

**FOUNDATION INVESTIGATION REPORT
STRAWBERRY CREEK BRIDGE 2 REHABILITATION
HIGHWAY 102
THUNDER BAY DISTRICT, ONTARIO**

G.W.P. 6073-09-00, SITE NO. 48W-2

Geocres Number: 52A-186

Report to:

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the existing Strawberry Creek Bridge 2 along Highway 102, in the District of Thunder Bay, 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 MMM Group Limited, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

2 SITE DESCRIPTION

The existing Strawberry Creek Bridge 2 is located on Highway 102 in the community of Kaministiquia, approximately 6 km east of the intersection of Highways 102 and 11/17, and 25 km northwest of Thunder Bay. The existing bridge is a single-span structure with a concrete deck and steel girders supported on concrete abutments and steel H-piles. The bridge spans a length of approximately 21.3 m and is 11 m wide.

Strawberry Creek flows from south to north at this bridge site, but flows in an overall northeast to southwest direction in the area crossing Highway 102 at three locations before draining into the Kaministiquia River. The creek channel is approximately 10 m wide and 1.5 m deep at the site. The surrounding lands are heavily wooded with occasional clearings for some residential and commercial usage along the highway. An active gravel pit is located approximately 500 m to the east.

Photographs in Appendix C show the general nature of the site and the existing bridge.

The site lies within the physiographic region known as the Wawa Subprovince of the Superior Province of the Canadian Shield. The soil deposits in the area comprise glaciofluvial outwash gravel. Bedrock at depth is formed of mafic to metavolcanic rocks.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between July 16 and 21, 2013 and consisted of drilling and sampling four boreholes, identified as Boreholes SBC2-01 to SBC2-04, through the highway embankment in the area of the existing west and east abutments and approaches. Boreholes SBC2-02 and SBC2-03 were drilled near the abutments to depths of 27.6 to 29.4 m, and Boreholes SBC2-01 and SBC2-04 were drilled through the approach embankments to depths of 9.8 m.

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. The coordinates and ground surface elevations for the boreholes were derived from topographic plans provided to Thurber by MMM Group Limited.

A truck-mounted CME 75 drill rig was used to advance the boreholes using NW casing/wash boring techniques. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Dynamic Cone Penetration Tests (DCPTs) were conducted adjacent to Boreholes SBC2-02 and SBC2-03 on completion of drilling.

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Groundwater conditions observed after completion of drilling were not representative of site conditions as water was used during wash boring operations. Standpipe piezometers were installed in two boreholes to monitor the groundwater level after drilling. The piezometers were subsequently decommissioned and the boreholes without piezometers were backfilled in general accordance with MOE Regulation 903. Completion details of the piezometers and boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Boreholes	Piezometer Tip Depth/ Elevation (m)	Completion Details
West Approach	SBC2-01	None installed	Borehole backfilled with bentonite holeplug from 9.8 m to 0.15 m, then asphalt to surface.
West Abutment	SBC2-02	27.3/ 291.5	Sand from 27.6 m to 23.2 m, bentonite holeplug from 23.2 m to 0.5 m, sand from 0.5 m to 0.15 m, then asphalt to surface.
East Abutment	SBC2-03	28.5/ 290.2	Sand from 29.4 m to 24.4 m, bentonite holeplug from 24.4 m to 0.15 m, then asphalt to surface.
East Approach	SBC2-04	None installed	Borehole backfilled with bentonite holeplug from 9.8 m to 0.15 m, then asphalt to surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits tests. The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and on the figures presented 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 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. It must be recognized that soil conditions may vary between and beyond the borehole locations.

The soil stratigraphy typically comprises a gravelly sand to sand and gravel embankment fill, underlain by native sand and gravel over sand. More detailed descriptions of the individual strata are presented below.

5.1 Asphalt and Concrete

Asphalt was encountered in all the boreholes, which were drilled from the existing Highway 102 roadway. The asphalt layer was 125 mm thick at the four borehole locations. A concrete slab (125 to 250 mm thick) with steel rebar was encountered below the asphalt in Boreholes SBC2-02 and SBC2-03 near the bridge abutments.

5.2 Embankment Fill

The existing highway embankment fill beneath the asphalt typically comprised a brown sand and gravel ranging to sandy gravel and containing trace silt and occasional cobbles. The lower

portion of the embankment fill at the bridge approaches (below 2.3 to 2.6 m depth at Boreholes SBC2-01 and SBC2-04) transitioned to clayey sand with some silt and trace gravel. The embankment fill has a total thickness of 3.9 to 4.3 m with a lower boundary at depths of 4.0 to 4.6 m (Elev. 314.7 to 314.1).

SPT 'N' values recorded in the sand and gravel fill typically ranged from 14 to 53 blows per 0.3 m penetration, indicating a compact to very dense relative density. The clayey sand fill was loose to compact, based on SPT 'N' values of 4 to 13 blows per 0.3 m penetration.

Measured moisture contents of the fill ranged from 1% to 12% in the sand and gravel and from 20% to 50% in the clayey sand.

The results of grain size analysis tests conducted on the embankment fill 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 shown on Figures B1 and B2 of Appendix B.

Sandy Gravel to Sand and Gravel Fill:

Gravel %	54 to 78
Sand %	21 to 42
Silt & Clay %	1 to 5

Clayey Sand Fill:

Gravel %	0 to 1
Sand %	50 to 53
Silt %	14 to 17
Clay %	32 to 35

Atterberg Limits testing conducted on one sample of the clayey sand indicate that the fill has intermediate plasticity, with a group symbol of CI. The results are plotted on Figure B5 of Appendix B.

5.3 Sand and Gravel

A native deposit of brown to grey sand and gravel containing occasional cobbles and boulders and trace to some silt was encountered below the embankment fill in Boreholes SBC2-01, SBC2-02 and SBC2-03. Where fully penetrated, the sand and gravel deposit had a thickness of 13.7 and 7.6 m, with lower boundary at depths of 18.3 and 12.2 m (Elev. 300.5 and 306.5). Borehole SBC2-01 was terminated within the sand and gravel deposit at a depth of 9.8 m (Elev. 309.0).

SPT 'N' values obtained in the sand and gravel ranged from 14 blows for 0.3 m penetration to 50 blows for 0.05 m penetration, indicating a compact to very dense relative density. Measured moisture contents ranged from 8% to 16%.

Selected samples of sand and gravel 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 shown on Figure B3 of Appendix B.

Gravel %	44 to 56
Sand %	38 to 50
Silt & Clay %	3 to 14

5.4 Sand

A native deposit of brown sand with trace to some gravel, trace silt to silty and occasional cobbles and boulders was encountered below the sand and gravel in Boreholes SBC2-02 and SBC2-03, and below the embankment fill in Borehole SBC2-04. The boreholes were each terminated within the sand deposit at depths of 9.8 to 29.4 m (Elev. 308.8 to 289.3).

SPT 'N' values obtained in the sand typically ranged from 17 blows for 0.3 m penetration to 100 blows for 0.025 m penetration, indicating a compact to very dense relative density. A loose zone with 'N' values of 8 and 6 blows for 0.3 m penetration was encountered between 13.0 and 16.0 m depths in Borehole SBC2-03. Measured moisture contents ranged from 14% to 35%.

Selected samples of the sand 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 shown on Figure B4 of Appendix B.

Gravel %	0 to 19
Sand %	70 to 94
Silt & Clay %	4 to 30

5.5 Water Levels

Where possible, water levels were monitored in the open boreholes during drilling operations. Wash boring methods were used to advance the boreholes and therefore water levels recorded during or upon completion of drilling may not reflect natural groundwater levels. Standpipe piezometers were installed in two boreholes to monitor the groundwater level after completion. The water levels observed in the open boreholes upon completion and measured in the piezometers are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
SBC2-02	July 21, 2013	4.7	314.1	Open Borehole
	August 1, 2013	5.3	313.5	In piezometer
	May 2, 2014	3.6	315.2	In piezometer
SBC2-03	July 19, 2013	4.6	314.1	Open borehole
	August 1, 2013	5.0	313.7	In piezometer
	May 2, 2014	3.7	315.0	In piezometer

The preliminary General Arrangement drawings provided by MMM Group Limited indicates a water level at approximate Elev. 314.5 in Strawberry Creek in February 1972. In general, the groundwater level is expected to be at or slightly above the water level in the creek.

The above values are short-term readings and seasonal fluctuations of the groundwater and creek level are to be expected. In particular, the water levels 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. The coordinates and the ground surface elevations for the boreholes were established based on topographic survey information provided by MMM Group Limited.

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

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied a truck-mounted CME-75 drill rig and conducted the drilling, sampling and in-situ testing operations for the boreholes. The drilling operations were supervised by Ms. Eckie Siu of Thurber.

Overall supervision of the field program, interpretation of the data, and preparation of the report were carried out by Mr. Mark Farrant P.Eng.

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

Thurber Engineering Ltd.

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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.

EXPLANATION OF ROCK LOGGING TERMS

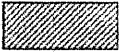




ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

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

TERMS

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

UNIFIED SOILS CLASSIFICATION

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

RECORD OF BOREHOLE No SBC2-01

1 OF 2

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 446.0 E 336 480.3 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2013.07.19 - 2013.07.19 CHECKED BY MEF

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			SHEAR STRENGTH kPa							
								20 40 60 80 100							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
					WATER CONTENT (%)										
					20 40 60										
318.8	GROUND SURFACE														
0.0	ASPHALT: (125mm)														
0.1	SAND and GRAVEL, trace silt Compact to Very Dense Brown Moist (FILL)		1	SS	19		318								54 42 4 (SI+CL)
	Wet		2	SS	51		317								
316.2			3	SS	50		316								0 53 15 32
2.6	Clayey SAND, some silt, trace gravel Loose Brown Wet (FILL)		4	SS	4		315								1 50 14 35
314.7							314								
4.1	SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Dense Brown Wet		5	SS	50/ 0.125		313								
			6	SS	30		312								
	Cobbles		7	SS	32		311								
							310								
	Cobbles (150mm)		8	SS	38										
309.0															
9.8	END OF BOREHOLE AT 9.8m.														

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SBC2-01

2 OF 2

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 446.0 E 336 480.3 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.07.19 - 2013.07.19 CHECKED BY MEF

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			SHEAR STRENGTH kPa		W _p	W	W _L		
	Continued From Previous Page													
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.15m, THEN ASPHALT TO SURFACE.													

RECORD OF BOREHOLE No SBC2-02

1 OF 3

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 455.0 E 336 492.1 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2013.07.19 - 2013.07.21 CHECKED BY MEF

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	WATER CONTENT (%)					
318.8	GROUND SURFACE													
0.0	ASPHALT: (125mm)													
318.5	CONCRETE: (125mm)													
0.3	Sandy GRAVEL to SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Compact Brown (FILL)		1	SS	50/ 0.125		318							
			2	SS	18		317							73 25 2 (SI+CL)
			3	SS	14		316							
			4	SS	19		315							
314.2														
4.6	SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Compact Brown Wet		5	SS	50/ 0.050		314							
			6	SS	17		313							47 50 3 (SI+CL)
			7	SS	14		312							
	Becoming grey		8	SS	21		311							
							310							
							309							

Continued Next Page

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

RECORD OF BOREHOLE No SBC2-02

2 OF 3

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 455.0 E 336 492.1 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2013.07.19 - 2013.07.21 CHECKED BY MEF

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20	40	60	80	100	20	40		60			
	Continued From Previous Page																			
	SAND and GRAVEL, trace silt, occasional cobbles Dense to Compact Grey Wet		9	SS	47		308								○					
								307								○				
								306												
								305								○				
								304												
								303								○				
								302								○				
								301												
300.5																				
18.3	SAND, trace gravel, trace silt, occasional cobbles Compact to Very Dense Grey Wet		14	SS	24		300								○					
								299												
	Cobbles (125mm)																			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SBC2-02

3 OF 3

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 455.0 E 336 492.1 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2013.07.19 - 2013.07.21 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	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						
								20 40 60 80 100						
	Continued From Previous Page													
	SAND , trace gravel, trace silt, occasional cobbles and boulders Very Dense Grey Wet <													

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 10/6/14

RECORD OF BOREHOLE No SBC2-03

1 OF 4

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 457.6 E 336 517.9 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2013.07.16 - 2013.07.19 CHECKED BY MEF

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			SHEAR STRENGTH kPa				
								20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W		
318.7	GROUND SURFACE											
0.0	ASPHALT: (125mm)											
0.1	CONCRETE SLAB, steel rebar: (250mm)											
318.3												
0.4												
	Sandy GRAVEL to SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Compact Brown Moist (FILL)		1	SS	53		318					64 31 5 (SI+CL)
			2	SS	17		317					
			3	SS	17		316					
			4	SS	20		315					
314.1												
4.6	SAND and GRAVEL, some silt Very Dense to Compact Brown Wet		5	SS	53		314					44 42 14 (SI+CL)
	Boulder (350mm) at 5.6m		6	SS	24		313					
							312					
							311					
	Occasional cobbles		7	SS	28		310					
			8	SS	16		309					

Continued Next Page

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SBC2-03

3 OF 4

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 457.6 E 336 517.9 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2013.07.16 - 2013.07.19 CHECKED BY MEF

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			SHEAR STRENGTH kPa	W P	W	W L	WATER CONTENT (%)		
	Continued From Previous Page													
	SAND, trace to some gravel, trace silt, trace clay Loose to Very Dense Brown Wet		15	SS	24									
	Becoming silty		16	SS	78									0 70 27 3
	Boulders (485mm)													
			17	SS	100/ 0.025									
289.3														
29.4	END OF BOREHOLE UPON REFUSAL TO DCPT AT 29.4m. WATER LEVEL AT 4.6m UPON COMPLETION.													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5 10
(%) STRAIN AT FAILURE

METRIC

[illegible]

RECORD OF BOREHOLE No SBC2-04

1 OF 2

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 466.5 E 336 529.7 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2013.07.21 - 2013.07.21 CHECKED BY MEF

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	○ UNCONFINED + FIELD VANE	W _P W W _L	20 40 60	GR SA SI CL							
318.6	GROUND SURFACE																		
0.0	ASPHALT: (125mm)																		
0.1	Sandy GRAVEL to SAND and GRAVEL, trace silt, occasional cobbles Compact to Dense Brown Wet (FILL)		1	SS	16										78 21 1 (SI+CL)				
			2	SS	36														
316.3																			
2.3	Clayey SAND, some silt, trace gravel Compact to Loose Brown (FILL)(CI)		3	SS	13														
			4	SS	6										1 50 17 32				
314.6																			
4.0	SAND, some gravel, trace silt, occasional cobbles Dense to Compact Brown Moist		5	SS	39										17 74 9 (SI+CL)				
			6	SS	32														
			7	SS	23														
308.8			8	SS	31														
9.8	END OF BOREHOLE AT 9.8m.																		

Continued Next Page

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

RECORD OF BOREHOLE No SBC2-04

2 OF 2

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 466.5 E 336 529.7 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.07.21 - 2013.07.21 CHECKED BY MEF

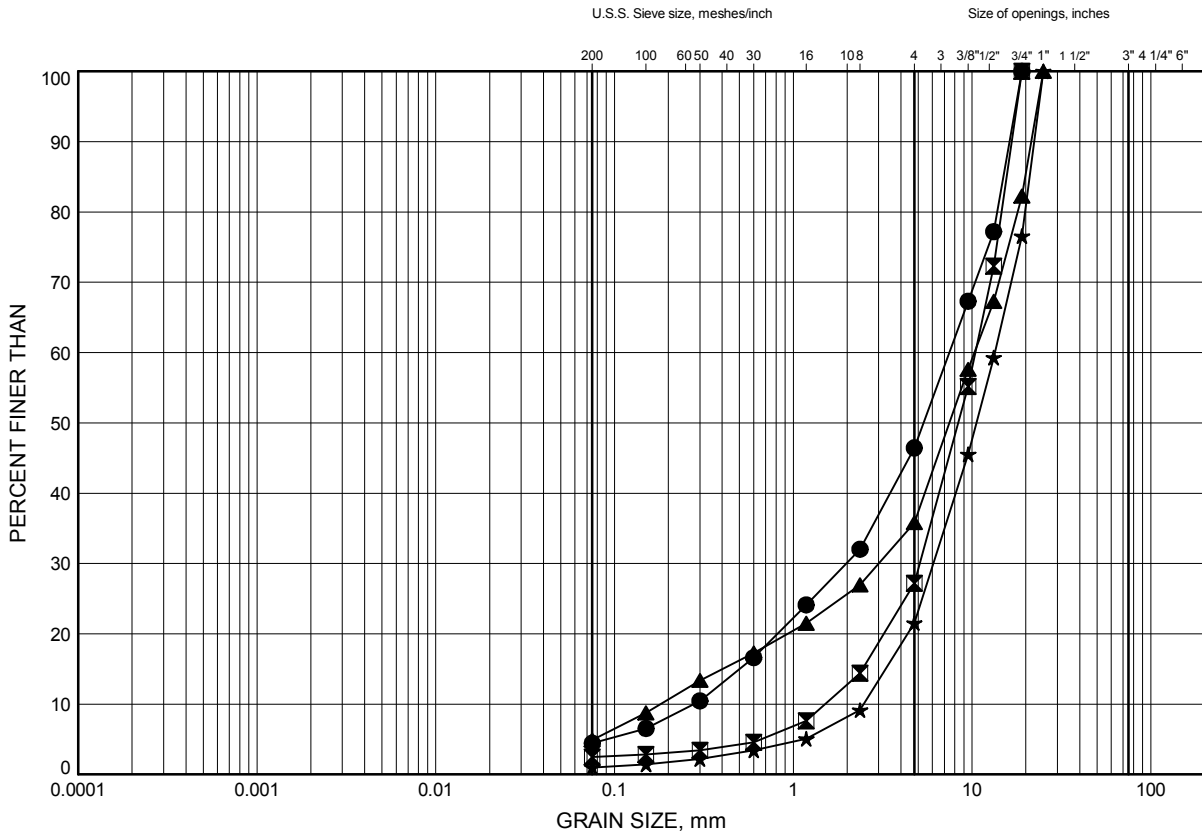
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.15m, THEN ASPHALT TO SURFACE.													

Appendix B
Laboratory Test Results

Strawberry Creek Bridge 2 GRAIN SIZE DISTRIBUTION

FIGURE B1

SANDY GRAVEL TO SAND & GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SBC2-01	1.07	317.73
⊠	SBC2-02	1.83	316.97
▲	SBC2-03	1.07	317.63
★	SBC2-04	1.07	317.53

Date September 2014
WP# 6073-09-00

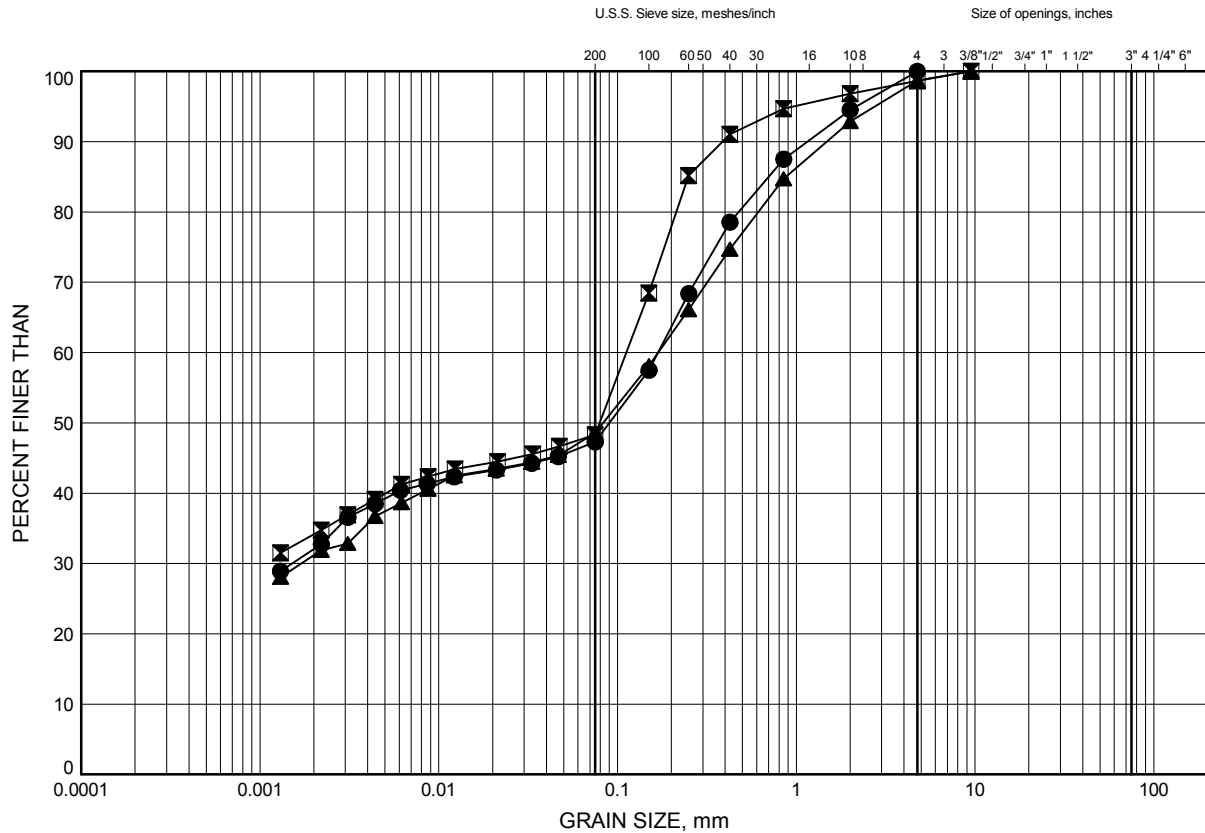


Prep'd AN
Chkd. MEF

Strawberry Creek Bridge 2 GRAIN SIZE DISTRIBUTION

FIGURE B2

CLAYEY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SBC2-01	2.59	316.21
⊠	SBC2-01	3.35	315.45
▲	SBC2-04	3.35	315.25

Date September 2014
WP# 6073-09-00



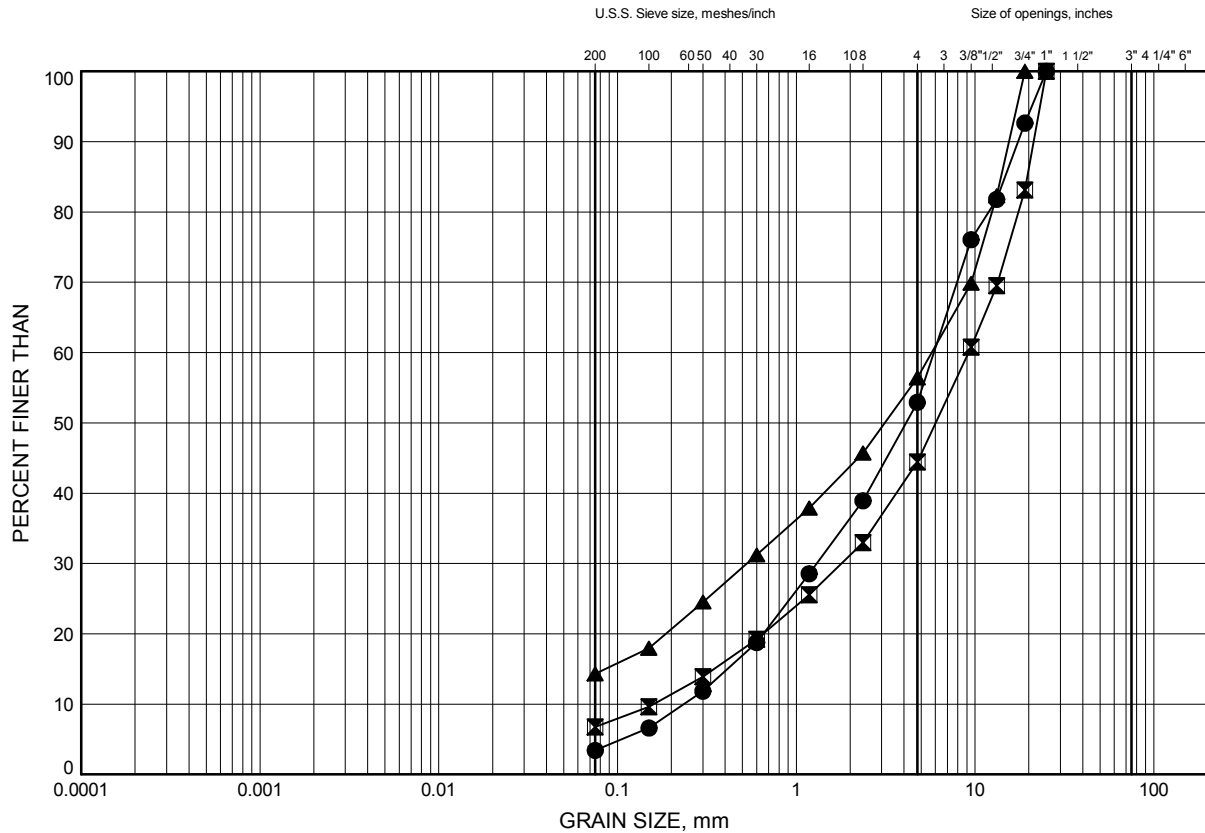
Prep'd AN
Chkd. MEF

Strawberry Creek Bridge 2

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SBC2-02	6.40	312.40
⊠	SBC2-02	14.02	304.78
▲	SBC2-03	4.80	313.90

Date September 2014
 WP# 6073-09-00

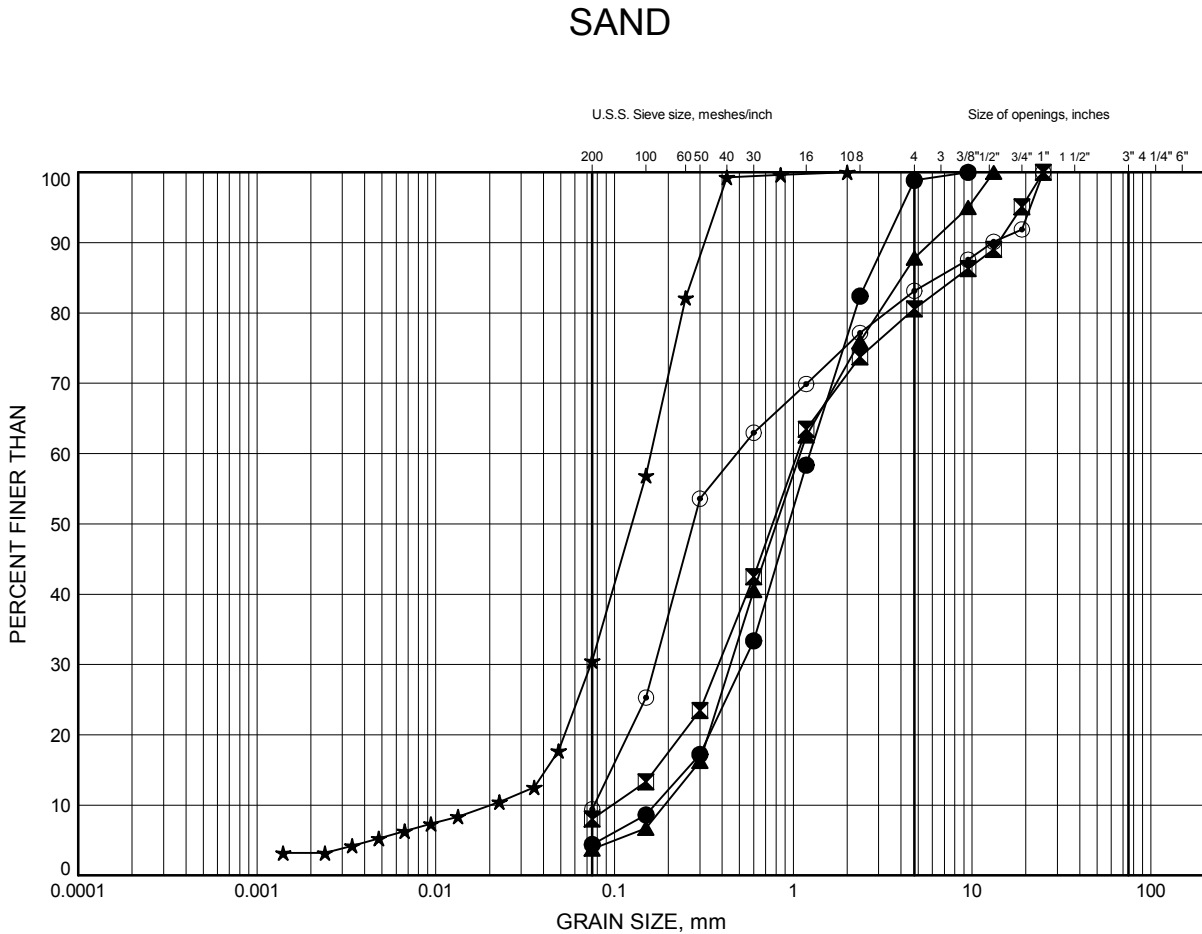


Prep'd AN
 Chkd. MEF

Strawberry Creek Bridge 2

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)
●	SBC2-02	18.59	300.21
⊠	SBC2-03	12.50	306.20
▲	SBC2-03	17.07	301.63
★	SBC2-03	24.65	294.05
⊙	SBC2-04	4.88	313.72

Date September 2014

WP# 6073-09-00



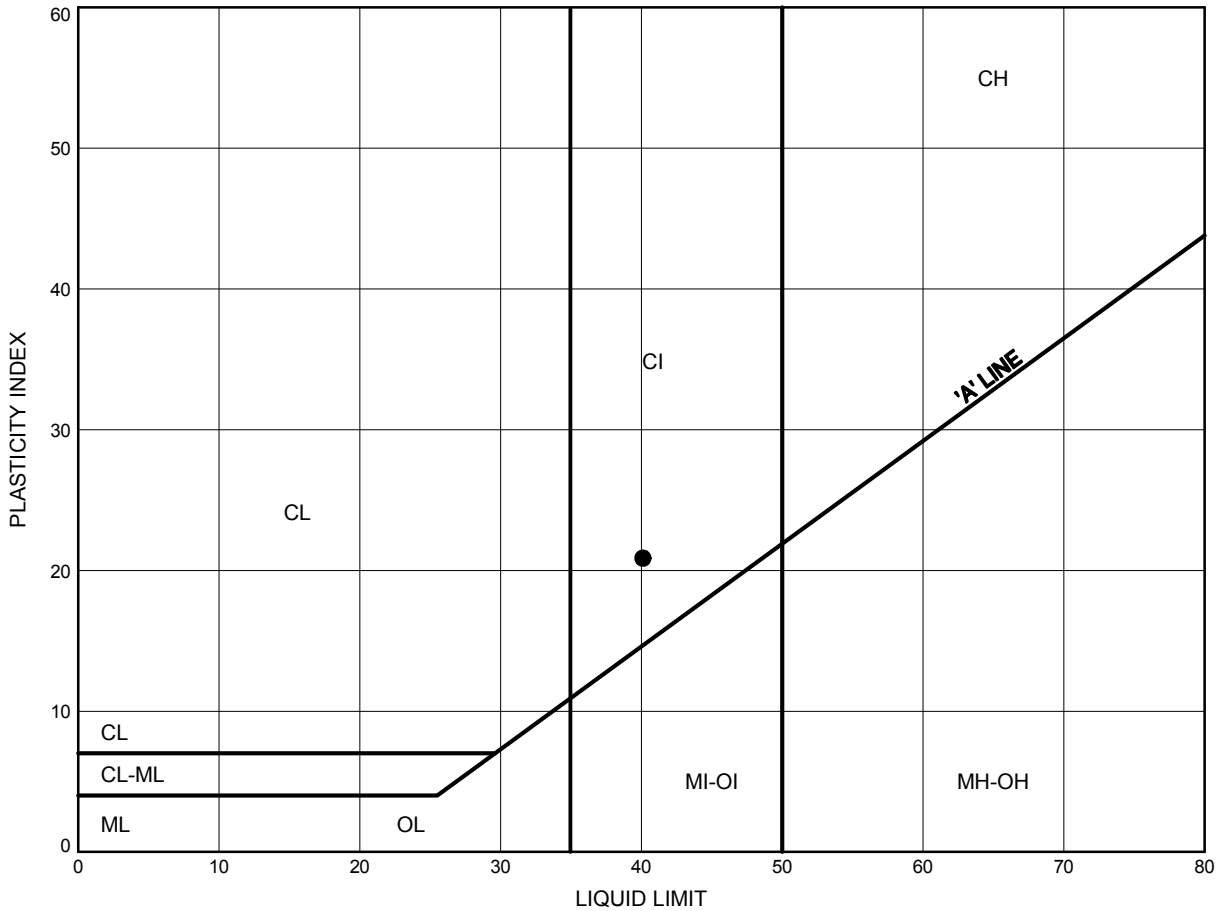
Prep'd AN

Chkd. MEF

Strawberry Creek Bridge 2
ATTERBERG LIMITS TEST RESULTS

FIGURE B5

CLAYEY SAND FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SBC2-04	3.35	315.25

Date September 2014
 WP# 6073-09-00



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Appendix C
Site Photographs



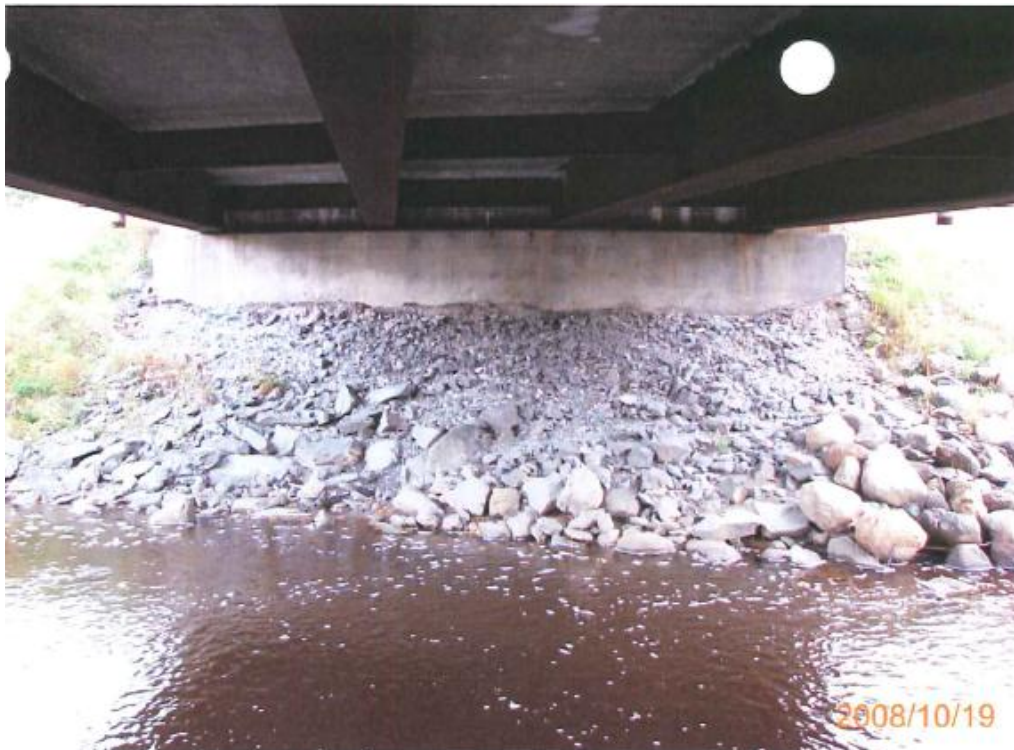
Photograph 1 – East approach, looking west



Photograph 2 – West approach, looking east



Photograph 3 – North Elevation



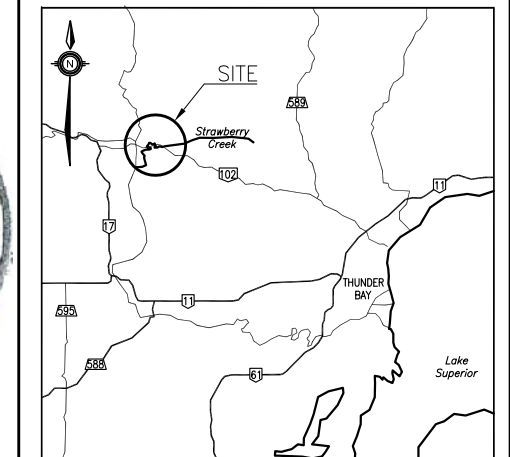
Photograph 4 – East Abutment

Appendix D
Borehole Locations and Soil Strata Drawing

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







HIGHWAY 102 STRAWBERRY CREEK BRIDGE 2 REHABILITATION BOREHOLE LOCATIONS AND SOIL STRATA	
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KEYPLAN

LEGEND

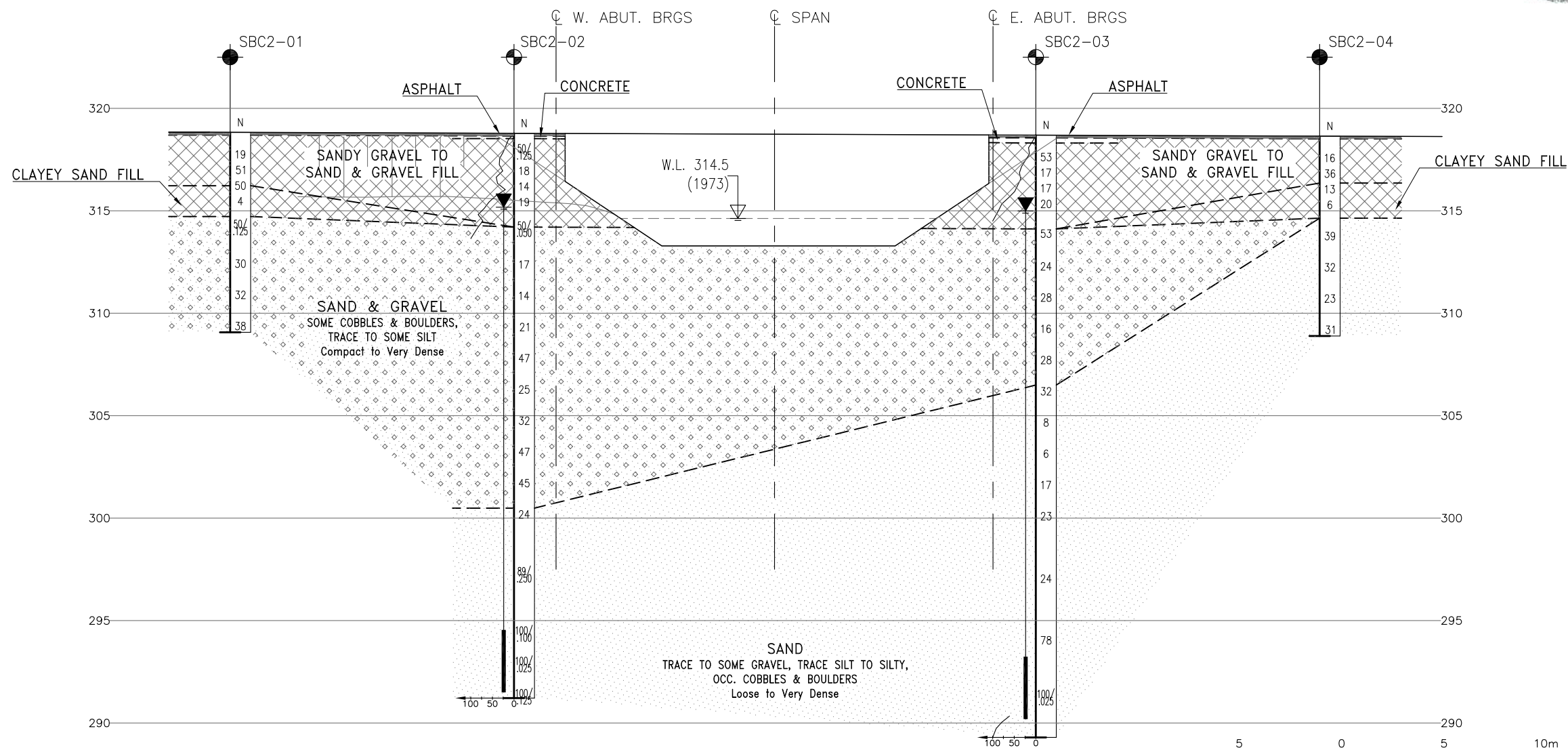
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level In Open Borehole
	Water Level In Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SBC2-01	318.8	5 377 446.0	336 480.3
SBC2-02	318.8	5 377 455.0	336 492.1
SBC2-03	318.7	5 377 457.6	336 517.9
SBC2-04	318.6	5 377 466.5	336 529.7

-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. 52A-186

[illegible]

PROFILE ALONG C HWY. 102

