THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
PRATT CREEK CULVERT REPLACEMENT
HIGHWAY 599, SITE No. 48W-244/C
DISTRICT OF KENORA
ONTARIO
G.W.P. No. 6836-14-00

GEOCRES Number: 52G-18

Latitude 49.506939 ° , Longitude -91.497888 °

Report

to

HATCH Corporation

Date: February 8, 2018
File: 17077

103, 2010 Winston Park Drive, Oakville, ON L6H 5R7 T: 905 829 8666 F: 905 829 1166
thurber.ca

THURBER

TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

APPENDICES

THURBER

FOUNDATION INVESTIGATION REPORT
PRATT CREEK CULVERT REPLACEMENT
HIGHWAY 599, SITE No. 48W-244/C
DISTRICT OF KENORA
ONTARIO

G.W.P. No. 6836-14-00

GEOCRES Number: 52G-18

PART 1: FACTUAL INFORMATION

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 Pratt Creek Culvert on Highway 599, located in the District of Kenora.

The purpose of this investigation was to explore the subsurface conditions at the culvert site 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-0030.

2. SITE DESCRIPTION

The site is located on Highway 599, approximately 17.2 km north of the intersection of Highway 599 and Highway 17 in Ignace, Ontario. The key plan showing the general location of the culvert site is presented on the Borehole Location and Soil Strata Drawings in Appendix D.

Highway 599 runs in a general east-west direction with the culvert generally crossing the highway at a 45 degree angle. The culvert allows Pratt Creek to flow in a south direction beneath the highway.

The Ontario Structural Inspection Manual (OSIM) prepared by MTO on November 2, 2015 indicates that the existing structure is a 28 m long, two span open footing, timber structure culvert. Each span is 1.8 m wide, resulting in a total culvert width of 3.6 m. The culvert is 2.8 m in height.

The grade level of Highway 599 at the existing culvert is at an approximate Elevation of 422.9 m. The height of the existing fill cover is approximately 1.5 m. The culvert invert is at approximately Elevation 419.4 m at the inlet and 419.5 m at the outlet. The upstream and downstream water levels of Pratt Creek were measured at Elevation 419.93 m and 419.23 m, respectively, in April, 2016, as shown on drawings provided by Hatch.

The lands surrounding the Pratt Creek Culvert site predominantly consist of heavily forested areas with occasional marsh lands and lakes. Local topography is generally of low relief and consists of long ridges, short mounds and extensive plains. Photographs of the culvert and surrounding area are presented in Appendix C.

Based on published geological information, the subsurface soils at the site generally consist largely of sand and fine gravel with the granular deposits which may include coarse gravel strata locally. Bedrock in the area has been identified as granodiorite to granite bedrock.

3. INVESTIGATION PROCEDURES

The borehole investigation and field testing program for this project was carried out between June 20 and August 1, 2017 and consisted of drilling and sampling eight (8) boreholes, designated as Boreholes PR17-01 to PR17-08, to depths ranging from 2.3 m to 14.6 m (Elevations 420.6 to 408.3) below the existing ground surface. Two attempts were made to advance PR17-04 to an appropriate depth and are designated as PR17-04A and PR17-04B.

Boreholes PR17-01 and PR17-04 were drilled near the inlet and outlet of the existing culvert, and all other boreholes were drilled through the paved section of Highway 599. Boreholes PR17-05 to PR17-08 were drilled east and west of the existing culvert, and drilled generally at 10 m intervals, to assess the existence and extents of any frost taper near the culvert. Also, Borehole PR17-06 was located approximately 11.4 m west of the centreline of the existing culvert, near the alignment of the proposed creek diversion pipe.

Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were derived from cross sections and topographic drawings provided to Thurber by Hatch. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix D.

The boreholes were drilled using a rubber track mounted drill rig equipped with continuous flight hollow and solid stem augers. Samples of the overburden soils were obtained from the boreholes

at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Dynamic Cone Penetration Tests (DCPT) were carried out in Boreholes PR17-02 and PR17-04B beyond the sampled depths of 14.6 m and 12.8 m (Elevations 408.5 and 410.1) and extended to refusal reached at approximately 18.5 m depth (Elevations 404.6 and 404.4).

A DCPT, numbered PR17-02 DCPT, was conducted in proximity to Borehole PR17-02 to further assess the subsurface/soil conditions. This DCPT was conducted from 3.0 m to refusal reached at 17.7 m depth (Elevation 405.4).

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 upon completion of drilling. A piezometer was installed in Borehole PR17-04B on July 14, 2017, and a piezometer reading was taken on July 19, 2017. The piezometer was decommissioned on July 19, 2017. Upon completion of drilling operations, 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)	Piezometer Tip Depth / Elevation (m)	Completion Details
PR17-01	12.8 / 408.3	None installed	Borehole backfilled with bentonite holeplug to 10.7 m, auger cuttings from 10.7 m to 3.0 m, then bentonite holeplug to surface.
PR17-02	18.5 / 404.6(1)	None installed	Borehole backfilled with auger cuttings to 1.0 m, concrete to from 1.0 m to 0.2 m, then asphalt to surface.
PR17-02 DCPT	17.7 / 405.4(1)	None installed	Borehole backfilled with auger cuttings to 0.9 m, gravel from 0.9 m to 0.6 m, concrete from 0.6 m to 0.2 m, then asphalt to surface.

Borehole Number	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
PR17-03	12.2 / 410.6	None installed	Borehole backfilled with aggregate to 1.5 m, concrete from 1.5 m to 0.1 m then asphalt to surface.
PR17-04A	2.3 / 420.6	None installed	Borehole backfilled with auger cuttings to surface.
PR17-04B	18.5 / 404.2(1)	12.2 / 410.7	Screened from 12.2 m to 9.2 m, sand backfill from 12.8 m to 8.6 m, bentonite holeplug from 8.6 m to surface.
PR17-05	3.7 / 420.1	None installed	Borehole backfilled with auger cuttings to 0.9 m, concrete from 0.9 m to 0.2 m, then asphalt to surface.
PR17-06	8.2 / 415.1	None installed	Borehole backfilled with auger cuttings to 1.7 m, gravel from 1.7 m to 0.6 m, concrete from 0.6 m to 0.2 m, then asphalt to surface.
PR17-07	3.7 / 419.1	None installed	Borehole backfilled with auger cuttings to 0.9 m, concrete from 0.9 m to 0.2 m, then asphalt to surface.
PR17-08	3.7 / 418.9	None installed	Borehole backfilled with auger cuttings to 0.9 m, concrete from 0.9 m to 0.2 m and asphalt to surface.

(1) DCPT

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). 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, a sample of the existing native soil, and a sample of the surface water from the creek upstream of the existing culvert were collected. The

samples were submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. 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 should be used for interpretation of 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 below the existing embankment fill typically consist of native sand, silty sand, sandy silt and gravelly sand layers. Cobbles and boulders were frequently encountered within the native sand and gravelly sand deposits depth at this site. Descriptions of the individual strata are presented below.

5.1 Topsoil

Topsoil was encountered in Borehole PR17-01 and was approximately 200 mm thick.

The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.2 Asphalt

The boreholes that were drilled through the paved portion of Highway 599 encountered approximately 25 mm to 40 mm of asphalt at the ground surface. The ground surface elevations of the boreholes drilled on the highway platform ranged from 422.6 to 423.8.

5.3 Embankment Fill

Embankment fill was encountered below the asphalt in five boreholes drilled on Highway 599, below the topsoil layer in Borehole PR17-01, and at the surface in Boreholes PR17-04A and PR17-04B. The embankment fill generally consisted of gravelly sand, silty sand, and sand and gravel containing trace to some silt and clay. Occasional wood pieces were encountered within the fill in PR17-03.

The embankment fill typically extended to depths ranging from 1.8 m to 4.6 m (Elevations 420.8 to 418.3).

Boreholes PR17-04A, PR17-05 and PR17-07 were terminated within the fill at depths ranging from 2.3 m to 3.7 m (Elevations 420.6 to 419.1).

SPT 'N' values in the fill ranged from 0 (weight of hammer) to 52 blows for 0.3 m penetration, indicating a very loose to very dense relative density. Higher blow counts 110 blows per 0.3 m of penetration and 50 blows per 0.125 m of penetration, were recorded within the fill in Boreholes PR17-02 and PR17-03, indicating a very dense state. However, these values are likely a result of cobbles or large gravel present within the fill. Measured moisture contents ranged from 2 percent to 21 percent.

The results of grain size distribution analyses conducted on samples of the fill are presented on the Record of Borehole sheets included in Appendix A and are summarized in the following table. The results are also presented on Figures B1 to B3 in Appendix B.

Soil Particle	Silty Sand/Sand Fill (percent)	Gravelly Sand Fill (percent)	Sand and Gravel Fill (percent)
Gravel	0 to 8	15 to 26	35 to 42
Sand	59 to 65	47 to 54	49 to 55
Silt	29 to 31	18 to 27	-
Clay	4	2 to 3	-
Silt & Clay	-	38	8 to 10

5.4 Silty Sand with organics

A layer of dark brown silty sand mixed with organics was encountered beneath the embankment fill in Borehole PR17-01, at 2.4 m depth (Elevation 418.7). The silty sand mixed with organics was approximately 1.2 m thick.

The depth to the base of this layer was approximately 3.6 m (Elevation 417.5).

SPT 'N' values recorded in the silty sand with organics were 2 and 3 blows for 0.3 m penetration, indicating a very loose relative density. Measured moisture contents in the silty sand with organics were 39 percent and 96 percent.

5.5 Silty Sand to Sand

Layers of silty sand to sand containing trace to some silt, trace to some gravel, and trace clay, were encountered at depths ranging from 3.6 m to 4.6 m (Elevations 417.5 to 419.3) in Boreholes PR17-01 to PR17-03, PR17-04B, and PR17-06. Where fully penetrated, in Boreholes PR17-01, PR17-03 and PR17-06, the thickness of the silty sand to sand was 6.2 m, 3.4 m and 2.1 m, respectively.

The depth to the base of the native silty sand to sand was at 9.8 m, 7.6 m and 6.1 m (Elevations 411.3, 415.2 and 417.2) in Boreholes PR17-01, PR17-03 and PR-17-06, respectively.

Boreholes PR17-02 and PR17-04B were terminated within the silty sand to sand layers at 14.6 m and 12.8 m depth, (Elevations 408.5 and 410.1), respectively.

SPT 'N' values recorded in the silty sand to sand ranged from 0 (weight of hammer) to 28 blows for 0.3 m penetration, typically 0 to 12, indicating a very loose to compact relative density. A higher blow count of 53 blows per 0.3 m of penetration, was recorded in Borehole PR17-01 towards its base, however is likely a result of presence of cobbles or boulders. Based on DCPT testing in Borehole PR17-02, the very loose conditions encountered in the boreholes, from approximate Elevations 413.0 to 417.0, with SPT 'N' values of 0 to 3, may have been the result of hydraulic disturbance during the drilling operations. Measured moisture contents of the silty sand to sand ranged from 6 percent to 33 percent.

The results of grain size distribution analyses conducted on samples of the silty sand to sand are presented on the Record of Borehole sheets included in Appendix A and are summarized in the following table. The results are also presented on Figure B4 in Appendix B.

Soil Particle	Sand (percent)	Silty Sand (percent)
Gravel	3 to 10	0
Sand	83 to 90	53 to 71
Silt	-	25 to 45
Clay	-	2 to 8
Silt & Clay	7	-

5.6 Silt and Sand to Sandy Silt

Layers of silt and sand to sandy silt, consisting of trace to some clay and trace gravel were encountered at 6.1 m and 1.8 m depth (Elevations 417.2 and 420.8) in Boreholes PR17-06 and PR17-08, respectively.

Boreholes PR17-06 and PR17-08 both terminated within the silt and sand to sandy silt layers at depths of 8.2 m and 3.7 m (Elevations 415.1 and 418.9), respectively.

SPT 'N' values recorded in the silt and sand to sandy silt ranged from 2 to 3 blows for 0.3 m penetration, indicating a very loose relative density. Measured moisture contents in the silt, and sand and silt ranged from 12 percent to 20 percent.

The results of grain size analyses conducted on samples of the sandy silt, and sand and silt 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:

Soil Particle	Silt and Sandy Silt (percent)
Gravel	0 to 5
Sand	22 to 44
Silt	47 to 66
Clay	4 to 12

5.7 Gravelly Sand/Sand and Gravel with Cobbles and Boulders

Layers of gravelly sand and, sand and gravel containing cobbles and boulders were encountered at depths of 9.8 m and 7.6 m (Elevations 411.3 and 415.2) in Boreholes PR17-01 and PR17-03, respectively. Coring was required to advance the borehole through cobbles and boulders within this layer.

Boreholes PR17-01 and PR17-03 were both terminated within this layer at depths of 12.8 m and 12.2 m (Elevations 408.3 and 410.6), respectively.

SPT 'N' values in the sand and gravel layer ranged from 21 to 28 blows for 0.3 m penetration of the sampler, indicating a compact state. Measure moisture contents in the gravelly sand/sand and gravel ranged from 7 percent to 9 percent.

The results of grain size analyses conducted on a sample of the sand and gravel are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B6 of Appendix B. The results are summarized as follows:

Soil Particle	Sand and Gravel (percent)
Gravel	49
Sand	49
Silt and Clay	2

5.8 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. A piezometer was also installed in Borehole PR17-04B. The piezometer was decommissioned upon taking a water level measurement. The groundwater levels measured in the open boreholes and in the piezometer are summarized in Table 5.1 below.

Table 5.1 – Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
PR17-01	July 11, 2017	0.9	420.2	Open borehole
PR17-02	June 21, 2017	3.5	419.6	Open borehole
PR17-03	July 13, 2017	2.4	420.4	Open borehole
PR17-04A	July 14, 2017	Dry	-	Open borehole
PR17-04B	July 19, 2017	3.0	419.9	Piezometer
PR17-05	June 21, 2017	Dry	-	Open borehole
PR17-06	June 21, 2017	3.5	419.8	Open borehole
PR17-07	June 20, 2017	2.9	419.9	Open borehole
PR17-08	June 20, 2017	2.9	419.7	Open borehole

The upstream and downstream water levels of Pratt Creek were measured at Elevation 419.93 m and 419.23 m, respectively, in April, 2016, as shown on drawings provided by Hatch. The groundwater level should be assumed to reflect the local creek water level.

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

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the native silty sand from Borehole PR17-02, and a sample of the creek water, taken from the inlet area, 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	
			PR17-02 SS 7 Depth 6.1 m	Pratt Creek
			(Soil Sample)	(Creek Water)
Sulphide	%	mg/L	0.02	<0.006
Chloride	µg/g	mg/L	6.9	2.9
Sulphate	µg/g	mg/L	26	1.2
pH	No unit	No unit	8.25	7.81
Electrical Conductivity	µS/cm	µS/cm	49	78
Resistivity	Ohms.cm	Ohms.cm	20300	12700
Redox Potential	mV	mV	325	272

7. MISCELLANEOUS

Thurber obtained subsurface utility clearances prior to drilling. Thurber obtained the northing and easting coordinates and ground surface elevations from measurements taken in the field 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. Ryan McCourt of Thurber. Overall supervision of the field program was provided by Mr. Cory Zanatta, EIT of Thurber.

Geotechnical laboratory testing was carried out at 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 Ms. R. Palomeque Reyna, The report was reviewed by Mr. Jason Lee, P.Eng and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER

Thurber Engineering Ltd.

Cory Zanatta, B.A.Sc.
Geotechnical EIT

Jason Lee, P.Eng.
Principal/Senior Geotechnical Engineer

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

THURBER

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

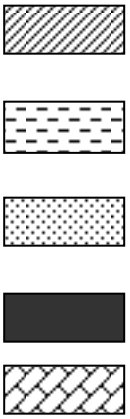
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

EXPLANATION OF ROCK LOGGING TERMS

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.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

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

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 percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
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

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-01 1 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 563.3 E 196 349.2 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.06.25 - 2017.07.11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
421.1	GROUND SURFACE										
0.0	**TOPSOIL:** (200mm)						421				
0.2	Dark Brown Moist		1	SS	4						
	Silty **SAND**, trace clay Very Loose Brown Wet (FILL)		2	SS	0	▽	420				0 65 31 4
			3	SS	0		419				
418.7											
2.4	Silty **SAND**, with organics Very Loose Dark Brown Moist		4	SS	2		418		99		
417.5			5	SS	3						
3.6	**SAND**, trace to some silt and clay, trace to some gravel Very Loose Dark Brown Moist		6	SS	1		417				
	Low SPT "N" values due to hydraulic ground disturbance from approx. elevation 417.0m to 414.5m Grey Wet		7	SS	0		416				
	Cobbles and boulders						415				
	Compact		8	SS	20		414				
							413				
	Very Dense		9	SS	53		412				10 83 7 (SI+CL)
411.3											
9.8	**SAND** and **GRAVEL**, with cobbles			RUN							

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-01 2 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 563.3 E 196 349.2 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.06.25 - 2017.07.11 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SAND and **GRAVEL**, with cobbles and boulders Brown Wet Boulder (280cm) at 10.5m CORED THROUGH COBBLES AND BOULDER BELOW 9.8m. Cobble (200cm) at 12.3m						411 410 409				
408.3 12.8	END OF BOREHOLE AT 12.8m. WATER LEVEL AT 0.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 10.7mm, AUGER CUTTINGS FROM 10.7m TO 3.0m, BENTONITE TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 10/24/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-02 1 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 552.6 E 196 335.3 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2017.06.21 - 2017.06.21 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
423.1	GROUND SURFACE										
0.0	**ASPHALT:** (25mm)						423				
	SAND and **GRAVEL**, trace to some silt and clay: (FILL) Very Dense to Compact Brown Damp (FILL)		1	GS					○		
			2	SS	52		422		○		35 55 10 (SI+CL)
			3	SS	22				○		
							421				
			4	SS	17				○		
			5	SS	110	▽	420		○		
419.4											
3.7	Silty **SAND**, trace clay Loose Brown Wet						419				
			6	SS	8				○		
							418				
	Grey		7	SS	5		417		○		0 71 25 4
							416				
			8	SS	6				○		
							415				
	Low SPT "N" values due to hydraulic ground disturbance from approx. elevation 414.5m to 413.0m Very Loose		9	SS	0		414		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-02 2 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 552.6 E 196 335.3 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2017.06.21 - 2017.06.21 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, trace clay Compact to Loose Grey Wet						413				
			10	SS	14		412				
							411				
			11	SS	28		410				
							409				
408.5			12	SS	7						0 61 31 8
14.6	End of sampling at 14.6m and start DCPT						408				
							407				
							406				
404.6							405				
18.5	END OF BOREHOLE AT 18.5m UPON DCPT REFUSAL. WATER LEVEL AT 3.5m. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 1.0m, CEMENT TO 0.2m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \quad 10 \quad 5}$ (%) STRAIN AT FAILURE

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 10/24/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-02 DCPT 1 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 551.6 E 196 332.9 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2017.08.01 - 2017.08.01 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ kN/m^3	GR SA SI CL
423.1	GROUND SURFACE							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	WATER CONTENT (%): 20 40 60		
0.0	Auger to 3.0m						423				
							422				
							421				
420.1											
3.0	Start DCPT from 3.0m						420				
							419				
							418				
							417				
							416				
							415				
							414				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-02 DCPT 2 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 551.6 E 196 332.9 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2017.08.01 - 2017.08.01 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						413	20 40 60 80 100	20 40 60		
							412				
							411				
							410				
							409				
							408				
							407				
							406				
405.4											
17.7	END OF DCPT AT 17.7m UPON REFUSAL. BOREHOLE BACKFILLED WITH SLOUGH TO 0.9m, GRAVEL TO 0.6m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 10/24/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-03 1 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 551.4 E 196 346.7 ORIGINATED BY STH

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.07.13 - 2017.07.13 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
422.8	GROUND SURFACE										
0.0	**ASPHALT:** (40mm)		1	GS							
	SAND and **GRAVEL**, trace to some silt and clay Very Dense Brown Moist (FILL)		2	SS	50/ 0.125		422				
421.3	Auger resistance										
1.5	**SAND**, trace gravel, some silt and clay Compact to Loose Brown Moist to Wet (FILL)		3	SS	23		421				8 59 33 (SI+CL)
			4	SS	5	▽	420				
	Occasional wood pieces at 3.0m		5	SS	4		419				
418.6											
4.2	**SAND** and **SILT**, trace clay Compact Grey Moist		6	SS	10		418				0 53 45 2
			7	SS	21		417				
	Occasional cobbles, auger grinding Some gravel and cobbles from 7.0m to 7.6m						416				
415.2											
7.6	**SAND** and **GRAVEL**, some silt and clay Compact Grey Wet Auger grinding		8	SS	28		415				
	Cored through cobbles and boulders (140mm)			RUN			414				
							413				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-03 2 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 551.4 E 196 346.7 ORIGINATED BY STH

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.07.13 - 2017.07.13 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND and **GRAVEL**, some silt and clay Compact Grey Wet Cored through cobbles and boulders (80mm, 280mm)			RUN			412				
410.6			9	SS	21		411		○		49 49 2 (SI+CL)
12.2	END OF BOREHOLE AT 12.2m. WATER LEVEL AT 2.40m. BOREHOLE BACKFILLED WITH AGGREGATE TO 1.5m, CONCRETE TO 0.1m, THEN COLD MIX TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 10/24/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-04A 1 OF 1 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 545.3 E 196 334.8 ORIGINATED BY STH

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
422.9	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, trace silt and clay Compact to Loose Brown Moist (FILL)		1	SS	10				○		
			2	SS	24		422		○		42 50 8 (SI+CL)
			3	SS	9		421				
420.6											
2.3	END OF BOREHOLE AT 2.3m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 10/24/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-04B 1 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 544.7 E 196 333.2 ORIGINATED BY STH

HWY 599 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
422.9	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, trace silt, trace clay, occasional cobbles Compact Brown to Grey Moist (FILL)		1	GS			422				
							421				
			2	SS	23		420				
							419				
418.3											
4.6	**SAND**, trace to some silt, trace to some gravel Very Loose to Compact Brown to Grey Wet		3	SS	12		418				
							417				
			4	SS	3						
							416				
			5	SS	9		415				
							414				
			6	SS	12						
							413				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-04B 2 OF 2 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 544.7 E 196 333.2 ORIGINATED BY STH

HWY 599 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, trace gravel, trace silt, trace clay Compact Grey Wet										
			7	SS	10		412				
							411				
410.1			8	SS							3 90 7 (SI+CL)
12.8	End of sampling and start DCPT						410				
							409				
							408				
							407				
							406				
							405				
404.4											
18.5	END OF BOREHOLE AT 18.5m UPON DCPT REFUSAL. WELL INSTALLATION CONSISTS OF 19mm DIAMETER SCHEDULE 40 PVC PIPE WITH A 3.05m SLOTTED SCREEN WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.07.19 3.0 419.9										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100
WATER CONTENT (%): 20 40 60

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 10/24/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-05 1 OF 1 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 548.0 E 196 319.1 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.06.21 - 2017.06.21 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
423.8	GROUND SURFACE										
0.0	**ASPHALT:** (25mm)										
	Gravelly **SAND**, trace to some silt and clay Very Loose Brown Moist (FILL)		1	GS			423		○		
			2	GS					○		
			3	GS			422		○		15 47 38 (SI+CL)
			4	GS					○		
			1	SS	1		421		○		
420.1											
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-06 1 OF 1 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 551.1 E 196 328.7 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.06.21 - 2017.06.21 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
423.3	GROUND SURFACE										
0.0	**ASPHALT:** (25mm)										
	SAND and **GRAVEL**, trace to some silt and clay Dense to Compact Brown Moist (FILL)		1	GS			423		○		
			2	SS	47		422		○		41 49 10 (SI+CL)
			3	SS	24				○		
	Wet		4	SS			421				No recovery
419.3			5	SS	39	▽	420		○		
4.0	**SAND**, some silt, occasional organics Loose Grey Wet		6	SS	9		419		○		
417.2							418				
6.1	Sandy **SILT**, some clay Very Loose Grey Wet		7	SS	2		417		○		0 22 66 12
							416				
415.1			8	SS	3				○		
8.2	END OF BOREHOLE AT 8.2m. WATER LEVEL AT 3.5m. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 1.7m, GRAVEL TO 0.6m, CEMENT TO 0.2m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 10/24/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-07 1 OF 1 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 552.7 E 196 352.6 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.06.20 - 2017.06.20 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
422.8	GROUND SURFACE										
0.0	**ASPHALT:** (25mm)										
	SAND and **GRAVEL** Brown Moist (FILL)		1	GS					○		
			2	GS			422		○		
421.3											
1.5	Gravelly **SAND**, some silt, trace clay Very Loose Grey to Brown Moist to Wet (FILL)		3	GS		▽	421		○		
			4	GS			420		○		
			5	SS	4				○		26 54 18 2
419.1											
3.7	END OF BOREHOLE AT 3.7m. WATER LEVEL AT 2.9m. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\overset{20}{15\oplus 5}$ $\underset{10}{}$ (%) STRAIN AT FAILURE

ONTMT4S MTO-17077.GPJ 2017TEMPLATE(MTO).GDT 10/24/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR17-08 1 OF 1 METRIC

GWP# 6836-14-00 LOCATION Pratt Creek Culvert N 5 486 555.0 E 196 362.3 ORIGINATED BY BRM

HWY 599 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.06.20 - 2017.06.20 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
422.6	GROUND SURFACE										
0.0	**ASPHALT:** (25mm)										
0.0	Gravelly **SAND**, some silt to silty, trace clay Brown Moist (FILL)		1	GS			422		○		18 52 27 3
			2	GS					○		
420.8			3	GS			421		○		
1.8	**SAND** and **SILT**, trace gravel, trace clay Very Loose Brown to Grey Moist		4	GS		▽	420		○		5 44 47 4
418.9			5	SS	3		419		○		
3.7	END OF BOREHOLE AT 3.7m. WATER LEVEL AT 2.9m. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

THURBER

Appendix B

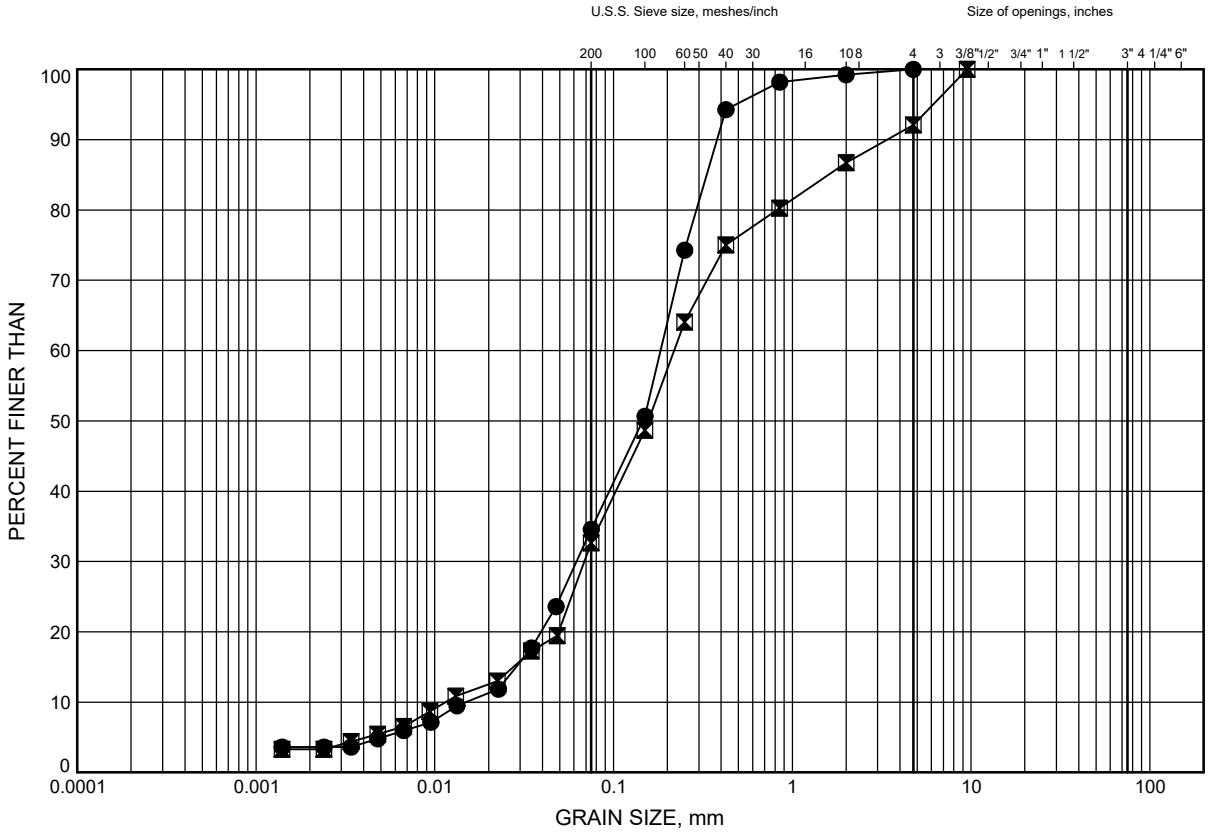
Geotechnical and Analytical Laboratory Test Results

Pratt Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND to Silty SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR17-01	1.1	420.0
⊠	PR17-03	1.8	421.0

Date October 2017

GWP# 6836-14-00

THURBER

Prep'd AN

Chkd. RPR

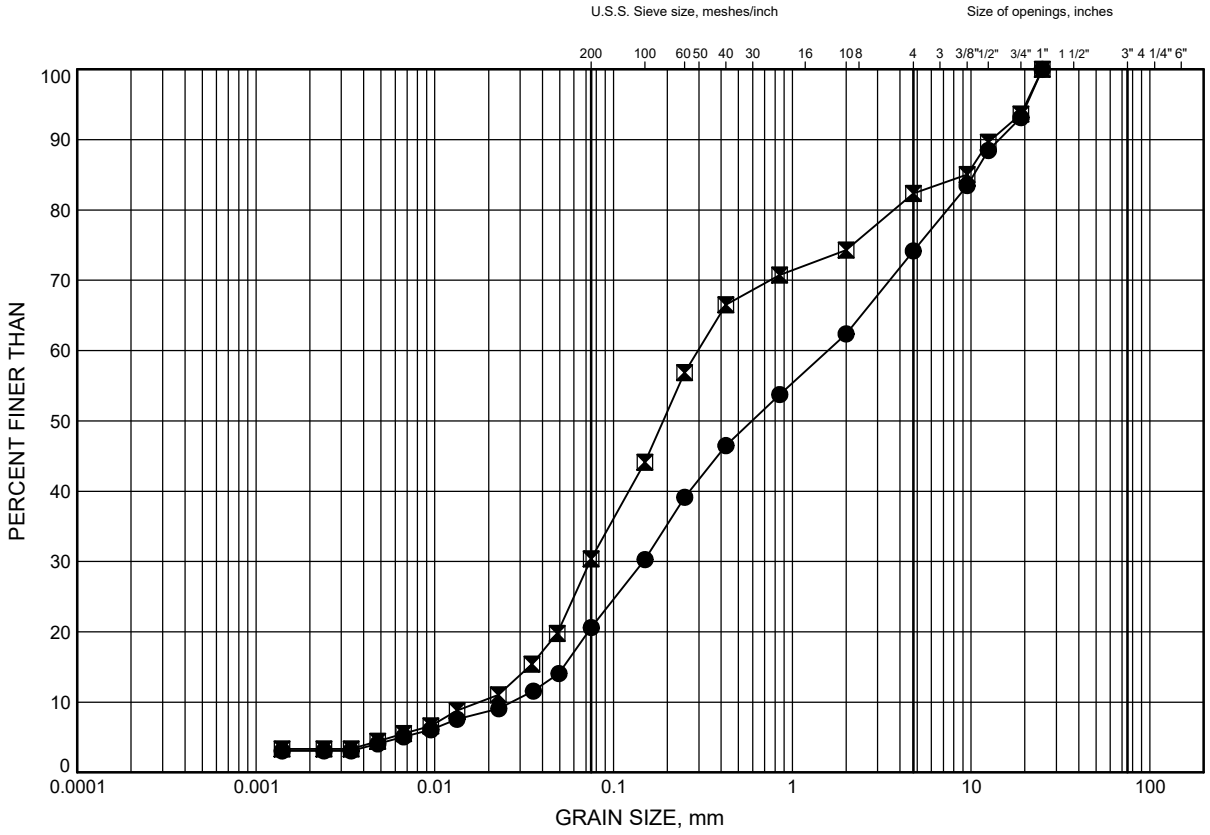
GRAIN SIZE DISTRIBUTION - THURBER MTO-17077.GPJ 10/24/17

Pratt Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B2

Gravelly SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR17-07	3.4	419.4
⊠	PR17-08	0.4	422.2

Date October 2017

GWP# 6836-14-00

THURBER

Prep'd AN

Chkd. RPR

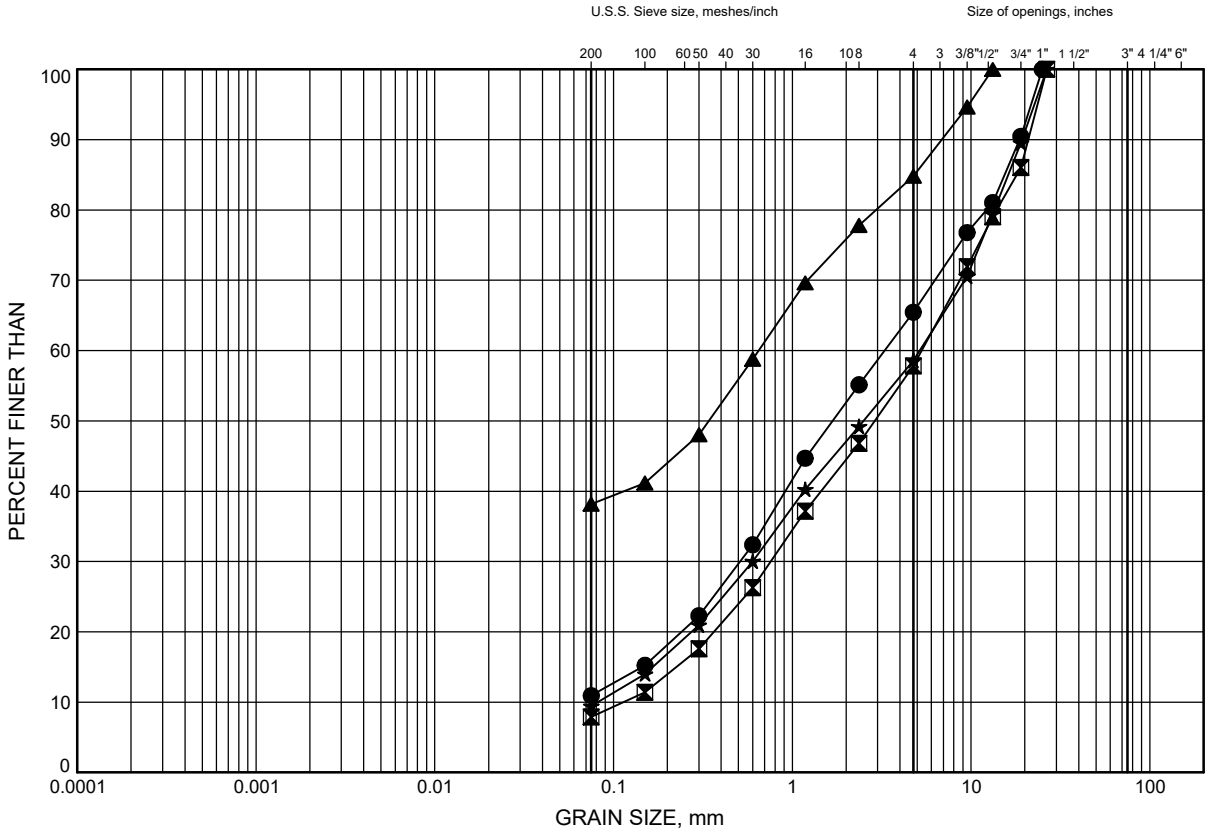
GRAIN SIZE DISTRIBUTION - THURBER MTO-17077.GPJ 10/24/17

Pratt Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND and GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR17-02	1.0	422.1
⊠	PR17-04A	1.1	421.8
▲	PR17-05	1.9	421.9
★	PR17-06	1.1	422.2

Date October 2017

GWP# 6836-14-00

THURBER

Prep'd AN

Chkd. RPR

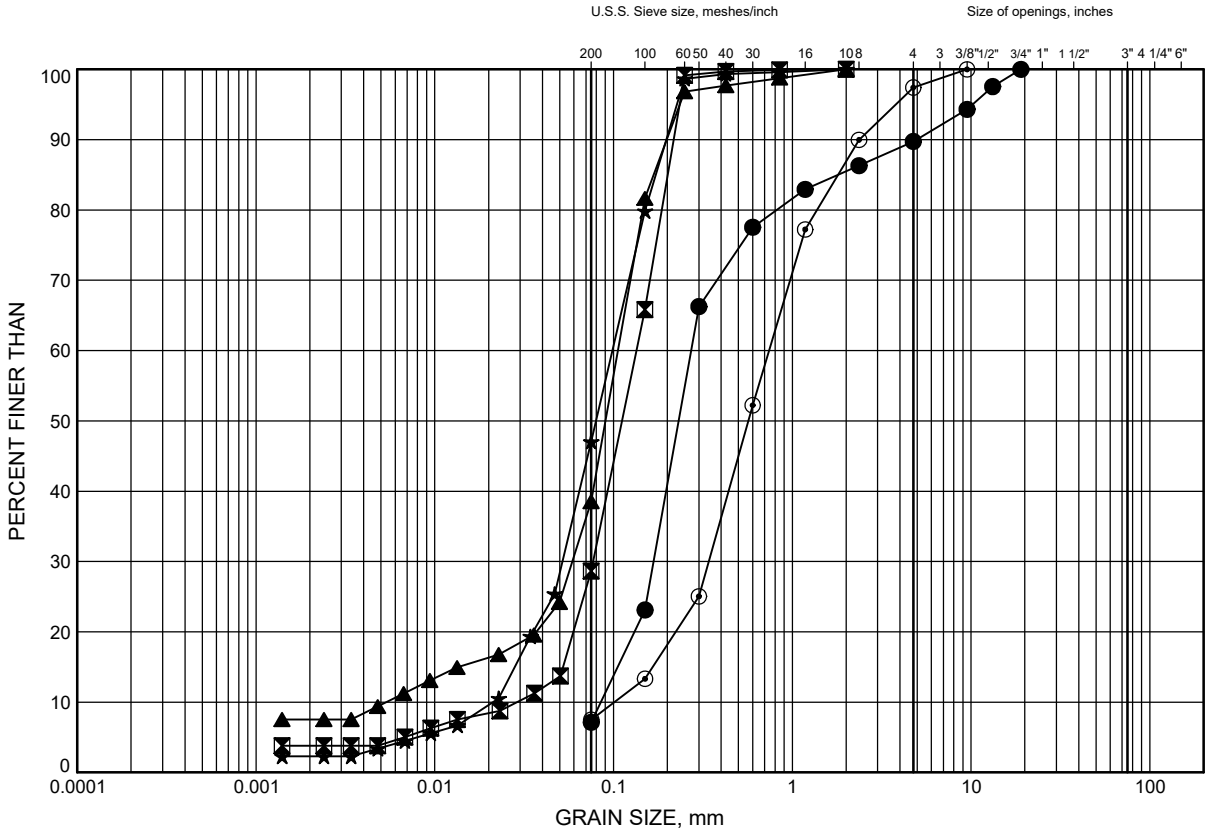
GRAIN SIZE DISTRIBUTION - THURBER MTO-17077.GPJ 10/24/17

Pratt Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B4

Silty SAND to SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR17-01	9.4	411.7
⊠	PR17-02	6.4	416.7
▲	PR17-02	14.0	409.1
★	PR17-03	5.0	417.8
⊙	PR17-04B	12.5	410.4

Date October 2017

GWP# 6836-14-00

THURBER

Prep'd AN

Chkd. RPR

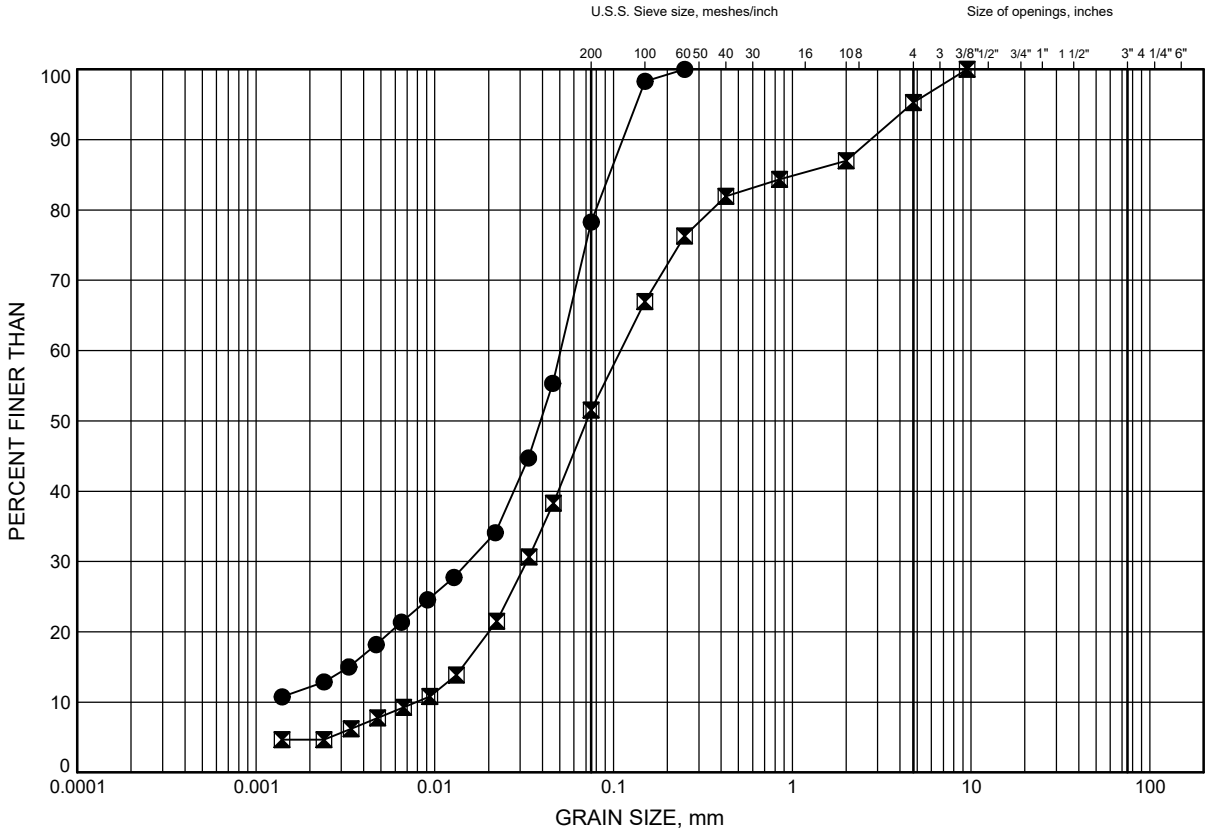
GRAIN SIZE DISTRIBUTION - THURBER MTO-17077.GPJ 10/24/17

Pratt Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B5

SILT and SAND to Sandy SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR17-06	6.4	416.9
⊠	PR17-08	2.6	420.0

Date October 2017

GWP# 6836-14-00

THURBER

Prep'd AN

Chkd. RPR

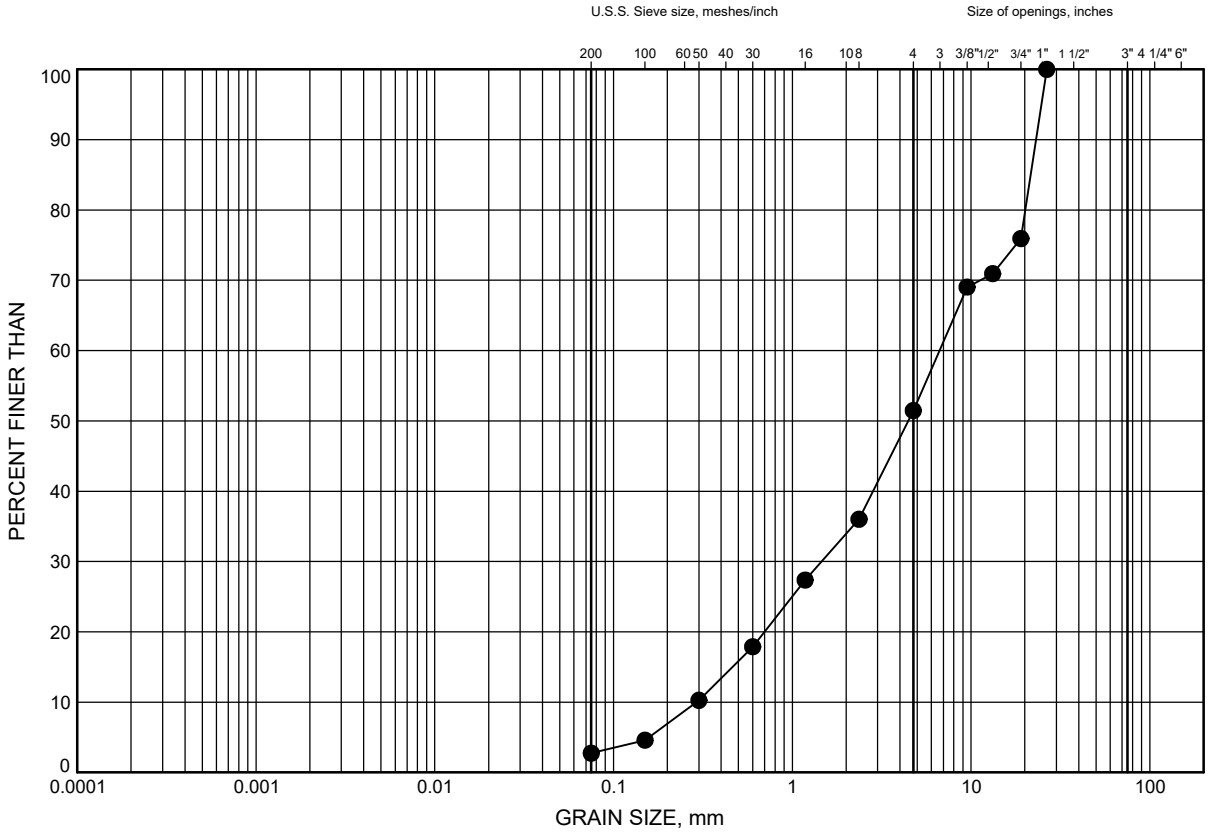
GRAIN SIZE DISTRIBUTION - THURBER MTO-17077.GPJ 10/24/17

Pratt Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND and GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR17-03	11.7	411.1

Date October 2017

GWP# 6836-14-00

THURBER

Prep'd AN

Chkd. RPR

GRAIN SIZE DISTRIBUTION - THURBER MTO-17077.GPJ 10/24/17

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

Attention: Cory Zanatta
Project#: 17077

Client Thurber Engineering Ltd.
SGS LIMS Number CA15302-AUG17
Analysis Package: **Corrosivity (Soil)**

Sample ID	Unit	PR17-02 SS7	KE 17-03 SS5	ME 17-03 SS3	TU 17-02 SPT5	CO 17-03 SS4	AG 147-02 SS4
Sample Date/Time		30-Jul-17	30-Jul-17	30-Jul-17	30-Jul-17	30-Jul-17	30-Jul-17
Moisture	%	15.6	7.0	7.7	22.2	15.6	21.0
pH	no unit	8.25	6.40	8.27	8.14	8.65	8.33
Corrosivity Index	none	4.5	1.0	1.0	1.0	4.0	1.0
Soil Redox Potential	mV	325	338	303	301	295	290
Sulphide	mg/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chloride	mg/L	6.9	240	2.4	25	1.2	150
Sulphate	mg/L	26	10	10	1.2	46	6.1
Conductivity	uS/cm	49	269	35	81	83	213
Resistivity (calculated)	ohms.cm	20300	3720	28700	12400	12000	4690

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

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

Certificate of Analysis

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

Attention: Cory Zanatta
Project#: 17077 Hwy 599

Client Thurber Engineering Ltd.
SGS LIMS Number CA15314-JUN17
Analysis Package: Corrosivity (Solution)

Sample ID	Unit	RL	Tug Creek	Pratt Creek	Mile Creek	Cobb Bay	Kekwanzik Lake	Agimak River
Sample Date/Time			10-Jun-17 12:10	10-Jun-17 12:30	10-Jun-17 10:40	10-Jun-17 11:20	10-Jun-17 12:45	10-Jun-17 13:10
Temperature Upon Receipt	°C		10.0	10.0	10.0	10.0	10.0	10.0
Soil Redox Potential	mV		334	272	352	301	312	345
Sulphide	mg/L	0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006
pH	no unit	0.05	7.78	7.81	7.62	7.70	7.38	7.26
Chloride	mg/L	0.04	2.1	2.9	2.7	1.7	8.8	7.8
Sulphate	mg/L	0.04	0.3	1.2	0.8	0.6	2.0	1.9
Conductivity	µS/cm	2	100	78	63	78	67	56
Resistivity (calculated)	ohms.cm		9990	12700	15800	12800	15000	17700

Corrosivity Index is based on the AWWA 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

THURBER

Appendix C

Selected Site Photographs

THURBER

Photo 1: Highway 599 at Pratt Creek Culvert looking west

Photo 2: Highway 599 at Pratt Creek Culvert looking east

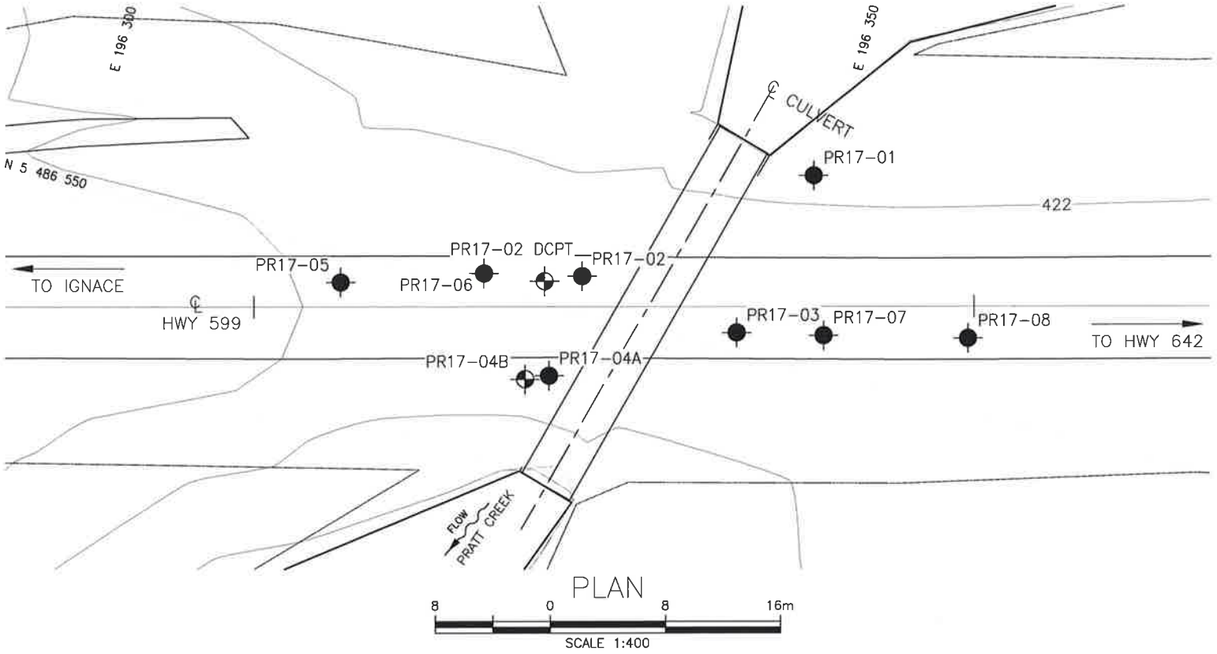
Photo 3: Pratt Creek Culvert outlet

Photo 4: Pratt Creek Culvert inlet

THURBER

Appendix D

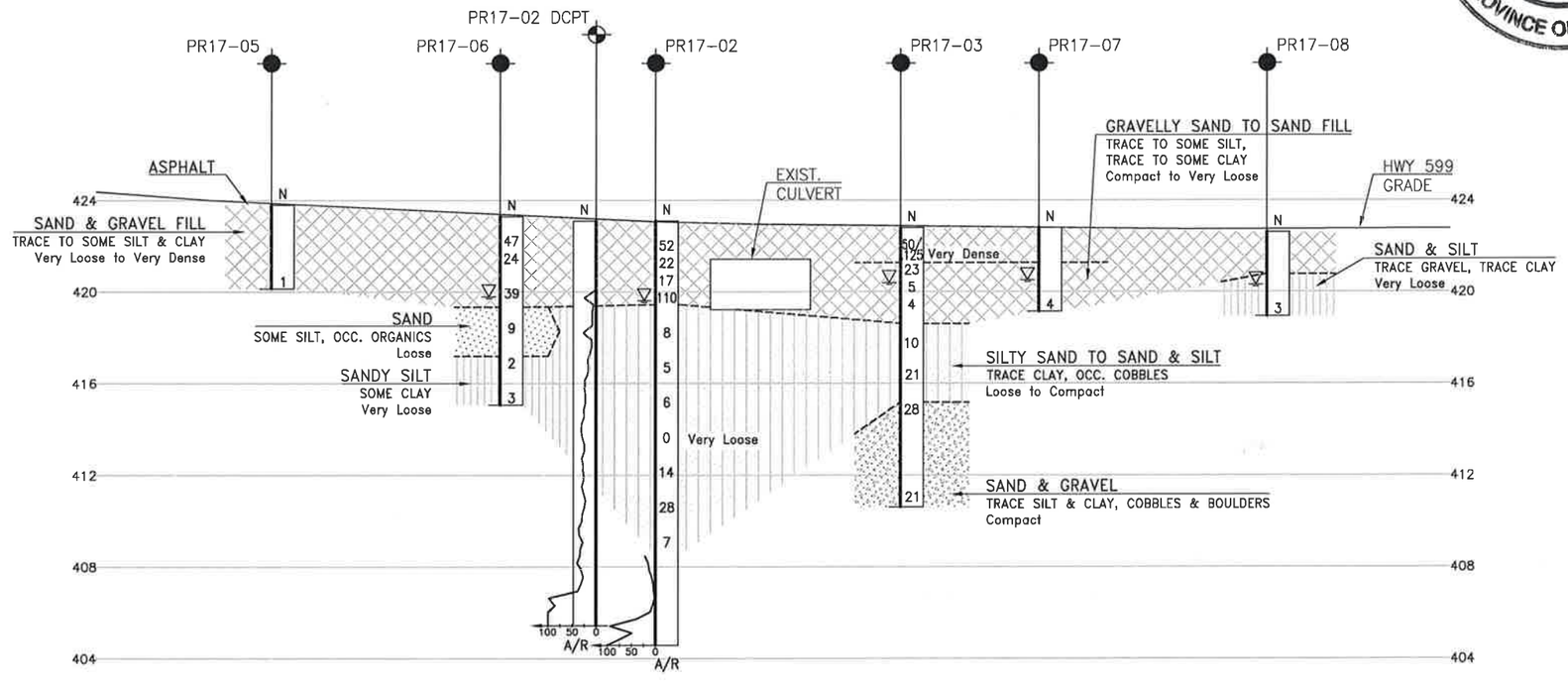
Borehole Locations and Soil Strata Drawings



PLAN

8 0 8 16m

SCALE 1:400



PROFILE ALONG ℄ HWY 599

5 0 5 10m

SCALE 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. R. CHATTERJI
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
R. PALOMEQUE REYNA
100083209
PROVINCE OF ONTARIO

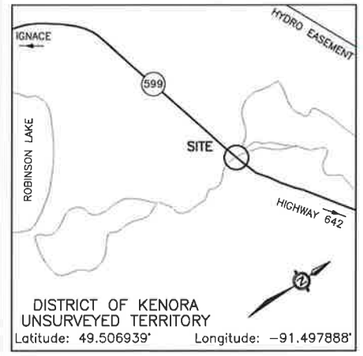
CONT No 2017-6036
WP No 6838-14-01

HIGHWAY 599
PRATT CREEK CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 42

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
PR17-01	421.1	5 486 563.3	196 349.2
PR17-02	423.1	5 486 552.6	196 335.3
PR17-02 DCPT	423.1	5 486 551.6	196 332.9
PR17-03	422.8	5 486 551.4	196 346.7
PR17-04A	422.9	5 486 545.3	196 334.8
PR17-04B	422.9	5 486 544.7	196 333.2
PR17-05	423.8	5 486 548.0	196 319.1
PR17-06	423.3	5 486 551.1	196 328.7
PR17-07	422.8	5 486 552.7	196 352.6
PR17-08	422.6	5 486 555.0	196 362.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 15.

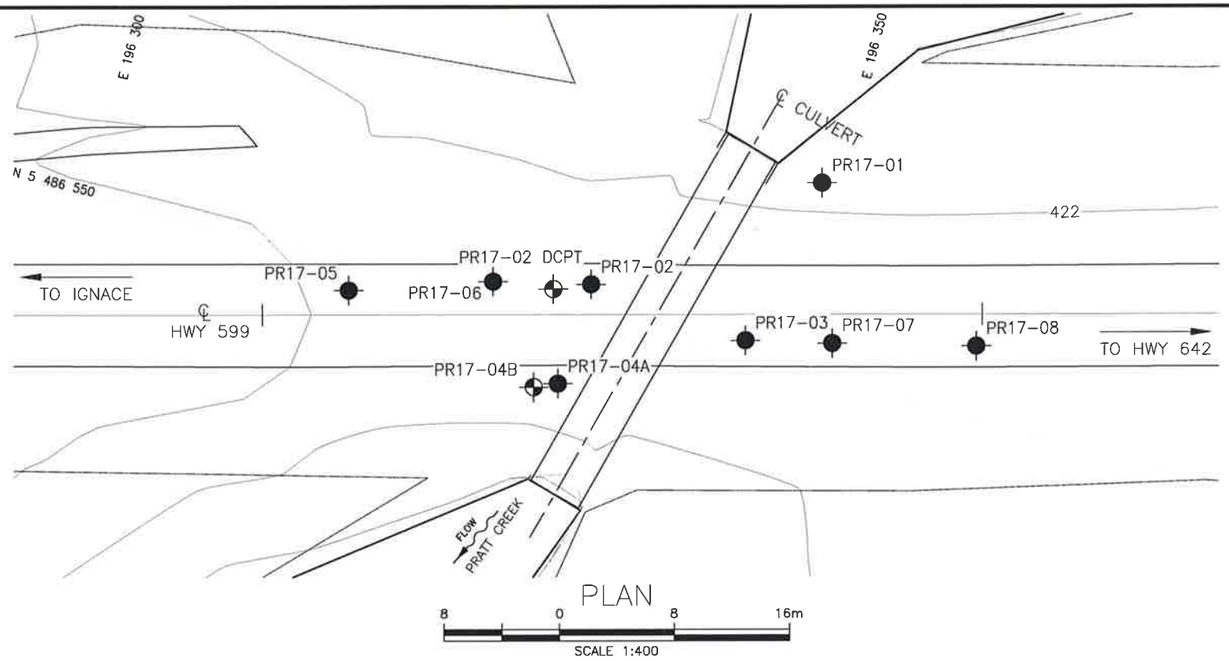
GEOCRES No. 52G-18

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	JPL	CODE	LOAD
DRAWN	AN	CHK	RPR	SITE 48W-244C	STRUCT

DATE JAN 2018
DWG 2

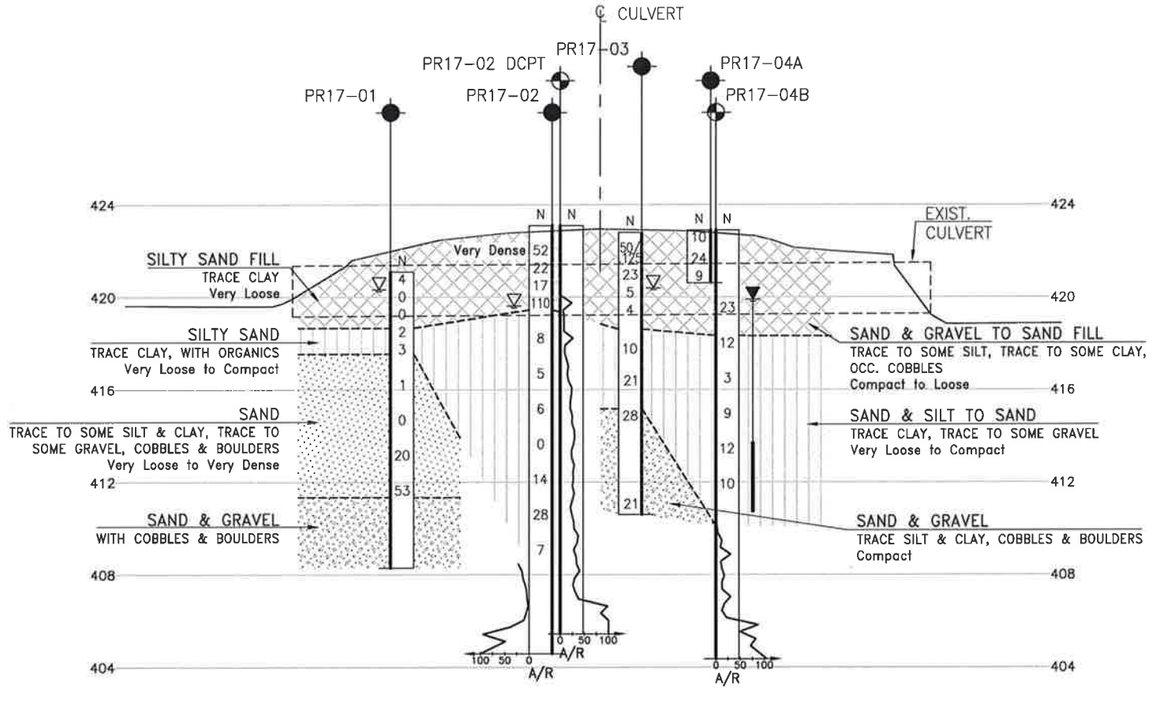
FILENAME: H:\Drafting\17000\17077\TED-17077-RLPR-PC.dwg
PLOTDATE: 1/26/2018 5:21 PM



PLAN

8 0 8 16m

SCALE 1:400



SECTION ALONG ℄ CULVERT

5 0 5 10m

SCALE 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

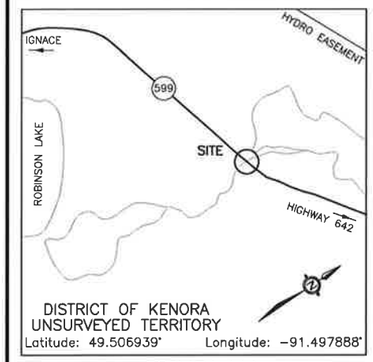
CONT No 2017-6036
WP No 6838-14-01

HIGHWAY 599
PRATT CREEK CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 43

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
PR17-01	421.1	5 486 563.3	196 349.2
PR17-02	423.1	5 486 552.6	196 335.3
PR17-02 DCPT	423.1	5 486 551.6	196 332.9
PR17-03	422.8	5 486 551.4	196 346.7
PR17-04A	422.9	5 486 545.3	196 334.8
PR17-04B	422.9	5 486 544.7	196 333.2
PR17-05	423.8	5 486 548.0	196 319.1
PR17-06	423.3	5 486 551.1	196 328.7
PR17-07	422.8	5 486 552.7	196 352.6
PR17-08	422.6	5 486 555.0	196 362.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 15.

GEOCRES No. 52G-18

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb 6/18
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
R. PALOMEQUE REYNA
100083209
Feb 8/18
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	JPL	CODE	LOAD
DRAWN	AN	CHK	RPR	SITE 48W-244C	STRUCT

DATE JAN 2018
DWG 3

FILENAME: H:\Drafting\17000\17077\TED-17077-PLPR-PC.dwg
PLOTDATE: 1/26/2018 5:21 PM