



THURBER ENGINEERING LTD.



**PRELIMINARY FOUNDATION INVESTIGATION REPORT
WAWIAG CREEK CULVERT REPLACEMENT
HIGHWAY 11, UNSURVEYED TERRITORY
DISTRICT OF THUNDER BAY, ONTARIO
LATITUDE: 48.647345°, LONGITUDE: -90.571420°**

G.W.P. No. 6805-14-00, W.P. No. 6805-14-01, SITE No. 48W-193/C

GEOCRES Number: 52B-33

Report

to

HATCH Corporation

Date: October 2, 2017
File: 15593

TABLE OF CONTENTS

1.	INTRODUCTION	1
2.	SITE DESCRIPTION	1
3.	INVESTIGATION PROCEDURES	2
4.	LABORATORY TESTING	3
5.	DESCRIPTION OF SUBSURFACE CONDITIONS	4
5.1	Asphalt	4
5.2	Embankment Fill	4
5.2.1	Gravelly Sand Fill	4
5.2.2	Sand Fill	5
5.3	Silty Sand	5
5.4	Gravelly Sand to Sand and Gravel	6
5.5	Sand	7
5.6	Bedrock	7
5.7	Groundwater Conditions	8
6.	CORROSIVITY AND SULPHATE TEST RESULTS	8
7.	MISCELLANEOUS	8

APPENDICES

Appendix A	Record of Borehole Sheets
Appendix B	Geotechnical and Analytical Laboratory Test Results
Appendix C	Site Photographs
Appendix D	Borehole Locations and Soil Strata Drawing

**PRELIMINARY FOUNDATION INVESTIGATION REPORT
WAWIAG CREEK CULVERT REPLACEMENT
HIGHWAY 11, UNSURVEYED TERRITORY
DISTRICT OF THUNDER BAY, ONTARIO**

G.W.P. No. 6805-14-00, W.P. No. 6805-14-01, SITE No. 48W-193/C

GEOCRES NUMBER: 52B-33

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the Wawiag Creek Culvert on Highway 11, located west of Kashabowie, in Unsurveyed Territory, District of Thunder Bay, Ontario.

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 Corporation (Hatch) to carry out this foundation investigation under the Ministry of Transportation Ontario (MTO) Agreement Number 6016-E-0012.

2. SITE DESCRIPTION

The site is located on Highway 11, approximately 10 km west of Highway 802, in Unsurveyed Territory, District of Thunder Bay, Ontario. The existing culvert allows Wawiag Creek to flow in a north to south direction under Highway 11. Highway 11 generally runs in an east-west direction at the culvert site.

The Ontario Structure Inspection Manual (Inspection Form) prepared by MTO on December 16, 2015 indicates that the existing structure is an open footing two span timber structure on the south side with a single span corrugated steel elliptical culvert extension on the north side. The inspection report indicates that the total span on the structure is 4.2 m, with each cell of the timber structure spanning 2.1 m. The overall length of the structure is 28 m. The estimated culvert invert

is at approximate Elevation 457.9 m at the inlet (north) and 457.8 m at the outlet (south) and the culvert is approximately 1.8 m high. The existing road grade at the culvert location is at approximate Elev. 461.5 m, which indicates approximately 1.8 m of fill above the culvert. The local creek water level was reportedly measured at Elev. 458.3 m in April 2015.

The lands surrounding the culvert site predominantly consist of densely forested areas, marsh areas, and small lakes. Wawiag Creek runs through swamp lands to the north of the culvert and outflows into a small lake approximately 100 m to the south of the culvert. Local topography is generally of moderate relief with hummocky bedrock outcrops and ridge bedrock outcrops. Bedrock outcrops are visible within 10 to 50 m of the creek alignment. Large rip rap rock pieces are present on the north embankment around the inlet 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 bedrock outcrops with nearby glacial outwash plain deposits of sand and gravel and organic deposits of peat and muck. Bedrock at the site is identified as metasedimentary rocks.

3. INVESTIGATION PROCEDURES

The site investigation and field testing program for this project was carried out between March 20 and 24, 2017, and consisted of drilling and sampling seven (7) boreholes (17-08 to 17-14) to depths of between approximately 1.2 m and 12.8 m below the existing ground surface. Boreholes 17-08, 17-10, and 17-12 to 17-14 were drilled through the paved portion of Highway 11. Boreholes 17-09 and 17-11 were drilled near the inlet and outlet of the existing culvert. Boreholes 17-12 to 17-14 were drilled to assess the existence and extent of any frost taper near the culvert.

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 15 was used for these boreholes.

A rubber buggy mounted drill rig was used to advance the boreholes using hollow stem and solid stem augers, with the exception of Borehole 17-09, which was advanced using portable tripod equipment. Soil samples were obtained in the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Dynamic Cone Penetration

Tests (DCPT) were driven to cone refusal adjacent to Boreholes 17-08 and 17-10.

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 were observed in the open boreholes throughout the drilling operations and in the open boreholes upon completion of drilling. The boreholes were backfilled in general accordance with Ontario Regulation 903.

Completion details of the boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
17-08	11.3 / 450.2	Borehole backfilled with bentonite holeplug and auger cuttings, then concrete to surface.
17-09	1.2 / 457.7	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17-10	12.8 / 448.8	Borehole backfilled with bentonite holeplug and auger cuttings, then concrete to surface.
17-11	5.2 / 453.2	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17-12	5.2 / 456.4	Borehole backfilled with bentonite holeplug and auger cuttings, then concrete to surface.
17-13	3.7 / 458.0	Borehole backfilled with bentonite holeplug and auger cuttings, then concrete to surface.
17-14	3.7 / 458.2	Borehole backfilled with bentonite holeplug and auger cuttings, then concrete 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) and point load testing on bedrock, where appropriate. 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, two samples of the native sand, 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 below the existing embankment fill consisted of sand and gravel to sand overlying shallow greywacke bedrock. Descriptions of the individual strata are presented below.

5.1 Asphalt

All boreholes, with the exception of Boreholes 17-09 and 17-11, were drilled through the paved portion of Highway 11, below Elev. 461.5 to 461.9 m. The asphalt was approximately 100 mm to 175 mm thick in all boreholes drilled in the paved portion.

5.2 Embankment Fill

Embankment fill was encountered in all boreholes drilled on Highway 11 beneath the asphalt. The fill generally consisted of gravelly sand, which was underlain by sand fill in Boreholes 17-08 and 17-10.

5.2.1 Gravelly Sand Fill

Gravelly sand fill was encountered beneath the asphalt in Boreholes 17-08, 17-10, and 17-12 to 17-14. The gravelly sand fill contained trace to some silt and some rock fill. The fill layer was 2.8 to 3.9 m thick and extended to depths of approximately 3.0 to 4.1 m below the existing road

surface (Elev. 457.5 to 458.6 m) or to the maximum depth drilled in Boreholes 17-13 and 17-14 of 3.7 m.

SPT 'N' values in the gravelly sand fill generally ranged from 10 to 37 blows for 0.3 m penetration, indicating a compact to dense relative density. Higher 'N' values from 97 blows to greater than 100 blows for 0.3 m penetration were also observed in Boreholes 17-08 and 17-10, and were likely a result of frozen material and the presence of rock fill. The measured moisture contents ranged from 2 to 7%.

The results of grain size analyses conducted on samples of the gravelly sand 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:

Gravel %	20 to 34
Sand %	57 to 67
Silt and Clay %	9 to 13

5.2.2 Sand Fill

Sand fill containing some silt, some gravel and trace clay was encountered below the gravelly sand fill in Boreholes 17-08 and 17-10. The sand fill layer was 1.0 to 1.3 m thick and extended to depths of approximately 4.0 to 4.3 m below the existing road surface (Elev. 457.3 to 457.5 m).

SPT 'N' values in the sand fill ranged from 8 to 19 blows for 0.3 m penetration, indicating a loose to compact relative density. The measured moisture contents were 9 to 10%.

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

Gravel %	11
Sand %	68
Silt %	18
Clay %	3

5.3 Silty Sand

A deposit of silty sand containing some gravel and some organic material was encountered at the ground surface in Boreholes 17-09 and 17-11, which were drilled near the inlet and outlet of the

culvert, beyond the base of the embankment. The silty sand layer extended to depths of approximately 0.6 to 0.7 m below the ground surface (Elev. 457.7 to 458.3 m).

SPT 'N' values in the silty sand ranged from 5 to 10 blows for 0.3 m penetration, indicating a loose to compact relative density. The measured moisture contents were 18 to 27%.

The results of a grain size analysis conducted on a sample of the silty sand 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:

Gravel %	0
Sand %	73
Silt %	21
Clay%	6

5.4 Gravelly Sand to Sand and Gravel

Gravelly sand to sand and gravel with trace to some silt was encountered beneath the embankment fill in Boreholes 17-08, 17-10, and 17-12, and below the silty sand in Boreholes 17-09 and 17-11. The deposit ranged in thickness from 0.6 to 1.6 m and extended to depths of approximately 1.2 to 5.6 m below the ground surface (Elev. 455.9 to 457.7 m), including to bedrock contact in Boreholes 17-09 and 17-11.

SPT 'N' values recorded in the gravelly sand to sand and gravel ranged between 13 to 25 blows for 0.3 m penetration, indicating a compact relative density. A higher 'N' value of greater than 100 blows for 0.3 m penetration was also observed in Borehole 17-11, which was likely indicative of the presence of boulders in the deposit. Measured moisture contents in the gravelly sand to sand and gravel ranged from 5 to 21%. A higher moisture content of 77% was also recorded, which is likely indicative of the presence of trace organic material in Borehole 17-10.

The results of grain size analyses conducted on samples of the gravelly sand to sand and gravel are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B4 of Appendix B. The results are summarized as follows:

Gravel %	21 to 52
Sand %	46 to 69
Silt and Clay %	2 to 10

5.5 Sand

A sand deposit containing trace to some silt and trace gravel was encountered below the gravelly sand to sand and gravel in Boreholes 17-08 and 17-10. The sand deposit ranged in thickness from 2.6 to 4.2 m and extended to bedrock contact at approximate depths from 8.2 to 9.8 m (Elev. 453.3 to 451.8 m).

SPT 'N' values recorded in the sand deposit ranged between 3 to 54 blows for 0.3 m penetration, indicating a very loose to very dense relative density. Measured moisture contents in the sand ranged from 13 to 28%.

The results of a grain size analysis conducted on a sample of the sand are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B5 of Appendix B. The results are summarized as follows:

Gravel %	7
Sand %	86
Silt and Clay %	7

5.6 Bedrock

Greywacke bedrock was encountered below the native deposits in Boreholes 17-08, 17-10, and 17-11, and tripod refusal occurred on probable bedrock in Borehole 17-09. Bedrock was inferred from tripod refusal at an approximate depth of 1.2 m (Elev. 457.7 m) in Borehole 17-09 at the inlet of the existing culvert. Bedrock was confirmed at a depth of 2.1 m (Elev. 456.3 m) in Borehole 17-11 at the outlet of the existing culvert; and 8.2 m to 9.8 m (Elev. 453.3 to 451.8 m) in Boreholes 17-08 and 17-10 below the existing road surface. Bedrock outcrops were also observed beside the road embankment, at approximately 10 m west of the culvert inlet and 50 m east of the culvert outlet.

The bedrock was proven in Boreholes 17-08, 17-10, and 17-11 by coring approximately 3 m in each borehole. The bedrock is generally described as moderately weathered, grey, metasedimentary greywacke. Total Core Recovery (TCR) in the bedrock ranged from 93% to 100% with Solid Core Recovery (SCR) ranging from 53% to 98%. The Rock Quality Designation (RQD) determined from the recovered cores generally ranged from 38% to 95%, indicating poor to excellent quality. Average unconfined compressive strengths (UCS) of the rock ranged between 82 MPa to greater than 239 MPa based on correlations with the point load tests (PLT), indicating the rock was strong to very strong.

5.7 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. All boreholes were noted to be dry upon completion, with the exception of Boreholes 17-08, 17-10, and 17-11 where water was added to the borehole to prevent blowback of the sandy soils and used for bedrock coring purposes. As a result, groundwater levels in these boreholes could not be measured.

The groundwater level should be assumed to reflect the local creek water level, which was reportedly measured by at Elev. 458.3 m in April 2015.

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

Samples of the native sand from Boreholes 17-08 and 17-10, 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		
			17-08 SS6	17-10 SS6	Wawiag Creek
			(Native Sand)	(Native Sand)	(Creek Water)
Sulphide	%	mg/L	<0.02	0.03	0.009
Chloride	µg/g	mg/L	120	78	5.8
Sulphate	µg/g	mg/L	26	420	1.8
pH	-	-	6.85	4.16	6.30
Conductivity	µS/cm	µS/cm	158	487	47
Resistivity	Ohms.cm	Ohms.cm	6330	2050	21200
Redox Potential	mV	mV	270	354	221

7. MISCELLANEOUS

Thurber obtained subsurface utility clearances prior to drilling. The northing and easting

Client: Hatch Corporation

Date: October 2, 2017

File No.: 15593

Page: 8 of 9

E file: H:\15000-15999\15593 Replace 3 Culverts 6016-E-0012\Reports and Memos\Wawiag Creek\FINAL\Wawiag Creek FIR

FINAL.docx

coordinates and ground surface elevations were estimated based on field measurements relative to the topographic plans provided by Hatch.

RPM Drilling Inc. of Thunder Bay, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field investigation. The field investigation was supervised on a full time basis by Mr. Amir Fereidouni of Thurber. Overall supervision of the field program was provided by Mr. Cory Zanatta, EIT. 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. Cory Zanatta, EIT and 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.

Cory Zanatta, B.A.Sc.
Geotechnical EIT



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.

EXPLANATION OF ROCK LOGGING TERMS


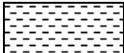



ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
	(MPa)	(psi)	
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
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

TERMS

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 % 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.

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			

RECORD OF BOREHOLE No 17-08

1 OF 2

METRIC

W.P. 6805-14-01 LOCATION Wawiag Creek Culvert, MTM NAD 83 Zone 15 N 5 390 031.0 E 262 713.7 ORIGINATED BY AHF
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.03.20 - 2017.03.22 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							
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		w _p w w _L						
461.5	GROUND SURFACE						20 40 60 80 100		20 40 60						
0.0	ASPHALT: (100mm) Gravelly SAND , some silt, some rockfill Very Dense to Compact Brown Moist (FILL)						20 40 60 80 100								
0.1															
			1	GS											
			1	SS	100/										
					0.125										
			2	SS	37										
			3	SS	14										
458.5															
3.0	SAND , some silt, some gravel, trace clay Loose Brown Wet (FILL)														
			4	SS	8										
457.5															
4.0	Gravelly SAND , some silt Compact Brown Wet														
			5	SS	25										
455.9															
5.6	SAND , trace gravel, trace silt Very Loose to Very Dense Brown Wet														
			6	SS	3										
			7	SS	54										
453.3															
8.2	GREYWACKE moderately weathered, strong, grey Highly broken zone (125mm) at 8.2m Sub-vertical fracture (200mm) at 8.4m and (175mm) at 9.4m Sub-horizontal fracture at 8.5m and 8.6m Horizontal fracture at 9.0m, 9.1m, 9.2m, 9.7m, 10.3m, 10.7m and 11.2m														
			1	RUN											
				</											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

ONTMT4S MTO-15593.GPJ 2017TEMPLATE(MTO).GDT 10/2/17

RECORD OF BOREHOLE No 17-08

2 OF 2

METRIC

W.P. 6805-14-01 LOCATION Wawia Creek Culvert, MTM NAD 83 Zone 15 N 5 390 031.0 E 262 713.7 ORIGINATED BY AHF
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.03.20 - 2017.03.22 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 (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)									
						20	40	60	80	100	20	40	60							
	Continued From Previous Page																			
	Sub-horizontal fracture at 10.2m and 10.5m		2	RUN		451														
	Vertical fracture (150mm) at 11.1m																			
	Highly broken zone (225mm) at 10.9m																			
450.2																				
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG, CUTTINGS AND CONCRETE TO SURFACE. DYNAMIC CONE PENETRATION TEST CONDUCTED ADJACENT TO BOREHOLE.																			

RECORD OF BOREHOLE No 17-09

1 OF 1

METRIC

W.P. 6805-14-01 LOCATION Wawia Creek Culvert, MTM NAD 83 Zone 15 N 5 390 045.1 E 262 706.1 ORIGINATED BY AHF
 HWY 11 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.03.23 - 2017.03.23 CHECKED BY CZ

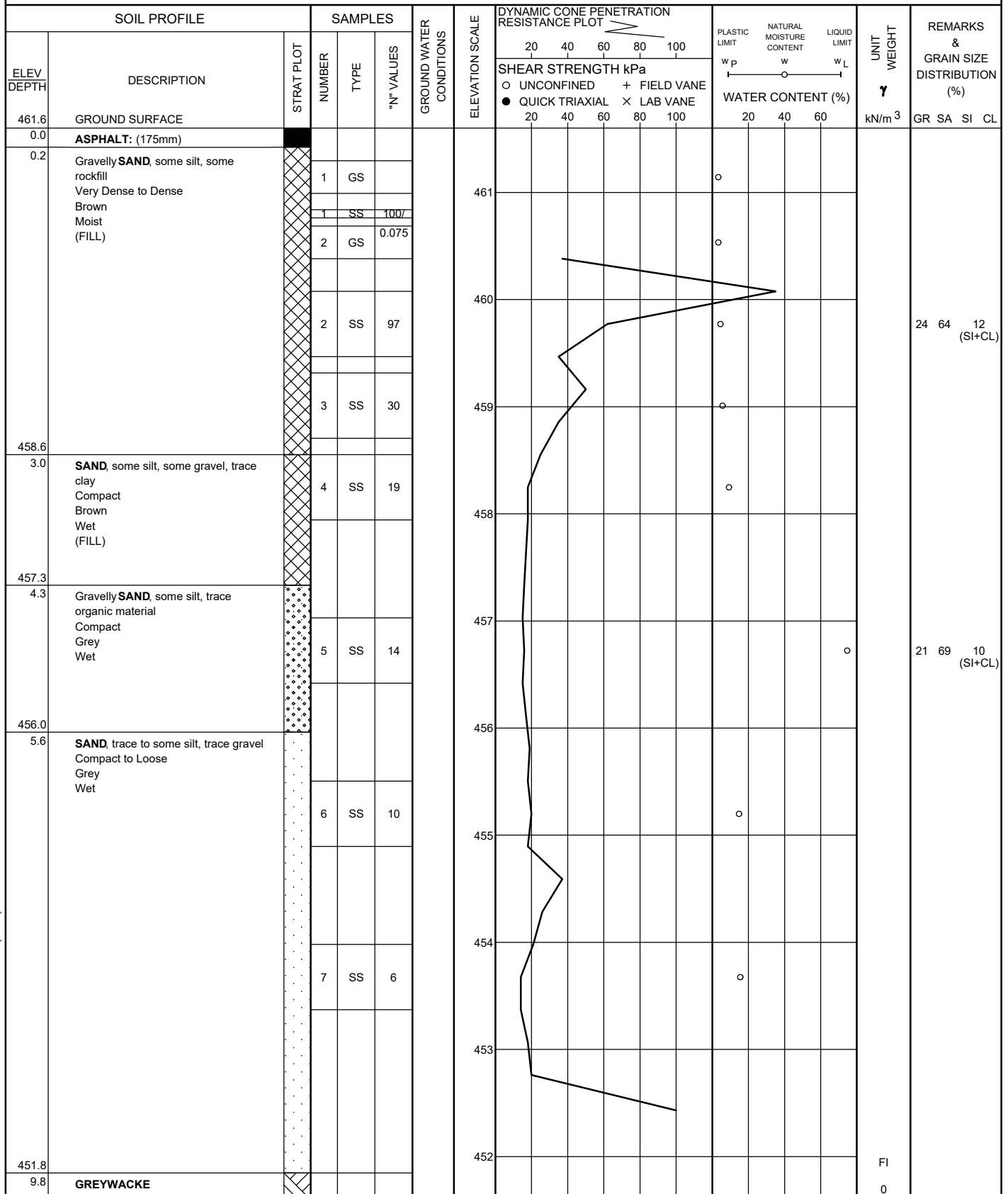
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT							UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
458.9	GROUND SURFACE							20	40	60	80	100							
0.0	Silty SAND , some gravel, some organics, trace roots and rootlets Compact Brown Wet		1	SS	10														
458.3																			
0.6	SAND and GRAVEL , trace silt Compact Dark Brown Wet		2	SS	14		458											52	46 2 (SI+CL)
457.7																			
1.2	END OF BOREHOLE AT 1.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																		

RECORD OF BOREHOLE No 17-10

1 OF 2

METRIC

W.P. 6805-14-01 LOCATION Wawia Creek Culvert, MTM NAD 83 Zone 15 N 5 390 027.1 E 262 704.9 ORIGINATED BY AHF
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.03.24 - 2017.03.24 CHECKED BY CZ



ONTMT4S MTO-15593.GPJ 2017TEMPLATE(MTO).GDT 10/2/17

Continued Next Page

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _P w w _L			
						20	40	60	80	100	20	40	60		
458.4	GROUND SURFACE														
0.0	Silty SAND , trace clay, some organics, trace roots and rootlets Loose Brown Wet		1	SS	5							○			
457.7															
0.7	Gravelly SAND , trace silt, some boulders Compact to Very Dense Brown Wet		2	SS	20							○			
			3	SS	100/ 0.125							○			
456.3														FI	
2.1	GREYWACKE moderately weathered, very strong, grey Horizontal fracture at 2.2m, 2.5m, 2.7m, 2.9m, 3.1m and 3.2m Sub-horizontal fracture at 2.5m, 3.3m and 3.4m Sub-vertical fracture (50mm) at 2.2m, (125mm) at 2.6m, (25mm) at 2.7m, (100mm) at 3.0m and 3.2m, (200mm) at 3.3m Sub-vertical fracture (175mm) at 3.7m and (450mm) at 4.6m Sub-horizontal fracture at 4.3m		1	RUN										2	
														4	
														2	
														5	
														2	
														1	
														0	
			2	RUN										1	
														1	
														6	
453.2	END OF BOREHOLE AT 5.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.														
5.2															





+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17-12

1 OF 1

METRIC

W.P. 6805-14-01 LOCATION Wawiag Creek Culvert, MTM NAD 83 Zone 15 N 5 390 030.5 E 262 697.1 ORIGINATED BY AHF
 HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.20 - 2017.03.20 CHECKED BY CZ

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	
461.6	GROUND SURFACE							20	40	60	80	100								
0.0	ASPHALT: (175mm)																			
0.2	Gravelly SAND , trace silt Brown Moist (FILL)		1	GS																
			2	GS																
457.5	Compact		1	SS	11															
4.1	Gravelly SAND , some silt Compact Brown Wet																			
456.4			2	SS	13															
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG, CUTTINGS AND CONCRETE TO SURFACE.																			

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

RECORD OF BOREHOLE No 17-13

1 OF 1

METRIC

W.P. 6805-14-01 LOCATION Wawia Creek Culvert, MTM NAD 83 Zone 15 N 5 390 030.1 E 262 687.1 ORIGINATED BY AHF
 HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.20 - 2017.03.20 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
461.7	GROUND SURFACE																
0.0	ASPHALT: (175mm)																
0.2	Gravelly SAND, trace silt Brown Moist (FILL)		1	GS													
			2	GS													
	Compact		1	SS	12											34 57 9 (SI+CL)	
458.0																	
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG, CUTTINGS AND CONCRETE TO SURFACE.																

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

RECORD OF BOREHOLE No 17-14

1 OF 1

METRIC

W.P. 6805-14-01 LOCATION Wawia Creek Culvert, MTM NAD 83 Zone 15 N 5 390 030.2 E 262 677.0 ORIGINATED BY AHF
 HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.20 - 2017.03.20 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
461.9	GROUND SURFACE																
0.0	ASPHALT: (175mm)																
0.2	Gravelly SAND, some silt Brown Moist (FILL)		1	GS			461										
			2	GS			460										
							459										
	Compact		1	SS	10											20 67 13 (SI+CL)	
458.2																	
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG, CUTTINGS AND CONCRETE TO SURFACE.																

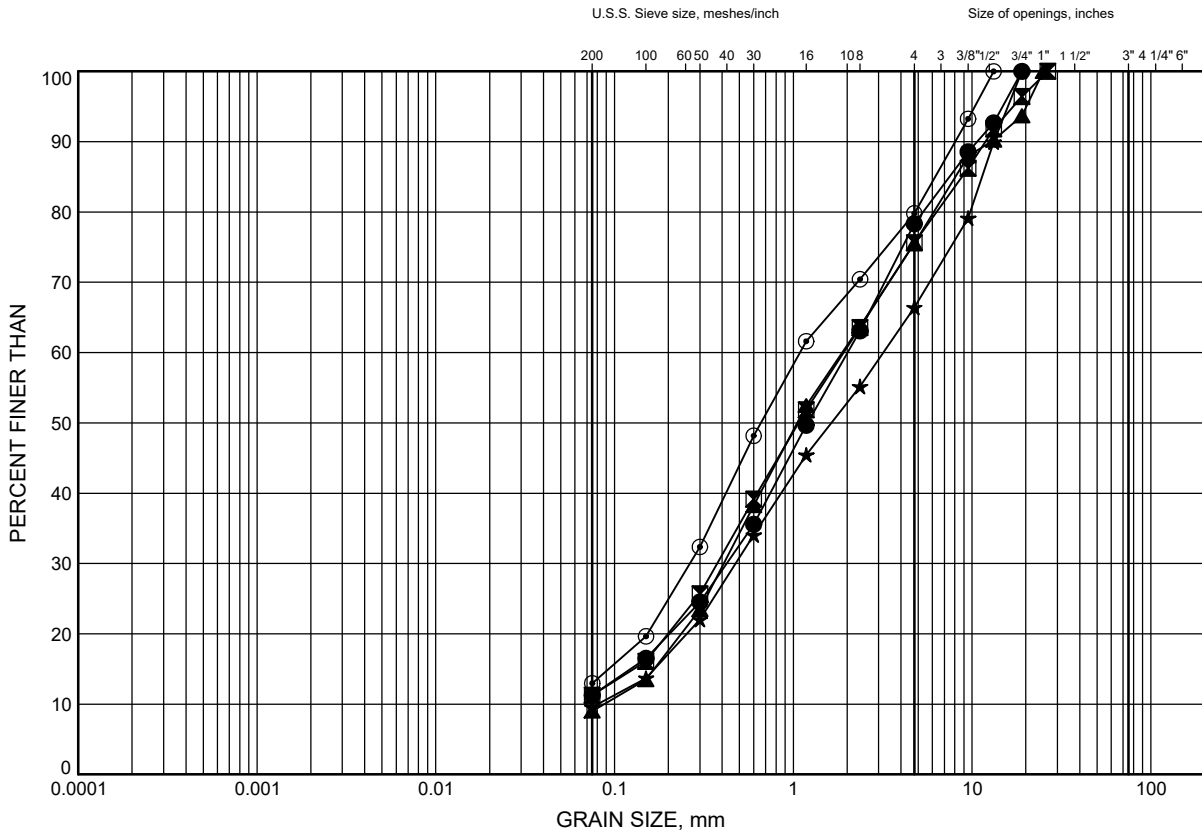
Appendix B

Geotechnical and Analytical Laboratory Test Results

Wawiag Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B1

Gravelly SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-08	2.6	458.9
⊠	17-10	1.8	459.8
▲	17-12	3.4	458.2
★	17-13	3.4	458.3
⊙	17-14	3.4	458.5

Date June 2017
W.P. 6805-14-01

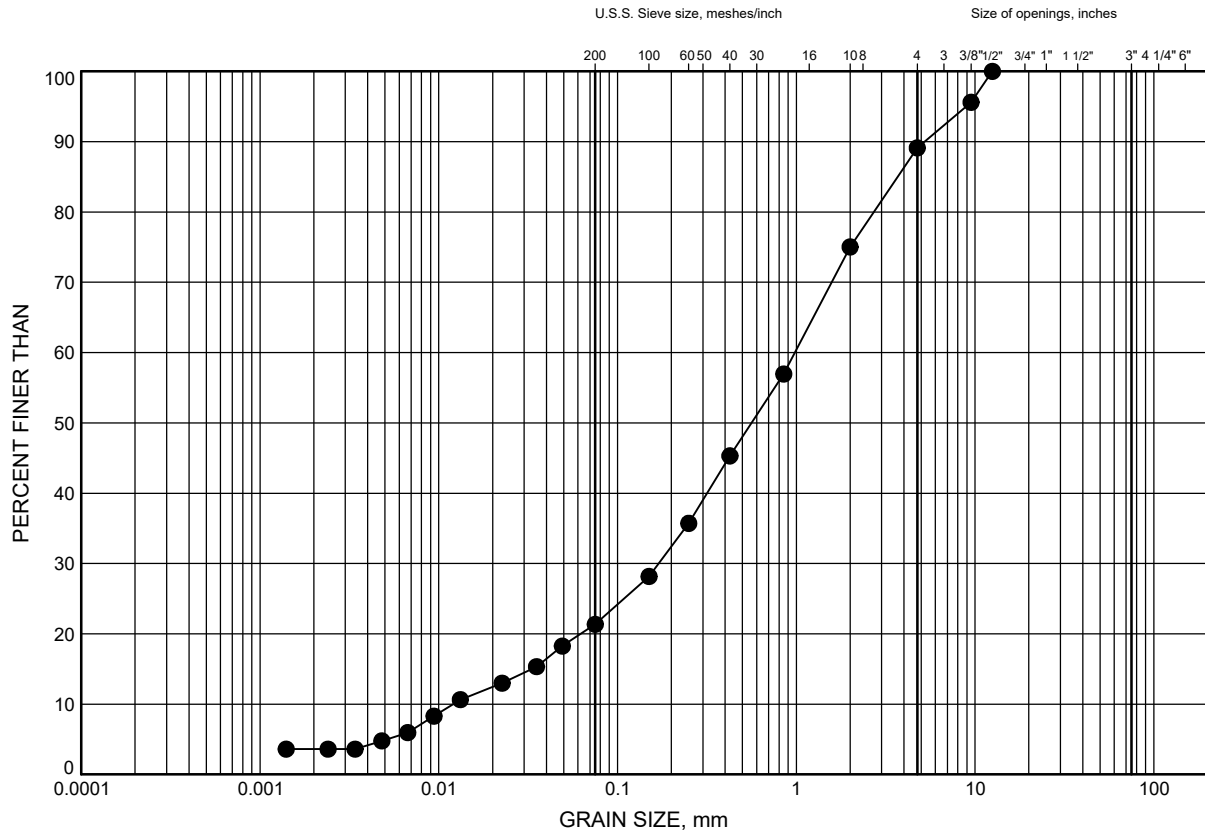


Prep'd AN
Chkd. MEF

Wawiag Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-08	3.4	458.1

Date June 2017
W.P. 6805-14-01

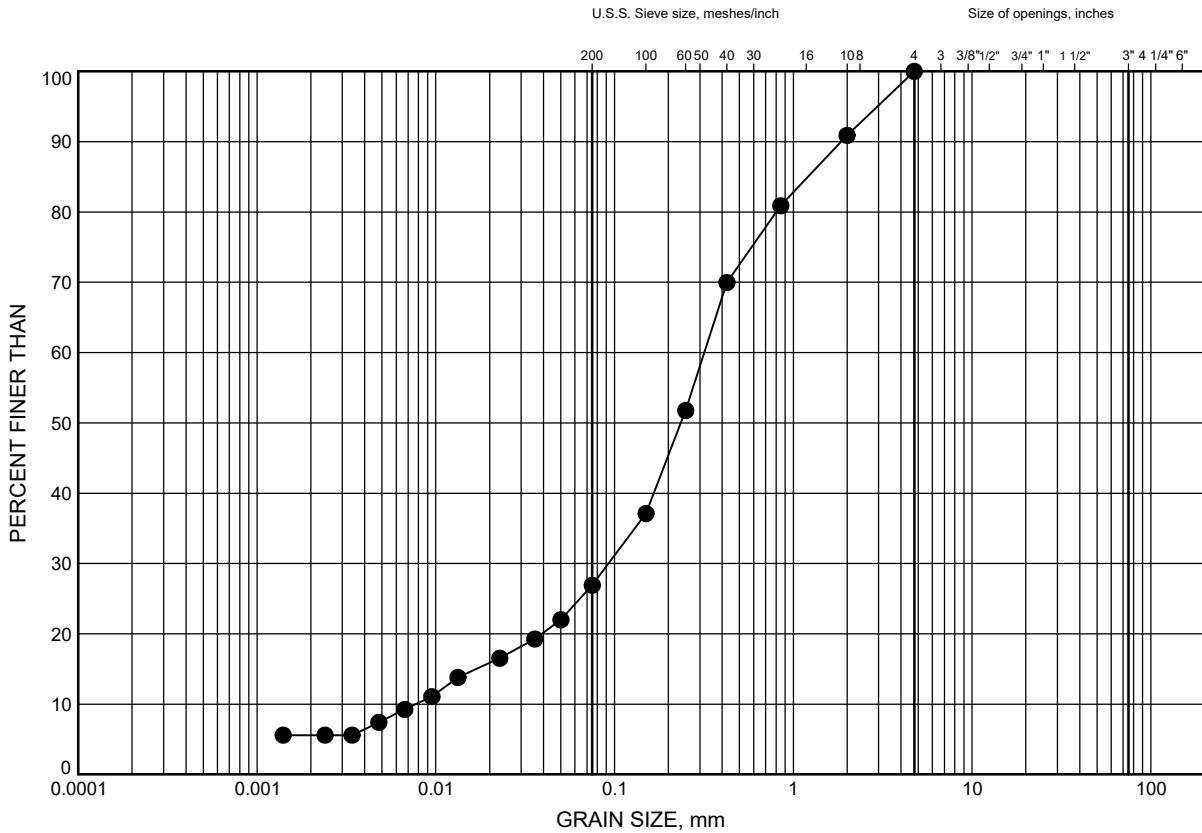


Prep'd AN
Chkd. MEF

Wawiag Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-11	0.3	458.1

Date June 2017
W.P. 6805-14-01

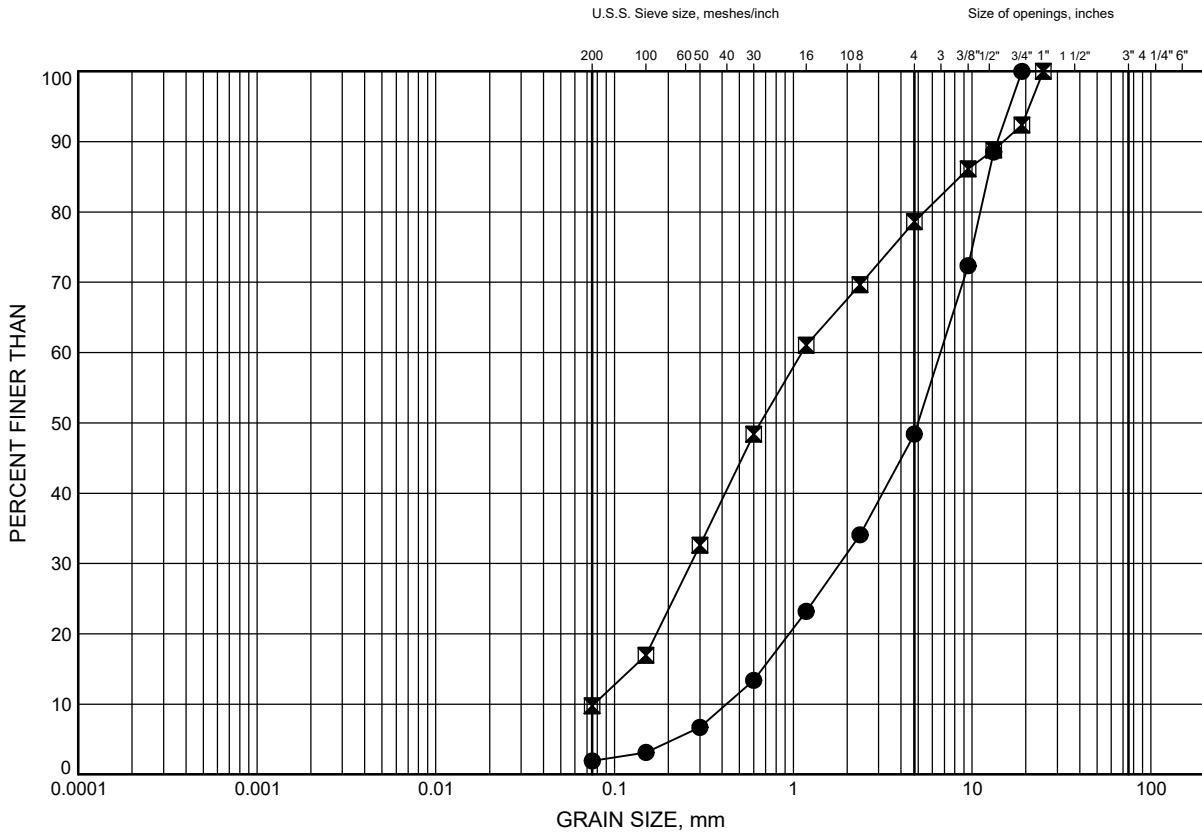


Prep'd AN
Chkd. MEF

Wawiag Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B4

Gravelly SAND to SAND and GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-09	0.9	458.0
⊠	17-10	4.9	456.7

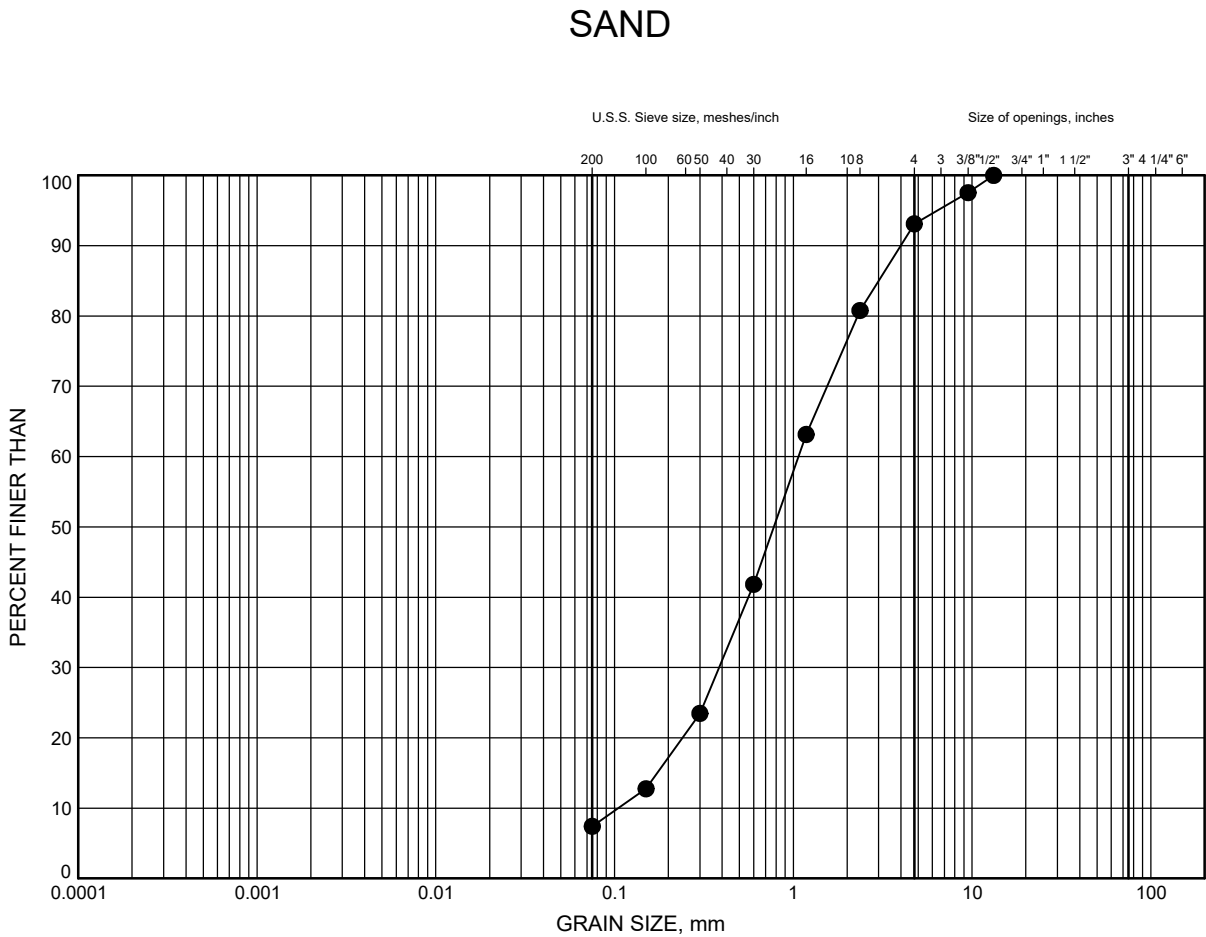
Date June 2017
W.P. 6805-14-01



Prep'd AN
Chkd. MEF

Wawiag Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B5



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-08	7.9	453.6

Date June 2017
W.P. 6805-14-01



Prep'd AN
Chkd. MEF



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 15593
 Client: Hatch
 Project Name: Wawiag Culvert
 Core Size: NQ BH No : 17-08

Date Drilled: 22-Mar-17
 Date Tested: 21-Apr-17
 Tester: WHW
 Reviewed by: CZ

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	8.6	D	6.9	47.0	57.7	2.9	68.6	Greywacke	Strong
2	1	9.1	A	11.4	47.3	36.2	4.8	115.8	Greywacke	Very Strong
3	1	9.3	D	7.1	47.1	59.8	3.0	70.9	Greywacke	Strong
4	2	10.0	D	7.8	47.3	63.2	3.2	77.2	Greywacke	Strong
5	2	10.4	A	11.2	47.2	50.6	3.7	87.6	Greywacke	Strong
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

- * It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
 Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
- * Diametral Test should have $0.7 \times D$ on either side of test point.
- * Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 15593
 Client: Hatch
 Project Name: Wawiag
 Core Size: NQ BH No : 17-10

Date Drilled: 24-Apr-17
 Date Tested: 01-May-17
 Tester: GA
 Reviewed by: CZ

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	7.1	D	24.7	47.1	15.7	10.3	246.6	Greywacke	Very Strong
2	1	7.8	A	27.0	47.1	59.8	7.7	186.0	Greywacke	Very Strong
3	1	7.5	D	20.0	47.1	90.8	8.3	200.0	Greywacke	Very Strong
4	1	7.3	D	17.7	47.1	111.2	7.4	177.1	Greywacke	Very Strong
5	1	7.6	A	24.9	47.1	73.1	6.1	146.7	Greywacke	Very Strong
6	2	7.8	D	8.2	47.1	102.1	3.4	82.3	Greywacke	Strong
7	2	8.0	D	23.8	47.1	117.8	9.9	238.0	Greywacke	Very Strong
8	2	8.4	D	20.2	47.1	270.1	8.4	201.5	Greywacke	Very Strong
9	2	8.8	D	24.1	47.1	92.1	10.0	240.2	Greywacke	Very Strong
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

- * It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
- * Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
- * Diametral Test should have $0.7 \times D$ on either side of test point.
- * Correlation factor to obtain UCS values is 24.

**THURBER ENGINEERING LTD.****POINT LOAD TEST SHEET****ASTM D5731-08**

Job No: 15593
 Client: Hatch
 Project Name: Wawiag Culvert
 Core Size: NQ BH No : 17-11

Date Drilled: 23-Mar-17
 Date Tested: 20-Apr-17
 Tester: RT
 Reviewed by: CZ

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	2.3	D	18.4	46.6	150.0	7.8	186.4	Greywacke	Very Strong
2	1	2.6	D	25.0	46.6	150.0	10.6	253.8	Greywacke	Extremely Strong
3	1	3.0	D	19.9	46.6	150.0	8.4	202.4	Greywacke	Very Strong
4	1	3.3	D	25.0	46.6	150.0	10.6	253.8	Greywacke	Extremely Strong
5	1	3.5	D	23.6	46.6	150.0	10.0	239.8	Greywacke	Very Strong
6	2	4.0	D	20.6	46.6	150.0	8.7	208.9	Greywacke	Very Strong
7	2	4.3	D	25.0	46.6	150.0	10.6	253.8	Greywacke	Extremely Strong
8	2	4.6	D	25.0	46.6	150.0	10.6	253.8	Greywacke	Extremely Strong
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1

Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.



Photo 1: Borehole 17-08 Bedrock Core Sample



Photo 2: Borehole 17-10 Bedrock Core Sample



Photo 3: Borehole 17-11 Bedrock Core Sample



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Thurber Engineering Ltd

Attn : Cory Zanatta

2010 Winston Park Dr
Oakville, ON
L6H 5R7,

Phone: 905-829-8666 x 240

Fax:

Project : 15593

08-May-2017

Date Rec. : 02 May 2017

LR Report: CA14060-MAY17

Reference: 15593 Cory Zanatta

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	7: 17-08 SS6	8: 17-10 SS6
Sample Date & Time					26-Mar-17	26-Mar-17
Temperature Upon Receipt [°C]	---	---	---	---	6.0	6.0
Corrosivity Index [none]	08-May-17	14:35	08-May-17	14:35	1.0	7.5
Soil Redox Potential [mV]	03-May-17	16:33	04-May-17	14:12	270	354
Sulphide [%]	05-May-17	13:47	05-May-17	15:54	< 0.02	0.03
% Moisture (wet wt) [%]	04-May-17	13:57	04-May-17	14:37	15.8	12.0
pH [no unit]	03-May-17	15:41	05-May-17	09:17	6.85	4.16
Chloride [µg/g]	05-May-17	17:42	08-May-17	14:40	120	78
Sulphate [µg/g]	05-May-17	17:42	08-May-17	14:40	26	420
Conductivity [uS/cm]	03-May-17	15:41	05-May-17	09:17	158	487
Resistivity (calculated) [Ohms.cm]	03-May-17	15:41	08-May-17	14:21	6330	2050

Temperature of Sample upon Receipt: 12 degrees C

Cooling Agent Present: Yes

Custody Seal Present: No

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - K0L 2H0

Phone: 705-652-2000 FAX: 705-652-6365

Project : 15593

LR Report : CA14060-MAY17

Method Descriptions

Parameter	SGS Method Code
Anions by IC	ME-CA-[ENV]IC-LAK-AN-001
Carbon/Sulphur	ME-CA-[ENV]ARD-LAK-AN-020
Conductivity	ME-CA-[ENV]EWL-LAK-AN-006
Metals Prep	ME-CA-[ENV]ARD-LAK-AN-013
pH	ME-CA-[ENV]EWL-LAK-AN-001

Deanna Edwards, B.Sc, C.Chem

Project Specialist

Environmental Services, Analytical



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2H0

Phone: 705-652-2000 FAX: 705-652-6365

Project : 15593

LR Report : CA14060-MAY17

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank				LCS / Spike Blank			Matrix Spike / Reference Material		
					RPD	Acceptance Criteria	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
						%		Low	High		Low	High
Anions by IC - QCBatchID: DIO0108-MAY17												
Chloride	0.4	µg/g	<0.4		3	20	101	80	120	105	75	125
Sulphate	0.4	µg/g	<0.4		2	20	97	80	120	87	75	125
Carbon/Sulphur - QCBatchID: ECS0006-MAY17												
Sulphide	0.02	%	<0.02		ND	20	113	80	120			
Conductivity - QCBatchID: EWL0047-MAY17												
Conductivity	2	uS/cm	< 2		2	10	93	90	110	NA		
pH - QCBatchID: EWL0047-MAY17												
pH	0.05	no unit	NA		0		100			NA		

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Project : 17840/17792

31-May-2017

Thurber Engineering Ltd**Attn :** Cory Zanatta

2010 Winston Park Dr
Oakville, ON
L6H 5R7,

Phone: 905-829-8666 x 240

Fax:

Date Rec. : 10 May 2017**LR Report:** CA14294-MAY17**Reference:** 17840/17792 Cory Zanatta**Copy:** #2

CERTIFICATE OF ANALYSIS


Final Report - Reissue

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: MDL	8: Wawia Creek
Sample Date & Time						25-Apr-17
Temperature Upon Receipt [°C]	---	---	--	--	---	9.0
pH [no unit]	11-May-17	10:30	15-May-17	10:54	0.05	6.30
Conductivity [µS/cm]	11-May-17	10:41	15-May-17	10:51	2	47
Resistivity (calculated) [ohms.cm]	---	---	---	---	---	21200
Redox Potential [mV]	11-May-17	13:57	15-May-17	10:32	---	221
Chloride [mg/L]	15-May-17	18:20	16-May-17	13:24	0.04	5.8
Sulphate [mg/L]	15-May-17	18:20	16-May-17	13:24	0.04	1.8
Sulphide [mg/L]	11-May-17	12:10	12-May-17	16:01	0.006	0.009

Temperature of Sample upon Receipt: 9 degrees C

Cooling Agent Present: yes

Custody Seal Present: no


Deanna Edwards, B.Sc, C.Chem
Project Specialist
Environmental Services, Analytical

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Project : 17840/17792**LR Report :** CA14294-MAY17

Method Descriptions

Parameter	SGS Method Code	Reference Method Code
Anions by IC	ME-CA-[ENV]IC-LAK-AN-001	EPA300/MA300-Ions1.3
Conductivity	ME-CA-[ENV]EWL-LAK-AN-006	SM 2510
pH	ME-CA-[ENV]EWL-LAK-AN-006	SM 4500
Redox Potential		SM 2580
Sulphide by SFA	ME-CA-[ENV]SFA-LAK-AN-008	SM 4500



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Project : 17840/17792

LR Report : CA14294-MAY17

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank		RPD		LCS / Spike Blank			Matrix Spike / Reference Material		
					Acceptance Criteria	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)		
							Low	High		Low	High	
Anions by IC - QCBatchID: DIO0256-MAY17												
Chloride	0.04	mg/L	<0.04		2	20	97	80	120	100	75	125
Sulphate	0.04	mg/L	<0.04		0	20	96	80	120	89	75	125
Anions by IC - QCBatchID: DIO0269-MAY17												
Chloride	0.04	mg/L	<0.04		0	20	100	80	120	119	75	125
Sulphate	0.04	mg/L	<0.04		0	20	97	80	120	102	75	125
Conductivity - QCBatchID: EWL0183-MAY17												
Conductivity	2	µS/cm	< 2		0	10	99	90	110	NA		
pH - QCBatchID: EWL0182-MAY17												
pH	0.05	no unit	NA		1		100			NA		
Redox Potential - QCBatchID: EWL0192-MAY17												
Redox Potential	no	mV	NA		0	20	103	80	120	NA		
Sulphide by SFA - QCBatchID: SKA0095-MAY17												
Sulphide	0.006	mg/L	<0.006		ND	20	80	80	120	NV	75	125
Sulphide by SFA - QCBatchID: SKA0105-MAY17												
Sulphide	0.006	mg/L	0.009		ND	20	96	80	120	125	75	125

Appendix C

Site Photographs



**Photo 1: Highway 11 embankment over Wawiag Creek Culvert,
looking southwest – drill rig setting up**



**Photo 2: Highway 11 embankment over Wawiag Creek Culvert,
facing east – drill rig setting up**



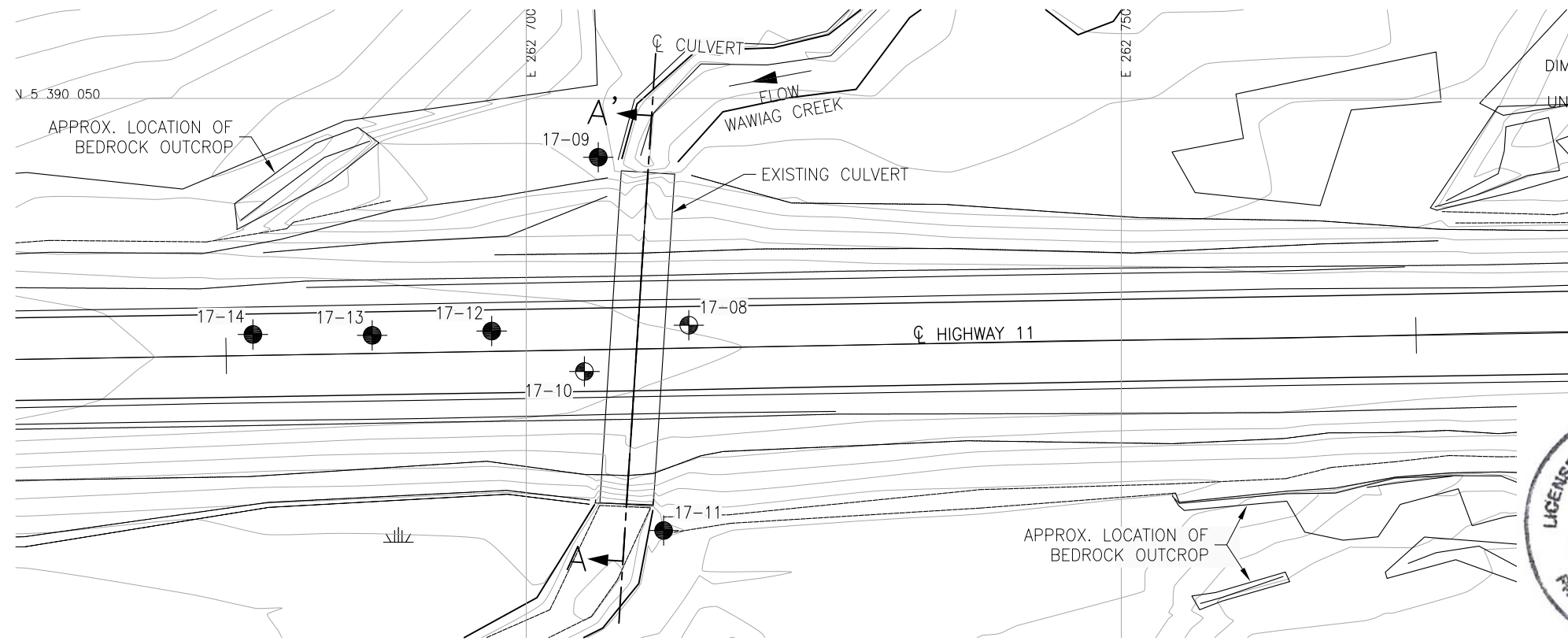
Photo 3: Wawiag Creek Culvert, north side – CSP extension



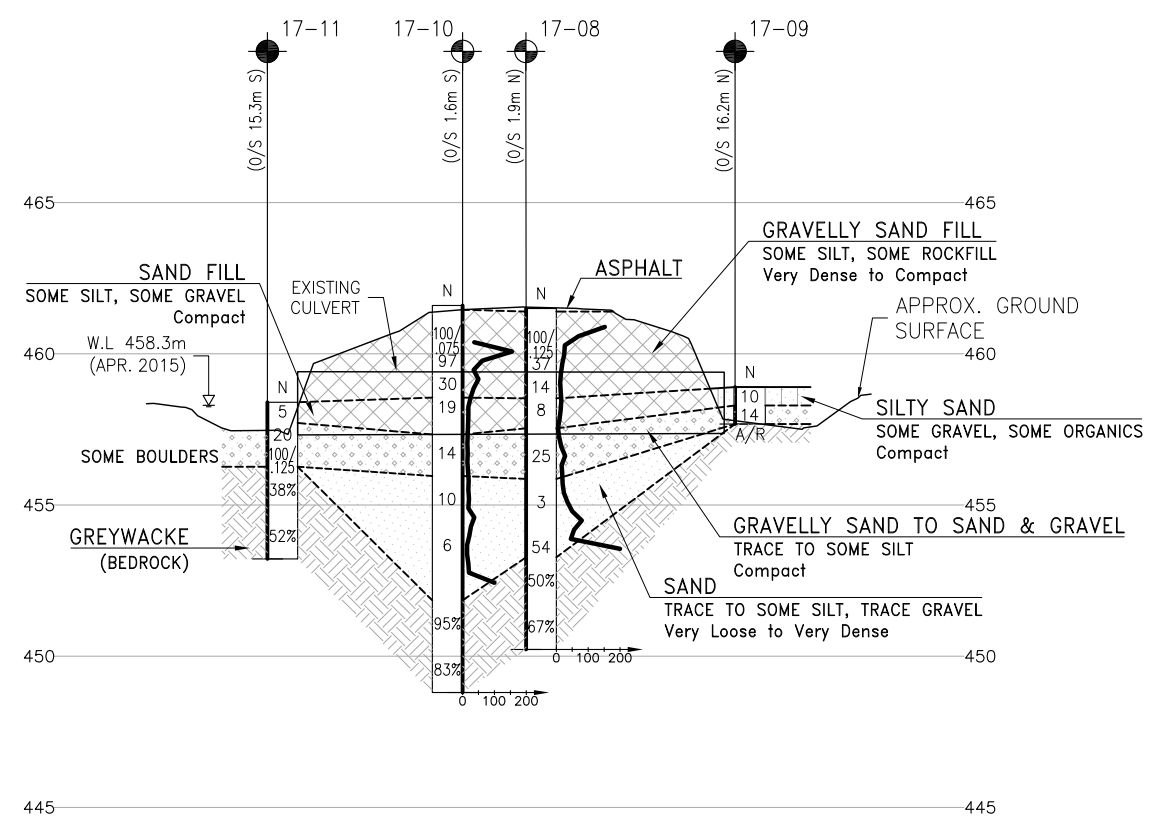
Photo 4: Wawiag Creek Culvert, south side – timber cells

Appendix D

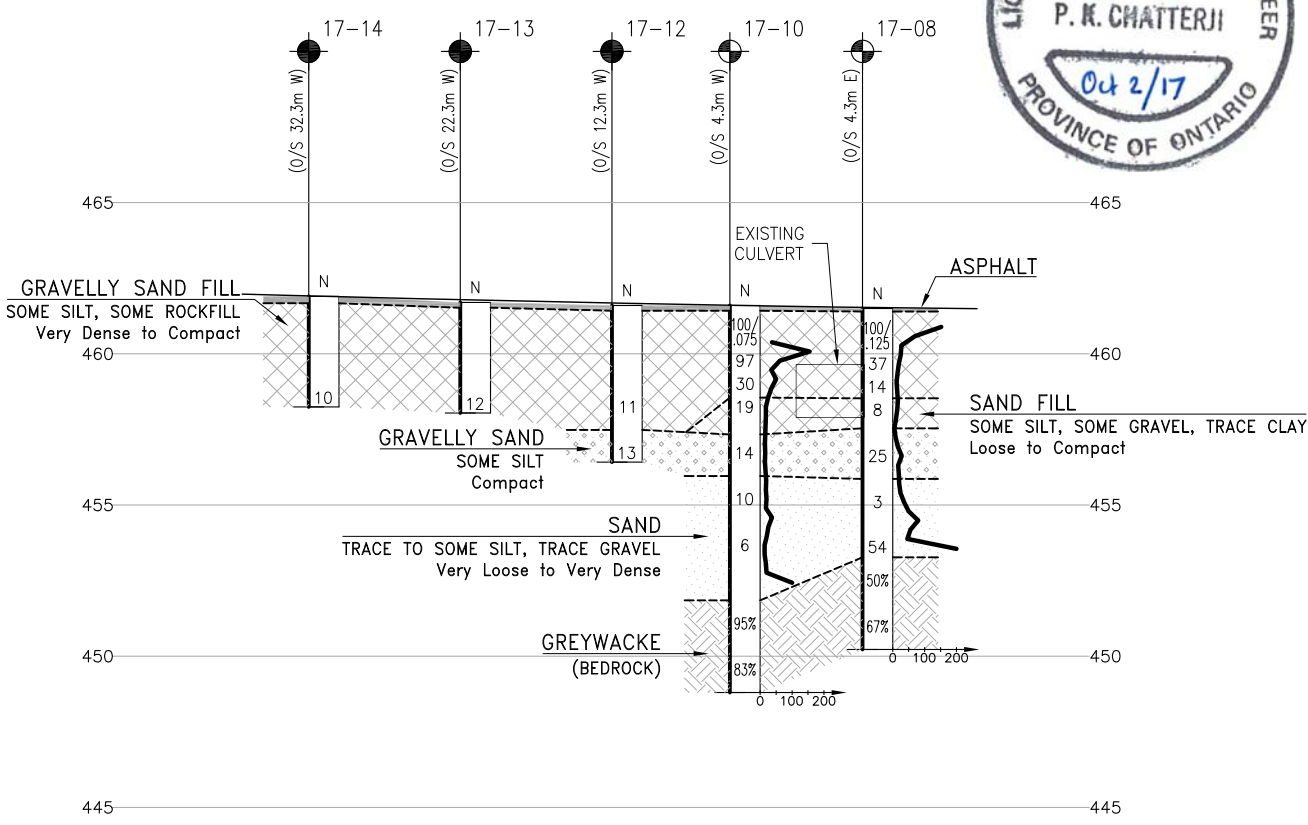
Borehole Locations and Soil Strata Drawing



PLAN
SCALE 1:500



SECTION A-A'



PROFILE ALONG CL HWY 11

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



CONT No 6016-E-0012
WP No 6805-14-01

HIGHWAY 11
WAWIAG CREEK
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

HATCH

THURBER ENGINEERING LTD.

KEYPLAN

LEGEND			
	Borehole		
	Borehole and Cone		
N	Blows /0.3m (Std Pen Test, 475J/blow)		
CONE	Blows /0.3m (60° Cone, 475J/blow)		
PH	Pressure, Hydraulic		
	Water Level		
	Head Artesian Water		
	Piezometer		
90%	Rock Quality Designation (RQD)		
A/R	Auger Refusal		
NO	ELEVATION	NORTHING	EASTING
17-08	461.5	5 390 031.0	262 713.7
17-09	458.9	5 390 045.1	262 706.1
17-10	461.6	5 390 027.1	262 704.9
17-11	458.4	5 390 013.7	262 711.5
17-12	461.6	5 390 030.5	262 697.1
17-13	461.7	5 390 030.1	262 687.1
17-14	461.9	5 390 030.2	262 677.0

- 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 15
- GEOCRES No. 52B-33**

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
-----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--