



Foundation Investigation Report

South Trout Creek Bridge Replacement

GWP 0476-00-00

Highway 11/17
14 km west of the Town of Nipigon

Geocres No.: 52A-140

Prepared for
Ministry of Transportation, Northwestern Region

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Part A - **FOUNDATION INVESTIGATION REPORT**

1 Introduction

TBT Engineering has been retained by the Ministry of Transportation to provide foundation investigation services for the bridge replacement at South Trout Creek.

The site is located on Highway 11/17 approximately 14 km west of the town of Nipigon where it crosses the South Trout Creek, within Nipigon Township, Ontario.

The foundation investigation was carried out to investigate subsurface conditions at the site. This investigation consisted of six boreholes drilled in the vicinity of the proposed bridge replacement, and laboratory testing. This report provides a summary of that work and of the conditions encountered.

The site is identified as Site No. 48C – 010, and has been assigned the MTO GEOCREs No. 52A-140.

2 Site Description

The site is located on Highway 11/17, approximately 14 km west of the Town of Nipigon. At this location Highway 11/17 runs locally in an east-west direction.

The existing bridge is a double lane timber structure and is approximately 28 m long. The approach embankments have side slopes of approximately 1.5 horizontal to 1 vertical or steeper as the highway approaches the South Trout Creek.

The site is within Ontario's boreal forest region. Highway 11/17 at the bridge location is generally higher than the surrounding area. The South Trout Creek water level at the time of the survey was approximately of 3.5 m (elevation 213.5 m) below the bridge deck (elevation 217 m).



South Trout Creek Bridge
Nipigon Township

3 Investigation Procedures

A site investigation was undertaken on July 15 to 21, 2008. Six boreholes were drilled for this project along the approaches (three on either side of the creek). The investigation was carried out using a CME drill rig equipped for geotechnical testing. The boreholes were drilled to depths ranging between 7.3 and 12.2 m below existing ground surface. Borehole locations and depths were determined through consultation with the client during an onsite meeting. Refer to the Drill Summary Table for specific depths and comments concerning each borehole.

Soil samples were obtained at the boreholes with a split spoon sampler as a part of the Standard Penetration Testing (SPT). The SPT involves driving a thick walled sampler into the soils under a standardized energy (63.5 kg, falling 760 mm). The number of blows required to drive the sampler 0.3 m, known as the SPT blow count (N), was recorded. In addition to SPTs, shear vane testing was conducted within cohesive soils. Thin walled tube samples were taken within cohesive materials to obtain relatively undisturbed samples.

Borehole locations and elevations were surveyed in the field by Hatch Mott MacDonald and referenced to a local benchmark. The local benchmark is a nut and washer in a root of a 0.4 m diameter spruce tree located at station 13+545.433, 27.979 m Lt.

A summary of the borehole location data is provided on the enclosed Borehole Location Plan and Soil Strata Drawing 1.

The borehole characteristics and drill techniques utilized are summarized for the various borehole locations in Table 1 below:

Table 1 - Drill Summary
South Trout Creek Bridge
Nipigon Township

Location	Borehole Depth (metres)	Comments
STC08-01	10.8	Hollow Stem Augers to 8.3 m, Casing advanced to 10.8 m in material with SPT "N" values of 100+blows/0.3 m
STC08-02	8.5	Hollow Stem Augers
STC08-03	7.3	Hollow Stem Augers
STC08-04	12.2	Hollow Stem Augers to 7.3 m, Casing advanced to 12.2 m in material with SPT "N" values of 100+blows/0.3 m
STC08-05	10.0	Hollow Stem Augers
STC08-06	9.6	Hollow Stem Augers

The boreholes were backfilled to ensure the environmental integrity of the site, utilizing appropriate bentonite/cement mixtures for the soils encountered (at individual locations).

Soil samples were transported to TBT Engineering's laboratory in Thunder Bay for testing. Routine testing included moisture content, grain size analysis, and liquid and plastic limits. The results of this testing are shown on the Borehole Logs (Appendix A) and on the laboratory data reports (Appendix B).

4 General Site Geology and Sub-Surface Conditions

4.1 Site Geology

The South Trout Creek flows approximately south-southeast at the Highway 11/17 bridge site, joining the Big Trout Creek approximately 2.8 km to the southeast. Flows from the creek report to Lake Superior, near the mouth of the Nipigon River, approximately 4 km east of this confluence.

Available surficial geology mapping (OGS NOEGTS Map 5046 – Black Bay) shows the northern extent of a peat/organic terrain deposit filling the creek basin near the site, and covering a large area south of the site. This deposit overlies a silty-clayey lacustrine plain deposit, associated with a former Lake Superior (glacial lake Minong) shoreline. Sandier units may also occur in the area, associated with an abandoned glacial spillway along the Black Sturgeon River valley, just west of the site. Relief is generally low and planar in the area of the bridge and south, while elevated bedrock hills exist to the north and northwest.

The site is adjacent to the erosional contact between the Proterozoic-aged Southern geologic province, and the underlying Archean-aged Quetico subprovince of the Superior geologic province. Available mapping (OGS Map 2232 – Nipigon-Schreiber Compilation) shows Sibley Group sedimentary rocks of the Southern province at surface in the area of the bridge, with metasedimentary rocks of the Quetico subprovince immediately to the north. The site's proximity to this contact suggests that at the bridge site bedrock may be composed of members of the Sibley Group, such as the Pass Lake red sandstone/conglomerate formation. The thickness of the Sibley Group and depth to the lower contact is unknown. Nearby regional and local faults are aligned approximately north-south; the South Trout Creek traces one such local fault north of the bridge site.

4.2 Subsurface Conditions

Details of the subsurface conditions are provided on the Borehole Logs, Appendix A, and on the Borehole Location Plan and Strata Drawing 1.

In general, the natural subsurface stratigraphy consists of clay overlying silt and sand till. The highway surface is constructed on a sand and gravel fill embankment.

The subsurface stratigraphy has been interpreted based on the findings at the boreholes and is illustrated on the Borehole Location and Soil Strata Drawing and on the borehole logs.

4.2.1 Asphalt

Asphalt was encountered at surface at all boreholes with the exception of Borehole 3. The asphalt thickness varied from 90 to 180 mm.

4.2.2 Fill

Granular fill was encountered at surface of Borehole 3 and beneath the asphalt at all remaining boreholes. Based on samples from Boreholes 1, 2, 3 and 5 the fill varies from sand to sand and gravel and can consist of 2 – 39 % gravel, 55 – 87 % sand, 4 – 12 % silt/clay sized particles. The fill varies in thickness from 1.2 to 2.2 m and extends to elevations ranging from 214.8 to 215.9 m. The condition of this material varies from very loose to compact as indicated by “N” values ranging from 4 to 14 blows per 0.3 m.

4.2.3 Clay

Clay was encountered beneath the sand and gravel fill. The clay varies in thickness from 1.9 to 6.2 m, extending to elevations ranging from 209.7 to 213.2 m. The clay has a firm to very stiff consistency as indicated by field vanes ranging from 50 to greater than 110 kPa. Atterberg limits tests conducted on samples from Boreholes 1, 3, 4, 5 and 6 indicate the clay is of medium to high plasticity with natural moisture contents below the liquid limits, with the exception of the sample taken from Borehole 6 where the natural moisture content exceeded the liquid limit.

4.2.4 Glacial Till

Silt and sand glacial till with trace to some gravel was encountered beneath the clay to the limits of the investigation at all boreholes. Based on selected samples from Boreholes 1, 2, 4 and 6 the till can consist of 2 – 11 % gravel, 28 – 52 % sand, 41 – 70 % silt sized particles. Occasional cobbles and boulders were also encountered. The material extends to the termination of each borehole. The upper metre of this stratum is

generally loose to compact with “N” values ranging from 4 to 17 blows /0.3 m. Below this, the till becomes dense to very dense as indicated by “N” values ranging from 34 to greater than 100 blows per 0.3 m. The till becomes very dense within Boreholes 1 to 5 below depths ranging from 6.1 to 7.6 m (elevations 209.4 to 211 m).

4.2.5 Refusal

Auger refusal, defined as SPT “N” values in excess of 100, was met at Boreholes 1, 2, 3, 4, and 5, within the till layer at elevations ranging from 207.1 to 211.0 m (depths from 6.1 to 10.0 m). Auger refusal may be on bedrock, cobbles and/or boulders. BW casing was advanced at Boreholes 1 and 4 below the auger refusal depths (8.3 and 7.3 m respectively) until borehole termination. The investigations were terminated at Boreholes 1 and 4 after “N” values in excess of 100 were recorded for three consecutive STP tests over a 3 m depth.

4.2.6 Ground Water

The water level of the South Trout Creek at the time of the survey was at elevation 213.5 m. Groundwater levels upon completion of drilling had not stabilized but were observed to range from 4.8 to 5.5 m from ground surface (elevations 211.4 to 212.3 m). Ground water levels will reflect the water level within the river, and will generally rise in elevation away from the river. Ground water levels will also fluctuate with precipitation events.

5 Miscellaneous

The field drilling services for this project were provided by TBT Engineering. Laboratory testing was carried out at the TBT Engineering laboratory in Thunder Bay. The field operations were supervised by H. Finke. This report was prepared by S Seller, P.Eng. and G. Maki, P.Eng., and reviewed by W. Hurley, P.Eng.

6 Closure

We trust the above addresses your project requirements at this time. Should you have any questions or comments, please do not hesitate to contact us at your convenience.

Yours truly,

For TBT ENGINEERING



Steven Seller, P. Eng
Geotechnical Engineering



Wayne Hurley, P. Eng
Vice-President, Engineering



Gordon Maki, P. Eng
Geotechnical Engineering

References

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2. Mollard, D.G., 1979, Northern Ontario Engineering Geology Terrain Study, Data Base Map, Frazer Lake. Ontario Geological Survey, Map 5046
3. Ontario Ministry of Transportation, Surveys and Design Office, Pavement Design and Rehabilitation Manual, The Queens Printer for Ontario, 1990, ISBN 0-7729-6379-7
4. Canadian Geotechnical Society, Canadian Foundation Engineering Manual, Fourth Edition, BiTech Publishers Ltd., 1992, ISBN 0-920505-28-7
5. Hunt, Roy E., Geotechnical Engineering Analysis and Evaluation, McGraw Hill Inc, 1986, ISBN 0-07-031310-5
6. CSA International, Canadian Highway Bridge Design Code, CSA International, CAN/CSA S6-06, ISBN 1-55436-252-0

MTO Special Provisions and Drawings

Special Provision 903.S01 (Pile Installations)

APPENDIX A

BOREHOLE LOGS

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

N (BLOWS/0.3 m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENS.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

SPACING	50mm	50 - 300mm	0.3 m - 1m	1m - 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	RUCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

u_w	kPa	PORE WATER PRESSURE
τ_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m^2/s	COEFFICIENT OF CONSOLIDATION
U	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U_c	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	$^\circ$	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	$^\circ$	APPARENT ANGLE OF INTERNAL FRICTION
τ_r	kPa	RESIDUAL SHEAR STRENGTH
T_R	kPa	REMOVED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{C_u}{\tau_f}$

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_U	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
ρ_{dsat}	kg/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m ²	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

APPENDIX B

Laboratory Test Data

APPENDIX C

Borehole Locations and Soil Strata Drawings

APPENDIX A

BOREHOLE LOGS

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3 m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENS.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN.
THE ROCK QUALITY DESIGNATION { R Q D }, FOR MODIFIED RECOVERY, IS :

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3 m - 1m	1m - 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	RUCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
σ_u	1	PORE PRESSURE RATIO
τ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ		COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	$k\sigma^{-1}$	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m^2/s	COEFFICIENT OF CONSOLIDATION
U	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U_c	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
T_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	$^\circ$	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	$^\circ$	APPARENT ANGLE OF INTERNAL FRICTION
T_R	kPa	RESIDUAL SHEAR STRENGTH
T_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY $= \frac{C_u}{T_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D_n	mm	GRAIN DIAMETER
ρ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_U	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
ρ	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m ²	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

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	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				
217.0	ASPHALT - 120 mm FILL - SAND & GRAVEL - trace silt, brown, loose to compact		1	AS					
216.0			2	SS	8				
			3	SS	12				
214.8	- some clay lumps, brown								
2.2	CLAY - Silty, brown, stiff to very stiff		4	SS	7				
			5	SS	6				
			6	SS	7				
			7	SS	4				
			8	SS	4				
211.1	GLACIAL TILL - SILT & SAND - trace gravel, occasional cobbles & boulders, grey, loose to very dense		9	SS	100+				
5.9			10	SS	100+				
			11	SS	100+				
206.2	End of Borehole @ 10.8 m.								
10.8									

DYNAMIC CONE PENETRATION RESISTANCE PLOT		SHEAR STRENGTH kPa		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
20 40 60 80 100		20 40 60 80 100		W _p		W		W _L		γ		GR SA SI CL	
UNCONFINED		FIELD VANE		SPT (N)		LAB VANE		WATER CONTENT (%)					
216	■		×										Water level @ 5.6 m on completion. 39 55 (7)
215	■		×										
214	■		×										
213	■		×										
212	■		×										
211	■		×										
209	■		×										
208	■		×										
207	■		×										
	■		×										
	■		×										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.
	■		×										50 Blows for 0.1 m.

ON_MOT_BH-10 08-085 SOUTH TROUT CREEK.GPJ ON_MOT_GDT 09/11/23

TBT Engineering Consulting Group			RECORD OF Borehole No STC08-2			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+599 o/s 5.6 Lt			TBTE JOB# 08-085		COMPILED BY TB	
DATE 2008 July 17			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic		CHECKED BY WH	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		DYNAMIC CONE PENETRATION RESISTANCE PLOT	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				
217.1 0.2	ASPHALT - 150 mm FILL - SAND & GRAVEL - trace silt, brown, loose		1	AS					
			2	SS	9				
			3	SS	10				
214.9 2.2	CLAY - Silty, grey/brown, stiff to very stiff		4	SS	9				
			5	SS	5				
			6	SS	7				
212.6 4.5	GLACIAL TILL - SILT & SAND - some gravel, occasional cobbles & boulders, compact to very dense		7	SS	15				
			8	SS	100+				
			9	SS	100+				
208.6 8.5	End of Borehole @ 8.5 m. Auger Refusal.								

SHEAR STRENGTH kPa		WATER CONTENT (%)		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
UNCONFINED ○ SPT (N)	FIELD VANE × LAB VANE	W _p	W	γ	GR SA SI CL
					Dry on completion.
					35 61 (4)
					11 41 (48)
					50 Blows for 0.1 m.

TBT Engineering Consulting Group		RECORD OF Borehole No STC08-3		1 OF 1 METRIC	
W.P. 496 00 00		PROJECT South Trout Creek		SITE NO. 48-C-010	
DIST 61 HWY 11/17		LOCATION Sta. 13+607 o/s 6 Lt		TBTE JOB# 08-085	
DATE 2008 July 17		BOREHOLE TYPE Hollow Stem Auger		DATUM Geodetic	
				ORIGINATED BY HF	
				COMPILED BY TB	
				CHECKED BY WH	

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	W _p	W	W _L			
217.1 0.0	FILL - SAND - some silt, trace gravel, loose		1	AS										Water level @ 4.8 m on completion. 2 87 (12)
			2	SS	9									
			3	SS	4									
214.9 2.2	CLAY - Silty, trace organics, stiff		4	SS	7									
			5	TW										
			6	SS	5									
212.6 4.5	GLACIAL TILL - SILT & SAND - trace gravel, occasional cobbles & boulders, grey, compact to very dense		7	SS	15									100 Blows for 0.15 m.
			8	SS	100+									
209.8 7.3	End of Borehole @ 7.3 m. Auger Refusal.													

\times^3, \star^3 : Numbers refer to Sensitivity

NP Non Plastic

\bigcirc 3% STRAIN AT FAILURE

ON_MOT_BH-10 08-085 SOUTH TROUT CREEK.GPJ ON_MOT_GDT 09/11/23

TBT Engineering Consulting Group			RECORD OF Borehole No STC08-4			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+599 o/s 5.4 Rt			TBTE JOB# 08-085		COMPILED BY TB	
DATE 2008 July 17			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic		CHECKED BY WH	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		ELEVATION SCALE	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				
217.1	ASPHALT - 160 mm FILL - SAND & GRAVEL - brown, loose to compact		1	AS					
216.9			2	SS	14				
0.2			3	SS	9				
215.1	CLAY - Silty, grey/brown, very stiff		4	SS	8				
2.0			5	SS	5				
			6	SS	5				
213.2	- trace organics GLACIAL TILL - SILT & SAND - some to trace gravel, occasional cobbles & boulders, grey, loose to very dense		7	SS	17				
3.9			8	SS	36				
			9	SS	62				
			10	SS	100+				
			11	SS	100+				
			12	SS	100+				
204.9	End of Borehole @ 12.2 m.								
12.2									

DYNAMIC CONE PENETRATION RESISTANCE PLOT		SHEAR STRENGTH kPa		WATER CONTENT (%)		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
20	40	60	80	100	20		
		○ UNCONFINED ✕ FIELD VANE		W _p W W _L			
		■ SPT (N) ★ LAB VANE					
217							
216							
215							
214							
213							
212							
211							11 40 (49)
210							
209							Auger Refusal @ 7.3 m advanced with casing to 12.2 m.
208							7 52 (41)
207							
206							50 Blows for 0.1 m.
205							50 Blows for 0.07 m.

TBT Engineering Consulting Group			RECORD OF Borehole No STC08-5			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+568 o/s 4.9 Rt			TBTE JOB# 08-085		COMPILED BY TB						
DATE 2008 July 21			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic		CHECKED BY WH						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ✕ FIELD VANE ■ SPT (N) ★ LAB VANE 20 40 60 80 100		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L WATER CONTENT (%) 20 40 60		γ	GR SA SI CL	
217.1	ASPHALT - 180 mm		1	AS										Water level @ 4.8 m on completion. 21 73 (7)
216.9	FILL - SAND - Gravelly, trace silt, brown, loose		2	SS	10									
215.7	CLAY - Silty, grey, firm to very stiff		3	SS	9									
215.0			4	SS	3									
214.3			5	TW										
213.6			6	SS	1									
212.9			7	TW										
211.2	GLACIAL TILL - SILT & SAND - trace gravel, occasional cobbles & boulders, grey, compact to very dense		8	SS	12									
210.5			9	SS	100+									
209.8			10	SS	100+									
209.1			11	SS	100+									
207.1	End of Borehole @ 10 m. Auger Refusal.												50 Blows for 0.05 m.	

ON_MOT_BH-10 08-085 SOUTH TROUT CREEK.GPJ ON_MOT_GDT 09/11/23

TBT Engineering Consulting Group		RECORD OF Borehole No STC08-6		1 OF 1 METRIC	
W.P. 496 00 00		PROJECT South Trout Creek		SITE NO. 48-C-010	
DIST 61 HWY 11/17		LOCATION Sta. 13+559 o/s 5 Rt		TBTE JOB# 08-085	
DATE 2008 July 21		BOREHOLE TYPE Hollow Stem Auger		DATUM Geodetic	
				ORIGINATED BY HF	
				COMPILED BY TB	
				CHECKED BY WH	

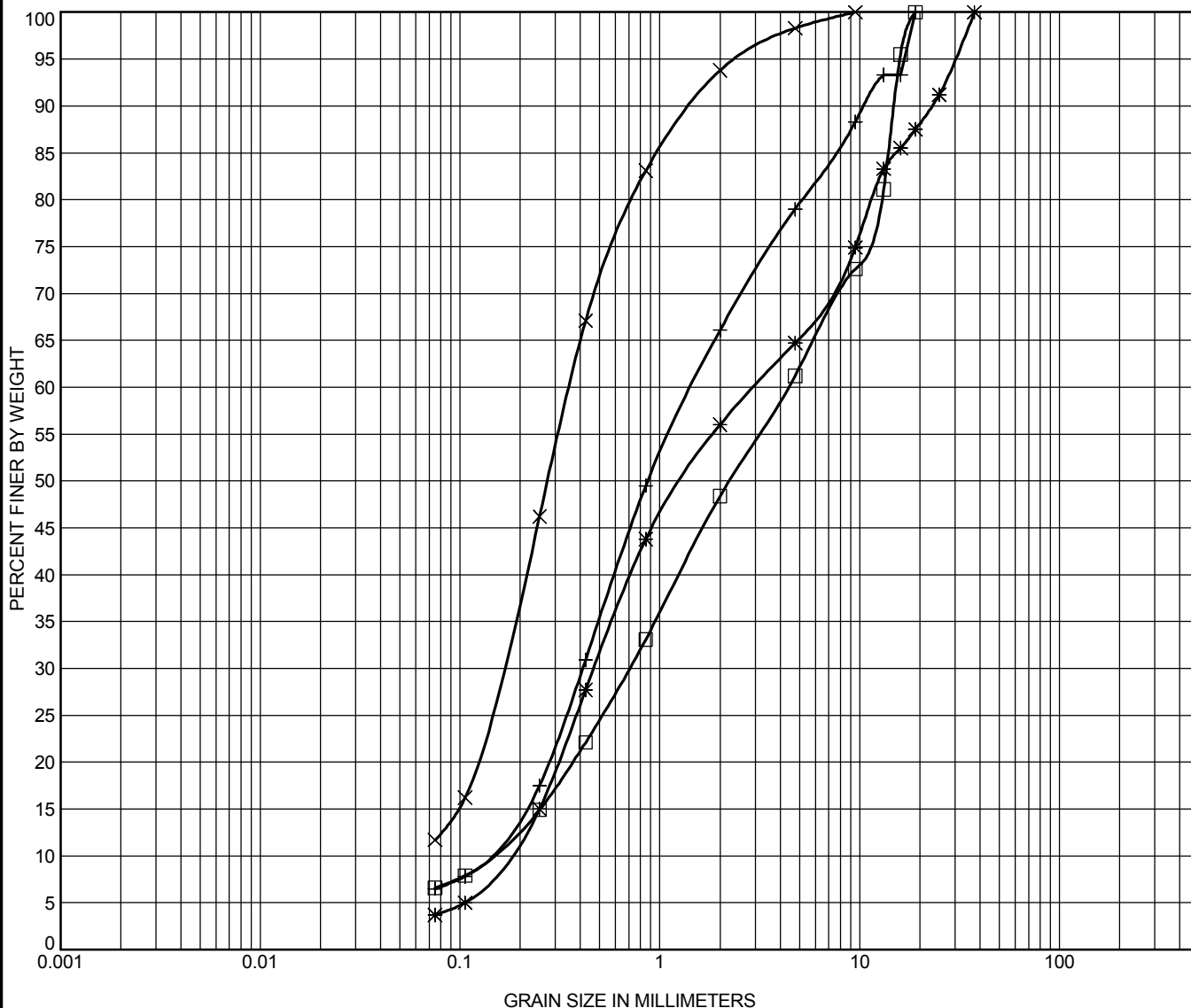
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
217.1	ASPHALT - 90 mm FILL - SAND & GRAVEL - brown, compact		1	AS												Water level @ 4.8 m on completion.	
216.0			2	SS	15												
215.9	CLAY - Silty, brown, firm to very stiff		3	SS	4											2 28 (70)	
1.2			4	TW													
			5	SS	1												
			6	TW													
			7	SS	2												
			8	SS	3												
			9	SS	12												
209.7	GLACIAL TILL - SILT - Sandy, trace gravel, occasional cobbles & boulders, grey, compact		10	SS	34												
7.4																	
207.5	End of Borehole @ 9.6 m. Auger Refusal.																
9.6																	

ON_MOT_BH-10_08-085 SOUTH TROUT CREEK.GPJ ON_MOT_GDT_09/11/23

\times^3, \star^3 : Numbers refer to Sensitivity
 NP Non Plastic
 ○ 3% STRAIN AT FAILURE

APPENDIX B

Laboratory Test Data



Remarks:
FILL

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ STC08-1	0.75	19	4.38	0.699	0.137	38.8	54.6	6.6	
* STC08-2	1.50	37.5	2.977	0.469	0.163	35.3	61.0	3.7	
× STC08-3	0.75	9.5	0.355	0.157		1.7	86.6	11.7	
+ STC08-5	0.75	19	1.46	0.41	0.129	21.0	72.5	6.5	



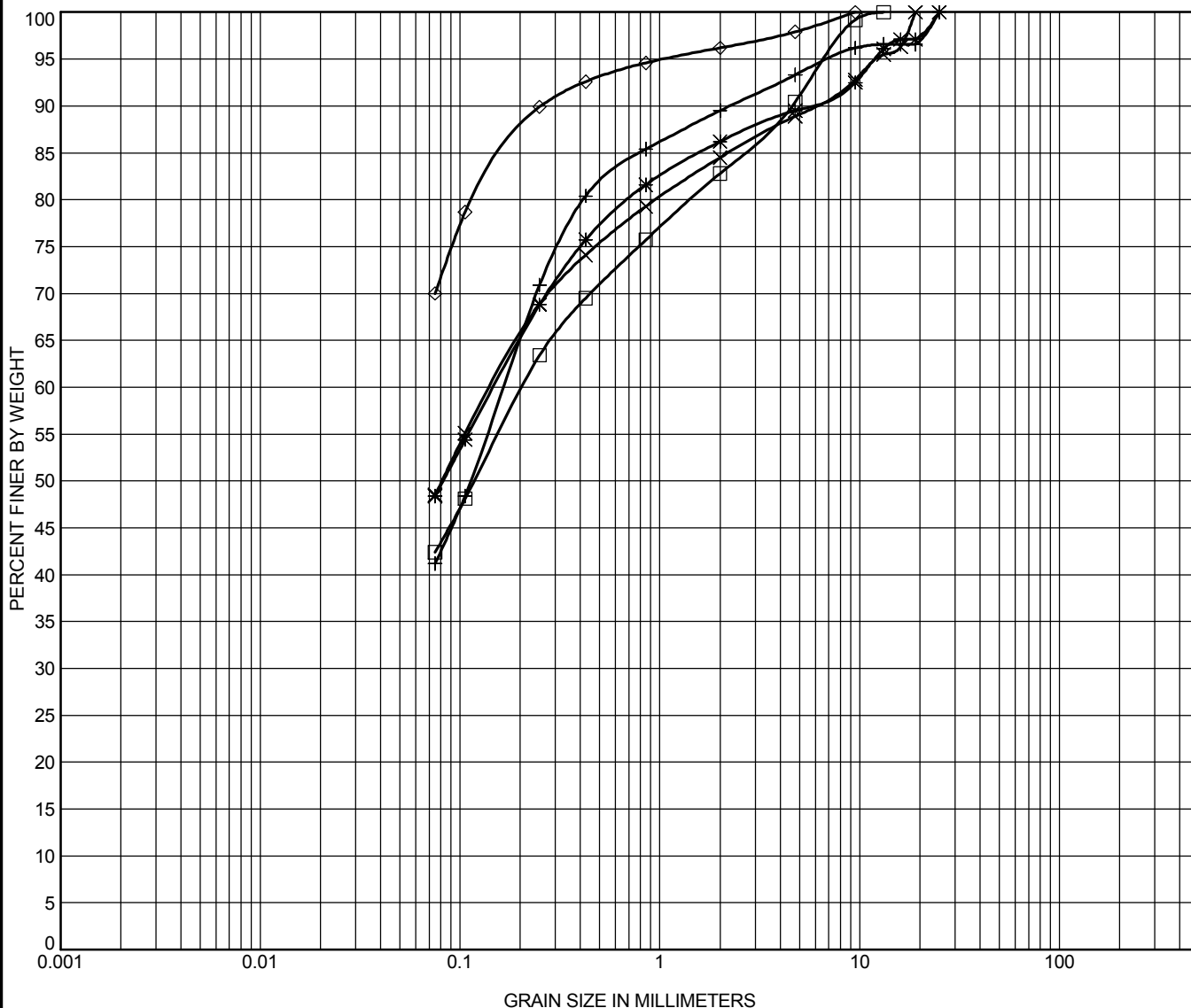
TBT Engineering Ltd.
Suite 200, 101 Syndicate Ave. N.
Thunder Bay, Ontario P7C 3V4
PH: 807-624-5160
FX: 807-264-5161
Email: tbte@tbte.ca
Web: www.tbte.ca

GRAIN SIZE DISTRIBUTION

Project: South Trout Creek

W P: 496 00 00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
TILL

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ STC08-1	7.60	13.2	0.207			9.6	48.0	42.4	
* STC08-2	6.10	25	0.148			10.5	41.1	48.4	
× STC08-4	6.10	19	0.144			11.1	40.4	48.5	
+ STC08-4	9.10	25	0.165			6.7	52.1	41.2	
◇ STC08-6	7.60	9.5				2.1	27.9	70.0	



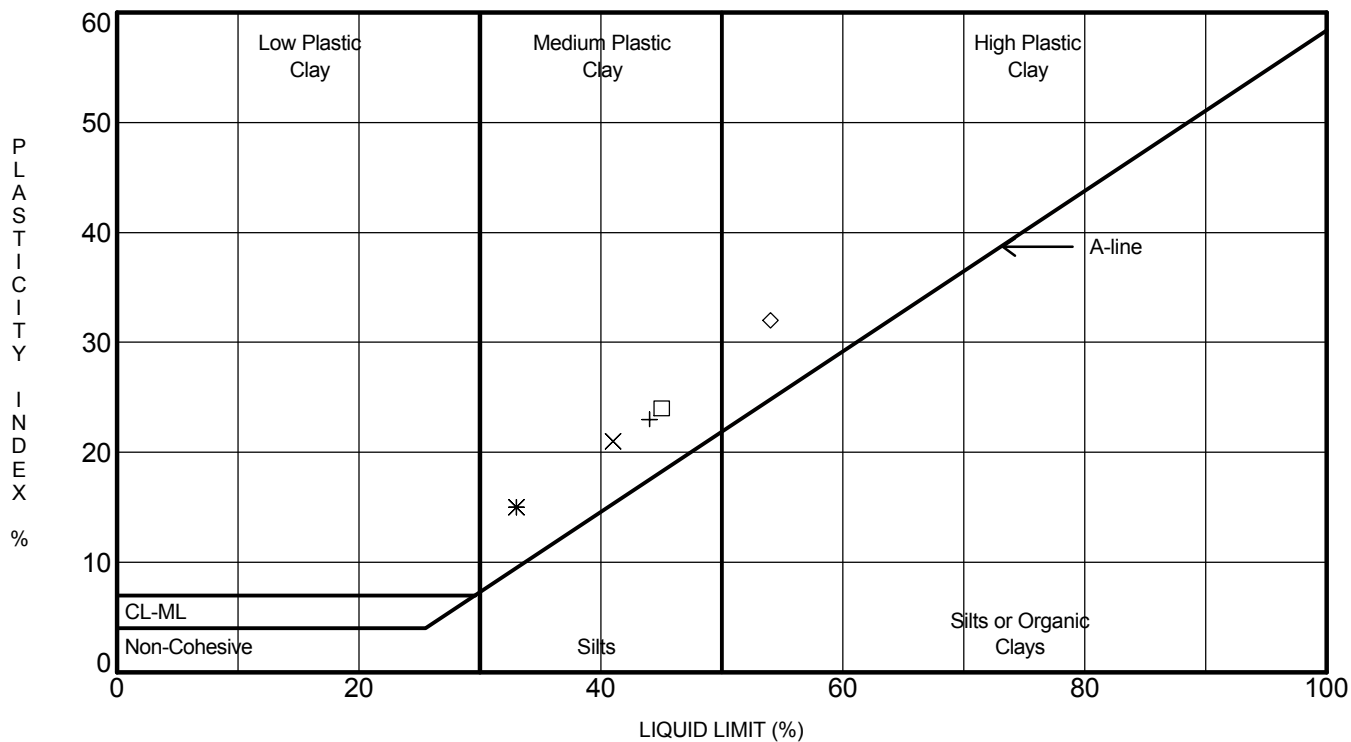
TBT Engineering Ltd.
Suite 200, 101 Syndicate Ave. N.
Thunder Bay, Ontario P7C 3V4
PH: 807-624-5160
FX: 807-264-5161
Email: tbte@tbte.ca
Web: www.tbte.ca

GRAIN SIZE DISTRIBUTION

Project: South Trout Creek

W P: 496 00 00

DIST: 61 HWY: 11/17



	Borehole No.	Sample No.	Depth (m)	LL %	PL %	PI %	M/C %	
□	STC08-1		3.80	45	21	24	28	
✱	STC08-3		2.30	33	18	15	24	
×	STC08-4		3.00	41	20	21	29	
+	STC08-5		1.50	44	21	23	9	
◇	STC08-6		4.60	54	22	32	56	



TBT Engineering Ltd.
 Suite 200, 101 Syndicate Ave. N.
 Thunder Bay, Ontario P7C 3V4
 Telephone: 807-624-5160
 Fax: 807-264-5161

ATTERBERG LIMIT RESULTS

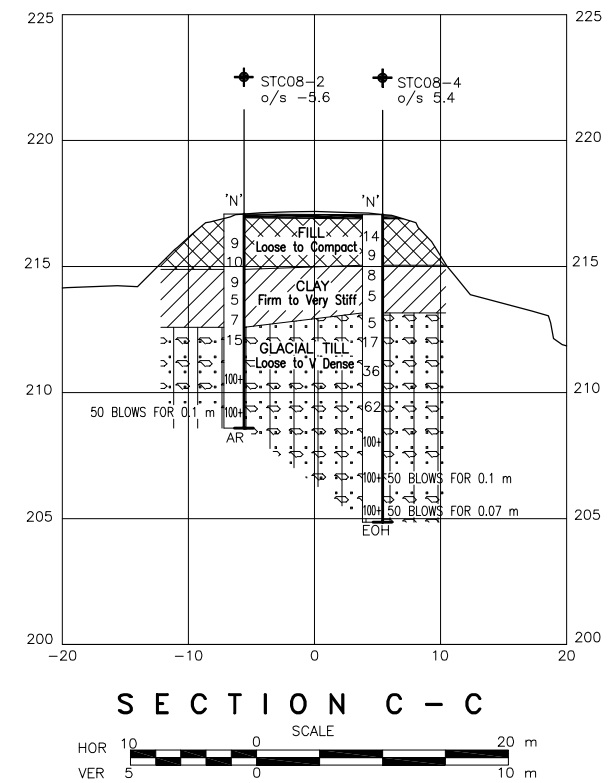
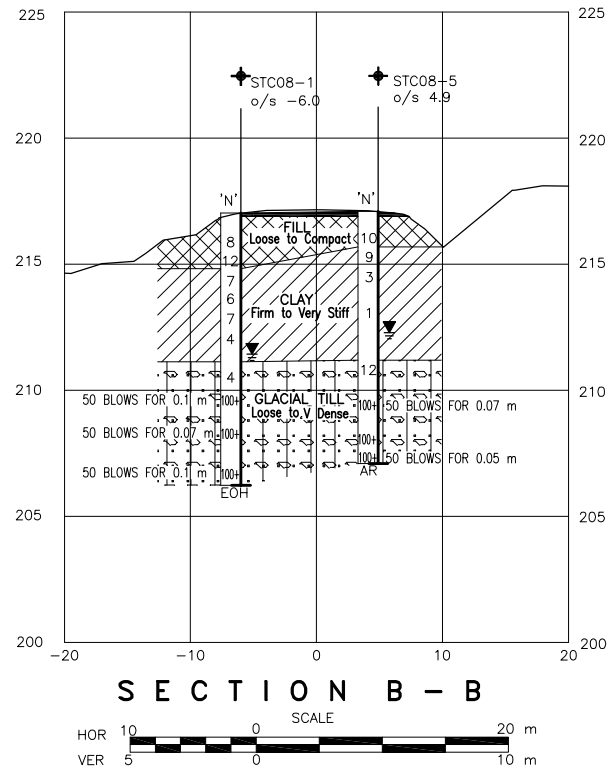
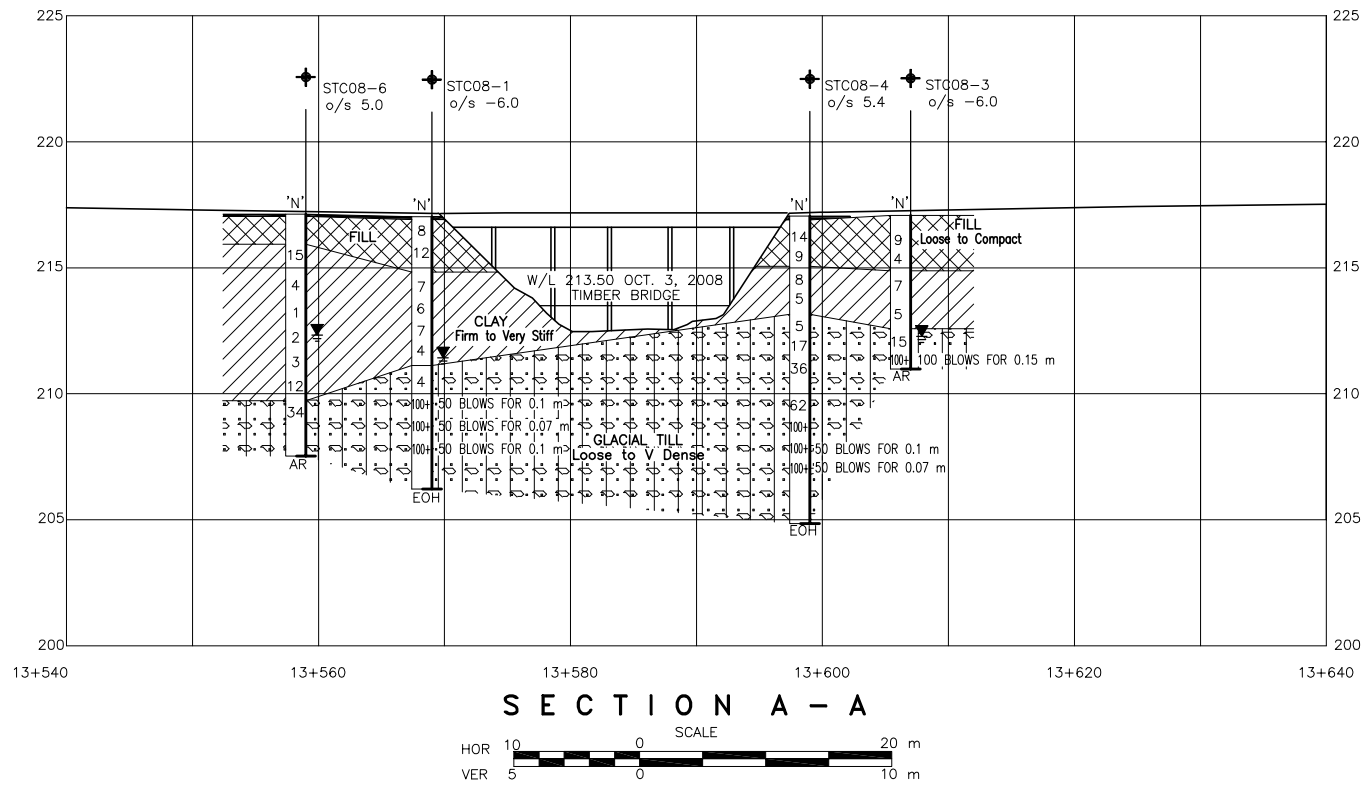
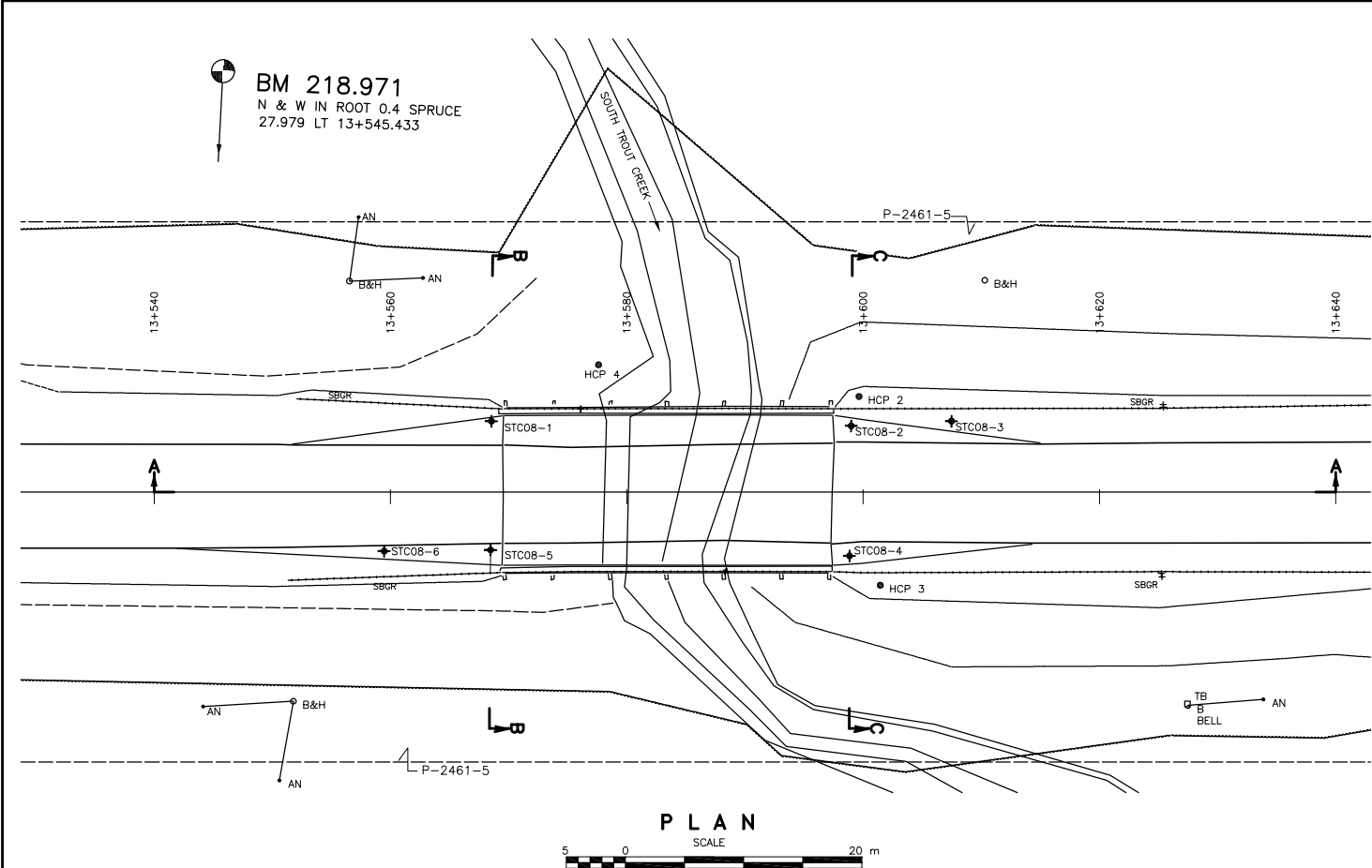
W P: 496 00 00

District: 61

Highway: 11/17

APPENDIX C

Borehole Locations and Soil Strata Drawings



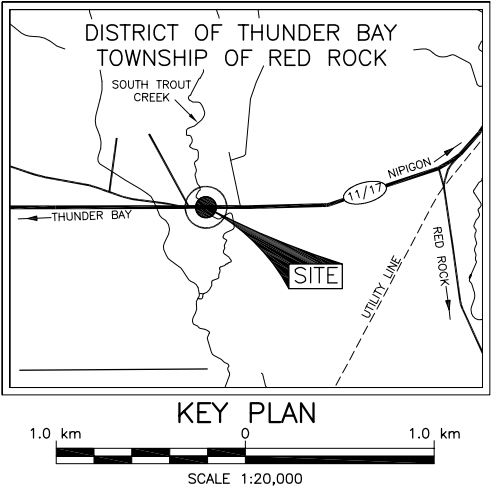
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No xxxxxx
GWP No 476-00-00
GEOCRES No xxx-xxx

SHEET

**TBT ENGINEERING
CONSULTING GROUP**

SOUTH TROUT CREEK BRIDGE
TOWNSHIP OF RED ROCK
BOREHOLE LOCATIONS AND SOIL STRATA



SOIL STRATA SYMBOLS	
	ASPHALT
	FILL
	CLAY
	GLACIAL TILLS Non Cohesive

LEGEND			
	Borehole		
	'N' Std Pen Test (Blows/0.3m)		
	WL at time of investigation		
	Auger Refusal		
	End of Borehole		
No	ELEVATION	CO-ORDINATES (MTM)	
		NORTH	EAST
STC08-1	217.0	14 5 424 476	205 910
STC08-2	217.1	14 5 424 490	205 937
STC08-3	217.1	14 5 424 494	205 945
STC08-4	217.1	14 5 424 480	205 942
STC08-5	217.1	14 5 424 467	205 915
STC08-6	217.1	14 5 424 463	205 907

—NOTE—
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS						
	2009/11/23	DS	ISSUE FOR FINAL			
	2009/09/25	DS	OUT IN DRAFT			
	DATE	BY	REVISION			
STCB						
SUBM'D ..		CHECKED	DATE .		DIST	THUNDER BAY
DRAWN DS		CHECKED	WH	APPROVED	HWY	11/17
					DWG	1