THURBER ENGINEERING LTD.

PRELIMINARY FOUNDATION INVESTIGATION REPORT
ALDER CREEK EAST CULVERT REPLACEMENT
HIGHWAY 17, UNSURVEYED TERRITORY
THUNDER BAY DISTRICT, ONTARIO
LATITUDE: 48.7199017º, LONGITUDE: -85.709616º

G.W.P. 6810-14-00, W.P. 6330-14-01, SITE No. 48E-075C

GEOCRES Number: 42C-43

Report

to

HATCH

Date: September 11, 2018
File: 15595

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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 Alder Creek East Culvert on Highway 17, located west of the town of White River, in the Unsurveyed District of Thunder Bay, Ontario. Thurber carried out the investigation as a sub-consultant to Hatch under the Ministry of Transportation Ontario (MTO) Agreement Number 6016-E-0008.

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.

A previous foundation investigation carried out at this site was documented in the report titled "Preliminary Foundation Investigation and Design Report, Alder Creek E. Culvert, Site No. 48E-75/C, Highway 17, District of Thunder Bay, Unsurveyed Territory, Ministry of Transportation, Ontario, G.W.P 6330-14-00" Geocres No. 42C-37, prepared by Golder Associates, dated October 30, 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 Investigation Report. The Record of Borehole sheets and Borehole Locations and Soil Strata drawing from the Golder 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 from the Golder Report should be included in the tender documents.

2. SITE DESCRIPTION

The site is located along Highway 17, approximately 39 km west of the town of White River, Ontario. Highway 17 generally runs in an east-west direction at the culvert site. Dunc Lake is located south of Highway 17 and Alder Creek East flows northerly from Dunc Lake.

Based on the Ontario Structure Inspection Manual (OSIM) prepared by MTO on November 20, 2014, the existing culvert is a corrugated steel pipe arch that is 3.9 m wide, 2.1 m high and 27.2 m long. The culvert barrel is in poor condition with medium corrosion on the bottom half of the culvert and rusted bolts. The culvert is sagging by approximately 0.2 m at the centre of the culvert and has excessive deformations at the outlet.

The estimated culvert invert is at approximate Elevation 324.1 m at the inlet (north) and 323.8 m at the outlet (south). The existing road grade at the culvert location is at approximate Elev. 327.4 m. The height of fill above the culvert is approximately 1.0 m to 1.5 m. The elevation of the water flowing through the culvert on May 20, 2014, was reported at approximately 325.1 m.

The area on either side of the creek near the inlet and outlet of the culvert is vegetated with tall grass, and shrubs. Photographs in Appendix D show the culvert and the surrounding area.

The site lies within the physiographic region known as the Wawa Subprovince of the Superior Province of the Canadian Shield. Based on OGS Map 2545, titled “Bedrock Geology of Ontario”, dated 1991, the bedrock is of the Archean age and consists of intrusive rocks, mainly massive to foliated granodiorite and granite. The subsoils on site generally consist of an alluvial plain comprised mainly of sand and glacial till with a predominantly sand to silty sand matrix

3. INVESTIGATION PROCEDURES

The field investigation for this project was carried out between July 14, and September 14, 2017, during which time four boreholes denoted as Boreholes 17-07 to 17-10 were advanced at selected locations at the culvert site. Borehole 17-07 was drilled near the inlet of the existing culvert and Boreholes 17-08 to 17-10 were advanced at selected locations within the eastbound lane of Highway 17 to assess the existence and extent of any frost taper near the culvert. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing provided in Appendix C.

A track-mounted CME 55 drill rig was used to drill Boreholes 17-08 to 17-10 and a Hilti DD 250 E portable drill rig was used to drill Borehole 17-07. The boreholes were advanced using solid stem

augers and diamond drilling to depths between 3.7 and 15.2 m. In all boreholes, soil samples were obtained at selected intervals using a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT), or from auger cuttings for surficial material. The results of the boreholes are presented on the Record of Borehole sheet in Appendix A.

In order to investigate the depth and extent of peat near the culvert, additional peat probes were conducted near the inlet and outlet of the culvert.

The field investigation was supervised on a full-time basis by a member of Thurber's technical staff who directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Four boreholes were previously drilled at this location and recorded within the October 30, 2015 report by Golder Associates. These boreholes (denoted as AL-1 to AL-4) were advanced to depths between 6.4 and 11.8 m. Based on a review of the Golder Borehole Locations and Soil Strata drawing, and topographic information provided by Hatch (Plan E-484854-17-1), the ground surface Elevations at Boreholes AL-1 and AL-4 have been re-interpreted as 325.1 m and 325.5 m respectively.

The groundwater level was measured within the open boreholes completed by Thurber upon completion of drilling. The boreholes were backfilled in general accordance with Ontario Regulation 903, as amended by Regulation 128/03.

Details of the borehole completion are summarized as follows:

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
17-07	15.2/310.1	Bentonite holeplug and cuttings to surface
17-08	3.7/323.8	Cuttings to 0.1 m below surface then cold patch asphalt to surface
17-09	3.7/323.9	Cuttings to 0.1 m below surface then cold patch asphalt to surface

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
17-10	3.7/323.9	Cuttings to 0.1 m below surface then cold patch asphalt to surface

4. LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (hydrometer and/or sieve). Laboratory testing results are summarized on the Record of Borehole sheets included in Appendix A and are presented 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 native silt, and a sample of the surface water from the lake upstream of the existing culvert were collected and submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters. The results of the analytical testing are summarized in this report and also presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A and Appendix 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 must be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the subsurface conditions encountered in these boreholes consisted of asphalt and sand fill where the boreholes were advanced through the embankment and silty to sandy peat where the boreholes were advanced through the native soil near the inlet and outlet. The sand fill or peat layer was underlain by silt to silt and sand, which was underlain by silt and sand till. Descriptions of the individual strata are presented below.

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5.1 Asphalt

Asphalt was encountered at the surface in Boreholes AL-2, AL-3, 17-08, 17-09 and 17-10. The thickness of the asphalt ranged from 180 mm to 325 mm.

5.2 Peat

A layer of black silty to sandy peat was encountered as the surface layer in Boreholes 17-07, AL-1 and AL-4. The layer ranged in thickness from 0.8 m to 2.7 m and extended to elevations ranging from 322.4 m to 324.5 m.

Additional peat probes were conducted up to 25 m to the east and west of the culvert inlet and outlet. The depth of the assumed base of the peat varied from approximately 0.5 m to 1.5 m at the inlet, and 0.4 m to 1.3 m at the outlet. At both the inlet and outlet, the thickness of the peat decreased with increased distance from the culvert.

SPT 'N' values within the peat ranged from 1 to 10 blows per 0.3 m of penetration, indicating a very soft to firm/compact consistency. Higher SPT 'N' values of 15 and 25 were also recorded but were likely due to frozen ground at the time of the Golder investigation. Moisture contents between 48 percent and 58 percent were measured in the peat.

5.3 Silty Sand to Sand Fill

A layer of brown to grey sand to silty sand fill was encountered below the asphalt in Boreholes AL-2, AL-3, 17-08, 17-09 and 17-10. This layer ranged from silty sand with trace gravel and trace clay to sand with some gravel and some silt. The fill layer ranged in thickness from 2.4 to 4.7 m and extended to Elevations of 324.9 m to 322.7 m.

Boreholes 17-08 to 17-10 and Boreholes AL-2 and AL-3 were drilled to assess the existence and extent of any frost taper near the culvert. Based on the information obtained from the borehole investigation, the granular base/subbase material extended below the frost penetration depth estimated in this area, and a defined frost taper was not observed at the culvert location.

SPT 'N' values within the fill layer ranged from 9 to 33 blows per 0.3 m of penetration, indicating a loose to dense relative density. Higher SPT 'N' values up to 93 were also recorded but were likely due to frozen ground at the time of the Golder investigation. Measured moisture contents within the fill varied between 4 percent and 16 percent.

The results of grain size distribution analyses carried out on samples of the sand to silty sand fill are presented on the Record of Borehole sheets included in Appendices A and E and on Figure B1 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	8 to 14
Sand	53 to 74
Silt	33
Clay	6
Silt and Clay	12 to 14

5.4 Silty Sand

A layer of native silty sand with trace gravel was encountered below the peat in Borehole 17-07 at a depth of 0.8 m. The silty sand layer was 1.4 m thick and extended to a depth of 2.2 m (Elevation 323.1 m). The silty sand deposit was compact, based on SPT 'N' values of 10 and 13 blows per 0.3 m of penetration. The measured moisture content of the silty sand was 11 percent.

5.5 Silt to Sand and Silt

A layer of dark brown to grey silt to sand and silt with trace clay, trace gravel, and occasional cobbles, was encountered below the peat, sand fill, and silty sand layers at depths ranging from 2.2 m to 4.9 m (Elevation 324.9 m to 322.4 m). Boreholes AL-1, 17-08, 17-09 and 17-10 were terminated in the silt to sand and silt layer at depths ranging from 3.7 m to 8.2 m (Elevation 323.9 m to 316.9 m). The thickness of the silt to sand and silt layer ranged from 2.3 to 6.5 m in Boreholes AL-2, AL-3, AL-4 and 17-07 and extended to depths ranging from 4.5 m to 10.2 m (Elevation 321.0 m to 316.6 m). A 0.6 m diameter boulder was encountered within the silt layer in Borehole 17-07 at a depth of 6.9 m (Elevation 318.4 m).

The SPT 'N' values for the silt to sand and silt ranged from 2 to 51 blows per 0.3 m penetration indicated a very loose to very dense relative density. The silt to sand and silt had a measured moisture content ranging from 6 percent to 26 percent.

The results of grain size distribution analyses carried out on selected samples of the sand fill are presented on the Record of Borehole sheets included in Appendices A and E and on Figure B2 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0 to 2
Sand	2 to 56
Silt	38 to 95
Clay	0 to 8

5.6 Silt and Sand Till

A layer of grey silt and sand till ranging from silt and sand with trace to some gravel and trace to some clay to gravelly silty sand with trace clay was encountered in Boreholes AL-2, AL-3, AL-4 and 17-07 at depths ranging from 4.5 m to 10.2 m (Elevation 321.0 m to 316.6 m). All four of these boreholes were terminated within the silt and sand till at depths ranging from 6.4 m to 15.2 m (Elevation 319.1 m to 310.1 m).

The SPT 'N' values recorded in the silt and sand till ranged from 8 to greater than 100 blows per 0.3 m penetration indicated a loose to very dense relative density. The silt and sand till had a measured moisture content ranging from 8 percent to 16 percent.

The results of grain size distribution analyses carried out on selected samples of the till are presented on the Record of Borehole sheets included in Appendices A and E and on Figure B3 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	6 to 50
Sand	31 to 36
Silt	13 to 55
Clay	1 to 22

5.7 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. The groundwater levels are summarized below:

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
AL-01	April 7, 2015	1.0	324.1	Open borehole
AL-02	March 17, 2015	2.9	324.7	Open borehole
AL-03	March 17, 2015	3.0	324.2	Open borehole
AL-04	April 7, 2015	0.8	324.7	Open borehole
17-07	September 12, 2017	0.3	325.0	Open borehole
17-08	June 14, 2017	2.1	325.4	Open borehole
17-09	June 14, 2017	2.4	325.2	Open borehole
17-10	June 14, 2017	Dry	Dry	Open borehole

The creek water level on May 20, 2014 was reported to be Elev. 325.1 m upstream and downstream of the outlet.

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 17-07 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	
			17-07, SS#6, 4.6 m – 5.2 m	Alder Creek East
			(Silt)	(Creek Water)
Sulphide	%	mg/L	<0.02	<0.006
Chloride	mg/L	mg/L	1000	23
Sulphate	mg/L	mg/L	73	1.5
pH	No unit	No unit	8.60	7.90
Electrical Conductivity	µS/cm	µS/cm	1090	170
Resistivity	Ohms.cm	Ohms.cm	910	5880
Redox Potential	mV	mV	196	291

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7. MISCELLANEOUS

Thurber marked the borehole locations in the field and obtained subsurface utility clearances prior to drilling.

RPM Drilling Ltd. of Thunder Bay, Ontario and OGS of Almonte, 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. Ty Tonus-Burman and Ms. Eckie Siu. Overall supervision of the field program was provided by Mr. Cory Zanatta, EIT of Thurber.

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. The coordinate system MTM NAD83 Zone 14 was used for these boreholes.

Routine laboratory testing was carried out at Thurber's geotechnical laboratory. Interpretation of the field data and preparation of this report was carried out by Dr. Nancy Berg, EIT and Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Sept. 11/18

Nancy Berg, Ph.D.
Geotechnical EIT

Mark Farrant, P.Eng.
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Review Principal, Designated MTO Contact

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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.

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			

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RECORD OF BOREHOLE No 17-07 1 OF 2 METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 650.8 E 399 721.8 ORIGINATED BY TTB

HWY 17 BOREHOLE TYPE Hilti Portable/Wash Boring/Coring COMPILED BY AN

DATUM Geodetic DATE 2017.09.12 - 2017.09.14 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.3	GROUND SURFACE										
0.0	**PEAT**, silty, trace sand, trace clay Compact Brown Wet		1	SS	10	▽	325		○		
324.5											
0.8	Silty **SAND**, trace gravel Compact Grey Wet		2	SS	10		324		○		
			3	SS	13				○		
323.1							323				
2.2	**SILT**, trace to some sand, trace clay, trace gravel, occasional cobbles Compact Grey Wet		4	SS	25				○		
			5	SS	22		322		○		0 2 91 7
			6	SS	14		321		○		
	Trace clay		7	SS	19		320		○		0 17 75 8
318.4							319				
6.9	**BOULDER**		1	GS			318				
317.8											
7.5	**SILT**, some sand, trace gravel Compact Grey Wet		8	SS	14		317		○		
316.6			2	GS							
8.7	**SILT** and **SAND**, trace to some clay, trace gravel, occasional cobbles and boulders Very Dense (TILL)		9	SS	100/ 0.100		316		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 1/26/18

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RECORD OF BOREHOLE No 17-07 2 OF 2 METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 650.8 E 399 721.8 ORIGINATED BY TTB

HWY 17 BOREHOLE TYPE Hilti Portable/Wash Boring/Coring COMPILED BY AN

DATUM Geodetic DATE 2017.09.12 - 2017.09.14 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT and **SAND**, trace to some clay, trace gravel, occasional cobbles and boulders Very Dense Grey Moist (TILL)		10	SS	100/ 0.125		315				
			3	GS			314				
			11	SS	50/ 0.025		313		○		6 34 38 22
			4	GS			312				
			12	SS	100/ 0.050		311		○		
310.1			13	SS	50/ 0.0						
15.2	END OF BOREHOLE AT 15.2m. BOREHOLE OPEN AND WATER LEVEL AT 0.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

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

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

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 1/26/18

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THURBER

RECORD OF BOREHOLE No 17-08 1 OF 1 METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 638.7 E 399 742.7 ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.5	GROUND SURFACE										
0.0 327.2	**ASPHALT:** (300mm)										
0.3	**SAND**, some silt, trace gravel Brown Moist (FILL)		1	GS			327		○		
						▽	326				
324.7							325				
2.8	**SAND** and **SILT**, trace clay, trace peat Compact Dark Brown Wet		2	GS					○		0 56 38 6
323.8			1	SS	12		324		○		
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND WATER LEVEL AT 2.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 1/11/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-09 1 OF 1 METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 640.6 E 399 752.6 ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.6	GROUND SURFACE										
0.0 327.3	**ASPHALT:** (325mm)										
0.3	Silty **SAND**, trace gravel, trace clay Brown Moist to Wet (FILL)		1	GS			327		○		8 53 33 6
			2	GS		▽	326		○		
324.6							325				
3.0 323.9	**SAND** and **SILT**, trace gravel Dense Grey Wet		1	SS	31		324		○		
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 1/11/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-10 1 OF 1 METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 642.3 E 399 762.4 ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Solid Stem Augers COMPILED BY AB

DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.6	GROUND SURFACE										
0.0 327.3	**ASPHALT:** (300mm)										
0.3	**SAND**, some silt, trace gravel Brown Moist (FILL)		1	GS			327		○		
324.9							326				
2.7	**SAND** and **SILT**, trace clay, occasional cobbles Dense Grey to Brown Wet		2	GS			325		○		
323.9			1	SS	42		324		○		0 55 38 7
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

THURBER

Appendix B

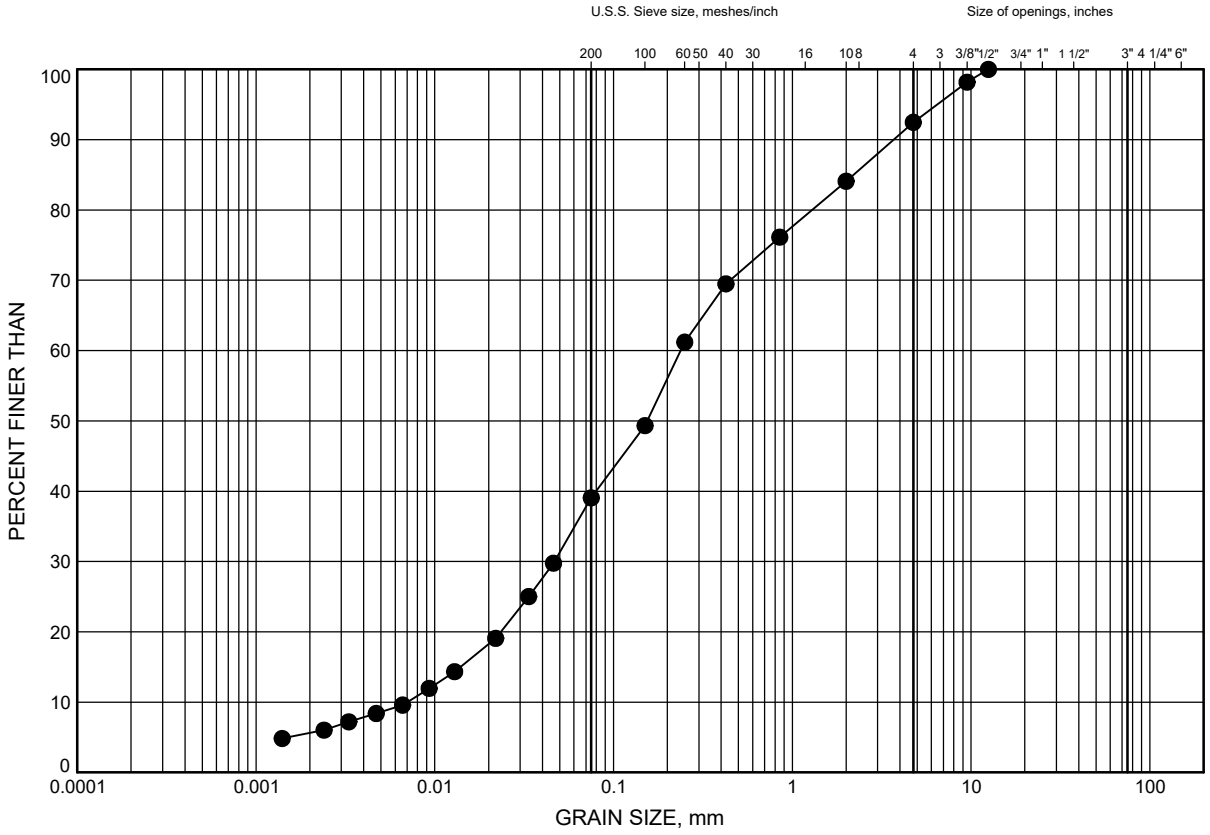
Laboratory Test Results

Alder Creek East Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-09	1.0	326.6

Date January 2018

W.P. 6330-14-01

THURBER

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Chkd. NLB

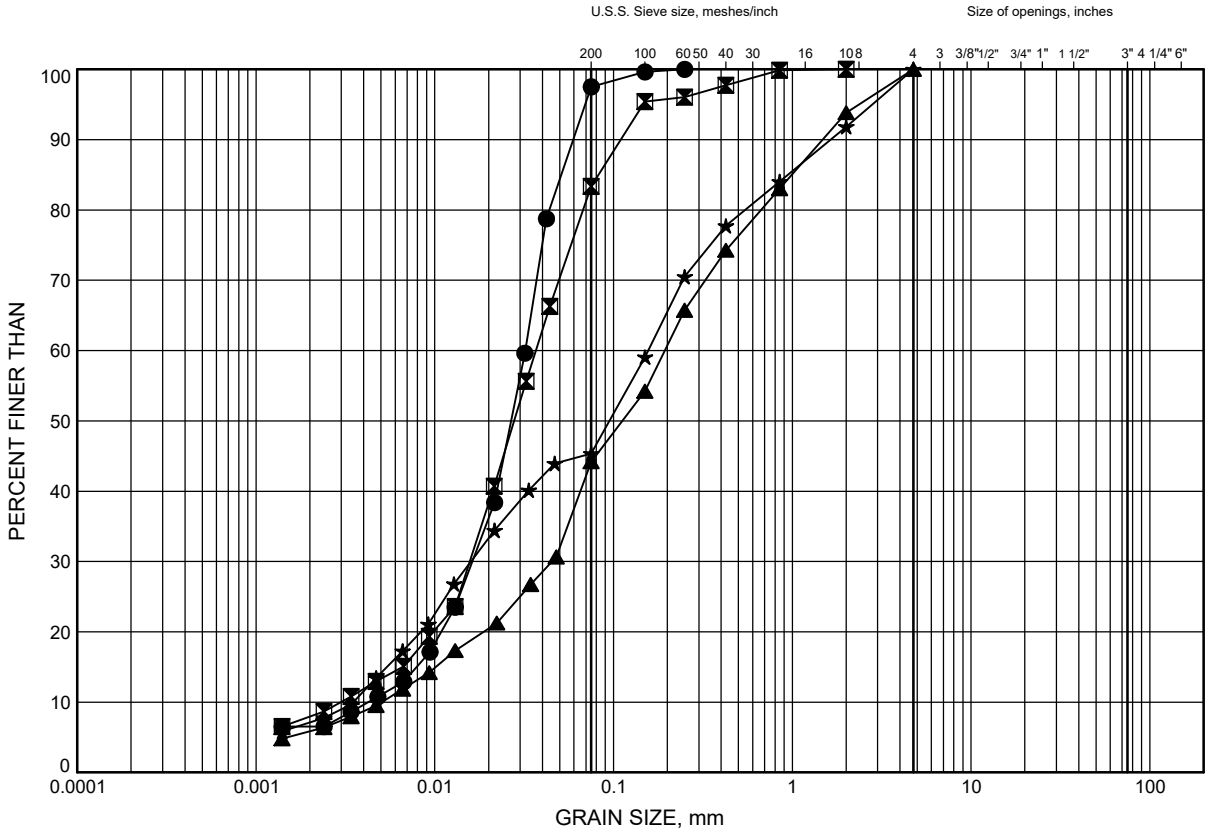
GRAIN SIZE DISTRIBUTION - THURBER MTO-15595.GPJ 1/11/18

Alder Creek East Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILT to SAND and SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-07	3.4	321.9
⊠	17-07	6.4	318.9
▲	17-08	2.9	324.6
★	17-10	3.4	324.2

Date January 2018

W.P. 6330-14-01

THURBER

Prep'd AN

Chkd. NLB

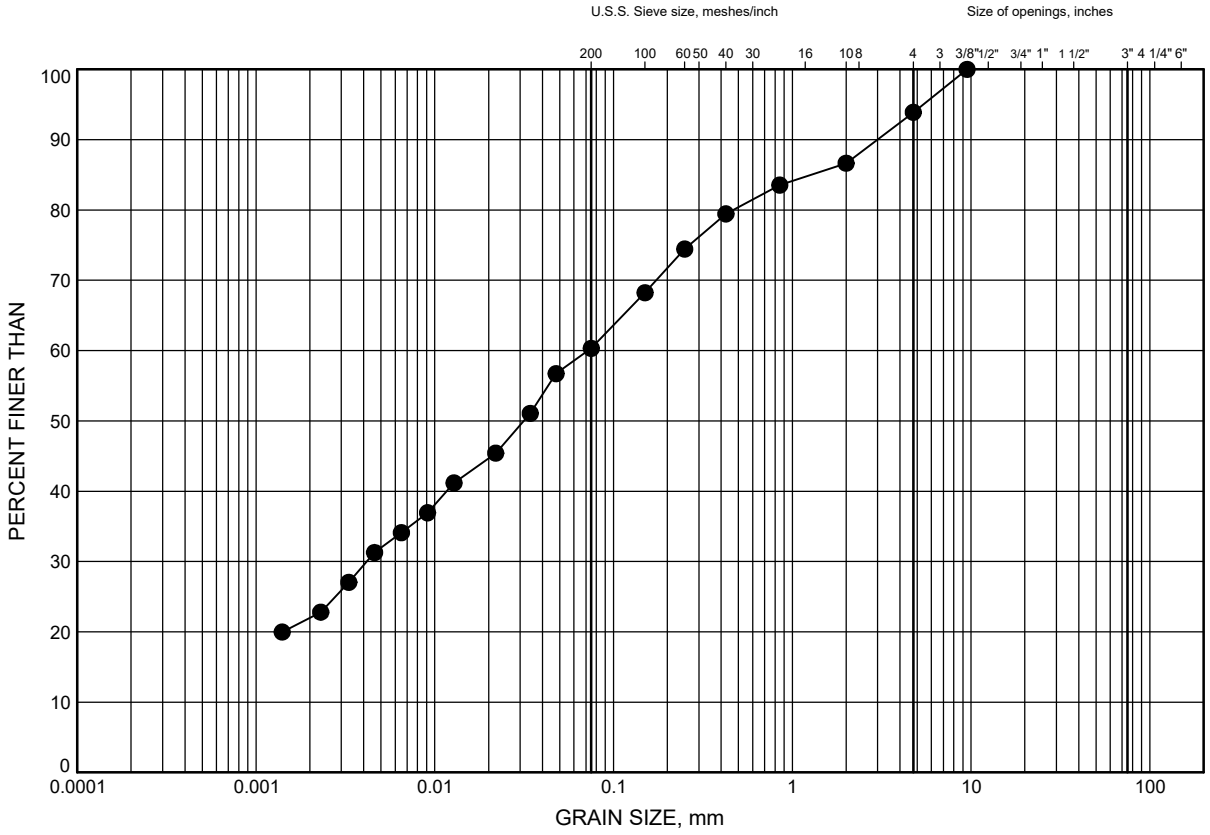
GRAIN SIZE DISTRIBUTION - THURBER MTO-15595.GPJ 1/11/18

Alder Creek East Culvert

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILT and SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-07	12.2	313.1

Date January 2018

W.P. 6330-14-01

THURBER

Prep'd AN

Chkd. NLB

GRAIN SIZE DISTRIBUTION - THURBER MTO-15595.GPJ 1/11/18

FINAL REPORT

CA14723-OCT17 R1

15595

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7.
Contact	Mark Farrant
Telephone	905-829-8666 x 228
Facsimile	
Email	mfarrant@thurber.ca
Project	15595
Order Number	
Samples	Soil (1)

LABORATORY DETAILS

Project Specialist	Deanna Edwards, B.Sc, C.Chem
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2000
Facsimile	705-652-6365
Email	deanna.edwards@sgs.com
SGS Reference	CA14723-OCT17
Received	10/25/2017
Approved	11/02/2017
Report Number	CA14723-OCT17 R1
Date Reported	11/02/2017

COMMENTS

Temperature of Sample upon Receipt: 6 degrees C
Cooling Agent Present: Yes
Custody Seal Present: No

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.

SIGNATORIES

Deanna Edwards, B.Sc, C.Chem

TABLE OF CONTENTS

RESULTS

Sample Number	5
Sample Name	BH-7, SS#6, 15'-17'
Sample Matrix	Soil
Sampled By	Mark Farrant
Sample Date	24/10/2017

Parameter	Units	RL	Result	
| Internal ref.: ME-CA-{ENV}EWL-LAK-AN-27				
Corrosivity Index	none	1	14	
Soil Redox Potential	mV	-	196	
Resistivity (calculated)	ohms.cm	-9999	910	
Anions by IC				
Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001				
Chloride	µg/g	0.4	1000	
Sulphate	µg/g	0.4	73	
Carbon/Sulphur				
Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020				
Sulphide	%	0.02	< 0.02	
Conductivity				
Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006				
Conductivity	uS/cm	2	1090	
Moisture				
Method: CCME Tier 1 | Internal ref.: ME-CA-[ENV]GC-LAK-AN-010				
Moisture Content	%	0.1	15.0	
pH				
Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001				
pH	no unit	0.05	8.60	

HOLDING TIME SUMMARY

Sample Name	QC Batch Reference	Sample Number	Sampled	Received	Extracted/ Prepared	Analysed	Holding Time	Approved
|								
BH-7, SS#6, 15'-17'	NA	5	10/24/2017	10/25/2017	10/31/2017	10/31/2017		10/31/2017
Anions by IC								
Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001								
BH-7, SS#6, 15'-17'	DIO0421-OCT17	5	10/24/2017	10/25/2017	10/27/2017	10/27/2017	11/21/2017	10/31/2017
Carbon/Sulphur								
Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020								
BH-7, SS#6, 15'-17'	ECS0041-OCT17	5	10/24/2017	10/25/2017	10/27/2017	10/27/2017	11/07/2017	10/30/2017
Conductivity								
Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006								
BH-7, SS#6, 15'-17'	EWL0401-OCT17	5	10/24/2017	10/25/2017	10/26/2017	10/26/2017	11/21/2017	10/30/2017
Moisture								
Method: CCME Tier 1 | Internal ref.: ME-CA-[ENV]GC-LAK-AN-010								
BH-7, SS#6, 15'-17'	GCM0415-OCT17	5	10/24/2017	10/25/2017	10/26/2017	10/26/2017	12/23/2017	10/31/2017
pH								
Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001								
BH-7, SS#6, 15'-17'	EWL0401-OCT17	5	10/24/2017	10/25/2017	10/26/2017	10/26/2017	10/31/2017	10/30/2017

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0421-OCT17	µg/g	0.4	<0.4	1	20	100	80	120	95	75	125
Sulphate	DIO0421-OCT17	µg/g	0.4	<0.4	5	20	96	80	120	94	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0041-OCT17	%	0.02	<0.02	ND	20	109	80	120			

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0401-OCT17	uS/cm	2	< 2	0	10	99	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0401-OCT17	no unit	0.05	NA	1		100			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

-- End of Analytical Report --

Certificate of Analysis

SGS Canada Inc.
185 Concession St. Box 4300
Lakefield, Ont.,Canada,K0L 2H0

Attention: Mark Farrant
Project#: 15595

Client Thurber Engineering Ltd
SGS LIMS Number CA13437-JUL17
Analysis Package: Corrosivity

Sample ID Sample Date/Time	Unit	Analysis Start Date	Analysis Approval Date	Alder Creek East
Temperature Upon Receipt	°C			21.0
Corrosivity Index	NA	01-Jun-17	01-Jun-17	
Redox Potential	mV	29-May-17	30-May-17	291
Sulphide	mg/L	01-Jun-17	01-Jun-17	<0.006
% Moisture (wet wt)	NA	30-May-17	01-Jun-17	
pH	units	30-May-17	31-May-17	7.90
Chloride	mg/L	31-May-17	01-Jun-17	23
Sulphate	mg/L	31-May-17	01-Jun-17	1.5
Conductivity	µS/cm	30-May-17	31-May-17	170
Resistivity (calculated)	ohms.cm	30-May-17	01-Jun-17	5880

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

Deanna Edwards

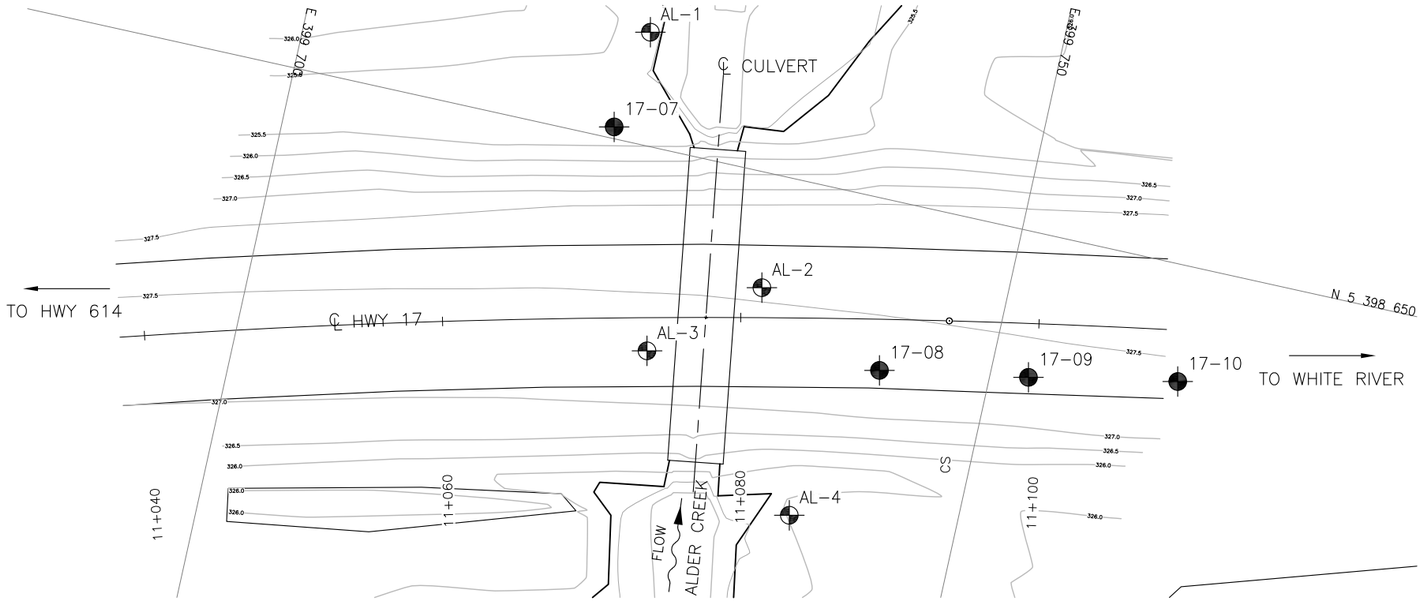
Deanna Edwards B.Sc., C.Chem
Project Specialist
Environment, Health and Safety

THURBER

Appendix C

Borehole Locations and Soil Strata Drawing

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

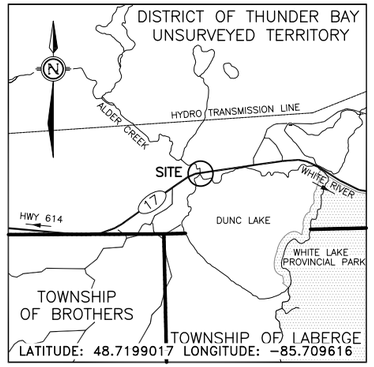
CONT No
WP No 6330-14-01

HIGHWAY 17
ALDER CREEK EAST
CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

HATCH

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

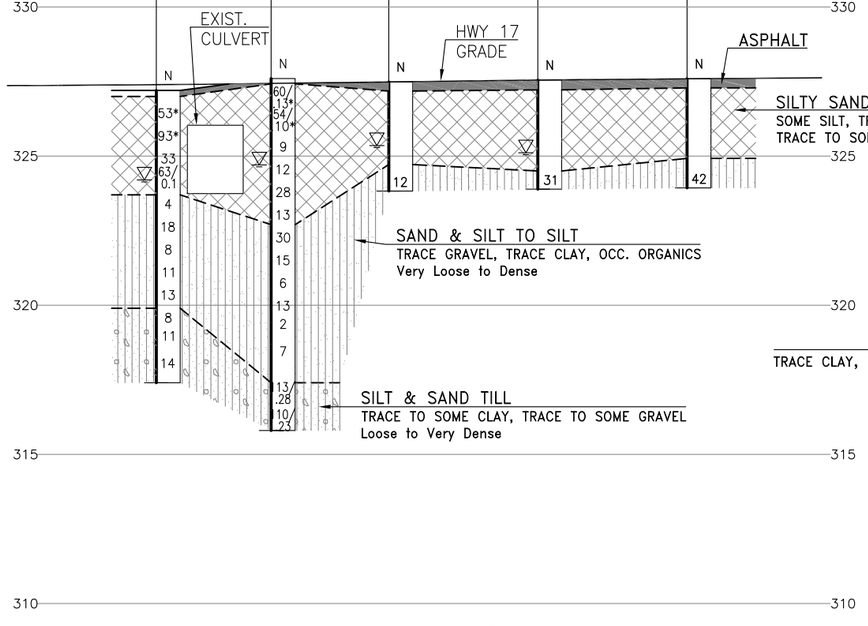
⊕	Borehole
⊕	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17-07	325.3	5 398 650.8	399 721.8
17-08	327.5	5 398 638.7	399 742.7
17-09	327.6	5 398 640.4	399 752.6
17-10	327.6	5 398 642.3	399 762.4
AL-1	325.1*	5 398 657.5	399 722.8
AL-2	327.6	5 398 642.4	399 733.8
AL-3	327.2	5 398 636.6	399 727.2
AL-4	325.5*	5 398 627.9	399 738.9

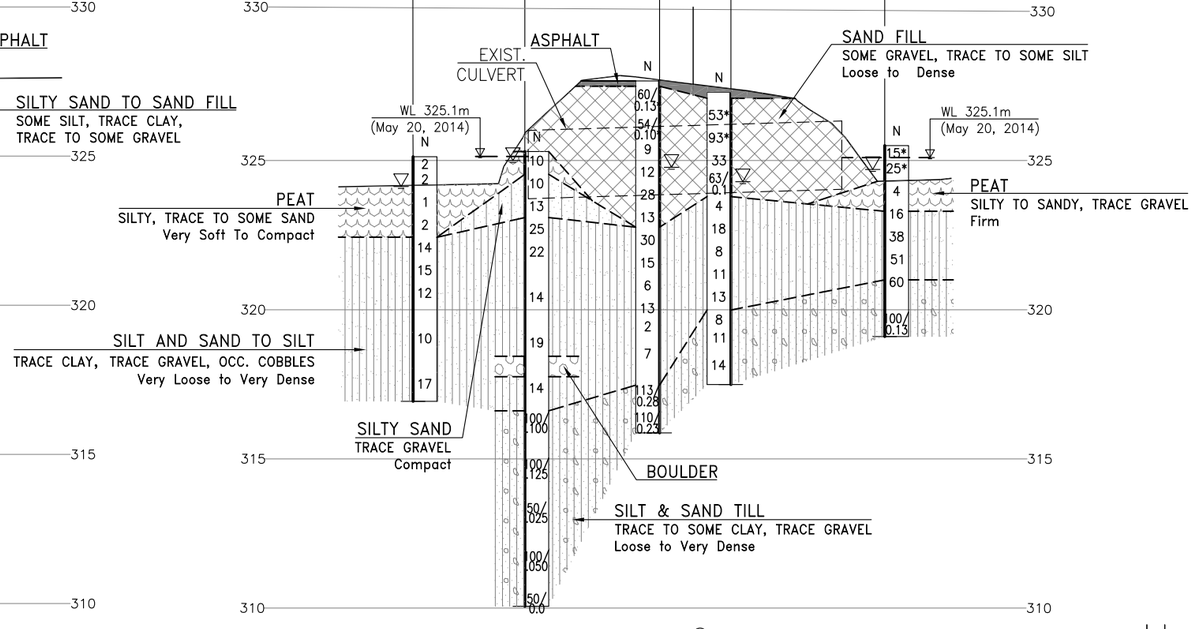
-NOTES-

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) Coordinate system is MTM NAD 83 Zone 14.
4) * Re-intepreted from original borehole logs.

GEOCRES No. 42C-43



PROFILE ALONG ℄ HWY 17



SECTION ALONG ℄ CULVERT

8 0 8 16m H 1:400

4 0 4 8m V 1:200

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	NLB	CHK	MEF	CODE	LOAD
DRAWN	AN	CHK	NLB	SITE	STRUCT

DATE SEP 2018
DWG 1

FILENAME: H:\Drafting\15000\15595\TED-15595-AC.dwg
PLOTDATE: 9/11/2018 11:54 AM

THURBER

Appendix D

Site Photographs

THURBER

Photo 1: Culvert outlet looking south (May 17, 2017)

Photo 2: Culvert inlet looking north (May 17, 2017)

Photo 3: Road approach looking west (May 17, 2017)

Photo 4: Road approach looking east (May 17, 2017)

Photo 5: Looking west on north side of road (outlet) (June 26, 2017)

Photo 6: Looking east on north side of road (outlet) (June 26, 2017)

Photo 7: Looking east on south side of road (inlet) (June 26, 2017)

Photo 8: Looking west on south side of road (inlet) (June 26, 2017)

Appendix E

Factual Data from 2015 Golder Foundation Investigation Report

Golder Associates

RECORD OF BOREHOLE No AL-1

1 OF 1 **METRIC**

PROJECT 1411523 | G.W.P. 6330-14-00 | LOCATION N 5398657.5; E 399722.8 | ORIGINATED BY MR

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers | COMPILED BY MT

DATUM GEODETIC | DATE April 7, 2015 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.9	GROUND SURFACE										
0.0	Silty PEAT, trace to some sand Very soft Black Wet		1	SS	2						
			2	SS	2	▽	325				
			3	SS	1		324				
323.2			A 4 B	SS	2				○		
2.7	SILT to Sandy SILT Compact Grey Wet		5	SS	14		323		○		0 26 74 0
			6	SS	15		322				
			7	SS	12		321				
			8	SS	10		320		○		0 5 95 0
	Some gravel encountered below 7.6 m depth.		9	SS	17		319				
317.7							318				
8.2	END OF BOREHOLE Note: 1. Water level at a depth of 1.0 m below ground surface (Elev. 324.9 m) upon completion of drilling.										

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

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 26/10/15 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No AL-2

1 OF 1 **METRIC**

PROJECT 1411523 | G.W.P. 6330-14-00 | LOCATION N 5398642.4; E 399733.8 | ORIGINATED BY RI

DIST | HWY 17 | BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers | COMPILED BY MT

DATUM GEODETIC | DATE March 17, 2015 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.6	GROUND SURFACE										
0.0	ASPHALT (180 mm)										
0.2	Sand, some gravel, trace to some silt (FILL) Loose to compact Brown to grey Frozen* to wet		1	SS	60/ 0.13*		327		○		14 74 (12)
			2	SS	54/ 0.10*		326				
			3	SS	9	▽	325				
			4	SS	12		324				
	Augers grinding on inferred cobbles below 3.8 m depth.		5	SS	28				○		
322.7			6A 6B	SS	13		323		○		0 55 44 1
4.9	Sandy SILT to SILT and SAND, trace gravel, trace clay Very loose to compact Grey Wet Trace organics in Sample 6B.		7	SS	30		322				
			8	SS	15		321				
			9	SS	6				○		2 28 68 2
			10	SS	13		320				
			11	SS	2		319				
			12	SS	7		318				
317.4											
10.2	SILT and SAND, some gravel, some clay (TILL) Very dense Grey Wet		13	SS	113/ 0.28		317				
315.8			14	SS	110/ 0.23		316		○		12 31 41 16
11.8	END OF BOREHOLE Note: 1. Water level at a depth of 2.9 m below ground surface (Elev. 324.7 m) upon completion of drilling.										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 26/10/15 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No AL-3

1 OF 1 **METRIC**

PROJECT 1411523 | G.W.P. 6330-14-00 | LOCATION N 5398636.6; E 399727.2 | ORIGINATED BY RI

DIST | HWY 17 | BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers | COMPILED BY MT

DATUM GEODETIC | DATE March 17, 2015 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.2	GROUND SURFACE						327				
0.0	ASPHALT (190 mm)										
0.2	Sand, some gravel, some silt (FILL) Dense Brown Frozen* to wet		1	SS	53*						
	Augers grinding on inferred cobbles below 1.5 m depth.		2	SS	93*		326		○		12 74 (14)
			3	SS	33		325				
323.7			4	SS	63/0.1	▽	324				
3.5	SILT to SILT and SAND, trace gravel, trace clay Loose to compact Grey Wet		5	SS	4		323				
			6	SS	18		322				
			7	SS	8				○		0 8 90 2
			8	SS	11		321				
319.9			A 9 B	SS	13		320				
7.3	SILT and SAND, trace to some gravel, trace clay (TILL) Loose to compact Grey Wet		10	SS	8						
			11	SS	11		319		○		7 36 55 2
317.4			12	SS	14		318				
9.8	END OF BOREHOLE Note: 1. Water level at a depth of 3.0 m below ground surface (Elev. 324.2 m) upon completion of drilling.										

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

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 26/10/15 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No AL-4

1 OF 1 **METRIC**

PROJECT 1411523 | G.W.P. 6330-14-00 | LOCATION N 5398627.9; E 399738.9 | ORIGINATED BY MR

DIST | HWY 17 | BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers | COMPILED BY MT

DATUM GEODETIC | DATE April 7, 2015 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.7	GROUND SURFACE										
0.0	Silty to Sandy PEAT, trace gravel, trace wood Firm Black to dark brown Frozen* to wet		1	SS	15*	▽	325	○	○		
			2	SS	25*						
			3	SS	5		324				
323.5											
2.2	SILT and SAND Compact to very dense Grey Wet Trace to some gravel below 3.0 m depth. Augers grinding on inferred cobbles below 3.8 m depth.		4	SS	16		323		○		0 56 44 0
			5	SS	38						
			6	SS	51		322				
321.2											
4.5	Gravelly SILTY SAND, trace clay (TILL) Very dense Grey Wet One large piece of gravel on 19 mm sieve in Sample 7.		7	SS	60		321		○		50 36 13 1
							320				
319.3			8	SS	100/0.13						
6.4	END OF BOREHOLE Note: 1. Water level at a depth of 0.8 m below ground surface (Elev. 324.9 m) upon completion of drilling.										

$+^{3}, \times^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 26/10/15 DATA INPUT:

MINISTRY OF TRANSPORTATION, ONTARIO

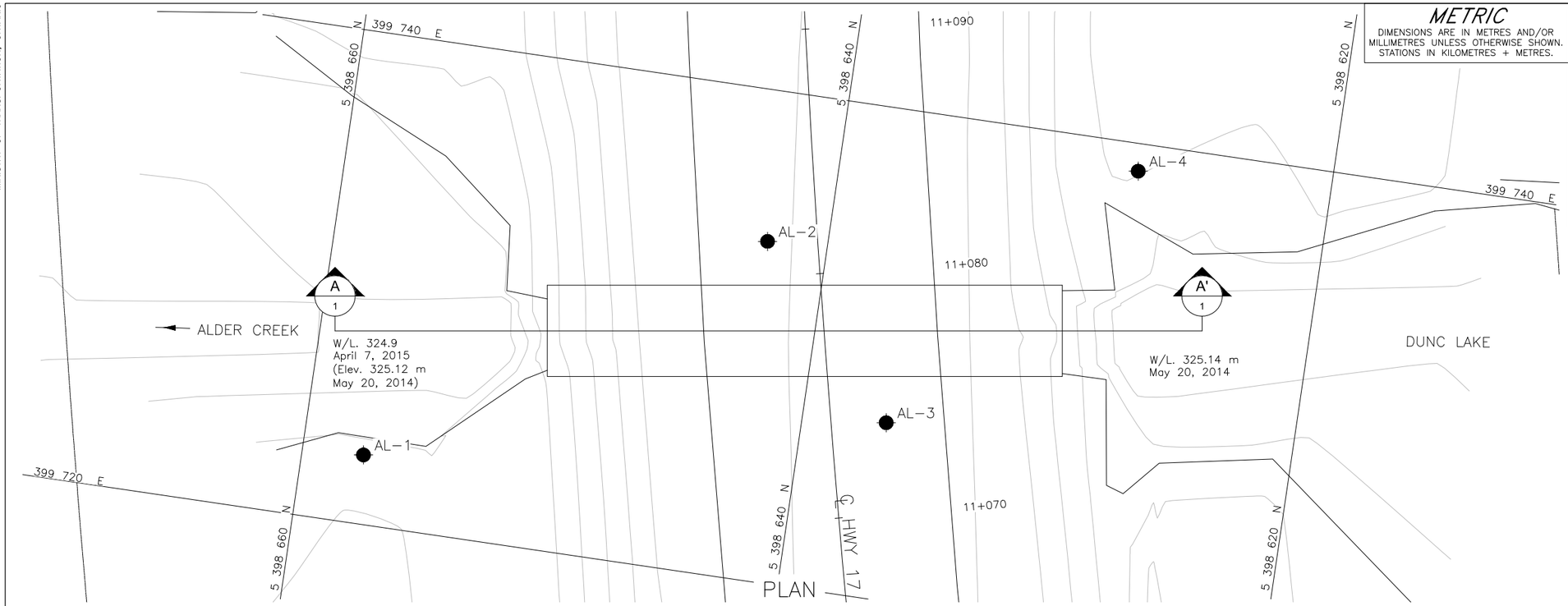
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 6330-14-00

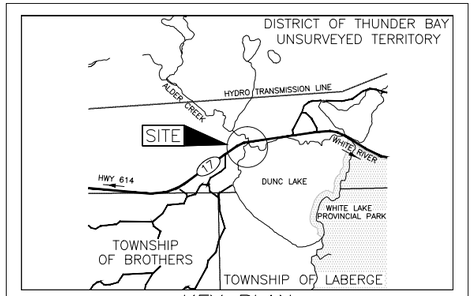
SHEET

HIGHWAY 17
ALDER CREEK CULVERT STA 11+078
BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates



PLAN
SCALE
2 0 2 4 m



KEY PLAN
1 0 1 2 km
1:50,000 m

LEGEND

- Borehole
- 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
AL-1	325.9	5398657.5	399722.8
AL-2	327.6	5398642.4	399733.8
AL-3	327.2	5398636.6	399727.2
AL-4	325.7	5398627.9	399738.9

NOTES

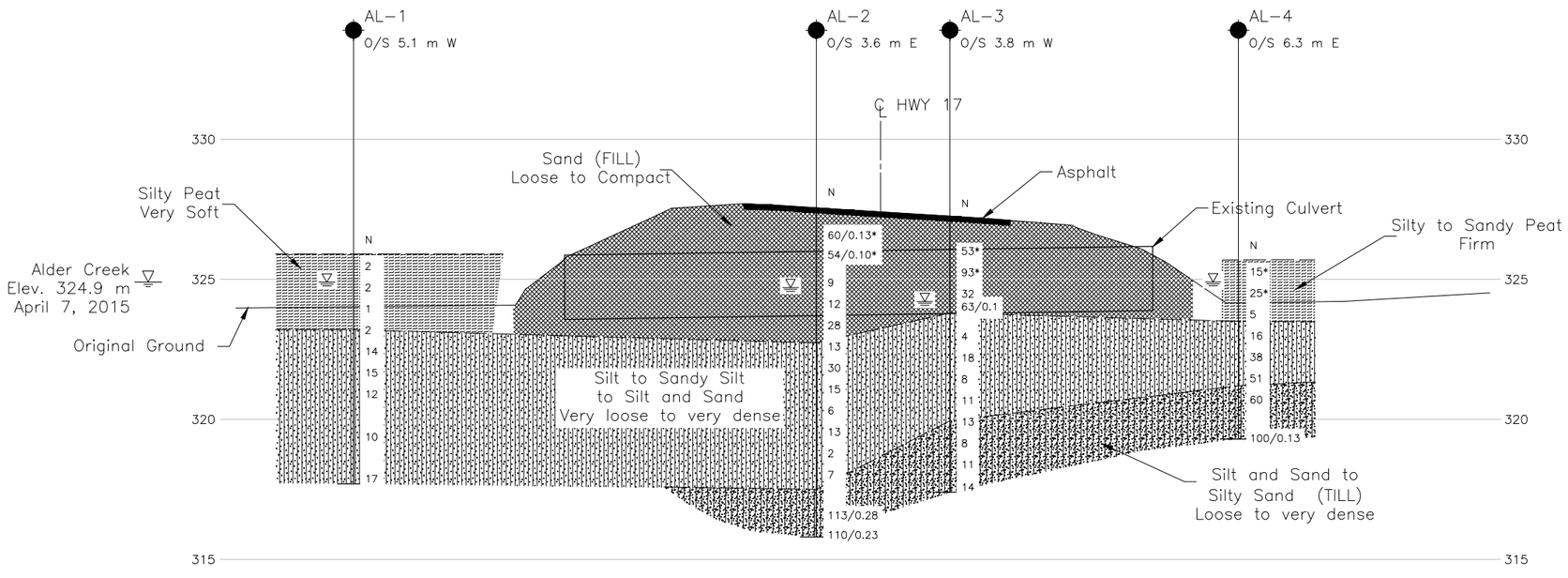
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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. E484854171, received FEB 20, 2015.



A-A'
1
PROFILE
HORIZONTAL SCALE
2 0 2 4 m
2 0 2 4 m
VERTICAL SCALE

LICENSED PROFESSIONAL ENGINEER
S.E.M. POOT
90471921
OCT 28, 2015
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J.M.A.COSTA
OCT 28, 2015
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 42C-37

HWY. 17		PROJECT NO. 1411523	DIST. .
SUBM'D. AC	CHKD. .	DATE: 10/22/2015	SITE: 48E-75/C
DRAWN: JJL/TB	CHKD. SEMP	APPD. JMAC	DWG. 1

PLOT DATE: October 22, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD Projects\2014\1411523 HWY 26 Culverts Thunder Bay\CIVIL 3D\1411523_Alder Creek.dwg