FOUNDATION INVESTIGATION REPORT
PINEWOOD RIVER BRIDGE REPLACEMENT
HIGHWAY 617, NORTH OF STRATTON, ONTARIO
RAINY RIVER DISTRICT
G.W.P. 6094-10-00, SITE 45-37

Geocres Number: 52D-13

Report to

GENIVAR

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of a proposed bridge replacement crossing the Pinewood River. The existing bridge carries Highway 617 over the Pinewood River, approximately 14.7 km north of Stratton, Ontario, in the Rainy River District.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile and sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to GENIVAR, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0012.

2 SITE DESCRIPTION

The Pinewood River bridge is located on Highway 617 between Brown Road and Neilson Road, approximately 14.7 km north of Stratton, Ontario.

Highway 617 is a paved two-lane road with narrow gravel shoulders. The existing structure consists of a five span bridge with a concrete and timber deck. The centre span is 8.0 m in length, while the other 4 spans are 5.0 m each. The total length and width of the existing bridge are 28.6 m and 9.1 m, respectively.

At this location, the Pinewood River flows from east to west. Based on the General Arrangement drawing (GA), the width of the river channel varies from 8.5 m to 11.5 m at the bridge location. The depth to the bottom of the river channel is 0.9 m below the water level (elevation 96.08).

The lands immediately surrounding the bridge site primarily consist of open fields with some forested areas. A photograph in Appendix C shows the general nature of the surrounding lands.

Based on the bedrock geology published by the Ontario Geological Society, the Pinewood River bridge site is underlain by felsic to intermediate metavolcanic rocks and minor sedimentary rocks. Locally, the bedrock is overlain by deposits of clays, silts and sands.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between August 14 and 16, 2011 and consisted of drilling and sampling six boreholes (identified as PINE-01 to PINE-06), at the existing bridge location. Boreholes PINE-01 and PINE-06 were drilled at the south and north approaches, respectively and were advanced to a depth of 11.3 m (elevations 88.5 and 88.6, respectively). Boreholes PINE-02 and PINE-03 were drilled near the south abutment and Boreholes PINE-04 and PINE-05 were drilled near the north abutment. These four boreholes were advanced to depths of 14.6 m to 22.7 m (elevation 85.3 to 77.1) where auger refusal was encountered. Bedrock was proved in Boreholes PINE-03 and PINE-04 by NQ size diamond coring. Boreholes PINE-03 and PINE-04 were advanced 3.0 m and 2.9 m into bedrock and terminated at 25.7 m and 19.5 m depth (elevations 74.1 and 80.4), respectively.

The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawing included in Appendix D.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

The drilling was carried out from the highway grade using a truck-mounted CME 75 drill rig. A combination of hollow-stem augers, casing and NQ coring methods were used to advance the boreholes. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and bedrock samples for transport to Thurber's laboratory for further examination and testing.

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

One standpipe piezometer consisting of 19 mm diameter PVC pipe with a slotted screen and enclosed in filter sand was installed at this site to permit longer term groundwater level monitoring. The boreholes were backfilled with bentonite holeplug in general accordance with O. Reg. 903 upon completion. The locations and completion details of the boreholes and piezometer are summarized in Table 3.1.

Table 3.1 – Borehole Abandonment Details

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Abandonment Details
South Approach	PINE-01	None installed	Backfilled with bentonite from 11.3 m to 0.2 m, sand from 0.2 m to 0.04 m, then asphalt to surface.
South Abutment	PINE-02	None installed	Backfilled with bentonite from 15.8 m to 0.2 m, sand from 0.2 m to 0.04 m, then asphalt to surface.
	PINE-03	None installed	Backfilled with bentonite from 25.7 m to 0.1 m, sand from 0.1 m to 0.04 m, then asphalt to surface.
North Abutment	PINE-04	None installed	Backfilled with bentonite from 19.5 m to 0.1 m, sand and gravel from 0.1 m to 0.07 m, then asphalt to surface.
	PINE-05	14.0 / 85.9	Piezometer with 1.5 m slotted screen installed with sand filter from 14.0 m to 9.8 m, holeplug from 9.8 m to 0.1 m, 50 mm of sand with asphalt patch at surface.
North Approach	PINE-06	None installed	Backfilled with bentonite from 11.3 m 0.7 m, sand from 0.7 m to 0.07 m, then asphalt to surface.

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 gradation analysis (hydrometer and sieve) and Atterberg Limits testing, where appropriate. The results of these tests are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B.

Point load tests were carried out on selected samples of intact bedrock upon arrival at the laboratory to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the rock core samples are summarized on the Record of Borehole sheets in Appendix A as average UCS per run and also included in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil and rock stratigraphy are presented in these sheets and on the "Borehole Locations and Soil Strata" drawing included in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions.

In general terms, the soil stratigraphy encountered at this site consists of a surficial layer of asphalt overlying sand fill. At the south abutment, a layer of silty clay fill was encountered below the sand fill. Organic clayey silt was encountered locally below the sand fill near the north abutment. The fill was found to be underlain by layers of native silty clay, clayey silt and a sequence of silts and sands and a layer of sand and gravel containing cobbles and boulders. These soils are underlain by moderately to slightly weathered metavolcanic bedrock. More detailed descriptions of the individual strata are presented below.

5.1 Asphalt

Asphalt was encountered at the surface in all of the boreholes since they were all drilled through the existing highway. The thickness of the asphalt ranged from 35 mm to 75 mm.

5.2 Sand Fill

Granular fill was encountered directly below the asphalt in all boreholes. The granular fill consists of brown sand containing some gravel and occasional cobbles and boulders.

The thickness of the sand fill ranged from 0.9 m to 1.8 m, with the base of the fill encountered at depths of 1.0 m to 1.9 m (elevations 98.9 to 97.9).

SPT N-values recorded in the sand fill ranged from 9 to 21 blows for 0.3 m penetration, indicating a loose to compact relative density.

Moisture contents of samples of the sand fill ranged from 8% to 17%.

One sample of the sand fill underwent laboratory gradation analysis, the results of which are summarized below. These results are also presented on the Record of Boreholes sheets included in Appendix A. The grain size distribution curve for this sample is plotted on Figure B1 of Appendix B.

Soil Particles	Sand fill (%)
Gravel	13
Sand	82
Silt and Clay	5

5.3 Silty Clay Fill

Cohesive fill was encountered below the sand fill in Boreholes PINE-01 to PINE-03 drilled near the south abutment. The cohesive fill consists of dark grey to dark brown silty clay containing trace to some sand, trace gravel and occasional organics and wood fibres. Occasional cobbles and boulders were encountered within the silty clay fill at a depth of 2.7 m (elevation 97.1) in Borehole PINE-02. Coring through the boulder(s) was required to advance the borehole. It must be recognized that embankment fills are heterogeneous in

nature and may contain cobbles, boulders and rock fill in areas away from the borehole location.

The thickness of the silty clay fill varied from 1.1 m to 3.4 m.

The depth to the base of the silty clay fill ranged from 3.0 m to 4.6 m (elevations 95.2 to 96.7).

SPT 'N' values measured in the silty clay fill ranged from 2 to 7 blows per 0.3 m of penetration, indicating a soft to firm consistency.

The moisture contents of samples of the silty clay fill ranged from 22% to 38%.

One sample of the silty clay fill underwent laboratory grain size analysis testing and Atterberg Limits testing. The results of these tests are presented on the Record of Boreholes sheets included in Appendix A. The grain size distribution curve for this sample of silty clay fill is plotted on Figure B2 of Appendix B. The results of the Atterberg Limits test are plotted on Figure B7, Appendix B. The results of these laboratory tests are summarized as follows:

Soil Particle	Silty clay fill (%)
Gravel	0
Sand	21
Silt	44
Clay	35

Index Property	(%)
Liquid Limit	48
Plastic Limit	18
Plasticity Index	30

Results of the Atterberg Limits tests indicate that the silty clay fill is of medium plasticity with a group symbol of CI.

5.4 Organic clayey silt

A layer of dark brown organic clayey silt containing trace sand and clay was encountered locally in Borehole PINE-04 below the sand fill.

The layer of organic clayey silt was 1.2 m thick, with the lower boundary at 2.4 m depth (elevation 97.5).

A single SPT N-value of 6 blows for 0.3 m penetration was recorded in the organic clayey silt, indicating a loose relative density.

The moisture content of one sample of organic clayey silt was 26%.

5.5 Silty Clay

Native silty clay was encountered below the silty clay fill in Boreholes PINE-01 to PINE-03, below the layer of organic clayey silt in Borehole PINE-04 and below the sand fill in Boreholes PINE-05 and PINE-06. The silty clay is brown to grey and contains trace sand to sandy, trace gravel and occasional sand seams and wood fibres. The silty clay was also described as varved and contains silt layers. The thickness of the native silty clay layer ranged from 6.1 m to 9.5 m.

The depth to the base of the silty clay ranged from 10.1 m to 12.2 m depth (elevations 89.8 to 87.6).

SPT N-values recorded in the native silty clay ranged from 0 to 7 blows for 0.3 m penetration, indicating a very soft to firm consistency.

Moisture contents of samples of the native silty clay generally ranged from 21% to 49%. Three high moisture contents ranging from 66% to 73% were measured at approximate elevation 95.0 in Boreholes PINE-04 to PINE-06.

Several samples of the native silty clay underwent laboratory gradation analysis testing and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figures B3 and B4 of Appendix B and the results of the Atterberg Limits tests are plotted on Figures B8 and B9.

Soil Particle	Silty clay (%)
Gravel	0 to 4
Sand	0 to 34
Silt	23 to 46
Clay	25 to 76

Index Property	(%)
Liquid Limit	31 to 87
Plastic Limit	13 to 29
Plasticity Index	18 to 58

Results of the Atterberg Limits tests indicate that the silty clay ranges from low to high plasticity with group symbols of CL, CI and CH.

5.6 Clayey Silt

Grey clayey silt containing trace sand was contacted below the silty clay at 10.7 m depth (elevation 89.1) in Borehole PINE-01.

The borehole was terminated within the clayey silt layer at 11.3 m depth (elevation 88.5).

An SPT N-value measured in the clayey silt was 11 blows per 0.3 m of penetration, indicating a stiff consistency.

The moisture content of the clayey silt was 38%.

A grain size distribution curve for a clayey silt sample is presented on the Record of Borehole sheets and on Figure B5 of Appendix B. The results of the Atterberg Limits tests are plotted on Figure B10, Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particle	Clayey Silt (%)
Gravel	0
Sand	2
Silt	79
Clay	19

Index Property	(%)
Liquid Limit	39
Plastic Limit	18
Plasticity Index	21

Results of the Atterberg Limits tests indicate that the clayey silt is of medium plasticity with a group symbol of CI.

5.7 Gravelly Sand

Grey gravelly sand was contacted below the silty clay at 10.1 m depth (elevation 89.8) in Borehole PINE-04, drilled at the north abutment. The thickness of the layer was 1.0 m.

The depth to the base of the gravelly sand was 11.1 m (elevation 88.8).

An SPT N-value measured in the gravelly sand was 61 blows per 0.3 m of penetration, indicating a very dense relative density.

A moisture content of the gravelly sand was 9%.

5.8 Silt and Sand

A layer of greenish grey silt and sand was encountered below the silty clay in Boreholes PINE-02, PINE-03, PINE-05 and PINE-06 and below the thin layer of gravelly sand in Borehole PINE-04. The silt and sand layer contains trace clay, trace gravel and occasional layers of coarse sand and cobbles and boulders.

The silt and sand layer was fully penetrated in Boreholes PINE-03 and PINE-04 where it was 3.8 m thick. The depth to the base of the silt and sand was at 14.9 m in Borehole PINE-04 (elevation 85.0) and at 16.0 m (elevation 83.8) in Borehole PINE-03.

Boreholes PINE-02 and PINE-05 were terminated below the silt and sand layer upon refusal on probable bedrock or boulder at 15.8 m and 14.6 m depth (elevations 84.0 and 85.3). Borehole PINE-06 was terminated within the silt and sand at 11.3 m depth (elevation 88.6).

SPT N-values recorded in the silt and sand layer ranged from 41 blows for 0.3 m penetration to 50 blows for 0.075 m penetration, indicating a dense to very dense relative density. SPT N-values of 20 and 21 blows per 0.3 m of penetration were measured in Boreholes PINE-02 and PINE-03 near elevation 87.6.

The moisture content of samples of the silt and sand ranged from 11% to 21%.

Five samples of the silt and sand layer underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure B6, Appendix B.

Soil Particles	Silt and sand (%)
Gravel	1 to 3
Sand	38 to 54
Silt	39 to 57
Clay	4 to 6

5.9 Sand and Gravel with Cobbles and Boulders

A layer of grey sand and gravel containing cobbles and boulders was encountered below the silt and sand layer at 16.0 m and 14.9 m (elevations 83.8 and 85.0) in Boreholes PINE-03 and PINE-04, respectively.

The thickness of the sand and gravel layer was 6.7 m in Borehole PINE-03 and 1.7 m in Borehole PINE-04. The lower boundary of the sand and gravel layer was encountered at a depth of 16.6 m in Borehole PINE-04 (elevation 83.3) and a depth of 22.7 m in Borehole PINE-03 (elevation 77.1).

Due to the presence of cobbles and possibly boulders within the sand and gravel layer, coring methods were required to advance the boreholes and no SPT N-values were recorded in the sand and gravel layer. Samples of the layer of sand and gravel with cobbles were collected from the core barrel.

The moisture content of samples of the sand and gravel layer collected from the core barrel ranged from 6% to 15%.

Photographs of the samples recovered from coring through this layer are included in Appendix C. The cobbles ranged in size from 75 mm to greater than 120 mm.

5.10 Bedrock and refusal

The overburden soils described above are underlain by grey metavolcanic bedrock. The bedrock is generally described as moderately weathered to fresh. Sub-vertical fractures were noted throughout the bedrock cores.

Bedrock was proved by coring in Boreholes PINE-03 and PINE-04 drilled at the south and north abutments, respectively. Table 5.1 summarizes depths and elevations to the top of bedrock and auger refusal on probable bedrock or boulders.

Table 5.1 – Depths and Elevations of Top of Bedrock and Auger Refusal

Location	Borehole	Top of Bedrock/ Auger Refusal	
		Depth (m)	Elevation (m)
South Abutment	PINE -02	15.8	84.0
	PINE-03	22.7[(1)]	77.1
North Abutment	PINE-04	16.6[(1)]	83.3
	PINE-05	14.6	85.3

[(1)] Bedrock proved by coring

Total core recovery (TCR) in the bedrock cores ranged from 92% to 100%. The RQD value ranged from 17% to 37% in Borehole PINE-03, indicating very poor to poor rock quality. The RQD was 80% in Borehole PINE-04, indicating good rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was generally less than 7.

The average estimated unconfined compressive strength of the rock cores ranged from 74 MPa to 135 MPa, indicating a strong to very strong rock. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. These results are summarized on the Record of Borehole sheets included in Appendix A. A summary of the Point Load Test Results is presented in Appendix B.

5.11 Water Levels

Water levels were not observed in the open boreholes during the drilling operations as water was introduced into the boreholes in order to complete and core them. One standpipe piezometer was installed in Borehole PINE-05 to monitor water levels after completion of drilling. However, this piezometer was destroyed prior to a subsequent site

visit for obtaining stabilized water level reading and no piezometric reading is therefore available.

GA drawings indicate that the water level in the Pinewood River was at elevation 96.08 m in May 2011.

6 MISCELLANEOUS

Borehole locations were selected in the field by Thurber Engineering Ltd. Borehole elevations and coordinates were provided by Genivar.

Thurber obtained utility clearances for the borehole locations prior to drilling.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied a truck mounted CME 75 drill rig and conducted the drilling, sampling and in-situ testing operations.

The field program was supervised on a full time basis by Ms. Eckie Siu of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall planning and supervision of the field program was conducted by Mr. Mark Farrant, P. Eng. Interpretation of the data and preparation of this report were carried out by Ms. Lindsey Blaine, E.I.T. and Ms. R. Palomeque Reyna, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundations Projects.

Lindsey Blaine, E.I.T.
Project Manager

L. Blaine
Dec. 5/12

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer

P. K. Chatterji, P.Eng.
Review Principal

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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

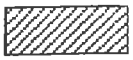
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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			

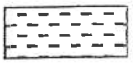
EXPLANATION OF ROCK LOGGING TERMS

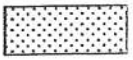
ROCK WEATHERING CLASSIFICATION

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

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Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No PINE-01 1 OF 2 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.16 - 2011.08.16 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
99.8											
0.0	**ASPHALT:** (35mm)										
	SAND, some gravel Brown Moist (FILL)										
98.6	Loose		1	SS	9		99				
1.2	Silty **CLAY**, trace to some sand, trace gravel Soft Dark Grey to Dark Brown (FILL)		2	SS	3		98				
			3	SS	2		97				0 21 44 35
95.2			4	SS	3		96				
4.6	Silty **CLAY**, trace to some sand, trace gravel Very Soft Grey		5	SS	2		95				
	Sand seams		6	SS	0		94				4 19 40 37
			7	SS	0		93				
			8	SS	0		92				
							91				
							90				

Continued Next Page

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

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

ONTMT4S 0840.GPJ 4/25/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-01 2 OF 2 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.16 - 2011.08.16 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
	Continued From Previous Page										
89.1	Silty **CLAY**, some sand Very Soft Grey Wet										
10.7 88.5	Clayey **SILT**, trace sand Stiff Grey		9	SS	11		89		w_P w w_L		0 2 79 19
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.2m, SAND TO 0.04m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 0840.GPJ 4/25/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-02 1 OF 2 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.16 - 2011.08.16 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
99.8											
0.0	**ASPHALT:** (35mm)										
	SAND, some gravel Compact Brown Moist (FILL)		1	SS	10		99				
98.5											
1.3	Silty **CLAY**, trace to some sand, trace gravel, occasional organics and wood fibres Firm to Soft Brown (FILL)		2	SS	7		98				
			3	SS	3		97				
	Cobble at 2.7m Cored through boulder (240mm) at 3.0m		4	CORE							
96.5											
3.3	Silty **CLAY**, some sand to sandy Soft to Very Soft Dark Grey to Grey						96				
			5	SS	4		95				0 34 39 27
			6	SS	0		94				
							93				
			7	SS	0		92				
							91				
			8	SS	1		90				0 15 38 47

Continued Next Page

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

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

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No PINE-02 2 OF 2 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.16 - 2011.08.16 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
	Continued From Previous Page										
	Silty **CLAY**, varved with silt layers Firm Grey										
			9	SS	6		89		c		
87.6							88				
12.2	**SILT** and **SAND**, trace clay, trace gravel Compact to Very Dense Grey Moist		10	SS	20		87		c		
	Occasional coarse sand seams		11	SS	57		86		o		2 48 46 4
			12	SS	50/		85		o		
	Occasional cobbles				0.075						
84.0							84				
15.8	END OF BOREHOLE AT 15.8m UPON CASING REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE TO 0.2m, SAND TO 0.04m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 0840.GPJ 5/9/12

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THURBER

RECORD OF BOREHOLE No PINE-03 1 OF 3 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.15 - 2011.08.15 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
99.8											
0.0	**ASPHALT:** (50mm)										
	SAND, some gravel Compact Brown Moist (FILL)		1	SS	12				○		
	Layer of grey silty sand (480mm)		2	SS	11				○		
97.9											
1.9	Silty **CLAY**, some sand, mixed with organics Soft Dark Brown (FILL)		3	SS	2				○		
96.7											
3.0	Silty **CLAY**, some sand to sandy Very Soft Brown		4	SS	0				⊢○⊣		0 29 46 25
	Coarse sand seam, occasional wood fibres Grey		5	SS	1				○		
			6	SS	0				○		
			7	SS	0				⊢○⊣		0 14 36 50
			8	SS	0				○		

99 98 97 96 95 94 93 92 91 90

Continued Next Page

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

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

ONTMT4S 0840.GPJ 4/25/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-03 2 OF 3 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES
HWY 617 BOREHOLE TYPE Casing COMPILED BY AN
DATUM Geodetic DATE 2011.08.15 - 2011.08.15 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
	Continued From Previous Page										
	Silty **CLAY**, varved, silt layers Firm Grey										
			9	SS	4		89		○		
87.6							88				
12.2	**SILT** and **SAND**, trace clay, trace gravel Compact Greenish Grey Moist		10	SS	21		87		c		1 38 57 4
	Dense		11	SS	48		86		○		
	Occasional cobbles		12	SS	45		85		○		
83.8	Casing refusal at 16.0m.						84				
16.0	**SAND** and **GRAVEL**, with cobbles and boulders Grey Cored through cobbles (50mm to 120mm) from 16.0m to 22.7m		1	CORE			83		○		
			2	CORE			82		○		
	Mostly sand and gravel, occasional cobbles		3	CORE			81		○		
							80				

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

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

ONTMT4S 0840.GPJ 11/7/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-03 3 OF 3 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.15 - 2011.08.15 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
	Continued From Previous Page										
	SAND and **GRAVEL**, with cobbles and boulders Grey Frequent cobbles and boulders, some sand						79		○		
			4	CORE			78				
77.1											
22.7	**BEDROCK**, metavolcanic, grey		1	RUN			77				RUN #1 TCR=100% SCR=47% RQD=17% UCS=100MPa (Average)
							76				
	Sub-vertical fractures (25mm to 75mm long) at 21.7m, 23.1m, 23.8m, 24.0m, 24.3m, 24.5m, 24.6m, 24.8m, 25.1m, 25.2m 150mm at 22.8m 150mm at 23.5m		2	RUN			75				RUN #2 TCR=100% SCR=68% RQD=37% UCS=74MPa (Average)
74.1											
25.7	END OF BOREHOLE AT 25.7m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.1m, SAND TO 0.04m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 0840.GPJ 6/27/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-04 1 OF 3 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.14 - 2011.08.14 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
99.9											
0.0	**ASPHALT:** (75mm)										
0.1	**SAND**, some gravel Compact Brown Wet (FILL)		1	SS	14		99		○		
98.7											
1.2	**ORGANIC**, clayey silt, trace sand, trace clay Loose Dark Brown Wet		2	SS	6		98		○		
97.5											
2.4	Silty **CLAY**, some sand to sandy Firm to Very Soft Grey		3	SS	7		97		○		
			4	SS	4		96		○		
			5	SS	0		95		○		
	Occasional sand seams		6	SS	0		94		⊢○⊣		0 24 44 32
			7	SS	0		93		○		
			8	SS	0		92		○		
							91		○		
							90				

Continued Next Page

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

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

ONTMT4S 0840.GPJ 6/20/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-04 2 OF 3 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.14 - 2011.08.14 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
89.8	Continued From Previous Page										
10.1	Gravelly **SAND**, coarse grained Very Dense Grey Moist										
88.8			9	SS	61		89		○		2 54 39 5
11.1	**SILT** and **SAND**, trace clay, trace gravel Very Dense Grey Moist						88				
			10	SS	64				○		3 44 48 5
							87				
			11	SS	63		86		○		
85.0	Cobbles and boulders										
14.9	**SAND** and **GRAVEL**, with cobbles and boulders Cored through cobbles and boulders from 14.9m to 16.6m		1	RUN			85				RUN #1 TCR=33%
							84				
83.3										FI	
16.6	**BEDROCK**, metavolcanic, grey Sub-vertical fractures (25mm to 75mm long) from 16.4m to 16.8m and 17.2m to 17.5m Clay seam (50mm thick) at 17.4m		2	RUN			83			5 3 7	RUN #2 TCR=92% SCR=83% RQD=80% UCS=135MPa (Average)
	Sub-vertical fractures (25mm to 50mm long) at 17.9m, 18.1m, 18.2m, 18.6m 125mm at 18.3m 100mm at 18.5m 300mm at 18.6m 150mm at 19.1m 100mm at 19.2m						82			3 1	
	Quartz interbeds (25mm to 75mm thick) at 18.3m, 18.9m, 19.1m, 19.3m 175mm at 18.0m		3	RUN			81			3 1 4 >4 2	RUN #3 TCR=100% SCR=100% RQD=80% UCS=106MPa (Average)
80.4											
19.5	END OF BOREHOLE AT 19.5m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.1m, SAND AND										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 0840.GPJ 6/27/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-04 3 OF 3 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.14 - 2011.08.14 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										
	GRAVEL TO 0.07m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 0840.GPJ 4/25/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-05 1 OF 2 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.14 - 2011.08.14 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 ● 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
99.9											
0.0 / 0.1	**ASPHALT:** (75mm)										
	SAND, some gravel, occasional cobbles and boulders Compact Brown Moist (FILL)		1	SS	21		99		○		13 82 5 (SI+CL)
98.0			2	SS	6		98		○		
1.9	Silty **CLAY**, trace sand, trace gravel Firm to Soft Brown		3	SS	6		97		○		
			4	SS	2		96		○		
	Very Soft Grey		5	SS	0		95		⊢○⊣		0 8 23 69
	Occasional sand seams		6	SS	0		94		○		
			7	SS	0		93				
			8	SS	0		92		○		
							91				
							90		○		

Continued Next Page

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

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

ONTMT4S 0840.GPJ 4/25/12

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THURBER

RECORD OF BOREHOLE No PINE-05 2 OF 2 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES
HWY 617 BOREHOLE TYPE Casing COMPILED BY AN
DATUM Geodetic DATE 2011.08.14 - 2011.08.14 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 ● 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
	Continued From Previous Page										
89.6	Silty **CLAY** Very Soft Grey										
10.3	**SILT** and **SAND**, trace gravel, trace clay Very Dense to Dense Greenish Grey Moist		9	SS	85		89		○		2 53 39 6
	Layer of coarse sand		10	SS	44		88		○		
	Occasional cobbles		11	SS	117		87				
85.3							86		○		
14.6	END OF BOREHOLE AT 14.6m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDERS. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. UNABLE TO TAKE READINGS AS PIEZOMETER WAS DESTROYED.										

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 0840.GPJ 11/7/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PINE-06 1 OF 2 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.16 - 2011.08.16 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
99.9											
0.0	**ASPHALT:** (50mm)										
	SAND, some gravel Brown Moist (FILL)										
98.9											
1.0	Silty **CLAY** Stiff to Soft Brown		1	SS	13		99		○		
			2	SS	3		98		○		
			3	SS	4				⊢○→		0 0 24 76
			4	SS	6		97				
							96				
			5	SS	1		95		○		
	Very Soft										
							94		○		
	Grey		6	SS	0						
							93				
			7	SS	1		92		⊢○⊣		
							91		○		
			8	SS	1						
							90				

Continued Next Page

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

15 20 5 10 (%) STRAIN AT FAILURE

ONTMT4S 0840.GPJ 4/25/12

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THURBER

RECORD OF BOREHOLE No PINE-06 2 OF 2 METRIC

W.P. 6094-10-00 LOCATION Pinewood River Bridge ORIGINATED BY ES

HWY 617 BOREHOLE TYPE Casing COMPILED BY AN

DATUM Geodetic DATE 2011.08.16 - 2011.08.16 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
	Continued From Previous Page										
89.4	Silty **CLAY** Very Soft Grey										
10.5 88.6	**SILT** and **SAND**, trace gravel Very Dense Greenish Grey Moist		9	SS	41		89		○		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.7m, SAND TO 0.07m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 0840.GPJ 4/25/12

Appendix B

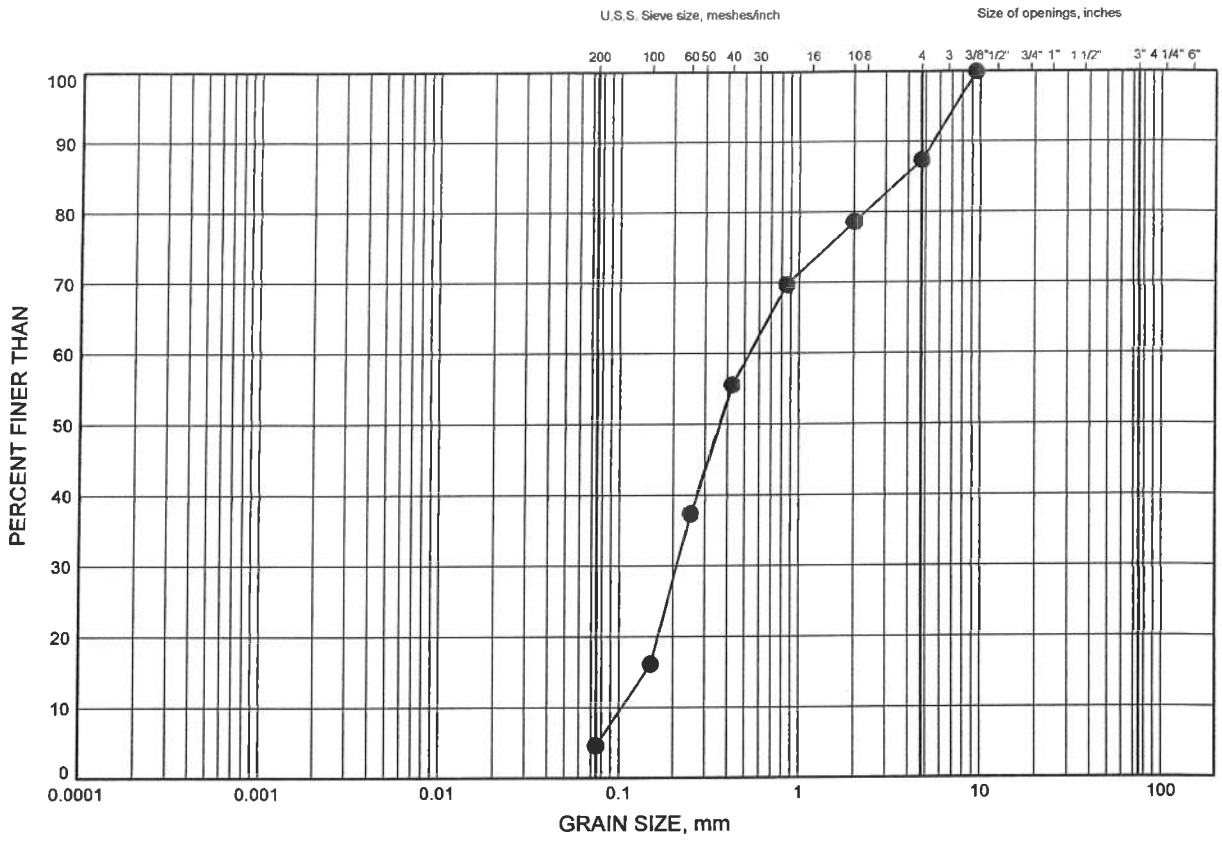
Laboratory Test Results

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PINE-05	1.07	98.79

W.P.# 6094-10-00
Prepared By AN
Checked By RPR

THURBER

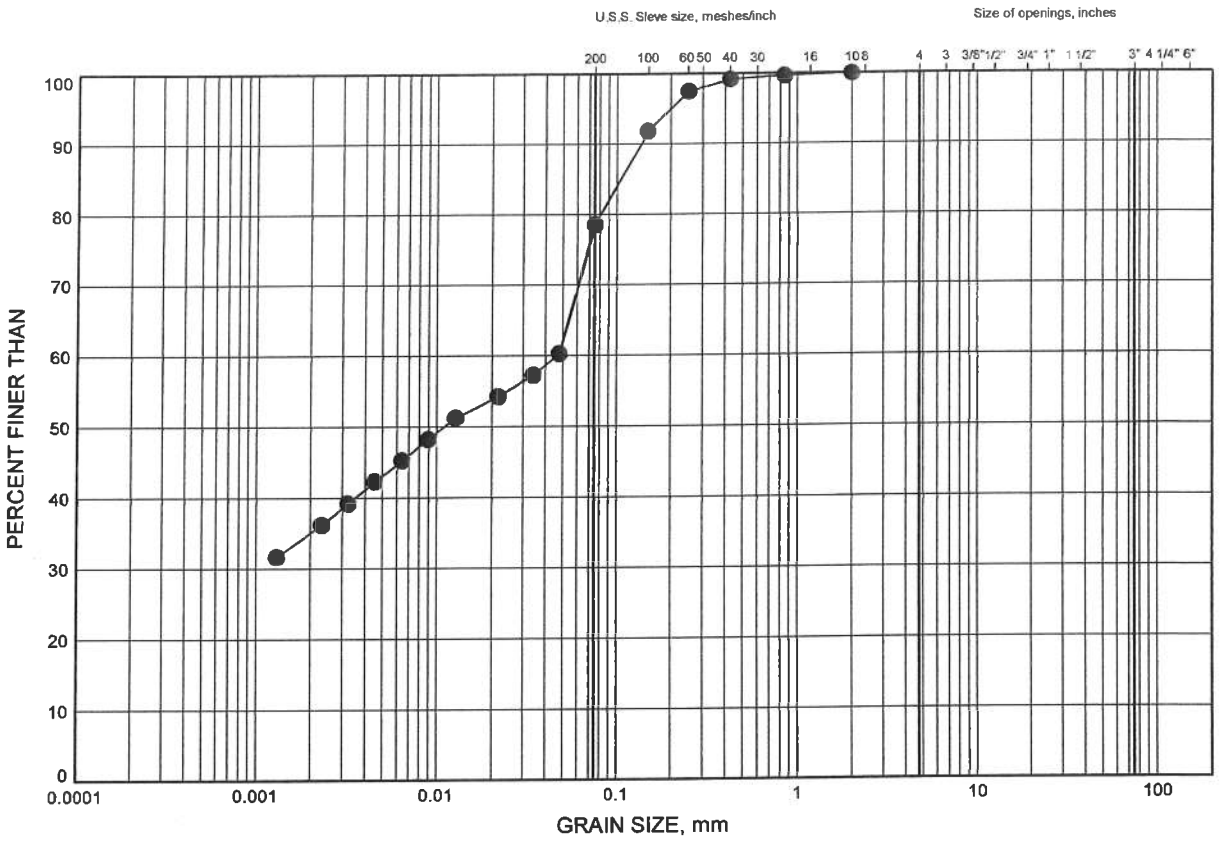
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 4/25/12

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PINE-01	2.59	97.17

W.P.# 6094-10-00
Prepared By AN
Checked By RPR

THURBER

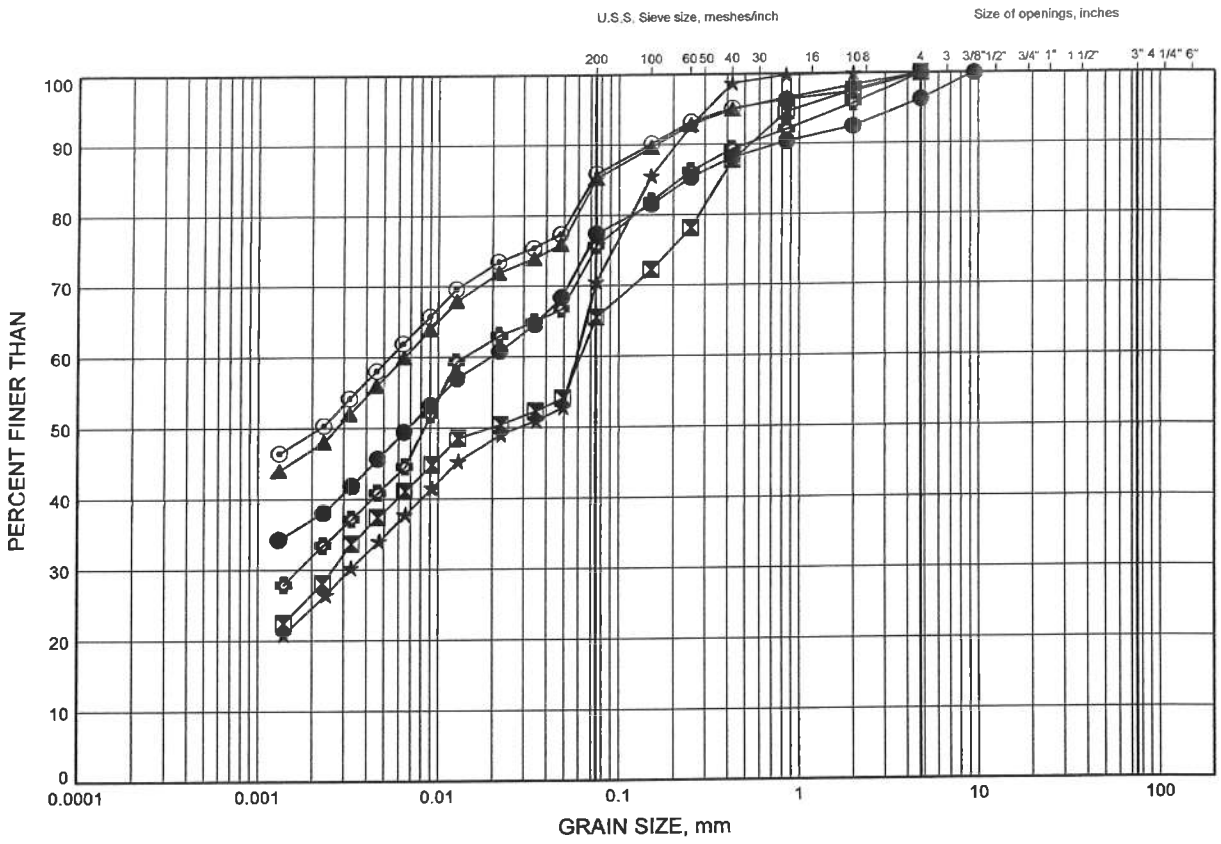
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 4/25/12

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PINE-01	6.40	93.36
⊠	PINE-02	4.88	94.89
▲	PINE-02	9.45	90.32
★	PINE-03	3.35	96.41
⊙	PINE-03	7.92	91.83
✿	PINE-04	6.40	93.47

W.P.# 6094-10-00
Prepared By AN
Checked By RPR

THURBER

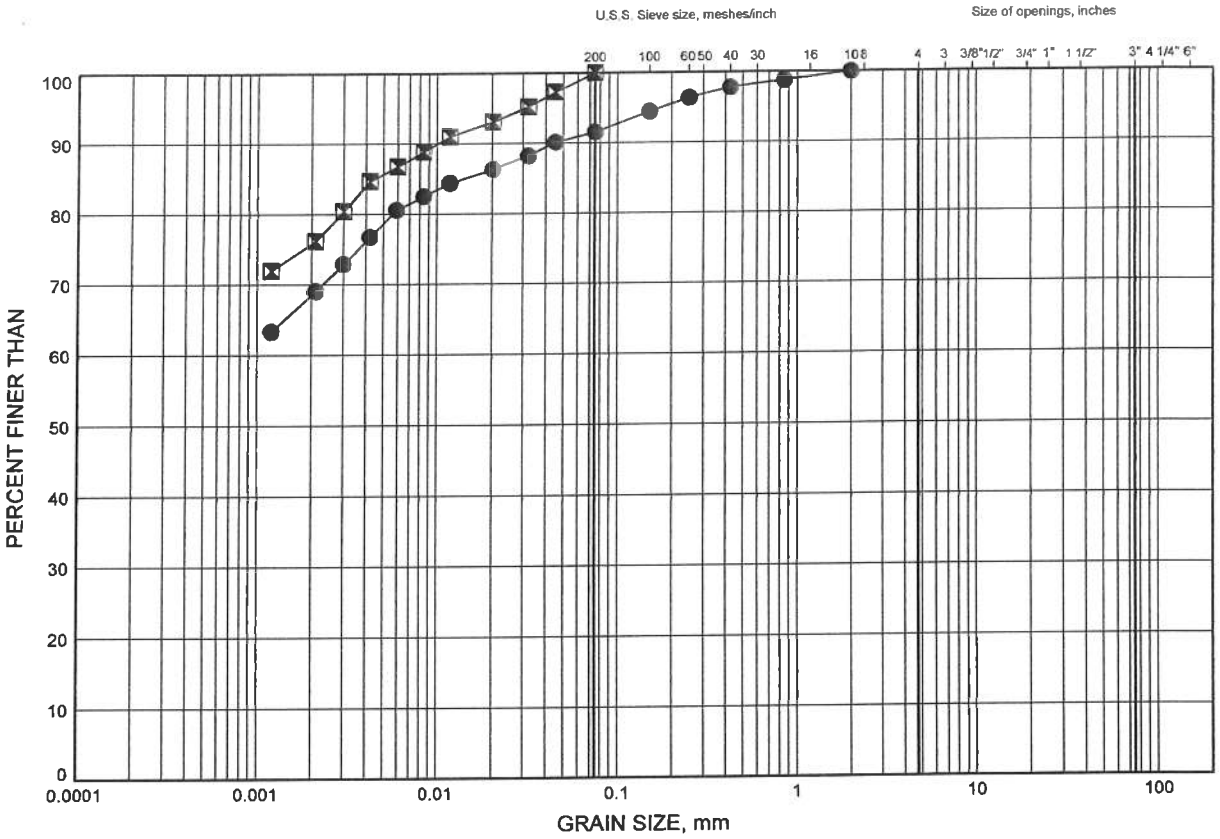
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 4/25/12

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PINE-05	4.88	94.98
⊠	PINE-06	2.59	97.31

W.P.# 6094-10-00
Prepared By AN
Checked By RPR

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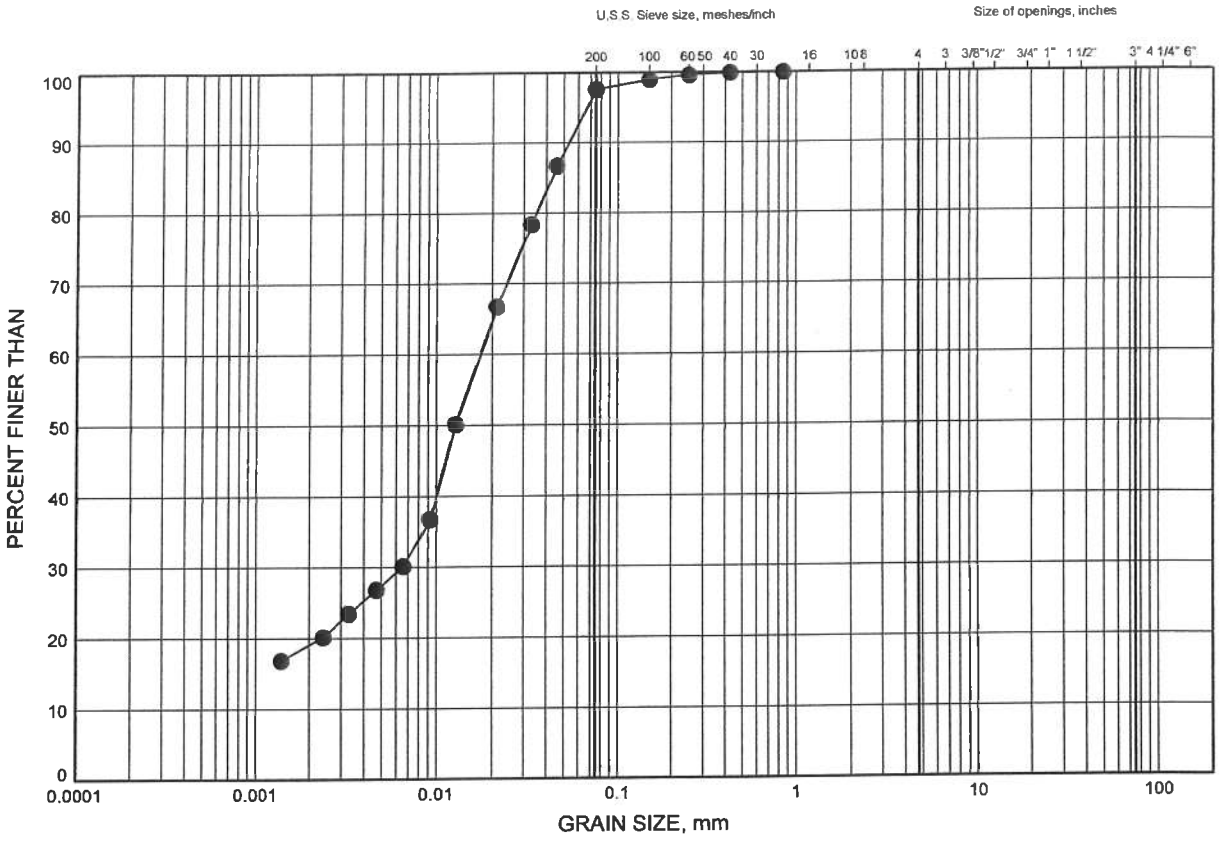
NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B5

CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PINE-01	10.97	88.79

W.P.# 6094-10-00
Prepared By AN
Checked By RPR

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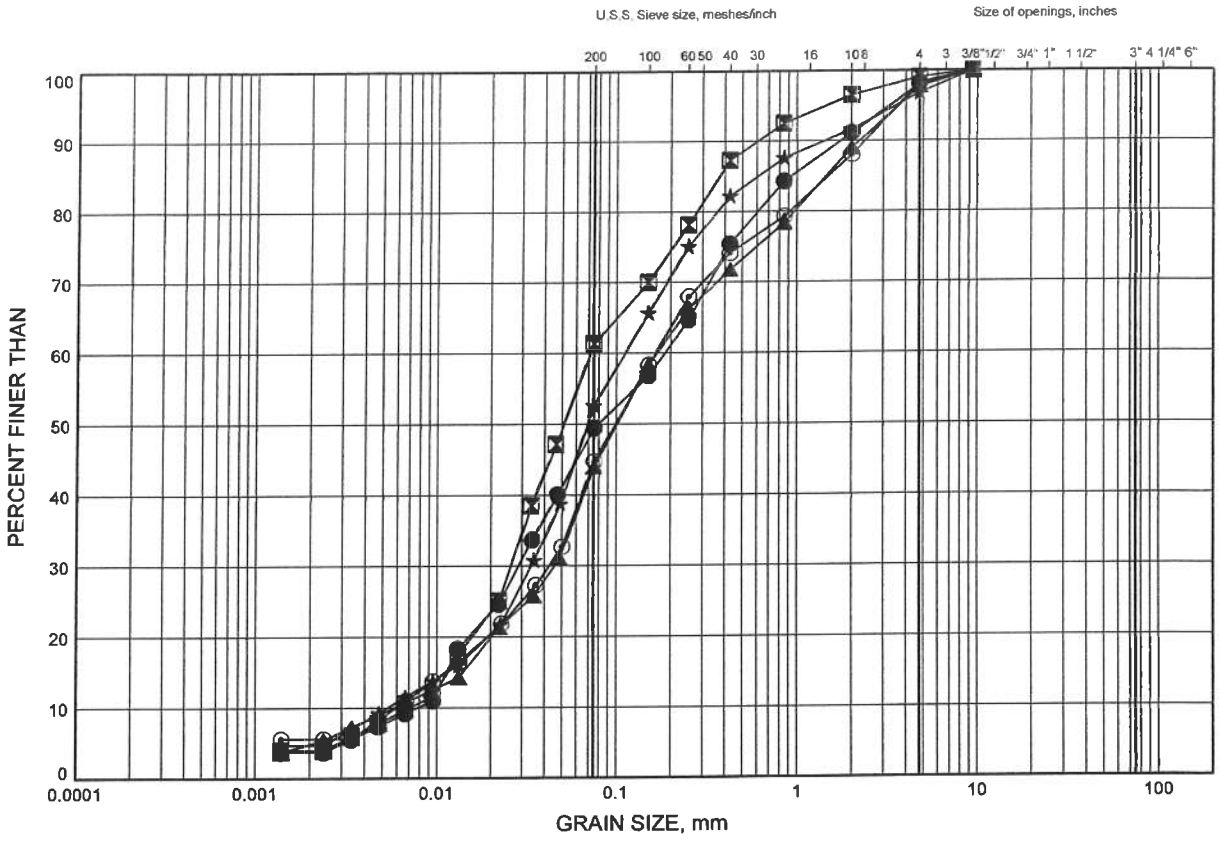
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 4/25/12

NWR HWY 11 Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B6

SILT & SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PINE-02	14.02	85.75
⊠	PINE-03	12.50	87.26
▲	PINE-04	11.13	88.74
★	PINE-04	12.50	87.37
⊙	PINE-05	10.97	88.89

W.P.# 6094-10-00
Prepared By AN
Checked By RPR

THURBER

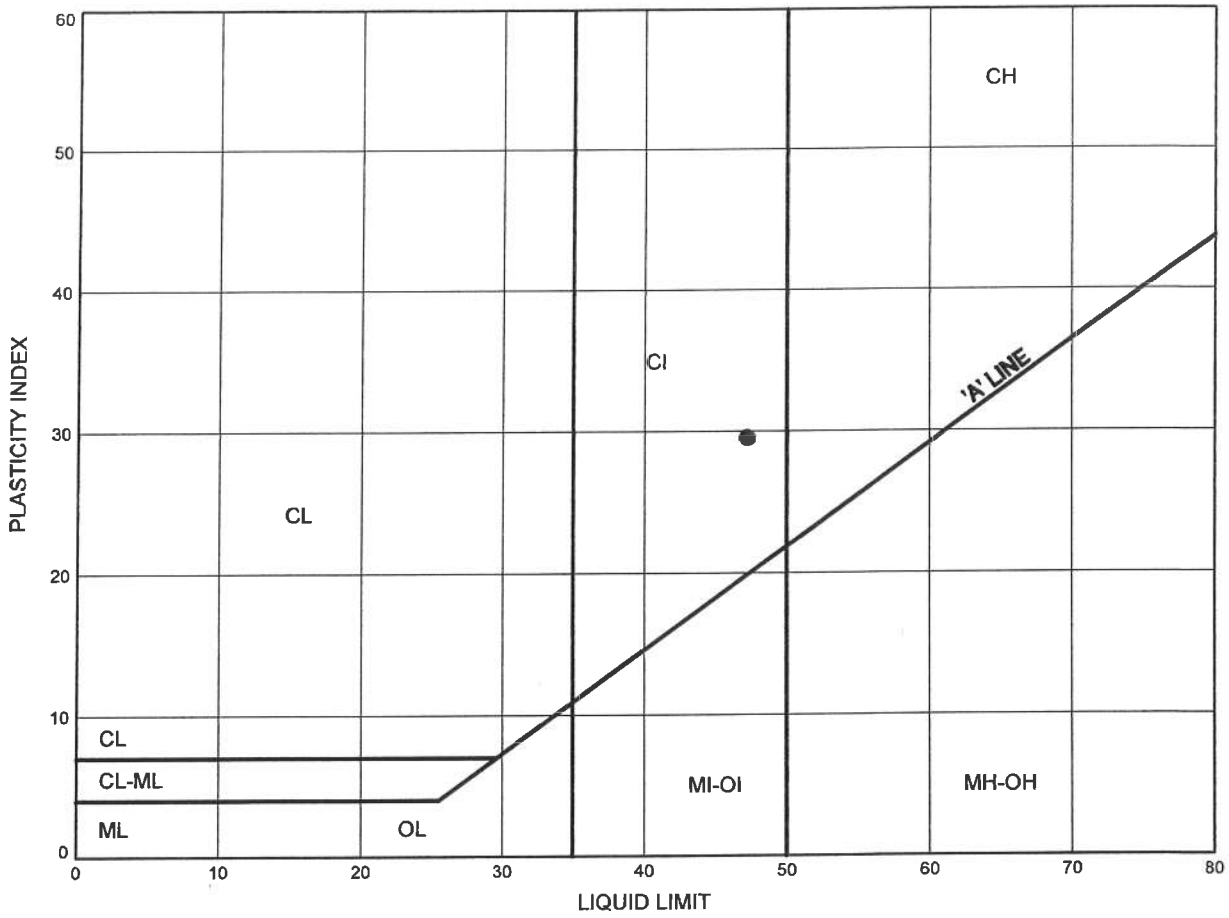
GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 4/25/12

NWR HWY 11 Bridge

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

SILTY CLAY FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PINE-01	2.59	97.17

Date April 2012

Project 6094-10-00

THURBER

Prep'd AN

Chkd. RPR

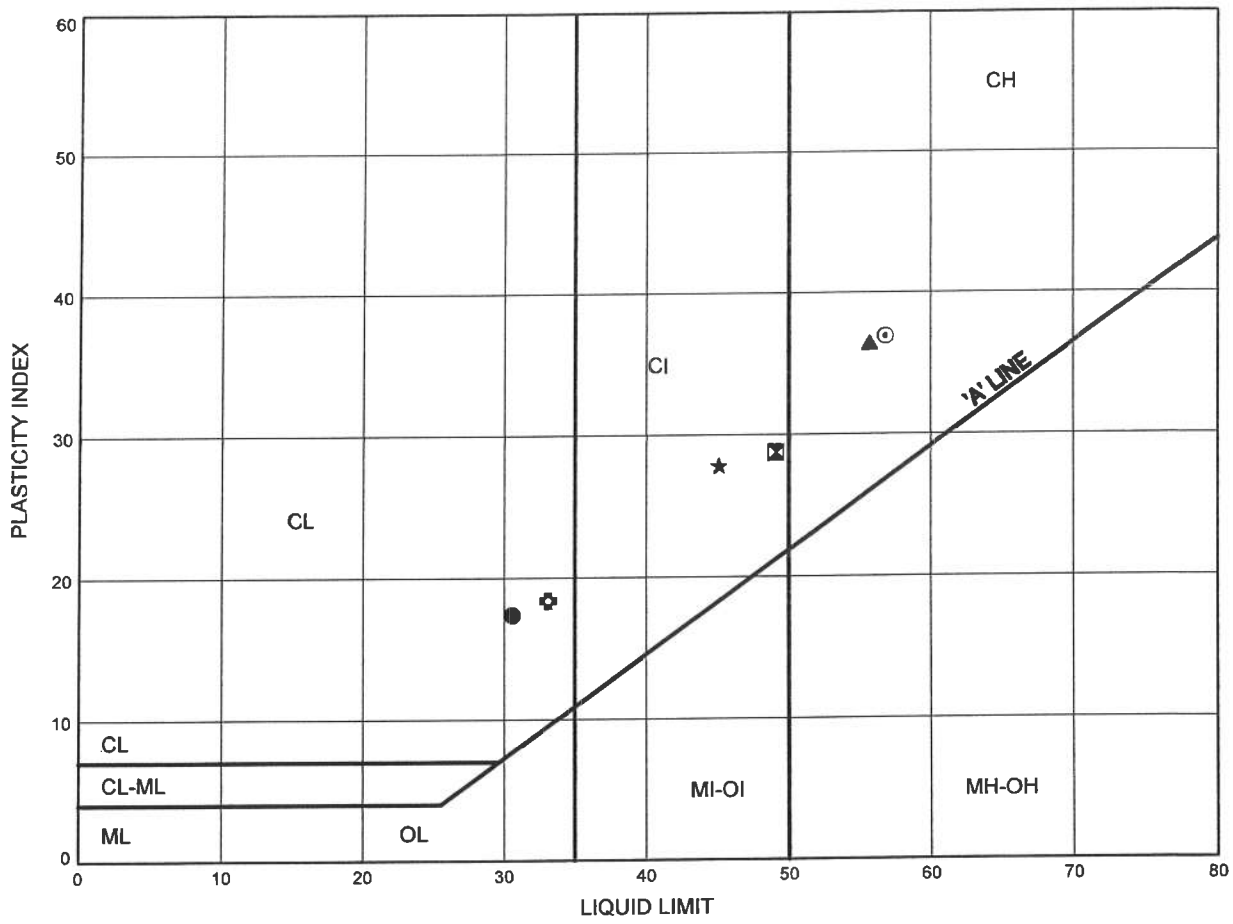
THURBALT 0840.GPJ 4/25/12

NWR HWY 11 Bridge

ATTERBERG LIMITS TEST RESULTS

FIGURE B8

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PINE-01	6.40	93.36
⊠	PINE-02	4.88	94.89
▲	PINE-02	9.45	90.32
★	PINE-03	3.35	96.41
⊙	PINE-03	7.92	91.83
✿	PINE-04	6.40	93.47

Date April 2012

Project 6094-10-00

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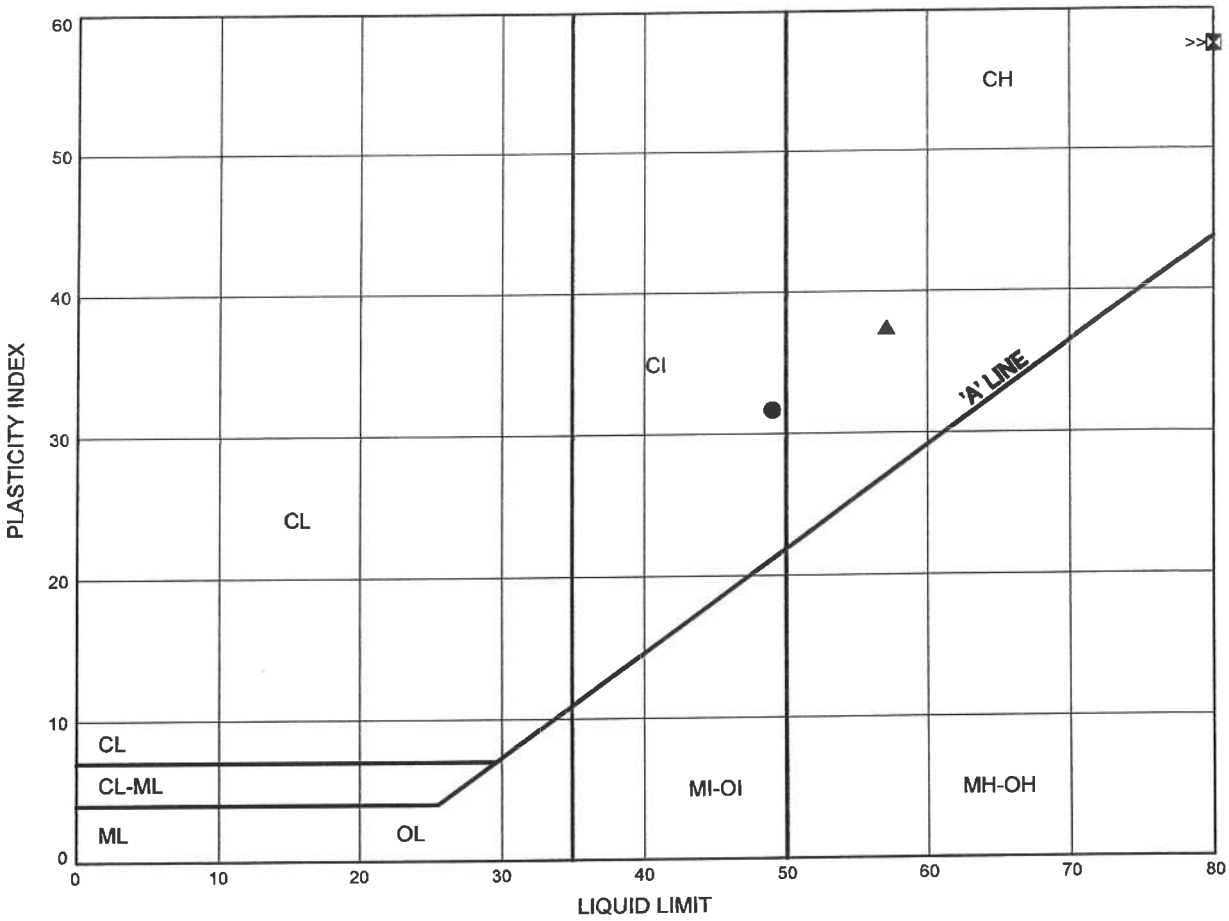
THURBALT 0840.GPJ 4/25/12

NWR HWY 11 Bridge

ATTERBERG LIMITS TEST RESULTS

FIGURE B9

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PINE-05	4.88	94.98
⊠	PINE-06	2.59	97.31
▲	PINE-06	7.92	91.97

Date April 2012

Project 6094-10-00

THURBER

Prep'd AN

Chkd. RPR

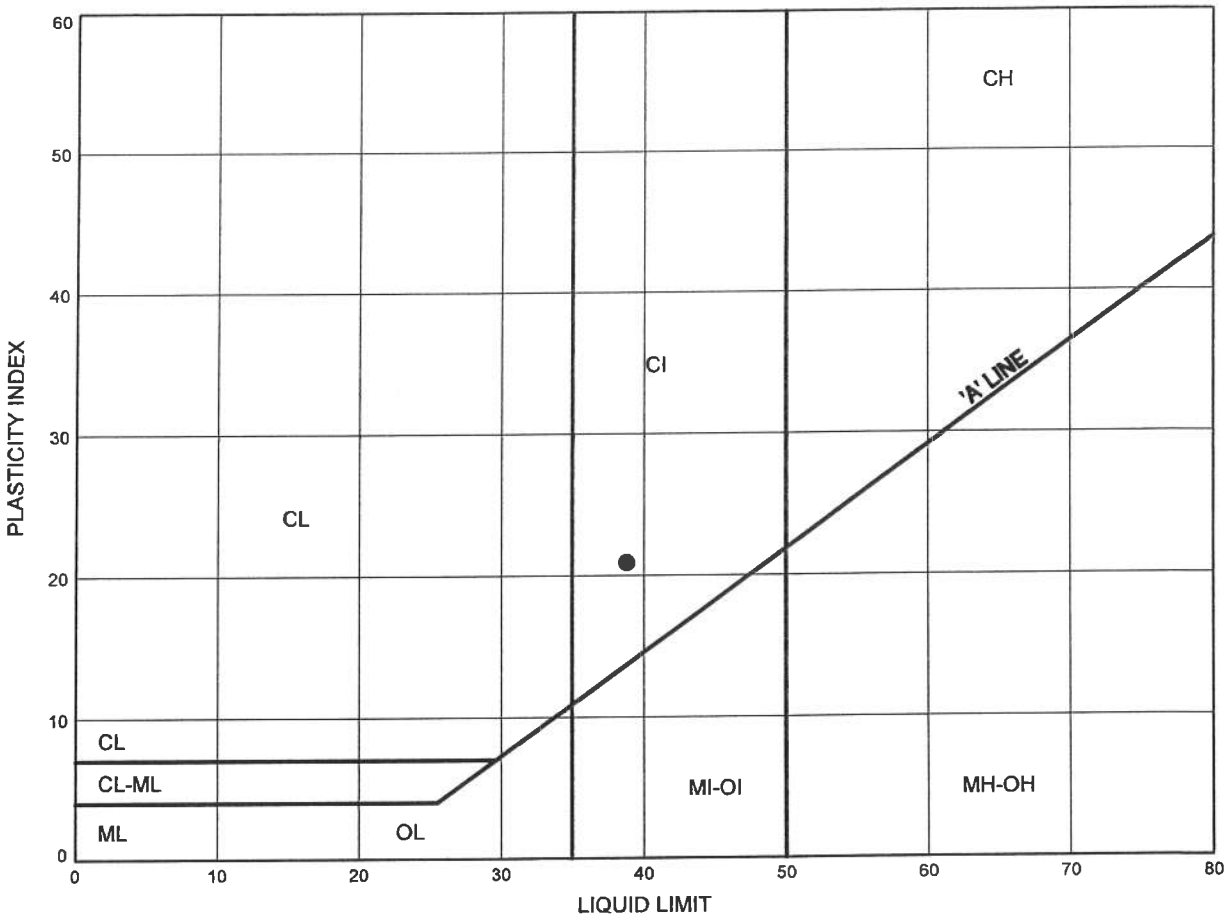
THURBALT 0840.GPJ 4/25/12

NWR HWY 11 Bridge

ATTERBERG LIMITS TEST RESULTS

FIGURE B10

CLAYEY SILT



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PINE-01	10.97	88.79

Date April 2012

Project 6094-10-00

THURBER

Prep'd AN

Chkd. RPR

THURBALT 0840.GPJ 4/25/12

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-5308-40 **Client :** GENIVAR

Date Drilled : August 15,2011

Project Name : Pinewood River Bridge **Date Tested :** September 02,2011

Core Size : NQ **BH No :** PINE-03 **Tester :** DB

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	23.5	D	11.9	47.4	84.5	124.4		Very Strong
2	1	23.7	D	6.8	45.8	70.8	74.9		Strong
3	2	24.3	D	7.1	47.4	71.0	74.2		Strong
4	2	25.2	D	7.3	47.7	77.1	75.6		Strong
5	2	25.5	D	6.8	47.5	47.3	70.8		Strong
6									
7									
8									
9									
10									
11									
12									
13									
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15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-5308-40 **Client :** GENIVAR

Date Drilled : August 14,2011

Project Name : Pinewood River Bridge **Date Tested :** September 02,2011

Core Size : NQ **BH No :** PINE-04 **Tester :** DB

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	15.2	D	21.5	47.3	82.0	225.1		Very Strong
2	2	16.6	D	13.4	47.4	80.6	139.8		Very Strong
3	2	17.0	D	19.9	47.2	82.8	208.5		Very Strong
4	2	17.9	D	5.3	47.4	68.8	55.3		Strong
5	3	18.0	D	13.2	47.5	67.3	137.7		Very Strong
6	3	18.7	D	7.3	47.3	61.0	76.4		Strong
7	3	19.3	D	10.0	47.4	66.0	104.1		Very Strong
8									
9									
10									
11									
12									
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25									
26									
27									
28									
29									
30									

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

Appendix C

Site Photographs
and
Photographs of samples recovered from coring through the layer of sand and gravel with cobbles and boulders

Photograph 1 – Pinewood River Bridge, looking south.

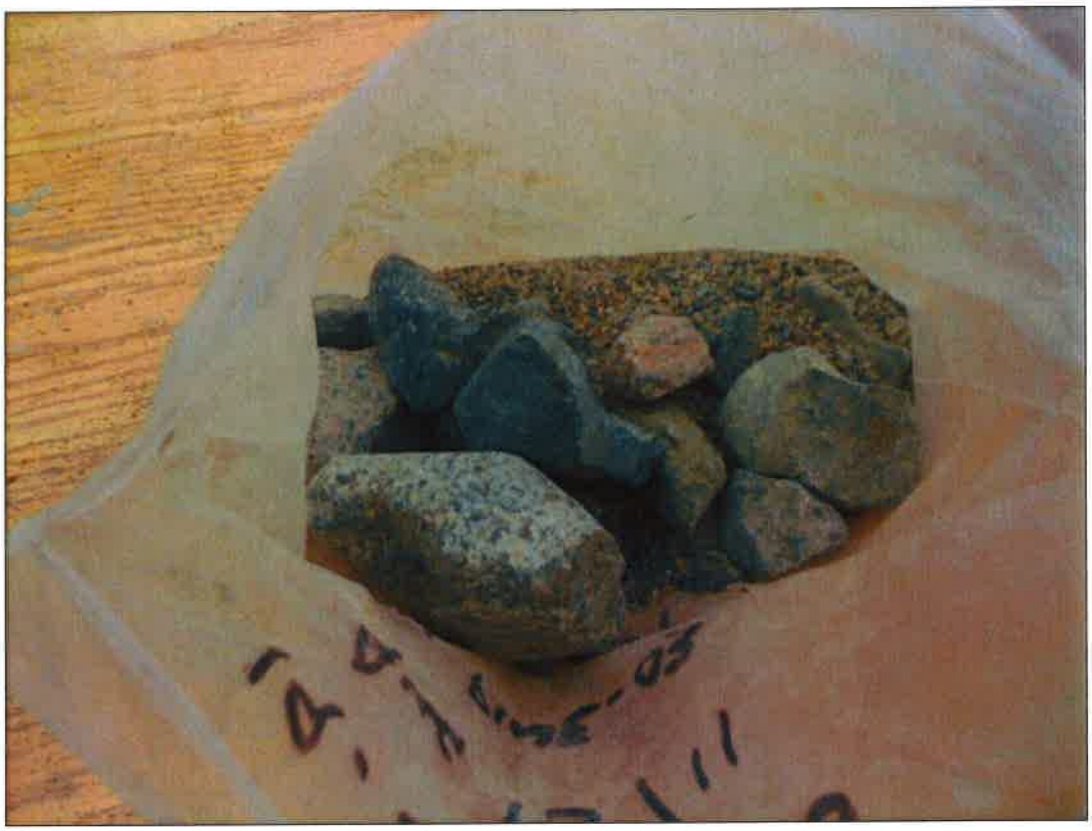
Photographs 2 and 3 – West side of Pinewood River Bridge

Photograph 4 – East side of Pinewood River Bridge

Photograph 5 - Sample from Borehole PINE-03, Run 2, Depth: 17.4 m to 18.9 m.
Soil description: Sand and gravel with cobbles.
Cobble diameter: 75 mm

Photograph 6- Sample from Borehole PINE-03, Run 3, Depth: 18.9 m to 20.4 m depth
Soil description: Sand and gravel with cobbles.
Cobble diameter: 75 mm

Photograph 7 - Sample from Borehole PINE-03, Run 4, Depth: 20.4 m to 21.9 m
Soil description: Sand and gravel with cobbles
Cobble diameter: 75 mm to 120 mm

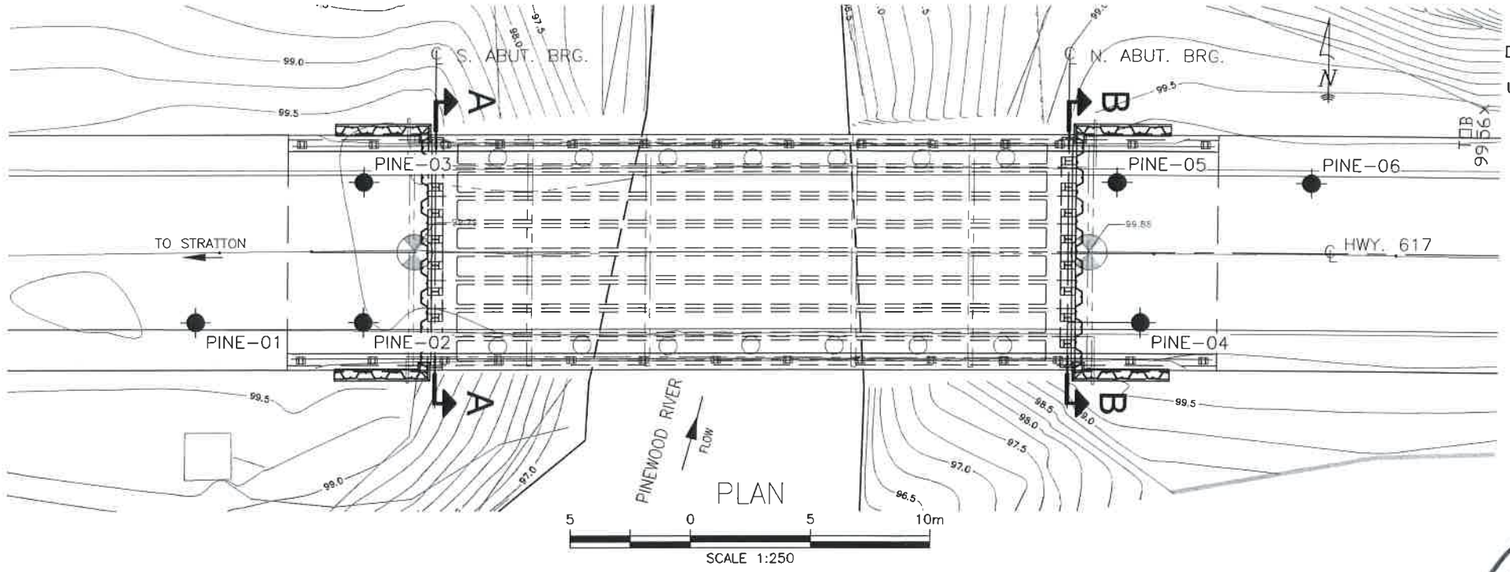


Photograph 8 - Sample from Borehole PINE-03, Run 1, Depth: 15.9 m to 17.4 m

Soil description: Sand and gravel with cobbles
Cobble diameter: 75 mm

Appendix D

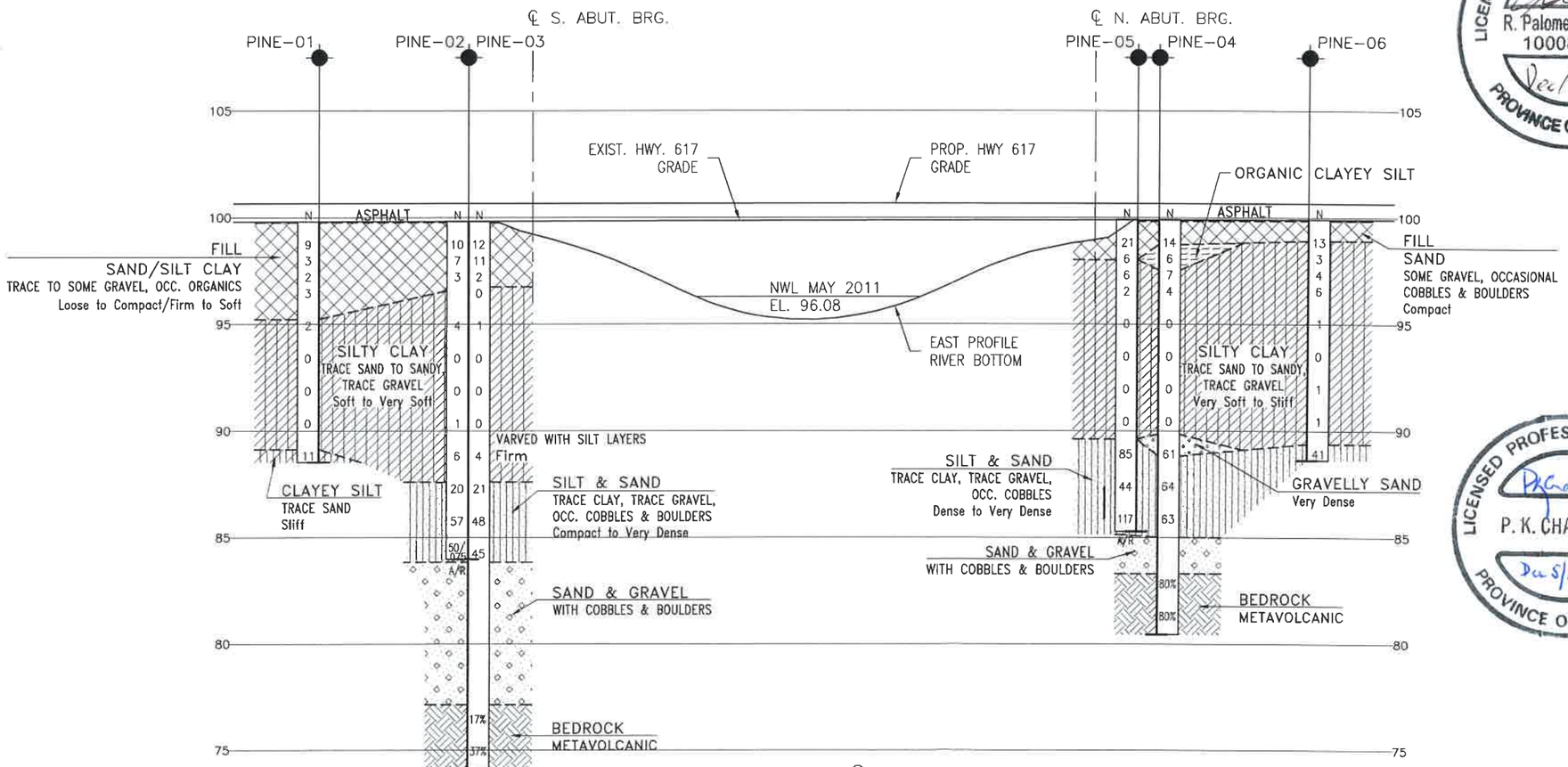
Borehole Locations and Soil Strata Drawings



PLAN

5 0 5 10m

SCALE 1:250



PROFILE ALONG ℄ HWY 617

5 0 5 10m

SCALE 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

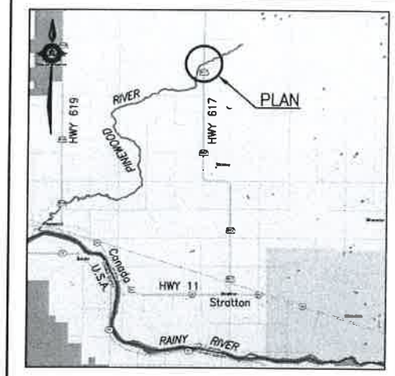
CONT No
WP No 6094-10-00

SHEET

HWY 617
PINEWOOD RIVER BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

GENIVAR

THURBER ENGINEERING LTD.



KEYPLAN

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Dec/5/12
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Dec 5/12
PROVINCE OF ONTARIO

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
PINE-01	99.8		
PINE-02	99.8		
PINE-03	99.8		
PINE-04	99.9		
PINE-05	99.9		
PINE-06	99.9		

-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.

GEOCRES No. 52D-13

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LRB	CHK	LRB	CODE		LOAD	
DRAWN	MFA	CHK	AEG	SITE		STRUCT	
						DATE	NOV. 2012
						DWG	1

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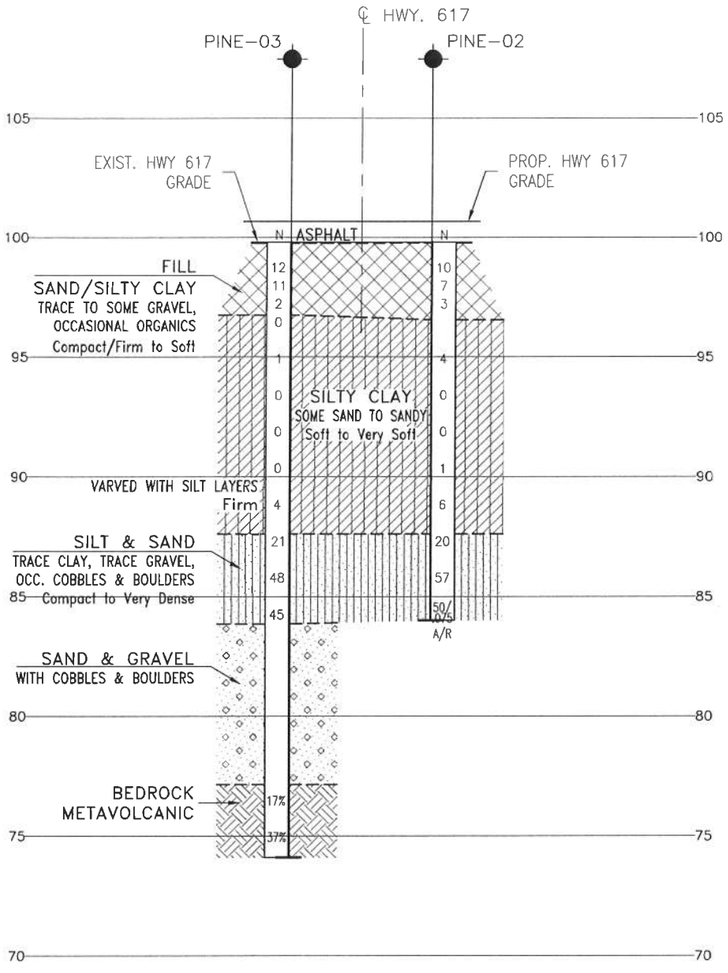
PLOTDATE: 11/7/2012 11:24 AM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



SECTION A–A

5 0 5 10m

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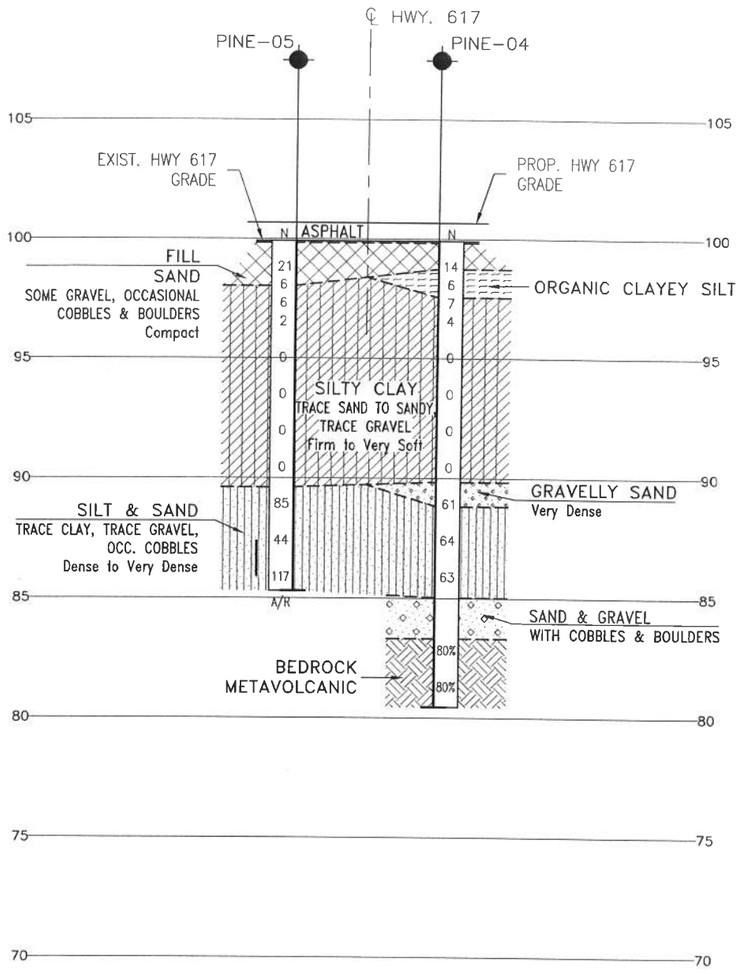


SECTION B–B

5 0 5 10m

SCALE 1:250

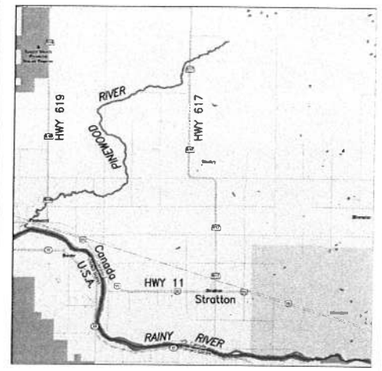
CONT No
WP No 6094-10-00

SHEET

HWY 617
PINEWOOD RIVER BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

GENIVAR

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
PINE-01	99.8		
PINE-02	99.8		
PINE-03	99.8		
PINE-04	99.9		
PINE-05	99.9		
PINE-06	99.9		

-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.

GEOCRES No. 52D-13

REVISIONS		
DATE	BY	DESCRIPTION

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DATE NOV. 2012
DWG 2

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