

**FOUNDATION INVESTIGATION REPORT
STILLWATER CREEK BRIDGE WBL
HIGHWAY 11/17 RED ROCK TO NIPIGON
FROM 4.8 KM WEST OF HWY 628 TO 1.5 KM WEST OF HWY 585
DISTRICT OF THUNDER BAY, ONTARIO**

G.W.P. 647-89-00, Site No. 48C-096

Geocres Number: 52H-20

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of a proposed bridge which will carry the new westbound lanes (WBL) of Highway 11/17 over Stillwater Creek in the Township of Nipigon. The proposed bridge is part of the Highway 11/17 four-laning project, involving construction of a divided highway from 4.8 km west of Highway 628 to 1.5 km west of Highway 585 in the District of Thunder Bay.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile and cross-sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to Hatch Mott MacDonald (HMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0006.

2 SITE DESCRIPTION

The site is located approximately 4 km west of Nipigon, Ontario, and approximately 2 km south-west of the intersection of Highway 11/17 and Highway 585. The proposed four-laning of Highway 11/17 will include construction of a new bridge to carry the westbound lanes of the highway over Stillwater Creek. The existing Highway 11/17 bridge, located immediately to the south, will carry the eastbound lanes.

Stillwater Creek at the site meanders within a flood plain, generally flowing towards the southeast into the Nipigon River. The surrounding area is typically heavily treed. A tent and trailer park is located on the north side of the east approach.

The existing Highway 11/17 bridge is a three-span steel girder structure supported on concrete abutments and piers. The bridge approaches consist of fill embankments placed within the creek floodplain. The embankment height is in the order of 4 m on the north side of the east approach and 7 to 8 m in the remaining quadrants.

Photographs in Appendix C show the general nature of the site.

The site lies within the physiographic region known as the Quetico Subprovince of the Superior Province of the Canadian Shield. The region is characterized by early Precambrian felsic igneous (granite) and metamorphic (granitic gneiss) bedrock. The surficial deposits at the site typically comprise glaciofluvial sand deposits.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period June 20 to June 27, 2012 and consisted of drilling and sampling ten boreholes identified as SCW-01 to SCW-10. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

The borehole locations were selected on the basis of a conceptual three-span structure being considered at the time of investigation. Boreholes SCW-01 and SCW-10 were drilled at the proposed west and east approaches to auger refusal at depths of 3.0 m and 12.7 m (Elev. 263.3 m and 255.8 m), respectively. Boreholes SCW-02 to SCW-05 were drilled at the proposed west abutment and piers, and Boreholes SCW-06 to SCW-09 were drilled at the east abutment and piers. These boreholes were terminated at depths of 7.6 m to 12.1 m (Elev. 257.3 to 255.3 m), and included recovery of 2.8 to 3.4 m of rock core from each borehole.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

A track-mounted CME-45 drill rig was used to drill the boreholes. A combination of hollow-stem augers, NW casing, and NQ coring methods were used to advance the boreholes. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Standpipe piezometers consisting of 19 mm PVC pipe with slotted screen enclosed in filter sand

were installed in four boreholes to monitor groundwater levels. The piezometers were subsequently decommissioned in general accordance with MOE Regulation 903. Boreholes without piezometers were backfilled in general accordance with Regulation 903. The installation and completion details of the boreholes and piezometers are summarized in Table 3.1.

Table 3.1 – Boreholes and Piezometers Completion Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Borehole Completion Details
SCW-01	None installed	Borehole backfilled with cuttings from 3.0 m to surface.
SCW-02	4.8 / 259.8	Sand filter from 7.8 m to 2.7 m, bentonite holeplug from 2.7 m to surface.
SCW-03	None installed	Borehole backfilled with bentonite holeplug from 7.8 m to surface.
SCW-04	None installed	Borehole backfilled with bentonite holeplug from 7.6 m to 2.8 m, cuttings from 2.8 m to surface.
SCW-05	7.6 / 256.1	Sand filter from 7.6 m to 2.4 m, bentonite holeplug from 2.4 m to surface.
SCW-06	None installed	Borehole backfilled with bentonite holeplug and cuttings from 10.0 m to surface.
SCW-07	7.6 / 259.0	Sand filter from 10.7 m to 5.5 m, bentonite holeplug from 5.5 m to surface.
SCW-08	7.6 / 259.5	Sand filter from 10.6 m to 5.6 m, bentonite holeplug from 5.6 m to surface.
SCW-09	None installed	Borehole backfilled with bentonite holeplug and cuttings from 12.1 m to surface.
SCW-10	None installed	Borehole caved from 12.7 m to 3.7 m upon completion, then backfilled with cuttings from 3.7 m to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determinations. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of this testing program are summarized on the Record of Borehole Sheets in Appendix A and shown on the figures in Appendix B.

Point load tests were carried out on selected samples of intact bedrock to evaluate the unconfined compressive strength (UCS) of the bedrock. The UCS values assessed from the point load data are reported on the Record of Borehole Sheets in Appendix A as an average UCS value per core run.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole Sheets in Appendix A and the Borehole Locations and Soil Strata drawings in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

The subsurface stratigraphy at this site varies, consisting of discontinuous layers of surficial topsoil, fill and/or peat, overlying successive layers of sand to silty sand, sand and gravel, silt to sandy silt, and silty clay of variable thickness and continuity. These deposits are typically underlain by a layer of sand, gravel and cobbles overlying bedrock. More detailed descriptions of the individual strata encountered along the proposed bridge alignment are presented below.

5.1 Topsoil

Topsoil was encountered at the ground surface in all boreholes except for Boreholes SCW-06 and SCW-08. The topsoil layer was between 25mm and 200mm thick. The topsoil thickness may vary between the borehole locations and in other areas of the site.

5.2 Sand Fill

Brown sand to silty sand fill containing trace to some gravel was encountered beneath the topsoil in Boreholes SCW-02 and SCW-03. The thickness of the fill layer was 0.6 m and 1.3 m, and the base of the fill was at depths of 0.8 m and 1.5 m (Elev. 263.8 and 263.6).

SPT 'N' values recorded in the sand fill ranged from 8 to 21 blows per 0.3 m of penetration, indicating a loose to compact relative density. The moisture content of the fill samples ranged from 11% to 21%.

A grain size distribution analysis was carried out on one sample. The results of the test are plotted on Figure B1 of Appendix B, and are summarized below:

Gravel %	17
Sand %	78
Silt and Clay %	5

5.3 Peat

A layer of black to dark brown sandy peat was encountered beneath the silty sand fill in Boreholes SCW-02 and SCW-03. The thickness of peat layer was 0.3 m and 0.8 m, with a lower boundary at depths of 1.1 m and 2.3 m (Elev. 263.5 m and 262.8 m).

An SPT 'N'-value of 7 blows per 0.3 m of penetration was recorded, and moisture contents of 49% and 78% were measured.

5.4 Sand to Silty Sand

Sand to silty sand was encountered below the peat in Borehole SCW-02 and below the topsoil in all other boreholes except Borehole SCW-03. On the west side of the creek, the sand layer ranged from 0.4 m to 2.5 m in thickness, with a lower boundary at depths of 0.6 m to 2.6 m (Elev. 262.5 m to 263.7 m). On the east side, the sand layer was 4.1 m to 7.1 m thick (9.0 m in Borehole SCW-10 but interrupted by a 1.7 m sand and gravel layer), and the lower boundary was at depths of 4.1 to 9.1 m (Elev. 262.5 to 259.4).

The sand to silty sand locally contained trace to some gravel, and contained organics and wood fragments in Boreholes SCW-01, SCW-02 and SCW-04.

SPT 'N' values recorded in the sand typically ranged from 4 to 26 blows per 0.3 m penetration, indicating a loose to compact relative density. "N" values of 34 blows per 0.3 m to 100 blows per 0.125 m penetration were recorded in isolated tests. Natural moisture contents of the sand deposit varied from 4% to 24%, locally up to 31% in three samples containing organics.

Grain size distribution analyses were carried out on eight samples of the sand deposit. Results of the tests are plotted on Figures B2 and B3 of Appendix B, and are summarized below:

Gravel %	0 to 4
Sand %	65 to 92
Silt and Clay %	8 to 35

5.5 Sand and Gravel

A layer of sand and gravel was encountered beneath the peat and sand in Boreholes SCW-02 to SCW-05 and within the sand deposit in Borehole SCW-10. The sand and gravel layer was 0.4 to 1.2 m thick in Boreholes SCW-02 to SCW-05 drilled on the west side of the creek, with a lower boundary at depths of 1.8 to 2.8 m (Elev. 262.3 to 261.9 m). In Borehole SCW-10, the sand and gravel layer was 1.7 m thick and encountered between 0.6 and 2.3 m depth (Elev. 267.9 and 266.2 m), within the sand deposit. Cobbles were encountered within this layer, and coring was used to penetrate these obstructions in Borehole SCW-05.

SPT 'N' values recorded in the sand and gravel ranged from 10 to 20 blows per 0.3 m penetration, indicating a compact relative density. Natural moisture contents varied from 4% to 20%.

Grain size distribution analyses were carried out on two samples of the sand and gravel deposit. The results are plotted on Figure B4 of Appendix B, and are summarized below:

Gravel %	18 to 41
Sand %	54 to 80
Silt and Clay %	2 to 5

5.6 Silt to Sandy Silt

Brown to grey silt with trace to some sand and clay was encountered beneath the sand to sand and gravel deposits in Boreholes SCW-01, SCW-04, SCW-05, SCW-09 and SCW-10. Sandy silt was encountered below the sand in Borehole SCW-07.

Borehole SCW-01 was terminated upon auger refusal at the probable base of the silt at 3.0 m depth (Elev. 263.3 m), indicating a thickness of 0.4 m. The silt layer was 0.5 m thick in Boreholes SCW-04 and SCW-05, with a lower boundary at 2.3 m depth (Elev. 261.4 to 261.6 m). In Boreholes SCW-07, SCW-09 and SCW-10, the thickness of silt to sandy silt was 1.7 to 3.6 m, with the lower boundary at depths of 7.7 m to 11.7 m (Elev. 258.9 to 256.8 m).

SPT 'N' values recorded in the silt typically ranged from 17 to 42 blows per 0.3 m penetration, indicating a compact to dense relative density. One 'N' value of 1 blow per 0.3 m penetration was recorded in Borehole SCW-10, possibly reflecting hydraulic disturbance. A value of 50 blows per 0.125 m penetration was recorded at the boundary of the underlying bedrock in Borehole SCW-07. Natural moisture contents of the silt layer ranged from 12% to 24%.

Grain size distribution analyses were carried out on five samples of the silt deposit. The results are plotted on Figure B5 of Appendix B, and are summarized below:

Gravel %	0
Sand %	3 to 21
Silt %	75 to 88
Clay %	4 to 12

5.7 Silty Clay

Grey silty clay with trace sand and trace to some gravel was encountered beneath the sand, gravel and silt layers in Boreholes SCW-02, SCW-04 to SCW-06, SCW-08 and SCW-10. The thickness of the silty clay layer varied from 0.2 m to 1.4 m. The lower boundary was at depths of 2.8 m to 3.7 m (Elev. 261.3 to 260.0 m) on the west side of the creek, and 6.6 to 12.5 m (Elev. 260.5 to 256.0 m) on the east side.

SPT 'N' values recorded in the clay typically ranged from 13 to 44 blows per 0.3m penetration, indicating a stiff to hard consistency. A value of 50 blows per 0.125 m penetration was recorded at the boundary with the underlying sand/gravel/cobble deposit in Borehole SCW-02. In Borehole SCW-10, the sampler sank 300 mm under self-weight in the clay before encountering an underlying sand and gravel deposit, indicating a very soft consistency at this location only.

Moisture contents of the silty clay ranged from 10% to 34%.

Grain size distribution curves from two silty clay samples are presented on the Record of Borehole Sheets and on Figure B6 of Appendix B. Atterberg Limits test results for three samples are presented on Figure B7 of Appendix B. The results are summarized as follows:

Gravel %	0 to 1
Sand %	1 to 9
Silt %	54 to 57
Clay %	33 to 45
Liquid Limits %	26 to 33
Plastic Limits %	13 to 15
Plastic Index %	12 to 19

The results indicate that the silty clay is of low plasticity with a group symbol of CL.

5.8 Sand, Gravel and Cobbles

A layer of sand, gravel and cobbles with occasional boulders was encountered beneath the silt and silty clay deposits, locally beneath the sand and gravel layer, in all boreholes except Boreholes SCW-01, SCW-06 and SCW-07. This layer directly overlies bedrock.

Borehole SCW-10 was terminated upon auger refusal within this deposit at a depth of 12.7 m (Elev. 255.8). In each of the other boreholes, coring was required to advance through this layer, and a thickness of 0.4 to 1.9 m was recorded. The lower boundary of the layer was encountered at depths of 4.3 m to 9.3 m (Elev. 260.4 to 258.1 m).

5.9 Bedrock

Pink and grey granitic bedrock was proved by coring in Boreholes SCW-02 to SCW-09. The depths and elevations of the bedrock surface encountered in the boreholes are summarized in Table 4.1. Boreholes SCW-01 and SCW-10 were terminated upon auger refusal at depths of 3.0 and 12.7 m (Elev. 263.3 and 255.8).

Table 4.1 – Depth and Elevation of Bedrock Surface

Borehole	Bedrock Surface Proved by Coring	
	Depth (m)	Elevation (m)
SCW-02	4.4	260.2
SCW-03	4.7	260.4
SCW-04	4.3	259.6
SCW-05	4.6	259.1
SCW-06	6.8	259.7
SCW-07	7.7	258.9
SCW-08	7.2	259.9
SCW-09	9.3	258.1

Rock core lengths of 2.8 m to 3.4 m were recovered from the boreholes. Total core recovery was generally between 89% and 100%, typically 100%. Lower recovery of 82% was obtained in the initial sample in Borehole SCW-08 which was partially advanced within the overlying sand, gravel and cobbles, and a recovery of 65% was obtained in a highly fractured zone in Borehole SCW-05.

RQD values measured in the bedrock cores recovered from boreholes on the west side of the creek ranged from 0% to 67%, indicating very poor to fair rock quality. In rock cores recovered from the east side of the creek, the RQD values ranged from 55% to 95%, indicating fair to excellent rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 7. A Fracture Index of 12 was noted in Borehole SCW-06 Run 2.

The unconfined compressive strength of the rock cores estimated from the results of point load tests ranged from 53 MPa to 149 MPa, indicating a strong to very strong rock. The results are presented on the Record of Borehole Sheets in Appendix A (as average per run).

5.10 Water Levels

Water levels were monitored in the open boreholes during and upon completion of drilling. Four standpipe piezometers were installed to monitor water levels after completion of drilling. The water levels measured in the piezometers and open boreholes are summarized in Table 4.2.

Table 4.2 – Measured Groundwater Levels

Borehole	Date	Water Level (m)		Comments
		Depth	Elevation	
SCW-01	June 24, 2012	2.0	264.3	Open Borehole
SCW-02	July 15, 2012	0.9	263.7	Piezometer
	March 2, 2013	1.3	263.3	Piezometer
SCW-03	June 23, 2012	0.8	264.3	Open Borehole
SCW-04	June 22, 2012	0.9	263.0	Open Borehole
SCW-05	June 22, 2012	0.6	263.1	Open Borehole
	July 15, 2012	0.3	263.4	Piezometer
SCW-07	June 24, 2012	3.0	263.6	Open Borehole
	July 15, 2012	3.0	263.6	Piezometer
	March 2, 2013	3.5	263.1	Piezometer
SCW-08	July 15, 2012	2.9	264.2	Piezometer
	March 2, 2013	3.8	263.3	Piezometer
SCW-09	June 20, 2012	4.3	263.1	Open Borehole
SCW-10	June 27, 2012	3.5	265.0	Open Borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In general, the groundwater level is expected to be at or slightly above the water level in Stillwater Creek, which is shown to be near Elev. 263.1 on the contour plan provided by HMM (Appendix D). The creek and groundwater levels may be higher at the time of construction, and in particular after the spring snowmelt or periods of heavy rainfall.

6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. The coordinates and the ground surface elevations at the boreholes were surveyed by TBT Engineering Limited. Thurber obtained utility clearances for the borehole locations prior to drilling.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied a track-mounted CME 45 drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations were supervised on a full time basis by Mr. Ryan Kromer E.I.T. of Thurber Engineering Ltd.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall planning and supervision of the field program was conducted by Mr. Mark Farrant, P.Eng. Interpretation of the data and preparation of the report were carried out by Ms. Mei Cheong, M.Phil. The report was reviewed by Mr. Murray Anderson, P.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


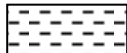



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				


<u>TERMS</u>		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.				
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.				
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No SCW-01

1 OF 1

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 060.5 E 208 142.8 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.06.24 - 2012.06.24 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										WATER CONTENT (%)
266.3								20	40	60	80	100						
0.0	TOPSOIL Black Moist SAND , some silt and clay, trace gravel Loose to Compact Brown Moist With black organics, trace clay Some gravel		1	SS	9		266											
0.1																		
			2	SS	16													
								265										
			3	SS	6													
263.7							264											
2.6	SILT , some sand, trace gravel, trace clay Compact Brown Wet END OF BOREHOLE AT 3.0m UPON AUGER REFUSAL. WATER LEVEL AT 2.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.		4	SS	22													
263.3																		
3.0																		

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SCW-03

1 OF 1

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 073.6 E 208 159.5 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE NW/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.23 - 2012.06.23 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
265.1								20	40	60	80	100								
0.0	TOPSOIL Black Moist		1	SS	21		265													
0.2	SAND , trace to some gravel, trace silt and clay Loose to Compact Brown Moist to Wet (FILL)		2	SS	8		264													
263.6	PEAT , sandy, wood fragments Loose Dark Brown Wet	3	SS	7	263															
262.8	SAND and GRAVEL , occasional cobbles, some clay Compact Brown Wet	4	SS	11	262															
262.3	SAND, GRAVEL and COBBLES	5	SS	50/ .125	261															
260.4	BEDROCK granite, jointed, grey/pink, strong, porphyritic texture	1	RUN		260															
4.7	Vertical joint from 5.8m to 6.0m	2	RUN		259															
		3	RUN		258															
257.3	END OF BOREHOLE AT 7.8m. WATER LEVEL AT 0.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																			
7.8																				

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCW-04

1 OF 1

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 087.0 E 208 162.5 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NW Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.22 - 2012.06.22 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
263.9								20	40	60	80	100		
0.0	TOPSOIL , wood fragments, sandy													
0.2	Black Moist		1	SS	5									
	Silty SAND , trace gravel, trace organics, wood fragments													
	Loose													
	Brown to Dark Brown		2	SS	4									
	Moist to Wet													
262.5														
1.4	SAND and GRAVEL , coarse													
262.1	Dense													
	Brown		3	SS	39									
1.8	Wet													
261.6	SILT , trace to some sand, trace clay													
	Compact to Dense													
2.3	Grey		4	SS	17									
	Wet													
261.1	Silty CLAY , trace sand													
2.8	Very Stiff		1	RUN										RUN #1 TCR=76%
	Grey													
	Wet													
	(TILL-LIKE)													
	SAND, GRAVEL and COBBLES													RUN #2 TCR=61%
	occasional boulders		2	RUN										
	Red/Grey/Brown													
259.6														
4.3	BEDROCK granite, jointed, grey/pink, fine grained, porphyritic texture, strong		3	RUN										RUN #3 TCR=100% SCR=40% RQD=0%
														RUN #4 TCR=100% SCR=58% RQD=43% UCS=82MPa (Average)
			4	RUN										
	Vertical joint from 5.8m to 6.3m													
	Granite/granitic gneiss													RUN #5 TCR=100% SCR=54% RQD=38% UCS=64MPa (Average)
			5	RUN										
	Vertical joint from 7.4m to 7.6m													
256.3														
7.6	END OF BOREHOLE AT 7.6m. WATER LEVEL AT 0.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.8m, CUTTINGS TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCW-05

1 OF 1

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 078.2 E 208 170.4 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.22 - 2012.06.22 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
263.7								20	40	60	80	100							
0.0	TOPSOIL , sandy Black Moist		1	SS	4														
263.1	Silty SAND , trace gravel Loose Dark Brown Moist																		
0.6																			
	SAND and GRAVEL , occasional cobble Dense Brown Wet																		
261.9	Cored from 0.6m to 1.5m		2	SS	30														
1.8	SILT , trace clay, trace sand Dense Grey Wet																		
261.4																			
2.3	Silty CLAY , trace sand Hard to Stiff Grey Wet (TILL-LIKE) Silt seams		3	SS	38														
			4	SS	13														
260.0																			
3.7	COBBLES and GRAVEL , some sand Brown/Grey/Red		1	RUN															
259.1	BEDROCK granite, jointed, grey/pink, strong to very strong, porphyritic texture Rubble zone at 4.6m to 4.8m																		
4.6			2	RUN															
	Highly fractured																		
			3	RUN															
256.1																			
7.6	END OF BOREHOLE AT 7.6m. WATER LEVEL AT 0.6m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul. 15/12 0.3 263.4																		

ONTMT4S 05117.GPJ 2012TEMPLATE(MTO).GDT 4/25/13

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCW-06

1 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 100.3 E 208 177.4 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NW/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.26 - 2012.06.26 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)					
266.5								20	40	60	80	100					
0.0	Silty SAND Loose to Compact Brown Moist		1	SS	4		266							○			
			2	SS	16		265							○			0 76 24 (SI+CL)
			3	SS	12		264							○			
			4	SS	6		263							○			0 91 9 (SI+CL)
	Trace silt		5	SS	4		262							○			
262.5							261										
4.0	SAND , medium grained, trace silt Very Dense Brown Wet		6	SS	100/ .125		260							○			
							259										
260.3							258							○			
6.2	Silty CLAY , some gravel Hard Grey Wet		7	SS	44		257							○			
259.7							256							○			
6.8	(TILL-LIKE) BEDROCK granite, coarse grained, strong to very strong, grey/pink, porphyritic texture		1	RUN			255							○			RUN #1 TCR=100% SCR=73% RQD=63% UCS=66MPa (Average)
			2	RUN			254										RUN #2 TCR=100% SCR=92% RQD=85% UCS=102MPa (Average)
			3	RUN			253										RUN #3 TCR=100% SCR=100% RQD=83% UCS=94MPa
256.5							252										

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCW-06

2 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 100.3 E 208 177.4 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NW/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.26 - 2012.06.26 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL (Average)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
10.0	Continued From Previous Page END OF BOREHOLE AT 10.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

RECORD OF BOREHOLE No SCW-07

1 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 094.1 E 208 186.3 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.24 - 2012.06.24 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL	
								20	40	60	80	100	W _p	W						W _L
266.6																				
0.0																				

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCW-07

2 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 094.1 E 208 186.3 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.24 - 2012.06.24 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
	Continued From Previous Page																
255.9																	
10.7	END OF BOREHOLE AT 10.7m. WATER LEVEL AT 3.0m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul. 15/12 3.0 263.6 Mar. 02/13 3.5 263.1																

METRIC

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W _P	W	W _L	WATER CONTENT (%)			
267.1 0.0	SAND , trace to some silt Loose to Dense Brown Moist		1	SS	7		20	40	60	80	100	20	40	60	GR SA SI CL	
	Gravelly zone at 0.7m to 1.2m		2	SS	34		20	40	60	80	100	20	40	60		
			3	SS	23		20	40	60	80	100	20	40	60		
			4	SS	13		20	40	60	80	100	20	40	60		
	Wet trace oxidation		5	SS	7		20	40	60	80	100	20	40	60		
			6	SS	4		20	40	60	80	100	20	40	60		
			7	SS	39		20	40	60	80	100	20	40	60		
261.5 5.6	SAND , medium grained, trace silt Compact Brown Wet		1	RUN			20	40	60	80	100	20	40	60	RUN #1 TCR=0%	
260.7 6.4	Silty CLAY , trace gravel Grey Wet (TILL-LIKE)		2	RUN			20	40	60	80	100	20	40	60		
259.9 7.2	SAND and GRAVEL , occasional cobble BEDROCK granite, strong to very strong, coarse grained, pink/grey		3	RUN			20	40	60	80	100	20	40	60		
							20	40	60	80	100	20	40	60		RUN #2 TCR=82% SCR=67% RQD=73% UCS=114MPa (Average)
							20	40	60	80	100	20	40	60		RUN #3 TCR=89% SCR=82% RQD=55% UCS=53MPa (Average)
							20	40	60	80	100	20	40	60		RUN #4 TCR=94% SCR=86% RQD=82% UCS=121MPa

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SCW-08

2 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 108.3 E 208 183.6 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NW/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.27 - 2012.06.27 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL (Average)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page		4	RUN			257										
256.5																	
10.6	END OF BOREHOLE AT 10.6m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jul. 15/12 2.9 264.2 Mar. 02/13 3.8 263.3																

RECORD OF BOREHOLE No SCW-09

1 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 100.2 E 208 193.5 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NW Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.20 - 2012.06.20 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
								WATER CONTENT (%)							
267.4							20	40	60	80	100	W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
0.0	TOPSOIL: (75mm)														
0.1	SAND , trace to some silt, trace gravel Loose to Compact Brown Moist		1	SS	8								○		
			2	SS	8								○		
			3	SS	8								○		
			4	SS	26								○		
			5	SS	19								○		
	Wet														
			6	SS	17								○		
	Very Dense		7	SS	67								○		
260.2															
7.2	SILT , trace sand, some clay Compact Grey Wet														
			8	SS	25								○		
258.5															
8.9	SAND, GRAVEL and COBBLES		1	RUN											
258.1															
9.3	BEDROCK granite, fine grained, porphyritic texture, strong, pink/grey														
			2	RUN											

0 91 9
(SI+CL)

RUN #1
TCR=27%

RUN #2
TCR=100%
SCR=96%
RQD=75%
UCS=62MPa

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCW-09

2 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 100.2 E 208 193.5 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NW Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.20 - 2012.06.20 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL (Average)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) W _p W W _L				
	Continued From Previous Page																
			3	RUN			257										
							256										
255.3																	
12.1	END OF BOREHOLE AT 12.1m. WATER LEVEL AT 4.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPUG AND CUTTINGS TO SURFACE.																

RECORD OF BOREHOLE No SCW-10

1 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 116.7 E 208 206.3 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.06.27 - 2012.06.27 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
268.5								20	40	60	80	100		
0.0	TOPSOIL: (75mm)													
0.1	Silty SAND , fine grained, trace roots		1	SS	4		268							
	Loose													
267.9	Brown													
0.6	Moist													
	SAND , some gravel to SAND and GRAVEL , coarse grained, trace silt		2	SS	10									18 80 2
	Compact													(SI+CL)
	Brown						267							
	Moist		3	SS	20									41 54 5
														(SI+CL)
266.2														
2.3	SAND , trace to some silt		4	SS	24		266							
	Compact													
	Light Brown to Brown													
	Moist to Wet		5	SS	20		265							
							264							
			6	SS	20									
263.2														
5.3	Silty SAND						263							
	Compact													
	Brown													
	Moist to Wet													
			7	SS	21		262							0 65 35
														(SI+CL)
							261							
			8	SS	7									
							260							
259.4														
9.1	SILT , trace sand, some clay		9	SS	1		259							
	Very Loose to Compact													
	Grey													
	Wet													

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SCW-10

2 OF 2

METRIC

GWP# 647-89-00 LOCATION Stillwater Creek N 5 431 116.7 E 208 206.3 ORIGINATED BY RK
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.06.27 - 2012.06.27 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
256.8	SILT, trace sand, some clay Very Loose to Compact Grey Wet		10	SS	17											0 3 84 11	
11.7	Silty CLAY Very Soft Grey Wet																
256.0			11	SS	33											Sample sank under self weight in clay	
255.6	SAND and GRAVEL Very Dense Grey Wet																
12.7	END OF BOREHOLE AT 12.7m UPON AUGER REFUSAL. WATER LEVEL AT 3.5m UPON COMPLETION. BOREHOLE CAVED TO 3.7m THEN BACKFILLED WITH CUTTINGS TO SURFACE.																

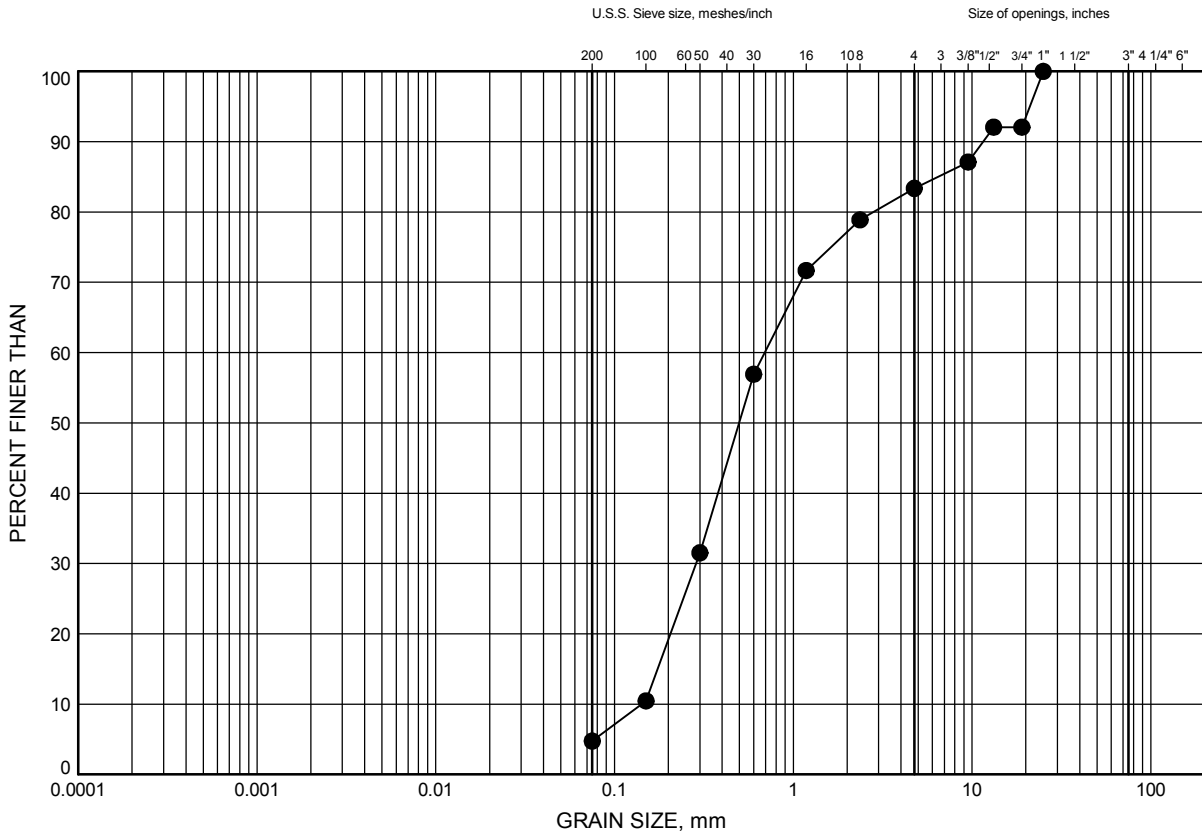
Appendix B

Laboratory Test Results

Hwy 11/17 Nipigon
GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SCW-03	1.07	264.04

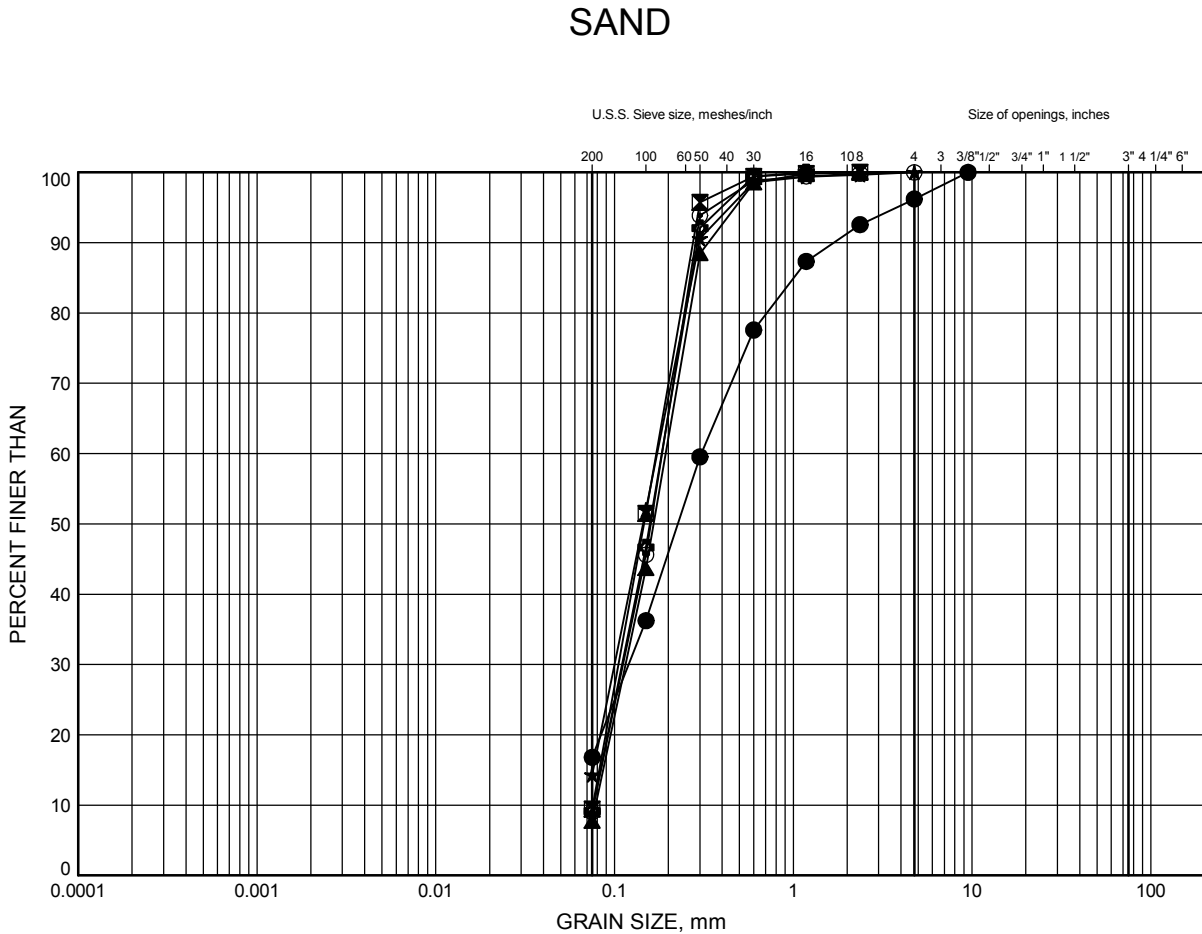
Date December 2012
W.P.# 647-89-00



Prep'd AN
Chkd. MC

Hwy 11/17 Nipigon GRAIN SIZE DISTRIBUTION

FIGURE B2



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SCW-01	1.07	265.24
⊠	SCW-06	3.35	263.15
▲	SCW-07	2.59	264.01
★	SCW-08	1.83	265.28
⊙	SCW-08	3.35	263.76
⊕	SCW-09	3.35	264.05

Date March 2013
W.P. 647-89-00

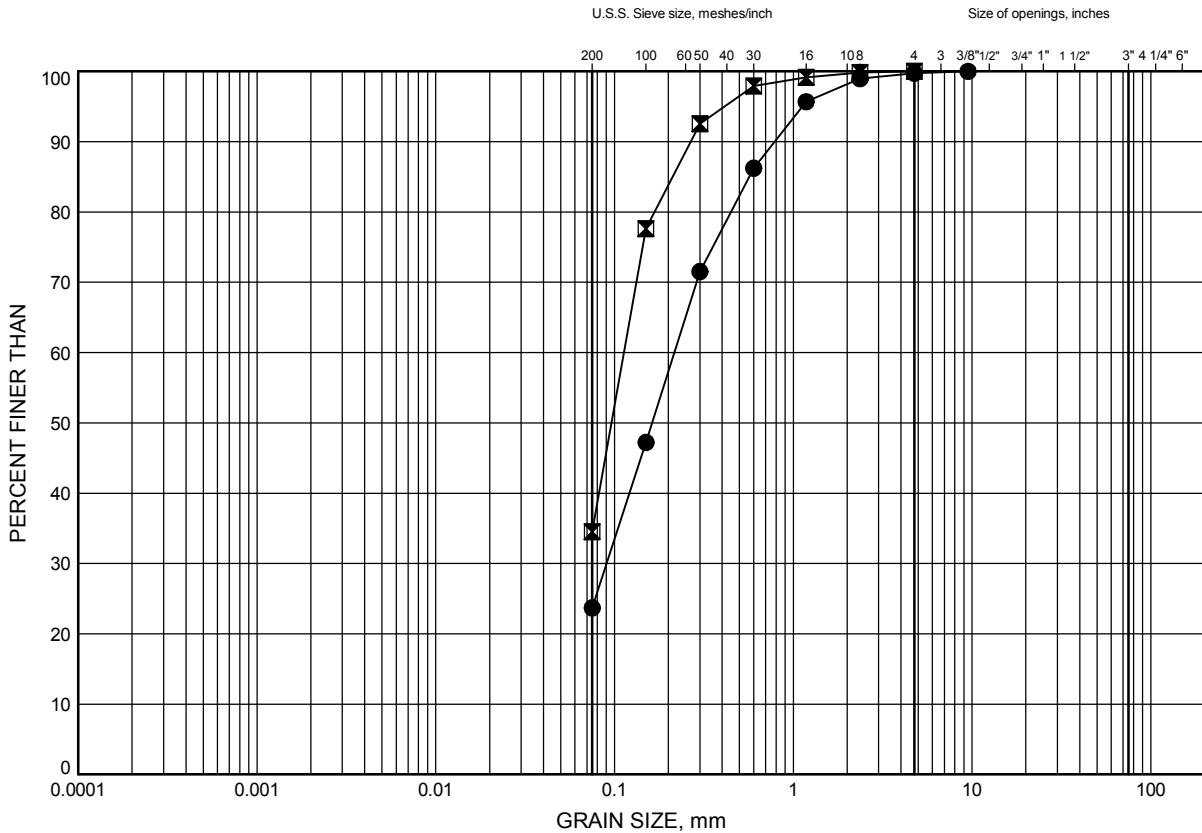


Prep'd AN
Chkd. MC

Hwy 11/17 Nipigon GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SCW-06	1.07	265.43
⊠	SCW-10	6.40	262.10

Date March 2013
W.P. 647-89-00

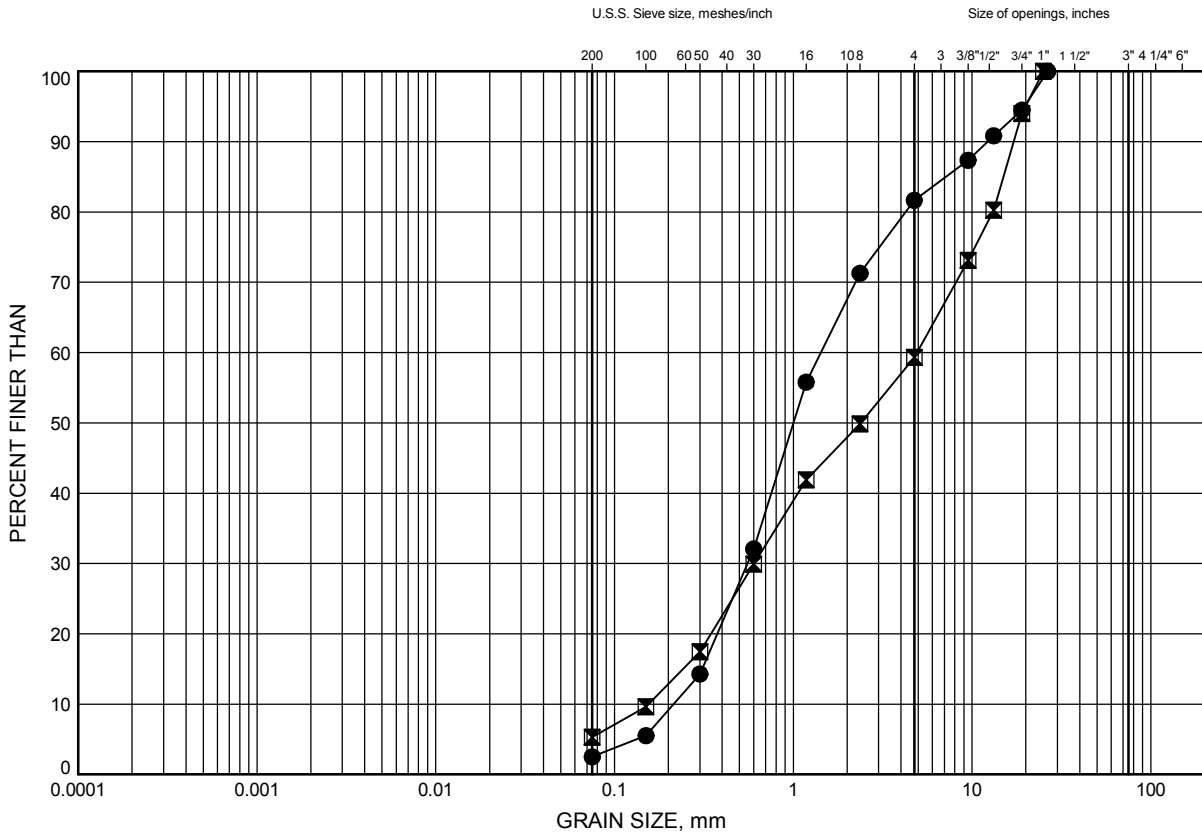


Prep'd AN
Chkd. MC

Hwy 11/17 Nipigon
GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND AND GRAVEL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SCW-10	1.07	267.43
⊠	SCW-10	1.83	266.67

Date December 2012
W.P.# 647-89-00

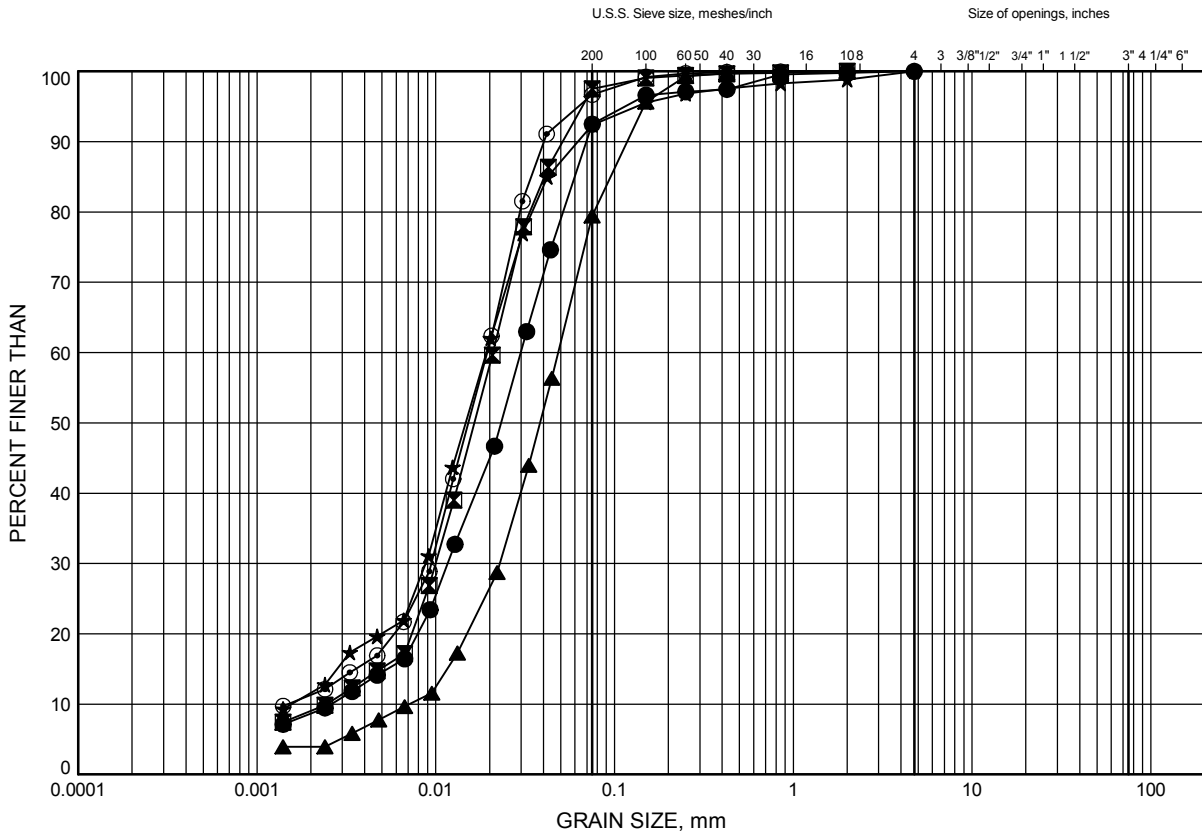


Prep'd AN
Chkd. MC

Hwy 11/17 Nipigon GRAIN SIZE DISTRIBUTION

FIGURE B5

SILT TO SANDY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SCW-04	1.98	261.90
⊠	SCW-05	1.98	261.72
▲	SCW-07	4.88	261.04
★	SCW-09	7.92	259.77
⊙	SCW-10	10.97	257.53

Date December 2012
W.P.# 647-89-00

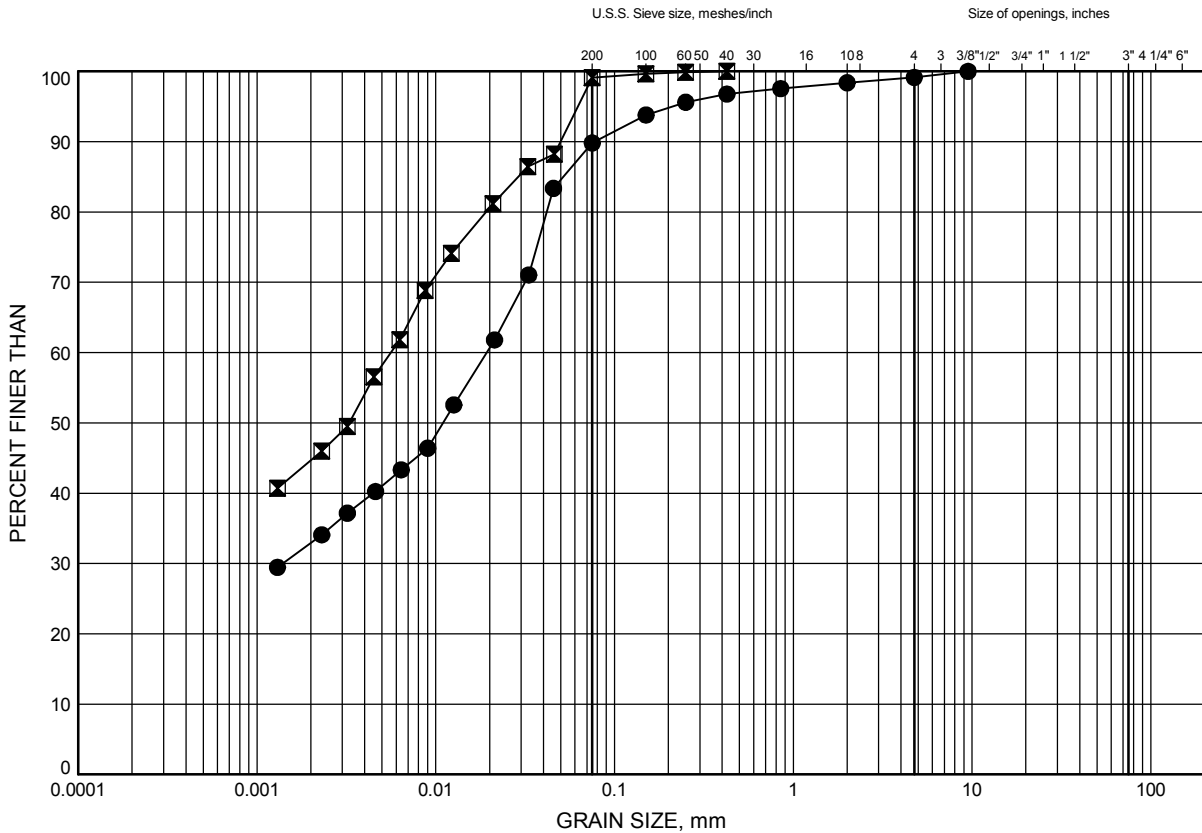


Prep'd AN
Chkd. MC

Hwy 11/17 Nipigon
GRAIN SIZE DISTRIBUTION

FIGURE B6

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SCW-02	2.59	262.01
⊠	SCW-05	2.59	261.11

Date December 2012
W.P.# 647-89-00



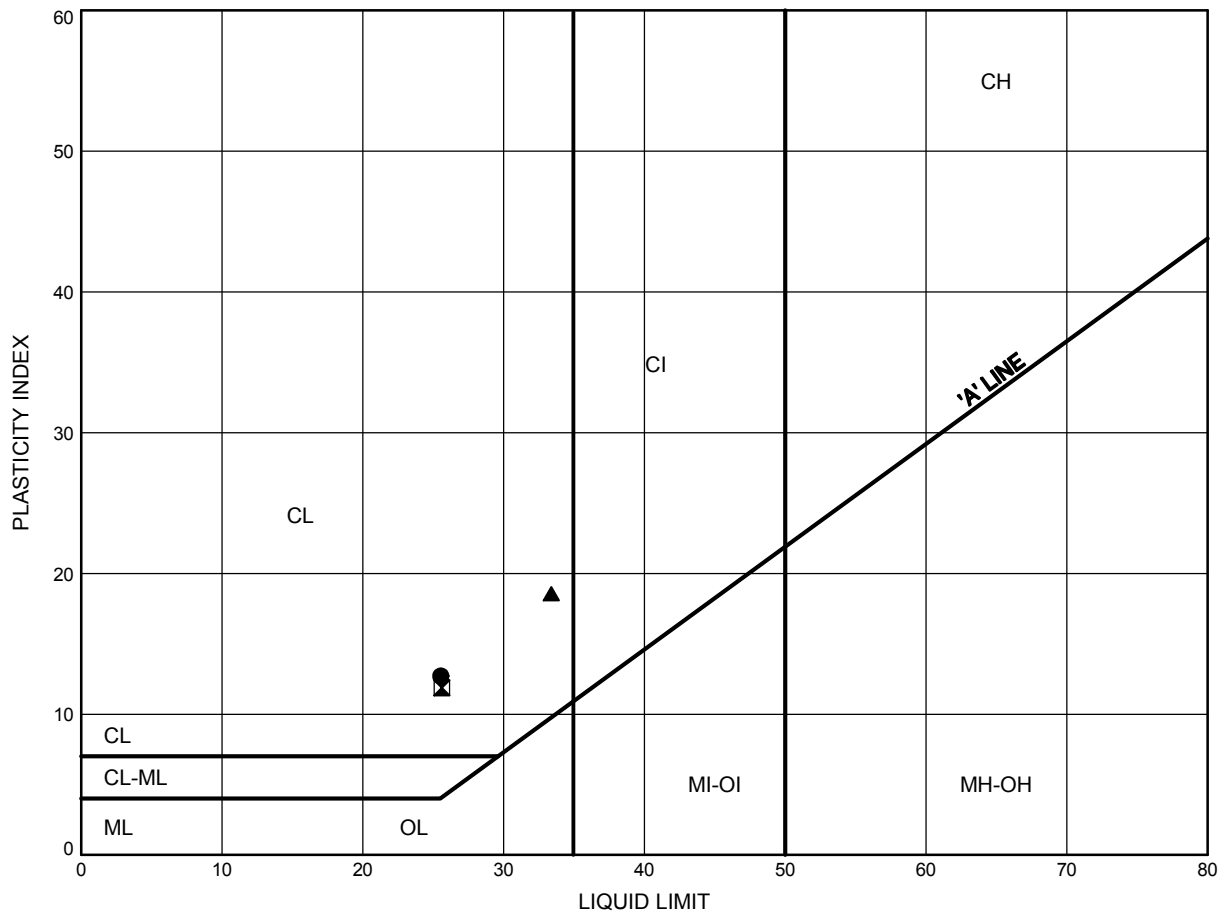
Prep'd AN
Chkd. MC

Hwy 11/17 Nipigon

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SCW-04	2.59	261.29
⊠	SCW-05	2.59	261.11
▲	SCW-06	6.52	259.98

Date December 2012
W.P.# 647-89-00



Prep'd AN
Chkd. MC

Appendix C

Site Photographs

Stillwater Creek Bridge WBL
Highway 11/17 Four Laning, Red Rock to Nipigon



Photograph 1 – North side of existing Highway 11/17 Bridge over Stillwater Creek, looking east



Photograph 2 – North side of existing Highway 11/17 Bridge over Stillwater Creek, looking southwest



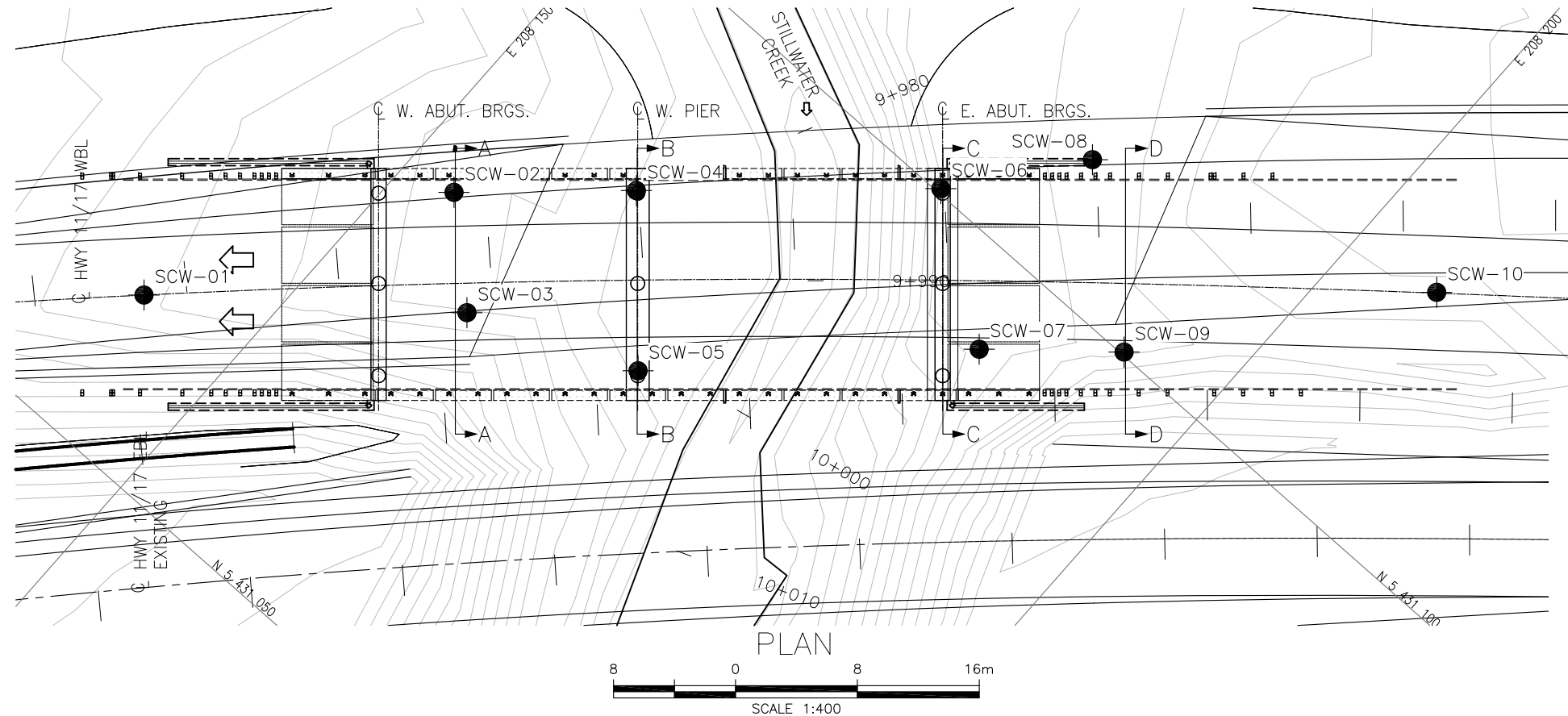
Photograph 3 – Site of proposed Stillwater Creek WBL Bridge, looking north



Photograph 4 – Site of proposed Stillwater Creek WBL Bridge, looking northeast

Appendix D

Drawing titled “Borehole Locations and Soil Strata”



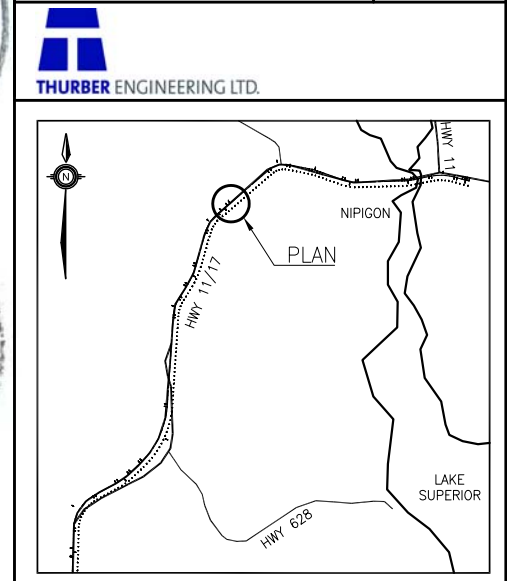
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



CONT No
WP No

HIGHWAY 11/17 FOUR LANE
STILLWATER CREEK BRIDGE
WESTBOUND LANES
BOREHOLE LOCATIONS AND SOIL STRATA

Hatch Mott MacDonald



KEYPLAN

LEGEND

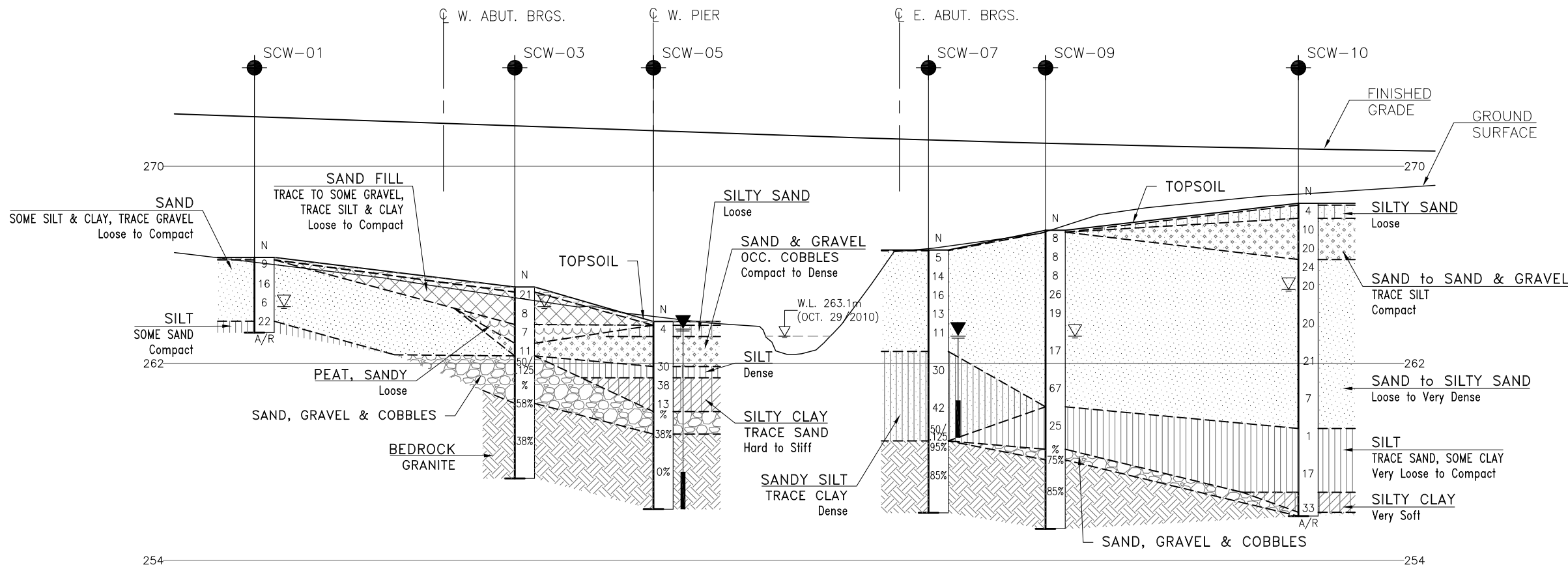
- Borehole
- Borehole and Cone
- N
- CONE
- PH
- Water Level During Drilling
- Water Level In Piezometer
- Rock Quality Designation (RQD)
- Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SCW-01	266.3	5 431 060.5	208 142.8
SCW-02	264.6	5 431 079.0	208 153.6
SCW-03	265.1	5 431 073.6	208 159.5
SCW-04	263.9	5 431 087.0	208 162.5
SCW-05	263.7	5 431 078.2	208 170.4
SCW-06	266.5	5 431 100.3	208 177.4
SCW-07	266.6	5 431 094.1	208 186.3
SCW-08	267.1	5 431 108.3	208 183.6
SCW-09	267.4	5 431 100.2	208 193.5
SCW-10	268.5	5 431 116.7	208 206.3

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 52H-20



PROFILE ALONG HWY 11/17 WBL



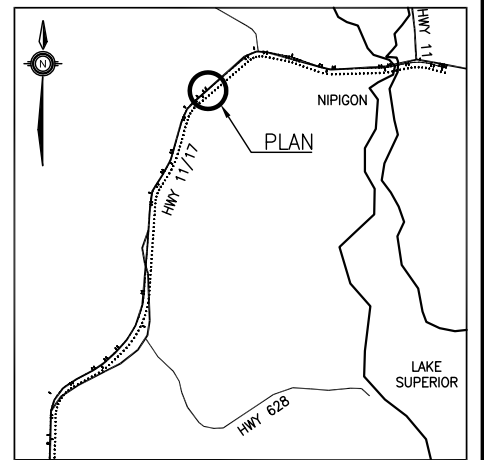
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MC	CHK	MC
DRAWN	AN	CHK	

CODE	LOAD	DATE	MAY 2013
SITE 48C-096	STRUCT	DWG	1

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No
HIGHWAY 11/17 FOUR LANE
STILLWATER CREEK BRIDGE
WESTBOUND LANES
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

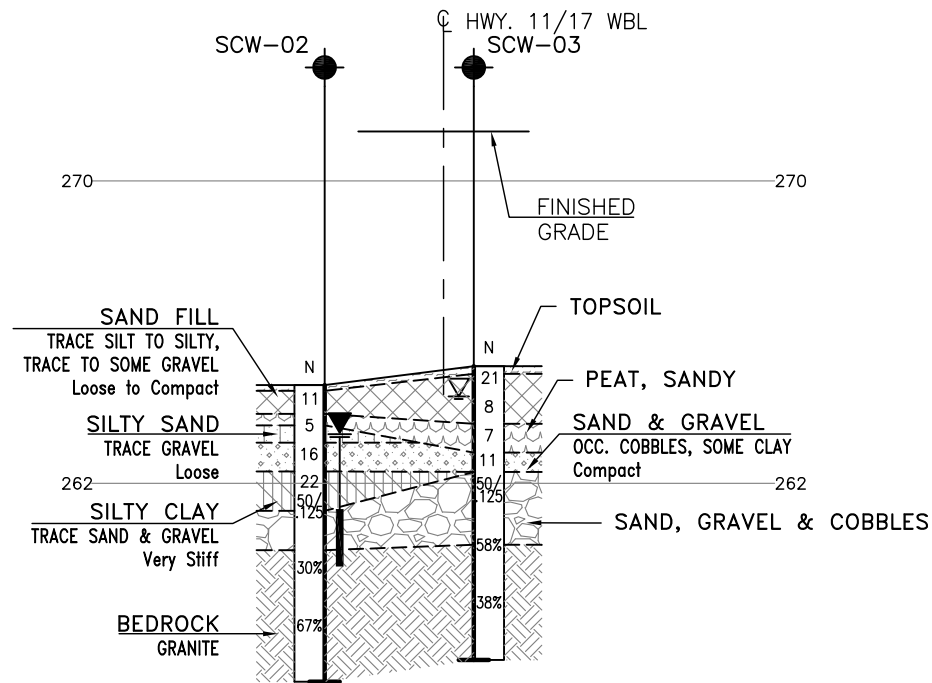
- Borehole
- Borehole and Cone
- N
Blows /0.3m (Std Pen Test, 475J/blow)
- CONE
Blows /0.3m (60° Cone, 475J/blow)
- PH
Pressure, Hydraulic
- Water Level During Drilling
- Water Level In Piezometer
- 90%
Rock Quality Designation (RQD)
- A/R
Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SCW-01	266.3	5 431 060.5	208 142.8
SCW-02	264.6	5 431 079.0	208 153.6
SCW-03	265.1	5 431 073.6	208 159.5
SCW-04	263.9	5 431 087.0	208 162.5
SCW-05	263.7	5 431 078.2	208 170.4
SCW-06	266.5	5 431 100.3	208 177.4
SCW-07	266.6	5 431 094.1	208 186.3
SCW-08	267.1	5 431 108.3	208 183.6
SCW-09	267.4	5 431 100.2	208 193.5
SCW-10	268.5	5 431 116.7	208 206.3

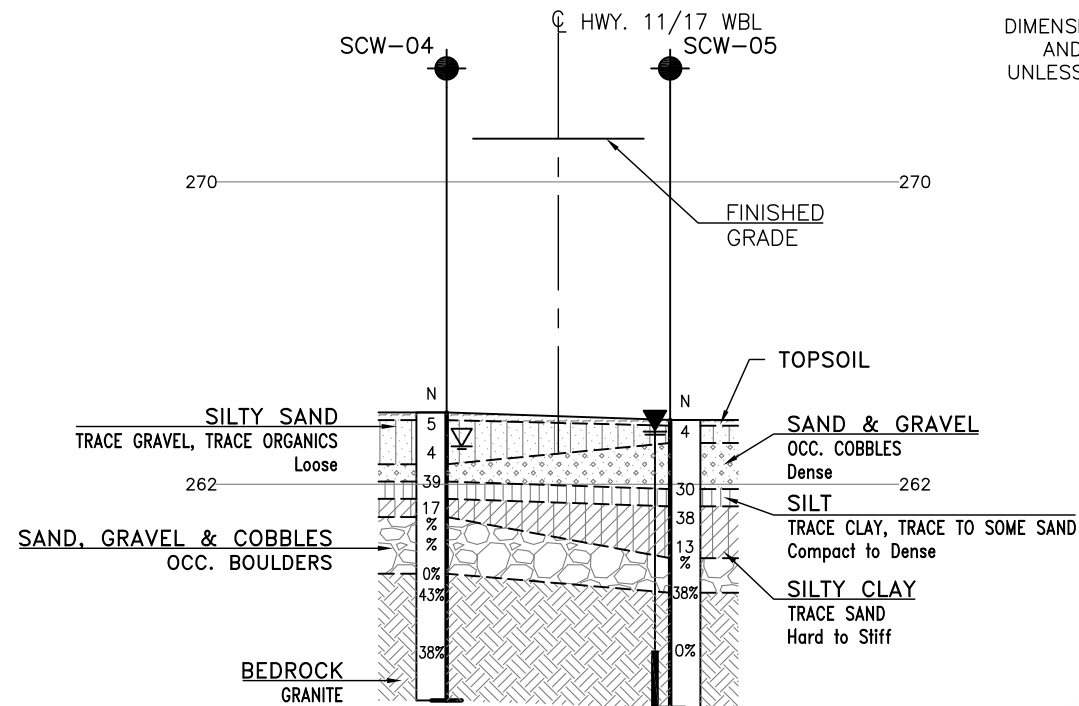
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

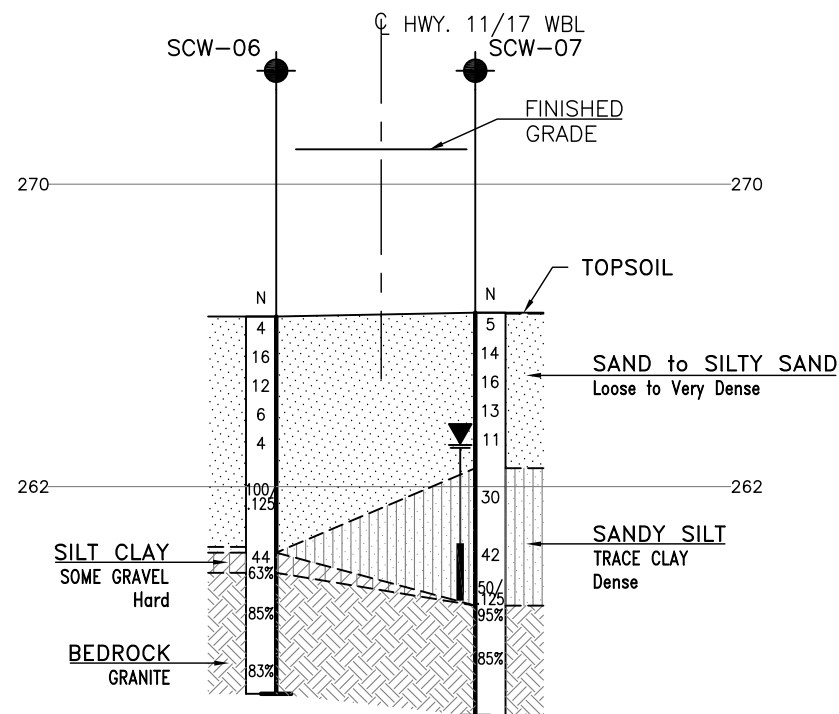
GEORES No. 52H-20



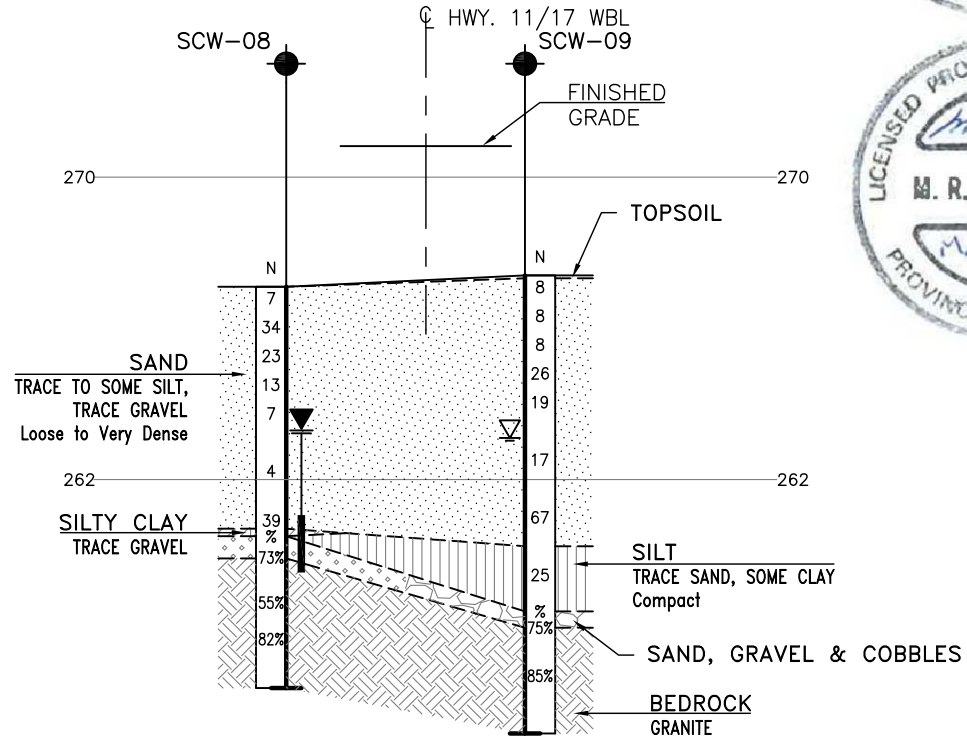
PROFILE ALONG A-A



PROFILE ALONG B-B



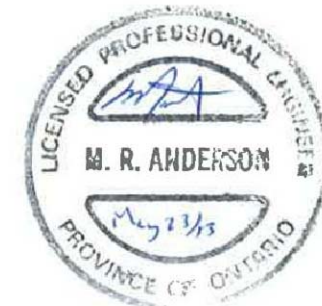
PROFILE ALONG C-C



PROFILE ALONG D-D



SCALE 1:400



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MC	CHK	MC
DRAWN	AN	CHK	

CODE	LOAD	DATE	MAY 2013
SITE	48C-096	STRUCT	DWG 2