



**March 12, 2015**

## **FOUNDATION INVESTIGATION REPORT**

### **SHAWANAGA RIVER SBL BRIDGE STRUCTURE**

**SITE NO. 44-443/2**

**HIGHWAY 69 FOUR-LANING FROM 1.0 KM NORTH OF THE NEW HIGHWAY  
559 INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF HIGHWAY 7182  
(SHEBESHEKONG ROAD) FOR 17 KM**

**MINISTRY OF TRANSPORTATION, ONTARIO**

**G.W.P. 5111-07-00, W.P. 5188-06-01 (Phase 2 of G.W.P. 5402-05-00)**

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**REPORT**



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## Table of Contents

### **PART A – FOUNDATION INVESTIGATION REPORT**

<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>
3.1 Foundation Investigation .....	2
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS.....</b>	<b>4</b>
4.1 Regional Geology.....	4
4.2 Subsurface Conditions .....	4
4.3 South Abutment and Approach Area.....	5
4.3.1 Topsoil.....	5
4.3.2 Silty Sand .....	5
4.3.3 Cobbles / Rock Fragments and Bedrock .....	5
4.3.4 Groundwater Conditions .....	7
4.4 South Pier (Pier 1).....	7
4.4.1 Shawanaga River .....	7
4.4.2 Peat .....	7
4.4.3 Sand to Sand and Silt (Upper Deposit).....	8
4.4.4 Clayey Silt to Silty Clay.....	8
4.4.5 Cobbles .....	9
4.4.6 Silty Sand to Sand to Sand and Gravel (Lower Deposit) .....	9
4.4.7 Bedrock .....	9
4.5 North Pier (Pier 2) .....	10
4.5.1 Shawanaga River .....	10
4.5.2 Organic Sand and Organic Clayey Silt .....	10
4.5.3 Clayey Silt to Clay .....	11
4.5.4 Sand to Silty Sand to Sandy Silt .....	11
4.5.5 Clay .....	11
4.5.6 Bedrock .....	12
4.6 North Abutment and Approach Embankment.....	13



# FOUNDATION REPORT – SHAWANAGA RIVER SBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

4.6.1	Topsoil/Peat.....	13
4.6.2	Organic Sandy Silt.....	13
4.6.3	Sand and Gravel to Sand and Silt to Sandy Silt (Upper Deposit) .....	13
4.6.4	Clayey Silt to Clay .....	14
4.6.5	Sand and Silt to Sand and Gravel (Lower Deposit) .....	14
4.6.6	Bedrock/Refusal .....	15
4.6.7	Groundwater Conditions.....	16
<b>5.0</b>	<b>CLOSURE .....</b>	<b>16</b>

## DRAWINGS

Drawing 1	Site Location Plan
Drawing 2	Borehole Locations and Soil Strata
Drawing 3	Soil Strata

## APPENDICES

### Appendix A Record of Boreholes and Drillholes

List of Symbols and Abbreviations	
Lithological and Geotechnical Rock Description Terminology	
Record of Boreholes	B5-01 to B5-22
Record of Drillholes	B5-01, B5-02, B5-05, B5-07 to B5-16 and B5-18

### Appendix B Laboratory Test Results

Table B1	Point Load Test Results on Rock Samples
Table B2-1	Summary of Unconfined Compression Test Results
Table B2-2	Unconfined Compression (UC) Test – Borehole B5-14, Run No. 1
Table B2-3	Unconfined Compression (UC) Test – Borehole B5-07, Run No. 3
Table B2-4	Unconfined Compression (UC) Test – Borehole B5-05, Run No. 1
Figure B1-1	Grain Size Distribution – Sand and Silt (Upper Deposit), South Pier (Pier 1)
Figure B1-2	Plasticity Chart – Clayey Silt to Silty Clay, South Pier (Pier 1)
Figure B1-3	Grain Size Distribution – Sand (Lower Deposit), South Pier (Pier 1)
Figure B1-4	Plasticity Chart – Silty Clay to Clay, North Pier (Pier 2)
Figure B1-5	Plasticity Chart – Clay, North Pier (Pier 2)
Figure B1-6	Grain Size Distribution – Sand and Silt to Sandy Silt (Upper Deposit), North Abutment and Approach
Figure B1-7	Plasticity Chart – Clay, North Abutment and Approach



# **PART A**

## **FOUNDATION INVESTIGATION REPORT**

**SHAWANAGA RIVER SBL BRIDGE STRUCTURE, SITE NO. 44-443/2**

**HIGHWAY 69 FOUR-LANING FROM 1.0 KM NORTH OF THE NEW  
HIGHWAY 559 INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF  
HIGHWAY 7182 (SHEBESHEKONG ROAD) FOR 17 KM**

**MINISTRY OF TRANSPORTATION, ONTARIO**

**G.W.P. 5111-07-00, W.P. 5188-06-01**





## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin (MRC), a member of MMM Group Limited on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed three-span Shawanaga River Southbound Lanes (SBL) Bridge structure over the Shawanaga River (Site No. 44-443/2). The proposed work is part of the four-laning of Highway 69 from 1.0 km north of the new Highway 559 Interchange northerly to 1.5 km north of Highway 7182 (Shebeshekong Road), which involves high fill embankments and embankments over swamps, the New Woods Road and Shebeshekong Road interchanges and structures, the Shawanaga River and Site 9 Road structures, as well as culvert crossings. The general location of this bridge structure along the new Highway 69 four-laning alignment is shown on Drawing 1.

The Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal, dated July 2006. Golder's proposal for foundation engineering services associated with the Shawanaga River SBL Bridge is contained in Section 6.8 of MRC'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 July 4, 2007. The General Arrangement (GA) Drawing and the subsequent updated drawing for the proposed Shawanaga River SBL Bridge were provided to Golder by MRC on January 12, 2009 and October 28, 2013, respectively.

This report addresses the investigation carried out for the Shawanaga River SBL Bridge and the associated approach embankments only. Separate reports address the foundation investigations for the swamp crossings, high fill areas associated with interchange ramps and roadways, culverts and other bridge structures for the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed structure, including the associated approach embankments, by borehole drilling, rock coring and laboratory testing on selected samples. The bridge structure centerline and the foundation units/limits for this investigation were located in the field prior to drilling by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by MRC. The investigation area is shown in plan on Drawing 2.

## **2.0 SITE DESCRIPTION**

The proposed Shawanaga River SBL Bridge is located approximately 450 m north of the intersection of the existing Shebeshekong Road and Highway 69 and is approximately 20.5 km northwest of Nobel, Ontario. The proposed new Highway 69 alignment will extend generally in a southeast-northwest direction along the west side of the existing Highway 69, which will become part of the future Shawanaga River Service Road (Site No. 9) in this area.

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 and rivers. The proposed bridge and associated approach embankments are to be situated on a bedrock outcrop on the south side of the Shawanaga River and on a flood plain/low-lying area on the north side of the river. On the south side of the river, the ground surface within the limits of the proposed structure generally slopes down from about Elevation 212.3 m at the south approach embankment, to about Elevation 205.2 m at the south abutment and to about Elevation 198.7 m (river level) near the south pier (Pier 1). On the north side of the river, the ground surface rises from about Elevation 199.1 m (river level) near the north pier (Pier 2) up to about Elevation 199.6 m at the north abutment and to about Elevation 200.7 m at the north approach. The water



level of Shawanaga River near the proposed pier locations ranges from about Elevation 198.5 m to a high water level of about Elevation 199.1 m, although it is noted that the water level in the river was as high as Elevation 199.7 m at the time of the investigation. All elevations are referenced to Geodetic datum.

### **3.0 INVESTIGATION PROCEDURES**

#### **3.1 Foundation Investigation**

The field work for the Shawanaga River SBL Bridge subsurface investigation was carried out between February 2 and 8, 2009, between April 8 and 15, 2009 and on July 24 and 25, 2009 during which time a total of twenty-two (22) boreholes were advanced: five (5) boreholes at the south abutment; five (5) boreholes at the south pier (Pier 1); five (5) boreholes at the north pier (Pier 2); five (5) boreholes at the north abutment; and one (1) borehole at each approach embankment. The boreholes, designated as Boreholes B5-01 to B5-22, were advanced at the locations shown in plan on Drawing 2. In addition, Dynamic Cone Penetration Tests (DCPTs) were advanced adjacent to Boreholes B5-03, B5-04 and B5-06 to confirm the depth to refusal at these locations. The results of the DCPTs are presented on the Record of Borehole sheets presented in Appendix A.

The field investigation was carried out using a Diedrich D-25 track- and skid/barge-mounted drill rig supplied and operated by Walker Drilling Ltd. of Utopia, Ontario and portable equipment supplied and operated by OGS Inc. of Almonte, Ontario. Hand excavation methods were used at three of the borehole locations to expose the bedrock in shallow overburden areas. The boreholes were advanced through the overburden using 108 mm inside diameter hollow-stem augers, 165 mm O.D. solid-stem augers and 'BW' or 'NW' casing. Soil samples were obtained at intervals of depth of about 0.75 m using a 50 mm outside diameter (O.D.) split-spoon sampler driven by automatic hammers in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586 Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the Soil), or using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587 Standard Practice for Thin-Walled Tube Sampling of Soil for Geotechnical Purposes) for obtaining relatively undisturbed samples in cohesive soils. Boreholes advanced by portable equipment employed one-third ( $\frac{1}{3}$ ) weight hammers lifted manually. Chunk samples were obtained in two (2) boreholes at locations of thin overburden over bedrock outcrops. Field vane shear tests were conducted in cohesive soils for assessment of undrained shear strengths (ASTM D2573 Standard Test Method for Field Vane Shear Test in Cohesive Soil) using a MTO Standard 'N'-size vane. Samples of the bedrock were obtained using 'NQ' and 'BQ' size rock core barrels.

The boreholes at the foundation elements were typically advanced to auger and/or sampler refusal (i.e. inferred bedrock) and bedrock was confirmed by coring in selected boreholes. The boreholes at the approaches were advanced to the bedrock surface / sampler refusal. The boreholes were advanced to depths of up to about 10 m below existing ground surface/riverbed (or up to 12.7 m below river water surface), including coring of between about 1.5 m and 9.0 m into the bedrock, at Boreholes B5-01, B5-02, B5-05, B5-07 to B5-16 and B5-18.

The groundwater conditions in the open boreholes were observed during the drilling operations and a piezometer was installed in each of Boreholes B5-01 and B5-18 to permit monitoring of the water level at these locations. The piezometers consist of 32 mm diameter PVC pipe, with a slotted screen sealed at a select depth within the borehole. The boreholes and annulus surrounding the piezometer pipe above the sand pack/screen were backfilled to the surface with bentonite pellets/grout. Piezometer installation details and water level measurements are described on the Record of Borehole sheets presented in Appendix A. All



## FOUNDATION REPORT – SHAWANAGA RIVER SBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

boreholes in which standpipe piezometers were not installed were backfilled with bentonite to the ground surface or river bottom surface upon completion in accordance with Ontario Regulation 903 (as amended).

The field work was monitored 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 and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. Strength tests such as unconfined compression strength and point load index, were carried out on specimens of the rock core. The results of the laboratory testing are included in Appendix B.

The boreholes at the pier locations were located relative to the fixed centerline of the bridge structure and surveyed stations on either side of the riverbanks. The as-drilled borehole locations and ground surface elevations were surveyed by a member of our technical staff, referenced to the survey stakes installed by Callon Dietz. The borehole locations given in the Record of Borehole/Drillhole sheets and shown on Drawings 2 and 3 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum, and are summarized below.

Borehole	Location (MTM Nad 83)		Ground Surface / Water Surface Elevation* (m)	Depth Drilled* (m)
	Northing	Easting		
B5-01	5045861.4	243441.1	199.5	6.3
B5-02	5045856.8	243435.3	198.7	5.9
B5-03	5045860.2	243431.8	199.4	3.0
B5-04	5045863.4	243448.8	199.1	2.4
B5-05	5045866.7	243445.3	199.6	4.9
B5-06	5045875.2	243426.7	200.7	0.7
B5-07	5045840.5	243462.7	199.7 (193.6)	9.8
B5-08	5045835.6	243458.7	199.4 (192.9)	12.7
B5-09	5045840.3	243456.5	199.2 (194.4)	11.1
B5-10	5045845.0	243466.4	199.2 (196.2)	5.6
B5-11	5045840.6	243468.5	199.1 (193.7)	9.6
B5-12	5045812.7	243491.5	199.1 (192.7)	12.0
B5-13	5045807.9	243487.4	199.0 (193.4)	11.3
B5-14	5045812.5	243485.2	198.9 (193.0)	11.8



Borehole	Location (MTM Nad 83)		Ground Surface / Water Surface Elevation* (m)	Depth Drilled* (m)
	Northing	Easting		
B5-15	5045817.2	243495.0	198.8 (193.5)	12.0
B5-16	5045812.8	243497.3	198.7 (193.1)	8.0
B5-17	5045786.4	243508.2	207.1	0.2
B5-18	5045790.7	243505.3	205.2	10.0
B5-19	5045791.9	243513.0	208.3	0.0
B5-20	5045793.0	243521.7	209.7	0.3
B5-21	5045795.7	243518.8	209.1	0.1
B5-22	5045778.0	243527.4	212.3	0.1

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario*<sup>1</sup>, this section of 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*<sup>2</sup>. Deposition of Palaeozoic strata initially covered, and later erosion during glaciation subsequently exposed, these Precambrian rocks.

### 4.2 Subsurface Conditions

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

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

<sup>2</sup> Ontario Geological Society, 1991. *Geology of Ontario, Special Volume 4, Part 2*. Ministry of Northern Development and Mines, Ontario.



samples, are presented in the record of Boreholes sheets provided in Appendix A. The results of the laboratory tests are also provided in Appendix B. The results of the in situ field tests (i.e. SPT 'N'-values and undrained shear strengths from the field vanes) as presented on the Record of Borehole sheets and in Section 4.3 to 4.6 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole and Drillhole sheets 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 change. Further, subsurface conditions will vary between and beyond the borehole locations. It should be noted that the interpreted stratigraphy shown on Drawings 2 and 3 is a simplification of the subsurface conditions.

In general, the subsurface conditions in the area of the proposed south abutment consist of bedrock outcrops or surficial layers of topsoil underlain by a thin layer of silty sand over bedrock, while in the areas of the proposed piers and the north abutment consist of organic sand to organic sandy silt or topsoil underlain by alternating layers of sand to sandy silt and clayey silt to clay underlain by bedrock.

A detailed description of the subsurface conditions encountered in the boreholes at the abutments, piers, and approach areas is provided in the following sections.

### **4.3 South Abutment and Approach Area**

A total of five (5) boreholes (Boreholes B5-17 to B5-21) were advanced at the location of the proposed south abutment and one (1) borehole (Borehole B5-22) was advanced on the centerline at the proposed south approach. In general, the subsurface conditions consist of topsoil, underlain by silty sand at some locations over cobbles / rock fragments and bedrock.

#### **4.3.1 Topsoil**

An approximately 0.1 m to 0.2 m thick layer of topsoil was encountered at the ground surface in Boreholes B5-17 and B5-20 to B5-22.

#### **4.3.2 Silty Sand**

In Borehole B5-20, a localized deposit of silty sand containing some gravel, trace clay, trace organics was encountered below the topsoil. The top of this deposit was encountered at about Elevation 209.6 m and the thickness of the deposit is about 0.2 m.

A Standard Penetration Test (SPT) 'N'-value measured within the silty sand deposit is 4 blows per 0.3 m of penetration indicating a very loose relative density.

#### **4.3.3 Cobbles / Rock Fragments and Bedrock**

A layer of cobbles / rock fragments ranging from gravel to cobbles sizes was encountered at ground surface in Borehole B5-18 at about Elevation 205.2 m and the thickness of this layer is about 1 m. In general, the size of the recovered cobbles/rock fragments ranges from about 30 mm to 110 mm.



## FOUNDATION REPORT – SHAWANAGA RIVER SBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

Bedrock was encountered and core samples were recovered in Borehole B5-18 and bedrock was observed to outcrop at Borehole B5-19. The presence of bedrock was inferred by refusal to split-spoon advancement in Boreholes B5-20 and B5-21 and identified by hand excavations at Boreholes B5-17 and B5-22.

The top of the bedrock surface generally varies between about Elevations 209.4 m and 204.2 m at the proposed south abutment and is at about Elevation 212.3 m at the south approach area. The depth to bedrock below ground surface and corresponding bedrock surface elevation is summarized below.

Foundation Element / Approach Area	Borehole No.	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Refusal Type
South Approach Area	B5-22	0.1	212.2	Hand Shovel
	B5-17	0.2	206.9	Hand Shovel
South Abutment	B5-18	1.0	204.2	Bedrock Cored
	B5-19	0.0	208.3	Bedrock Outcrop
	B5-20	0.3	209.4	Split-Spoon
	B5-21	0.1	209.0	Split-Spoon

Across the south abutment from the southeast corner to the northwest corner of the abutment footprint (a distance of approximately 16.5 m between borehole locations), the bedrock surface elevation varies by about 5.2 m, corresponding to an approximately 3.2H:1V slope or a dip angle of approximately 17° from the horizontal.

Based on the bedrock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as slightly weathered to fresh, coarse grained, highly to moderately foliated, slightly to moderately porous, light grey to pink. The Rock Quality Designation (RQD) measured on the core samples ranges from 0 percent to 100 percent, indicating a rock mass of very poor to excellent quality according to Table 3.10 in CFEM (2006)<sup>3</sup>. The Total Core Recovery (TCR) of the samples recovered is between 7 percent and 100 percent and the Solid Core Recovery (SCR) of samples recovered is between 19 percent and 96 percent.

Point load strength tests were performed on selected samples of the rock core. The diametral point load strength index values are shown on the Record of Drillhole sheets in Appendix A and are presented in Table B1 in Appendix B. The diametral tests carried out on three (3) samples of the gneiss bedrock from this location measured  $Is_{50}$  values ranging from about 6.2 MPa to 9.9 MPa.

Also presented in Table B1 are the estimated Unconfined Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between  $Is_{50}$  and UCS which is given by a correlation factor (K) in accordance with (ASTM D5731 Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification), which may vary depending on the size of the core sample and the strength of the rock. For this site, the UCS values are based on an estimated average correlation factor (K) of 14, which was calculated based on a comparison of the Unconfined Compression (UC) test results and the average of the corresponding point load strength test

<sup>3</sup> Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual, 4th Edition. The Canadian Geotechnical Society c/o BiTech Publisher Ltd, British Columbia.





results. These values have been given for comparison only and should be interpreted together with the results of the UC tests.

Based on the point load test results, according to Table 3.5 in CFEM (2006)<sup>3</sup>, the gneiss bedrock at this location is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

#### **4.3.4 Groundwater Conditions**

A standpipe piezometer was installed in Borehole B5-18 to allow monitoring of the groundwater level at this location. Details of the piezometer installation are shown on the Record of Borehole and Drillhole sheets in Appendix A. In general, the overburden samples taken in the boreholes advanced in this area were moist to wet. The groundwater levels measured in the piezometer installation are summarized below.

<b>Foundation Element</b>	<b>Borehole No.</b>	<b>Ground Surface Elevation (m)</b>	<b>Groundwater Elevation (m)</b>	<b>Date of Measurement</b>
South Abutment	B5-18	205.2	203.0 202.8	July 28, 2009 August 26, 2009

It should be noted that the groundwater level in the area is subject to seasonal fluctuations due to snow melt and precipitation events. The water level in the adjacent Shawanaga River is also affected by run-off during periods of the year which can influence the groundwater conditions on the adjacent banks. Groundwater levels should be expected to be higher during wet periods of the year.

### **4.4 South Pier (Pier 1)**

A total of five (5) boreholes (Boreholes B5-12 to B5-16) were completed to investigate the subsurface conditions at the proposed south pier (Pier 1), located within the Shawanaga River. In general, the subsurface conditions consist of peat at some locations, underlain by alternating layers of non-cohesive soils comprised of sand and gravel, sand and sandy silt and cohesive soils comprised of clayey silt and silty clay, underlain by bedrock.

#### **4.4.1 Shawanaga River**

Boreholes B5-12 to B5-16 are in-water boreholes. At the time of the foundation investigation, the river level or water surface varied and was measured to range from about Elevations 199.1 m to 198.7 m, and the depth of water to the river bed ranges between about 5.3 m and 6.4 m. The surface of the riverbed varies between about Elevations 193.5 m and 192.7 m.

It should be noted that the elevation of the river level fluctuates on a seasonal basis especially during periods of rain or snow melt and run-off.

#### **4.4.2 Peat**

A deposit of brown, wet, amorphous peat containing wood fragments and interlayers of sand was encountered at the riverbed in Boreholes B5-12 and B5-15. The top of the peat deposit was encountered at



about Elevations 192.7 m and 193.5 m and the thickness of the deposit is about 0.6 m and 1.0 m at the respective boreholes.

The Standard Penetration Test (SPT) 'N'-values measured within the peat deposit are 0 blows (weight of hammer) and 1 blow per 0.3 m of penetration, suggesting a very soft consistency.

The natural water content measured on a sample of this deposit is about 279 percent.

#### **4.4.3 Sand to Sand and Silt (Upper Deposit)**

A non-cohesive deposit comprised of sand trace gravel and sand and silt trace clay, trace organics and containing wood fragments was encountered below the whe peat deposit in Boreholes B5-12 and B5-15 and at the riverbed in Boreholes B5-13 and B5-14. The top of this deposit varies between about Elevations 193.4 m and 192.1 m and the thickness of the deposit ranges from about 0.5 m to 2.5 m.

The SPT 'N'-values measured within the sand to sand and silt deposit range from 0 blows (weight of rod and weight of hammer) to 6 blows per 0.3 m of penetration, indicating a very loose to loose relative density. A SPT 'N'-value of 25 blows per 0.08 m of penetration was recorded at the interface of this deposit with the underlying layer of cobbles.

The natural water content measured on samples of this deposit ranges from about 24 percent to 66 percent.

A grain size distribution of a sample of the sand and silt portion of this deposit is shown on Figure B1-1 in Appendix B.

#### **4.4.4 Clayey Silt to Silty Clay**

A cohesive deposit of clayey silt to silty clay containing silt interlayers was encountered below the sand to sand and silt deposit in Boreholes B5-12 to B5-14. The top of this deposit varies between about Elevations 192.9 m and 190.5 m and the thickness of the deposit ranges from about 0.3 m to 0.7 m.

The SPT 'N'-values measured within the clayey silt to silty clay deposit range from 0 blows (weight of rod and weight of hammer) to 6 blows per 0.3 m of penetration. An in situ field vane test carried out within this deposit measured an undrained shear strength of about 27 kPa, and the sensitivity is calculated to be about 5. The SPT 'N'-values together with the field vane test result suggest that the clayey silt to silty clay has a very soft to firm consistency.

The natural water content measured on two (2) samples of this deposit is about 47 percent and 53 percent.

Atterberg limits tests carried out on two (2) samples of the clayey silt to silty clay deposit yielded liquid limits of about 34 percent and 48 percent, plastic limits of about 15 percent and 16 percent and corresponding plasticity indices of about 19 percent and 32 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B1-2 in Appendix B and indicate that this material is classified as clayey silt of low plasticity to silty clay of intermediate plasticity.



#### **4.4.5 Cobbles**

An approximately 0.4 m and 0.2 m thick layer of cobbles was encountered below the silty clay deposit at about Elevation 191.4 m in Borehole B5-12 and below the sand deposit at about Elevation 191.7 m in Borehole B5-15.

#### **4.4.6 Silty Sand to Sand to Sand and Gravel (Lower Deposit)**

A lower non-cohesive deposit comprised of silty sand, sand trace to some silt and trace to some gravel, and sand and gravel was encountered underlying the layer of cobbles in Borehole B5-12 and below the clayey silt to silty clay deposit in Boreholes B5-13 and B5-14. The top of this deposit varies between about Elevations 192.5 m and 189.8 m and the thickness of the deposit ranges from about 0.5 m to 1.1 m.

The SPT 'N'-values measured within this deposit range from 8 blows to 55 blows per 0.3 m of penetration, indicating a loose to very dense relative density. SPT 'N'-values of 100 blows per 0.18 m of penetration and 20 blows per 0.02 m of penetration were measured in Boreholes B5-13 and B5-14, respectively, immediately above the bedrock surface.

The natural water content measured on two (2) samples of this deposit is about 8 percent and 22 percent.

A grain size distribution of a sample from the sand portion of the deposit is shown on Figure B1-3 in Appendix B.

#### **4.4.7 Bedrock**

Bedrock was encountered below the subsoils in Boreholes B5-12 to B5-15 and at the river bed in Borehole B5-16, and core samples were recovered at the borehole locations.

The top of the bedrock surface varies between about Elevations 193.1 m and 188.7 m. The depth to bedrock from the river bed and the corresponding bedrock surface elevation is summarized below.

<b>Foundation Element</b>	<b>Borehole No.</b>	<b>Depth to Bedrock Surface from Riverbed (m)</b>	<b>Bedrock Surface Elevation (m)</b>	<b>Refusal Type</b>
South Pier (Pier 1)	B5-12	2.1	190.6	Bedrock Cored
	B5-13	1.8	191.7	Bedrock Cored
	B5-14	4.3	188.7	Bedrock Cored
	B5-15	2.0	191.5	Bedrock Cored
	B5-16	0.0	193.1	Bedrock Cored

Across the south pier, from the southeast corner to the northwest corner of the pier footprint (a distance of approximately 12.5 m between borehole locations), the bedrock surface elevation varies by about 4.4 m, corresponding to an approximately 2.8H:1V slope or a dip angle of approximately 19° from the horizontal.

Based on the bedrock core samples, the bedrock consists of granite gneiss. In general, the bedrock samples are described as slightly weathered to fresh, fine to coarse grained with feldspar banding, foliated, black, pink, dark grey and grey. The Rock Quality Designation (RQD) measured on the core samples ranges between 0 percent and 80 percent, indicating a rock mass of very poor to good quality according to



Table 3.10 in CFEM (2006)<sup>3</sup>. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the core samples are between about 91 percent and 100 percent and 11 percent and 88 percent, respectively.

Point load strength tests were performed on selected sample of the rock core. The diametral point load strength index values are shown on the Record of the Drillhole sheets in Appendix A and in Table B1 in Appendix B. The diametral tests carried out in six (6) samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from approximately 3.8 MPa to 7.0 MPa.

One (1) Unconfined Compression (UC) test was carried out in accordance with ASTM D7102 on a selected sample of the granite gneiss bedrock measured a compressive strength of about 99 MPa, as summarized in Table B2-1 and detailed in Table B2-2 in Appendix B.

Also presented in Table B1 are the estimated Unconfined Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between  $Is_{50}$  and UCS and a correlation factor (K) of 14, which was calculated based on a comparison of the UC test results and the point load strength test results. These values have been given for comparison only and should be interpreted together with the results of the UC test.

Based on the laboratory UC test and the point load test results, according to Table 3.5 in CFEM (2006)<sup>3</sup>, the granite gneiss bedrock at this location is classified as strong (R4, 50 MPa < UCS < 100 MPa).

## **4.5 North Pier (Pier 2)**

A total of five (5) boreholes (Boreholes B5-07 to B5-11) were completed to investigate the subsurface conditions at the proposed north pier (Pier 2), located within the Shawanaga River. In general, the subsurface conditions consist of organic sand and organic clayey silt at some locations underlain by alternating layers of non-cohesive soils comprised of sand, silty sand and sandy silt and cohesive soils comprised of clayey silt, silty clay and clay, underlain by bedrock.

### **4.5.1 Shawanaga River**

Boreholes B5-07 to B5-11 are in-water boreholes. At the time of the foundation investigation, the river level or water surface varied and was measured to range from about Elevations 199.7 m to 199.1 m, and the depth of water to the river bed ranges between about 3.0 m and 6.6 m. The surface of the riverbed varies between about Elevations 196.2 m and 192.9 m.

It should be noted that elevation of the river level fluctuates on a seasonal basis especially during periods of rain or snow melt and run-off.

### **4.5.2 Organic Sand and Organic Clayey Silt**

A deposit of organic sand containing wood fragments and rootlets was encountered at the riverbed in Boreholes B5-07 and B5-08. The top of the organic sand deposit is at about Elevations 193.6 m and 192.9 m and the thickness of the deposit is about 0.6 m and 1.5 m in the respective boreholes. In Borehole B5-09, an approximately 0.5 m thick deposit of organic clayey silt was encountered at the river bed at about Elevation 194.4 m. The organic clayey silt deposit contains trace gravel, trace sand and wood fragments.



The Standard Penetration Test (SPT) 'N'-values measured within the organic sand and organic clayey silt deposits are 0 blows (weight of rod) per 0.3 m of penetration, indicating a very loose relative density and very soft consistency, respectively.

The natural water content measured on one (1) sample of the organic clayey silt is about 93 percent.

#### **4.5.3 Clayey Silt to Clay**

A cohesive deposit comprised of clayey silt to silty clay to clay was encountered below the organic sand and organic clayey silt deposits in Boreholes B5-07 to B5-09. The top of this deposit varies between about Elevations 193.9 m and 191.3 m and the thickness of the deposit ranges from about 0.7 m to 2.0 m.

The SPT 'N'-values measured within the cohesive deposit are 0 blows (weight of the rod) per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strength of about 17 kPa and 18 kPa; and the sensitivity is calculated to be between about 4 and 5. The field vane test results indicate that the clayey silt to clay deposit has a soft consistency.

The natural water content measured on two (2) samples of the clayey silt to clay deposit is about 39 percent and 67 percent.

Atterberg limits tests were carried out on two (2) samples of the cohesive deposit and yielded liquid limits of about 45 percent and 53 percent, plastic limits of about 16 percent and 20 percent, and corresponding plasticity indices of about 29 percent and 33 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B1-4 in Appendix B and indicate that the cohesive material tested is classified as silty clay of intermediate plasticity to clay of high plasticity.

#### **4.5.4 Sand to Silty Sand to Sandy Silt**

A non-cohesive deposit of sand some silt to silty sand to sandy silt was encountered below the clayey silt to clay deposit in Boreholes B5-07 to B5-09 and at the river bed in Boreholes B5-10 and B5-11. The deposit encountered in Boreholes B5-10 and B5-11 contains trace gravel, organics and wood fragments. The top of the non-cohesive deposit varies between about Elevations 192.3 m and 189.3 m in Boreholes B5-07 to B5-09, while the top of the deposit was encountered at a higher Elevations 196.2 m and 193.7 m in Boreholes B5-10 and B5-11, respectively. The overall thickness of this deposit ranges from about 0.2 m to 1.1 m.

The SPT 'N'-values measured within this deposit range between 0 blows (weight of rod) and 3 blows per 0.3 m of penetration, 10 blows per 0.03 m of penetration and 5 blows per 0.13 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on a sample of the silty sand and on a sample of the sandy silt portion of this deposit is about 22 percent and 94 percent, respectively. The high water content indicates the presence of organics within the sandy silt material.

#### **4.5.5 Clay**

In Borehole B5-08, a localized deposit of clay containing silt interlayers was encountered below the silty sand deposit at about Elevation 188.9 m. The thickness of this deposit is about 0.7 m.



## FOUNDATION REPORT – SHAWANAGA RIVER SBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

An SPT 'N'-value of 1 blow per 0.3 m of penetration was recorded within this deposit, suggesting a very soft consistency.

The natural water content measured on a sample of the clay deposit is about 66 percent.

An Atterberg limits test was carried out in one (1) sample of this deposit and yielded a liquid limit of about 54 percent, a plastic limit of about 20 percent and a plasticity index of about 34 percent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B1-5 in Appendix B and indicates that this material is clay of high plasticity.

### 4.5.6 Bedrock

Bedrock was encountered below the overburden soils or at the riverbed surface and core samples were recovered at all borehole locations.

The top of bedrock surface generally varies between about Elevations 195.1 m and 188.2 m. The depth to the bedrock from the river bed and the corresponding bedrock surface elevation is summarized below.

Foundation Element	Borehole No.	Depth to Bedrock Surface from Riverbed (m)	Bedrock Surface Elevation (m)	Refusal Type
North Pier (Pier 2)	B5-07	1.5	192.1	Bedrock Cored
	B5-08	4.6	188.2	Bedrock Cored
	B5-09	2.9	191.5	Bedrock Cored
	B5-10	1.1	195.1	Bedrock Cored
	B5-11	0.4	193.3	Bedrock Cored

Across the north pier from the northeast corner to the southwest corner of the pier footprint (a distance of approximately 12.5 m between borehole locations), the bedrock surface elevation varies by about 6.9 m, corresponding to an approximately 1.8H:1V slope and a dip angle of approximately 29° from the horizontal.

Based on the bedrock core samples, the bedrock consists of granite gneiss. In general, the bedrock samples are describes as slightly weathered to fresh, fine to coarse grained with feldspar banding, foliated, black, pink, dark grey and grey. The Rock Quality Designation (RQD) measured on the core samples ranges between 39 percent and 78 percent, indicating a rock mass of poor to good quality according to Table 3.10 in CFEM (2006)<sup>3</sup>. The Total Recovery (TCR) and Solid Core Recovery (SCR) of core samples are between about 92 percent and 100 percent and about 39 percent and 92 percent, respectively.

Point load strength tests were performed on selected sample of the rock core. The diametral point load strength index values are shown on the Record of the Drillhole sheets in Appendix A and in Table B1 in Appendix B. The diametral tests carried out on four (4) samples of granite gneiss bedrock measured  $Is_{50}$  values ranging from approximately 7.7 MPa to 9.3 MPa.

One (1) Unconfined Compression (UC) test was carried out in accordance with ASTM D7102, on a selected sample of the granite gneiss bedrock and measured a compressive strength of about 118 MPa, as summarized in Table B2-1 and detailed in Table B2-3 in Appendix B.

Also presented in Table B1 are the estimated Unconfined Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between  $Is_{50}$  and UCS and a correlation factor





(K) of 14, which was calculated based on a comparison of the UC test results and the point load strength test results. These values have been given for comparison only and should be interpreted together with the results of the UC test.

Based on the laboratory UC test and the point load test results, according to Table 3.5 in CFEM (2006)<sup>3</sup>, the granite gneiss bedrock at this location is classified as very strong (R5, 100 MPa < UCS < 250 MPa).

## **4.6 North Abutment and Approach Embankment**

A total of five (5) boreholes (Boreholes B5-01 to B5-05) was advanced at the location of the proposed north abutment and one (1) borehole (Borehole B5-06) was advanced on the centerline at the north approach embankment. In general, the subsurface conditions consist topsoil/peat and organic sandy silt underlain by alternating layers of non-cohesive soils comprised of sand and gravel, sandy silt and sand and silt and cohesive soils comprised of clayey silt, silty clay and clay, underlain by bedrock.

### **4.6.1 Topsoil/Peat**

An approximately 0.2 m to 0.9 m thick deposit of topsoil/peat was encountered at the ground surface in all boreholes except for Borehole B5-04. The peat deposit contains wood fragments. In general, the top of the topsoil/peat deposit varies from about Elevations 200.7 m to 198.7 m.

The Standard Penetration Test (SPT) 'N'-values measured within the topsoil deposit range from 2 blows to 6 blows per 0.3 m of penetration, indicating a very loose to loose relative density. A SPT 'N'-value of 53 blows per 0.3 m of penetration was measured within the peat deposit in Borehole B5-05, suggesting a hard consistency. This high SPT 'N' value could be a result of wood fragments present within the peat deposit.

The natural water content measured on one (1) sample of topsoil is about 44 percent and the natural water content measured on one (1) sample of peat deposit is about 229 percent.

### **4.6.2 Organic Sandy Silt**

A deposit of dark brown to grey organic sandy silt trace to some clay, containing silty sand layers and rootlets was encountered below the topsoil in Borehole B5-03 and at the ground surface in B5-04. The top of this deposit is at about Elevations 199.2 m and 199.1 m and the thickness of this deposit is about 1.2 m and 0.6 m at the respective boreholes.

The SPT 'N'-values measured within this deposit are 2 blows and 3 blows per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on samples of this deposit ranges from about 28 percent to 87 percent. The organic content measured on one (1) sample this deposit in Borehole B5-04 is about 13 percent.

### **4.6.3 Sand and Gravel to Sand and Silt to Sandy Silt (Upper Deposit)**

A non-cohesive deposit comprised of sand and gravel trace silt, sand and silt trace to some clay and sandy silt trace clay was encountered either below the topsoil/peat or organic sandy silt in all the boreholes except



for Borehole B5-04. In Boreholes B5-01, B5-02 and B5-05, the deposit contains organics and rootlets. The top of this deposit at the boreholes typically ranges from about Elevations 198.9 m to 198.0 m, while in Borehole B5-06 the surface of the deposit is at about Elevation 200.5 m. The thickness of this deposit ranges from about 0.5 m to 1.4 m. The bottom of this deposit was defined by refusal to auger advancement and/or dynamic cone penetration in Boreholes B5-03 and B5-06.

The SPT 'N'-values measured within the sand and silt to sandy silt deposit typically range from 2 blows to 14 blows per 0.3 m of penetration, and a SPT 'N'-value of 30 blows per 0.3 m of penetration was recorded within the sand and gravel portion of deposit, all indicating a very loose to dense relative density. In addition, a SPT 'N'-value of 69 blows per 0.1 m of penetration was recorded in Borehole B5-05 immediately above the bedrock surface.

The natural water content measured on one (1) sample of the sand and gravel portion of the deposit in Borehole B5-06 is about 8 percent. The natural water content measured on five (5) samples of the sand and silt to sand silt portions of the deposit ranges from about 20 percent to 82 percent, with the high water content recorded within the upper portion of the deposit containing organics.

The grain size distributions of two (2) samples of the sand and silt to sandy silt portion of this deposit are shown on Figure B1-6 in Appendix B.

#### **4.6.4 Clayey Silt to Clay**

A cohesive deposit comprised of clayey silt, silty clay and clay was encountered below the sand and silt deposit in Boreholes B5-01 and B5-02 and below the organic sandy silt deposit in Borehole B5-04. The clayey silt deposit encountered in Borehole B5-04 contains trace to some sand. The top of this deposit varies between about Elevations 198.5 m and 197.2 m and the thickness of the deposit ranges from about 0.1 m to 1.8 m. The bottom of this deposit was defined by refusal to split-spoon and auger advancement and dynamic cone penetration in Boreholes B5-04.

The SPT 'N'-values measured within this deposit range from 1 blow to 8 blows per 0.3 m of penetration. Two in situ field vane tests carried out within the clay deposit measured undrained shear strengths of about 21 kPa and 53 kPa, and the sensitivity is calculated to be about 3 and 6. The SPT 'N'-values and the field vane test results suggest that the clayey silt to clay deposit has a very soft to stiff consistency.

The natural water content measured on three (3) samples of this deposit ranges from about 21 percent to 66 percent.

Atterberg limits tests were carried out on two (2) samples of the clay portion of this deposit, and measured liquid limits of about 51 percent, plastic limits of about 18 percent and the corresponding plasticity indices of about 33 percent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B1-7 in Appendix B, and indicate that the material is classified as clay of high plasticity.

#### **4.6.5 Sand and Silt to Sand and Gravel (Lower Deposit)**

A lower non-cohesive deposit of sand and silt containing trace clay was encountered immediately below the silty clay to clay deposit in Boreholes B5-01 and B5-02. In Borehole B5-02, the sand and silt deposit grades to sand and gravel immediately over the bedrock surface. The sand and gravel layer contains trace silt and



## FOUNDATION REPORT – SHAWANAGA RIVER SBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

cobbles. The top of this deposit was encountered at about Elevations 197.7 m and 196.6 m, and the thickness of the deposit is about 0.7 m and 0.6 m at the respective boreholes.

The SPT 'N'-values measured within this deposit are 4 blows and 11 blows per 0.3 m of penetration, indicating a loose to compact relative density. A SPT 'N'-value of 100 blows per 0.07 m of penetration was recorded at the transition zone of sand and silt to sand and gravel in Borehole B5-01, which is immediately above the bedrock surface.

The natural water content measured on two (2) samples of this deposit is about 14 percent and 25 percent.

### 4.6.6 Bedrock/Refusal

In Boreholes B5-03, B5-04 and B5-06, the presence of bedrock was inferred from refusal to auger advancement and resistance to cone penetration. Bedrock was encountered and core samples were recovered in Boreholes B5-01, B5-02 and B5-05.

The top of bedrock surface varies between about Elevations 197.8 m and 195.9. The depth to bedrock surface from the ground surface and the corresponding bedrock elevation is summarized below.

Foundation Element / Approach Embankment	Borehole No.	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Refusal Type
North Abutment	B5-01	2.5	197.0	Bedrock Cored
	B5-02	2.8	195.9	Bedrock Cored
	B5-03	2.8	196.6	Auger Refusal
	B5-04	2.4	196.7	Auger Refusal
	B5-05	1.8	197.8	Bedrock Cored
North Approach Embankment	B5-06	0.7	200.0	Auger Refusal

Across the north abutment from the northeast corner to the southwest corner of the abutment footprint (a distance of approximately 14.5 m between borehole locations), the bedrock surface elevation varies by about 1.9 m, corresponding to an approximately 7.6H:1V slope and a dip angle of approximately 7° from the horizontal.

Based on the bedrock core samples, the bedrock consists of granite gneiss. In general the bedrock samples are described as slightly weathered to fresh, fine to coarse grained with feldspar banding, foliated, black, pink and grey. The Rock Quality Designation (RQD) measured on the cored samples ranges from 45 percent to 88 percent, indicating a rock mass of poor to good quality according to Table 3.10 in CFEM (2006)<sup>3</sup>. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the core samples are between about 91 percent and 100 percent and between about 29 percent and 90 percent, respectively.

Point load strength tests were performed on selected samples of the rock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets in Appendix A and are presented in Table B1 in Appendix B. The axial point load test carried out on two (2) samples of the granite gneiss bedrock measured  $Is_{50}$  values of 4.2 MPa and 4.5 MPa. The diametral tests carried out on six (6) core samples of the granite gneiss bedrock measured  $Is_{50}$  values ranging from approximately 5.3 MPa to 8.5 MPa.



One (1) Unconfined Compression (UC) test was carried out in accordance to ASTM D7102, on a selected sample of the granite gneiss bedrock and measured a compressive strength of about 58 MPa, as summarized on Table B2-1 and detailed on Table B2-4 in Appendix B.

Also presented in Table B1 are the estimated Unconfined Compressive Strength (UCS) values for each sample tested for point load strength based on a relationship between  $Is_{50}$  and UCS and a correlation factor (K) of 14, which was calculated based on a comparison of the UC test results and the point load strength test results. These values have been given for comparison only and should be interpreted together with the results of the UC test.

Based on the laboratory UC test and the point load test results, according to Table 3.5 in CFEM (2006)<sup>3</sup>, the granite gneiss bedrock at this location is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

#### **4.6.7 Groundwater Conditions**

A standpipe piezometer was installed in Borehole B5-01 to allow monitoring of the groundwater level at the site. Details of the piezometer installation are shown on the Record of Borehole and Drillhole sheets in Appendix A. In general, the overburden samples taken in boreholes advanced in this area were moist to wet. The groundwater levels measured in the piezometer installation are summarized below.

Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
North Abutment	B5-01	199.5	199.3	April 16, 2009
			199.0	August 26, 2009

It should be noted that groundwater level in the area is subject to seasonal fluctuations, snow melt and precipitation events. The water level in the adjacent Shawanaga River is also affected by run-off during periods of the year which can influence the groundwater conditions on the adjacent banks. Groundwater levels should be expected to be higher during wet periods of the year.

## **5.0 CLOSURE**

Messrs. Matt Rhody and Chris Radway, senior technicians with Golder, directed the drilling program. This report was prepared Ms. T. Veronica Ayetan, P.Eng., and was reviewed by Mr. J. Paul Dittrich, Ph.D., P.Eng., a senior geotechnical engineer and Principal with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report.



## FOUNDATION REPORT – SHAWANAGA RIVER SBL BRIDGE STRUCTURE – HIGHWAY 69 G.W.P. 5111-07-00

### Report Signature Page

Christopher Ng, P. Eng.  
Geotechnical Engineer, Associate



Jorge M. A. Costa, P. Eng.  
Designated MTO Contact, Principal

TVA/CN/JPD/JMAC/jl



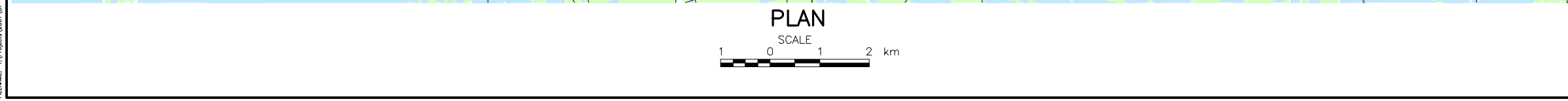
J. Paul Dittrich, Ph.D., P. Eng.,  
Senior Geotechnical Engineer, Principal

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# **DRAWINGS**





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

CONT No.  
WP No. 5188-06-01



HIGHWAY 69  
SITE LOCATION PLAN



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN  
NOT TO SCALE

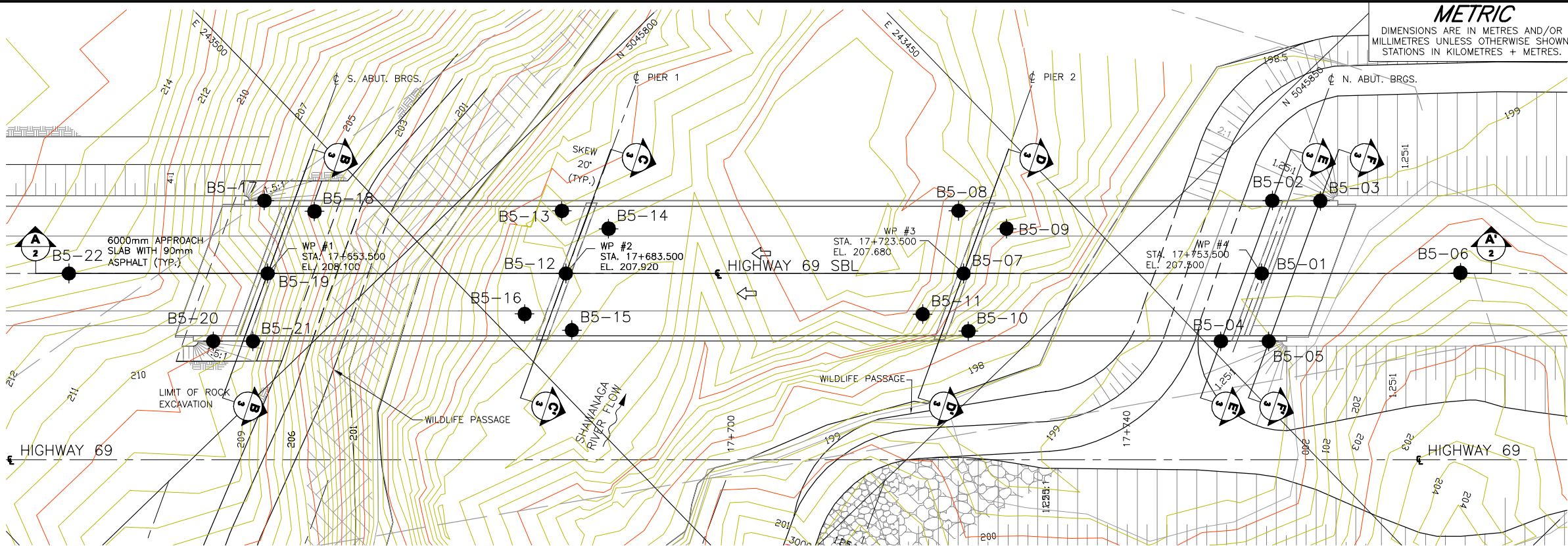


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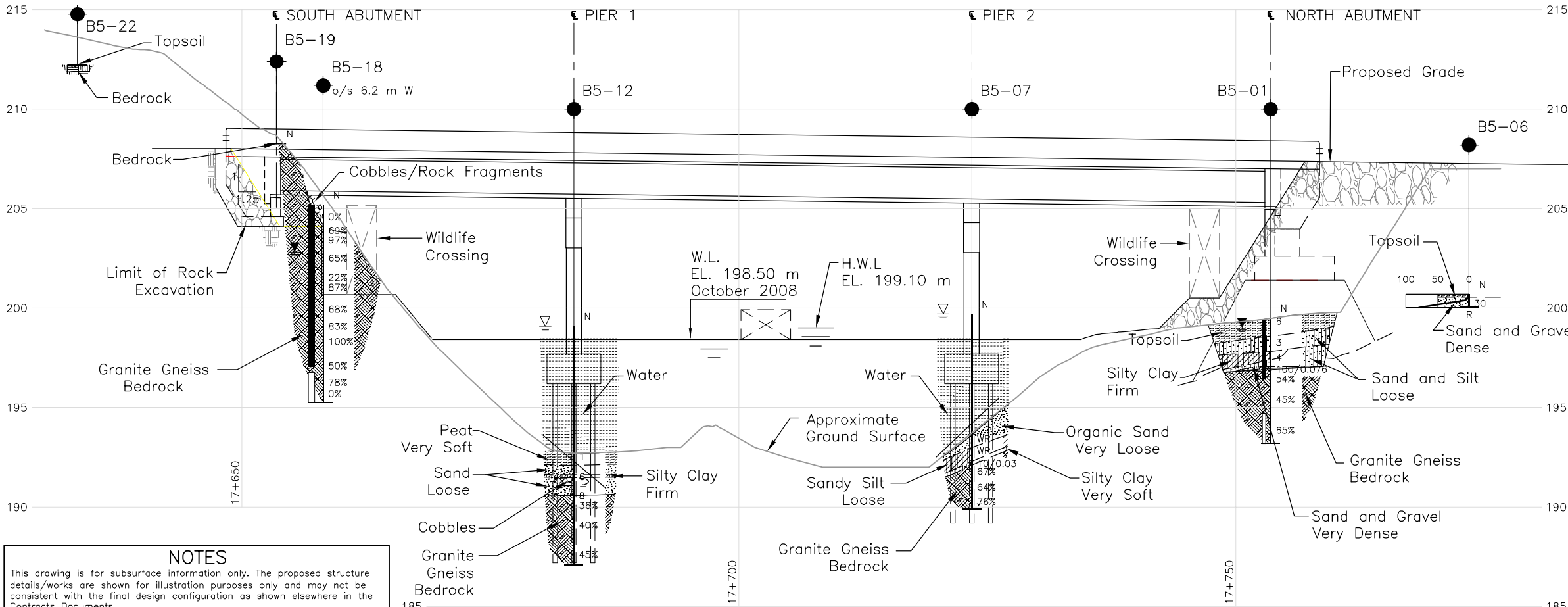
Base Data – MNR NRVIS, obtained 2004, CANMAP v2006.4  
Produced by Golder Associates Ltd under licence from  
Ontario Ministry of Natural Resources, © Queens Printer 2008  
Datum : NAD 83 Projection : MTM Zone 10

NO.	DATE	BY	REVISION		
Geocres No. 41H-146					
HWY. 69			PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA		CHKD. VA	DATE: Mar. 2015	SITE: 44-443/2	
DRAWN: DD/CD		CHKD. CN	APPD. JPD/JMAC	DWG. 1	

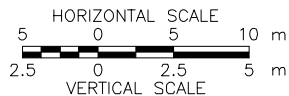




PLAN



A-A' CENTRELINE PROFILE



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.

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

CONT No.  
WP No. 5188-06-01

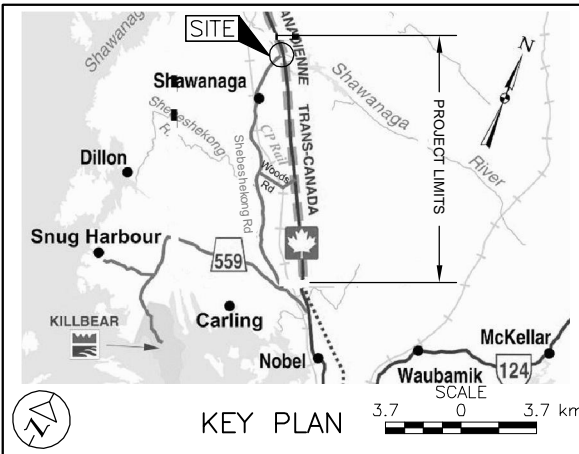
HIGHWAY 69  
SHAWANAGA RIVER BRIDGE (SBL)  
BOREHOLE LOCATIONS  
AND SOIL STRATA



SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



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 26/08/2009
- WL upon completion of drilling
- R Refusal

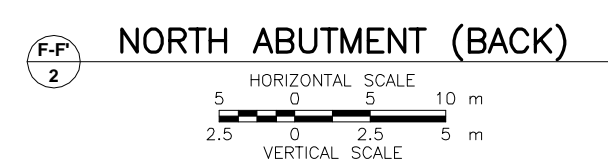
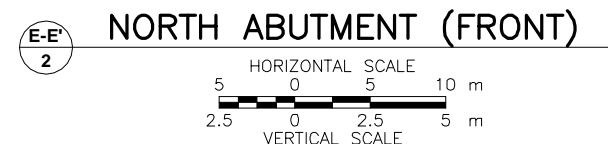
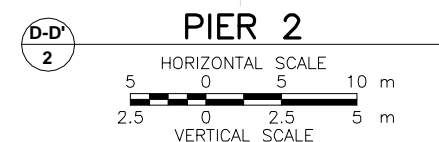
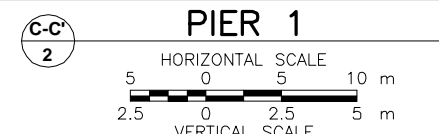
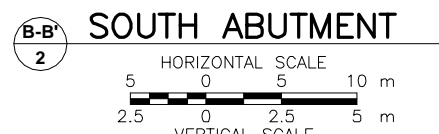
No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
B5-01	199.5	5045861.4	243441.1
B5-02	198.7	5045856.8	243435.3
B5-03	199.4	5045860.2	243431.8
B5-04	199.1	5045863.4	243448.8
B5-05	199.6	5045866.7	243445.3
B5-06	200.7	5045875.2	243426.7
B5-07	199.7	5045840.5	243462.7
B5-08	199.4	5045835.6	243458.7
B5-09	199.2	5045840.3	243456.5
B5-10	199.2	5045845.0	243466.4
B5-11	199.1	5045840.6	243468.5
B5-12	199.1	5045812.7	243491.5
B5-13	199.0	5045807.9	243487.4
B5-14	198.9	5045812.5	243485.2
B5-15	198.8	5045817.2	243495.0
B5-16	198.7	5045812.8	243497.3
B5-17	207.1	5045786.4	243508.2
B5-18	205.2	5045790.7	243505.3
B5-19	208.3	5045791.9	243513.0
B5-20	209.7	5045793.0	243521.7
B5-21	209.1	5045795.7	243518.8
B5-22	212.3	5045778.0	243527.4

REFERENCE

Base plans provided in digital format by MRC, drawing files 271XB01.DWG, 5271-XPD-SHAWANAGA.dwg, PR # 377-02-00-PR-1.dwg, received October 1, 2007, and by MMM, file S6878-310-001GA.dwg, received February 9, 2015.  
Approximate centerline profile based on topographic data provided by MRC, drawing file h6878xb07 Phase-2 contours 1m intervals.dwg, received September 10, 2014.

NO.	DATE	BY	REVISION
Geocres No. 41H-146			
HWY. 69	PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA	CHKD. VA/OK	DATE: Mar. 2015	SITE: 44-443/2
DRAWN: JS/JFC	CHKD. CN	APPD. JPD/JMAC	DWG. 2

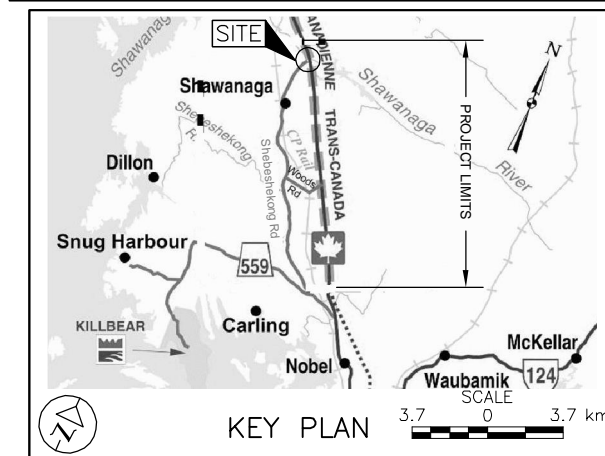









**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

HIGHWAY 69  
SHAWANAGA RIVER BRIDGE (SBL)  
SOIL STRATA

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 26/08/2009                           |
|  | WL upon completion of drilling                                     |
| R   | Refusal  |

No.	ELEVATION	CO—ORDINATES	
		NORTHING	EASTING
B5—01	199.5	5045861.4	243441.1
B5—02	198.7	5045856.8	243435.3
B5—03	199.4	5045860.2	243431.8
B5—04	199.1	5045863.4	243448.8
B5—05	199.6	5045866.7	243445.3
B5—07	199.7	5045840.5	243462.7
B5—08	199.4	5045835.6	243458.7
B5—10	199.2	5045845.0	243466.4
B5—12	199.1	5045812.7	243491.5
B5—14	198.9	5045812.5	243485.2
B5—16	198.7	5045812.8	243497.3
B5—18	205.2	5045790.7	243505.3
B5—19	208.3	5045791.9	243513.0
B5—20	209.7	5045793.0	243521.7

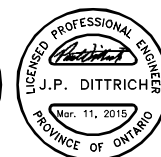
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NOTES

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.



NO.	DATE	BY	REVISION
Geocres No. 41H-146			
HWY. 69		PROJECT NO. 07-1111-0029	DIST.
SUBM'D. VA	CHKD. VA/OK	DATE: Mar. 2015	SITE: 44-443
DRAWN: JS/JFC	CHKD. CN	APPD. JPD/JMAC	DWG. 3



# APPENDIX A

## RECORD OF BOREHOLES AND DRILLHOLES





## 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

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

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

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

#### (b) Hydraulic Properties

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

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

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

#### (d) Shear Strength

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

Notes: 1  
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) Cohesionless Soils

Density Index	N
Relative Density	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

	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 <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

Percent 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 (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° 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 B5-01		SHEET 1 OF 1		METRIC															
W.P. 07-1111-0029		LOCATION		N 5045861.4 ; E 243441.1		ORIGINATED BY		MR															
DIST		HWY 69		BOREHOLE TYPE		165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY															
DATE		Geodetic		DATE		February 2 & 3, 2009		CHECKED BY															
								OK															
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															
199.5	GROUND SURFACE							20 40 60 80 100															
0.0	TOPSOIL		1	SS	6		199						43.6										
198.6			2A																				
0.9	SAND and SILT, trace clay, trace organics, containing rootlets		2B	SS	3								81.3	0 42 54 4									
197.8	Loose Brown to grey Moist		3A				198																
1.8	SILTY CLAY Firm Brown Wet		3B	SS	4																		
197.1			3C																				
2.5	SAND and SILT, trace clay Loose Grey Wet		4A	SS	100/0.07		197																
	SAND and GRAVEL, trace silt, inferred cobbles Very dense Grey Wet		1	RC	REC 97%		196							RQD = 54%									
	Granite Gneiss (BEDROCK)		2	RC	REC 91%		195							RQD = 45%									
	Bedrock cored from depths of 2.5 m to 6.3 m																						
	For bedrock coring details, refer to Record of Drillhole B5-01		3	RC	REC 100%		194							RQD = 65%									
193.2	END OF BOREHOLE																						
6.3	NOTES: 1. Water level in open borehole at a depth of 1.8 m below ground surface (Elev. 197.7 m) upon completion of overburden drilling. 2. Water level measurements in Piezometer: <table border="1" style="margin-left: 20px;"> <tr> <th>Date</th> <th>Depth (m)</th> <th>Elev. (m)</th> </tr> <tr> <td>16/04/09</td> <td>0.2</td> <td>199.3</td> </tr> <tr> <td>26/08/09</td> <td>0.5</td> <td>199.0</td> </tr> </table>														Date	Depth (m)	Elev. (m)	16/04/09	0.2	199.3	26/08/09	0.5	199.0
Date	Depth (m)	Elev. (m)																					
16/04/09	0.2	199.3																					
26/08/09	0.5	199.0																					

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Walker Drilling

CHECKED: OK

PROJECT 07-1111-0029			RECORD OF BOREHOLE No B5-02			SHEET 1 OF 1			METRIC								
W.P. 5188-06-01			LOCATION N 5045856.8 ; E 243435.3			ORIGINATED BY MR											
DIST HWY 69			BOREHOLE TYPE 165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring			COMPILED BY VA											
DATUM Geodetic			DATE February 3, 2009			CHECKED BY OK											
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									
198.7	GROUND SURFACE																
0.0	TOPSOIL																
0.2	SAND and SILT, trace to some clay, trace organics, containing rootlets Very loose to loose Brown to brown and grey Wet		1	SS	2												
197.2			2	SS	9												
1.5	CLAY Soft Mottled brown Wet		3	SS	1												
196.6																	
2.1	SAND and SILT, trace clay Compact Grey Wet		4	SS	11												
195.9																	
2.8	Granite Gneiss (BEDROCK)																
	Bedrock cored from depths of 2.8 m to 5.9 m  For bedrock coring details, refer to Record of Drillhole B5-02		1	RC	REC 93%												RQD = 82%
			2	RC	REC 95%												RQD = 77%
192.8																	
5.9	END OF BOREHOLE																
NOTES:																	
1. Water level in open borehole at a depth of 0.3 m below ground surface (Elev. 198.4 m) upon completion of overburden drilling.																	
2. An additional borehole was drilled 1.0 m east of Borehole B5-02 to carry out in situ vane testing at a depth of 1.8 m below ground surface (Elev. 196.9 m).																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B5-02**

SHEET 1 OF 1

LOCATION: N 5045856.8 ;E 243435.3

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	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.	NOTES
		Continued from Record of Borehole B5-02		195.90									
3	NW Casing February 3, 2009	GRANITE GNEISS Slightly weathered to fresh, fine to coarse grained, foliated, black and grey		2.80	1								
4	HQ RC February 3, 2009												
5					2								
6		END OF DRILLHOLE		192.79									
7				5.91									
8													
9													
10													
11													
12													

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B5-03		SHEET 1 OF 1		METRIC						
W.P. 07-1111-0029		LOCATION		N 5045860.2 ; E 243431.8		ORIGINATED BY		MR						
DIST		HWY 69		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY						
VA		DATE		February 5, 2009		CHECKED BY		OK						
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						
199.4	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	TOPSOIL													
0.2	Organic Sandy SILT, some clay, containing rootlets Very loose Brown to grey Moist		1A	SS	3		199							
			1B											
			2A											
			2B	SS	2									
			2C											
198.0	Sandy SILT, trace clay Loose Grey Wet						198							
1.4			3	SS	5									
			4	SS	7		197							
196.6	END OF BOREHOLE AUGER REFUSAL													
3.0	END OF DCPT Refusal to Further Penetration (100 Blows / 0.23 m)													
NOTES: 1. Water level in open borehole at a depth of 1.4 m below ground surface (Elev. 198.0 m) upon completion of drilling. 2. A Dynamic Cone Penetration Test was carried out at 1.5 m east of Borehole B5-03; refusal encountered at a depth of 3.0 m below ground surface (Elev. 196.4 m).														

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC



PROJECT		RECORD OF BOREHOLE		No B5-04		SHEET 1 OF 1		METRIC																
W.P. 5188-06-01		LOCATION		N 5045863.4 ; E 243448.8		ORIGINATED BY		MR																
DIST		HWY 69		BOREHOLE TYPE		108 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY																
VA		DATE		February 5, 2009		CHECKED BY		OK																
DATUM		Geodetic																						
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	80	100	10	20
199.1	GROUND SURFACE																							
0.0	Organic Sandy SILT, trace clay, containing silty sand layers		1	SS	3		199																	
198.5	Very loose Dark brown Moist		2	SS	8		198																	
0.6	CLAYEY SILT, trace to some sand																							
197.9	Firm Brown to grey Wet		3	SS	6		197																	
1.2	CLAY Stiff Brown Wet																							
196.7	END OF BOREHOLE SPOON AND AUGER REFUSAL																							
2.4	END OF DCPT Refusal to Further Penetration (100 Blows / 0.28 m)																							
NOTES: 1. Water level in open borehole at a depth of 1.7 m below ground surface (Elev. 197.4 m) upon completion of drilling. 2. A Dynamic Cone Penetration Test was carried out 1.5 m west of Borehole B5-04; refusal encountered at a depth of 2.4 m below ground surface (Elev. 196.7 m). 3. An additional borehole was drilled 1.5 m north-west of Borehole B5-04 to obtain a Shelby tube sample between depths of 1.8 m and 2.3 m.																								

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B5-05		SHEET 1 OF 1		METRIC								
W.P. 5188-06-01		LOCATION		N 5045866.7 ; E 243445.3		ORIGINATED BY		MR								
DIST		HWY 69		BOREHOLE TYPE		165 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring		COMPILED BY								
DATUM		Geodetic		DATE		February 8, 2009		CHECKED BY								
								OK								
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								
199.6	GROUND SURFACE															
0.0	PEAT, containing wood fragments		1	SS	53										229.2	
198.9	Hard Brown Moist		2A	SS	14										54.9	
0.7	SAND and SILT, trace clay, trace organics, containing rootlets to a depth of 1.1 m		2B	SS												
197.8	Compact Dark brown to grey Moist to wet		3	SS	59/0.10											
1.8	Granite Gneiss (BEDROCK)															
	Bedrock cored from depths of 1.8 m to 4.9 m		1	RC	REC 100%											RQD = 88%
	For bedrock coring details, refer to Record of Drillhole B5-05															
			2	RC	REC 100%											RQD = 85%
195																
194.7	END OF BOREHOLE															
4.9	NOTE: 1. Water level in open borehole at a depth of 1.5 m below ground surface (Elev. 198.1 m) upon completion of overburden drilling.															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Walker Drilling

T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL & SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

CHECKED: OK

PROJECT		RECORD OF BOREHOLE		No B5-06		SHEET 1 OF 1		METRIC									
W.P. 5188-06-01		LOCATION		N 5045875.2 ; E 243426.7		ORIGINATED BY		MR									
DIST		HWY 69		BOREHOLE TYPE		165 mm O.D. Continuous Flight Solid Stem Augers		COMPILED BY									
VA		DATE		February 6, 2009		CHECKED BY		OK									
Geodetic																	
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									
200.7	GROUND SURFACE																
0.0	TOPSOIL		1A														
0.2	SAND and GRAVEL, trace silt		1B	SS	30												
200.0	Dense Brown Moist																
0.7	END OF BOREHOLE AUGER REFUSAL																
NOTES: 1. Open borehole dry upon completion of drilling. 2. A Dynamic Cone Penetration Test was carried out 1.5 m east of Borehole B5-06; refusal encountered at a depth of 0.5 m below ground surface (Elev. 200.2 m).																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT 07-1111-0029		RECORD OF BOREHOLE No B5-07		SHEET 1 OF 1		METRIC											
W.P. 5188-06-01		LOCATION N 5045840.5 ; E 243462.7		ORIGINATED BY MR													
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring		COMPILED BY TZ													
DATUM Geodetic		DATE April 8, 2009		CHECKED BY OK													
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	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	10 20 30					
199.7 0.0	WATER SURFACE Water					▽											
193.6 6.1	Organic SAND, containing wood fragments Very loose Brown Wet		1	SS	WR												
193.0 6.7	SILTY CLAY Very soft Brown Wet		2	SS	WR												
192.3 7.6	Sandy SILT, trace gravel Loose Grey Wet		3	SS	10/0.03												
	Granite Gneiss (BEDROCK)																
	Bedrock cored from depths of 7.6 m to 9.8 m																
	For bedrock coring details, refer to Record of Drillhole B5-07																
189.9 9.8	END OF BOREHOLE																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B5-07**

SHEET 1 OF 1

LOCATION: N 5045840.5 ;E 243462.7

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec		Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES							
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn				10 10 10 10	10 10 10 10					
																							JN - Joint	BD - Bedding	PL - Planar	PO - Polished	MB - Mechanical Break
																							FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	BR - Broken Rock
SH - Shear	CO - Contact	UN - Undulating	SM - Smooth																								
VN - Vein	OR - Orthogonal	ST - Stepped	RO - Rough																								
CJ - Conjugate	CL - Cleavage	IR - Irregular	VR - Very Rough																								
NOTE: For additional abbreviations refer to list of abbreviations & symbols.																											

8	NW Casing April 9, 2009	Continued from Record of Borehole B5-07		192.11 7.59	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC



PROJECT		RECORD OF BOREHOLE		No B5-08		SHEET 1 OF 1		METRIC						
W.P. 07-1111-0029		LOCATION		N 5045835.6 ; E 243458.7		ORIGINATED BY		MR						
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring		COMPILED BY						
DATUM		Geodetic		DATE		April 9, 2009		CHECKED BY						
								OK						
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						
199.4 0.0	WATER SURFACE Water							20 40 60 80 100	20 40 60 80 100	10 20 30				GR SA SI CL
192.8 6.6	Organic SAND, containing wood fragments and rootlets Very loose Black Wet		1	SS	WR									
191.3 8.1	CLAYEY SILT Soft Grey Wet		2	SS	WR									
			3	SS	WR									
			4	TO	PM									
189.3 10.5	Silty SAND Very loose Grey Wet		5A	SS	1									
188.2 11.2	CLAY, containing silt interlayers Very soft Brown Wet		5B	SS	1									
	Granite Gneiss (BEDROCK)													
	Bedrock cored from depths of 11.2 m to 12.7 m		1	RC	REC 98%									RQD = 63%
186.7 12.7	For bedrock coring details, refer to Record of Drillhole B5-08 END OF BOREHOLE													

GTA-MTO 001 T:\PROJECTS\2007-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B5-08**

SHEET 1 OF 1

LOCATION: N 5045835.6 ;E 243458.7

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	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.												NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
								RECOVERY				R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA								HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
								TOTAL CORE %	SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS			TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	K <sub>10</sub>	K <sub>25</sub>	K <sub>50</sub>	K <sub>100</sub>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
	NW Casing April 9, 2009	Continued from Record of Borehole B5-08  GRANITE GNEISS Slightly weathered to fresh, fine to coarse grained with feldspar banding, foliated, black, pink and grey		188.20 11.20	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MASS.GDT 03/12/15 SAC

PROJECT 07-1111-0029		RECORD OF BOREHOLE No B5-09		SHEET 1 OF 1		METRIC												
W.P. 5188-06-01		LOCATION N 5045840.3 ; E 243456.5		ORIGINATED BY MR														
DIST _____ HWY 69		BOREHOLE TYPE NW Casing, Wash Boring		COMPILED BY TZ														
DATUM Geodetic		DATE April 10, 2009		CHECKED BY OK														
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	SHEAR STRENGTH kPa					WATER CONTENT (%)					
199.2 0.0	WATER SURFACE Water							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	10 20 30	γ	GR SA SI CL			
194.4 4.8	Organic CLAYEY SILT, trace gravel, trace sand, containing wood fragments		1A	SS	WR		199							92.8				
193.9 5.3	Very soft Brown Wet CLAY Soft Grey Wet		1B	SS	WR		198							67.5				
			2	SS	WR		197											
							196											
							195											
192.0 7.2	Sandy SILT Grey Wet		3A	TO	PM		194											
191.5 7.7	Granite Gneiss (BEDROCK)		3B				193	5 + 5 +										
	Bedrock cored from depths of 7.7 m to 11.1 m		1	RC	REC 92%		192											
	For bedrock coring details, refer to Record of Drillhole B5-09		2	RC	REC 100%		191								RQD = 39%			
			3	RC	REC 100%		190								RQD = 70%			
							189								RQD = 58%			
188.1 11.1	END OF BOREHOLE																	

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B5-09**

SHEET 1 OF 1

LOCATION: N 5045840.3 ;E 243456.5

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	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.	NOTES
8	NW Casing April 10, 2008	Continued from Record of Borehole B5-09		191.46 7.74	1								
9	NO RC April 10, 2009	GRANITE GNEISS Slightly weathered to fresh, fine to coarse grained with feldspar banding, foliated, black, pink and grey			2								
10					3								
11		END OF DRILLHOLE		188.10 11.10									
12													
13													
14													
15													
16													
17													

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MASS.GDT 03/12/15 SAC

PROJECT 07-1111-0029			RECORD OF BOREHOLE No B5-10			SHEET 1 OF 1			METRIC								
W.P. 5188-06-01			LOCATION N 5045845.0 ; E 243466.4			ORIGINATED BY MR											
DIST HWY 69			BOREHOLE TYPE NW Casing, Wash Boring			COMPILED BY TZ											
DATUM Geodetic			DATE April 10, 2009			CHECKED BY OK											
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									
199.2 0.0	WATER SURFACE Water							20	40	60	80	100					
196.2 3.0	Sandy SILT, trace gravel, trace organics, containing wood fragments Very loose Grey Wet		1	SS	WR												
195.1 4.1	Granite Gneiss (BEDROCK)		2	SS	3												
	Bedrock cored from depths of 4.1 m to 5.6 m																
	For bedrock coring details, refer to Record of Drillhole B5-10		1	RC	REC 98%												
193.6 5.6	END OF BOREHOLE																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B5-10**

SHEET 1 OF 1

LOCATION: N 5045845.0 ;E 243466.4

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	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.	NOTES
5	NQ RC April 10, 2009	GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, dark grey to pink		195.09 4.11	1								
6		END OF DRILLHOLE		193.56 5.64									
7													
8													
9													
10													
11													
12													
13													
14													

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MASS.GDT 03/12/15 SAC



PROJECT 07-1111-0029		RECORD OF BOREHOLE No B5-11		SHEET 1 OF 1		METRIC											
W.P. 5188-06-01		LOCATION N 5045840.6 ; E 243468.5		ORIGINATED BY MR													
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring		COMPILED BY TZ													
DATUM Geodetic		DATE April 11, 2009		CHECKED BY OK													
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	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W <sub>p</sub> — W — W <sub>L</sub>			γ	GR SA SI CL
199.1 0.0	WATER SURFACE Water					▽	199										
							198										
							197										
							196										
							195										
							194										
193.7 5.8	SAND, some silt, trace gravel, trace organics, containing wood fragments Loose Black Wet Granite Gneiss (BEDROCK)  Bedrock cored from depths of 5.8 m to 9.6 m  For bedrock coring details, refer to Record of Drillhole B5-11		1	SS	5/0.13		193										RQD = 43%
			1	RC	REC 96%		192										RQD = 70%
			2	RC	REC 93%		191										RQD = 78%
			3	RC	REC 100%		190										
189.5 9.6	END OF BOREHOLE																

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B5-11

SHEET 1 OF 1

LOCATION: N 5045840.6 ;E 243468.5

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	COLOUR % RETURN	FLUSH	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.	NOTES	
				DEPTH										
				(m)										
6	NW Casing April 11, 2009	Continued from Record of Borehole B5-11  GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, black, pink and grey		193.34 5.76										
7					1									
8	NQ RC April 11, 2009				2									
9					3									
10		END OF DRILLHOLE		189.53 9.57										
11														
12														
13														
14														
15														

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MASS.GDT 03/12/15 SAC

PROJECT 07-1111-0029		RECORD OF BOREHOLE No B5-12		SHEET 1 OF 1		METRIC										
W.P. 5188-06-01		LOCATION N 5045812.7 ; E 243491.5		ORIGINATED BY MR												
DIST _____ HWY 69		BOREHOLE TYPE NW Casing, Wash Boring		COMPILED BY TZ												
DATUM Geodetic		DATE April 11 & 12, 2009		CHECKED BY OK												
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 (%)	
199.1	WATER SURFACE						20	40	60	80	100					
0.0	Water						20	40	60	80	100					
192.7	6.4	PEAT (Amorphous), containing wood fragments														
192.1	7.0	Very soft Brown Wet	1	SS	1											
191.6		SAND, trace organics, containing wood fragments	2A	SS	6											
191.1	8.0	Loose Brown Wet	2B													
190.6	8.5	SILTY CLAY	2C													
		Firm Brown Wet	3	RC	-											
		COBBLES	4	SS	8											
		SAND, trace to some silt, trace gravel	1	RC	REC 97%											
		Loose Grey Wet														
		Granite Gneiss (BEDROCK)	2	RC	REC 100%											
		Bedrock cored from depths of 8.5 m to 12 m														
		For bedrock coring details, refer to Record of Drillhole B5-12	3	RC	REC 100%											
187.1	12.0	END OF BOREHOLE														

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Walker Drilling

T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL & SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

CHECKED: OK

PROJECT 07-1111-0029			RECORD OF BOREHOLE No B5-13			SHEET 1 OF 1			METRIC											
W.P. 5188-06-01			LOCATION N 5045807.9 ; E 243487.4			ORIGINATED BY MR														
DIST HWY 69			BOREHOLE TYPE NW Casing, Wash Boring			COMPILED BY TZ														
DATUM Geodetic			DATE April 12 & 13, 2009			CHECKED BY OK														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			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		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m <sup>3</sup>	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W <sub>p</sub>	W	W <sub>L</sub>								
199.0 0.0	WATER SURFACE Water					▽														
193.4 5.6	SAND, trace gravel, trace organics, containing wood fragments Very loose Brown Wet CLAYEY SILT, containing silt interlayers Very soft Brown Wet SAND and GRAVEL Very dense Grey Wet Granite Gneiss (BEDROCK) Bedrock cored from depths of 7.4 m to 11.3 m For bedrock coring details, refer to Record of Drillhole B5-13		1A																	
192.9 6.1			1B	SS	WR															
192.5 6.6			2	SS	55															
191.7 7.4			3	SS	100/0.18															
			1	RC	REC 100%												RQD = 53%			
			2	RC	REC 91%												RQD = 16%			
			3	RC	REC 100%												RQD = 0%			
			4	RC	REC 100%												RQD = 64%			
187.7 11.3	END OF BOREHOLE																			

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Walker Drilling

T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL & SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

CHECKED: OK

PROJECT 07-1111-0029			RECORD OF BOREHOLE No B5-14			SHEET 1 OF 1			METRIC							
W.P. 5188-06-01			LOCATION N 5045812.5 ; E 243485.2			ORIGINATED BY MR										
DIST HWY 69			BOREHOLE TYPE NW Casing, Wash Boring			COMPILED BY TZ										
DATUM Geodetic			DATE April 13, 2009			CHECKED BY OK										
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
198.9 0.0	WATER SURFACE Water															
193.0 5.9	SAND, trace gravel, containing organics and wood fragments to a depth of 7.3 m Very loose Brown Wet		1	SS	WR											
			2A	SS	WH											
			2B	SS	WH											
			3	SS	WR											
190.9	SAND and SILT, trace clay															
190.5	Very loose		4A	SS	2											
8.4	Grey Wet		4B	SS	2											
189.8	SILTY CLAY															
9.1	Firm Brown Wet															
189.2	Silty SAND		5A	SS	18											
9.8	Compact Grey Wet		5B	SS	18											
188.7	SAND, some gravel		6	SS	20.0.02											
10.2	Compact Grey Wet															
	Granite Gneiss (BEDROCK)		1	RC	REC 100%											
	Bedrock cored from depths of 10.2 m to 11.8 m															
187.1	For bedrock coring details, refer to Record of Drillhole B5-14															
11.8	END OF BOREHOLE															

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B5-14**

SHEET 1 OF 1

LOCATION: N 5045812.5 ;E 243485.2

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	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 <b>NOTE:</b> For additional abbreviations refer to list of abbreviations & symbols.														NOTES		
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	B Angle	DIP w.r.t CORE AXIS	DISCONTINUITY DATA			HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)		RMC -Q AVG	
								TOTAL CORE %	SOLID CORE %					TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 <sup>-6</sup>	10 <sup>-5</sup>				10 <sup>-4</sup>
	NW Casing April 13, 2009	Continued from Record of Borehole B5-14		188.70																			
11		GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, dark grey and pink		10.20	1															UC=99.2MPa			

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC



PROJECT 07-1111-0029		RECORD OF BOREHOLE No B5-15		SHEET 1 OF 1		METRIC											
W.P. 5188-06-01		LOCATION N 5045817.2 ; E 243495.0		ORIGINATED BY MR													
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring		COMPILED BY TZ													
DATUM Geodetic		DATE April 14, 2009		CHECKED BY OK													
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	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W <sub>p</sub> — W — W <sub>L</sub>			γ	GR SA SI CL
198.8 0.0	WATER SURFACE Water					▽		20 40 60 80 100									
193.5 5.3	PEAT (Amorphous), containing wood fragments and interlayers of sand Very soft Brown Wet		1	SS	WH		198										
192.6 6.3	SAND, trace gravel, trace organics, containing wood fragments Very loose Grey Wet		2	SS	1		197										
191.7 7.3	Cobbles Granite Gneiss (BEDROCK)		3	SS	25/0.08		196										
			4	RC	-		195										
			1	RC	REC 96%		194										
	Bedrock cored from depths of 7.3 m to 12 m For bedrock coring details, refer to Record of Drillhole B5-15		2	RC	REC 100%		193										RQD = 28%
			3	RC	REC 92%		192										
			4	RC	REC 98%		191										
186.8 12.0	END OF BOREHOLE						190										RQD = 58%
							189										RQD = 14%
							188										RQD = 80%
							187										

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B5-15

SHEET 1 OF 1

LOCATION: N 5045817.2 ;E 243495.0

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN No.	COLOUR % RETURN	FLUSH	RECOVERY				R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY				Diameter Point Load Index (MPa)	RMC -Q AVG	NOTES						
				DEPTH (m)					TOTAL CORE %	SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS			TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	K, cm <sup>3</sup> /sec	10 <sup>6</sup>	10 <sup>4</sup>	10 <sup>2</sup>				10					
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.			
		Continued from Record of Borehole B5-15		191.52																											
	NW Casing April 14, 2009	GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, dark grey and pink laminated		7.28		1																									
8																															
						2																									
9																															
10	NQ RC April 14, 2009					3																									
11						4																									
12		END OF DRILLHOLE		186.80																											
				12.00																											
13																															
14																															
15																															
16																															
17																															

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B5-16		SHEET 1 OF 1		METRIC									
W.P. 5188-06-01		LOCATION		N 5045812.8 ; E 243497.3		ORIGINATED BY		MR									
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring		COMPILED BY		TZ							
DATUM		Geodetic		DATE		April 15, 2009		CHECKED BY		OK							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
198.7 0.0	WATER SURFACE Water																
							198										
							197										
							196										
							195										
							194										
193.1 5.6	Granite Gneiss (BEDROCK)  Bedrock cored from depths of 5.6 m to 8 m  For bedrock coring details, refer to Record of Drillhole B5-16		1	RC	REC 94%		193										RQD = 28%
			2	RC	REC 100%		192										RQD = 65%
190.7 8.0	END OF BOREHOLE						191										

PROJECT: 07-1111-0029

**RECORD OF DRILLHOLE: B5-16**

SHEET 1 OF 1

LOCATION: N 5045812.8 ;E 243497.3

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY				R.Q.D. %	FRACT. INDEX PER 0.3 m	B Angle	DIP w.r.t CORE AXIS D.D. O.D. O.D.	DISCONTINUITY DATA	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES
								TOTAL CORE %	SOLID CORE %														
								80 60 40 20	80 60 40 20	80 60 40 20	80 60 40 20												
								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												
6	NW Casing April 15, 2009	Continued from Record of Borehole B5-16  GRANITE GNEISS Slightly weathered to fresh, fine to coarse grained with feldspar banding, foliated, dark grey and pink		193.12 5.58	1																		
7	NQ RC April 15, 2009				2																		
8		END OF DRILLHOLE		190.71 7.99																			
9																							
10																							
11																							
12																							
13																							
14																							
15																							

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/12/15 SAC



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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL & SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT		RECORD OF BOREHOLE		No B5-18		SHEET 1 OF 1		METRIC																		
W.P. 07-1111-0029		LOCATION		N 5045790.7 ; E 243505.3		ORIGINATED BY		CR																		
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, BW Casing, Wash Boring		COMPILED BY																		
VA		DATE		July 24 & 25, 2009		CHECKED BY		OK																		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			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	ELEVATION SCALE	SHEAR STRENGTH kPa					W <sub>p</sub>			W			W <sub>L</sub>			γ			GR SA SI CL		
205.2	GROUND SURFACE						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					20 40 60 80 100			10 20 30			kN/m <sup>3</sup>								
0.0	BOULDERS/ROCK FRAGMENTS		1	RC	REC 48%	205																				
204.2	Granite Gneiss (BEDROCK)		2	RC	REC 100%	204																				
1.0	Coring started at 0.3 m below ground surface. Bedrock cored from depths of 1.0 m to 10.0 m  For bedrock coring details, refer to Record of Drillhole B5-18		3	RC	REC 100%	203																				
			4	RC	REC 98%	202																				
			5	RC	REC 100%	201																				
			6	RC	REC 100%	200																				
			7	RC	REC 100%	199																				
			8	RC	REC 100%	198																				
			9	RC	REC 100%	197																				
			10	RC	REC 100%	196																				
			11	RC	REC 100%																					
			12	RC	REC 17%																					
195.2	END OF BOREHOLE																									
10.0	NOTES:  1. Water level measurements in piezometer: Date      Depth (m)      Elev. (m) 28/07/09    2.2        203.0 26/08/09    2.4        202.8																									

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

SHEET 1 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: OGS

CHECKED: OK

PROJECT: 07-1111-0029

## RECORD OF DRILLHOLE: B5-18

SHEET 2 OF 2

LOCATION: N 5045790.7 ;E 243505.3

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	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.														NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA						HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 <sup>-6</sup>	10 <sup>-5</sup>	10 <sup>-4</sup>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
10		-- CONTINUED FROM PREVIOUS PAGE -- END OF DRILLHOLE		9.96																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

DEPTH SCALE

1 : 50

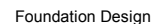


LOGGED: CR

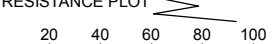


CHECKED: OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-MISS.GDT 03/17/15 SAC





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

PROJECT		RECORD OF BOREHOLE		No B5-20		SHEET 1 OF 1		METRIC													
W.P. 5188-06-01		LOCATION		N 5045793.0 ; E 243521.7		ORIGINATED BY		CR													
DIST		HWY 69		BOREHOLE TYPE		Portable Equipment, BW Casing, Wash Boring		COMPILED BY													
DATUM		Geodetic		DATE		July 24, 2009		CHECKED BY													
								OK													
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					 W <sub>p</sub> W W <sub>L</sub>			 γ			GR SA SI CL		
209.7	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) 10 20 30								
0.0	TOPSOIL		1A	SS	4																
0.3	Silty SAND, trace clay, some gravel, trace organics Very loose Brown Wet END OF BOREHOLE SPOON REFUSAL  NOTES: 1. Borehole advanced using Portable drilling equipment with one-third weight hammer. SPT 'N' value shown has been adjusted to infer value that would obtained with standard weight hammer.  2. Open borehole dry upon completion of drilling.		1B																		

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NEL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC

PROJECT 07-1111-0029		<b>RECORD OF BOREHOLE No B5-21</b>				SHEET 1 OF 1		<b>METRIC</b>										
W.P. 5188-06-01		LOCATION N 5045795.7 ; E 243518.8				ORIGINATED BY CR												
DIST HWY 69		BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring				COMPILED BY VA												
DATUM Geodetic		DATE July 24, 2009				CHECKED BY OK												
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										
209.1	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div>											
0.0	TOPSOIL	1	CS			209												
0.1	END OF BOREHOLE SPOON REFUSAL																	
	NOTE:																	
	1. Open borehole dry upon completion of drilling.																	

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SHAWANAGA NBL &amp; SBL-PHASE III.GPJ GAL-GTA.GDT 03/12/15 SAC



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



# **APPENDIX B**

## **LABORATORY TEST RESULTS**

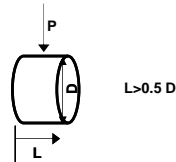
**TABLE B1**  
**POINT LOAD TEST RESULTS ON ROCK SAMPLES**

Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)	Approx. <sup>(1)</sup> UCS (MPa)
B5-02	1	3.2	195.5	Granite Gneiss	Diametral	6.737	94.0
B5-02	1	3.4	195.3	Granite Gneiss	Diametral	5.311	74.0
B5-02	1	3.6	195.1	Granite Gneiss	Diametral	5.253	74.0
B5-05	1	2.0	197.6	Granite Gneiss	Diametral	8.523	119.0
B5-05	1	2.1	197.5	Granite Gneiss	Diametral	6.741	94.0
B5-05	1	2.2	197.4	Granite Gneiss	Axial	4.539	64.0
B5-05	1	2.2	197.4	Granite Gneiss	Axial	4.225	59.0
B5-05	1	2.3	197.3	Granite Gneiss	Diametral	6.311	88.0
B5-07	1	8.1	191.6	Granite Gneiss	Diametral	8.264	116.0
B5-07	1	8.1	191.6	Granite Gneiss	Diametral	7.917	111.0
B5-07	3	9.6	190.1	Granite Gneiss	Diametral	9.274	130.0
B5-07	3	9.7	190.0	Granite Gneiss	Diametral	7.688	108.0
B5-14	1	10.3	188.6	Granite Gneiss	Diametral	7.020	98.0
B5-14	1	10.4	188.5	Granite Gneiss	Diametral	5.205	73.0
B5-14	1	10.9	188.0	Granite Gneiss	Diametral	3.827	54.0
B5-15	1	7.5	191.3	Granite Gneiss	Diametral	3.923	55.0
B5-15	2	8.3	190.5	Granite Gneiss	Diametral	5.676	79.0
B5-15	2	8.7	190.1	Granite Gneiss	Diametral	6.636	93.0
B5-18	6	4.9	200.3	Granite Gneiss	Diametral	9.870	138.0
B5-18	8	5.9	199.3	Granite Gneiss	Diametral	9.870	138.0
B5-18	9	7.7	197.5	Granite Gneiss	Diametral	6.179	87.0

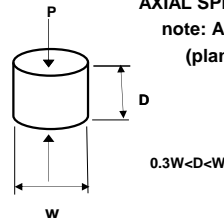
<sup>(1)</sup>  $I_{s50} \times K$  (actual value could be confirmed by UCS testing), from ISRM. This range has been given based on  $K=14$ , calculated from  $I_{s50}$  Average (12 tests) equal to 6.6 Mpa on Diametral orientation and UCS Average (3 tests) equal to 91.7 Mpa.  
 "Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int. J. Rock. Mech. Min. Sci. and Geomechanical Abstr., Vol 22, No. 2 1985, pp. 51-60.

**DIAMETRAL SPECIMEN SHAPE REQUIREMENTS**

note: Diametral tests are perpendicular to core axis  
(planes of weakness)

**AXIAL SPECIMEN SHAPE REQUIREMENTS**

note: Axial tests are parallel to core axis  
(planes of weakness)



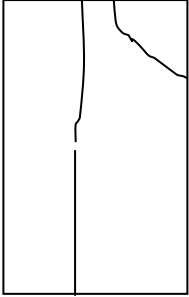
Compiled by: TVA/OK  
 Reviewed by: CN  
 Reviewed By: JPD/JMAC

**TABLE B2-1**  
**SUMMARY OF UNCONFINED COMPRESSION TEST RESULTS**  
**SHAWANAGA RIVER SBL BRIDGE STRUCTURE**  
**HIGHWAY 69, TOWNSHIP OF PARRY SOUND**  
**GWP 5111-07-00 AND WP 5188-06-01**

<b>Borehole Number (Core Run)</b>	<b>Sample Depth (m)</b>	<b>Sample Elevation (m)</b>	<b>Rock Type</b>	<b>Core Diameter (mm)</b>	<b>Unconfined Compressive Strength (MPa)</b>
B5-14 (1)	10.6	188.3	Granite Gneiss	47.8	99
B5-07 (3)	9.3	190.4	Granite Gneiss	47.5	118
B5-05 (1)	2.6	197.0	Granite Gneiss	47.5	58

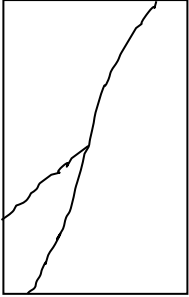
Compiled By: TVA/OKChecked By: CNReviewed By: JPD/JMAC

**Table B2-2**  
**UNCONFINED COMPRESSION (UC) TEST**  
**ASTM D 7012-04**

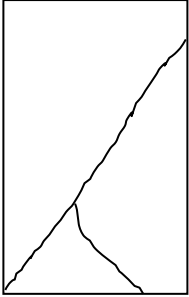
SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	RUN NUMBER	1
BOREHOLE NUMBER	B5-14	SAMPLE DEPTH, m	10.5-10.7
TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.18
SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	10.42	WATER CONTENT, (specimen) %	0.19
SAMPLE DIAMETER, cm	4.78	UNIT WEIGHT, kN/m <sup>3</sup>	25.70
SAMPLE AREA, cm <sup>2</sup>	17.95	DRY UNIT WT., kN/m <sup>3</sup>	25.65
SAMPLE VOLUME, cm <sup>3</sup>	186.99	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	490.13	VOID RATIO	0.03
DRY WEIGHT, g	489.20		
VISUAL INSPECTION	FAILURE SKETCH		
			
TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	99.2
REMARKS:	DATE:		6/16/2009
CHECKED BY: TVA	REVIEWED BY:		JPD/JMAC



**Table B2-3**  
**UNCONFINED COMPRESSION (UC) TEST**  
**ASTM D 7012-04**

SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	RUN NUMBER	3
BOREHOLE NUMBER	B5-07	SAMPLE DEPTH, m	9.1-9.4
TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.30
SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	10.94	WATER CONTENT, (specimen) %	0.17
SAMPLE DIAMETER, cm	4.75	UNIT WEIGHT, kN/m <sup>3</sup>	25.35
SAMPLE AREA, cm <sup>2</sup>	17.72	DRY UNIT WT., kN/m <sup>3</sup>	25.30
SAMPLE VOLUME, cm <sup>3</sup>	193.86	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	501.22	VOID RATIO	0.05
DRY WEIGHT, g	500.37		
VISUAL INSPECTION	FAILURE SKETCH		
			
TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	118.0
REMARKS:	DATE:		6/16/2009
CHECKED BY: TVA	REVIEWED BY:		JPD/JMAC

**Table B2-4**  
**UNCONFINED COMPRESSION (UC) TEST**  
**ASTM D 7012-04**

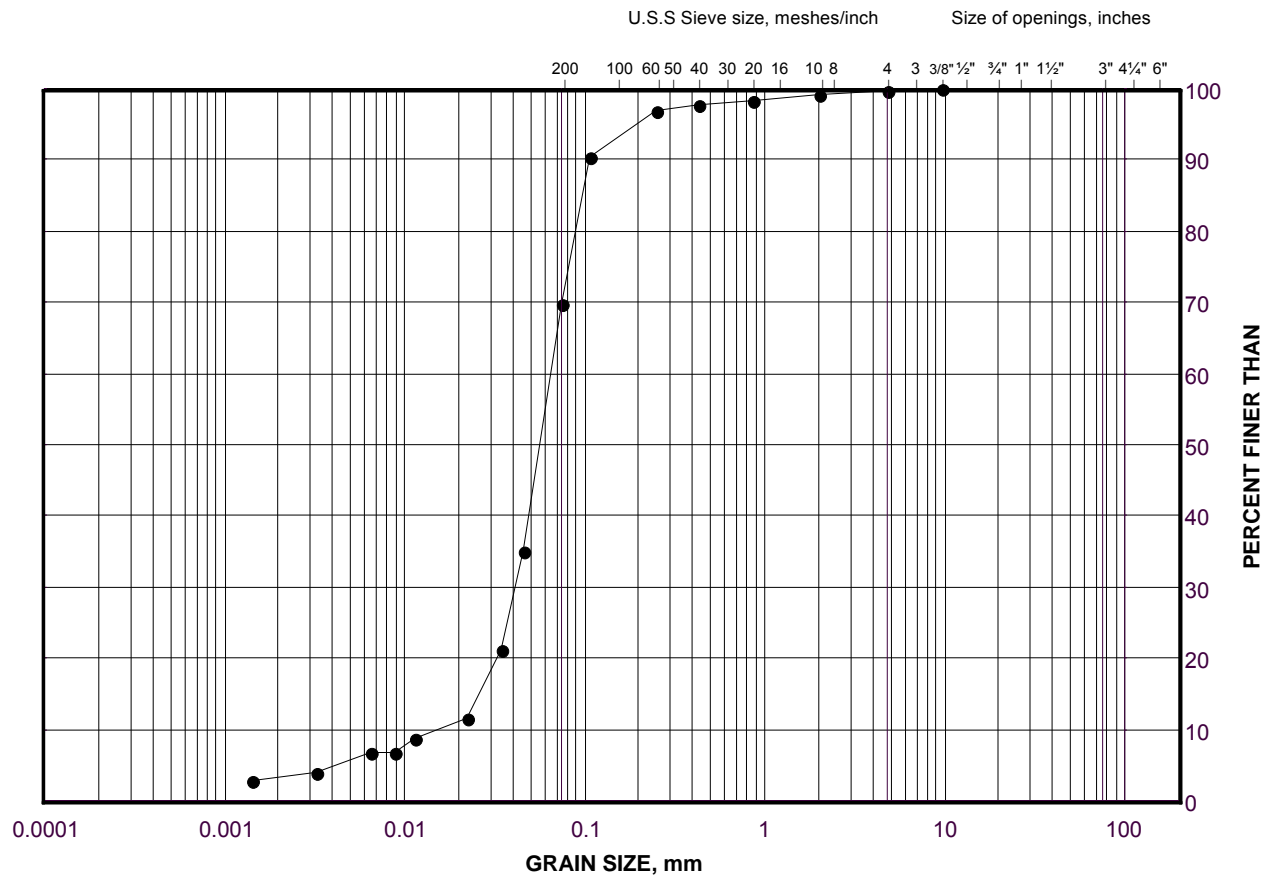
SAMPLE IDENTIFICATION			
PROJECT NUMBER	07-1111-0029	RUN NUMBER	1
BOREHOLE NUMBER	B5-05	SAMPLE DEPTH, m	2.5-2.7
TEST CONDITIONS			
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.10
SPECIMEN INFORMATION			
SAMPLE HEIGHT, cm	9.95	WATER CONTENT, (specimen) %	0.08
SAMPLE DIAMETER, cm	4.75	UNIT WEIGHT, kN/m <sup>3</sup>	26.84
SAMPLE AREA, cm <sup>2</sup>	17.68	DRY UNIT WT., kN/m <sup>3</sup>	26.82
SAMPLE VOLUME, cm <sup>3</sup>	175.95	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	481.82	VOID RATIO	-0.01
DRY WEIGHT, g	481.43		
VISUAL INSPECTION	FAILURE SKETCH		
			
TEST RESULTS			
STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	57.9
REMARKS:	DATE:		6/16/2009
CHECKED BY: TVA	REVIEWED BY:		JPD/JMAC

# GRAIN SIZE DISTRIBUTION

Sand and Silt (Upper Deposit)

South Pier (Pier 1)

FIGURE B1-1



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

## LEGEND

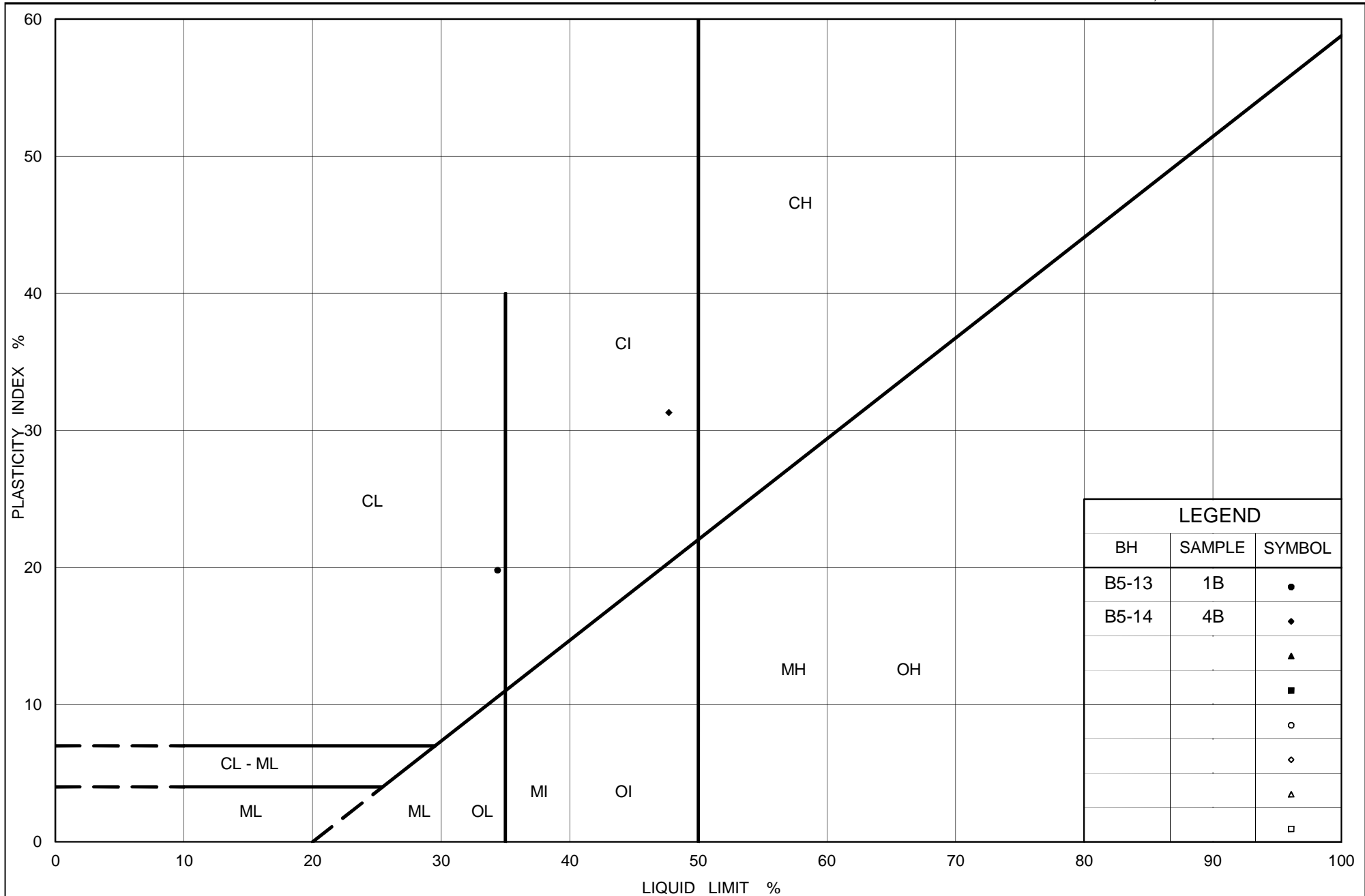
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	B5-14	4A	190.7

Project Number: 07-1111-0029

Checked By: TVA

**Golder Associates**

Date: 08-Nov-13



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Ontario

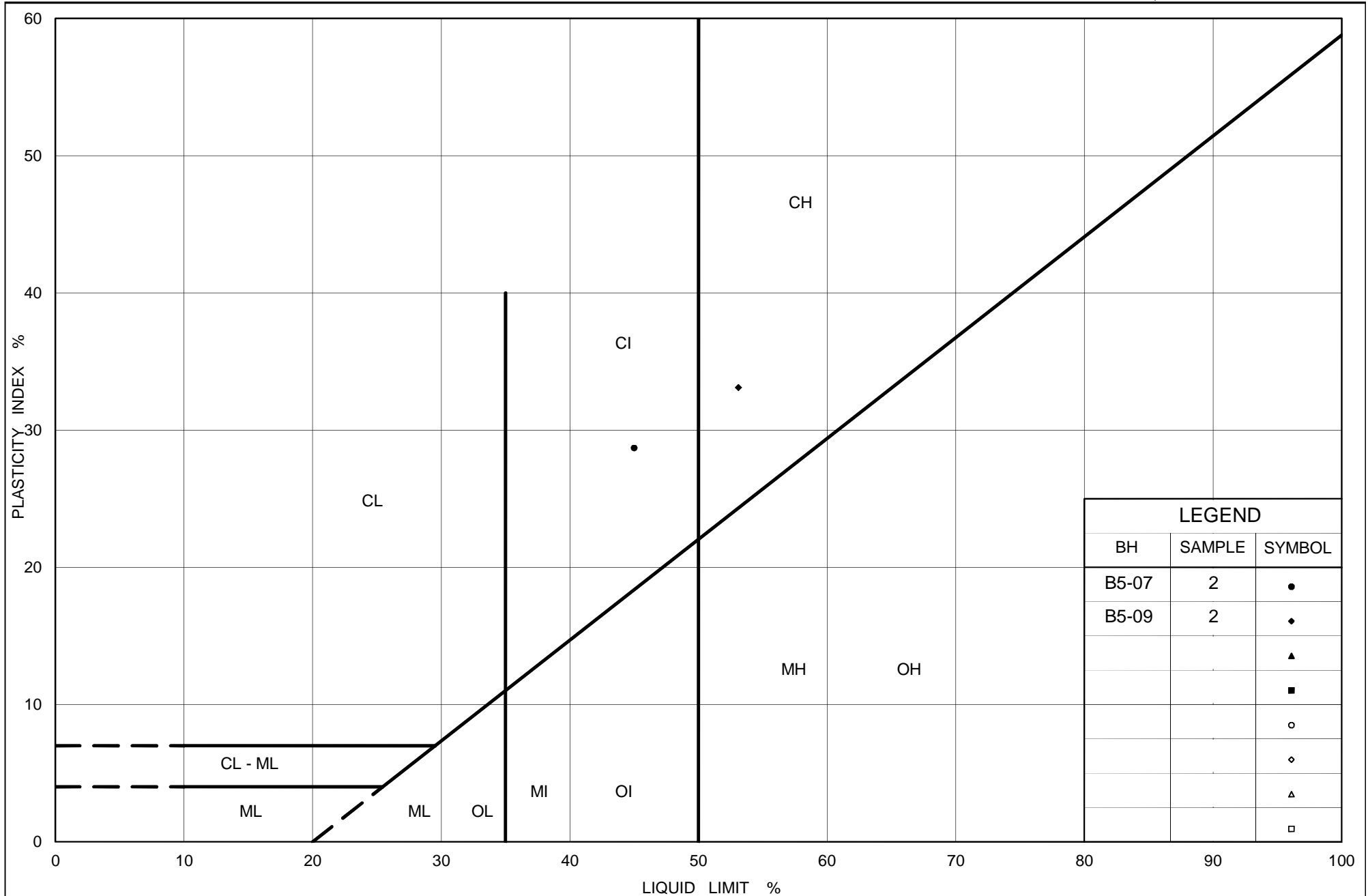
PLASTICITY CHART  
Clayey Silt to Silty Clay  
South Pier (Pier 1)

Figure No. B1-2

Project No. 07-1111-0029

Checked By: TVA





Ministry of Transportation

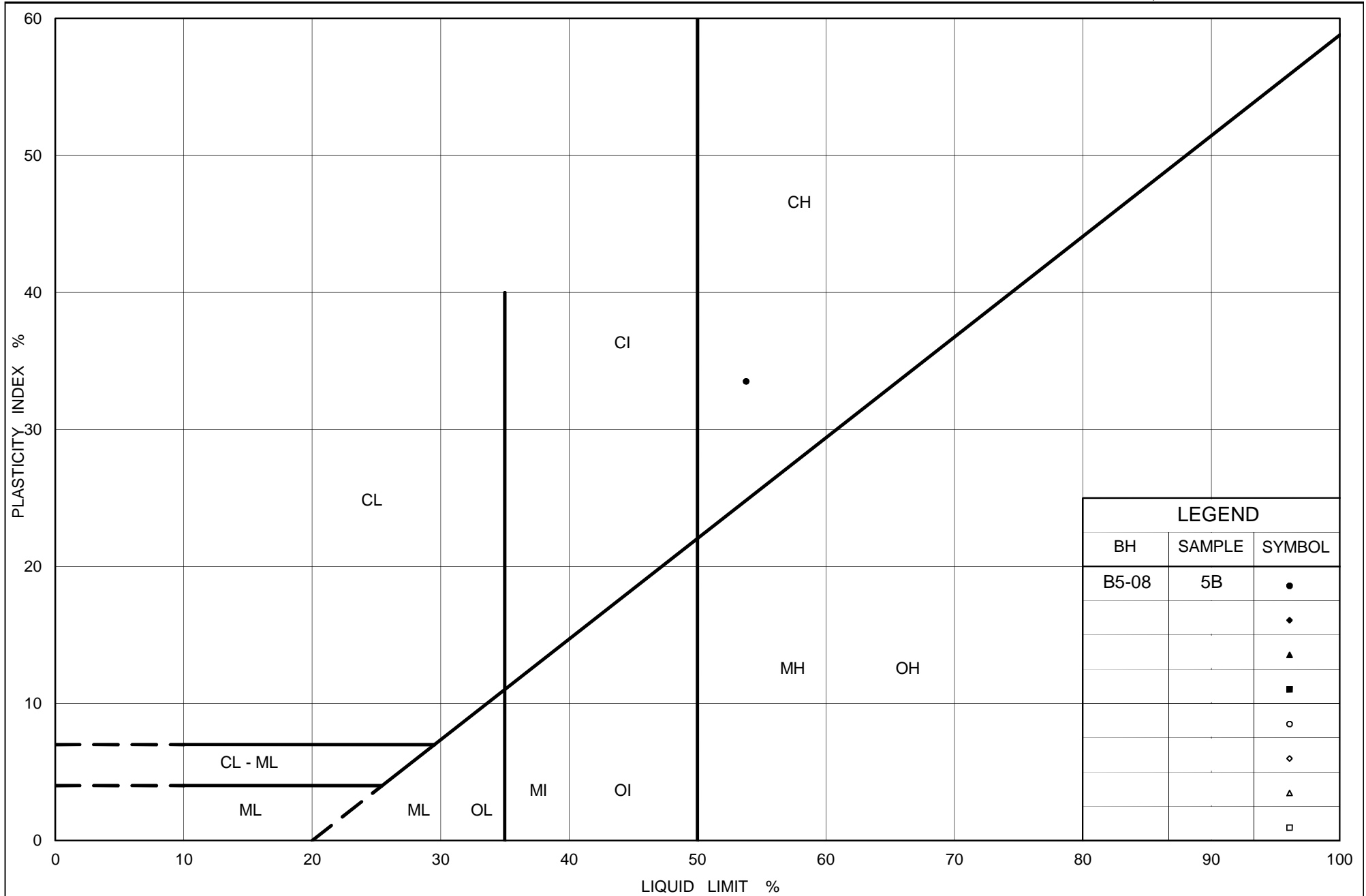
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# PLASTICITY CHART Silty Clay to Clay North Pier (Pier 2)

Figure No. B1-4

Project No. 07-1111-0029

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# PLASTICITY CHART Clay North Pier (Pier 2)

Figure No. B1-5

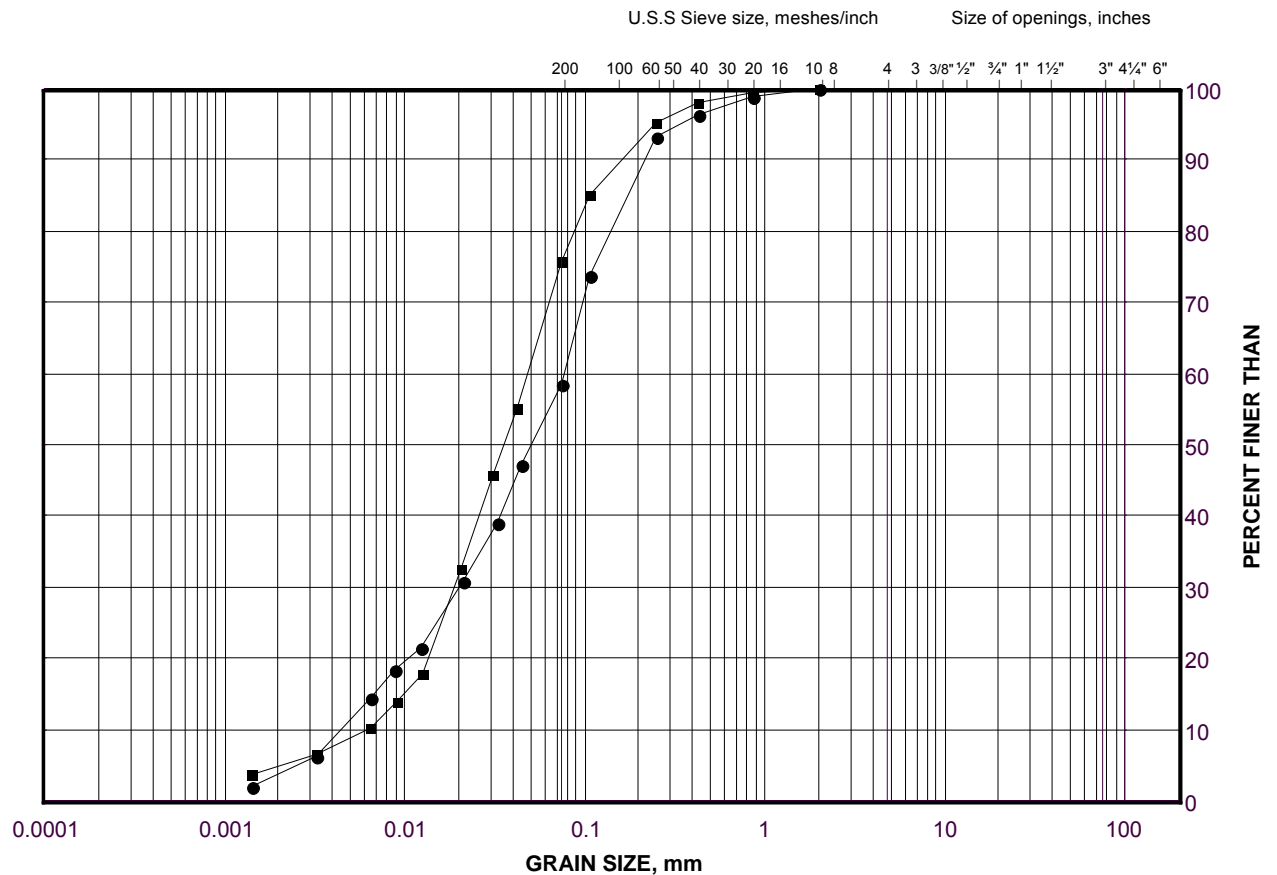
Project No. 07-1111-0029

Checked By: TVA

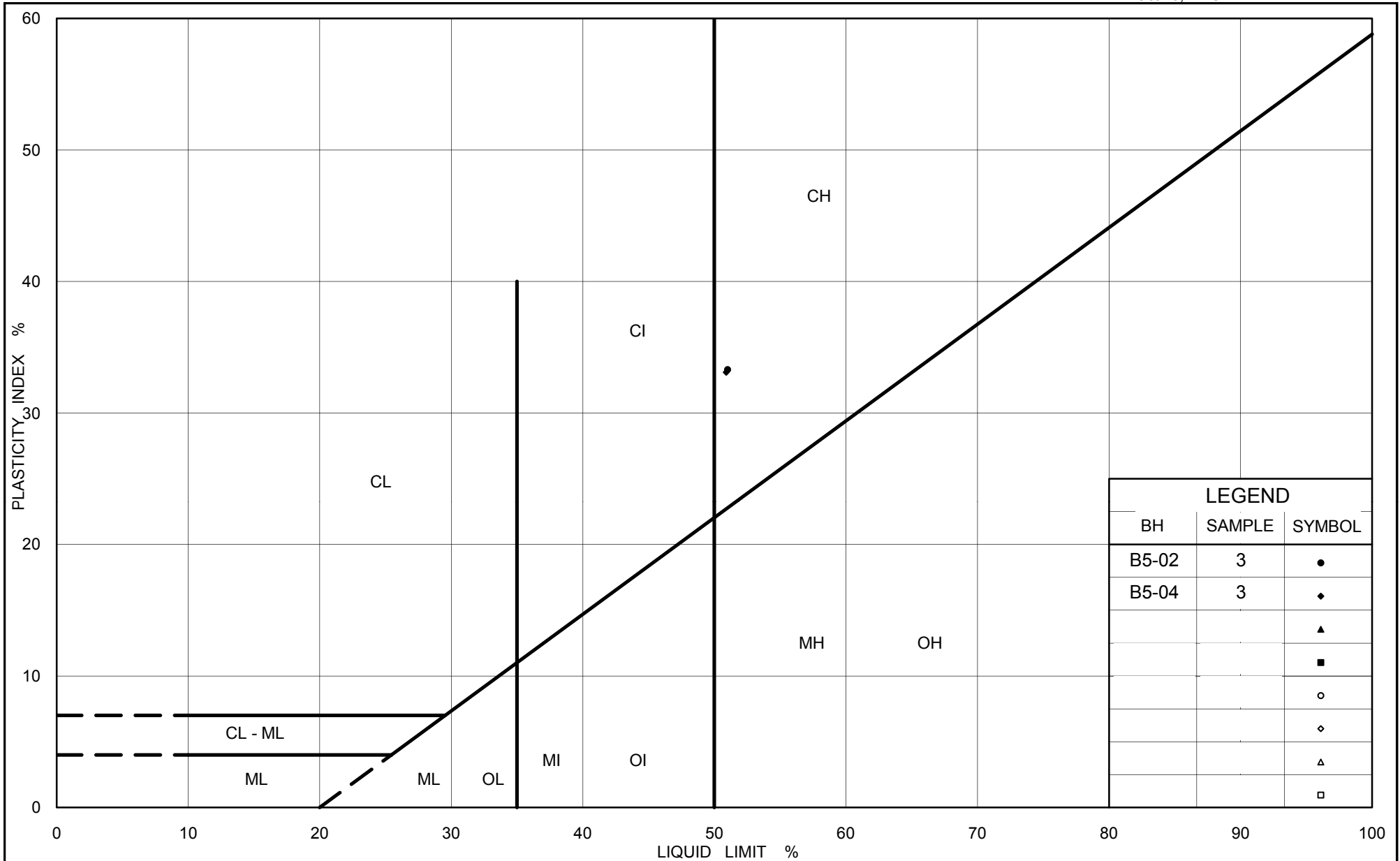
# GRAIN SIZE DISTRIBUTION

Sand and Silt to Sandy Silt (Upper Deposit)  
North Abutment and Approach

FIGURE B1-6







Ministry of Transportation

Ontario

**PLASTICITY CHART**  
Clay  
North Abutment and Approach

Figure No. B1-7

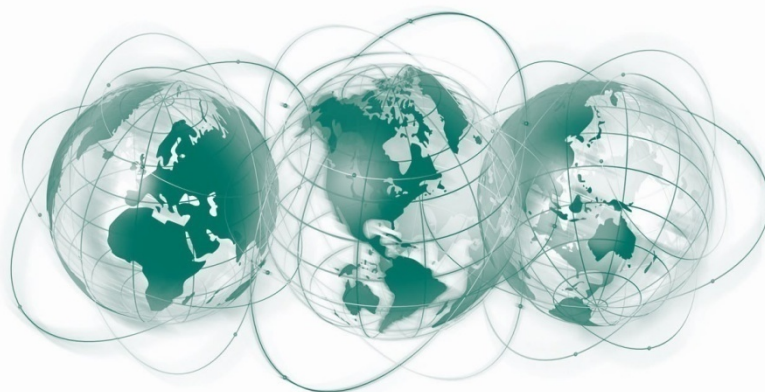
Project No. 07-1111-0029

Checked By: TVA

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. 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 now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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