



THURBER ENGINEERING LTD.

**DETAILED FOUNDATION INVESTIGATION REPORT
ANGLER CREEK TRIBUTARY CULVERT REPLACEMENT
HIGHWAY 17, TOWNSHIP OF MCCOY
DISTRICT OF THUNDER BAY, ONTARIO
LATITUDE: 48.770526°, LONGITUDE: -86.380302°**

G.W.P. No. 6810-14-00, W.P. No. 6812-14-01, SITE No. 48E-079/C

GEOCRES Number: 42D-55

Report

to

HATCH

Date: December 18, 2018
File: 15595



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1. INTRODUCTION

This report presents the factual data obtained from a detailed foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the Angler Creek Tributary Corrugated Steel Pipe (CSP) Culvert on Highway 17, located in the Township of McCoy, District of Thunder Bay, Ontario. Thurber previously completed a preliminary foundation investigation at the culvert site in 2018.

The purpose of this investigation was to explore the subsurface conditions at the culvert location and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber was retained by Hatch to carry out this detailed foundation investigation under the Ministry of Transportation (MTO) Agreement 6016-E-0008.

The preliminary investigation previously conducted by Thurber is described in the following report:

- Preliminary Foundation Investigation and Design Report, Angler Creek Tributary Culvert Replacement, Highway 17, Township of McCoy, District of Thunder Bay, Ontario, GEOCRES Number 42D-52, prepared by Thurber Engineering Ltd.

The borehole logs from the preliminary investigation are included in this report.

2. SITE DESCRIPTION

The site is located on Highway 17, approximately 4.0 km west of Peninsula Road, in the Township of McCoy, District of Thunder Bay, Ontario. The existing culvert allows a tributary of Angler Creek to flow in a northeast to southwest direction under Highway 17. Highway 17 generally runs in an

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east-west direction at the culvert site.

The Ontario Structure Inspection Manual (Inspection Form) prepared by MTO on November 20, 2014 indicates that the existing structure is a corrugated steel round pipe culvert. The inspection report indicates that the diameter of the pipe is 3 m. The overall length of the structure is approximately 34 m. The estimated culvert invert is at approximate Elevation 270.31 m at the inlet (north) and 269.89 m at the outlet (south). The existing road grade at the culvert location is at approximate Elev. 274.3 m. The height of fill above the culvert approximately 1.2 m. The local creek water level downstream of the culvert was reportedly measured at Elev. 268.55 m in August 2012. The culvert currently sits high above the creek bed at the outlet.

The lands surrounding the culvert site predominantly consist of heavily forested areas with occasional lakes, gullies, rivers, and creeks. Local topography is jagged, rugged, cliffed, and knobby and is generally of medium to high relief. Bedrock outcrops are visible along Highway 17 within 50 m of the existing culvert. Large cobbles and boulders are present on the south embankment around the outlet of the culvert.

Photographs of the culvert and surrounding areas are presented in Appendix C.

Based on published geological information, the culvert lies within an area of mainly shallow or exposed bedrock with thin layers of till or peat overlying the bedrock. Based on local geological maps the bedrock in the area is identified as intrusive igneous rocks (syenite).

3. INVESTIGATION PROCEDURES

The current detailed field investigation for this project was carried out from July 21 to 28, 2018, and consisted of drilling and sampling five (5) boreholes, denoted as Boreholes 18-18 to 18-22, to depths ranging from 3.9 to 7.8 m below the existing ground surface. Boreholes 18-18, 18-19, 18-21 and 18-22 were located within the paved section of Highway 17, and Borehole 18-20 was located near the existing culvert outlet. Boreholes 18-18 and 18-19 were drilled at the locations of proposed abutments for a temporary modular bridge, Boreholes 18-20 and 18-21 were drilled along the culvert alignment to obtain additional information on the bedrock profile, and Borehole 18-22 was drilled near the location of the proposed creek diversion pipe.

The previous preliminary investigation for this project was carried out between July 16 and 17, and September 15 and 16, 2017, during which time three (3) boreholes (denoted as 17-11, 17-12, and 17-14) were drilled to depths of between approximately 2.1 m and 9.1 m below the existing ground surface.



The Record of Borehole sheets for the boreholes from the current and previous preliminary investigations are included in Appendix A. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing included in Appendix D.

Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were estimated from the cross sections and topographic drawings provided to Thurber by Hatch. The coordinate system MTM NAD 83, Zone 14 was used for these boreholes.

For the boreholes located within the paved portion of Highway 17, a truck-mounted drill rig was used to advance the boreholes using wash boring and rock coring techniques. Borehole 18-20 was advanced using a Hilti DD 250 E portable drill with rock coring techniques. Soil samples were obtained in the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Bedrock was proven by NQ coring in all of the boreholes.

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.

All rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions were observed in the open boreholes throughout the drilling operations and in standpipe piezometers that were installed in Boreholes 18-18 and 18-19. The creek water level at the culvert outlet was also measured during the preliminary investigation. The boreholes and piezometers were backfilled on completion of the field investigation in general accordance with Ontario Regulation 903 as amended by Regulation 128/03.

Completion details of the boreholes and piezometers are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
18-18	7.3 / 267.1	4.6 / 269.8	Sand to 2.7 m, then bentonite holeplug to 0.3 m, then sand and gravel to 0.15 m, then asphalt to surface.



Borehole Number	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
18-19	7.5 / 266.8	6.1 / 268.1	Sand to 2.7 m, then bentonite holeplug to 0.15 m, then asphalt to surface.
18-20	3.9 / 265.5	None Installed	Bentonite holeplug to surface.
18-21	7.8 / 266.4	None Installed	Cuttings to 3.9 m, then bentonite holeplug to 0.6 m, then sand to 0.2 m, then asphalt to surface.
18-22	7.7 / 266.5	None Installed	Cuttings to 3.9 m, then bentonite holeplug to 0.6 m, then sand to 0.2 m, then asphalt to surface.
17-11	7.2 / 264.3	None Installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17-12	9.1 / 265.2	None Installed	Borehole backfilled with bentonite holeplug to 0.9 m, auger cuttings to 0.6 m, concrete to 0.1m, then asphalt patch to surface
17-13	0.0 / 269.8	None Installed	Visual observation only. No excavation.
17-14	2.1 / 272.1	None Installed	Borehole backfilled with auger cuttings to 0.1 m then asphalt patch to surface.

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and/or hydrometer). Point load tests were conducted on bedrock cores. The results of this laboratory testing program are shown on the Record of Borehole sheets included in Appendix A and on the figures included in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, during the previous investigation, a sample



of the fill soil, and a sample of the surface water from the creek upstream of the existing culvert were collected and submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters. The results of the analytical testing are summarized in this report and also 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 stratigraphy are presented on the Record of Borehole sheets and on the Borehole Locations and Soil Strata Drawing included in Appendix D. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It must be recognized and expected that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered in the boreholes consisted of asphalt and sand and gravel embankment fill underlain by native sandy silt, sand and silt, gravel deposits and shallow syenite bedrock. Descriptions of the individual strata are presented below.

5.1 Asphalt

Boreholes 18-18, 18-19, 18-21, 18-22, 17-12 and 17-14 were drilled through the paved portion of Highway 17 and encountered a layer of asphalt that ranged in thickness from approximately 150 to 250 mm.

5.2 Sand and Gravel Fill

Sand and gravel embankment fill, ranging to gravelly sand fill, and containing trace to some silt, trace clay, and occasional cobbles and boulders, was encountered beneath the asphalt in Boreholes 18-18, 18-19, 18-21, 18-22, 17-12 and 17-14. The thickness of the sand and gravel fill, where fully penetrated (in all of these boreholes except Borehole 17-14) ranged from 1.9 to 3.8 m and extended to depths from 2.1 to 4.0 m (Elevation 272.1 to 270.2 m). Borehole 17-14 was terminated within the fill at a depth of 2.1 m (Elevation 272.1 m).

SPT 'N' values in the sand and gravel fill ranged from 4 to greater than 50 blows for 0.3 m penetration, indicating a loose to very dense relative density (typically compact to dense). The measured moisture contents in the fill ranged from 2 to 15 percent.



The results of grain size analyses conducted on samples of the sand and gravel fill are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B1 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage
Gravel	23 to 59
Sand	39 to 70
Silt & Clay	2 to 10

5.3 Sandy Silt with organics

A layer of sandy silt, containing organics, some gravel, and trace clay, and occasional cobbles was encountered at the surface of Borehole 17-11. The sandy silt layer with organics was approximately 1.8 m thick, extending to a depth of 1.8 m (Elevation 269.7 m).

The SPT 'N' value recorded in the sandy silt was 50 blows for 50 mm penetration on refusal, indicating the presence of cobbles or boulders. Measured moisture contents in the sandy silt were 32 to 37 percent.

The results of a grain size analysis conducted on a sample of the sandy silt with organics is provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B2 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage
Gravel	11
Sand	26
Silt	58
Clay	5

5.4 Sand and Silt

A layer of sand and silt, containing trace clay, trace gravel and trace organics was encountered at depths of 1.8 and 2.4 m in Boreholes 17-11 and 18-18 respectively. The sand and silt layer was approximately 1.6 to 2.4 m thick and extended to a depths from 4.0 to 4.2 m (Elevation 270.3 to 267.3 m).



SPT 'N' values measured in the sand and silt ranged from 8 to greater than 50 blows for 0.3 m penetration, indicating a loose to very dense relative density (typically loose to compact). Measured moisture contents in the sand and silt ranged from 11 to 40 percent.

The results of grain size analyses conducted on samples of the sand and silt are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B3 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage
Gravel	0 to 2
Sand	44
Silt	47 to 51
Clay	5 to 7

5.5 Gravel

A gravel deposit containing some sand and some cobbles and boulders was encountered below the fill in Boreholes 18-19, 18-21, 18-22 and 17-12 at depths from 2.1 to 4.0 m (Elevation 272.1 to 270.2 m), and at the creek bed level (Elevation 268.7 m) in Borehole 18-20. The gravel deposit ranging from 0.3 to 2.3 m thick and extended to bedrock contact at depths from 1.2 to 5.7 m (Elevation 270.0 to 268.2 m).

SPT 'N' values recorded in the gravel deposit ranged from 11 to 33 blows for 0.3 m penetration indicating a compact to dense relative density. The measured moisture content of the gravel ranged from 8 to 10 percent.

5.6 Bedrock

The overburden soils described above are underlain by igneous bedrock described as syenite. The bedrock was grey to pinkish grey and was described as moderately weathered to fresh.

Bedrock was proven by coring approximately 3 m of bedrock in Boreholes 18-18 to 18-22, 17-11 and 17-12. In addition to the coring, exposed bedrock was observed at the ground surface at Test Pit 17-13 near the outlet of the culvert. The exposed bedrock was located on the east bank of the creek, approximately 3 to 5 m south of the culvert outlet. The table below summarizes the depths and elevations to the top of bedrock.



Table 5.1 - Depths and Elevations of Top of Bedrock

Borehole/ Test Pit	Top of Bedrock	
	Depth (m)	Elevation (m)
18-18	4.0	270.3
18-19	4.4	269.8
18-20	1.2	268.2
18-21	4.3	269.9
18-22	4.2	270.0
17-11	4.2	267.3
17-12	5.7	268.6
17-13	0.0	269.8

Total Core Recovery (TCR) in the bedrock ranged from 77 to 100 percent. Solid Core Recovery (SCR) ranged from 67 to 100%. The Rock Quality Designation (RQD) determined from the recovered cores ranged from 17% to 100%, indicating fair to excellent rock quality (typically fair to excellent).

Average unconfined compressive strengths (UCS) of the rock typically ranged between 57 MPa and 218 MPa, indicating the rock is strong to very strong. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. A summary of the Point Load Test Results is presented in Appendix B.

5.7 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes 18-18 and 18-19 to monitor the groundwater level at the site. The groundwater levels measured in the open boreholes and in the standpipe piezometers are summarized in Table 5.2 below.

Groundwater levels were not measured in Boreholes 18-21 and 17-11, because water was added to the boreholes for drilling and coring purposes and had not dissipated by the time that the boreholes were backfilled.

Table 5.2 – Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
18-18	July 23, 2018	2.2	272.2	Standpipe piezometer
	July 24, 2018	2.4	271.9	
18-19	July 22, 2018	4.6	269.6	Standpipe piezometer
	July 24, 2018	4.7	269.5	
18-20	July 28, 2018	0.0	269.4	In creek
18-22	July 21, 2018	Dry	Dry	Open borehole
17-12	July 17, 2017	3.7	270.6	Open borehole
17-13	August 25, 2017	Dry	Dry	Bedrock outcrop
17-14	July 16, 2017	Dry	Dry	Open borehole

The groundwater level should be assumed to reflect the local creek water level. The creek water level at the culvert outlet was measured by Thurber during the previous investigation at Elevation 269.1 m on August 25, 2017, based on the depth below the bottom of the existing pipe. The water level at the outlet was subsequently measured by Thurber at Borehole 18-20 on July 28, 2018 at Elevation 269.4 m, and the water depth was 0.7 m to the creek bed. The creek water level downstream of the culvert was reported at Elevation 268.6 m on August 21, 2012.

Groundwater levels are short-term observations and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the sand and gravel fill from Borehole 17-12, and a sample of the surface water from the creek were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.



Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Units (Water)	Test Results	
			17-12 SS4	Angler Creek
			(Sand and Gravel Fill)	(Creek Water)
Sulphide	mg/L	mg/L	<0.02	<0.006
Chloride	mg/L	mg/L	25	1.6
Sulphate	mg/L	mg/L	7	2.4
pH	-	-	9.62	6.82
Conductivity	µS/cm	µS/cm	168	55
Resistivity	Ohms.cm	Ohms.cm	5950	18000
Redox Potential	mV	mV	264	217

7. MISCELLANEOUS

Thurber obtained subsurface utility clearances prior to drilling. The northing and easting coordinates and ground surface elevations were estimated based on field measurements relative to the topographic plans provided by Hatch.

OGS Inc. of Almonte, Ontario, and Eastern Ontario Diamond Drilling of Hawkesbury, Ontario, supplied and operated the drilling, sampling and in-situ testing equipment for the current field investigation. The field investigation was supervised on a full time basis by Mr. Ryan McCourt and Mr. Liam Steers of Thurber. Overall supervision of the field program was provided by Mr. Mark Farrant, P.Eng. of Thurber.

Geotechnical laboratory testing was carried out in Thurber's geotechnical laboratory. Analytical laboratory testing was carried out by SGS Canada Inc.

Interpretation of the field data and preparation of this report was carried out by Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Thurber Engineering Ltd.



Mark Farrant, P.Eng.
Geotechnical Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact



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>						
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty Can be peeled by a pocket knife, crumbles under firm blows of geological pick. Indented by thumbnail	
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750		
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.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150		
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 18-18

1 OF 1

METRIC

W.P. 6812-14-01 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 746.4 E 350 370.2 ORIGINATED BY BRM
DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY MP
DATUM Geodetic DATE 2018.07.23 - 2018.07.23 LATITUDE LONGITUDE 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					
274.4	GROUND SURFACE												
0.0	ASPHALT (150mm)												
0.2	SAND and GRAVEL to Gravelly SAND, some silt Very Dense to Dense Brown Moist (FILL)		1	SS	50/ 0.100		274						
			2	SS	46		273						33 57 10 (SI+CL)
272.7			3	SS	50/ 0.025		272						
1.7	Boulders from 1.7m to 2.4m						271						
271.9			4	SS	21		270						2 44 47 7
2.4	SILT and SAND, trace clay, trace gravel, trace organics Compact to Very Dense Dark Brown to Grey Wet		5	SS	50/ 0.100		269						
270.3							268						
4.0	BEDROCK(SYENITE), moderately weathered, medium to fresh, very strong, grey						270						
	Sub vertical fracture (125mm) at 4.2m and (150mm) at 4.8m		1	RUN			269						
	Horizontal fracture at 4.3m, 4.9m and 5.2m												
	Sub horizontal fracture at 4.7m												
	Sub vertical fracture (225mm) at 5.7m, (125mm) at 5.9m, (300mm) at 6.4m, (75mm) at 6.7m, at 6.8m and (75mm) at 7.0m		2	RUN			268						
	Sub horizontal fracture at 6.0m												
	Horizontal fracture at 6.1m and 6.4m												
267.1													
7.3	END OF BOREHOLE AT 7.3m. WATER LEVEL AT 2.2m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.07.24 2.4 271.9												


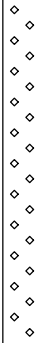

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-19

1 OF 1

METRIC

W.P. 6812-14-01 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 764.9 E 350 328.7 ORIGINATED BY BRM
DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY MP
DATUM Geodetic DATE 2018.07.22 - 2018.07.22 LATITUDE LONGITUDE 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						
274.2	GROUND SURFACE													
0.0	ASPHALT (175mm)													
0.2	SAND and GRAVEL to Gravelly SAND, trace silt, occasional rock fragments Very Dense Brown Moist (FILL)		1	SS	57/ 0.150									
			2	SS	51									
			3	SS	28									
272.1														
2.1	GRAVEL, some sand, some cobbles and boulders Compact Brown Wet													
			4	SS	11									
269.8														
4.4	BEDROCK (SYENITE), moderately weathered, pinkish grey to grey, strong to very strong Sub horizontal fracture at 4.5m, 4.8m and 5.3m Horizontal fracture at 4.8m, 5.2m, 5.3m, 5.4m and 5.6m Vertical fracture from 5.5m to 7.0m Horizontal fracture at 5.6m, 5.8m, 5.9m, 6.0m, 6.3m, 6.4m and 6.8m Sub horizontal fracture at 5.7m and 6.2m Sub vertical fracture (75mm) at 6.5m and (100mm) at 7.4m		1	RUN										
			2	RUN										
266.8														
7.5	END OF BOREHOLE AT 7.5m. WATER LEVEL AT 4.6m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.07.24 4.7 269.5													

ONTMT452 MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 9/27/18




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

RECORD OF BOREHOLE No 18-20

1 OF 1

METRIC

W.P. 6812-14-01 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 742.6 E 350 334.5 ORIGINATED BY LS
DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY MP
DATUM Geodetic DATE 2018.07.28 - 2018.07.28 LATITUDE LONGITUDE 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									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
								WATER CONTENT (%)									
269.4	GROUND SURFACE																
0.0	WATER						269										
268.7																	
0.7	GRAVEL , some sand, some cobbles and boulders																
268.2																	
1.2	BEDROCK (SYENITE), moderately weathered, strong to very strong, grey		1	RUN			268										
	Sub-horizontal fracture (38mm) at 1.7m and (75mm) at 1.8m		2	RUN													
	Sub-horizontal fracture (75mm) at 3.4m, 3.6m and (25mm) at 3.7m		3	RUN													
	Vertical fracture (125mm) at 3.5m		4	RUN				267									
			5	RUN													
	Rubble zone (100mm) at 3.8m		6	RUN				266									
265.5																	
3.9	END OF BOREHOLE AT 3.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-21

1 OF 1

METRIC

W.P. 6812-14-01 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 754.2 E 350 342.2 ORIGINATED BY BRM
DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY MP
DATUM Geodetic DATE 2018.07.22 - 2018.07.22 LATITUDE LONGITUDE 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			SHEAR STRENGTH kPa				WATER CONTENT (%)						
274.2	GROUND SURFACE							20	40	60	80	100						
0.0	ASPHALT																	
0.2	SAND and GRAVEL , trace silt Loose to very Dense Brown Moist to Wet (FILL)		1	SS	58		274											
			2	SS	10		273											
			3	SS	4		272											
			4	SS	23		271											
			5	SS	19		270											
270.2																		
4.0	GRAVEL , some sand, some cobbles and boulders						269											
269.9																		
4.3	BEDROCK (SYENITE), moderately weathered, very strong, grey		1	RUN			268											
	Horizontal fracture at 4.3m, 4.5m, 4.7m, 4.9m and 5.5m						267											
	Sub horizontal fracture at 5.0m, 5.2m, 5.5m and 5.8m																	
	Sub horizontal fracture at 6.2m, 6.4m, 6.8m, 7.2m and 7.7m		2	RUN														
	Sub vertical fracture at 6.3m, 6.5m, (100mm) at 6.9m, (150mm) at 7.0m, (75mm) at 7.2m, (100mm) at 7.4m, 7.5m, (125mm) at 7.6m and 7.7m																	
266.4	Horizontal fracture at 7.1m																	
7.8	END OF BOREHOLE AT 7.8m. BOREHOLE BACKFILLED WITH CUTTINGS TO 3.9m, BENTONITE HOLEPLUG TO 0.6m, SAND TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.																	

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-22

1 OF 1

METRIC

W.P. 6812-14-01 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 760.6 E 350 343.1 ORIGINATED BY BRM
DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY MP
DATUM Geodetic DATE 2018.07.21 - 2018.07.21 LATITUDE LONGITUDE 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					
274.2	GROUND SURFACE												
0.0	ASPHALT (150mm)												
0.2	SAND and GRAVEL, trace silt Very Dense to Compact Brown Moist (FILL)		1	SS	50/ 0.125								
			2	SS	33								
			3	SS	26								
			4	SS	36								
270.6													
3.7	GRAVEL, some sand, some cobbles and boulders												
270.0													
4.2	BEDROCK (SYENITE), moderately weathered, very strong, pinkish grey to grey												
	Sub vertical fracture at 4.5m, (125mm) at 5.2m		1	RUN									
	Sub horizontal fracture at 4.7m, 4.8m, 5.2m and 5.3m												
	Horizontal fracture at 4.9m, 5.1m and 5.3m												
	Sub vertical fracture at 6.7m												
	Sub horizontal fracture at 6.3m and 6.7m		1	RUN									
	Horizontal fracture at 7.0m												
266.5													
7.7	END OF BOREHOLE AT 7.7m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 3.9m, BENTONITE HOLEPLUG TO 0.6m, SAND TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.												

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

RECORD OF BOREHOLE No 17-11

1 OF 1

METRIC

W.P. 6810-14-00 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 771.5 E 350 355.0 ORIGINATED BY TTB
 HWY 17 BOREHOLE TYPE Tripod/BW Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.09.15 - 2017.09.16 CHECKED BY CZ

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								
271.5	GROUND SURFACE							20	40	60	80	100				
0.0	Sandy SILT , with organics, some gravel, trace clay, occasional cobbles Brown Moist		1	SS	50/ 0.050		271									
			1	GS												
269.7			2	GS			270									
1.8	SAND and SILT , trace clay Loose to Compact Brown Moist															11 26 58 5
			2	SS	8		269									
			3	SS	24		268									0 44 51 5
267.3																
4.2	BEDROCK (SYENITE) , slightly to moderately weathered, very strong to strong, grey		1	RUN			267									RUN #1 TCR=100% SCR=100% RQD=100% UCS=144MPa (Average)
			2	RUN			266									RUN #2 TCR=100% SCR=100% RQD=87% UCS=181MPa (Average)
			3	RUN			265									RUN #3 TCR=100% SCR=94% RQD=94% UCS=218MPa (Average)
264.3																
7.2	END OF BOREHOLE AT 7.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.															

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

RECORD OF BOREHOLE No 17-12

1 OF 2

METRIC

W.P. 6810-14-00 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 752.9 E 350 351.2 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Solid Stem Augers/NW/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.17 - 2017.07.17 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				
274.3	GROUND SURFACE							<div>20406080100</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div> <div>20406080100</div> <div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</div> <div>W_P W W_L</div> <div>WATER CONTENT (%)</div> <div>204060</div>				
0.0	ASPHALT: (250mm)											GR SA SI CL
0.3	SAND and GRAVEL, trace silt and clay, occasional cobbles Compact to Loose Brown Moist (FILL)		1	GS			274					42 49 9 (SI+CL)
			1	SS	23		273					
			2	SS	7		272					41 53 6 (SI+CL)
			3	SS	19		271					
			4	SS	18		270					
270.3	GRAVEL, some sand Dense Brown Wet		5	SS	33		269					
268.6	BEDROCK (SYENITE) , slightly to moderately weathered, very strong, grey Sub-vertical fracture (25mm) at 6.6m Sub-horizontal fracture (25mm) at 7.1m, 7.2m and 8.0m Sub-vertical fracture (75mm) at 7.2m, (50mm) at 7.4m and 7.9m Vertical fracture (50mm) at 8.1m		1	RUN			268					RUN #1 TCR=77% SCR=77% RQD=56% UCS=131MPa (Average)
			2	RUN			267					RUN #2 TCR=100% SCR=100% RQD=68% UCS=161MPa (Average)
			3	RUN			266					RUN #3 TCR=100% SCR=100% RQD=100% UCS=145MPa (Average)
265.2	END OF BOREHOLE AT 9.1m. WATER LEVEL AT 3.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, CUTTINGS TO 0.6m, CONCRETE											
9.1												

Continued Next Page

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

ONTMT4S MTO-15595 GPJ 2017 TEMPLATE(MTO) GDT 12/5/17

METRIC

[illegible]

RECORD OF TEST PIT No 17-13

1 OF 1

METRIC

W.P. 6810-14-00 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 740.0 E 350 335 ORIGINATED BY JZ
 HWY 17 BOREHOLE TYPE Visual Observation COMPILED BY AN
 DATUM Geodetic DATE 2017.08.25 - 2017.08.25 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
269.8	GROUND SURFACE																
0.0	BEDROCK OUTCROP EXPOSED AT GROUND SURFCE (SYENITE).																

RECORD OF BOREHOLE No 17-14

1 OF 1

METRIC

W.P. 6810-14-00 LOCATION Angler Creek Tributary Culvert, MTM NAD 83 Zone 14 N 5 403 757.9 E 350 333.6 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.16 - 2017.07.16 CHECKED BY MEF

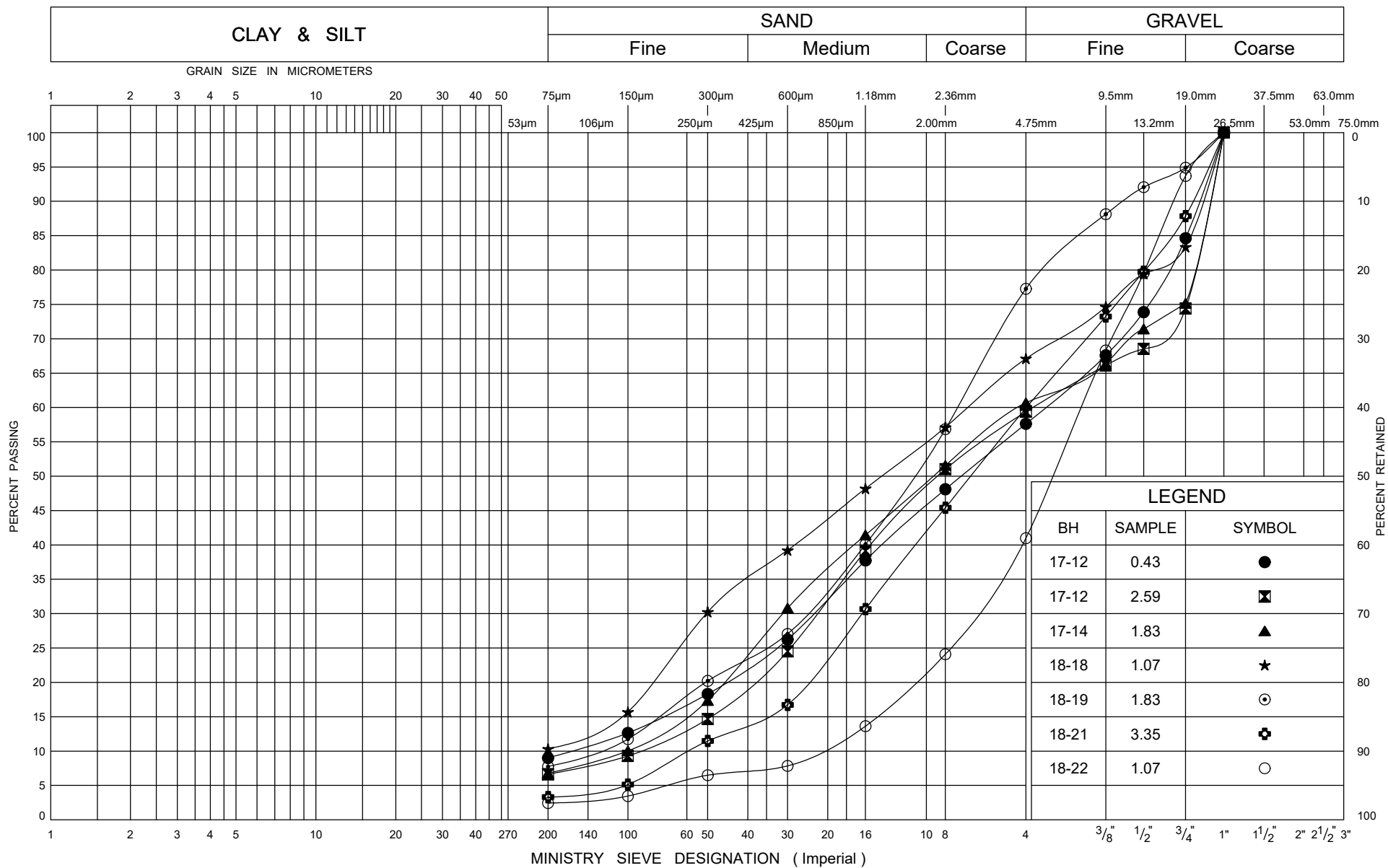
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _P w w _L				GR	SA	SI	CL					
274.2	GROUND SURFACE							20	40	60	80	100												
0.0	ASPHALT: (250mm)						274																	
273.9	SAND and GRAVEL, trace silt and clay Compact Brown Moist (FILL)		1	GS			273																	
0.3																								
272.1			1	SS	17														39 54 7 (SI+CL)					
2.1	END OF BOREHOLE AT 3.1m. BOREHOLE OPEN TO 1.1m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.																							

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



Appendix B

Geotechnical and Analytical Laboratory Test Results



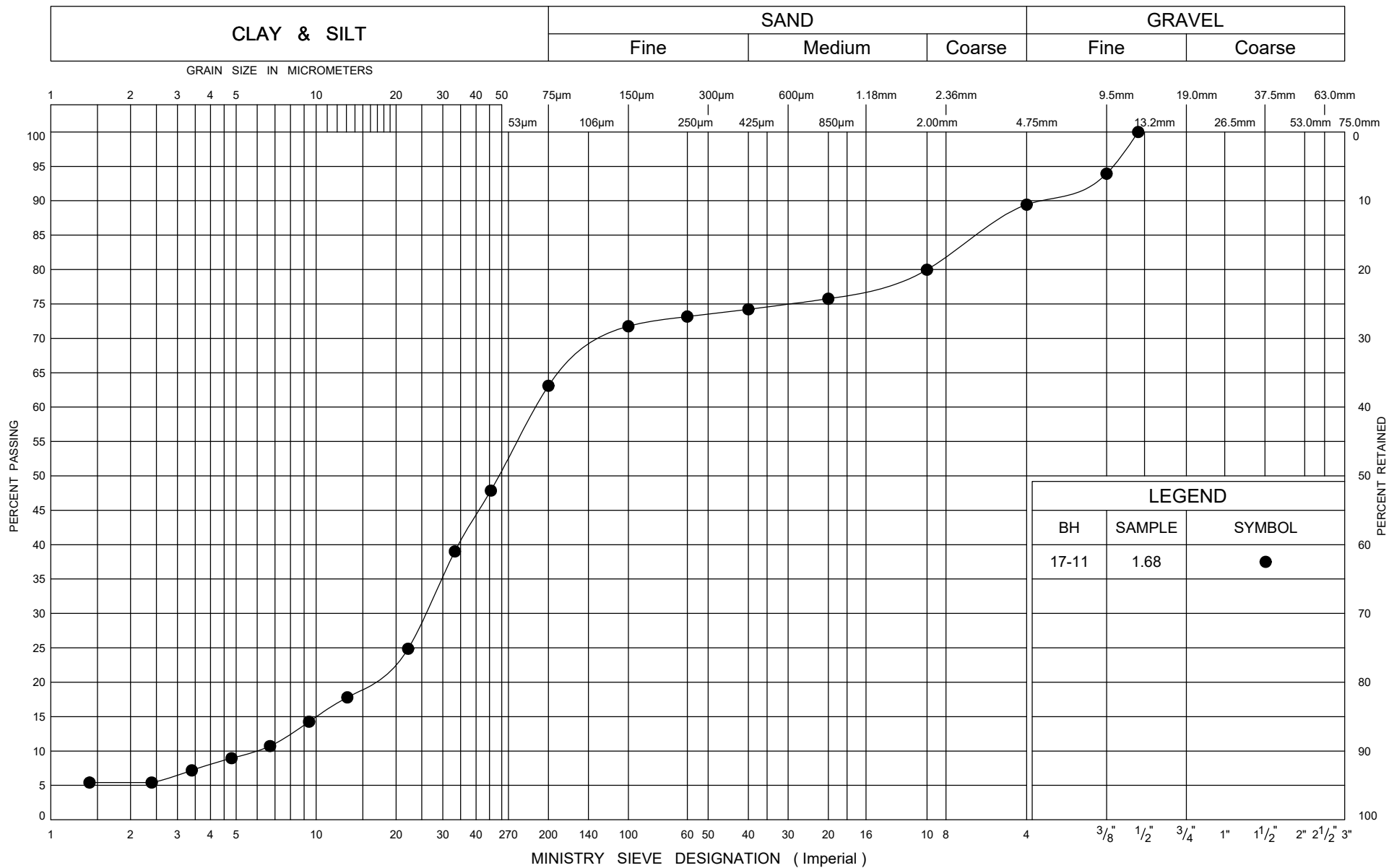




FIG No B3
W P 6812-14-01
Angler Creek Tributary Culvert



ASTM D5731-08

Date Drilled:	July 23/18
Date Tested:	August 17/18
Tester:	BS
Reviewed by:	MEF

[illegible]



ASTM D5731-08

Date Drilled:	July 22/18
Date Tested:	August 8/18
Tester:	KF
Reviewed by:	MEF

[illegible]



ASTM D5731-08

Date Drilled:	July 29/18
Date Tested:	August 17/18
Tester:	BS
Reviewed by:	MEF

[illegible]



ASTM D5731-08

Date Drilled:	July 22/18
Date Tested:	August 17/18
Tester:	BS
Reviewed by:	MEF

[illegible]



ASTM D5731-08

Date Drilled:	July 21/18
Date Tested:	August 17/18
Tester:	BS
Reviewed by:	MEF

[illegible]



ASTM D5731-08

Date Drilled:	Sep 15-16/17
Date Tested:	Sep 25/17
Tester:	GA
Reviewed by:	WM

[illegible]



ASTM D5731-08

Date Drilled:	July 17/17
Date Tested:	Sep 6/17
Tester:	JZ
Reviewed by:	WM

[illegible]

Certificate of Analysis

SGS Canada Inc.
185 Concession St. Box 4300
Lakefield, Ont., Canada, K0L 2H0



Client
SGS LIMS Number
Analysis Package:

Attention: Mark Farrant
Project#: 15595
Thurber Engineering Ltd.
CA14253-SEP17
Corrosivity (Soil)

Sample ID Unit BH-12, SS#4, 10'-12'

Sample Date/Time 17-Jul-17

Moisture	%	2.8
pH	no unit	9.62
Corrosivity Index	none	3.0
Soil Redox Potential	mV	264
Sulphide	mg/L	<0.02
Chloride	mg/L	25.0
Sulphate	mg/L	7
Conductivity	uS/cm	168
Resistivity (calculated)	ohms.cm	5950

Corrosivity Scale according to AWWA C-105.
An index greater than 10 indicates the
soil matrix may be corrosive to cast iron alloys.

Deanna Edwards B.Sc., C.Chem
Project Specialist
Environment, Health and Safety

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(Printed copies are available upon request.). Test Method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Certificate of Analysis

SGS Canada Inc.
185 Concession St. Box 4300
Lakefield, Ont., Canada, K0L 2H0



Client
SGS LIMS Number
Analysis Package:

Attention: Mark Farrant
Project#: 15595
Thurber Engineering Ltd.
CA15528-JUL17
Corrosivity (Soil)

Sample ID Unit Angler Creek CSP

Sample Date/Time 17-Jul-17 16:10

Moisture	%	N/A
pH	no unit	6.82
Corrosivity Index	none	
Redox Potential	mV	217
Sulphide	mg/L	<0.006
Chloride	mg/L	1.6
Sulphate	mg/L	2.4
Conductivity	uS/cm	55
Resistivity (calculated)	ohms.cm	18000

Corrosivity Scale according to AWWA C-105.
An index greater than 10 indicates the
soil matrix may be corrosive to cast iron alloys.

Deanna Edwards B.Sc., C.Chem
Project Specialist
Environment, Health and Safety

Data reported represents the sample submitted to SGS. Reproduction of this analytical report in full or in part is prohibited without prior written approval. Please refer to SGS General Conditions of Services located at http://www.sgs.com/terms_and_conditions_service.htm.
(Printed
copies are available upon request.). Test Method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.



Appendix C

Site Photographs



**Photo 1: Looking east along Highway 17 from outlet of culvert
(Date taken: August 23, 2017)**



**Photo 2: Looking West along Highway 17 from outlet of culvert
(Date taken: August 23, 2017)**



**Photo 3: Looking east along Highway 17 from inlet of culvert
(Date taken: June 27, 2017)**



**Photo 4: Looking west along Highway 17 and inlet of culvert
(Date taken: June 27, 2017)**



Photo 5: Inlet of culvert, looking southwest (Date taken: May 16, 2017)



Photo 6: Outlet of culvert, looking northeast (Date taken: August 23, 2017)



**Photo 7: Looking southwest from inside culvert outlet
(bedrock outcrops visible on left bank) (Date taken: August 23, 2017)**

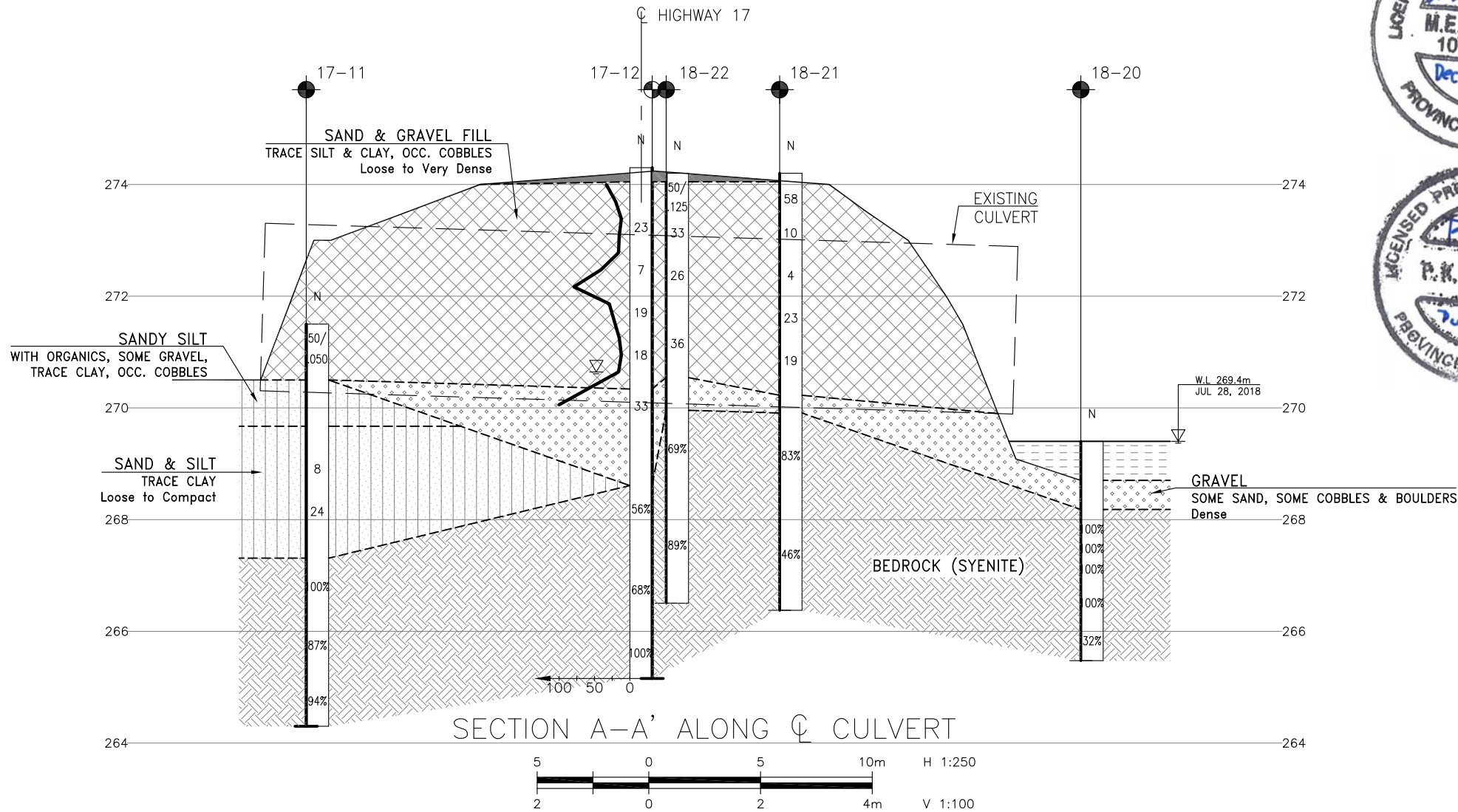
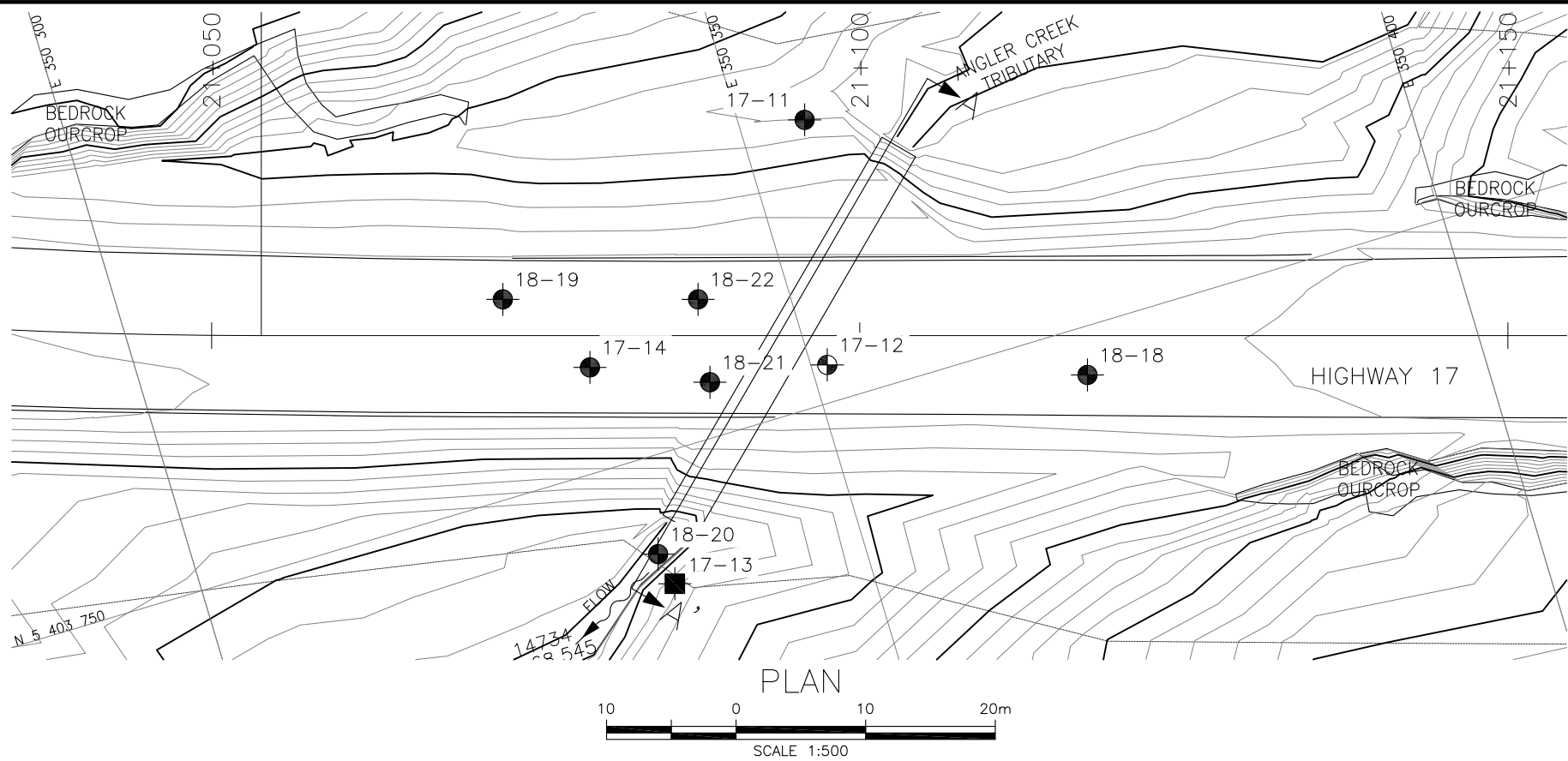


Photo 8: Outlet of culvert resting on sand, gravel and cobbles (possibly fill)
(Date taken: August 23, 2017)



Appendix D

Borehole Locations and Soil Strata Drawing



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

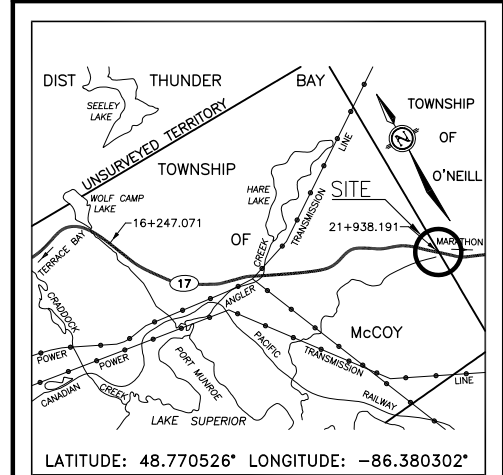


CONT No
WP No 6812-14-01

HIGHWAY 17
ANGLER CREEK TRIBUTARY
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

HATCH

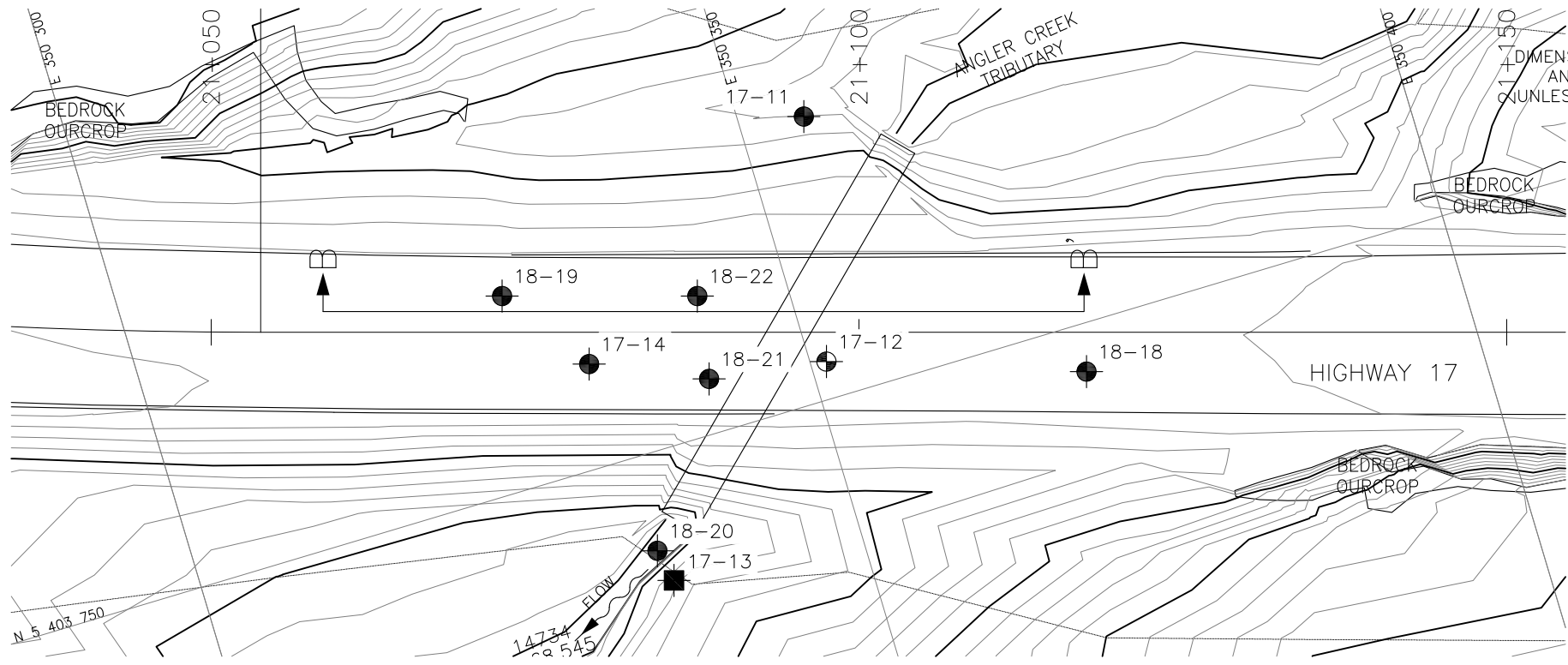
SHEET



KEYPLAN			
LEGEND			
	Borehole		
	Borehole and Cone		
	Test Pit		
N	Blows /0.3m (Std Pen Test, 475J/blow)		
CONE	Blows /0.3m (60° Cone, 475J/blow)		
PH	Pressure, Hydraulic		
	Water Level		
	Head Artesian Water		
	Piezometer		
90%	Rock Quality Designation (RQD)		
A/R	Auger Refusal		
NO	ELEVATION	NORTHING	EASTING
17-11	271.5	5 403 771.5	350 355.0
17-12	274.3	5 403 752.9	350 351.2
17-13	269.8	5 403 740.0	350 335.1
17-14	274.2	5 403 757.9	350 333.6
18-18	274.4	5 403 746.4	350 370.2
18-19	274.2	5 403 764.9	350 328.7
18-20	269.4	5 403 742.6	350 334.5
18-21	274.2	5 403 754.2	350 342.2
18-22	274.2	5 403 760.6	350 343.1

- 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.
 - Coordinate system is MTM NAD 83 Zone 14.

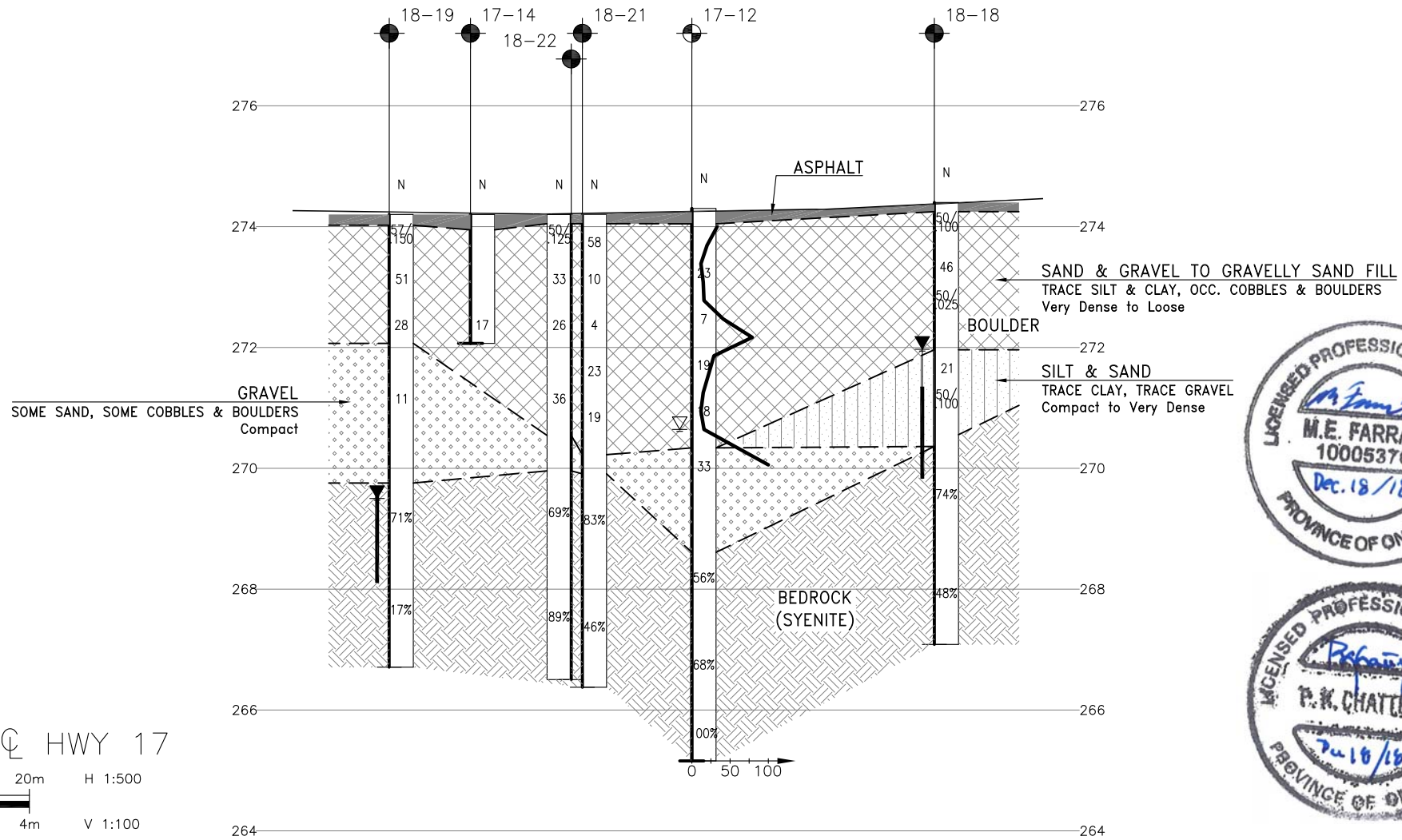
GEOCRES No.			
DESIGN	MEF	CHK	PKC
DRAWN	AN	CHK	MEF
CODE	LOAD	DATE	DEC 2018
SITE	48E-079/C	STRUCT	DWG 1



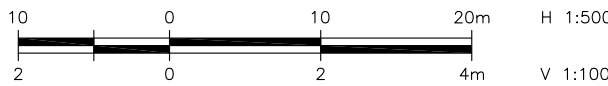
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



PLAN



SECTION B-B' ALONG ϕ HWY 17



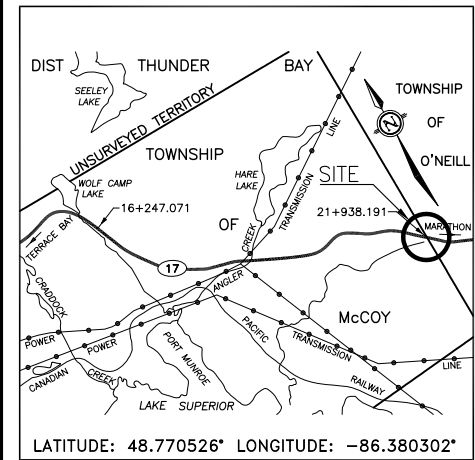
CONT No
WP No 6812-14-01

HIGHWAY 17
ANGLER CREEK TRIBUTARY
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

HATCH



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
17-11	271.5	5 403 771.5	350 355.0
17-12	274.3	5 403 752.9	350 351.2
17-13	269.8	5 403 740.0	350 335.1
17-14	274.2	5 403 757.9	350 333.6
18-18	274.4	5 403 746.4	350 370.2
18-19	274.2	5 403 764.9	350 328.7
18-20	269.4	5 403 742.6	350 334.5
18-21	274.2	5 403 754.2	350 342.2
18-22	274.2	5 403 760.6	350 343.1

-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.
- Coordinate system is MTM NAD 83 Zone 14.

GEORES No.



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MEF	CHK PKC	CODE
DRAWN	AN	CHK MEF	SITE 48E-079/C/STRUCT
			LOAD
			DATE DEC 2018
			DWG 2