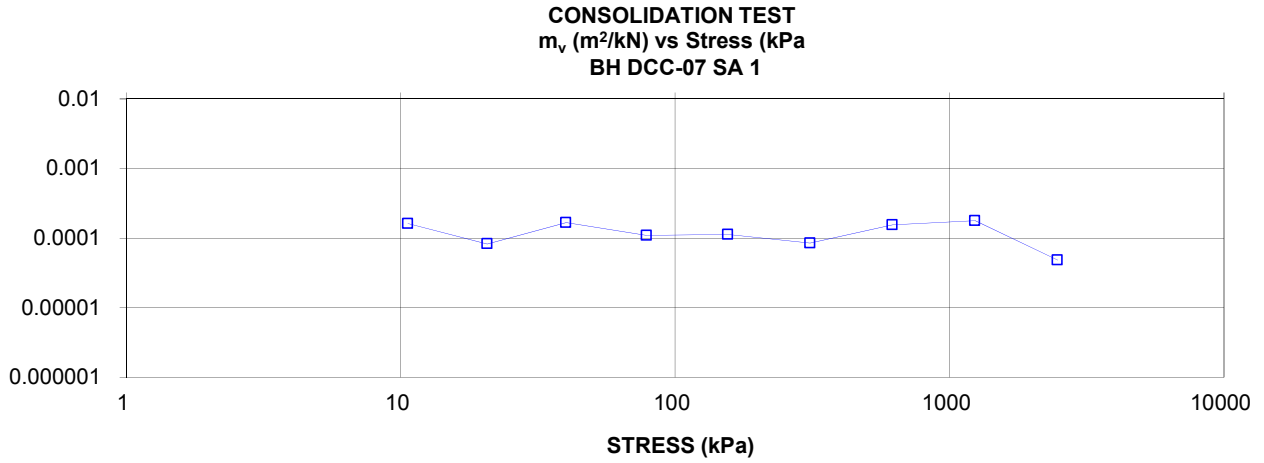
# CONSOLIDATION TEST SUMMARY

FIGURE B13  
(2 of 4)

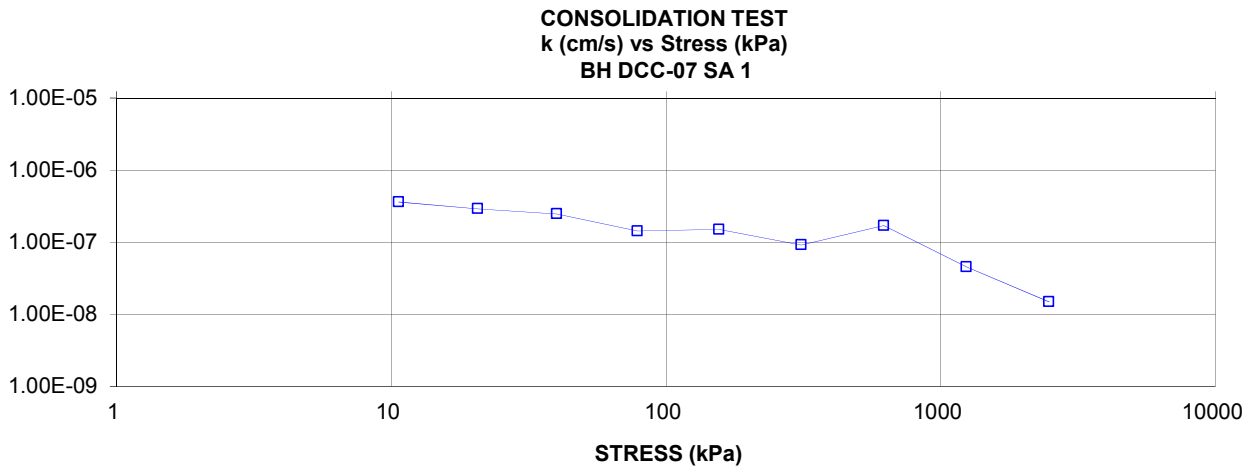
COEFFICIENT OF CONSOLIDATION,  
 $c_v$ , cm<sup>2</sup>/s



VOLUME COMPRESSIBILITY,  
 $m_v$ , m<sup>2</sup>/kN



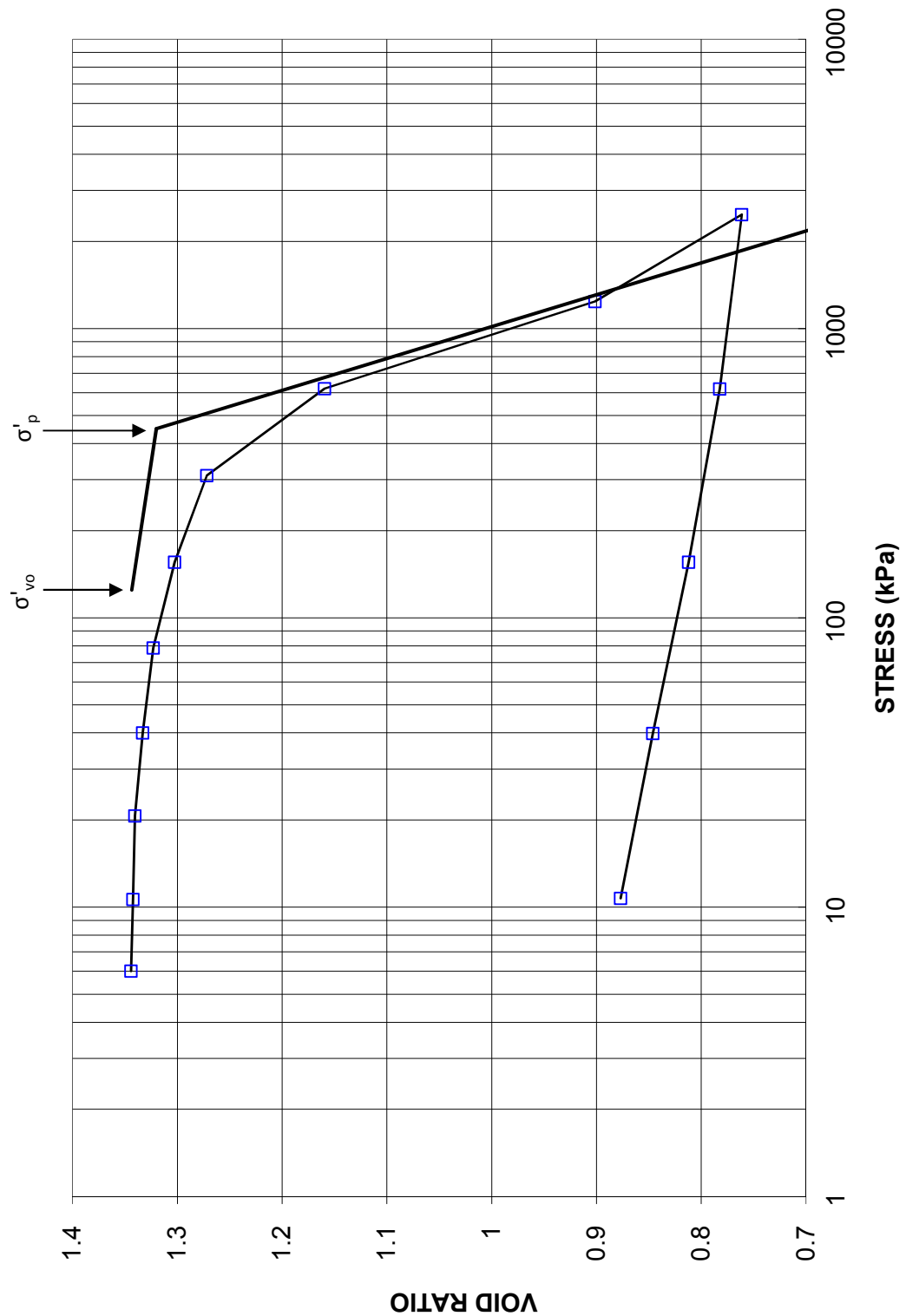
HYDRAULIC CONDUCTIVITY,  
 $k$ , cm/s



**CONSOLIDATION TEST  
VOID RATIO VS LOG STRESS**

**FIGURE B13  
(3 of 4)**

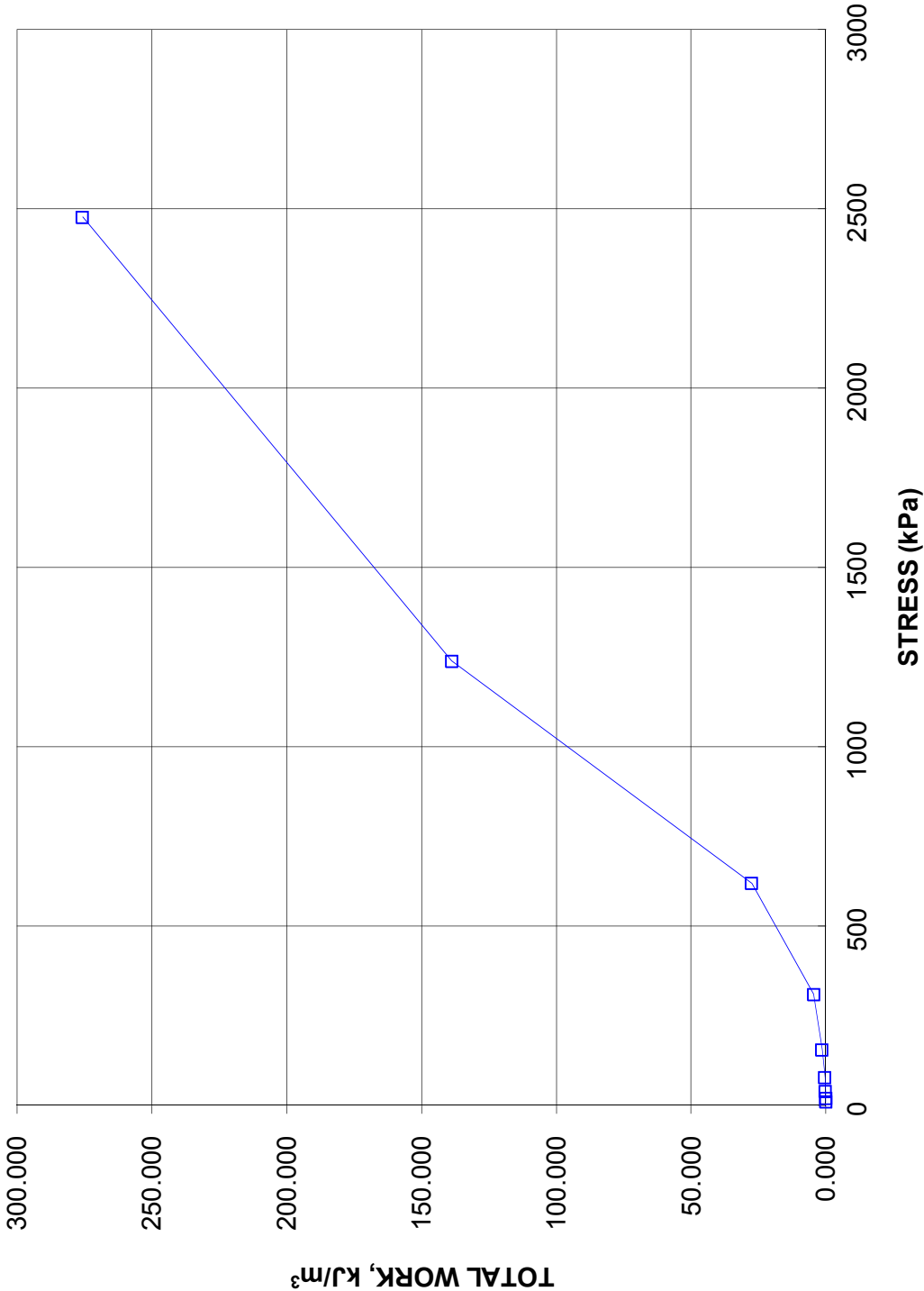
**CONSOLIDATION TEST  
VOID RATIO vs STRESS  
BH DCC-07 SA 1**



CONSOLIDATION TEST  
TOTAL WORK VS STRESS

FIGURE B13  
(4 of 4)

CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs STRESS  
BH DCC-07 SA 1



**CONSOLIDATION TEST SUMMARY**  
**ASTM D2435/D2435M**

**FIGURE B14**  
**(1 of 4)**

**SAMPLE IDENTIFICATION**

Project Number	1670846(1023)	Sample Number	2
Borehole Number	DCC-07	Sample Depth, ft	9.4

**TEST CONDITIONS**

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	1		
Date Started	08/21/2018		
Date Completed	09/04/2018		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.56	Unit Weight, kN/m <sup>3</sup>	17.06
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	11.76
Area, cm <sup>2</sup>	31.67	Specific Gravity, assumed	2.75
Volume, cm <sup>3</sup>	80.91	Solids Height, cm	1.114
Water Content, %	45.05	Volume of Solids, cm <sup>3</sup>	35.29
Wet Mass, g	140.77	Volume of Voids, cm <sup>3</sup>	45.62
Dry Mass, g	97.05	Degree of Saturation, %	95.8

**TEST COMPUTATIONS**

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	c <sub>v</sub> cm <sup>2</sup> /s	m <sub>v</sub> m <sup>2</sup> /kN	k cm/s
0.00	2.555	1.293	2.555				
5.90	2.549	1.287	2.552				
10.72	2.544	1.283	2.547	60	2.29E-02	3.90E-04	8.75E-07
20.43	2.539	1.278	2.541	135	1.01E-02	2.22E-04	2.20E-07
39.86	2.525	1.266	2.532	74	1.84E-02	2.72E-04	4.89E-07
78.56	2.509	1.252	2.517	86	1.56E-02	1.62E-04	2.48E-07
155.86	2.486	1.231	2.498	98	1.35E-02	1.17E-04	1.55E-07
310.89	2.447	1.196	2.466	101	1.28E-02	9.92E-05	1.24E-07
620.01	2.358	1.116	2.403	217	5.64E-03	1.12E-04	6.17E-08
1239.14	2.146	0.926	2.252	623	1.73E-03	1.34E-04	2.27E-08
2478.41	2.014	0.807	2.080	290	3.16E-03	4.19E-05	1.30E-08
620.30	2.035	0.826	2.024				
160.20	2.064	0.852	2.050				
40.05	2.096	0.880	2.080				
10.63	2.121	0.904	2.108				

Notes:  
k calculated using cv based on t<sub>90</sub> values.  
Specimen swelled under 5.90 kPa.

**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	2.04	Unit Weight, kN/m <sup>3</sup>	19.43
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	14.77
Area, cm <sup>2</sup>	31.67	Specific Gravity, assumed	2.75
Volume, cm <sup>3</sup>	64.45	Solids Height, cm	1.114
Water Content, %	31.58	Volume of Solids, cm <sup>3</sup>	35.29
Wet Mass, g	127.70	Volume of Voids, cm <sup>3</sup>	29.16
Dry Mass, g	97.05		

Prepared By: LH

**Golder Associates Ltd.**

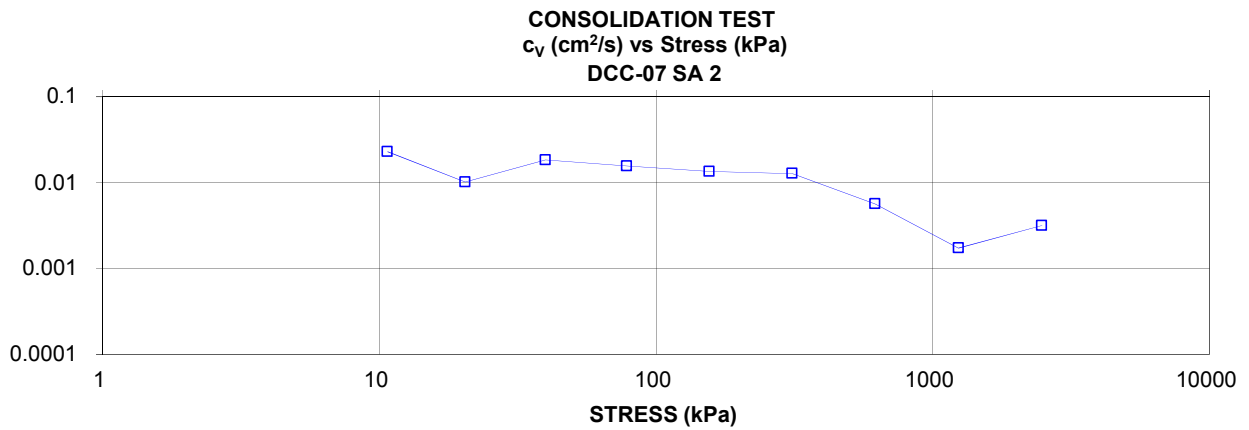
Checked By: TZ



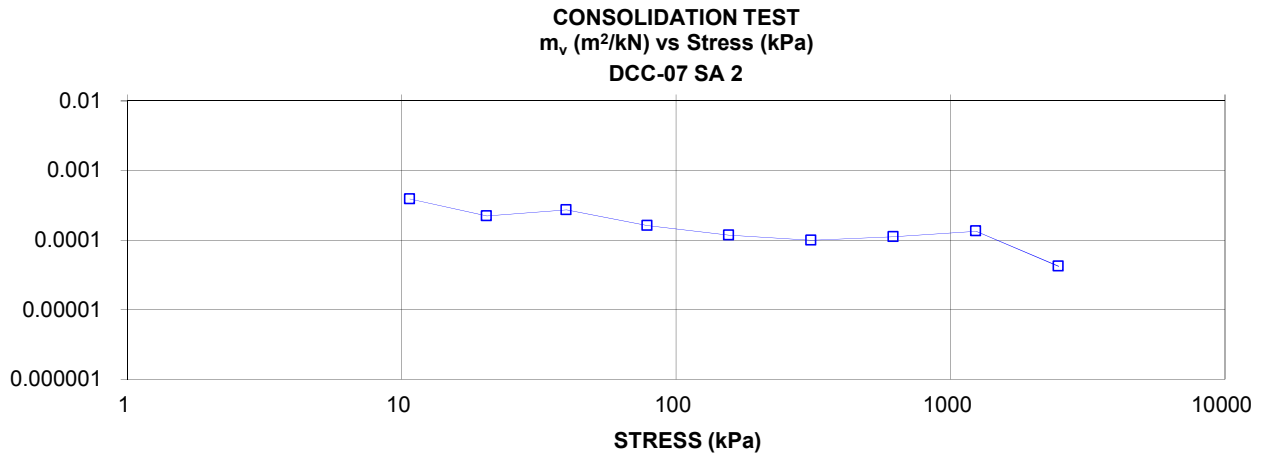
# CONSOLIDATION TEST SUMMARY

FIGURE B14  
(2 of 4)

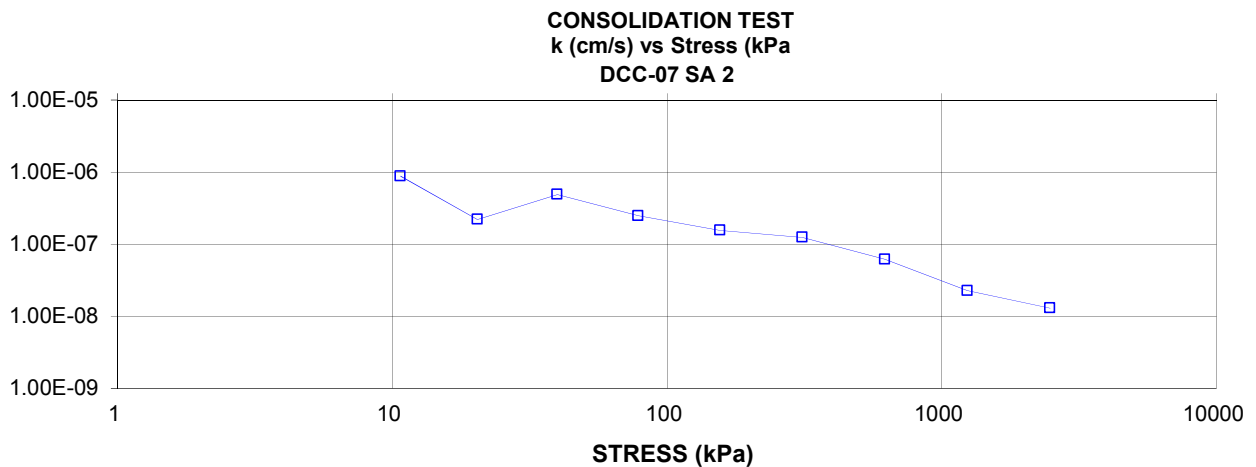
COEFFICIENT OF CONSOLIDATION,  
 $c_v$  cm<sup>2</sup>/s



VOLUME COMPRESSIBILITY,  
 $m_v$  m<sup>2</sup>/kN



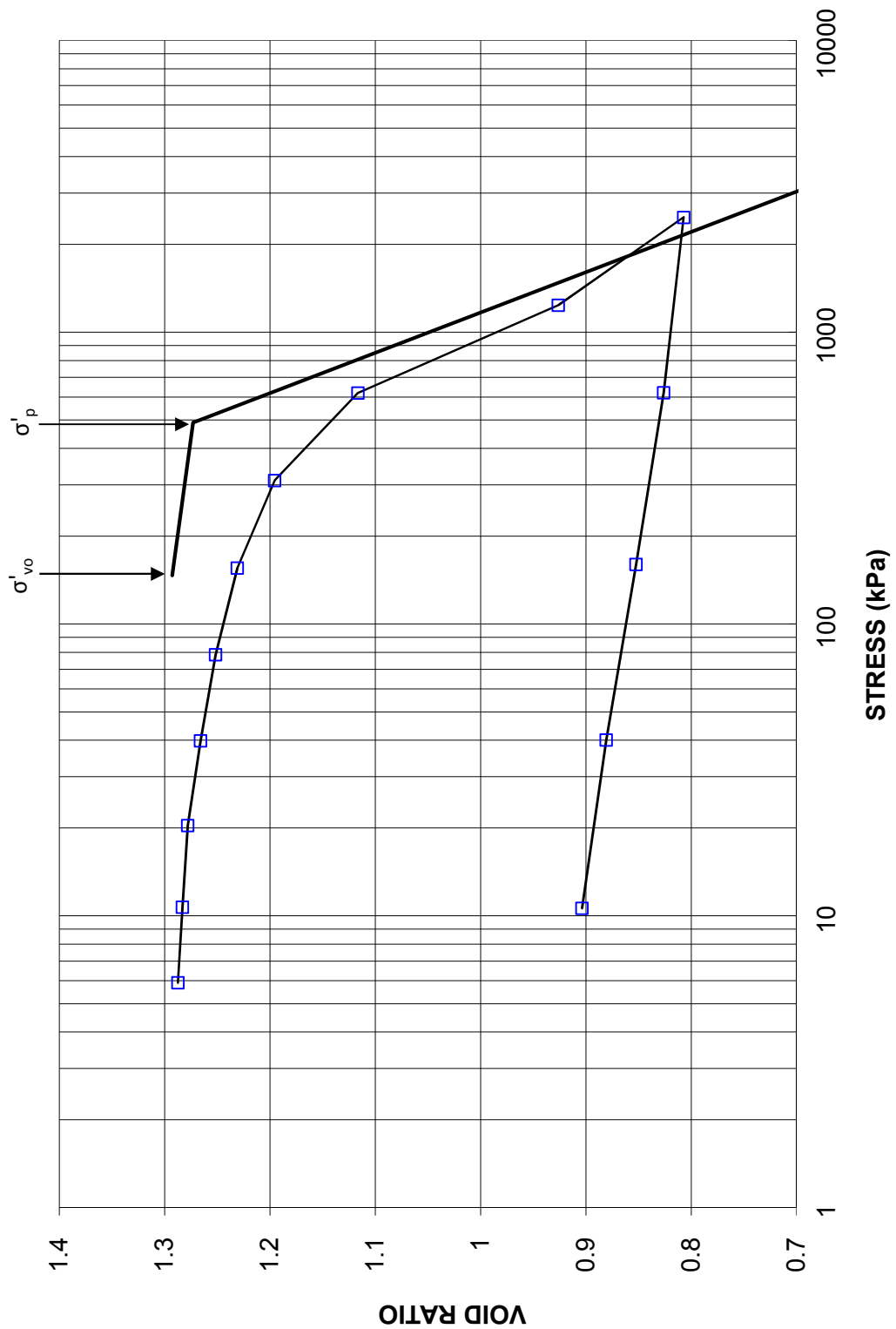
HYDRAULIC CONDUCTIVITY,  
 $k$  cm/s



**CONSOLIDATION TEST  
VOID RATIO VS LOG STRESS**

**FIGURE B14  
(3 of 4)**

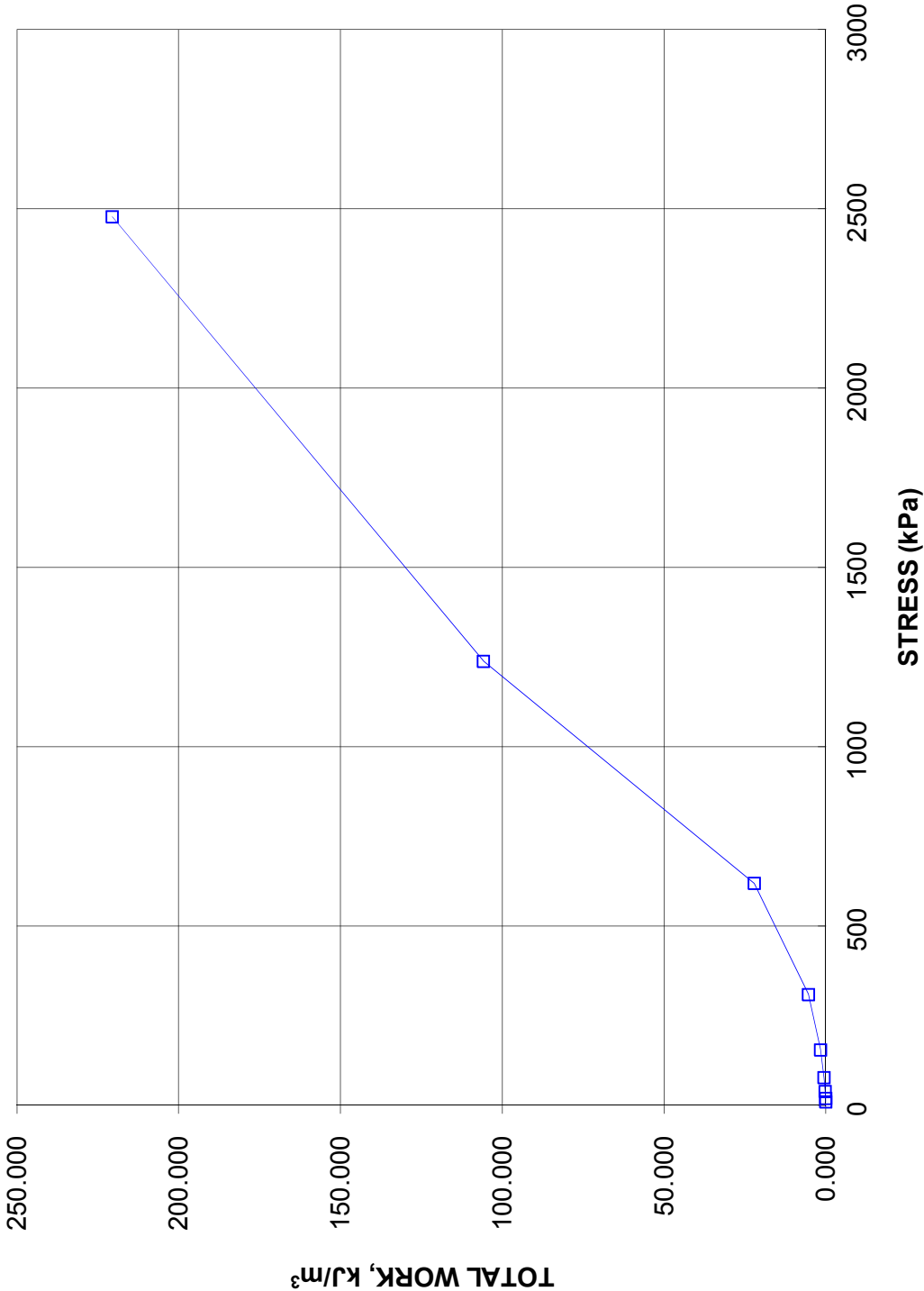
**CONSOLIDATION TEST  
VOID RATIO vs STRESS  
DCC-07 SA 2**



CONSOLIDATION TEST  
TOTAL WORK VS STRESS

FIGURE B14  
(4 of 4)

CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs STRESS  
DCC-07 SA 2





# APPENDIX C

## Analytical Laboratory Test Results

Your Project #: 1670846  
Your C.O.C. #: 628368-01-01

**Attention: Darcy Hansen**

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

**Report Date: 2017/09/20**  
Report #: R4722990  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B7J9789**

**Received: 2017/09/13, 11:39**

Sample Matrix: Soil  
# Samples Received: 8

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	8	N/A	2017/09/18	CAM SOP-00463	EPA 325.2 m
Conductivity	8	N/A	2017/09/18	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl <sub>2</sub> EXTRACT	8	2017/09/15	2017/09/15	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	8	2017/09/14	2017/09/18	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	8	N/A	2017/09/18	CAM SOP-00464	EPA 375.4 m
Sulphide (from Campobello) (1)	8	N/A	N/A		

**Remarks:**

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

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

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

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

Results relate to samples tested.

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

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

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

(1) This test was performed by Campo to Burnaby Subcontract

Your Project #: 1670846  
Your C.O.C. #: 628368-01-01

**Attention:Darcy Hansen**

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

**Report Date: 2017/09/20**  
Report #: R4722990  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B7J9789**  
**Received: 2017/09/13, 11:39**

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

Email: EGitej@maxxam.ca

Phone# (905)817-5829

=====

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

### RESULTS OF ANALYSES OF SOIL

<b>Maxxam ID</b>		FCS510	FCS510	FCS511	FCS512	FCS513	FCS514		
<b>Sampling Date</b>		2017/08/23	2017/08/23	2017/09/07	2017/09/06	2017/07/16	2017/07/11		
<b>COC Number</b>		628368-01-01	628368-01-01	628368-01-01	628368-01-01	628368-01-01	628368-01-01		
	<b>UNITS</b>	<b>ACB-03 SA4</b>	<b>ACB-03 SA4 Lab-Dup</b>	<b>ACC1-03 SA2</b>	<b>ACCS-03 SA2</b>	<b>MRB-04 SA3</b>	<b>MRB-03 SA5</b>	<b>RDL</b>	<b>QC Batch</b>

<b>Calculated Parameters</b>									
Resistivity	ohm-cm	7300		15000	4100	5900	2400		5165355
<b>Inorganics</b>									
Soluble (20:1) Chloride (Cl)	ug/g	55	58	24	130	58	260	20	5167700
Conductivity	umho/cm	137	133	69	246	169	424	2	5167946
Available (CaCl2) pH	pH	6.48		6.20	5.13	5.62	5.77		5165977
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	64	22	29	<20	20	5167702
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									
Lab-Dup = Laboratory Initiated Duplicate									

<b>Maxxam ID</b>		FCS515	FCS516	FCS517		
<b>Sampling Date</b>		2017/08/23	2017/07/29	2017/08/02		
<b>COC Number</b>		628368-01-01	628368-01-01	628368-01-01		
	<b>UNITS</b>	<b>DCC-01 SA2</b>	<b>MCC-03 SA1</b>	<b>WRC-01 SA3</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>						
Resistivity	ohm-cm	2200	24000	43000		5165355
<b>Inorganics</b>						
Soluble (20:1) Chloride (Cl)	ug/g	190	<20	<20	20	5167700
Conductivity	umho/cm	450	41	23	2	5167946
Available (CaCl2) pH	pH	8.18	6.90	6.62		5165977
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	24	20	5167702
RDL = Reportable Detection Limit						
QC Batch = Quality Control Batch						

## TEST SUMMARY

**Maxxam ID:** FCS510  
**Sample ID:** ACB-03 SA4  
**Matrix:** Soil

**Collected:** 2017/08/23  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

**Maxxam ID:** FCS510 Dup  
**Sample ID:** ACB-03 SA4  
**Matrix:** Soil

**Collected:** 2017/08/23  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine

**Maxxam ID:** FCS511  
**Sample ID:** ACC1-03 SA2  
**Matrix:** Soil

**Collected:** 2017/09/07  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

**Maxxam ID:** FCS512  
**Sample ID:** ACCS-03 SA2  
**Matrix:** Soil

**Collected:** 2017/09/06  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

**Maxxam ID:** FCS513  
**Sample ID:** MRB-04 SA3  
**Matrix:** Soil

**Collected:** 2017/07/16  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine



## TEST SUMMARY

**Maxxam ID:** FCS513  
**Sample ID:** MRB-04 SA3  
**Matrix:** Soil

**Collected:** 2017/07/16  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

**Maxxam ID:** FCS514  
**Sample ID:** MRB-03 SA5  
**Matrix:** Soil

**Collected:** 2017/07/11  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

**Maxxam ID:** FCS515  
**Sample ID:** DCC-01 SA2  
**Matrix:** Soil

**Collected:** 2017/08/23  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

**Maxxam ID:** FCS516  
**Sample ID:** MCC-03 SA1  
**Matrix:** Soil

**Collected:** 2017/07/29  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

## TEST SUMMARY

**Maxxam ID:** FCS517  
**Sample ID:** WRC-01 SA3  
**Matrix:** Soil

**Collected:** 2017/08/02  
**Shipped:**  
**Received:** 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

### GENERAL COMMENTS

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

Package 1	5.7°C
-----------	-------

Custody seal was present and intact.

Sample FCS513 [MRB-04 SA3] : Sample submitted and analyzed past the recommended hold time for pH, Chloride, Sulphate and Conductivity/Resistivity analysis.

Sample FCS514 [MRB-03 SA5] : Sample submitted and analyzed past the recommended hold time for pH, Chloride, Sulphate and Conductivity/Resistivity analysis.

Sample FCS517 [WRC-01 SA3] : Sample submitted and analyzed past the recommended hold time for pH, Chloride, Sulphate and Conductivity/Resistivity analysis.

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

## QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5165977	Available (CaCl <sub>2</sub> ) pH	2017/09/15			99	97 - 103			0.11	N/A
5167700	Soluble (20:1) Chloride (Cl)	2017/09/18	NC	70 - 130	104	70 - 130	<20	ug/g	5.5	35
5167702	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2017/09/18	124	70 - 130	107	70 - 130	<20	ug/g	NC	35
5167946	Conductivity	2017/09/18			101	90 - 110	<2	umho/cm	3.2	10

N/A = Not Applicable

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

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

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

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

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

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

### VALIDATION SIGNATURE PAGE

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

*Cristina Carriere*

---

Cristina Carriere, Scientific Service Specialist

---

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Your Project #: 1670846  
Your C.O.C. #: 628368-02-01

**Attention: Darcy Hansen**

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

**Report Date: 2017/10/23**  
Report #: R4798069  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B7L2287**

**Received: 2017/09/27, 12:13**

Sample Matrix: Soil  
# Samples Received: 2

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	2	N/A	2017/10/03	CAM SOP-00463	EPA 325.2 m
Conductivity	2	N/A	2017/10/02	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl <sub>2</sub> EXTRACT	2	2017/09/29	2017/09/29	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	2	2017/09/27	2017/10/02	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	2	N/A	2017/10/03	CAM SOP-00464	EPA 375.4 m
Sulphide (from Campobello) (1)	2	N/A	N/A		

**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.

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

Results relate to samples tested.

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

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

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

(1) This test was performed by Campo to Burnaby Subcontract

Your Project #: 1670846  
Your C.O.C. #: 628368-02-01

**Attention:Darcy Hansen**

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

**Report Date: 2017/10/23**  
Report #: R4798069  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B7L2287**  
**Received: 2017/09/27, 12:13**

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

Email: EGitej@maxxam.ca

Phone# (905)817-5829

=====

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### RESULTS OF ANALYSES OF SOIL

<b>Maxxam ID</b>		FFD202	FFD203	FFD203		
<b>Sampling Date</b>		2017/08/26	2017/09/09	2017/09/09		
<b>COC Number</b>		628368-02-01	628368-02-01	628368-02-01		
	<b>UNITS</b>	<b>DCC-04 SA-2</b>	<b>ACB-06 SA-3</b>	<b>ACB-06 SA-3 Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>						
Resistivity	ohm-cm	5100	7200			5185712
<b>Inorganics</b>						
Soluble (20:1) Chloride (Cl)	ug/g	<20	70	69	20	5191890
Conductivity	umho/cm	198	139	131	2	5191368
Available (CaCl2) pH	pH	8.03	4.97			5188854
Soluble (20:1) Sulphate (SO4)	ug/g	39	<20	<20	20	5191917
RDL = Reportable Detection Limit						
QC Batch = Quality Control Batch						
Lab-Dup = Laboratory Initiated Duplicate						

## TEST SUMMARY

**Maxxam ID:** FFD202  
**Sample ID:** DCC-04 SA-2  
**Matrix:** Soil

**Collected:** 2017/08/26  
**Shipped:**  
**Received:** 2017/09/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5191890	N/A	2017/10/03	Alina Dobreanu
Conductivity	AT	5191368	N/A	2017/10/02	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5188854	2017/09/29	2017/09/29	Tahir Anwar
Resistivity of Soil		5185712	2017/10/02	2017/10/02	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5191917	N/A	2017/10/03	Alina Dobreanu
Sulphide (from Campobello)	SPEC	5223606	N/A		Ema Gitej

**Maxxam ID:** FFD203  
**Sample ID:** ACB-06 SA-3  
**Matrix:** Soil

**Collected:** 2017/09/09  
**Shipped:**  
**Received:** 2017/09/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5191890	N/A	2017/10/03	Alina Dobreanu
Conductivity	AT	5191368	N/A	2017/10/02	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5188854	2017/09/29	2017/09/29	Tahir Anwar
Resistivity of Soil		5185712	2017/10/02	2017/10/02	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5191917	N/A	2017/10/03	Alina Dobreanu
Sulphide (from Campobello)	SPEC	5223606	N/A		Ema Gitej

**Maxxam ID:** FFD203 Dup  
**Sample ID:** ACB-06 SA-3  
**Matrix:** Soil

**Collected:** 2017/09/09  
**Shipped:**  
**Received:** 2017/09/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5191890	N/A	2017/10/03	Alina Dobreanu
Conductivity	AT	5191368	N/A	2017/10/02	Neil Dassanayake
Sulphate (20:1 Extract)	KONE/EC	5191917	N/A	2017/10/03	Alina Dobreanu

### GENERAL COMMENTS

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

Package 1	1.7°C
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**Results relate only to the items tested.**

## QUALITY ASSURANCE REPORT

Golder Associates Ltd  
Client Project #: 1670846  
Sampler Initials: DH

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5188854	Available (CaCl <sub>2</sub> ) pH	2017/09/29			100	97 - 103			0.80	N/A
5191368	Conductivity	2017/10/02			98	90 - 110	<2	umho/cm	5.7	10
5191890	Soluble (20:1) Chloride (Cl)	2017/10/03	NC	70 - 130	108	70 - 130	<20	ug/g	0.87	35
5191917	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2017/10/03	102	70 - 130	104	70 - 130	<20	ug/g	NC	35

N/A = Not Applicable

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

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

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

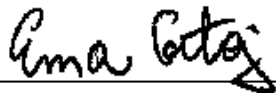
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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

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

### VALIDATION SIGNATURE PAGE

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



Ema Gitej, Senior Project Manager



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

---

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Your Project #: MB7J9789  
Site Location: 1670846  
Your C.O.C. #: B7J9789-M058-01-01

**Attention:EMA GITEJ**

MAXXAM ANALYTICS  
CAMPOBELLO  
6740 CAMPOBELLO ROAD  
MISSISSAUGA, ON  
CANADA L5N 2L8

**Report Date: 2017/09/18**  
Report #: R2445858  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B780085**

**Received: 2017/09/16, 12:10**

Sample Matrix: Soil  
# Samples Received: 8

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Moisture	8	2017/09/18	2017/09/18	BBY8SOP-00017	BCMOE BCLM Dec2000 m
Sulphide in Soil	8	2017/09/18	2017/09/18	BBY6SOP-00006	SM 22 4500 S2- D m

**Remarks:**

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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.

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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.

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

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

Your Project #: MB7J9789  
Site Location: 1670846  
Your C.O.C. #: B7J9789-M058-01-01

**Attention:EMA GITEJ**

MAXXAM ANALYTICS  
CAMPOBELLO  
6740 CAMPOBELLO ROAD  
MISSISSAUGA, ON  
CANADA L5N 2L8

**Report Date: 2017/09/18**  
Report #: R2445858  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B780085**  
**Received: 2017/09/16, 12:10**

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Letitia Prefontaine, B.Sc., Senior Project Manager

Email: LPrefontaine@maxxam.ca

Phone# (604)639-2616

=====

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Maxxam Job #: B780085  
Report Date: 2017/09/18

MAXXAM ANALYTICS  
Client Project #: MB7J9789  
Site Location: 1670846  
Sampler Initials: DH

### RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		RZ2662	RZ2662	RZ2663		RZ2664		
Sampling Date		2017/08/23	2017/08/23	2017/09/07		2017/09/06		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01		B7J9789-M058-01-01		
	UNITS	ACB-03 SA4	ACB-03 SA4 Lab-Dup	ACC1-03 SA2	RDL	ACCS-03 SA2	RDL	QC Batch

#### MISCELLANEOUS

Sulphide	ug/g	0.69 (1)	<0.50	0.52	0.50	1.06 (2)	0.55	8761700
----------	------	----------	-------	------	------	----------	------	---------

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

(1) Matrix spike exceeds acceptance limits due to matrix interference. Re-analysis yields similar results.

(2) RDL raised due to high sample moisture content.

Maxxam ID		RZ2665	RZ2666		RZ2667		
Sampling Date		2017/07/16	2017/07/11		2017/08/23		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01		B7J9789-M058-01-01		
	UNITS	MRB-04 SA3	MRB-03 SA5	RDL	DCC-01 SA2	RDL	QC Batch

#### MISCELLANEOUS

Sulphide	ug/g	<0.50	0.52	0.50	0.68 (1)	0.55	8761700
----------	------	-------	------	------	----------	------	---------

RDL = Reportable Detection Limit

(1) RDL raised due to high sample moisture content.

Maxxam ID		RZ2668	RZ2669		
Sampling Date		2017/07/29	2017/08/02		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01		
	UNITS	MCC-03 SA1	WRC-01 SA3	RDL	QC Batch

#### MISCELLANEOUS

Sulphide	ug/g	0.78	0.57	0.50	8761700
----------	------	------	------	------	---------

RDL = Reportable Detection Limit

Maxxam Job #: B780085  
Report Date: 2017/09/18

MAXXAM ANALYTICS  
Client Project #: MB7J9789  
Site Location: 1670846  
Sampler Initials: DH

### PHYSICAL TESTING (SOIL)

<b>Maxxam ID</b>		RZ2662	RZ2663	RZ2664	RZ2665		
<b>Sampling Date</b>		2017/08/23	2017/09/07	2017/09/06	2017/07/16		
<b>COC Number</b>		B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01		
	<b>UNITS</b>	<b>ACB-03 SA4</b>	<b>ACC1-03 SA2</b>	<b>ACCS-03 SA2</b>	<b>MRB-04 SA3</b>	<b>RDL</b>	<b>QC Batch</b>

<b>Physical Properties</b>							
Moisture	%	24	22	28	8.2	0.30	8761682
RDL = Reportable Detection Limit							

<b>Maxxam ID</b>		RZ2666	RZ2667	RZ2668	RZ2669		
<b>Sampling Date</b>		2017/07/11	2017/08/23	2017/07/29	2017/08/02		
<b>COC Number</b>		B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01		
	<b>UNITS</b>	<b>MRB-03 SA5</b>	<b>DCC-01 SA2</b>	<b>MCC-03 SA1</b>	<b>WRC-01 SA3</b>	<b>RDL</b>	<b>QC Batch</b>

<b>Physical Properties</b>							
Moisture	%	13	32	14	17	0.30	8761682
RDL = Reportable Detection Limit							

Maxxam Job #: B780085  
Report Date: 2017/09/18

MAXXAM ANALYTICS  
Client Project #: MB7J9789  
Site Location: 1670846  
Sampler Initials: DH

## TEST SUMMARY

**Maxxam ID:** RZ2662  
**Sample ID:** ACB-03 SA4  
**Matrix:** Soil

**Collected:** 2017/08/23  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

**Maxxam ID:** RZ2662 Dup  
**Sample ID:** ACB-03 SA4  
**Matrix:** Soil

**Collected:** 2017/08/23  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

**Maxxam ID:** RZ2663  
**Sample ID:** ACC1-03 SA2  
**Matrix:** Soil

**Collected:** 2017/09/07  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

**Maxxam ID:** RZ2664  
**Sample ID:** ACCS-03 SA2  
**Matrix:** Soil

**Collected:** 2017/09/06  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

**Maxxam ID:** RZ2665  
**Sample ID:** MRB-04 SA3  
**Matrix:** Soil

**Collected:** 2017/07/16  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

**Maxxam ID:** RZ2666  
**Sample ID:** MRB-03 SA5  
**Matrix:** Soil

**Collected:** 2017/07/11  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam Job #: B780085  
Report Date: 2017/09/18

MAXXAM ANALYTICS  
Client Project #: MB7J9789  
Site Location: 1670846  
Sampler Initials: DH

## TEST SUMMARY

**Maxxam ID:** RZ2667  
**Sample ID:** DCC-01 SA2  
**Matrix:** Soil

**Collected:** 2017/08/23  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

**Maxxam ID:** RZ2668  
**Sample ID:** MCC-03 SA1  
**Matrix:** Soil

**Collected:** 2017/07/29  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

**Maxxam ID:** RZ2669  
**Sample ID:** WRC-01 SA3  
**Matrix:** Soil

**Collected:** 2017/08/02  
**Shipped:**  
**Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam Job #: B780085  
Report Date: 2017/09/18

MAXXAM ANALYTICS  
Client Project #: MB7J9789  
Site Location: 1670846  
Sampler Initials: DH

## GENERAL COMMENTS

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

Package 1	9.0°C
Package 2	6.0°C

Sample RZ2662 [ACB-03 SA4] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2663 [ACC1-03 SA2] : Sample analyzed past method specified hold time for Sulphide in Soil. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2664 [ACCS-03 SA2] : Sample analyzed past method specified hold time for Sulphide in Soil. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2665 [MRB-04 SA3] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2666 [MRB-03 SA5] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2667 [DCC-01 SA2] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2668 [MCC-03 SA1] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

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

Maxxam Job #: B780085  
Report Date: 2017/09/18

## QUALITY ASSURANCE REPORT

MAXXAM ANALYTICS  
Client Project #: MB7J9789  
Site Location: 1670846  
Sampler Initials: DH

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8761682	Moisture	2017/09/18					<0.30	%	0 (1)	20
8761700	Sulphide	2017/09/18	39 (2,3)	75 - 125	84	75 - 125	<0.50	ug/g	NC (4)	30

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  $\leq 2 \times \text{RDL}$ ).

(1) Duplicate Parent ID

(2) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

(3) Matrix Spike Parent ID [RZ2662-01]

(4) Duplicate Parent ID [RZ2662-01]

Maxxam Job #: B780085  
Report Date: 2017/09/18

MAXXAM ANALYTICS  
Client Project #: MB7J9789  
Site Location: 1670846  
Sampler Initials: DH

### VALIDATION SIGNATURE PAGE

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



Andy Lu, Ph.D., P.Chem., Scientific Specialist

---

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Your Project #: MB7L2287  
Site Location: 1670846  
Your C.O.C. #: B7L2287-M058-01-01

**Attention: SUBCONTRACTOR**

MAXXAM ANALYTICS  
OTTAWA  
32 COLONNADE RD N  
UNIT 1000  
NEPEAN, ON  
CANADA K2E7J6

**Report Date: 2017/10/04**  
Report #: R2454826  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B785668**  
**Received: 2017/10/02, 08:55**

Sample Matrix: Soil  
# Samples Received: 2

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Moisture	2	2017/10/03	2017/10/03	BBY8SOP-00017	BCMOE BCLM Dec2000 m
Sulphide in Soil	2	2017/10/02	2017/10/04	BBY6SOP-00006	SM 22 4500 S2- D m

**Remarks:**

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

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

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

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

Results relate to samples tested.

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

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

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



Your Project #: MB7L2287  
Site Location: 1670846  
Your C.O.C. #: B7L2287-M058-01-01

**Attention:SUBCONTRACTOR**

MAXXAM ANALYTICS  
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UNIT 1000  
NEPEAN, ON  
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**Report Date: 2017/10/04**  
Report #: R2454826  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B785668**  
**Received: 2017/10/02, 08:55**

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Letitia Prefontaine, B.Sc., Senior Project Manager

Email: LPrefontaine@maxxam.ca

Phone# (604)639-2616

=====

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Maxxam Job #: B785668  
Report Date: 2017/10/04

MAXXAM ANALYTICS  
Client Project #: MB7L2287  
Site Location: 1670846

### RESULTS OF CHEMICAL ANALYSES OF SOIL

<b>Maxxam ID</b>		SC4339		SC4340	SC4340		
<b>Sampling Date</b>		2017/08/26		2017/09/09	2017/09/09		
<b>COC Number</b>		B7L2287-M058-01-01		B7L2287-M058-01-01	B7L2287-M058-01-01		
	<b>UNITS</b>	<b>DCC-04 SA-2</b>	<b>RDL</b>	<b>ACB-06 SA-3</b>	<b>ACB-06 SA-3 Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>
<b>MISCELLANEOUS</b>							
Sulphide	ug/g	0.92	0.55	0.60	0.50	0.50	8779137
RDL = Reportable Detection Limit							
Lab-Dup = Laboratory Initiated Duplicate							

Maxxam Job #: B785668  
Report Date: 2017/10/04

MAXXAM ANALYTICS  
Client Project #: MB7L2287  
Site Location: 1670846

### PHYSICAL TESTING (SOIL)

<b>Maxxam ID</b>		SC4339	SC4340	SC4340		
<b>Sampling Date</b>		2017/08/26	2017/09/09	2017/09/09		
<b>COC Number</b>		B7L2287-M058-01-01	B7L2287-M058-01-01	B7L2287-M058-01-01		
	<b>UNITS</b>	<b>DCC-04 SA-2</b>	<b>ACB-06 SA-3</b>	<b>ACB-06 SA-3 Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Physical Properties</b>						
Moisture	%	29	18	17	0.30	8779668
RDL = Reportable Detection Limit						
Lab-Dup = Laboratory Initiated Duplicate						

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MAXXAM ANALYTICS  
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## GENERAL COMMENTS

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

Package 1	7.3°C
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Samples received past hold time for sulphide in soil analysis.

Sample SC4339 [DCC-04 SA-2] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil. Sample analyzed past method specified hold time for Moisture.

Sample SC4340 [ACB-06 SA-3] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil. Sample analyzed past method specified hold time for Moisture.

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

Maxxam Job #: B785668  
Report Date: 2017/10/04

MAXXAM ANALYTICS  
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### QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8779137	KAB	Matrix Spike [SC4340-01]	Sulphide	2017/10/04		33 (1)	%	75 - 125
8779137	KAB	Spiked Blank	Sulphide	2017/10/04		114	%	75 - 125
8779137	KAB	Method Blank	Sulphide	2017/10/04	<0.50		ug/g	
8779137	KAB	RPD [SC4340-01]	Sulphide	2017/10/04	17		%	30
8779668	LO1	Method Blank	Moisture	2017/10/03	<0.30		%	
8779668	LO1	RPD [SC4340-01]	Moisture	2017/10/03	5.0		%	20

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.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Job #: B785668  
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MAXXAM ANALYTICS  
Client Project #: MB7L2287  
Site Location: 1670846

### VALIDATION SIGNATURE PAGE

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



Rob Reinert, B.Sc., Scientific Specialist

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