REPORT

August 30, 2018

FOUNDATION INVESTIGATION REPORT

STRUCTURAL BUNDLE - 11 STRUCTURES ON HIGHWAYS 129, 532, AND 556
HIGHWAY 532 - ACHIGAN CREEK BRIDGE REPLACEMENT, 5.1 KM NORTH OF HIGHWAY 556 (SITE NO. 38S-041)
LAT. 46.789744° ; LONG. -84.054775°
HODGINS AND GAUDETTE TOWNSHIPS, ALGOMA DISTRICT, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5378-11-00 ; WP 151-97-01

Submitted to:
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Golder Associates

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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 detailed foundation engineering services for the replacement of the Achigan Creek Bridge on Highway 532 (Site No. 38S-041) in the Townships of Gaudette and Hodgins, Algoma District, Ontario.

The purpose of this field investigation is to establish the subsurface conditions at the location of the existing bridge abutments and at the abutments and approach embankments of a proposed temporary modular bridge to be located west of the existing bridge along a temporary detour alignment, by methods of borehole drilling and coring, 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 Achigan Creek Bridge site.

The Terms of Reference and Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal, dated December 8, 2015. 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 Triple-Double Reinforced Bailey Bridge at the site carries Highway 532 over Achigan Creek in a generally north to south direction. The bridge was constructed as a Triple-Single Chord Reinforced Bailey in 1985 under Contract No. 84-214 and converted to the present configuration in 2012. The bridge underwent a structural assessment in 2015 and was identified as being in good condition with minor deterioration of several elements. However, more significant deterioration of the structural steel coatings and curbs was noted. The current bridge is to be replaced with a new two lane bridge.

2.2 Site Description

The site of the proposed modular bridge replacement is located about 5.1 km north of Highway 556, north of Searchmont, at the boundary between Hodgins Township and Gaudette Township within the Algoma District, Ontario.

The existing structure is a single span, 48.8 m long, Triple-Double Reinforced Bailey Bridge. The structure accommodates a single lane of traffic and is approximately 6.1 m wide. A cantilevered sidewalk is affixed on the west side of the structure. The travelled surface of bridge and the sidewalk is comprised of wooden deck. The bridge is supported on Size 36 timber piles (ten piles per abutment) driven to approximately Elevation 223.4 m.

The Achigan Creek at the location of the existing modular bridge is approximately 20 m wide and flows in a generally northwest to southeast direction. The downstream end of Achigan Creek flows into the Goulais River about 1.5 km southeast of the bridge.

Residential dwellings are located near the bridge on both sides of the creek, particularly at the southwest, northwest and northeast quadrats. Overhead electrical transmission lines run along the highway on the east side of Highway 532 (i.e., about 8 m east of the edge of pavement). However, the overhead lines also cross the highway at several locations south and north of the bridge where the residences are located.

In general, the topography of the area in the immediate vicinity of the bridge is relatively flat to undulating, except for the creek banks which are about 4 m to 5 m high. The presence of a ski resort near Searchmont, located about 2.5 km south of the site, is an indicator of the high relief and rugged topography beyond the site limits. The natural ground surface in the vicinity of the existing bridge varies between about Elevations 238 m and 239 m, and slopes down towards the creek. Despite the presence of several dwellings near the bridge, the site is relatively heavily vegetated, especially near the banks of the Achigan Creek. The vegetation is comprised of grasses, shrubs as well as deciduous and coniferous trees.

3.0 FIELD INVESTIGATION PROCEDURES

3.1 Previous (1981) Investigation

A previous foundation investigation was carried out at the site by MTO's Foundation Design Section in September 1981, following a structural assessment which indicated that the bridge had lost much of its structural integrity and that the adjoining wooden walkway showed signs of severe deterioration. A total of two boreholes (designated as Boreholes 1 and 2) were advanced at the southwest and northeast portion of the bridge, respectively. A Dynamic Cone Penetration Test (DCPT, designated as Borehole 3) was also carried on the northwest side of the bridge. The existing information is summarized in the following report:

- **MTO Geocres No. 41K-041**: "Foundation Investigation Report for Achigan Creek Crossing and Highway 532; W.P. 148-65-00, Site 38S-41; District 18, Sault Ste. Marie" by Engineering Materials Office – Pavement & Foundation Design Section, dated November 4, 1981.

The two boreholes were advanced to depths of about 26.8 m and 26.1 m below existing ground surface, respectively, while the cone was driven to a depth of about 27.5 m. The subsurface conditions encountered in the boreholes consists of a 6.2 m thick deposit of very loose to loose sandy silt and a 2.8 m thick deposit of loose fine sand. These granular deposits are underlain by an extensive cohesive deposit described as a stiff to very stiff "stratified silty clay with alternating layers of silty clay of low plasticity and silty clay of medium plasticity". The boreholes were terminated within the silty clay deposit at depths of about 26.8 m and 26.1 m below the existing ground surface in the respective boreholes. The subsurface conditions encountered during the 1981 field investigation are consistent with the subsurface conditions encountered during the 2017 investigation (described herein).

The approximate locations of the previous boreholes and the DCPT are shown on Drawing 1 along with the boreholes advanced as part of the current investigation (described below). However, the original borehole location and soil strata drawing associated with the 1981 field investigation has also been provided in Appendix A. The original borehole records and geotechnical laboratory test results are also provided in Appendix A.

3.2 Current (2017) Investigation

The recent field work at the Achigan Creek Bridge site was carried out between August 22 and 30, and between September 9 and 12, 2017, during which time a total of eight boreholes were advanced in close proximity to the existing foundation elements and near the abutments and approach embankments of the proposed temporary modular bridge to be located west of the existing bridge along a temporary detour alignment. The borehole locations were selected in consultation with AECOM and a proposed borehole location plan was submitted to MTO Foundations on July 24, 2017. The boreholes were advanced as close as possible to the existing bridge

abutments, the new bridge abutments associated with the temporary modular bridge, and along the temporary detour alignment. The approximate locations of the boreholes are summarized as follows:

Approximate Location	Relevant Borehole(s)
Temporary Modular Bridge – South Portion of Temporary Detour Alignment	ACB-01
Achigan Creek Bridge – South Abutment	ACB-02 [1] and ACB-03
Temporary Modular Bridge – South Abutment	ACB-04 [2]
Temporary Modular Bridge – North Abutment	ACB-05
Achigan Creek Bridge – North Abutment	ACB-06 and ACB-07
Temporary Modular Bridge – North Portion of Temporary Detour Alignment	ACB-08

Notes:
1. It was not possible to advance Borehole ACB-02 immediately next to the east side of the existing south bridge abutment since the single lane of traffic along the bridge had to remain open to traffic and the terrain on the east side of the highway was steep and heavily vegetated with large trees.
2. It was not possible to advance Borehole ACB-04 immediately next to the south abutment of the proposed temporary modular bridge due to access restrictions and proximity to the steep and heavily vegetated creek bank slope.

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

All boreholes, except Boreholes ACB-02 and ACB-06 were advanced using a CME-75 track-mounted drill rig, while Boreholes ACB-02 and ACB-06 were advanced using a CME-55 truck-mounted drill rig. The drill rigs were supplied and operated by Landcore Drilling Inc. of Chelmsford, Ontario. Boreholes ACB-01 and ACB-08 were advanced through the overburden using 210 mm outer diameter, continuous flight, hollow-stem augers. The remaining boreholes were advanced through the upper portion of the overburden (i.e., generally through the upper 1.5 m) using 95 mm outer diameter, continuous flight, solid-stem augers or 210 mm outer diameter hollow-stem augers. The rest of the overburden was advanced using 'NW' casing with wash boring techniques and also coring using an 'NQ' double-tube rock core barrel to penetrate through cobbles and boulders encountered below the cohesive deposit at depths between about 27 m and 30 m below the existing ground surface. Photographs of the recovered cobbles and boulders are provided in Appendix C. Soil samples were generally obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter, split-spoon sampler driven by an automatic hammer 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 deposit for assessment of undrained shear strengths (ASTM D2573, *Standard Test Method for Field Vane Shear Strength Test in Cohesive Soils*) using the MTO Standard 'N'-size vanes.

The boreholes were advanced to depths ranging between about 15.9 m and 32.5 m below the existing ground surface. In Boreholes ACB-02 to ACB-06 coring methods were used to advance the boreholes below the cohesive deposit due to the presence of cobbles and boulders. A DCPT was carried in Borehole ACB-07 between depths of about 30.6 m and 32.4 m below existing ground surface.

The groundwater conditions and water levels in the boreholes (i.e., generally inside the 'NW' casing) were typically observed during drilling operations and measured upon completion of drilling. However, the measured water levels are considered not representative of the groundwater conditions at the site due to introduction of drilling water during wash boring and coring operations. Artesian groundwater conditions were encountered in

Borehole ACB-02 at a depth of about 28.2 m below the existing ground surface; however, flowing artesian groundwater conditions were not observed. All boreholes were backfilled upon completion of drilling/coring in accordance with Ontario Regulation 903 (Wells) (as amended). During a subsequent 2018 field investigation at several culvert sites associated with the Highways 129, 532 and 556 project, the Achigan Creek Bridge site was revisited and a standpipe piezometer was installed at the southwest corner of the bridge (immediately next to Borehole ACB-03) to permit groundwater monitoring at this site. The standpipe piezometer consisted of a 50 mm diameter PVC pipe, with a slotted screen sealed partially in the surficial granular fill and partially within the underlying native granular deposit. The borehole and the annulus surrounding the screen and the solid portion of the piezometer pipe was backfilled with sand. The standpipe piezometer installation details and the water level readings are provided on the Record of Borehole sheet for ACB-03 presented in Appendix B. The standpipe piezometer was decommissioned on August 15, 2018 in accordance with Ontario Regulation 903 (Wells) (as amended).

Prior to commencement of the 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/coring, in-situ testing and sampling operations, and logged the boreholes in the field. The soil and cobble/boulder core samples were transported to Golder's Mississauga geotechnical laboratory where the samples underwent further visual examination and geotechnical laboratory testing.

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

Two soil samples were also collected from Boreholes ACB-04 and ACB-06 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 Achigan Creek Bridge by Callon Dietz Inc. prior to the drilling crew mobilizing to site. Upon completion of drilling/coring operations, borehole offsets and corresponding ground surface elevation differences were recorded and tied-in to the surveyed benchmarks 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 with latitude/longitiude coordinate systems) and the ground surface elevations referenced to Geodetic datum, are provided on the borehole records in Appendix B, presented on Drawing 1, and summarized below.

Approximate Location	Borehole Designation	Coordinates (MTM NAD83 Zone 13)		Ground Surface Elevation	Borehole Depth
		Northing (Latitude)	Easting (Longitude)		
Temporary Modular Bridge – South Portion of Temporary Detour Alignment	ACB-01	5183314.9 m (46.789381°)	300612.5 m (-84.054853°)	238.9 m	15.9 m

Approximate Location	Borehole Designation	Coordinates (MTM NAD83 Zone 13)		Ground Surface Elevation	Borehole Depth
		Northing (Latitude)	Northing (Latitude)		
Achigan Creek Bridge – South Abutment	ACB-02	5183317.1 m (46.789401°)	300617.3 m (-84.054790°)	238.9 m	32.0 m
	ACB-03	5183333.1 m (46.789545°)	300610.5 m (-84.054880°)	238.3 m	32.0 m
Temporary Modular Bridge – South Abutment	ACB-04	5183335.1 m (46.789563°)	300606.0 m (-84.054938°)	238.0 m	32.5 m
Temporary Modular Bridge – North Abutment	ACB-05	5183392.1 m (46.790075°)	300606.9 m (-84.054927°)	237.8 m	32.3 m
Achigan Creek Bridge – North Abutment	ACB-06	5183385.9 m (46.790020°)	300615.1 m (-84.054820°)	238.8 m	32.0 m
	ACB-07	5183380.3 m (46.790020°)	300627.3 m (-84.054660°)	238.2 m	32.4 m [1]
Temporary Modular Bridge – North Portion of Temporary Detour Alignment	ACB-08	5183407.7 m (46.790216°)	300610.7 m (-84.054878°)	238.4 m	15.9 m

Note:
1. Borehole depth includes DCPT carried out between depths of about 30.6 m and 32.4 m below the existing ground surface.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain (NOEGTS)[1] mapping, the Achigan Creek Bridge site is located within a valley train/outwash plain 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)[2], 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 Soil and Bedrock Conditions

The subsurface soil and groundwater conditions encountered in the boreholes advanced at this site as part of the current foundation investigation, together with the results of the in-situ and geotechnical/analytical laboratory testing, are presented on the Records of Boreholes (provided in Appendix B) and the laboratory test figures/sheets (provided in Appendices C and D). The results of the in-situ field tests (i.e., measured SPT ‘N’-values and undrained shear strengths) as presented on the borehole records and in Section 4.2 are uncorrected, and are based on SPT sampling procedures carried out with an automatic hammer and field vane shear test procedures carried out with an MTO ‘N’-size vane, respectively.

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

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

The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic profiles and sections (i.e., Drawings 1 to 3) are inferred from observations of drilling progress, non-continuous sampling, coring, and in-situ testing, and therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions encountered at the Achigan Creek Bridge site consist of granular fill underlain by an upper granular deposit (comprised predominantly of sandy silt to silty sand to sand), underlain by an extensive deposit of clayey silt to silty clay which is varved near the upper portion of deposit and irregularly stratified at depth. The cohesive deposit is in turn underlain by a lower granular deposit with cobbles and boulders.

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

4.2.1 Asphalt

An approximately 40 mm thick layer of asphalt was encountered at the ground surface in Borehole ACB-02, which was advanced through the travelled portion of Highway 532 on the south side of the Achigan Creek Bridge.

4.2.2 Sandy Silt to Silty Sand to Sand to Sand and Gravel (Fill)

A granular fill was encountered below the layer of asphalt in Borehole ACB-02 and immediately at the ground surface in the remaining boreholes, except in Borehole ACB-07. The composition of the fill is quite variable, ranging from more fine-grained material (i.e., sandy silt to sand and silt to silty sand) to more coarse-grained material (i.e., sand to gravelly sand to sand and gravel). Trace organics were noted within the fill in Borehole ACB-04. The top of the fill was encountered at elevations between about 238.9 m and 237.8 m, and the overall thickness of the fill varies between approximately 0.7 m and 3.0 m.

The SPT ‘N’-values measured within the fill generally range from 6 blows to 24 blows per 0.3 m of penetration, indicating a loose to compact state of compactness. Higher SPT ‘N’-values ranging from 38 blows to 52 blows per 0.3 m of penetration, and indicating a dense to very dense state of compactness, were measured within the sand to gravelly sand to sand gravel portion of the fill.

The water content measured on nine samples of the fill ranges between about 4% and 19%.

The results of grain size distribution tests carried out on three samples of the fill recovered from Boreholes ACB-03, ACB-04, and ACB-08 are shown on Figure C1 in Appendix C.

4.2.3 Sandy Silt to Sand and Silt to Silty Sand to Sand (Upper Granular Deposit)

An upper granular deposit comprised predominantly of sandy silt to sand and silt to silty sand to sand was encountered immediately at the ground surface in Borehole ACB-07 and below the fill in the remaining boreholes. A more coarse-grained deposit comprised of sand and gravel was encountered below the sand fill in Borehole ACB-08 advanced on the north side of the creek. In Borehole ACB-03, inclusions/layers of organic silt and peat were encountered within the sand and silt deposit between depths of about 2.6 m and 3.7 m below existing ground surface. Trace organics were also noted within the upper granular deposit encountered in Borehole ACB-05. The top of this deposit was encountered at depths ranging between about 0 m (i.e., at the ground surface in Borehole ACB-07) and 3.0 m below the existing ground surface (between Elevations 238.2 m and 235.0 m), and the thickness of this deposit varies between approximately 0.9 m and 2.6 m.

In general, the SPT 'N'-values measured within the sandy silt to sand and silt to silty sand to sand portion of the upper granular deposit range from 0 blows (weight of hammer) to 9 blows per 0.3 m of penetration, indicating a very loose to loose state of compactness. Two SPT 'N'-values of 31 blows and 39 blows per 0.3 m of penetration were measured within the sand and gravel deposit encountered in Borehole ACB-08, indicating dense state of compactness.

The water contents measured on 15 samples of the upper granular deposit generally range between about 6% and 33%. A water content measured on a sample of the sand and silt deposit recovered from Borehole ACB-03 is about 56%, and the high water content is likely attributed to the presence of organic silt and peat inclusions/layers.

The results of grain size distribution tests carried out on seven samples of the sandy silt to sand and silt to silty sand to sand portion of the upper granular deposit are shown on Figure C2A in Appendix C. The result of a grain size distribution test carried out on a sample of the sand and gravel portion of the upper granular deposit is shown on Figure C2B in Appendix C.

Atterberg limits tests were also carried out on the fines portion of three samples of the upper granular deposit. A test carried out on a sample of a sandy silt recovered from Borehole ACB-02 measured a liquid limit of 25%, a plastic limit of 23%, and a corresponding plasticity index of about 2%. The results of this Atterberg limits test are shown in Figure C3 of Appendix C, and indicate that the fines portion of this material is classified as a silt of low plasticity. The results of Atterberg limits tests carried out on two other samples recovered from Boreholes ACB-03 and ACB-05 indicate that the fines portion of these materials is non-plastic.

A consolidated drained direct shear test was also carried out on samples of the sand and silt to silty sand deposit recovered from Borehole ACB-05. The results are presented on Figure C4.

4.2.4 Clayey Organic Silt

A thin layer of clayey organic sandy silt, was encountered below the sand and silt deposit in Borehole ACB-03. The top of this layer was encountered at a depth of about 4.7 m below existing ground surface, corresponding to Elevation 233.6 m, and is approximately 0.3 m thick.

The SPT 'N'-value measured within this deposit is 2 blows per 0.3 m of penetration, indicating a very soft to soft consistency.

The water content measured on a sample of this deposit is about 44%.

4.2.5 Clayey Silt to Silty Clay (Varved to Irregularly Stratified)

An extensive cohesive deposit comprised of clayey silt to silty clay was encountered below the upper granular deposit in all boreholes, except in Borehole ACB-03, where the cohesive deposit was encountered below the layer of clayey organic silt. The upper portion of the cohesive deposit (above approximately Elevation 228.0 m) is varved (i.e., generally comprised of clayey silt and silty clay laminae). Photographs of the varved cohesive specimens recovered from six Shelby tube samples are shown on Figure C5A in Appendix C. The lower portion of the cohesive deposit (below approximately Elevation 228.0 m) is stratified, but the layers are not oriented or shaped in a regularly repeating pattern as compared to the varved upper portion of the cohesive deposit where the laminae are arranged in horizontal layers parallel to each other. Photographs of the irregularly stratified cohesive specimens recovered from four Shelby tube samples are shown on Figure C5B in Appendix C. The top of this

cohesive deposit was encountered at depths ranging between about 2.6 m and 5.0 m (between Elevations 235.6 m and 233.3 m). Boreholes ACB-01 and ACB-08 were terminated within this deposit at a depth of about 15.9 m below existing ground surface, corresponding to Elevations 223.1 m and 222.6 m, respectively. The thickness of the clayey silt to silty clay deposit that was fully penetrated ranges from approximately 22.1 m to 27.4 m.

The SPT 'N'-values measured within the cohesive deposit generally range between 0 blows (i.e., weight of hammer) and 18 blows per 0.3 m of penetration. In-situ vane tests carried out within the varved upper portion of the deposit (above Elevation 228 m) measured (uncorrected) undrained shear strength ranging from about 38 kPa to 72 kPa, but on average is about 62 kPa. In-situ vane tests carried out within the lower irregularly stratified portion of the deposit measured undrained shear strength ranging from about 67 kPa to 112 kPa, but on average is about 94 kPa. The sensitivity (defined as the quotient between the undisturbed shear strength and the remoulded shear strength) ranges between about 4 and 13, but typically varies from 5 to 8. The higher sensitivities (i.e., 10 or greater) were only recorded in Borehole ACB-04. The in-situ field vanes tests results together with the SPT 'N'-values indicate that this deposit has a predominantly stiff to very stiff consistency; however, one field vane test measured in Borehole ACB-07 indicates that the cohesive deposit is firm. One SPT 'N'-value measured near the bottom of the cohesive deposit in Borehole ACB-06 is 109 blows per 0.23 m of penetration. The high blow count can likely be attributed to the presence of a cobble.

The water content measured on 62 samples of this deposit ranges from about 27% to 44% and on average is 37%. A single water content measured on a sample recovered from Borehole ACB-07 is about 3%, but this low water content is likely associated with a sand seam/inclusion encountered within the deposit.

The results of grain size distribution tests carried out on six samples of the clayey silt to silty clay deposit are shown on Figure C6 in Appendix C. Atterberg limits tests were carried out on 39 samples of the clayey silt to silty clay deposit. The tests measured liquid limits between about 24% and 39%, plastic limits between about 18% and 21%, and plasticity indices between about 5% and 13%. The results of the Atterberg limits tests are shown on the plasticity charts on Figures C7A to C7E in Appendix C, and indicate that the material can be generally classified as a mixture of clayey silt of low plasticity and silty clay of intermediate plasticity.

Laboratory consolidation tests were also carried out on two specimens of the clayey silt to silty clay deposit obtained from Shelby tube samples recovered from Boreholes ACB-04 and ACB-05. The preconsolidation stresses was estimated for each specimen from the respective void ratio versus logarithmic pressure plot and from the total work versus pressure plot. Details of the test results are shown on Figures C8 and C9 in Appendix C and the test results are summarized below.

Borehole/ Sample No.	Sample Depth (Elevation)	γ (kN/m^3) (G_s)	σ'_{vo} (kPa)	σ'_p (kPa)	$\sigma'_{vo} - \sigma'_p$ (kPa)	OCR	C_c	C_r	e_o	c_v [1] (cm^2/s)
ACB-04 SA 12	12.7 m (237.9 m)	17.7 (2.74)	140	450	330	3.2	0.52	0.025	1.15	1.7×10^{-2}
ACB-05 SA 11	11.1 m (238.0 m)	17.6 (2.71)	125	275	130	2.2	0.43	0.025	1.16	7.2×10^{-3}

Note:
1. The coefficient of consolidation is based on a stress range between the existing in-situ effective overburden stress and the stress due to an up to about 1.5 m high embankment constructed along the proposed temporary detour alignment. The final stress is estimated to be less than the preconsolidation stress and within the over consolidated stress range.

where: γ is the bulk unit weight in kN/m^3
G_s is the specific gravity
σ'_{vo} is the effective overburden stress in kPa
σ'_p is the preconsolidation stress in kPa
OCR is the overconsolidation ratio
OCR is the overconsolidation ratio
C_c is the compression index
C_r is the recompression index
e_o is the initial void ratio
c_v is the coefficient of consolidation in cm^2/s

4.2.6 Sandy Silt to Silty Sand to Silty Sand and Gravel with Cobbles and Boulders (Lower Granular Deposit)

A lower granular deposit comprised of sandy silt to silty sand to silty sand and gravel was encountered below the clayey silt to silty clay deposit, and sampled with a split-spoon sampler in in Boreholes ACB-02, ACB-06 and ACB-07. In Boreholes ACB-03 to ACB-05, the granular deposit in the lower portion of the boreholes was not sampled with a split-spoon sampler, but is inferred to consist of a deposit of a silty sand, some gravel based on: i) close proximity to the other boreholes advanced at the site to similar depths that were sampled with a split-spoon sampler; ii) difficulties with casing advancement, and; iii) presence of cobbles and/or boulders which were confirmed in six boreholes (not including in Borehole ACB-07 where a DCPT was carried out) by rock coring.

Frequent rock fragments, cobbles, and boulders were encountered within this lower granular deposit. The size of the cobbles and boulders recovered from zones which required rock coring to advance the boreholes were noted to range between about 100 mm and 620 mm. Frequent gravel pieces and rock fragments ranging in size from about 20 mm to 70 mm were also recovered. Photographs of the recovered rock fragments, cobbles, and boulders are shown on Figure C10 in Appendix C. The top of this deposit was encountered at depths ranging between about 27.1 m and 30.0 m below existing ground surface (between Elevations 211.2 m and 208.2 m). Boreholes ACB-02 to ACB-07 were terminated with the lower granular deposit at depths ranging from about 30.6 m to 32.5 m (between Elevations 207.6 m and 205.5 m). In Borehole ACB-07, a DCPT was also carried out between depths ofabout 30.6 m (Elevation 207.6 m) and 32.4 m (Elevation 205.8 m).

The SPT 'N'-values measured within this lower granular deposit were 78 blows for 0.03 m of penetration, 101 blows per 0.3 m of penetration, and 100 blows per 0.15 m of penetration, indicating a very dense state of compactness. These high blow counts can be attributed to the cobbley/bouldery nature of this deposit.

The water content measured on three samples of the lower granular deposit range between about 10% and 23%.

The results of grain size distribution tests carried out on three samples of the lower granular deposit are shown on Figure C11 in Appendix C. Atterberg limits tests were carried out on the fines portion of two samples recovered from Boreholes ACB-02 and ACB-06. The results indicate that the fines portion of this material is non-plastic.

4.3 Groundwater Conditions

The majority of the boreholes were advanced using wash boring techniques which involved the introduction of drilling water. As such, the water level measurements taken upon completion of drilling operations are not considered representative of the groundwater conditions at the site. However, the lower portion of the upper granular deposit, which was typically advanced using hollow- or solid-stem augers, was noted to be wet. Wet soil samples were collected below elevations ranging between about 236.9 m and 234.1 m, and on average below approximately Elevation 235.8 m

As described in Section 3.2, during a subsequent 2018 field investigation at several culvert sites associated with the Highways 129, 532 and 556 project, the Achigan Creek Bridge site was revisited and a standpipe piezometer was installed at the southwest corner of the bridge (immediately next to Borehole ACB-03) to permit groundwater monitoring at the site. Details of the piezometer installation are shown on the Record of Borehole sheet for ACB-03 in Appendix B. The groundwater level was measured daily between August 12 and 15, 2018 at a depth of about 4.5 m below existing ground surface, corresponding to Elevation 233.8 m. The standpipe piezometer was decommissioned on August 15, 2018 in accordance with Ontario Regulation 903 (Wells) (as amended).

It is also noted that artesian groundwater conditions were encountered in Borehole ACB-02 at a depth of about 28.2 m (Elevation 210.7 m), which likely corresponds to the top of the lower granular deposit. Although the groundwater was not observed to be flowing out of the drill casing (i.e., flowing artesian groundwater conditions were not observed) when the lower granular deposit was penetrated, the drillers did note "higher groundwater pressures" making casing advancement more difficult.

The groundwater level at the site is anticipated to fluctuate seasonally in response to changes in precipitation, and should be expected to be higher during wet seasons or during any heavy and/or sustained periods of precipitation. Furthermore, given the presence of a layer of granular fill and/or an upper granular deposit encountered near the ground surface, and considering that the granular deposit is underlain by a cohesive deposit with a relatively low permeability, a perched water table condition may exist within the granular fill/upper granular deposit. The perched water table is also subject to seasonal fluctuations and precipitation events.

The water level measured in the Achigan Creek on November 1, 2017 was at approximately Elevation 234.9 m.

4.4 Analytical Testing of Soil

Two soil samples were selected from Boreholes ACB-04 (advanced near the south abutment of the Achigan Creek Bridge) and ACB-06 (advanced near the north abutment of the Achigan Creek Bridge) and submitted to Maxxam Analytics of Mississauga, Ontario for corrosivity testing. The analytical laboratory test results are provided on the Certificate of Analysis presented in Appendix D, and summarized below.

Borehole Designation	Sample No.	Average Approx. Sample Depth (m)	Average Approx. Sample Elevation (m)	Material Type	Resistivity (ohm·cm)	Conductivity (µohm/cm)	pH	Chloride (Cl) Content (ppm or µg/g)	Sulphate (SO_4) Content (ppm or µg/g)
ACB-04 [1]	SA 4	2.6 m	235.7	Silt and Sand	7,300	135	6.5	58	<20 [2]
ACB-06 [1]	SA 3	2.6 m	236.2	Sand	7,200	139	5.0	70	<20 [2]

Notes:
1. It is noted that corrosivity 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. The sulphate concentration is below the reportable detection limit of 20 µg/g.

It is noted that the sulphide content measured on the soil samples recovered from Boreholes ACB-04 and ACB-06 was also analyzed and is approximately 0.69 µg/g and 0.60 µg/g, respectively.

5.0 CLOSURE

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

Report Signature Page

GOLDER ASSOCIATES LTD.

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Tomasz Zalucki, P.Eng.
Geotechnical Engineer

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J. P. DITTRICH
Aug 30, 2018
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Paul Dittrich, Ph.D. P.Eng.
MTO Foundations Designated Contact, Principal

AK/TZ/JPD/ak

https://golderassociates.sharepoint.com/sites/14262g/deliverables/04-final fidr/achigan creek bridge/1670846-08a-rpt-rev0-achigan creek bridge fir-20180830.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 D2573 Standard Test Method for Field Vane Shear Strength Test in Cohesive Soils

Ontario Regulations:

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

DRAWINGS

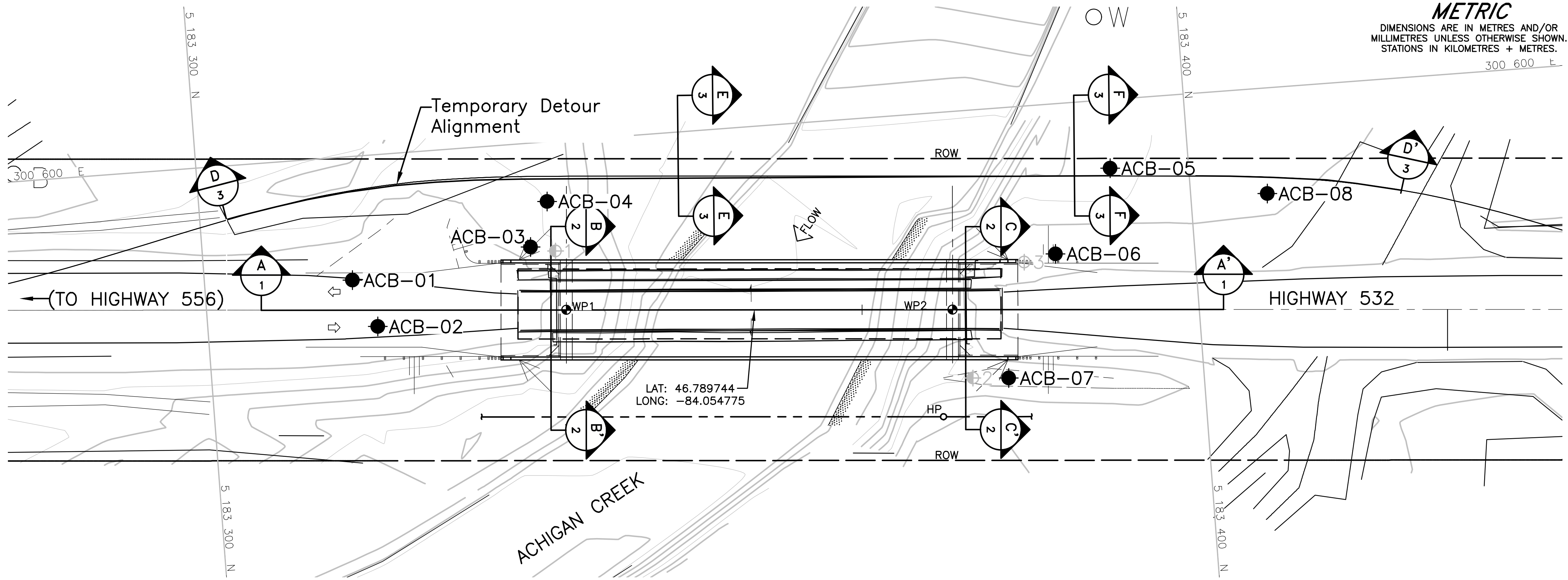
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 151–97–01

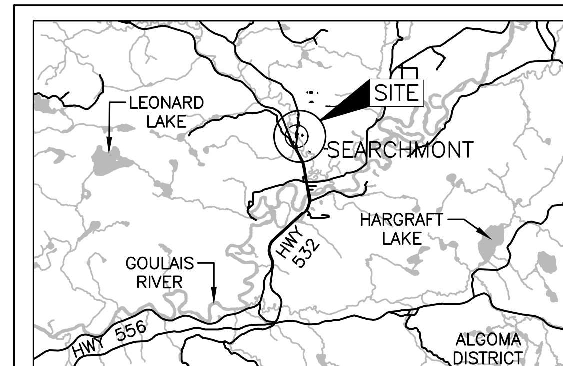
HIGHWAY 532
ACHIGAN CREEK BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates



PLAN
SCALE
5 0 5 10 m

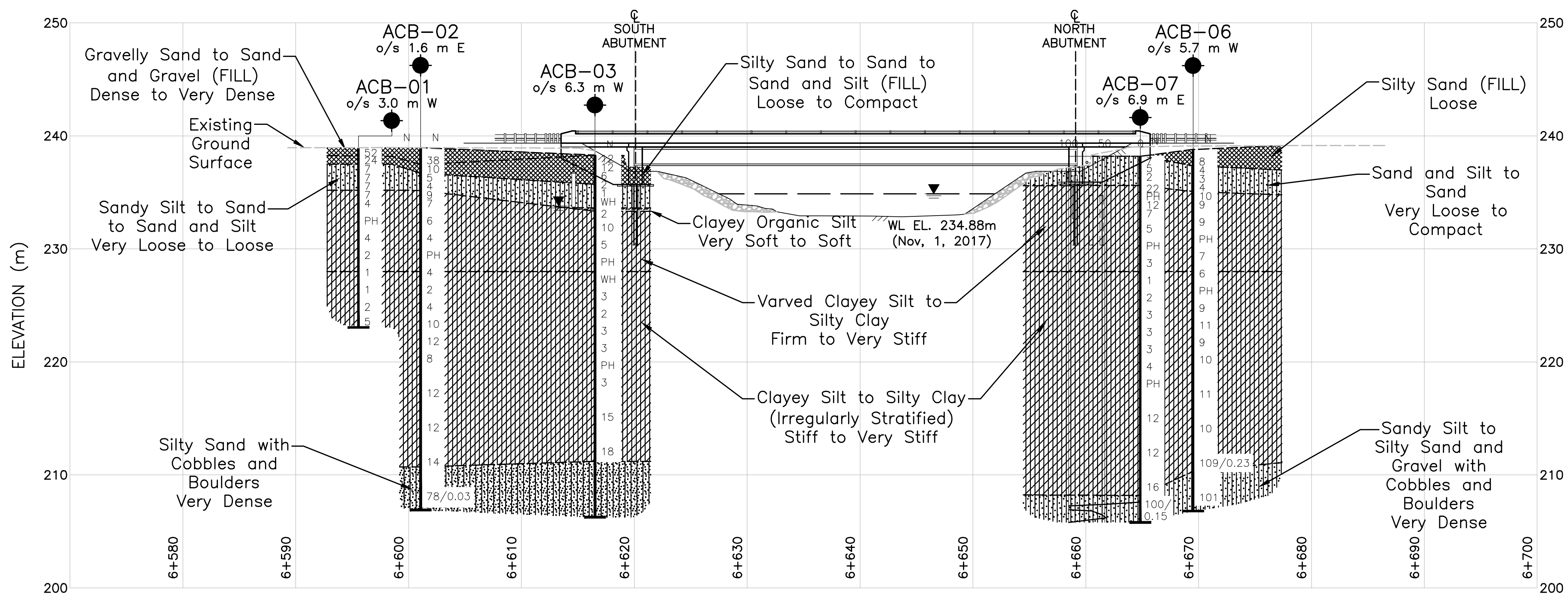


LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation (MTO Geocres No. 41K–041)
- DCPT – Previous Investigation (MTO Geocres No. 41K–041)
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Piezometer
- WL in piezometer, measured on August 15, 2018

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 13)

No.	ELEVATION	NORTHING	EASTING
1	237.8	5183335.6	300611.1
2	237.8	5183376.7	300627.0
3	238.3	5183382.7	300615.7
ACB–01	238.9	5183314.9	300612.5
ACB–02	238.9	5183317.1	300617.3
ACB–03	238.3	5183333.1	300610.5
ACB–04	238.0	5183335.1	300606.0
ACB–05	237.8	5183392.1	300606.9
ACB–06	238.8	5183385.9	300615.1
ACB–07	238.2	5183380.3	300627.3
ACB–08	238.4	5183407.7	300610.7



A–A' / 1 CENTRELINE PROFILE
ACHIGAN CREEK BRIDGE
SCALE
5 0 5 10 m

NOTES

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

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

REFERENCE

Base plans provided in digital format by AECOM, drawing file nos. 60546679-S1.dwg and GWP 5378-11-00 Achigan Creek Bridge Detour Alignment.dwg, received on August 27, 2018.

LICENSED PROFESSIONAL ENGINEER J.P. DITTRICH August 29, 2018 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER T. ZALUCKI 100128614 August 29, 2018 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	

Geocres No. 41K–108

HWY. 532	PROJECT NO. 1670846		DIST. ALGOMA
SUBM'D. AK	CHKD.	DATE: 8/29/2018	SITE: 38S–041
DRAWN: TB	CHKD. TZ	APPD. JPD	DWG. 1

MINISTRY OF TRANSPORTATION, ONTARIO

PLOT DATE: August 30, 2018

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

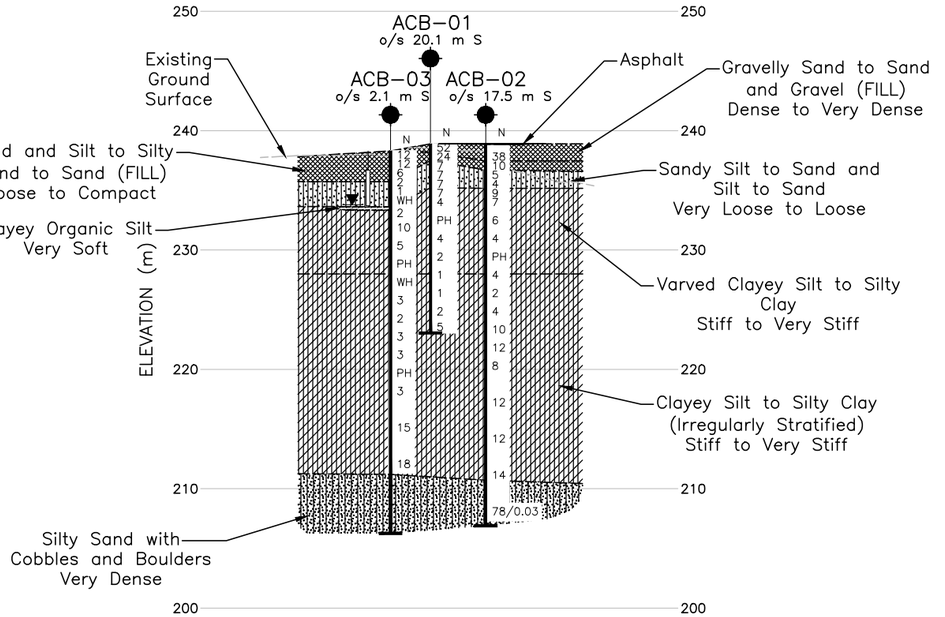
CONT No.
WP No. 151-97-01

HIGHWAY 532
ACHIGAN CREEK BRIDGE

SOIL STRATA

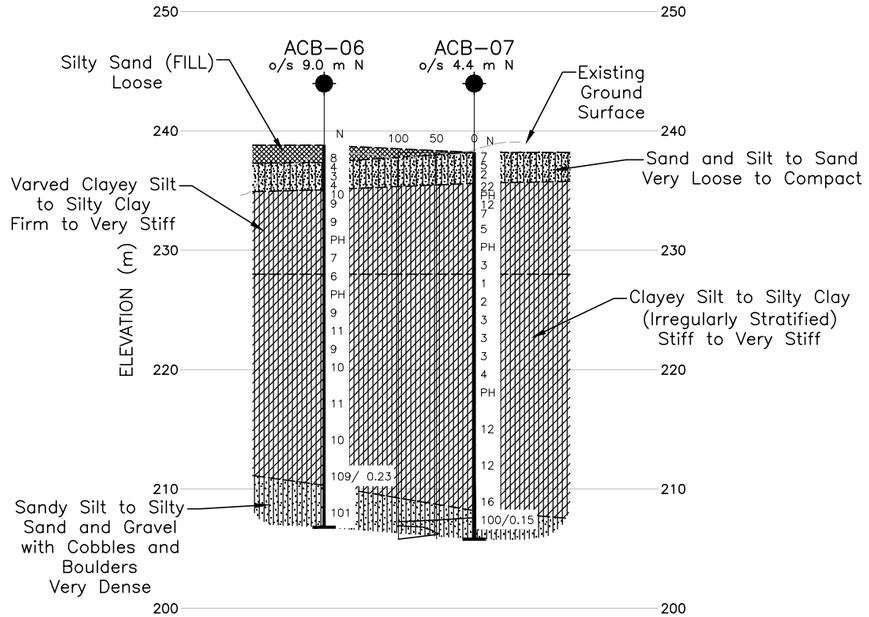
SHEET

Golder Associates



B-B' / 1 SOUTH ABUTMENT CROSS-SECTION
ACHIGAN CREEK BRIDGE

SCALE
5 0 5 10 m



C-C' / 1 NORTH ABUTMENT CROSS-SECTION
ACHIGAN CREEK BRIDGE

SCALE
5 0 5 10 m

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Piezometer
- WL in piezometer, measured on August 15, 2018

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 13)

No.	ELEVATION	NORTHING	EASTING
ACB-01	238.9	5183314.9	300612.5
ACB-02	238.9	5183317.1	300617.3
ACB-03	238.3	5183333.1	300610.5
ACB-06	238.8	5183385.9	300615.1
ACB-07	238.2	5183380.3	300627.3

NOTES

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August 29, 2018
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
T.ZALUCKI
100128614
August 29, 2018
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41K-108

HWY. 532		PROJECT NO. 1670846	DIST. ALGOMA
SUBM'D. AK	CHKD. .	DATE: 8/29/2018	SITE: 38S-041
DRAWN: TB	CHKD. TZ	APPD. JPD	DWG. 2

PLOT DATE: August 30, 2018
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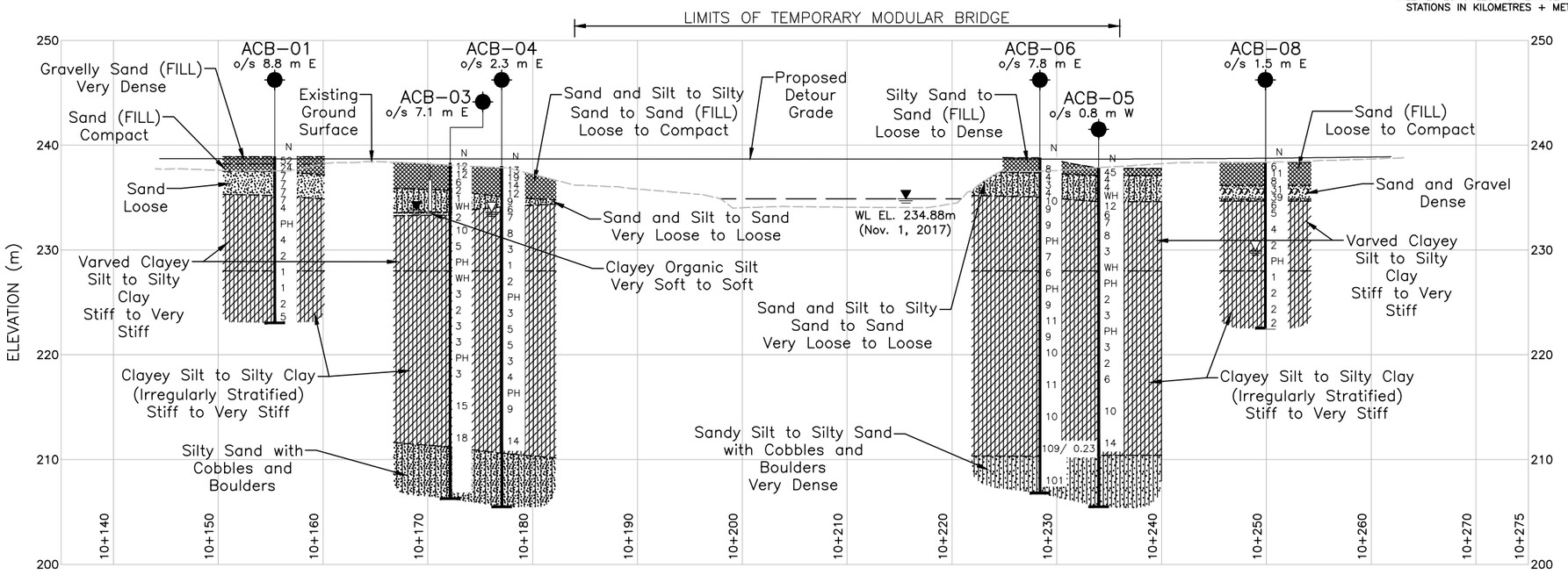
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 151-97-01

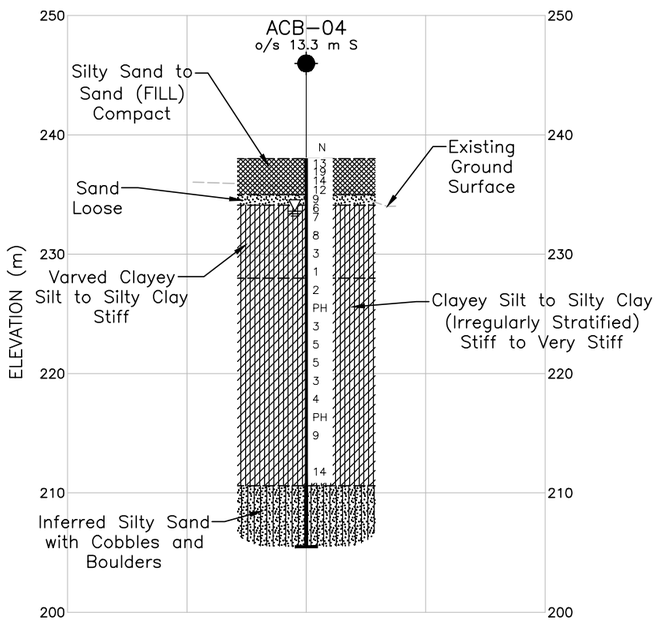
HIGHWAY 532
TEMPORARY MODULAR BRIDGE
SOIL STRATA

SHEET
.

Golder Associates



D-D' / 1 CENTRELINE PROFILE
TEMPORARY MODULAR BRIDGE
SCALE
5 0 5 10 m



E-E' / 1 SOUTH ABUTMENT CROSS-SECTION
TEMPORARY MODULAR BRIDGE
SCALE
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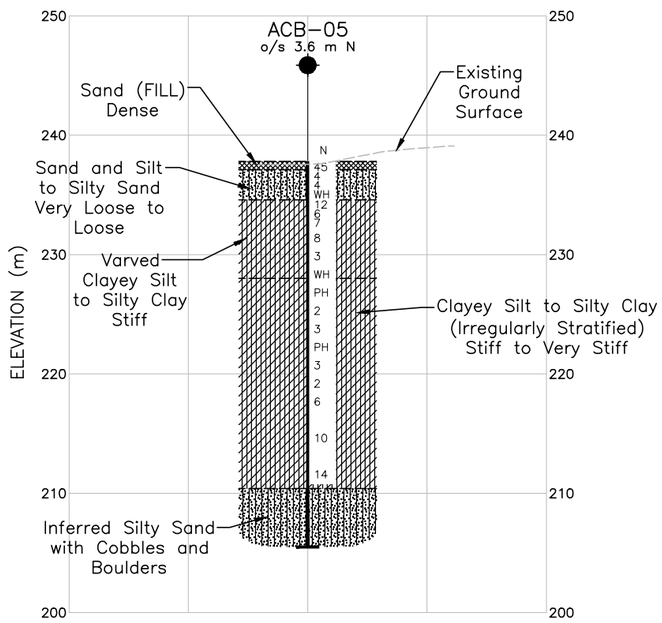

F-F' / 1 NORTH ABUTMENT CROSS-SECTION
TEMPORARY MODULAR BRIDGE
SCALE
5 0 5 10 m

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling
- Piezometer
- WL in piezometer, measured on August 15, 2018

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 13)

No.	ELEVATION	NORTHING	EASTING
ACB-01	238.9	5183314.9	300612.5
ACB-03	238.3	5183333.1	300610.5
ACB-04	238.0	5183335.1	300606.0
ACB-05	237.8	5183392.1	300606.9
ACB-06	238.8	5183385.9	300615.1
ACB-08	238.4	5183407.7	300610.7

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.

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REFERENCE

Base plans provided in digital format by AECOM, drawing file nos. 60546679-S2.dwg and GWP 5378-11-00 Achigan Creek Detour Alignment.dwg, received on August 27, 2018.

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LICENSED PROFESSIONAL ENGINEER
T.ZALUCKI
100128614
August 29, 2018
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41K-108

HWY. 532	PROJECT NO. 1670846		DIST. ALGOMA
SUBM'D. AK	CHKD. ,	DATE: 8/29/2018	SITE: 38S-041
DRAWN: TB	CHKD. TZ	APPD. JPD	DWG. 3

APPENDIX A

Previous Borehole Investigation (MTO Geocres No. 41K-041)

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO 08-MT-3088 6-78

METRIC

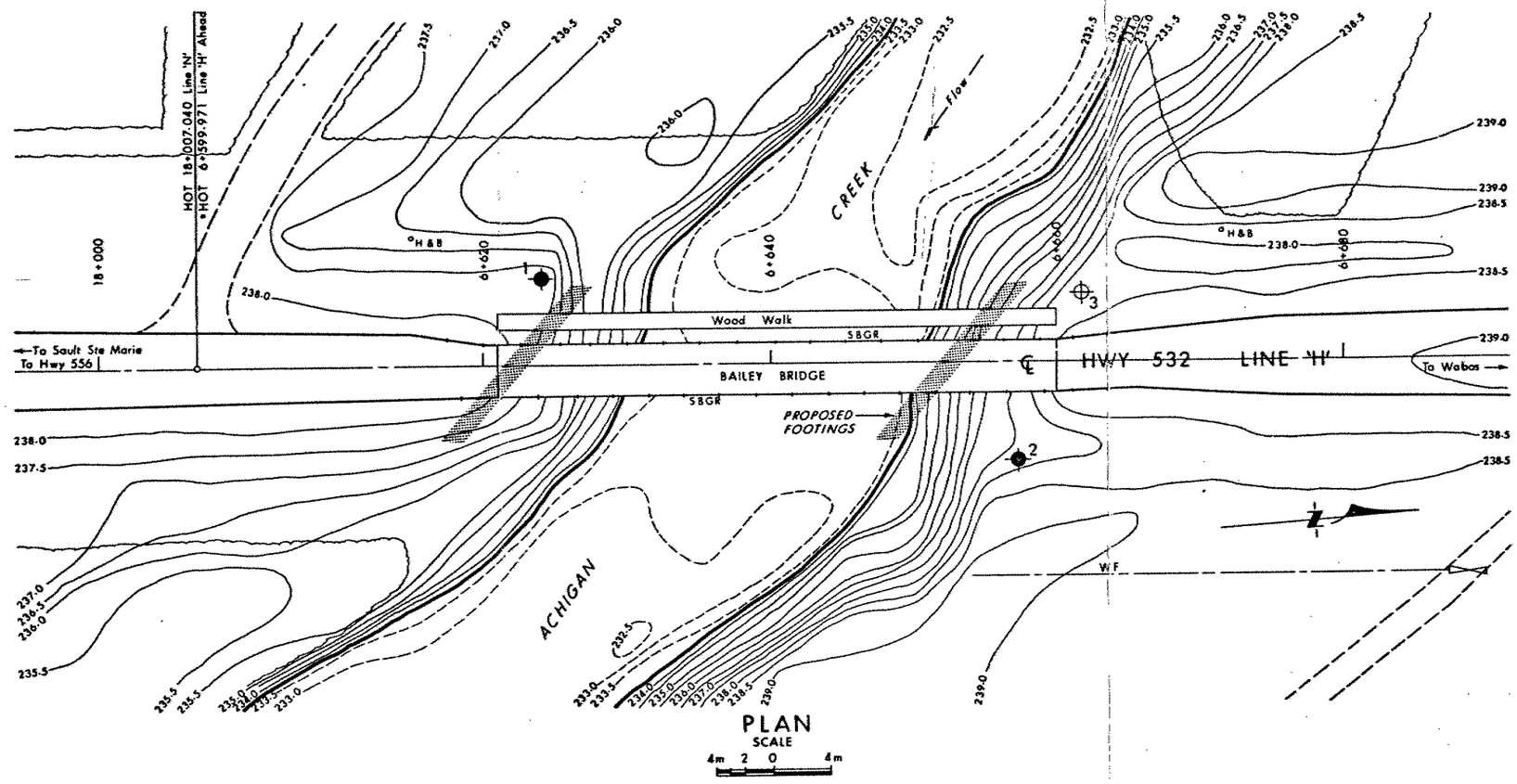
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 148-65-00

ACHIGAN CREEK BRIDGE

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



PLAN
SCALE
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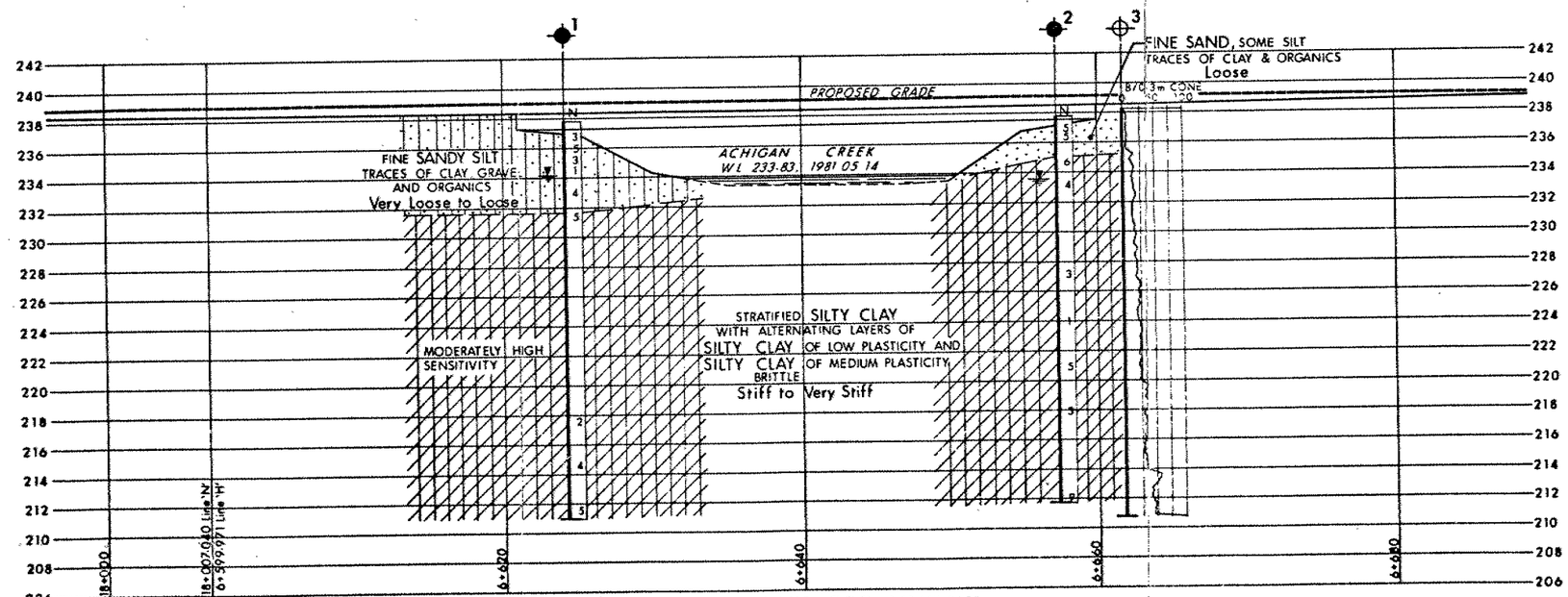

℄ PROFILE HWY 532 LINE 'H'
SCALE
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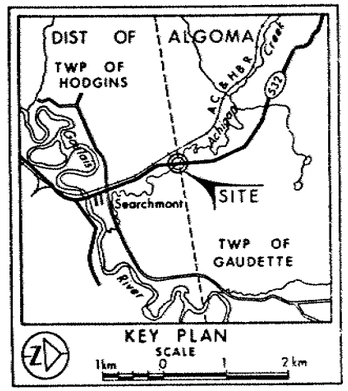


LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1981 09

No	ELEVATION	STATION	OFFSET
1	237.8	6+624.1	6.1m Lt
2	237.8	6+657.2	6.9m Rt
3	238.3	6+661.7	4.8m Lt

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS

DATE	BY	DESCRIPTION

Geocres No 41K-41

HWY No 532			DIST 18
SUBM'D N S	CHECKED	DATE 1981 10 27	SITE 38S-41
DRAWN	CHECKED	APPROVED	DWG 148650O-A

REF No E-8002-1 ; 1981 06

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 148-65-00 LOCATION Sta. 6+624.1; o/s 6.1 m Lt. of ℄ Highway 532 ORIGINATED BY N. S.

DIST 18 HWY 532 BOREHOLE TYPE Hollow Stem Continuous Flight Augers COMPILED BY N. S.

DATUM Geodetic DATE 81 09 05 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.8	Ground Surface										
0.0	Fine sandy silt with traces of clay and gravel and organics Very loose to loose		1	SS	3						
			2	SS	5		236				4 39 48 9
			3	SS	3	*					
			4	SS	1	▼	234				2 40 52 6
	Brown		5	SS	4						
231.6							232				
6.2	Stratified silty clay with alternating layers of silty clay of low plasticity and silty clay of medium plasticity Moderately high sensitivity stiff very stiff		6	SS	5			+8 +4			
			7	TW	PH		230	○ ● +2 +4	⊢○	18.5	0 0 60 40
			8	TW	PH		228	+7 +7			
							226	+8 +4			
			9	TW	PH		224	○ ● +10 +5 >+	⊢●	17.7	0 0 54 46
	Brittle Grey						222				
			10	TW	PH		220	>+			
			11	SS	2		218	>+	⊢○		
							216				
			12	SS	4		214	>+			
211.0			13	SS	5		212	>+	⊢○		
26.8	End of Borehole *Water level obtained on 81 09 06										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 148-65-00 LOCATION Sta. 6+657.2; o/s 6.9 m Rt. of ℄ Highway 532 ORIGINATED BY N. S.

DIST 18 HWY 532 BOREHOLE TYPE Hollow Stem Continuous Flight Augers COMPILED BY N. S.

DATUM Geodetic DATE 81 09 06 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.8	Ground Surface										
0.0	Fine sand with some silt and traces of clay and organics		1	SS	5						0 77 15 8
			2	SS	5		236				
	Loose										
235.0	Brown										
2.8			3	SS	6	*					
	Stratified silty clay with alternating layers of silty clay of low plasticity and silty clay of medium plasticity						234				
			4	SS	4			>+			
							232				
			5	TW	PH			b ● +5			18.6 0 1 54 45
							230				
	Very stiff										
							228				
			6	SS	3						
							226				
	Brittle										
	Grey		7	SS	1		224	+5			
							222				
			8	SS	5						
								>+			
							220				
			9	SS	3		218				
							216				
			10	TW	PH			a ● >+			18.0 0 1 50 49
							214				
211.7											
			11	SS	9		212				
26.1	End of Borehole										
	*Water level obtained on 81 09 06										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 148-65-00 LOCATION Sta. 6+661.7; o/s 4.8 m Lt. of ℄ Highway 532 ORIGINATED BY N. S.

DIST 18 HWY 532 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N. S.

DATUM Geodetic DATE 81 09 06 CHECKED BY

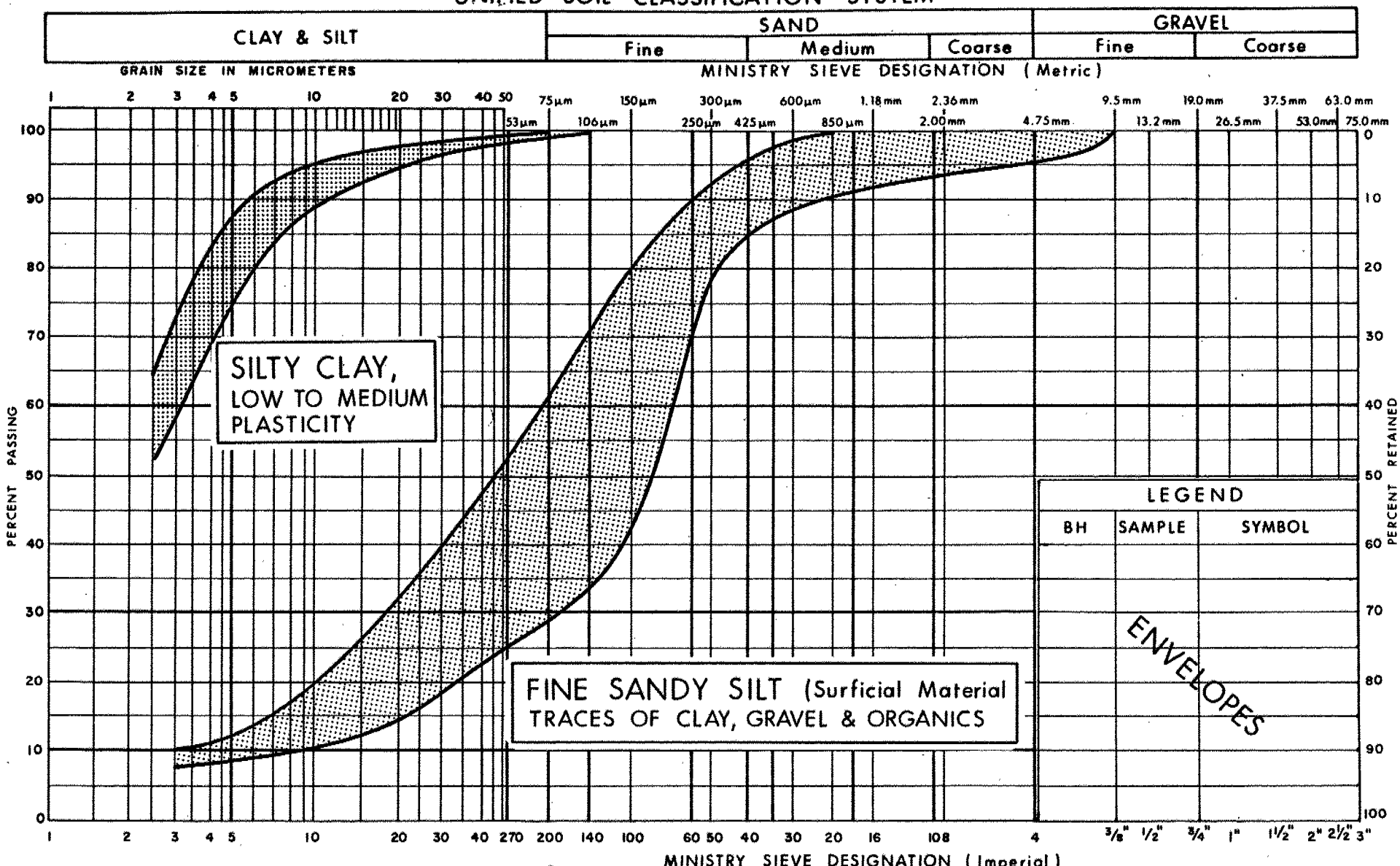
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
238.3	Ground Surface										
0.0							238				
							236				
							234				
							232				
							230				
							228				
							226				
							224				
							222				
							220				
							218				
							216				
							214				
							212				
210.8											
27.5	End of Cone Test							100/76 mm			

$+^3$, $\times^5$: Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



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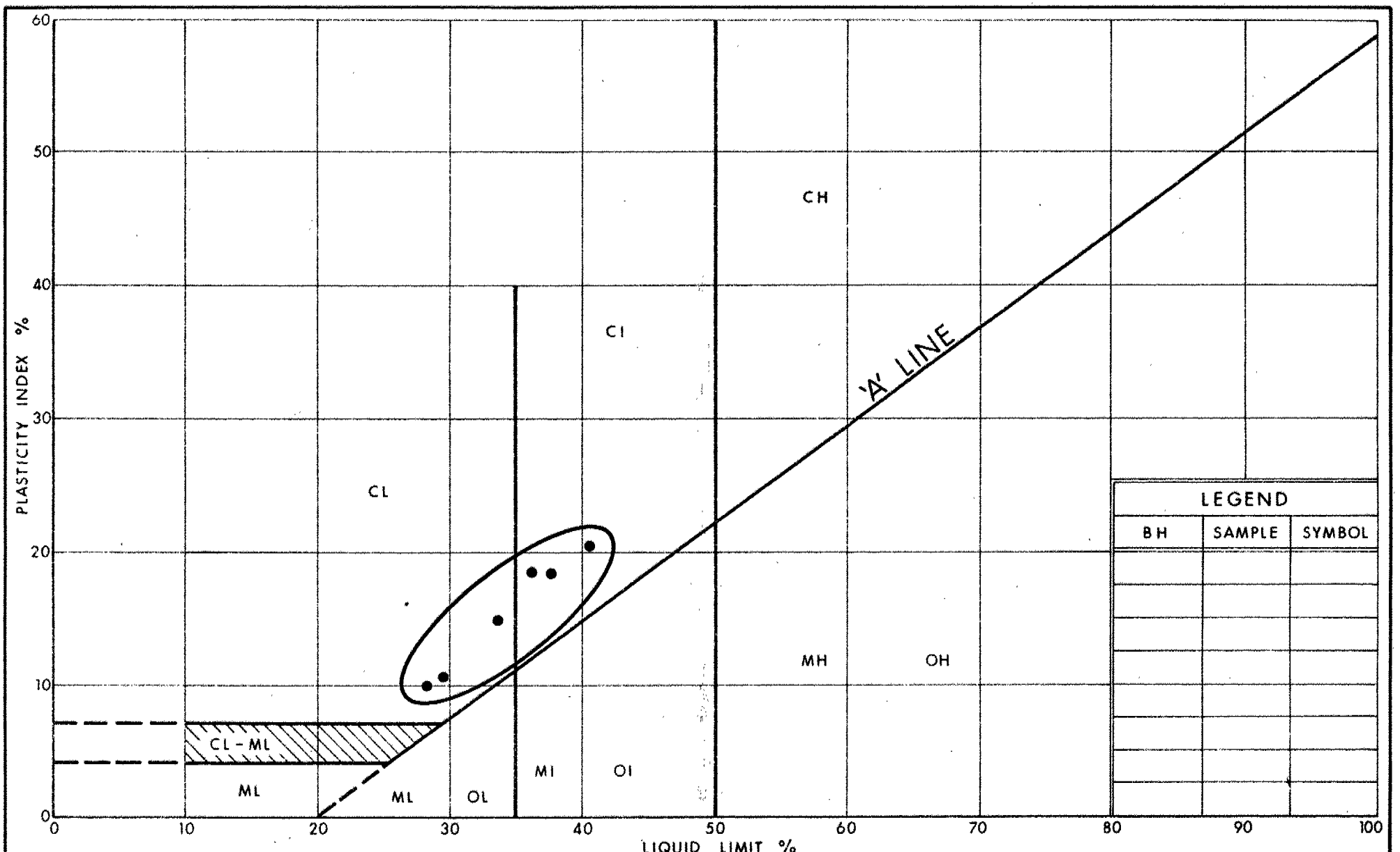
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 1
W P 148-65-00



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PLASTICITY CHART

SILTY CLAY, OF LOW TO MEDIUM PLASTICITY

FIG No 2

W P 148-65-00

APPENDIX B

Records of Borehole Sheets

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

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

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

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

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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

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

(b) Cohesive Soils
Consistency

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

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

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

GOLDER

RECORD OF BOREHOLE No ACB-01

SHEET 1 OF 2

METRIC

PROJECT 1670846

W.P. 151-97-01

LOCATION N 5183314.9; E 300612.5 MTM NAD 83 ZONE 13 (LAT. 46.789381; LONG. -84.054853)

ORIGINATED BY JL

DIST ALGOMA HWY 532

BOREHOLE TYPE 210 mm O.D. Continuous Flight Hollow Stem Augers

COMPILED BY AK

DATUM Geodetic

DATE August 22, 2017

CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.9	GROUND SURFACE										
0.0	Gravelly sand, trace silt (FILL) Very dense Brown		1	SS	52						
238.2	Moist										
0.7	Sand, trace to some gravel, trace silt (FILL) Compact		2	SS	24		238				
237.5	Brown Moist										
1.4	SAND, some silt, trace gravel, trace clay Loose Brown Moist to wet		3	SS	7		237				
			4	SS	7						4 76 19 1
	- Wet below a depth of about 3.0 m		5	SS	7		236				
235.2											
3.7	Varved CLAYEY SILT to SILTY CLAY, trace sand Stiff to very stiff Grey Wet		6	SS	7		235				
			7	SS	4		234	>96			
							233	>96			
			8	TO	PH						
							232	7			
			9	SS	4		231				
								8			
			10	SS	2		230				
							229	6			
228.0											
10.9	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		11	SS	1		228				
								6			
							227				
			12	SS	1						
							226	4			
							225				
			13	SS	2						
							224	>96			

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No ACB-01

SHEET 2 OF 2 **METRIC**

PROJECT 1670846
W.P. 151-97-01
DIST ALGOMA HWY 532
DATUM Geodetic
LOCATION N 5183314.9; E 300612.5 MTM NAD 83 ZONE 13 (LAT. 46.789381; LONG. -84.054853)
BOREHOLE TYPE 210 mm O.D. Continuous Flight Hollow Stem Augers
DATE August 22, 2017
ORIGINATED BY JL
COMPILED BY AK
CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
223.1			14	SS	5						
15.9	END OF BOREHOLE NOTE: 1. Borehole dry upon completion of drilling, prior to auger removal.										

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

GOLDER

RECORD OF BOREHOLE No ACB-02

SHEET 1 OF 3

METRIC

PROJECT 1670846

W.P. 151-97-01 LOCATION N 5183317.1; E 300617.3 MTM NAD 83 ZONE 13 (LAT. 46.789401; LONG. -84.054790) ORIGINATED BY AJ

DIST ALGOMA HWY 532 BOREHOLE TYPE 95 mm O.D. Solid Stem Augers; Wash Boring; NQ Coring COMPILED BY AK

DATUM Geodetic DATE September 11 and 12, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.9	GROUND SURFACE										
0.0 / 0.0	ASPHALT (about 40 mm thick)										
	Sand and gravel, trace silt (FILL) Dense Brown Moist		1	SS	38		238		○		
237.5											
1.4	Silty sand, trace clay (FILL) Compact Brown Moist		2	SS	10		237				
236.7											
2.2	Sandy SILT of slight plasticity, trace clay Very loose to loose Brown Moist		3	SS	5		236		‖ ○		0 23 75 2
			4A 4B	SS	4				○		
235.2	- An approximately 0.2 m thick layer of wet gravel, some sand encountered at a depth of about 3.5 m						235		⊢○		3 1 83 13
3.7	Varved CLAYEY SILT to SILTY CLAY, trace gravel, some sand Stiff to very stiff Grey Wet		5	SS	9						
			6	SS	7		234	+ 9			
			7	SS	6		233		○		
							232	+ >96			
			8	SS	4		231		⊢○		
								+ >96			
			9	TO	PH		230				
							229	+ >96			
228.0											
10.9	CLAYEY SILT to SILTY CLAY, trace gravel, trace sand, irregularly stratified Stiff to very stiff Grey Wet		10	SS	4		228				
			11	SS	2		227		⊢○		
							226	+ >96			
			12	SS	4		225				
							224	+ >96			

Continued Next Page

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

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACB-02

SHEET 2 OF 3

METRIC

W.P. 151-97-01 LOCATION N 5183317.1; E 300617.3 MTM NAD 83 ZONE 13 (LAT. 46.789401; LONG. -84.054790) ORIGINATED BY AJ

DIST ALGOMA HWY 532 BOREHOLE TYPE 95 mm O.D. Solid Stem Augers; Wash Boring; NQ Coring COMPILED BY AK

DATUM Geodetic DATE September 11 and 12, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT to SILTY CLAY, trace gravel, trace sand, irregularly stratified Stiff to very stiff Grey Wet		13	SS	10		223				
			14	SS	12		222				
			15	SS	8		221				
			16	SS	12		220	>96			
			17	SS	12		219				
			18	SS	14		218				
210.7							217				
28.2	SILTY SAND, some gravel, trace clay, with cobbles and boulders Very dense Grey Wet		-	RC	-		216				
							215				
							214				
							213				
							212				
							211				
							210				
							209				

Continued Next Page

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

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACB-02

SHEET 3 OF 3

METRIC

W.P. 151-97-01 LOCATION N 5183317.1; E 300617.3 MTM NAD 83 ZONE 13 (LAT. 46.789401; LONG. -84.054790) ORIGINATED BY AJ

DIST ALGOMA HWY 532 BOREHOLE TYPE 95 mm O.D. Solid Stem Augers; Wash Boring; NQ Coring COMPILED BY AK

DATUM Geodetic DATE September 11 and 12, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY SAND, some gravel, trace clay, with cobbles and boulders Very dense Grey Wet		-	RC	-						
			19	SS	78/0.03				○	Non-Plastic	15 61 23 1
							208				
206.9							207				
32.0	CASING AND SPLIT-SPOON REFUSAL END OF BOREHOLE										

NOTES:

1. Artesian groundwater conditions encountered below a depth of about 28.2 m (Elev. 210.8 m) during casing advancement.

2. The cored depth intervals and particle sizes of recovered cobbles/boulders are summarized as follows:

Depth (m)	Recovered
28.7 - 30.5	620mm; 110mm 100mm; 50mm to 70mm rock fragments/ gravel pieces

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

GOLDER

RECORD OF BOREHOLE No ACB-03

SHEET 1 OF 3

METRIC

PROJECT 1670846

W.P. 151-97-01

LOCATION N 5183333.1; E 300610.5 MTM NAD 83 ZONE 13 (LAT. 46.789545; LONG. -84.054880)

ORIGINATED BY JL

DIST ALGOMA HWY 532

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring; NQ Coring

COMPILED BY AK

DATUM Geodetic

DATE August 23 and 24, 2017

CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
238.3	GROUND SURFACE										
0.0	Sand and silt, trace to some gravel, trace clay, trace organics (FILL) Loose to compact Brown to grey Moist to wet		1	SS	12						
			2	SS	12						
			3	SS	6			11	58	30	1
235.7	- Wet below a depth of about 2.3 m		4A 4B	SS	2						
2.6	SAND and SILT, trace clay, trace organics Very loose Brown to black Wet - Inclusions/layers of organic silt and peat encountered between depths of about 2.6 m and 3.7 m		5	SS	1						
			6	SS	WH		Non-Plastic	0	53	46	1
233.6			7A 7B 7C	SS	2						
233.3	CLAYEY ORGANIC SILT Very soft to soft Grey to black Moist										
5.0	Varved CLAYEY SILT to SILTY CLAY, trace sand Stiff Grey Wet		8	SS	10						
			9	SS	5						
			10	TO	PH						
228.0											
10.3	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		11	SS	WH						
			12	SS	3						
			13	SS	2						

ELEVATION SCALE: 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225, 224

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

+9 +6 +6 +9 +9 +>96 +6

Continued Next Page

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

GTA-MTO 001 \\GOLDER.GDS\GAL\MISSISSAUGA\SIM\CLIENTS\MTO\SAULT_STE_MARIE\02_DATA\GINT\SAULT_STE_MARIE.GPJ GAL-GTA.GDT 8-28-18

GOLDER

RECORD OF BOREHOLE No ACB-03 SHEET 2 OF 3 METRIC

PROJECT 1670846
W.P. 151-97-01 LOCATION N 5183333.1; E 300610.5 MTM NAD 83 ZONE 13 (LAT. 46.789545; LONG. -84.054880) ORIGINATED BY JL
DIST ALGOMA HWY 532 BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring; NQ Coring COMPILED BY AK
DATUM Geodetic DATE August 23 and 24, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		14	SS	3		223				
							222	>96			
			15	SS	3		221				
							221	>96			
			16	TO	PH		220				
							219	>96			
			17	SS	3		218				
							218	>96			
							217				
							216				
			18	SS	15		215				
							214				
							213				
			19	SS	18		212				
211.2											
27.1	Inferred SILTY SAND, some gravel, with cobbles and boulders						211				
							210				
			-	RC	-						
				RC	-		209				
				RC	-						

Continued Next Page

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

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACB-03

SHEET 3 OF 3

METRIC

W.P. 151-97-01 LOCATION N 5183333.1; E 300610.5 MTM NAD 83 ZONE 13 (LAT. 46.789545; LONG. -84.054880) ORIGINATED BY JL

DIST ALGOMA HWY 532 BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring; NQ Coring COMPILED BY AK

DATUM Geodetic DATE August 23 and 24, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Inferred SILTY SAND, some gravel, with cobbles and boulders			RC	-		208				
				RC	-		207				
206.3											
32.0	END OF BOREHOLE										

NOTES:

1. Water level measured in casing at a depth of about 10.3 m below ground surface (Elev. 227.8 m) on August 24, 2017.

2. The cored depth intervals and particle sizes of recovered cobbles / boulders are summarized as follows:

Depth (m)	Recovered
28.3 - 29.0	130mm; 20mm to 70mm rock fragments/ gravel pieces
29.0 - 29.9	440mm
29.9 - 30.6	40mm to 70mm rock fragments/ gravel pieces
30.6 - 32.0	20mm to 60mm rock fragments/ gravel pieces

3. A borehole was advanced on August 12, 2018 to a depth of about 4.6 m below ground surface immediately next to Borehole ACB-03 in order to install a standpipe piezometer.

4. Water level measurments in standpipe piezometer:

Date	Depth (m)	Elev. (m)
12/08/18	4.5	233.8
13/08/18	4.5	233.8
14/08/18	4.5	233.8
15/08/18	4.5	233.8

5. The standpipe piezometer was decommissioned on August 15, 2018 in accordance with Ontario Regulation 903 (as amended).

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

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GOLDER

RECORD OF BOREHOLE No ACB-04

SHEET 1 OF 3

METRIC

PROJECT 1670846

W.P. 151-97-01 LOCATION N 5183335.1; E 300606.0 MTM NAD 83 ZONE 13 (LAT. 46.789563; LONG. -84.054938) ORIGINATED BY JL

DIST ALGOMA HWY 532 BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring; NQ Coring COMPILED BY AK

DATUM Geodetic DATE August 24 and 25, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.0	GROUND SURFACE								
0.0	Silty sand, some gravel, trace clay to sand, trace to some gravel, trace silt, trace clay (FILL) Compact Brown Moist		1	SS	13				
			2	SS	19		237		
			3	SS	14		236		
	- Trace organics encountered above a depth of about 2.1 m		4	SS	12				16 56 27 1
235.0							235		
3.0	SAND, some silt, trace gravel Loose Brown Moist		5	SS	9				
234.1							234		
3.9	Varved CLAYEY SILT to SILTY CLAY, trace sand Stiff Grey Wet		6	SS	6	▽			
			7	SS	7		233		
							232		
			8	SS	8				
							231		
			9	SS	3		230		
							229		
			10	SS	1				
228.0							228		
10.0	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		11	SS	2		227		
							226		
			12	TO	PH			17.7	(C)
							225		
			13	SS	3		224		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

+7 (232); +13 (231); +13 (229); +10 (228); +10 (226); +7 (225); +>96 (224)

Continued Next Page

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

GTA-MTO 001 \\GOLDER.GDS\GAL\MISSISSAUGA\SIM\CLIENTS\MTO\SAULT_STE_MARIE\02_DATA\GINT\SAULT_STE_MARIE.GPJ GAL-GTA.GDT 8-28-18

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACB-04

SHEET 2 OF 3

METRIC

W.P. 151-97-01 LOCATION N 5183335.1; E 300606.0 MTM NAD 83 ZONE 13 (LAT. 46.789563; LONG. -84.054938) ORIGINATED BY JL

DIST ALGOMA HWY 532 BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring; NQ Coring COMPILED BY AK

DATUM Geodetic DATE August 24 and 25, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		14	SS	5		222	>96			
			15	SS	5		221	>96			
			16	SS	3		220				
			17	SS	4		219	>96			
			18	TO	PH		218	>96			
			19	SS	9		217	>96			
			20	SS	14		216	>96			
210.6							215				
27.4	Inferred SILTY SAND, some gravel, with cobbles and boulders		-	RC	-		214	>96			
				RC	-		213				
							212				
							211				
							210				
							209				

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No ACB-04

SHEET 3 OF 3 **METRIC**

PROJECT 1670846
W.P. 151-97-01
DIST ALGOMA HWY 532
DATUM Geodetic
LOCATION N 5183335.1; E 300606.0 MTM NAD 83 ZONE 13 (LAT. 46.789563; LONG. -84.054938)
BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring; NQ Coring
DATE August 24 and 25, 2017
ORIGINATED BY JL
COMPILED BY AK
CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Inferred SILTY SAND, some gravel, with cobbles and boulders			RC	-						
							207				
				RC	-						
205.5							206				
32.5	END OF BOREHOLE										

NOTES:

1. Water level measured in casing at a depth of about 4.4 m below ground surface (Elev. 233.6 m) on August 25, 2017.

2. The cored length intervals and particle sizes of recovered cobbles/boulders are summarized as follows:

Depth (m)	Recovered
28.7 - 29.5	130mm; 30mm to 45mm rock fragments/ gravel pieces
29.5 - 31.0	20mm to 70mm rock fragments/ gravel pieces
31.0 - 32.5	45mm to 60mm rock fragments/ gravel pieces

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

RECORD OF BOREHOLE No ACB-05

SHEET 1 OF 3

METRIC

PROJECT 1670846

W.P. 151-97-01

LOCATION N 5183392.1; E 300606.9 MTM NAD 83 ZONE 13 (LAT. 46.790075; LONG. -84.054927)

ORIGINATED BY JL

DIST ALGOMA HWY 532

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring:; NQ Coring

COMPILED BY AK

DATUM Geodetic

DATE August 28 and 29, 2017

CHECKED BY TZ

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	UNIT WEIGHT γ kN/m³
237.8	GROUND SURFACE					
0.0	Sand, some gravel, trace to some silt (FILL) Dense Brown Moist	1	SS	45		
237.1 / 0.7	SAND and SILT, trace clay to SILTY SAND, trace clay, trace organics Very loose to loose Brown to grey Wet	2	SS	4		
		3	SS	4	0 75 23 2	
	- Grey below a depth of about 2.3 m	4	SS	WH	0 61 36 3	Non-Plastic
234.6 / 3.2	Varved CLAYEY SILT to SILTY CLAY, trace sand Stiff Grey Wet	5A / 5B	SS	12		
		6	SS	6		
		7	SS	7		
		8	SS	8		
		9	SS	3		
		10	WH	WH		
228.0 / 9.8	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet	11	TO	PH	(C)	17.6
		12	SS	2		
		13	SS	3		

Elevation scale: 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225, 224, 223

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

Field vane sensitivity values plotted: 6, 6, 5, 7, 5, >96, >96

PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT W_L — WATER CONTENT (%): 20 40 60

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No ACB-05

SHEET 2 OF 3

METRIC

PROJECT 1670846

W.P. 151-97-01 LOCATION N 5183392.1; E 300606.9 MTM NAD 83 ZONE 13 (LAT. 46.790075; LONG. -84.054927) ORIGINATED BY JL

DIST ALGOMA HWY 532 BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring:; NQ Coring COMPILED BY AK

DATUM Geodetic DATE August 28 and 29, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		14	TO	PH		222				
								>96			
			15	SS	3		221				
								>96			
			16	SS	2		220				
							219	>96			
			17	SS	6		218				
							217	>96			
			18	SS	10		216				
							215				
			19	SS	14		214				
							213				
							212				
210.4	- Casing grinding at a depth of about 27.4 m						211				
27.4	Inferred SILTY SAND, some gravel, with cobbles and boulders		-	RC	-		210				
							209				
				RC	-		208				

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No ACB-05

SHEET 3 OF 3 **METRIC**

PROJECT 1670846
W.P. 151-97-01
DIST ALGOMA HWY 532
DATUM Geodetic
LOCATION N 5183392.1; E 300606.9 MTM NAD 83 ZONE 13 (LAT. 46.790075; LONG. -84.054927)
BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring:; NQ Coring
DATE August 28 and 29, 2017
ORIGINATED BY JL
COMPILED BY AK
CHECKED BY TZ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Inferred SILTY SAND, some gravel, with cobbles and boulders			RC	-						
							207				
				RC	-						
							206				
205.5											
32.3	END OF BOREHOLE										
	NOTE:										
	1. The cored depth intervals and particle sizes of recovered rock fragments are summarized as follows:										
	Depth (m) Recovered 28.7 - 32.3 20mm to 70mm rock fragments/ gravel pieces										

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

GOLDER

RECORD OF BOREHOLE No ACB-06

SHEET 1 OF 3

METRIC

PROJECT 1670846 | W.P. 151-97-01 | DIST ALGOMA HWY 532 | DATUM Geodetic

LOCATION N 5183385.9; E 300615.1 MTM NAD 83 ZONE 13 (LAT. 46.790020; LONG. -84.054820) | ORIGINATED BY AJ

BOREHOLE TYPE 95 mm O.D. Solid Stem Augers; Wash Boring; NQ Coring | COMPILED BY AK

DATE September 9 and 10, 2017 | CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.8	GROUND SURFACE										
0.0	Silty sand, trace to some gravel, trace organics (FILL) Loose Brown Moist		1	SS	8		238				
237.4											
1.4	SAND, some silt, trace gravel, trace clay Very loose to loose Brown Moist to wet		2	SS	4		237				
			3	SS	3		236				0 78 19 3
	- Wet below a depth of about 3.0 m		4	SS	4						
235.1							235				
3.7	Varved CLAYEY SILT to SILTY CLAY, trace sand Stiff to very stiff Grey Wet		5	SS	10						0 0 84 16
			6	SS	9		234				
			7	SS	9		233				
			8	TO	PH		232	+ >96			
			9	SS	7		231	+ >96			
							230				
228.0							229	+ >96			
10.8	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		10	SS	6		228				
			11	TO	PH		227	+ >96			
			12	SS	9		226	+ >96			
							225				
							224				

Continued Next Page

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

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACB-06

SHEET 2 OF 3

METRIC

W.P. 151-97-01 LOCATION N 5183385.9; E 300615.1 MTM NAD 83 ZONE 13 (LAT. 46.790020; LONG. -84.054820) ORIGINATED BY AJ

DIST ALGOMA HWY 532 BOREHOLE TYPE 95 mm O.D. Solid Stem Augers; Wash Boring; NQ Coring COMPILED BY AK

DATUM Geodetic DATE September 9 and 10, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		13	SS	11		223				
			14	SS	9		222				
			15	SS	10		221				
			16	SS	11		220				0 13 64 23
			17	SS	10		219				
			18	SS	109/ 0.23		218				0 0 85 15
210.3							217				
28.5	Sandy SILT, some gravel, with cobbles and boulders Very dense Grey Wet		-	RC	-		216				
							215				
							214				
							213				
							212				
							211				
							210				
							209				

Continued Next Page

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

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACB-06

SHEET 3 OF 3

METRIC

W.P. 151-97-01 LOCATION N 5183385.9; E 300615.1 MTM NAD 83 ZONE 13 (LAT. 46.790020; LONG. -84.054820) ORIGINATED BY AJ

DIST ALGOMA HWY 532 BOREHOLE TYPE 95 mm O.D. Solid Stem Augers; Wash Boring; NQ Coring COMPILED BY AK

DATUM Geodetic DATE September 9 and 10, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Sandy SILT, some gravel, with cobbles and boulders Very dense Grey Wet		-	RC	-						
			19	SS	101		208			Non-Plastic	0 22 78 0
	- Casing grinding between depths of about 31.1 m to 31.8 m										
206.8							207				
32.0	CASING AND SPLIT-SPOON REFUSAL END OF BOREHOLE NOTES: 1. The cored depth intervals and particle sizes of recovered cobbles/boulders are summarized as follows: Depth (m) Recovered 29.3 - 30.5 100mm; 340mm; 20mm to 50mm rock fragments/ gravel pieces										

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

GOLDER

RECORD OF BOREHOLE No ACB-07

SHEET 1 OF 3

METRIC

PROJECT 1670846

W.P. 151-97-01

LOCATION N 5183380.3; E 300627.3 MTM NAD 83 ZONE 13 (LAT. 46.790020; LONG. -84.054660)

ORIGINATED BY JL

DIST ALGOMA HWY 532

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring

COMPILED BY AK

DATUM Geodetic

DATE August 26 and 27, 2017

CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.2	GROUND SURFACE										
0.0	SAND and SILT, trace gravel, trace clay Very loose to compact Brown Moist to wet		1	SS	7		238				
			2	SS	5		237				0 67 31 2
	- Wet below a depth of about 1.5 m		3	SS	2		236				
	- Sand and gravel layer encountered below a depth of about 2.5 m		4A 4B 4C	SS	22						
235.6							235				
2.6	Varved CLAYEY SILT to SILTY CLAY, trace sand Firm to stiff Grey Wet		5	TO	PH						
			6	SS	12		234				2 3 80 15
			7	SS	7		233	5			
			8	SS	5		232				0 1 76 23
			9	TO	PH		231	6			
							230	7			
			10	SS	3		229				
228.0							228	5			
10.2	CLAYEY SILT to SILTY CLAY, trace gravel, trace sand, irregularly stratified Stiff to very stiff Grey Wet		11	SS	1		227				
								>96			
			12	SS	2		226				
							225	>96			
			13	SS	3		224				
								>96			

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACB-07

SHEET 2 OF 3

METRIC

W.P. 151-97-01 LOCATION N 5183380.3; E 300627.3 MTM NAD 83 ZONE 13 (LAT. 46.790020; LONG. -84.054660) ORIGINATED BY JL

DIST ALGOMA HWY 532 BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring COMPILED BY AK

DATUM Geodetic DATE August 26 and 27, 2017 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT to SILTY CLAY, trace gravel, trace sand, irregularly stratified Stiff to very stiff Grey Wet		14	SS	3		223				
							222	>96			
			15	SS	3		221				
								>96			
			16	SS	4		220				
							219				
			17	TO	PH		218				
								>96			
							217				
							216				
			18	SS	12		215				
							214				
							213				
			19	SS	12		212				
							211				
							210				
			20	SS	16		209				
208.2											

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No ACB-07

SHEET 3 OF 3

METRIC

PROJECT 1670846

W.P. 151-97-01 LOCATION N 5183380.3; E 300627.3 MTM NAD 83 ZONE 13 (LAT. 46.790020; LONG. -84.054660) ORIGINATED BY JL

DIST ALGOMA HWY 532 BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash Boring COMPILED BY AK

DATUM Geodetic DATE August 26 and 27, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
	--- *CONTINUED FROM PREVIOUS PAGE* ---							20 40 60 80 100	20 40 60		
30.0	SILTY SAND and GRAVEL, trace clay						208				
207.6	Very dense Grey Wet		21	SS	100/0.15				○		41 30 27 2
	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)						207	155			
205.8							206				
32.4	END OF DCPT										

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

GTA-MTO 001 \\GOLDER.GDS\GAL\MISSISSAUGA\SIM\CLIENTS\MTO\SAULT_STE_MARIE\02_DATA\GINT\SAULT_STE_MARIE.GPJ GAL-GTA.GDT 8-28-18

GOLDER

RECORD OF BOREHOLE No ACB-08

SHEET 1 OF 2

METRIC

PROJECT 1670846

W.P. 151-97-01

LOCATION N 5183407.7; E 300610.7 MTM NAD 83 ZONE 13 (LAT. 46.790216; LONG. -84.054878)

ORIGINATED BY JL

DIST ALGOMA HWY 532

BOREHOLE TYPE 210 mm O.D. Continuous Flight, Hollow Stem Augers

COMPILED BY AK

DATUM Geodetic

DATE August 29 and 30, 2017

CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.4	GROUND SURFACE								
0.0	Sand, trace to some gravel, trace to some silt (FILL) Loose to compact Brown Moist to wet		1	SS	6		238		12 76 12 0
			2	SS	11				
	- Wet below a depth of about 1.5 m		3	SS	8		237		
236.2									
2.2	SAND and GRAVEL, trace to some silt, trace clay Dense Brown to grey Wet		4	SS	31		236		51 42 6 1
			5	SS	39		235		
234.7									
3.7	Varved CLAYEY SILT to SILTY CLAY, trace sand Stiff Grey Wet		6	SS	6		234		
			7	SS	5				
							233		
			8	SS	4		232		
			9	SS	2		231		
						▽	230		
			10	TO	PH		229		
228.0									
10.4	CLAYEY SILT to SILTY CLAY, trace sand, irregularly stratified Stiff to very stiff Grey Wet		11	SS	1		228		
							227		
			12	SS	2		226		
							225		
			13	SS	2		224		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

+5 (238)
+6 (232)
+7 (230)
+8 (228)
+7 (227)
+>96 (225)
+>96 (224)

Continued Next Page

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACB-08

SHEET 2 OF 2

METRIC

W.P. 151-97-01 LOCATION N 5183407.7; E 300610.7 MTM NAD 83 ZONE 13 (LAT. 46.790216; LONG. -84.054878) ORIGINATED BY JL

DIST ALGOMA HWY 532 BOREHOLE TYPE 210 mm O.D. Continuous Flight, Hollow Stem Augers COMPILED BY AK

DATUM Geodetic DATE August 29 and 30, 2017 CHECKED BY TZ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
222.6			14	SS	2		223				
15.9	END OF BOREHOLE NOTE: 1. Water level measured in casing at a depth of about 8.5 m below ground surface (Elev. 229.9 m) on August 30, 2017.										

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

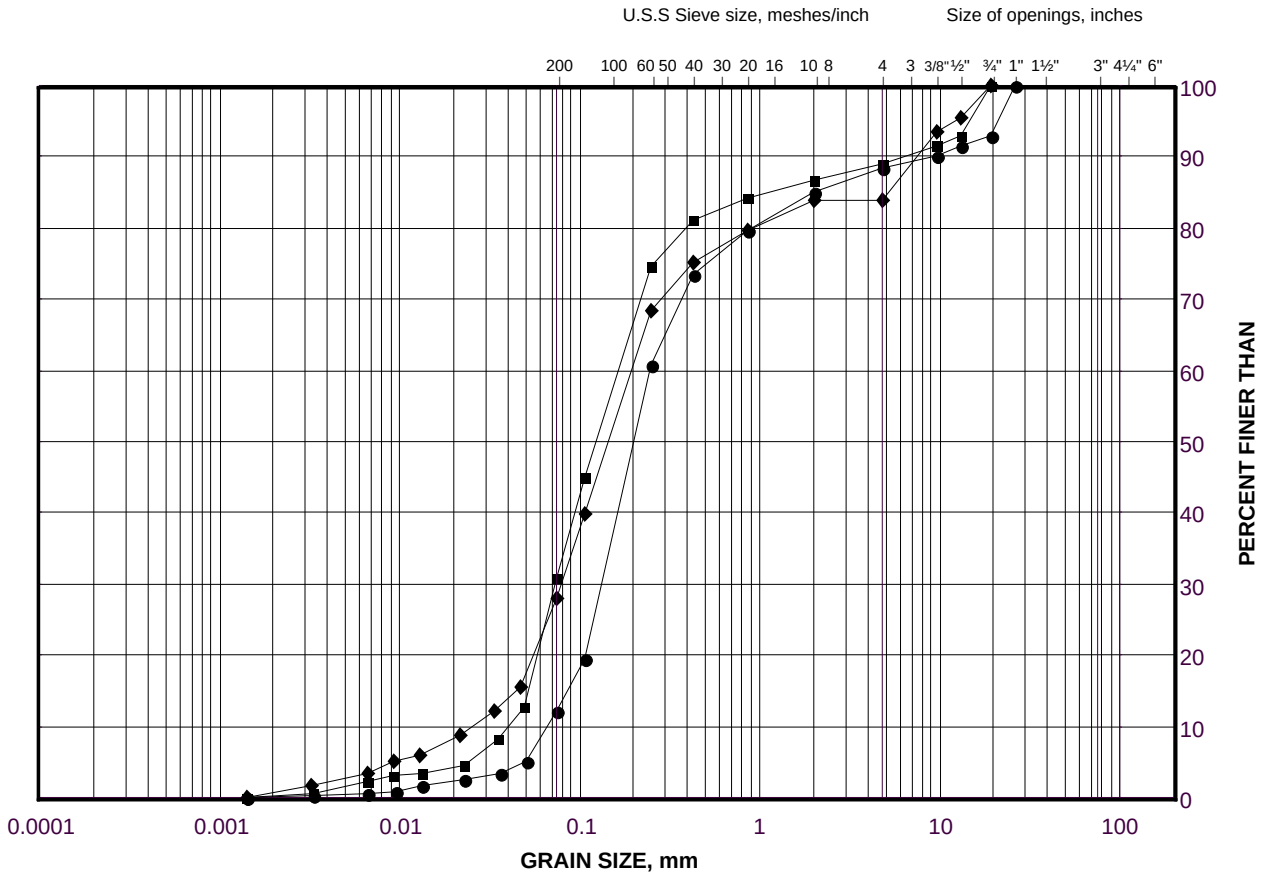
APPENDIX C

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand to Sand (Fill)

FIGURE C1



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ACB-08	1	238.1
■	ACB-03	3	236.5
◆	ACB-04	4	235.4

Project Number: 1670846

Checked By: TZ

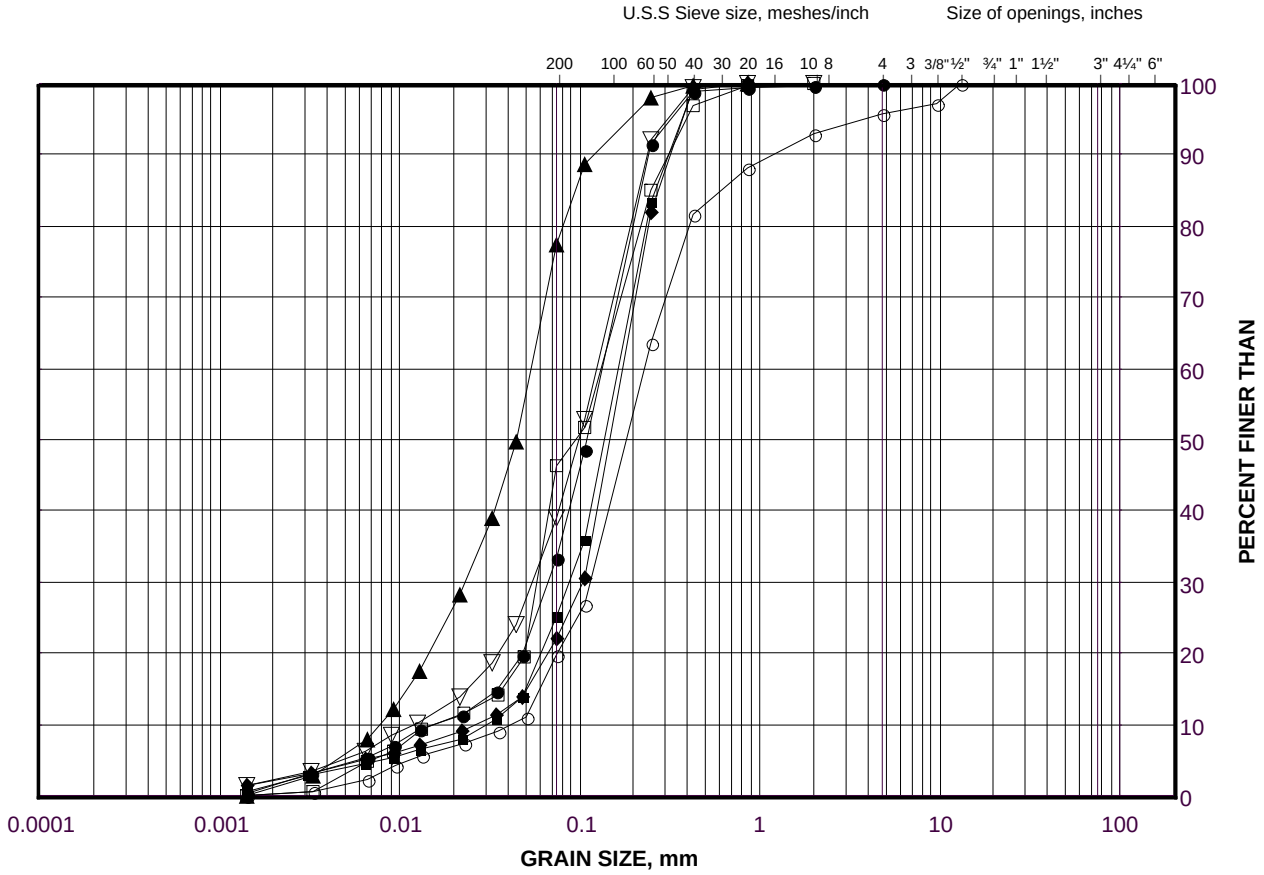
Golder Associates

Date: 11-Jun-18

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand and Silt to Silty Sand to Sand (Upper Granular Deposit)

FIGURE C2A



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ACB-07	2	237.1
■	ACB-05	3	236.0
◆	ACB-06	3	236.2
▲	ACB-02	3	236.3
▽	ACB-05	4	235.2
❍	ACB-01	4	236.3
□	ACB-03	6	234.2

Project Number: 1670846

Checked By: TZ

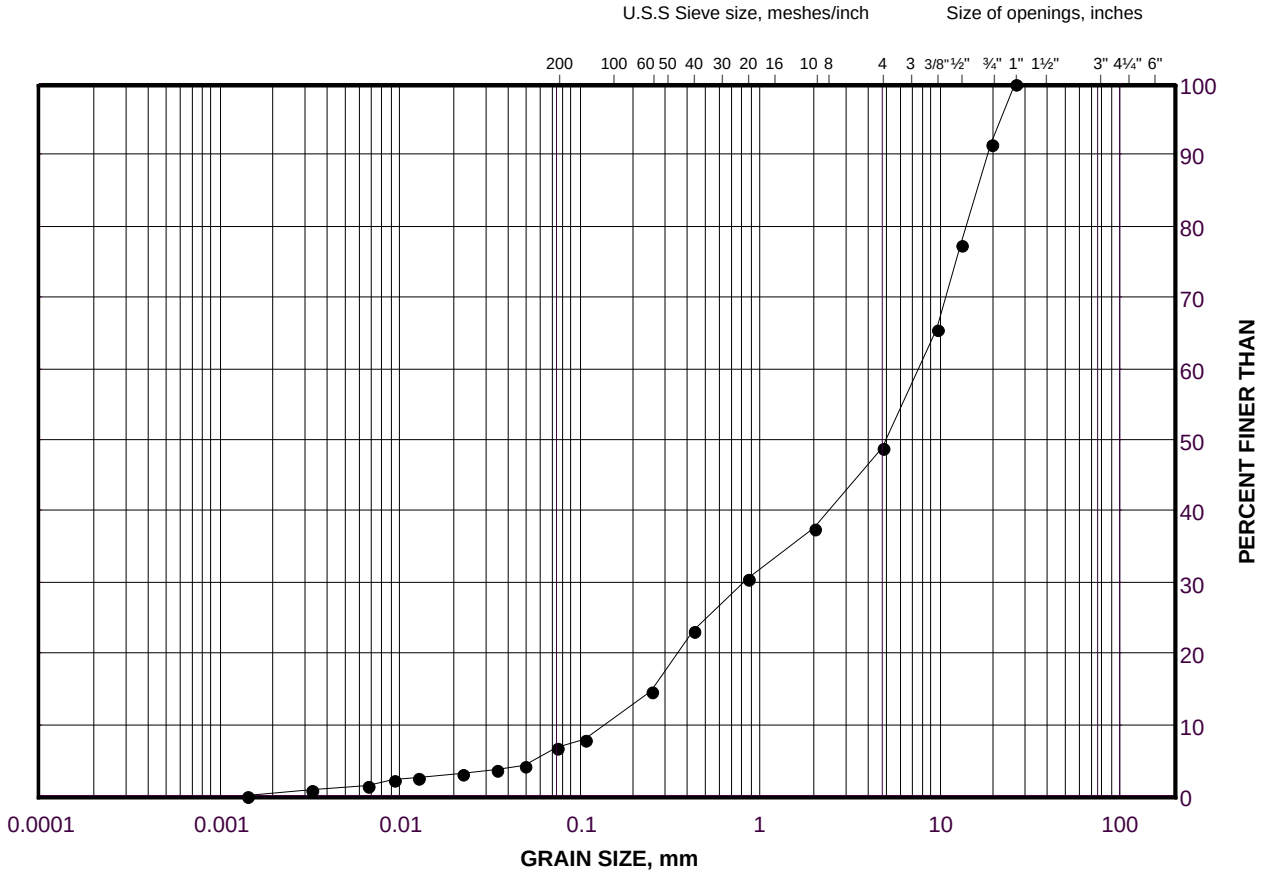
Golder Associates

Date: 11-Jun-18

GRAIN SIZE DISTRIBUTION

Sand and Gravel (Upper Granular Deposit)

FIGURE C2B



LEGEND

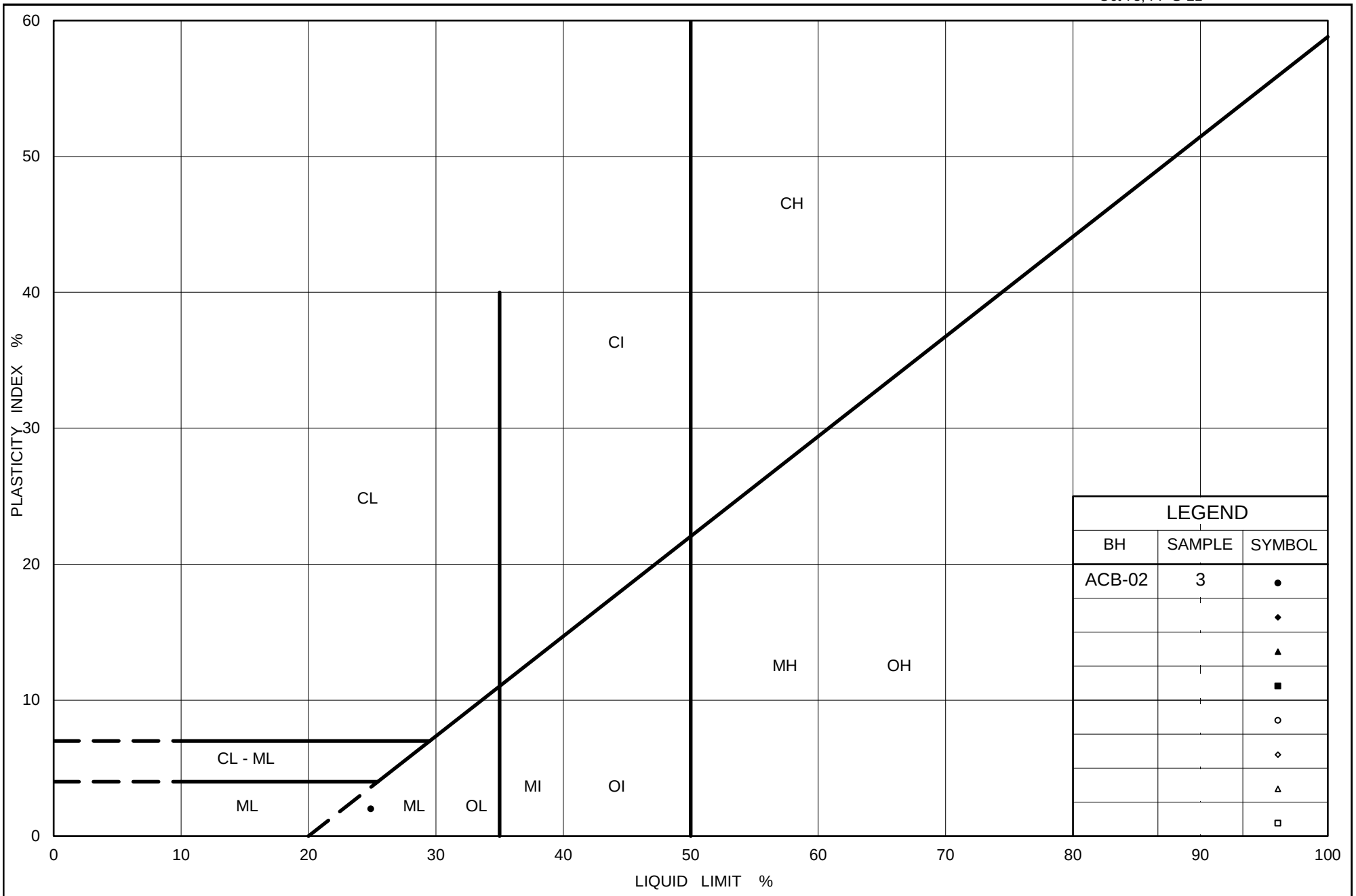
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ACB-08	4	235.8

Project Number: 1670846

Checked By: TZ

Golder Associates

Date: 11-Jun-18



Ministry of Transportation

Ontario

PLASTICITY CHART
Sandy Silt of Slight Plasticity (Fines Portion)

Figure No. C3

Project No. 1670846

Checked By: TZ

CONSOLIDATED DRAINED DIRECT SHEAR TEST SHEET 1 OF 3			FIGURE C4A
TEST STAGE	A	B	C
BOREHOLE NUMBER		ACB-05	
SAMPLE		2, 3 and 4	
SAMPLE DEPTH, (m)		-	
SAMPLE HEIGHT, (mm)	27.41	27.44	27.51
SAMPLE LENGTH, (mm)	60.00	60.00	60.00
WATER CONTENT, BEFORE TEST, (%)	25.01	25.01	25.01
NORMAL (CONSOLIDATION) STRESS, (kPa)	25	50	100
WATER CONTENT, AFTER TEST, (%)	20.07	19.34	19.55
DISPLACEMENT RATE, mm/min	0.012	0.012	0.012
TIME TO FAILURE, hours	2.4	4.8	6.2
PEAK SHEAR STRESS[1], (kPa)	22.7	46.8	90.0
HORIZONTAL DISPLACEMENT AT PEAK, (mm)	1.7	3.5	4.5
DRY DENSITY, initial, Mg/m^3	1.553	1.521	1.521
WET DENSITY, initial, Mg/m^3	1.942	1.902	1.901

TEST NOTES:

1 In the absence of a peak, the shear stress reported is at 10 percent relative horizontal displacement (ASTM D3080).

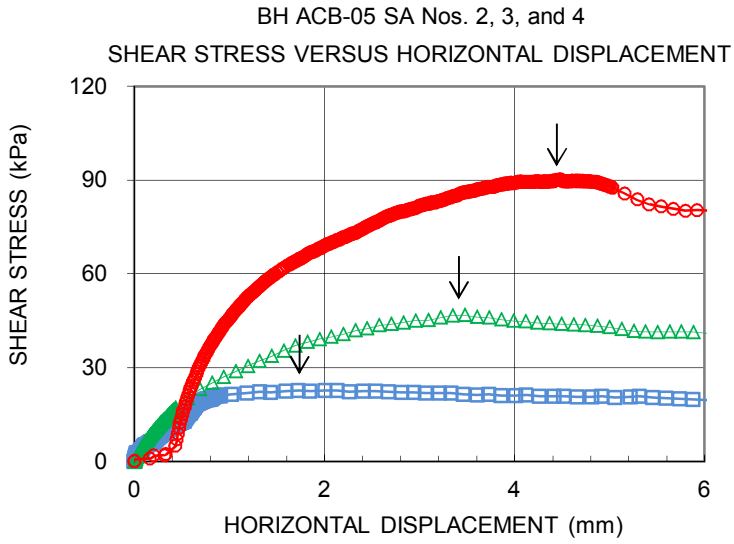
2 Direct Shear Tests carried out under submerged conditions.

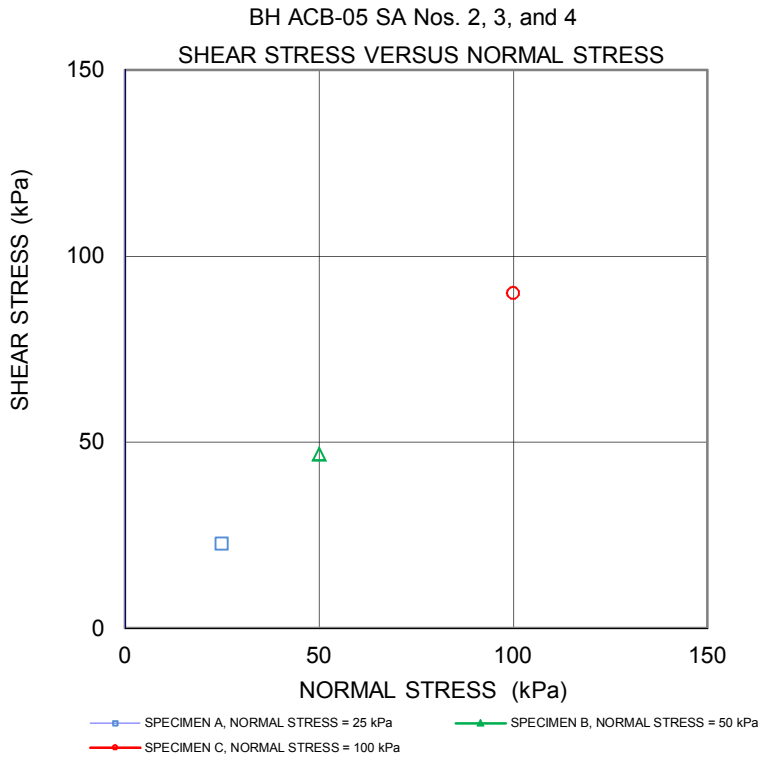
Date: 6/21/2018 Prepared By: LH

Project No. 1670846 **Golder Associates Ltd.** Checked By: TZ

CONSOLIDATED DRAINED DIRECT SHEAR TEST
SHEET 2 OF 3

FIGURE C4B





Date: 6/21/2018
Project No. 1670846

Golder Associates Ltd.

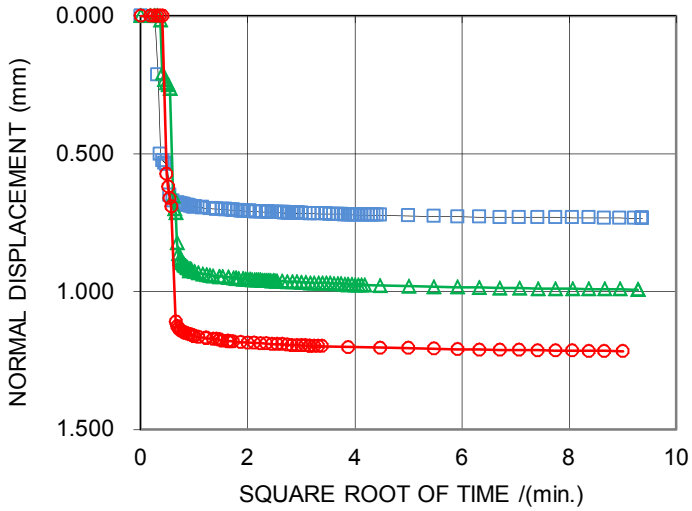
Prepared By: LH
Checked By: TZ

CONSOLIDATED DRAINED DIRECT SHEAR TEST
SHEET 3 OF 3

FIGURE C4C

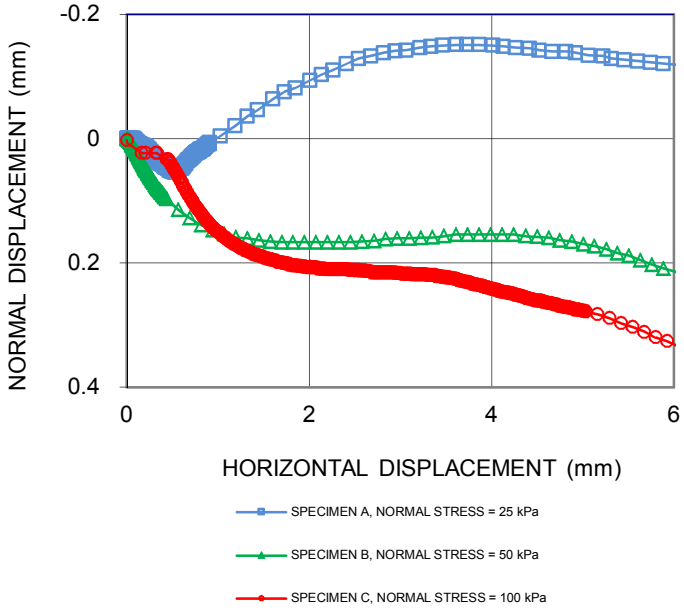
BH ACB-05 SA Nos. 2, 3, and 4

NORMAL DISPLACEMENT VERSUS SQUARE ROOT OF TIME



BH ACB-05 SA Nos. 2, 3, and 4

NORMAL DISPLACEMENT VERSUS HORIZONTAL DISPLACEMENT



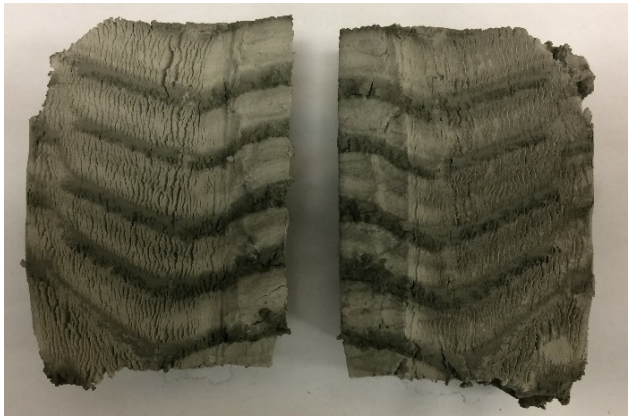
Date: 6/21/2018
Project No. 1670846

Golder Associates Ltd.

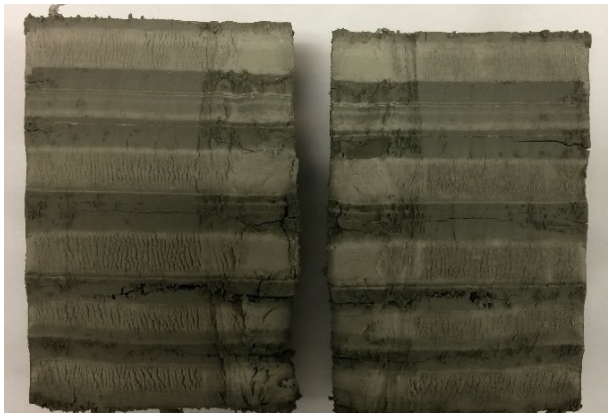
Prepared By: LH
Checked By: TZ

Varved Clayey Silt to Silty Clay

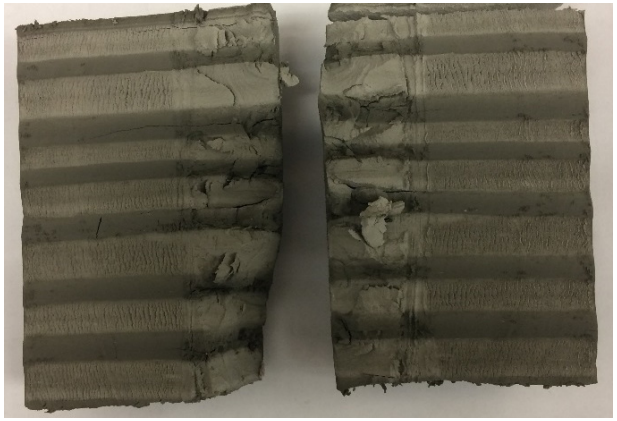
Figure C5A



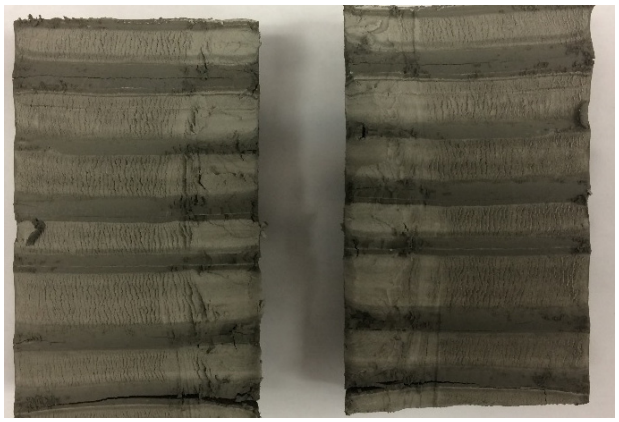
Photograph 1: Soil sample from Borehole ACB-01 Sample 8



Photograph 2: Soil sample from Borehole ACB-02 Sample 9

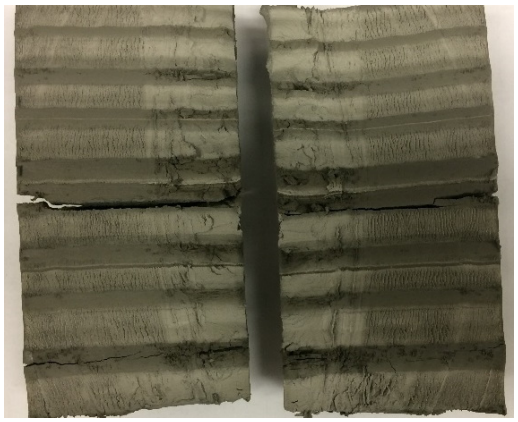


Photograph 3: Soil sample from Borehole ACB-03 Sample 10



Photograph 4: Soil sample from Borehole ACB-06 Sample 8

Photograph 5: Soil sample from Borehole ACB-07 Sample 9



Photograph 6: Soil sample from Borehole ACB-08 Sample 10

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.

Date: June 22, 2018

Project No: 1670846

Golder Associates

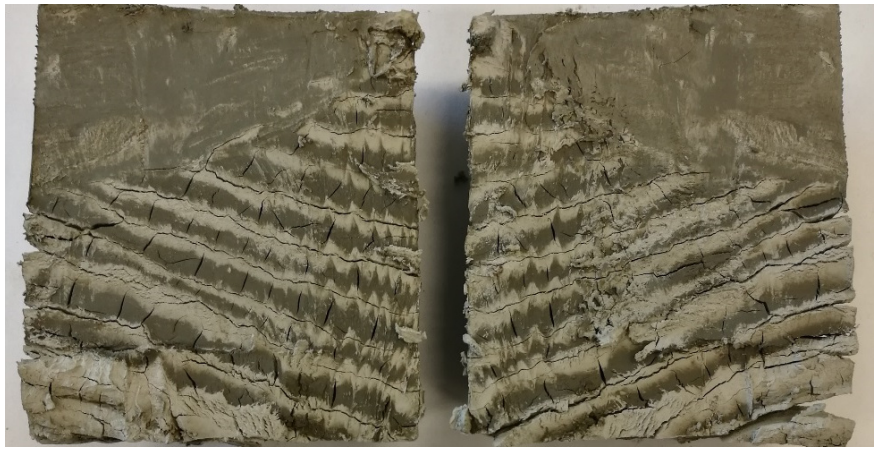
Clayey Silt to Silty Clay (Irregularly Stratified)

Figure C5B

Photograph 1: Soil sample from Borehole ACB-04 Sample 12

Photograph 2: Soil sample from Borehole ACB-04 Sample 18

Photograph 3: Soil sample from Borehole ACB-05 Sample 11



Photograph 4: Soil sample from Borehole ACB-05 Sample 14

Notes:

1. The dark layers represent silty clay of intermediate plasticity, while the lighter layers 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 layers.

Date: June 22, 2018

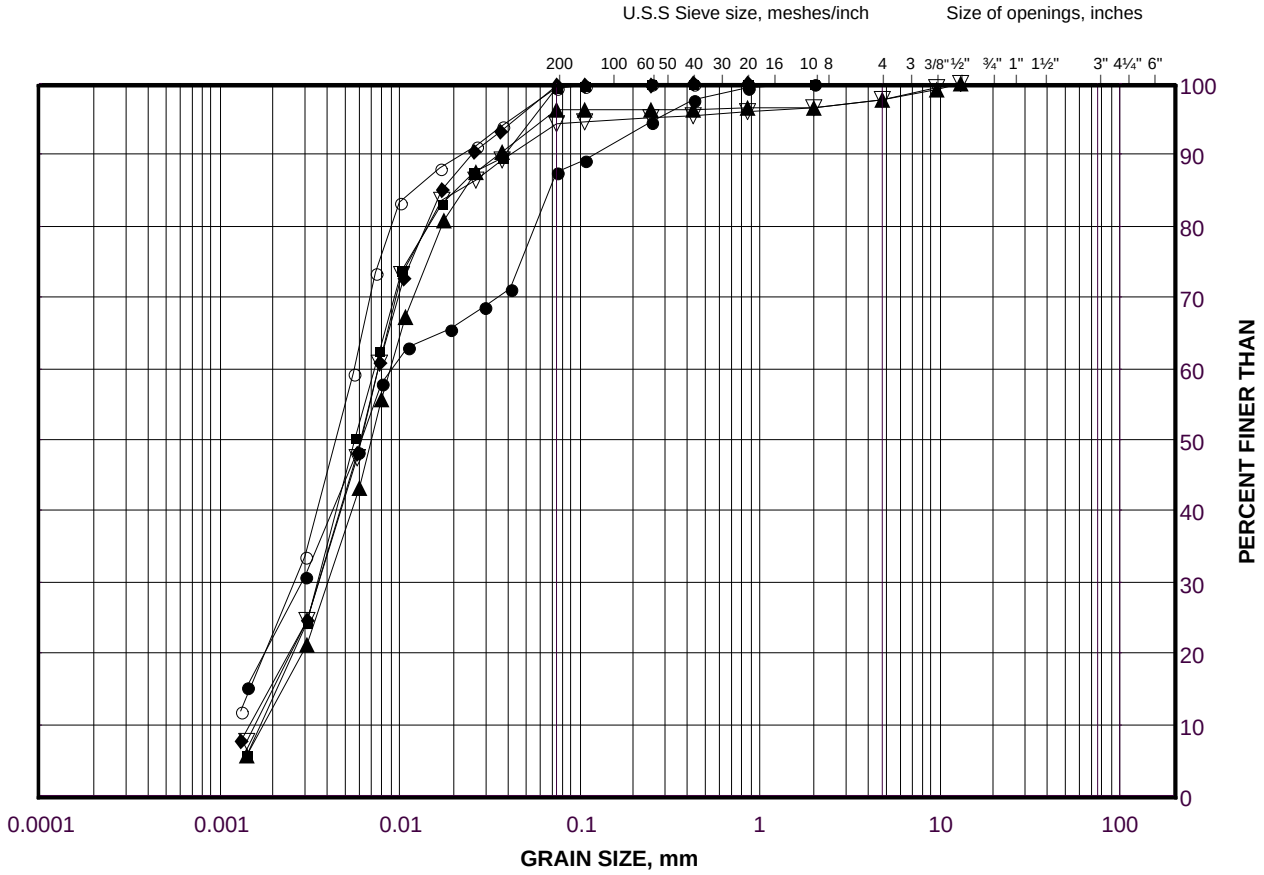
Project No: 1670846

Golder Associates

GRAIN SIZE DISTRIBUTION

Clayey Silt to Silty Clay

FIGURE C6



LEGEND

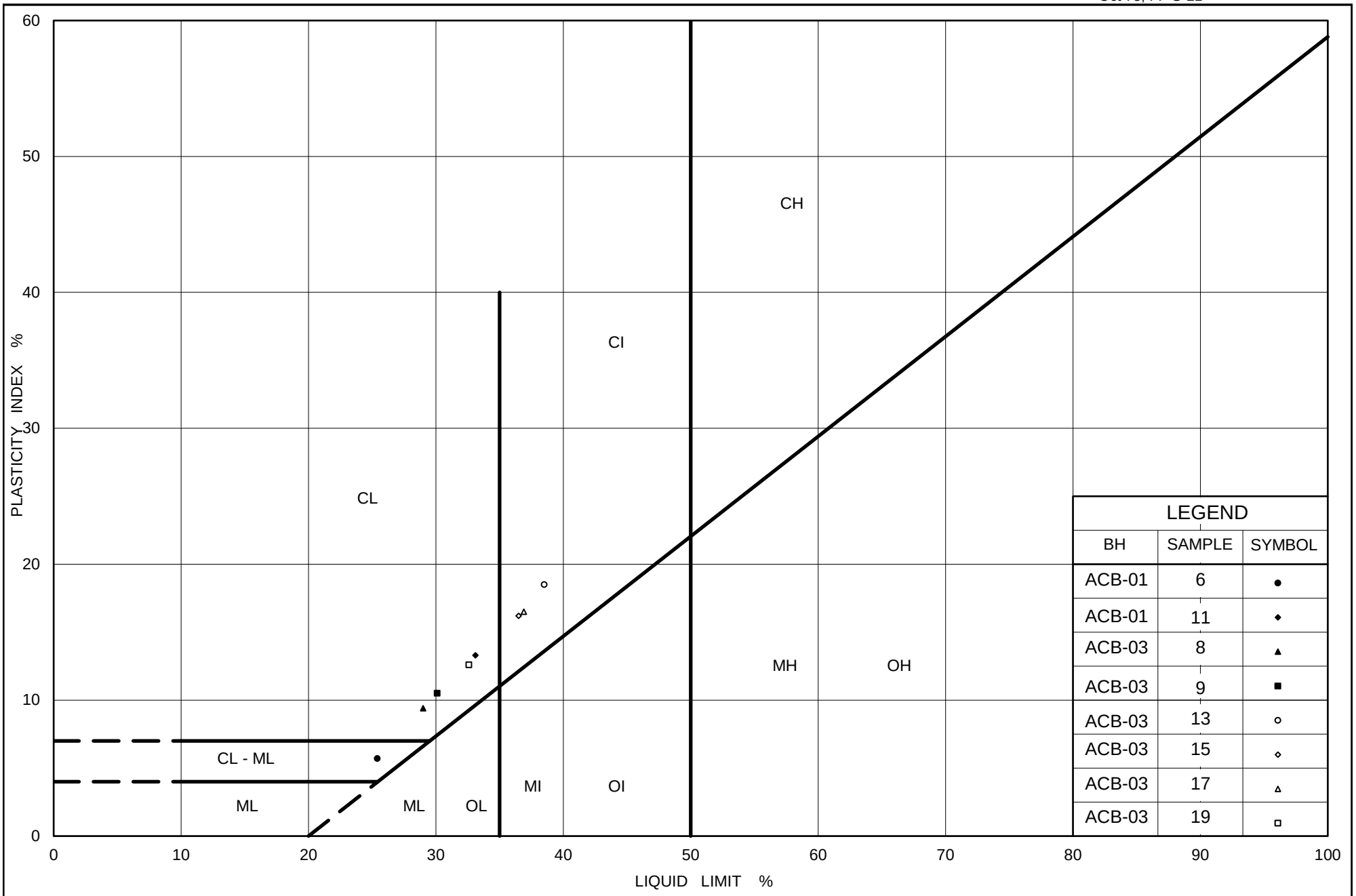
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ACB-06	16	217.2
■	ACB-06	18	211.2
◆	ACB-06	5	234.7
▲	ACB-02	5	234.8
▽	ACB-07	6	234.1
❍	ACB-07	8	231.8

Project Number: 1670846

Checked By: TZ

Golder Associates

Date: 13-Apr-18



Ministry of Transportation

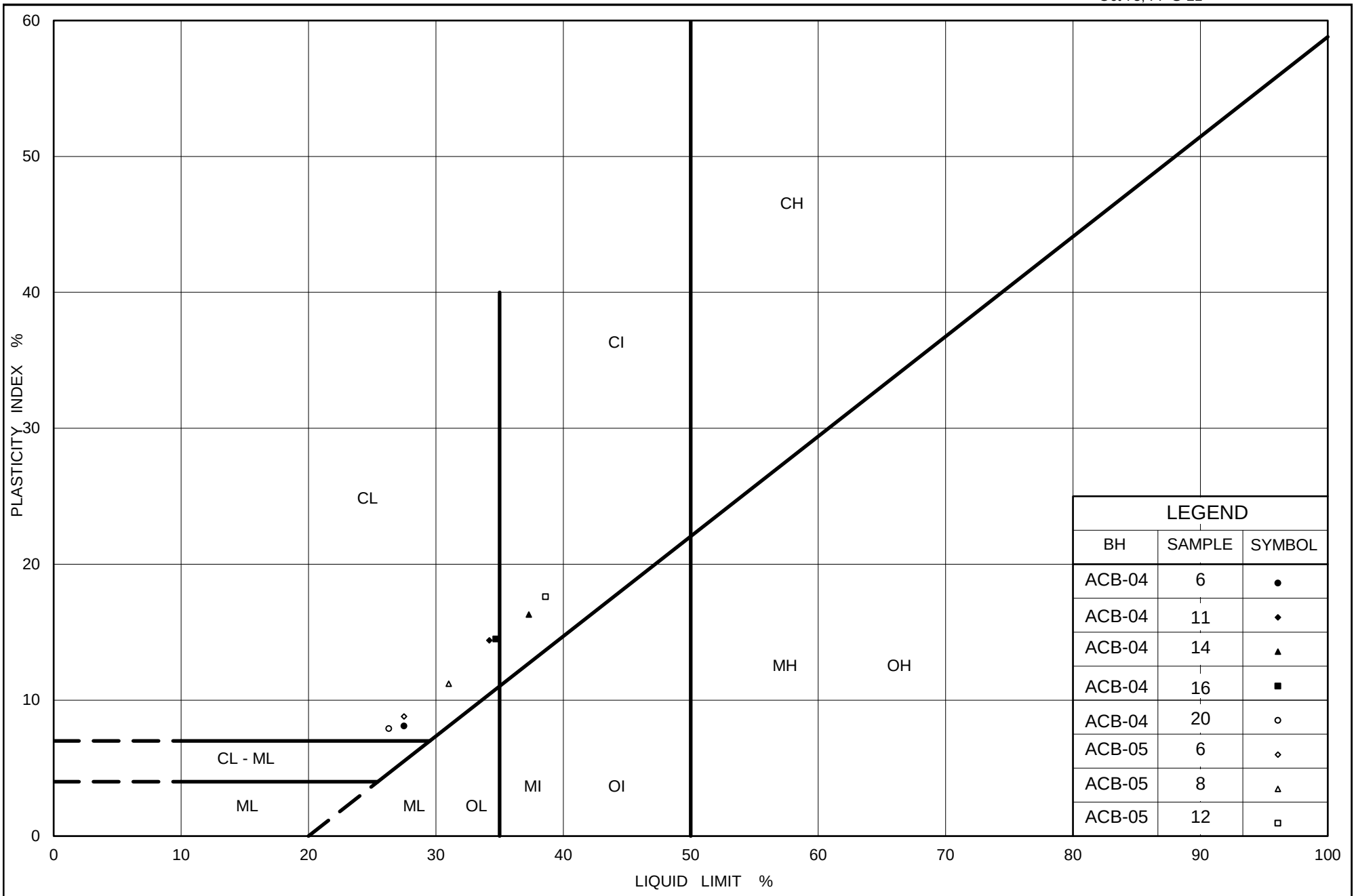
Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay

Figure No. C7A

Project No. 1670846

Checked By: TZ



Ministry of Transportation

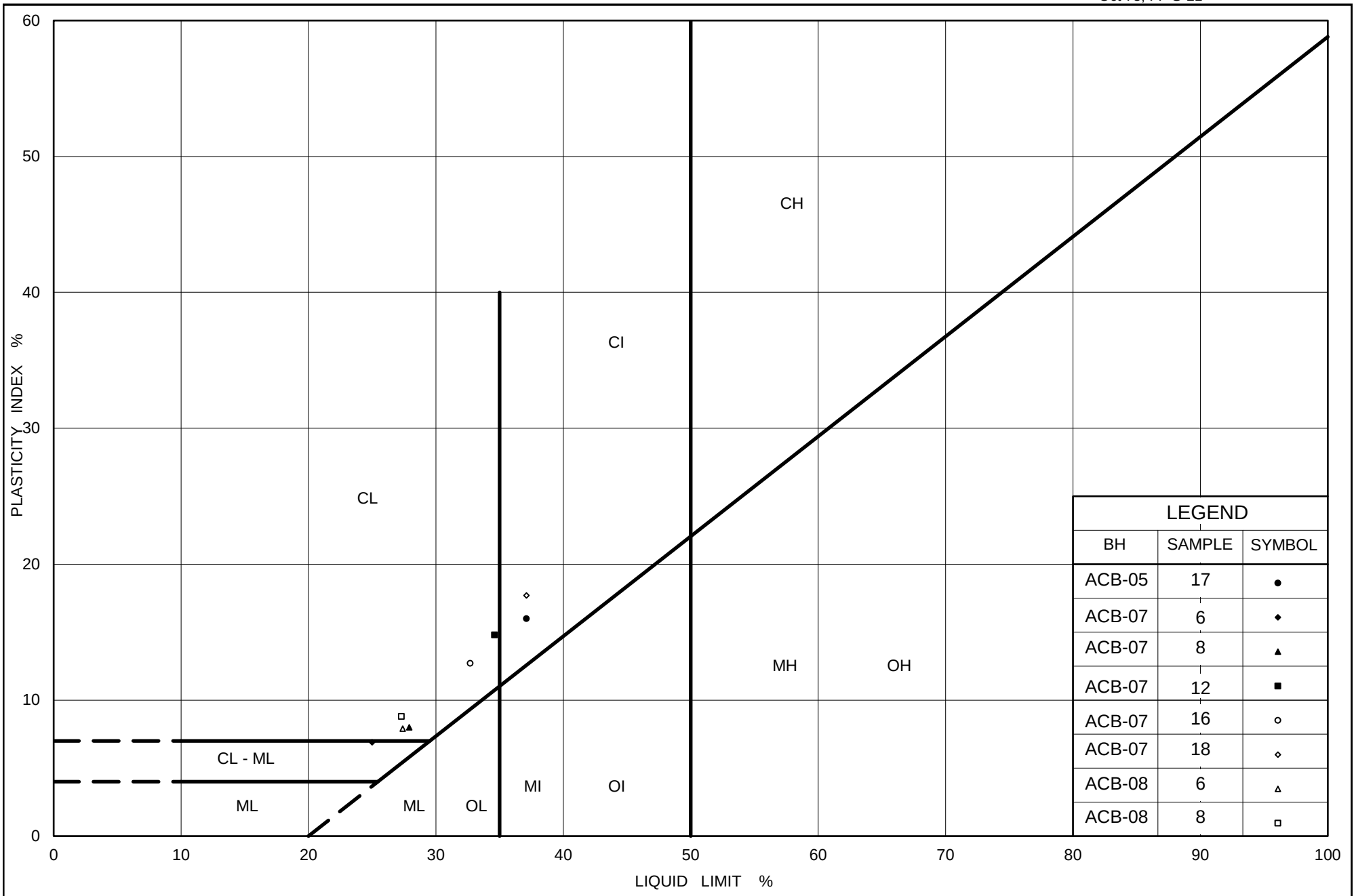
Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay

Figure No. C7B

Project No. 1670846

Checked By: TZ



Ministry of Transportation

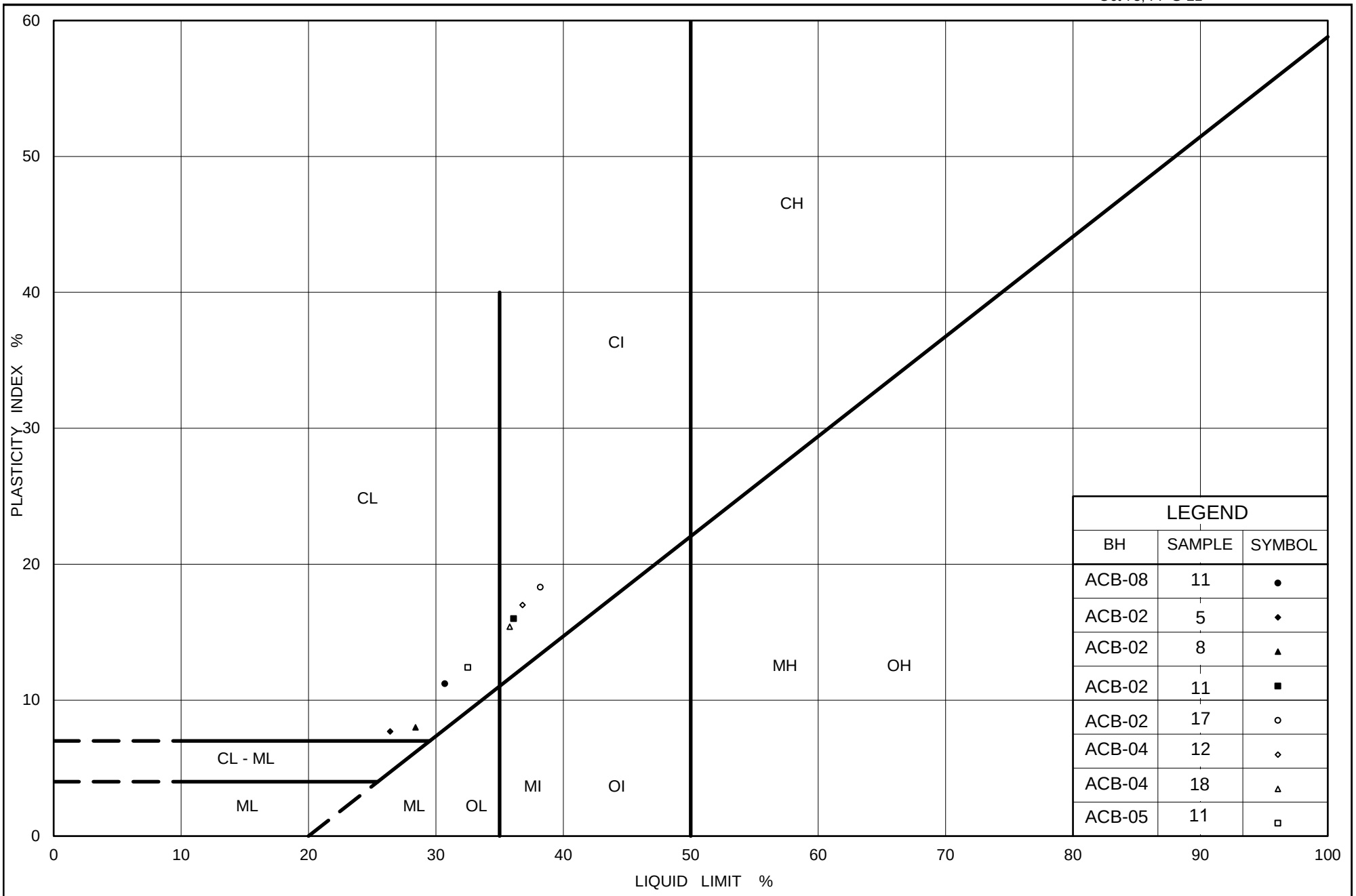
Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay

Figure No. C7C

Project No. 1670846

Checked By: TZ



Ministry of Transportation

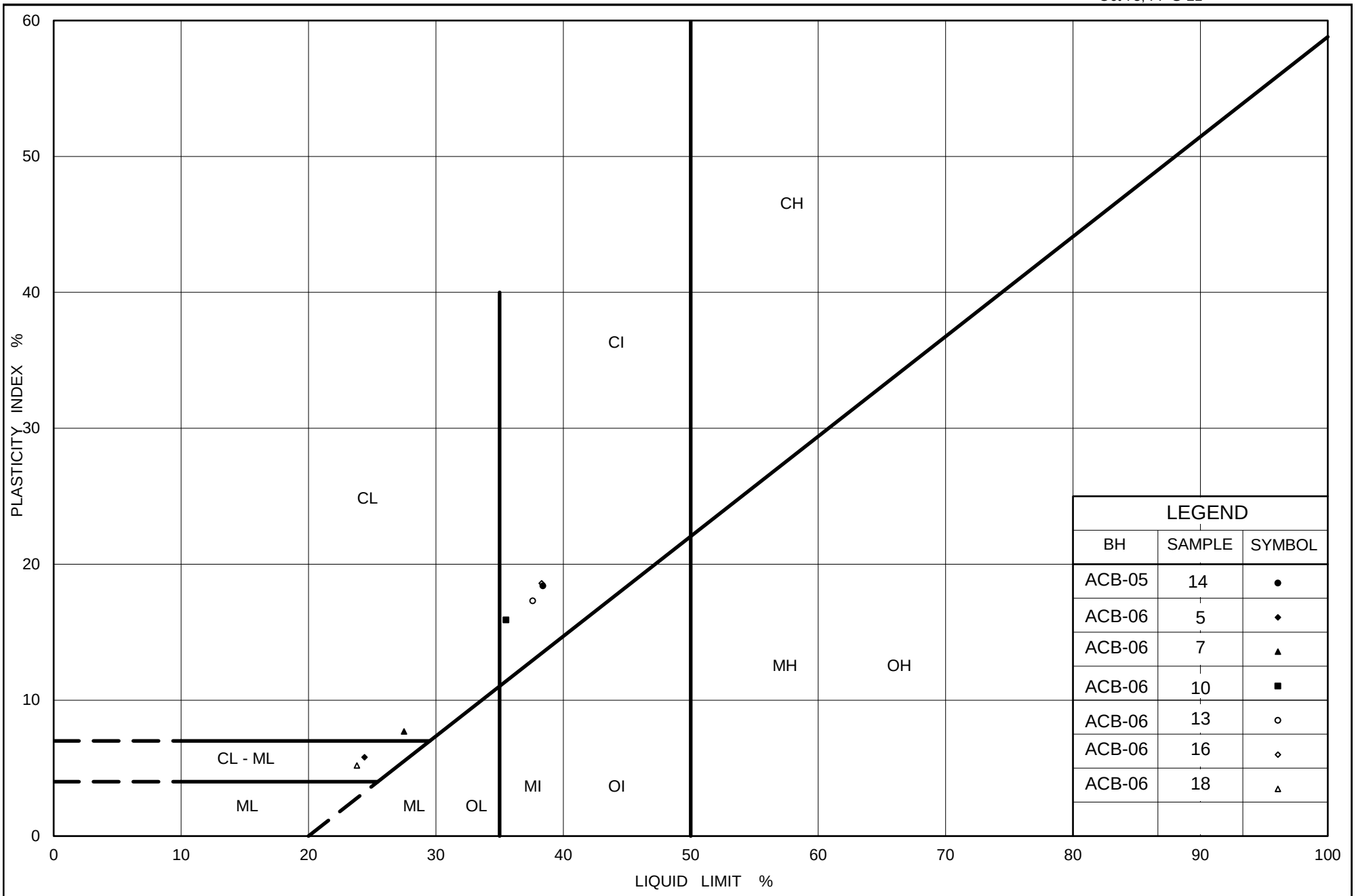
Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay

Figure No. C7D

Project No. 1670846

Checked By: TZ



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay

Figure No. C7E

Project No. 1670846

Checked By: TZ

CONSOLIDATION TEST SUMMARY

ASTM D2435/D2435M

FIGURE C8A

SAMPLE IDENTIFICATION

Project Number	1670846	Sample Number	12
Borehole Number	ACB-04	Sample Depth, m	12.65-12.73

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	8		
Date Started	09/25/2017		
Date Completed	10/11/2017		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m^3	17.73
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m^3	12.52
Area, cm^2	31.50	Specific Gravity, measured	2.74
Volume, cm^3	59.94	Solids Height, cm	0.887
Water Content, %	41.61	Volume of Solids, cm^3	27.94
Wet Mass, g	108.40	Volume of Voids, cm^3	32.01
Dry Mass, g	76.55	Degree of Saturation, %	99.5

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.903	1.146	1.903				
6.36	1.902	1.144	1.903				
11.14	1.902	1.144	1.902	83	9.24E-03	2.20E-05	1.99E-08
21.23	1.898	1.140	1.900	60	1.28E-02	1.87E-04	2.34E-07
40.61	1.893	1.134	1.896	54	1.41E-02	1.46E-04	2.02E-07
79.44	1.878	1.117	1.885	79	9.54E-03	2.00E-04	1.87E-07
123.31	1.866	1.104	1.872	86	8.64E-03	1.45E-04	1.23E-07
40.53	1.877	1.116	1.871				
21.23	1.879	1.119	1.878				
60.12	1.869	1.107	1.874	34	2.19E-02	1.41E-04	3.02E-07
123.33	1.864	1.102	1.866	22	3.36E-02	4.16E-05	1.37E-07
157.10	1.858	1.095	1.861	43	1.71E-02	9.49E-05	1.59E-07
312.55	1.829	1.062	1.844	38	1.90E-02	9.67E-05	1.80E-07
623.50	1.759	0.983	1.794	113	6.04E-03	1.19E-04	7.07E-08
1245.54	1.608	0.813	1.683	129	4.66E-03	1.27E-04	5.79E-08
2488.87	1.517	0.710	1.562	98	5.28E-03	3.88E-05	2.01E-08
623.50	1.529	0.724	1.523				
123.38	1.560	0.759	1.545				
40.53	1.578	0.779	1.569				
11.24	1.603	0.807	1.590				

Notes:

Consolidation loading and unloading schedule assigned by the client.

c_v and k are approximate only and based on t_{90} estimated from the Square Root of Time Method (ASTMD2435/2435M).

Specimen swelled under a stress of 6.36 kPa.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

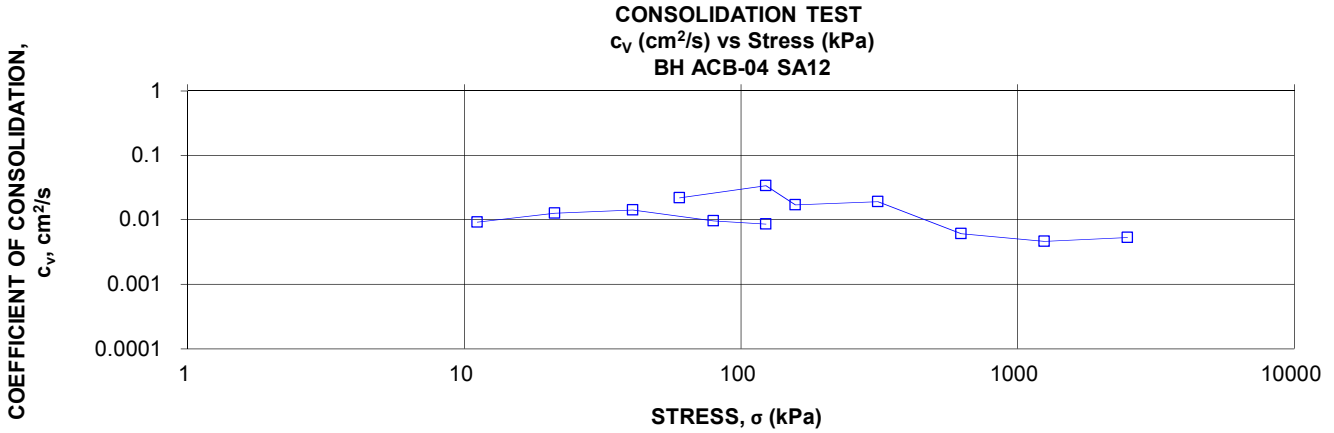
Sample Height, cm	1.60	Unit Weight, kN/m^3	19.43
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m^3	14.87
Area, cm^2	31.50	Specific Gravity, measured	2.74
Volume, cm^3	50.48	Solids Height, cm	0.887
Water Content, %	30.62	Volume of Solids, cm^3	27.94
Wet Mass, g	99.99	Volume of Voids, cm^3	22.54
Dry Mass, g	76.55		

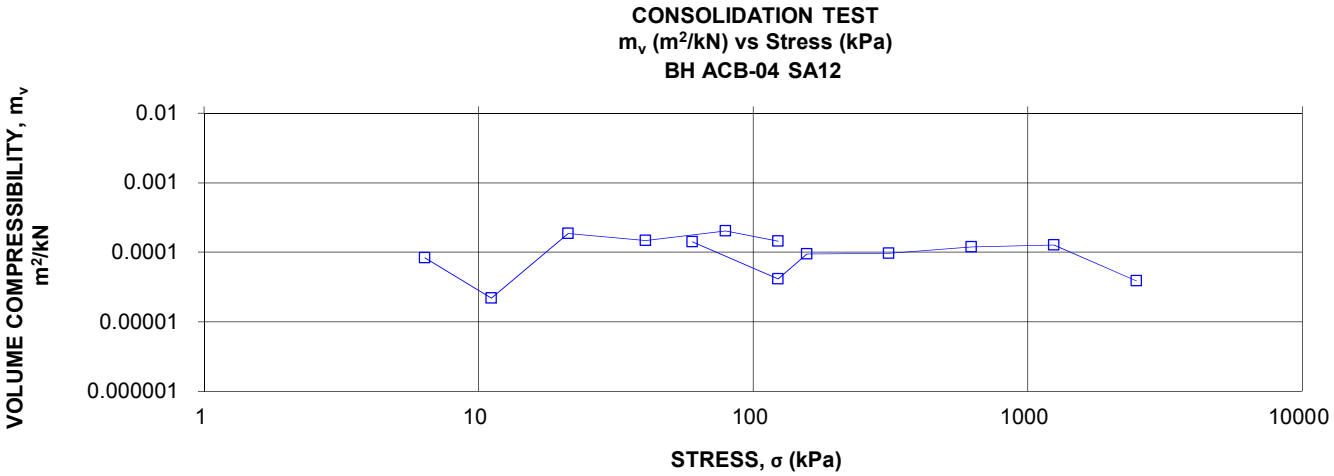
Prepared By: LH

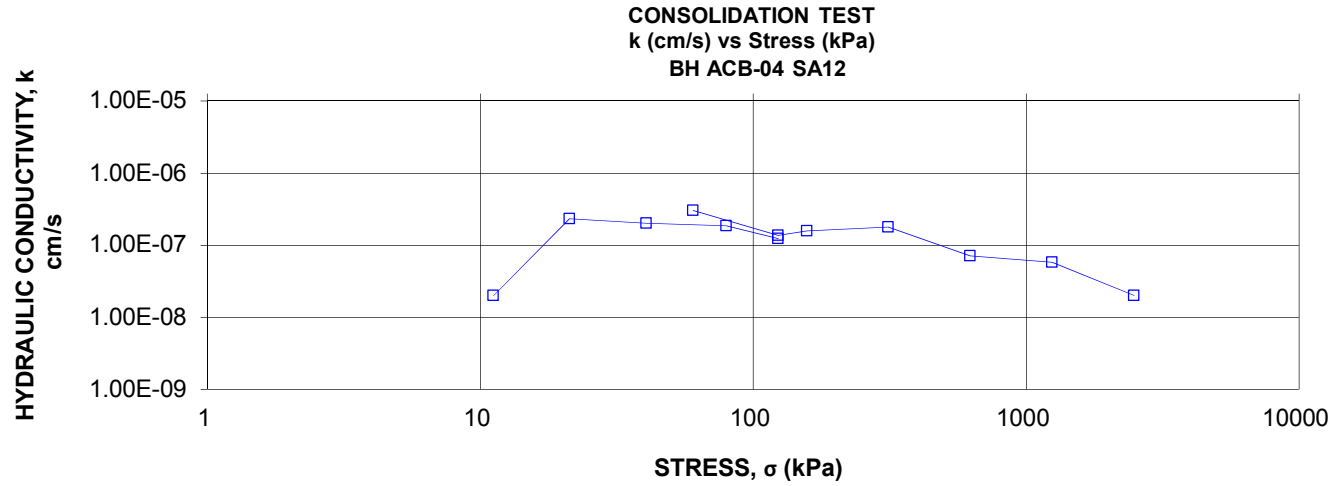
Golder Associates Ltd.

Checked By: TZ

CONSOLIDATION TEST SUMMARY	FIGURE C8B





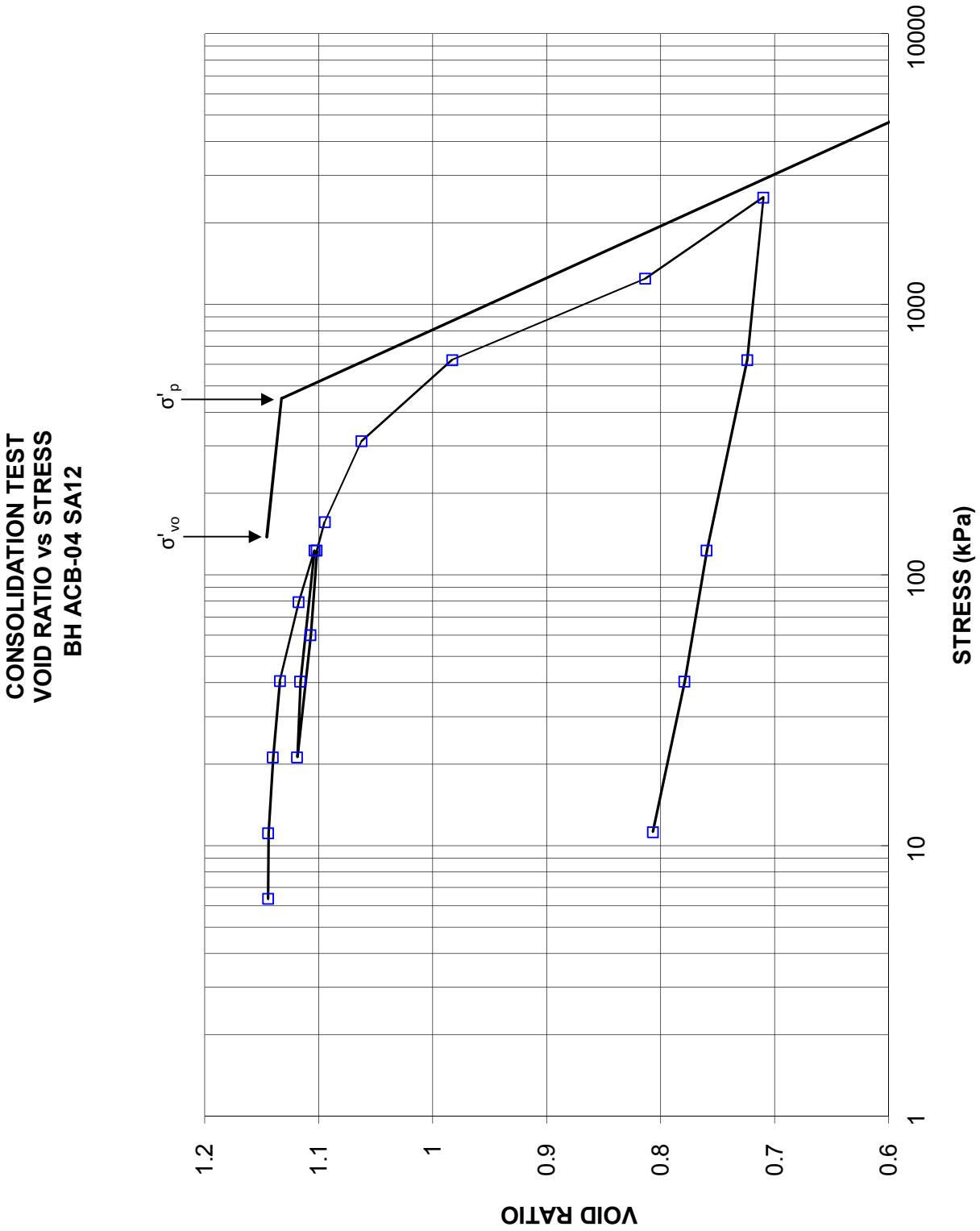


Project No. 1670846
Prepared By: LH

Golder Associates Ltd.

Checked By: TZ

CONSOLIDATION TEST VOID RATIO VS LOG STRESS	FIGURE C8C



Project No. 1670846

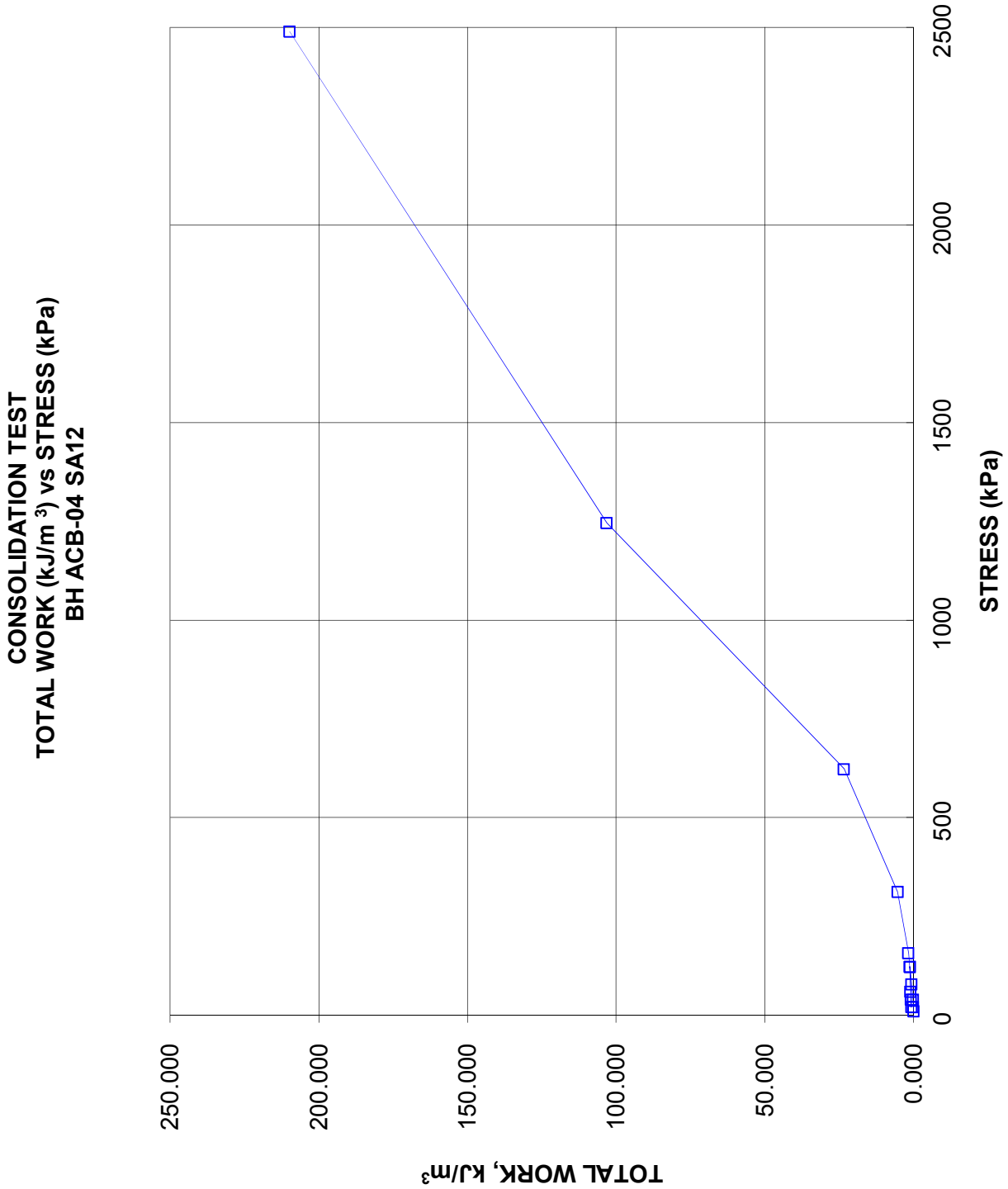
Prepared By: LH

Golder Associates Ltd.

Checked By: TZ

CONSOLIDATION TEST
TOTAL WORK VS STRESS

FIGURE C8D



Project No. 1670746

Prepared By: LH

Golder Associates Ltd.

Checked By: TZ

CONSOLIDATION TEST SUMMARY

ASTM D2435/D2435M

FIGURE C9A

SAMPLE IDENTIFICATION

Project Number	1670846	Sample Number	11
Borehole Number	ACB-05	Sample Depth, m	11.03-11.13

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	6		
Date Started	09/25/2017		
Date Completed	10/11/2017		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.89	Unit Weight, kN/m^3	17.55
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	12.30
Area, cm^2	31.60	Specific Gravity, measured	2.71
Volume, cm^3	59.69	Solids Height, cm	0.875
Water Content, %	42.68	Volume of Solids, cm^3	27.63
Wet Mass, g	106.85	Volume of Voids, cm^3	32.06
Dry Mass, g	74.89	Degree of Saturation, %	99.7

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.889	1.160	1.889				
5.85	1.887	1.158	1.888				
10.70	1.882	1.152	1.885	79	9.53E-03	5.46E-04	5.10E-07
20.47	1.875	1.144	1.879	147	5.09E-03	3.79E-04	1.89E-07
39.89	1.868	1.136	1.872	135	5.50E-03	1.91E-04	1.03E-07
78.74	1.853	1.119	1.861	231	3.18E-03	2.04E-04	6.36E-08
117.30	1.824	1.086	1.846	936	7.72E-04	3.01E-04	2.28E-08
39.86	1.829	1.091	1.827				
20.47	1.834	1.097	1.832				
59.18	1.831	1.094	1.833	22	3.24E-02	4.10E-05	1.30E-07
117.21	1.818	1.079	1.825	34	2.08E-02	1.19E-04	2.41E-07
156.07	1.799	1.057	1.809	97	7.15E-03	2.59E-04	1.81E-07
311.03	1.744	0.994	1.772	109	6.10E-03	1.88E-04	1.12E-07
620.91	1.673	0.913	1.709	126	4.91E-03	1.21E-04	5.84E-08
1240.45	1.578	0.804	1.626	118	4.75E-03	8.12E-05	3.78E-08
2480.16	1.485	0.698	1.532	173	2.87E-03	3.97E-05	1.12E-08
620.91	1.509	0.725	1.497				
117.78	1.544	0.766	1.527				
39.86	1.564	0.788	1.554				
10.70	1.590	0.818	1.577				

Note:
Consolidation loading and unloading schedule assigned by the client.
cv and k are approximate only based on t_{90} estimated from Square Root of Time Method (ASTMD2435/2435M)
Specimen swelled under 5.85 kPa

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

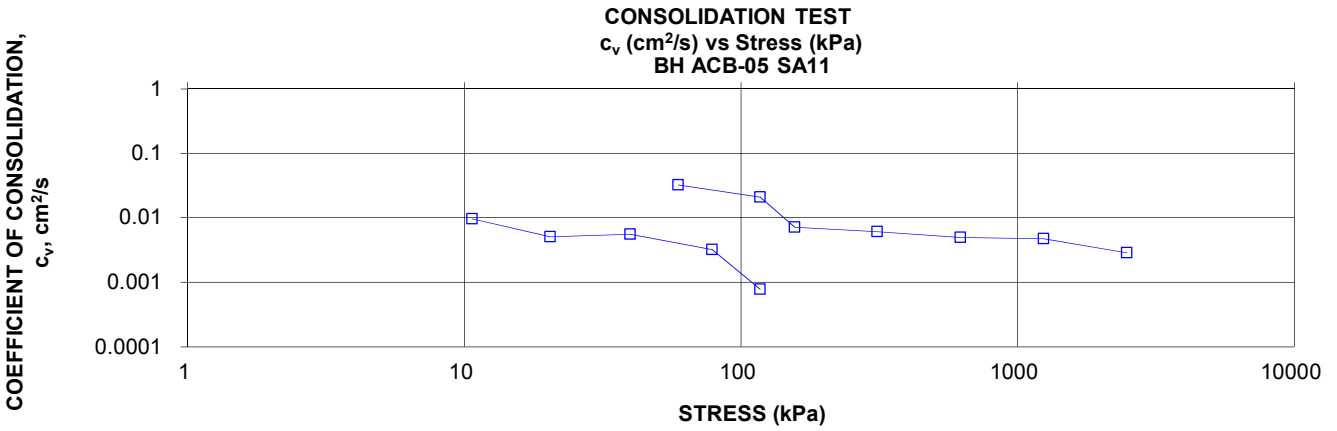
Sample Height, cm	1.59	Unit Weight, kN/m^3	19.22
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	14.62
Area, cm^2	31.60	Specific Gravity, measured	2.71
Volume, cm^3	50.24	Solids Height, cm	0.875
Water Content, %	31.46	Volume of Solids, cm^3	27.63
Wet Mass, g	98.45	Volume of Voids, cm^3	22.61
Dry Mass, g	74.89		

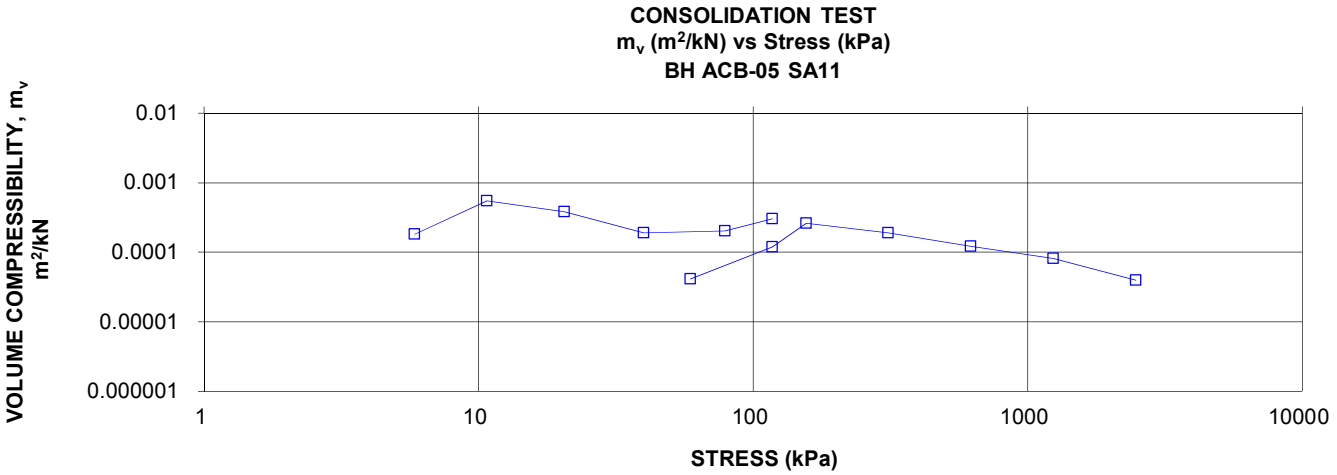
Prepared By: LH

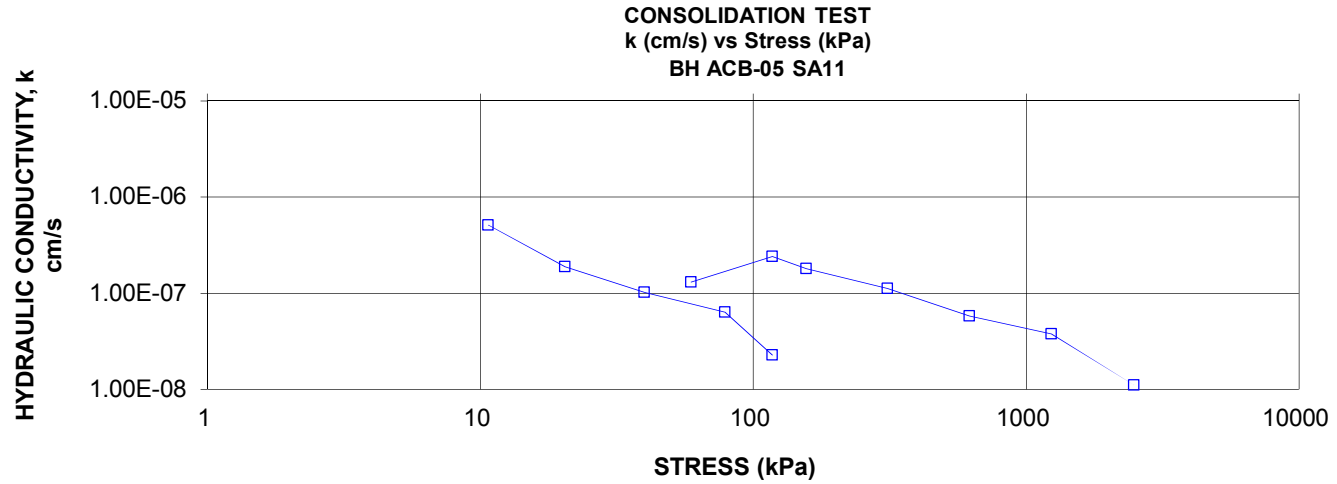
Golder Associates Ltd.

Checked By: TZ

CONSOLIDATION TEST SUMMARY	FIGURE C9B





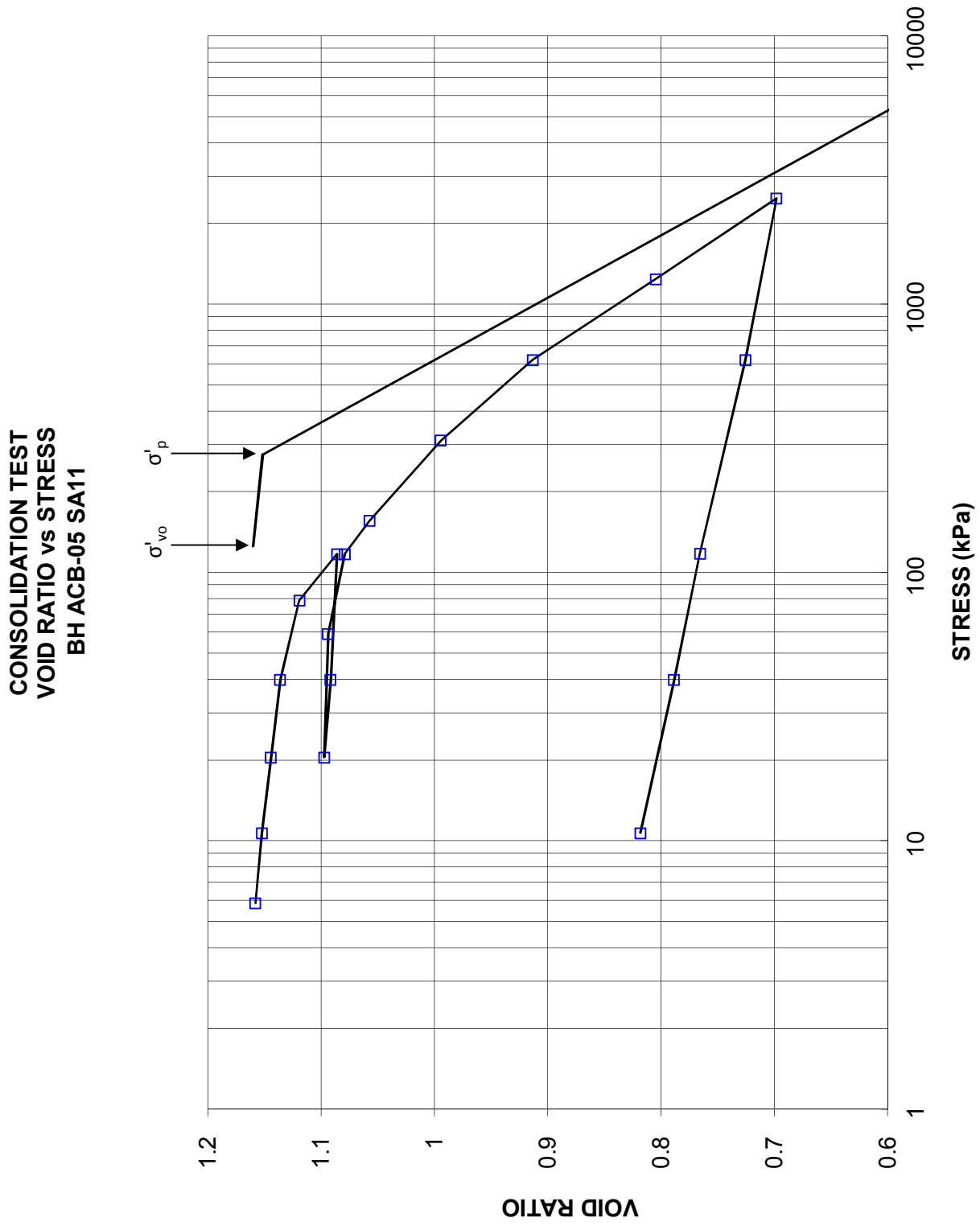


Project No. 1670846
Prepared By: LH

Golder Associates Ltd.

Checked By: TZ

CONSOLIDATION TEST VOID RATIO VS LOG STRESS	FIGURE C9C



Project No. 1670846

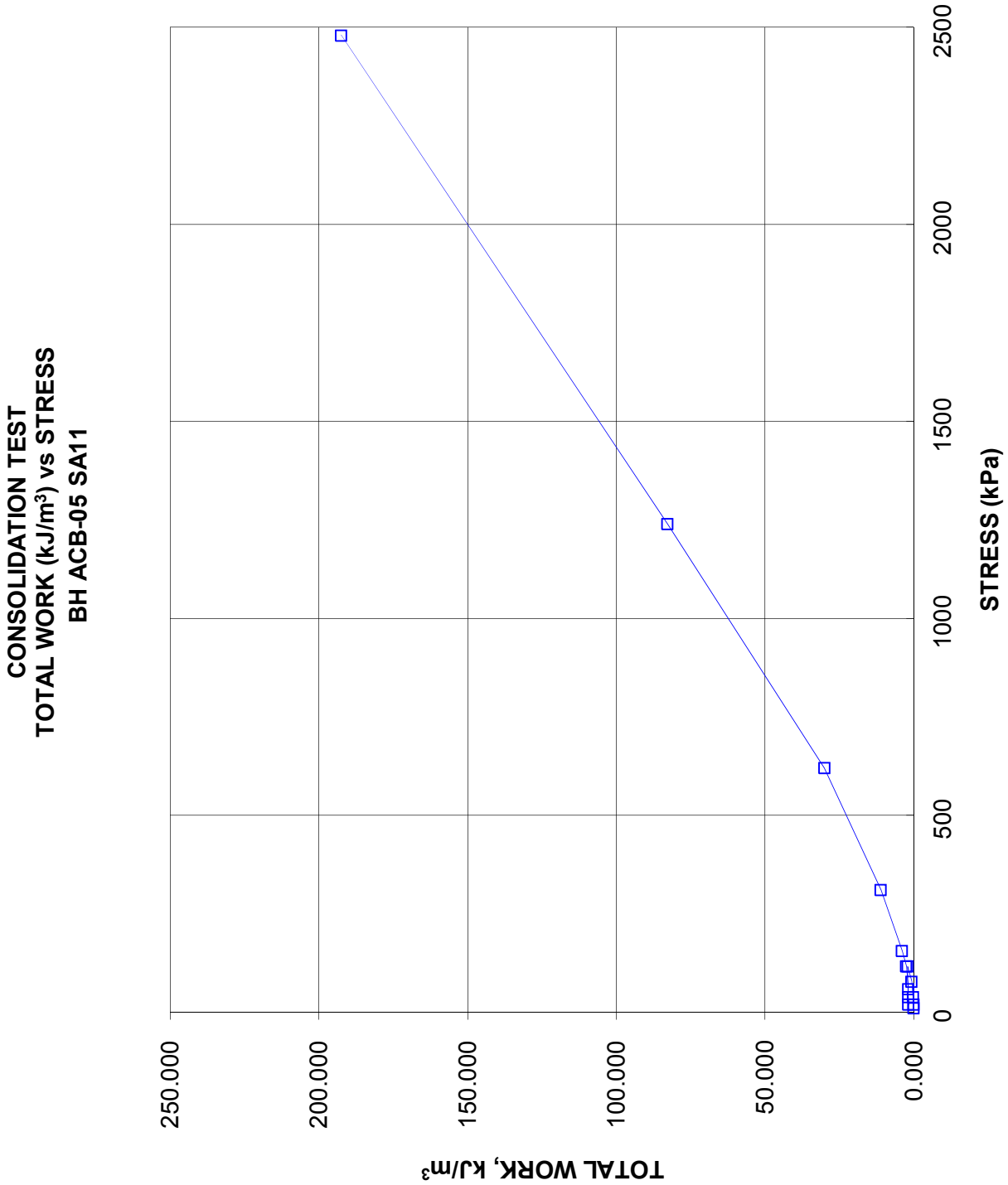
Prepared By: LH

Golder Associates Ltd.

Checked By: TZ

CONSOLIDATION TEST
TOTAL WORK VS STRESS

FIGURE C9D



Project No. 1670746

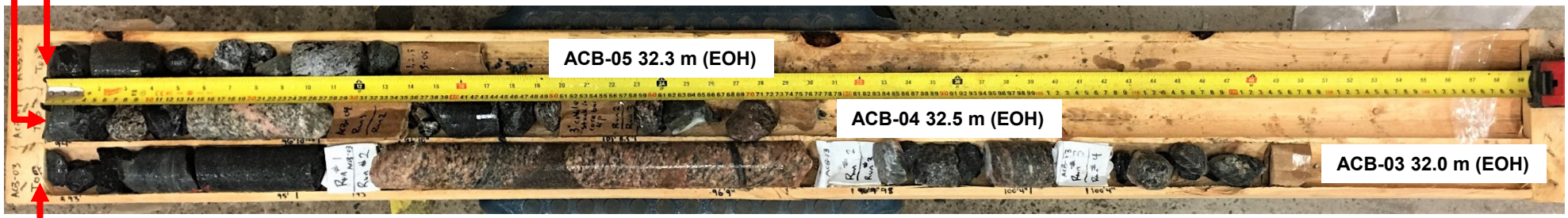
Prepared By: LH

Golder Associates Ltd.

Checked By: TZ

Borehole ACB-04: Cobbles and boulders cored between 28.7 m and 32.5 m

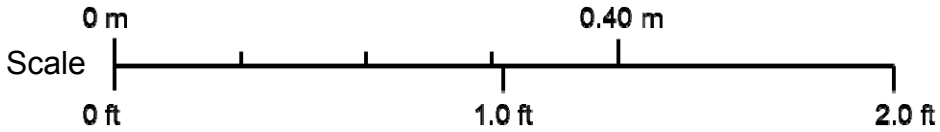
Borehole ACB-05: Cobbles and boulders cored between 28.7 m and 32.3 m



Borehole ACB-03: Cobbles and boulders cored between 28.3 m and 32.0 m

Borehole ACB-06: Cobbles and boulders cored between 29.3 m and 30.5 m

Borehole ACB-02: Cobbles and boulders cored between 28.2 m and 30.5 m



NOTE:
'EOH' represents End of Borehole.

PROJECT **Highway 532 – Achigan Creek Bridge Replacement, 5.1 km North of Highway 556 (Site No. 38S-041) Gaudette and Hodgins Townships, Algoma District, Ontario**

TITLE **COBBLES AND BOULDERS CORE PHOTOGRAPHS BOREHOLES ACB-02 TO ACB-06**

Golder Associates

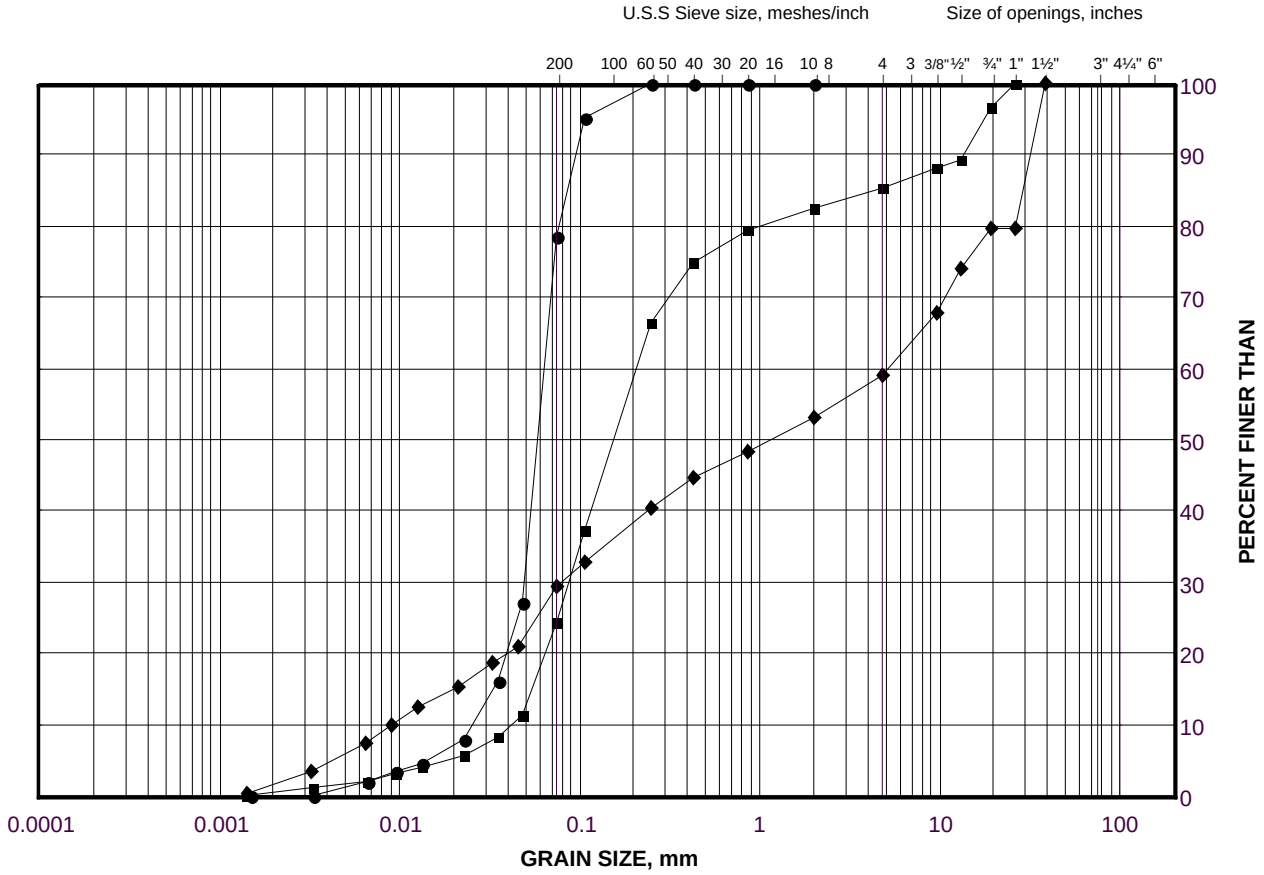
PROJECT No. 1670846			FILE No. ----		
DESIGN	AK	20180422	SCALE	NTS	VER. 1.
CADD	--		**FIGURE C10**		
CHECK	ACK	20180516			
REVIEW	TZ	20180622			

REVISION DATE: June 11, 2018 BY: AK Project: 1670846

GRAIN SIZE DISTRIBUTION

Sandy Silt to Silty Sand to Silty Sand and Gravel
(Lower Granular Deposit)

FIGURE C11



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ACB-06	19	208.0
■	ACB-02	19	208.3
◆	ACB-07	21	207.7

Project Number: 1670846
Checked By: TZ

Golder Associates

Date: 11-Jun-18

APPENDIX D

Analytical Laboratory Test Results

Maxxam
A Bureau Veritas Group Company

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	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
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 CaCl2 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.

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

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

Your Project #: 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.

Maxxam Job #: B7J9789
Report Date: 2017/09/20

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

RESULTS OF ANALYSES OF SOIL

Maxxam ID		FCS510	FCS510	FCS511	FCS512	FCS513	FCS514		
Sampling Date		2017/08/23	2017/08/23	2017/09/07	2017/09/06	2017/07/16	2017/07/11		
COC Number		628368-01-01	628368-01-01	628368-01-01	628368-01-01	628368-01-01	628368-01-01		
	UNITS	ACB-03 SA4	ACB-03 SA4 Lab-Dup	ACC1-03 SA2	ACCS-03 SA2	MRB-04 SA3	MRB-03 SA5	RDL	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	7300		15000	4100	5900	2400		5165355
Inorganics									
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

Maxxam ID		FCS515	FCS516	FCS517		
Sampling Date		2017/08/23	2017/07/29	2017/08/02		
COC Number		628368-01-01	628368-01-01	628368-01-01		
	UNITS	DCC-01 SA2	MCC-03 SA1	WRC-01 SA3	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	2200	24000	43000		5165355
Inorganics						
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

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

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

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

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

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

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

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

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

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

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

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

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.

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

QUALITY ASSURANCE REPORT

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

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5165977	Available (CaCl2) 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 (SO4)	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).

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

Golder Associates Ltd
Client Project #: 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).

Cristina Carriere

Cristina Carriere, Scientific Service Specialist

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

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

13-Sep-17 11:39
Ema Gitej
B7J9789
KES ENV-689
C#628368-01-01

Page of
Bottle Order #: 628368
Project Manager: Ema Gitej

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name:	#1326 Golder Associates Ltd	Company Name:		Quotation #:	B70916
Attention:	Accounts Payable	Attention:	Darcy Hansen	P.O. #:	
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	[redacted] 1670846
Tel:	(905) 567-4444 x Fax: (905) 567-6561 x	Tel:	(905) 567-4444 x2064 Fax:	Project Name:	
Email:	AP_CustomerService@golder.com	Email:	Darcy_Hansen@golder.com	Site #:	
				Sampled By:	

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

Regulation 153 (2011)
☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ For RSC
☐ Table ___

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

Special Instructions

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

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

ANALYSIS REQUESTED (PLEASE BE SPECIFIC):

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

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

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

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Chloride & SO4 (20:1 extract)	Conductivity/Resistivity	pH CaCl2 EXTRACT	Sulphide (Maxxam BIC)	# of Bottles	Comments
1		ACB-03 SA4	Aug 23, 2017	-		1	1	1	1	2	
2		ACC1-03 SA2	sept 7, 2017	—		1	1	1	1	2	
3		ACC2-03 SA2	sept 6, 2017	—		1	1	1	1	2	
4		MRB-04 SA3	Jul 16, 2017	—		1	1	1	1	2	
5		MRB-03 SA5	Jul 11, 2017	—		1	1	1	1	2	
6		PCC-01 SA2	Aug 23, 2017	—		1	1	1	1	2	
7		MCC-03 SA1	Jul 29 2017	—		1	1	1	1	2	
8		WRC-01 SA3	Aug 2, 2017	—		1	1	1	1	2	
9											
10											

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Darcy Hansen	12/09/13	10am	[illegible] USA MUNSTER	2017/09/13	11:39	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal Present	Yes	No
	5 5 7	Intact	✓	

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

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

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

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

White: Maxxa Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Maxxam
A Bureau Veritas Group Company

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	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
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 CaCl2 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.

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

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

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Campo to Burnaby Subcontract

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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

Encryption Key

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

==========

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

Maxxam Job #: B7L2287
Report Date: 2017/10/23

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

RESULTS OF ANALYSES OF SOIL

Maxxam ID		FFD202	FFD203	FFD203		
Sampling Date		2017/08/26	2017/09/09	2017/09/09		
COC Number		628368-02-01	628368-02-01	628368-02-01		
	UNITS	DCC-04 SA-2	ACB-06 SA-3	ACB-06 SA-3 Lab-Dup	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	5100	7200			5185712
Inorganics						
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

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Maxxam Job #: B7L2287
Report Date: 2017/10/23

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

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

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Maxxam Job #: B7L2287
Report Date: 2017/10/23

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

GENERAL COMMENTS

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

Package 1	1.7°C

Results relate only to the items tested.

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Maxxam Job #: B7L2287
Report Date: 2017/10/23

QUALITY ASSURANCE REPORT

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

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5188854	Available (CaCl2) 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 (SO4)	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).

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Maxxam Job #: B7L2287
Report Date: 2017/10/23

Golder Associates Ltd
Client Project #: 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).

Ema Gitej, Senior Project Manager

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

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

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

IMMEDIATE TEST

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

CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#1326 Golder Associates Ltd	Company Name:		Quotation #:		Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:	Darcy Hansen,	P.O. #:			628368
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	1670846	COC #:	Project Manager:
Tel:	(905) 567-4444 x Fax: (905) 567-6561 x	Tel:	(905) 567-4444 x2064 Fax:	Project Name:		C#628368-02-01	Ema Gitej
Email:	AP_CustomerService@golder.com	Email:	Darcy_Hansen@golder.com	Site #:			
				Sampled By:			

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

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine	☐ CCME ☐ Sanitary Sewer Bylaw	
☐ Table 2 ☐ Ind/Comm ☐ Coarse	☐ Reg 558 ☐ Storm Sewer Bylaw	
☐ Table 3 ☐ Agri/Other ☐ For RSC	☐ MISA Municipality	
☐ Table	☐ PWQO	
	☐ Other	

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

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	ANALYSIS REQUESTED (PLEASE BE SPECIFIC): Chloride & SO4 (20:1 extract)	Conductivity/Resistivity	pH CaCl2 EXTRACT	Sulphide (Maxxam BC)	# of Bottles	Comments
1	[redacted]	DCL-04 S.A.2	26/08/17	—	SOIL		1	1	1	1	2	
2		ACB-06 S.A.3	09/09/17	—	SOIL		1	1	1	1	2	
3												
4												
5												
6												
7												
8												
9												
10												

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

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

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

27-Sep-17 12:13
Ema Gitej
B7L2287
SEL ENV-1117

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
DARCY HANSEN	17/09/27	9:15	[illegible]	17/09/27	12:13	

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Recei	Custody Seal Present	Yes	No
	2 | 1 | 2	Intact		

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

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

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

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

White: Maxxa Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Maxxam
A Bureau Veritas Group Company

Success Through Science®

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 Extracted	Date Analyzed	Laboratory Method	Analytical Method
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:

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

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

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

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

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

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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

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

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

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

PHYSICAL TESTING (SOIL)

Maxxam ID		RZ2662	RZ2663	RZ2664	RZ2665		
Sampling Date		2017/08/23	2017/09/07	2017/09/06	2017/07/16		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01		
	UNITS	ACB-03 SA4	ACC1-03 SA2	ACCS-03 SA2	MRB-04 SA3	RDL	QC Batch
Physical Properties							
Moisture	%	24	22	28	8.2	0.30	8761682
RDL = Reportable Detection Limit							

Maxxam ID		RZ2666	RZ2667	RZ2668	RZ2669		
Sampling Date		2017/07/11	2017/08/23	2017/07/29	2017/08/02		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01		
	UNITS	MRB-03 SA5	DCC-01 SA2	MCC-03 SA1	WRC-01 SA3	RDL	QC Batch
Physical Properties							
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 **Collected:** 2017/08/23
Sample ID: ACB-03 SA4 **Shipped:**
Matrix: Soil **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 **Collected:** 2017/08/23
Sample ID: ACB-03 SA4 **Shipped:**
Matrix: Soil **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 **Collected:** 2017/09/07
Sample ID: ACC1-03 SA2 **Shipped:**
Matrix: Soil **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 **Collected:** 2017/09/06
Sample ID: ACCS-03 SA2 **Shipped:**
Matrix: Soil **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 **Collected:** 2017/07/16
Sample ID: MRB-04 SA3 **Shipped:**
Matrix: Soil **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 **Collected:** 2017/07/11
Sample ID: MRB-03 SA5 **Shipped:**
Matrix: Soil **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

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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

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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.

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

QUALITY ASSURANCE REPORT

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

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% 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 <= 2x 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]

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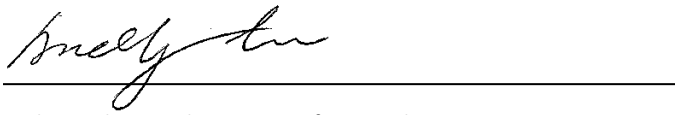
Maxxam Job #: B780085
Report Date: 2017/09/18

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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A Bureau Veritas Group Company

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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 Extracted	Date Analyzed	Laboratory Method	Analytical Method
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.

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

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Your Project #: 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

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

Maxxam ID		SC4339		SC4340	SC4340		
Sampling Date		2017/08/26		2017/09/09	2017/09/09		
COC Number		B7L2287-M058-01-01		B7L2287-M058-01-01	B7L2287-M058-01-01		
	UNITS	DCC-04 SA-2	RDL	ACB-06 SA-3	ACB-06 SA-3 Lab-Dup	RDL	QC Batch
MISCELLANEOUS							
Sulphide	ug/g	0.92	0.55	0.60	0.50	0.50	8779137

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

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

MAXXAM ANALYTICS
Client Project #: MB7L2287
Site Location: 1670846

PHYSICAL TESTING (SOIL)

Maxxam ID		SC4339	SC4340	SC4340		
Sampling Date		2017/08/26	2017/09/09	2017/09/09		
COC Number		B7L2287-M058-01-01	B7L2287-M058-01-01	B7L2287-M058-01-01		
	UNITS	DCC-04 SA-2	ACB-06 SA-3	ACB-06 SA-3 Lab-Dup	RDL	QC Batch
Physical Properties						
Moisture	%	29	18	17	0.30	8779668

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

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

MAXXAM ANALYTICS
Client Project #: MB7L2287
Site Location: 1670846

GENERAL COMMENTS

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

Package 1	7.3°C

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.

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

MAXXAM ANALYTICS
Client Project #: MB7L2287
Site Location: 1670846

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 Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

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

MAXXAM ANALYTICS
Client Project #: MB7L2287
Site Location: 1670846

VALIDATION SIGNATURE PAGE

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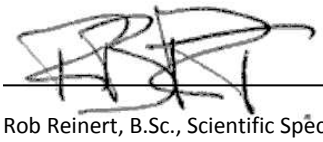

Rob Reinert, B.Sc., Scientific Specialist

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