



## Foundation Investigation Report

*Replacement of QEW Twin Structures over CN and CP Rails, Site Nos. 34-129-1 and 34-129-2, QEW from 1.4 km North of Bowen Road Interchange Southerly to Gilmore Road Interchange, Niagara Region, Ontario, GWP 2116-16-00*

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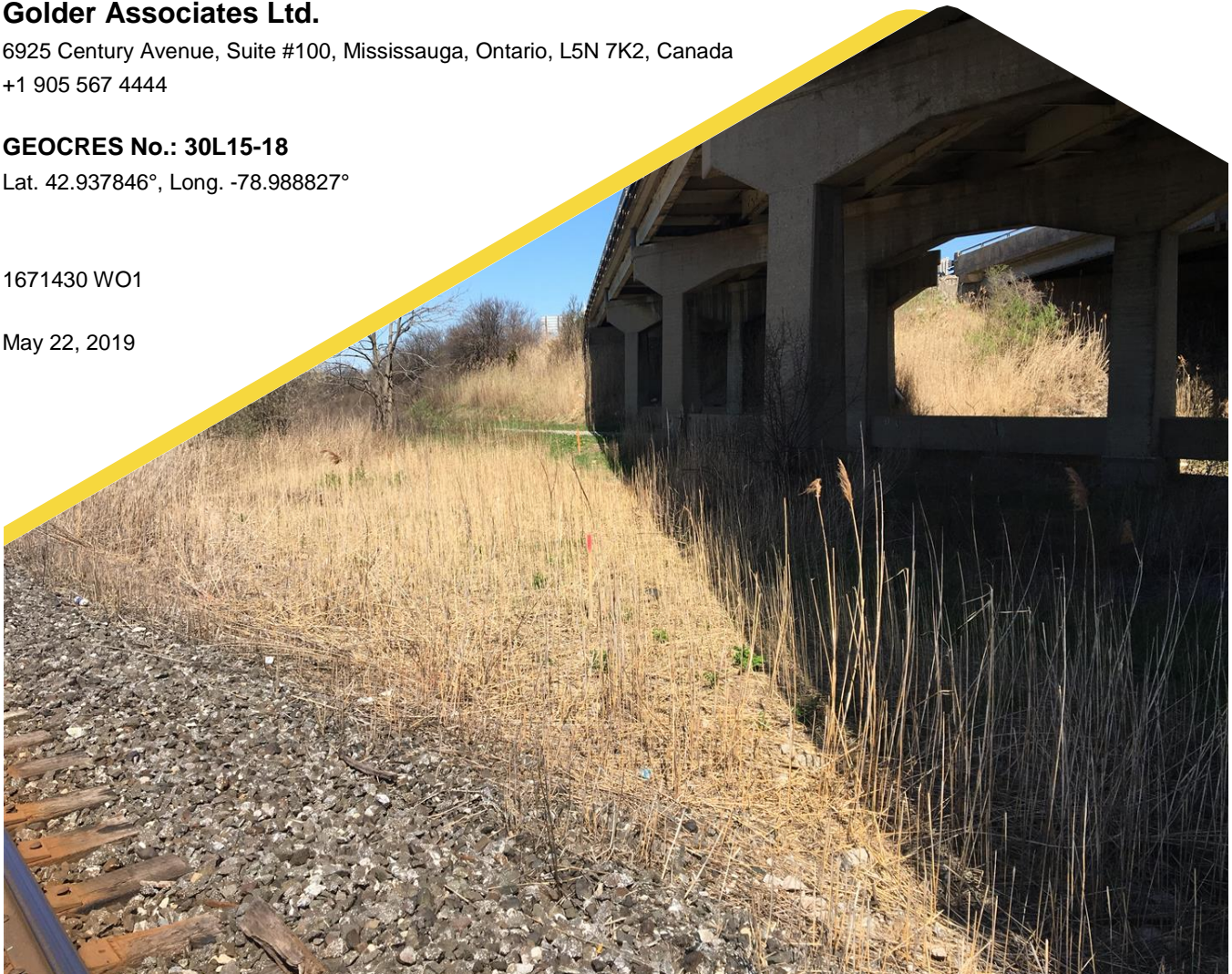
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# Table of Contents

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION.....</b>	<b>1</b>
<b>3.0 INVESTIGATION PROCEDURES.....</b>	<b>2</b>
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS.....</b>	<b>4</b>
4.1 Regional Geology.....	4
4.2 General Overview of Subsurface Conditions.....	4
4.2.1 Asphalt/Topsoil/Crushed Stone.....	5
4.2.2 Fill.....	5
4.2.3 Silty Clay to Clay.....	6
4.2.4 Clayey Silt to Clayey Silt with Sand.....	6
4.2.5 Sandy Silt to Silt and Sand to Sand.....	7
4.2.6 Gravelly Sand to Sand and Gravel to Gravel.....	7
4.2.7 Dolomitic Limestone Bedrock.....	8
4.3 Groundwater Conditions.....	10
4.4 Analytical Testing Results.....	11
<b>5.0 CLOSURE.....</b>	<b>12</b>

## DRAWINGS

Drawing 1	Borehole Locations and Soil Strata
Drawing 2	Soil Strata
Drawing 3	Soil Strata

## APPENDICES

### APPENDIX A - Borehole and Drillhole Records

Lists of Symbols and Abbreviations
Lithological and Geotechnical Rock Description Terminology
Record of Boreholes CN/CP1 to CN/CP13
Record of Drillholes CN/CP2, CN/CP3, CN/CP5 to CN/CP12

**APPENDIX B - Geotechnical Laboratory Test Results and Bedrock Core Photographs**

Figure B-1	Grain Size Distribution –Silty Clay to Clay (Fill)
Figure B-2	Plasticity Chart – Silty Clay to Clay (Fill)
Figure B-3	Grain Size Distribution – Silty Clay to Clay
Figure B-4	Plasticity Chart – Silty Clay to Clay
Figure B-5	Grain Size Distribution – Clayey Silt to Clayey Silt with Sand
Figure B-6	Plasticity Chart – Clayey Silt to Clayey Silt with Sand
Figure B-7	Grain Size Distribution – Sandy Silt to Silt and Sand to Sand
Figure B-8	Plasticity Chart – Silt
Figure B-9	Grain Size Distribution – Gravelly Sand to Sand and Gravel
Figure B-10	Plasticity Chart – Sand and Gravel (Fines Portion)
Figures B-11 to B-20	Bedrock Core Photographs
Figure B-21	Point Load Test Results

**APPENDIX C - Rock Laboratory Testing Results****APPENDIX D - Analytical Chemical Test Results**

## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of the replacement of the twin structures over Canadian National (CN) and Canadian Pacific (CP) Rails (Site Nos. 34-129-1 and 34-129-2), along the Queen Elizabeth Way (QEW) near the Town of Fort Erie, Regional Municipality of Niagara (Assignment No. 2016-E-0029-001/008), located as shown on the Key Plan on Drawing 1, attached.

This report summarizes the results of the foundation investigation carried out for the replacement of the QEW twin structures over the CN and CP Rail lines. Separate foundation investigation reports are provided for the high fill embankments and retaining walls, and for the culvert replacement / extensions / rehabilitations. The purpose of this investigation is to establish the subsurface soil, bedrock and shallow groundwater conditions at the proposed overhead structure locations by borehole drilling, rock coring and laboratory testing on selected soil and rock core samples.

The Terms of Reference for the foundation engineering services are outlined in MTO's Work Item Order No. 2016-E-0029-001, dated July 2017, and MTO's Work Item Order No. 2016-E-0029-008, dated March 2018, which form part of the Consultant's Assignment for the Central Region Large Value Retainer under Agreement No. 2016-E-0029-001 and 2016-E-0029-008.

## 2.0 SITE DESCRIPTION

The existing CN and CP Rail overheads are located approximately 650 m north of the QEW - Bowen Road interchange in the Town of Fort Erie Ontario.

The existing CN and CP Rail overheads consist of two six-span structures with the abutments and piers supported on shallow foundations. The ground surface along the QEW at the CN and CP Rail overheads location varies from approximately Elevations 188 m to 189 m, rising slightly from northwest to southeast. The CN and CP Rail grade is at approximately Elevations 180 m to 181 m. The existing QEW was constructed on embankments that are approximately 8 m to 9 m high relative to the natural ground surface. The existing approach embankments appear to have performed well (i.e., no indications of excessive settlements or instability) based on field observations of the embankment slopes, crest and existing pavement made during Golder's 2018 subsurface investigation.

Review of historical information from MTO GEOCRETS No. 30L15-011 for "QEW and Michigan Central Railway" suggests that an embankment failure occurred on the east side of the NBL, north of the existing CN and CP overhead structures. The exact location and extents of the failure cannot be confirmed based on the available information. The available drawing, dated August 1961, presents a plan view and three sections depicting details of the failure including tension cracks at the crest and bulging material at the toe of the highway embankment. The drawing also illustrates a mid-slope stabilization berm which is approximately 11.3 m wide, by 3.0 to 3.5 m high, by at least 100 m long. One of the sections shows stratigraphy inferred from boreholes drilled post-failure indicating that the failure surface was contained within the embankment fill material (i.e., not a foundation failure). Review of electronic design files provided to Golder by AECOM reveal a mid-slope bench exists along the east side of the NBL embankment between approximately Stations 13+845 to 13+940 (north abutment).

### 3.0 INVESTIGATION PROCEDURES

The field work for the replacement of the CN and CP Rail overheads investigation was carried out between August 20, 2018 and November 30, 2018, during which time 13 boreholes (designated as Boreholes CN/CP1 through CN/CP13) were advanced at the site. Boreholes CN/CP1, CN/CP3 through CN/CP5, and CN/CP10 through CN/CP13 were advanced from QEW highway grade, while Boreholes CN/CP2 and CN/CP6 through CN/CP9 were advanced from near rail grade below the QEW, at the approximate locations shown on Drawing 1.

Boreholes CN/CP1, CN/CP3 through CN/CP5, and CN/CP10 through CN/CP13 were advanced using 152 mm or 203 mm outer diameter hollow-stem augers with a CME 75 truck-mounted drill rig. Boreholes CN/CP2 and CN/CP6 through CN/CP9 were advanced using 203 mm outer diameter hollow stem augers with a CME 55 track-mounted drill rig. Both drill rigs were supplied and operated by Geo-Environmental Drilling Ltd. of Halton Hills, Ontario. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in all boreholes in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586)<sup>1</sup>. Bedrock was cored at Boreholes CN/CP2, CN/CP3, and CN/CP5 through CN/CP12, for depths between 2.9 m and 4.0 m. Bedrock core samples were obtained using an 'HQ3' size (96 mm outer diameter) rock core barrel. Photographs of the recovered rock samples are provided in Appendix B.

The groundwater conditions in the open boreholes were observed during and immediately following the drilling operations. At some locations, boreholes were kept open overnight or for several days and the corresponding water level within the borehole (hollow stem augers) was measured. A standpipe piezometer was installed in Borehole CN/CP6 to permit monitoring of the water level. The installed piezometer consists of a 50 mm diameter PVC pipe, with a 1.5 m slotted screen within a filter sand pack sealed within the sand and gravel deposit. The annulus surrounding the piezometer pipe above the filter sand pack and the remaining boreholes were backfilled to near ground surface with bentonite pellets in accordance with Ontario Regulation 903, Wells (as amended). Boreholes CN/CP1, CN/CP3 through CN/CP5, and CN/CP10 to CN/CP13 were sealed at ground surface with about 200 mm of cold patch asphalt.

The field work was monitored on a full-time basis by a member of Golder's technical staff who located the boreholes in the field, directed the sampling and in situ testing operations, logged the boreholes and examined the soil and bedrock core samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further visual review and geotechnical laboratory testing. Rock quality (i.e., Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD), weathering and strength index), discontinuity characteristics and classification data were recorded in the field based on visual inspection of the recovered bedrock cores upon extraction from the core barrel. The bedrock was sequentially photographed, packed in core boxes and transported to Golder's Mississauga laboratory for further visual examination. Classification of the rock mass quality of the bedrock with respect to the RQD is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM, 2006)<sup>2</sup> while the strength of the bedrock core samples is based on Table 3.5 of (CFEM, 2006)<sup>2</sup>. The degree of weathering of the bedrock core samples and the strength classification of the intact rock mass based on field identification are described in accordance with Table B.3 and Table B.6, respectively of the International Society of Rock Mechanics (ISRM, 1985)<sup>3</sup> standard classification system.

<sup>1</sup> ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

<sup>2</sup> Canadian Foundation Engineering Manual. 2006. Fourth Edition, Canadian Geotechnical Society: Richmond, British Columbia

<sup>3</sup> International Society for Rock Mechanics Commission on test Methods. 1985. Int. J. Rock Mech. Min. Sci & Geomech. Abstr. Vol 22, No. 2, pp.51-60

Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. Unconfined compression (uniaxial) strength (UCS) testing was carried out on selected rock samples in the Geomechanics laboratory in Oakville, Ontario. Point load testing was carried out on selected specimens of the bedrock core in Golder's laboratory. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. The results of the geotechnical (soil and bedrock samples) laboratory testing are included in Appendices B and C.

Nine soil samples were submitted to Maxxam Analytics (Maxxam) of Mississauga, Ontario which is a Standards Council of Canada (SCC) accredited laboratory for chemical analysis. The samples were analyzed for corrosivity testing (parameters include conductivity, resistivity, soluble chloride, soluble sulphate and pH). The chemical analyses results are presented in Appendix D.

The as-drilled borehole locations were generally surveyed by Callon Dietz, Ontario Land Surveyors with an accuracy of less than 5 cm in the horizontal and vertical directions, respectively. Some borehole locations were surveyed using a handheld GPS by Golder personnel and the corresponding elevations obtained from the digital terrain model provided by AECOM. The locations given on the borehole records and shown on Drawings 1 to 3 are positioned relative to MTM NAD 83 (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, including geographic (Latitude / Longitude) coordinates, the ground surface elevations and borehole drilled depths are summarized below.

Borehole No.	MTM NAD83 Zone 10		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude (°))	Easting (m) (Longitude (°))		
CN/CP1	4,755,516.6 (42.938311)	346,465.5 (-78.989487)	188.1	9.8
CN/CP2	4,755,491.7 (42.938077)	346,477.2 (-78.989342)	180.6	18.5
CN/CP3	4,755,515.3 (42.938298)	346,479.4 (-78.989317)	188.4	27.2
CN/CP4	4,755,522.0 (42.938358)	346,486.2 (-78.989233)	188.0	9.8
CN/CP5	4,755,507.6 (42.938227)	346,500.1 (-78.989063)	188.3	27.2
CN/CP6	4,755,466.4 (42.937848)	346,496.4 (-78.989108)	180.0	18.5
CN/CP7	4,755,467.2 (42.937863)	346,520.4 (-78.988818)	180.0	18.1
CN/CP8	4,755,462.6 (42.937812)	346,536.3 (-78.988621)	180.1	18.7
CN/CP9	4,755,424.5 (42.937469)	346,532.6 (-78.988668)	180.0	18.6

Borehole No.	MTM NAD83 Zone 10		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude (°))	Easting (m) (Longitude (°))		
CN/CP10	4,755,407.5 (42.937321)	346,584.2 (-78.988041)	188.2	27.2
CN/CP11	4,755,402.3 (42.937274)	346,602.8 (-78.987813)	188.3	27.1
CN/CP12	4,755,416.3 (42.937402)	346,563.7 (-78.988291)	188.6	27.2
CN/CP13	4,755,394.3 (42.937202)	346,597.0 (-78.987885)	187.9	9.8

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

This section of the QEW is located in the Clay Plains within the Haldimand Clay Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)<sup>4</sup>. The Beaches and Limestone Plains, also within the Haldimand Clay Plain physiographic region, are located in close proximity to the site.

Generally this section of the Haldimand Clay Plain, located in the farthest southeast reach of the Niagara peninsula, consists of fine-textured glaciolustrine deposits of silt and clay with minor amounts of sand and gravel. These deposits range from massive to well-laminated. This area of the clay plains can be considered a separate subregion, characterized by levelness and poor drainage.

Underlying the overburden in this area is dolomitic limestone and dolostone of the Bois Blanc and Salina formations, specifically the Bertie member of the Salina formation. These limestone and dolostone units are typically characterized as medium strong to extremely strong, grey, crystalline and slightly argillaceous.

### 4.2 General Overview of Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes of the current investigation including piezometer installation details and water level readings, and the results of the in situ and laboratory tests are provided on the Record of Borehole Sheets in Appendix A. The results of the in-situ field tests (i.e., SPT 'N'-values) as presented on the borehole records and in Section 4 are uncorrected. The results of the geotechnical laboratory testing on soil and bedrock core samples are presented in Appendices B and C. The results of the analytical testing are provided in Appendix D.

The stratigraphic boundaries shown on the borehole records and on the profiles / cross-sections on Drawings 1 to 3 are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological

<sup>4</sup>Chapman, L.J. and Putnam, D.F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P. 2715, Scale 1:600,000.

change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected, however, the factual data presented on the borehole records governs any interpretation of the site conditions.

In general, the ground surface consists of either: asphalt pavement underlain by sand and gravel fill and variable cohesive embankment fill (for those boreholes drilled through the QEW lanes or shoulder); crushed stone underlain by sand and gravel fill (for those boreholes drilled in close proximity to the rail tracks); or topsoil (for those boreholes drilled near the rail grade but further from the railway tracks). The topsoil and fill materials are generally underlain by a silty clay to clay deposit, further underlain by a clayey silt deposit. A sand and gravel deposit was generally encountered underlying the clayey silt deposit and overlying the dolomitic limestone bedrock. A more detailed description of the major soil strata and groundwater conditions throughout the site is provided in the following sections of this report.

#### 4.2.1 Asphalt/Topsoil/Crushed Stone

Boreholes CN/CP1, CN/CP3 through CN/CP5 and CN/CP10 through CN/CP13 were advanced through the QEW highway surface; layers of asphalt pavement between 75 mm and 460 mm thick were encountered immediately below ground surface.

Boreholes CN/CP2, CN/CP7 and CN/CP8 were advanced below QEW highway grade in the vicinity of the decommissioned CP rail line. Layers of crushed stone, track ballast, and wooden railway tie fragments were encountered, with thicknesses ranging between 50 mm and 250 mm.

Boreholes CN/CP6 and CN/CP9 encountered approximately 100 mm and 200 mm thick layers of topsoil, respectively. Borehole CN/CP6 was advanced in the median between the live CN Rail tracks and the decommissioned CP rail line and Borehole CN/CP9 was advanced from the toe of the embankment west of the QEW and south of the CN Rail tracks.

#### 4.2.2 Fill

Below the surficial layer of asphalt pavement / topsoil / crushed stone, a 0.4 m to 1.2 m thick layer of sand to sand and gravel to sandy gravel fill was encountered in all boreholes except Boreholes CN/CP6 and CN/CP9, extending to depths between 0.5 m and 1.5 m (Elevations 179.2 m to 187.7 m). A cohesive fill layer comprising clay to sandy silty clay was encountered underlying the non-cohesive fill in Boreholes CN/CP1, CN/CP3 through CN/CP5, CN/CP7, CN/CP8, and CN/CP10 through CN/CP13 and underlying the topsoil in Borehole CN/CP6. Trace pockets of organics and topsoil were encountered throughout the cohesive fill. The cohesive fill layer ranged in thickness from 0.6 m to 7.9 m, was encountered at depths between 0.1 m and 0.5 m (Elevations 179.4 m and 187.2 m) and extended to depths between 0.8 m and 8.7 m (Elevations 178.6 m and 179.9 m).

The Standard Penetration Test (SPT) 'N'-values measured within the non-cohesive fill range between 6 blows and 56 blows per 0.3 m of penetration, indicating a loose to very dense state of compactness. The SPT 'N'-values measured within the cohesive fill range between 3 blows and 15 blows per 0.3 m of penetration, suggesting a soft to very stiff, typically firm to stiff consistency.

The results of grain size distribution testing completed on seven samples of the cohesive fill are shown on Figure B-1 in Appendix B. Atterberg limits tests were carried out on nine samples of the cohesive fill layer and measured liquid limits between 39 per cent and 58 per cent, plastic limits between 17 per cent and 23 per cent, and plasticity indices between 21 per cent and 36 per cent. These results, which are plotted on a plasticity chart on Figure B-2 in Appendix B, indicate that the cohesive fill varies from a silty clay of intermediate plasticity to a clay of high plasticity.

The water content measured on one sample of the non-cohesive fill was about 8 per cent. The water content measured on 32 samples of the cohesive fill range from about 14 per cent to about 50 per cent, generally above the plastic limit. Laboratory organic content testing on specific samples of the cohesive fill containing trace organics / pockets of topsoil measured 4.8 per cent and 5.6 per cent.

#### 4.2.3 Silty Clay to Clay

A silty clay to clay deposit was encountered underlying the topsoil in Borehole CN/CP9 and underlying the fill layers in Boreholes CN/CP1 through CN/CP8, and CN/CP10 through CN/CP13. The surface of the deposit was encountered between Elevations 179.9 m and 178.6 m, corresponding to depths between 0.2 m and 1.4 m from rail grade and a depth of about 8.7 m from QEW grade. Boreholes CN/CP1, CN/CP4, and CN/CP13 were terminated within the silty clay to clay deposit, penetrating it for a thickness of 1.1 m. The silty clay to clay deposit was 3.0 m to 5.8 m thick where fully penetrated and extended to between Elevations 177.3 m and 174.4 m, corresponding to depths between 4.5 m and 5.6 m from rail grade and depths between 10.9 m and 13.3 m from QEW grade.

The SPT 'N'-values measured within the silty clay to clay deposit range from 3 blows to 30 blows per 0.3 m of penetration, suggesting a soft to hard, but typically stiff to very stiff consistency.

The results of grain size distribution testing completed on ten samples of the silty clay to clay deposit are shown on Figure B-3 in Appendix B. Atterberg limits tests were carried out on eight samples of the silty clay to clay deposit, and measured liquid limits ranging between 38 per cent and 53 per cent, plastic limits ranging between 18 per cent and 24 per cent, and plasticity indices ranging between 19 per cent and 32 per cent. These results, which are plotted on a plasticity chart on Figure B-4 in Appendix B, indicate that the deposit is comprised of silty clay of intermediate plasticity to clay of high plasticity. The water content measured on twenty-one samples of the clay to silty clay deposit range between about 12 per cent and about 29 per cent, generally near the plastic limit of the material.

#### 4.2.4 Clayey Silt to Clayey Silt with Sand

A 1.7 m to 7.7 m thick deposit of clayey silt to clayey silt with sand was encountered underlying the silty clay to clay deposit, cohesive fill deposit, or silt and sand layers in Boreholes CN/CP2, CN/CP3, CN/CP5 through CN/CP12. The surface of the deposit was encountered between Elevations 176.7 m and 174.4 m, corresponding to depths between 4.5 m and 5.6 m from rail grade and depths between 11.7 m and 13.3 m from QEW grade. The deposit extended to between Elevations 172.8 m to 168.9 m, corresponding to depths between 7.9 m and 10.9 m from rail grade and depths between 15.5 m and 19.4 from QEW grade.

The SPT 'N'-values measured within the clayey silt to clayey silt with sand deposit range from 6 blows to 41 blows per 0.3 m of penetration, suggesting a firm to hard consistency. Two SPT 'N'-values of 4 blows per 0.3 m of penetration were measured at the base of the deposit in Boreholes CN/CP7 and CN/CP8; however, artesian conditions were encountered in the underlying sand to sand and gravel deposits at these depths which likely resulted in disturbance of the in-situ soil conditions; thus, these low 'N'-values are not considered to be representative of the general consistency of this deposit.

The results of grain size distribution testing completed on fourteen samples of the clayey silt to clayey silt with sand deposit are shown on Figure B-5 in Appendix B. Atterberg limits tests were carried out on sixteen samples of the clayey silt to clayey silt with sand deposit, and measured liquid limits ranging between 15 per cent and 33 per cent, plastic limits ranging between 10 per cent and 19 per cent, and plasticity indices ranging between 2 per cent and 16 per cent. The results, which are plotted on a plasticity chart on Figure B-6 in Appendix B, and along with the

results of the grain size distribution testing, indicate that the deposit is comprised of clayey silt of low plasticity to silt of slight plasticity. The water content measured on nineteen samples of the clayey silt to clayey silt with sand range between about 10 per cent and about 19 per cent.

#### 4.2.5 Sandy Silt to Silt and Sand to Sand

A 0.8 m to 3.1 m thick deposit of sandy silt to silt and sand to sand was encountered between the silty clay to clay and clayey silt deposits in Boreholes CN/CP10 and CN/CP11 and underlying the clayey silt to clayey silt with sand deposit in Boreholes CN/CP2, CN/CP3, CN/CP5 through CN/CP7, CN/CP10 and CN/CP11. The surface of the deposit was encountered between Elevations 177.3 m and 168.9 m, corresponding to depths between 8.7 m and 10.2 m from rail grade and depths between 10.8 m and 19.4 m from QEW grade. The deposit extends to between Elevations 172.0 m and 166.7 m, corresponding to depths between 10.7 m and 13.3 m from rail grade and depths between 16.3 m and 21.6 m from QEW grade.

The SPT 'N'-values measured within the sandy silt to silt and sand to sand deposit generally range from 8 blows to 34 blows per 0.3 m of penetration, indicating a loose to dense state of compactness. SPT 'N'-values of 1 and 4 blows per 0.3 m of penetration were measured in this deposit in Boreholes CN/CP2 and CN/CP7; however, artesian groundwater conditions were encountered at these depths which likely resulted in disturbance of the in-situ soil conditions. These lower 'N'-values are not considered to be representative of the general state of compactness of this deposit.

The results of grain size distribution testing completed on eight samples of the sandy silt to silt and sand to sand deposit are shown on Figure B-7 in Appendix B. An Atterberg limits test was carried out on the fines content of one sample of the silt and sand deposit, and measured a liquid limit of 13 per cent, a plastic limit of 12 per cent, and a corresponding plasticity index of about 1 per cent. The result, which is plotted on a plasticity chart on Figure B-8 in Appendix B, indicates that the deposit contains silt of slight plasticity. The water content measured on eight samples of the sandy silt to silt and sand to sand deposit range between about 10 per cent and about 22 per cent.

#### 4.2.6 Gravelly Sand to Sand and Gravel to Gravel

A 1.6 m to 7.6 m thick deposit of gravelly sand to sand and gravel to gravel was encountered underlying the clayey silt to clayey silt with sand deposit in Boreholes CN/CP8, CN/CP9 and CN/CP12, and underlying the sandy silt to silt and sand to sand deposit in Boreholes CN/CP2, CN/CP3, CN/CP5 through CN/CP7, CN/CP10 and CN/CP11. The surface of the deposit was encountered between Elevations 172.3 m and 166.7 m, corresponding to depths between 7.9 m and 13.3 m from rail grade and depths between 16.3 m and 21.6 m from QEW grade. The deposit extended to between Elevations 165.3 m and 164.5 m, corresponding to depths between 15.2 m and 15.5 m from rail grade and depths between 23.2 m and 23.8 m from QEW grade. Auger grinding was noted during drilling in the gravelly sand to sand and gravel to gravel deposit in a number of the boreholes, suggesting the presence of cobbles and/or boulders.

The SPT 'N'-values measured within the gravelly sand to sand and gravel to gravel deposit range from 9 blows per 0.3 m of penetration to 100 blows per 0.03 m of penetration, indicating a loose to very dense state of compactness. An SPT 'N'-value of 4 blows per 0.3 m of penetration was measured within the sand and gravel deposit in Borehole CN/CP8; however, artesian conditions were encountered at this depth which likely resulted in disturbance of the in-situ soil conditions. The lower 'N'-values are not considered to be representative of the general state of compactness of this deposit.

The results of grain size distribution testing completed on eight samples of the gravelly sand to sand and gravel to gravel deposit are shown on Figure B-9 in Appendix B. An Atterberg limits test was carried out on one sample of the fines portion of the sand and gravel, and measured a liquid limit of 16 per cent, a plastic limit of 15 per cent, and a corresponding plasticity index of about 1 per cent. The result, which is plotted on a plasticity chart on Figure B-10 in Appendix B, indicates that the fines portion of the sample contains silt of slight plasticity. The water content measured on nineteen samples of the gravelly sand to sand and gravel to gravel deposit range between about 6 per cent and about 26 per cent.

#### 4.2.7 Dolomitic Limestone Bedrock

Bedrock was encountered underlying the gravelly sand to sand and gravel to gravel deposit in Boreholes CN/CP2, CN/CP3, and CN/CP5 through CN/CP12, between Elevations 165.3 and 164.5 m. The depths to bedrock, corresponding bedrock surface elevations, and recovered core lengths are summarized below:

Borehole	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Cored Length (m)
CN/CP2	15.3	165.3	3.2
CN/CP3	23.2	165.2	3.9
CN/CP5	23.8	164.5	3.4
CN/CP6	15.2	164.8	3.3
CN/CP7	15.2	164.8	2.9
CN/CP8	15.4	164.7	3.3
CN/CP9	15.5	164.5	3.1
CN/CP10	23.2	165.0	4.0
CN/CP11	23.2	165.1	3.9
CN/CP12	23.3	165.3	3.9

Based on the review of the bedrock core samples, the bedrock consists of dolomitic limestone of the Bois Blanc formation with some gypsum and siltstone layers. In general, the bedrock core samples are described as fresh to moderately weathered (W1 to W3), crystalline, grey, fine to medium grained, non-porous to moderately porous, medium strong to very strong (R3 to R5) dolomitic limestone with weak (R2) gypsum layers, as presented on the relevant Record of Drillhole sheets, and shown on the photographs of the recovered cores samples on Figures B-11 to B-20 in Appendix B. The degree of weathering of the bedrock samples and the strength classification of the intact rock mass based on field identification are described in accordance with the International Society for Rock Mechanics (ISRM<sup>5</sup>) standard classification system.

<sup>5</sup> International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

The Rock Quality Designation (RQD) measured on the core samples generally ranges from about 51 per cent to 100 per cent, indicating a rock mass of fair to excellent quality as per Table 3.10 of CFEM (2006)<sup>6</sup>. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered are between 82 per cent and 100 per cent and between 53 per cent and 100 per cent, respectively.

The majority of the logged discontinuities are joints or faults within the dolomitic limestone bedrock or contacts between siltstone/limestone interbeds. In general, the identified discontinuity surfaces are undulating, planar or irregular in shape, with smooth to rough surface roughness. The surfaces of the identified discontinuities generally range from clean to completely coated (< 1 mm) with gypsum. Where the discontinuities have an infilling greater than 1 mm, the infill material is generally identified as gypsum.

Six uniaxial (unconfined) compressive strength (UCS) tests (ASTM D7012)<sup>7</sup> were carried out on core specimens of the limestone bedrock and strength values ranged from 62.9 MPa to 215.6 MPa, as shown on the drillhole records in Appendix A, laboratory results contained in Appendix C and summarized in the table below.

Borehole No.	Depth From (m)	Depth to (m)	Density (g/cm <sup>3</sup> )	UCS (MPa)
CN/CP3	25.96	26.22	2.70	133.2
CN/CP5	25.03	25.39	2.54	62.9
CN/CP6	17.88	18.08	2.70	136.9
CN/CP8	16.18	16.37	2.79	215.6
CN/CP9	15.97	16.14	2.75	96.8
CN/CP12	23.37	23.62	2.62	92.5

Point load strength tests (ASTM D5731)<sup>8</sup> were carried out on selected core specimens. The axial and diametral point load strength index values ( $I_{s(50)}$ ) are shown on the drillhole records in Appendix A, and on Figure B-21 in Appendix B. Sixteen axial tests measured  $I_{s(50)}$  values of between about 0.9 MPa and 7.7 MPa and an average of 4.0 MPa. Fourteen diametral tests measured  $I_{s(50)}$  values of between about 0.1 MPa and 8.5 MPa, with an average of 1.1 MPa.

Based on the laboratory UCS and Point Load tests, the bedrock is classified as medium strong (R3, 25 MPa < UCS < 50 MPa, 1 MPa <  $I_{s50}$  < 2 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa, 4 MPa <  $I_{s50}$  < 10 MPa) in accordance with Table 3.5 of CFEM (2006)<sup>9</sup>.

<sup>6</sup> Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual (CFEM), 4<sup>th</sup> Edition. The Canadian Geotechnical Society, BiTech Published Ltd., British Columbia.

<sup>7</sup> ASTM D7012 - Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures

<sup>8</sup> ASTM D5731 - Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

<sup>9</sup> Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual (CFEM), 4<sup>th</sup> Edition. The Canadian Geotechnical Society, BiTech Published Ltd., British Columbia.

### 4.3 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling and in the piezometer installed in Borehole CN/CP6, as summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)	Date	Comments
CN/CP1	188.1	Dry	-	23-Aug-18	Open borehole – completion of Drilling
CN/CP2	180.6	1.9	*178.7	21-Nov-18	Open borehole prior to coring – measured within hollow stem augers
		2.2	*178.4	22-Nov-18	Open borehole prior to coring – measured within hollow stem augers
		2.0	*178.6	23-Nov-18	Open borehole prior to coring – measured within hollow stem augers
		1.1	*179.5	30-Nov-18	Open borehole prior to coring – measured within hollow stem augers
CN/CP3	188.4	12.5	175.9	27-Aug-18	Open borehole prior to rock coring
CN/CP4	188.0	Dry	-	22-Aug-18	Open borehole – completion of drilling
CN/CP5	188.3	12.6	175.7	21-Aug-18	Open borehole prior to rock coring
CN/CP6	180.0	0.3	*179.7	28-Nov-18	Open borehole prior to coring – measured within hollow stem augers
		2.7	*177.3	30-Nov-18	Piezometer
		2.5	*177.5	5-Dec-18	Piezometer
		2.3	*177.7	15-Jan-19	Piezometer
CN/CP7	180.0	0.5	*179.5	22-Nov-18	Open borehole - overnight
		0.4	*179.6	23-Nov-18	Open borehole prior to coring – measured within hollow stem augers
CN/CP8	180.1	1.1	*179.0	23-Nov-18	Open borehole – overnight
CN/CP9	180.0	7.9	172.1	29-Nov-18	Open borehole prior to coring
CN/CP10	188.2	15.2	173.0	28-Aug-18	Open borehole – completion of drilling for the day
		11.6	176.6	29-Aug-18	Open borehole – overnight measured within hollow stem augers
		12.5	175.7	29-Aug-18	Open borehole prior to rock coring
CN/CP11	188.3	12.0	176.3	20-Aug-18	Open borehole prior to rock coring
CN/CP12	188.6	12.2	176.4	23-Aug-18	Open borehole prior to rock coring

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)	Date	Comments
CN/CP13	187.9	Dry	-	30-Aug-18	Open borehole on completion of drilling

\* Sub-artesian groundwater conditions – refer to Record of Borehole for more details

Sub-artesian groundwater conditions were observed within the cohesionless deposits within and below the clayey silt layer. These groundwater pressures were encountered and measured predominantly within the sand to sand and gravel layers / deposits below depths ranging from 6.1 m (Elevation 173.9 m) to 11.7 m (Elevation 168.9 m) during drilling of Boreholes CN/CP2, and CN/CP6 to CN/CP8 (all advanced at rail grade). The sub-artesian water pressures measured at least one day following drilling were observed to have risen to depths ranging from 0.4 m (Elevation 179.6) to 2.3 m (Elevation 177.7 m) below ground surface.

Based on the soil moisture contents and the observed oxidized zone (i.e., soil colour), together with measurements from the open boreholes and the piezometer installed in Borehole CN/CP6, the piezometric groundwater surface at this site is inferred to be between about Elevations 180 m and 178 m.

As some of the water levels were measured immediately or shortly after completion of drilling, they do not represent the stabilized groundwater level / piezometric surface at the site. The groundwater level / piezometric surface will be subject to seasonal fluctuations and should be expected to be higher during the spring season or during and following periods of heavy precipitation. Perched water should also be expected to be present above the cohesive soils.

## 4.4 Analytical Testing Results

Nine soil samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. Detailed analytical test results are included in Appendix D and the test results are summarized below:

Borehole No. - Sample No.	pH	Resistivity (ohm-cm)	Electrical Conductivity (µmho/cm)	Soluble Chlorides (µg/g)	Soluble Sulphates (µg/g)
CN/CP3 - 12	7.91	680	1,470	<20*	2,900
CN/CP5 - 5	7.46	730	1,370	39	1,400
CN/CP11 - 15	7.91	1,600	618	<20*	810
CN/CP12 - 11	7.89	3,400	297	<20*	180
CN/CP2 - 6	8.00	870	1,150	<20*	1,300
CN/CP6 - 5	7.83	420	2,370	30	2,900
CN/CP7 - 2	7.75	980	1,020	480	140
CN/CP8 - 3	7.78	1,500	667	88	390

Borehole No. - Sample No.	pH	Resistivity (ohm-cm)	Electrical Conductivity (µmho/cm)	Soluble Chlorides (µg/g)	Soluble Sulphates (µg/g)
CN/CP9 - 4	7.86	300	3,300	310	7,400

\* Reportable Detection Limit

## 5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Eric Naylor, EIT, and reviewed by Ms. Nikol Kochmanová, P.Eng., a geotechnical engineer with Golder. Mr. Kevin Bentley, P.Eng., an MTO Foundations Designated Contact and Associate of Golder, conducted an independent technical and quality control review of the report.

### Golder Associates Ltd.



Nikol Kochmanová, Ph.D., P.Eng., PMP  
Geotechnical Engineer

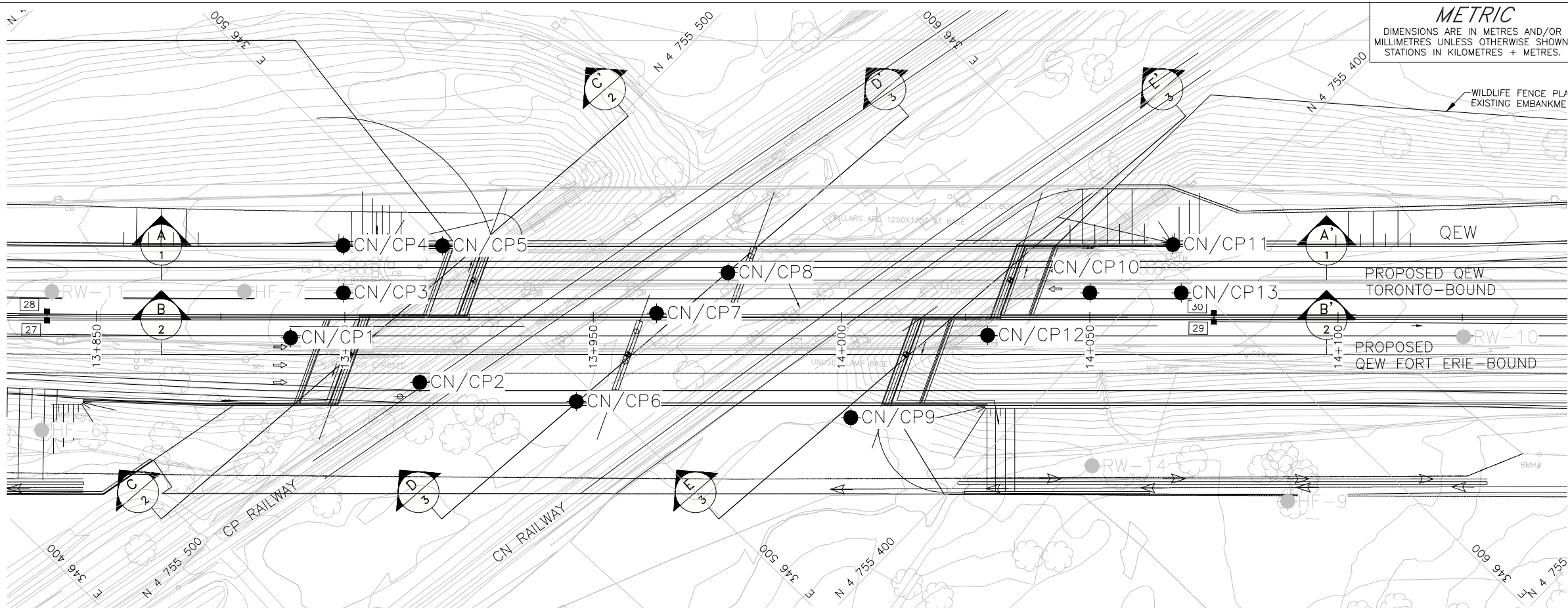


Kevin J. Bentley, M.E.Sc., P.Eng.  
Associate, MTO Designated Foundations Contact

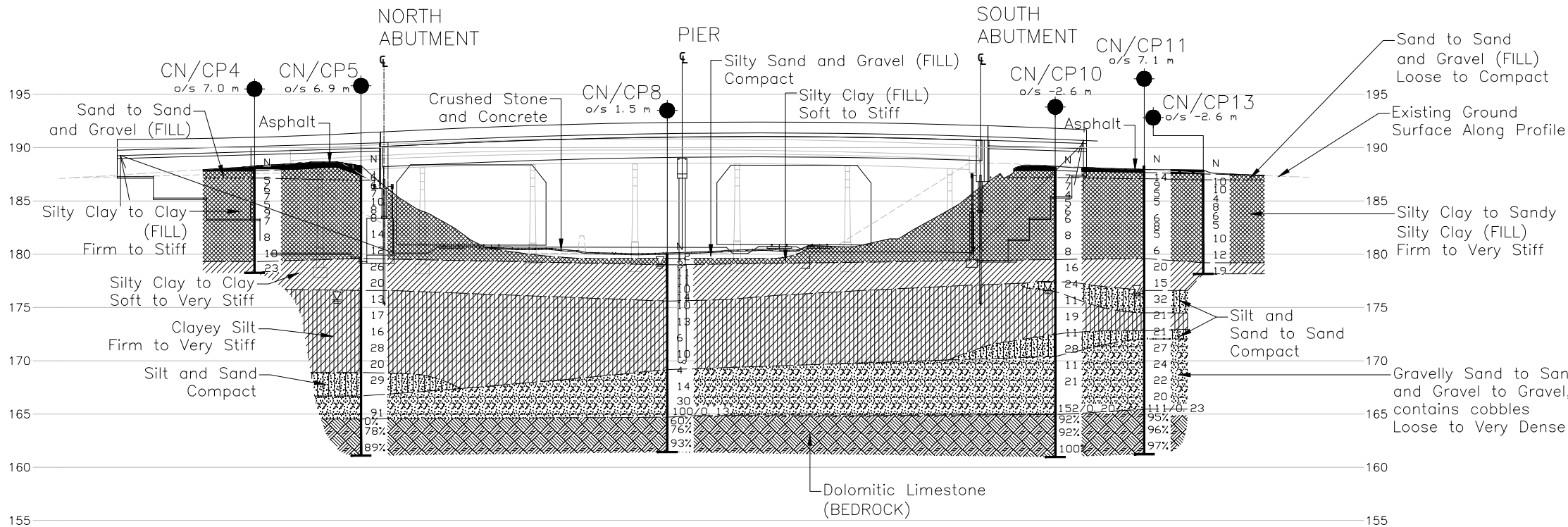
EN/NK/KJB/LCC/rb

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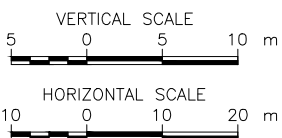
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PLAN



PROFILE A-A'



NOTES

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

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

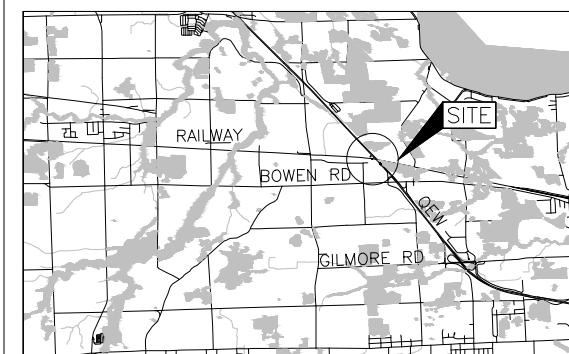
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General Arrangement provided in digital format by AECOM, drawing file nos. 01\_60581660 QEW Bertie CNR\_GA.DWG, received January 7, 2019 and 60581660\_ELEVATION.dwg, received March 19, 2019.  
Existing ground provided in digital format by AECOM, file no. B&C-191-QEW OCT UPDATE.dwg, received March 19, 2019.

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

CONT No. 2019-2003  
WP No. 2116-16-00

QEW  
CN/CP OVERHEADS REPLACEMENT  
BOREHOLE LOCATIONS AND SOIL STRATA



KEY PLAN  
SCALE  
1.5 0 1.5 3 km

LEGEND

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL upon completion of drilling

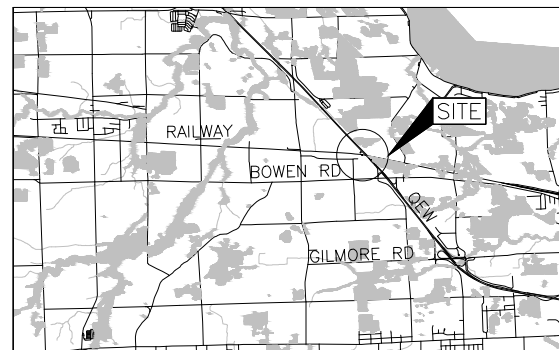
BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
CN/CP1	188.1	4755516.6	346465.5
CN/CP2	180.6	4755491.7	346477.2
CN/CP3	188.4	4755515.3	346479.4
CN/CP4	188.0	4755522.0	346486.2
CN/CP5	188.3	4755507.6	346500.1
CN/CP6	180.0	4755466.4	346496.4
CN/CP7	180.0	4755467.2	346520.4
CN/CP8	180.1	4755462.6	346536.3
CN/CP9	180.0	4755424.5	346532.6
CN/CP10	188.2	4755407.5	346584.2
CN/CP11	188.3	4755402.3	346602.8
CN/CP12	188.6	4755416.3	346563.7
CN/CP13	187.9	4755394.3	346597.0








NO.	DATE	BY	REVISION
Geocres No. 30L15-18			
HWY. QEW	PROJECT NO. 1671430		DIST. CENTRAL
SUBM'D. MS	CHKD. EN	DATE: 05/22/2019	SITE: 34-129
DRAWN: DD	CHKD. NK	APPD. KJB	DWG. 1

CONT No. 2019-2003  
WP No. 2116-16-00

SHEET



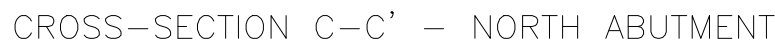
LEGEND

- |   |  |
|---|--|
|  | Borehole – Current Investigation                                   |
|  | Seal   |
|  | Piezometer   |
| N   | Standard Penetration Test Value                                    |
| 16  | Blows/0.3m unless otherwise stated<br>(Std. Pen. Test, 475 j/blow) |
| 100%  | Rock Quality Designation (RQD)                                     |
|  | WL in piezometer, measured on Jan 15, 2019                         |
|  | WL upon completion of drilling                                     |

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
CN/CP1	188.1	4755516.6	346465.5
CN/CP2	180.6	4755491.7	346477.2
CN/CP3	188.4	4755515.3	346479.4
CN/CP5	188.3	4755507.6	346500.1
CN/CP6	180.0	4755466.4	346496.4
CN/CP9	180.0	4755424.5	346532.6
CN/CP10	188.2	4755407.5	346584.2
CN/CP12	188.6	4755416.3	346563.7
CN/CP13	187.9	4755394.3	346597.0

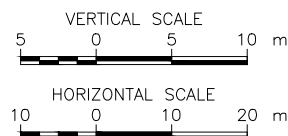


NO.	DATE	BY	REVISION
Geocres No. 30L15-18			
HWY. QEW		PROJECT NO. 1671430	DIST. CENTRAL
SUBM'D. MS	CHKD. EN	DATE: 05/22/2019	SITE: 34-129
DRAWN: SW	CHKD. NK	APPD. KJB	DWG. 2



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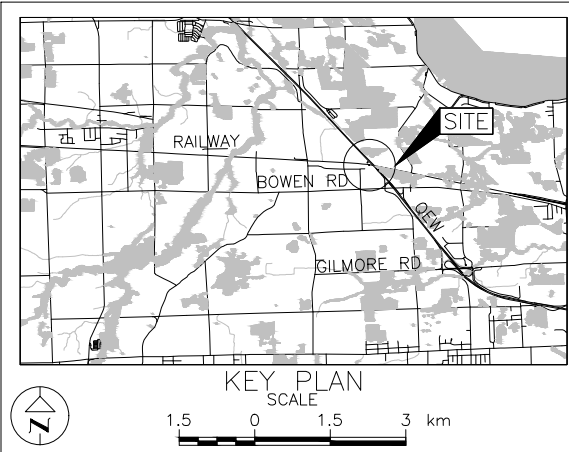
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General Arrangement provided in digital format by AECOM, drawing file nos. 01-60581660 QEW Bertie CNR\_CPR\_GA.DWG, received January 7, 2019 and 60581660-ELEVATION.dwg, received March 19, 2019.  
Existing ground provided in digital format by AECOM, file no. B&C-191-QEW OCT UPDATE.dwg, received March 19, 2019.

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

CONT No. 2019-2003  
WP No. 2116-16-00

QEW  
CN/CP OVERHEADS REPLACEMENT  
SOIL STRATA

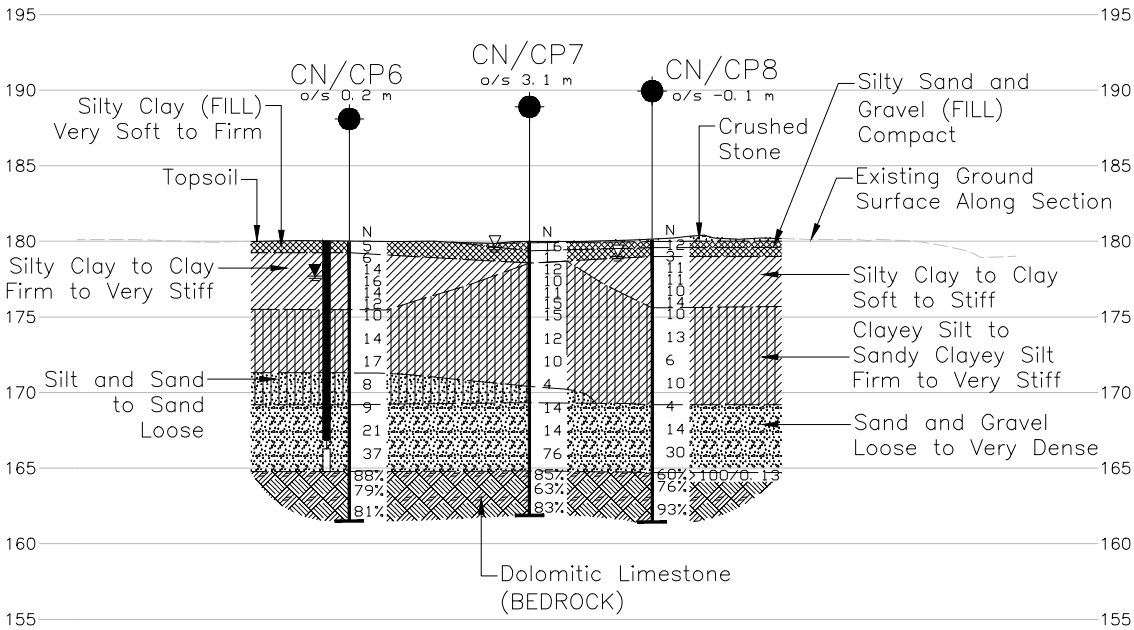
SHEET



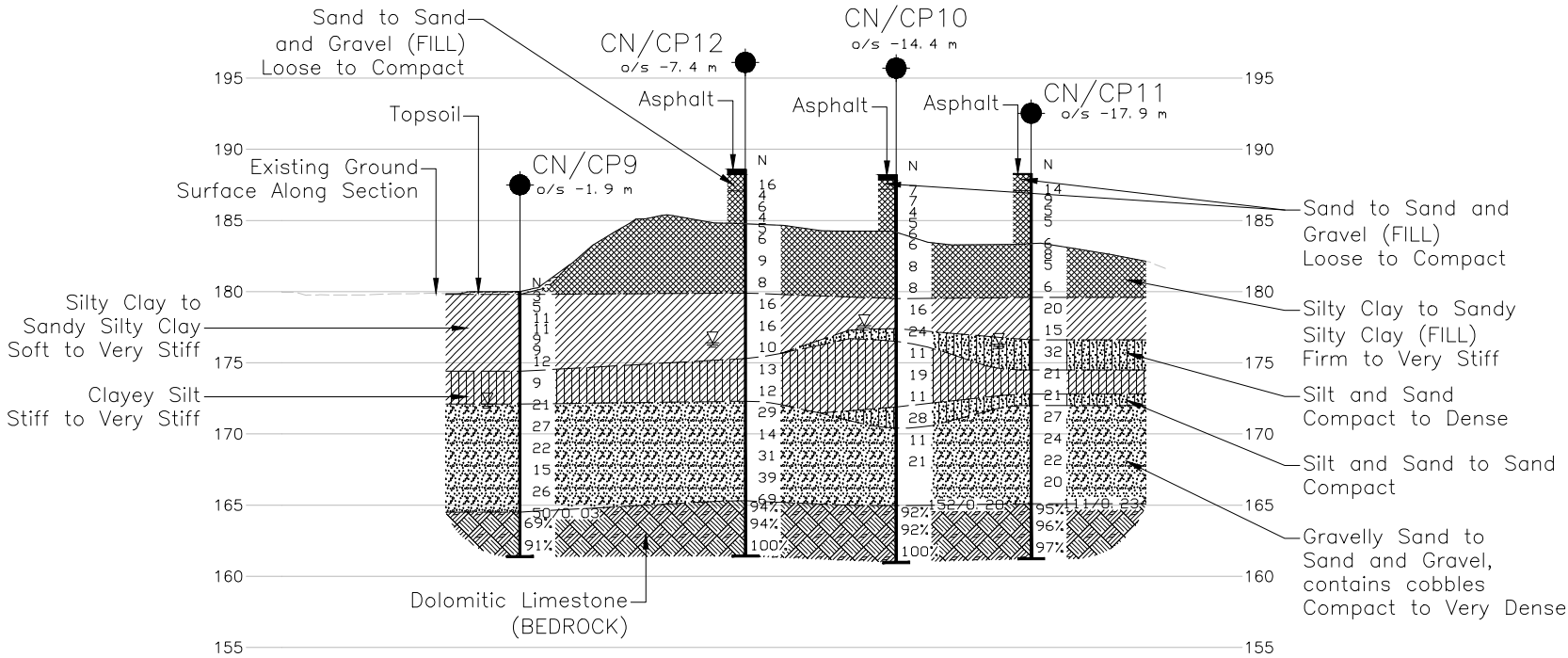
LEGEND

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer, measured on Jan 15, 2019
- WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
CN/CP6	180.0	4755466.4	346496.4
CN/CP7	180.0	4755467.2	346520.4
CN/CP8	180.1	4755462.6	346536.3
CN/CP9	180.0	4755424.5	346532.6
CN/CP10	188.2	4755407.5	346584.2
CN/CP11	188.3	4755402.3	346602.8
CN/CP12	188.6	4755416.3	346563.7



CROSS-SECTION D-D' - CENTRE PIER

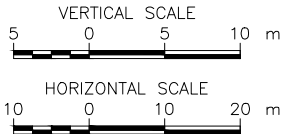


CROSS-SECTION E-E' - SOUTH ABUTMENT

NOTES

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REFERENCE

Base plan provided in digital format by AECOM, drawing file nos. X-60581660-C-CNCP-QEW-DES.dwg, received November 15, 2018, X-60581660-C-CNCP-QEW-BASE.dwg and 60581660 QEW Berti Alignments\_2019Jan03mw.dwg, received January 08, 2019.

General Arrangement provided in digital format by AECOM, drawing file nos. 01\_60581660 QEW Berti CNR\_CPR\_GA.DWG, received January 7, 2019 and 60581660\_ELEVATION.dwg, received March 19, 2019.

Existing ground provided in digital format by AECOM, file no. B&C-191-QEW OCT UPDATE.dwg, received March 19, 2019.



NO.	DATE	BY	REVISION
Geocres No. 30L15-18			
HWY. QEW	PROJECT NO. 1671430		DIST. CENTRAL
SUBM'D. MS	CHKD. EN	DATE: 5/22/2019	SITE: 34-129
DRAWN: SW	CHKD. NK	APPD. KJB	DWG. 3

**APPENDIX A**

# Borehole and Drillhole Records

## LIST OF SYMBOLS

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

### I. GENERAL

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

### II. STRESS AND STRAIN

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

### III. SOIL PROPERTIES

#### (a) Index Properties

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

#### (a) Index Properties (continued)

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

#### (b) Hydraulic Properties

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

#### (c) Consolidation (one-dimensional)

$C_c$	compression index (normally consolidated range)
$C_r$	recompression index (over-consolidated range)
$C_s$	swelling index
$C_{\alpha}$	secondary compression index
$m_v$	coefficient of volume change
$C_v$	coefficient of consolidation (vertical direction)
$C_h$	coefficient of consolidation (horizontal direction)
$T_v$	time factor (vertical direction)
U	degree of consolidation
$\sigma'_p$	pre-consolidation stress
OCR	over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$

#### (d) Shear Strength

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

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

Notes: 1  
2

$\tau = c' + \sigma' \tan \phi'$   
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, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

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

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

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

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

### III. SOIL DESCRIPTION

#### (a) Non-Cohesive (Cohesionless) Soils

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

#### (b) Cohesive Soils Consistency

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

### IV. SOIL TESTS

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

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

### V. MINOR SOIL CONSTITUENTS

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

## WEATHERINGS STATE

**Fresh:** no visible sign of weathering

**Faintly weathered:** weathering limited to the surface of major discontinuities.

**Slightly weathered:** penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

**Moderately weathered:** weathering extends throughout the rock mass but the rock material is not friable.

**Highly weathered:** weathering extends throughout rock mass and the rock material is partly friable.

**Completely weathered:** rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

## BEDDING THICKNESS

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

## JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

## GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: \* Grains greater than 60 microns diameter are visible to the naked eye.

## CORE CONDITION

### Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

### Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

### Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

## DISCONTINUITY DATA

### Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

### Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

### Description and Notes

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

### Abbreviations

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




PROJECT		RECORD OF BOREHOLE				No CN/CP2		SHEET 1 OF 2		METRIC		
G.W.P.		2116-16-00		LOCATION		N 4755491.7; E 346477.2 MTM NAD 83 ZONE 10 (LAT. 42.938077; LONG. -78.989342)		ORIGINATED BY		LK		
DIST		Central HWY QEW		BOREHOLE TYPE		203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig		COMPILED BY		EN		
DATUM		Geodetic		DATE		November 20 to 23 and 30, 2018		CHECKED BY		NK		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
180.6	GROUND SURFACE											
0.0	VEGETATION (50 mm)											
0.2	WOODEN TIES and BALLAST (200 mm)		1	SS	56							
	Sandy gravel (FILL) Very dense to compact Grey Moist		2	SS	22							
179.2												
1.4	- Hydrocarbon odour noted at 1.1 m		3	SS	17							
	SILTY CLAY, trace to some sand, trace gravel, trace organics to a depth of 2.2 m Stiff to very stiff Brown Moist		4	SS	17							
			5	SS	15							
			6	SS	13							
176.1												
4.5	CLAYEY SILT, some sand to sandy, trace gravel to gravelly Stiff to hard Grey-brown Moist		7	SS	19							
			8	SS	17							
			9	SS	41							
			10	SS	14							
170.4												
10.2	SILT and SAND, some clay Compact Grey-brown Wet		11	SS	19							
168.9												
11.7	SAND, trace clay, trace silt, trace gravel Very loose Grey Wet		12	SS	1							
	- Sub-Artesian condition encountered; water level rose to a depth of 1.9 m below ground surface overnight. See Notes 1 and 2.											
167.3	SAND and GRAVEL, trace to some silt Dense Grey Wet		13	SS	31							
13.3												

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-BERTIE02\_DATAGINT\QEW-BERTIE.GPJ GAL-GTA.GDT 05/22/19

PROJECT		1671430 WO1		RECORD OF BOREHOLE No CN/CP2				SHEET 2 OF 2		METRIC						
G.W.P.		2116-16-00		LOCATION				N 4755491.7; E 346477.2 MTM NAD 83 ZONE 10 (LAT. 42.938077; LONG. -78.989342)		ORIGINATED BY LK						
DIST		Central HWY QEW		BOREHOLE TYPE				203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig		COMPILED BY EN						
DATUM		Geodetic		DATE				November 20 to 23 and 30, 2018		CHECKED BY NK						
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
165.3			14	SS	100/0.05											
15.3	DOLOMITIC LIMESTONE (BEDROCK)  Bedrock cored from 15.3 m to 18.5 m depth.  For coring detail see Record of Drillhole CN/CP2		1	RC	REC 98%											RQD = 87%
			2	RC	REC 100%											RQD = 81%
162.1	END OF BOREHOLE															
18.5	NOTES:  1. Sub-Artesian conditions encountered at a depth of 11.7 m below ground surface.  2. Water level at a depth of 1.9 m (Elev. 178.7 m) at start of drilling on November 21, 2018 (i.e. after borehole left open overnight).  3. Water level at a depth of 2.2 m (Elev. 178.4 m) on November 22, 2018 and approximately 1.2 m of sand was encountered in the augers.  4. Water level at a depth of 2.0 m (Elev. 178.6 m) on November 23, 2018.  5. Water level at a depth of 1.1 m (Elev. 179.5 m) prior to rock coring and approximately 6.8 m of sand was encountered in the hollow stem augers on November 30, 2018.															

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PROJECT: 1671430 W01

**RECORD OF DRILLHOLE: CN/CP2**

SHEET 1 OF 1

LOCATION: N 4755491.70 ;E 346477.20

DRILLING DATE: November 30, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track-Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY															FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: LK/JL

CHECKED: EN





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PROJECT		1671430 WO1		<b>RECORD OF BOREHOLE No CN/CP3</b>		SHEET 1 OF 3		<b>METRIC</b>					
G.W.P.		2116-16-00		LOCATION		N 4755515.3; E 346479.4 MTM NAD 83 ZONE 10 (LAT. 42.938298; LONG. -78.989317)		ORIGINATED BY JK					
DIST		Central HWY QEW		BOREHOLE TYPE		203 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig		COMPILED BY EN					
DATUM		Geodetic		DATE		August 27 and 28, 2018		CHECKED BY NK					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)		
188.4 0.0	GROUND SURFACE ASPHALT (460 mm)												
187.9 0.8	Sand and gravel (FILL) Brown Moist		1	SS	11								
187.6 1.4	Sand, some gravel, trace silt (FILL) Compact Red-brown Moist		2	SS	6								
	Silty clay to clay, trace gravel, trace organics, trace topsoil between 7.6 m and 8.2 m (FILL) Firm to stiff Brown with black inclusions below 3.8 m to mottled grey-black below 7.6 m (topsoil) Moist		3	SS	6								
			4	SS	10								
			5	SS	9								
			6	SS	8								
			7	SS	10								
			8	SS	15								
179.7 8.7	SILTY CLAY, trace to some sand, trace to some gravel Very stiff Red-brown Moist		9	SS	30								
			10	SS	18								
176.7 11.7	CLAYEY SILT, trace sand to sandy, trace to some gravel Stiff to very stiff Red to brown Moist		11	SS	15								
			12	SS	21								

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

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-BERTIE02\_DATAGINT\QEW-BERTIE.GPJ GAL-GTA.GDT 05/22/19

PROJECT		1671430 WO1		RECORD OF BOREHOLE No CN/CP3				SHEET 2 OF 3		METRIC							
G.W.P.		2116-16-00		LOCATION		N 4755515.3; E 346479.4 MTM NAD 83 ZONE 10 (LAT. 42.938298; LONG. -78.989317)		ORIGINATED BY		JK							
DIST		Central HWY QEW		BOREHOLE TYPE		203 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig		COMPILED BY		EN							
DATUM		Geodetic		DATE		August 27 and 28, 2018		CHECKED BY		NK							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
--- CONTINUED FROM PREVIOUS PAGE ---								20	40	60	80	100					
169.0	CLAYEY SILT, trace sand to sandy, trace to some gravel Stiff to very stiff Red to brown Moist - Auger grinding on inferred cobbles at 15.8 m		13	SS	20												
169.4	SANDY SILT, trace to some clay, trace gravel Dense Red-brown Moist - Seepage noted at 19.8 m		14	SS	27												8 19 43 30
166.8	SAND and GRAVEL, some silt, trace clay Very dense Grey Moist		15	SS	18												
165.2	DOLOMITIC LIMESTONE (BEDROCK)  Bedrock cored from 23.2 m to 27.1 m.  For rock coring details refer to Record of Drillhole CN/CP3.		16	SS	34												1 28 63 8
165.2			17	SS	55/0.20												37 48 13 2
23.2			1	RC	REC 93%												RQD = 51%
			2	RC	REC 89%												RQD = 84%
			3	RC	REC 100%												RQD = 100%
161.3	END OF BOREHOLE																
27.1	NOTES:  1. Water level at a depth of 12.5 m below ground surface (Elev. 175.9 m) prior to rock coring.  2. Water level at a depth of 12.3 m (Elev. 176.1 m) after rock coring.																

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-BERTIE02\_DATAGINT\QEW-BERTIE.GPJ GAL-GTA GDT 05/22/19

PROJECT: 1671430 W01

**RECORD OF DRILLHOLE: CN/CP3**

SHEET 3 OF 3

LOCATION: N 4755515.30 ;E 346479.40

DRILLING DATE: August 28, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 Truck Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA				WEATH- ERING INDEX				Diametral Point Load Index (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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DEPTH SCALE

1 : 50






LOGGED: JK/EN

CHECKED: EN

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PROJECT		1671430 WO1		<b>RECORD OF BOREHOLE No CN/CP4</b>		SHEET 1 OF 1		<b>METRIC</b>						
G.W.P.		2116-16-00		LOCATION		N 4755522.0; E 346486.2 MTM NAD 83 ZONE 10 (LAT. 42.938358; LONG. -78.989233)		ORIGINATED BY JK						
DIST		Central HWY QEW		BOREHOLE TYPE		152 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig		COMPILED BY EN						
DATUM		Geodetic		DATE		August 22, 2018		CHECKED BY NK						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
188.0	GROUND SURFACE													
0.0	ASPHALT (200 mm)													
0.2	Sand and gravel (FILL)													
187.2	Brown Moist													
0.8	Sand (FILL) Loose Brown Wet		1	SS	5									
	Silty clay to clay, trace sand to sandy, trace to some organics between 3.0 m and 8.2 m, sand seams between 3.0 m and 3.7 m (FILL) Firm to stiff Red-brown Moist		2	SS	6									
			3	SS	7									
			4	SS	5									
			5	SS	9									
			6	SS	7									
			7	SS	8									
			8	SS	10									
179.3	CLAY, trace sand													
8.7	Very stiff Red-brown Moist													
178.3			9	SS	23									
9.8	END OF BOREHOLE													
	NOTE: 1. Open borehole dry on completion of drilling.													



PROJECT 1671430 WO1		RECORD OF BOREHOLE No CN/CP5				SHEET 2 OF 3		METRIC								
G.W.P. 2116-16-00		LOCATION N 4755507.6; E 346500.1 MTM NAD 83 ZONE 10 (LAT. 42.938227; LONG. -78.989063)				ORIGINATED BY JK										
DIST Central HWY QEW		BOREHOLE TYPE 203 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig				COMPILED BY EN										
DATUM Geodetic		DATE August 21 and 22, 2018				CHECKED BY NK										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
--- CONTINUED FROM PREVIOUS PAGE ---																
168.9 19.4	CLAYEY SILT, some sand to sandy, trace to some gravel Stiff to very stiff Red-brown Moist  - Inferred cobble at 18.9 m		13	SS	16											
			14	SS	28											
			15	SS	20											
			16	SS	29											
			17A 17B	SS	91											
166.7 21.6	GRAVEL, some sand Very dense Grey Wet		1	RC	REC 83%											
2	RC		REC 82%													
3	RC		REC 100%													
END OF BOREHOLE																
164.5 23.8	DOLOMITIC LIMESTONE (BEDROCK)  Bedrock cored from 23.8 m to 27.2 m.  For rock coring details refer to Record of Drillhole CN/CP5.		1	RC	REC 83%											
2	RC		REC 82%													
3	RC		REC 100%													
END OF BOREHOLE																
161.1 27.2	END OF BOREHOLE  NOTES:  1. Water level at a depth of 12.6 m (Elev. 175.7 m) prior to rock coring.  2. No water return during coring.  3. Water level at a depth of 24.7 m (Elev. 163.6 m) after rock coring based on observation within the casing.															

PROJECT: 1671430 WO1

LOCATION: N 4755507.60 ;E 346500.10

INCLINATION: -90° AZIMUTH: ---

**RECORD OF DRILLHOLE: CN/CP5**


DRILLING DATE: August 22, 2018

DRILL RIG: CME 75 Truck Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

SHEET 3 OF 3

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY												FEATURES	PIEZOMETER					
						FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP W/L CORE AXIS	DISCONTINUITY DATA				WEATH- ERING INDEX								
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jzon	W1	W2	W3	W4	W5	W6			
																						Diametral Point Load Index (MPa)		
							000000	000000	000000	000000	000000													
24	Rotary Diamond Drill HQ Core	Continued from Record of Borehole CN/CP5		164.53	1																			
		Moderately to slightly weathered, crystalline, grey, fine to medium grained, moderately to slightly porous, medium strong, DOLOMITIC LIMESTONE (Bois Blanc Formation)		23.77								JN, UN, SM JN, UN, RO JN, UN, RO												
		- Lost core due to inferred sand layer between 24.75 m and 25.03 m										BD, UN, SM BD, PL, SM BD, PL, SM	3	1	20									
25					2																			
26					3							JN, PL, SM	1	1	16									
		- Gypsum layer below 26.45 m; 3 - 8 cm long in discrete sections																						
27		END OF DRILLHOLE		161.10																				
				27.20																				
28																								
29																								
30																								
31																								
32																								
33																								

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: JK/EN

CHECKED: EN

GTA-RCK 046 S:\CLIENTS\MTQ\QEW-BERTIE\02\_DATA\GINT\QEW-BERTIE.GPJ GAL-MISS GDT 19-5-22

PROJECT		1671430		<b>RECORD OF BOREHOLE No CN/CP6</b>		SHEET 1 OF 2		<b>METRIC</b>								
G.W.P.		2116-16-00		LOCATION		N 4755466.4; E 346496.4 MTM NAD 83 ZONE 10 (LAT. 42.937848; LONG. -78.989108)		ORIGINATED BY								
DIST		Central HWY QEW		BOREHOLE TYPE		203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig		COMPILED BY								
DATUM		Geodetic		DATE		November 23 and 28, 2018		CHECKED BY								
								NK								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
180.0	GROUND SURFACE															
0.0	TOPSOIL (100 mm)		1A	SS	5											
0.1	Silty clay, trace sand, trace gravel, trace topsoil (FILL)		1B													
179.2	Firm Brown-black Moist		1C													
0.8	SILTY CLAY to CLAY, trace to some sand, trace rootlets to 2.2 m		2	SS	6											
	Firm to very stiff Mottled grey-black Moist		3	SS	14											
			4	SS	16											
			5	SS	14											
			6	SS	12											
175.5	CLAYEY SILT, with sand, trace gravel		7	SS	10											
4.5	Stiff to very stiff Grey-brown Moist to wet below 7.2 m															
	- Sand layer encountered at a depth of 5.8 m															
	- Seepage noted between 6.1 m and 6.7 m		8	SS	14											
	- Sub-Artesian condition encountered at Elev. 173.3 m; water level rose to a depth of 0.3 m below ground surface overnight. See Notes 1 and 2.															
			9	SS	17											
171.3	SILT and SAND, some gravel, trace to some clay															
8.7	Loose Grey Wet		10	SS	8											
169.8	SAND, some silt															
10.2	Loose Grey Wet															
169.2	SAND and GRAVEL, trace silt, trace clay		11	SS	9											
10.8	Loose to dense Grey Wet															
			12	SS	21											
			13	SS	37											

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-BERTIE\02\_DATAGINT\QEW-BERTIE.GPJ GAL-GTA.GDT 05/22/19

PROJECT		1671430		RECORD OF BOREHOLE No CN/CP6				SHEET 2 OF 2		METRIC							
G.W.P.		2116-16-00		LOCATION				N 4755466.4; E 346496.4 MTM NAD 83 ZONE 10 (LAT. 42.937848; LONG. -78.989108)		ORIGINATED BY							
DIST		Central HWY QEW		BOREHOLE TYPE				203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig		COMPILED BY							
DATUM		Geodetic		DATE				November 23 and 28, 2018		CHECKED BY							
NK																	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---																
164.8																	
15.2	DOLOMITIC LIMESTONE (BEDROCK)		1	RC	REC 90%												RQD = 88%
	Bedrock cored from 15.2 m to 18.5 m depth.																
	For coring detail see Record of Drillhole CN/CP6		2	RC	REC 99%												RQD = 79%
			3	RC	REC 100%												RQD = 81%
161.5	END OF BOREHOLE																
18.5	NOTES:																
	1. Artesian conditions encountered at a depth of 6.7 m below ground surface (Elev. 173.3 m) during drilling.																
	2. Water level at a depth of 0.3 m (Elev. 179.7 m) at start of drilling on November 28, 2018 (i.e. after borehole left open for 5 days).																
	3. Water level in standpipe piezometer:																
	Date      Depth (m)																
	Elev (m)																
	Nov 30, 2018    2.7    177.3																
	Dec 5, 2018    2.5    177.5																
	Jan 15, 2019    2.3    177.7																

PROJECT: 1671430

**RECORD OF DRILLHOLE: CN/CP6**

SHEET 1 OF 1

LOCATION: N 4755466.40 ;E 346496.40

DRILLING DATE: November 28, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track-Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	<b>NOTE:</b> For abbreviations, symbols and descriptions refer to <b>LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY</b>												FEATURES	PIEZOMETER							
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA				WEATH- ERING INDEX	Diametral Point Load Index (MPa)										
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jzon												
		Continued from Record of Borehole CN/CP6		164.76																						
		Moderately weathered to fresh, crystalline, brown to grey, fine to medium grained, faintly to moderately porous, weak to medium strong, DOLOMITIC LIMESTONE (Bois Blanc Formation)		15.24	1													LC								
16																										
		Gypsum Layer: 16.43 m-16.54 m			2						BD, UN, SM BD, UN, SM BD, UN, SM CO, UN, SM						BC									
17																	BC									
											BD, UN, SM, PC, GY BD, UN, SM, SA, GY BD, UN, SM, LL, GY BD, UN, SM, PC, GY JN, PL, SM, CC, SA BD, UN, SM, SA, GY						(Axial)									
18					3																					
		END OF DRILLHOLE		161.50																						
19				18.50																						
20																										
21																										
22																										
23																										
24																										
25																										

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: LK/JL

CHECKED: EN

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<b>PROJECT</b> 1671430		<b>RECORD OF BOREHOLE No CN/CP7</b>		SHEET 1 OF 2		<b>METRIC</b>	
<b>G.W.P.</b> 2116-16-00		<b>LOCATION</b> N 4755467.2; E 346520.4 MTM NAD 83 ZONE 10 (LAT. 42.937863; LONG. -78.988818)		<b>ORIGINATED BY</b> LK			
<b>DIST</b> Central <b>HWY</b> QEW		<b>BOREHOLE TYPE</b> 203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig		<b>COMPILED BY</b> EN			
<b>DATUM</b> Geodetic		<b>DATE</b> November 21, 22, 26 and 27, 2018		<b>CHECKED BY</b> NK			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE   LIQUID LIMIT LIMIT   CONTENT   LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × REMOULDED	20   40   60   80   100	10   20   30				
180.0	GROUND SURFACE													
0.0	CRUSHED STONE (50 mm diameter 100 mm thick)		1	SS	16									
179.4	Silty sand and gravel, trace topsoil (FILL)													
0.6	Compact Grey-black Moist		2	SS	1									
178.6	Silty clay, trace to some sand, trace gravel (FILL)													
1.4	Very soft Grey-brown Moist		3	SS	12									
	CLAYEY SILT, some sand to sandy, trace gravel													
	Firm to very stiff Brown Moist		4	SS	10									
			5	SS	11									
			6	SS	15									
			7	SS	15									
			8	SS	12									
			9	SS	10									

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

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PROJECT 1671430		RECORD OF BOREHOLE No CN/CP7				SHEET 2 OF 2		METRIC									
G.W.P. 2116-16-00		LOCATION N 4755467.2; E 346520.4 MTM NAD 83 ZONE 10 (LAT. 42.937863; LONG. -78.988818)				ORIGINATED BY LK											
DIST Central HWY QEW		BOREHOLE TYPE 203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig				COMPILED BY EN											
DATUM Geodetic		DATE November 21, 22, 26 and 27, 2018				CHECKED BY NK											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100						
164.8	DOLOMITIC LIMESTONE (BEDROCK)  Bedrock cored from 15.2 m to 18.1 m.  For coring details see record of drillhole CN/CP7.		1	RC	REC 100%												RQD = 85%
15.2			2	RC	REC 100%												RQD = 63%
			3	RC	REC 83%												RQD = 83%
161.9																	
18.1	END OF BOREHOLE  NOTES: 1. Sub-Artesian conditions encountered at a depth of 9.6 m below ground surface.  2. Water level at a depth of 0.5 m (Elev. 179.5 m) at start of drilling on November 22, 2018 (i.e. after 12.1 m borehole left open overnight).  3. Water level at a depth of 0.4 m (Elev. 179.6 m) and approximately 5.2 m of sand encountered in the hollow stem augers on November 23, 2018.																

PROJECT: 1671430

**RECORD OF DRILLHOLE: CN/CP7**

SHEET 1 OF 1

LOCATION: N 4755467.22 ;E 346520.40

DRILLING DATE: November 26 and 27, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track-Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY												FEATURES	PIEZOMETER		
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA				WEATH- ERING INDEX		Diametral Point Load Index (MPa)				
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION				Jr	Ja	Jzon				
						00000000	00000000	00000000	00000000	00000000								W1			
		Continued from Record of Borehole CN/CP7		164.82																	
		Slightly weathered to fresh, crystalline, brown to grey, fine to medium grained, faintly to moderately porous, weak to medium strong, DOLOMITIC LIMESTONE (Bois Blanc Formation)		15.18	1						•	BD, PL, SM, PC, GY									
16		Gypsum Layer: 16.16 m-16.31 m			2						•	BD, UN, SM									
											•	CO, UN, SM									
											•	BD, CU, SM									
											•	BD, UN, SM, PC, GY									
											•	BD, UN, SM, PC, GY									
											•	BD, UN, SM, PC, GY									
											•	BD, UN, SM, SO, GY									
											•	BD, UN, SM									
17											•	BD, UN, SM, SO, GY									
											•	BD, UN, SM, PC, M									
					3						•	BD, UN, SM									
18		END OF DRILLHOLE		161.87																	
				18.13																	
19																					
20																					
21																					
22																					
23																					
24																					
25																					

DEPTH SCALE

1 : 50



LOGGED: LK/JL

CHECKED: EN

GTA-RCK 046 S:\CLIENTS\MTQ\QEW-BERTIE\02\_DATA\GINT\QEW-BERTIE.GPJ GAL-MISS GDT 19-5-22

PROJECT 1671430		RECORD OF BOREHOLE No CN/CP8		SHEET 1 OF 2		METRIC														
G.W.P. 2116-16-00		LOCATION N 4755462.6; E 346536.3 MTM NAD 83 ZONE 10 (LAT. 42.937812; LONG. -78.988621)		ORIGINATED BY LK																
DIST Central HWY QEW		BOREHOLE TYPE 203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig		COMPILED BY EN																
DATUM Geodetic		DATE November 22, 23 and 27, 2018		CHECKED BY NK																
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60	80	100	20	40	60
180.1	GROUND SURFACE																			
0.0	CRUSHED STONE AND CONCRETE (50 mm)		1A	SS	12															
179.6	Silty sand and gravel, some organics and topsoil (FILL)		1B																	
0.5	Very loose to compact Black-grey Moist		2A	SS	3															
179.0	Silty clay, trace sand to sandy, trace gravel, some organics and topsoil (FILL)		2B																	
1.1	Soft to stiff Black Moist		3	SS	11															
	SILTY CLAY, some sand, trace to some gravel, trace organics to 1.4 m		4	SS	11															
	Soft to stiff Mottled grey-brown Moist		5	SS	10															
			6	SS	14															
175.6	Sandy CLAYEY SILT to CLAYEY SILT with SAND, trace gravel		7	SS	10															
4.5	Firm to stiff Brown to grey below 7.2 m Moist		8	SS	13															
			9	SS	6															
			10	SS	10															
			11A	SS	4															
169.2	SAND and GRAVEL, trace silt, trace clay		11B																	
10.9	Loose to compact Grey Wet																			
	- Sub-Artesian condition encountered at Elev. 169.2 m; water level rose to a depth of 1.1 m below ground surface overnight. See Notes 1 and 2.		12	SS	14															
			13	SS	30															

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

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PROJECT		RECORD OF BOREHOLE				No CN/CP8		SHEET 2 OF 2		METRIC						
G.W.P. 2116-16-00		LOCATION				N 4755462.6; E 346536.3 MTM NAD 83 ZONE 10 (LAT. 42.937812; LONG. -78.988621)				ORIGINATED BY LK						
DIST Central HWY QEW		BOREHOLE TYPE				203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig				COMPILED BY EN						
DATUM Geodetic		DATE				November 22, 23 and 27, 2018				CHECKED BY NK						
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100					
164.7			14	SS	>100/0.13											
15.4	DOLOMITIC LIMESTONE (BEDROCK)		1	RC	REC 99%											RQD = 60%
	Bedrock cored from 15.4 m to 18.7 m.		2	RC	REC 91%											RQD = 76%
	For coring details see Record of Drillhole CN/CP8		3	RC	REC 100%											RQD = 93%
161.4	END OF BOREHOLE															
18.7	NOTES:  1. Sub-Artesian conditions encountered at a depth of 10.9 m below ground surface.  2. Water level at a depth of 1.1 m (Elev. 179.0 m) at start of drilling on November 23, 2018 (i.e. after 12 m deep borehole left open overnight).															

PROJECT: 1671430

LOCATION: N 4755462.60 ;E 346536.30

INCLINATION: -90° AZIMUTH: ---

**RECORD OF DRILLHOLE: CN/CP8**

DRILLING DATE: November 27, 2018

DRILL RIG: CME 55 Track-Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

SHEET 1 OF 1

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
							RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °/°	DISCONTINUITY DATA				WEATH- ERING INDEX	Diametral Point Load Index (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jzon		W1	W2	W3	W4	W5	W6			W7	W8	W9	W10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
		Continued from Record of Borehole CN/CP8		164.70																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: LK/JL

CHECKED: EN


GTA-RCK 046 S:\CLIENTS\MTQ\QEW-BERTIE\02 DATA\GINT\QEW-BERTIE.GPJ GAL-MISS GDT 19-5-22

PROJECT 1671430		RECORD OF BOREHOLE No CN/CP9		SHEET 1 OF 2		METRIC											
G.W.P. 2116-16-00		LOCATION N 4755424.5; E 346532.6 MTM NAD 83 ZONE 10 (LAT. 42.937469; LONG. -78.988668)		ORIGINATED BY LK													
DIST Central HWY QEW		BOREHOLE TYPE 203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig		COMPILED BY EN													
DATUM Geodetic		DATE November 29, 2018		CHECKED BY NK													
SOIL PROFILE			SAMPLES			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	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	γ	GR	SA	SI	CL
180.0	GROUND SURFACE																
0.0	TOPSOIL (200 mm)		1A	SS	3												
0.2	SILTY CLAY, trace to some sand, trace gravel, trace rootlets to a depth of 1.4 m Soft to stiff Mottled grey-brown Moist		1B										44	1	12	32	55
			2	SS	5		179										
			3	SS	11		178										
			4	SS	11		177										
			5	SS	9		176						43	0	8	42	50
			6	SS	9		175										
			7	SS	12		174										
174.4	Gravelly Sandy CLAYEY SILT Stiff to very stiff Brown Moist		8	SS	9		173							23	21	34	22
172.1	SAND and GRAVEL, trace to some silt, trace clay Compact Grey Wet		9A	SS	21		172										
7.9			9B				171										
			10	SS	27		170										
			11	SS	22		169										
			12	SS	15		168							52	40	6	2
			13	SS	26		167										
							166										

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-BERTIE02\_DATAGINT\QEW-BERTIE.GPJ GAL-GTA.GDT 05/22/19

PROJECT 1671430		RECORD OF BOREHOLE No CN/CP9				SHEET 2 OF 2		METRIC										
G.W.P. 2116-16-00		LOCATION N 4755424.5; E 346532.6 MTM NAD 83 ZONE 10 (LAT. 42.937469; LONG. -78.988668)				ORIGINATED BY LK												
DIST Central HWY QEW		BOREHOLE TYPE 203 mm O.D Hollow Stem Augers; CME 55 Track-mounted Drill Rig				COMPILED BY EN												
DATUM Geodetic		DATE November 29, 2018				CHECKED BY NK												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100							
164.5	DOLOMITIC LIMESTONE (BEDROCK)  Bedrock cored from 15.5 m to 18.6 m.  For coring details refer to Record of Drillhole CN/CP9		14	SS	50/0.03													
15.5			1	RC	REC 100%	164												RQD = 69%
			2	RC	REC 100%	163												
161.4																	RQD = 91%	
18.6	END OF BOREHOLE  NOTES:  1. Water level at a depth of 7.9 m below ground surface (Elev. 172.1 m) in hollow stem augers on completion of drilling and prior to rock coring.																	

PROJECT: 1671430

**RECORD OF DRILLHOLE: CN/CP9**

SHEET 1 OF 1

LOCATION: N 4755424.50 ;E 346532.60

DRILLING DATE: November 29, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Track-Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES	PIEZOMETER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
						FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS °	DISCONTINUITY DATA			WEATH- ERING INDEX	Diametral Point Load Index (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja		Jzon	W1	W2	W3			W4	W5	W6	2	4	6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
		Continued from Record of Borehole CN/CP9		164.51																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															</

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: LK/JL

CHECKED: EN




GTA-RCK 046 S:\CLIENTS\MTQ\QEW-BERTIE\02\_DATA\GINT\QEW-BERTIE.GPJ GAL-MISS GDT 19-5-22

PROJECT 1671430 WO1				RECORD OF BOREHOLE No CN/CP10 SHEET 1 OF 3				METRIC									
G.W.P. 2116-16-00				LOCATION N 4755407.5; E 346584.2 MTM NAD 83 ZONE 10 (LAT. 42.937321; LONG. -78.988041)				ORIGINATED BY JK									
DIST Central HWY QEW				BOREHOLE TYPE 203 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig				COMPILED BY EN									
DATUM Geodetic				DATE August 28 and 29, 2018				CHECKED BY NK									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)
188.2	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT (360 mm)																
187.8																	
187.4	Sand and gravel (FILL) Brown Moist		1A	SS	7												
1.0	Sand, some silt (FILL) Loose Red-brown Moist		1B														
	Sandy silty clay, trace gravel (FILL) Soft to stiff Red-brown Moist		2	SS	7												
			3	SS	4												
			4	SS	5												
			5	SS	6												
	- Wood fragments between 4.5 m and 5.6 m		6	SS	6												
			7	SS	8												
			8	SS	8												
179.5																	
8.7	Sandy SILTY CLAY, trace gravel Very stiff Red-brown Moist		9	SS	16												
177.4			10A														
10.8	SILT and SAND, trace clay Compact Brown Wet - Seepage observed at 11 m		10B	SS	24												
176.5																	
11.7	CLAYEY SILT, some sand to sandy, trace gravel Stiff to very stiff Red-brown Moist		11	SS	11												
			12	SS	19												

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-BERTIE\02\_DATA\GINT\QEW-BERTIE.GPJ GAL-GTA.GDT 05/22/19

PROJECT		RECORD OF BOREHOLE				No CN/CP10		SHEET 2 OF 3		METRIC							
G.W.P. 2116-16-00		LOCATION				N 4755407.5; E 346584.2 MTM NAD 83 ZONE 10 (LAT. 42.937321; LONG. -78.988041)				ORIGINATED BY JK							
DIST Central HWY QEW		BOREHOLE TYPE				203 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig				COMPILED BY EN							
DATUM Geodetic		DATE				August 28 and 29, 2018				CHECKED BY NK							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
--- CONTINUED FROM PREVIOUS PAGE ---																	
171.9	CLAYEY SILT, some sand to sandy, trace gravel Stiff to very stiff Red-brown Moist		13	SS	11												5 16 47 32
16.3	SAND, some gravel, trace to some silt, trace clay Compact Grey Moist		14	SS	28												16 73 9 2
170.4	SAND and GRAVEL, trace to some silt, trace clay Compact Grey Wet - Auger grinding on inferred cobbles at 18.6 m		15	SS	11												36 56 8 0
17.8	- Auger grinding on inferred cobbles at 20.4 m, 21.6 m, 22.3 m and 22.6 m		16	SS	21												
165.0	DOLOMITIC LIMESTONE (BEDROCK)		17	SS	52/0.20												
23.2	Bedrock cored from 23.2 m to 27.2 m.  For rock coring details refer to Record of Drillhole CN/CP10.		1	RC	REC 100%												RQD = 92%
			2	RC	REC 100%												RQD = 92%
			3	RC	REC 100%												RQD = 100%
161.0																	
27.2																	

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\MTQ\QEW-BERTIE02\_DATAGINT\QEW-BERTIE.GPJ GAL-GTA.GDT 05/22/19

PROJECT <u>1671430 WO1</u>		<b>RECORD OF BOREHOLE No CN/CP10</b>				SHEET 3 OF 3		<b>METRIC</b>										
G.W.P. <u>2116-16-00</u>		LOCATION <u>N 4755407.5; E 346584.2 MTM NAD 83 ZONE 10 (LAT. 42.937321; LONG. -78.988041)</u>				ORIGINATED BY <u>JK</u>												
DIST <u>Central</u> HWY <u>QEW</u>		BOREHOLE TYPE <u>203 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig</u>				COMPILED BY <u>EN</u>												
DATUM <u>Geodetic</u>		DATE <u>August 28 and 29, 2018</u>				CHECKED BY <u>NK</u>												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)					
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED + FIELD VANE</span> <span>● QUICK TRIAXIAL × REMOULDED</span> </div>					<div style="display: flex; justify-content: space-between;"> <span>W<sub>p</sub></span> <span>W</span> <span>W<sub>L</sub></span> </div>						
	END OF BOREHOLE  NOTES:  1. Water level at a depth of 15.2 m below ground surface (Elev. 173.0 m) at end of drilling soil on August 28, 2019.  2. Water level at a depth of 11.6 m below ground surface (Elev. 176.6 m) at start of drilling on August 29, 2018 (i.e. after 15 m deep borehole left open overnight).  3. Water level at a depth of 12.5 m below ground surface (Elev. 175.7 m) prior to rock coring.																	

PROJECT: 1671430 W01

## RECORD OF DRILLHOLE: CN/CP10

SHEET 3 OF 3

LOCATION: N 4755407.50 ;E 346584.20

DRILLING DATE: August 29, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 Truck Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY												FEATURES	PIEZOMETER							
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA				WEATH- ERING INDEX												
						TOTAL CORE %	SOLID CORE %			DIP W/L CORE AXIS	TYPE AND SURFACE DESCRIPTION				W1	W2	W3	W4	W5	W6	Diametral Point Load Index (MPa)	2	4	6		
											Jr	Ja	Jss	Jss												
		Continued from Record of Borehole CN/CP10		164.96																						
		Slightly weathered, crystalline, grey, fine to medium grained, non-porous to faintly porous, medium strong, DOLOMITIC LIMESTONE (Bois Blanc Formation)		23.24	1																					
24																										
					2																					
25																										
26					3																					
27																										
		END OF DRILLHOLE		160.97																						
				27.23																						
28																										
29																										
30																										
31																										
32																										
33																										

DEPTH SCALE

1 : 50



LOGGED: JK/EN

CHECKED: EN

GTA-RCK 046 S:\CLIENTS\MTQ\QEW-BERTIE\02 DATA\GINTQEW-BERTIE.GPJ GAL-MISS.GDT 19-5-22

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

PROJECT		RECORD OF BOREHOLE				No CN/CP11		SHEET 2 OF 3		METRIC							
G.W.P. 2116-16-00		LOCATION				N 4755402.3; E 346602.8 MTM NAD 83 ZONE 10 (LAT. 42.937274; LONG. -78.987813)				ORIGINATED BY JK							
DIST Central HWY QEW		BOREHOLE TYPE				203 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig				COMPILED BY EN							
DATUM Geodetic		DATE				August 20 and 21, 2018				CHECKED BY NK							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	---	CONTINUED FROM PREVIOUS PAGE ---															
172.8			13A				173										
15.5	SILT and SAND Compact Grey Moist		13B	SS	21												
172.0							172										
16.3	GRAVELLY SAND to SAND and GRAVEL, trace to some silt, trace clay Compact Grey Wet		14	SS	27		171										
							170										
			15	SS	24		169										
							168										
			16	SS	22		167										
							166										
			17	SS	20		165										
							164										
165.1			18	SS	11/0.23		163										
23.2	DOLOMITIC LIMESTONE (BEDROCK)  Bedrock cored from 23.2 m to 27.1 m.  For rock coring details refer to Record of Drillhole CN/CP11.		1	RC	REC 100%		162										
			2	RC	REC 100%												
			3	RC	REC 100%												
161.2	END OF BOREHOLE																
27.1	NOTES:  1. Water level at a depth of 12.0 m (Elev. 176.3 m) prior to rock coring.																

PROJECT: 1671430 W01

**RECORD OF DRILLHOLE: CN/CP11**

SHEET 3 OF 3

LOCATION: N 4755402.30 ;E 346602.80

DRILLING DATE: August 21, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 Truck Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	<b>NOTE:</b> For abbreviations, symbols and descriptions refer to <b>LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY</b>												FEATURES	PIEZOMETER		
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP W/L CORE AXIS	DISCONTINUITY DATA				WEATH- ERING INDEX						
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION				Jr Ja Jso Jss						
						000000	000000				000000	000000	000000	000000	000000	000000	000000	000000			
		Continued from Record of Borehole CN/CP11		165.14																	
		Slightly weathered, crystalline, grey, fine to medium grained, non-porous, medium strong, DOLOMITIC LIMESTONE (Bois Blanc Formation)		23.16																	
24					1						CO,PL,SM,SG										
											JN,UN,SM,PC,GY										
											JN,UN,RO										
					2						JN,PL,SM										
											JN,PL,SM										
											JN,UN,SM										
											CO,PL,SM										
											,UN,RO										
											JN,UN,RO,CC,QZ										
											JN,UN,RO										
26					3																
											JN,UN,RO										
27		END OF DRILLHOLE		161.23																	
				27.07																	
28																					
29																					
30																					
31																					
32																					
33																					

DEPTH SCALE

1 : 50




**GOLDER**

LOGGED: JK/EN

CHECKED: EN

GTA-RCK 046 S:\CLIENTS\MTQ\QEW-BERTIE\02\_DATA\GINT\QEW-BERTIE.GPJ GAL-MISS.GDT 19-5-22



PROJECT		RECORD OF BOREHOLE				No CN/CP12		SHEET 2 OF 2		METRIC							
G.W.P. 2116-16-00		LOCATION				N 4755416.3; E 346563.7 MTM NAD 83 ZONE 10 (LAT. 42.937402; LONG. -78.988291)				ORIGINATED BY JK							
DIST Central HWY QEW		BOREHOLE TYPE				203 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig				COMPILED BY EN							
DATUM Geodetic		DATE				August 23 and 24, 2018				CHECKED BY NK							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
--- CONTINUED FROM PREVIOUS PAGE ---								20	40	60	80	100					
172.3	CLAYEY SILT, trace sand to sandy, trace to some gravel Stiff Red-brown Moist		13	SS	12												
16.3	SAND and GRAVEL, trace to some silt, trace clay Compact to very dense Grey Wet		14	SS	29												
			15	SS	14												
	- 0.1 m sand layer at 19.8 m		16A 16B	SS	31												
	- Augers grinding on inferred cobbles at 20.7 m and between 21.6 m and 22.9 m		17	SS	39												
			18	SS	69												
165.3	DOLOMITIC LIMESTONE (BEDROCK)		1	RC	REC 94%												RQD = 94%
23.3	Bedrock cored from 23.3 m to 27.2 m.  For rock coring details refer to Record of Drillhole CN/CP12.		2	RC	REC 100%												RQD = 94%
			3	RC	REC 100%												RQD = 100%
161.4	END OF BOREHOLE																
27.2	NOTES:  1. Water level at a depth of 12.2 m below ground surface (Elev. 176.4 m) prior to rock coring.																

PROJECT: 1671430 W01

**RECORD OF DRILLHOLE: CN/CP12**

SHEET 1 OF 1

LOCATION: N 4755416.30 ;E 346563.70

DRILLING DATE: August 24, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME75 Truck Mounted Drill Rig

DRILLING CONTRACTOR: Geo-Environmental

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY												FEATURES	PIEZOMETER						
						RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP W/L CORE AXIS	DISCONTINUITY DATA				WEATH- ERING INDEX										
						TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jzon	W1	W2	W3	W4	W5	W6	Diametral Point Load Index (MPa)				
		Continued from Record of Borehole CN/CP12		165.31																					
		Slightly weathered, crystalline, grey, fine to medium grained, faintly porous, medium strong, DOLOMITIC LIMESTONE (Bois Blanc Formation)		23.29																					
24					1						CO,UN,RO	3	1	25											
											JN,UN,SM	2	1	20											
25					2						BD,PL,SM BD,PL,SM JN,PL,RO	1	1	16									(Axial)		
											JN,PL,SM,PC,GY	1	2	16											
26																									
					3						JN,PL,SM,CC,GY JN,UN,SM	1	2	16									(Axial)		
											JN,PL,SM,IN,GY	1	2	16											
27											JN,UN,SM,IN,GY	2	2	20											
		END OF DRILLHOLE		161.42																					
				27.18																					
28																									
29																									
30																									
31																									
32																									
33																									

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: JK/EN

CHECKED: EN

GTA-RCK 046 S:\CLIENTS\MTQ\QEW-BERTIE\02 DATA\GINT\QEW-BERTIE.GPJ GAL-MISS GDT 19-5-22

PROJECT		RECORD OF BOREHOLE				No CN/CP13		SHEET 1 OF 1		METRIC			
G.W.P. 2116-16-00		LOCATION		N 4755394.3; E 346597.0 MTM NAD 83 ZONE 10 (LAT. 42.937202; LONG. -78.987885)				ORIGINATED BY JK					
DIST Central HWY QEW		BOREHOLE TYPE		152 mm O.D Hollow Stem Augers; CME 75 Truck-mounted Drill Rig				COMPILED BY EN					
DATUM Geodetic		DATE		August 30, 2018				CHECKED BY NK					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)		
187.9	GROUND SURFACE												
0.0	ASPHALT (360 mm)												
187.5													
187.1	Sand and gravel (FILL) Brown Moist		1A	SS	10		187						
0.9	Sand (FILL) Red-brown Moist		1B										
	Silty clay, trace sand to sandy, trace gravel, trace organics to 8.4 m (FILL) Soft to stiff Red-brown Moist		2	SS	10		186						
			3	SS	4		185					41	2 10 43 45
			4	SS	8		184						
			5	SS	6		183						
			6	SS	5		182						
			7	SS	10		181						0 12 43 45
			8	SS	12		180						
179.2							179						
8.7	Sandy SILTY CLAY, trace gravel Very stiff Red-brown Moist		9	SS	19								
178.1													
9.8	END OF BOREHOLE												
	NOTE: 1. Open borehole dry on completion of drilling.												

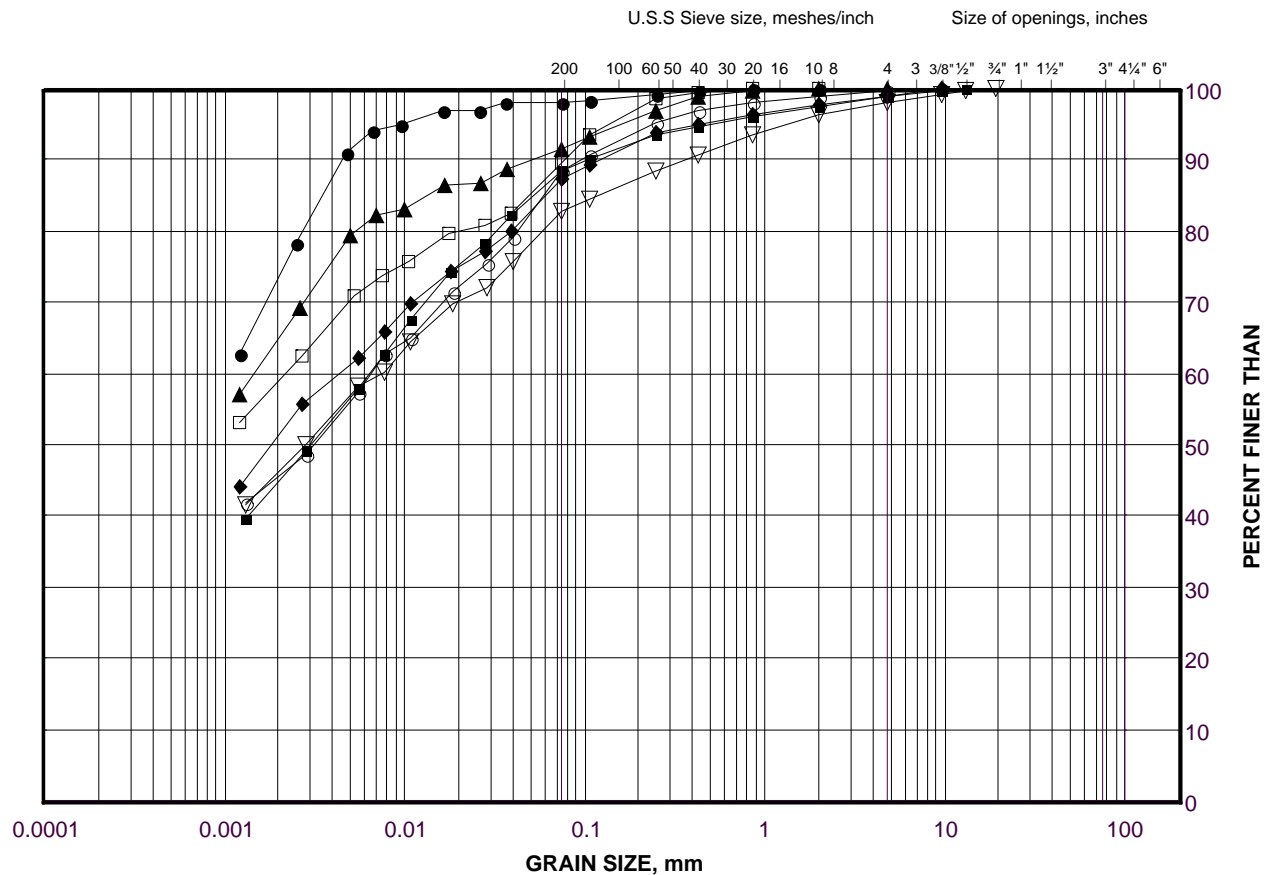
**APPENDIX B**

**Geotechnical Laboratory Test  
Results and Bedrock Core  
Photographs**

# GRAIN SIZE DISTRIBUTION

Silty Clay (Fill)

FIGURE B-1



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

## LEGEND

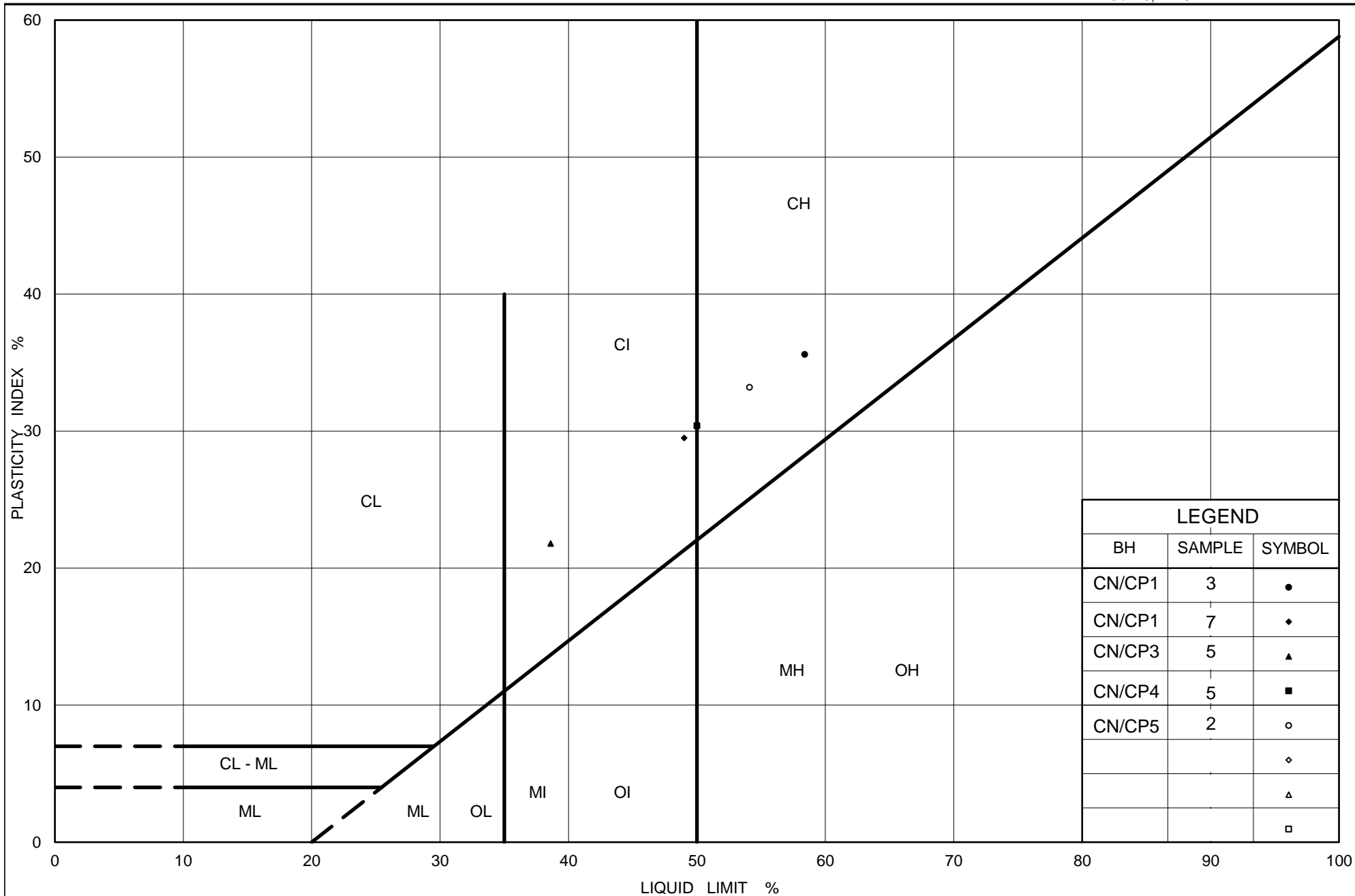
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP1	3	185.5
■	CN/CP13	3	185.3
◆	CN/CP12	4	185.2
▲	CN/CP4	5	183.9
▽	CN/CP11	5	183.4
○	CN/CP13	7	181.5
□	CN/CP1	7	181.7

Project Number: 1671430

Checked By: NK

**Golder Associates**

Date: 25-Apr-19



Ministry of Transportation

Ontario

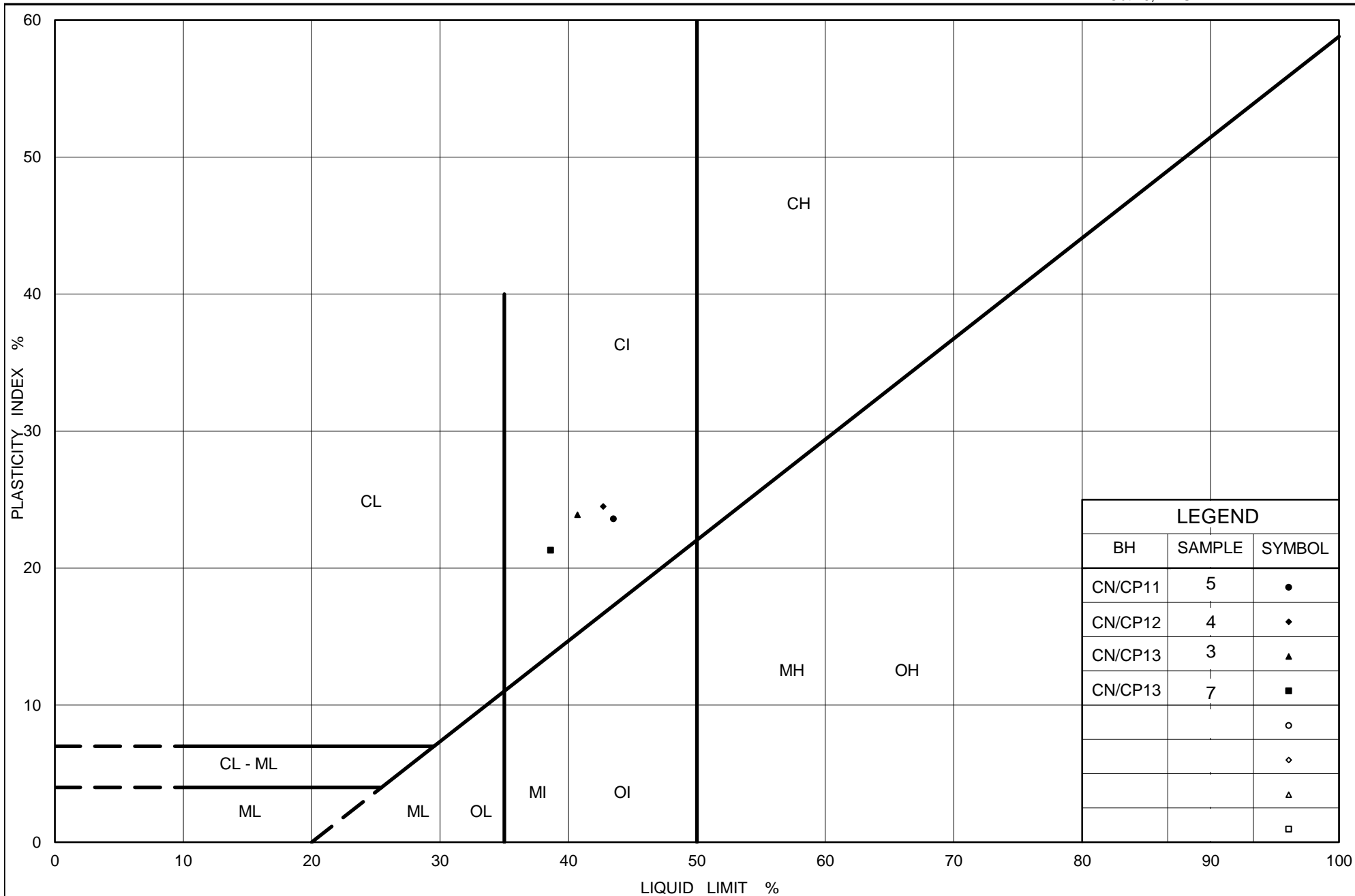
## PLASTICITY CHART

### Silty Clay to Clay (Fill)

Figure No. B-2A

Project No. 1671430 (W01)

Checked By: NK



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Ontario

## PLASTICITY CHART

### Silty Clay to Clay (Fill)

Figure No. B-2B

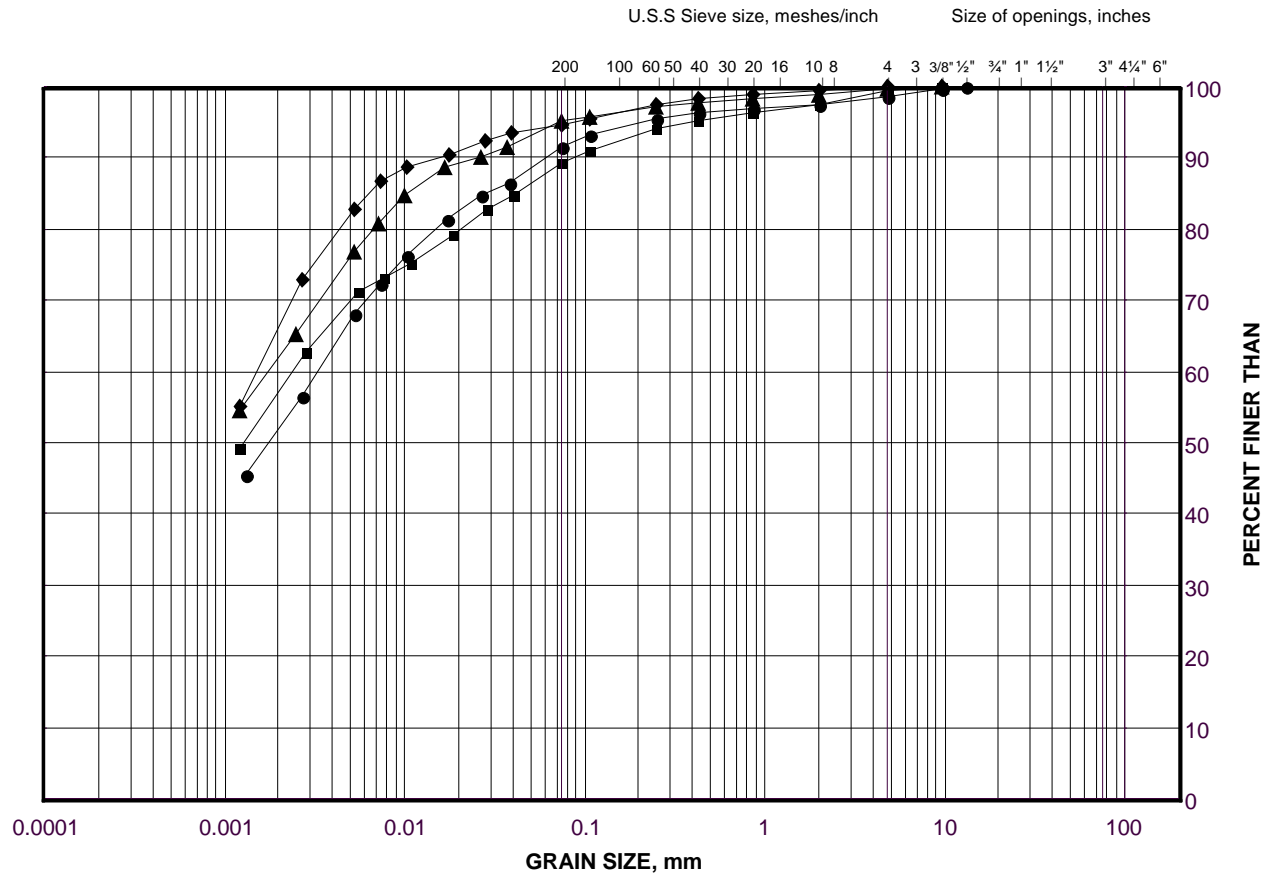
Project No. 1671430 (W01)

Checked By: NK

# GRAIN SIZE DISTRIBUTION

Silty Clay to Clay

FIGURE B-3A



## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP5	10	177.3
■	CN/CP2	3	178.8
◆	CN/CP6	4	177.4
▲	CN/CP4	9	178.6

Project Number: 1671430

Checked By: NK

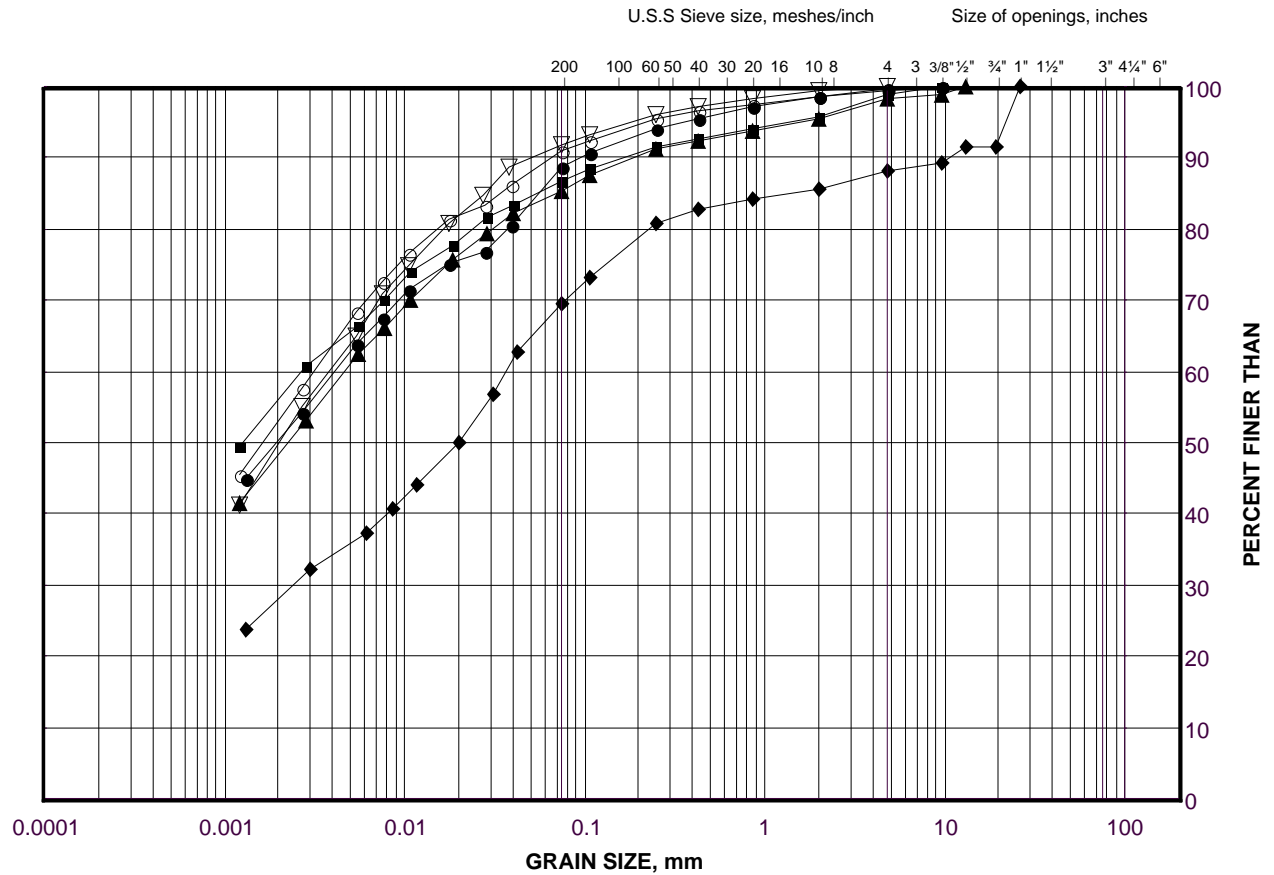
**Golder Associates**

Date: 17-May-19

# GRAIN SIZE DISTRIBUTION

Silty Clay to Clay

FIGURE B-3B



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

## LEGEND

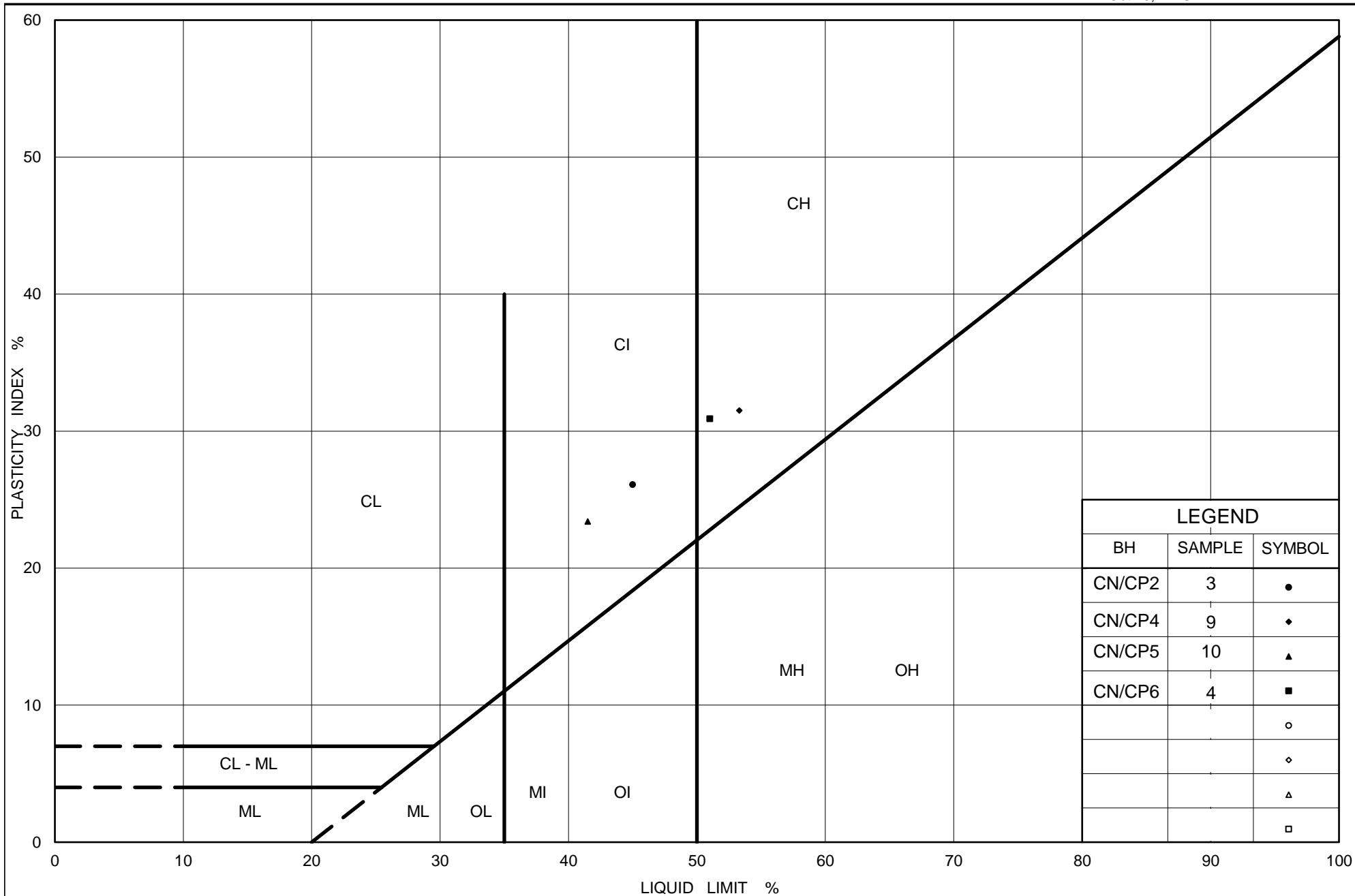
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP12	10	177.6
■	CN/CP9	1B	179.6
◆	CN/CP8	4	177.5
▲	CN/CP7	4	177.4
▽	CN/CP9	5	176.6
○	CN/CP11	9	178.9

Project Number: 1671430

Checked By: NK

**Golder Associates**

Date: 25-Apr-19



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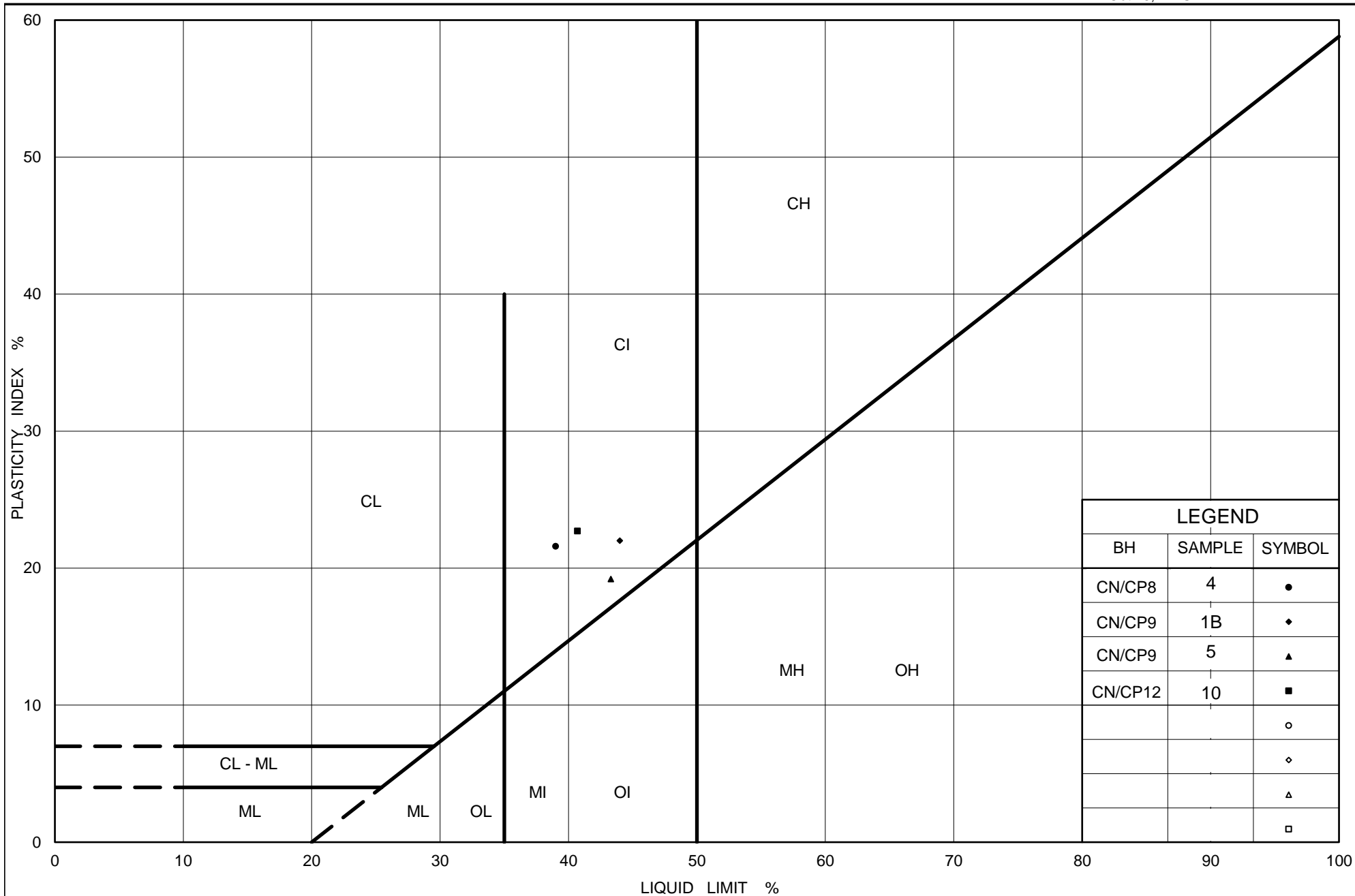
## PLASTICITY CHART

### Silty Clay to Clay

Figure No. B-4A

Project No. 1671430 (W01)

Checked By: NK



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# **PLASTICITY CHART** **Silty Clay to Clay**

Figure No. B-4B

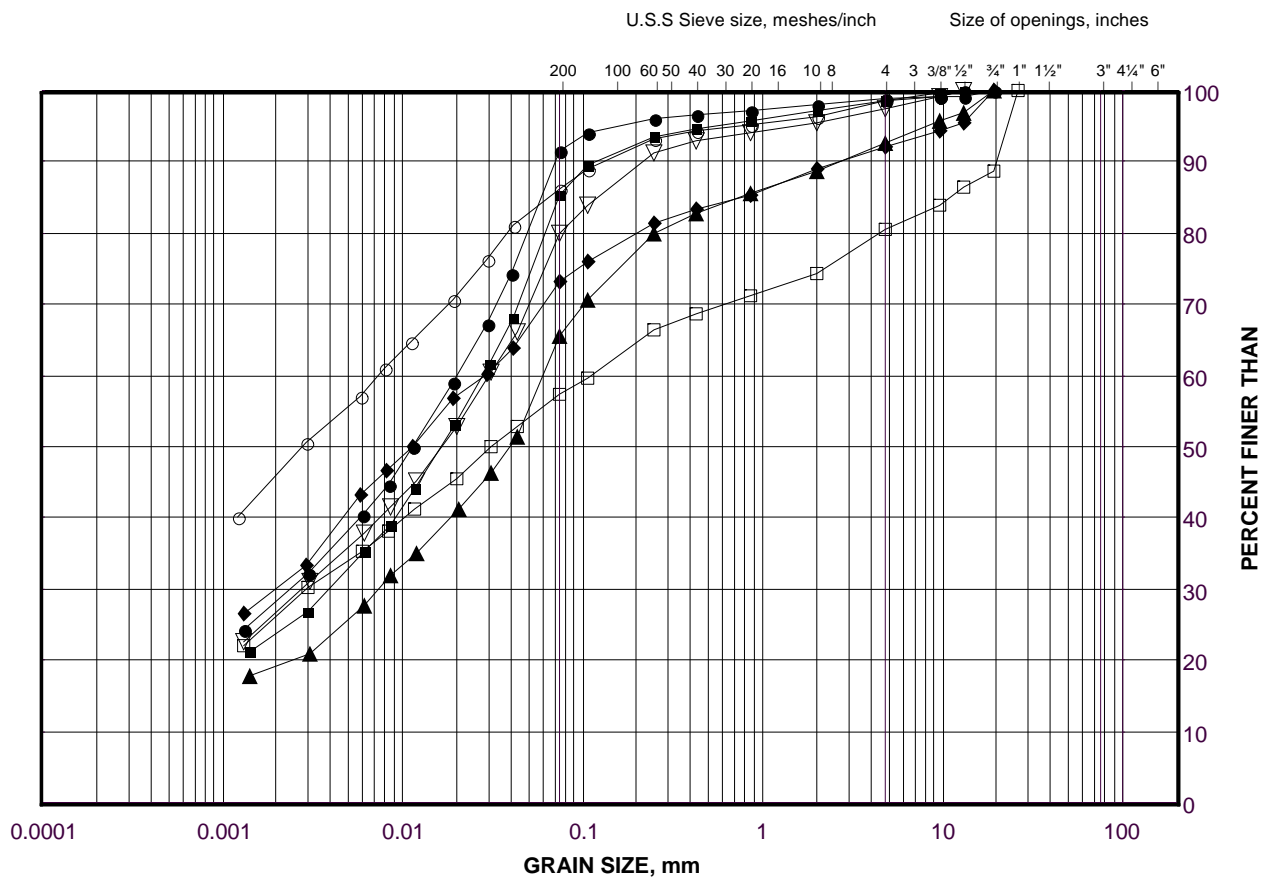
Project No. 1671430 (W01)

Checked By: NK

# GRAIN SIZE DISTRIBUTION

Clayey Silt to Clayey Silt with Sand

FIGURE B-5A



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP3	11	175.9
■	CN/CP5	13	172.8
◆	CN/CP3	14	171.3
▲	CN/CP5	15	169.7
▽	CN/CP6	7	175.1
○	CN/CP2	7	175.7
□	CN/CP2	9	172.7

Project Number: 1671430

Checked By: NK

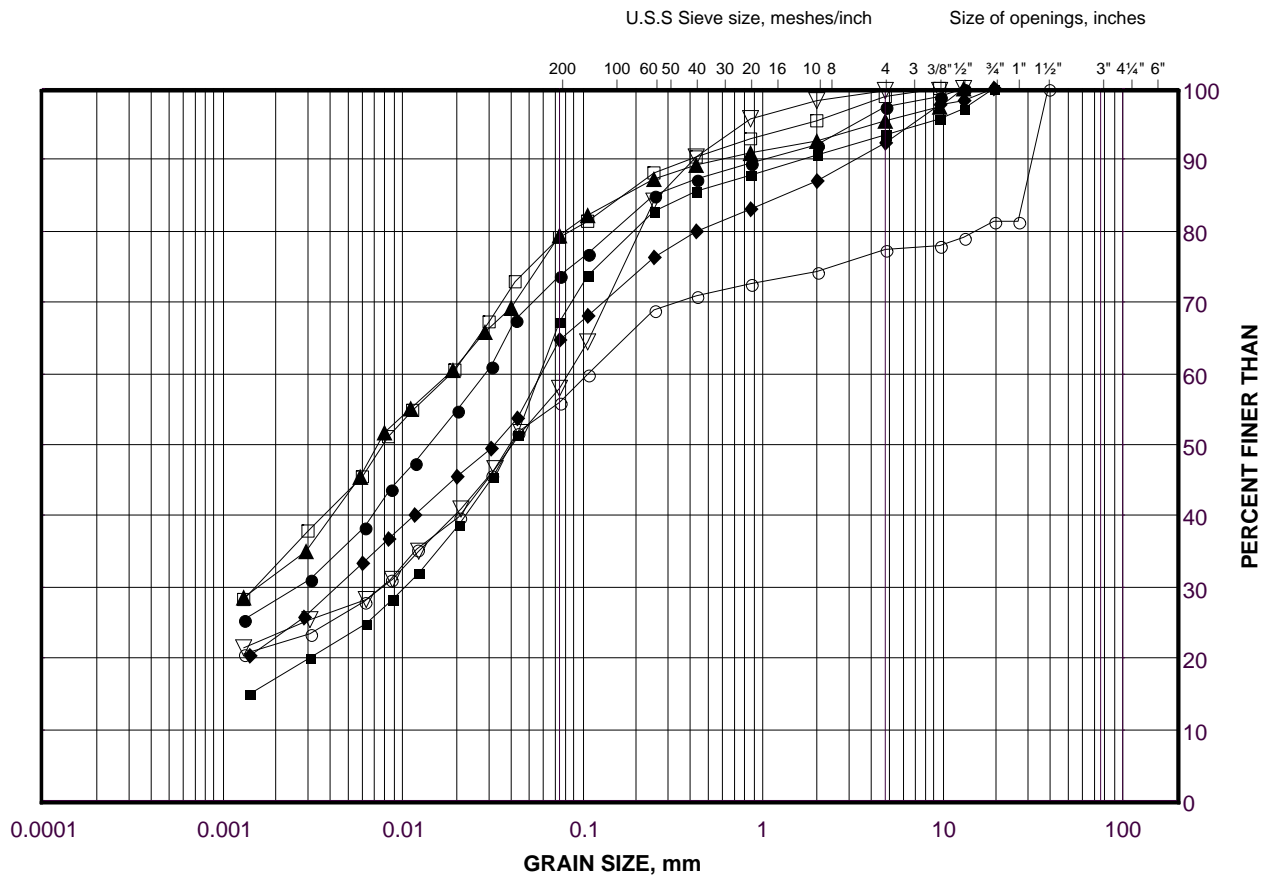
**Golder Associates**

Date: 17-May-19

# GRAIN SIZE DISTRIBUTION

Clayey Silt to Clayey Silt with Sand

FIGURE B-5B



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

## LEGEND

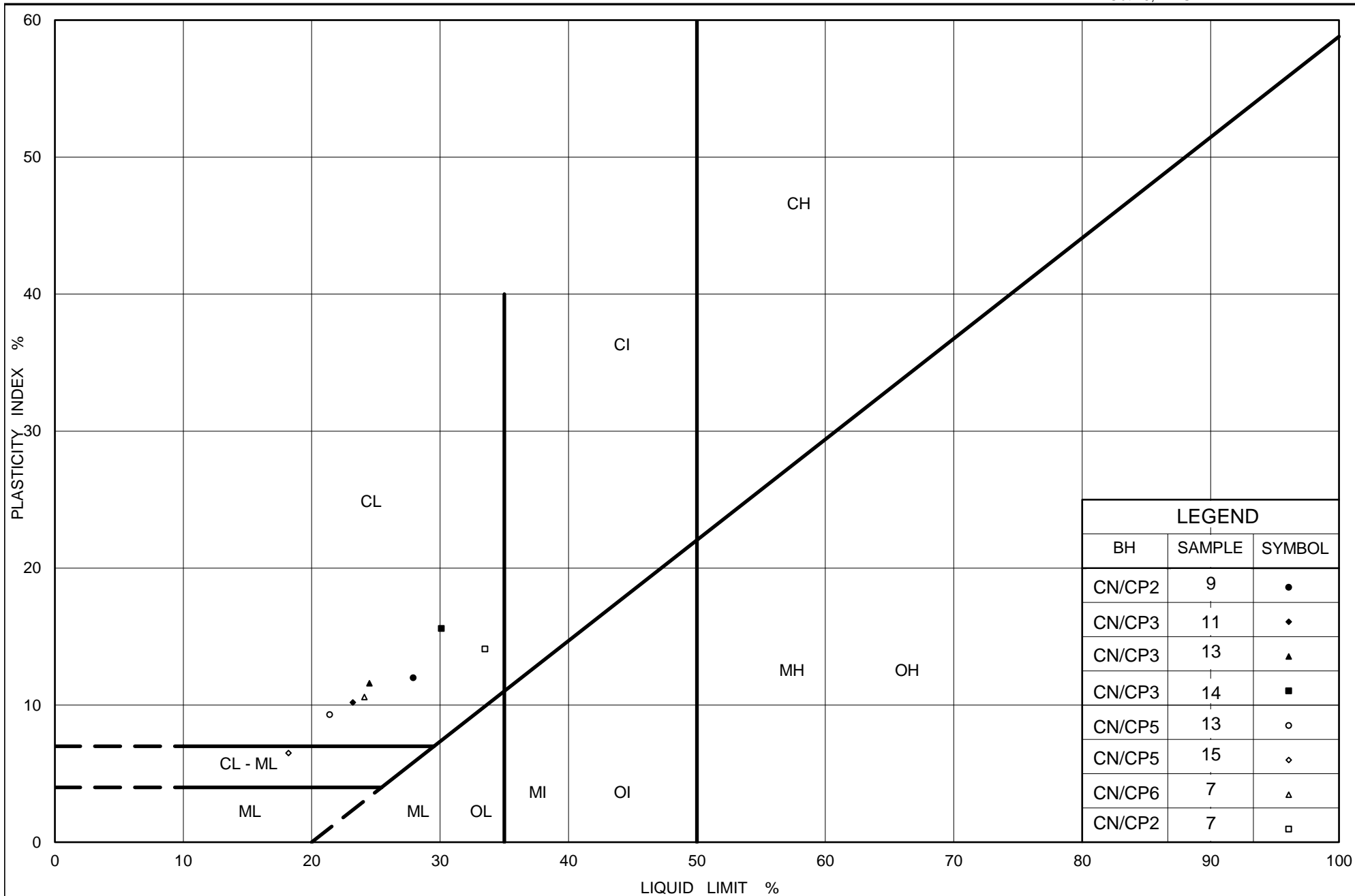
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP8	10	170.7
■	CN/CP10	11	175.7
◆	CN/CP12	12	174.6
▲	CN/CP10	13	172.7
▽	CN/CP8	7	175.2
○	CN/CP9	8	173.6
□	CN/CP7	9	172.1

Project Number: 1671430

Checked By: NK

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Date: 25-Apr-19



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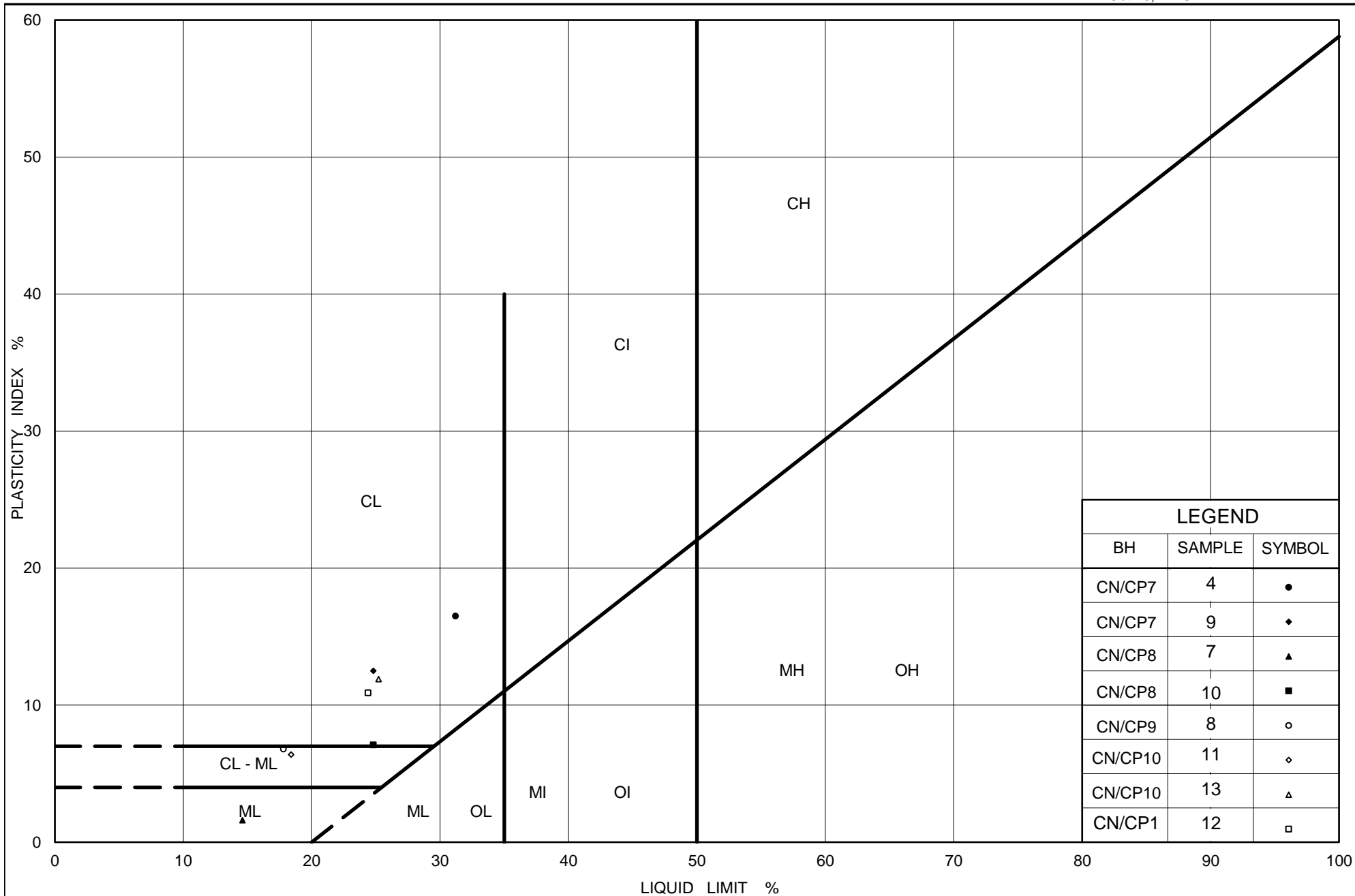
Ontario

# PLASTICITY CHART Clayey Silt to Clayey Silt with Sand

Figure No. B-6A

Project No. 1671430 (W01)

Checked By: NK



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# PLASTICITY CHART Clayey Silt to Clayey Silt with Sand

Figure No. B-6B

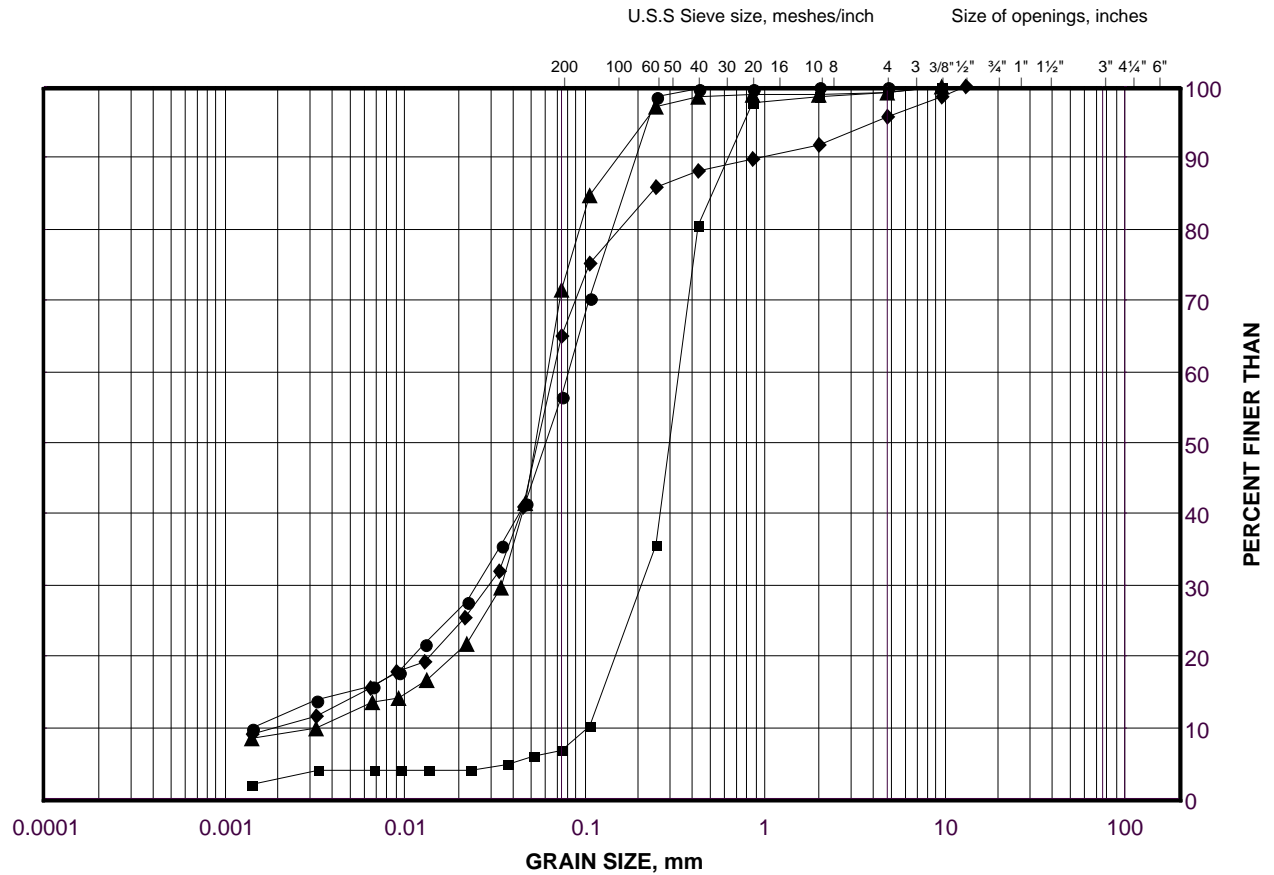
Project No. 1671430 (W01)

Checked By: NK

# GRAIN SIZE DISTRIBUTION

Sandy Silt to Silt and Sand to Sand

FIGURE B-7A



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

## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP2	11	169.6
■	CN/CP2	12	168.1
◆	CN/CP5	16	168.2
▲	CN/CP3	16	168.3

Project Number: 1671430

Checked By: NK

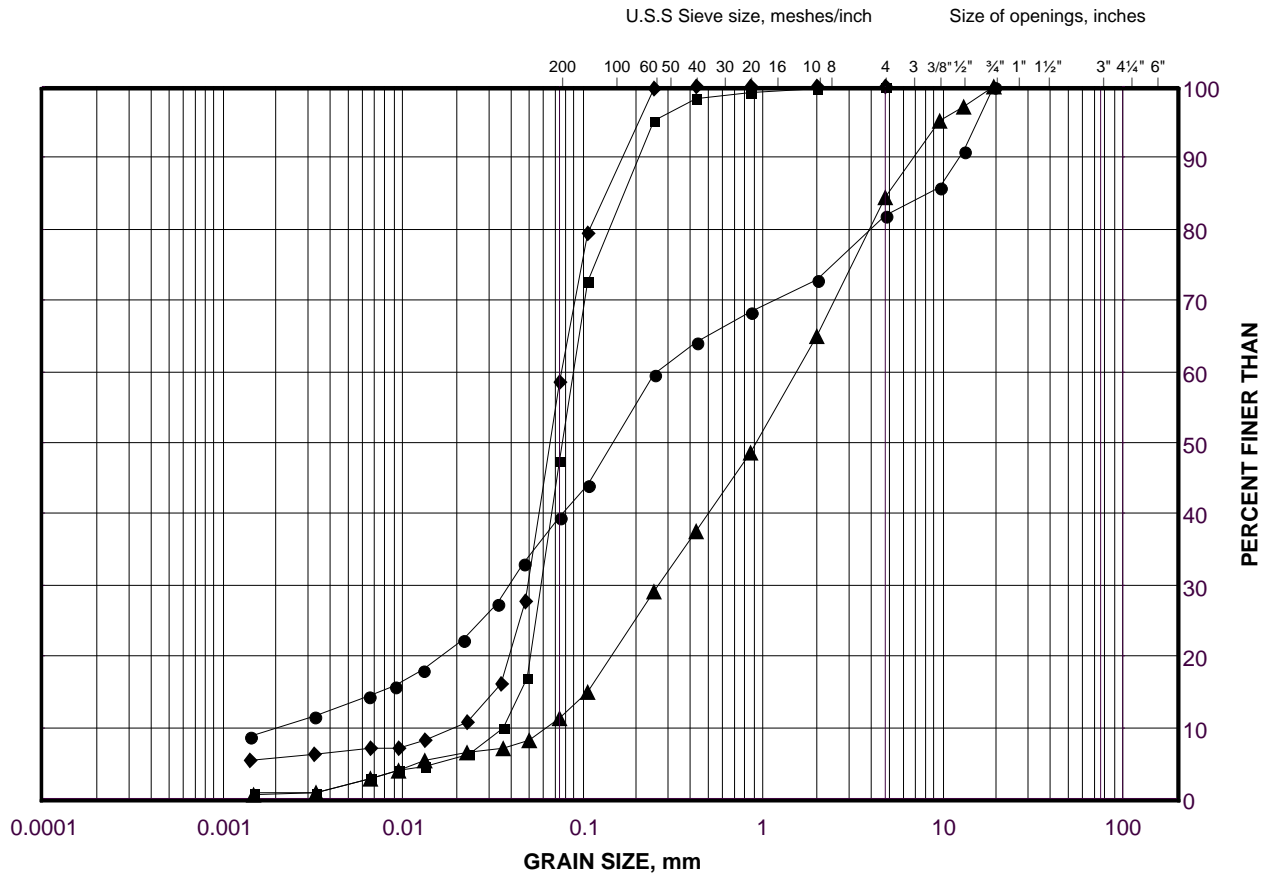
**Golder Associates**

Date: 25-Apr-19

# GRAIN SIZE DISTRIBUTION

Sandy Silt to Silt and Sand to Sand

FIGURE B-7B



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

## LEGEND

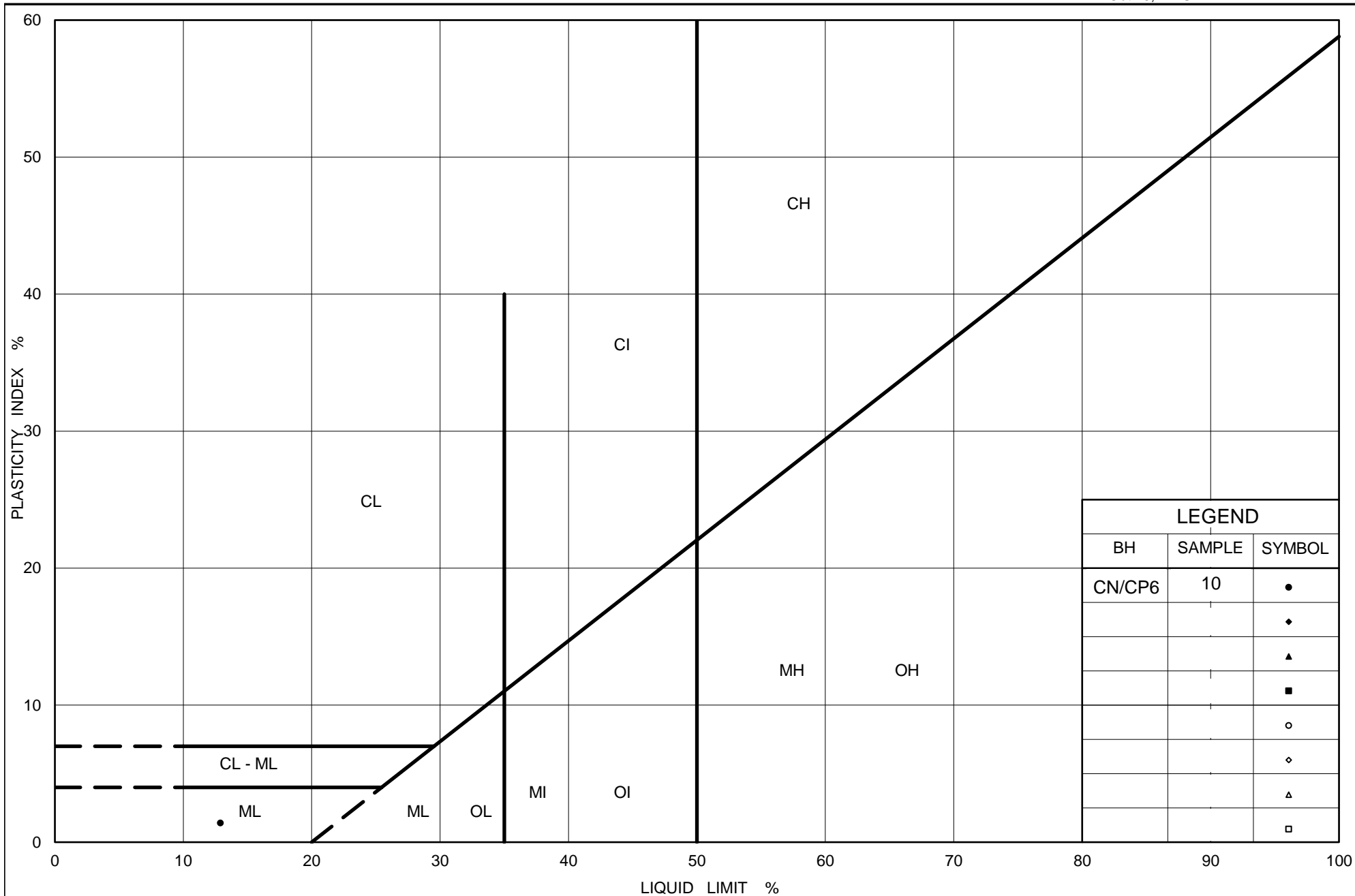
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP6	10	170.6
■	CN/CP10	10B	177.1
◆	CN/CP11	11	175.8
▲	CN/CP10	14	171.2

Project Number: 1671430

Checked By: NK

**Golder Associates**

Date: 25-Apr-19



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# PLASTICITY CHART Silt

Figure No. B-8

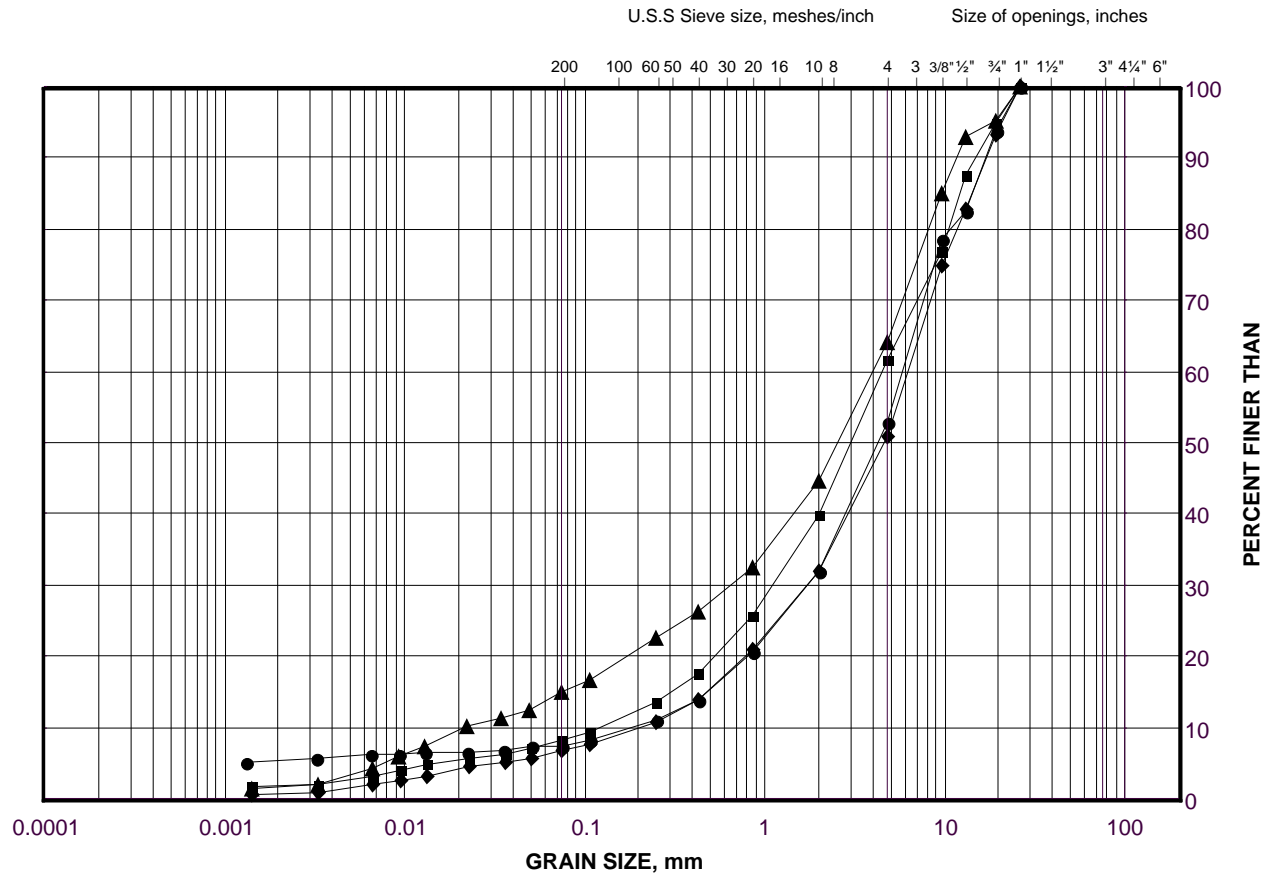
Project No. 1671430 (W01)

Checked By: NK

# GRAIN SIZE DISTRIBUTION

Gravelly Sand to Sand and Gravel

FIGURE B-9A



## LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP8	12	167.6
■	CN/CP7	12	167.5
◆	CN/CP6	12	167.5
▲	CN/CP3	17	165.4

Project Number: 1671430

Checked By: NK

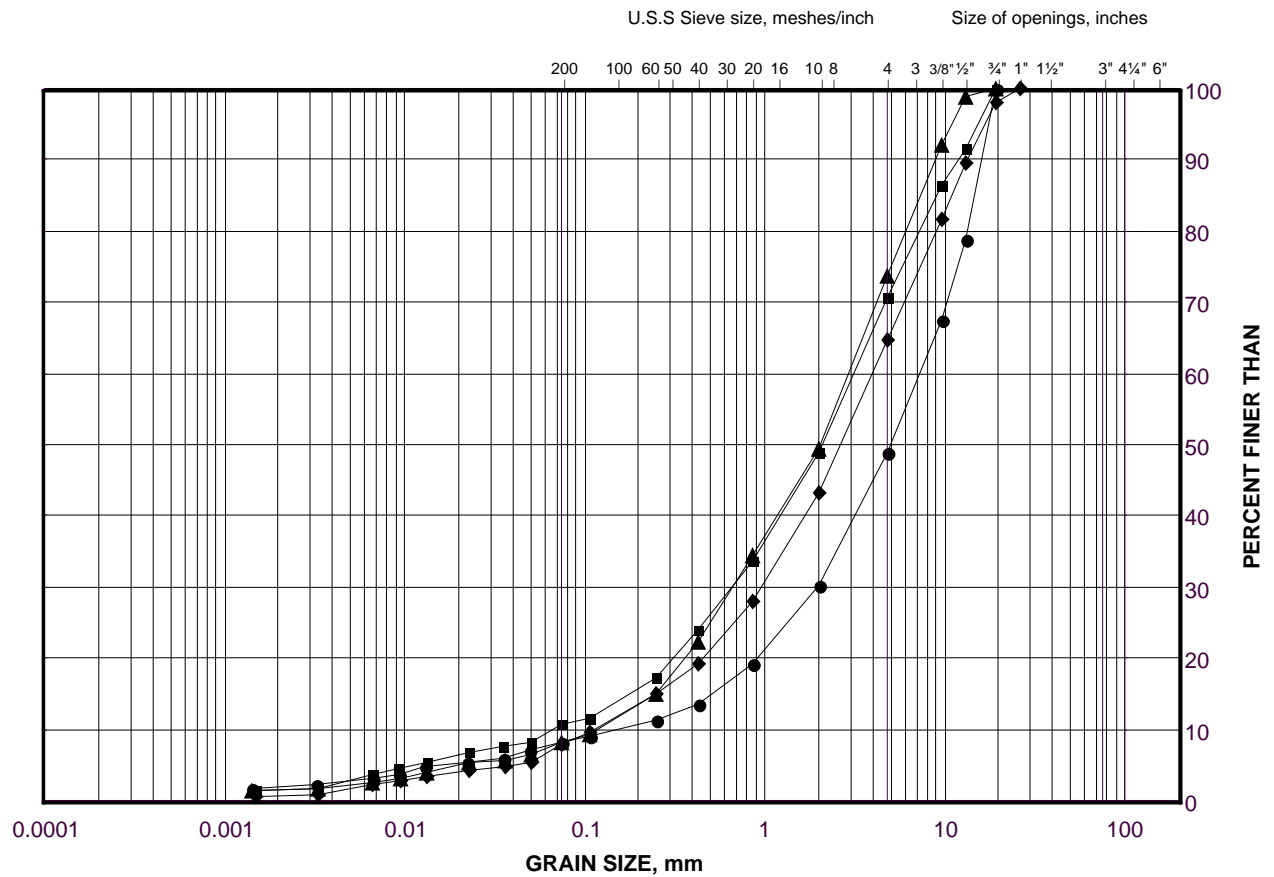
**Golder Associates**

Date: 25-Apr-19

# GRAIN SIZE DISTRIBUTION

Gravelly Sand to Sand and Gravel

FIGURE B-9B



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

## LEGEND

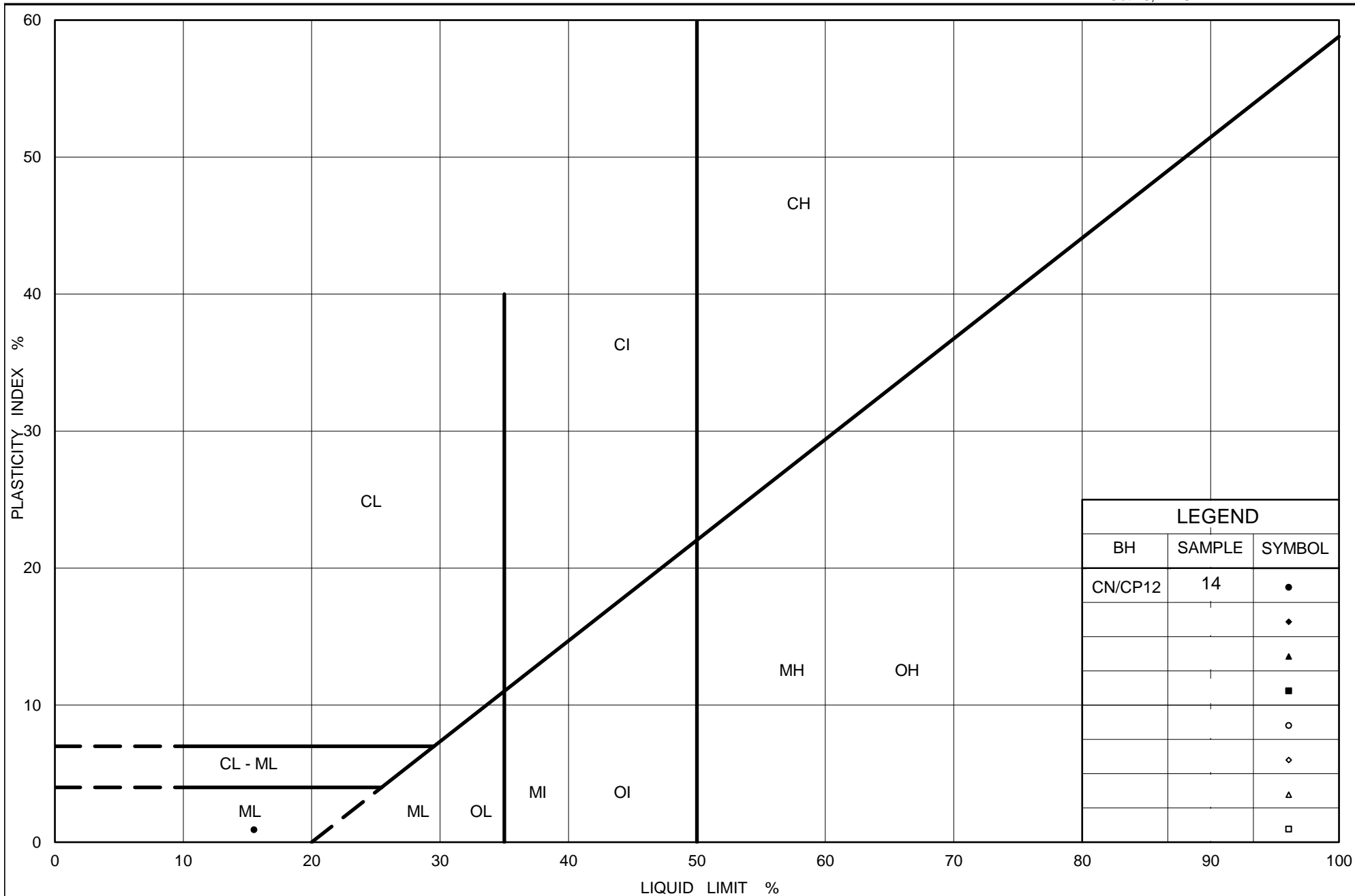
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	CN/CP9	12	167.5
■	CN/CP12	14	171.5
◆	CN/CP10	15	169.6
▲	CN/CP11	17	166.7

Project Number: 1671430

Checked By: NK

**Golder Associates**

Date: 25-Apr-19



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# PLASTICITY CHART Sand and Gravel (Fines Portion)

Figure No. B-10

Project No. 1671430 (W01)

Checked By: NK

15.27 m

Run 1



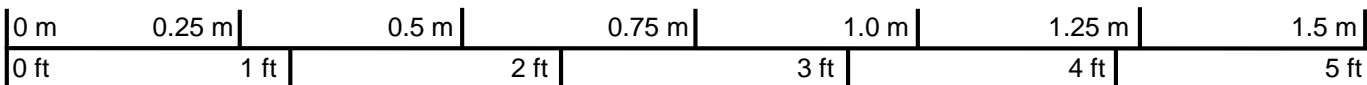
Run 1

17.10 m

Run 2

Run 2

18.63 m



Scale

PROJECT  
REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO  
GWP 2116-16-00

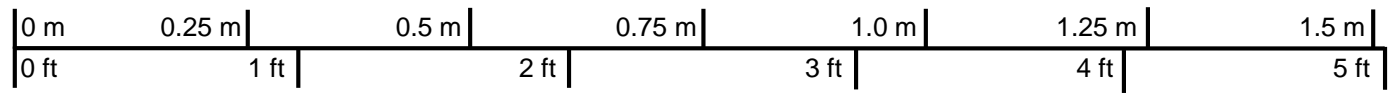
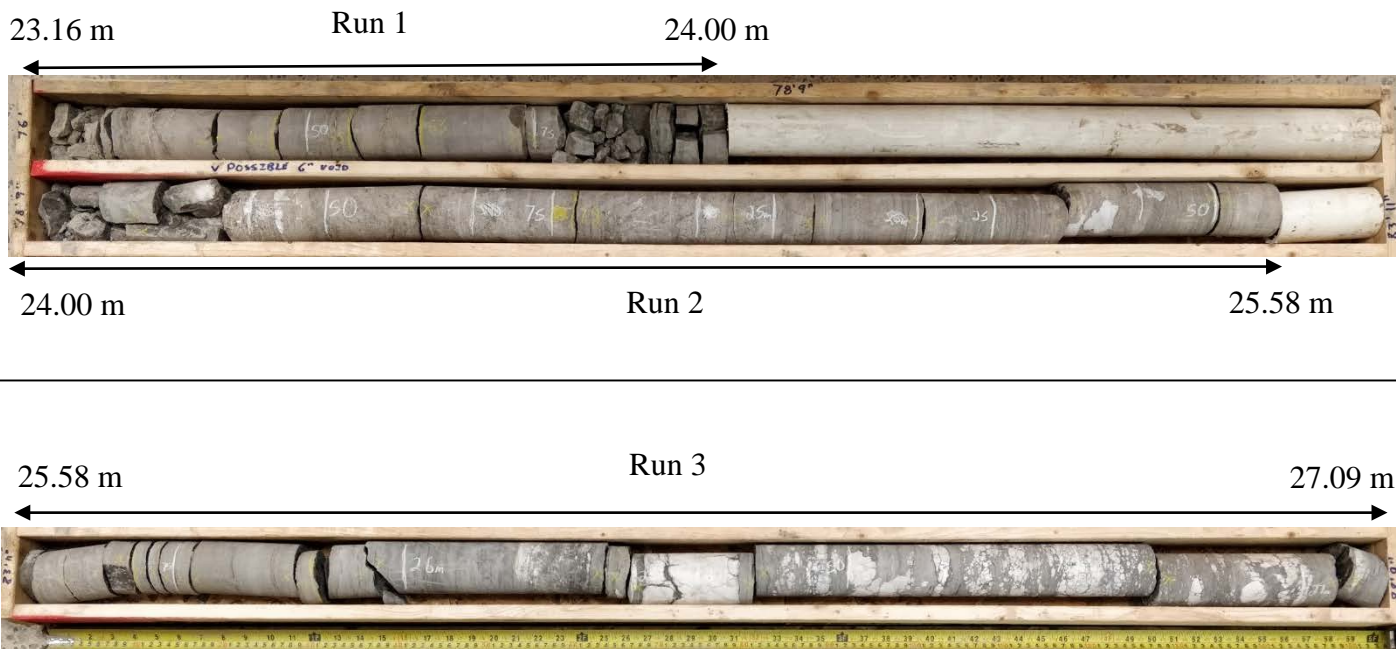
CLIENT  
**MINISTRY OF TRANSPORTATION, ONTARIO (MTO)**

TITLE  
**BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP2**




PROJECT NO.	1671430	PHASE	WO001
DESIGNED	SE	REV.	A
PREPARED	SE		
REVIEWED			
APPROVED			

Figure B-11



**Scale**

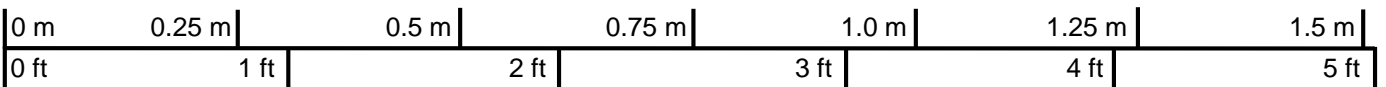
PROJECT REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO GWP 2116-16-00			
CLIENT <b>MINISTRY OF TRANSPORTATION, ONTARIO (MTO)</b>			
TITLE <b>BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP3</b>			
 <b>GOLDER</b>	PROJECT NO. <b>1671430</b>		PHASE <b>WO001</b>
	DESIGNED	SE	REV. <b>A</b>
	PREPARED	SE	
	REVIEWED		
			<b>Figure B-12</b>

23.77 m Run 1 24.13 m



24.13 m Run 2 25.65 m

25.65 m Run 3 27.20 m



Scale

PROJECT  
REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO  
GWP 2116-16-00

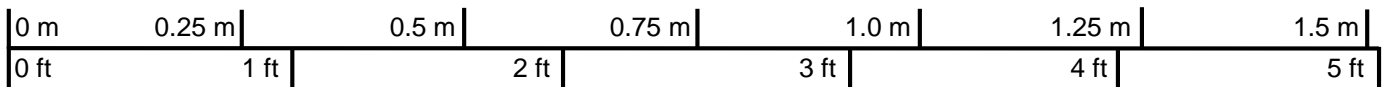
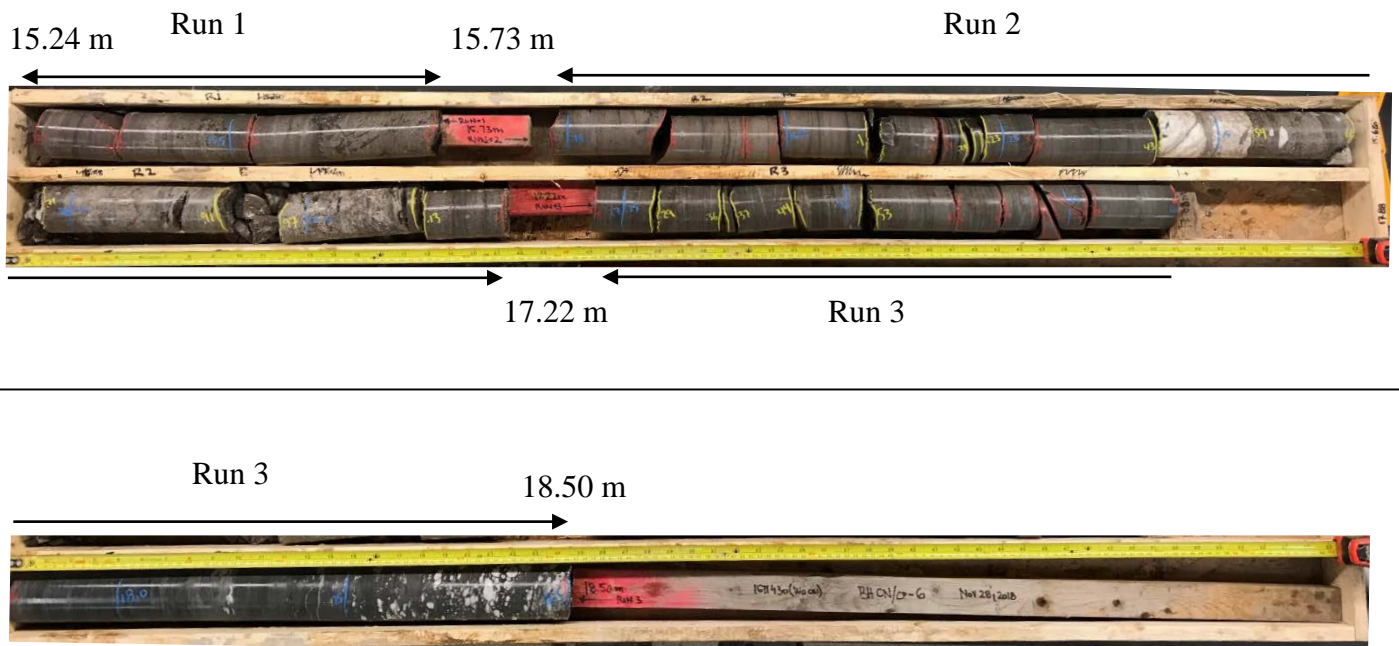
CLIENT  
**MINISTRY OF TRANSPORTATION, ONTARIO (MTO)**

TITLE  
**BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP5**



PROJECT NO.	1671430	PHASE	WO001
DESIGNED	SE	REV.	A
PREPARED	SE		
REVIEWED			
APPROVED			

Figure B-13



**Scale**

PROJECT  
REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO  
GWP 2116-16-00

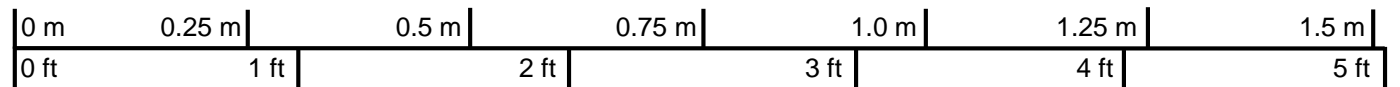
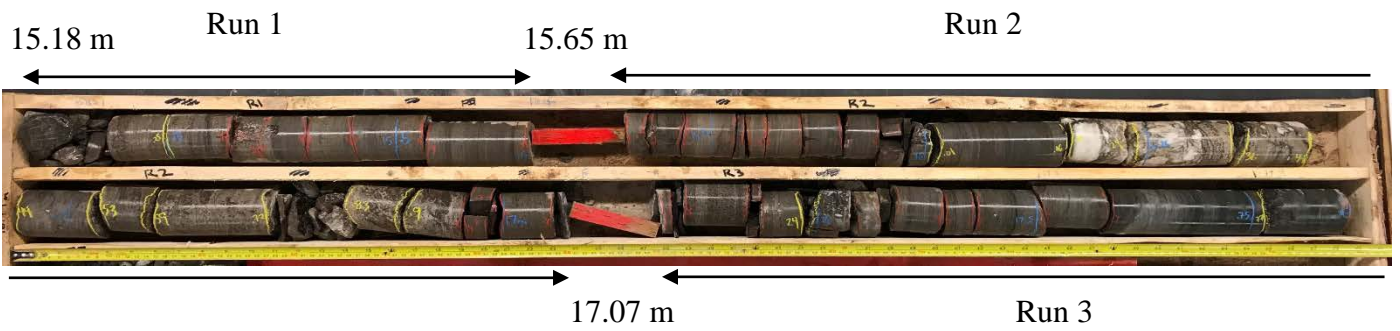
CLIENT  
**MINISTRY OF TRANSPORTATION, ONTARIO (MTO)**

TITLE  
**BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP6**




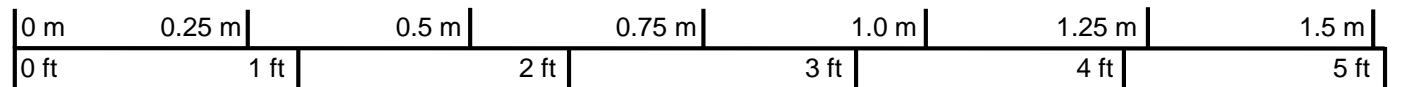
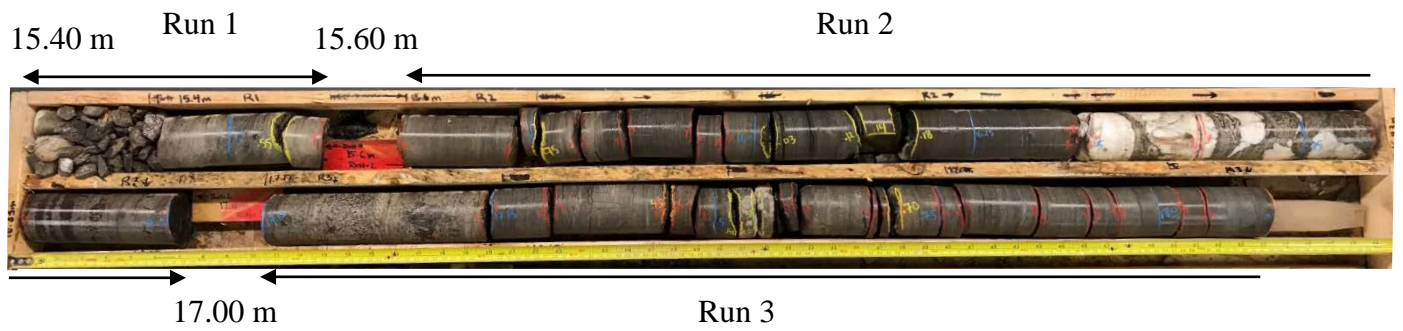
PROJECT NO.	1671430	PHASE	WO001
DESIGNED	SE	REV.	A
PREPARED	SE		
REVIEWED			
APPROVED			

**Figure B-14**



**Scale**

PROJECT REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO GWP 2116-16-00			
CLIENT <b>MINISTRY OF TRANSPORTATION, ONTARIO (MTO)</b>			
TITLE <b>BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP7</b>			
 <b>GOLDER</b>	PROJECT NO. <b>1671430</b>		PHASE <b>WO001</b>
	DESIGNED	SE	REV. <b>A</b>
	PREPARED	SE	
	REVIEWED		
			APPROVED
<b>Figure B-15</b>			




**Scale**

PROJECT  
REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO  
GWP 2116-16-00

CLIENT  
**MINISTRY OF TRANSPORTATION, ONTARIO (MTO)**

TITLE  
**BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP8**

 <b>GOLDER</b>	PROJECT NO. <b>1671430</b>		PHASE <b>WO001</b>	
	DESIGNED	SE	REV.	A
	PREPARED	SE		
	REVIEWED			
	APPROVED			

**Figure B-16**

15.49 m

Run 1

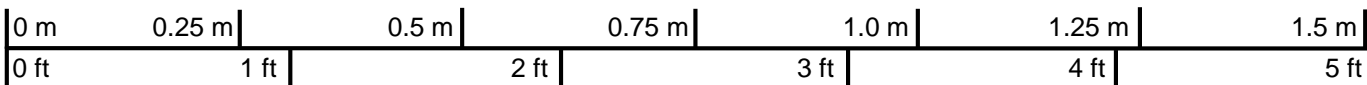


17.04 m

Run 2

Run 2

18.62 m



Scale

PROJECT  
REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO  
GWP 2116-16-00

CLIENT  
**MINISTRY OF TRANSPORTATION, ONTARIO (MTO)**

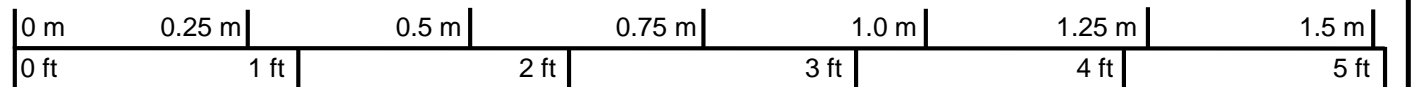
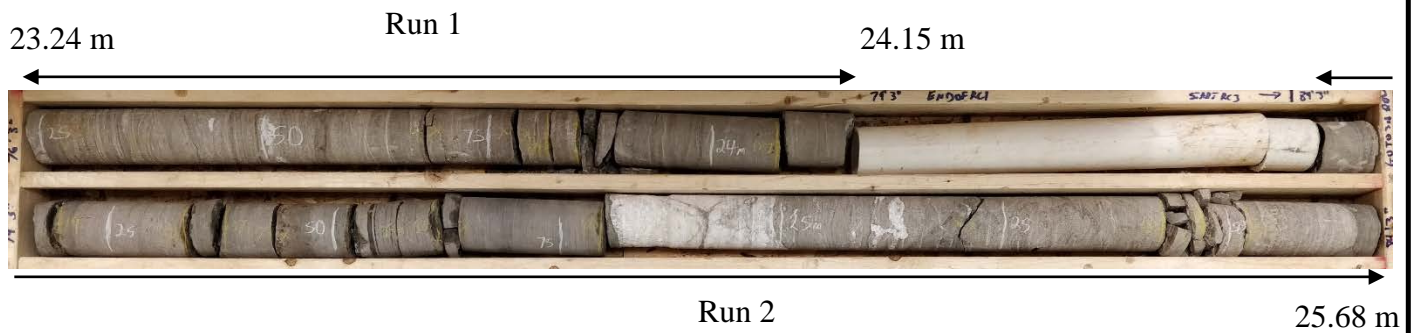
TITLE  
**BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP9**



GOLDER

PROJECT NO. 1671430		PHASE	WO001
DESIGNED	SE	REV.	A
PREPARED	SE		
REVIEWED			
APPROVED			

Figure B-17




**Scale**

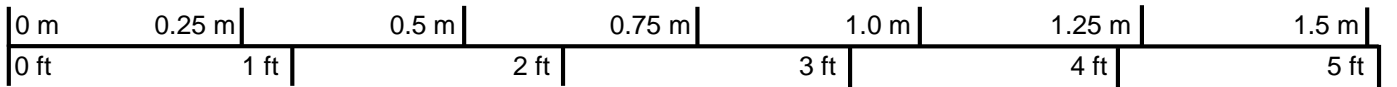
PROJECT  
REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO  
GWP 2116-16-00

CLIENT  
**MINISTRY OF TRANSPORTATION, ONTARIO (MTO)**

TITLE  
**BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP10**

 <b>GOLDER</b>	PROJECT NO. <b>1671430</b>		PHASE <b>WO001</b>	
	DESIGNED	SE	REV.	A
	PREPARED	SE		
	REVIEWED			
	APPROVED			

**Figure B-18**




**Scale**

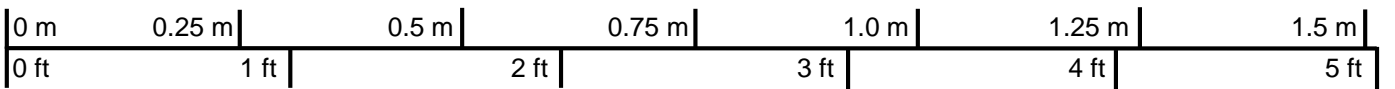
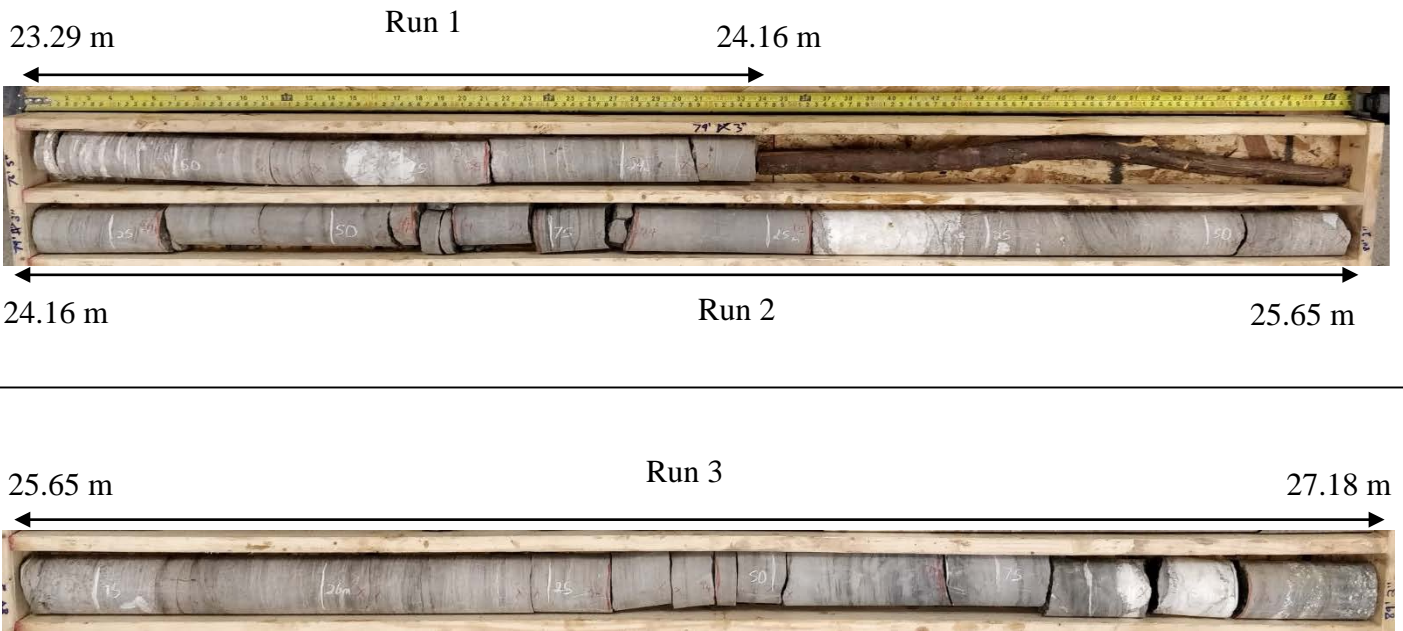
PROJECT  
REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO  
GWP 2116-16-00

CLIENT  
**MINISTRY OF TRANSPORTATION, ONTARIO (MTO)**


TITLE  
**BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP11**

 <b>GOLDER</b>	PROJECT NO. <b>1671430</b>		PHASE <b>WO001</b>	
	DESIGNED	SE		REV. <b>A</b>
	PREPARED	SE		
	REVIEWED			
	APPROVED			

**Figure B-19**



**Scale**

PROJECT REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-129-1 AND 34-129-2, QEW FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO GWP 2116-16-00			
CLIENT <b>MINISTRY OF TRANSPORTATION, ONTARIO (MTO)</b>			
TITLE <b>BEDROCK CORE PHOTOGRAPHS – BOREHOLE CN/CP12</b>			
 <b>GOLDER</b>	PROJECT NO. <b>1671430</b>		PHASE <b>WO001</b>
	DESIGNED	SE	REV. <b>A</b>
	PREPARED	SE	
	REVIEWED		
			APPROVED
<b>Figure B-20</b>			

POINT LOAD STRENGTH TEST (ISRM, 1985)

Min W (mm)

A Axial Test

19

D Diametral Test

63

Test #	Borehole	Rock type	Depth (top)	W	D	Gauge Reading	Load P	$D_e^2$	$I_s = P/D_e^2$	$F = (D_e/50)^{0.45}$	$I_{s(50)}$	Type	Valid Test	Remarks
			m	mm	mm	Mpa	MN	mm <sup>2</sup>	MPa		MPa			
1	CN/CP10	Limestone	26.44	63	60	9.76	0.00944	4812.8	1.96	1.159	2.27	A	Y	
2	CN/CP10	Limestone	24.68	95	63	0.86	0.00083	3969.0	0.21	1.110	0.23	D	Y	
3	CN/CP10	Limestone	25.34	70	63	1.16	0.00112	3969.0	0.28	1.110	0.31	D	Y	
4	CN/CP11	Limestone	23.88	63	41	7.12	0.00689	3288.8	2.09	1.064	2.23	A	Y	
5	CN/CP11	Limestone	26.21	75	63	2.56	0.00248	3969.0	0.62	1.110	0.69	D	Y	
6	CN/CP11	Limestone	24.52	57	63	14.10	0.01363	3969.0	3.44	1.110	3.81	D	Y	
7	CN/CP12	Limestone	24.58	63	25	16.78	0.01623	2005.4	8.09	0.952	7.70	A	Y	
8	CN/CP12	Limestone	26.44	63	25	14.58	0.01410	2005.4	7.03	0.952	6.69	A	Y	
9	CN/CP12	Limestone	25.55	110	63	0.18	0.00017	3969.0	0.04	1.110	0.05	D	Y	
10	CN/CP2	Limestone	15.43	63	32	2.42	0.00234	2566.9	0.91	1.006	0.92	A	Y	
11	CN/CP2	Limestone	16.20	63	40	14.92	0.01443	3208.6	4.50	1.058	4.76	A	Y	
12	CN/CP2	Limestone	17.23	63	35	10.46	0.01011	2807.5	3.60	1.026	3.70	A	Y	
13	CN/CP3	Limestone	23.39	63	40	18.94	0.01831	3208.6	5.71	1.058	6.04	A	Y	
14	CN/CP3	Limestone	24.95	100	63	7.28	0.00704	3969.0	1.77	1.110	1.97	D	Y	
15	CN/CP3	Limestone	26.39	60	63	1.02	0.00099	3969.0	0.25	1.110	0.28	D	Y	
16	CN/CP5	Limestone	26.15	63	63	2.04	0.00197	3969.0	0.50	1.110	0.55	D	Y	
17	CN/CP5	Limestone	25.39	63	63	17.98	0.01739	5053.5	3.44	1.172	4.03	A	Y	
18	CN/CP5	Limestone	23.80	63	35	15.86	0.01534	2807.5	5.46	1.026	5.61	A	Y	
19	CN/CP6	Limestone	17.68	63	45	12.22	0.01182	3609.6	3.27	1.086	3.56	A	Y	
20	CN/CP6	Limestone	15.85	95	63	2.94	0.00284	3969.0	0.72	1.110	0.79	D	Y	
21	CN/CP6	Limestone	16.71	125	63	0.46	0.00044	3969.0	0.11	1.110	0.12	D	Y	
22	CN/CP7	Limestone	16.53	63	55	10.92	0.01056	4411.8	2.39	1.136	2.72	A	Y	
23	CN/CP7	Limestone	17.86	63	25	3.80	0.00367	2005.4	1.83	0.952	1.74	A	Y	
24	CN/CP7	Limestone	15.45	85	63	2.06	0.00199	3969.0	0.50	1.110	0.56	D	Y	
25	CN/CP8	Limestone	15.60	125	63	31.28	0.03025	3969.0	7.62	1.110	8.46	D	Y	
26	CN/CP8	Limestone	17.25	63	60	16.08	0.01555	4812.8	3.23	1.159	3.74	A	Y	
27	CN/CP8	Limestone	18.29	85	63	8.44	0.00816	3969.0	2.06	1.110	2.28	D	Y	
28	CN/CP9	Limestone	17.47	110	63	11.12	0.01075	3969.0	2.71	1.110	3.01	D	Y	
29	CN/CP9	Limestone	18.40	63	30	18.84	0.01822	2406.4	7.57	0.991	7.51	A	Y	
30	CN/CP9	Limestone	16.48	63	45	12.30	0.01189	3609.6	3.30	1.086	3.58	A	Y	

$I_{s(50)}$  = Size Corrected Point Load Strength

$F$  = Size Correction Factor

$F = (D_e/50)^{0.45}$

$I_s$  = Uncorrected Point Load Strength

$I_s = P/D_e^2$

Ram Area = 9.67 E-04 m<sup>2</sup>

$D_e$  = equivalent core diameter (mm)

Diametral -  $D_e^2 = D^2$  (mm<sup>2</sup>)

Axial -  $D_e^2 = 4/\pi * D * W$  (mm<sup>2</sup>)

D = diametral

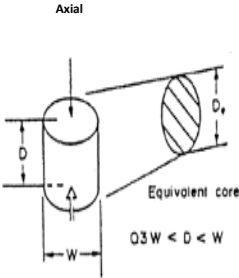
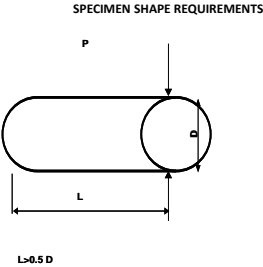
A = axial


b = block

l = irregular lump

\\ = parallel

p = perpendicular to planes of weakness



PROJECT REPLACEMENT OF TWIN STRUCTURES OVER CN AND CP RAILS, SITE NOS. 34-125-1 AND 34-125-2, DEV FROM 1.4 KM NORTH OF BOWEN ROAD INTERCHANGE SOUTHERLY TO GILMORE ROAD INTERCHANGE, TOWN OF FORT ERIE, NIAGARA REGION, ONTARIO					
GWP 2116-16-00					
CLIENT MINISTRY OF TRANSPORTATION, ONTARIO (MTO)					
TITLE POINT LOAD TEST RESULTS					
	PROJECT NO.	1671430		PHASE	W0001
	DESIGNED	EN		REV.	A
	PREPARED	EN			
	REVIEWED				
	APPROVED				
				Figure B-21	

**APPENDIX C**

# Rock Laboratory Test Results

January 22, 2019

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

Re: UCS testing  
(Golder Project No. 1671430 WO-1)

Dear Mr. Naylor:

On November 15, 2018 and January 10, 2019 four (4) and five (5) HQ-sized samples were received by Geomechanica Inc. via drop-off by Golder Personnel, respectively. These samples were identified as being from Golder project 1671430 WO-1 (QEW Bertie). From these samples, six (6) UCS tests were completed.

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

Sincerely,



Bryan Tatone Ph.D., P. Eng.

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

# Rock Laboratory Testing Results

**A report submitted to:**

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

**Prepared by:**

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

**January 22, 2019**

Project number: 1671430-WO1

**Abstract**

This document summarizes the results of rock laboratory testing, including the results of 6 Uniaxial Compressive Strength (UCS) tests. These samples are from a drilling investigation for the QEW Bertie Project (Golder Project No. 1671430-WO1). Results including uniaxial compressive strength (UCS) along with photographs of samples before and after testing are presented herein.

**In this document:**

1 Uniaxial Compressive Strength Tests	1
Appendices	3

# 1 Uniaxial Compressive Strength Tests

## 1.1 Overview

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

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



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

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

- Rather than a spherical seat diameter equal to 1 to 2 times the specimen diameter, the setup used here employed a 25.4 mm diameter high precision ball bearing and seat. Despite the smaller diameter, this seat could move freely to accommodate small angular rotations in any direction, as needed, and therefore did not appreciably influence the results.

## 1.2 Results

The testing results are summarized in Table 1. Please note that additional specimen details and measurements are provided in the summary spreadsheet that accompanies this report.

Table 1: Summary of Uniaxial Compression test results.

Sample	Depth (m)	Bulk density $\rho$ (g/cm <sup>3</sup> )	UCS (MPa)	Lithology	Failure description
CN-CP3	25.96 - 26.22	2.703	133.2	Limestone	1
CN-CP5	25.03 - 25.39	2.540	62.9	Limestone	2
CN-CP12	23.37 - 23.62	2.615	92.5	Limestone	2
CN-CP6	17.88 - 18.08	2.696	136.9	Limestone	3
CN-CP9	15.97 - 16.14	2.745	96.8	Limestone	1
CN-CP8	16.18 - 16.37	2.794	215.6	Limestone	3
Average		2.682	123.0		
Standard deviation		0.084	48.5		

<sup>1</sup> Inclined shear band failure

<sup>2</sup> Axial splitting failure

<sup>3</sup> Hourglass failure

## 1.3 Specimen photographs



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

# Appendices


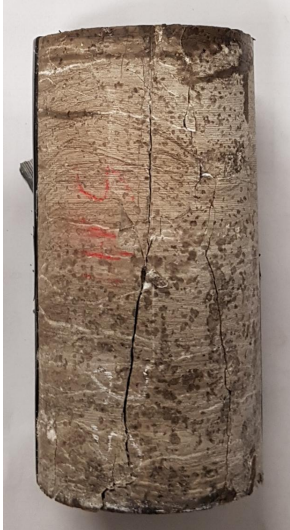
## Specimen sheets

- CN-CP3
- CN-CP5
- CN-CP12
- CN-CP6
- CN-CP9
- CN-CP8



## Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-WO1														
Sample	CN-CP3	Depth	25.96 - 26.22														
<table><tr><th colspan="2">Specimen parameters</th></tr><tr><td>Diameter (mm) <sup>a</sup></td><td>63.20</td></tr><tr><td>Length (mm) <sup>a</sup></td><td>127.70</td></tr><tr><td>Bulk density <math>\rho</math> (g/cm<sup>3</sup>)</td><td>2.703</td></tr><tr><td>UCS (MPa)</td><td>133.2</td></tr><tr><td>Lithology</td><td>Limestone</td></tr><tr><td>Failure description <sup>b</sup></td><td>1</td></tr></table>		Specimen parameters		Diameter (mm) <sup>a</sup>	63.20	Length (mm) <sup>a</sup>	127.70	Bulk density $\rho$ (g/cm <sup>3</sup> )	2.703	UCS (MPa)	133.2	Lithology	Limestone	Failure description <sup>b</sup>	1	<p>Prior to testing</p> 	<p>After testing</p> 
Specimen parameters																	
Diameter (mm) <sup>a</sup>	63.20																
Length (mm) <sup>a</sup>	127.70																
Bulk density $\rho$ (g/cm <sup>3</sup> )	2.703																
UCS (MPa)	133.2																
Lithology	Limestone																
Failure description <sup>b</sup>	1																
<p><sup>a</sup> Additional specimen measurement/details provides in accompanying summary spreadsheet.</p> <p><sup>b</sup> Failure description: <sup>1</sup> Inclined shear band failure;</p>																	
Remarks:																	
Performed by	BSAT	Date	2018-12-18														



## Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-WO1														
Sample	CN-CP5	Depth	25.03 - 25.39														
<table><tr><th colspan="2">Specimen parameters</th></tr><tr><td>Diameter (mm) <sup>a</sup></td><td>63.05</td></tr><tr><td>Length (mm) <sup>a</sup></td><td>127.90</td></tr><tr><td>Bulk density <math>\rho</math> (g/cm<sup>3</sup>)</td><td>2.540</td></tr><tr><td>UCS (MPa)</td><td>62.9</td></tr><tr><td>Lithology</td><td>Limestone</td></tr><tr><td>Failure description <sup>b</sup></td><td>2</td></tr></table>		Specimen parameters		Diameter (mm) <sup>a</sup>	63.05	Length (mm) <sup>a</sup>	127.90	Bulk density $\rho$ (g/cm <sup>3</sup> )	2.540	UCS (MPa)	62.9	Lithology	Limestone	Failure description <sup>b</sup>	2	<p>Prior to testing</p> 	<p>After testing</p> 
Specimen parameters																	
Diameter (mm) <sup>a</sup>	63.05																
Length (mm) <sup>a</sup>	127.90																
Bulk density $\rho$ (g/cm <sup>3</sup> )	2.540																
UCS (MPa)	62.9																
Lithology	Limestone																
Failure description <sup>b</sup>	2																
<p><sup>a</sup> Additional specimen measurement/details provides in accompanying summary spreadsheet.</p> <p><sup>b</sup> Failure description: <sup>2</sup> Axial splitting failure;</p>																	
Remarks:																	
Performed by	BSAT	Date	2018-12-18														



## Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-WO1												
Sample	CN-CP12	Depth	23.37 - 23.62												
<div>Specimen parameters</div> <table><tr><td>Diameter (mm) <sup>a</sup></td><td>63.31</td></tr><tr><td>Length (mm) <sup>a</sup></td><td>128.16</td></tr><tr><td>Bulk density <math>\rho</math> (g/cm<sup>3</sup>)</td><td>2.615</td></tr><tr><td>UCS (MPa)</td><td>92.5</td></tr><tr><td>Lithology</td><td>Limestone</td></tr><tr><td>Failure description <sup>b</sup></td><td>2</td></tr></table>		Diameter (mm) <sup>a</sup>	63.31	Length (mm) <sup>a</sup>	128.16	Bulk density $\rho$ (g/cm <sup>3</sup> )	2.615	UCS (MPa)	92.5	Lithology	Limestone	Failure description <sup>b</sup>	2	<div>Prior to testing</div> 	<div>After testing</div> 
Diameter (mm) <sup>a</sup>	63.31														
Length (mm) <sup>a</sup>	128.16														
Bulk density $\rho$ (g/cm <sup>3</sup> )	2.615														
UCS (MPa)	92.5														
Lithology	Limestone														
Failure description <sup>b</sup>	2														
<div><sup>a</sup> Additional specimen measurement/details provides in accompanying summary spreadsheet.</div> <div><sup>b</sup> Failure description: <sup>2</sup> Axial splitting failure;</div>															
Remarks:															
Performed by	BSAT	Date	2018-12-18												



## Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-WO1												
Sample	CN-CP6	Depth	17.88 - 18.08												
<div>Specimen parameters</div> <table><tr><td>Diameter (mm)<sup>a</sup></td><td>63.38</td></tr><tr><td>Length (mm)<sup>a</sup></td><td>128.45</td></tr><tr><td>Bulk density <math>\rho</math> (g/cm<sup>3</sup>)</td><td>2.696</td></tr><tr><td>UCS (MPa)</td><td>136.9</td></tr><tr><td>Lithology</td><td>Limestone</td></tr><tr><td>Failure description<sup>b</sup></td><td>3</td></tr></table>		Diameter (mm) <sup>a</sup>	63.38	Length (mm) <sup>a</sup>	128.45	Bulk density $\rho$ (g/cm <sup>3</sup> )	2.696	UCS (MPa)	136.9	Lithology	Limestone	Failure description <sup>b</sup>	3	<div>Prior to testing</div> 	<div>After testing</div> 
Diameter (mm) <sup>a</sup>	63.38														
Length (mm) <sup>a</sup>	128.45														
Bulk density $\rho$ (g/cm <sup>3</sup> )	2.696														
UCS (MPa)	136.9														
Lithology	Limestone														
Failure description <sup>b</sup>	3														
<div><sup>a</sup> Additional specimen measurement/details provides in accompanying summary spreadsheet.</div> <div><sup>b</sup> Failure description: <sup>3</sup> Hourglass failure;</div>															
Remarks:															
Performed by	BSAT	Date	2019-01-17												

### Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-WO1														
Sample	CN-CP9	Depth	15.97 - 16.14														
<table><tr><th colspan="2">Specimen parameters</th></tr><tr><td>Diameter (mm) <sup>a</sup></td><td>63.32</td></tr><tr><td>Length (mm) <sup>a</sup></td><td>127.37</td></tr><tr><td>Bulk density <math>\rho</math> (g/cm<sup>3</sup>)</td><td>2.745</td></tr><tr><td>UCS (MPa)</td><td>96.8</td></tr><tr><td>Lithology</td><td>Limestone</td></tr><tr><td>Failure description <sup>b</sup></td><td>1</td></tr></table>		Specimen parameters		Diameter (mm) <sup>a</sup>	63.32	Length (mm) <sup>a</sup>	127.37	Bulk density $\rho$ (g/cm <sup>3</sup> )	2.745	UCS (MPa)	96.8	Lithology	Limestone	Failure description <sup>b</sup>	1	<p>Prior to testing</p> 	<p>After testing</p> 
Specimen parameters																	
Diameter (mm) <sup>a</sup>	63.32																
Length (mm) <sup>a</sup>	127.37																
Bulk density $\rho$ (g/cm <sup>3</sup> )	2.745																
UCS (MPa)	96.8																
Lithology	Limestone																
Failure description <sup>b</sup>	1																
<p><sup>a</sup> Additional specimen measurement/details provides in accompanying summary spreadsheet.</p> <p><sup>b</sup> Failure description: <sup>1</sup> Inclined shear band failure;</p>																	
Remarks:																	
Performed by	BSAT	Date	2019-01-17														

# Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	1671430-WO1												
Sample	CN-CP8	Depth	16.18 - 16.37												
<div>Specimen parameters</div> <table><tr><td>Diameter (mm)<sup>a</sup></td><td>63.27</td></tr><tr><td>Length (mm)<sup>a</sup></td><td>128.53</td></tr><tr><td>Bulk density <math>\rho</math> (g/cm<sup>3</sup>)</td><td>2.794</td></tr><tr><td>UCS (MPa)</td><td>215.6</td></tr><tr><td>Lithology</td><td>Limestone</td></tr><tr><td>Failure description<sup>b</sup></td><td>3</td></tr></table>		Diameter (mm) <sup>a</sup>	63.27	Length (mm) <sup>a</sup>	128.53	Bulk density $\rho$ (g/cm <sup>3</sup> )	2.794	UCS (MPa)	215.6	Lithology	Limestone	Failure description <sup>b</sup>	3	<div>Prior to testing</div> 	<div>After testing</div> 
Diameter (mm) <sup>a</sup>	63.27														
Length (mm) <sup>a</sup>	128.53														
Bulk density $\rho$ (g/cm <sup>3</sup> )	2.794														
UCS (MPa)	215.6														
Lithology	Limestone														
Failure description <sup>b</sup>	3														
<div><sup>a</sup> Additional specimen measurement/details provides in accompanying summary spreadsheet.</div> <div><sup>b</sup> Failure description: <sup>3</sup> Hourglass failure;</div>															
Remarks:															
Performed by	BSAT	Date	2019-01-17												

**APPENDIX D**

# Analytical Chemical Test Results

Your Project #: 1671430-W01

Site Location: BERTIC CNR

Your C.O.C. #: 654003-14-01

**Attention: Nikol Kochmanova**

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

**Report Date: 2018/10/05**

Report #: R5429894

Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B8P6311**

**Received: 2018/09/28, 19:45**

Sample Matrix: Soil  
# Samples Received: 4

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	4	N/A	2018/10/05	CAM SOP-00463	EPA 325.2 m
Conductivity	4	N/A	2018/10/04	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl <sub>2</sub> EXTRACT	4	2018/10/03	2018/10/03	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	4	2018/10/02	2018/10/04	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	4	N/A	2018/10/05	CAM SOP-00464	EPA 375.4 m

**Remarks:**

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

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

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

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

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.

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

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

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

Your Project #: 1671430-W01  
Site Location: BERTIC CNR  
Your C.O.C. #: 654003-14-01

**Attention: Nikol Kochmanova**

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

**Report Date: 2018/10/05**  
Report #: R5429894  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B8P6311**

**Received: 2018/09/28, 19:45**

**Encryption Key**

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

Ema Gitej, Senior Project Manager

Email: EGitej@maxxam.ca

Phone# (905)817-5829

=====

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

### SOIL CORROSIVITY PACKAGE (SOIL)

<b>Maxxam ID</b>		HWS185		HWS186		HWS187		HWS187		
<b>Sampling Date</b>		2018/08/27		2018/08/23		2018/08/18		2018/08/18		
<b>COC Number</b>		654003-14-01		654003-14-01		654003-14-01		654003-14-01		
	<b>UNITS</b>	<b>CNCP3-SA12</b>	<b>RDL</b>	<b>CNCP12-SA11</b>	<b>RDL</b>	<b>CNCP11-SA15</b>	<b>QC Batch</b>	<b>CNCP11-SA15 Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>										
Resistivity	ohm-cm	680		3400		1600	5761982			
<b>Inorganics</b>										
Soluble (20:1) Chloride (Cl-)	ug/g	<20	20	<20	20	<20	5766534	<20	20	5766534
Conductivity	umho/cm	1470	2	297	2	618	5765367	614	2	5765367
Available (CaCl2) pH	pH	7.91		7.89		7.91	5764259			
Soluble (20:1) Sulphate (SO4)	ug/g	2900	200	180	20	810	5766535	800	40	5766535
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										
Lab-Dup = Laboratory Initiated Duplicate										

<b>Maxxam ID</b>		HWS188		
<b>Sampling Date</b>		2018/08/21		
<b>COC Number</b>		654003-14-01		
	<b>UNITS</b>	<b>CNCP5-SA5-AB</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>				
Resistivity	ohm-cm	730		5761982
<b>Inorganics</b>				
Soluble (20:1) Chloride (Cl-)	ug/g	39	20	5766534
Conductivity	umho/cm	1370	2	5765367
Available (CaCl2) pH	pH	7.46		5764259
Soluble (20:1) Sulphate (SO4)	ug/g	1400	60	5766535
RDL = Reportable Detection Limit				
QC Batch = Quality Control Batch				

## TEST SUMMARY

**Maxxam ID:** HWS185  
**Sample ID:** CNCP3-SA12  
**Matrix:** Soil

**Collected:** 2018/08/27  
**Shipped:**  
**Received:** 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5766534	N/A	2018/10/05	Deonarine Ramnarine
Conductivity	AT	5765367	N/A	2018/10/04	Barbara Kalbasi Esfahani
pH CaCl2 EXTRACT	AT	5764259	2018/10/03	2018/10/03	Gnana Thomas
Resistivity of Soil		5761982	2018/10/04	2018/10/04	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5766535	N/A	2018/10/05	Deonarine Ramnarine

**Maxxam ID:** HWS186  
**Sample ID:** CNCP12-SA11  
**Matrix:** Soil

**Collected:** 2018/08/23  
**Shipped:**  
**Received:** 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5766534	N/A	2018/10/05	Deonarine Ramnarine
Conductivity	AT	5765367	N/A	2018/10/04	Barbara Kalbasi Esfahani
pH CaCl2 EXTRACT	AT	5764259	2018/10/03	2018/10/03	Gnana Thomas
Resistivity of Soil		5761982	2018/10/04	2018/10/04	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5766535	N/A	2018/10/05	Deonarine Ramnarine

**Maxxam ID:** HWS187  
**Sample ID:** CNCP11-SA15  
**Matrix:** Soil

**Collected:** 2018/08/18  
**Shipped:**  
**Received:** 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5766534	N/A	2018/10/05	Deonarine Ramnarine
Conductivity	AT	5765367	N/A	2018/10/04	Barbara Kalbasi Esfahani
pH CaCl2 EXTRACT	AT	5764259	2018/10/03	2018/10/03	Gnana Thomas
Resistivity of Soil		5761982	2018/10/04	2018/10/04	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5766535	N/A	2018/10/05	Deonarine Ramnarine

**Maxxam ID:** HWS187 Dup  
**Sample ID:** CNCP11-SA15  
**Matrix:** Soil

**Collected:** 2018/08/18  
**Shipped:**  
**Received:** 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5766534	N/A	2018/10/05	Deonarine Ramnarine
Conductivity	AT	5765367	N/A	2018/10/04	Barbara Kalbasi Esfahani
Sulphate (20:1 Extract)	KONE/EC	5766535	N/A	2018/10/05	Deonarine Ramnarine

**Maxxam ID:** HWS188  
**Sample ID:** CNCP5-SA5-AB  
**Matrix:** Soil

**Collected:** 2018/08/21  
**Shipped:**  
**Received:** 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5766534	N/A	2018/10/05	Deonarine Ramnarine
Conductivity	AT	5765367	N/A	2018/10/04	Barbara Kalbasi Esfahani
pH CaCl2 EXTRACT	AT	5764259	2018/10/03	2018/10/03	Gnana Thomas

Maxxam Job #: B8P6311  
Report Date: 2018/10/05

Golder Associates Ltd  
Client Project #: 1671430-W01  
Site Location: BERTIC CNR  
Sampler Initials: CN

## TEST SUMMARY

**Maxxam ID:** HWS188  
**Sample ID:** CNCP5-SA5-AB  
**Matrix:** Soil

**Collected:** 2018/08/21  
**Shipped:**  
**Received:** 2018/09/28

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Resistivity of Soil		5761982	2018/10/04	2018/10/04	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5766535	N/A	2018/10/05	Deonarine Ramnarine

### GENERAL COMMENTS

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

Package 1	-0.7°C
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**Results relate only to the items tested.**

## QUALITY ASSURANCE REPORT

Golder Associates Ltd  
Client Project #: 1671430-W01  
Site Location: BERTIC CNR  
Sampler Initials: CN

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5764259	Available (CaCl <sub>2</sub> ) pH	2018/10/03			100	97 - 103			0.028	N/A
5765367	Conductivity	2018/10/04			104	90 - 110	<2	umho/cm	0.65	10
5766534	Soluble (20:1) Chloride (Cl <sup>-</sup> )	2018/10/05	109	70 - 130	103	70 - 130	<20	ug/g	NC	35
5766535	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2018/10/05	NC	70 - 130	104	70 - 130	<20	ug/g	0.39	35

N/A = Not Applicable

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

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

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

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

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

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

### VALIDATION SIGNATURE PAGE

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

*Cristina Carriere*

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Cristina Carriere, Scientific Service Specialist

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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 Campbell 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: Golder Associates Ltd.	Quotation #: 00000	Maxxam Job #:	Bottle Order #:			
Attention: Accounts Payable	Attention: Brad Crowe Nikol Kochmanova	P.O. #:					
Address: 6925 Century Ave Suite 100	Address: 6925 Century Ave - Suite 100	Project: 1668076 1671430-WO1					
Mississauga ON L5N 7K2	Mississauga ON	Project Name: Bertie CNR					
Tel: (905) 567-4444 x	Tel: (905) 567-6100 x100 2134	Site #:					
Email: AP_CustomerService@golder.com	Email: bcrowe@golder.com Nikol-Kochmanova@golder.com	Shipped By: JK					

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				Field Filtered (please circle):				Metals / Hg / Cr / VI				Corrosivity Package (pH, sulphate, chloride, resistivity, conductivity)				ANALYSIS REQUESTED (PLEASE BE SPECIFIC)				Turnaround Time (TAT) Required:			
<input type="checkbox"/> Table 1	<input type="checkbox"/> Res/Park	<input type="checkbox"/> Medium/Fine	<input type="checkbox"/> CCME	<input type="checkbox"/> Sanitary Sewer Bylaw																					Regular (Standard) TAT:						
<input type="checkbox"/> Table 2	<input type="checkbox"/> Ind/Comm	<input type="checkbox"/> Coarse	<input type="checkbox"/> Reg 558	<input type="checkbox"/> Storm Sewer Bylaw																					(will be applied if Rush TAT is not specified):						
<input type="checkbox"/> Table 3	<input type="checkbox"/> Agri/Other	<input type="checkbox"/> For RSC	<input type="checkbox"/> MISA	<input type="checkbox"/> Municipality																					Standard TAT = 5-7 Working days for most tests.						
<input type="checkbox"/> Table			<input type="checkbox"/> PWQO	<input type="checkbox"/> Other																					Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.						
Include Criteria on Certificate of Analysis (Y/N)?																Job Specific Rush TAT (if applies to entire submission)															
																Date Required: Time Required: Rush Confirmation Number: (call lab for #)															
																# of Bottles: Comments:															
1 CNCP3-SA12 2018/08/27 PM SOIL																1 Standard Corrosivity Package															
2 CNCP2-SA11 2018/08/23 PM SOIL																1															
3 CNCP11-SA15 2018/08/18 PM SOIL																1															
4 CNCP5-SA5-AB 2018/08/21 AM SOIL																1															
5																															
6																															
7																															
8																															
9																															
10																															

28-Sep-18 19:45

Ema Gitej



B8P6311

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ENV-1151

RELINQUISHED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		RECEIVED BY: (Signature/Print)		Date: (YY/MM/DD)		Time		# jars used and not submitted		Laboratory Use Only	
Kare Neo Kishor		18/09/28		7:44 PM		Kare Neo Kishor		2018/09/28		19:45				Time Sensitive: Temperature (°C) on Recd: -11-10	
												Custody Seal: Present: Intact: Yes: No: [X]			

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

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

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

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

White: Maxxa Yellow: Client

Your Project #: 1671430WO001  
Site Location: QEW BERTIE  
Your C.O.C. #: 641804-08-01

**Attention: Nikol Kochmanova**

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

**Report Date: 2018/12/12**  
Report #: R5522750  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B8W6726**

**Received: 2018/12/06, 12:29**

Sample Matrix: Soil  
# Samples Received: 5

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	5	N/A	2018/12/12	CAM SOP-00463	EPA 325.2 m
Conductivity	5	N/A	2018/12/12	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	5	2018/12/11	2018/12/11	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	5	2018/12/06	2018/12/12	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	5	N/A	2018/12/12	CAM SOP-00464	EPA 375.4 m

**Remarks:**

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

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

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

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

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.

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

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

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

**Encryption Key**

Please direct all questions regarding this Certificate of Analysis to your Project Manager.  
Ema Gitej, Senior Project Manager

Your Project #: 1671430WO001  
Site Location: QEW BERTIE  
Your C.O.C. #: 641804-08-01

**Attention: Nikol Kochmanova**

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

**Report Date: 2018/12/12**  
Report #: R5522750  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B8W6726**

**Received: 2018/12/06, 12:29**

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.

### SOIL CORROSIVITY PACKAGE (SOIL)

<b>Maxxam ID</b>		IMF686		IMF687		IMF688	IMF689		IMF690		
<b>Sampling Date</b>		2018/11/20		2018/11/28		2018/11/22	2018/11/23		2018/11/29		
<b>COC Number</b>		641804-08-01		641804-08-01		641804-08-01	641804-08-01		641804-08-01		
	<b>UNITS</b>	<b>CN/CP 2 SA6</b>	<b>RDL</b>	<b>CN/CP 6 SA5</b>	<b>RDL</b>	<b>CN/CP 7 SA2</b>	<b>CN/CP 8 SA3</b>	<b>RDL</b>	<b>CN/CP 9 SA4</b>	<b>RDL</b>	<b>QC Batch</b>

#### Calculated Parameters

Resistivity	ohm-cm	870		420		980	1500		300		5875238
-------------	--------	-----	--	-----	--	-----	------	--	-----	--	---------

#### Inorganics

Soluble (20:1) Chloride (Cl-)	ug/g	<20	20	30	20	480	88	20	310	20	5882065
Conductivity	umho/cm	1150	2	2370	2	1020	667	2	3300	2	5882455
Available (CaCl2) pH	pH	8.00		7.83		7.75	7.78		7.86		5882163
Soluble (20:1) Sulphate (SO4)	ug/g	1300	60	2900	100	140	390	20	7400	200	5882077

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

<b>Maxxam ID</b>		IMF690	
<b>Sampling Date</b>		2018/11/29	
<b>COC Number</b>		641804-08-01	
	<b>UNITS</b>	<b>CN/CP 9 SA4 Lab-Dup</b>	<b>QC Batch</b>
<b>Inorganics</b>			
Available (CaCl2) pH	pH	7.70	5882163
QC Batch = Quality Control Batch			
Lab-Dup = Laboratory Initiated Duplicate			

## TEST SUMMARY

**Maxxam ID:** IMF686  
**Sample ID:** CN/CP 2 SA6  
**Matrix:** Soil

**Collected:** 2018/11/20  
**Shipped:**  
**Received:** 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5882065	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5882455	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5882163	2018/12/11	2018/12/11	Gnana Thomas
Resistivity of Soil		5875238	2018/12/12	2018/12/12	Brad Newman
Sulphate (20:1 Extract)	KONE/EC	5882077	N/A	2018/12/12	Alina Dobreanu

**Maxxam ID:** IMF687  
**Sample ID:** CN/CP 6 SA5  
**Matrix:** Soil

**Collected:** 2018/11/28  
**Shipped:**  
**Received:** 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5882065	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5882455	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5882163	2018/12/11	2018/12/11	Gnana Thomas
Resistivity of Soil		5875238	2018/12/12	2018/12/12	Brad Newman
Sulphate (20:1 Extract)	KONE/EC	5882077	N/A	2018/12/12	Alina Dobreanu

**Maxxam ID:** IMF688  
**Sample ID:** CN/CP 7 SA2  
**Matrix:** Soil

**Collected:** 2018/11/22  
**Shipped:**  
**Received:** 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5882065	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5882455	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5882163	2018/12/11	2018/12/11	Gnana Thomas
Resistivity of Soil		5875238	2018/12/12	2018/12/12	Brad Newman
Sulphate (20:1 Extract)	KONE/EC	5882077	N/A	2018/12/12	Alina Dobreanu

**Maxxam ID:** IMF689  
**Sample ID:** CN/CP 8 SA3  
**Matrix:** Soil

**Collected:** 2018/11/23  
**Shipped:**  
**Received:** 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5882065	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5882455	N/A	2018/12/12	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	5882163	2018/12/11	2018/12/11	Gnana Thomas
Resistivity of Soil		5875238	2018/12/12	2018/12/12	Brad Newman
Sulphate (20:1 Extract)	KONE/EC	5882077	N/A	2018/12/12	Alina Dobreanu

**Maxxam ID:** IMF690  
**Sample ID:** CN/CP 9 SA4  
**Matrix:** Soil

**Collected:** 2018/11/29  
**Shipped:**  
**Received:** 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5882065	N/A	2018/12/12	Deonarine Ramnarine
Conductivity	AT	5882455	N/A	2018/12/12	Kazzandra Adeva

Maxxam Job #: B8W6726  
Report Date: 2018/12/12

Golder Associates Ltd  
Client Project #: 1671430WO001  
Site Location: QEW BERTIE  
Sampler Initials: LKE

## TEST SUMMARY

**Maxxam ID:** IMF690  
**Sample ID:** CN/CP 9 SA4  
**Matrix:** Soil

**Collected:** 2018/11/29  
**Shipped:**  
**Received:** 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl <sub>2</sub> EXTRACT	AT	5882163	2018/12/11	2018/12/11	Gnana Thomas
Resistivity of Soil		5875238	2018/12/12	2018/12/12	Brad Newman
Sulphate (20:1 Extract)	KONE/EC	5882077	N/A	2018/12/12	Alina Dobreanu

**Maxxam ID:** IMF690 Dup  
**Sample ID:** CN/CP 9 SA4  
**Matrix:** Soil

**Collected:** 2018/11/29  
**Shipped:**  
**Received:** 2018/12/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl <sub>2</sub> EXTRACT	AT	5882163	2018/12/11	2018/12/11	Gnana Thomas

### GENERAL COMMENTS

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

Package 1	5.3°C
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**Results relate only to the items tested.**

## QUALITY ASSURANCE REPORT

Golder Associates Ltd  
Client Project #: 1671430WO001  
Site Location: QEW BERTIE  
Sampler Initials: LKE

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5882065	Soluble (20:1) Chloride (Cl <sup>-</sup> )	2018/12/12	NC	70 - 130	100	70 - 130	<20	ug/g	0.59	35
5882077	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2018/12/12	NC	70 - 130	96	70 - 130	<20	ug/g	NC	35
5882163	Available (CaCl <sub>2</sub> ) pH	2018/12/11			100	97 - 103			2.1	N/A
5882455	Conductivity	2018/12/12			104	90 - 110	<2	umho/cm	0.13	10

N/A = Not Applicable

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

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

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


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

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

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

### VALIDATION SIGNATURE PAGE

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



---

Brad Newman, 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.

<b>Maxxam</b> <b>IMMEDIATE</b>		Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campbell Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca				<b>CHAIN OF CUSTODY RECORD</b> Page of															
Company Name: <b>#1326 Golder Associates Ltd</b> Attention: <b>Accounts Payable</b> Address: <b>6925 Century Ave Suite 100</b> <b>Mississauga ON L5N 7K2</b> Tel: <b>(905) 567-4444 x</b> Fax: <b>(905) 567-6561 x</b> Email: <b>AP_CustomerService@golder.com</b>		REPORT TO: Company Name: <b>N. Kol Kochmanova</b> Attention: <b>N. Kol Kochmanova</b> Address: <b>905 567 6100 x 2134</b> Tel: <b>905 567 6100 x 2134</b> Email: <b>n.kol.kochmanova@golder.com</b>		PROJECT INFORMATION: Quotation #: <b>B70916</b> P.O. #: <b>1671430 WD 001</b> Project: <b>QEW Bertie</b> Project Name: Site #: <b>LK/EN</b> Sampled By:		Laboratory Use Only: Maxxam Job #: Bottle Order #: COC #: Project Manager: <b>Ema Gitej</b>															
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY						ANALYSIS REQUESTED (PLEASE BE SPECIFIC)															
Regulation 153 (2011) <input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC <input type="checkbox"/> Table			Other Regulations <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> MISA Municipality <input type="checkbox"/> PWQO <input type="checkbox"/> Other			Special Instructions			Field Filtered (please circle): Metals / Hg / Cr VI Composite Package pH, Sulphate, Chlorides Resistivity, Conductivity												
Include Criteria on Certificate of Analysis (Y/N)?						Turnaround Time (TAT) Required: Please provide advance notice for rush projects <b>Regular (Standard) TAT:</b> (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. <input checked="" type="checkbox"/>															
# of Bottles						Comments															
1 CN/ICP 2 SA6 Nov 20, 18 AM Soil X						1 Standard Corrosivity Package															
2 CN/ICP 6 SAS Nov 28, 18 PM X						1															
3 CN/ICP 7 SA2 Nov 22, 18 AM X						1															
4 CN/ICP 8 SA3 Nov 23, 18 AM X						1															
5 CN/ICP 9 SA4 Nov 29, 18 PM X						1															
6						06-Dec-18 12:29 Ema Gitej  <b>B8W6726</b> URE ENV-414															
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* RELINQUISHED BY: (Signature/Print) 		Date: (YY/MM/DD) 18/12/06		Time 12:15		RECEIVED BY: (Signature/Print) 		Date: (YY/MM/DD) 20/12/06		Time 12:29		# jars used and not submitted		Laboratory Use Only Time Sensitive		Temperature (°C) on Recl 2/3/5		Custody Seal Present Intact		Yes No	
* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.														* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.							
** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.														SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM							



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