



THURBER ENGINEERING LTD.



**FOUNDATION INVESTIGATION REPORT
CHOWDER CREEK EAST CULVERT REPLACEMENT
HIGHWAY 11, SITE No. 48E-084/C
DISTRICT OF THUNDER BAY
ONTARIO
G.W.P. No. 6310-14-00, W.P. No. 6312-14-01
GEOCRES Number: 42F-41**

Report

to

HATCH

Date: February 6, 2017
File: 13662

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1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the Chowder Creek East Culvert on Highway 11, located east of Longlac, in Unsurveyed Territory in the District of Thunder Bay, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the culvert location and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber was retained by Hatch Ltd. (Hatch) to carry out this foundation investigation under the Ministry of Transportation Ontario (MTO) Agreement Number 6015-E-0018-04.

A previous foundation investigation carried out at this site was documented in the report titled "*Preliminary Foundation Investigation and Design Report, Chowder Creek East Culvert, Highway 11, District of Thunder Bay, Unsurveyed Territory, Ministry of Transportation, Ontario, G.W.P 6312-14-00*" Geocres No. 42F-35, prepared by Golder Associates, dated September 8, 2015. Reference should be made to that report for a written description of the subsurface conditions, borehole location plan, stratigraphic profile, record of borehole sheets and laboratory test results obtained during the preliminary stage of the design. It should be noted that Golder is solely responsible for the subsurface information provided in the Preliminary Foundation Report. The Record of Borehole sheets and Borehole Locations and Soil Strata drawing from the Golder's report have been enclosed in Appendix E of this report for reference, and the subsurface information presented in that report was incorporated in the current report, as appropriate. The

borehole logs and stratigraphic profile from the Golder Report should be included in the tender documents.

2. SITE DESCRIPTION

The site is located on Highway 11, approximately 40.4 km east of the intersection of Highway 625 and Highway 11 in unsurveyed territory in the District of Thunder Bay, Ontario. The key plan showing the general location of the culvert site is presented on the Borehole Location and soil Strata Drawings in Appendix D.

Highway 11 runs in a general east-west direction with the culvert perpendicular to the centreline of the highway. The culvert allows Chowder Creek to flow in a southerly direction and drain into Inman Lake which subsequently drains into Chowder Lake.

The Structural Design Report provided to Thurber by Hatch indicates that the existing structure is a 26 m long, two cell (2.1 m, 2.1 m) timber box culvert with an unknown construction date. A Biennial Inspection on August 22, 2012 indicates that the structure generally is in fair to poor condition. The grade level of Highway 11 at the existing culvert is at an approximate Elevation of 280.7 m. The culvert invert is at approximately Elevation 278.02 m at the inlet (north end) and 277.74 m at the outlet (south end). The Chowder Creek water level was measured at Elevation 278.6 m and Elevation 278.0 m by others on November 8, 2008 and March 24, 2015, respectively.

The lands surrounding Chowder Creek East and the culvert at the site predominantly consist of heavily forested areas with occasional marsh lands and lakes. Local topography is generally of low relief swampy terrain with bedrock outcrops visible along Highway 11 approximately 400 m west of the site. Photographs of the culvert and surrounding area are presented in Appendix C.

Based on published geological information, the subsurface soils in at the site generally consist of organic terrain deposits of mainly peat/marsh bordering with areas of undulating rolling bedrock knobs. Bedrock in the area has been identified as mafic to intermediate metavolcanic bedrock of Archean era, comprised of massive granodiorite to granite rocks.

3. INVESTIGATION PROCEDURES

The borehole investigation and field testing program for this project was carried out on August 10 and 11, 2016, and consisted of drilling and sampling six (6) boreholes, designated as Borehole 16-16, 16-17, 16-17B and 16-18 to 16-20. All boreholes were located in the paved section of Highway 11 in the east bound lane with the exception of borehole 16-17 and 16-17B which were

located near the outlet. Borehole 16-16 was located approximately 13 m east of the centreline of the existing culvert near the alignment of the proposed stream diversion pipe. Boreholes 16-18 to 16-20 were located west of the existing culvert structure and distributed at 10 m intervals to assess the existence and extents of any frost taper near the culvert.

Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were derived from cross sections and topographic drawings provided to Thurber by Hatch. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix D.

Boreholes were drilled using a rubber track mounted CME 55 drill rig equipped with continuous flight, hollow and solid stem augers. Boreholes were advanced to depths of between approximately 2.1 m and 14.3 m below existing ground surface elevation. 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). A Dynamic Cone Penetration Test (DCPT) was carried out at 16-17 approximately 1 m west of the original auger hole to cone refusal depth of approximately 11.9 m.

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 were observed in the open boreholes throughout the drilling operations and in the open boreholes upon completion of drilling. The boreholes were backfilled in general accordance with Ontario Regulation 903.

Completion details of the borehole are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
16-16	14.3 / 266.4	Borehole backfilled with bentonite holeplug and cuttings and surface reinstated with asphalt.
16-17	11.9 / 266.9	Borehole backfilled with bentonite holeplug and cuttings to surface.

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
16-17B	8.2 / 272.1	Borehole backfilled with bentonite holeplug and cuttings to 1.5 m depth then gravel to surface.
16-18	3.7 / 277.2	Borehole backfilled with bentonite holeplug and cuttings and surface reinstated with asphalt.
16-19	3.7 / 277.2	Borehole backfilled with bentonite holeplug and cuttings and surface reinstated with asphalt.
16-20	2.1 / 278.9	Borehole backfilled with bentonite holeplug and cuttings and surface reinstated with asphalt.

The previous investigation, Geocres No. 42F-35, included four (4) boreholes, numbered CH-1 to CH-4. Boreholes CH-1 and CH-4 were advanced at the toe of the embankment slope near the culvert inlet/outlet to depths of approximately 5.9 m and 9.8 m, respectively, and boreholes CH-2 and CH-3 were advanced from the existing highway platform to depths of approximately 11.0 m and 10.0 m respectively. The MTM NAD83 northing and easting coordinates, ground surface elevations referenced to Geodetic datum and borehole depths at each borehole location for Golder boreholes are presented below in Table 3.2. The approximate locations of the Golder boreholes are shown on the Borehole Locations and Soil Strata Drawing included in Appendix E.

4. LABORATORY TESTING

All 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/or hydrometer) and plasticity testing (Atterberg Limits) where appropriate. The results of this laboratory testing program are shown on the Record of Borehole sheets included in Appendix A and on the figures included in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the existing native soil, and a sample of the surface water from the creek upstream of the existing culvert were collected. The samples were submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendices A and E. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description and should be used for interpretation of site conditions. It must be recognized and expected that soil conditions may vary between and beyond the borehole locations.

The borehole logs from the previous Golder investigation are presented in Appendix E and are generally consistent with the results of the current investigation.

In general, the subsurface conditions encountered in the boreholes drilled through the highway platform from the current and previous investigation contain embankment fill, of which the upper portion contains gravelly sand to sand and gravel beneath the asphalt surface and the lower portion of the embankment fill contains sand to silt and sand. Beneath the embankment fill, peat was encountered, followed by silty sand and silt to silt and sand. A sand to sand and gravel deposit was encountered below the silt and sand deposit. Descriptions of the individual strata are presented below.

5.1 Asphalt

The boreholes that were drilled through the paved portion of Highway 11 indicate that the pavement structure consists of approximately 125 mm to 150 mm of asphalt.

5.2 Embankment Fill

Embankment fill was encountered below the asphalt or ground surface in all Boreholes except in CH-1, and generally ranged in composition from gravelly sand to sand and gravel in the upper portions and sand to sand and silt, trace clay, trace gravel and trace organics in the lower part of the fill.

5.2.1 Gravelly Sand to Sand and Gravel Fill

The gravelly sand to sand and gravel fill was approximately 0.5 to 2.3 m thick with the base of the fill ranging between 0.6 to 2.3 m below the existing road surface (Elev. 278.1 to 280.3).

The relative density of the fill ranged from loose to compact with SPT 'N' values of 9 to 18 blows for 0.3 m penetration of the sampler. Measured moisture contents ranged from 2% to 4%.

The results of grain size distribution analyses conducted on a sample of the fill are presented on the Record of Borehole sheets included in Appendix A and summarized in the following table. The results are also presented on Figure B1 in Appendix B.

Soil Particle	Percentage (%)
Gravel	36
Sand	55
Silt and Clay	9

5.2.2 Sand to Sand and Silt Fill

The sand to sand and silt fill was approximately 0.6 m to 4.0 m thick with the base of the fill ranging between 0.6 m and 4.1 m below the existing road surface (Elev. 276.6 to Elev. 278.2).

The relative density of the fill ranged from very loose to compact with SPT 'N' values of 0 to 24 blows for 0.3 m penetration of the sampler. Higher SPT 'N' values ranging from 32 to 64 blows per 0.3 m penetration were noted in frozen fill in Boreholes CH-2 and CH-3.

Measured moisture contents ranged from 5% to 26%. A high moisture content of 48% was recorded near ground surface in CH-4 which contained trace organics.

The results of grain size distribution analyses conducted on samples of the fill are presented on the Record of Borehole sheets included in Appendices A and E and are summarized in the following table. The results from the Thurber boreholes are also presented on Figure B2 in Appendix B.

Soil Particle	Percentage (%)
Gravel	0 to 16
Sand	45 to 86
Silt and Clay	12 to 55

5.3 Peat

Peat was encountered in boreholes 16-16, 16-17, 16-17B, and CH-2 to CH-4 beneath the fill and in Borehole CH-1 at the surface. The peat ranged in thickness from 0.7 m to 4.3 m and extended to depths of approximately 0.7 m to 6.1 m below ground surface (Elev. 273.9 to Elev. 278.5). The peat contains occasional silt seams. The peat is generally very loose to loose with SPT 'N' values of 0 to 5 blows for 0.3 m penetration. Measured moisture contents in the peat ranged from 39% to 349%.

5.4 Silty Sand

A layer of silty sand was encountered beneath the peat deposits in boreholes CH-1 and CH-2. The silty sand generally contains trace organics, and is grey. The silty sand layer ranged in thickness from 0.6 m to 0.7 m and extended to depths of between 1.4 m to 5.6 m (Elev. 275.1 to Elev. 277.8). The silty sand is typically compact with an SPT 'N' value of 15 blows for 0.3 m penetration.

5.5 Upper Silt to Silt and Sand

Silt to silt and sand were encountered in all boreholes typically beneath the peat deposits or silty sand layer. The silt to silt and sand generally contains trace to some clay, trace gravel, occasional cobbles and is brown to grey. Peat seams were encountered at approximately 7.9 m below ground surface in borehole 16-16, and organic lenses were encountered in boreholes 16-18 and 16-19 at depths between 1.8 m and 3.0 m below ground surface, respectively.

Where fully penetrated, the upper silt to silt and sand layer was approximately 3.1 m to 5.2 m thick and extended to depths of between 4.5 m and 10.5 m (Elev. 268.8 to Elev. 274.7). The formation is typically very loose to loose with SPT 'N' values of 0 to 13 blows for 0.3 m penetration of the sampler. Higher SPT 'N' values of 30 and 49 blows for 0.3 m penetration of the sampler were recorded in boreholes CH-1 and 16-16, respectively, indicative of inferred cobbles. Measure moisture contents in the silt to silt and sand ranged from 11% to 26%

The results of grain size analyses conducted on samples of the upper silt to silt and sand are provided on the Record of Borehole sheets in Appendices A and E and are summarized in the following table. The results from the Thurber boreholes are also presented on Figures B3 and B4 of Appendix B.

Soil Particle	Percentage (%)
Gravel	0
Sand	0 to 56
Silt	36 to 90
Clay	5 to 19

5.6 Silty Sand to Sand and Gravel

Silty sand to sand and gravel was encountered in boreholes 16-16, 16-17, and CH-1 to CH-4. In borehole 16-16 the sand layer was encountered beneath the upper silt to silt and sand layer and extended from approximately 10.5 m to 11.0 m below existing ground surface (Elev. 270.2 to Elev. 269.7). In boreholes 16-17, and CH-1 to CH-4, the silty sand to sand and gravel layer was encountered at a depth of approximately 4.5 m to 10.1 m below ground surface (Elev. 274.7 to Elev. 268.8) and extended to the borehole termination depth. The silty sand to sand and gravel layer contains some gravel, trace silt and occasional cobbles.

The silty sand to sand and gravel is compact to very dense with SPT-N values of 14 to 103 blows for 0.3 m penetration. Measured moisture contents ranged from 9% to 18%.

The results of grain size analyses conducted on samples of the silty sand to sand and gravel are provided on the Record of Borehole sheets in Appendices A and E and are summarized in the following table. The results from the Thurber borehole are also presented on Figure B5 of Appendix B.

Soil Particle	Percentage (%)
Gravel	4 to 37
Sand	59 to 70
Silt and Clay	4 to 28

5.7 Lower Silt to Sandy Silt

A deposit of silt to sandy silt was encountered in borehole 16-16 below the sand layer at a depth of 11.0 m below existing ground surface elevation (Elev. 269.7). The deposit extended to the maximum depth drilled of 14.3 m. The silt to sandy silt typically contained some clay and was grey in colour.

The silt to sandy silt was very dense with SPT 'N' values of 57 to 75 blows for 0.3 m penetration. Measured moisture contents ranged from 12% to 17%.

The results of grain size analysis conducted on a sample of the sandy silt are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B6 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	32
Silt	50
Clay	18

5.8 Groundwater Conditions

Groundwater conditions were observed during drilling and groundwater levels were measured in the open boreholes upon completion of drilling. The groundwater levels measured in the open borehole are summarized in Table 5.1 below. Groundwater levels reported in the Golder report are also included.

Table 5.1 – Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
16-16	August 11, 2016	2.1	278.6	Open borehole
16-17	August 11, 2016	0.9	277.9	Open borehole
16-17B	August 11, 2016	2.3	278.1	Open borehole
16-18	August 10, 2016	2.4	278.4	Open borehole
CH-2	March 23, 2015	4.0	276.7	Geocres No. 42F-35
CH-3	March 24, 2015	2.6	278.1	Geocres No. 42F-35
CH-4	March 25, 2015	1.7	277.0	Geocres No. 42F-35

A water level measurement near the outlet of the culvert was reported at Elevation 278.6 m on November 4, 2008 on the drawings provided by Hatch and Elevation 278.0 m on March 24, 2015 on Golder's Soil Strata drawing. The groundwater level should be assumed to reflect the local creek water level. The groundwater levels above are short-term readings and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the native silt from Borehole 16-16, and a sample of the creek water were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.

Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Units (Water)	Test Results	
			16-16, SS#7, 7.6 m – 8.2 m	Chowder Creek East
			(Silt)	(Creek Water)
Sulphide	%	mg/L	<0.02	<0.006
Chloride	µg/g	mg/L	9.1	1.4
Sulphate	µg/g	mg/L	19	0.22
pH	No unit	No unit	7.86 to 8.89	7.96
Electrical Conductivity	µS/cm	µS/cm	78	240
Resistivity	Ohms.cm	Ohms.cm	12800	4170
Redox Potential	mV	mV	207	215

7. MISCELLANEOUS

Thurber obtained subsurface 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.

RPM Drilling Inc. of Thunder Bay, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field investigation. The field investigation was supervised on a full time basis by Mr. Tim Sivak of Thurber. Overall supervision of the field program was provided by Mr. Mark Farrant, P.Eng. of Thurber.

Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory. Analytical laboratory testing was carried out by SGS Canada Inc. Interpretation of the field data and preparation of this report was carried out by Mr. Cory Zanatta, B.A.Sc., EIT. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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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
 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 16-16

1 OF 2

METRIC

W.P. 6312-14-01 LOCATION Chowder Creek Culvert N 5 518 872.7 E 393 820.5 ORIGINATED BY TS
 HWY 11 BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.08.11 - 2016.08.11 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											
280.7	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (150mm)							20	40	60	80	100							
0.2	Gravelly SAND Compact Brown		1	GS		▽	280												
280.0	Moist (FILL)		1	SS	24														
0.7	SAND, some silt, trace gravel Compact Brown Moist (FILL)																		
			2	SS	19														
278.5								279											
2.2	SAND and SILT, trace clay, trace gravel Very Loose to Loose Grey Moist/Wet (FILL)		3	SS	4			278											
			4	SS	3														
							277												
276.6																			
4.1	PEAT, trace sand Very Loose Brown Wet		5	SS	1		276												
								275											
274.6																			
6.1	SILT, some clay, trace sand Very Loose to Dense Grey Moist to Wet		6	SS	4		274												
							273												
	25mm peat seam at 7.9m		7	SS	0														
							272												
	Cobbles noted at 9.1m and 10.2m		8	SS	49		271												

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-16

2 OF 2

METRIC

W.P. 6312-14-01 LOCATION Chowder Creek Culvert N 5 518 872.7 E 393 820.5 ORIGINATED BY TS
 HWY 11 BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.08.11 - 2016.08.11 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									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page						20	40	60	80	100	20	40	60			
270.2	SAND , some gravel, trace silt, occasional cobbles Very Dense Brown Moist to Wet																
10.5																	
269.7																	
11.0	SILT , some sand, trace clay Very Dense Grey Wet																
268.5	Sandy SILT , some clay Very Dense Grey Wet																
12.2																	

+³, ×³: Numbers refer to
Sensitivity

20
15
10
5
0
(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE						SAMPLES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	NATURAL MOISTURE CONTENT W 	LIMIT PLASTIC LIMIT LIQUID LIMIT W _P W _L	UNIT WEIGHT γ 	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION		PLASTICITY INDEX I _p	GRAVIMETER DRY UNIT WEIGHT γ _d	% GR SA SI CL FILL				
278.8	GROUND SURFACE	[Cross-hatch pattern]												
0.0	Silty SAND, some gravel, trace organics	[Hatched pattern]	1	SS	3								No recovery	
278.2	Loose Brown (FILL)	[Vertical wavy pattern]	2	SS	2									
0.6	PEAT, occasional sandy silt seams Very Loose Black Wet	[Horizontal wavy pattern]	3	SS	2									
		[Horizontal wavy pattern]	4	SS	0									
	300mm layer of sandy silt at 3.3m depth	[Horizontal wavy pattern]	5	SS	0								0 34 58 8	
273.9		[Horizontal wavy pattern]	6	SS	6									
4.9	SILT, trace sand, trace clay Loos Grey Moist to Wet	[Vertical straight pattern]	7	SS	4								0 6 89 5	
		[Vertical straight pattern]	8	SS	0									
		[Vertical straight pattern]	9	SS	9									

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 16-17

2 OF 2

METRIC

W.P. 6312-14-01 LOCATION Chowder Creek Culvert N 5 518 860.3 E 393 813.3 ORIGINATED BY TS
 HWY 11 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2016.08.10 - 2016.08.11 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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
268.8	Continued From Previous Page																
10.1	SAND and GRAVEL, trace silt Compact Brown Moist to Wet		10	SS	16											37 59 4 (SI+CL)	
266.9																	
11.9	END OF BOREHOLE AT 11.9m. WATER LEVEL AT 0.9m BELOW SURFACE AFTER DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

RECORD OF BOREHOLE No 16-17B

1 OF 1

METRIC

W.P. 6312-14-01 LOCATION Chowder Creek Culvert N 5 518 868.6 E 393 802.3 ORIGINATED BY TS
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.08.11 - 2016.08.11 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
								20	40	60	80	100	W _P	W	W _L					
280.4	GROUND SURFACE																			
0.0	SAND and GRAVEL , trace silt Loose to Compact Brown Moist (FILL)		1	SS	18													36 55 9 (SI+CL)		
			2	SS	9															
			3	SS	10															
278.1																				
2.3	SAND , some silt, trace clay and gravel, trace organics Very Loose Grey Wet (FILL)		4	SS	0													9 66 19 6		
			5	SS	2													No recovery		
277.0	PEAT , trace silt Very Loose to Loose Brown Wet		6	SS	5													No recovery		
			7	SS	3															
274.7																				
5.6	Sandy SILT , some clay Loose Grey Wet		8	SS	6															
			9	SS	3													0 23 58 19		
272.1																				
8.2	END OF BOREHOLE AT 8.2m. WATER LEVEL AT 2.3m BELOW SURFACE AFTER DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPUG AND CUTTINGS TO 1.5m, THEN GRAVEL TO SURFACE.																			

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-18

1 OF 1

METRIC

W.P. 6312-14-01 LOCATION Chowder Creek Culvert N 5 518 872.5 E 393 794.5 ORIGINATED BY TS
 HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.08.10 - 2016.08.10 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						
280.8	GROUND SURFACE							20 40 60 80 100						
0.0	ASPHALT: (140mm)		1	GS				○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
0.1	Gravelly SAND, trace silt							20 40 60 80 100						
280.2	Compact							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _P W W _L						
0.6	Brown		2	GS			280	WATER CONTENT (%)						5 68 27 (SI+CL)
	Moist (FILL)													
	SAND, some silt to silty, trace gravel, trace clay													
279.0	Brown													
	Moist (FILL)													
1.8	SAND and SILT, trace clay, trace gravel, trace organics		3	GS			279	○						
	Very Loose													
	Brown		4	GS				○						
	Moist						278							
	Thin black lenses of organic silt at 2.4m													
277.2			5	SS	2			○						0 56 36 8
3.7	END OF BOREHOLE AT 3.7m. WATER LEVEL AT 2.4m BELOW SURFACE AFTER DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS AND PATCHED WITH ASPHALT AT SURFACE.													

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

RECORD OF BOREHOLE No 16-19

1 OF 1

METRIC

W.P. 6312-14-01 LOCATION Chowder Creek Culvert N 5 518 872.3 E 393 784.5 ORIGINATED BY TS
 HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.08.10 - 2016.08.10 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						
280.9	GROUND SURFACE													
0.0	ASPHALT: (140mm)		1	GS										
0.1	Gravelly SAND, trace silt													
280.3	Compact													
0.6	Brown Moist (FILL)		2	GS										
	Silty SAND, trace to some gravel, trace clay													
	Brown Moist (FILL)		3	GS										16 45 32 7
			4	GS										
	Possible cobbles at 2.7m		5	GS										8 46 37 9
277.9														
3.0	SAND and SILT, trace gravel, trace clay, trace organics/rootlets, peat lenses (<20mm thick)		6	SS	6									
277.2	Loose Grey Moist													
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS AND PATCHED WITH ASPHALT AT SURFACE.													

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

RECORD OF BOREHOLE No 16-20

1 OF 1

METRIC

W.P. 6312-14-01 LOCATION Chowder Creek Culvert N 5 518 872.2 E 393 774.5 ORIGINATED BY TS
 HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.08.10 - 2016.08.10 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											
281.0	GROUND SURFACE							20 40 60 80 100											
0.0	ASPHALT: (125mm)							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
0.1	Gravelly SAND, some silt Compact Brown Dry (FILL)		1	GS															
			2	GS															
279.8							280												
1.2	SAND and SILT, trace to some clay Compact Brown Moist to Wet		3	GS														0 44 46 10	
			4	GS														0 46 45 9	
278.9							279												
2.1	END OF BOREHOLE AT 2.1m ON AUGER REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS AND PATCHED WITH ASPHALT AT SURFACE.																		

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

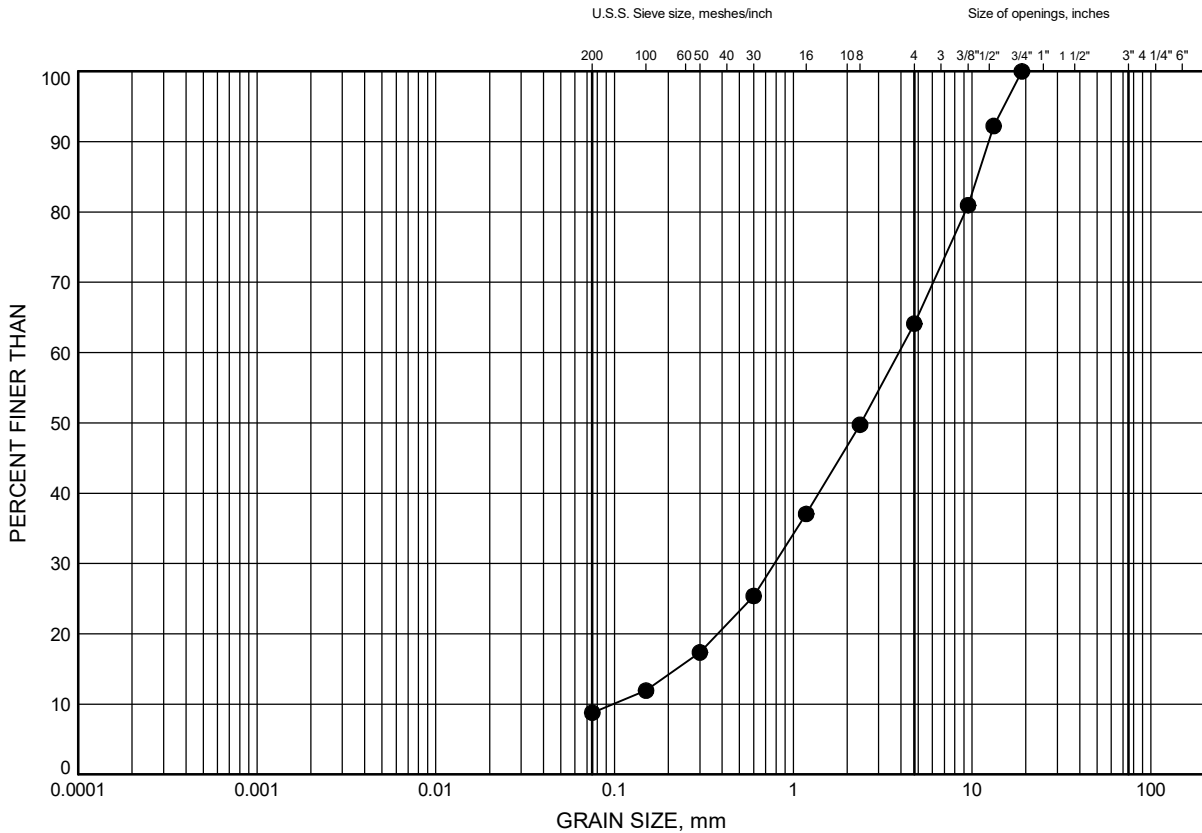
Appendix B

Geotechnical and Analytical Laboratory Test Results

Chowder Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B1

Sand and Gravel Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-17B	0.38	279.98

Date February 2017
W.P. 6312-14-01

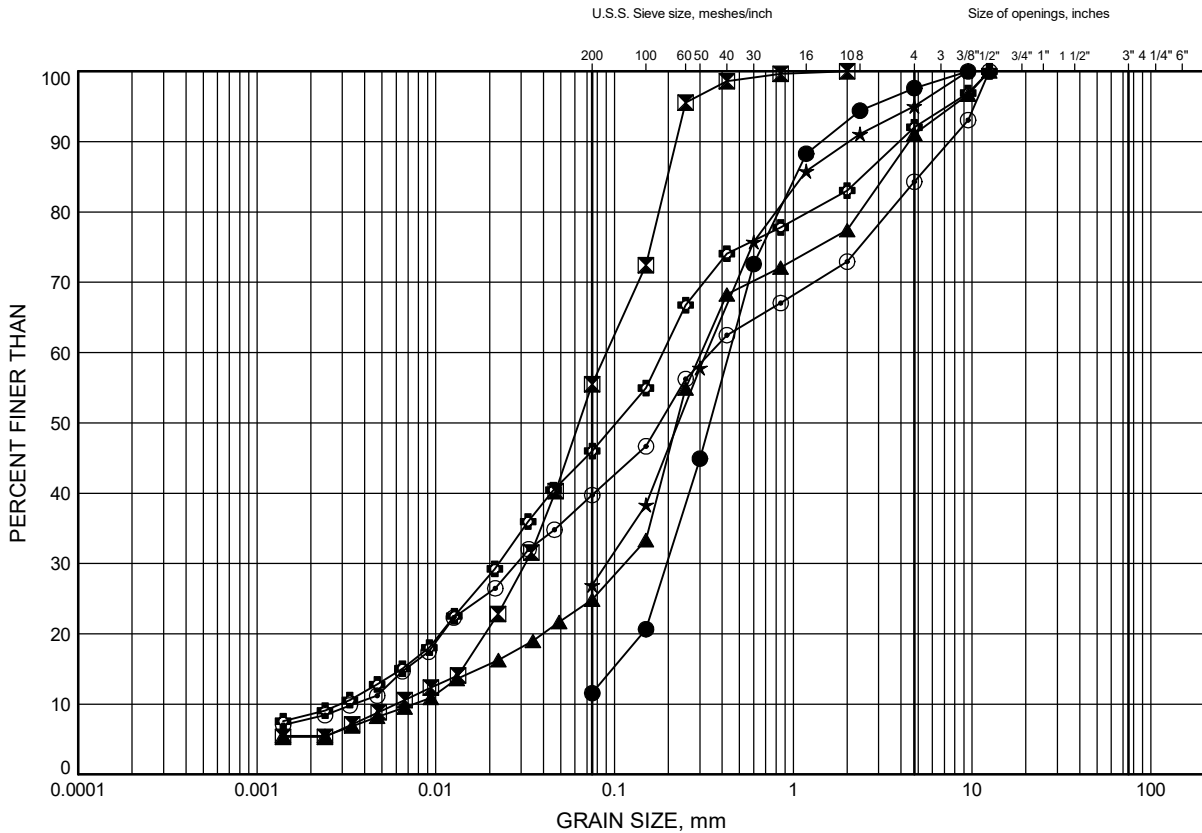


Prep'd MFA
Chkd. AMP

Chowder Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B2

Sand to Sand and Silt Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-16	1.07	279.63
⊠	16-16	2.59	278.11
▲	16-17B	2.59	277.77
★	16-18	0.76	280.09
⊙	16-19	1.41	279.49
⊕	16-19	2.82	278.08

Date February 2017
W.P. 6312-14-01

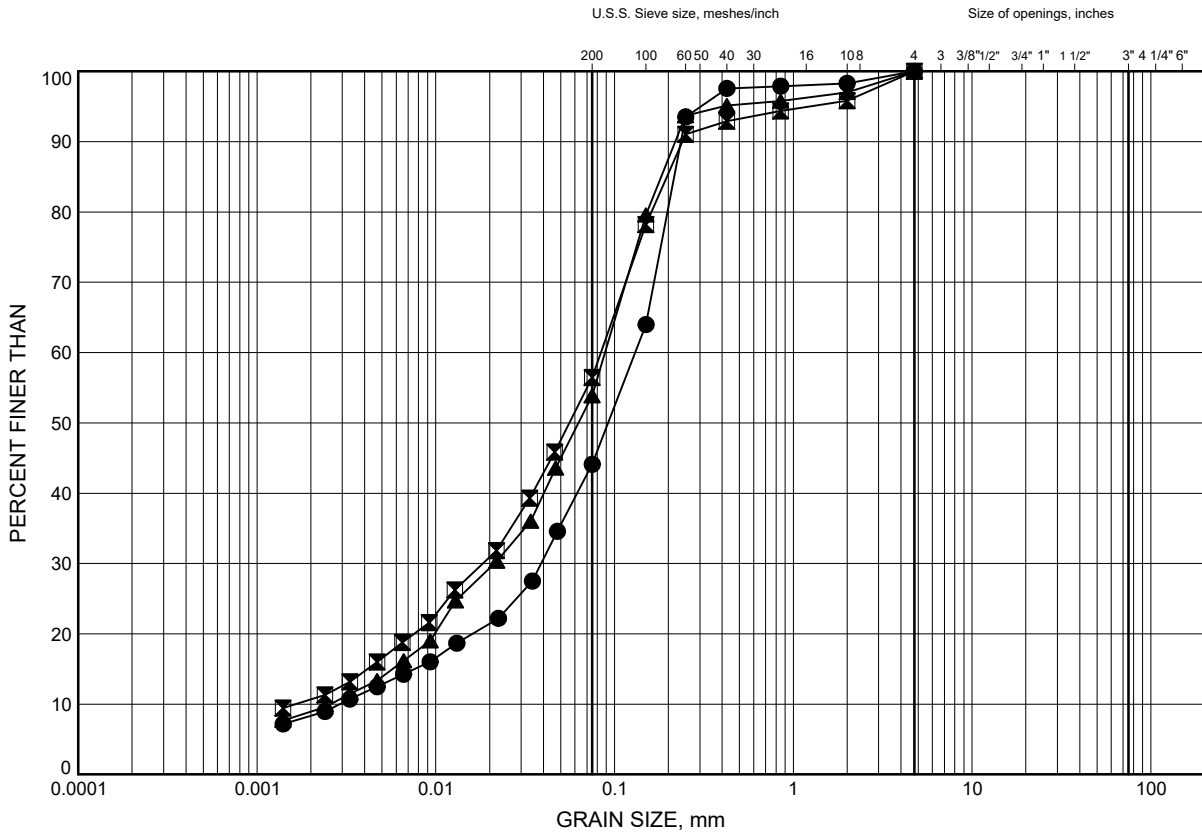


Prep'd MFA
Chkd. AMP

Chowder Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B3

Upper Sand and Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-18	3.35	277.49
⊠	16-20	1.30	279.66
▲	16-20	1.91	279.05

Date February 2017
W.P. 6312-14-01

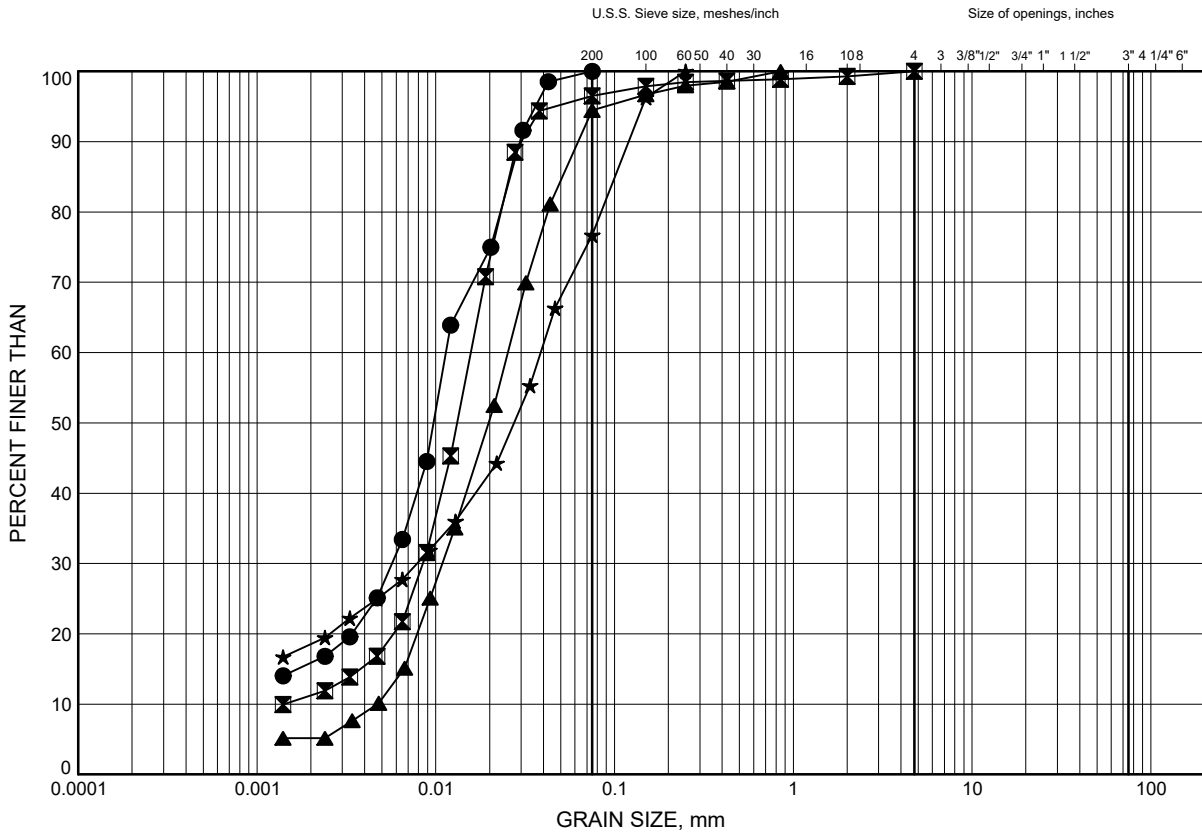


Prep'd AN
Chkd. AMP

Chowder Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B4

Upper Silt to Sandy Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-16	6.40	274.30
⊠	16-16	9.45	271.25
▲	16-17	6.40	272.42
★	16-17B	7.92	272.44

Date February 2017
W.P. 6312-14-01

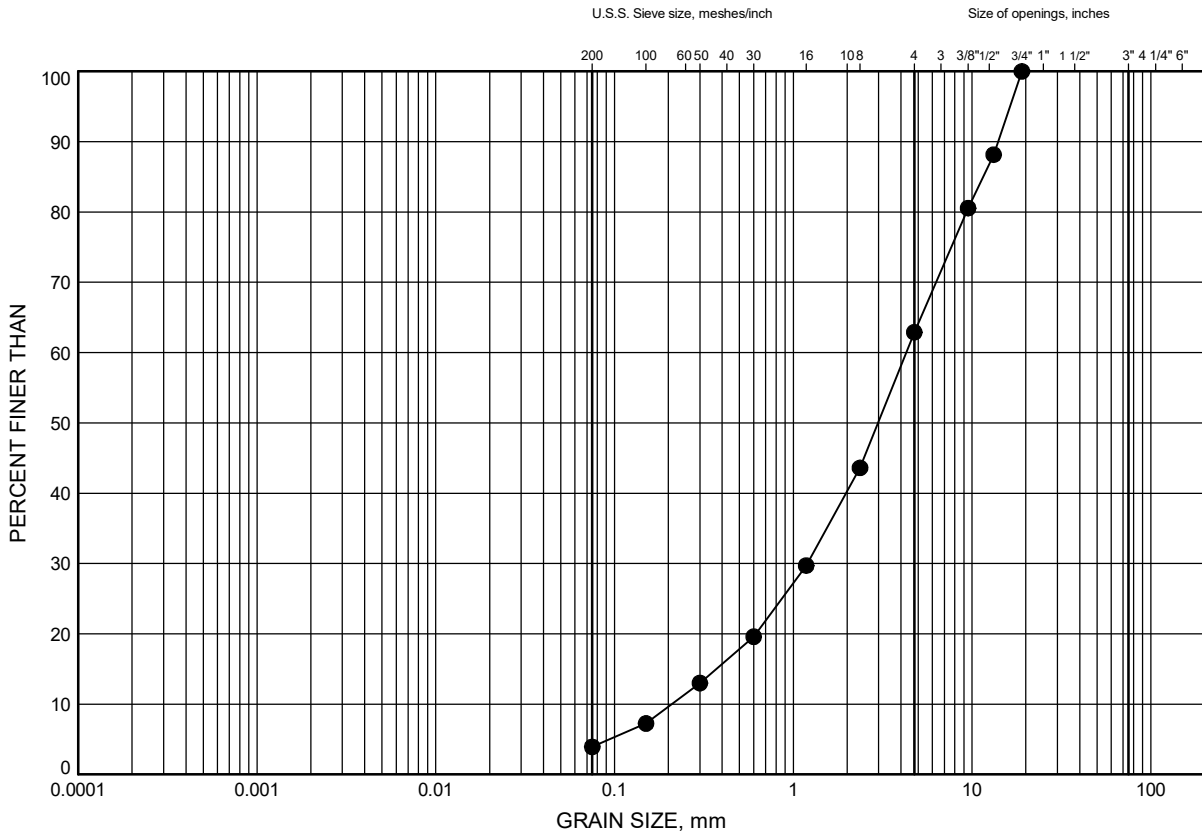


Prep'd AN
Chkd. AMP

Chowder Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B5

Sand and Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-17	11.28	267.55

Date February 2017
W.P. 6312-14-01

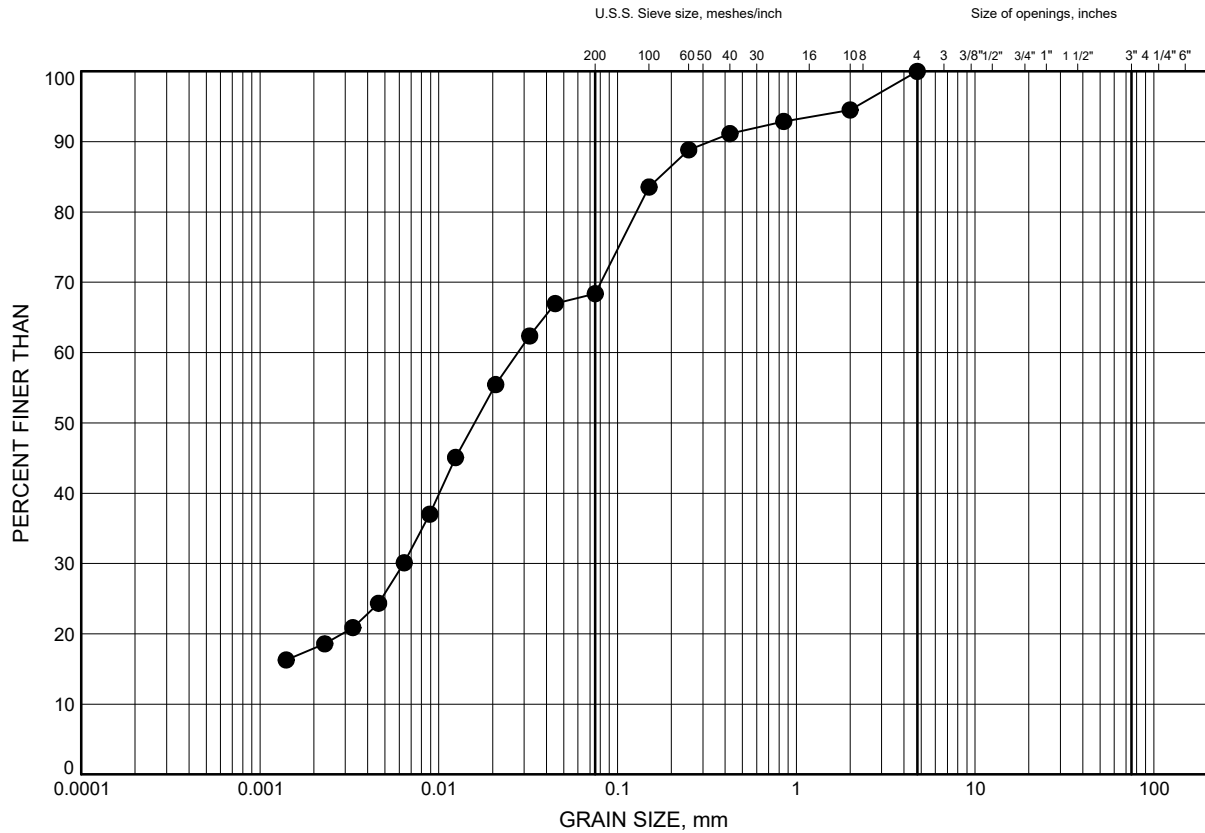


Prep'd MFA
Chkd. AMP

Chowder Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B6

Lower Sandy Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-16	14.02	266.68

Date February 2017
W.P. 6312-14-01



Prep'd AN
Chkd. AMP

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13662**29-August-2016****Thurber Engineering Ltd.****Attn : Mark Farrant**

103, 2010 Winston Park Drive
Oakville, ON
L6H 5R7,

Phone: 905-829-8666 x 228
Fax:

Date Rec. : 25 August 2016
LR Report: CA15493-AUG16
Reference: 13662 Mark Farrant

Copy: #1

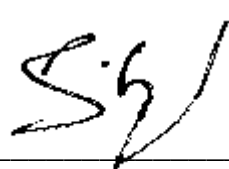
CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: BH-16, SS#7, 25'-27'
Sample Date & Time					24-Aug-16
Temperature Upon Receipt [°C]	---	---	---	---	16.0
Corrosivity Index [none]	---	---	29-Aug-16	15:32	1
pH [no unit]	27-Aug-16	10:28	29-Aug-16	15:29	7.86
Soil Redox Potential [mV]	26-Aug-16	13:46	29-Aug-16	11:43	207
Sulphide [%]	26-Aug-16	14:07	26-Aug-16	14:13	< 0.02
% Moisture (wet wt) [%]	25-Aug-16	15:23	25-Aug-16	15:23	13.8
pH [no unit]	26-Aug-16	08:44	29-Aug-16	11:36	8.89
Chloride [µg/g]	25-Aug-16	19:10	29-Aug-16	13:38	9.1
Sulphate [µg/g]	25-Aug-16	19:10	29-Aug-16	13:38	19
Conductivity [µS/cm]	26-Aug-16	08:44	29-Aug-16	12:11	78
Resistivity (calculated) [Ohms.cm]	---	---	29-Aug-16	14:39	12800

Temperature of Samples upon receipt 28.3 degrees C
No cooling agent present
Custody Seal not present

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.



Brian Graham B.Sc.
Project Specialist
Environmental Services, Analytical

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Project : 13662

17-November-2016

Thurber Engineering Ltd.

Attn : Mark Farrant

103, 2010 Winston Park Drive
Oakville, ON
L6H 5R7,

Phone: 905-829-8666 x 228
Fax:

Date Rec. : 16 August 2016
LR Report: CA15286-AUG16
Reference: 13662 Mark Farrant

Copy: #1


CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: MDL	7: Chowder Creek
Sample Date & Time						12-Aug-16
Temperature Upon Receipt [°C]	---	---	--	--	---	4.0
Corrosivity Index [none]	23-Aug-16	16:05	23-Aug-16	16:05		3
pH [no unit]	16-Aug-16	11:00	16-Aug-16	14:58	0.05	7.96
Conductivity [µS/cm]	16-Aug-16	11:00	16-Aug-16	14:58	2	240
Resistivity (calculated) [Ohms.cm]	16-Aug-16	11:00	24-Aug-16	09:08	---	4170
Redox Potential [mV]	16-Aug-16	14:10	17-Aug-16	11:15	---	215
Chloride [mg/L]	16-Aug-16	13:23	19-Aug-16	16:55	0.04	1.4
Sulphate [mg/L]	16-Aug-16	13:23	19-Aug-16	16:55	0.04	0.22
Sulphide [mg/L]	17-Aug-16	13:02	18-Aug-16	15:07	0.006	< 0.006

Method Descriptions

Parameter	SGS Method Code	Reference Method Code
Anions by IC	ME-CA-[ENV]IC-LAK-AN-001	EPA300/MA300-Ions1.3
Conductivity	ME-CA-[ENV]EWL-LAK-AN-006	SM 2510
pH	ME-CA-[ENV]EWL-LAK-AN-006	SM 4500
Redox Potential		SM 2580
Sulphide by SFA	ME-CA-[ENV]SFA-LAK-AN-008	SM 4500


Deanna Edwards, B.Sc, C.Chem
Project Specialist
Environmental Services, Analytical



SGS Canada Inc.

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Lakefield - Ontario - KOL 2HO

Phone: 705-652-2000 FAX: 705-652-6365

Project : 13662

LR Report : CA15286-AUG16

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank				LCS / Spike Blank			Matrix Spike / Reference Material		
					RPD	Acceptance Criteria	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
						%		Low	High		Low	High
Anions by IC - QCBatchID: DIO0220-AUG16												
Chloride	0.04	mg/L	<0.04		NV	20	101	80	120	NV	75	125
Sulphate	0.04	mg/L	<0.04		3	20	100	80	120	97	75	125
Conductivity - QCBatchID: EWL0226-AUG16												
Conductivity	2	µS/cm	4.44		6	10	99	90	110	NA		
pH - QCBatchID: EWL0226-AUG16												
pH	0.05	no unit	NA		1		101			NA		
Redox Potential - QCBatchID: EWL0230-AUG16												
Redox Potential	no	mV	NA		3	20	106	80	120	NA		
Sulphide by SFA - QCBatchID: SKA0139-AUG16												
Sulphide	0.006	mg/L	<0.006		100	20	101	80	120	104	75	125

Appendix C

Selected Site Photographs



Photo 1: Chowder Creek Culvert, south side looking west



Photo 2: Chowder Creek Culvert, north side looking east



Photo 3: Chowder Creek Culvert, north side looking west



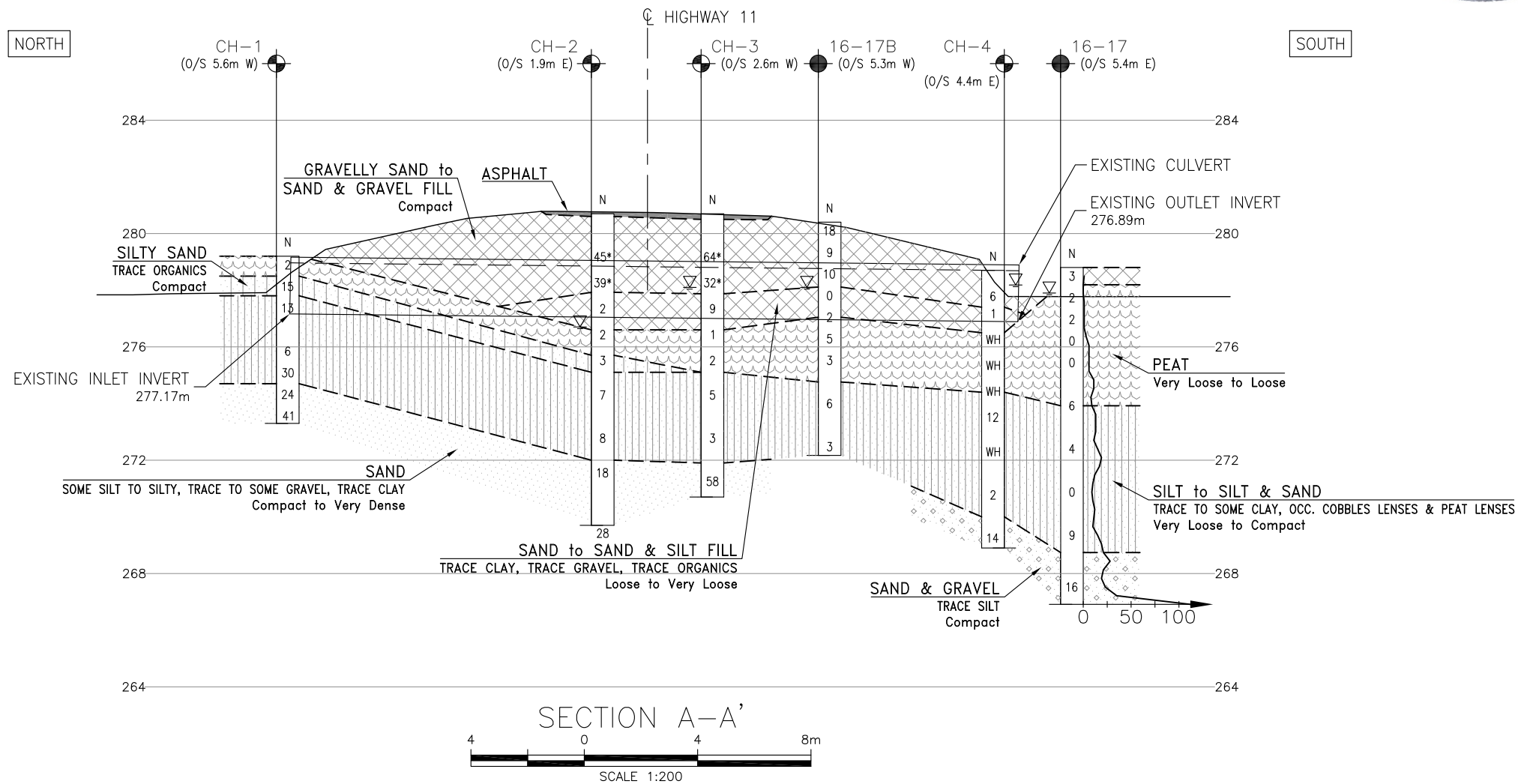
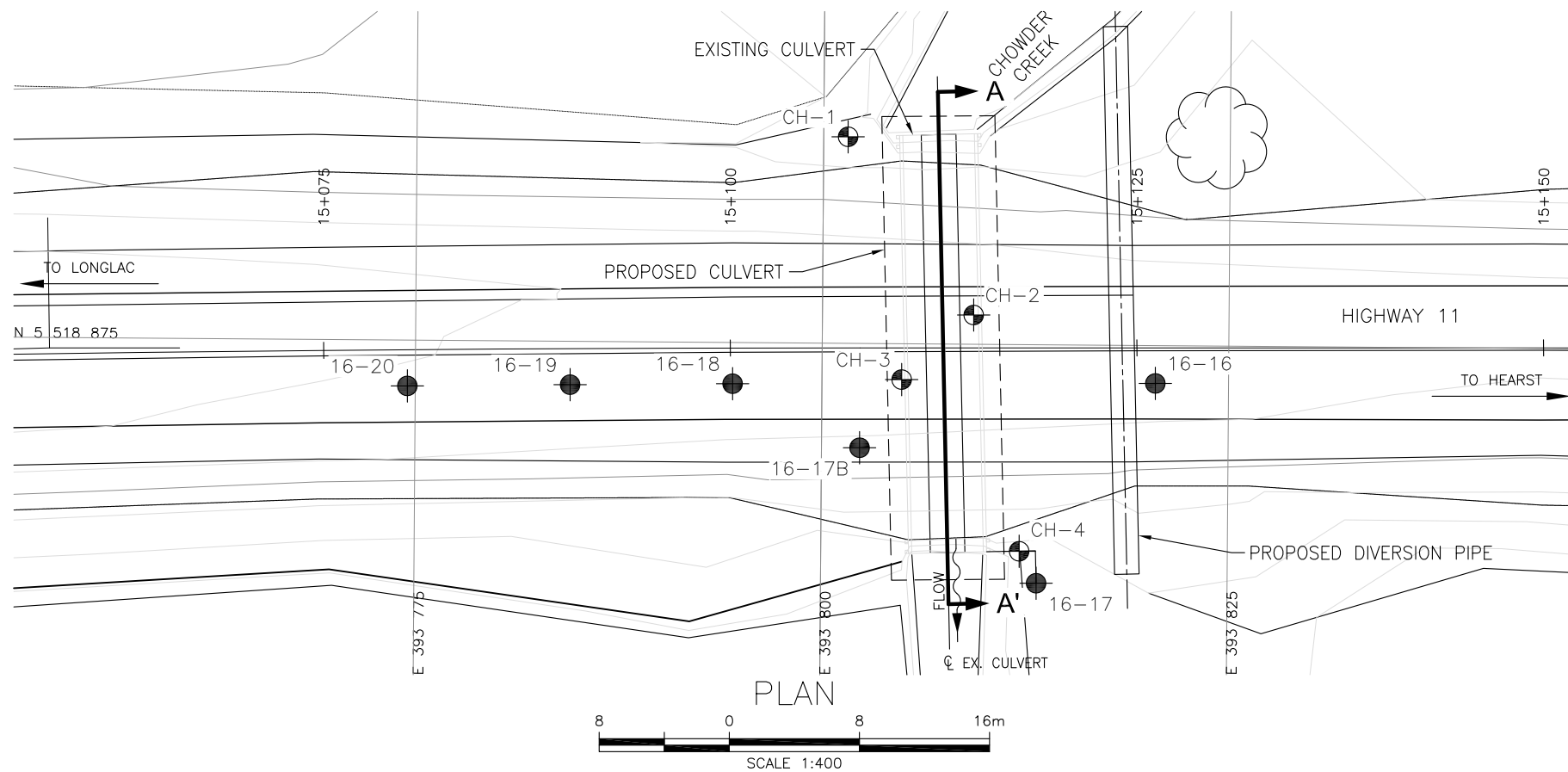
Photo 4: Chowder Creek Culvert, inlet (north side)



Photo 5: Chowder Creek Culvert, outlet (south side)

Appendix D

Borehole Locations and Soil Strata Drawing



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



CONT No 2017-6001
WP No 6312-14-01

HIGHWAY 11
CHOWDER CREEK EAST
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

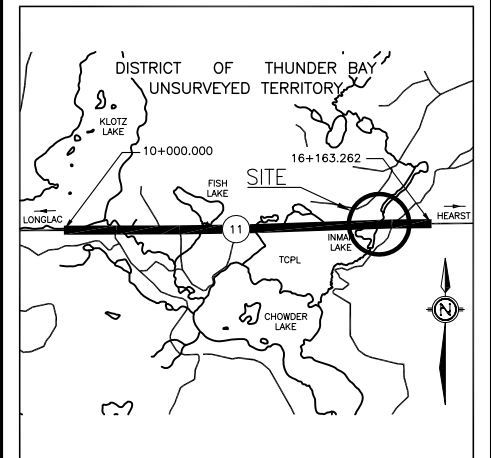


SHEET
9

HATCH



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Borehole (by Thurber)
○	Borehole (by Others)
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

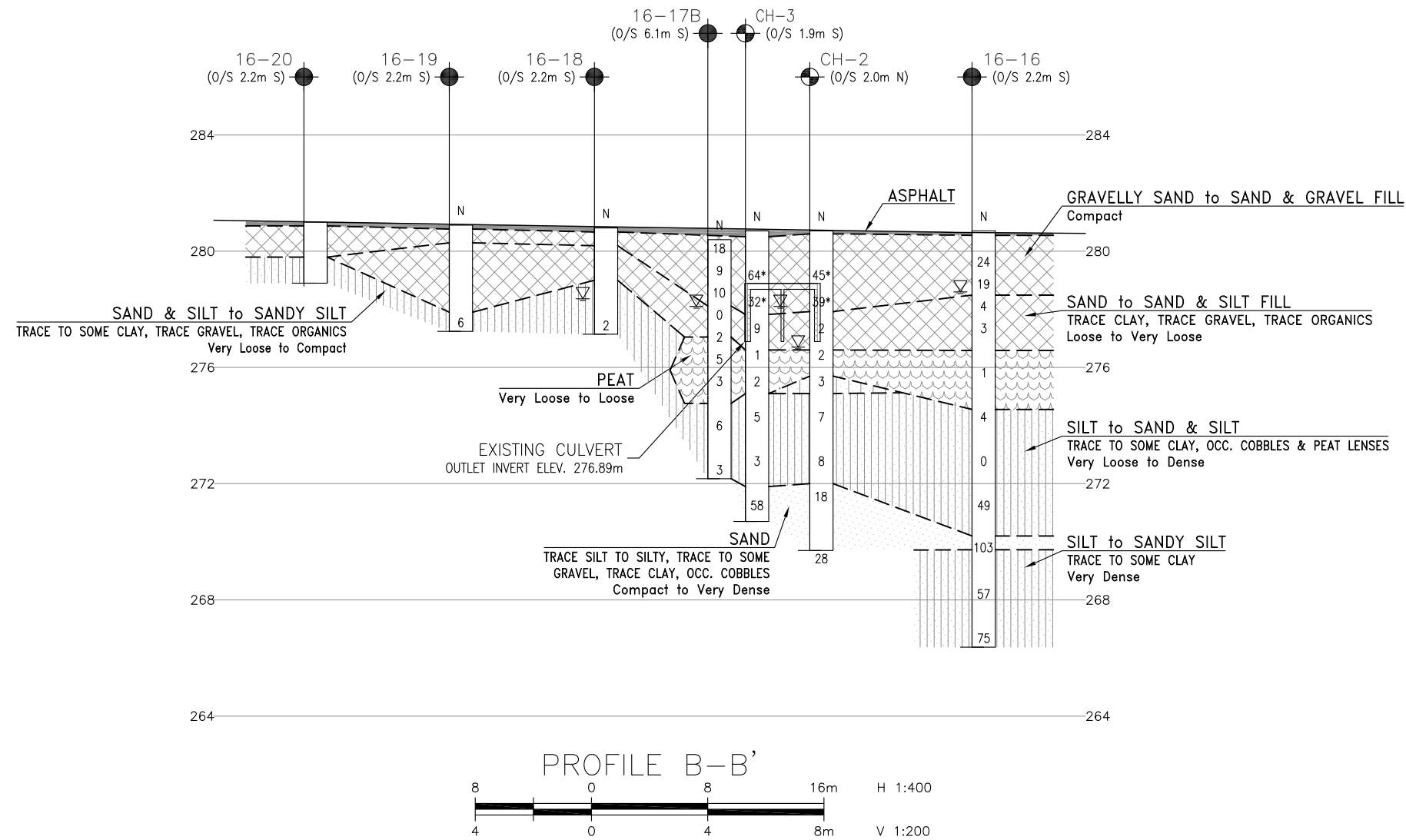
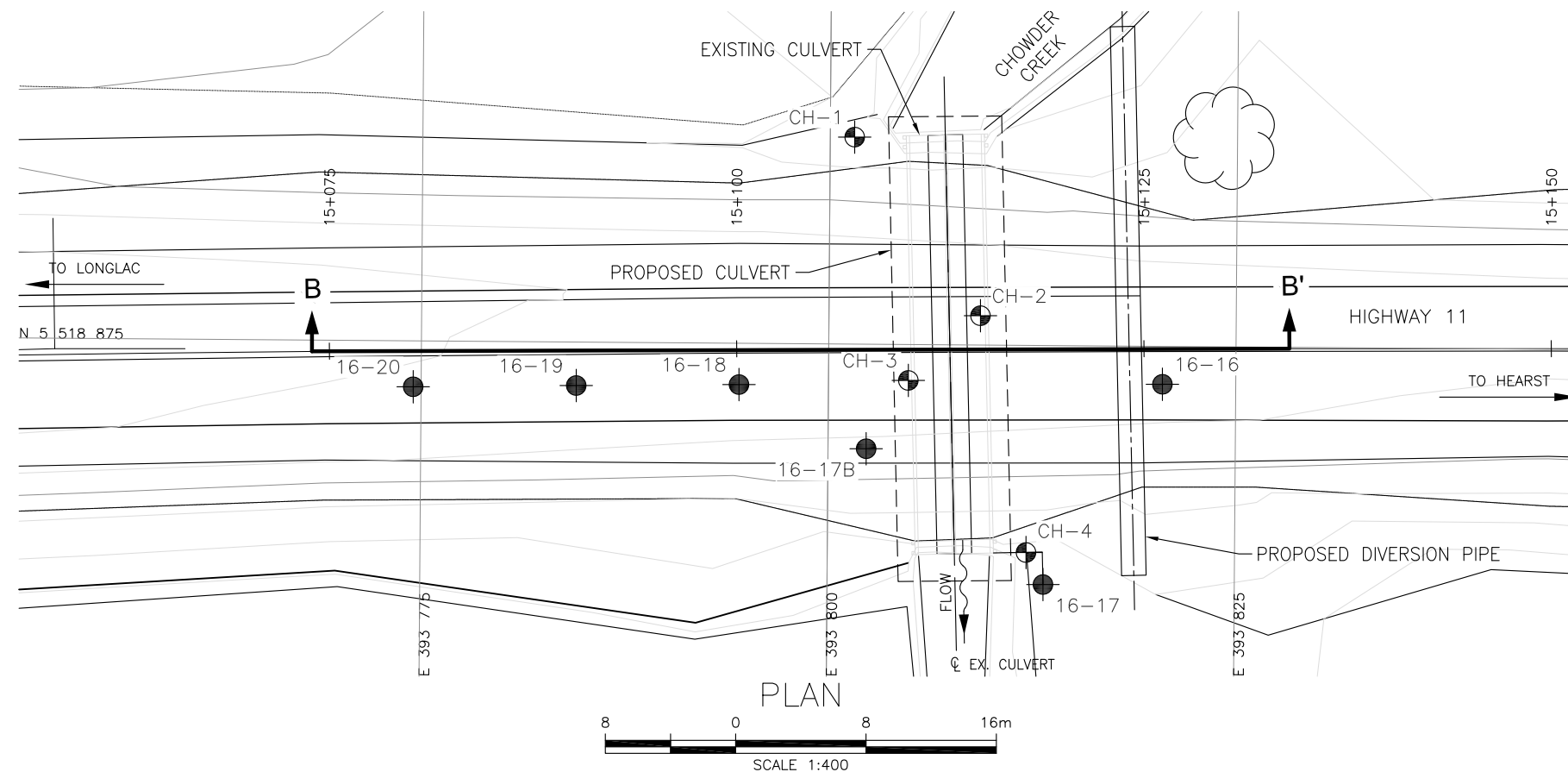
NO	ELEVATION	NORTHING	EASTING
16-16	280.7	5 518 872.7	393 820.5
16-17	278.8	5 518 860.3	393 813.3
16-17B	280.4	5 518 868.6	393 802.3
16-18	280.8	5 518 872.5	393 794.5
16-19	280.9	5 518 872.3	393 784.5
16-20	281.0	5 518 872.2	393 774.5
CH-1	279.2	5 518 887.7	393 801.5
CH-2	280.7	5 518 876.8	393 809.3
CH-3	280.7	5 518 872.8	393 804.9
CH-4	278.7	5 518 862.3	393 812.2

-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.
- MTM Zone 14 co-ordinate system used to obtain borehole Northings and Eastings.
- Preliminary general arrangement drawing provided by Hatch in digital format.

GEOCRES No. 42F-41

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AMP	CHK	PKC
DRAWN	MFA	CHK	AMP
CODE	LOAD	DATE	JAN 2017
SITE	STRUCT	DWG	2



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



CONT No 2017-6001 (S
WP No 6312-14-01

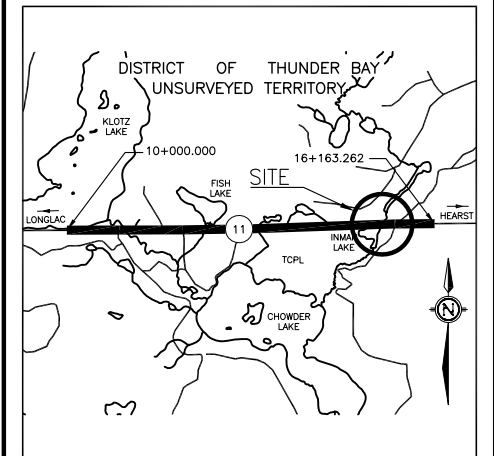
HIGHWAY 11
CHOWDER CREEK EAST
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
10

HATCH








THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole (by Thurber)
	Borehole (by Others)
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
16-16	280.7	5 518 872.7	393 820.5
16-17	278.8	5 518 860.3	393 813.3
16-17B	280.4	5 518 868.6	393 802.3
16-18	280.8	5 518 872.5	393 794.5
16-19	280.9	5 518 872.3	393 784.5
16-20	281.0	5 518 872.2	393 774.5
CH-1	279.2	5 518 887.7	393 801.5
CH-2	280.7	5 518 876.8	393 809.3
CH-3	280.7	5 518 872.8	393 804.9
CH-4	278.7	5 518 862.3	393 812.2

-NOTES-

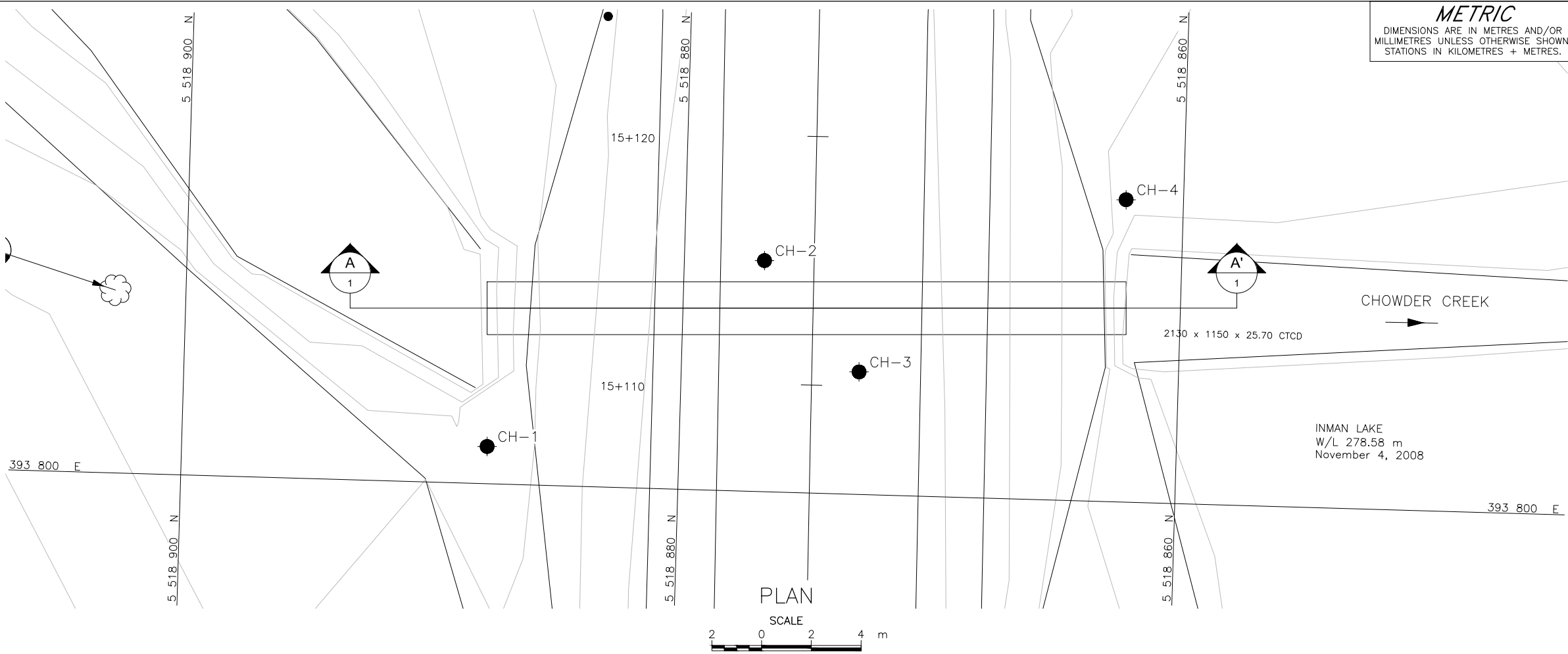
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) MTM Zone 14 co-ordinate system used to obtain borehole Northings and Eastings.
- 4) Preliminary general arrangement drawing provided by Hatch in digital format.

GEOCRES No. 42F-41

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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Appendix E

**Record of Borehole Sheets and Borehole Location and Soil Strata Drawing
Geocres No 42F-35**

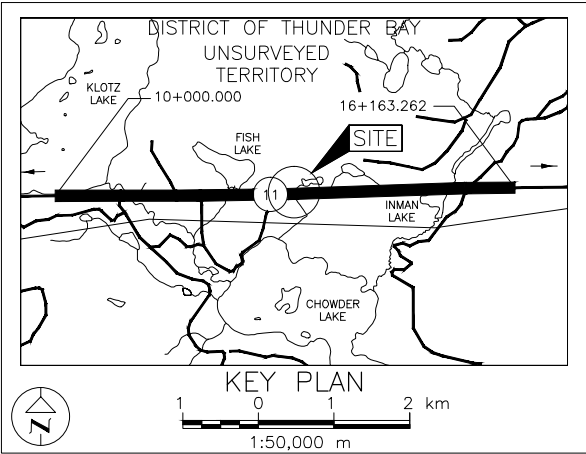


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 6312-14-00

HIGHWAY 11
CHOWDER CREEK CULVERT STA 15+113
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
CH-1	279.2	5518887.7	393801.5
CH-2	280.7	5518876.8	393809.3
CH-3	280.7	5518872.8	393804.9
CH-4	278.7	5518862.3	393812.2

NOTES

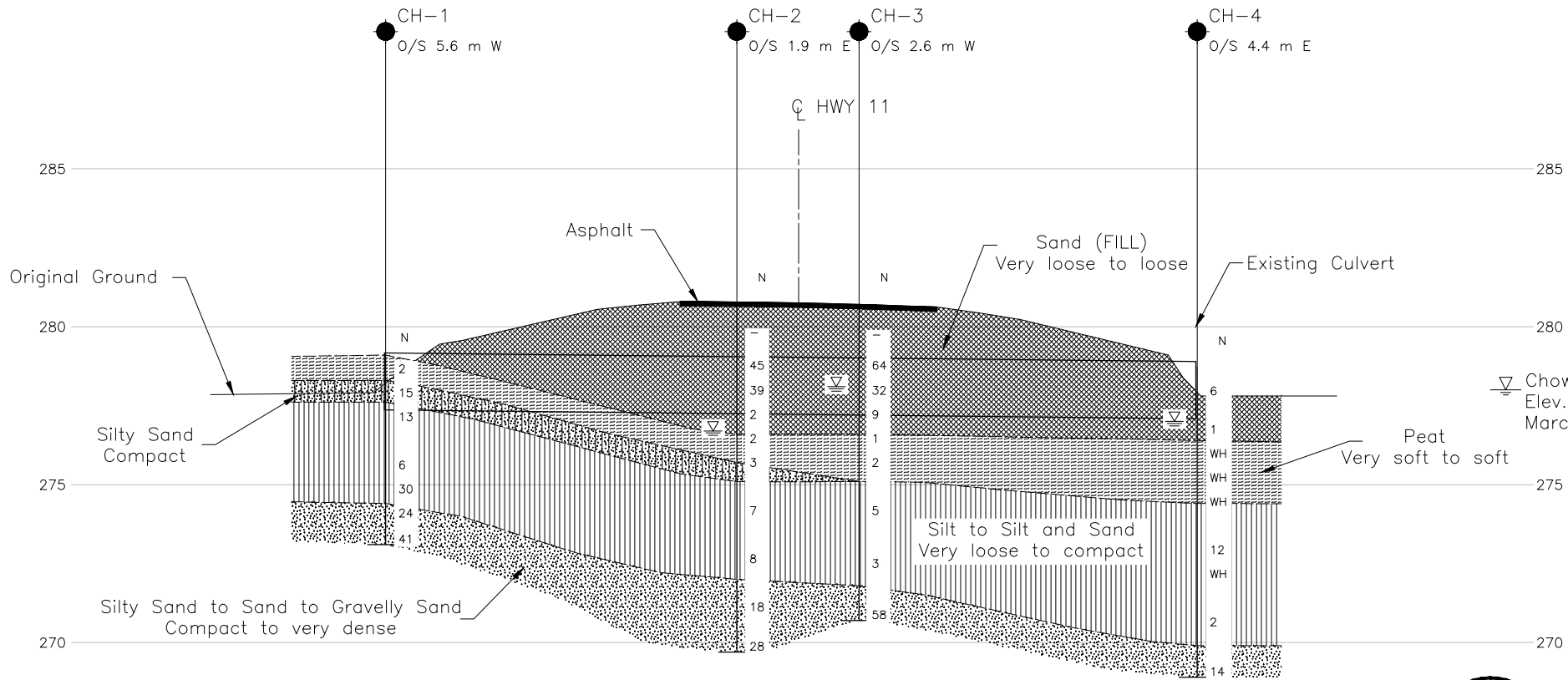
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by MTO, drawing file no. BC494854113, received FEB 20, 2015.



PROFILE

HORIZONTAL SCALE






VERTICAL SCALE



NO.	DATE	BY	REVISION
1	8/26/2015	JJL	1

Geocres No. 42F-35

HWY. 11	PROJECT NO. 1411523	DIST. .
SUBM'D. AC	CHKD. .	DATE: 8/26/2015
DRAWN: JJL	CHKD. DAM	APPD. JMAC
		SITE: 48E-84/C
		DWG. 1

PROJECT 1411523			RECORD OF BOREHOLE No CH-1			1 OF 1 METRIC											
G.W.P. 6312-14-00			LOCATION N 5518887.7; E 393801.5			ORIGINATED BY NJ											
DIST _____ HWY 11			BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers			COMPILED BY AC											
DATUM GEODETIC			DATE March 27, 2015			CHECKED BY DAM											
SOIL PROFILE			SAMPLES			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	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p W W _L			γ	GR SA SI CL
279.2	GROUND SURFACE							20 40 60 80 100									
0.0	PEAT, some sand Very soft Black Moist		1	SS	2		279										
278.5																	
0.7	Silty SAND Compact Grey Moist to wet		2	SS	15		278										
277.8																	
1.4	SILT, trace to some clay, trace sand Loose to compact Grey Wet		3	SS	13		277										
	Augers grinding from 3.0 m to 3.8 m depth on inferred cobbles.		4	SS	6		276										
			5	SS	30		275										
274.7																	
4.5	SAND, some silt, some gravel, trace clay Compact to dense Grey Wet		6	SS	24		274										
			7	SS	41												
273.3																	
5.9	END OF BOREHOLE Note: 1. Water level not obtained.																

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 03/09/15 DATA INPUT:

PROJECT 1411523			RECORD OF BOREHOLE No CH-2			1 OF 1 METRIC											
G.W.P. 6312-14-00			LOCATION N 5518876.8; E 393809.3			ORIGINATED BY NJ											
DIST _____ HWY 11			BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers			COMPILED BY AC											
DATUM GEODETIC			DATE March 23, 2015			CHECKED BY DAM											
SOIL PROFILE			SAMPLES			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	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	20 40 60	KN/m ³		
280.7	GROUND SURFACE																
0.0	ASPHALT (140 mm)																
0.1	Sand, trace to some gravel, trace to some silt (FILL) Very loose Brown Frozen* to wet		1	AS	-		280										
			2	SS	45*		279										
			3	SS	39*		278									9 78 (13)	
			4	SS	2		277										
276.6	PEAT Very soft to soft Black Wet		A 5 B	SS	2		276										
275.7	Silty SAND, trace organics Grey Wet		A 6 B	SS	3		275										
275.1	SILT, some sand, trace to some clay Loose Grey Wet						274										
272.0	Silty SAND, trace gravel Compact Grey Wet		7	SS	7		273										
			8	SS	8		272										
			9	SS	18		271										
			10	SS	28		270										
269.7	END OF BOREHOLE																
11.0	Note: 1. Water level at a depth of 4.0 m below ground surface (Elev. 276.7 m) upon completion of drilling.																

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 03/09/15 DATA INPUT:

PROJECT 1411523			RECORD OF BOREHOLE No CH-3			1 OF 1 METRIC											
G.W.P. 6312-14-00			LOCATION N 5518872.8; E 393804.9			ORIGINATED BY NJ											
DIST _____ HWY 11			BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers			COMPILED BY AC											
DATUM GEODETIC			DATE March 24, 2015			CHECKED BY DAM											
SOIL PROFILE			SAMPLES			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	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p W W _L WATER CONTENT (%)			γ	GR SA SI CL
280.7	GROUND SURFACE							20 40 60 80 100									
0.0	ASPHALT (150 mm)																
0.2	Sand, trace to some gravel, trace to some silt (FILL) Loose Brown Frozen* to wet		1	AS	-		280										
			2	SS	64*		279										
			3	SS	32*		278									5 83 (12)	
			4	SS	9		277										
276.6	PEAT Very soft Black Wet		A 5 B	SS	1		276										
			6	SS	2												
275.1	SILT, trace sand, trace clay Very loose to loose Grey Wet						275										
			7	SS	5		274									NP 0 4 90 6	
							273										
			8	SS	3		272										
271.9	SAND, some silt, trace to some gravel, trace clay Very dense Grey Wet						271										
			A 9 B	SS	58											11 70 15 4	
270.7	Augers grinding from 8.8 m to 9.1 m depth on inferred cobbles. END OF BOREHOLE																
10.0	Note: 1. Water level at a depth of 2.6 m below ground surface (Elev. 278.1 m) upon completion of drilling.																

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 03/09/15 DATA INPUT:

PROJECT 1411523			RECORD OF BOREHOLE No CH-4			1 OF 1 METRIC											
G.W.P. 6312-14-00			LOCATION N 5518862.3; E 393812.2			ORIGINATED BY NJ											
DIST _____ HWY 11			BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers			COMPILED BY AC											
DATUM GEODETIC			DATE March 25, 2015			CHECKED BY DAM											
SOIL PROFILE			SAMPLES			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	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	20 40 60	KN/m ³				
278.7	GROUND SURFACE																
0.0	Sand, some gravel (FILL) Very loose to loose Brown to black Moist to wet Trace organics in the upper 0.8 m.		1	SS	6		278										
			2	SS	1		277										
276.5	PEAT																
2.2	Very soft Black Moist to wet		3	SS	WH		276										
			4	SS	WH		275										
274.4			A														
4.3	SILT and SAND, trace to some clay, trace gravel Very loose to compact Grey Wet		5	SS	WH		274										
			6	SS	12		273										
			7	SS	WH		272										
			8	SS	2		271										
270.0							270										
8.7	Gravelly SAND, trace to some silt Compact Grey Wet		9	SS	14		269										
268.9	END OF BOREHOLE																
9.8	Note: 1. Water level at a depth of 1.7 m below ground surface (Elev. 277.0 m) upon completion of drilling.																

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 03/09/15 DATA INPUT: