REPORT

March 13, 2015

FOUNDATION INVESTIGATION REPORT

CULVERT REPLACEMENTS, TOWNSHIP OF SHAWANAGA
HIGHWAY 7182 RECONSTRUCTION
FROM THE CARLING/SHAWANAGA TOWNSHIP BOUNDARY, NORTHERLY 7.3 KM
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5163-10-00

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Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (MH) on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for one embankment over swamp and two culverts as part of the reconstruction of Highway 7182 (Shebeshekong Road) in the Townships of Shawanaga. The proposed reconstruction of Highway 7182 extends from the boundary of the Township of Carling and Shawanaga northerly for 7.3 km. The locations of the embankment over swamp and proposed culvert replacements are shown on Drawing 1.

The original Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal, dated November 2012. Golder's proposal for foundation engineering services associated with the swamp crossing and culverts is contained in Section 6.8 of MH's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated June 18, 2013. The drawings showing the proposed swamp crossing and culvert alignments were provided to Golder by MH on December 17, 2014.

This report addresses the investigation carried out for the two culverts, both of which have been identified for potential replacement. The foundation investigation for the swamp crossing, which forms part of the Foundation assignment, is presented in a separate report.

The purpose of this investigation is to obtain subsurface information specific to the culvert locations by methods of borehole drilling, bedrock coring, in situ testing and laboratory testing on selected soil samples. The boreholes for these culverts were located in the field by Golder and were surveyed relative to stakes and/or nail pins installed by Tulloch Engineering (Tulloch), a professional surveying company retained by MH. The culvert locations and ground surface elevations at the investigation locations were also surveyed in the field by Tulloch.

2.0 SITE DESCRIPTION

The two existing culverts are located at approximately STA 10+443 and STA 11+290 on Highway 7182 in the Township of Shawanaga and the details (width, height, length, etc.) of which are summarized in Table 1, following the text of this report.

In general, the topography in the area of the overall project limits consists of rolling terrain, including densely treed areas and numerous bedrock outcrops separated by low-lying swamps containing areas of standing water and various types of vegetation and organic soils. The ground surface at the borehole and DCPT locations advanced within the limits of the study area, including through the existing Highway 7182 embankment, varies between Elevations 207.9 m and 205.0 m, referenced to Geodetic datum. Section 4.0 of this report presents a description of the topography in the vicinity of each culvert.

3.0 INVESTIGATION PROCEDURES

The fieldwork for the investigation associated with the two culverts in GWP 5163-10-00 was carried out between June 9 and 16, 2014 during which period a total of seven boreholes and seven Dynamic Cone Penetration Tests (DCPTs) were advanced at, or in the immediate vicinity of, the culvert alignments, as summarized in Table 1 and as shown on Drawings A1 and B1 in Appendices A and B, respectively.

The field investigation was carried out using a truck-mounted CME55 drill rig and portable equipment supplied and operated by Landcore Drilling of Sudbury, Ontario.

The boreholes were advanced through the overburden using 108 mm inside diameter hollow-stem augers, or NW casing with wash boring techniques. In general, soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm O.D. split-spoon sampler operated by an automatic hammer on the drill rig, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Boreholes advanced by portable equipment employed a full-weight hammer lifted manually and dropped from the SPT height. Rock coring to a depth of approximately 3 m beyond the augered/cased borehole was carried out using 'NQ' and 'BQ' core barrels for coring using a drill rig and portable equipment, respectively. All open boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (Wells), as amended.

The boreholes and DCPTs were advanced to depths generally penetrating about 3 m below the culvert invert, terminating on refusal to further auger, casing and/or split spoon advancement likely on, or in proximity to, the bedrock surface. The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets in Appendices A and B.

A sample of the creek water was obtained during the field investigation at the culvert locations, using appropriate sampling protocols and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of parameters. The results of the analytical testing are summarized in Table A1 and B1, included in Appendices A and B, respectively.

The fieldwork was observed by members of our engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples and rock core. The soil samples and rock core were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury geotechnical laboratory where the samples and core underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO Laboratory Standards and/or ASTM Standards, as appropriate. Classification testing (water content, organic content and grain size distribution) was carried out on selected soil samples. Selected samples of the bedrock core were tested for uniaxial compressive strength (UCS). The results of the laboratory testing are provided in Appendices A and B.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM, 2006)[1] while the strength of the bedrock core samples is based on Table 3.5 of CFEM, 2006. 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)[2] standard classification system.

Survey stakes and/or nail pins were installed by Tulloch at selected locations in the area of each culvert prior to the commencement of drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the applicable stakes and/or nail pins and were subsequently converted into MTM NAD 83 coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevations at applicable survey stakes and/or nail pins installed by Tulloch. The borehole locations given on the Record of Borehole sheets and shown on Drawing A1 and B1 are positioned relative to

[1] Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

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

MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and depths drilled are as follows:

Culvert Location	Borehole/DCPT	Location (m)		Ground Surface Elevation (m)	Depth of Borehole/DCPT (m)
		Northing	Easting		
STA 10+443	C1-01	5039724.8	246154.6	205.1	7.8
	C1-02	5039731.2	246164.1	206.9	9.3
	C1-03	5039745.4	246164.6	205.0	4.9 / 6.4
	C1-04	5039720.5	246163.6	205.2	6.3
	C1-DC01	5039721.5	246161.9	205.2	3.0
	C1-DC02	5039733.8	246157.8	206.9	9.1
	C1-DC03	5038743.4	246169.0	205.3	0.8
STA 11+290	C2-01	5040334.6	245640.1	206.7	4.4
	C2-02	5040329.8	245649.2	207.9	7.2
	C2-03	5040341.7	245657.0	206.9	3.6
	C2-DC01	5040327.6	245646.4	207.5	4.0
	C2-DC02A	5040335.3	245647.2	207.9	1.5
	C2-DC02B	5040336.2	245646.9	207.9	1.7
	C2-DC03	5040333.5	245659.8	206.7	0.9

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in The Physiography of Southern Ontario[3] , this section of Highway 7182 (formerly Highway 69) lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

This part of the Georgian Bay Fringe physiographic region was never submerged during periods of glacial recession. As a result, the surficial soils in this area consist of very shallow deposits of sand, silt and clay underlain by metamorphic bedrock; numerous bare knobs and ridges of bedrock are present throughout the area. Localized low-lying swampy areas, containing peat and/or organic soils underlain by soft/loose native soils, are present in valleys between the bedrock knobs and ridges.

The bedrock in the area consists typically of gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in Geology of Ontario, OGS Special Volume 4[4]. Deposition of Paleozoic strata and later erosion during glaciation exposed these Precambrian rocks.

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil and bedrock core

[3] 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.

[4] Geology of Ontario, 1991. Ontario Geological Society, Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.

samples, are presented on the Record of Borehole and Drillhole sheets and the laboratory test sheets in Appendices A and B. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and in situ testing and are approximate. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations.

In general, the stratigraphy encountered at the culvert locations is similar, however, the thickness of overburden ranges from 0.3 m to 6.3 m. The stratigraphy at the locations of the culverts generally consists of surficial layers of peat or topsoil, or of embankment fill, underlain by interlayers of native organic deposits, non-cohesive soil deposits and cohesive deposits over bedrock. A detailed description of the subsurface conditions at the culvert locations is provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit or stratum.

4.3 Culvert at STA 10+443

The plan and profile along the centreline of the culvert at STA 10+443 showing the borehole locations and interpreted stratigraphy are shown on Drawing A1. The height of the embankment at this location is about 1.9 m and the existing concrete box culvert is about 19.6 m long with dimensions of 2400 mm wide by 1200 mm high. A total of four boreholes and three DCPTs were completed to investigate the subsurface conditions at the culvert location: three boreholes (C1-01, C1-03 and C1-04) and two companion DCPTs (C1-DC01 and C1-DC03) were advanced near the ends of the culvert; and one borehole (C1-02) and one DCPT (C1-DC02) was advanced through the roadway embankment near the midpoint of the culvert. In addition, a DCPT was advanced immediately adjacent to Borehole C1-03 to confirm the depth to refusal recorded in the borehole. In general, the topography in the area of the culvert consists of low-lying swamp areas, bedrock outcrops and treed areas.

4.3.1 Embankment Fill

Asphalt and embankment fill were encountered in Borehole C1-02, advanced immediately adjacent to the culvert. A layer of asphalt 75 mm thick was encountered at ground surface at Elevation 206.9 m and is underlain by a 2.9 m thick deposit of embankment fill consisting of silty sand to sand and gravel. Cobbles are inferred to be present in the fill deposit in Borehole C1-02 below a depth of 2.3 m corresponding to Elevation 203.6 m.

The SPT ‘N’-values measured within the embankment fill range between 13 blows and 38 blows per 0.3 m of penetration indicating a compact to dense relative density.

The natural water content measured on one samples of the fill deposit is about 11 per cent.

The result of a grain size distribution test completed on one sample of the silty sand fill is shown on Figure A1 in Appendix A.

4.3.2 Peat (Upper Layer)

A deposit of brown to black amorphous peat was encountered at the ground surface in Boreholes C1-01, C1-03 and C1-04 between Elevations 205.2 m and 205.0 m. Sand seams approximately 0.75 m thick were

encountered in the peat deposit in Borehole C1-03 at a depth of 0.15 m, corresponding to Elevation 204.8 m. The thickness of this upper deposit of peat ranges from 0.5 m to 0.6 m.

The SPT 'N'-values measured within the peat range from 0 blows (weight of hammer) to 1 blow per 0.3 m of penetration suggesting a very soft consistency.

4.3.3 Sand (Interlayer)

An interlayer of brown to grey sand, trace silt, trace organics was encountered underlying the upper peat deposit in Boreholes C1-01, C1-03 and C1-04. The top of the deposit was encountered between Elevations 204.7 m and 204.4 m and the thickness of the interlayer ranges from 0.3 m to 0.6 m.

The SPT 'N'-value measured within the sand interlayer is 1 blow per 0.3 m of penetration indicating a very loose relative density.

The natural water content measured on two samples of the sand deposit range from about 39 per cent to about 56 per cent.

The results of the grain size distribution tests completed on two samples of the sand deposit are shown on Figure A2 in Appendix A.

4.3.4 Peat (Lower Layer)

A deposit of brown to black amorphous peat was encountered below the upper sand layer in Boreholes C1-01, C1-03 and C1-04 between Elevations 204.4 m and 203.9 m, and below the granular fill deposit in Borehole C1-02 at Elevation 203.9 m. The thickness of the deposit ranges from 0.4 m to 1.6 m.

The SPT 'N'-values measured within the organic sand range from 0 blows (weight of hammer) to 2 blows per 0.3 m of penetration suggesting a very soft consistency.

The natural water content measured on two samples of the organic sand range from about 488 per cent and about 611 per cent.

4.3.5 Organic Silt and Clayey Silt

A deposit of brown to grey organic silt and clayey silt was encountered below the lower peat deposit. A deposit of organic silt was encountered in Boreholes C1-01 and C1-03 at Elevations 202.8 m and 203.5 m and the thickness of the deposit is 0.8 m in both boreholes. A clayey silt deposit was encountered in Boreholes C1-02 and C1-04 at Elevations 203.1 m and 202.8 m and the thickness of the deposit is 1.5 m and 0.4 m in the respective boreholes.

The SPT 'N'-values measured within the organic silt are 0 blows (weight of hammer) per 0.3 m of penetration suggesting a very soft consistency. The SPT 'N'-values measured within the clayey silt range from 0 blows (weight of hammer) to 1 blow per 0.3 m of penetration suggesting a very soft consistency. Two in situ field vane tests carried out within the clayey silt measured undrained shear strengths of 14.4 kPa and 16.3 kPa, and a sensitivity of 3. The results of the field vane tests indicate that the clayey silt has a soft consistency.

The natural water content measured on two samples of the organic silt is about 183 per cent and 27 per cent. The natural water content measured on two samples of the clayey silt deposit is about 31 per cent and 43 per cent.

An Atterberg limits test carried out on one sample of the organic silt yielded a liquid limit of about 157 per cent and a plastic limit of about 67 per cent, corresponding to a plastic index of about 90 per cent. Atterberg limits tests carried out on two samples of the clayey silt yielded liquid limits of about 23 per cent and about 24 per cent and plastic limits of about 16 per cent and about 15 per cent, corresponding to plastic indices of about 7 per cent and about 9 per cent, respectively. The results of the Atterberg limits tests are shown on the plasticity chart in Figure A3 in Appendix A, and indicate that the material is classified as organic silt of high plasticity and clayey silt of low plasticity, respectively.

The organic content measured on one sample of the organic silt is about 11 per cent.

4.3.6 Silt and Sand to Gravelly Sand

A deposit of brown to grey silt and sand, silty sand to sand, to gravelly sand was encountered below the organic silt to clayey silt deposits in Boreholes C1-01 to C1-04. The top of the deposit was encountered between Elevations 202.7 m and 201.6 m and the thickness of the deposit ranges from 0.3 m to 2.5 m. Cobbles are inferred to be present in Borehole C1-02 in the gravelly sand deposit below a depth of 2.3 m, corresponding to Elevation 204.6 m.

The SPT 'N'-values measured within the deposit typically range from 4 blows to 7 blows per 0.3 m of penetration indicating a loose relative density. The SPT 'N'-value measured within the gravelly sand deposit in Borehole C1-02 is 13 blows for 0.15 m inferred to be on cobbles as the split-spoon was observed to be bouncing.

The natural water content measured on three samples of the deposit ranged from about 19 per cent to 30 per cent.

The result of the grain size distribution tests completed on a sample of the silt and sand and a sample of the gravelly sand are shown on Figures A4 and A5, respectively, in Appendix A.

4.3.7 Silty Clay to Clay

A deposit of grey silty clay to clay was encountered below the non-cohesive deposit in Boreholes C1-01 and C1-03 at Elevations 205.1 m and 205.0 m and the thickness of the deposit is 2.2 m to 0.8 m in the respective boreholes.

The SPT 'N'-values measured within the deposit are 0 blows (weight of hammer) and 1 blow per 0.3 m of penetration with an SPT 'N'-values of 6 blows per 0.15 m of penetration at the bottom of Borehole C1-01, however, the split-spoon was observed to be bouncing. Two in situ field vane tests carried out within the silty clay to clay deposit measured undrained shear strengths are about 13 kPa and 19 kPa, and the sensitivity is 3 and 5. The results of the field vane tests indicate that the silty clay to clay has a soft consistency.

The natural water content measured on two samples of the clay to silty clay deposit was about 46 per cent and 81 per cent.

Atterberg limits tests carried out on two samples of the cohesive deposit yielded liquid limits of about 52 per cent and 35 per cent, plastic limits of about 24 per cent and 15 per cent and corresponding plastic indexes of about 28 per cent and about 20 per cent. The results of the Atterberg limits tests are shown on the plasticity chart in Figure A6 in Appendix A, and indicate that the material is classified as silty clay of intermediate plasticity and clay of high plasticity, respectively.

4.3.8 Refusal / Bedrock

Refusal to casing and split-spoon advancement in Borehole C1-01 and C1-03 and to further DCPT penetration adjacent to Boreholes C1-03 and DCPTs C1-DC01 to C1-DC03 was encountered at depths ranging from 0.8 m to 9.1 m below ground surface, ranging from Elevations 204.5 m to 197.3 m.

Bedrock was encountered in Boreholes C1-02 and C1-04 at Elevations 200.6 m and 202.1 m and core samples 3.0 m and 3.2 m long were obtained, respectively. Based on a review of the bedrock core samples, the bedrock consists of fine to coarse grained, fresh, dark grey to grey granitic gneiss.

The Total Core Recovery (TCR) for the core samples ranges from 94 per cent to 100 per cent and the Solid Core Recovery (SCR) ranges from 58 per cent to 97 per cent. The Rock Quality Designation (RQD) measured on the recovered bedrock core samples ranges between 53 per cent and 96 per cent, with values typically greater than 85 per cent, indicating the rock is typically of good to excellent quality, according to Table 3.10 in CFEM (2006)[1].

One Unconfined Compression (UC) test (ASTM D7012[5]) was carried out on one core sample of the granitic gneiss bedrock obtained in Borehole C1-04 and measured a Uniaxial Compressive Strength (UCS) value of about 113 MPa, as detailed in Table A2. Based on the laboratory UC test, in accordance with Table 3.5 in CFEM (2006)[1], the gneiss bedrock is classified as very strong (R5, 100 MPa < UCS < 250 MPa).

4.3.9 Groundwater Conditions

The water level was measured in Boreholes C1-01 to C1-04 upon completion of drilling operations at depths between 0.3 m and 3.1 m below ground surface, ranging from Elevations 204.8 m to 203.8 m. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

4.4 Culvert at STA 11+290

The plan and profile along the centreline of the culvert at STA 11+290 showing the borehole locations and interpreted stratigraphy are shown on Drawing B1. The height of the embankment at this location is about 1.2 m and the two existing corrugated steel pipe (CSP) culverts have a diameter of 910 mm and are about 11.9 m and 12.0 m long. A total of three boreholes and four DCPTs were completed to investigate the subsurface conditions at the culvert location: two boreholes (C2-01 and C2-03) and two companion DCPTs (C2-DC01 and C2-DC03) were advanced near the ends of the culvert; and one borehole (C2-02) and two DCPTs (C2-DC02A and C2-DC02B) were advanced through the roadway embankment near the midpoint of the culvert. In general, the topography in the area of the culvert consists of low-lying and swamp areas, bedrock outcrops and treed areas.

[5] ASTM D7012 - Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens.

4.4.1 Embankment Fill

Asphalt and embankment fill were encountered in Borehole C2-02, advanced immediately adjacent to the culvert. A layer of asphalt 75 mm thick was encountered at ground surface at Elevation 207.9 m and is underlain by a 2.2 m thick deposit of embankment fill comprised of sand and gravel.

The SPT 'N'-values measured within the embankment fill range between 13 blows and 55 blows per 0.3 m of penetration indicating a compact to very dense relative density.

The natural water content measured on one samples of the fill deposit is about 2 per cent.

The results of a grain size distribution test completed on one sample of the embankment fill are shown on Figure B1 in Appendix B.

4.4.2 Topsoil / Peat

A 0.3 m and 0.2 m thick layer of topsoil and peat, respectively, was encountered from ground surface at Boreholes C2-01 and C2-03 drilled near the ends of the culverts.

4.4.3 Clayey Silt to Silty Clay (Upper Deposit)

A 0.5 m to 0.1 m thick upper deposit of clayey silt and silty clay was encountered below the topsoil/peat in Boreholes C2-01 and C2-03, respectively, at Elevations 206.4 m and 206.7 m.

A SPT 'N'-value measured within the clayey silt layer is 3 blows per 0.3 m of penetration indicating a soft consistency.

The natural water content and the organic content measured on a sample of the clayey silt layer is about 20 per cent and about 2 per cent, respectively.

An Atterberg limits test carried out on one sample of the clayey silt yielded a liquid limit of about 25 per cent and a plastic limit of about 16 per cent, corresponding to a plastic index of about 9 per cent. The results of the Atterberg limits tests are shown on the plasticity chart in Figure B2 in Appendix B, and indicate that the material is classified as clayey silt of low plasticity.

4.4.4 Silt and Sand to Sand

A 0.5 m and 0.7 m thick deposit of grey silt and sand to sand was encountered underlying the clayey silt in Borehole C2-01 and below the embankment fill in Borehole C2-02 at Elevations 205.9 m and 205.6 m, respectively.

The SPT 'N'-value measured within the silt and sand deposit is 20 blows per 0.3 m of penetration. A SPT 'N'-value of 8 blows and per 0.15 m of penetration was recorded in Borehole C2-01 where it was observed that the split-spoon was bouncing on inferred cobbles.

The natural water content of two samples of the sand deposit is about 21 per cent and 26 per cent.

The result of a grain size distribution test on a sample of the silt and sand deposit is shown on Figure B3, in Appendix B.

4.4.5 Clayey Silt (Lower Deposit)

A lower deposit of grey clayey silt was encountered underlying the silt and sand to sand deposit in Borehole C2-02. The top of the deposit was encountered at Elevation 204.9 m and the thickness of the deposit is 0.8 m.

The SPT 'N'-value measured within the clayey silt deposit is 4 blow per 0.3 m of penetration. An in situ field vane test carried out within the cohesive deposit measured an undrained shear strength of about 48 kPa, and a sensitivity of 4. The result of the field vane test indicates that the clayey silt has a firm consistency.

The natural water content measured on a sample of the clayey silt deposit is about 38 per cent.

An Atterberg limits test carried out on one sample of the cohesive deposit yielded a liquid limit of about 23 per cent and a plastic limit of about 15 per cent, corresponding to a plastic index of about 8 per cent. The result of the Atterberg limits test is shown on the plasticity chart in Figure B4 in Appendix B, and indicates that the material is classified as clayey silt of low plasticity.

4.4.6 Silty Sand

A layer of silty sand was encountered underlying the clayey silt deposit in Boreholes C2-02. The top of the deposit was encountered at Elevation 204.1 m and the thickness of the deposit is 0.2 m.

The SPT 'N'-value measured at the interface of the bedrock is 4 blows per 0.15 m of penetration.

The natural water content measured on one sample of the silty sand is about 20 per cent.

4.4.7 Refusal / Bedrock

Refusal to further penetration was encountered in DCPTs C2-DC01, C2-DC02A, C2-DC02B and C2-DC03 at depths between 0.9 m and 4.0 m below ground surface ranging from Elevations 206.4 m to 203.5 m.

Bedrock was encountered in Boreholes C2-01 to C2-03 at between Elevations 206.6 m and 203.9 m and core samples between 3.1 m and 3.3 m long were obtained. Based on a review of the bedrock core samples, the bedrock consists of very fine to medium grained, fresh, grey-black to pinkish grey gneiss.

The Total Core Recovery (TCR) for the core samples is 100 per cent and the Solid Core Recovery (SCR) ranges from 89 per cent to 100 per cent. The Rock Quality Designation (RQD) measured on the recovered bedrock core samples ranges between 66 per cent and 100 per cent, with values typically greater than 89 per cent, indicating the rock is of fair to excellent quality, according to Table 3.10 in CFEM (2006)[1].

One Unconfined Compression (UC) test (ASTM D7012[5]) was carried out on one core sample of the granitic gneiss bedrock obtained in Borehole C2-03 and measured a Uniaxial Compressive Strength (UCS) value of about 131 MPa, as detailed in Table B2. Based on the laboratory UC test, in accordance with Table 3.5 in CFEM (2006)[1], the gneiss bedrock is classified as very strong (R5, 100 MPa < UCS < 250 MPa).

4.4.8 Groundwater Conditions

The water level was measured in the open Boreholes C2-01 and C2-02 upon completion of drilling operations at depths of 0.2 m and 1.7 m below ground surface, corresponding to Elevations 206.5 m and 206.2 m, respectively. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

5.0 CLOSURE

Messr. Indulis Dumpis and Gabriel Mathieu, senior technicians with Golder, directed the drilling program. This report was prepared by Ms. Madison Kennedy, B.A.Sc. and reviewed by Mr. Christopher Ng, P.Eng., an Associate of Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, carried out a quality control review of the report.

Report Signature Page

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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.

ASTM International:

ASTM D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D7012	Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Ontario Water Resources Act:

Ontario Regulation Amendment to Ontario Regulation 903

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance; N_d:

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

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

Piezo-Cone Penetration Test (CPT)

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

III. SOIL DESCRIPTION

(a) Non-Cohesive Soils

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

(b) Cohesive Soils

Consistency

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

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

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

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

JN Joint
FLT Fault
SH Shear
VN Vein
FR Fracture
SY Stylolite
BD Bedding
FO Foliation
CO Contact
AXJ Axial Joint
KV Karstic Void
MB Mechanical Break

PL Planar
CU Curved
UN Undulating
IR Irregular
K Slickensided
PO Polished
SM Smooth
SR Slightly Rough
RO Rough
VR Very Rough

TABLES

Table 1: Summary of Culvert Details

Culvert Location (Township)	Culvert ID	Approximate Height of Embankment [1]	Existing Culvert			Approximate Invert Elevation [2]		Boreholes	Dynamic Cone Penetration Tests	Reference Appendix
			Type	Approximate Dimension	Approximate Length	North End of Culvert	South End of Culvert			
STA 10+443 (Shawanaga)	C1	1.9 m	Concrete Box	2.4 m wide by 1.2 m high	19.6 m	204.9 m	204.5 m	4 Boreholes (C1-01 to C1-04)	3 DCPTs (C1-DC01 to C1-DC03)	A
STA 11+290 (Shawanaga) [3]	C2	1.2 m	CSP Culverts	910 mm diameter	11.9 m / 12.0 m	205.7 m / 206.0 m	205.8 m / 206.1 m	3 Boreholes (C2-01 to C2-03)	4 DCPTs (C2-DC01, C2-DC02A, C2-DC02B and C2-DC03)	B

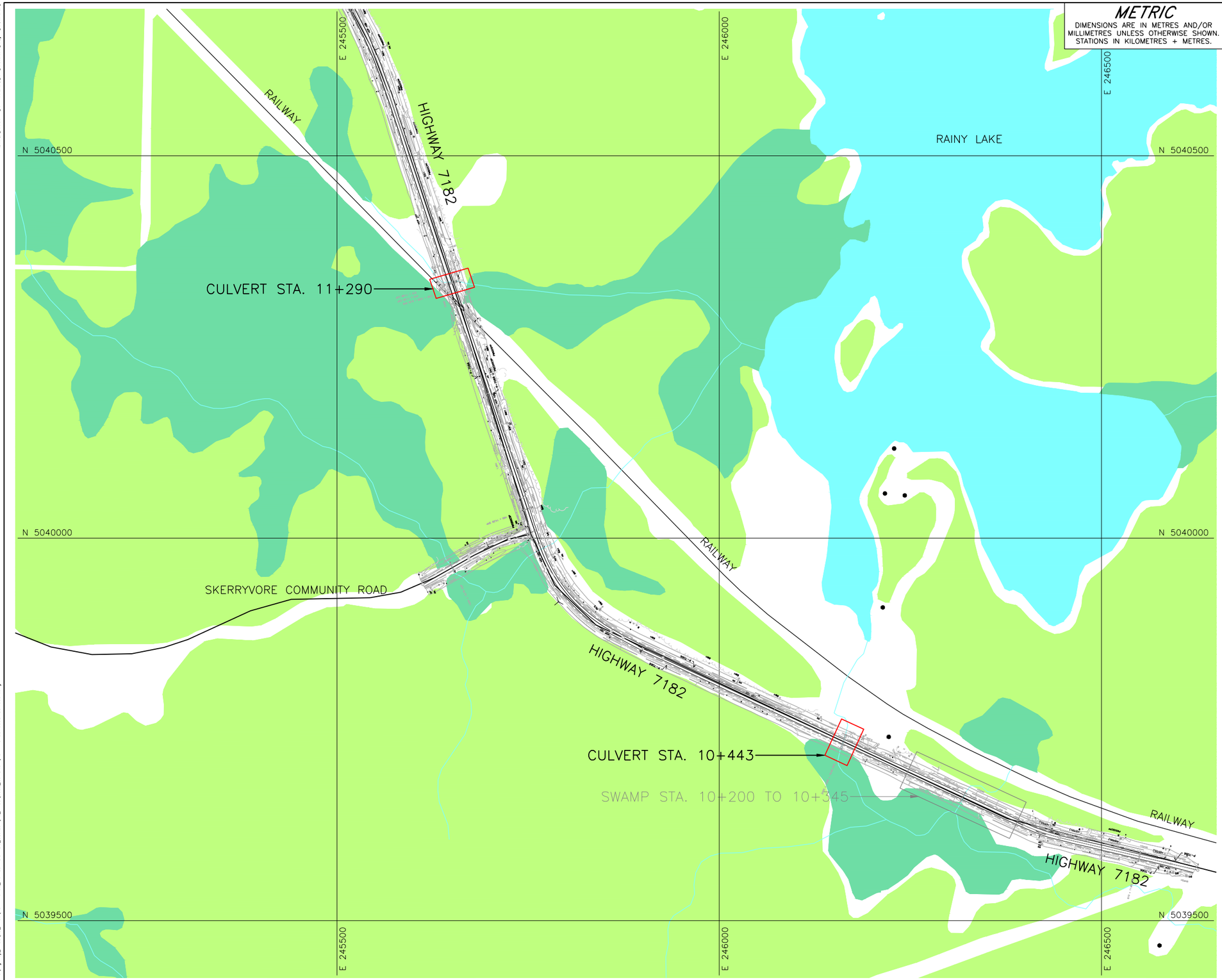
Notes: 1. Embankment height is relative to existing ground surface level at the toe of embankment adjacent to the culvert.

2. Culvert invert elevations are estimated based on the top of culvert surveys and culvert dimensions provided by MH.

3. At STA. 11+290 the existing culvert structure consists of two parallel CSP culverts.

DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO



METRIC

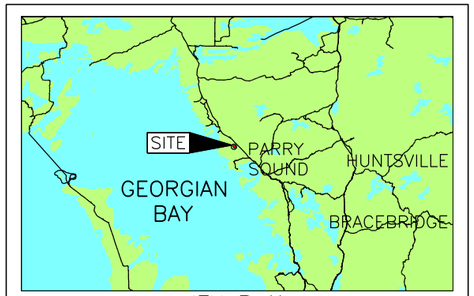
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5163-10-00

HIGHWAY 7182
CULVERT STA. 10+443 AND 11+290
INDEX PLAN

SHEET

Golder Associates



KEY PLAN
SCALE
40 0 40 80 km

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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans, profile and topographic data provided in digital format by Morrison Hershfield, drawing file nos. bc04537182001.dwg and Alignment-profile.dwg, dated Dec., 2013, received Dec. 17, 2014

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41H-148

HWY. 7182		PROJECT NO. 12-1111-0102	DIST. .
SUBM'D. CN	CHKD. MCK	DATE: 3/13/2015	SITE: .
DRAWN: MR	CHKD. CN	APPD. JMAC	DWG. 1

PLOT DATE: March 13, 2015
FILENAME: S:\Clients\MTO\Highway_7182\09_PROJ\12111102_MorrisonHershfield_Geotech\40_PROD\0002_Culvert\12111102-0002-BC-0001.dwg

APPENDIX A

Culvert at STA 10+443 – Highway 7182 – Township of Shawanaga

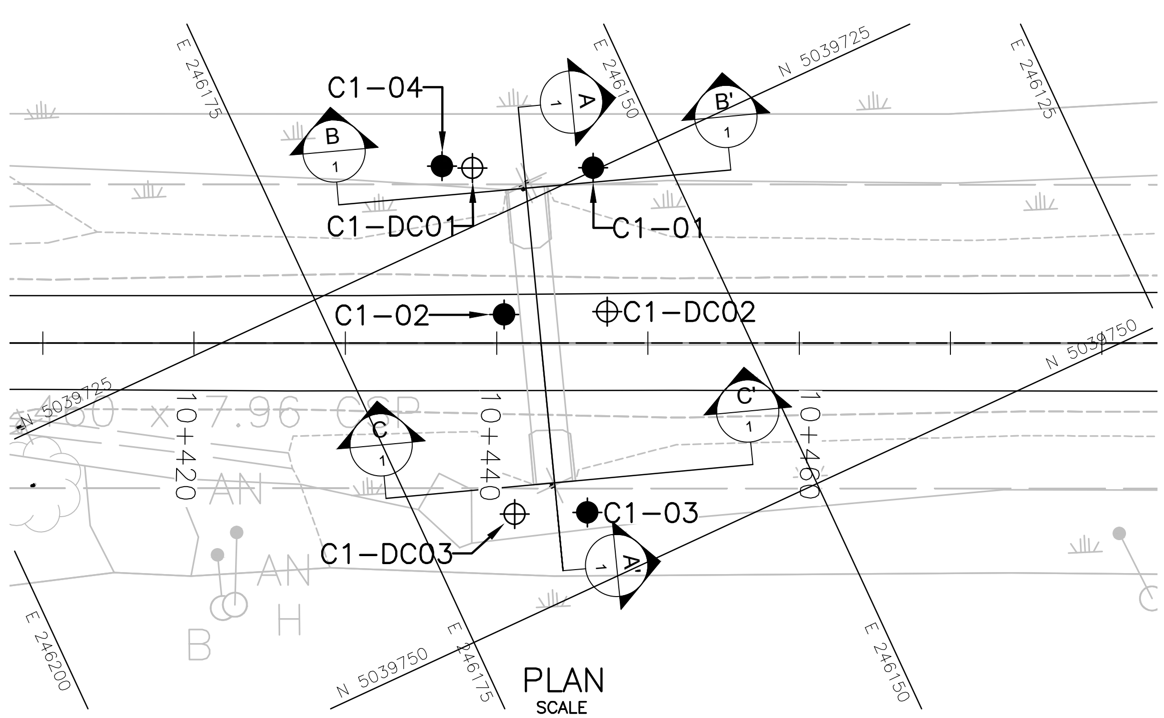
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5163-10-00

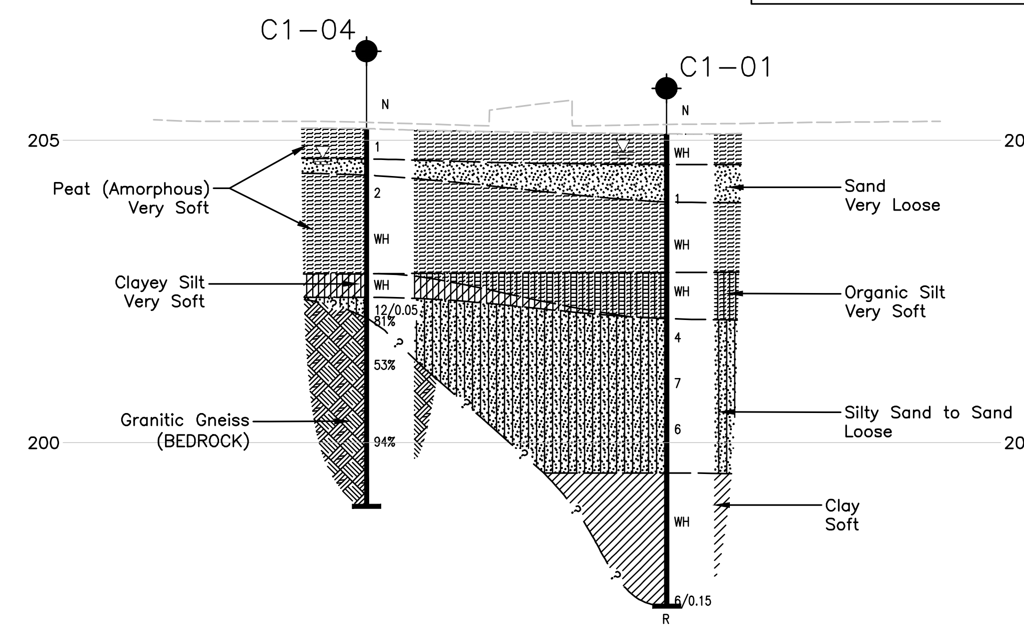
HIGHWAY 7182
CULVERT STA. 10+443 (SBL AND NBL)
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

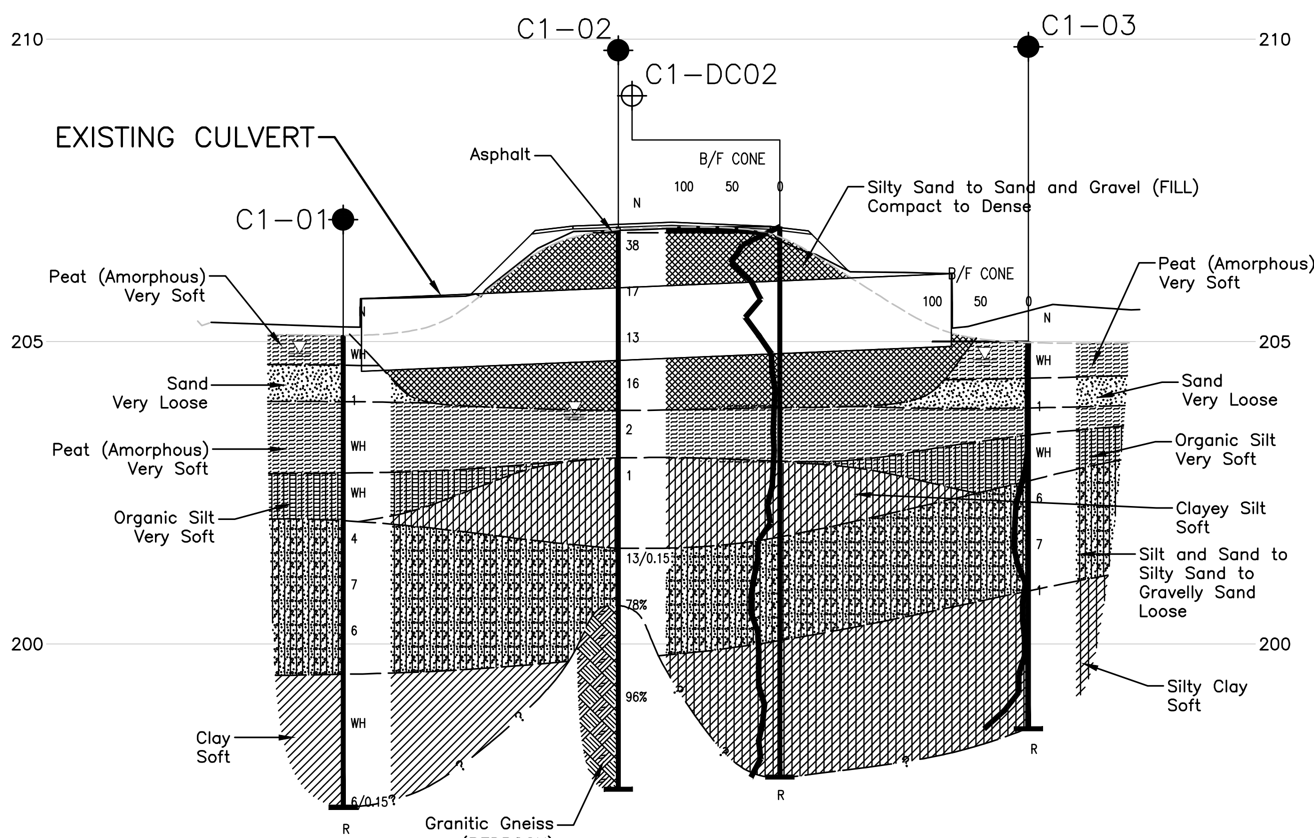
Golder Associates



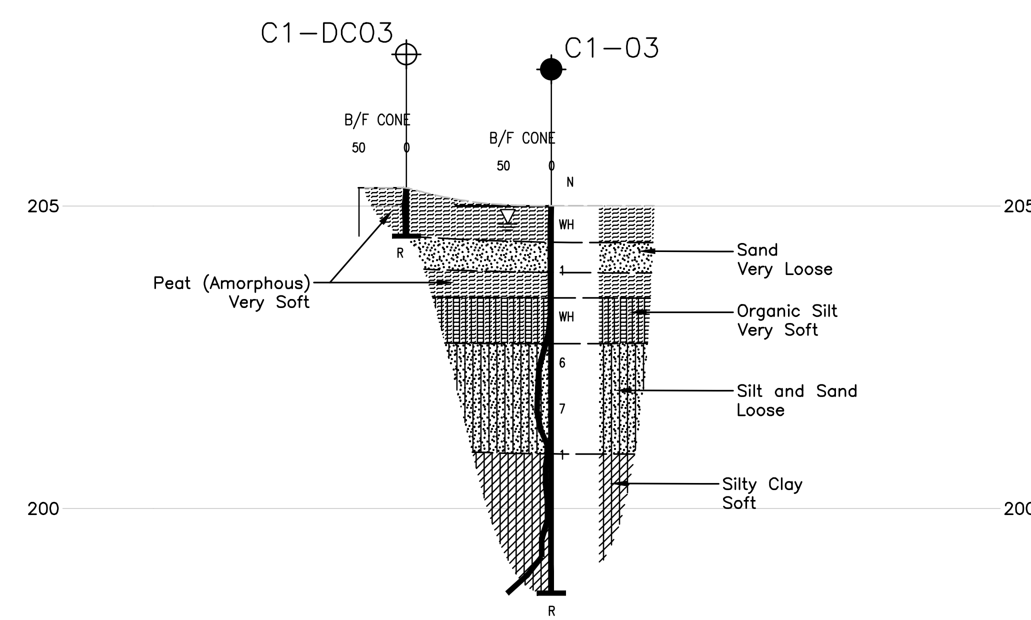
PLAN
SCALE
5 0 5 10 m



B-B' / A1 CROSS-SECTION B-B'



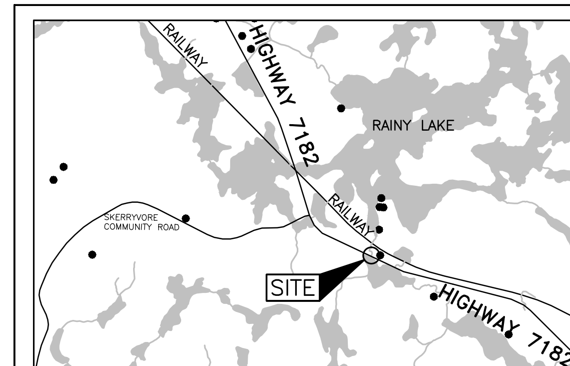
A-A' / A1 CULVERT STA. 10+433
SECTION A-A'



C-C' / A1 CROSS-SECTION C-C'

HORIZONTAL SCALE
2.5 0 2.5 5 m

VERTICAL SCALE
1.25 0 1.25 2.5 m



KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Dynamic Cone Penetration Test
- 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
- R — Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
C1-01	205.1	5039724.8	246154.6
C1-02	206.9	5039731.2	246164.1
C1-03	205.0	5039745.4	246164.6
C1-04	205.2	5039720.5	246163.6
C1-DC01	205.2	5039721.5	246161.9
C1-DC02	206.9	5039733.8	246157.8
C1-DC03	205.3	5039743.4	246169.0

NOTES

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The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans and topographic data provided in digital format by Morrison Hershfield, drawing file nos. bc04537182001.dwg and Alignment-profile.dwg, dated Dec., 2013, received Dec. 17, 2014.
Cross-Section provided in digital format by Morrison Hershfield, drawing file no. Culver x-secs.dwg, received Sept. 30, 2014.

LICENSED PROFESSIONAL ENGINEER C.C. NG 100086170 Mar. 13, 2015 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Mar. 13, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	

Geocres No. 41H-148

HWY. 7182	PROJECT NO. 12-1111-0102		DIST.
SUBM'D. CN	CHKD. MCK	DATE: 1/30/2015	SITE:
DRAWN: MR	CHKD. CN	APPD. JMAC	DWG. A1

Golder Associates

RECORD OF BOREHOLE No C1-01

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0102

G.W.P. 5163-10-00 LOCATION N 5039724.8 ;E 246154.6 ORIGINATED BY GM

DIST HWY 7182 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY DAM

DATUM Geodetic DATE June 9, 2014 CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
205.1	GROUND SURFACE						205				
0.0 / 204.6	PEAT (Amorphous) Very soft Brown Moist to wet		1	SS	WH	▽					
0.5 / 204.0	SAND, trace silt, trace organics Very loose Grey Wet		2A 2B	SS	1		204				0 98 (2)
1.1 / 202.8	PEAT (Amorphous) Very soft Black Wet		3	SS	WH		203		611		
2.3 / 202.1	ORGANIC SILT Very soft Grey Wet		4A 4B	SS	WH		202		157 183 OC=11.3%		
3.1 / 199.5	Silty SAND Loose Grey Wet		5	SS	4		201				
			6	SS	7		200				
			7	SS	6		199				
5.6 / 197.3	CLAY Soft Brown Wet		8	SS	WH		198	+ 3	81		
			9	SS	6/0.15						
7.8	END OF BOREHOLE CASING AND SPOON REFUSAL (HAMMER BOUNCING)										

NOTE:

1. Water level in open borehole measured at a depth of 0.3 m below ground surface (Elev. 204.8 m) upon completion of drilling.

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

GTA-MTO 001 S:\CLIENTS\MTO\HIGHWAY_7182\02_DATA\GINT\1211110102.GPJ GAL-GTA.GDT 03/12/15 TB

Golder Associates

RECORD OF BOREHOLE No C1-02

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0102
G.W.P. 5163-10-00
LOCATION N 5039731.2 ;E 246164.1
ORIGINATED BY ID
DIST HWY 7182
BOREHOLE TYPE 108 mm I.D. Hollow Stem Auger
COMPILED BY DAM
DATUM Geodetic
DATE June 9, 2014
CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.9	GROUND SURFACE										
0.0	ASPHALT (75 mm)										
0.1	Silty sand, some gravel to sand and gravel, trace to some silt (FILL) Compact to dense Brown to grey Moist		1	SS	38		206				
			2	SS	17						
			3	SS	13		205		○		18 56 (26)
	Auger grinding below a depth of 2.3 m (cobbles inferred).		4	SS	16		204				
203.9						▽					
3.0	PEAT (Amorphous) Very soft Black Wet		5	SS	2						
203.1							203		H ○		
3.8	CLAYEY SILT Soft Grey Wet		6	SS	1			3 + 3			
201.6							202				
5.3	Gravelly SAND, some silt, trace clay Grey Wet		7	SS	*13/0.15		201		○		28 47 20 5
200.6											
6.3	Auger grinding below a depth of 5.3 m (cobbles inferred). Granitic Gneiss (BEDROCK)		1	RC	REC 100%		200				RQD = 78%
	Bedrock cored from depths of 6.3 m to 9.3 m. For bedrock coring details refer to Record of Drillhole C1-02.						199				
			2	RC	REC 100%						RQD = 96%
197.6							198				
9.3	END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 3.1 m below ground surface (Elev. 203.8 m) upon completion of drilling. * Split-Spoon Bouncing										

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

PROJECT: 12-1111-0102

RECORD OF DRILLHOLE: C1-02

SHEET 1 OF 1

LOCATION: N 5039731.2 ;E 246164.1

DRILLING DATE: June 9, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Truck Mount

DRILLING CONTRACTOR: LANDCORE DRILLING

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

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole C1-02		200.60																
7	NQ Coring; Double-Tube Sampling	Fresh, foliated, grey, medium to coarse crystalline, faintly to moderately porous, strong to very strong GRANITIC GNEISS		6.30	1	GREY 100%							JN,IR,RO JN,IR,RO JN,IR,RO JN,IR,RO JN,IR,RO JN,IR,RO JN,IR,RO							
8					2	GREY 100%							JN,IR,RO JN,IR,RO							
9				197.60									JN,IR,RO							
		END OF DRILLHOLE		9.30																
10																				
11																				
12																				
13																				
14																				
15																				
16																				

DEPTH SCALE

1 : 50

LOGGED: ID

CHECKED: CN

Golder Associates

GTA-RCK 018 S:\CLIENTS\MTO\HIGHWAY_7182\02_DATA\GINT\1211110102.GPJ GAL-MISS.GDT 03/12/15 TB

Golder Associates

RECORD OF BOREHOLE No C1-03

SHEET 1 OF 1 **METRIC**

PROJECT 12-1111-0102
G.W.P. 5163-10-00 LOCATION N 5039745.4 ;E 246164.6 ORIGINATED BY GM
DIST HWY 7182 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY DAM
DATUM Geodetic DATE June 12, 2014 CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
205.0	GROUND SURFACE										
0.0 / 204.4	PEAT (Amorphous), some sand Very soft Black Wet		1	SS	WH	▽					
0.6 / 203.9	Approximately 75 mm thick sand seam encountered at a depth of 0.15 m.		2A 2B	SS	1		204				0 97 (3)
1.1 / 203.5	SAND, trace silt, trace organics Very loose Brown Wet		3	SS	WH		203		210.4		
1.5 / 202.7	PEAT (Amorphous), some sand Very soft Brown Wet		4	SS	6		202				0 47 51 2
2.3	ORGANIC SILT, trace to some clay, trace sand Very soft Brown Wet		5	SS	7						
200.9 / 4.1	SILT and SAND, trace clay Loose Grey Wet		6A 6B	SS	1		201				
200.1 / 4.9	SILTY CLAY, tace sand Soft Grey Wet						200	5			
198.6	END OF BOREHOLE CASING REFUSAL (HAMMER BOUNCING)						199				
6.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

NOTES:

1. Water level in open borehole measured at a depth of 0.3 m below ground surface (Elev. 204.7 m) upon completion of drilling.

2. A Dynamic Cone Penetration Test was advanced 2.0 m East of Borehole C1-03.

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

Golder Associates

RECORD OF BOREHOLE No C1-04

SHEET 1 OF 1 **METRIC**

PROJECT 12-1111-0102
G.W.P. 5163-10-00 LOCATION N 5039720.5 ;E 246163.6 ORIGINATED BY GM
DIST HWY 7182 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY MT
DATUM Geodetic DATE June 12, 2014 CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
205.2	GROUND SURFACE										
0.0 / 204.7	PEAT (Amorphous) Very soft Black to brown Moist		1	SS	1	▽	205				
0.8	SAND, trace organics Brown Moist		2	SS	2						
	PEAT (Amorphous), trace sand Very soft Black Wet		3	SS	WH		204		488 ○		
202.8							203				
202.4	CLAYEY SILT Very soft Grey		4	SS	WH				⊢ ○		
202.1	Wet		5	SS	~~12/0.05~~				○		
3.1	SAND, some silt Brown Wet		1	RC	REC 100%		202				RQD = 81%
	Granitic Gneiss (BEDROCK) Bedrock cored from depths of 3.1 m to 6.3 m. For bedrock coring details refer to Record of Drillhole C1-04.		2	RC	REC 94%		201				RQD = 53%
			3	RC	REC 100%		200				RQD = 94%
198.9							199				
6.3	END OF BOREHOLE										

NOTE:

1. Water level in open borehole measured at a depth of 0.5 m below ground surface (Elev. 204.7 m) upon completion of drilling.

* Split-Spoon Bouncing

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

PROJECT: 12-1111-0102

RECORD OF DRILLHOLE: C1-04

SHEET 1 OF 1

LOCATION: N 5039720.5 ;E 246163.6

DRILLING DATE: June 12, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Tripod

DRILLING CONTRACTOR: LANDCORE DRILLING

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

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole C1-04		202.10																
4	BQ Thin-walled Coring; Double-Tube Sampling	Fresh, foliated, grey, medium to coarse crystalline, faintly to moderately porous, strong to very strong GRANITIC GNEISS		3.10	1	GREY 100							JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO							
5					2	GREY 100							JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO; JN,IR,RO						UCS = 113 MPa
6					3	GREY 100							JN,IR,RO							
				198.90																
		END OF DRILLHOLE		6.30																
7																				
8																				
9																				
10																				
11																				
12																				
13																				

DEPTH SCALE
1 : 50

LOGGED: GM
CHECKED: CN

Golder Associates

GTA-RCK 018 S:\CLIENTS\MTO\HIGHWAY_7182\02_DATA\GINT\1211110102.GPJ GAL-MISS.GDT 03/12/15 TB

Golder Associates

RECORD OF DCPT No C1-DC01

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0102

G.W.P. 5163-10-00 LOCATION N 5039721.5 ;E 246161.9 ORIGINATED BY GM

DIST HWY 7182 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY TB

DATUM Geodetic DATE June 9, 2014 CHECKED BY DAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
205.2	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						205				
							204				
							203				
202.2											
3.0	END OF DCPT Refusal to Further Penetration (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No C1-DC02

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0102

G.W.P. 5163-10-00 LOCATION N 5039733.8 ;E 246157.8 ORIGINATED BY ID

DIST HWY 7182 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY TB

DATUM Geodetic DATE June 9, 2014 CHECKED BY DAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
206.9 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						206				
							205				
							204				
							203				
							202				
							201				
							200				
							199				
197.8							198				
9.1	END OF DCPT Refusal to Further Penetration (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No C1-DC03

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0102

G.W.P. 5163-10-00 LOCATION N 5039743.4 ;E 246169.0 ORIGINATED BY GM

DIST HWY 7182 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY TB

DATUM Geodetic DATE June 12, 2014 CHECKED BY DAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
205.3	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						205				
204.5											
0.8	END OF DCPT Refusal to Further Penetration (HAMMER BOUNCING)										

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

Table A1: Summary of Analytical Testing of Surface Water

Culvert Location Highway 7182 (Township)	Parameter (Units, Detection Limit)				
	Chloride (mg/L, 1)	Sulfate (mg/L, 1)	Conductivity (µS/cm, 1.0)	Resistivity (Ω-cm)	pH
STA 10+443 (Shawanaga Township)	38	1	150	6,600	6.87

Notes: 1. Samples obtained June 16, 2014
2. Analytical testing carried out by Maxxam Analytics.

Prepared by: MCK
Checked by: CN
Reviewed by: JMAC

Golder Associates Ltd.

1010 Lorne Street
Sudbury, Ontario, Canada P3C 4R9
Telephone: (705) 524-6861
Fax: (705) 524-1984

TABLE A2 - SUMMARY OF ROCK CORE TEST DATA

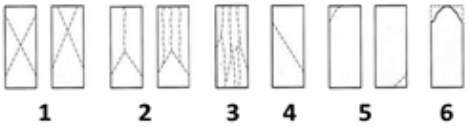
PROJECT NO.: **12-1111-0102**

JOB NAME: **Culvert at Station 10+443 - Highway 7182/Shawanaga**

TYPE OF UNIT: **Bedrock Core**

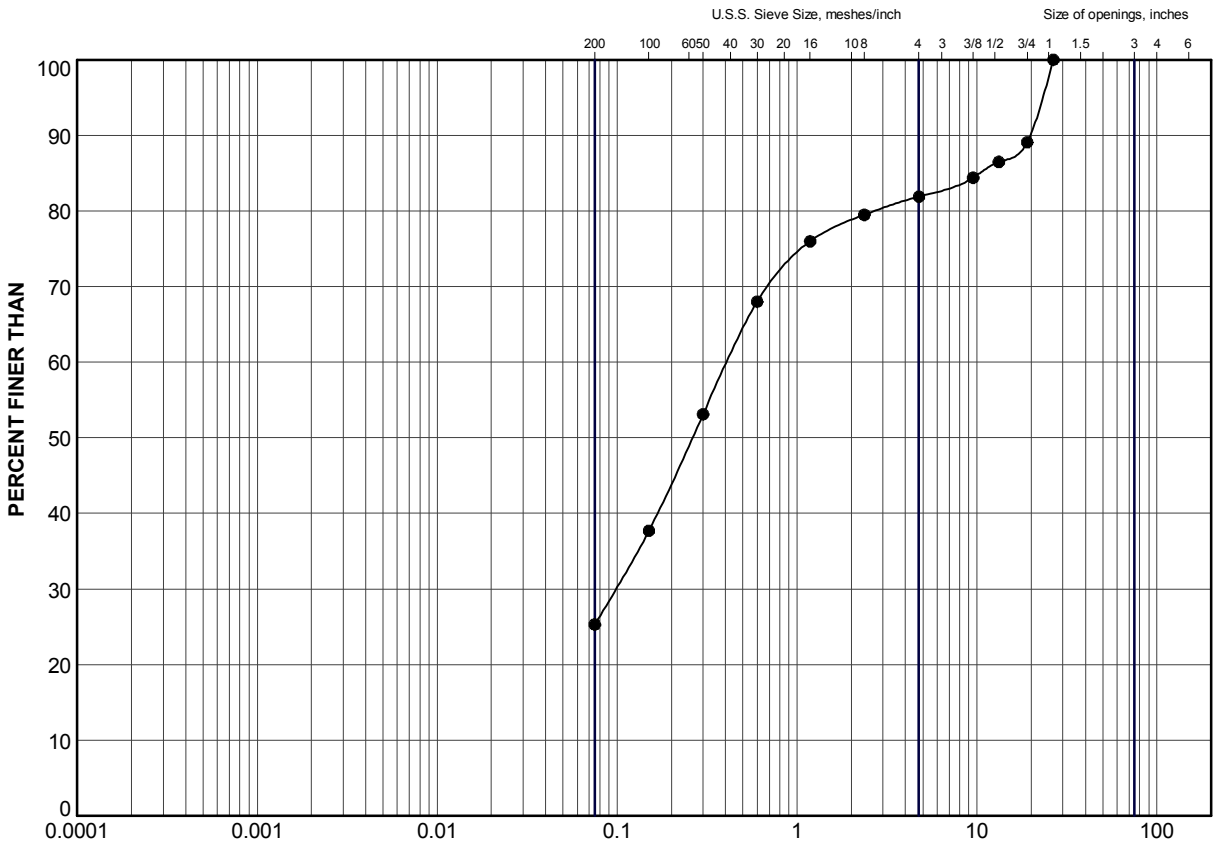
GOLDER LAB NUMBER	**G0732**
BOREHOLE	**C1-04**
DATE TESTED	**Aug. 12, 2014**
DEPTH OF TESTED CORE (m)	4.9
LENGTH AS CUT (mm)	90.0
DIAMETER (mm)	42.6
DENSITY (kg/m3)	2778
UNIAXIAL COMPRESSIVE STRENGTH (MPa)	**112.5**
TYPE OF FRACTURE	**2**

Type of Fracture



Tested by: SA

Reviewed by: CN



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-02	3	205.1

PROJECT

HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 10+443

TITLE

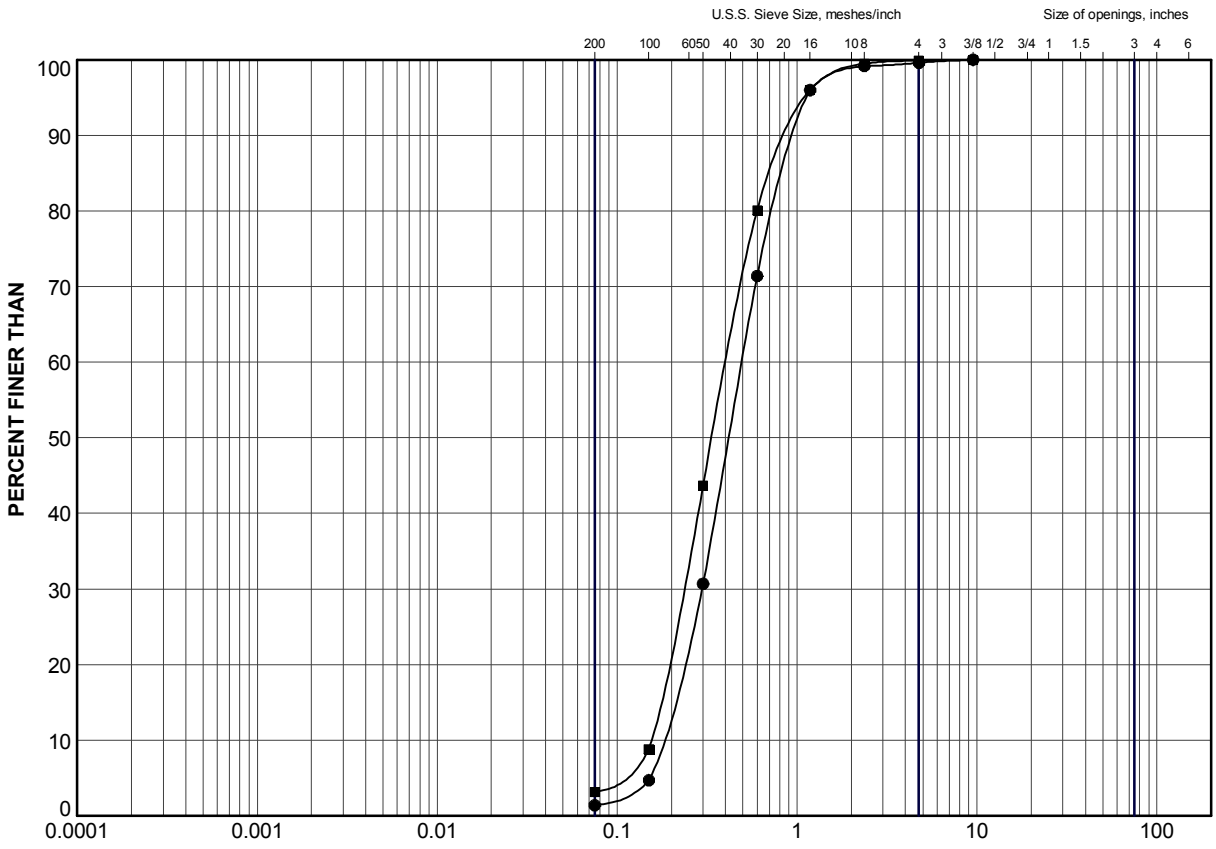
GRAIN SIZE DISTRIBUTION

SILTY SAND (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE A1**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-01	2A	204.2
■	C1-03	2A	204.1

PROJECT

HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 10+443

TITLE

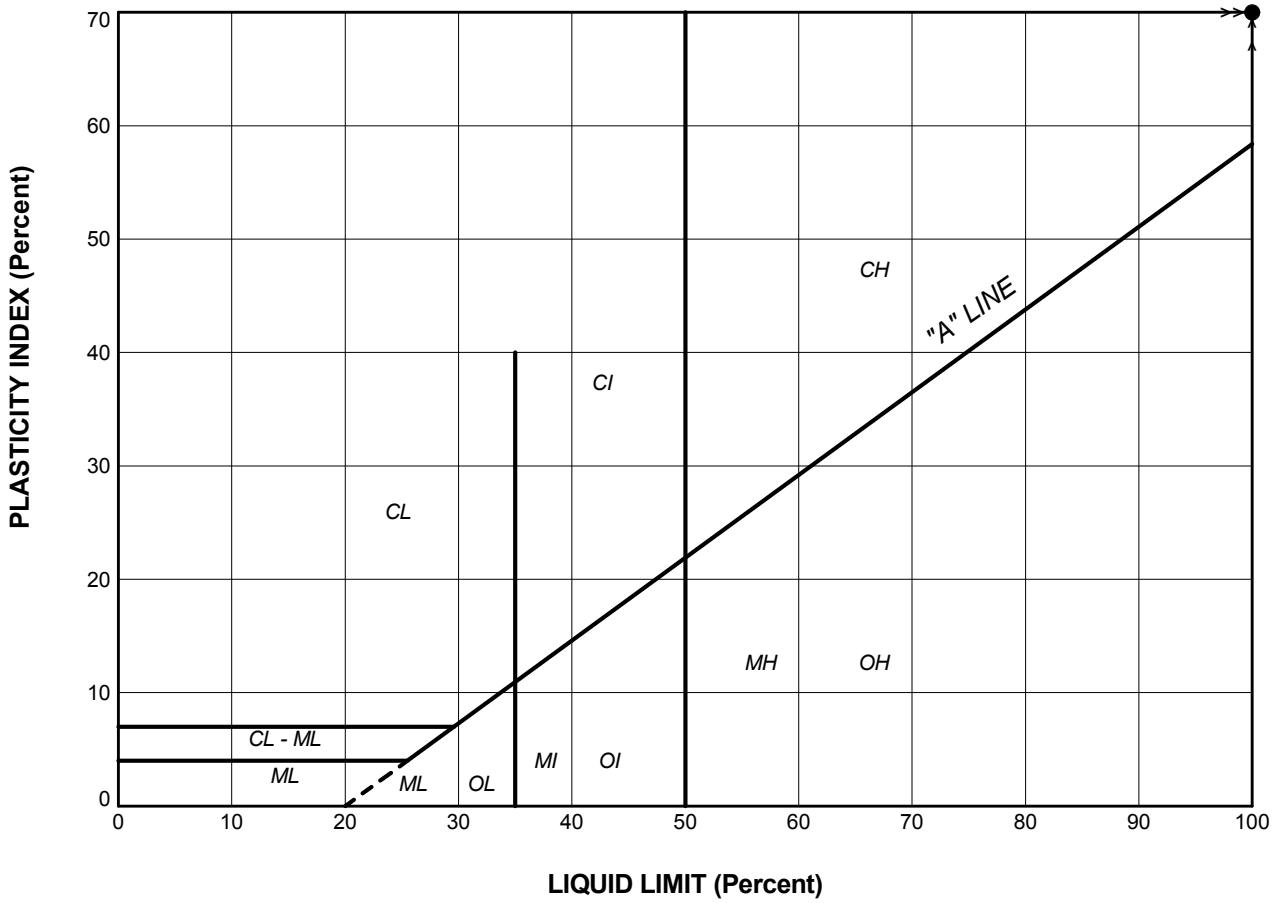
GRAIN SIZE DISTRIBUTION

SAND (INTERLAYER)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE A2**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C1-01	4A	156.5	67.0	89.5

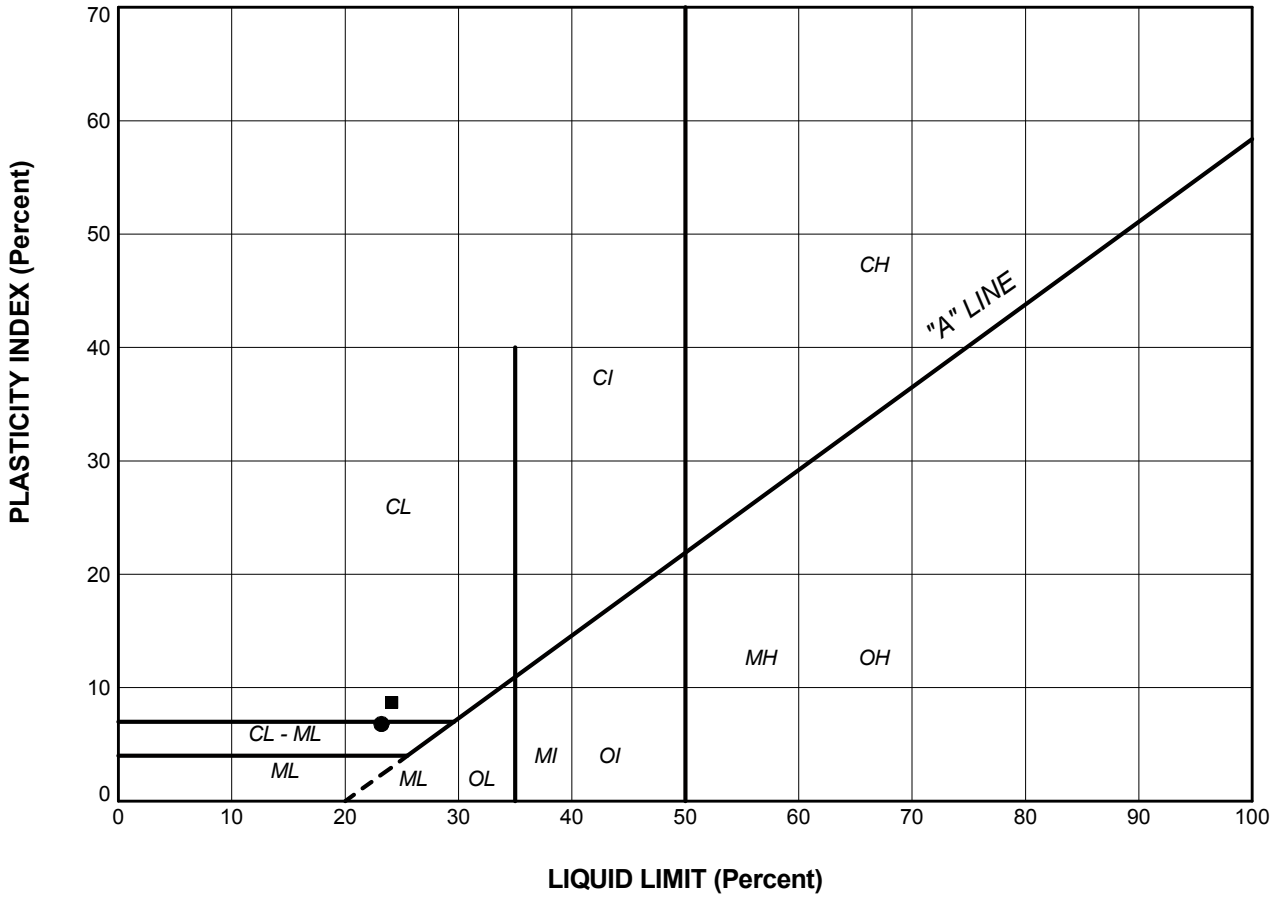
PROJECT
HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 10+443

TITLE
PLASTICITY CHART
ORGANIC SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE A3A**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C1-02	6	23.2	16.4	6.8
■	C1-04	4	24.1	15.4	8.7

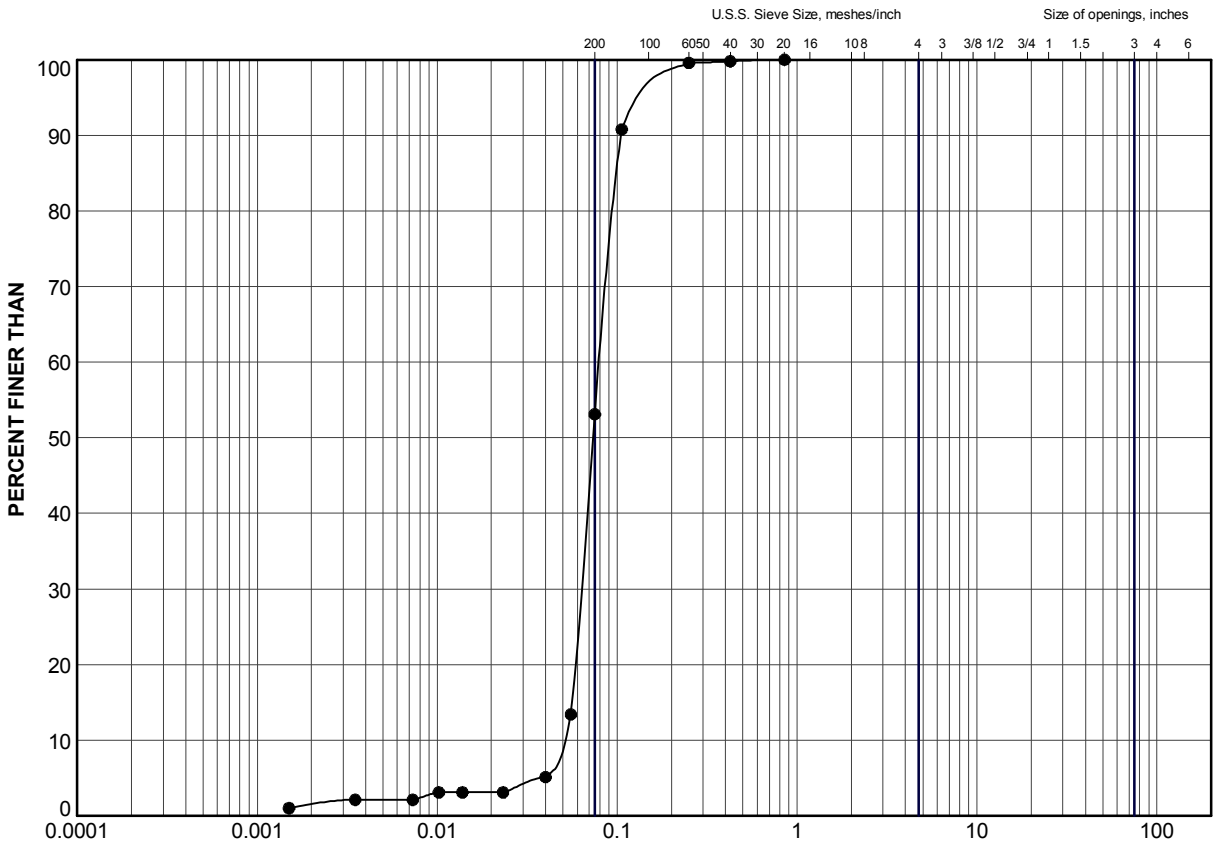
PROJECT
HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 10+443

TITLE
PLASTICITY CHART
CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE A3B**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-03	4	202.4

PROJECT

HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 10+443

TITLE

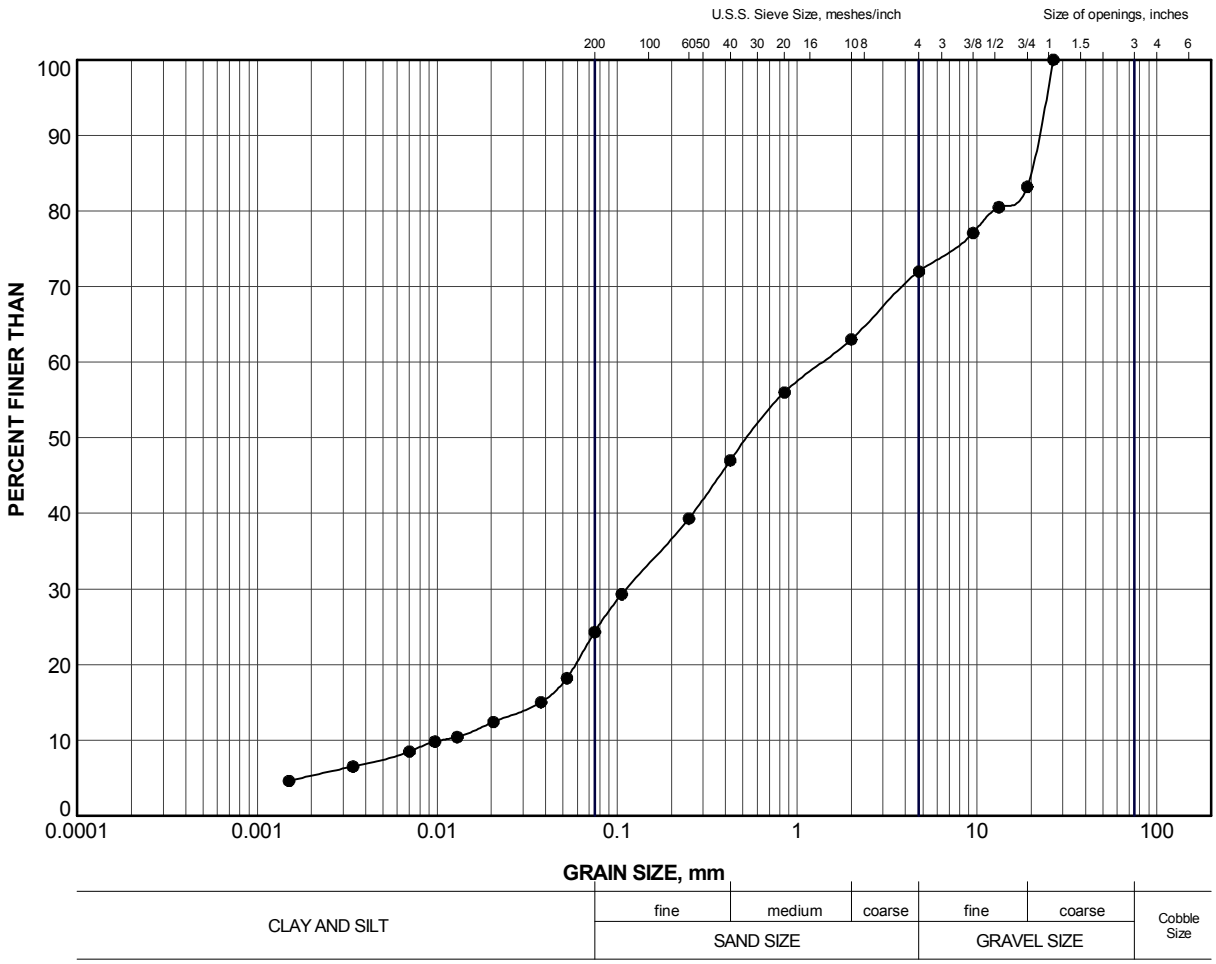
GRAIN SIZE DISTRIBUTION

SILT and SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE A4**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-02	7	201.5

PROJECT

HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 10+443

TITLE

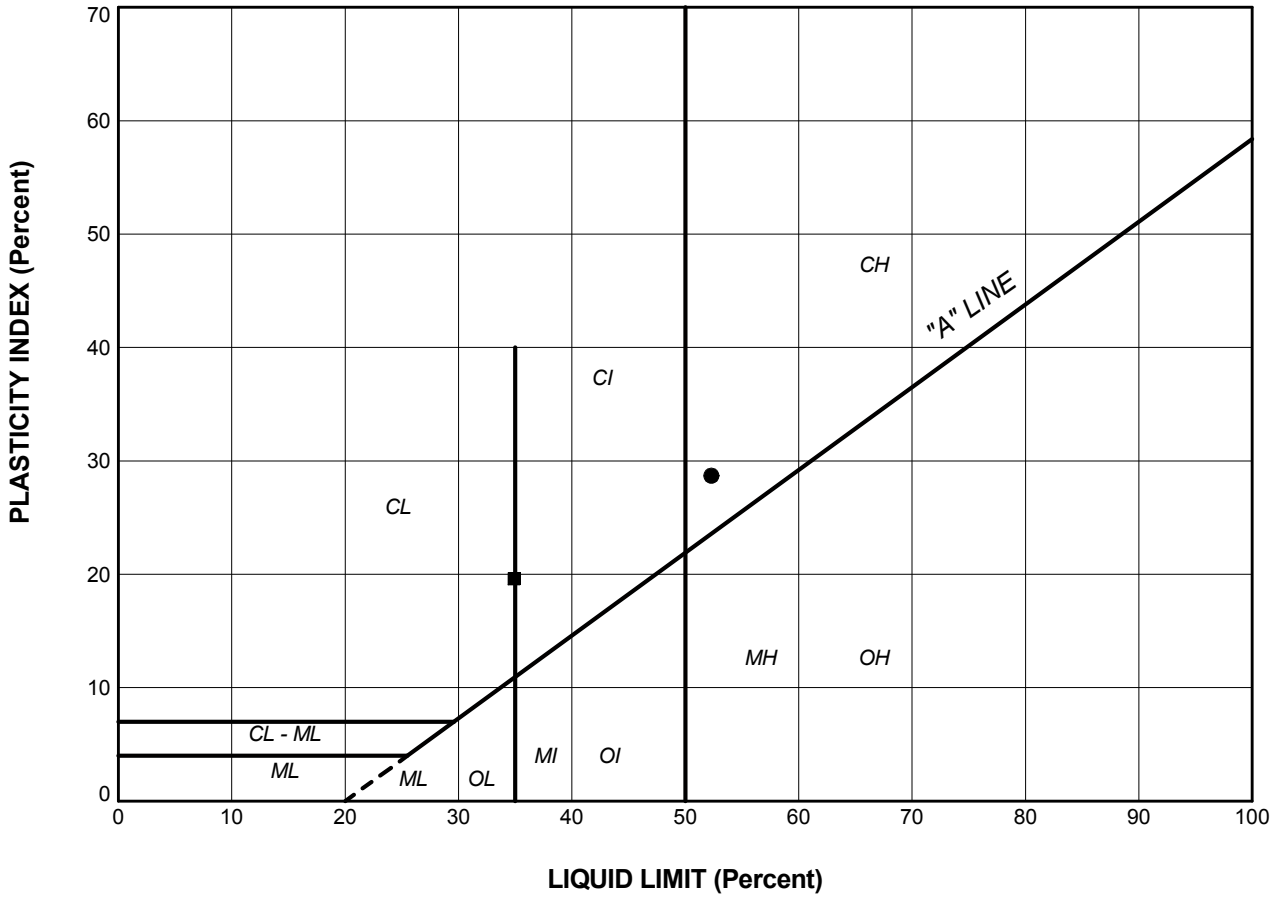
GRAIN SIZE DISTRIBUTION

GRAVELLY SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE A5**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C1-01	8	52.3	23.6	28.7
■	C1-03	6B	34.9	15.3	19.6

PROJECT
HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 10+443

TITLE
PLASTICITY CHART
SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

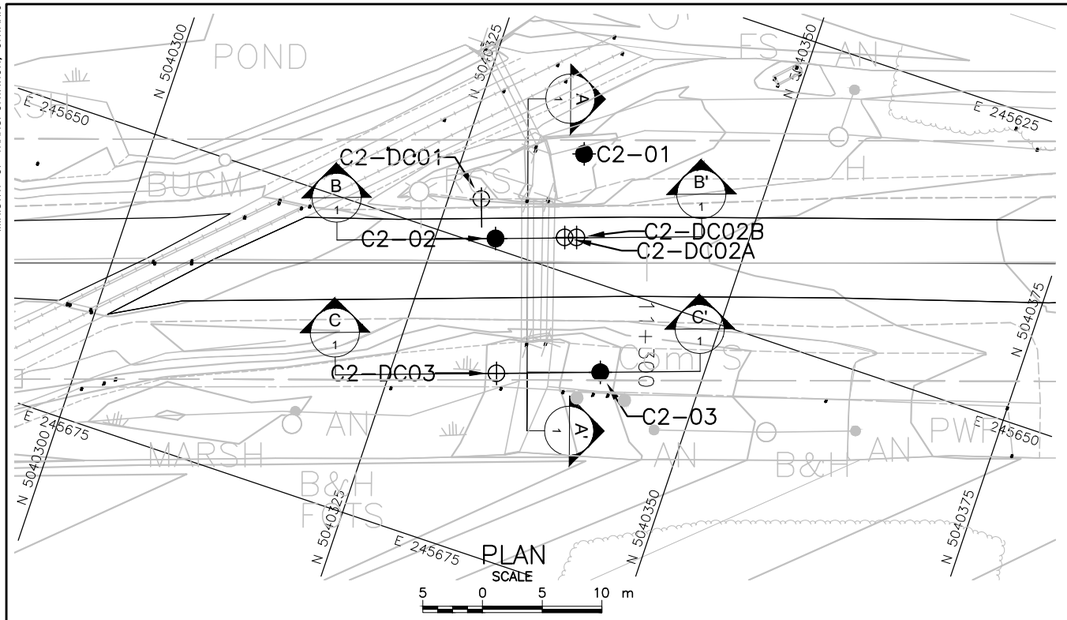
PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE A6**	

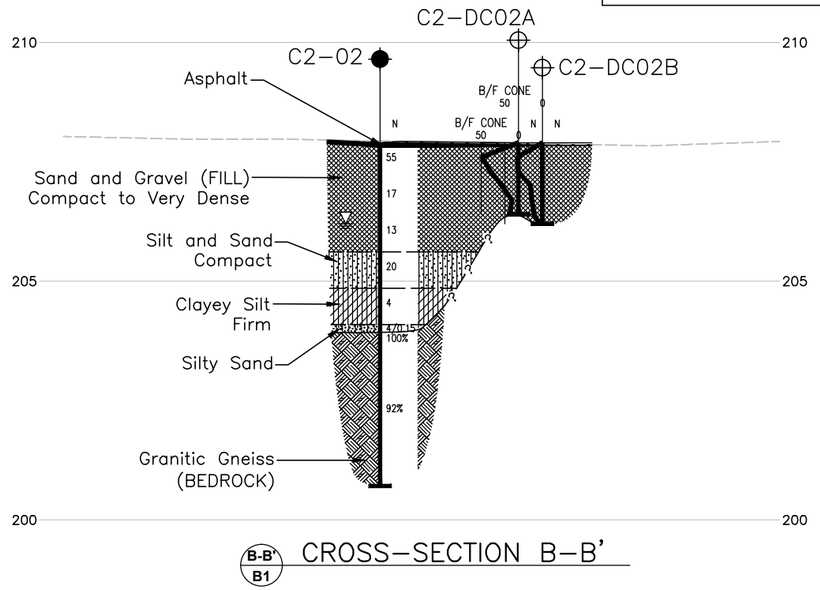
SUD-MTO PL (NEW) GLDR_LDN.GDT

APPENDIX B

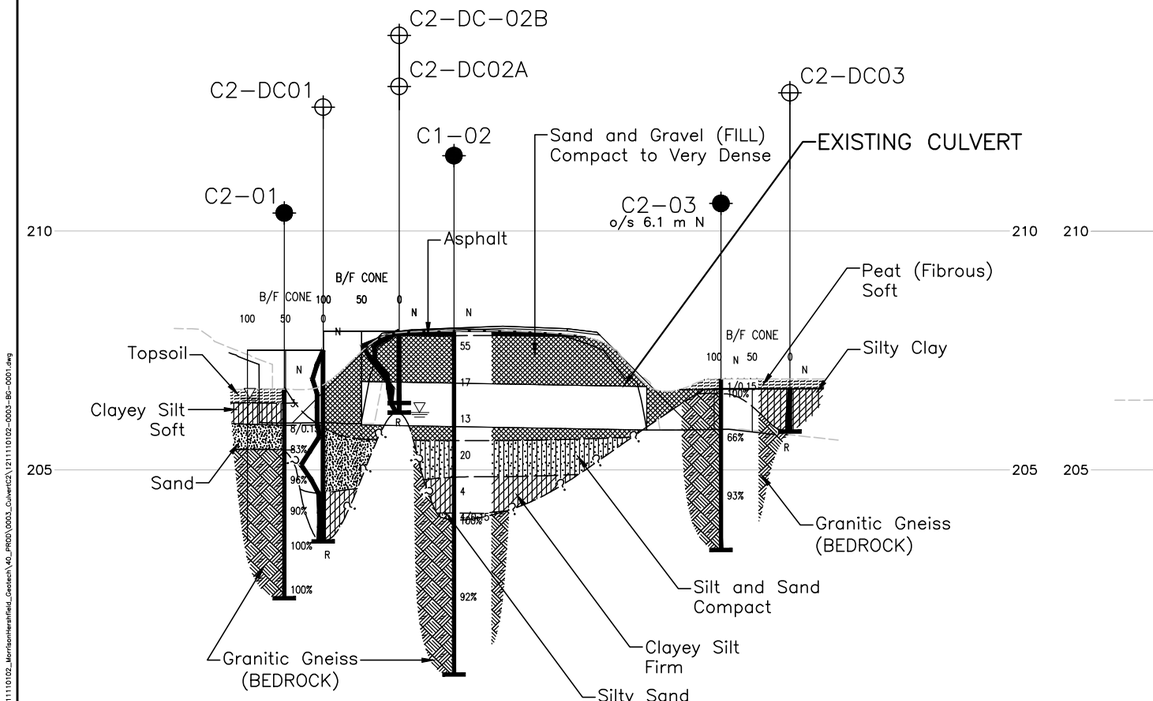
Culvert at STA 11+290 – Highway 7182 – Township of Shawanaga

MINISTRY OF TRANSPORTATION, ONTARIO





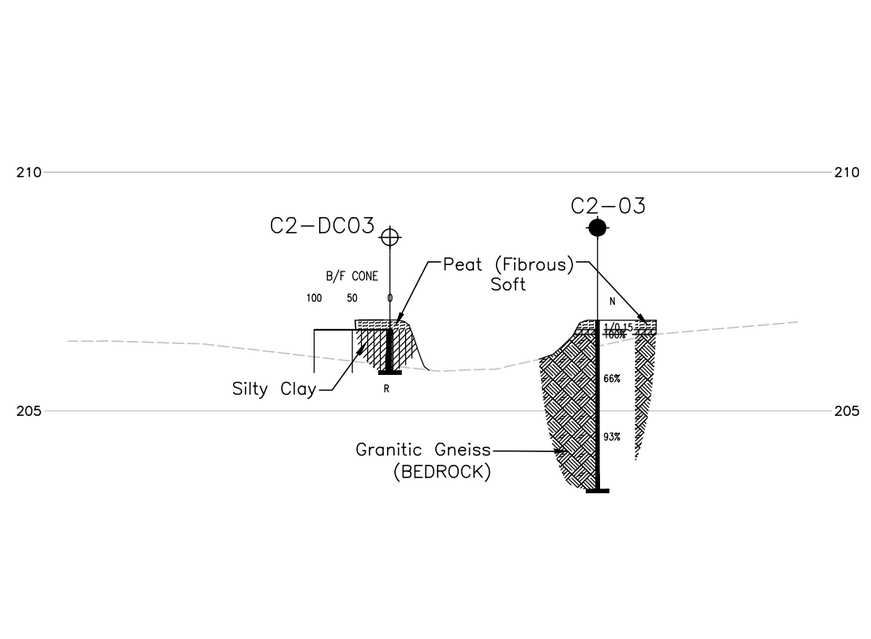
B-B' B1 CROSS–SECTION B–B'



A-A' B1 CULVERT STA. 11+290
SECTION A–A'

HORIZONTAL SCALE
2.5 0 2.5 5 m

VERTICAL SCALE
1.25 0 1.25 2.5 m



C-C' B1 CROSS–SECTION C–C'

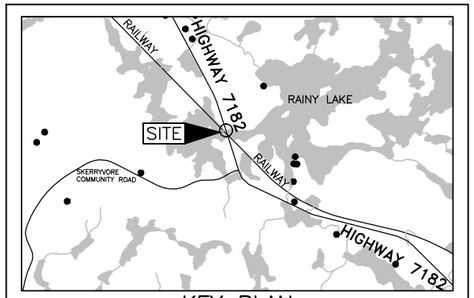
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. .
GWP No. 5163–10–00

HIGHWAY 7182
CULVERT STA. 11+290 (SBL AND NBL)
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET .

Golder Associates



LEGEND

- Borehole
- Dynamic Cone Penetration Test
- 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
- R — Refusal

BOREHOLE CO–ORDINATES

No.	ELEVATION	NORTHING	EASTING
C2–01	206.7	5040334.6	245640.1
C2–02	207.9	5040329.8	245649.2
C2–03	206.9	5040341.7	245657.0
C2–DC01	207.5	5040327.6	245646.4
C2–DC02A	207.9	5040335.3	245647.2
C2–DC02B	207.9	5040336.2	245646.9
C2–DC03	206.7	5040333.5	245659.8

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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans and topographic data provided in digital format by Morrison Hershfield, drawing file nos. bc04537182001.dwg and Alignment–profile.dwg, dated Dec., 2013, received Dec. 17, 2014.
Cross–Section provided in digital format by Morrison Hershfield, drawing file no. Culver x–secs.dwg, received Sept. 30, 2014.

LICENSED PROFESSIONAL ENGINEER C.C. NG 100086170 Mar. 13, 2015 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Mar. 13, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41H–148

HWY. 7182		PROJECT NO. 12–1111–0102	DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 1/30/2015	SITE: .
DRAWN: MR	CHKD. CN	APPD. JMAC	DWG. B1

PLOT DATE: March 13, 2015
FILENAME: S:\Clients\MTO\Highway_7182\09_PROJ\12111101102_MorrisonHershfield_Geotech\40_PROD\0003_Culvert2\12111101102-0003-BC-0001.dwg

Golder Associates

RECORD OF BOREHOLE No C2-01

SHEET 1 OF 1 **METRIC**

PROJECT 12-1111-0102
G.W.P. 5163-10-00
LOCATION N 5040334.6 ;E 245640.1
ORIGINATED BY GM
DIST HWY 7182
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY MT
DATUM Geodetic
DATE June 10, 2014
CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.7	GROUND SURFACE										
0.0 / 206.4	TOPSOIL		1A	SS	3	▽					
0.3 / 205.9	CLAYEY SILT, some sand, trace organics Soft Brown to grey Moist		1B				206			OC=1.9%	
			2	SS	*8/0.15						
0.8 / 205.4	SAND, some silt, trace organics Grey Wet										
1.3	Granitic Gneiss (BEDROCK) Bedrock cored from depths of 1.3 m to 4.4 m. For bedrock coring details refer to Record of Drillhole C2-01.		1	RC	REC 100%		205				RQD = 83%
			2	RC	REC 100%						RQD = 96%
			3	RC	REC 100%		204				RQD = 90%
			4	RC	REC 100%		203				RQD = 100%
202.3			5	RC	REC 100%						RQD = 100%
4.4	END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 0.2 m below ground surface (Elev. 206.5 m) upon completion of drilling. * Split-Spoon Bouncing										

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

PROJECT: 12-1111-0102

RECORD OF DRILLHOLE: C2-01

SHEET 1 OF 1

LOCATION: N 5040334.6 ;E 245640.1

DRILLING DATE: June 10, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Tripod

DRILLING CONTRACTOR: LANDCORE DRILLING

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

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole C2-01		205.43																
2	BQ Thin-walled Coring; Double-Tube Sampling	Fresh, foliated, grey, medium to coarse crystalline, faintly to moderately porous, strong to very strong GRANITIC GNEISS		1.27	1	GREY 100%							JN,IR,RO							
													JN,IR,RO							
													JN,IR,RO							
					2	GREY 100%							JN,IR,RO							
													JN,IR,RO							
3					3	GREY 100%							JN,IR,RO							
													JN,IR,RO							
					4	GREY 100%							JN,IR,RO							
4													JN,IR,RO							
					5	GREY 100%							JN,IR,RO							
		END OF DRILLHOLE		202.31 4.39																

GTA-RCK 018 S:\CLIENTS\MTO\HIGHWAY_7182\02_DATA\GINT\1211110102.GPJ GAL-MISS.GDT 03/12/15 TB

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: GM

CHECKED: CN

Golder Associates

RECORD OF BOREHOLE No C2-02

SHEET 1 OF 1 **METRIC**

PROJECT 12-1111-0102
G.W.P. 5163-10-00
DIST HWY 7182
DATUM Geodetic

LOCATION N 5040329.8 ;E 245649.2
BOREHOLE TYPE 108 mm I.D. Hollow Stem Auger
DATE June 10, 2014

ORIGINATED BY ID
COMPILED BY MT
CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
207.9	GROUND SURFACE										
0.0	ASPHALT (75 mm)										
0.1	Sand and gravel, trace to some silt (FILL) Compact to very dense Grey Moist to wet		1	SS	55				○		54 36 (10)
			2	SS	17		207				
			3	SS	13	▽	206				
205.6											
2.3	SILT and SAND, trace gravel, trace clay Compact Grey Wet		4	SS	20				○		2 59 36 3
204.9							205				
3.0	CLAYEY SILT Firm Grey Wet		5	SS	4			+ 4	⊢ ○		
204.1							204				
			6	SS	*4/0.15				○		
4.0	Silty SAND, some gravel, trace clay Grey Wet										
	Granitic Gneiss (BEDROCK) Bedrock cored from depths of 4.0 m to 7.2 m. For bedrock coring details refer to Record of Drillhole C2-02.		1	RC	REC 100%		203				RQD = 100%
			2	RC	REC 100%		202				RQD = 92%
200.7							201				
7.2	END OF BOREHOLE NOTES: 1. Water level in open borehole measured at a depth of 1.7 m below ground surface (Elev. 206.2 m) upon completion of drilling. 2. An additional borehole was advanced approximately 1.1 m North of Borehole C2-02 to carry out an in situ field vane test at a depth of 3.4 m. * Split-Spoon Bouncing										

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

PROJECT: 12-1111-0102

RECORD OF DRILLHOLE: C2-02

SHEET 1 OF 1

LOCATION: N 5040329.8 ;E 245649.2

DRILLING DATE: June 10, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: LANDCORE DRILLING

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

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR, % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole C2-02		203.94																
4	NQ Coring; Double-Tube Sampling	Fresh, foliated, grey, medium to coarse crystalline, faintly to moderately porous, strong to very strong GRANITIC GNEISS		3.96	1	GREY 100%							JN,IR,RO JN,IR,RO JN,IR,RO							
5																				
6					2	-														
7				200.71									JN,IR,RO JN,IR,RO JN,IR,RO							
		END OF DRILLHOLE		7.19																
8																				
9																				
10																				
11																				
12																				
13																				

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ID

CHECKED: CN

GTA-RCK 018 S:\CLIENTS\MTO\HIGHWAY_7182\02_DATA\GINT\1211110102.GPJ GAL-MISS.GDT 03/12/15 TB

Golder Associates

RECORD OF BOREHOLE No C2-03

SHEET 1 OF 1 **METRIC**

PROJECT 12-1111-0102
G.W.P. 5163-10-00
LOCATION N 5040341.7 ;E 245657.0
ORIGINATED BY GM
DIST HWY 7182
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY MT
DATUM Geodetic
DATE June 11, 2014
CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.9	GROUND SURFACE										
0.0	PEAT (Fibrous) Soft Black Moist		1A 1B	SS	1/0.15						
0.3	SILTY CLAY with sand, trace organics Grey to brown Wet		1	RC	REC 100%		206				RQD = 100%
	Granitic Gneiss (BEDROCK) Bedrock cored from depths of 0.3 m to 3.6 m. For bedrock coring details refer to Record of Drillhole C2-03.		2	RC	REC 100%		205				RQD = 66%
			3	RC	REC 100%		204				RQD = 93%
203.3											
3.6	END OF BOREHOLE NOTE: 1. Water level in open borehole was not recorded.										

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

PROJECT: 12-1111-0102

RECORD OF DRILLHOLE: C2-03

SHEET 1 OF 1

LOCATION: N 5040341.7 ;E 245657.0

DRILLING DATE: June 11, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Tripod

DRILLING CONTRACTOR: LANDCORE DRILLING

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

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole C2-03		206.60																
1	BQ Thin-walled Coring; Double-Tube Sampling	Fresh, foliated, grey, medium to coarse crystalline, faintly to moderately porous, strong to very strong GRANITIC GNEISS		0.30	1	GREY 100%														
2					2	GREY 100%							JN,IR,RO JN,IR,RO JN,IR,RO JN,IR,RO JN,IR,RO JN,IR,RO							UCS = 131 MPa
3				203.32	3	GREY 100%							JN,IR,RO JN,IR,RO JN,IR,RO							
		END OF DRILLHOLE		3.58																
4																				
5																				
6																				
7																				
8																				
9																				
10																				

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: GM
CHECKED: CN

GTA-RCK 018 S:\CLIENTS\MTO\HIGHWAY_7182\02_DATA\GINT\1211110102.GPJ GAL-MISS.GDT 03/12/15 TB

Golder Associates

RECORD OF DCPT No C2-DC01

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0102

G.W.P. 5163-10-00 LOCATION N 5040327.6 ;E 245646.4 ORIGINATED BY ID

DIST HWY 7182 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY TB

DATUM Geodetic DATE June 10, 2014 CHECKED BY DAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
207.5	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						207 206 205 204				
203.5											
4.0	END OF DCPT Refusal to Further Penetration (HAMMER BOUNCING)										

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

GTA-MTO 001 S:\CLIENTS\MTO\HIGHWAY_7182\02_DATA\GINT\1211110102.GPJ GAL-GTA.GDT 03/12/15 TB

Golder Associates

RECORD OF DCPT No C2-DC02A

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0102

G.W.P. 5163-10-00 LOCATION N 5040335.3 ;E 245647.2 ORIGINATED BY ID

DIST HWY 7182 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY TB

DATUM Geodetic DATE June 10, 2014 CHECKED BY DAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ	
207.9	GROUND SURFACE							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%) 20 40 60	kN/m³	GR SA SI CL
0.0	Dynamic Cone Penetration Test (DCPT)						207				
206.4											
1.5	END OF DCPT Refusal to Further Penetration (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No C2-DC02B

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0102

G.W.P. 5163-10-00 LOCATION N 5040336.2 ;E 245646.9 ORIGINATED BY ID

DIST HWY 7182 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY TB

DATUM Geodetic DATE June 10, 2014 CHECKED BY DAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
207.9 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)						207				
206.2 1.7	END OF DCPT Refusal to Further Penetration (HAMMER BOUNCING)										

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

Golder Associates

PROJECT 12-1111-0102

RECORD OF DCPT No C2-DC03

SHEET 1 OF 1

METRIC

G.W.P. 5163-10-00 LOCATION N 5040333.5 ;E 245659.8 ORIGINATED BY GM

DIST HWY 7182 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY TB

DATUM Geodetic DATE June 10, 2014 CHECKED BY DAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
206.7	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						206				
205.8											
0.9	END OF DCPT Refusal to Further Penetration (HAMMER BOUNCING)										

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

Table B1: Summary of Analytical Testing of Surface Water

Culvert Location Highway 7182 (Township)	Parameter (Units, Detection Limit)				
	Chloride (mg/L, 1)	Sulfate (mg/L, 1)	Conductivity (µS/cm, 1.0)	Resistivity (Ω-cm)	pH
STA 11+290 (Shawanaga Township)	3	<1	24	41,000	5.84

Notes: 1. Samples obtained June 16, 2014
2. Analytical testing carried out by Maxxam Analytics.

Prepared by: MCK
Checked by: CN
Reviewed by: JMAC

Golder Associates Ltd.

1010 Lorne Street
Sudbury, Ontario, Canada P3C 4R9
Telephone: (705) 524-6861
Fax: (705) 524-1984

TABLE B2 - SUMMARY OF ROCK CORE TEST DATA

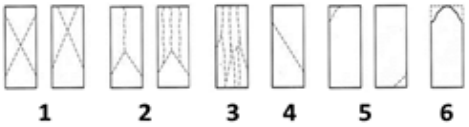
PROJECT NO.: **12-1111-0102**

JOB NAME: **Culvert at Station 11+290 - Highway 7182/Shawanaga**

TYPE OF UNIT: **Bedrock Core**

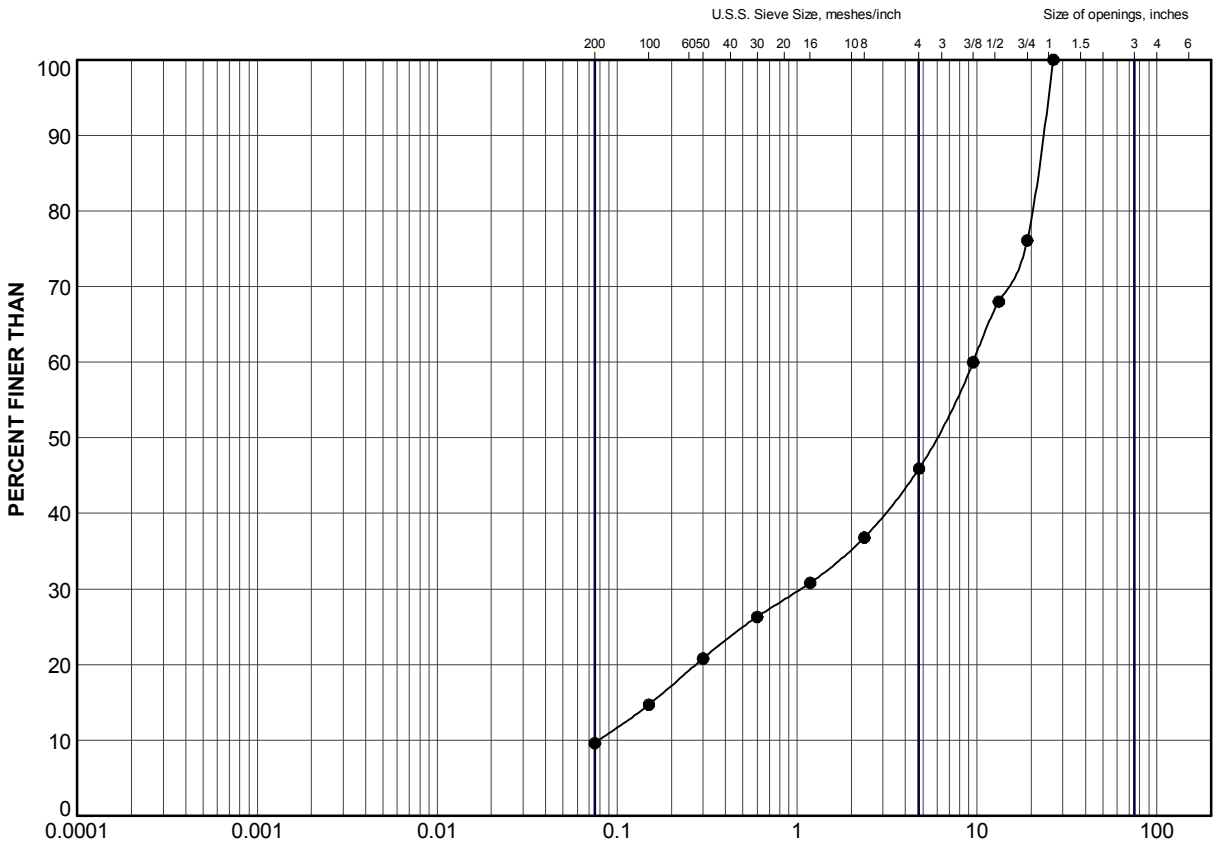
GOLDER LAB NUMBER	**G0733**
BOREHOLE	**C2-03**
DATE TESTED	**Aug. 12, 2014**
DEPTH OF TESTED CORE (m)	2.3
LENGTH AS CUT (mm)	93.0
DIAMETER (mm)	43.5
DENSITY (kg/m3)	2717
UNIAXIAL COMPRESSIVE STRENGTH (MPa)	**131.4**
TYPE OF FRACTURE	**3**

Type of Fracture



Tested by: SA

Reviewed by: CN



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C2-02	1	207.6

PROJECT

HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 11+290

TITLE

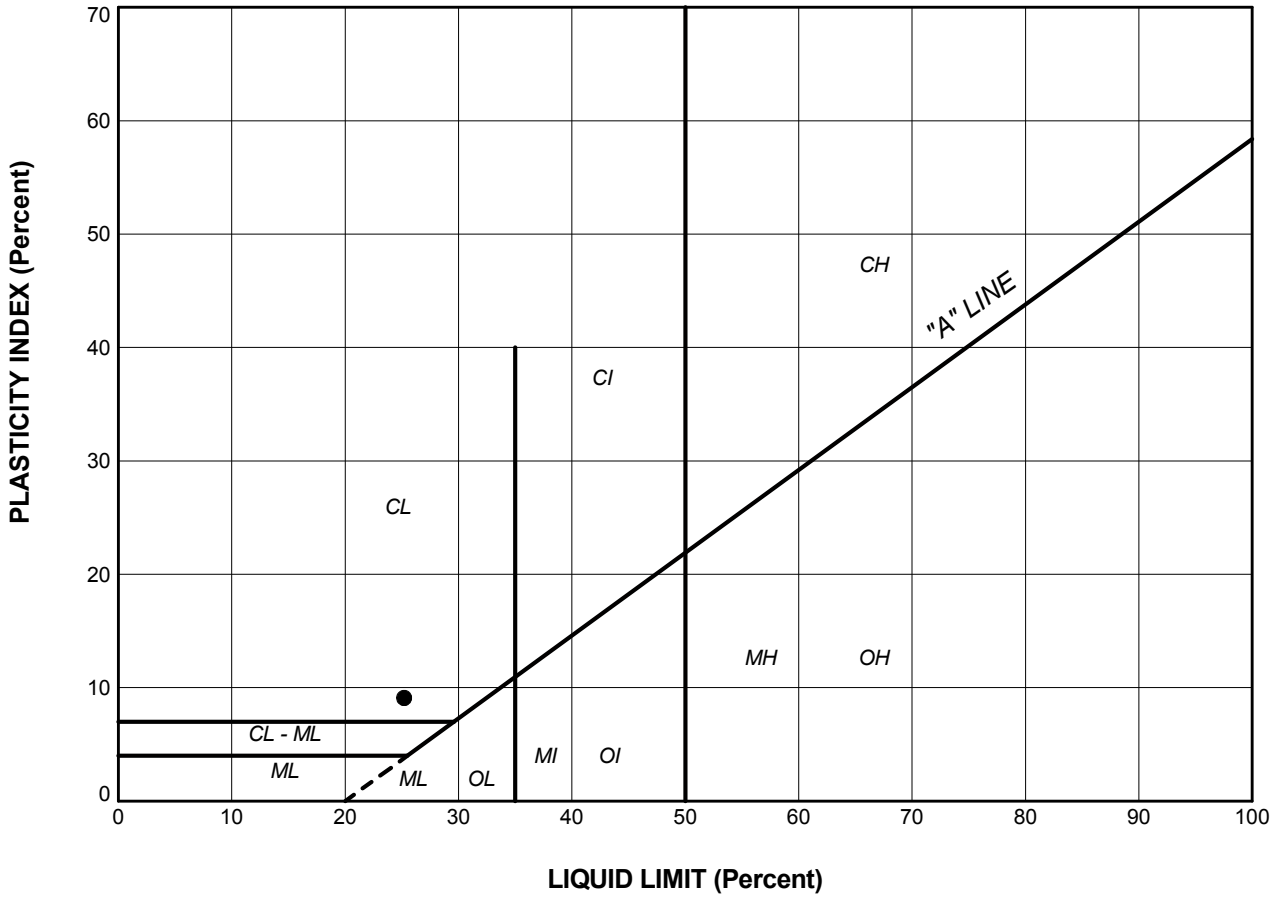
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE B1**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C2-01	1B	25.2	16.1	9.1

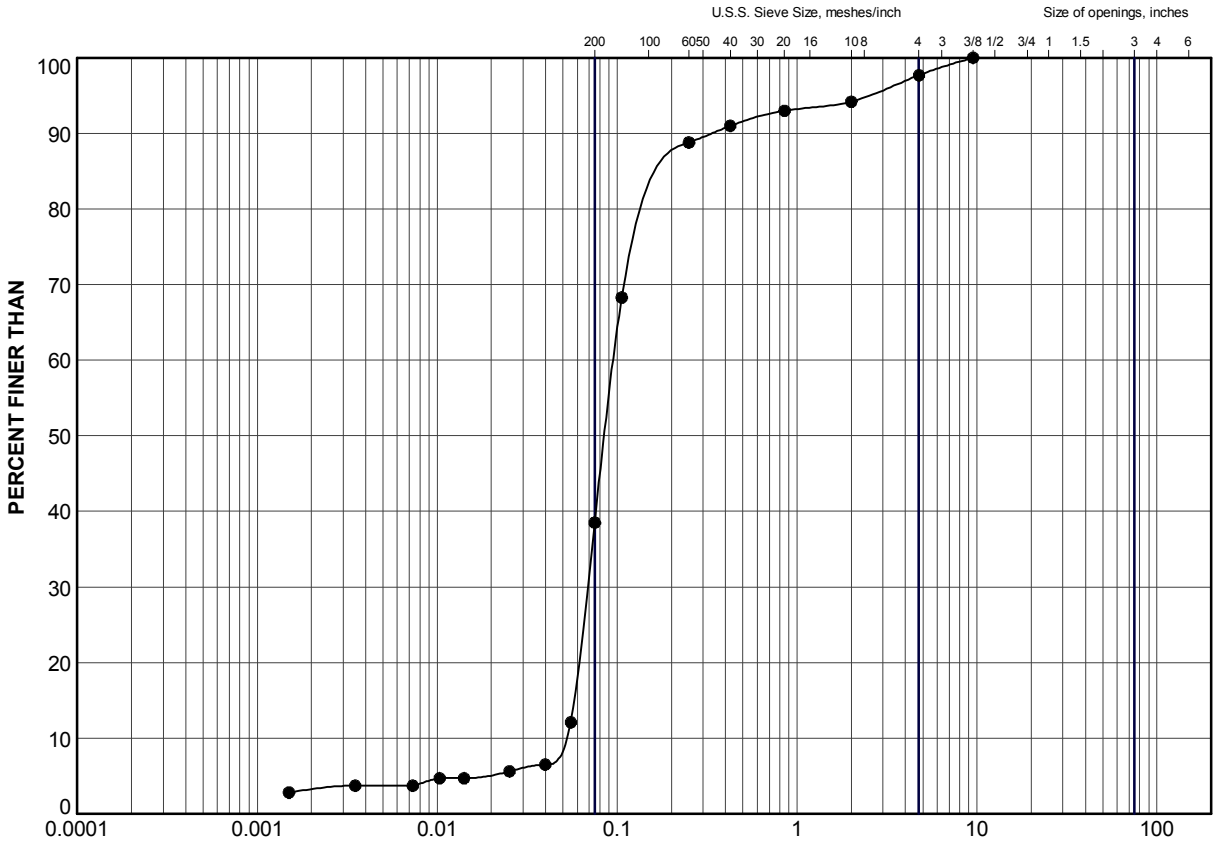
PROJECT
HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 11+290

TITLE
PLASTICITY CHART
CLAYEY SILT (UPPER DEPOSIT)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE B2**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C2-02	4	205.3

PROJECT

HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 11+290

TITLE

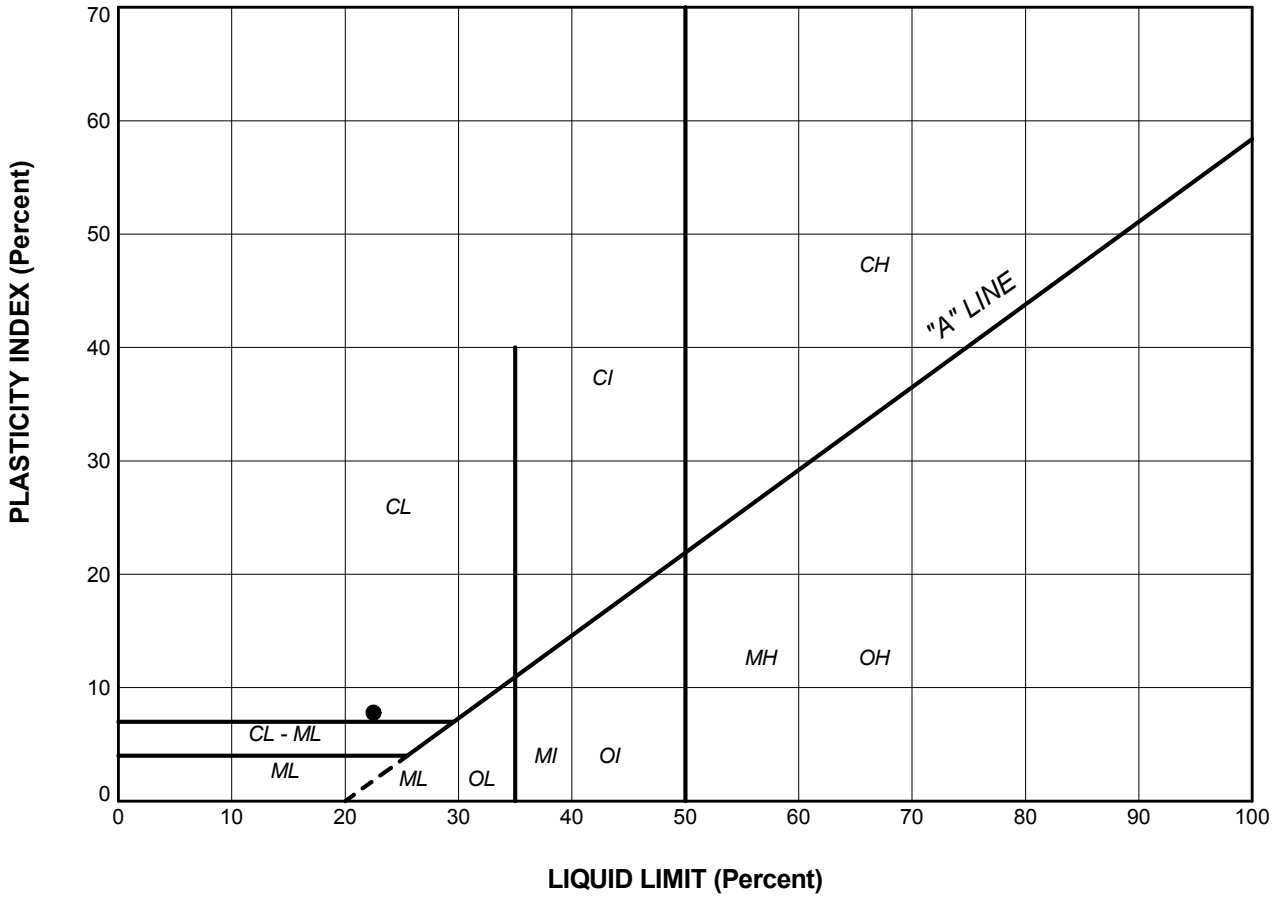
GRAIN SIZE DISTRIBUTION

SILT and SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE B3**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LIQUID LIMIT (Percent)

SOIL TYPE	**PLASTICITY**
C = Clay	L = Low
M = Silt	I = Intermediate
O = Organic	H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C2-02	5	22.5	14.7	7.8

PROJECT

HIGHWAY 7182 RECONSTRUCTION
HIGHWAY 7182 (SBL and NBL)
CULVERT 11+290

TITLE

PLASTICITY CHART

CLAYEY SILT (LOWER DEPOSIT)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	12-1111-0102		FILE No.	1211110102.GPJ
DRAWN	TB	Mar 2015	SCALE N/A	REV.
CHECK	MCK	Mar 2015		
APPR	CN	Mar 2015	**FIGURE B4**	

SUD-MTO PL (NEW) GLDR_LDN.GDT

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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