



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
CHICKEN FARM LAKE CULVERT REPLACEMENT
TOWNSHIP OF LESLIE, THUNDER BAY DISTRICT, ONTARIO
SITE No. 48E-127/C
HIGHWAY 614**

G.W.P. No. 6332-14-00, W.P. No. 6332-14-01

GEOCRES Number: 42F-39

Report

to

HATCH

Date: December 20, 2016
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 Chicken Farm Lake Culvert on Highway 614, located in the Township of Leslie, Thunder Bay District, Ontario.

The purpose of this investigation was to explore the subsurface conditions in the culvert area to supplement the existing information obtained during the preliminary design of the project 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 to carry out this foundation investigation under the Ministry of Transportation Ontario (MTO) Agreement Number 6015-E-0018-004.

A preliminary foundation investigation carried out at this site was documented in the report titled "Preliminary Foundation Investigation and Design Report, Chicken Farm Lake Culvert - Site No. 48E-127/C, Highway 614, District of Thunder Bay, Township of Leslie, Ministry of Transportation, Ontario, G.W.P. 6332-14-00", Geocres No. 42F-33, prepared by Golder Associates (Golder), 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.

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2. SITE DESCRIPTION

The Chicken Farm Lake Culvert site is located on Highway 614, in the Township of Leslie approximately 2.1 km south of the end of Highway 614, and approximately 50 km north of the junction of Highway 17 and Highway 614, in the Thunder Bay District, Ontario. The key plan showing the general location of the culvert site is presented on the Borehole Location and Soil Strata drawing in Appendix D.

Highway 614 runs in the general north-south direction with the culvert perpendicular to the centreline of the highway. Chicken Farm Lake is situated on the east side of the highway and drains to the stream flowing to the west through the culvert.

The terrain in the culvert area is gently undulating and forested outside of the right-of-way. The right-of-way is well vegetated with tall grass and occasional shrubs. The existing culvert is a twin cell (1.3 m span each) timber box approximately 18 m in length constructed prior to 1965. The Structural Design Report (SDR) prepared in December 2015 by Hatch refers to the evidence of deterioration of the culvert including decayed and splitting timber, as well as fair to poor culvert conditions at the inlet and outlet. The existing culvert invert was indicated at approximate Elev. 329.7 at the inlet and Elev. 329.6 at the outlet. The stream water level was reported to be at Elev. 330.2 on November 8, 2014.

At the culvert location, the highway embankment grade is at approximately Elev. 331.7. The depth of cover over the existing culvert is approximately 0.8 m.

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

Based on published geological information, the culvert lies within an area of glaciolacustrine plain deposits comprising of sands and silts and interlayered with areas of organic/peat deposits and bedrock knobs. The bedrock at the site consists of granitic gneiss.

3. INVESTIGATION PROCEDURES

The field investigation and testing program for this project was specified in the Terms of Reference. The field work was carried out between July 26 and 27, 2016, and consisted of drilling and sampling of four (4) boreholes, designated as Boreholes 16-11 to 16-14. Borehole 16-11 was located near a proposed stream diversion pipe, approximately 10 m to the north from the existing culvert centreline, and Boreholes 16-12 to 16-14 were located on the south side of the culvert and distributed at 10 m intervals to determine the existence and extent of any frost taper near the



culvert. All boreholes were advanced from the top of the highway embankment.

Utility clearances were obtained prior to the start of drilling. The coordinates and ground surface elevations for the boreholes were derived from topographic plans provided to Thurber by Hatch. The coordinate system MTM NAD 83, Zone 14 was used for the boreholes. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing included in Appendix D.

A track-mounted CME 55 drill rig was used to advance Borehole 16-11 using hollow stem augers, and solid stem augers were used to advance Boreholes 16-12 to 16-14.

Borehole 16-11 was advanced to a depth of 14.3 m, and Boreholes 16-12 to 16-14 were terminated at depths ranging from 1.2 m to 1.7 m following refusal on probable bedrock. In the boreholes, soil samples were obtained at selected intervals with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT) procedures as per ASTM D1586. 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 boreholes were backfilled on completion of drilling in general accordance with Ontario Regulation 903, as amended. Completion details of the boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
16-11	14.3 / 317.4	Bentonite holeplug and cuttings to 14.2 m then asphalt cold patch to ground surface.
16-12	1.7 / 330.0	Cuttings to 1.6 m then asphalt cold patch to ground surface.
16-13	1.7 / 330.0	Cuttings to 1.6 m then asphalt cold patch to ground surface.
16-14	1.2 / 330.5	Cuttings to 1.6 m then asphalt cold patch to ground surface.



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). The results of the 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 fill near the invert level, 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 Appendix A. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the "Borehole Locations and Soil Strata" drawing included in Appendix D. 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 must be recognized and expected that soil conditions may vary between and beyond the borehole locations.

The description of the subsurface conditions in the immediate vicinity of the existing culvert were documented in the Preliminary Foundation Investigation and Design Report prepared by Golder Associates, Geocres No 42F-33, and reference should be made to that report to obtain details of the subsurface conditions. The Record of Borehole sheets numbered CK-1 to CK-4 and Borehole Locations and Soil Strata drawing excerpted from that report are enclosed in Appendix E, for quick reference.

The descriptions provided below refer to boreholes drilled during current investigation as well as the previous/preliminary investigation, as appropriate.

In general, the subsurface conditions encountered in the boreholes from the current and previous



investigations consisted of embankment fill overlying native cohesionless deposit comprising various proportions of silt, sand and gravel. Peat and organic silt were encountered beneath embankment fill and outside of the embankment. Granitic gneiss bedrock was encountered at various depths underlying the overburden in three of the Golder boreholes. The bedrock surface appears to slope down to the northwest in the general area of the culvert.

Descriptions of the individual strata are presented below.

5.1 Asphalt

Boreholes 16-11 to 16-14 were drilled through the existing asphalt pavement on Highway 614. The asphalt thickness of 100 mm was measured in the current boreholes; however, the asphalt thickness of 65 mm and 75 mm was encountered in two boreholes drilled during preliminary investigation. The thickness of asphalt may vary along the highway.

5.2 Sand and Gravel (Embankment Fill)

Underlying the asphalt in all current boreholes was a layer of granular fill. The classification of fill ranged from sand and gravel to silty sand. The fill was 3.7 m thick in Borehole 16-11 located to the north of the culvert with the base of the fill at 3.8 m depth (Elev. 327.9). The relative density of the fill was loose to dense with the SPT-N values recorded between 7 and 30 blows per 0.3 m of penetration.

In Boreholes 16-12 to 16-14 located to the south of the culvert, for investigation of existing frost taper, the granular fill under the pavement ranged in thickness from 1.1 m to 1.6 m. These boreholes were terminated upon meeting refusal on probable bedrock at Elev. 330.0 to Elev. 330.5. In Borehole 16-12, a 200 mm layer of gravel and rock fragments was encountered beneath the granular fill.

The measured moisture content of the fill generally ranged from 2% to 10%. The results of grain size analyses conducted on samples of the fill are presented on the Record of Borehole sheets included in Appendix A, and on Figures B1 and B2 in Appendix B.

The results are summarized in the following table:



Soil Particle	Percentage (%)	
	Sand and Gravel	Sand/Silty Sand
Gravel	45 to 51	16 to 17
Sand	41 to 47	60 to 64
Silt and Clay	8	20 to 23

The fill encountered in the previously drilled boreholes located in the area of the existing culvert was classified as gravelly silty sand to gravelly sand and ranged generally in thickness from 0.4 m to 3.6 m. Cobbles were encountered in the fill during drilling. The base of fill from the top of the embankment in Boreholes CK-2 and CK-3 was measured at 3.7 m depth or Elev. 328.0. Boreholes CK-1 and CK-4 drilled on the east and west sides of the embankment encountered fill extending to 0.8 m and 1.4 m depth or to Elev. 329.8 and Elev. 329.0, respectively, overlying fibrous to amorphous peat. The fill was noted to be very loose to compact.

5.3 Peat and Organic Silt

A layer of fibrous to amorphous peat with trace sand and trace wood was encountered beneath the fill materials in the previously drilled boreholes located outside of the embankment. The peat thickness ranged from 1.6 m to 1.8 m in Boreholes CK-1 and CK-4, and extended to depths of 2.6 m (Elev. 328.0) and 3.0 m (Elev. 327.4), respectively. Moisture contents of 333% to 531% were measured in the peat.

A 400 mm layer of organic silt was encountered in Borehole CK-2 beneath the granular fill with the base at a depth of 4.1 m (Elev. 327.6).

5.4 Silty Sand to Sand

A deposit of grey silty sand was encountered underlying the fill in Borehole 16-11. The silty sand contained some gravel, and trace of organic matter (wood fragments). The silty sand graded to sand at 6.1 m depth. The base of the deposit was encountered at a depth of 6.4 m or at Elev. 325.3. The deposit was compact, as indicated by SPT 'N' values of 11 and 12 blows per 0.3 m of penetration. A moisture content of 18% and 22% were measured on samples of the sand and silty sand.

The results of grain size analysis conducted on a sample of sand are presented on the Record of Borehole sheet included in Appendix A and on Figure B3 in Appendix B.

The results are summarized in the following table:



Soil Particle	Percentage (%)
Gravel	2
Sand	93
Silt and Clay	5

The cohesionless deposit classified as sand and silt to sandy silt was identified in the previously drilled boreholes. The deposit was grey in colour, very loose to compact and varied in thickness from 0.4 m to 6.6 m. The base of the deposit was encountered between Elev. 327.2 and Elev. 320.8.

5.5 Sand and Silt to Sand Till

A deposit of till was encountered below the sand layer in Borehole 16-11. The upper 4.3 m of the deposit extending to 10.7 m depth (Elev. 321.0) was classified as sand and silt with trace gravel and some clay, and below that depth, the deposit became coarser and graded to becoming predominantly a sand till. The borehole was terminated in the sand till at a depth of 14.3 m (Elev. 317.4).

SPT 'N' values within the sand and silt till of 2 and 8 blows per 0.3 m penetration were recorded, indicating a very loose to loose relative density. The sand till was typically very dense with the SPT-N values generally above 85 blows per 0.3 m of penetration. The measured moisture content of the sand and silt till ranged from 18% to 22%, and moisture content in the sand till ranged from 2% to 12%.

The results of grain size distribution analyses conducted on a sample of the sand and silt till and sand till are presented on the Record of Borehole sheet included in Appendix A and on Figures B4 and B5 in Appendix B. The results are summarized in the following table:

Soil Particle	Percentage (%)	
	Sand and Silt Till	Sand Till
Gravel	0	1
Sand	43	89
Silt	44	-
Clay	13	-
Silt and Clay		10



The till deposit classified as sand and silt to gravelly sandy silt was encountered in the three boreholes drilled during the preliminary investigation. The deposit varied in thickness between 0.7 m and 2.9 m, extending to bedrock surface at Elev. 327.3 and Elev. 324.3 in Boreholes CK-1 and CK-2. Borehole CK-4 was terminated in the till deposit at 11.3 m depth (Elev. 319.1).

Cobbles and boulders should be expected in the till deposits.

5.6 Bedrock

Boreholes 16-12 to 16-14 encountered refusal to further auger penetration on probable bedrock.

Boreholes CK-1 to CK-3 drilled for preliminary investigation encountered bedrock, which was cored for 1.7 m to 2.9 m length. The bedrock was described as a black to white to pink, fine to coarse grained, granitic gneiss. The depth to bedrock surface and bedrock elevation are summarized in the table below; for more details including bedrock properties, reference should be made to Geocres Report 42F-33.

Table 5.1 Bedrock Surface Depths and Elevations at Borehole Locations

Borehole Number	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)
16-12 ^{*)}	1.7	330.0
16-13 ^{*)}	1.7	330.0
16-14 ^{*)}	1.2	330.5
CK-1	3.3	327.3
CK-2	7.4	324.3
CK-3	5.2	326.5

Note: ^{*)} Probable bedrock as inferred from refusal to further auger penetration.

Based on the borehole information, the bedrock surface seems to slope down towards northwest in the general area of the culvert.

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 level in the open Borehole 16-11 was measured at 1.2 m depth below the ground surface or at Elev. 330.5. Boreholes 16-12 to 16-14 were dry upon completion of drilling.



The groundwater level should be assumed to reflect the stream water level, and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant or prolonged precipitation.

The measurements of water level in the stream documented in various sources are summarized in Table 5.2, below.

Table 5.2 Water Level in the Stream

Date	Water Level Elevation (m)	Comments/Reference
March 18, 2015	330.4	Geocres No. 42F-33 Report
November 8, 2014	330.21	Preliminary General Arrangement drawing
	330.73	High water level - Preliminary General Arrangement drawing

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the existing fill near the invert level from Borehole 16-11, and a sample of the surface water from the creek 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	
			16-11, SS#3, 7'6"-9'6"	Chicken Farm Creek
			(Sand and Gravel Fill)	(Creek Water)
Sulphide	%	mg/L	<0.02	<0.006
Chloride	µg/g	mg/L	110	51
Sulphate	µg/g	mg/L	29	0.22
pH	No unit	No unit	7.84 to 8.91	7.47
Electrical Conductivity	µS/cm	µS/cm	358	371
Resistivity	Ohms.cm	Ohms.cm	2790	270
Redox Potential	mV	mV	217	280



7. MISCELLANEOUS

Thurber obtained the borehole northing and easting coordinates and ground surface elevations from measurements taken in the field and 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. George Azzopardi 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 Ms. Anna Piascik, P.Eng 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.

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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.

EXPLANATION OF ROCK LOGGING TERMS


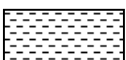

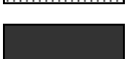

ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

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

TERMS

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

UNIFIED SOILS CLASSIFICATION

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

RECORD OF BOREHOLE No 16-11

1 OF 2

METRIC

W.P. 6332-14-01 LOCATION Chicken Farm Lake Culvert N 5 441 407.3 E 388 856.3 ORIGINATED BY OA
 HWY 614 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.07.26 - 2016.07.27 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE											
331.7	GROUND SURFACE							20	40	60	80	100								
0.0	ASPHALT: (100mm)							20	40	60	80	100								
0.1	SAND and GRAVEL, trace silt Compact Grey to Brown Moist (FILL)		1	GS										○						
			1	SS	23									○						
			2	SS	30									○						
			3	SS	17									○						
			4	SS	7									○						
327.9	Silty SAND, some gravel, trace organics (wood fragments) Compact Grey Wet																			
3.8			5	SS	11									○						
325.6																				
6.1	SAND, trace gravel, trace silt Compact Grey Wet		6	SS	12									○						
325.3														○						
6.4	SAND and SILT, trace gravel, some clay Very Loose to Loose Grey Moist to Wet (TILL)																			
			7	SS	2									○						
														○						
			8	SS	8									○						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-11

2 OF 2

METRIC

W.P. 6332-14-01 LOCATION Chicken Farm Lake Culvert N 5 441 407.3 E 388 856.3 ORIGINATED BY OA
 HWY 614 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.07.26 - 2016.07.27 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 (%)				
								20 40 60 80 100				w _p w w _L				
Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
321.0																
10.7	SAND, trace to some gravel, some silt Very Dense Grey Moist (TILL)		9	SS	85/ 0.225		321								1 89 10 (SI+CL)	
							320									
				10	SS	85		319								
								318								
				11	SS	50/ 0.125										
317.4																
14.3	END OF BOREHOLE AT 14.3m. WATER LEVEL AT 1.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS, ASPHALT COLD PATCH AT SURFACE.															

ONTMT4S 13662-MTO.GPJ 2015TEMPLATE(MTO).GDT 8/23/16

RECORD OF BOREHOLE No 16-12

1 OF 1

METRIC

W.P. 6332-14-01 LOCATION Chicken Farm Lake Culvert N 5 441 386.0 E 388 850.8 ORIGINATED BY OA
 HWY 614 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.07.26 - 2016.07.26 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											
331.7	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (100mm)																		
0.1	SAND, some gravel, some silt Compact Grey Moist (FILL)		1	GS			331												16 64 20 (SI+CL)
330.2			2	GS															
330.6	Rock fragments, some gravel (PROBABLY BEDROCK) Grey Wet		1	SS	50/														
1.7	END OF BOREHOLE AT 1.7m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH CUTTINGS, ASPHALT COLD PATCH AT SURFACE.				0.125														

RECORD OF BOREHOLE No 16-13

1 OF 1

METRIC

W.P. 6332-14-01 LOCATION Chicken Farm Lake Culvert N 5 441 376.3 E 388 848.3 ORIGINATED BY OA
 HWY 614 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.07.26 - 2016.07.26 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									
331.7	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT: (100mm)																
0.1	SAND and GRAVEL, trace silt Compact to Very Dense Grey Moist (FILL)		1	GS			331										
			2	GS													
330.0			1	SS	50/												51 41 8 (SI+CL)
1.7	END OF BOREHOLE AT 1.7m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH CUTTINGS, ASPHALT COLD PATCH TO SURFACE.				0.150												

RECORD OF BOREHOLE No 16-14

1 OF 1

METRIC

W.P. 6332-14-01 LOCATION Chicken Farm Lake Culvert N 5 441 366.6 E 388 845.8 ORIGINATED BY OA
 HWY 614 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.07.26 - 2016.07.26 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														
331.7	GROUND SURFACE							<div>20406080100</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>							<div>PLASTIC LIMIT</div> <div>NATURAL MOISTURE CONTENT</div> <div>LIQUID LIMIT</div> <div>W_P W W_L</div> <div>WATER CONTENT (%)</div>							
0.0	ASPHALT: (100mm)																					
0.1	SAND to Silty SAND, some gravel Grey Moist (FILL)		1	GS			331								o176023 (SI+CL)							
330.5																						
1.2	END OF BOREHOLE AT 1.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH CUTTINGS, ASPHALT COLD PATCH AT SURFACE.																					

ONTMT4S 13662-MTO.GPJ 2015TEMPLATE(MTO).GDT 8/23/16

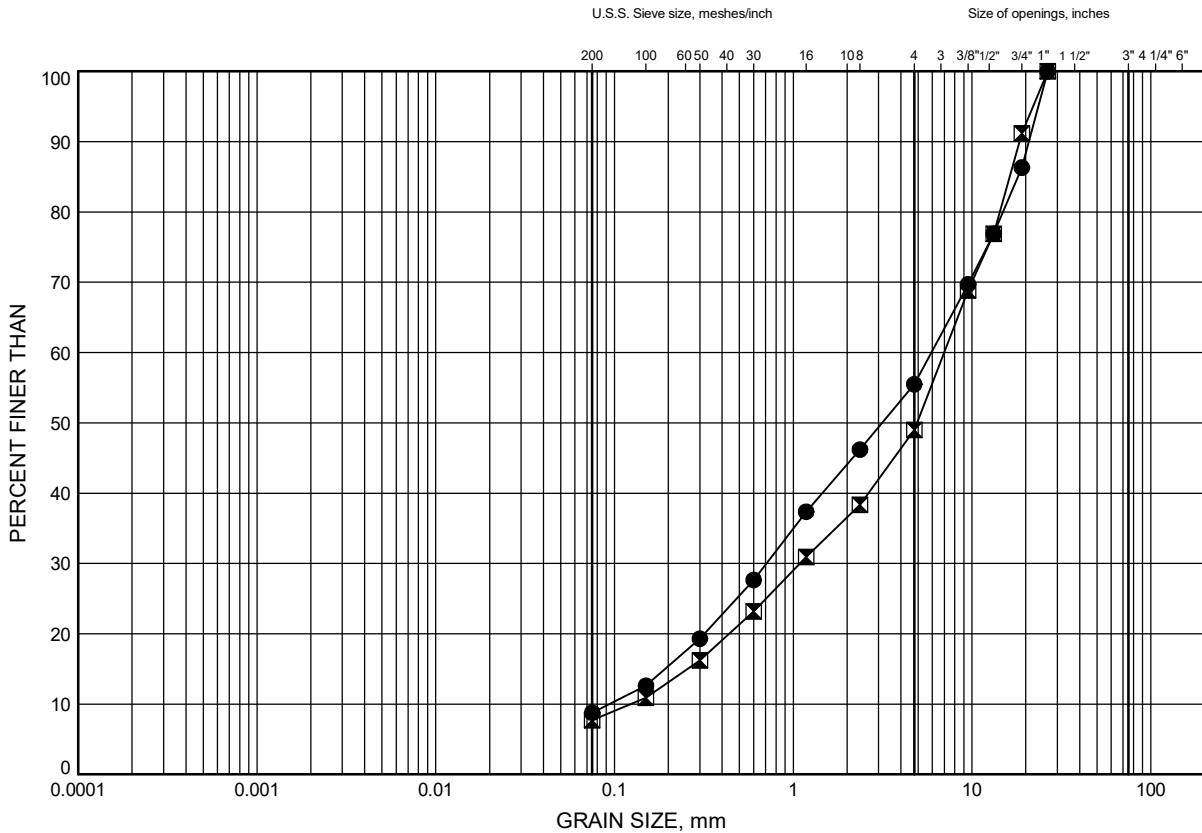
Appendix B

Geotechnical and Analytical Laboratory Test Results

MTO NW Region Retainer
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)
●	16-11	1.83	329.87
⊠	16-13	1.37	330.33

Date August 2016
W.P. 6332-14-01

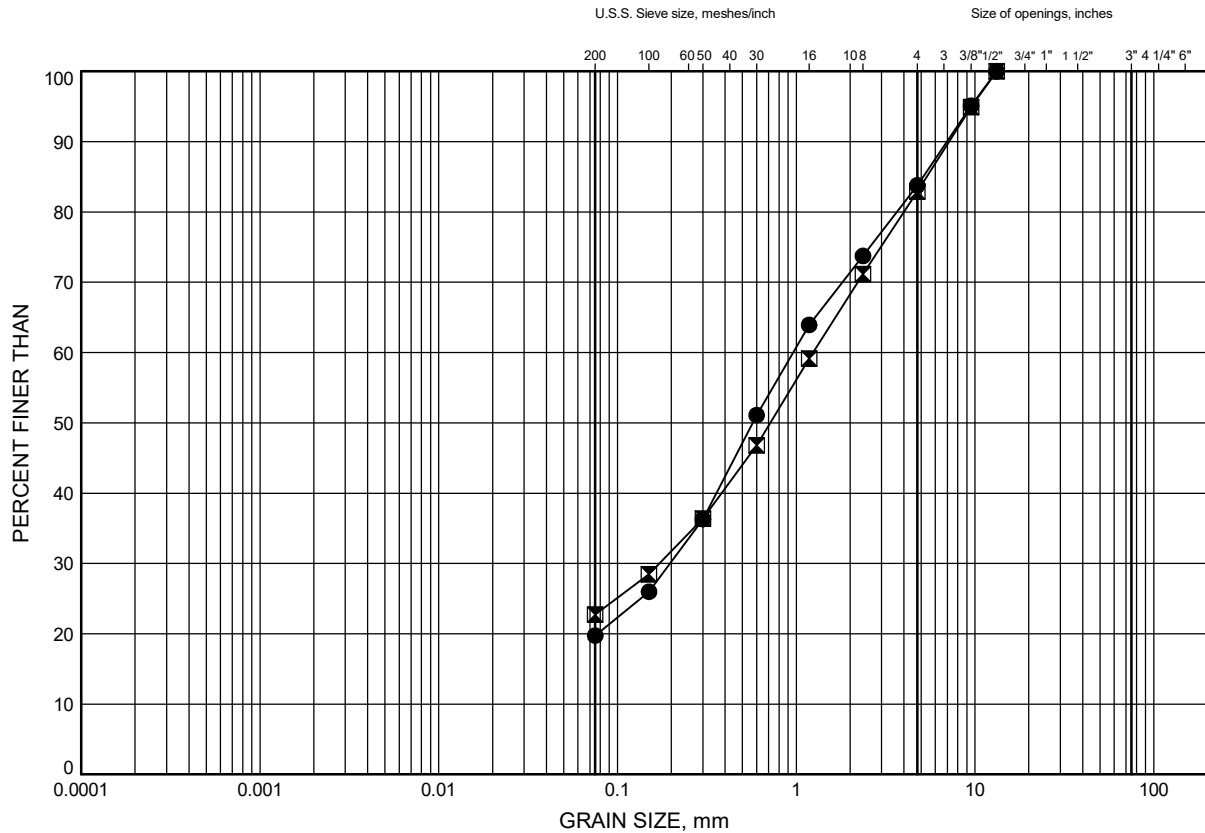


Prep'd MFA
Chkd. AMP

MTOW NW Region Retainer GRAIN SIZE DISTRIBUTION

FIGURE B2

Sand to Silty Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-12	0.61	331.09
⊠	16-14	0.53	331.17

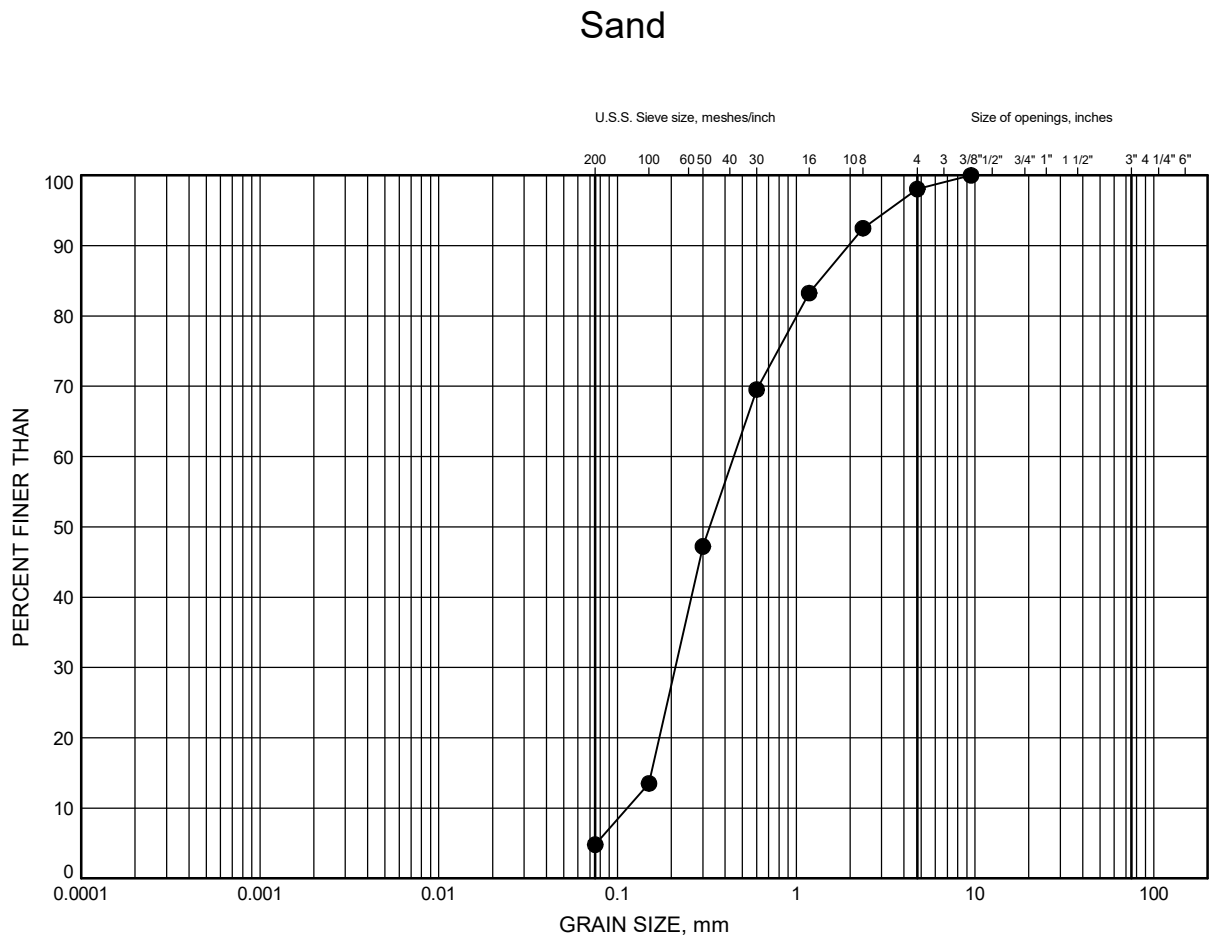
Date August 2016
W.P. 6332-14-01



Prep'd MFA
Chkd. AMP

MTO NW Region Retainer GRAIN SIZE DISTRIBUTION

FIGURE B3



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-11	6.25	325.45

Date August 2016
W.P. 6332-14-01

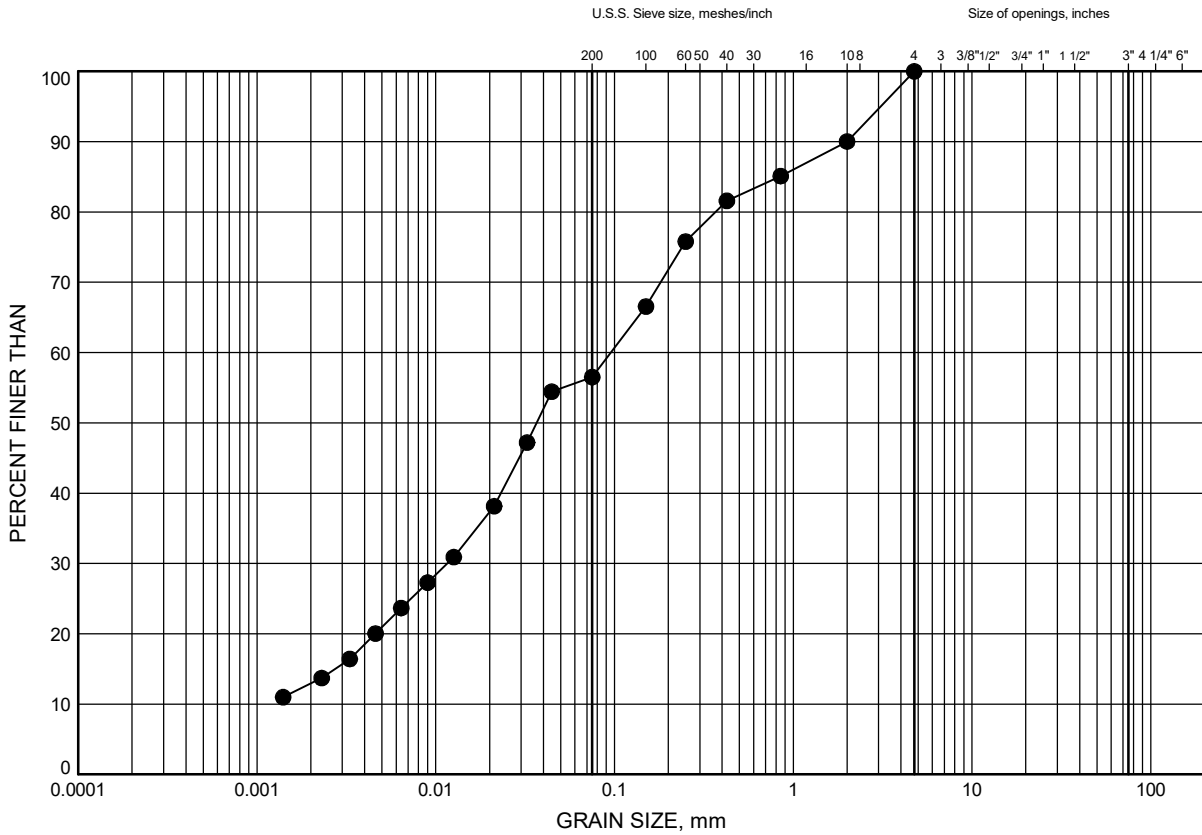


Prep'd MFA
Chkd. AMP

MTO NW Region Retainer GRAIN SIZE DISTRIBUTION

FIGURE B4

Sand and Silt Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-11	8.08	323.62

Date August 2016
W.P. 6332-14-01



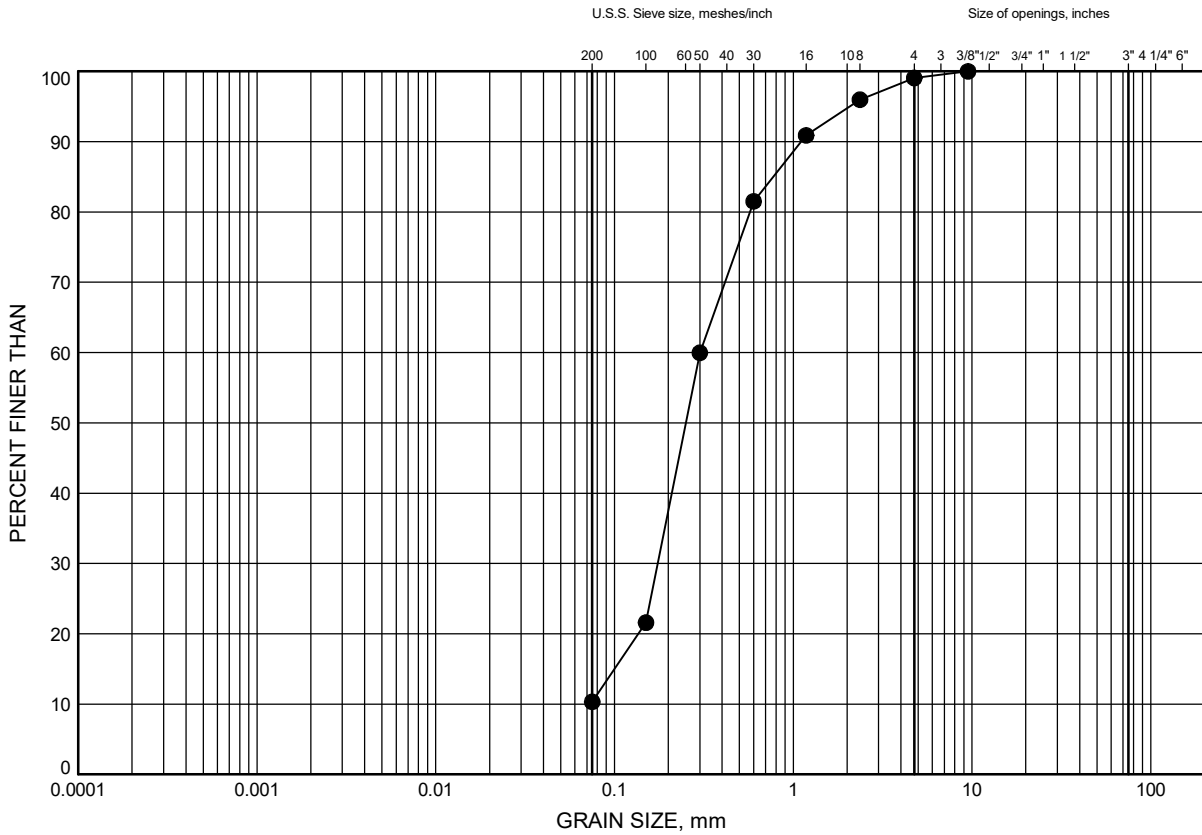
Prep'd MFA
Chkd. AMP

MTOW NW Region Retainer

GRAIN SIZE DISTRIBUTION

FIGURE B5

Sand Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-11	10.97	320.73

Date August 2016
W.P. 6332-14-01



Prep'd MFA
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**09-August-2016****Thurber Engineering Ltd.****Attn : Mark Farrant**

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

Phone: 905-829-8666 x 228
Fax:

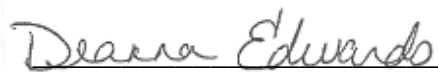
Date Rec. : 03 August 2016
LR Report: CA14112-AUG16
Reference: 13662

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: BH16-11, SS3 7'6"-9'-6"
Sample Date & Time					26-Jul-16
Temperature Upon Receipt [°C]	---	---	---	---	24.2
Corrosivity Index [none]	09-Aug-16	13:29	09-Aug-16	14:28	2
pH [no unit]	08-Aug-16	11:40	09-Aug-16	09:32	7.84
Soil Redox Potential [mV]	08-Aug-16	18:47	09-Aug-16	08:27	217
Sulphide [%]	08-Aug-16	10:07	09-Aug-16	09:35	< 0.02
% Moisture (wet wt) [%]	05-Aug-16	07:02	05-Aug-16	09:08	7.2
pH [no unit]	04-Aug-16	09:56	04-Aug-16	15:49	8.91
Chloride [µg/g]	05-Aug-16	18:51	09-Aug-16	09:15	110
Sulphate [µg/g]	05-Aug-16	18:51	09-Aug-16	09:15	29
Conductivity [uS/cm]	04-Aug-16	09:56	04-Aug-16	15:49	358
Resistivity (calculated) [Ohms.cm]	09-Aug-16	12:55	09-Aug-16	14:28	2790


Deanna Edwards, B.Sc, C.Chem
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

LR Report : CA14112-AUG16

Temperature of Samples upon receipt 24 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.

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - K0L 2H0

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

Project : 13662**LR Report :** CA14112-AUG16

Method Descriptions

Parameter	SGS Method Code	Reference Method Code
Anions by IC	ME-CA-[ENV]IC-LAK-AN-001	EPA300/MA300-Ions1.3
Carbon/Sulphur	ME-CA-[ENV]ARD-LAK-AN-020	ASTM E1918
Conductivity	ME-CA-[ENV]EWL-LAK-AN-006	SM 2510
Metals Prep	ME-CA-[ENV]ARD-LAK-AN-013	
pH	ME-CA-[ENV]EWL-LAK-AN-001	SM 4500



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2H0

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

Project : 13662

LR Report : CA14112-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 (%)
						%	Low	High		Low	High	
Anions by IC - QCBatchID: DIO0053-AUG16												
Chloride	0.4	µg/g	<0.4		0	20	109	80	120	111	75	125
Sulphate	0.4	µg/g	<0.4		3	20	101	80	120	101	75	125
Carbon/Sulphur - QCBatchID: ECS0007-AUG16												
Sulphide	0.02	%	<0.02		NV	20	113	80	120			
Conductivity - QCBatchID: EWL0045-AUG16												
Conductivity	2	uS/cm	2		1	10	99	90	110	NA		
pH - QCBatchID: EWL0045-AUG16												
pH	0.05	no unit	NA		0		100			NA		

**SGS Canada Inc.**

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

Project : 13662

16-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. : 02 August 2016
LR Report: CA13006-AUG16
Reference: 13662

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

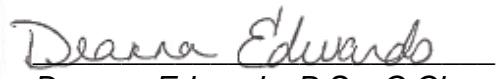
Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: MDL	6: Chicken Farm Creek
Sample Date & Time						27-Aug-16 09:00
Temperature Upon Receipt [°C]	---	---	--	--	---	26.0
Corrosivity Index [none]	04-Aug-16	15:49	04-Aug-16	15:49		12
pH [no unit]	03-Aug-16	07:59	04-Aug-16	10:21	0.05	7.47
Conductivity [µS/cm]	03-Aug-16	07:59	04-Aug-16	10:21	2	371
Resistivity (calculated) [Ohms.cm]	03-Aug-16	07:59			---	270
Redox Potential [mV]	02-Aug-16	17:51	03-Aug-16	12:43	---	280
Chloride [mg/L]	03-Aug-16	08:25	04-Aug-16	09:21	0.04	51
Sulphate [mg/L]	03-Aug-16	08:25	04-Aug-16	09:21	0.04	0.22
Sulphide [mg/L]	03-Aug-16	08:00	03-Aug-16	12:20	0.006	< 0.006

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.

Temperature of samples upon receipt 26 degrees C

Cooling Agent Present

Custody Seal not used to seal cooler


Deanna Edwards, B.Sc, C.Chem
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**LR Report :** CA13006-AUG16**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



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - K0L 2H0

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

Project : 13662

LR Report : CA13006-AUG16

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank		RPD		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: DIO0016-AUG16												
Anions by IC - QCBatchID: DIO0024-AUG16												
Chloride	0.04	mg/L	<0.04		0	20	102	80	120	90	75	125
Sulphate	0.04	mg/L	<0.04		0	20	102	80	120	88	75	125
Conductivity - QCBatchID: EWL0020-AUG16												
Conductivity	2	µS/cm	< 2		0	10	101	90	110	NA		
pH - QCBatchID: EWL0020-AUG16												
pH	0.05	no unit	NA		0		100			NA		
Redox Potential - QCBatchID: EWL0019-AUG16												
Redox Potential	no	mV	NA		1	20	106	80	120	NA		
Sulphide by SFA - QCBatchID: SKA0010-AUG16												
Sulphide	0.006	mg/L	<0.006		ND	20	103	80	120	125	75	125

Appendix C

Selected Site Photographs



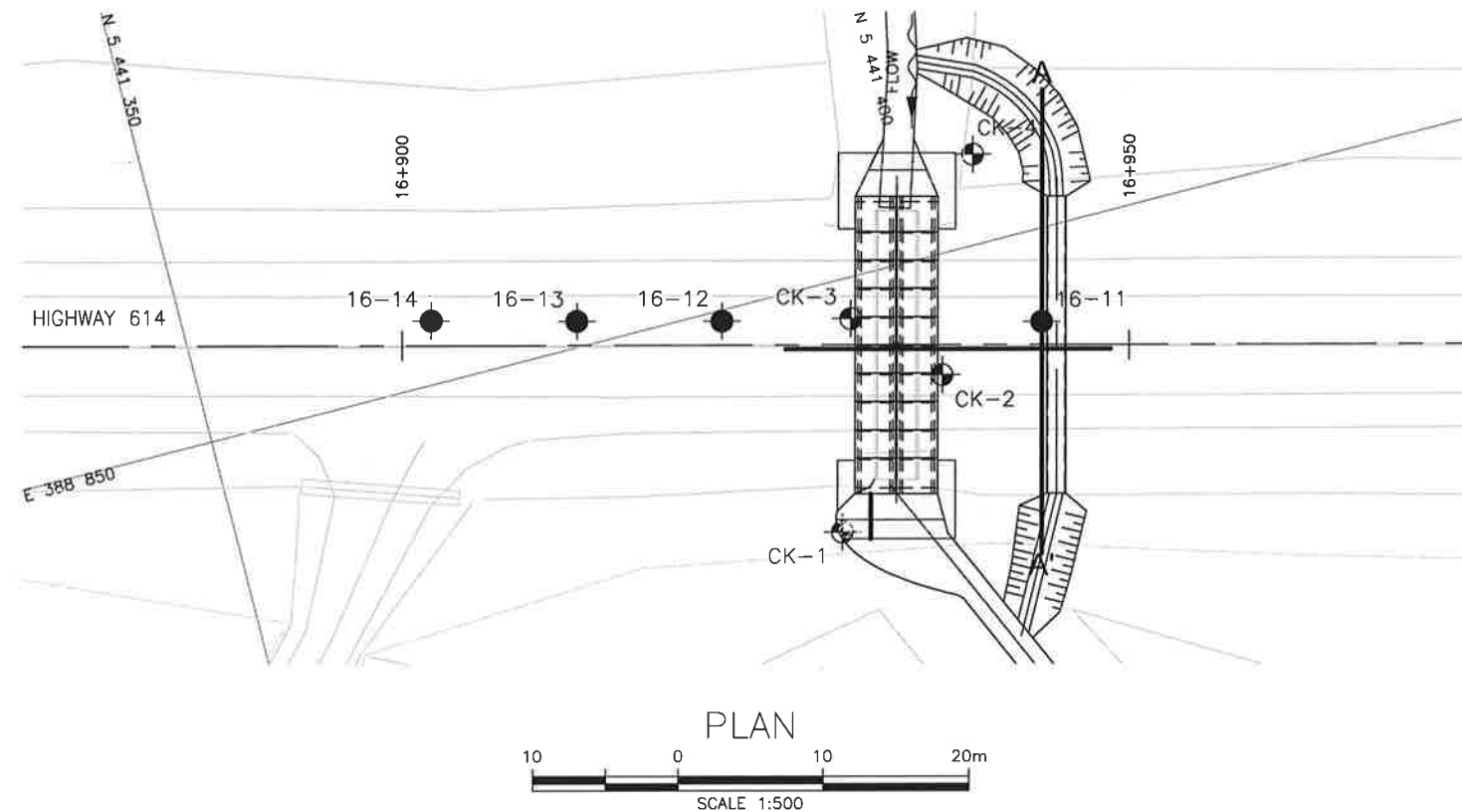
Photograph 1 – Chicken Farm Lake Culvert, East End (Outlet)



Photograph 2 – Chicken Farm Lake Culvert, West End (Inlet)

Appendix D

Borehole Locations and Soil Strata Drawing



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



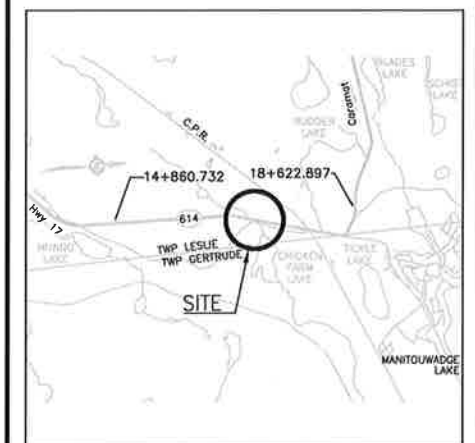
CONT No
WP No 6332-14-01

HIGHWAY 614
CHICKEN FARM LAKE
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

HATCH








THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

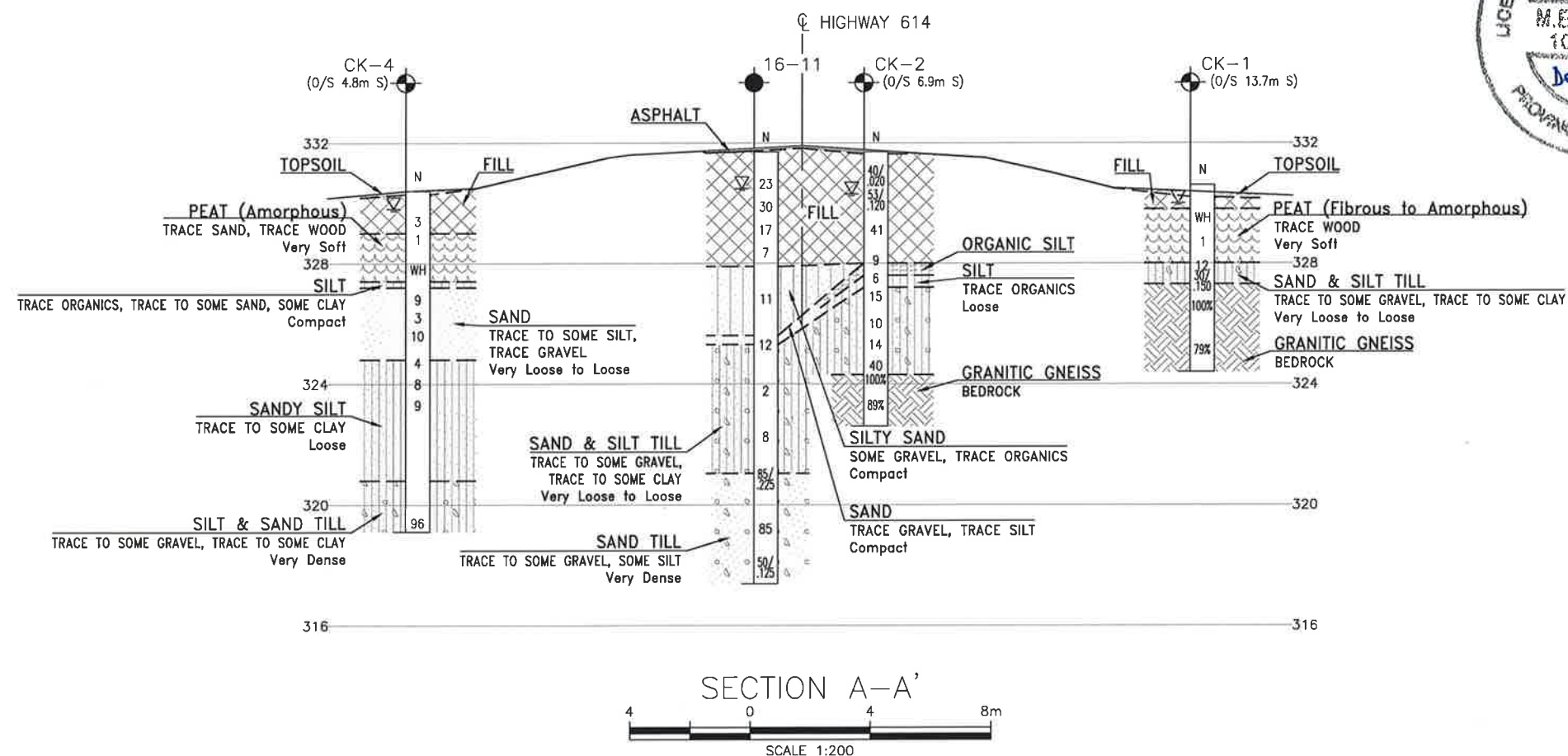
	Borehole (by Thurber)
	Borehole (by Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
16-11	331.7	5 441 407.3	388 856.3
16-12	331.7	5 441 386.0	388 850.8
16-13	331.7	5 441 376.3	388 848.3
16-14	331.7	5 441 366.6	388 845.8
CK-1	330.6	5 441 390.4	388 866.9
CK-2	331.7	5 441 399.7	388 858.1
CK-3	331.7	5 441 394.6	388 852.8
CK-4	330.4	5 441 405.5	388 843.9

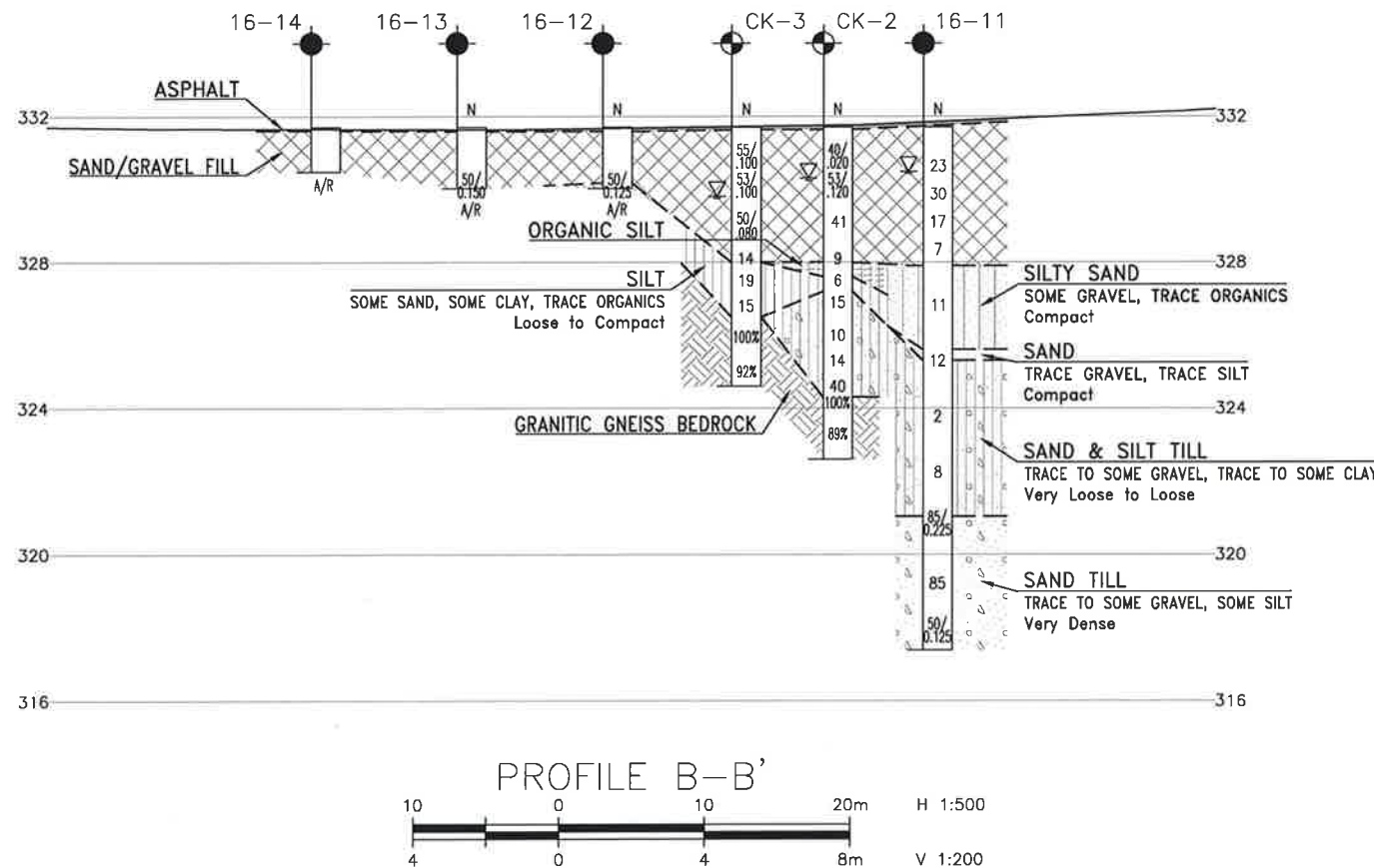
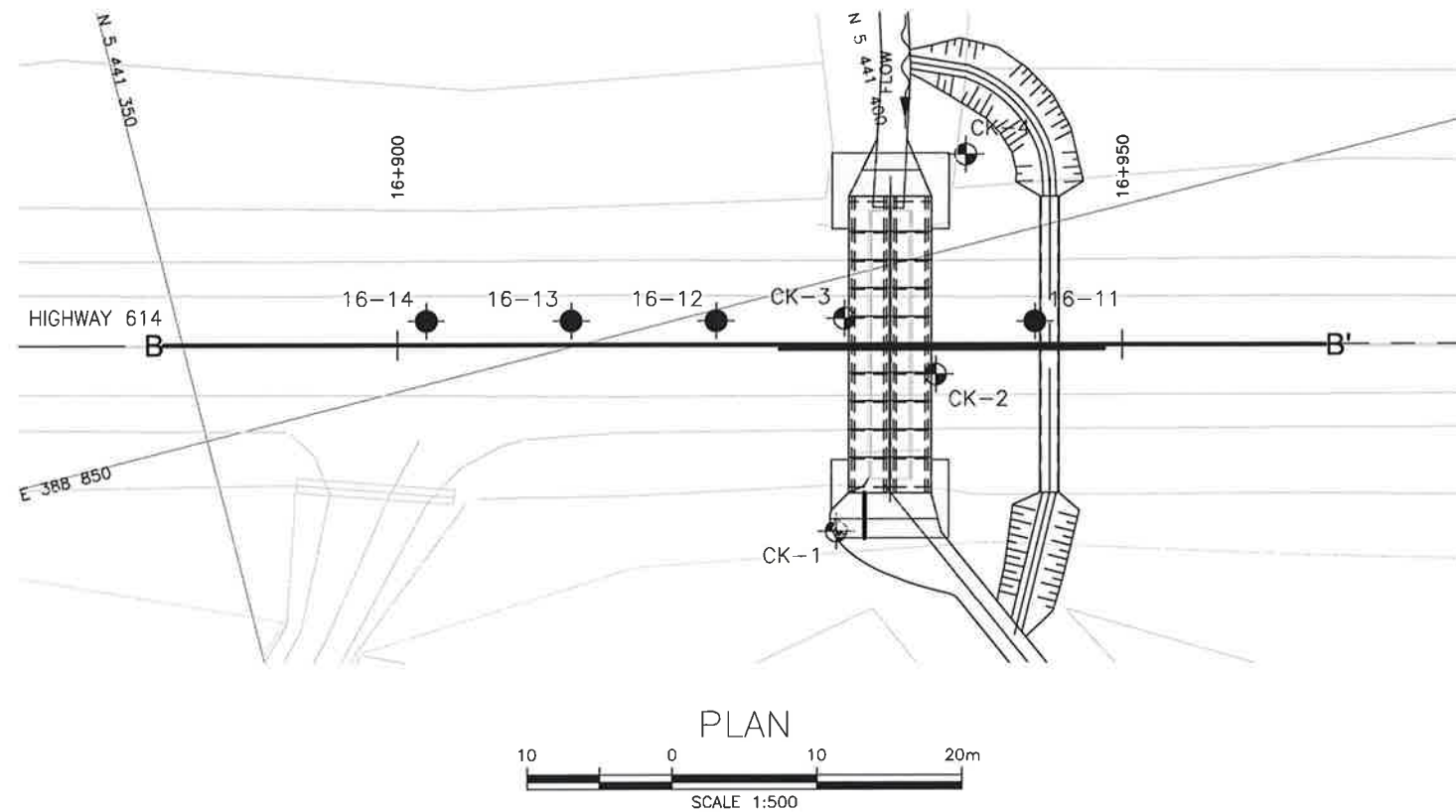
-NOTES-

- 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) 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-39



REVISIONS									
	DATE	BY	DESCRIPTION						
DESIGN	MEF	CHK	PKC	CODE	LOAD	DATE	DEC 2016		
DRAWN	MFA	CHK	MEF	SITE	STRUCT	DWG	1		



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



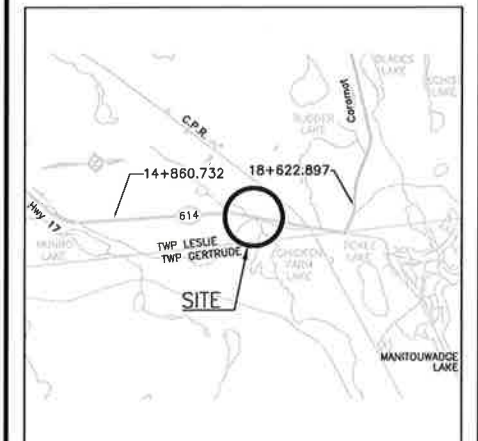
CONT No
WP No 6332-14-01

HIGHWAY 614
CHICKEN FARM LAKE
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

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
16-11	331.7	5 441 407.3	388 856.3
16-12	331.7	5 441 386.0	388 850.8
16-13	331.7	5 441 376.3	388 848.3
16-14	331.7	5 441 366.6	388 845.8
CK-1	330.6	5 441 390.4	388 866.9
CK-2	331.7	5 441 399.7	388 858.1
CK-3	331.7	5 441 394.6	388 852.8
CK-4	330.4	5 441 405.5	388 843.9

-NOTES-

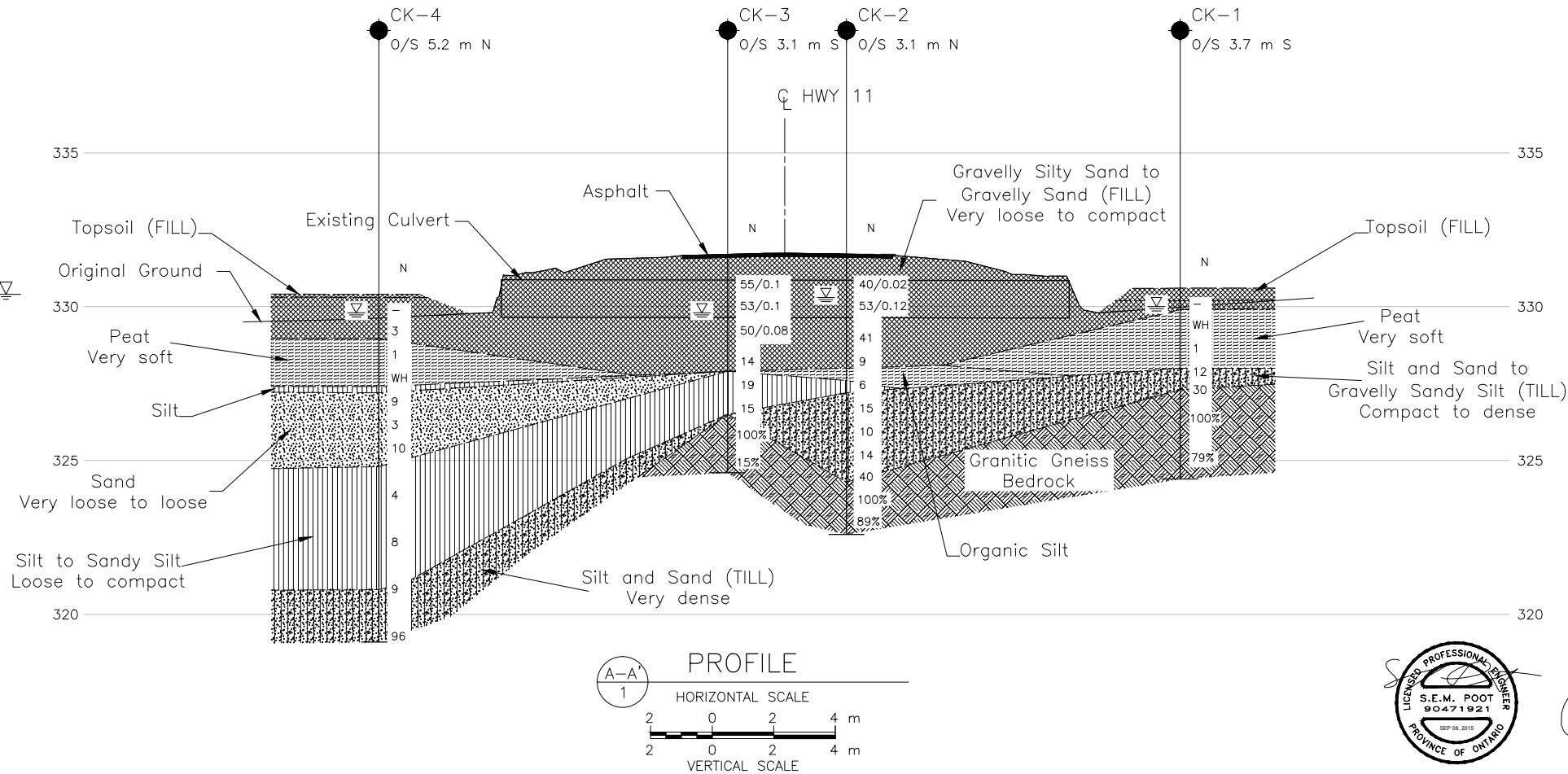
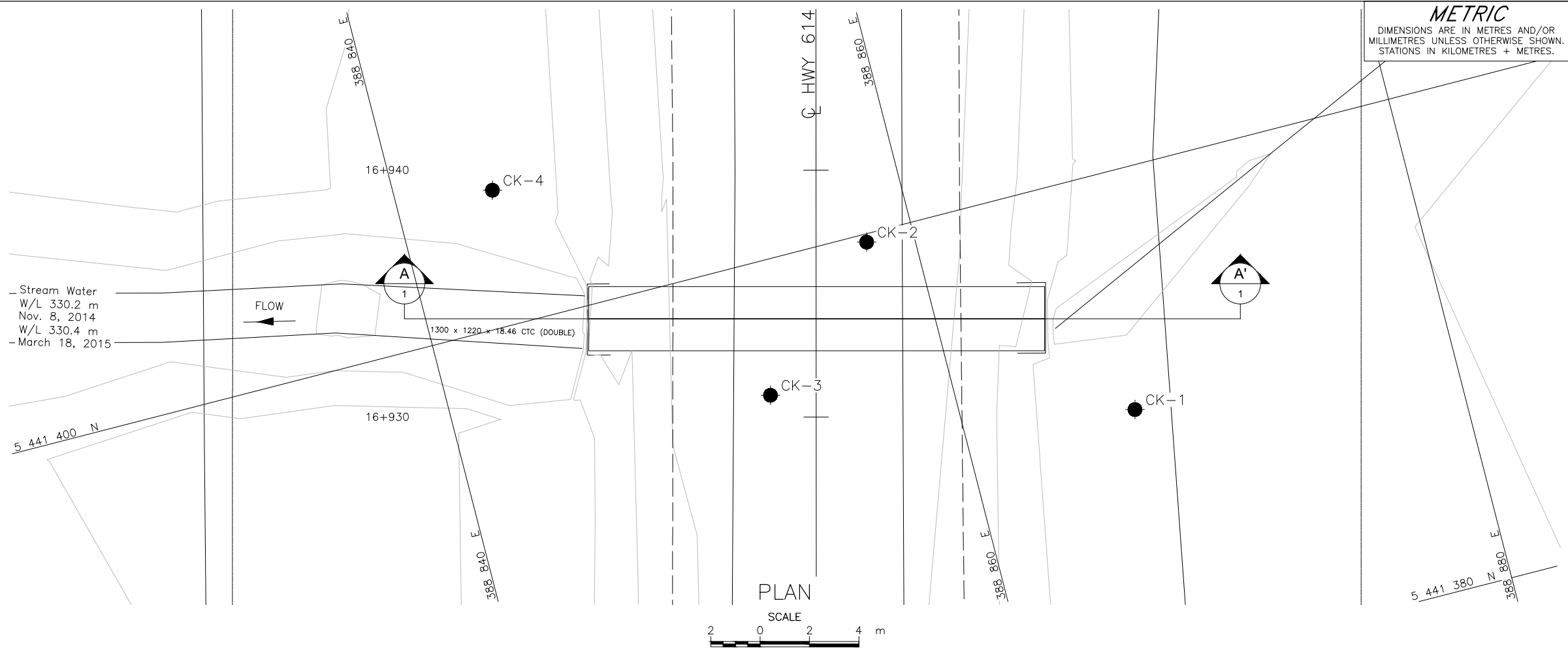
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- MTM Zone 14 co-ordinate system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

GEOCRES No. 42F-39

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MEF	CHK PKC	CODE
DRAWN	MFA	CHK MEF	SITE
LOAD	DATE	DEC 2016	
STRUCT	DWG 2		

Appendix E

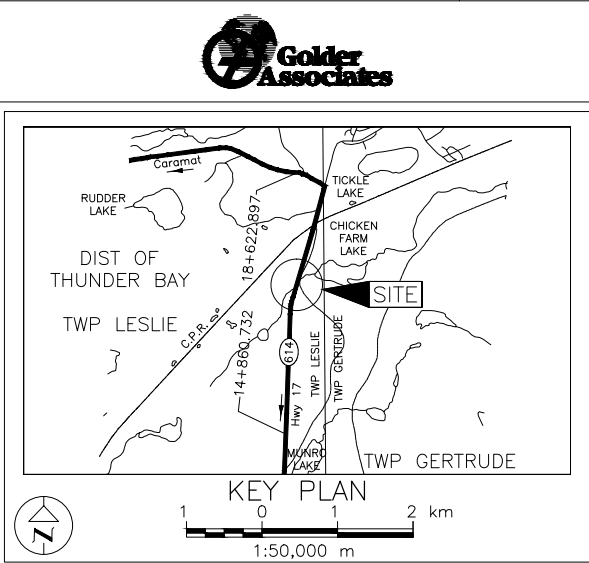
**Record of Borehole Sheets and Borehole Location and Soil Strata Drawing
From Preliminary Foundation Investigation and Design Report prepared by Golder
Associates, dated September 8, 2015, Geocres No. 42F-33**



CONT No. GWP No. 6332-14-00

HIGHWAY 614
CHICKEN FARM LAKE CULVERT STA 16+934
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



LEGEND

- Borehole
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ▽ WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
CK-1	330.6	5441390.4	388866.9
CK-2	331.7	5441399.7	388858.1
CK-3	331.7	5441394.6	388852.8
CK-4	330.4	5441405.5	388843.9

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. BC10686145, received FEB 20, 2015.



NO.	DATE	BY	REVISION
Geocres No. 42F-33			
HWY. 614	PROJECT NO. 1411523		DIST. .
SUBM'D. AC	CHKD. .	DATE: 8/26/2015	SITE: 48E-127/C
DRAWN: JJL	CHKD. SEMP	APPD. JMAC	DWG. 1

PROJECT 1411523				RECORD OF BOREHOLE No CK-1				1 OF 1 METRIC									
G.W.P. 6332-14-00				LOCATION N 5441390.4; E 388866.9				ORIGINATED BY RI									
DIST _____ HWY 614				BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers, NW Casing and NQ Coring				COMPILED BY AC									
DATUM GEODETIC				DATE March 25, 2015				CHECKED BY SEMP									
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									
330.6	GROUND SURFACE							20	40	60	80	100					
0.0	Topsoil (FILL)																
330.2	Black Frozen		1A	AS	-												
329.8	Gravelly sand (FILL)																
0.8	Brown Frozen		1B	SS	WH												
	PEAT (Fibrous to Amorphous), trace wood																
	Very soft		2	SS	1												
	Black Wet																
328.0			3A	SS	12												
2.6	Gravelly Sandy SILT, trace clay (TILL)		3B														
	Compact																
	Grey		4	SS	30/0.15												
	Wet																
327.3	GRANITIC GNEISS BEDROCK																
3.3	Bedrock cored from 3.3 m depth to 6.2 m depth.		1	RC	REC 100%												
	For coring details see Record of Drillhole CK-1.																
			2	RC	REC 100%												
324.4	END OF BOREHOLE																
6.2	Note: 1. Water level at a depth of 0.6 m below ground surface (Elev. 330.0 m) upon completion of drilling. 2. Split-spoon Sample 4, sliding along bedrock surface at 3.3 m depth.																

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 22/06/15 DATA INPUT:

DATUM: GEODETIC

DRILL RIG: CME 55

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

[illegible]

DEPTH SCALE

1 : 50

LOGGED: RI

CHECKED: SEMP

PROJECT 1411523		RECORD OF BOREHOLE No CK-2				1 OF 1 METRIC							
G.W.P. 6332-14-00		LOCATION N 5441399.7; E 388858.1				ORIGINATED BY RI							
DIST _____ HWY 614		BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers, NW Casing and NQ Coring				COMPILED BY AC							
DATUM GEODETIC		DATE March 18 and 20, 2015				CHECKED BY SEMP							
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
331.7	GROUND SURFACE							20 40 60 80 100	20 40 60				
0.9	ASPHALT (65 mm)							○ UNCONFINED + FIELD VANE	W _p W W _L				
	Gravelly sand, trace silt (FILL)							● QUICK TRIAXIAL × REMOULDED					
	Loose Brown Frozen* to wet		1	SS	40/ 0.02		331						
	Augers grinding from 0.8 m to 2.7 m depth on inferred cobbles.		2	SS	53/ 0.12		330						
			3	SS	41*		329						
			4	SS	9		328						
328.0	ORGANIC SILT		5A	SS	6		328						
327.6	Brown Wet		5B	SS	6		327						
327.2	SILT, trace organics						326						
4.5	Loose Brown to dark grey Wet		6	SS	15		325						
	SILT and SAND, trace to some gravel, trace to some clay (TILL)		7	SS	10		324						
	Compact to dense Grey Wet		8	SS	14		323						
			9	SS	40								
324.3	GRANITIC GNEISS BEDROCK		1	RC	REC 100%								
7.4	Bedrock cored from 7.4 m depth to 9.1 m depth.		2	RC	REC 100%								
	For coring details see Record of Drillhole CK-2.												
322.6	END OF BOREHOLE												
9.1	Note: 1. Water level at a depth of 1.4 m below ground surface (Elev. 330.3 m) upon completion of drilling. 2. Auger refusal encountered at 7.4 m depth. Advanced additional borehole 1 m north of CK-2 and cored bedrock from 7.4 m to 9.1 m depth.												

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

PROJECT: 1411523

RECORD OF DRILLHOLE: CK-2

SHEET 1 OF 1

LOCATION: N 5441399.7 ;E 388858.1

DRILLING DATE: March 20, 2015

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
								RECOVERY			R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY k, cm/s			Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
	FLUSH	TOTAL CORE %						SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS			TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 ⁰	10 ¹	10 ²																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: SEMP

SUD-RCK 1411523.GPJ GAL-MISS.GDT 030715 DATA INPUT:

PROJECT 1411523			RECORD OF BOREHOLE No CK-3			1 OF 1 METRIC											
G.W.P. 6332-14-00			LOCATION N 5441394.6; E 388852.8			ORIGINATED BY RI											
DIST _____ HWY 614			BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers, NW Casing and NQ Coring			COMPILED BY AC											
DATUM GEODETIC			DATE March 18 and 20, 2015			CHECKED BY SEMP											
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	W _p	W	W _L				
331.7	GROUND SURFACE																
0.9	ASPHALT (75 mm)																
	Gravelly sand, trace silt (FILL)																
	Compact																
	Brown																
	Frozen* to wet																
	Augers grinding from 0.8 m to 3.0 m depth on inferred cobbles.																
			1	SS	55/0.1*												
			2	SS	53/0.1*												
			3	SS	50/0.08												
			4	SS	14												
328.0																	
3.7	SILT, some sand, some clay																
	Compact																
	Grey																
	Wet																
			5	SS	19												
			6	SS	15												
326.5																	
5.2	GRANITIC GNEISS BEDROCK																
	Bedrock cored from 5.2 m depth to 7.2 m depth.																
	For coring details see Record of Drillhole CK-3.																
			1	RC	REC 100%												
			2	RC	REC 100%												
324.6																	
7.1	END OF BOREHOLE																
	Note:																
	1. Water level at a depth of 1.9 m below ground surface (Elev. 329.8 m) upon completion of drilling.																
	2. Auger refusal encountered at 5.2 m depth. Advanced additional borehole 1.1 m north of CK-3 and cored bedrock from 5.2 m to 7.1 m depth.																

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

[illegible]

PROJECT 1411523		RECORD OF BOREHOLE No CK-4				1 OF 1 METRIC								
G.W.P. 6332-14-00		LOCATION N 5441405.5; E 388843.9				ORIGINATED BY RI								
DIST _____ HWY 614		BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers				COMPILED BY AC								
DATUM GEODETIC		DATE March 24, 2015				CHECKED BY SEMP								
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						
330.4	GROUND SURFACE							20 40 60 80 100	20 40 60					
0.9	Topsoil (FILL) Gravelly silty sand (FILL) Very loose Dark brown Frozen* to wet		1A	AS	1									
329.0			1B	SS	3									
1.4	PEAT (Amorphous), trace sand, trace wood Very soft Black Wet		2	SS	1									
			3	SS	WH									
327.4														
3.2	SILT, trace organics, trace sand Brown Wet		4A	SS	9									
	SAND, trace to some silt, trace gravel Very loose to loose Grey Wet		4B	SS										
			5	SS	3									
			6	SS	10									
324.8														
5.6	Sandy SILT, trace to some clay Loose Grey Wet		7	SS	4									
			8	SS	8									
320.8			9A	SS	9									
9.6	SILT and SAND, trace to some gravel, trace to some clay (TILL) Very dense Grey Wet		9B											
			10	SS	96									
319.1														
11.3	END OF BOREHOLE													
	Note: 1. Water level at a depth of 0.6 m below ground surface (Elev. 329.8 m) upon completion of drilling.													

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 22/06/15 DATA INPUT: