

**FOUNDATION INVESTIGATION REPORT
McCAULEY CREEK BRIDGE REPLACEMENT
HIGHWAY 11
WEST OF THE TOWNSHIP OF ATIKOKAN
DISTRICT OF RAINY RIVER, ONTARIO**

W.P. 6043-08-00, Site No. 45-106

Geocres Number: 52B-14

Report to

Hatch Mott MacDonald

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

January 23, 2012
File: 19-1605-121

H:\19\1605\121 Bridge & Culvert Rehabs NWR\Reports &
Memos\McCauley\191605121 McCauley Creek Bridge-FIDR-
FINAL.doc

TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

1	INTRODUCTION	1
2	SITE DESCRIPTION	1
3	SITE INVESTIGATION AND FIELD TESTING	2
4	LABORATORY TESTING	3
5	DESCRIPTION OF SUBSURFACE CONDITIONS	4
5.1	Pavement structure	4
5.2	Fill	4
5.3	Peat	5
5.4	Sand	5
5.5	Silt	6
5.6	Silty Clay	6
5.7	Sand and silt	7
5.8	Bedrock	8
5.9	Water Levels	8
6	MISCELLANEOUS	9

Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Site Photographs
Appendix D	Drawing titled “Borehole Locations and Soil Strata”

FOUNDATION INVESTIGATION REPORT
McCAULEY CREEK BRIDGE REPLACEMENT
HIGHWAY 11
WEST OF THE TOWNSHIP OF ATIKOKAN
DISTRICT OF RAINY RIVER, ONTARIO

W.P. 6043-08-00, Site No. 45-106

Geocres Number: 52B-14

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of a proposed replacement of the existing bridge structure which carries Highway 11 over McCauley Creek, west of The Township of Atikokan, Ontario.

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 cross-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 Hatch Mott MacDonald, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0010.

2 SITE DESCRIPTION

The McCauley Creek Bridge is located on Highway 11 approximately 22 km west of The Township of Atikokan, Ontario and approximately 15 km east of Flanders, Ontario in the Rainy River District.

At present, the highway crosses the McCauley Creek on a seven-span structure supported on timber piles. The end spans are 4.0 m each and the interior spans are 5.0 m each. The total length of the bridge is 33 m and the width is 9.75 m. The McCauley Creek flows to the north.

The surrounding area near the site is relatively flat. The areas to the east and west of the site are treed.

Photographs in Appendix C show the general nature of the site.

The site lies within the physiographic region known as the Quetico Subprovince of the Superior Province of the Canadian Shield. The region is characterized by Precambrian meta-volcanic and meta-sedimentary rocks intruded by later stage diabase dykes. In some areas the Precambrian rocks are covered by sedimentary rocks of the Huronian Supergroup. The bedrock is mantled by glaciolacustrine varved clays and sand and gravel deposits.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried out from July 13 to 16, 2011 and consisted of drilling and sampling six boreholes (numbered MCB-01 to MCB-06) through the highway embankment in the area of the existing west and east approaches and abutments. Boreholes MCB-02 to MCB-05 were drilled at the two abutments and advanced within the overburden to depths ranging from 11.6 m to 13.5 m (elevations 371.2 to 373.2) where the drill rig encountered refusal. Boreholes MCB-01 and MCB-06 were drilled at the west and east approaches, respectively, and terminated at 11.4 m and 9.6 m depths (elevations 373.3 and 375.1) upon refusal. Bedrock was proved in Boreholes MCB-02 and MCB-05 by NQ size diamond coring. Boreholes MCB-02 and MCB-05 were advanced 3.1 m and 3.4 m into bedrock and terminated at 14.7 m and 15.0 m depths (elevations 370.1 and 369.8).

Boreholes were supplemented by dynamic cone penetration testing (DCPT) conducted adjacent to each borehole. The depths to the DCPT ranged from 9.7 m to 13.4 m (elevations 371.3 to 375.1).

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

The borehole locations were marked in the field and utility clearances were obtained prior to drilling. Road occupancy permits were obtained for boreholes drilled on the existing Highway 11 platform.

The drilling was carried out from the highway grade using a CME75 truck-mounted drill rig. A combination of hollow-stem auger drilling techniques, casing and 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). In situ vane shear testing was carried out to assess the undrained shear strength of soft to firm cohesive deposits.

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 rock 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.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Two standpipe piezometers consisting of 19 mm PVC pipe with slotted screen were installed in Boreholes MCB-03 and MCB-04, and enclosed in filter sand to permit longer term groundwater level monitoring. The boreholes were backfilled with bentonite holeplug in general accordance with O.Reg. 903 upon completion. The location and completion details of the piezometers and boreholes are shown in Table 3.1.

Table 3.1 – Borehole Abandonment Details

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Abandonment Details
West approach	MCB-01	None installed	Borehole backfilled with auger cuttings to 0.1 m, then asphalt to surface.
West abutment	MCB-02	None installed	Borehole backfilled with holeplug from 14.7 m to 1.5 m, sand and gravel from 1.5 m to 0.1 m, then asphalt to surface.
	MCB-03	13.5/371.2	Sand from 13.5 m to 11.3 m, holeplug from 11.3 m to 10.5 m, auger cuttings from 10.5 m to 0.2 m, then asphalt to surface.
East abutment	MCB-04	12.3/372.5	Sand from 12.3 m to 9.8 m, holeplug from 9.8 m to 0.2 m, then asphalt to surface.
	MCB-05	None installed	Borehole backfilled with holeplug from 15.0 m to 9.1 m, auger cuttings to 0.6 m, holeplug to 0.1 m, then asphalt to surface.
East approach	MCB-06	None installed	Borehole backfilled with holeplug from 9.6 m to 1.5 m, sand and gravel from 1.5 m to 0.9 m, concrete from 0.9 m to 0.1 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 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 to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the rock core samples are included in Appendix B and 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. Details of the encountered soil stratigraphy are presented in these sheets and on the “Borehole Locations and Soil Strata” drawing 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. It must be recognized that soil conditions may vary between and beyond borehole locations.

In general terms, the stratigraphy encountered at this site consists of pavement structure overlying granular fill (embankment fill). Peat was encountered below the fill in one borehole location at the east approach. Layers of native silt and sand were contacted below the fill and peat. The native silt and sand are underlain by silty clay and sand and silt layers. Slightly weathered to fresh, grey, arkose/sandstone bedrock was contacted below the sand and silt layers at depths ranging from 9.6 m to 13.5 m.

More detailed descriptions of the individual strata are presented below.

5.1 Pavement structure

Pavement structure was encountered in all the boreholes drilled at this site. The boreholes were drilled through the existing Highway 11 shoulders. The pavement structure consists of approximately 50 mm to 150 mm of asphalt overlying granular fill.

5.2 Fill

Fill was contacted below the asphalt pavement in all the boreholes. The fill generally consists of brown sand containing some gravel, trace to some silt and clay. In Borehole MCB-06, drilled at the east approach, the fill consisted of brown sand and gravel. Cobbles and boulders were encountered within the fill in Boreholes MCB-01 and MCB-06, drilled at the west and east approaches, respectively. A layer of gravel fill was contacted at 1.5 m depth (elevation 383.2) in Borehole MCB-01. The thickness of the fill ranged from 1.4 m to 4.1m.

The depth to the base of the fill varied from 1.4 m to 4.1m (elevations 380.6 to 383.4).

SPT ‘N’ values recorded in the cohesionless fill ranged from 14 to 54 blows per 0.3 m of penetration, indicating a compact to very dense relative density. A low SPT ‘N’ value of 7 blows per 0.3 m of penetration, indicating a loose relative density, was recorded in Borehole MCB-02 near elevation 383.0. In Borehole MCB-01, SPT ‘N’ values of 50 blows per 0.1 m of penetration were measured within the upper 1.0 m of sand fill. These values indicate a very dense relative density and might reflect the presence of cobbles.

The moisture content of the fill ranged from 3% to 18%.

Grain size distribution curves for samples of the fill tested are presented on the Record of Borehole sheet and on Figures B1 and B2 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Sand fill (%)	Gravel fill (%)
Gravel	9	81
Sand	71	17
Silt and Clay	20	2

5.3 Peat

Dark brown peat containing some roots and trace of gravel was contacted below the sand fill at 3.4 m depth (elevation 381.4) in Borehole MCB-06, drilled at the east approach. The thickness of the peat was 700 mm.

The depth to the base of the peat was 4.1 m (elevation 380.6).

SPT 'N' value recorded in the peat was 5 blows per 0.3 m penetration indicating a loose relative density.

The moisture content of the peat was 169%.

5.4 Sand

Native brown to grey sand containing trace gravel, trace to some silt and clay and occasional cobbles was contacted in Boreholes MCB-02 to MCB-05, drilled at the abutments, at depths ranging from 1.4 m to 2.3 m (elevations 382.5 to 383.4). A 900-mm thick layer of sand mixed with organics was encountered at 3.7 m depth (elevation 381.1) in Borehole MCB-04. The thickness of the native sand layer ranged from 1.8 m to 3.3 m.

The depth to the base of the sand ranged from 3.5 m to 4.7 m (elevations 380.0 to 381.2).

SPT 'N' values recorded in the native sand layer ranged from 4 to 17, indicating a loose to compact relative density. A SPT 'N' value of 1 blow per 0.3 m of penetration was measured in Borehole MCB-02 near elevation 381.5, indicating a very loose relative density.

The moisture contents of samples from the sand generally vary between 15% and 22%.

Grain size distribution curves for the sand samples tested are presented in Figure B3 in Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	(%)
Gravel	2 to 6
Sand	81 to 88
Silt and Clay	10 to 13

5.5 Silt

Grey silt containing some clay and trace to some sand was contacted below the fill at 4.1 m depth (elevation 380.6) in Borehole MCB-01 and below the native sand at 3.5 m depth (elevation 381.2) in Borehole MCB-03. The thickness of the silt was 0.6 m and 1.2 m.

The depths to the base of the silt were 4.7 m and 4.9 m (elevations 380.0 and 379.8), in Boreholes MCB-01 and MCB-03, respectively.

Standard Penetration tests in the silt layer gave SPT 'N' values of 5 and 8 blows per 0.3 m of penetration, indicating a loose relative density.

The moisture contents of samples from the silt layer were 38% and 39%.

5.6 Silty Clay

Native reddish brown to grey silty clay containing trace sand and occasional wood fibres was contacted below the silt in Boreholes MCB-01 and MCB-03, below the sand in Boreholes MCB-02, MCB-04 and MCB-05 and below the peat in Borehole MCB-06. The native silty clay was generally encountered at depths ranging from 4.1 m to 4.9 m (elevations 379.8 to 380.7). The thickness of the silty clay ranged from 4.6 m to 7.5 m.

The depth to the base of the silty clay was from 8.7 m to 12.4 m (elevations 372.3 to 376.1).

SPT 'N' values recorded in the silty clay ranged from 0 to 11 blows for 0.3 m of penetration, indicating a very soft to stiff consistency. Typically, N-values in the native silty clay were 0 to 2 blows for 0.3 m penetration. In situ vane shear tests performed during drilling indicated undrained shear strengths ranging from 16 to 32 kPa. Locally in Boreholes MCB-01 and MCB-02, the undrained shear strength was 40 kPa and 48 kPa near elevation 377.8.

The moisture content of samples collected from the silty clay layer generally varies between 28% and 82%.

Grain size distribution curves for selected silty clay samples are presented in Appendix B, Figures B4 and B5. The results are also summarized on the Record of Borehole sheets included in Appendix A. Atterberg Limits test results are presented in Figures B7 and B8 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 3
Silt	44 to 70
Clay	28 to 56

Index Property	Percentage (%)
Liquid Limit	30 to 60
Plastic Limit	22 to 23

The above results show that the silty clay is of medium to high plasticity with group symbols of CI-CH. One sample from Borehole MCB-04 revealed low plasticity with a group symbol of CL.

5.7 Sand and silt

A layer of grey sand and silt containing trace to some gravel and trace clay was contacted in all the boreholes below the silty clay at depths ranging from 8.7 m to 12.4 m (elevations 372.3 to 376.1). The thickness of the sand and silt layer varied from 0.4 m to 1.8 m.

Boreholes were terminated within sand and silt layer upon refusal on bedrock at depths ranging from 9.6 m to 13.5 m (elevations 371.2 to 375.1).

SPT 'N' values recorded in the sand and silt layer ranged from 5 to 20 blows per 0.3 m of penetration, indicating a loose to compact relative density. SPT 'N' values of 33 and 47 blows per 0.3 m of penetration, indicating dense to very dense relative density, were measured in Borehole MCB-01 and MCB-06 drilled at the approaches.

The moisture contents of samples from the sand generally vary between 19% and 24%. A high moisture content of 52% was measured in Borehole MCB-02, near elevation 374.2.

Grain size distribution curves for the sand samples tested are presented in Figure B6 in Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	42
Silt	56
Clay	2

5.8 Bedrock

The overburden soils described above are underlain by grey metasedimentary bedrock described as arkose/sandstone. The bedrock was slightly weathered to fresh. Occasional mechanical breaks and sub-vertical fractures were noted throughout the bedrock cores.

Bedrock was proved by coring at two boreholes. Table 5.1 summarizes depths and elevations to the top of bedrock and auger refusal on probable bedrock in the boreholes.

**Table 5.1 – Depths and Elevations of Top of Bedrock
and auger refusal on probable bedrock**

Borehole	Top of Bedrock/Auger refusal	
	Depth (m)	Elevation (m)
MCB-01	11.4	373.3
MCB-02*	11.6	373.2
MCB-03	13.5	371.2
MCB-04	12.3	372.5
MCB-05*	11.6	373.2
MCB-06	9.6	375.1

* Bedrock proved by coring.

Core recovery in the bedrock was 97% in one core and 100% in the remaining cores. The RQD values ranged from 75% to 100%, indicating fair to excellent rock quality. In Borehole MCB-02 Run 1 the RQD value was 7%, indicating a very poor rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was generally less than 4.

The estimated unconfined compressive strength of the rock cores ranged from 59 MPa to 207 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. A summary of the Point Load Test Results is presented in Appendix B.

5.9 Water Levels

Water levels were monitored in the boreholes during and upon completion of drilling. Two standpipe piezometers were installed in Boreholes MCB-03 and MCB-04, drilled at the west and east abutments to monitor water levels after completion of drilling. The water levels measured in the piezometers and open boreholes are summarized in Table 5.2.

Table 5.2 – Water Level Measurements

Foundation Unit	Borehole	Date	Water Level (m)		Comments
			Depth	Elevation	
West approach	MCB-01	July 14, 2011	1.8	382.9	Open borehole
West abutment	MCB-02	July 15, 2011	1.9	382.9	Open borehole
	MCB-03	September 18, 2011	1.9	382.8	In piezometer
East abutment	MCB-04	August 27, 2011	2.0	382.8	In piezometer
		September 18, 2011	1.9	382.9	
East approach	MCB-06	July 16, 2011	3.0	381.8	Open borehole

Piezometric readings indicate that water level is near elevation 382.9.

Preliminary GA drawing indicates that water level in the McCauley Creek was near Elevation 382.5 on October 23, 2009.

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. Hatch Mott MacDonald provided the co-ordinates and the ground surface elevations.

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 drilling and sampling operations in the field were 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 the report were carried out by 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.

Thurber Engineering Ltd.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer

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

Interpretation of the data and preparation of the report were carried out by 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.

Thurber Engineering Ltd.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer



P. K. Chatterji, P.Eng.
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

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


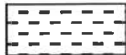



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

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
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			


EXPLANATION OF ROCK LOGGING TERMS

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

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a 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.

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES						
							20 40 60 80 100	WATER CONTENT (%)			
284.7							20 40 60 80 100	20 40 60	kN/m ³	GR SA SI C	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa					WATER CONTENT (%)	
384.7							20 40 60 80 100		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
0.8	ASPHALT: (50mm)		1	SS	50/								
	SAND, some gravel, trace silt and clay Very Dense to Dense Brown Damp (FILL) Occasional cobbles		2	SS	50/								
	Wet		3	SS	32								
	Layer of gravel at 1.5m Auger refusal at 2.1m Boulder from 2.0m to 2.7m												
	Compact		4	SS	16								
380.6													
4.1	SILT, some clay, trace sand Loose Grey Moist		5	SS	5								
380.0													
4.7	Silty CLAY, trace sand Firm Reddish Brown		6	SS	18								
	Very Stiff		7	SS	0								
	Very Soft Grey		8	SS	0								

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No MCB-01

2 OF 2

METRIC

W.P. 6043-08-00 LOCATION N 5 398 543.1 E 385 455.7 McCauley Creek Bridge ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.07.14 - 2011.07.14 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W _P W W _L									
	Continued From Previous Page							SHEAR STRENGTH kPa		WATER CONTENT (%)								
								○ UNCONFINED + FIELD VANE										
								● QUICK TRIAXIAL x LAB VANE										
								20 40 60 80 100		20 40 60								
373.7	Silty CLAY, trace sand		9	SS	33		374											
11.0	SAND and SILT, trace clay																	
373.3	Dense																	
11.4	Grey Wet																	
END OF BOREHOLE AT 11.4m UPON CASING REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 1.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.																		

+³, x³: Numbers refer to
Sensitivity

20
15
10




(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MCB-02

2 OF 2

METRIC

W.P. 6043-08-00 LOCATION N 5 398 537.1 E 385 462.0 McCauley Creek Bridge ORIGINATED BY JM
HWY 11 BOREHOLE TYPE NQ Casing COMPILED BY AN
DATUM Geodetic DATE 2011.07.15 - 2011.07.15 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
374.2	Silty CLAY , trace sand Very Soft Grey							+						
10.6	SAND and SILT , trace gravel Compact Grey Wet		10	SS	10		374							
373.2														
11.6	BEDROCK ARKOSE/SANDSTONE , slightly weathered to fresh, grey, occasional mechanical breaks Coring started at 11.6m Sub-vertical breaks at 11.9m and 12.3m Horizontal breaks at 12.2m, 12.3m, 12.5m, 12.6m, 12.8m		1	RUN			373						FI	
													0	
													1	RUN #1
													4	TCR=97%
													3	SCR=97%
													3	RQD=7%
													3	UCS=158MPa
													4	(Average)
													3	
	Sub-vertical breaks (25mm to 75mm thick) at 13.5m, 13.8m and 14.1m Fresh Horizontal breaks at 13.2m, 13.3m, 13.5m and 13.6m		2	RUN			371						3	RUN #2
													3	TCR=100%
													3	SCR=95%
													4	RQD=75%
													4	UCS=113MPa
370.1													0	(Average)
14.7	END OF BOREHOLE AT 14.7m. BOREHOLE OPEN TO 14.7m AND WATER LEVEL AT 1.9m. BOREHOLE BACKFILLED WITH HOLEPLUG FROM 14.7m TO 1.5m, SAND AND GRAVEL FROM 1.5m TO 0.1m, THEN ASPHALT TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MCB-03

1 OF 2

METRIC

W.P. 6145-04-00 LOCATION N 5 398 542.0 E 385 463.3 McCauley Creek Bridge ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.14 - 2011.07.14 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
384.7								20 40 60 80 100		20 40 60				GR SA SI CL
0.0 0.1	ASPHALT: (75mm)													
	SAND, some gravel, trace to some silt and clay Very Dense to Compact Brown Damp (FILL)		1	SS	52									
			2	SS	28									
383.0														
1.7	SAND, fine grained, trace gravel, some silt and clay Compact to Loose Brown to Grey Moist		3	SS	17									6 81 13 (SI+CL)
			4	SS	12									
			5	SS	5									
381.2														
3.5	SILT, some sand, some clay Loose Grey Moist													
			6	SS	8									
379.8														
4.9	Silty CLAY, trace sand Firm Reddish Brown													
			7	SS	8									
	Very Soft		8	SS	0									0 1 45 54
			9	SS	1									

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MCB-03

2 OF 2

METRIC

W.P. 6145-04-00 LOCATION N 5 398 542.0 E 385 463.3 McCauley Creek Bridge ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.14 - 2011.07.14 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%) 20 40 60			GR SA SI CL
372.3	Silty CLAY, varved, trace sand Very Soft Grey		10	SS	0		374					0 2 70 28
12.4	SAND and SILT, fine grained, trace clay Compact Grey Wet		11	SS	11		373					
371.2							372					
13.5	END OF BOREOLE AT 13.5m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 1.9m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.18/11 1.9 382.8											

+³ x³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

METRIC

W.P.	6145-04-00	LOCATION	N 5 398 529.8 E 385 499.2 McCauley Creek Bridge	ORIGINATED BY	JM
HWY	17	BOREHOLE TYPE	Hollow Stem Augers	COMPILED BY	AN
DATUM	Geodetic	DATE	2011.07.16 - 2011.07.16	CHECKED BY	RPR

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No MCB-04

2 OF 2

METRIC

W.P. 6145-04-00 LOCATION N 5 398' 529.8 E 385 499.2 McCauley Creek Bridge ORIGINATED BY JM
 HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.07.16 - 2011.07.16 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
374.2	Silty CLAY, trace sand Soft Grey												
10.5	SAND and SILT, trace clay Compact Grey Wet		10	SS	20		374						0 42 56 2
372.5							373						
12.3	END OF BOREHOLE AT 12.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Aug.27/11 2.0 382.8 Sep.18/11 1.9 382.9		11	SS	100/	0.100							

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

DATUM Geodetic DATE 2011.07.13 - 2011.07.13 CHECKED BY RPR

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No MCB-05

2 OF 2

METRIC

W.P. 6043-08-00 LOCATION N 5 398 534.4 E 385 500.0 McCauley Creek Bridge ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.13 - 2011.07.13 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								WATER CONTENT (%)
	Continued From Previous Page						20	40	60	80	100	20	40	60		
373.8	Silty CLAY, trace sand Very Soft Grey															
10.9	SAND and SILT, trace clay Loose Grey Wet		10	SS	5											
373.2	Casing refusal		11	SS	50/											
11.6	BEDROCK ARKOSE/SANDSTONE, slightly weathered, occasional mechanical breaks, grey, quartz interbeds Start coring at 11.5m		1	RUN	0.025											
	50mm thick vertical breaks at 11.6m Sub-vertical breaks at 12.2m, 12.7m, 12.9m		2	RUN												
	Quartz interbeds (between 25mm to 75mm) at 12.6m, 12.7m, 13.1m, 13.5m, 13.6m and 13.7m															
	Sub-vertical breaks (between 25mm to 75mm) at 13.1m, 13.3m, 13.4m, 13.5m 200mm at 13.1m		3	RUN												
369.8																
15.0	END OF BOREHOLE AT 15.0m. BOREHOLE BACKFILLED WITH HOLEPLUG TO 9.1m, AUGER CUTTINGS TO 0.6m, HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.															

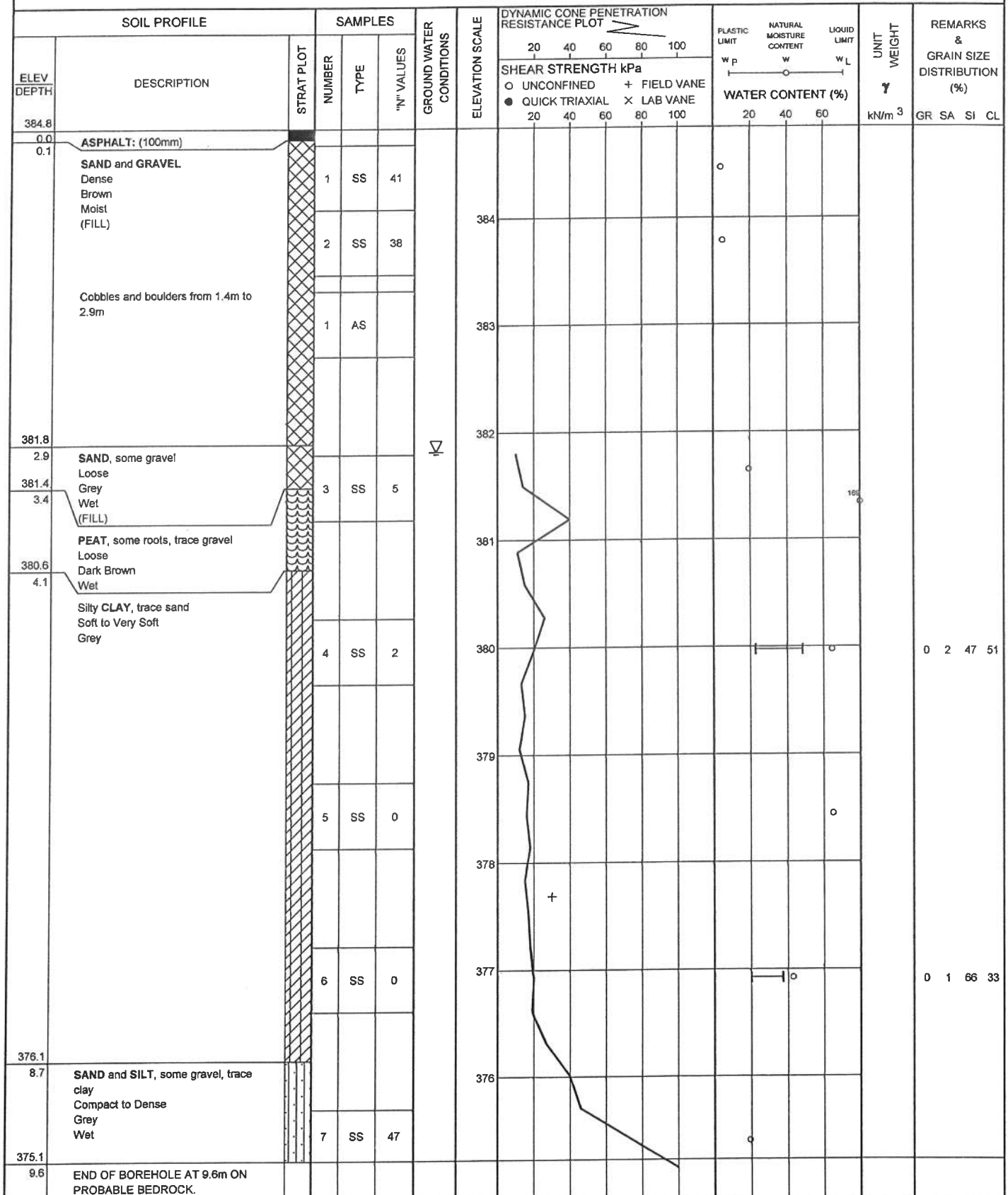
+³, ×³: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MCB-06

1 OF 2

METRIC

W.P. 6043-08-00 LOCATION N 5 398 528.2 E 385 507.8 McCauley Creek Bridge ORIGINATED BY JM
HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.16 - 2011.07.16 CHECKED BY RPR



Continued Next Page

+³, X³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MCB-06

2 OF 2

METRIC

W.P. 6043-08-00 LOCATION N 5 398 528.2 E 385 507.8 McCauley Creek Bridge ORIGINATED BY JM
HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.07.16 - 2011.07.16 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page													
	BOREHOLE OPEN TO 9.6m AND WATER LEVEL AT 3.0m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG FROM 9.6m TO 1.5m, SAND AND GRAVEL FROM 1.5m TO 0.9m, CONCRETE FROM 0.9m TO 0.1m, THEN ASPHALT TO SURFACE.													

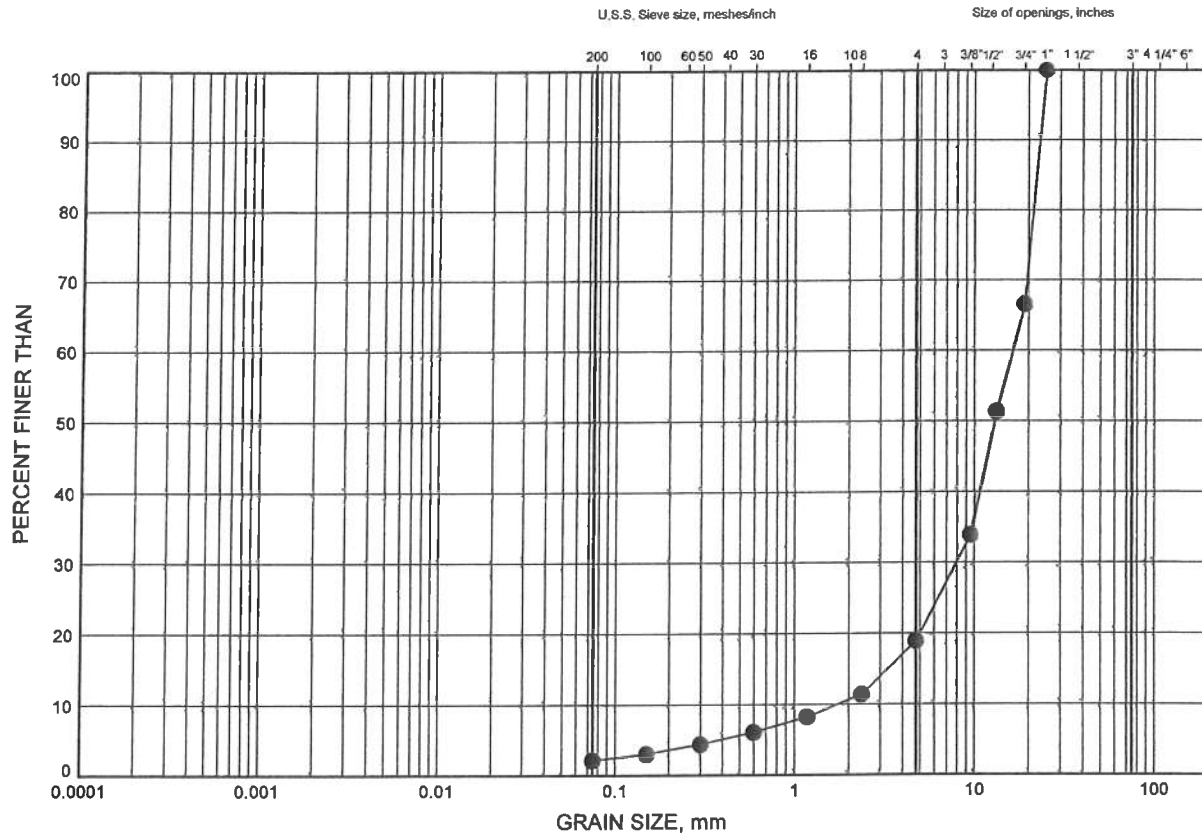
Appendix B

Laboratory Test Results

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B1

GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MCB-01	1.75	382.98

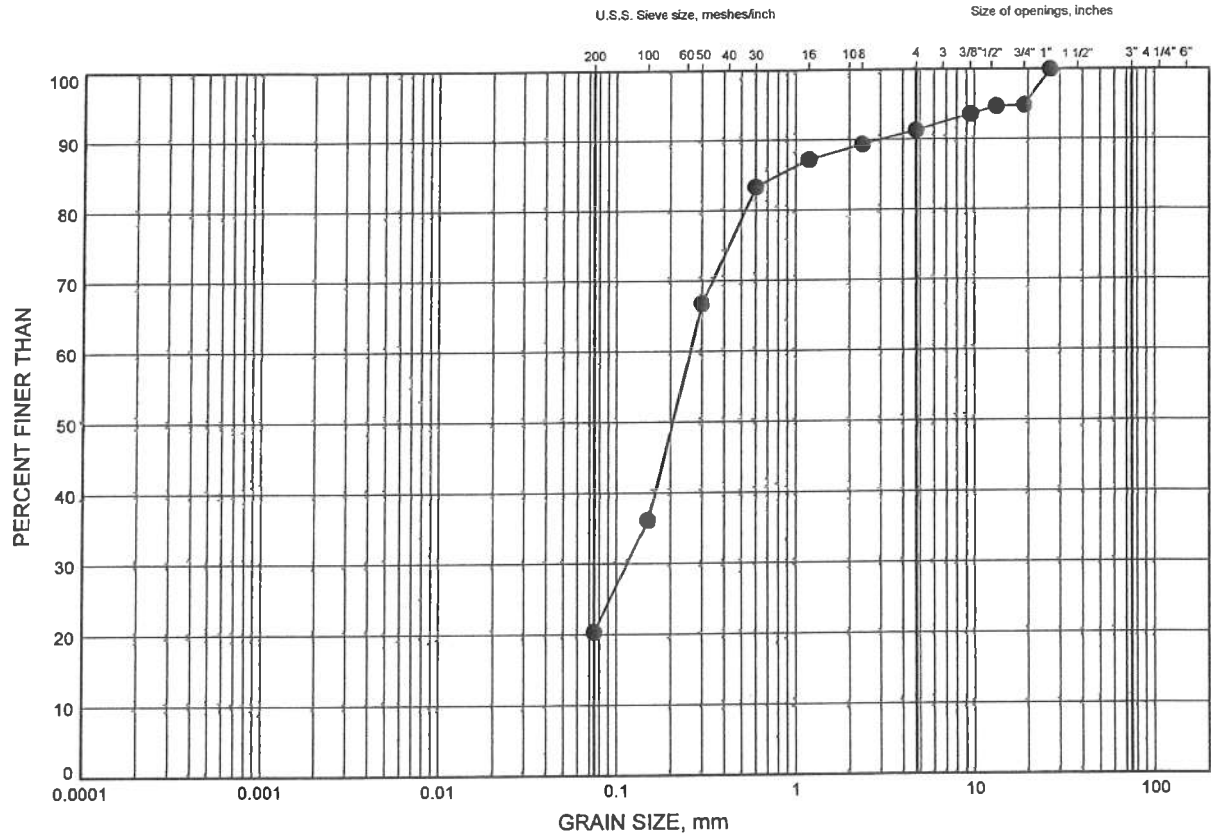


W.P.# 6043-08-00.....
Prepared By AN.....
Checked By RPR.....

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND FILL



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

LEGEND

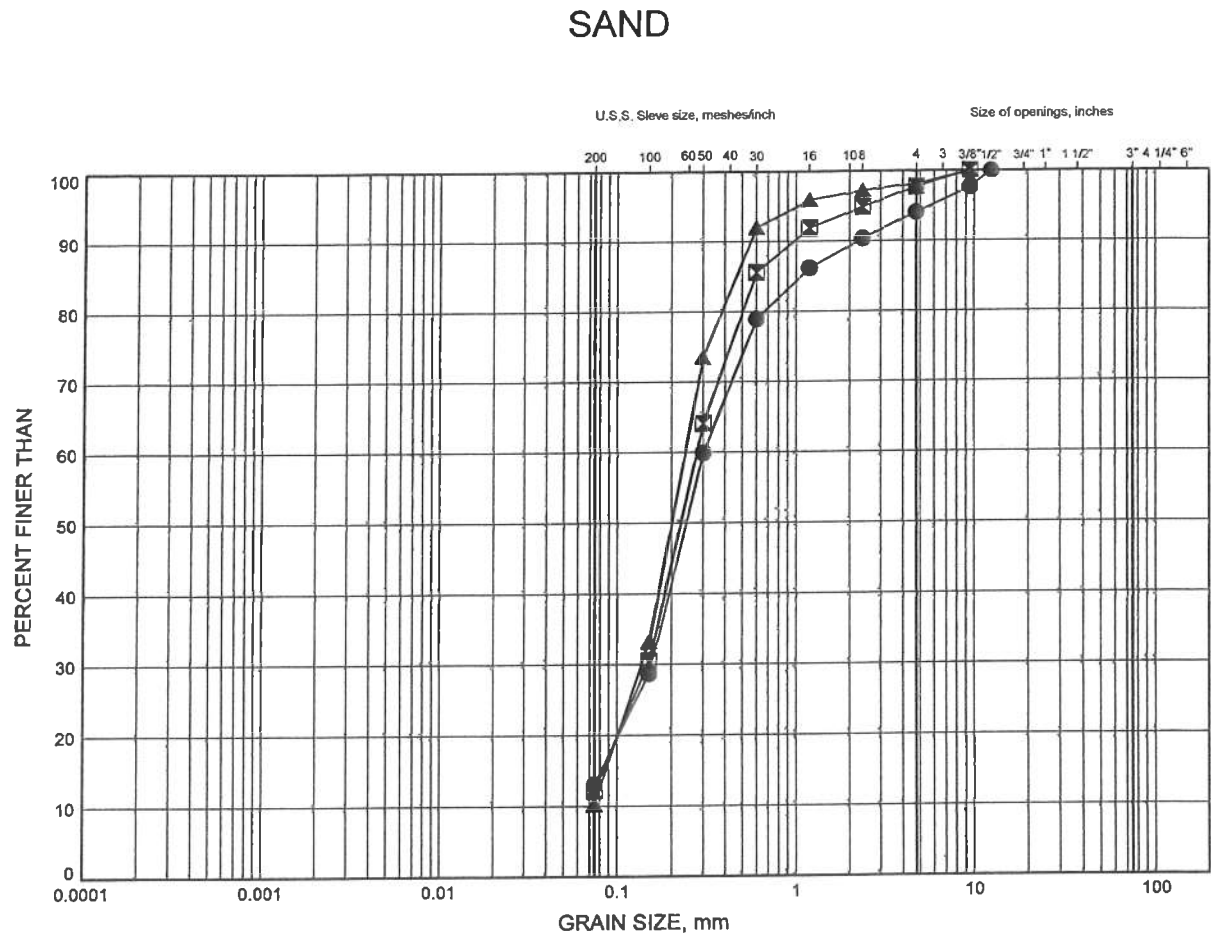
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MCB-02	1.83	382.95



W.P.# 6043-08-00
Prepared By AN
Checked By RPR

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B3



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

LEGEND

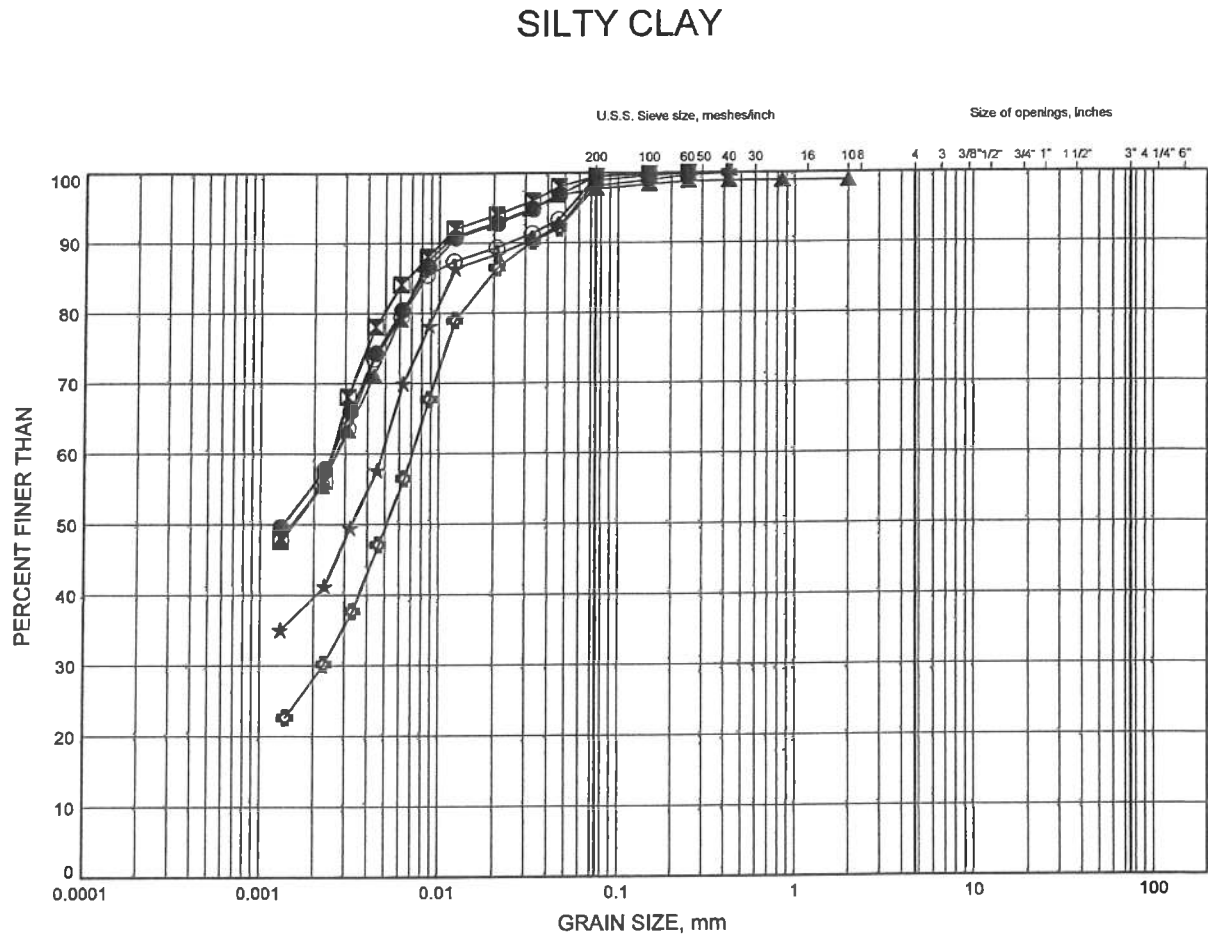
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MCB-03	2.59	382.11
■	MCB-04	3.35	381.41
▲	MCB-05	3.35	381.40



W.P.# 6043-08-00
Prepared By .AN.
Checked By .RPR.

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B4



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

LEGEND

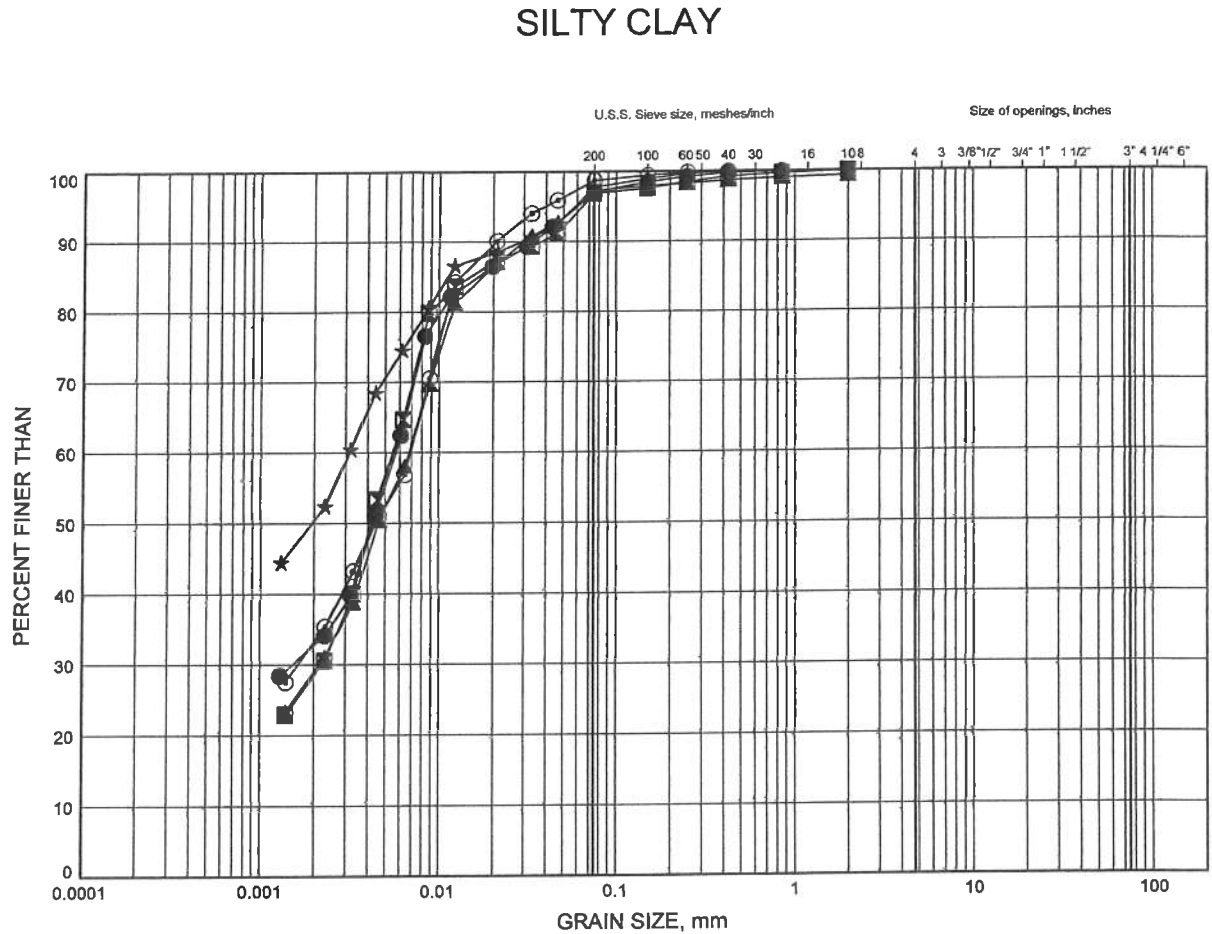
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MCB-01	6.40	378.33
⊠	MCB-01	9.45	375.28
▲	MCB-02	6.40	378.38
★	MCB-02	9.45	375.33
⊙	MCB-03	7.92	376.78
⊕	MCB-03	10.97	373.73



W.P.# 6043-08-00.....
Prepared By AN.....
Checked By RPR.....

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B5



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MCB-04	4.88	379.88
⊠	MCB-05	4.88	379.87
▲	MCB-05	9.45	375.30
★	MCB-06	4.88	379.88
⊙	MCB-06	7.92	376.83

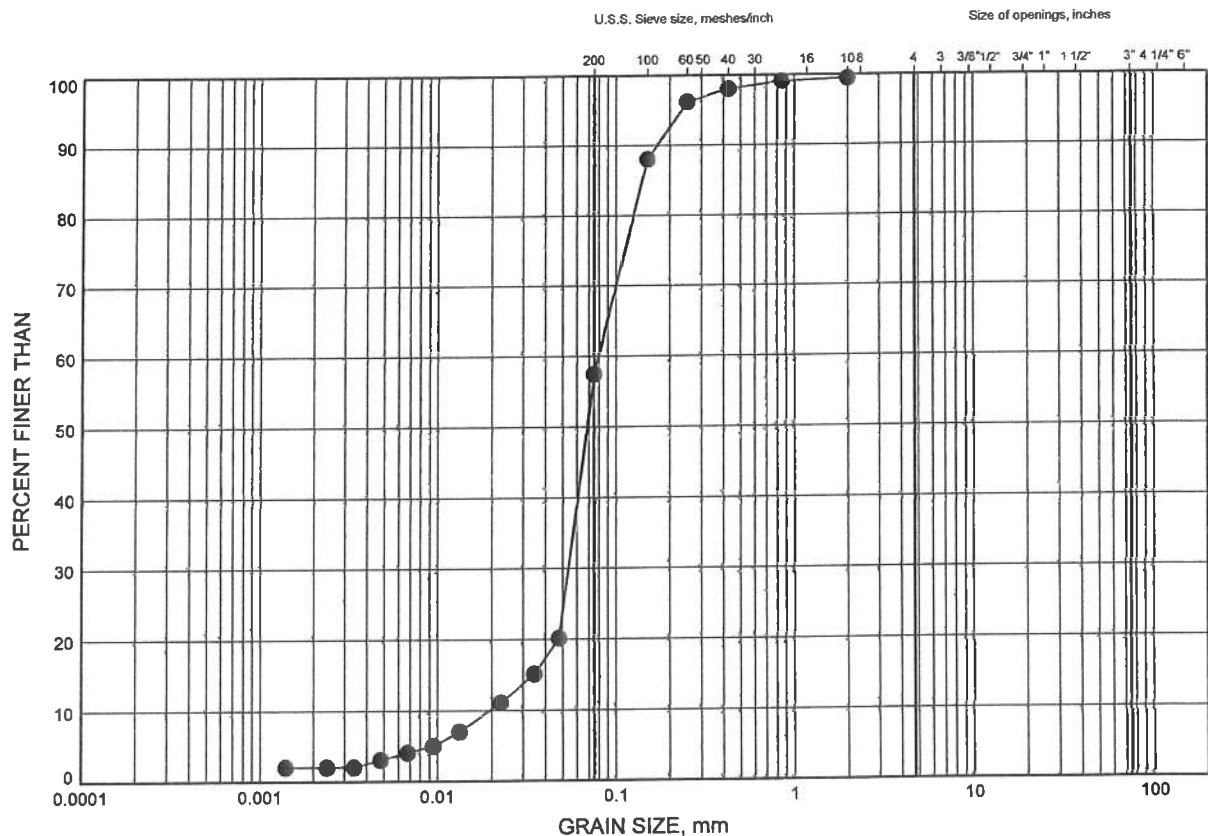


W.P.# 6043-08-00
Prepared By AN
Checked By RPR

6010-E-0010 Bridge and Culvert Rehabs NWR
GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND & SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MCB-04	10.97	373.79

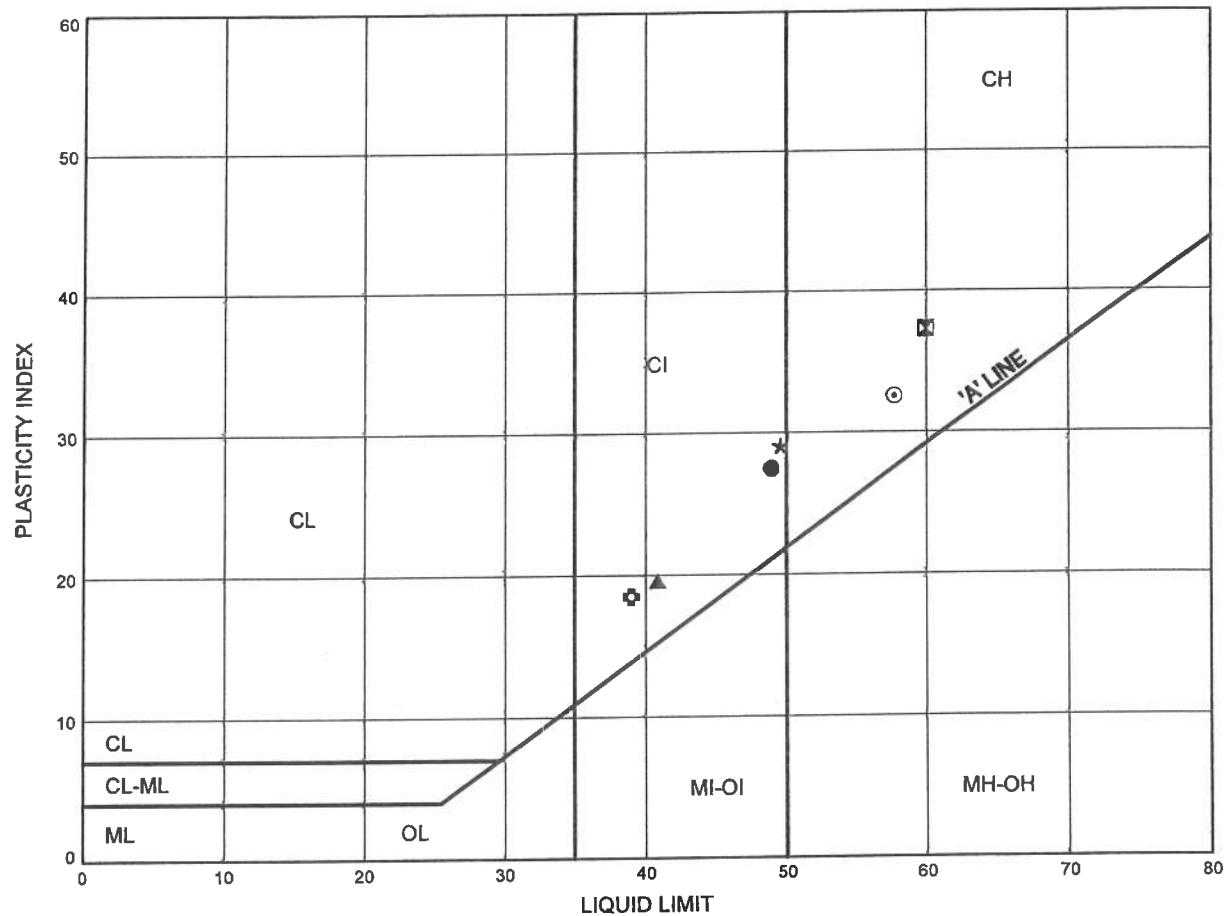


W.P.# 6043-08-00
Prepared By AN
Checked By RPR

6010-E-0010 Bridge and Culvert Rehabs NWR
ATTERBERG LIMITS TEST RESULTS

FIGURE B7

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	MCB-01	6.40	378.33
⊠	MCB-01	9.45	375.28
▲	MCB-02	6.40	378.38
★	MCB-02	9.45	375.33
⊙	MCB-03	7.92	376.78
⊕	MCB-03	10.97	373.73

Date September 2011
 Project 6043-08-00

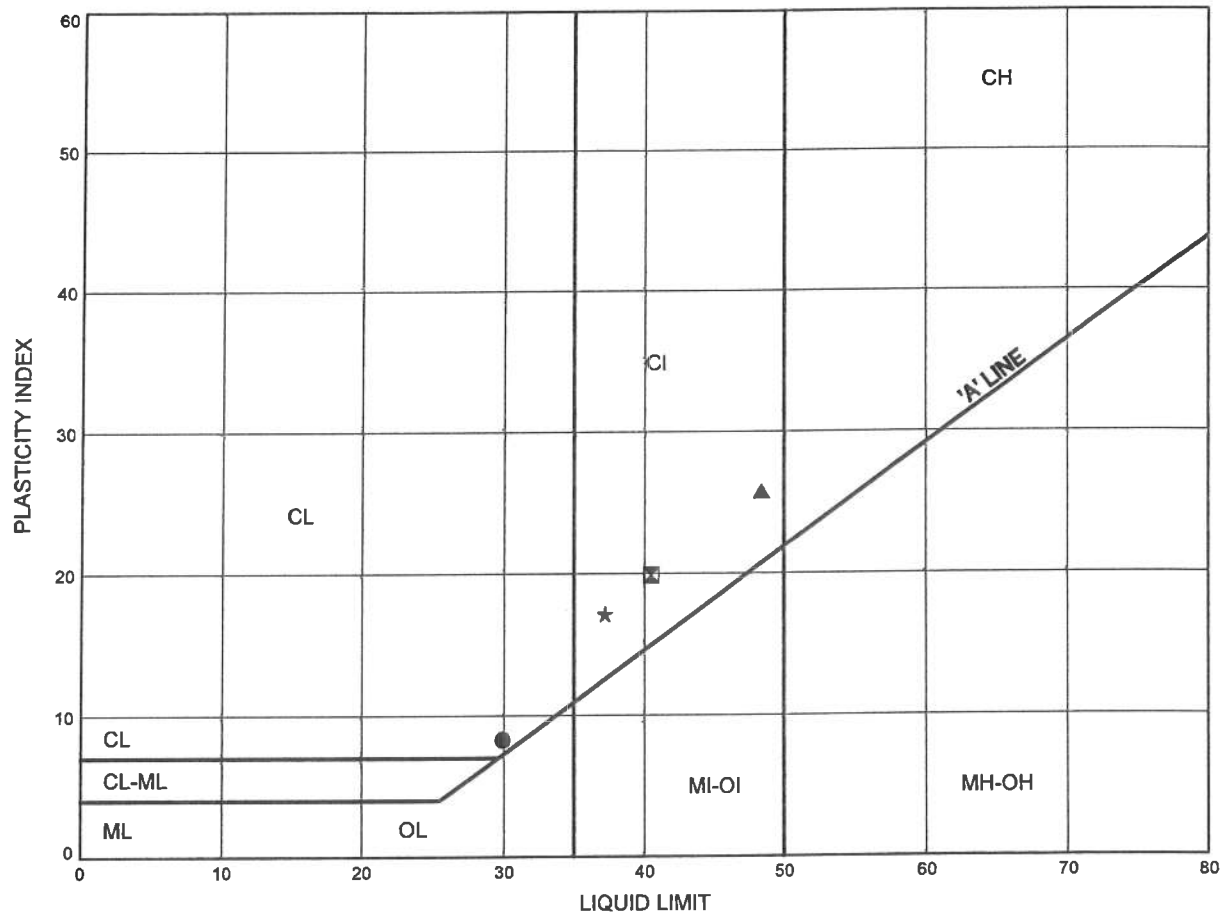


Prep'd AN
 Chkd. RPR

6010-E-0010 Bridge and Culvert Rehabs NWR
ATTERBERG LIMITS TEST RESULTS

FIGURE B8

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	MCB-04	4.88	379.88
⊠	MCB-05	9.45	375.30
▲	MCB-06	4.88	379.88
★	MCB-06	7.92	376.83

THURBALT 5121.GPJ 9/28/11

Date September 2011
 Project 6043-08-00



Prep'd AN
 Chkd. RPR



THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-1605-121 Client : HMM
Date Drilled : 15/7/2011
Project Name : McCauley Bridge Creek Date Tested : 2/8/2011
Core Size : NQ BH No : MCB-02 Tester : MAT

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	11.8	D	12.0	47.5	74.3	125.1	Arkose/sandstone	Very Strong
2	1	12.2	D	18.5	47.5	83.6	191.9	Arkose/sandstone	Very Strong
3	1	25.3	D	15.0	47.5	85.8	156.1	Arkose/sandstone	Very Strong
4	2	13.4	D	19.4	47.5	86.1	201.3	Arkose/sandstone	Very Strong
5	2	13.7	D	16.0	47.5	90.6	166.2	Arkose/sandstone	Very Strong
6	2	14.1	D	8.6	47.5	93.0	89.1	Arkose/sandstone	Strong
7	2	13.9	A	7.7	47.5	55.8	58.4	Arkose/sandstone	Strong
8	2	14.7	D	5.0	47.5	102.6	52.0	Arkose/sandstone	Strong
9									
10									
11									
12									
13									
14									
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 $0.7 \times D$ on either side of test point.



THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-1605-121 Client : HMM
Date Drilled : 15/7/2011
Project Name : McCauley Bridge Creek Date Tested : 2/8/2011
Core Size : NQ BH No : MCB-05 Tester : MAT

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	11.8	D	7.0	47.6	83.0	72.8	Arkose/sandstone	Strong
2	1	12.0	D	12.3	47.6	87.4	127.6	Arkose/sandstone	Very Strong
3	1	12.7	D	5.8	47.6	104.7	59.8	Arkose/sandstone	Strong
4	3	13.8	D	20.0	47.6	86.1	207.2	Arkose/sandstone	Very Strong
5	3	14.0	D	20.0	47.6	90.6	207.3	Arkose/sandstone	Very Strong
6	3	14.4	D	20.0	47.6	93.0	207.3	Arkose/sandstone	Very Strong
7	3	14.8	D	20.0	47.6	55.8	207.0	Arkose/sandstone	Very Strong
8									
9									
10									
11									
12									
13									
14									
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 $0.7 \times D$ on either side of test point.

Appendix C

Site Photographs



Photograph 1– McCauley Creek Bridge - Looking West



Photograph 2 – McCauley Creek Bridge- Looking East



Photograph 3 – North side of the McCauley Creek Bridge



Photograph 4 – North side of the McCauley Creek Bridge



Photograph 5 – South side of the McCauley Creek Bridge

Appendix D

Drawing titled “Borehole Locations and Soil Strata”

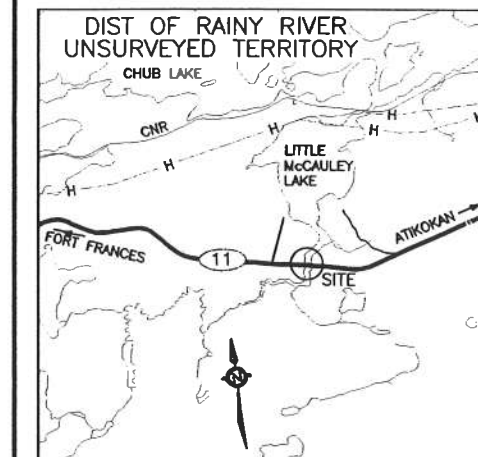
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 6043-08-00

HIGHWAY 11
BRIDGE & CULVERT REHABS
McCAULEY CREEK BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

**Hatch Mott
MacDonald**

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

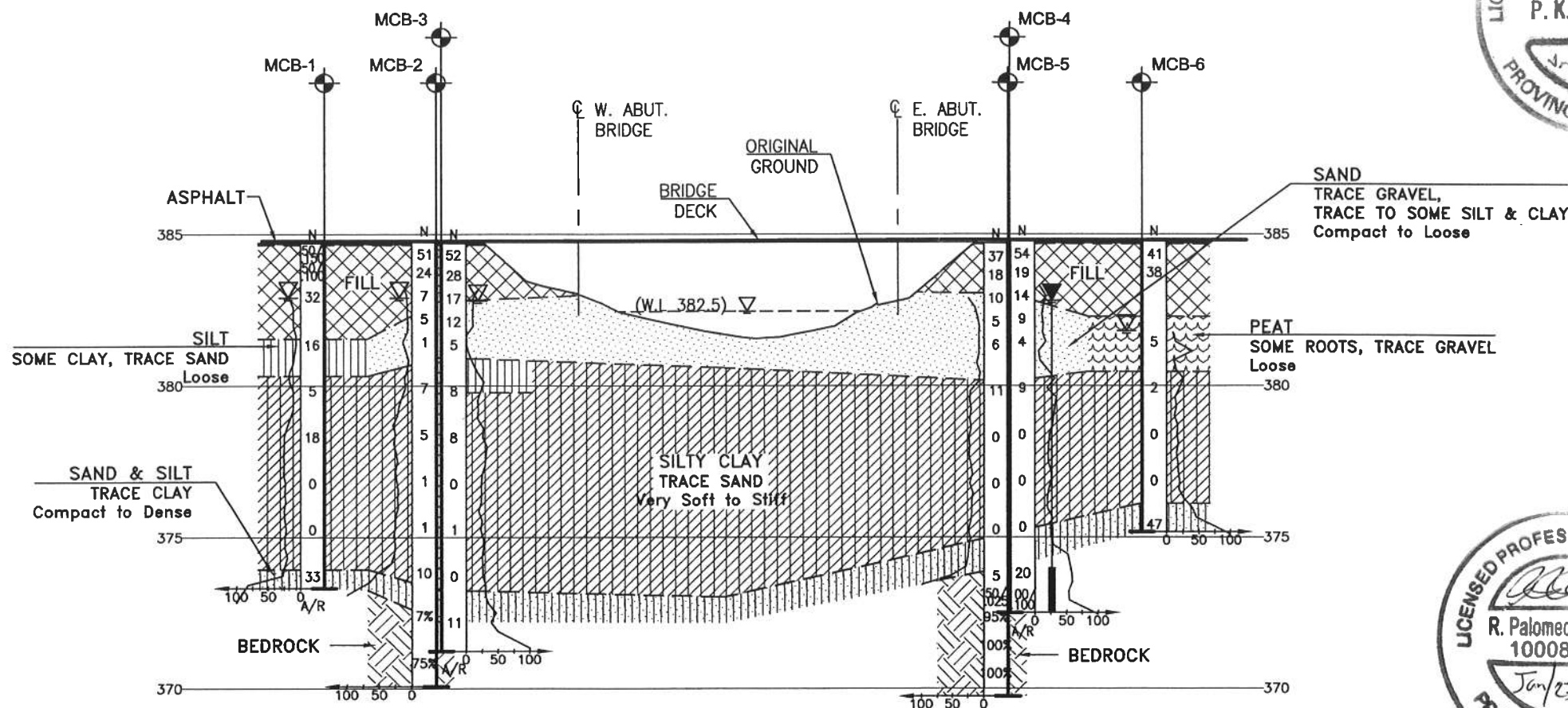
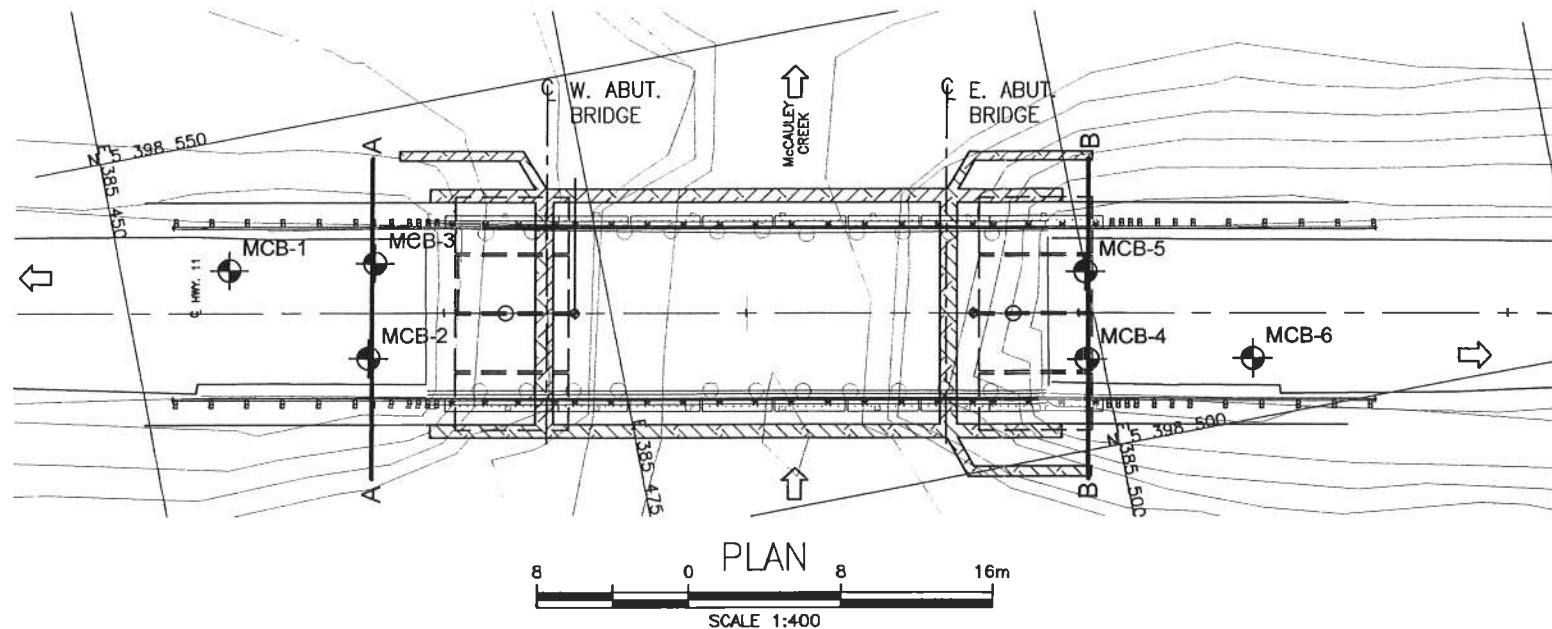
- ◆ Borehole
- ◆ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- ▽ Water Level
- ▽ Head Artesian Water
- ▽ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
MCB-01	384.7	5 398 543.1	385 455.7
MCB-02	384.8	5 398 537.1	385 462.0
MCB-03	384.7	5 398 542.0	385 463.3
MCB-04	384.8	5 398 529.8	385 499.2
MCB-05	384.7	5 398 534.4	385 500.0
MCB-06	384.8	5 398 528.2	385 507.8

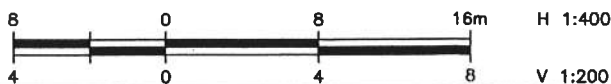
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCREs No. 52B-14



PROFILE ALONG HWY. 11



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK	RPR
DRAWN	AN	CHK	SITE
			LOAD
			STRUCT
			DWG 1

SCALE 1:200