

**FOUNDATION INVESTIGATION REPORT
SOUTH TROUT CREEK BRIDGE EBL
HIGHWAY 11/17 RED ROCK TO NIPIGON
FROM 4.8 KM WEST OF HWY 628 TO 1.5KM WEST OF HWY 585
DISTRICT OF THUNDER BAY**

G.W.P. 647-89-00, SITE NO. 48C-10B

Geocres Number: 52A-166

Report to

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TABLE OF CONTENTS

PART 1 **FACTUAL INFORMATION**

1	INTRODUCTION	1
2	SITE DESCRIPTION	2
3	SITE INVESTIGATION AND FIELD TESTING	2
4	LABORATORY TESTING	4
5	DESCRIPTION OF SUBSURFACE CONDITIONS	4
5.1	Sand Fill	4
5.2	Topsoil/Alluvium	4
5.3	Sandy Clayey Silt	5
5.4	Silty Clay	5
5.5	Silt and Sand	6
5.6	Sandy Silt to Silt and Sand Till	6
5.7	Sand / Gravelly Sand	7
5.8	Water Levels	8
6	MISCELLANEOUS	9

Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Site Photographs
Appendix D	Drawing titled “Borehole Locations and Soil Strata”

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the proposed location of a bridge planned to carry the new Highway 11/17 eastbound lanes (EBL) over the South Trout Creek in the Township of Red Rock, Ontario. 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, a stratigraphic profile, 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.

A previous foundation investigation report was prepared for replacement of the bridge on the current Highway 11/17 alignment with a temporary structure (Foundation Investigation and Design Report, South Trout Creek Bridge Replacement, Highway 11/17, 14 km west of the Town of Nipigon, January 22, 2010, by TBT Engineering; Geocres 52A-140). The existing bridge is located approximately 8 to 12 m southeast of the new location. Selected boreholes from the previous foundation investigation report have been used in the preparation of this report.

2 SITE DESCRIPTION

The site is located approximately 12 km (by highway) southwest of Nipigon, Ontario and about 1.3 km southwest of the intersection of Highway 11/17 and Highway 628. At the bridge location, the new eastbound lanes of Highway 11/17 will be approximately 12 to 19 m northwest of the existing highway.

South Trout Creek at the proposed crossing generally flows southerly and then easterly towards Lake Superior at Red Rock. The creek bed is situated at an approximate elevation of 212 m. The creek channel is approximately 6 m wide and 1.5 m deep. The ground elevation surrounding the site drops from approximately 218.5 m on the west side to approximately 213.5 m on the east side. The surrounding lands are typically heavily treed with occasional vacant areas of grass and shrubs.

The site is located between local roads Red Rock Road No. 7 and Red Rock Road No. 6, which are approximately 60 m southwest and 200 m northeast of South Trout Creek respectively. Overhead hydro cables run parallel to the northwest side of the highway, in close proximity to the centreline of the new eastbound lanes of Highway 11/17. The existing bridge crossing South Trout Creek was replaced in the fall of 2012 with a temporary double-lane modular steel structure.

Photographs in Appendix C show the general nature of the site and the surrounding lands.

The site lies within the physiographic region known as the Quetico Subprovince of the Superior Province of the Canadian Shield. The bedrock consists of sedimentary rock of the Sibley Group, which is overlain by deposits of lacustrine clay and silt and glacial till.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period of April 24 to May 8, 2013 and consisted of drilling and sampling four boreholes (numbered STE-01 to STE-04) in the area of the proposed foundation units and approach embankments. A foundation investigation which consisted of six boreholes for the proposed westbound bridge over South Trout Creek was conducted concurrently with this investigation. Two boreholes from the westbound investigation (numbered STW-03 and STW-05) are incorporated into this report.

Based on the limited access conditions at the site, including a steep slope in close proximity to the creek as well as overhead hydro wires near the alignment of the eastbound lanes, it was not practical to advance two boreholes at each foundation element of the eastbound bridge. Therefore, it was agreed during discussions with MTO Foundations Office that abutment boreholes would be drilled where access was practical and boreholes drilled for the westbound bridge would be used to supplement this data. Similarly, one borehole (numbered STC08-1) from the previous investigation for the existing temporary bridge was used to supplement the data.

A summary of the locations, designations, termination depths and termination elevations of all boreholes used in this report is provided in Table 3.1. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

Table 3.1 – Borehole Designations

Foundation Unit	Borehole Number	Borehole Termination Depth (m)	Borehole Termination Elevation (m)
West approach	STE-01	9.8	208.7
West abutment	STE-02, STC08-1 and STW-03	10.8 to 16.9	206.2 to 201.9
East abutment	STE-03 and STW-05	10.7 to 12.3	203.0 to 201.7
East approach	STE-04	9.5	204.6

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

Drilling was carried out using a track-mounted CME 55 drill rig and the boreholes were advanced with hollow-stem augers. In general, samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the native soils.

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 samples for transport to Thurber’s laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. The boreholes were backfilled with bentonite holeplug in general accordance with O.Reg. 903 upon completion. Standpipe piezometers consisting of 19 mm PVC pipe with slotted screen enclosed in filter sand were installed in Boreholes STE-02, STE-03, and STW-05 to permit longer term groundwater level monitoring. The piezometers will be subsequently decommissioned in general accordance with MOE Regulation 903 following additional water level monitoring. The installation and completion details of the piezometer and boreholes are shown in Table 3.2.

Table 3.2 – Borehole Completion Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
STE-01	None installed	Borehole backfilled with bentonite to surface.
STE-02	10.7/204.1	Sand from 10.9 m to 6.3 m, bentonite from 6.3 m to surface.
STE-03	10.7/203.0	Sand from 10.7 m to 6.7 m, bentonite to surface.
STE-04	None installed	Borehole backfilled with bentonite to surface.
STW-03	None installed	Borehole backfilled with bentonite to surface.
STW-05	11.9/202.1	Sand from 12.3 m to 5.9 m, bentonite to surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and natural moisture content determination. 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 included in Appendix A and on the figures presented in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil and rock stratigraphy are presented in these sheets and on the “Borehole Locations and Soil Strata” drawing included 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.

The subsurface stratigraphy at this site varies between the west and east portions of the site. At the west portion, the stratigraphy typically consists of a topsoil layer over a relatively thick deposit of silty clay, underlain by deposits of clayey silt, sandy silt, and silt and sand glacial till. At the east portion, topsoil/alluvium is underlain by deposits of clayey silt, sandy silt, and silt and sand glacial till, with no thick silty clay deposit encountered. Refusal was generally encountered within the silt and sand till deposit. The boreholes for this investigation did not reach bedrock. More detailed descriptions of the individual strata are presented below.

5.1 Sand Fill

A layer of sand fill with trace gravel was encountered surficially in Borehole STE-02. The borehole was located beside the existing Highway 11/17, and the fill comprises the edge of the existing approach embankment for the bridge over South Trout Creek. The fill layer was 1.7 m thick. The base of the fill layer was at Elev. 213.1 m.

An SPT N-value recorded in the sand fill layer was 10 blows per 0.3 m of penetration, indicating a compact relative density.

The moisture content of one sample of the sand fill was 14%.

5.2 Topsoil/Alluvium

Topsoil and/or alluvial stream deposits were identified at the ground surface in all of the boreholes except Borehole STE-02. The topsoil layer ranged from a thin veneer of topsoil 175 mm thick to a 1.3 m thick layer of silty sand alluvium containing trace gravel, wood and roots and rootlets. The topsoil/alluvium thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

An SPT N-value of 12 blows per 0.3 m penetration was recorded in the alluvial layer in Borehole STE-03. The moisture content of the sample was 75%.

5.3 Sandy Clayey Silt

A layer of sandy, clayey silt was encountered underlying the alluvial deposits in Boreholes STE-03, STE-04, and STW-05, and below the sand fill in Borehole STE-02. The sandy clayey silt contained organic material including topsoil, roots and wood fragments. The thickness of the clayey silt layer was 0.9 m to 1.7 m. The depth to the base of the clayey silt layer was 1.7 m to 2.9 m (Elev. 211.5 m to 212.4 m)

SPT N-values in the clayey silt ranged from 0 to 13 blows per 0.3 m penetration, indicating a very soft to stiff relative density. The moisture content of the clayey silt samples ranged from 28% to 39%.

Grain size distribution curves for two samples of the clayey silt are presented on Figure B1 of Appendix B. The results are summarized on the Record of Borehole sheets and are as follows:

Gravel %	0
Sand %	24 to 36
Silt %	41 to 52
Clay %	23 to 24

5.4 Silty Clay

A thick deposit of native brown to grey silty clay with trace sand and occasional silt seams and sand pockets was encountered below the topsoil in Boreholes STE-01 and STW-03 drilled above the west valley slope, and below a layer of clayey silt in Borehole STE-02.

At Boreholes STE-01 and STW-03, which were drilled from a higher elevation, the clay deposit was encountered at Elev. 218.0 m and ranged in thickness from 8.3 m to 8.8 m. At Borehole STE-02, the clay was encountered at Elev. 211.9 m and was 1.5 m thick. The lower boundary of the silty clay layer ranged from Elev. 209.1 to 210.4.

Standard Penetration tests performed in the silty clay deposit gave SPT N-values ranging from 0 to 7 blows per 0.3 m of penetration, indicating a very soft to firm consistency. The values higher than 3 were obtained in the upper 2.0 to 2.5 m of the clay in Boreholes STE-01 and STW-03 drilled above the west slope, indicating the presence of an upper firm to soft crust.

In-situ vane shear tests carried out on the cohesive deposits measured undrained shear strengths of 30 kPa to 70 kPa. It is likely however that the measured strengths, particularly the higher values, are affected by the silt seams in the clay. The Sensitivity ranged from 2 to 6.

The moisture contents of samples of the silty clay varied from 26% to 59%.

Selected samples of the silty clay underwent laboratory grain size analysis testing and Atterberg Limits tests. The grain size distribution curves for tested samples of silty clay are presented in Appendix B, Figure B2. The results of the Atterberg Limits tests are presented in Figure B6, Appendix B. The results are summarized on the Record of Borehole sheets included in Appendix A, and in the following tables:

Gravel %	0
Sand %	0
Silt %	29 to 49
Clay %	51 to 71

Liquid Limit	41 to 61
Plastic Limit	19 to 23

The above results indicate that the silty clay varies from intermediate to high plasticity with group symbols of CI and CH.

5.5 Silt and Sand

In Boreholes STE-02, STW-03, and STW-05, a layer of grey silt and sand containing trace gravel was contacted below the silty clay and clayey silt at depths from 1.9 m to 9.6 m (Elev. 209.1 m to 212.1 m). The layer was 1.7 m to 2.6 m thick and the base of the silt and sand was encountered at 3.8 m to 12.2 m depth (Elev. 206.6 m to 210.2 m).

SPT N-values recorded in the silt and sand ranged from 4 to 10 blows per 0.3 m of penetration, indicating a loose to compact relative density. The moisture content of the silt and sand samples ranged from 13% to 18%.

5.6 Sandy Silt to Silt and Sand Till

A deposit of grey glacial till ranging in composition from silt and sand to sandy silt was encountered below the silty clay, clayey silt, or silt and sand layers in all of the boreholes at depths ranging from 1.7 m to 12.2 m (Elev. 206.6 m to 212.4 m). The till contained trace to some gravel, trace clay, and occasional cobbles. All of the boreholes were terminated within the till deposit at depths ranging from 9.5 m to 16.9 m (Elev. 201.7 m to 208.7 m). All boreholes except Borehole STE-01 were terminated in the till deposit after advancing at least 3 m into refusal soil as defined by SPT N-values of greater than 100 blows per 0.3 m penetration.

SPT N-values recorded in the till deposit ranged from 19 blows per 0.3 m of penetration to 100 blows per 0.1 m of penetration, indicating a compact to very dense relative density.

The moisture content of samples of the till ranged from 10% to 18%, with one higher value of 28% recorded.

Selected samples of the till underwent laboratory grain size analysis testing. The grain size distribution curves for tested samples are presented in Appendix B, Figures B3 and B4. The results are summarized on the Record of Borehole sheets included in Appendix A, and in the following table:

Gravel %	0 to 10
Sand %	21 to 41
Silt %	44 to 71
Clay %	4 to 9

Till deposits inherently contain cobbles and boulders, and these should be anticipated during construction.

5.7 Sand / Gravelly Sand

Boreholes STE-02 and STW-05 encountered deposits of sand to gravelly sand within the glacial till described above. The sand was grey to dark grey in colour, and contained some silt. The boreholes encountered the sand at depths of 9.1 m and 9.6 m (Elev. 205.7 m and 204.4 m). In Borehole STE-02, the sand layer was 0.7 m thick, and in Borehole STW-05, the sand deposit was 2.6 m thick. The base of the sand was contacted at depths of 9.8 m and 12.2 m (Elev. 205.0 m and 201.8 m).

SPT N-values of 100 blows per 0.1 to 0.2 m of penetration were recorded within the sand, indicating a very dense relative density. Moisture contents of 15% and 16% were measured.

The results of a grain size distribution analysis conducted on a sample of the sand are presented on the Record of Borehole sheet and on Figure B5 of Appendix B. The results are summarized as follows:

Gravel %	6
Sand %	82
Silt & Clay%	12

The sand and gravel deposits may contain cobbles and boulders, and these should be anticipated during construction.

5.8 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in Boreholes STE-02, STE-03, and STW-05 to monitor water levels after completion of drilling. The water levels measured upon drilling completion and in the piezometers are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
STE-02	May 9, 2013	0.3	214.5	In piezometer
	June 23, 2013	2.6	212.2	In piezometer
STE-03	April 30, 2013	0.0	213.7	Upon completion
	May 9, 2013	0.2	213.5	In piezometer
	June 23, 2013	0.8	212.9	In piezometer
STE-04	April 24, 2013	7.9	206.2	Upon completion
STW-03	May 2, 2013	6.2	212.6	Upon completion
STW-05	May 9, 2013	0.6	213.4	In piezometer
	June 23, 2013	0.7	213.3	In piezometer

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

The groundwater level is also expected to be influenced by the water level in South Trout Creek, which is shown on the preliminary GA drawing provided by HMM to be at Elev. 212.9 m (date not noted). The high water level is indicated at Elev. 213.6.

6 MISCELLANEOUS

Borehole locations were selected by Thurber Engineering Ltd. The borehole locations were staked in the field by TBT Engineering Limited surveyors. The co-ordinates and ground surface elevations at the boreholes were provided by the surveyors.

TBT Engineering Limited from Thunder Bay, Ontario supplied a track mounted CME 55 drill rig and conducted the drilling, sampling and in-situ testing operations.

Full time supervision of the field activities was carried out by Ms. Eckie Siu of Thurber. Overall 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 Mr. Mark Farrant, P.Eng. and Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Murray R. Anderson, P.Eng.
Senior Foundations Engineer



P. K. Chatterji, P.Eng.
Review Principal



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
 C_{pen} 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 (MPa) (psi)	Field Estimation of Hardness*
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			
Very thinly bedded	20 to 60mm	Strong	50-100 7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm			
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0 3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0 750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0 150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0 35 to 150	Indented by thumbnail
<u>TERMS</u>				
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 STE-01

2 OF 2

METRIC

GWP# 647-89-00 LOCATION N 5 424 485.5 E 205 884.3 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.05.04 - 2013.05.04 CHECKED BY MEF

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
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	Continued From Previous Page BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

ONTMT4S_05117.GPJ_2012TEMPLATE(MTO).GDT 6/6/13

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

RECORD OF BOREHOLE No STE-02

1 OF 2

METRIC

GWP# 647-89-00 LOCATION N 5 424 487.5 E 205 907.3 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.05.08 - 2013.05.08 CHECKED BY MEF

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						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
214.8	SAND , fine grained, trace gravel, occasional cobbles Compact Brown Moist (FILL)	[Hatched pattern]	1	SS	10									
213.1			2	SS	0									
211.9	Clayey SILT , sandy, trace gravel, trace roots and rootlets Soft Brown Moist Becoming grey with wood fibres	[Hatched pattern]	3	SS	2									
210.4			4	SS	1									
208.7	SILT and SAND , trace gravel Loose Grey Wet	[Dotted pattern]	5	SS	7									
205.7			6	SS	104/ 0.200									
205.0	Sandy SILT to SILT and SAND , trace clay, trace gravel Very Dense Grey Moist (TILL)	[Dotted pattern]	7	SS	100/ 0.075									
205.7			8	SS	100/ 0.200									
205.0	Gravelly SAND Very Dense Grey Wet	[Dotted pattern]	9.1	SS	100/ 0.200									
205.0			9.8	SS	100/ 0.200									
205.0	Sandy SILT , trace clay, trace gravel	[Dotted pattern]												

ONTMT4S_051117.GPJ_2012TEMPLATE(MTO).GDT 6/28/13

Continued Next Page

+ 3, x 3. Numbers refer to 20
Sensitivity 15 (5) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No STE-02 2 OF 2 METRIC

GWP# 647-89-00 LOCATION N 5 424 487.5 E 205 907.3 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.05.08 - 2013.05.08 CHECKED BY MEF

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			20	40	60	80	100						W _p	W	W _L
203.9	Continued From Previous Page Sandy SILT , trace clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/															
10.9	END OF BOREHOLE AT 10.9m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May 09/13 0.3 214.5 Jun. 23/13 2.6 212.2				0.225															

ONTMT4S_05117.GPJ_2012TEMPLATE(MTO).GDT_6/26/13

+³, ×³: Numbers refer to Sensitivity 20
15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No STE-03

1 OF 2

METRIC

GWP# 647-89-00 LOCATION N 5 424 509.5 E 205 929.3 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.04.28 - 2013.04.30 CHECKED BY MEF

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	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
213.7																
0.0	TOPSOIL/ALLUVIUM silty sand, trace gravel, trace roots and rootlets Loose to Compact Dark Brown Wet															
212.4		1	SS	12												
1.3	Clayey SILT , sandy, trace gravel Stiff Grey															
211.5		2	SS	13												
2.2	SILT and SAND , trace clay, trace gravel Very Dense Grey Moist (TILL)															
		3	SS	25												
		4	SS	100/ 0.225												
	Occasional cobbles	5	SS	100/ 0.200												
	Compact	6	SS	28												
		7	SS	100/ 0.150												
		8	SS	100/ 0.100												

ONTMT4S_05117.GPJ_2012TEMPLATE(MTO).GDT_6/28/13

Continued Next Page

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

RECORD OF BOREHOLE No STE-03

2 OF 2

METRIC

GWP# 647-89-00 LOCATION N 5 424 509.5 E 205 929.3 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.04.28 - 2013.04.30 CHECKED BY MEF

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								
						20	40	60	80	100						
	Continued From Previous Page															
203.0	SILT and SAND , trace clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/											
10.7	END OF BOREHOLE AT 10.7m. WATER AT SURFACE UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May 09/13 0.2 213.5 Jun. 23/13 0.8 212.9				0.075											

ONTMT4S_05117.GPJ_2012TEMPLATE(MTO).GDT_6/28/13

+ 3 , × 3 : Numbers refer to Sensitivity
 20
 15 5
 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No STW-03 2 OF 2 METRIC

GWP# 647-89-00 LOCATION N 5 424 495.0 E 205 881.2 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.05.02 - 2013.05.02 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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						
	Continued From Previous Page					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100								
						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L WATER CONTENT (%) 20 40 60								
206.6	SILT and SAND , trace gravel Compact Grey Moist		9	SS	10									
12.2	Sandy SILT , trace clay, trace gravel Compact to Very Dense Grey Moist (TILL) Occasional cobbles		10	SS	27									0 27 68 5
			11	SS	100/ 0.175									
			12	SS	100/ 0.125									
201.9			13	SS	100/ 0.150									
16.9	END OF BOREHOLE AT 16.9m. WATER LEVEL AT 6.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S_05117.GPJ_2012TEMPLATE(MTO).GDT 6/6/13

+³, ×³: Numbers refer to Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No STW-05

1 OF 2

METRIC

GWP# 647-89-00 LOCATION N 5 424 516.7 E 205 909.1 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.04.25 - 2013.04.27 CHECKED BY MEF

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
214.0	TOPSOIL: (175mm)												
0.0													
0.2	Clayey SILT, sandy, trace rootlets, occasional wood fibres Soft to Firm Brown	1	SS	3									0 24 52 24
212.1		2	SS	5									
1.9	SILT and SAND, trace clay, trace gravel Loose Grey Wet	3	SS	4									
		4	SS	8									
210.0													
4.0	Sandy SILT to SILT and SAND, trace clay, trace gravel, occasional coarse sand seams, occasional cobbles/boulders Very Dense to Dense Grey Moist (TILL) Sand layer at 4.6m	5	SS	100/ 0.125									
		6	SS	51									4 33 54 9
	Occasional sand pockets	7	SS	37									
		8	SS	100/ 0.175									
204.4													
9.6	SAND, coarse grained, some silt, trace gravel												

ONTMT4S_05117.GPJ_2012TEMPLATE(MTO).GDT 6/28/13

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity
 20
 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No STW-05 2 OF 2 METRIC

GWP# 647-89-00 LOCATION N 5 424 516.7 E 205 909.1 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.04.25 - 2013.04.27 CHECKED BY MEF

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 (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
							20	40	60	80	100							
	Continued From Previous Page																	
201.7	SAND , coarse grained, some silt, trace gravel Very Dense Dark Grey Wet (TILL)		9	SS	100/ 0.125												6 82 12 (SI+CL)	
12.3	END OF BOREHOLE AT 12.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May 09/13 0.6 213.4 Jun. 23/13 0.7 213.3		10	SS	100/ 0.100													

ONTMT4S_05117.GPJ_2012TEMPLATE(MTO).GDT_6/26/13

TBT Engineering Consulting Group **RECORD OF Borehole No STC08-1** 1 OF 1 **METRIC**

W.P. **496 00 00** PROJECT **South Trout Creek** SITE NO. **48-C-010** ORIGINATED BY **HF**

DIST **61** HWY **11/17** LOCATION **Sta. 13+569 o/s 6.0 Lt** TBTE JOB# **08-085** COMPILED BY **TB**

DATE **2008 July 15** BOREHOLE TYPE **Hollow Stem Auger** DATUM **Geodetic** CHECKED BY **WH**

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						WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	GR	SA	SI	CL			
217.0	ASPHALT - 120 mm FILL - SAND & GRAVEL - trace silt, brown, loose to compact		1	AS										Water level @ 5.6 m on completion. 39 55 (7)						
216.0			2	SS	8															
214.8			3	SS	12															
214.8	CLAY - Silty, brown, stiff to very stiff - some clay lumps, brown		4	SS	7															
214.2			5	SS	6															
213.8			6	SS	7															
213.2			7	SS	4															
212.2			8	SS	4															
211.1	GLACIAL TILL - SILT & SAND - trace gravel, occasional cobbles & boulders, grey, loose to very dense		9	SS	100+									10 48 (42) 50 Blows for 0.1 m. Auger Refusal @ 8.3 m advanced with casing to 10.8 m. 50 Blows for 0.07 m.						
209.8			10	SS	100+															
208.2			11	SS	100+															
206.2	End of Borehole @ 10.8 m.													50 Blows for 0.1 m.						

ON_MOT_BH-10_08-085 SOUTH TROUT CREEK.GPJ ON_MOT_GDT_08/11/23

×³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE
NP Non Plastic

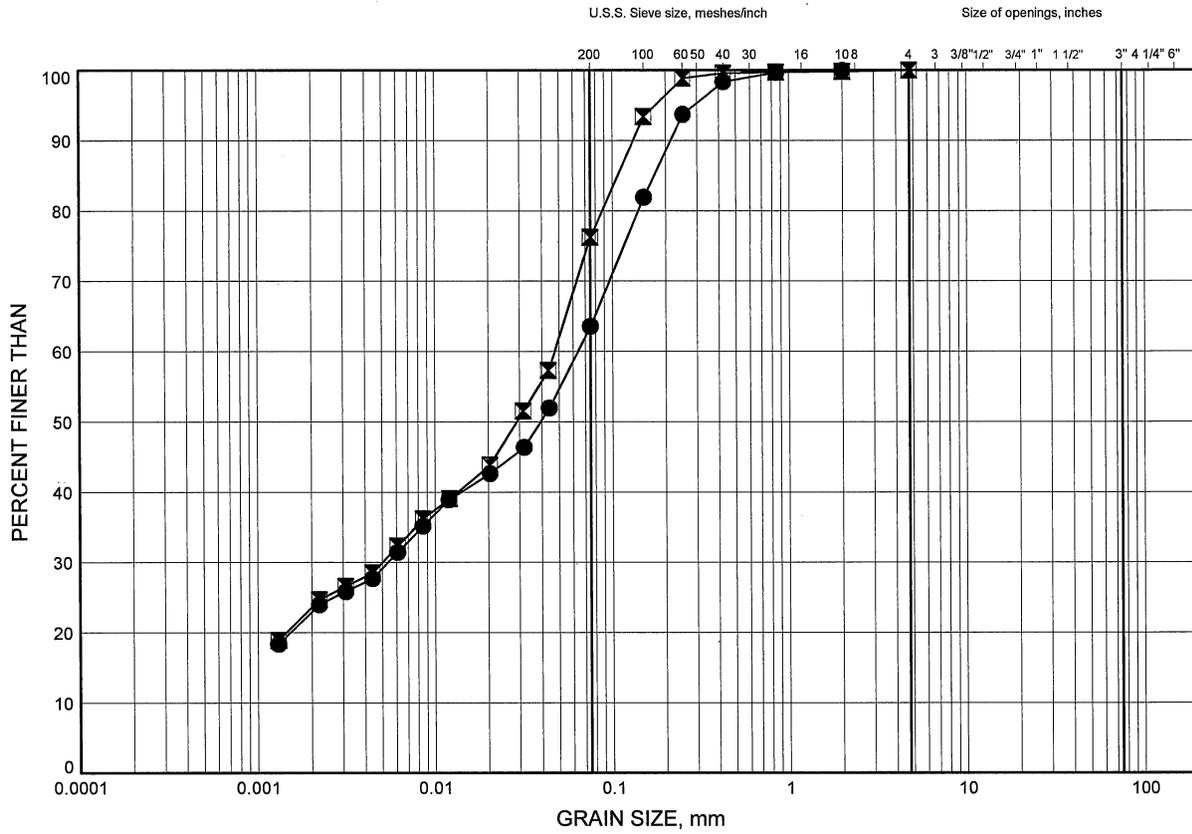
Appendix B

Laboratory Test Results

South Trout Creek - EBL
GRAIN SIZE DISTRIBUTION

FIGURE B1

SANDY, CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STE-04	1.07	213.00
⊠	STW-05	1.07	212.92

GRAIN SIZE DISTRIBUTION - THURBER 05117.GPJ 6/5/13

Date June 2013
 GWP# 647-89-00

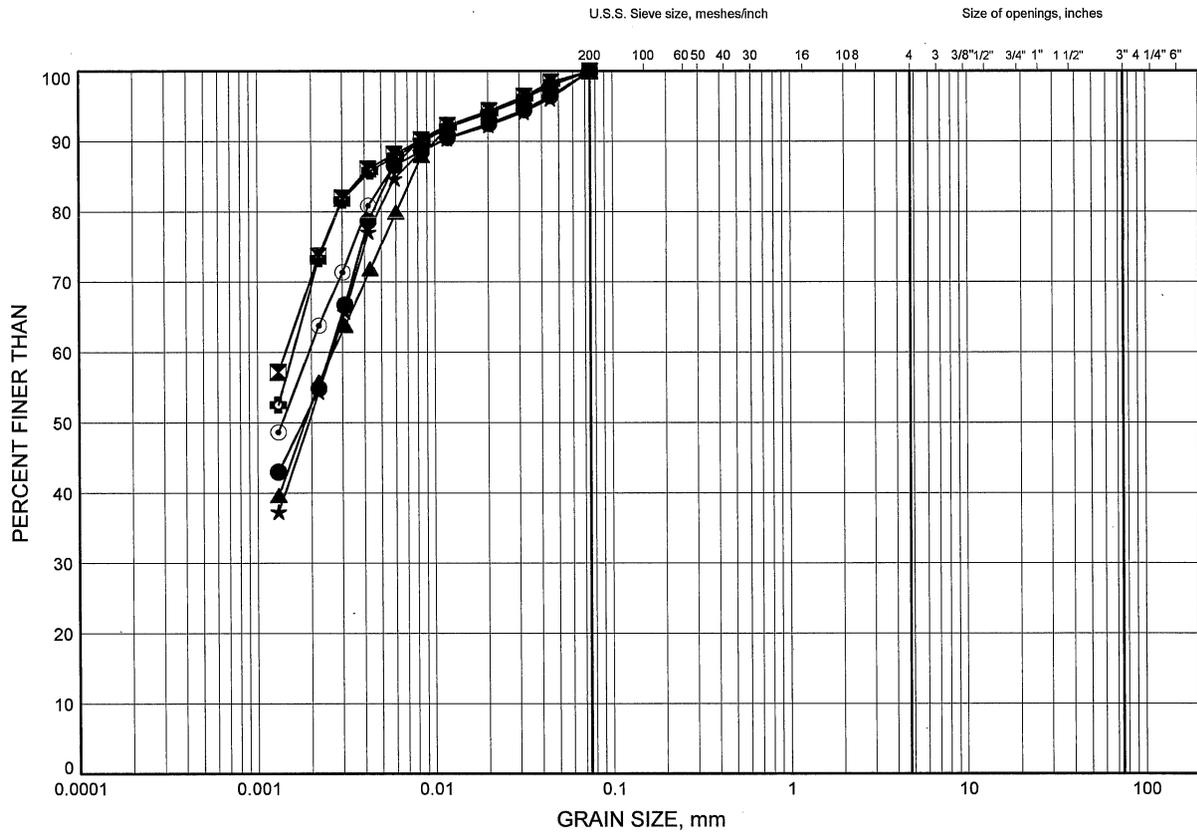


Prep'd AN
 Chkd. KS

South Trout Creek - EBL
GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STE-01	1.83	216.67
⊠	STE-01	6.40	212.10
▲	STE-02	3.35	211.45
★	STW-03	1.83	216.94
⊙	STW-03	3.35	215.42
⊕	STW-03	7.92	210.84

GRAIN SIZE DISTRIBUTION - THURBER 05117.GPJ 6/5/13

Date June 2013
 GWP# 647-89-00

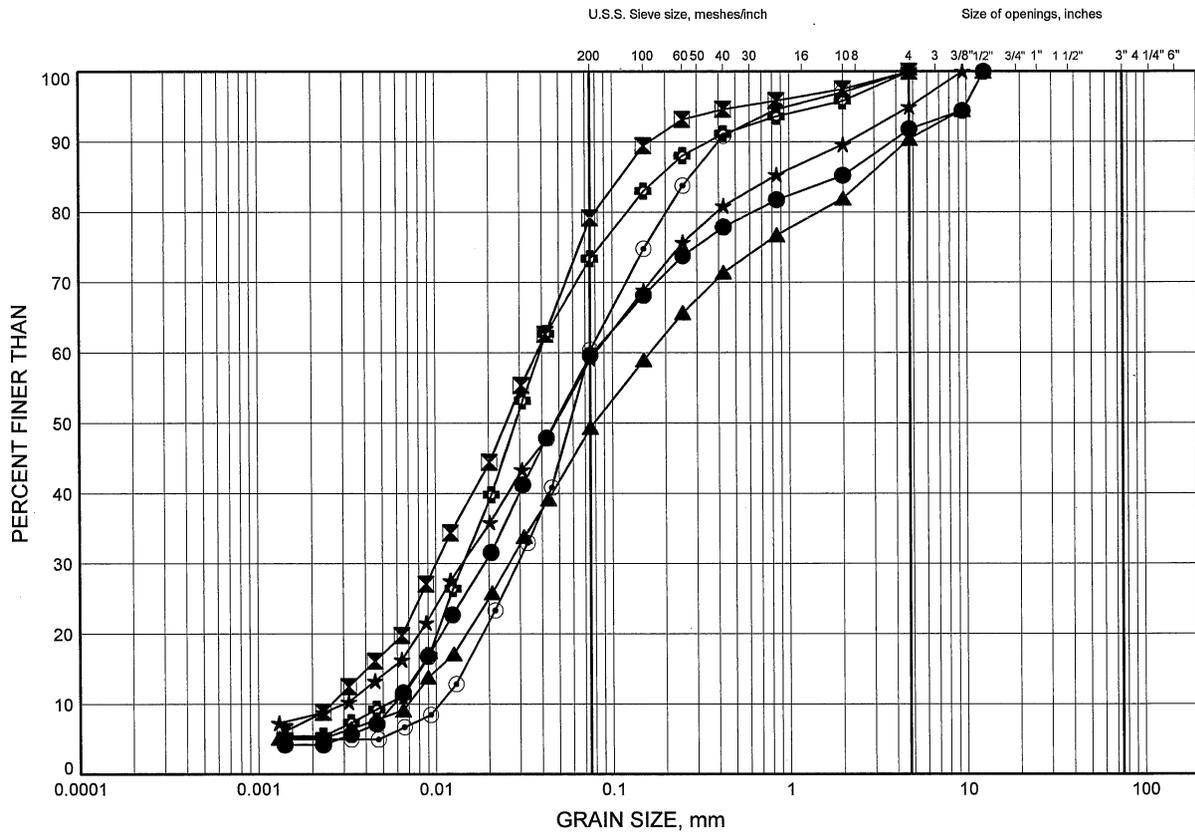


Prep'd AN
 Chkd. KS

South Trout Creek - EBL
GRAIN SIZE DISTRIBUTION

FIGURE B3

SANDY SILT TO SILT & SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STE-02	6.27	208.53
⊠	STE-02	10.78	204.02
▲	STE-03	2.59	211.11
★	STE-03	4.67	209.02
⊙	STE-04	4.74	209.33
⊕	STW-03	12.50	206.27

GRAIN SIZE DISTRIBUTION - THURBER 05117.GPJ 6/5/13

Date June 2013
 GWP# 647-89-00

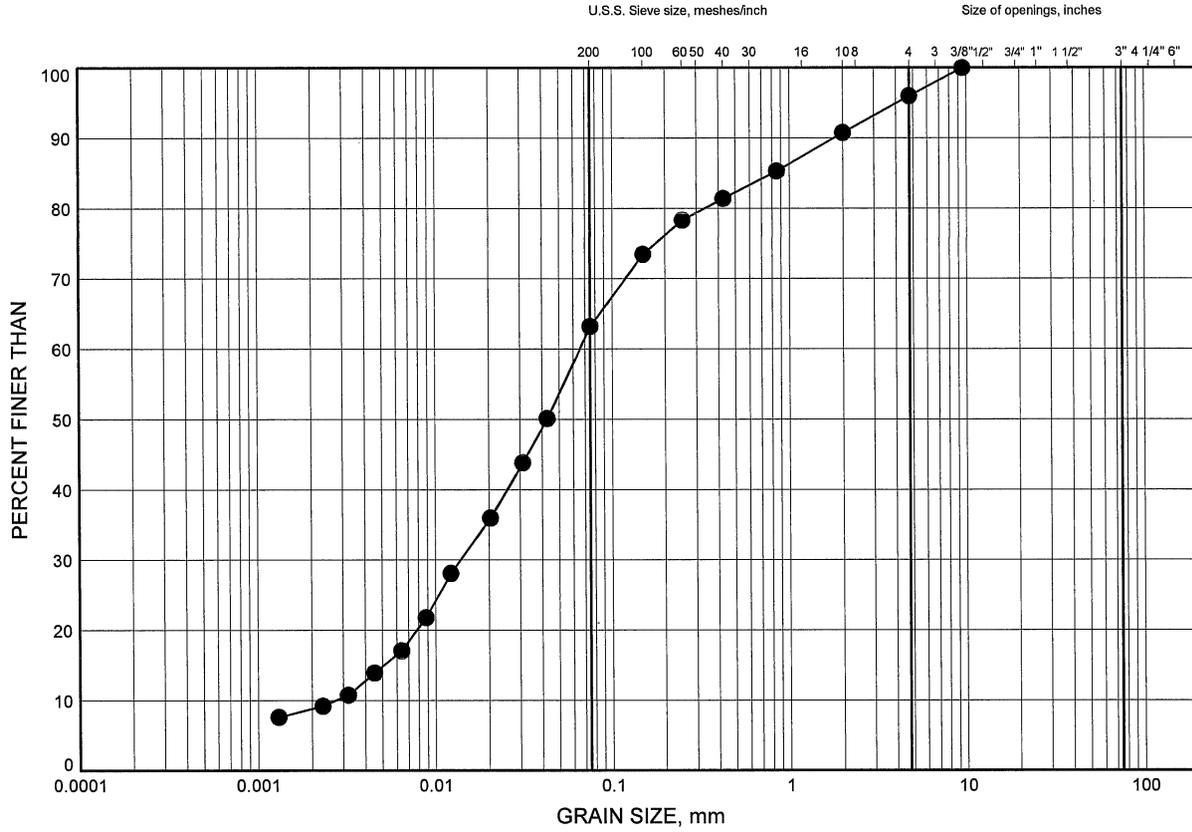


Prep'd AN
 Chkd. KS

South Trout Creek - EBL
GRAIN SIZE DISTRIBUTION

FIGURE B4

SANDY SILT TO SILT & SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STW-05	6.40	207.59

GRAIN SIZE DISTRIBUTION - THURBER 05117.GPJ 6/5/13

Date June 2013
 GWP# 647-89-00

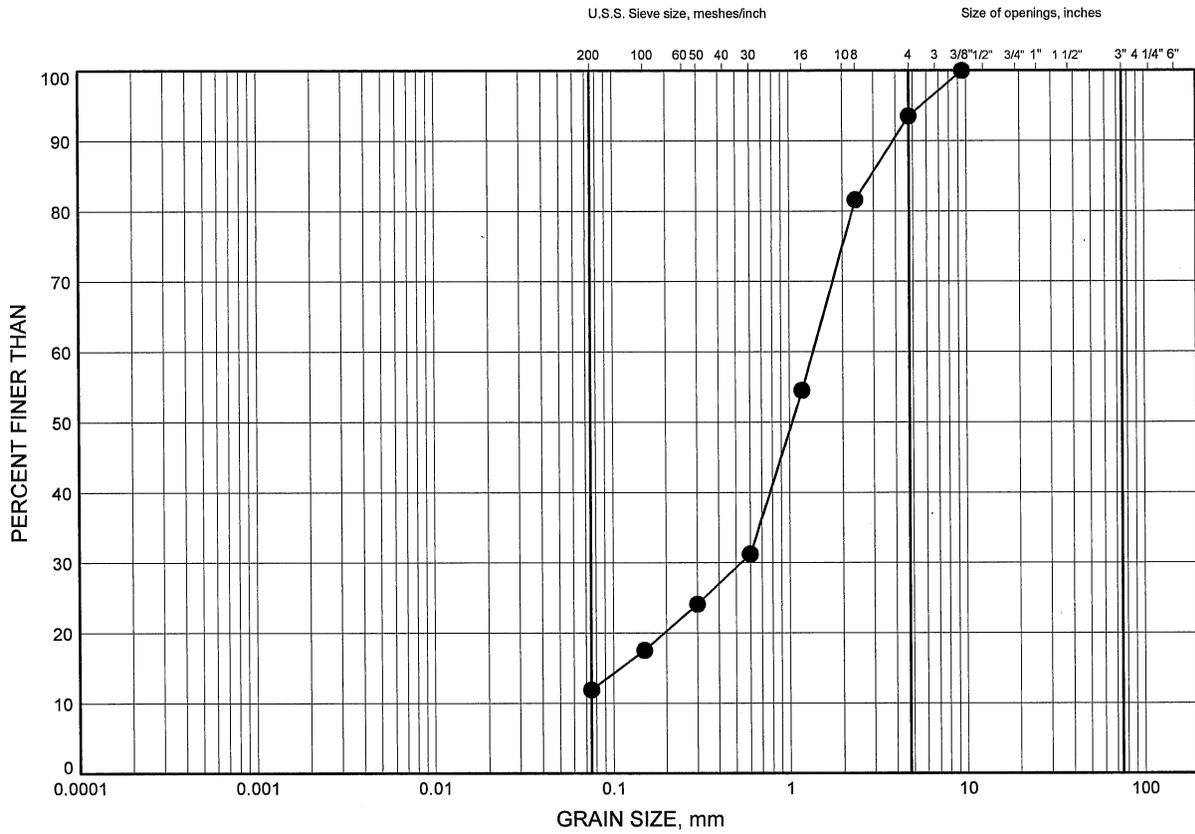


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 Chkd. KS

South Trout Creek - EBL
GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STW-05	10.73	203.25

GRAIN SIZE DISTRIBUTION - THURBER 05117.GPJ 6/5/13

Date June 2013
 GWP# 647-89-00

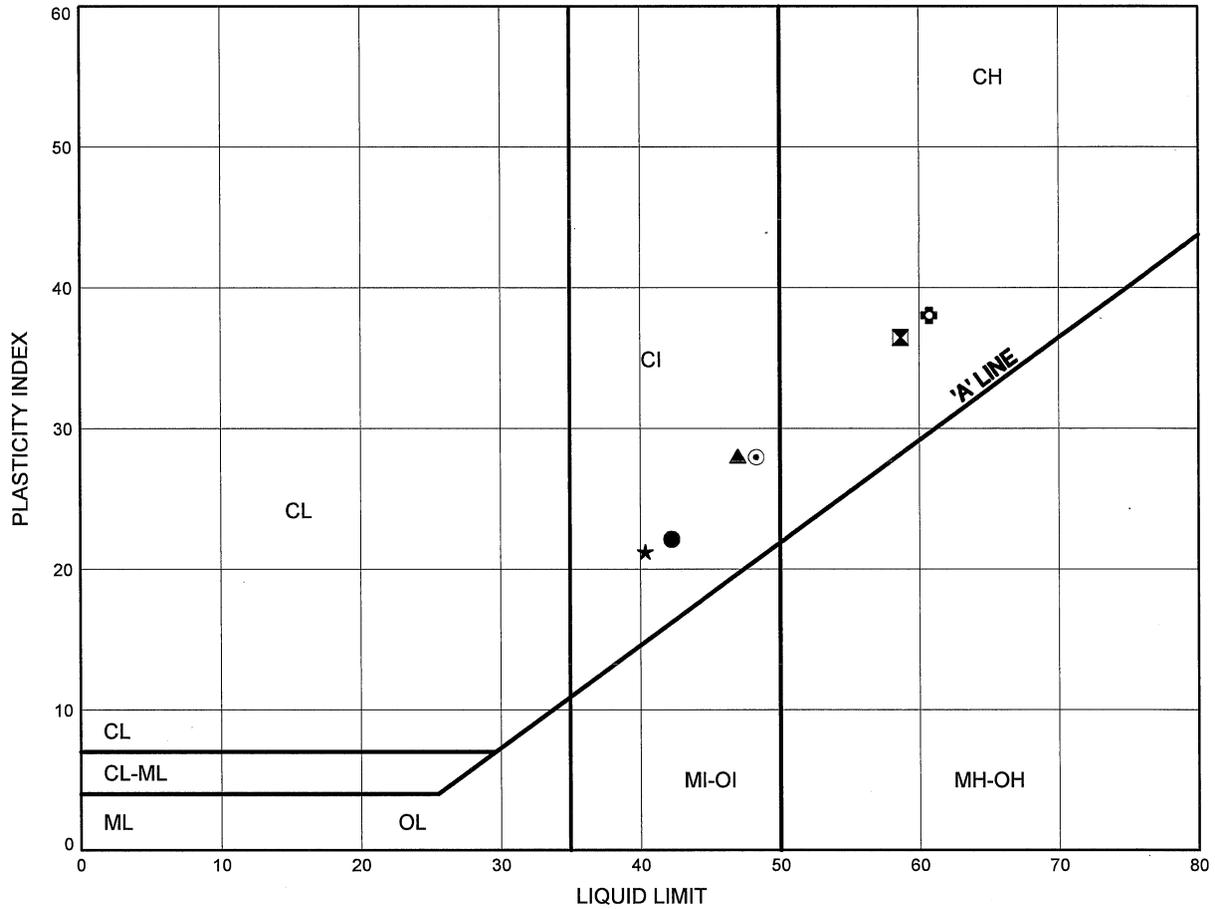


Prep'd AN
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South Trout Creek - EBL
ATTERBERG LIMITS TEST RESULTS

FIGURE B6

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STE-01	1.83	216.67
⊠	STE-01	6.40	212.10
▲	STE-02	3.35	211.45
★	STW-03	1.83	216.94
⊙	STW-03	3.35	215.42
⊛	STW-03	7.92	210.84

THURBALT 05117.GPJ 6/5/13

Date June 2013
 GWP# 647-89-00



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 Chkd. KS

Appendix C

Site Photographs



Photograph 1 – Existing South Trout Creek bridge, looking west from east bank.



Photograph 2 – Existing conditions at South Trout Creek, looking east from west approach.



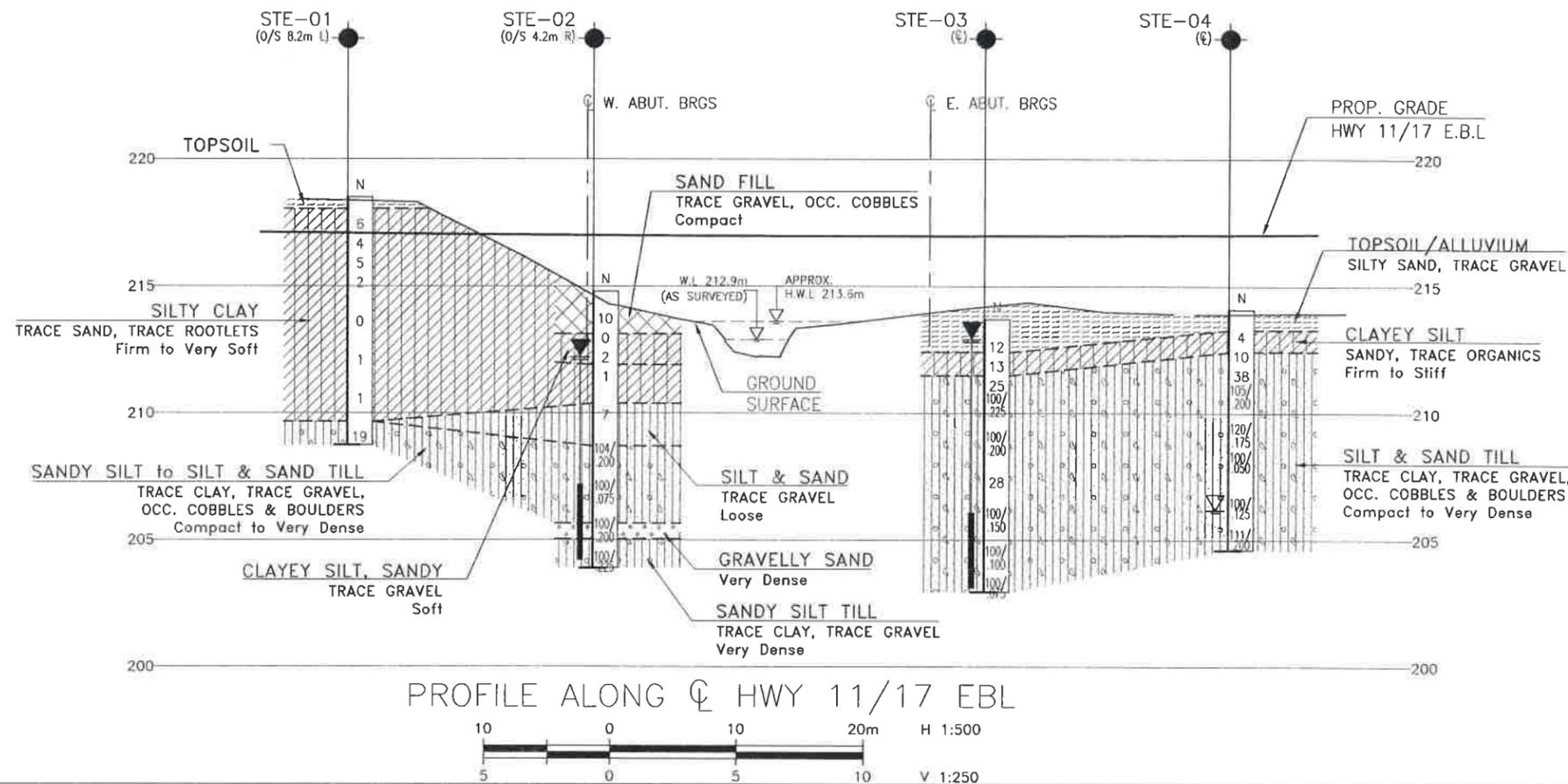
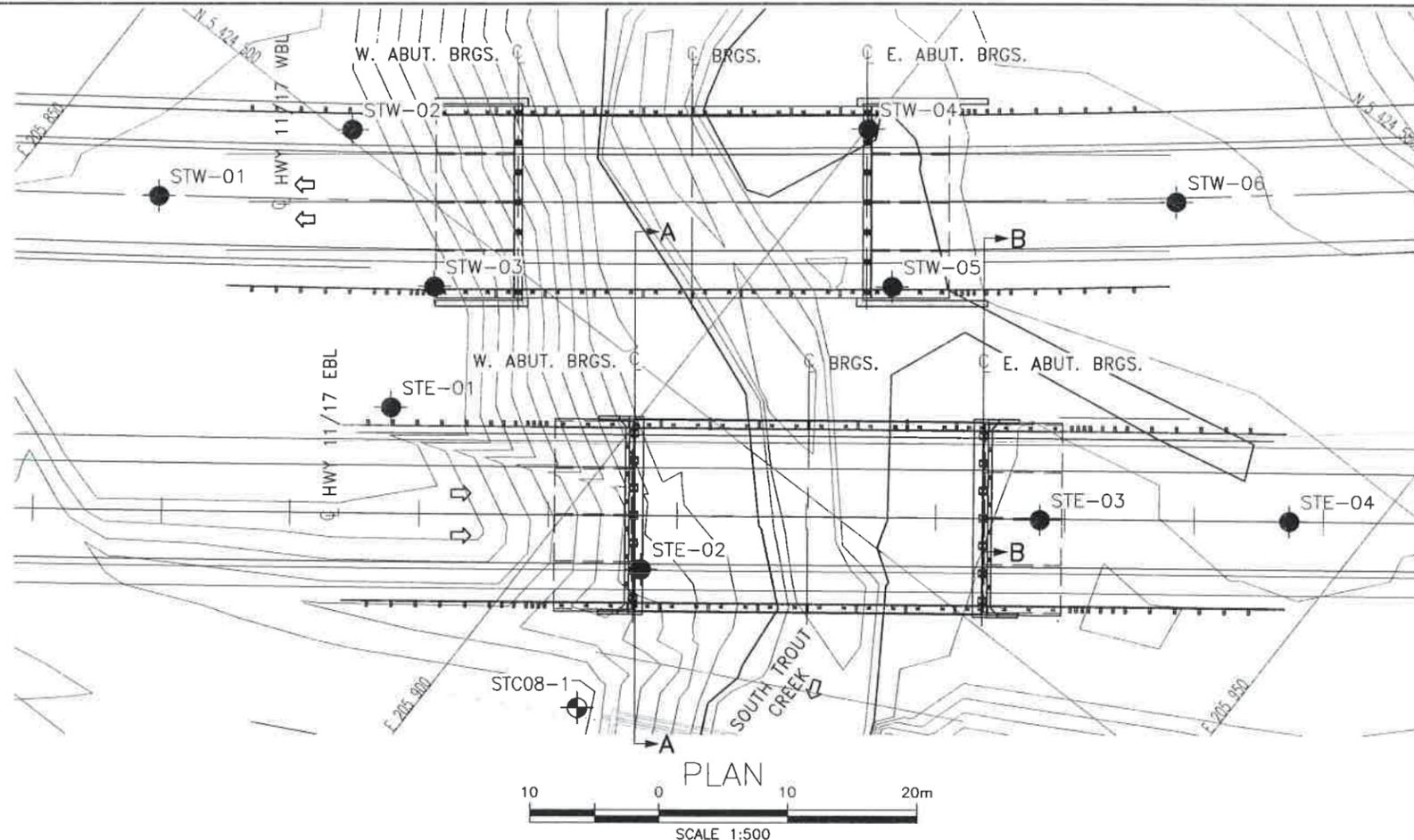
Photograph 3 – Existing conditions on east side of South Trout Creek



Photograph 4 – Existing conditions on west side of South Trout Creek

Appendix D

Borehole Locations and Soil Strata Drawing



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

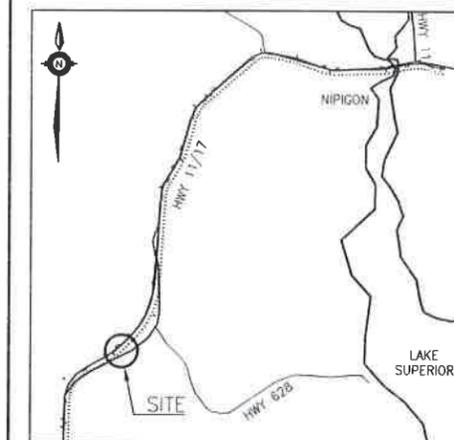


CONT No 2013-6016
WP No 6132-13-00

HIGHWAY 11/17 FOUR LANING
SOUTH TROUT CREEK
EASTBOUND LANE
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET
26



KEYPLAN

LEGEND

- ◆ Borehole (Current Investigation)
- ◊ Borehole (Previous Investigation)
- 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
STE-01	218.5	5 424 485.5	205 884.3
STE-02	214.8	5 424 487.5	205 907.3
STE-03	213.7	5 424 509.5	205 929.3
STE-04	214.1	5 424 521.3	205 944.6
STW-01	219.1	5 424 487.4	205 859.9
STW-02	218.9	5 424 500.7	205 868.6
STW-03	218.8	5 424 495.0	205 881.2
STW-04	213.7	5 424 525.3	205 900.1
STW-05	214.0	5 424 516.7	205 909.1
STW-06	214.5	5 424 535.5	205 922.4

-NOTES-

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

GEORES No. 52A-166

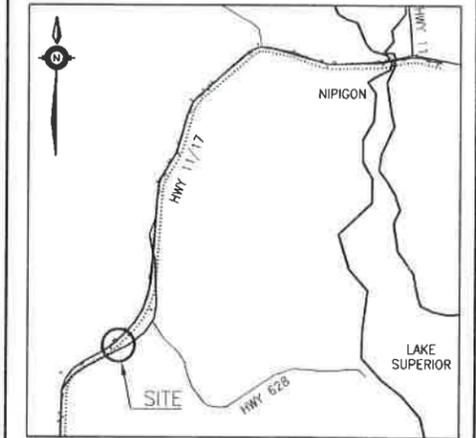
REVISIONS	DATE	BY	DESCRIPTION

DESIGN	MEF	CHK	MEF	CODE	LOAD	DATE
DRAWN	AN	CHK	MRA	SITE 48C-10B	STRUCT	JUN. 2013

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

CONT No 2013-6016
WP No 6132-13-00
HIGHWAY 11/17 FOUR LANING
SOUTH TROUT CREEK
EASTBOUND LANE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
27



KEYPLAN

LEGEND

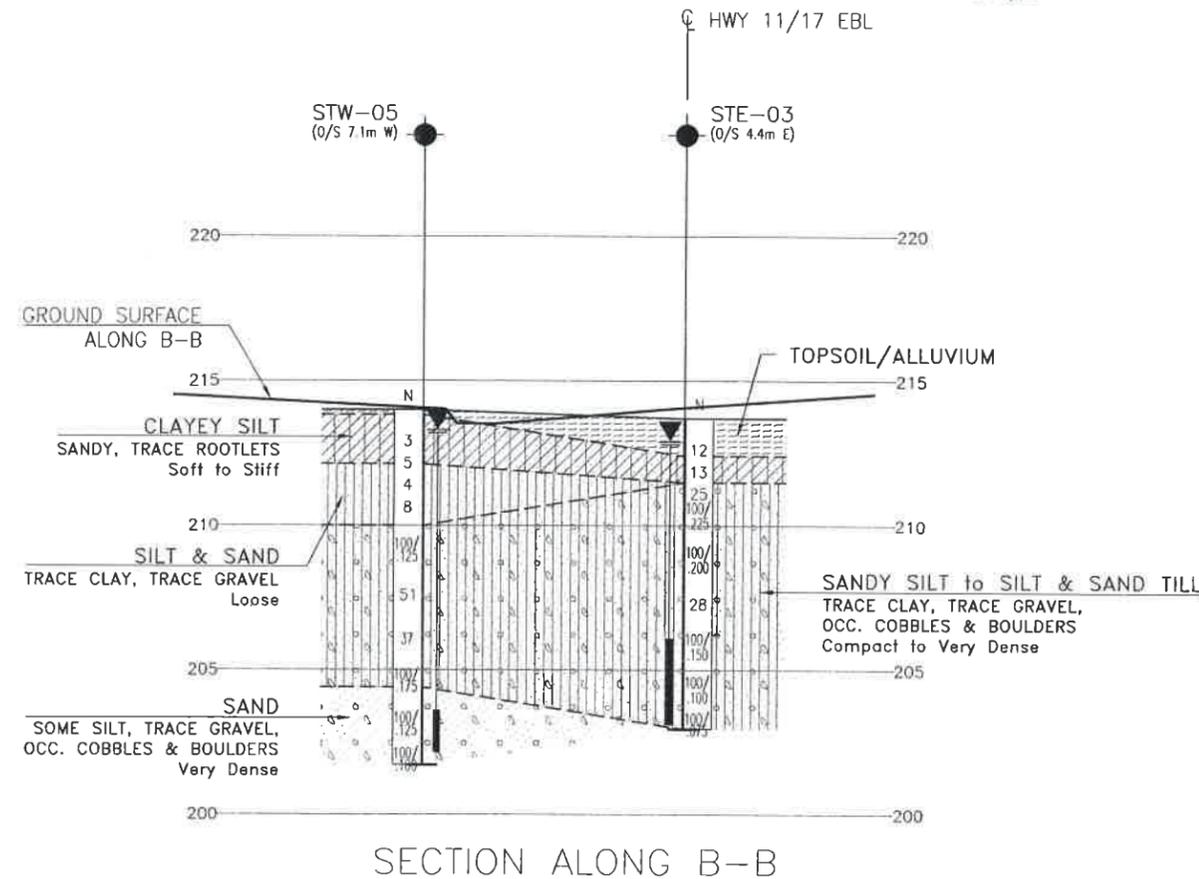
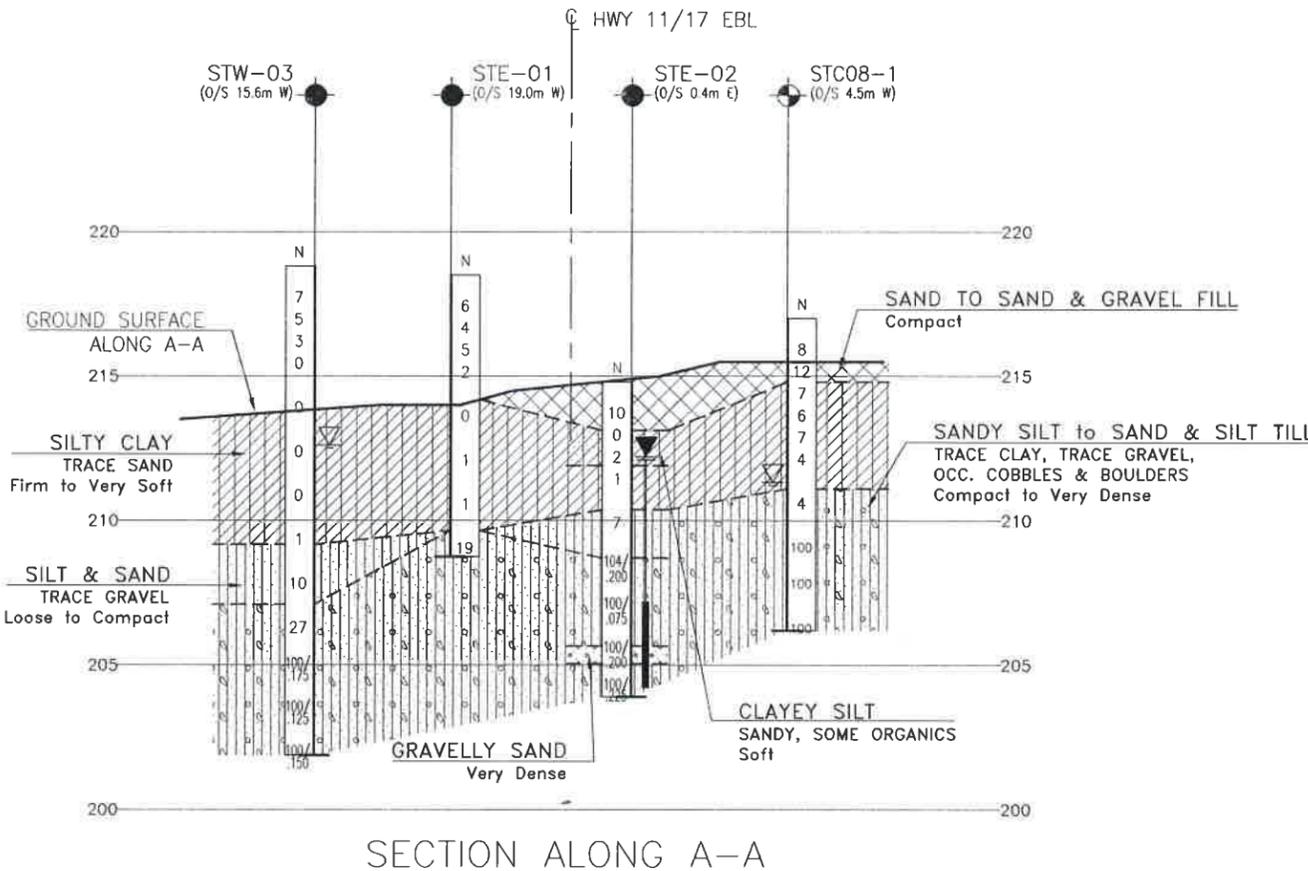
- Borehole (Current Investigation)
- ◐ Borehole (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- ∇ Water Level During Drilling
- ↑ Water Level In Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
STE-01	218.5	5 424 485.5	205 884.3
STE-02	214.8	5 424 487.5	205 907.3
STE-03	213.7	5 424 509.5	205 929.3
STE-04	214.1	5 424 521.3	205 944.6
STW-01	219.1	5 424 487.4	205 859.9
STW-02	218.9	5 424 500.7	205 868.6
STW-03	218.8	5 424 495.0	205 881.2
STW-04	213.7	5 424 525.3	205 900.1
STW-05	214.0	5 424 516.7	205 909.1
STW-06	214.5	5 424 535.5	205 922.4

-NOTES-

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

GEOCREs No. 52A-166



DATE	BY	DESCRIPTION
DESIGN	MEF	CHK MEF
DRAWN	AN	CHK MRA

CODE: SITE 48C-10B | LOAD: STRUCT | DATE: JUN. 2013 | DWG: 2

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