



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
EVERETT CREEK CULVERT REPLACEMENT
HIGHWAY 11, TOWNSHIP OF EMO
RAINY RIVER DISTRICT, ONTARIO
GWP 6902-12-00, SITE NO. 45-138/C
Geocres Number: 52C-048**

Report to

Hatch

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April 20, 2016
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Creek\Reports & Memos\3 - Everett Creek Culvert\Final
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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed replacement of the existing Everett Creek Culvert located on Highway 11 in the Township of Emo in the Rainy River District, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the site, and based on the data obtained, to provide a borehole location plan, record of borehole sheets, a stratigraphic profile, 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 (formerly Hatch Mott MacDonald), under the Ministry of Transportation Ontario (MTO) Agreement Number 6013-E-0027-007.

A previous foundation investigation was carried out at this site and documented in a report titled "Foundation Investigation Report, Everett Creek Culvert Replacement, Highway 11, Township of Lash, Rainy River District, Agreement No. 6013-E-0023, Assignment No.2, Site No. 45-138/C, Geocres No. 52C-037", dated September 19, 2014, prepared by DST Consulting Engineers Inc. Following review of this report, additional field investigation was recommended and conducted by Thurber, the results of which are documented in this report. The borehole information and borehole location plan from the previous investigation are reproduced in Appendix D for information purposes.

2 SITE DESCRIPTION

The project site is located on Highway 11, 140 m west of Off Lake Road in the Township of Emo, Geographic Township of Lash, in the Rainy River District, Ontario.

The existing culvert carrying Everett Creek under Highway 11 is a cast-in-place reinforced concrete box structure approximately 4.3 m in width, 3.4 m in height and 49.7 m in length. The Everett Creek flows from the north to the south in a direction approximately perpendicular to the highway. The

highway embankment is estimated to be between 7.0 and 9.0 m in height with as much as 7 m of earth fill cover above the culvert.

The culvert was built in the 1930s and extended in the late 1960s. The existing condition of the culvert was documented in an MTO Structure Inspection report dated February 7, 2014 for an inspection carried out on July 26, 2013, and summarized in a Structural Replacement Options Study dated November 5, 2015 prepared by Hatch. The north end of the culvert (inlet) was reported to have settled by more than a metre, the inlet extension had separated from the original culvert, and the top slab had failed. The inlet area is covered by timber debris, and scour/erosion has occurred around and above the culvert inlet, as well as behind the wing walls. In addition, three major cracks were reported in the walls and ceiling inside the culvert, apparently under the roadbed.

The land surrounding the site is relatively flat to gently undulating, with a mixture of agricultural lands, woodlands, and occasional commercial/residential properties. The village of Emo is located to the east, and Rainy River is located approximately 280 m to the south. Vegetation on the embankment slopes consists of grass, brush and trees. Photographs of the culvert and surrounding area are presented in Appendix C.

The site lies within the Canadian Shield, which is characterized by Pre-Cambrian igneous and metamorphic bedrock. According to Canadian Geological Survey (CGS) data, the bedrock at this site generally consists of massive to foliated granodiorite and granite of the Wabigoon Subprovince of the Superior Province. The bedrock is overlain by glaciolacustrine deep-water clay and silt deposits of the Pleistocene age.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out on December 14 and 15, 2015, and on January 25 and 26, 2016, when a total of three boreholes, denoted as EC-01, EC-02 and EC-04 were advanced at the culvert site. Borehole EC-01 and EC-04 were drilled to depths of 6.1 m and 12.8 m near the inlet and outlet of the culvert (at the north and south toes of the embankment), respectively. Borehole EC-02 was advanced to a depth of 25 m from the top of the embankment. Details of the borehole locations, drilling depths and completion details are summarized in Table 3.1 below.

Table 3.1 – Borehole Summary

Location	Boreholes	Drilling Depth/ Base of Hole Elevation(m)	Completion Details
Culvert Inlet	EC-01	6.1 / 319.7	Borehole backfilled with cuttings and bentonite to surface.
Top of Embankment	EC-02	25.0 / 310.8	Borehole backfilled with bentonite to 0.3 m then concrete to surface.
Culvert Outlet	EC-04	12.8 /318.0	Borehole backfilled with bentonite to 0.3 m then cuttings to surface.

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

Boreholes EC-02 and EC-04 were advanced using a track-mounted CME-45 drill rig in combination with hollow stem augers and wash boring techniques. Borehole EC-01 was advanced using portable tripod equipment. Samples of the overburden soils were obtained from the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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

Groundwater conditions in the boreholes were observed during the drilling operations. However, due to the use of water during drilling, the water levels do not reflect the groundwater conditions in the boreholes.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets included in Appendix A. Selected samples were also subjected to grain size distribution analysis and Atterberg Limits testing, and the results of this testing program are summarized on the Record of Borehole sheets in Appendix A and are shown on the figures included in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented in these sheets and on the "Borehole Locations and Soil Strata" drawings in Appendix E. An overall description of the stratigraphy based on the present investigation is given in the following paragraphs. The factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It should be noted that the subsurface conditions may vary beyond the borehole locations.

In summary, the soil stratigraphy encountered at the site consists of silty clay embankment fill overlying a thick deposit of silty clay extending to the depths investigated in the boreholes. The silty clay was encountered to depths ranging from 6.1 m to 25 m corresponding to Elev. 319.7 and Elev. 310.8, respectively. Descriptions of the individual strata are presented below.

5.1 Pavement Structure

Borehole EC-02 drilled from the shoulder of the highway embankment encountered a pavement structure consisting of 125 mm of asphalt underlain by a road base fill. The fill was classified as sand and gravel with some silt, trace clay and occasional cobbles. The fill was 1.4 m thick and extended to 1.5 m depth (Elev. 334.3).

An SPT 'N' value of 33 blows per 0.3 m penetration was recorded in the sand and gravel fill, indicating a dense relative density.

A moisture content of 10% was measured in the granular fill.

5.2 Silty Clay Fill

Embankment fill was encountered below the pavement structure in Borehole EC-02. The fill material extended to 10.4 m depth (Elev. 325.4), and consisted of silty clay with some sand, trace gravel, trace organic matter (rootlets), and occasional gravel lenses. Wood fragments were noted in the lower portion of the fill. The fill was grey and brown in colour to approximately 7 m depth and then became dark brown.

SPT 'N' values recorded in the silty clay fill ranged from 0 (weight of rod or weight of hammer) to 6 blows per 0.3 m penetration, indicating a very soft to firm consistency.

The results of a grain size analysis conducted on a fill sample are provided on the Record of Borehole sheet in Appendix A, and are illustrated in Figure B1 of Appendix B. The results are summarized as follows:

Gravel	0%
Sand	19%
Silt	33%
Clay	48%

Moisture contents of the cohesive fill ranged from 13% to 30%.

5.3 Sand and Gravel

A 0.3 m thick layer of sand and gravel with a boulder was encountered below the silty clay fill in Borehole EC-02 at a depth of 10.4 m. Coring methods were used to penetrate the boulder. The deposit extended to 10.7 m depth (Elev. 325.1), and probably represents the original creek channel base.

5.4 Sandy Silt

Borehole EC-01 drilled near the inlet of the creek encountered approximately 0.9 m of sandy silt material presumably placed by creek waters during flooding. The sandy silt contained some clay, some gravel and woody debris. The underside of the silty sand layer was encountered at Elev. 324.9.

5.5 Silty Clay

Underlying the sandy silt in Borehole EC-01, the sand and gravel in Borehole EC-02, and extending from the ground surface in Borehole EC-04 is a deposit of native silty clay with trace gravel and trace to some sand. Trace organic matter was noted in the upper zone of the

deposit in Borehole EC-04. The silty clay was typically grey in colour, although the upper 3.8 m of the silty clay in Borehole EC-04 was mottled brown and grey. The boreholes were terminated in the silty clay at depths ranging from 6.1 m in Borehole EC-01 to 25.0 m in Borehole EC-02, corresponding to Elev. 319.7 and Elev. 310.8, respectively.

SPT 'N' values recorded in the silty clay ranged from 0 (weight of rod or weight of hammer) to 26 blows for 0.3 m penetration, however, typically ranging from 4 to 7 blows for 0.3 m penetration. The lowest SPT "N" values ranging from 0 to 1 were obtained in the upper 3.8 m zone of the silty clay in Borehole EC-04. Field vane shear tests (VST) measured in-situ undrained shear strengths ranging from 68 kPa to 100 kPa. Based on the SPT and VST data, the consistency of the silty clay varied from firm to stiff.

The results of grain size analyses conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figures B2 and B3 of Appendix B. The results are summarized as follows:

Gravel	0%
Sand	0% to 15%
Silt	27 to 40%
Clay	47 to 73%

The results of Atterberg Limits tests conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B4 of Appendix B. The results indicate that the deposit has plastic limits ranging from 20 to 27 and liquid limits ranging from 47 to 54, suggesting medium to high plasticity. Plasticity indices, determined as the difference between the plastic limit and liquid limit, ranged from 21 to 29. Natural moisture contents of the silty clay ranged from 21 to 52%, with typical values between 25 % and 35%.

5.6 Water Levels

Water levels in the boreholes were measured upon completion of drilling operations. Since water was used to advance the boreholes, the measured water levels do not reflect prevailing groundwater levels at the site.

It is anticipated that the groundwater level will be governed by the water level in the creek. The preliminary GA drawing indicates a water level in Everett Creek at Elev. 328.52 on June 5, 2013. This level is noted to represent flooding conditions.

The water level in the creek and groundwater levels are expected to fluctuate seasonally and subject to precipitation patterns, and therefore may vary from the levels presented above.

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber obtained the northing and easting coordinates and ground surface elevations from measurements taken in the field relative to the topographic plans provided by Hatch.

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied and operated a track-mounted CME-45 hi-torque drill rig and portable tripod drilling equipment to carry out the drilling, sampling and in-situ testing operations.

The drilling and sampling operations were supervised in the field on a full time basis by Mr. Zane Burk of Thurber. Overall supervision of the field program was conducted by Mr. Stephane Loranger, CET.

Geotechnical laboratory testing was carried out by Thurber in its MTO-approved laboratory.

The report was prepared by Ms. Anna Piascik, P.Eng., and 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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MTO Review Principal



Everett Creek Culvert Replacement
Site No. 45-138/C

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer


4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

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

 Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

RECORD OF BOREHOLE No EC-01

1 OF 1

METRIC

W.P. _____ LOCATION Everett Creek Culvert, Site 45-138/C N 5 388 824.5 E 242 075.1 ORIGINATED BY TS
 HWY 11 BOREHOLE TYPE Tripod / Wash Boring COMPILED BY MFA
 DATUM Geodetic DATE 2016.01.25 - 2016.01.25 CHECKED BY AMP

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							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
								WATER CONTENT (%)							
325.8	GROUND SURFACE						20	40	60	80	100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
0.0	Sandy SILT , some clay, some gravel, some organics (woody debris) Loose Grey Wet														
324.9															
0.9	Silty CLAY , some sand, trace gravel Stiff to Very Stiff Grey Moist														
			1	SS	15								○		0 13 36 51
			2	SS	10								○		
			3	SS	22								○		
			4	SS	12								○		
			5	SS	26								○		
319.7															
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE TO SURFACE.														

ONTMT4S 10203.GPJ 2015TEMPLATE(MTO).GDT 3/15/16

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No EC-02

2 OF 3

METRIC

W.P. _____ LOCATION Everett Creek Culvert, Site 45-138/C N 5 388 803.1 E 242 059.3 ORIGINATED BY ZRB
 HWY 11 BOREHOLE TYPE NW Casing / Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2015.12.14 - 2015.12.14 CHECKED BY AMP

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													
325.4														
10.4	SAND and GRAVEL and 300mm boulder													Cored through boulder
325.1														
10.7	Silty CLAY , some sand, trace gravel Firm to Stiff Grey Moist		8	SS	6		325							0 15 33 52
							324							
			9	SS	7		323							
							322							
			10	SS	5		321							
							320							0 15 35 50
							319							
			12	SS	5		318							
							317							
			13	SS	3		316							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC-02

3 OF 3

METRIC

W.P. _____ LOCATION Everett Creek Culvert, Site 45-138/C N 5 388 803.1 E 242 059.3 ORIGINATED BY ZRB
 HWY 11 BOREHOLE TYPE NW Casing / Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2015.12.14 - 2015.12.14 CHECKED BY AMP

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			W _P	W	W _L						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)										
	Continued From Previous Page		14	SS	7			20	40	60	80	100				0	14	29	57
							315												
			15	SS	4		314												
							313												
			16	SS	7		312												
							311												
310.8 25.0	END OF BOREHOLE AT 25.0m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m, THEN CONCRETE TO SURFACE.																		

RECORD OF BOREHOLE No EC-04

1 OF 2

METRIC

W.P. _____ LOCATION Everett Creek Culvert, Site 45-138/C N 5 388 780.9 E 242 044.6 ORIGINATED BY ZRB
 HWY 11 BOREHOLE TYPE NW Casing / Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2015.12.15 - 2015.12.15 CHECKED BY AMP

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 (%)					
330.8	GROUND SURFACE													
0.0	Silty CLAY , trace to some sand, occasional sand lenses, trace gravel, trace organics (grass, wood fragments) in the upper 1.5m zone Very Soft to Firm Mottled Brown and Grey Moist to Wet		1	GS										
			1	SS	4									0 13 40 47
			2	SS	1									
			3	SS	1									
			4	SS	0									0 0 27 73
327.0														
3.8	Silty CLAY , trace to some sand, trace gravel Firm to Stiff Grey Moist													
			5	SS	6									
			6	SS	6									
			7	SS	3									
			8	SS	4									0 13 39 48

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC-04

2 OF 2

METRIC

W.P. _____ LOCATION Everett Creek Culvert, Site 45-138/C N 5 388 780.9 E 242 044.6 ORIGINATED BY ZRB
 HWY 11 BOREHOLE TYPE NW Casing / Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2015.12.15 - 2015.12.15 CHECKED BY AMP

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				WATER CONTENT (%)				
								20 40 60 80 100	W _P W W _L							
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page															
			9	SS	5		320									
							319									
318.0			10	SS	4											
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m, THEN CUTTINGS TO SURFACE.						318									

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

Everett Creek Culvert Replacement
Site No. 45-138/C

Appendix B

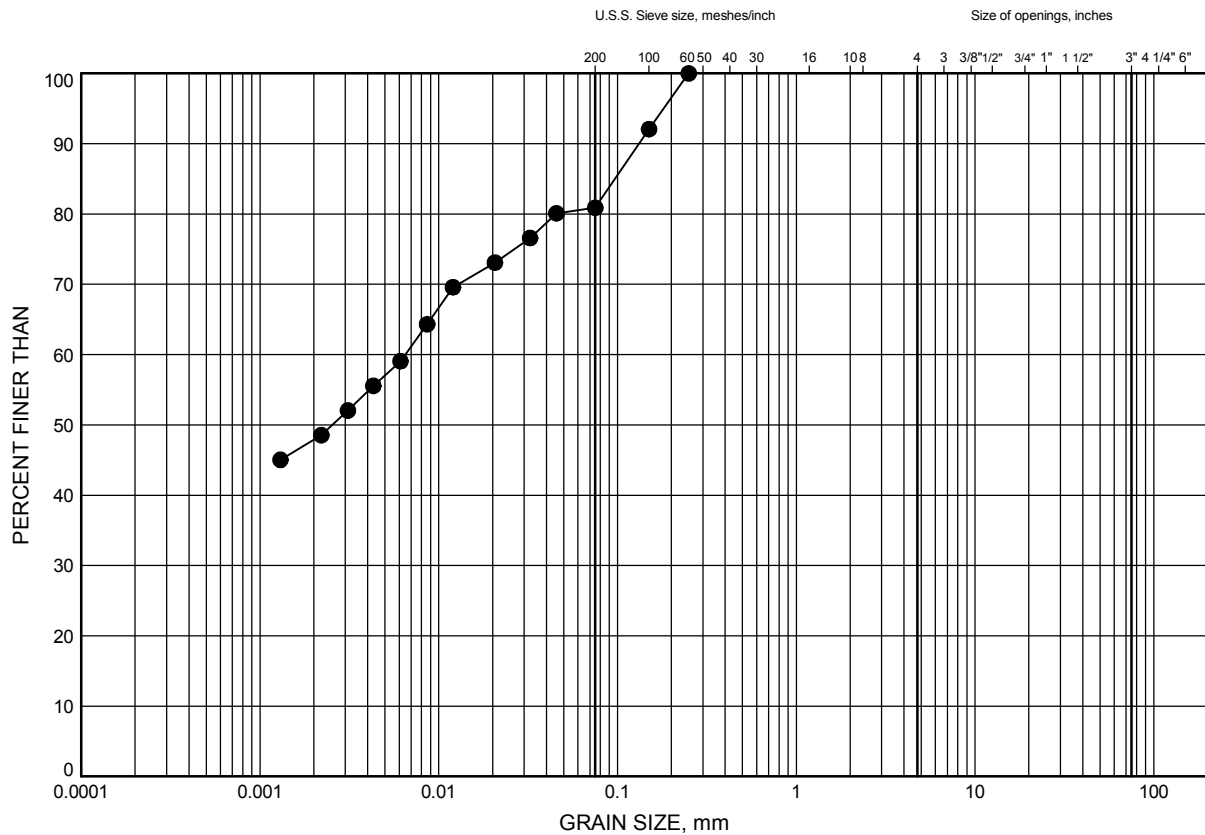
Laboratory Test Results

Everett Creek Culvert, Site 45-138/C

GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EC-02	4.88	330.92

Date March 2016

W.P. _____



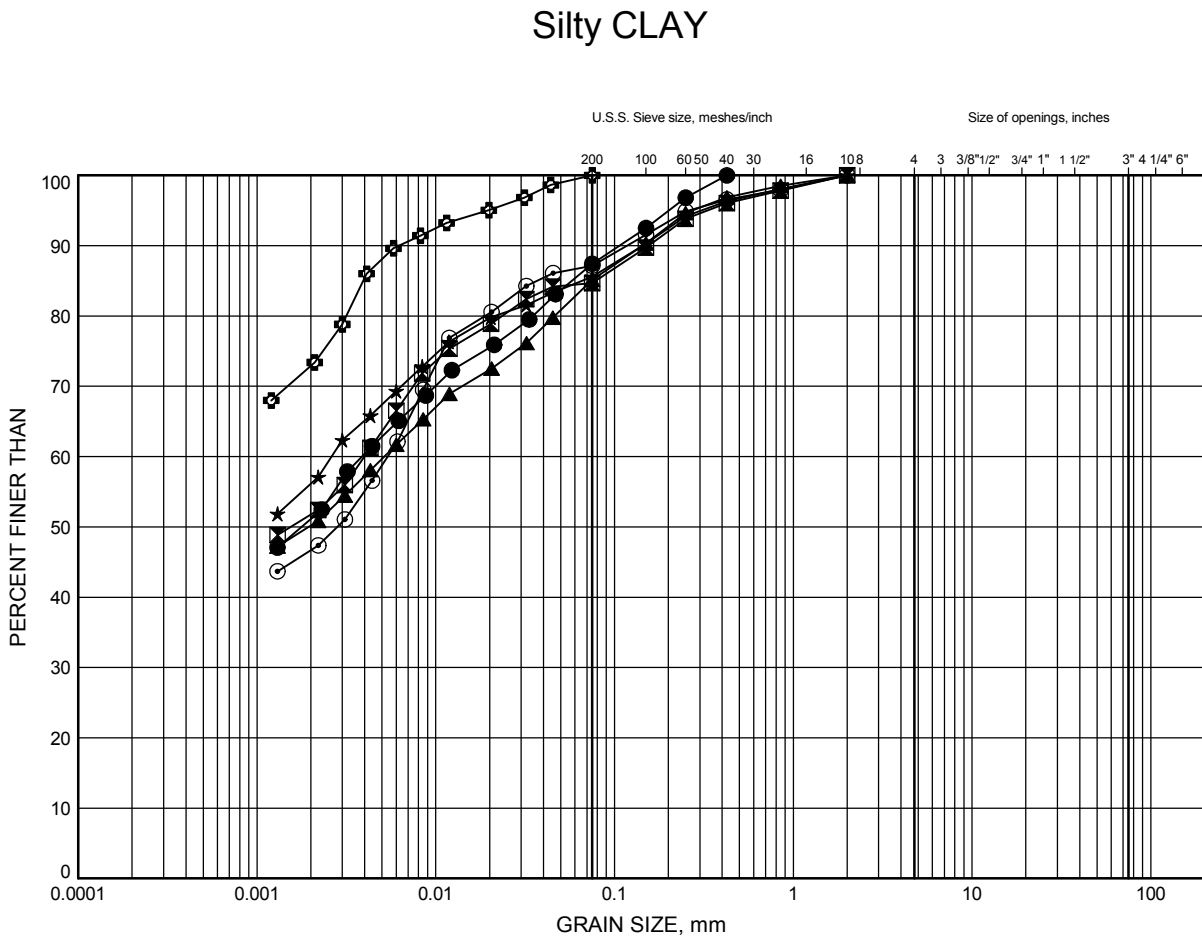
Prep'd MFA

Chkd. AMP

Everett Creek Culvert, Site 45-138/C

GRAIN SIZE DISTRIBUTION

FIGURE B2



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EC-01	1.83	323.97
⊠	EC-02	10.97	324.83
▲	EC-02	15.54	320.26
★	EC-02	20.12	315.68
⊙	EC-04	1.07	329.73
⊕	EC-04	3.35	327.45

Date March 2016
W.P. _____

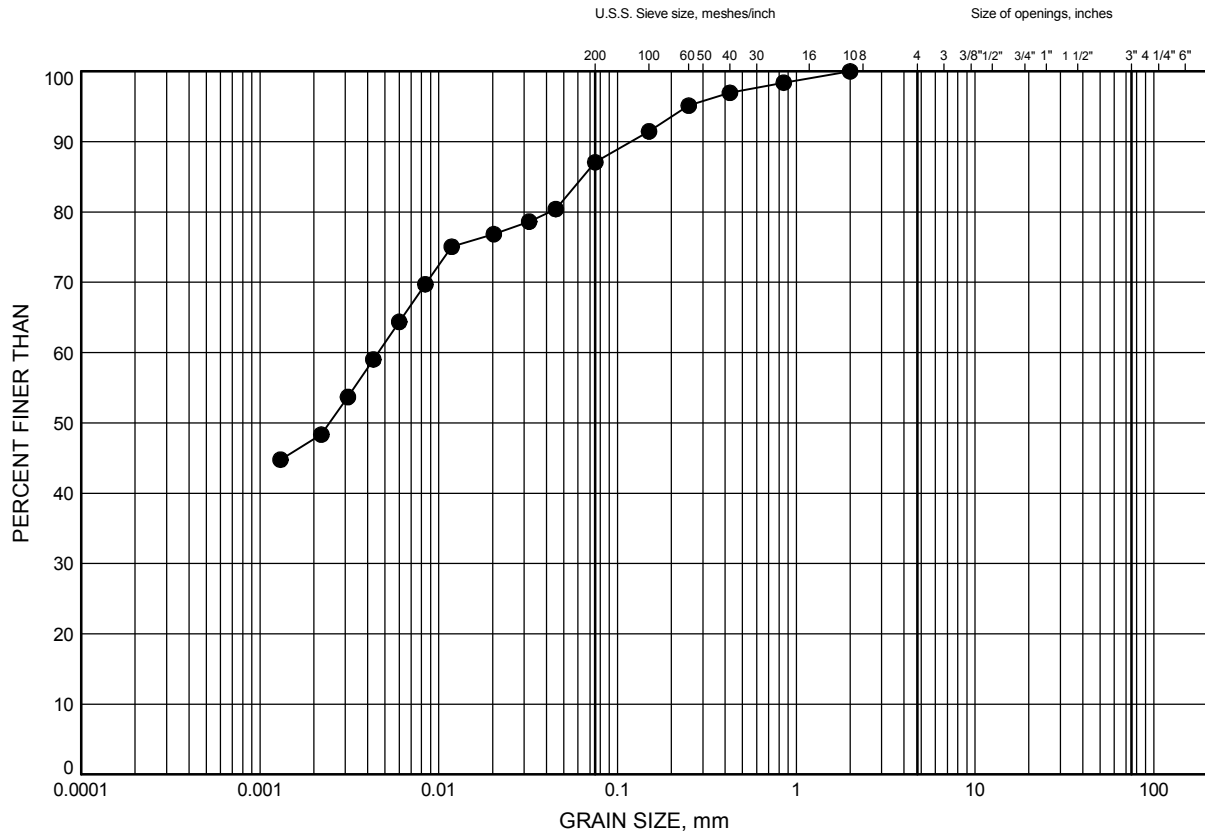


Prep'd MFA
Chkd. AMP

Everett Creek Culvert, Site 45-138/C
GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EC-04	9.45	321.35

Date March 2016
W.P. _____



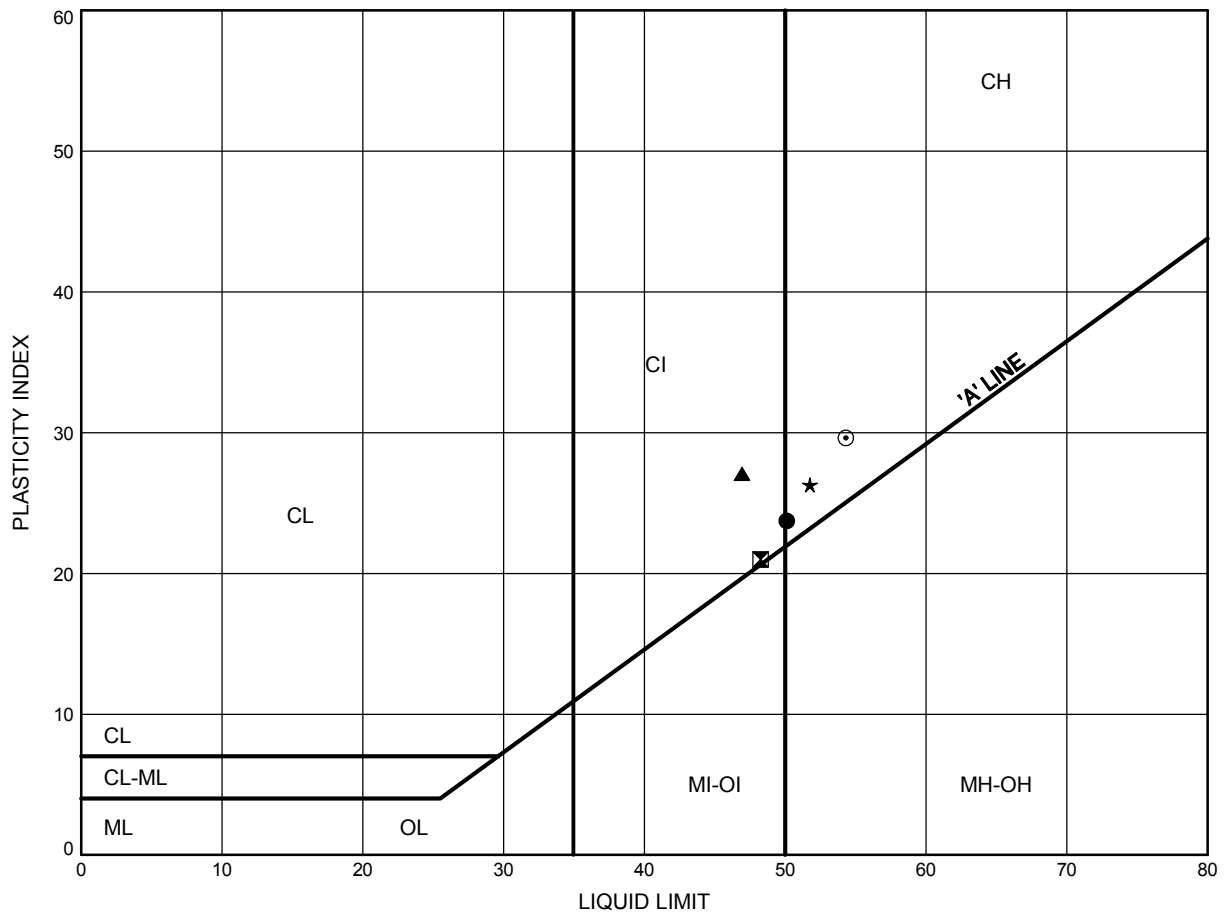
Prep'd MFA
Chkd. AMP

Everett Creek Culvert, Site 45-138/C

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EC-02	10.97	324.83
⊠	EC-02	15.54	320.26
▲	EC-02	20.12	315.68
★	EC-04	3.35	327.45
⊙	EC-04	9.45	321.35

Date March 2016
W.P. _____



Prep'd MFA
Chkd. AMP

Appendix C

Site Photographs

Everett Creek Culvert Replacement
Site No. 45-138/C



Photograph 1 – North side of Highway 11 embankment at Everett Creek, looking east



Photograph 2 – South side of Highway 11 embankment at Everett Creek, looking west

Everett Creek Culvert Replacement
Site No. 45-138/C



Photograph 3 – Everett Creek Culvert Inlet (north end)



Photograph 4 – Debris, scour and erosion at the north end of the culvert

Everett Creek Culvert Replacement
Site No. 45-138/C



Photograph 5 – North embankment slope in December 2015, from the top of slope



Photograph 6 – North embankment slope failure above the culvert location

Everett Creek Culvert Replacement
Site No. 45-138/C



Photograph 7 – Culvert outlet, at the time of field investigation



Photograph 8 – South embankment slope at the culvert location

Everett Creek Culvert Replacement
Site No. 45-138/C

Appendix D

Borehole Logs and Location Plan from Previous Investigation

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION EVERETT CREEK CULVERT - STA 10+ 008 5 m, LT ORIGINATED BY JOE
DIST HWY HWY 11 BOREHOLE TYPE HOLLOW STEM AUGER (80 mm ID) COMPILED BY MD
DATUM LOCAL DATE 2014 05 04 CHECKED BY DB

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		W _P	W	W _L								
								○ UNCONFINED + FIELD VANE	WATER CONTENT (%)											
						□ QUICK TRIAXIAL × LAB VANE	20 40 60 80 100							GR	SA	SI	CL			
99.6	GROUND SURFACE																			
99.4	ASPHALT - 130 mm																			
99.4	FILL - SAND AND CRUSHED GRAVEL, trace silt, brown		1	AS			99											35 49 (13)		
98.8	FILL-SAND- trace gravel, some silt		2	SS	18															
98.1	CLAY - Silty, trace sand, trace gravel, trace organics, brown/grey, stiff to very stiff		3	SS	10		98													
1.5			4	SS	7		97													
			5	SS	26		96													
			6	SS	4		95													
			7	SS	7		94													
			8	SS	7		93													
			9	SS	8		92													
			10	SS	7		91													
			11	SS	9		90													
			90.3	SAND - some silt, trace organics, black																
			90.0	CLAY - Silty, trace sand, trace gravel, trace organics, grey																
88.9	Auger Refusal - End of Borehole																			

ON MOT-HIGH VANES GS-TB-018736 EVERETT CREEK LOGS.GPJ DST_MIN.GDT 9/8/14

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 1

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION EVERETT CREEK CULVERT - STA 9 + 999.5 m, RT ORIGINATED BY JOE
DIST HWY HWY 11 BOREHOLE TYPE HOLLOW STEM AUGER (80 mm ID) COMPILED BY MD
DATUM LOCAL DATE 2014 05 04 CHECKED BY DB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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 (%)				
99.6	GROUND SURFACE							20 40 60 80 100		20 40 60				
99.5	Asphalt - 130 mm							50 100 150 200 250		20 40 60				
98.9	FILL - SAND AND CRUSHED GRAVEL, trace silt, brown		1	AS			99							24 54 (16)
0.8	FILL-SAND - with gravel, some silt, brown		2	SS	12		98							
			3	SS	8									
97.3														
2.3	CLAY - Silty, some sand, trace gravel, trace organics, grey, Stiff to very stiff		4	SS	4		97							
			5	SS	4		96							
			6	SS	6									
			7	SS	9		95							
			8	SS	7		94							
			9	SS	9		93							
			10	SS	12		92							
			11	SS	7		90							
			12	SS	8		89							
							88							
			13	SS	7		87							
			14	SS	7		86							

ON MOT-HIGH VANES GS-TB-018736 EVERETT CREEK LOGS.GPJ DST_MIN.GDT 9/8/14

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 2

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION EVERETT CREEK CULVERT - STA 9 + 998 23 m, LT ORIGINATED BY JOE
 DIST HWY HWY 11 BOREHOLE TYPE HOLLOW STEM AUGER (80 mm ID) COMPILED BY MD
 DATUM LOCAL DATE 2014 05 04 CHECKED BY DB

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					WATER CONTENT (%)				
							20	40	60	80	100	W _p	W	W _L			
92.1	GROUND SURFACE																
	Clay-silty, some sand, some gravel, organics, grey		1	AS		92											
91.1																	
1.0	Auger Refusal at 1.0 m																

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 3

ON MOT-HIGH VANES GS-TB-018736 EVERETT CREEK LOGS.GPJ DST_MIN.GDT 9/8/14

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION EVERETT CREEK CULVERT - STA 10 + 009 20 m, LT ORIGINATED BY JOE
 DIST HWY HWY 11 BOREHOLE TYPE HOLLOW STEM AUGER (80 mm ID) COMPILED BY MD
 DATUM LOCAL DATE 2014 05 04 CHECKED BY DB

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			20	40	60	80	100		
91.3	GROUND SURFACE													
91.1	TOPSOIL													
0.2	CLAY - Silty, some sand, some gravel, trace organics, grey		1	AS			91							
			2	AS			90							
			3	AS			89							
88.3	End of Borehole													
3.0														

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 4

ON MOT-HIGH VANES GS-TB-018736 EVERETT CREEK LOGS.GPJ DST_MIN.GDT 9/8/14

Everett Creek Culvert Replacement
Site No. 45-138/C

Appendix E

Borehole Locations and Soil Strata Drawing



CONT No 2016-6029
GWP No 6902-12-00

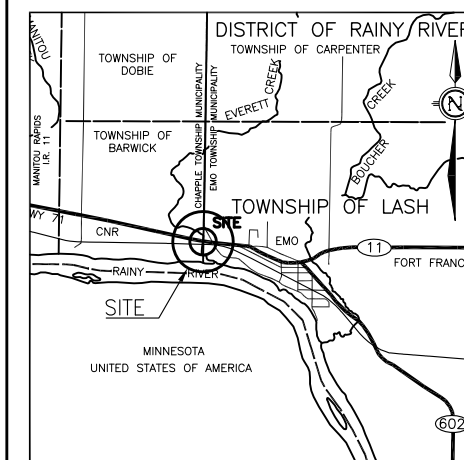
HIGHWAY 11
EVERETT CREEK
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
8

HATCH








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
EC-01	325.8	5 388 824.5	242 075.1
EC-02	335.8	5 388 803.1	242 059.3
EC-04	330.8	5 388 780.9	242 044.6

-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. 52C-048

REVISIONS											
	DATE	BY	DESCRIPTION								
DESIGN	AMP	CHK	PKC	CODE	CAN/CSA	S6/06	LOAD	CL-625-ONT	DATE	APR 2016	
DRAWN	MFA	CHK	AMP	SITE	45-138/C	STRUCT		DWG	2		

C:\Program Files\Autodesk\AutoCAD 2016\acad.dwg

