THURBER ENGINEERING LTD.

celebrating 60 YEARS

FOUNDATION INVESTIGATION REPORT
PINEWOOD RIVER TRIBUTARY CULVERT
SITE NO. 45-259/C, 12.7 KM NORTH OF HIGHWAY 11
PATTULLO TOWNSHIP, ONTARIO
G.W.P. 6813-14-00

GEOCRES No. 52D-29

Report

to

HATCH

Date: February 17, 2017
File: 13983

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THURBER

60 YEARS

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the results of a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the replacement of Pinewood River Tributary Culvert #2 (Site 45-259/C) in the Township of Pattullo, Ontario.

The purpose of this investigation was to explore the subsurface conditions in the vicinity of the culvert and based on the findings, to provide a plan of borehole locations, records of boreholes, laboratory test results, a written description of the subsurface conditions and geotechnical recommendations for the culvert foundation.

Thurber carried out the investigation as a sub-consultant to Hatch under the Ministry of Transportation Ontario (MTO) Agreement Number 6015-E-0018-005.

2. SITE DESCRIPTION

The existing culvert carries Highway 617 over a tributary of Pinewood River and is located on Highway 617, approximately 13 km north of Highway 11 and just north of Brown Road. The stream crosses Highway 617 in a predominantly north-south direction. The site is surrounded by agricultural properties and forested areas.

The existing structure is a three-cell rectangular timber culvert with an approximate length of 18 m and a total width of 4.5 m with each cell measuring 1.5 m.

Based on an Ontario Bridge Management System (OBMS) inspection report dated November 2, 2015, it is understood that the culvert has experienced prolonged deterioration including decay at the waterline, laterally tilting walls, severe splitting and checking at the waterline and gaps

between the timbers. Transverse crack is visible in the pavement above the culvert. The OBMS inspection report indicates that the existing structure is in an overall poor condition and recommends replacement.

Photographs included in Appendix D show the general conditions observed at the culvert inlet and outlet during the time of investigation.

3. INVESTIGATION PROCEDURES

The field work for the current investigation was carried out between August 24 and August 26, 2016. A total of four (4) boreholes (16-35 to 16-38) were advanced approximately 2 to 3 m on either side of the existing culvert. Three (3) additional boreholes (16-39 to 16-41) were advanced north of the culvert to investigate the frost taper requirement at this site. The approximate locations of the boreholes are shown on the Borehole Location and Soil Strata drawings provided in Appendix E.

The boreholes were drilled using a CME 55 drill rig supplied by RPM Drilling Inc. of Thunder Bay, Ontario using hollow stem augers. Soil samples were obtained at selected intervals of depth with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT) procedure.

Groundwater conditions in the open boreholes were noted during drilling and upon completion of drilling. A 25 mm diameter standpipe piezometer was installed in borehole 16-35. All boreholes were backfilled in general accordance with Ontario Regulation (O. Reg.) 903.

The field work was supervised on a full time basis by a member of Thurber's technical staff, who staked the boreholes in the field, arranged for the clearance of subsurface utilities, directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

4. LABORATORY TESTING

The recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analysis (hydrometer and/or sieve) and Atterberg Limits testing, where appropriate. Laboratory testing results are summarized on the Record of Borehole sheets included in Appendix A and presented on the figures included in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered stratigraphy are presented on 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 must be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the subsurface conditions beneath the existing embankment fill consist predominantly of a stiff to very stiff silty clay deposit with localized surficial sand deposit.

More detailed descriptions of the individual strata are provided in the following sections.

5.1 Topsoil

Topsoil was encountered at the ground surface in 16-38 with a thickness of 35 mm.

5.2 Asphalt

Five boreholes (16-36, 16-37, 16-39, 16-40 and 16-41) were drilled through the existing pavement structure of Highway 617. Thickness of the asphalt ranged from about 25 mm to 38 mm.

5.3 Sand Fill

Fill material was encountered below the asphalt in 16-36, 16-37, 16-39, 16-40 and 16-41, and below the topsoil in Borehole 16-38. The fill consisted of silty sand, sand to gravelly sand. Trace organics were encountered in 16-36. The fill thickness ranged between 0.6 m and 1.4 m.

SPT ‘N’ values obtained within the cohesionless fill ranged from 7 to 44 blows per 0.3 m of penetration, indicating a loose to dense relative density. Moisture contents between 3% and 13% were measured in the fill.

The results of grain size distribution analyses carried out on selected fill samples are presented on the Record of Borehole sheets included in Appendix A and on Figure B1 in Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	11 to 32
Sand	47 to 63
Silt & Clay	16 to 27

5.4 Sand

An approximately 0.6 m thick layer of sand was encountered at the ground surface in borehole 16-35 extending to a depth of about 0.6 m (Elevation 334.2 m). The sand was brown in colour and contained some silt.

An SPT 'N' value of 3 blows per 0.3 m of penetration was recorded within the sand, indicating a very loose relative density.

5.5 Silty Clay

A discontinuous layer of dark grey to grey silty clay with sand was encountered underlying the fill in Boreholes 16-38 and 16-39. The material extended to a depth of 3.0 m (Elevation 333.4 m) in Borehole 16-38. Borehole 16-39 was terminated within this layer at a depth of 3.7 m (Elevation 333.4 m).

SPT 'N' values of 4 to 8 blows per 0.3 m of penetration were recorded in the layer. A field vane test measured an undrained shear strength of 53 kPa, indicating a stiff consistency. Moisture contents of 23 to 40% was measured in the deposit. An Atterberg Limits analysis showed that this soil has a plastic limit of 17% and a liquid limit of 50%.

A deposit of brown to grey silty clay was encountered below the sand in Borehole 16-35, underlying the fill in Boreholes 16-36, 16-37, 16-40 and 16-41, and below the silty clay with sand in Borehole 16-38. The cohesive deposit contained trace to some sand and occasional sand seams. All boreholes were terminated within this layer at depths ranging from 3.7 to 15.8 m (Elevation 333.6 to 321.2 m). A dynamic cone penetration test (DCPT) was carried out to a depth of 19.3 m (Elevation 317.2 m) in Borehole 16-38 from the bottom of the drilled portion.

SPT 'N' values obtained within the silty clay ranged from 0 to 15 blows per 0.3 m of penetration. Field vane shear tests measured undrained shear strengths between 56 kPa and 105 kPa, indicating a stiff to very stiff consistency. Moisture contents between 20% and 53% were measured in this cohesive deposit.

The results of grain distributions and Atterberg Limits analyses carried out on representative

samples of the material are presented on the Record of Borehole sheets in Appendix A and on Figures B2 to B7 in Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)	
	Silty Clay with Sand	Silty Clay
Gravel	0	0
Sand	31 to 44	0 to 25
Silt	25 to 30	17 to 53
Clay	31 to 39	28 to 83

5.6 Groundwater Conditions

A temporary standpipe piezometer was installed in Borehole 16-35 to measure the groundwater level following the completion of the field program. In addition, water levels were observed in most of the open boreholes during drilling prior to backfilling. The standpipe piezometer measurements and open hole water levels are summarized in the table below.

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
16-35	August 26, 2016	2.2	332.6	Standpipe piezometer
16-36	August 25, 2016	Dry	-	Open borehole
16-37	August 26, 2016	Dry	-	Open borehole
16-39	August 24, 2016	Dry	-	Open borehole
16-40	August 24, 2016	Dry	-	Open borehole
16-41	August 24, 2016	Dry	-	Open borehole

It should be noted that these are short term observations and the groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year such as spring or after periods of significant or prolonged precipitation.

6. CORROSIVITY AND SULPHATE TEST RESULTS

One representative sample of silty clay soil from Borehole 16-38 and a sample of surface water from the tributary were submitted to SGS laboratories for chemical analysis related to potential for corrosion of buried steel and sulphate attack on buried concrete. The results are shown in the table below and included in Appendix C.

Parameter	Units (Soil)	Units (Water)	Test Results	
			Borehole SS4 (2.3 to 2.9 m) - Soil	Pinewood River Tributary - Water
Corrosivity Index	-	-	1	< 1
pH	-	-	8.12	7.46
Conductivity	µS/cm	µS/cm	65	120
Resistivity	Ohms.cm	MOhms.cm	15400	4280
Redox Potential	mV	mV	139	234
Chloride	µg/g	mg/L	5.6	1.1
Sulphate	µg/g	mg/L	170	0.7
Sulphide	%	mg/L	< 0.02	< 0.006

7. MISCELLANEOUS

Thurber marked the borehole locations in the field and obtained utility locates prior to drilling.

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. Tim Sivak of Thurber. Overall supervision of the field program was provided by Mr. Mark Farrant, P.Eng. of Thurber.

The coordinates and ground surface elevations at the borehole locations were established by measurements taken in the field by Thurber relative to the topographic plans provided by Hatch.

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

THURBER

60 YEARS

Thurber Engineering Ltd.

Michael Eastman, EIT
Geotechnical Engineer-in-Training

Keli Shi, 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

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.

EXPLANATION OF ROCK LOGGING TERMS

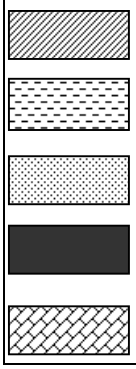
ROCK WEATHERING CLASSIFICATION

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 (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

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			

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THURBER

RECORD OF BOREHOLE No 16-35 1 OF 2 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 466.8 E 217 709.9 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2016.08.25 - 2016.08.25 CHECKED BY MKE

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
334.8	GROUND SURFACE										
0.0	**SAND**, some silt Very Loose Brown		1	SS	3						
334.2											
0.6	Silty **CLAY**, trace to some sand Very Soft to Very Stiff Grey Moist		2	SS	0		334				0 16 35 49
			3	SS	0		333				
			4	SS	8		332				
			5	SS	5		331				0 0 24 76
			6	SS	3		330	2.1			
			7	SS	2		329				
			8	SS	4		328	1.4			
			9	SS	4		327				0 9 32 59
325.1							326				
9.8	END OF BOREHOLE AT 9.8 m.										

Continued Next Page

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

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

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THURBER

RECORD OF BOREHOLE No 16-35 2 OF 2 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 466.8 E 217 709.9 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2016.08.25 - 2016.08.25 CHECKED BY MKE

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
	Continued From Previous Page										
	Piezometer installation consists of 25 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2016.08.26 2.2 332.6										

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

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

ONTMT4S 13983-MTO.GPJ 2015TEMPLATE(MTO).GDT 2/21/17

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Ontario

THURBER

RECORD OF BOREHOLE No 16-36 1 OF 2 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 473.8 E 217 717.9 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2016.08.25 - 2016.08.25 CHECKED BY MKE

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
337.0	GROUND SURFACE										
0.0	**ASPHALT:**(25 mm)										
	Silty **SAND**, some gravel, trace organics Compact Brown Moist (FILL)		1	GS					○		16 60 24 (SI+CL)
335.7			2	SS	11		336				
1.4	Silty **CLAY**, trace to some sand Stiff Grey Moist		3	SS	7		335		○		
			4	SS	4				○		
			5	SS	2		334		○		0 5 43 52
							333	2 2 +			
			1	TW			332				
			6	SS	5		331		○		
			7	SS	3		330		○		
							329	1.7 +			
			8	SS	6		328		○		0 18 27 55

Continued Next Page

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

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

ONTMT4S 13983-MTO.GPJ 2015TEMPLATE(MTO).GDT 2/21/17

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RECORD OF BOREHOLE No 16-36 2 OF 2 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 473.8 E 217 717.9 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2016.08.25 - 2016.08.25 CHECKED BY MKE

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							20 40 60 80 100	20 40 60		
			9	SS	7		326				
							325				
			10	SS	6						
							324				
			11	SS	9		323				0 16 39 45
							322				
321.2			12	SS	6						
15.8	END OF BOREHOLE AT 15.8 m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1 m, AND ASPHALT TO GROUND SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 13983-MTO.GPJ 2015TEMPLATE(MTO).GDT 2/21/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-37 1 OF 2 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 454.5 E 217 721.5 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2016.08.26 - 2016.08.26 CHECKED BY MKE

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
337.1	GROUND SURFACE						337				
0.0	**ASPHALT:** (38 mm)										
0.0	Gravelly **SAND**, some silt Dense Brown Moist (FILL)		1	GS					○		31 48 21 (SI+CL)
			2	SS	44		336		○		
335.7											
1.4	Silty **CLAY**, some sand, occasional sand seams Stiff to Very Stiff Brown to Grey Moist		3	SS	7		335		○		
			4	SS	5				○		
			5	SS	4		334		○		0 19 53 28
			6	SS	4		333		○		
							332	+ 2.2			
			7	SS	4		331		○		
			8	SS	3		330		⊢○⊣		0 25 37 38
							329				
			9	SS	5		328		○		

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-37 2 OF 2 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 454.5 E 217 721.5 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2016.08.26 - 2016.08.26 CHECKED BY MKE

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 ● QUICK TRIAXIAL + FIELD VANE × 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
	Continued From Previous Page						327				
			10	SS	8		326		○		
							325				
			11	SS	8				⊢○⊣		0 18 31 51
							324				
322.7			12	SS	15		323		○		
14.3	END OF BOREHOLE AT 14.3 m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1 m, AND ASPHALT TO GROUND SURFACE.										

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

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

ONTMT4S 13983-MTO.GPJ 2015TEMPLATE(MTO).GDT 2/21/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-38 1 OF 2 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 463.3 E 217 727.7 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.08.26 - 2016.08.26 CHECKED BY MKE

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
336.5	GROUND SURFACE										
0.0	**TOPSOIL:** (35 mm)										
0.0	Gravelly **SAND**, some silt Dense to Loose Brown Moist (FILL)		1	SS	34		336		○		25 59 16 (SI+CL)
			2	SS	7				○		
335.1							335				
1.4	Silty **CLAY**, with sand Stiff Dark Grey Moist		3	SS	4				○		0 44 25 31
			4	SS	4		334	5.0 +			
333.4											
3.0	Silty **CLAY** Stiff to Very Stiff Grey Moist		1	TW			333				
			5	SS	3		332		○		
			6	SS	2		331		○ →		0 0 17 83
			7	SS	0		330		○		
			8	SS	3		329	1.7 +			
							328				
							327		○		

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-38 2 OF 2 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 463.3 E 217 727.7 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.08.26 - 2016.08.26 CHECKED BY MKE

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			SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	WATER CONTENT (%)	γ kN/m³	GR SA SI CL
326.4	Continued From Previous Page							20 40 60 80 100	w_P w w_L		
10.1	End of sampling and start DCPT at 10.1 m							1.5	20 40 60		
317.2											
19.3	END OF BOREHOLE AT 19.3 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 13983-MTO.GPJ 2015TEMPLATE(MTO).GDT 2/21/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-39 1 OF 1 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 481.8 E 217 721.9 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2016.08.24 - 2016.08.24 CHECKED BY MKE

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
337.1	GROUND SURFACE						337				
0.0	**ASPHALT:** (25 mm)										
	Gravelly **SAND**, some silt Brown Moist (FILL)		1	AS					○		32 47 21 (SI+CL)
335.7			2	AS			336		○		
1.4	Silty **CLAY**, with sand Stiff Grey Moist		3	AS			335		⊢○⊣		0 31 30 39
333.4			1	SS	8		334		○		
3.7	END OF BOREHOLE AT 3.7 m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1 m, AND ASPHALT TO GROUND SURFACE.										

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

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

ONTMT4S 13983-MTO.GPJ 2015TEMPLATE(MTO).GDT 2/21/17

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-40 1 OF 1 METRIC

WP# 6813-14-00 LOCATION Pinewood River Tributary Creek N 5 405 491.8 E 217 721.9 ORIGINATED BY TS

HWY 617 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2016.08.24 - 2016.08.24 CHECKED BY MKE

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
337.1	GROUND SURFACE										
0.0	**ASPHALT:** (25 mm)						337				
	SAND, some silt, some gravel, trace clay Brown Dry to Moist (FILL)		1	AS					○		
			2	AS					○		12 61 18 9
335.9							336				
1.2	Silty **CLAY**, some sand, trace organics Firm Grey Moist		3	AS					○		
			4	AS			335		○		0 11 37 52
			1	SS	6		334		○		
333.5											
3.7	END OF BOREHOLE AT 3.7 m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.1 m, AND ASPHALT TO GROUND SURFACE.										

+ 3, × 3: Numbers refer to Sensitivity

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

ONTMT4S 13983-MTO.GPJ 2015TEMPLATE(MTO).GDT 2/21/17

THURBER

60 YEARS

Appendix B

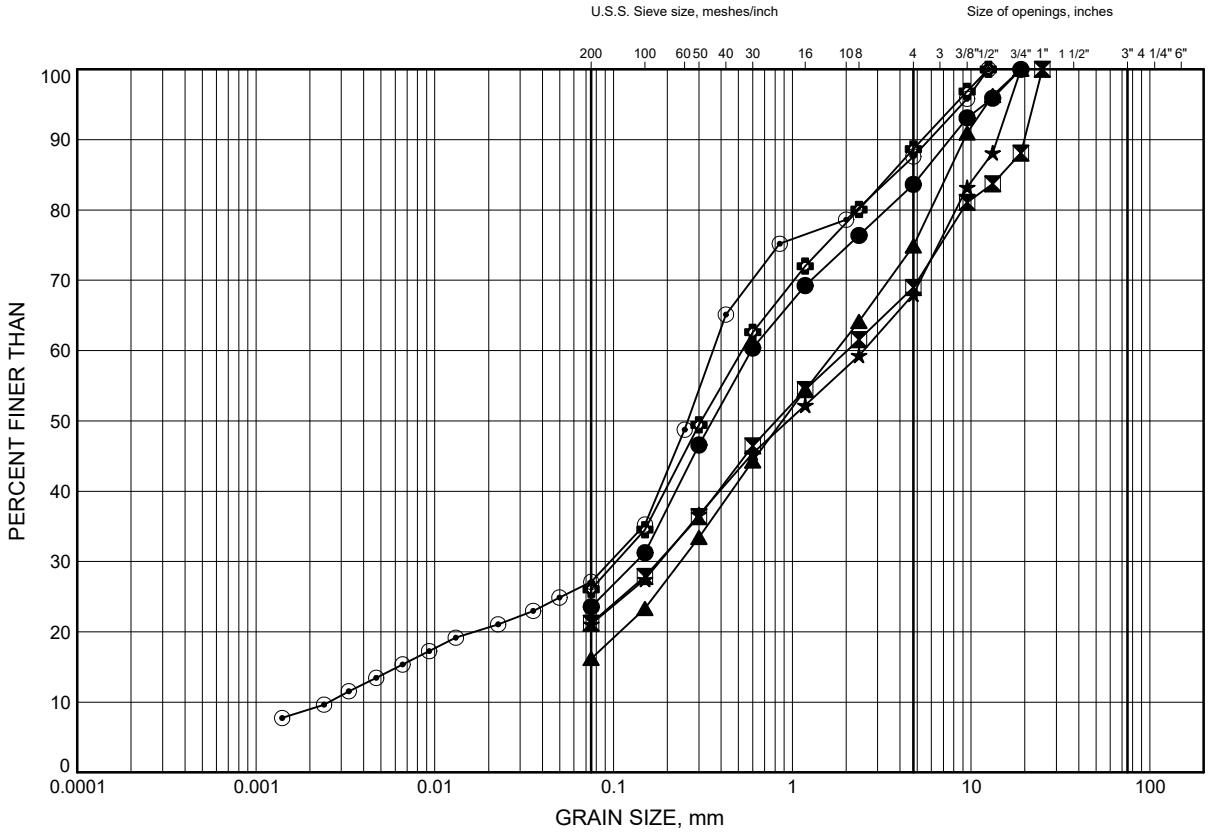
Laboratory Test Results

Pinewood River Tributary Creek

GRAIN SIZE DISTRIBUTION

FIGURE B1

FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-36	0.33	336.70
⊠	16-37	0.30	336.76
▲	16-38	0.30	336.18
★	16-39	0.30	336.79
⊙	16-40	0.91	336.23
✿	16-41	0.46	336.75

Date February 2017

WP# 6813-14-00

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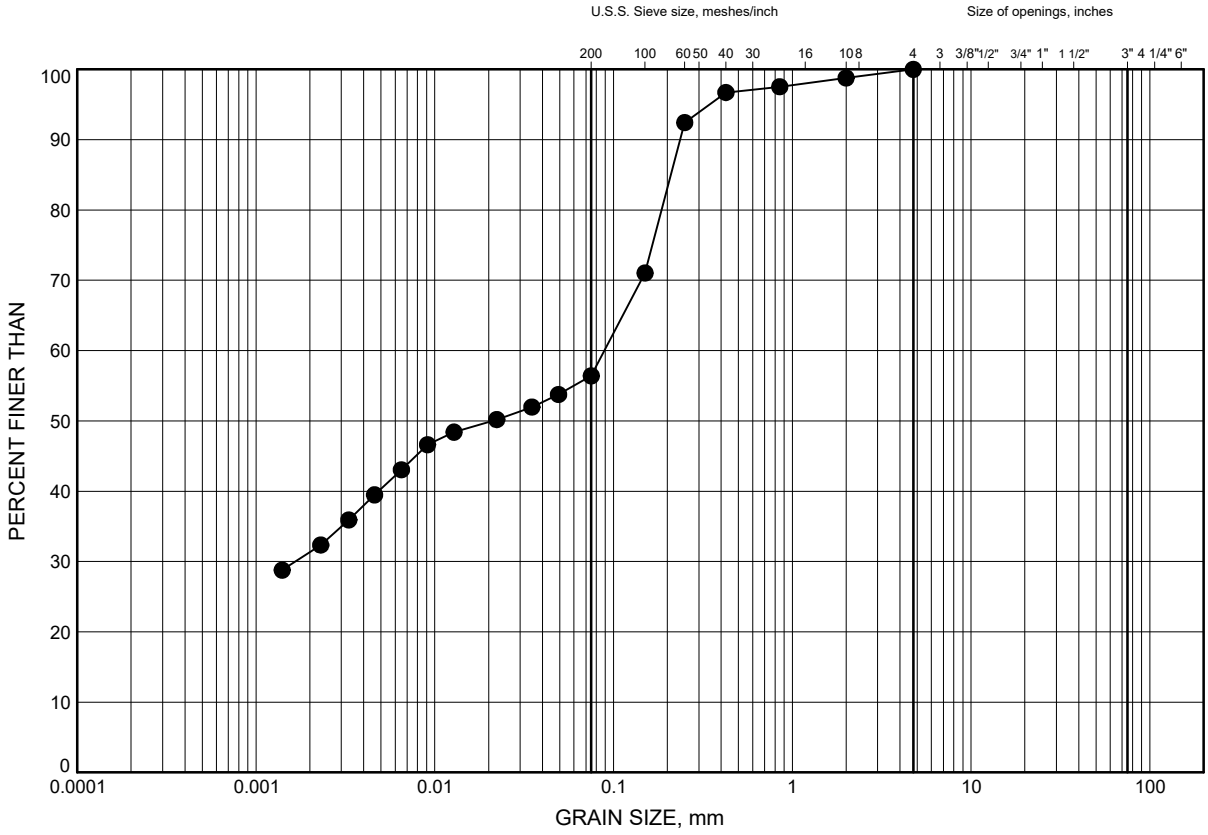
GRAIN SIZE DISTRIBUTION - THURBER 13983-MTO.GPJ 2/21/17

Pinewood River Tributary Creek

GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty CLAY with SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-38	1.83	334.66

Date February 2017

WP# 6813-14-00

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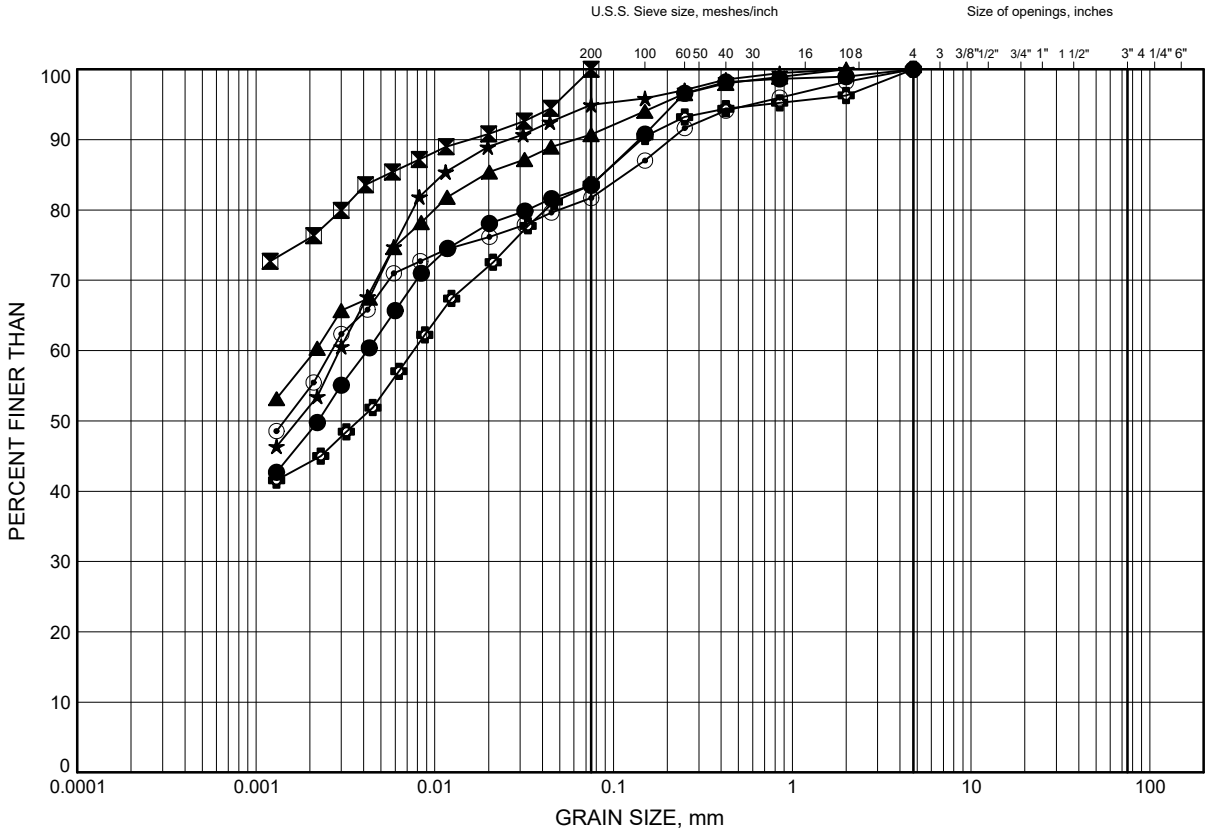
GRAIN SIZE DISTRIBUTION - THURBER 13983-MTO.GPJ 2/21/17

Pinewood River Tributary Creek

GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty CLAY to CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-35	1.07	333.76
⊠	16-35	3.35	331.48
▲	16-35	7.92	326.91
★	16-36	3.35	333.68
⊙	16-36	9.45	327.58
✿	16-36	14.02	323.01

Date February 2017

WP# 6813-14-00

THURBER

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Chkd. MKE

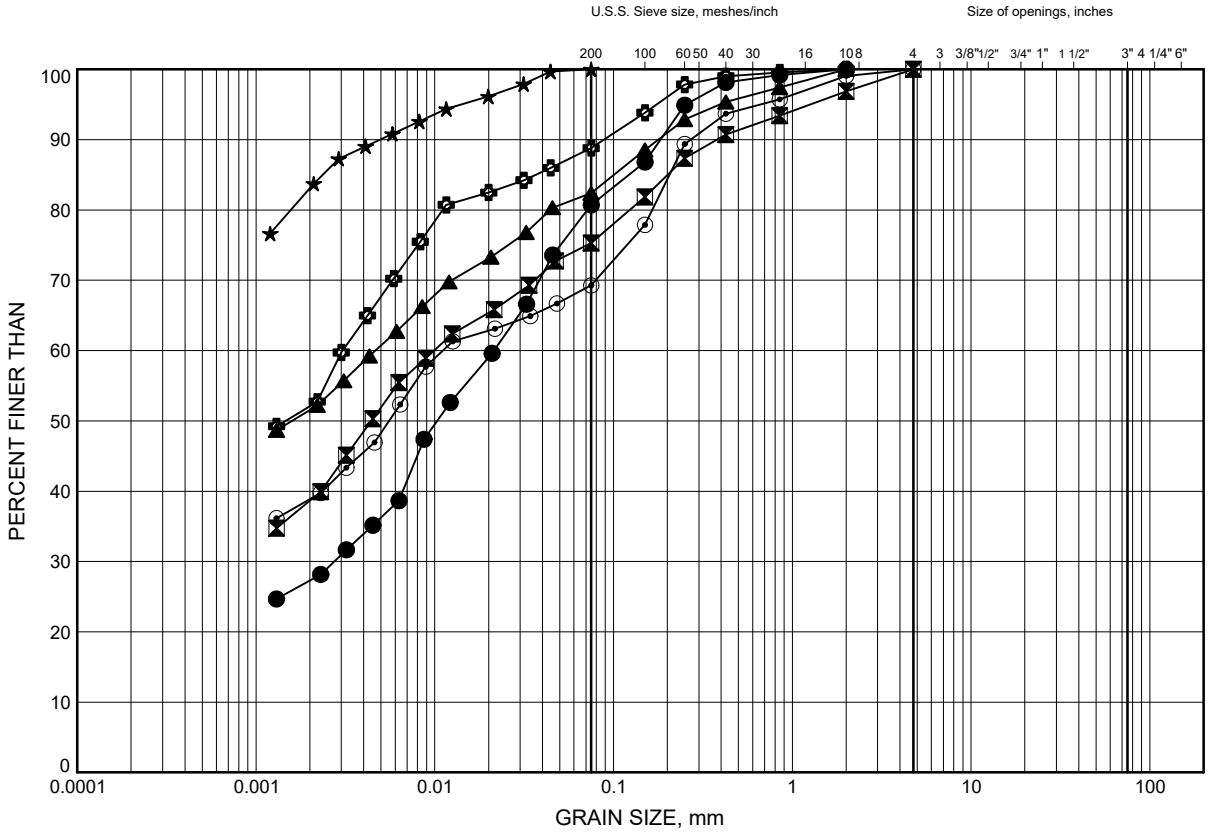
GRAIN SIZE DISTRIBUTION - THURBER 13983-MTO.GPJ 2/21/17

Pinewood River Tributary Creek

GRAIN SIZE DISTRIBUTION

FIGURE B4

Silty CLAY to CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-37	3.35	333.71
⊠	16-37	7.92	329.14
▲	16-37	12.50	324.57
★	16-38	6.40	330.09
⊙	16-39	2.29	334.81
✿	16-40	2.13	335.01

Date February 2017

WP# 6813-14-00

THURBER

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Chkd. MKE

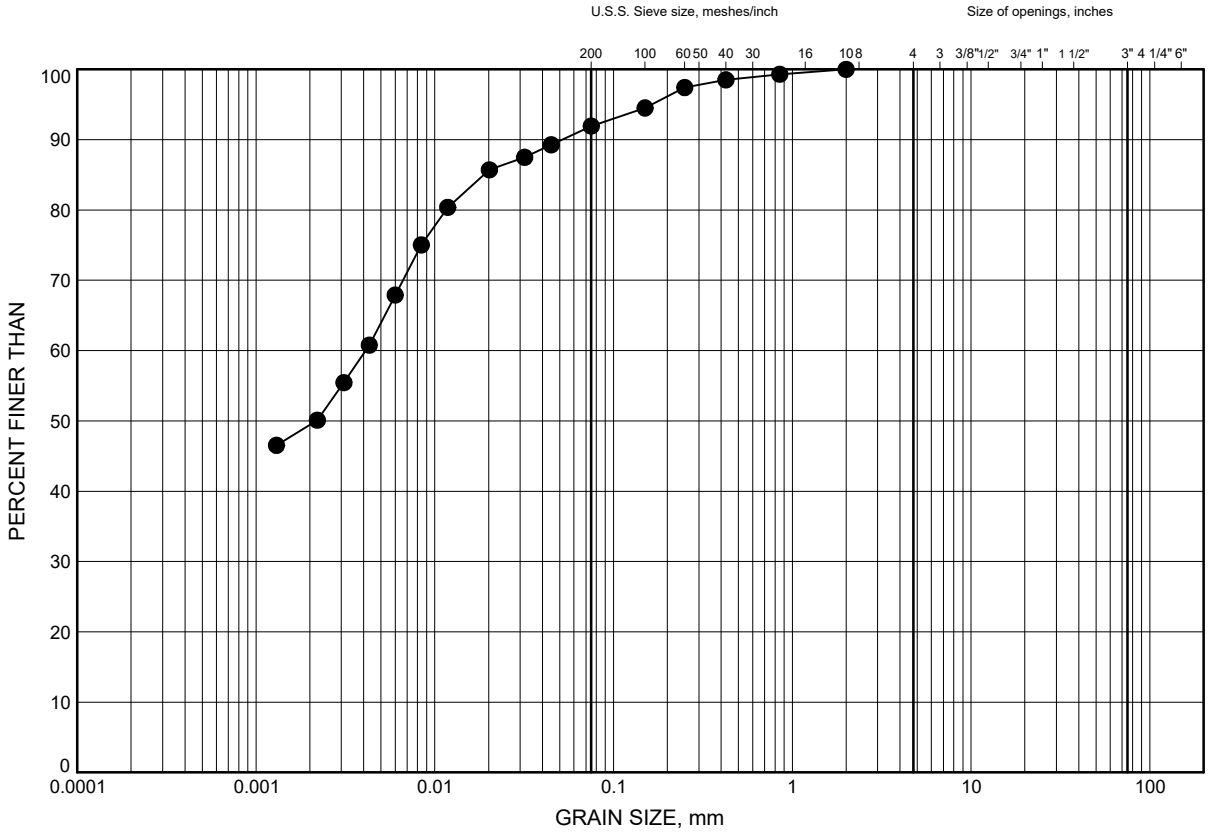
GRAIN SIZE DISTRIBUTION - THURBER 13983-MTO.GPJ 2/21/17

Pinewood River Tributary Creek

GRAIN SIZE DISTRIBUTION

FIGURE B5

Silty CLAY to CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-41	2.13	335.08

Date February 2017

WP# 6813-14-00

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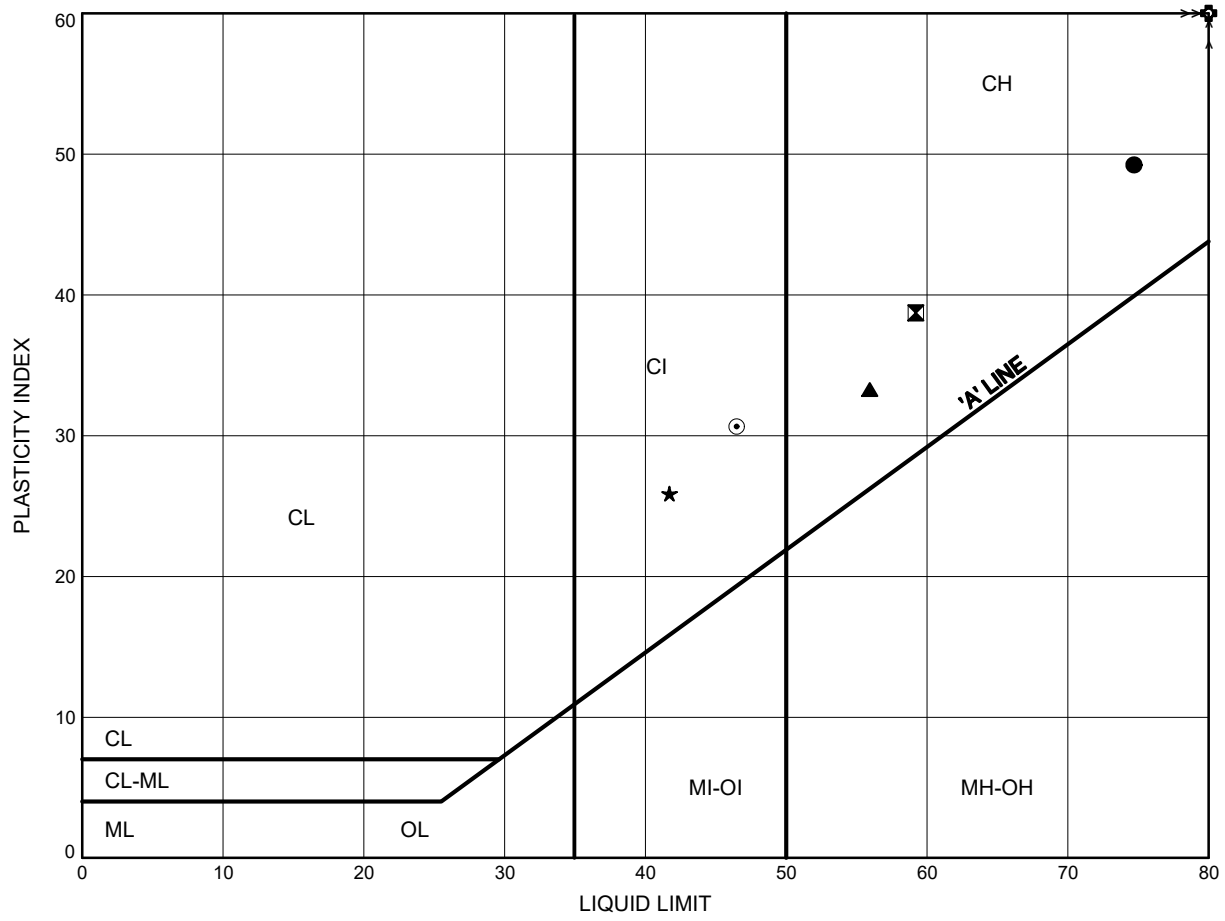
GRAIN SIZE DISTRIBUTION - THURBER 13983-MTO.GPJ 2/21/17

Pinewood River Tributary Creek

ATTERBERG LIMITS TEST RESULTS

FIGURE B6

Silty CLAY to CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-35	3.35	331.48
⧓	16-36	9.45	327.58
▲	16-36	14.02	323.01
★	16-37	7.92	329.14
⊙	16-37	12.50	324.57
✿	16-38	6.40	330.09

Date February 2017

WP# 6813-14-00

THURBER

Prep'd AN

Chkd. MKE

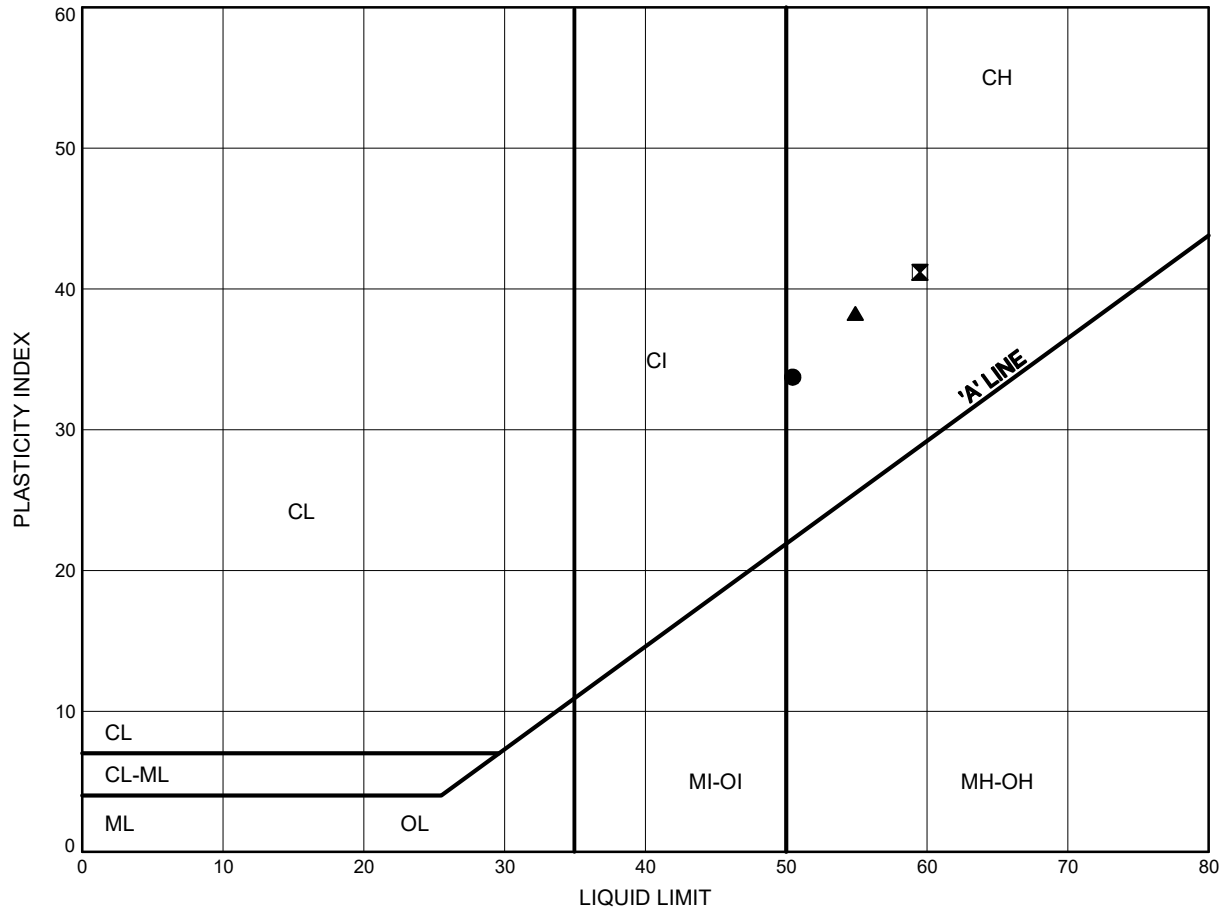
THURBALT 13983-MTO.GPJ 2/21/17

Pinewood River Tributary Creek

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

Silty CLAY to CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-39	2.29	334.81
⧓	16-40	2.13	335.01
▲	16-41	2.13	335.08

Date February 2017

WP# 6813-14-00

THURBER

Prep'd AN

Chkd. MKE

THURBALT 13983-MTO.GPJ 2/21/17

THURBER

60 YEARS

Appendix C

Chemical Analysis Results

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13983

22-September-2016

Thurber Engineering Ltd.
Attn : Mark Farrant

103, 2010 Winston Park Drive
Oakville, ON
L6H 5R7,

Phone: 905-829-8666 x 228
Fax:

Date Rec. : 16 September 2016
LR Report: **CA14401-SEP16**
Reference: 13983 Mark Farrant

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: 16-38 SS#4 7.5'-9.5'
Sample Date & Time					12-Sep-16
Temperature Upon Receipt [°C]	---	---	---	---	9.0
Corrosivity Index [none]	21-Sep-16	16:51	21-Sep-16	16:51	1
pH [no unit]	19-Sep-16	10:18	19-Sep-16	13:26	8.12
Soil Redox Potential [mV]	19-Sep-16	16:42	20-Sep-16	10:53	139
Sulphide [%]	21-Sep-16	11:12	21-Sep-16	11:40	< 0.02
% Moisture (wet wt) [%]	21-Sep-16	07:55	21-Sep-16	08:50	20.0
pH [no unit]	19-Sep-16	06:59	20-Sep-16	10:41	8.54
Chloride [µg/g]	20-Sep-16	20:39	21-Sep-16	16:30	5.6
Sulphate [µg/g]	20-Sep-16	20:39	21-Sep-16	16:30	170
Conductivity [uS/cm]	19-Sep-16	06:59	20-Sep-16	10:42	65
Resistivity (calculated) [Ohms.cm]	21-Sep-16	10:49	21-Sep-16	10:49	15400

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

OnLine LIMS

00007876

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13983

LR Report : **CA14401-SEP16**

Temperature of Samples upon receipt 15 degrees C
No cooling agent present

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.

Temperature of Samples upon receipt 9 degrees C
Cooling agent present
Custody Seal not present

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13983

LR Report : **CA14401-SEP16**

Method Descriptions

Parameter	SGS Method Code	Reference Method Code
Anions by IC	ME-CA-[ENV]IC-LAK-AN-001	EPA300/MA300-Ions1.3
Carbon/Sulphur	ME-CA-[ENV]ARD-LAK-AN-020	ASTM E1918
Conductivity	ME-CA-[ENV]EWL-LAK-AN-006	SM 2510
pH	ME-CA-[ENV]EWL-LAK-AN-001	SM 4500

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13983
LR Report : **CA14401-SEP16**

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank		RPD	Acceptance Criteria	LCS / Spike Blank			Matrix Spike / Reference Material		
							Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
						%		Low	High		Low	High
Anions by IC - QCBatchID: DIO0260-SEP16												
Chloride	0.4	µg/g	<0.4		1	20	107	80	120	105	75	125
Sulphate	0.4	µg/g	<0.4		0	20	101	80	120	100	75	125
Carbon/Sulphur - QCBatchID: ECS0026-SEP16												
Sulphide	0.02	%	<0.02		4	20	106	80	120			
Conductivity - QCBatchID: EWL0235-SEP16												
Conductivity	2	uS/cm	< 2		ND	10				NA		
pH - QCBatchID: ARD0047-SEP16												
pH	0.05	no unit			0	20	100	80	120			

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13983

12-September-2016

Thurber Engineering Ltd.
Attn : Mark Farrant

103, 2010 Winston Park Drive
Oakville, ON
L6H 5R7,

Phone: 905-829-8666 x 228
Fax:

Date Rec. : 06 September 2016
LR Report: **CA15062-SEP16**
Reference: 13983 Mark Farrant

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: MDL	8: Pinewood
Sample Date & Time						21-Aug-16
Temperature Upon Receipt [°C]	---	---	--	--	---	23.0
Corrosivity Index [none]	12-Sep-16	17:18	12-Sep-16	17:18		< 1
pH [no unit]	07-Sep-16	06:39	07-Sep-16	15:48	0.05	7.46
Conductivity [µS/cm]	07-Sep-16	06:39	07-Sep-16	15:48	2	120
Resistivity (calculated) [MOhms.cm]	07-Sep-16	14:35	07-Sep-16	14:35	---	4280
Redox Potential [mV]	06-Sep-16	14:30	07-Sep-16	08:34	---	234
Chloride [mg/L]	08-Sep-16	09:42	12-Sep-16	13:27	0.04	1.1
Sulphate [mg/L]	08-Sep-16	09:42	12-Sep-16	13:27	0.04	0.70
Sulphide [mg/L]	07-Sep-16	12:00	08-Sep-16	10:41	0.006	< 0.006

Temperature of Samples upon receipt 23 degrees C
Cooling Agent Present
Custody Seal not Present

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.

Deanna Edwards

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

OnLine LIMS

0000779931

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13983

LR Report : **CA15062-SEP16**

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 - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13983
LR Report : **CA15062-SEP16**

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank		RPD	Acceptance Criteria	LCS / Spike Blank			Matrix Spike / Reference Material		
							Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
						%		Low	High		Low	High
Anions by IC - QCBatchID: DIO0089-SEP16												
Anions by IC - QCBatchID: DIO0105-SEP16												
Chloride	0.04	mg/L	<0.04		2	20	94	80	120	105	75	125
Sulphate	0.04	mg/L	<0.04		0	20	101	80	120	100	75	125
Conductivity - QCBatchID: EWL0061-SEP16												
Conductivity	2	µS/cm	< 2		0	10	98	90	110	NA		
pH - QCBatchID: EWL0061-SEP16												
pH	0.05	no unit	NA		0		100			NA		
Redox Potential - QCBatchID: EWL0056-SEP16												
Redox Potential	no	mV	NA		2	20	100	80	120	NA		
Sulphide by SFA - QCBatchID: SKA0038-SEP16												
Sulphide	0.006	mg/L	<0.006		ND	20	84	80	120	nv	75	125

Appendix D

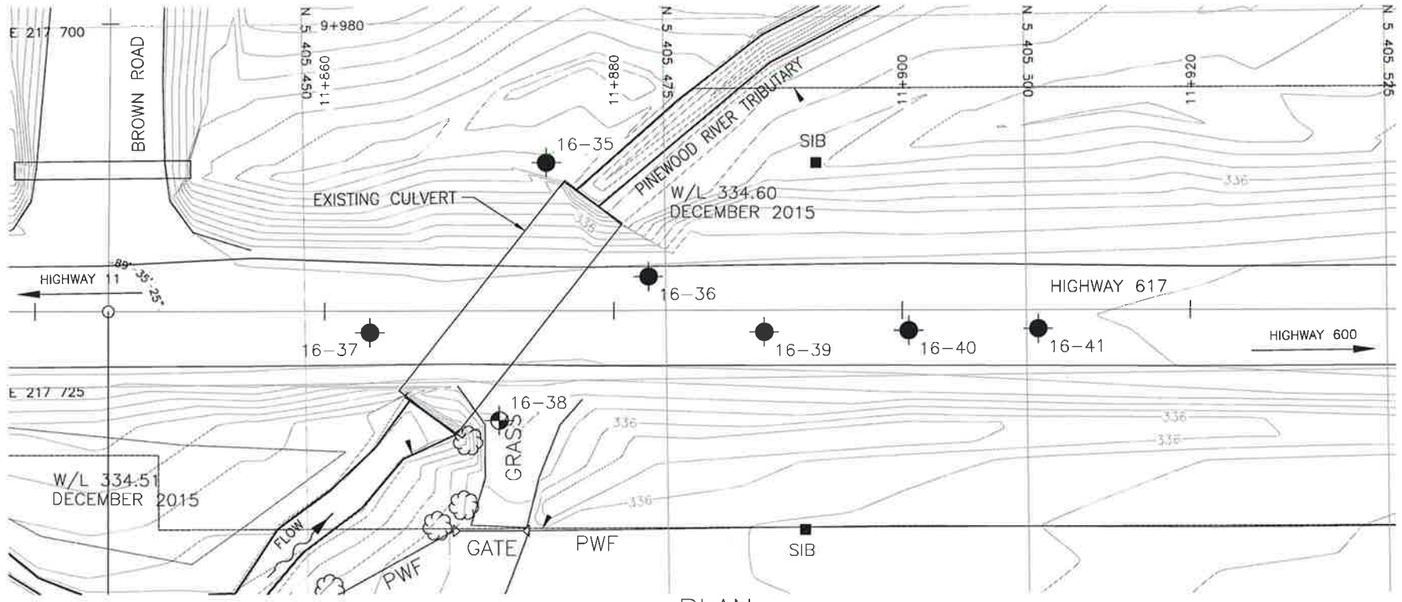
Site Photographs

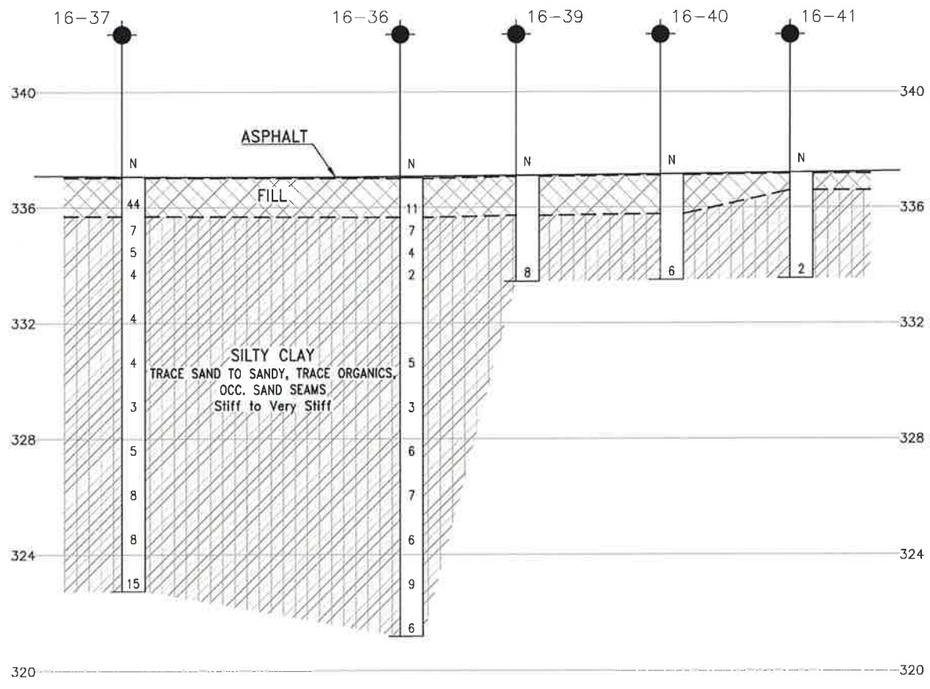
Photo 1: Looking south at north end of existing culvert.

Photo 2: Wood debris accumulation at south end of existing culvert.

Appendix E

Borehole Location Plan and Stratigraphic Profiles





METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
WP No

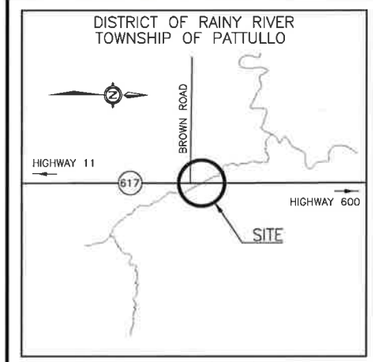
HIGHWAY 617
PINEWOOD RIVER TRIBUTARY
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

HATCH

THURBER ENGINEERING LTD.

DISTRICT OF RAINY RIVER
TOWNSHIP OF PATTULLO



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
16-35	334.8	5 405 466.8	217 709.9
16-36	337.0	5 405 473.8	217 717.9
16-37	337.1	5 405 454.5	217 721.5
16-38	336.5	5 405 463.3	217 727.7
16-39	337.1	5 405 481.8	217 721.9
16-40	337.1	5 405 491.8	217 721.9
16-41	337.2	5 405 500.8	217 721.9

-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) MTM Zone 16 co-ordinate system used to obtain borehole Northings and Eastings.
4) Preliminary general arrangement drawing provided by Hatch in digital format.

GEOCRES No. 52D-29

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb 17/17
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
K L SHI
100141639
Feb17/17
PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN MKE	CHK PKC	CODE	LOAD
DRAWN MFA	CHK MKE	SITE	STRUCT

DATE FEB 2017
DWG 1

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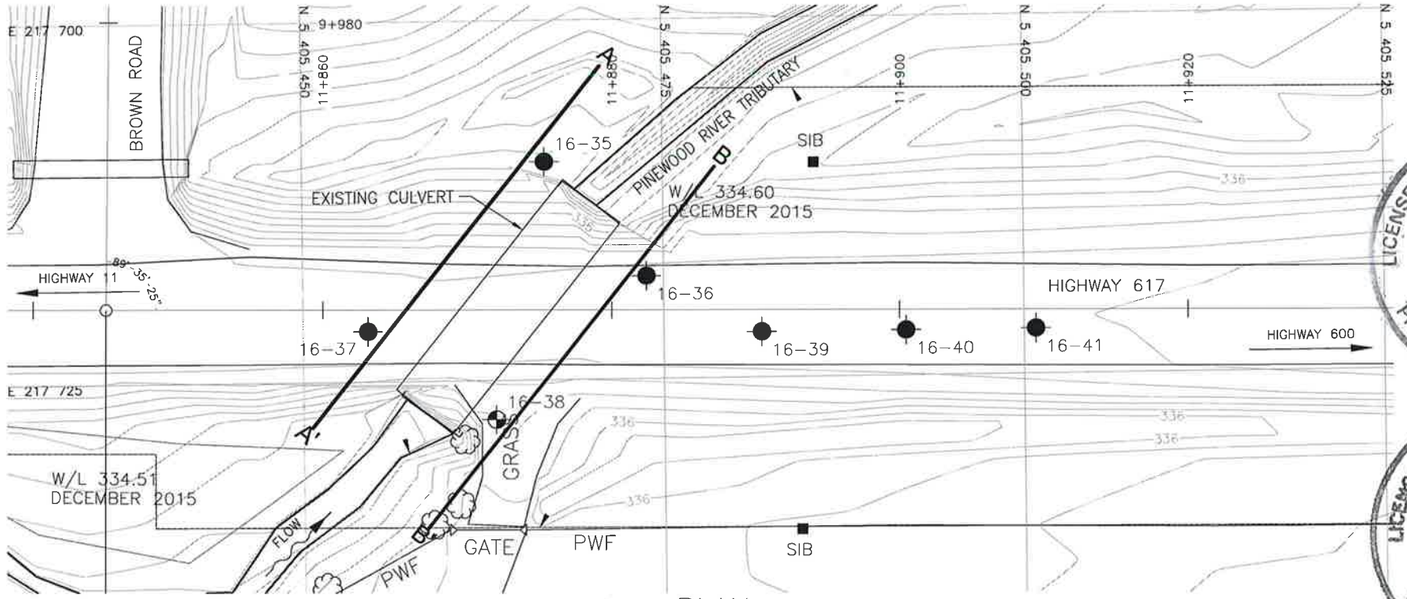
MINISTRY OF TRANSPORTATION, ONTARIO

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
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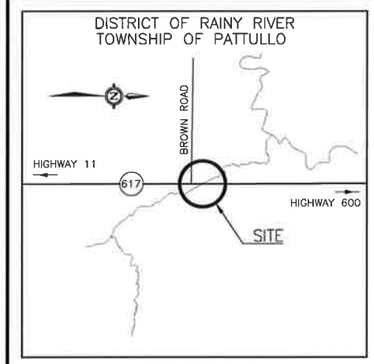
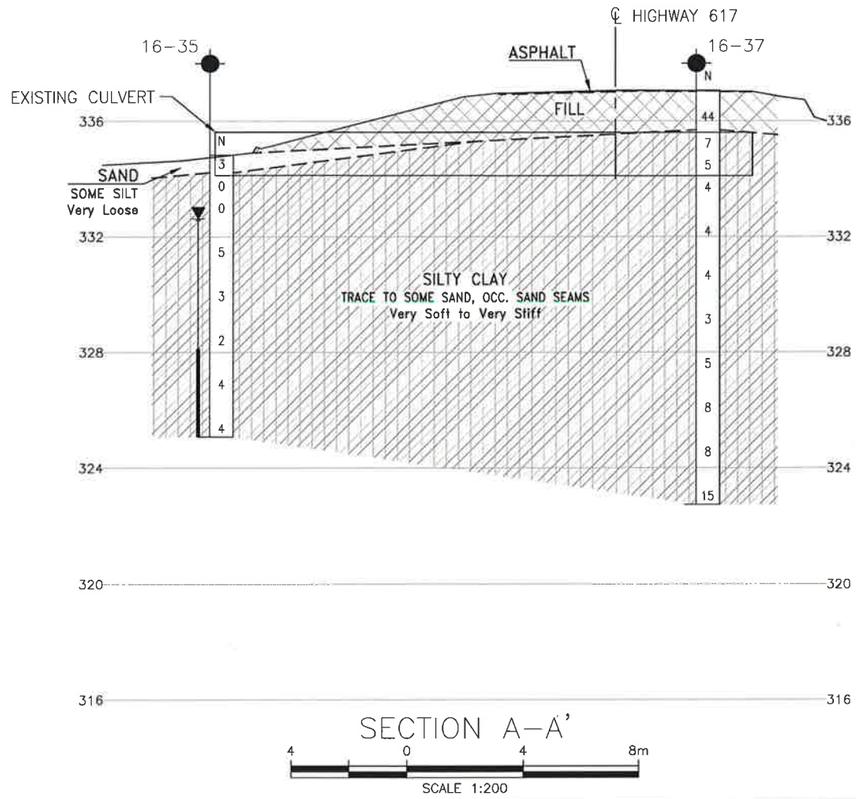


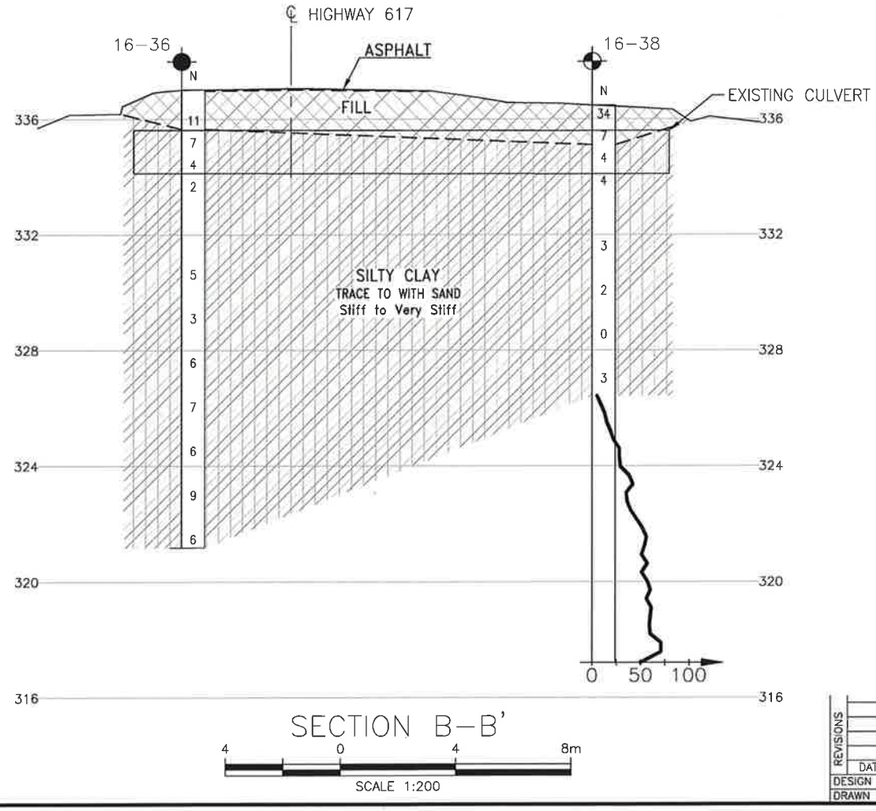
KEYPLAN



SECTION A–A'

4 0 4 8m

SCALE 1:200



SECTION B–B'

4 0 4 8m

SCALE 1:200

LEGEND

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GEOCRES No. 52D-29

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MKE	CHK	PKC	CODE		LOAD	DATE FEB 2017
DRAWN	MFA	CHK	MKE	SITE		STRUCT	DWG 2

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