FOUNDATION INVESTIGATION REPORT
BEAVER CREEK BRIDGE REHABILITATION
HIGHWAY 17, DISTRICT OF KENORA
G.W.P. 6047-08-00, STRUCTURE NO. 41S-35

Geocres Number: 52F-34

Report to

McCormick Rankin Corporation

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

February 6, 2012
File: 19-1351-197

H:\19\1351\197 NWR 32 Rehabs\Reports & Memos\Beaver Ck Hwy 17\Beaver Ck 17 Bridge FINAL FIR.doc

TABLE OF CONTENTS

Appendices

FOUNDATION INVESTIGATION AND DESIGN REPORT
BEAVER CREEK BRIDGE REHABILITATION
HIGHWAY 17, DISTRICT OF KENORA
G.W.P. 6047-08-00, STRUCTURE NO. 41S-35

Geocres Number: 52F-34

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a geotechnical investigation conducted at the location of the bridge carrying Highway 17 over Beaver Creek in the District of Kenora, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the bridge site and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profile, cross-sections, laboratory test results and a written description of the subsurface conditions.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

2 SITE DESCRIPTION

The site is located on Highway 17 approximately 200 m east of Kondra Road and Calvert's Road, and 24 km west of Dryden in the Geographic Township of Machin, District of Kenora, Ontario.

Highway 17 at the bridge location is a two-lane paved roadway. The existing Beaver Creek Bridge is a three-span structure with a total length of 36.6 m. The west abutment and piers are supported on concrete-filled steel tube piles socketed into bedrock at depths ranging from about 6 m at the east pier to 26 m at the west abutment. The east abutment is supported on spread footings on bedrock. Photographs of the site are presented in Appendix C.

The surrounding lands consist of a mix of grass and brush covered floodplain adjacent to the creek, heavily wooded areas, and agricultural fields. The ground surface has a flat to gently undulating topography.

The site lies within the Canadian Shield, characterized by low, rounded hills of Pre-Cambrian bedrock mantled by varying thicknesses of overburden. At this site, the overburden primarily consists of glaciolacustrine clays. The thickness of this geologic stratum is in the order of 27 m at

the west end of the bridge, and bedrock is exposed at the east approach. The bedrock comprises a metasedimentary granitic complex of the Ghost Lake Batholith.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period February 2 to 8, 2011. A total of four sampled boreholes (numbered BCR-01 to BCR-04) were drilled to depths of 1.3 to 31.6 m. Bedrock was confirmed in two boreholes by obtaining approximately 4.5 m of rock core, and the remaining two boreholes were terminated upon refusal on probable bedrock.

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing in Appendix D. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets in Appendix A.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

Hollow stem augers and wash-boring with casing were used to advance the boreholes. Samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT).

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, visually examined the recovered samples, and transported them to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. The boreholes were backfilled in accordance with O.Reg. 903 upon completion. The borehole completion details are shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole	Completion Details
BCR-01	Borehole backfilled with bentonite and cuttings to 0.6 m, then sand to 0.1 m and cold patch asphalt to surface.
BCR-02	Borehole backfilled with sand to 0.1 m and cold patch asphalt to surface.
BCR-03	Borehole backfilled with bentonite and cuttings to 0.6 m, then sand to 0.1 m and cold patch asphalt to surface.
BCR-04	Borehole backfilled with sand to 0.1 m and cold patch 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 grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

Point load tests were carried out on selected samples of intact bedrock core to assist in evaluation of the compressive strength of the bedrock. Results of the point load tests are included on the Record of Borehole sheets in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A for details of the encountered soil stratigraphy. A stratigraphic profile is presented on the Borehole Locations and Soil Strata Drawing in Appendix D, for illustrative purposes. Overall descriptions of the stratigraphy are given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

The soil stratigraphy encountered at the borehole locations varied between the west and east ends of the bridge:

- West of the bridge (Boreholes BCR-01 and BCR-03), the stratigraphy consisted of a surficial asphalt layer overlying gravelly sand fill, underlain by a thick deposit of silty clay, over a discontinuous silty sand layer and bedrock.
- East of the bridge, bedrock was encountered immediately below the asphalt and sand fill.

More detailed descriptions of the individual strata are presented below.

5.1 Asphalt

A 150 mm thick layer of asphalt was encountered in each borehole drilled on the travelled lanes of Highway 17.

5.2 Sand Fill and Concrete

The asphalt was underlain by gravelly sand fill. In Boreholes BCR-01 and BCR-04, a 340 to 400 mm thick concrete slab was encountered within the fill at depths of 0.6 and 0.4 m below the pavement surface. The lower boundary of the gravelly sand fill was encountered at depths of 1.1 to 3.0 m (Elev. 344.5 to 346.4 m). Locally in Borehole BCR-03, a 0.8 m thick layer of mixed silty sand and clay fill was encountered below the gravelly sand fill.

SPT 'N' values in the sand fill typically ranged from 34 blows/0.3 m to 50 blows/0.075 m penetration, indicating a dense to very dense condition (possibly frozen). 'N' values of 11,

59 and 10 blows/0.3m were obtained in Borehole BCR-01, indicating a compact to very dense condition. Moisture contents varied from 1 to 12%.

Grain size distribution curves for two samples of the fill are presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Gravel %	13 to 18
Sand %	72 to 81
Silt & Clay %	5 to 10

5.3 Silty Clay

Native silty clay was encountered below the fill in Boreholes BCR-01 and BCR-03 located to the west of the bridge. The thickness of the silty clay layer was 22.8 and 23.6 m, and the lower boundary was at 25.8 and 25.9 m (Elev. 321.7 and 321.6 m).

SPT 'N' values of 6 to 14 blows/0.3 m were obtained in the upper 2.0 m of the silty clay, indicating a firm to stiff consistency. The 'N' values below this depth ranged from 0 to 2 blows/0.3 m (very soft), with the sampler typically sinking under the weight of the hammer and drilling rods. The undrained shear strength determined by in situ vane testing ranged from 16 to 36 kPa (soft to firm). Moisture contents of 28 to 73% were measured.

The results of grain size distribution analyses conducted on samples of the silty clay are presented on the Record of Borehole sheets and on Figure B2 of Appendix B. Atterberg Limits test results are presented on Figure B3. The results are summarized as follows:

Gravel %	0
Sand %	0 to 7
Silt %	16 to 26
Clay %	67 to 84
Liquid Limit	51 to 68
Plastic Limit	22 to 26

The above results show that the silty clay is of high plasticity with a group symbol of CH.

5.4 Silty Sand

A 1.3 m thick layer of silty sand was encountered below the silty clay in Borehole BCR-01. This layer was described as brown and saturated. The lower boundary was on bedrock at 27.1 m depth (Elev. 320.4 m).

5.5 Bedrock

Bedrock was proven by coring in two boreholes and probable bedrock was inferred by auger refusal in two boreholes. The depths and elevations at which bedrock and probable bedrock were encountered are summarized in Table 5.1.

Table 5.1 – Depths and Elevations of Bedrock Surface

Borehole	Location	Bedrock Surface		Basis
		Depth (m)	Elevation (m)	
BCR-01	West abutment	27.1	320.4	Proven by coring
BCR-02	East approach	1.3	346.3	Auger refusal
BCR-03	West approach	25.9	321.6	Auger refusal
BCR-04	East abutment	1.1	346.4	Proven by coring

The bedrock was described as granite at the west abutment (Borehole BCR-01) and quartz at the east abutment (Borehole BCR-04). Total Core Recovery (TCR) in the bedrock ranged from 90 to 100%. The RQD values ranged from 50 to 92%, indicating fair to excellent rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was generally less than 5, except in Borehole BCR-01 Run 2 where one value exceeding 25 was recorded.

The estimated unconfined compressive strength of the rock cores ranged from 101 to 141 MPa in the granite (Borehole BCR-01) and 153 to 165 MPa in the quartz (Borehole BCR-04), indicating very strong rock. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes.

5.6 Water Levels

Water was added into the boreholes as part of the drilling and coring operations and therefore natural groundwater levels were not measured during drilling.

The water level in Beaver Creek was at Elev. 343.9 m in January 2011 (from preliminary General Arrangement drawing).

The groundwater level at the site is expected to be at or slightly above the water level in the creek. Fluctuations of the groundwater level and creek level are to be expected subject to seasonal conditions. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

The borehole locations were established in the field by Thurber Engineering. The coordinates and ground surface elevations at the boreholes were subsequently determined by MMM Group Limited survey personnel.

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

Eastern Ontario Diamond Drilling Ltd. supplied truck-mounted drilling equipment and conducted the drilling, sampling and in-situ testing operations for the boreholes.

The field program was supervised on a full time basis by Mr. Ryan Kromer of Thurber Engineering Ltd. Overall supervision of the field program was provided by Mr. Alastair E. Gorman, P.Eng. and Mr. Tony Harte, M.Sc.

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

Thurber Engineering Ltd.

Murray R. Anderson, P.Eng., M.Eng.
Senior Foundations Engineer

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

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

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

$\blacktriangledown$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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

UNIFIED SOILS CLASSIFICATION

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

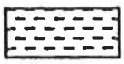
EXPLANATION OF ROCK LOGGING TERMS

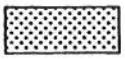
ROCK WEATHERING CLASSIFICATION

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

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-01 1 OF 4 METRIC

W.P. 6047-08-00 LOCATION Beaver Creek Bridge N 5 519 730.3 E 295 079.9 ORIGINATED BY RK

HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN

DATUM Geodetic DATE 2011.02.02 - 2011.02.05 CHECKED BY MRA

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
347.5											
0.0	**ASPHALT:** (150mm)										
0.2 / 346.9	Gravelly **SAND** (FILL)		1	SS	46/ 0.050		347				
0.6 / 346.6	**CONCRETE:** (340mm)										
0.9	Gravelly **SAND** Compact to Very Dense Brown (FILL)		2	SS	11						
			3	SS	59		346				13 82 5 (SI+CL)
			4	SS	10		345				
344.5											
3.0	Silty **CLAY**, trace sand Stiff to Very Soft Brown		5	SS	9		344				
			6	SS	7		343				0 4 19 77
							342	+4			
							341				
			7	SS	2		340				
	Grey						339	+			
							338				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 1197.GPJ 7/20/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-01 2 OF 4 METRIC

W.P. 6047-08-00 LOCATION Beaver Creek Bridge N 5 519 730.3 E 295 079.9 ORIGINATED BY RK

HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN

DATUM Geodetic DATE 2011.02.02 - 2011.02.05 CHECKED BY MRA

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										
	Silty **CLAY**, trace sand Very Soft Grey						337				
			8	SS	1						
							336				
			9	SS	0		335				
							334				
							333				
			10	SS	0		332				0 0 16 84
							331				
							330				
			11	SS	0		329				
							328				

Continued Next Page

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

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

ONTMT4S 1197.GPJ 7/20/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-01 3 OF 4 METRIC

W.P. 465-00-00 LOCATION Beaver Creek Bridge N 5 519 730.3 E 295 079.9 ORIGINATED BY RK
HWY 594 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
DATUM Geodetic DATE 2011.02.02 - 2011.02.05 CHECKED BY MRA

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: o 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**, trace sand Very Soft Grey						327			
							326			
							325			
			12	SS	0			o		
							324			
							323	+		
321.7							322			
25.8	Silty **SAND** Brown Saturated									
320.4							321			
27.1	**GRANITE**, horizontal and sub-horizontal fractures		1	RUN			320		FI 4 0 0 1 0	RUN #1 TCR=98% SCR=93% RQD=92% UCS=101MPa (Average)
	25mm thick vertical fracture at 28.9m		2	RUN			319		3 4 1 5	RUN #2 TCR=98% SCR=95% RQD=53% UCS=141MPa
							318			

Continued Next Page

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-01 4 OF 4 METRIC

W.P. 465-00-00 LOCATION Beaver Creek Bridge N 5 519 730.3 E 295 079.9 ORIGINATED BY RK
HWY 594 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
DATUM Geodetic DATE 2011.02.02 - 2011.02.05 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page									>25	(Average)
										4	
							317			3	
			3	RUN						2	RUN #3 TCR=93% SCR=92% RQD=50% UCS=102MPa (Average)
315.9							316			2	
										5	
31.6	END OF BOREHOLE AT 31.6m. BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS TO 0.6m, THEN SAND TO 0.1m AND COLD PATCH ASPHALT TO SURFACE.										

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

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

ONTMT4S 1197.GPJ 9/14/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-02 1 OF 1 METRIC

W.P. 6047-08-00 LOCATION Beaver Creek Bridge N 5 519 730.9 E 295 150.3 ORIGINATED BY RK

HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.02.06 - 2011.02.06 CHECKED BY MRA

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: O 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
347.6											
0.0	**ASPHALT:** (150mm)										
0.2	Gravelly **SAND** Very Dense Brown Damp (FILL)		1	GS			347		o		
346.3			1	SS	89				o		
1.3	END OF BOREHOLE AT 1.3m UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH GRAVELLY SAND AND COLD PATCH TO SURFACE.										

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

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

ONTMT4S 1197.GPJ 7/20/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-03 1 OF 3 METRIC

W.P. 6047-08-00 LOCATION Beaver Creek Bridge N 5 519 724.9 E 295 065.2 ORIGINATED BY RK
HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
DATUM Geodetic DATE 2011.02.05 - 2011.02.07 CHECKED BY TJH

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
347.5											
0.0	**ASPHALT:** (150mm)										
0.2	Gravelly **SAND** Brown Moist (FILL)		1	GS			347		○		
			2	SS	110				○		
346.0							346				
1.5	Silty **SAND** and **CLAY** Dense Brown (FILL)		3	SS	34				○		
345.2							345		○		0 7 26 67
2.3	Silty **CLAY**, trace sand Stiff to Very Soft Brown		4	SS	14						
			5	SS	6				○		
							344				
			6	SS	13		343		○		
							342				
	Grey		7	SS	1				○		
							341				
							340	+			
							339				
			8	SS	1		338				0 0 17 83

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1197.GPJ 7/20/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-03 2 OF 3 METRIC

W.P. 6047-08-00 LOCATION Beaver Creek Bridge N 5 519 724.9 E 295 065.2 ORIGINATED BY RK
HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
DATUM Geodetic DATE 2011.02.05 - 2011.02.07 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE			GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Very Soft Brown						337 336 335 334 333 332 331 330 329 328				
			9	SS	0						
			10	SS	0						
			11	SS	0						

Continued Next Page

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

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

ONTMT4S 1197.GPJ 7/20/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-03 3 OF 3 METRIC

W.P. 6047-08-00 LOCATION Beaver Creek Bridge N 5 519 724.9 E 295 065.2 ORIGINATED BY RK

HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN

DATUM Geodetic DATE 2011.02.05 - 2011.02.07 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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										
	Silty **CLAY** Very Soft Grey						327 326 325 324 323 322				
			12	SS	0						0 0 22 78
321.6											
25.9	END OF BOREHOLE AT 25.9m UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS 0.6m THEN SAND AND COLD PATCH TO SURFACE.										

ONTMT4S 1197.GPJ 7/20/11

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BCR-04 1 OF 1 METRIC

W.P. 465-00-00 LOCATION Beaver Creek Bridge N 5 519 725.8 E 295 131.9 ORIGINATED BY RK

HWY 594 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN

DATUM Geodetic DATE 2011.02.08 - 2011.02.08 CHECKED BY MRA

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 (O 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
347.5											
0.0	**ASPHALT:** (150mm)										
347.1	Gravelly **SAND** Brown (FILL)		1	GS					o		18 72 10 (SI+CL)
0.4							347				
346.7	**CONCRETE:** (400mm)		1	SS	50/ 0.075				o	FI	
0.8	Gravelly **SAND** Very Dense Brown Damp (FILL)									>5	
346.4							346			4	
1.1	**QUARTZ**, horizontal and sub-horizontal fractures		1	RUN						1	RUN #1 TCR=100% SCR=85% RQD=60% UCS=153MPa (Average)
										1	
							345			0	
			2	RUN						1	
										0	
										2	RUN #2 TCR=90% SCR=90% RQD=90% UCS=165MPa (Average)
							344			1	
										1	
										3	
							343			2	
			3	RUN						2	RUN #3 TCR=100% SCR=100% RQD=80% UCS=162MPa (Average)
										1	
341.8							342			1	
5.7	END OF BOREHOLE AT 5.6m. BOREHOLE BACKFILLED WITH SAND TO 0.1m THEN COLD PATCH TO SURFACE.										

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

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

ONTMT4S 1197.GPJ 9/14/11

Appendix B

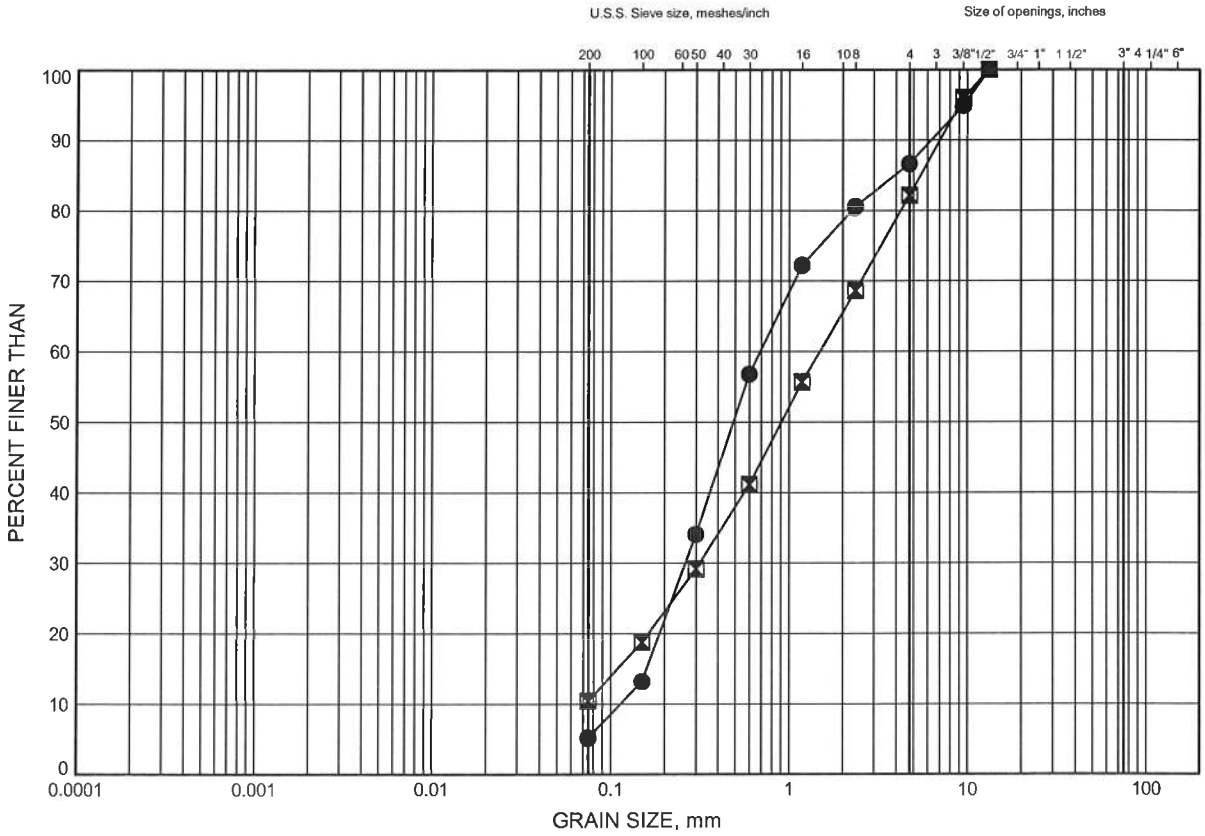
Laboratory Test Results

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B1

GRAVELLY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BCR-01	1.83	345.67
⊠	BCR-04	0.23	347.27

W.P.# 6047-08-00
Prepared By AN
Checked By MRA

THURBER

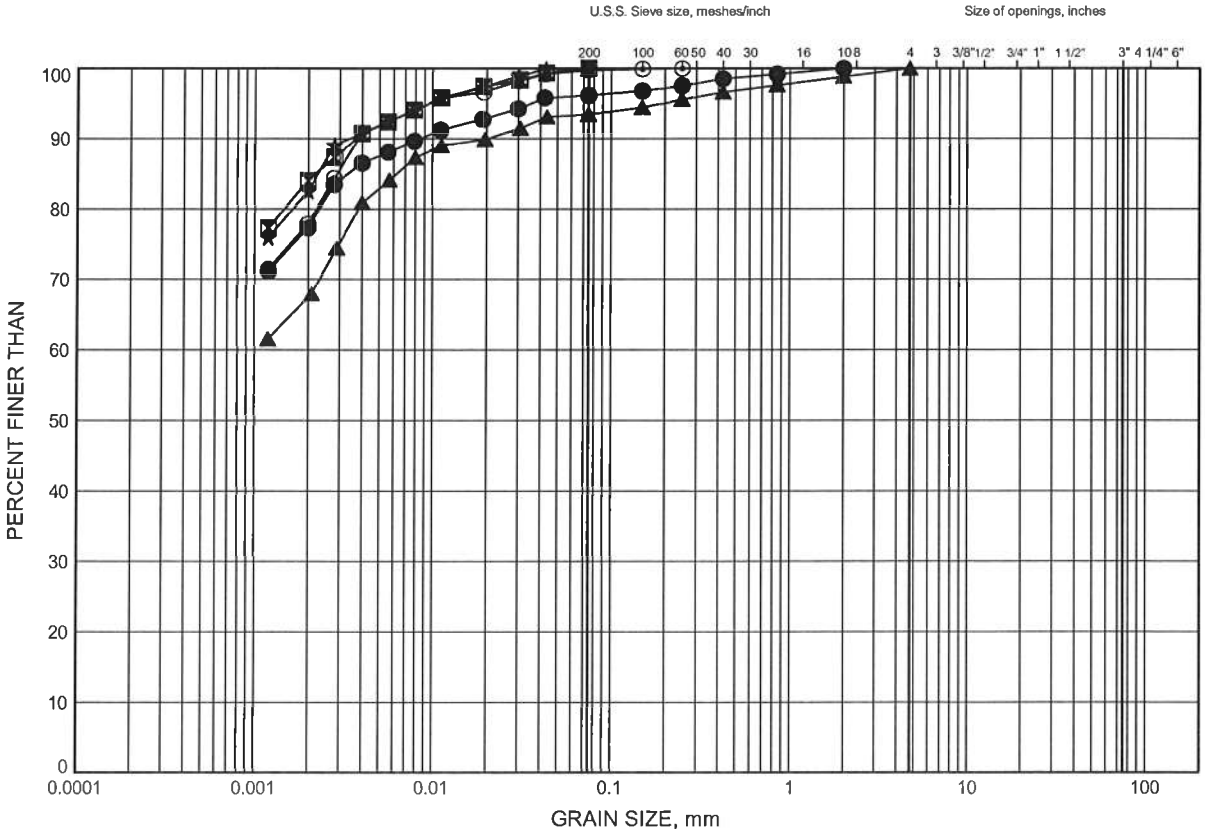
GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 7/20/11

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BCR-01	4.88	342.62
⊠	BCR-01	15.54	331.96
▲	BCR-03	2.59	344.91
★	BCR-03	9.45	338.05
⊙	BCR-03	23.16	324.34

W.P.# 6047-08-00
Prepared By AN
Checked By MRA

THURBER

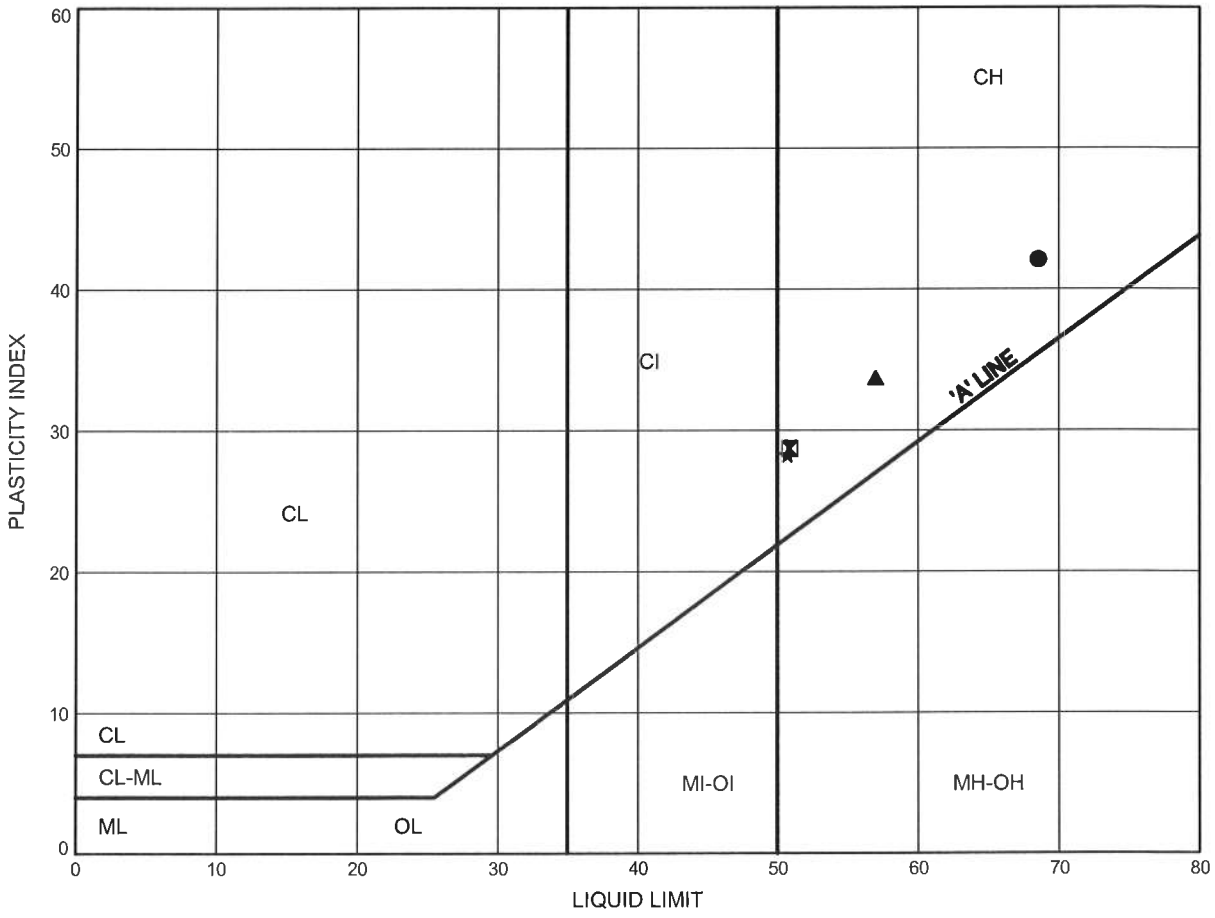
GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 7/20/11

NWR 32 Rehabs

ATTERBERG LIMITS TEST RESULTS

FIGURE B3

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BCR-01	4.88	342.62
⊠	BCR-03	2.59	344.91
▲	BCR-03	9.45	338.05
★	BCR-03	23.16	324.34

Date July 2011

Project 6047-08-00

THURBER

Prep'd AN

Chkd. MRA

THURBALT 1197.GPJ 7/20/11

Appendix C

Site Photographs

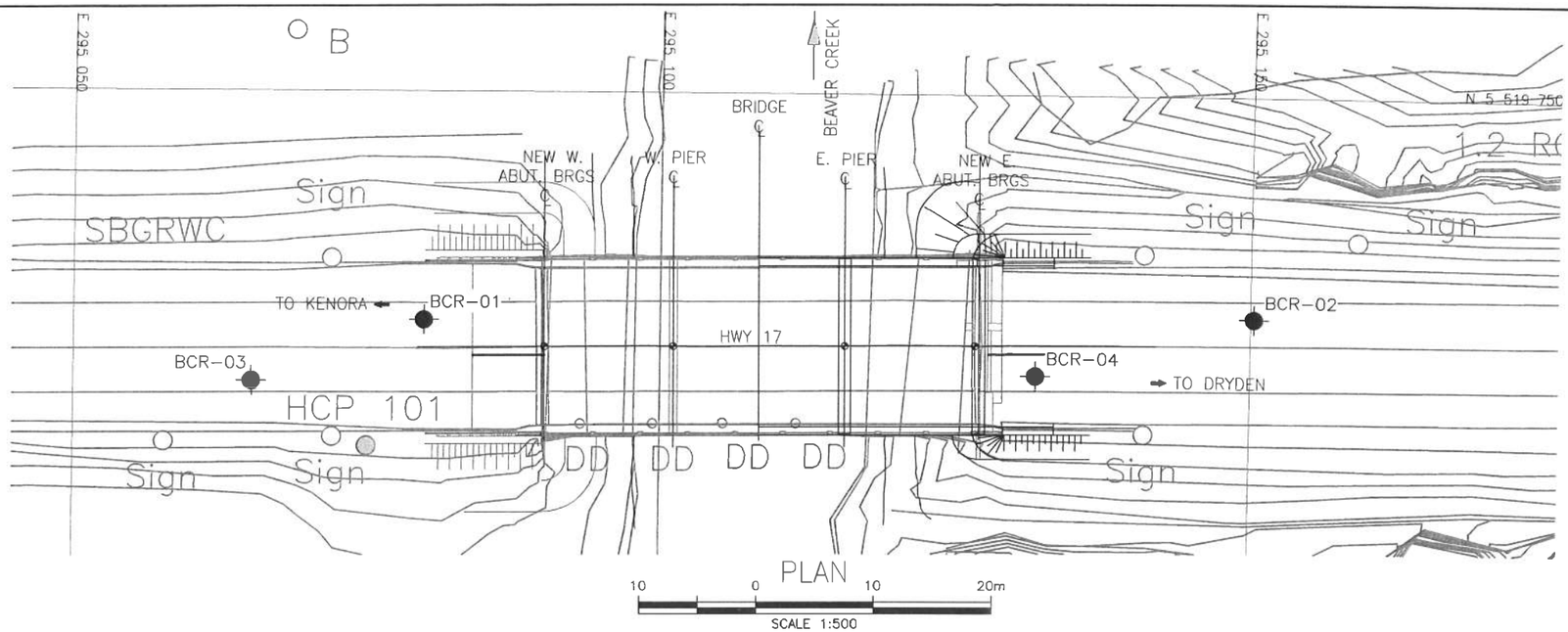
Photograph 1: South side of Beaver Creek bridge.

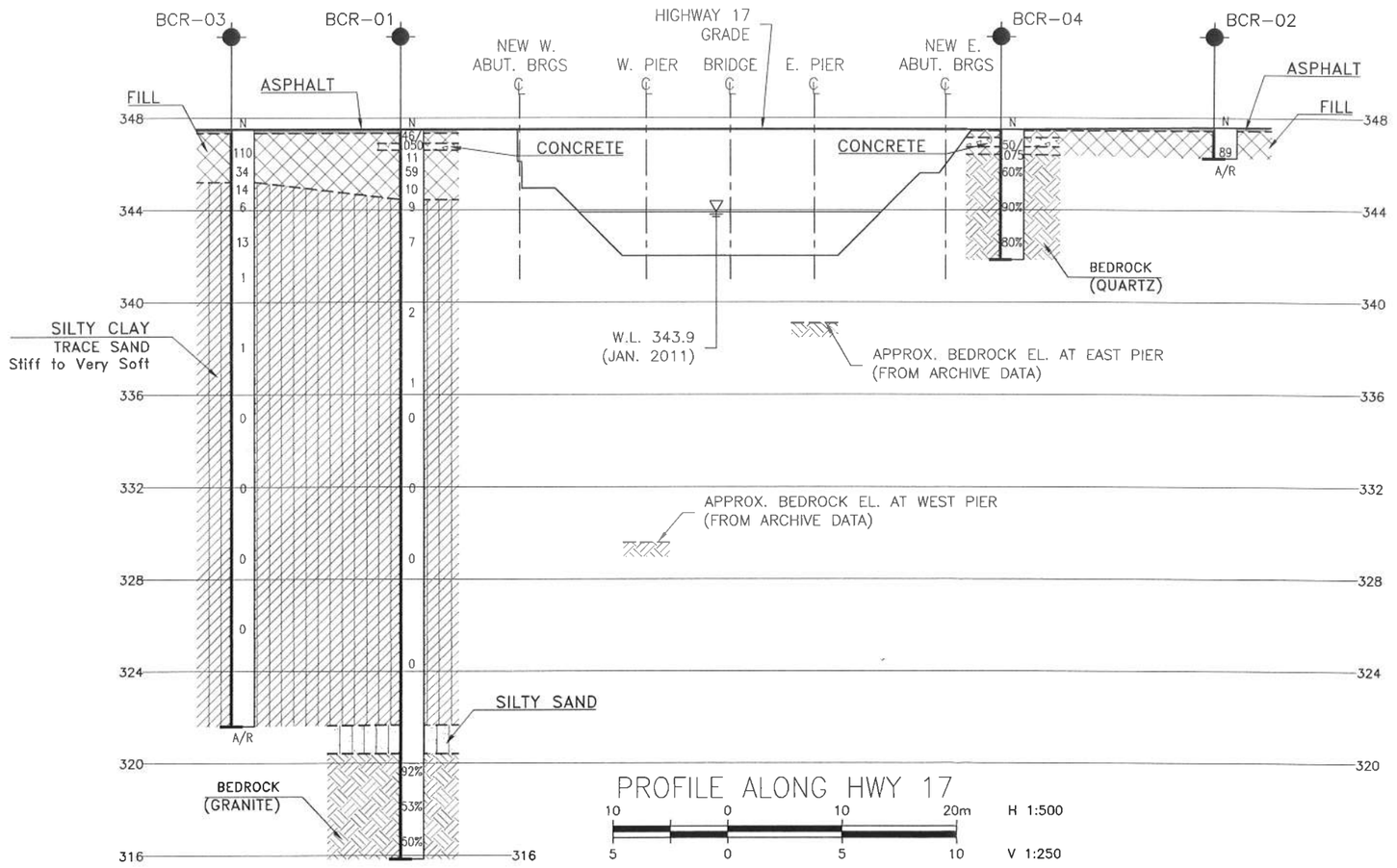
Photograph 2: Highway 17 looking east at east abutment; rock outcrop.

Appendix D

Drawing titled "Borehole Locations and Soil Strata"

MINISTRY OF TRANSPORTATION, ONTARIO





METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

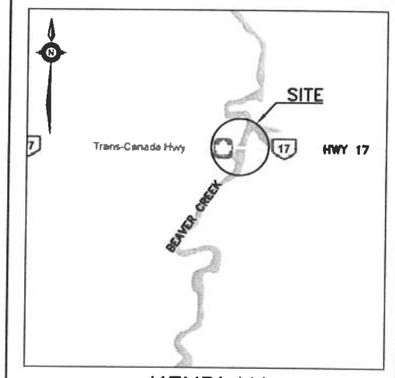
CONT No
WP No

BEAVER CREEK BRIDGE REHABILITATION HWY 17
BOREHOLE LOCATIONS AND SOIL STARTA

SHEET

McCORMICK RANKIN CORPORATION

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
BCR-01	347.5	5 519 730.3	295 079.9
BCR-02	347.6	5 519 730.9	295 150.3
BCR-03	347.5	5 519 724.9	295 065.2
BCR-04	347.5	5 519 725.8	295 131.9

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Feb 6/12
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb 6/12
PROVINCE OF ONTARIO

-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. 52F-34

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MRA	CHK	MRA	CODE		LOAD	DATE FEB. 2012
DRAWN	AN	CHK		SITE		STRUCT	DWG 1

FILENAME: H:\Drafting\19\351\1197\ted1197-BeaverCreekRiver(BCR)(Plan&Profile).dwg
PLOTDATE: 2/6/2012 3:09 PM