FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF CULVERT No. CV-0252-0400-0076
HIGHWAY 400 SOUTHBOUND
TOWNSHIP OF SEVERN
G.W.P. 2041-13-00
ASSIGNMENT NUMBER: 2013-E-0053

GEOCRES NUMBER: - 31D-662

SUBMITTED TO

MCINTOSH PERRY CONSULTING ENGINEERS

September 2016
19-3405-5

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the replacement of Culvert No. CV-0252-0400-0076 (Site) located on Highway 400 southbound, within the Township of Severn. Thurber carried out the investigation as a sub-consultant to McIntosh Perry Consulting Engineers (MPCE) as part of a change order to Agreement No. 2013-E-0053.

No previous foundation investigation information for the subject culvert was available. Base plan mapping and survey data was provided by MPCE for the preparation of this report.

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

2 SITE DESCRIPTION

The Site is located on Highway 400 within the southbound lanes, approximately 1.2 km south of Highway 400 / Vasey Road interchange. It is noted that for project orientation purposes, Highway 400 within the project limits, will be assumed to run north-south. The location of the twin culvert is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

Highway 400 at this location has two through lanes in each direction with granular shoulders. The northbound and southbound lanes are separated by a wide median that is vegetated with brush and small trees. Based on the 60% Design Complete Package, Highway 400 southbound lanes consists of two, 4.0 m wide lanes with a rural cross-section, and granular shoulders that are approximately 1.5 m and 3.0 m wide on the east and west side of the highway respectively. The highway alignment is on a curve at this site. Based on the information provided by MPCE the existing twin CSP culverts have an internal span of 1.4 m and a length of 25.8 m and water flows through from west to east.

The slopes of the road embankment were observed to be grass and brush covered and graded at approximately 4.3H:1V (Horizontal:Vertical) and 3.2H:1V near the east and west ends of the culvert respectively. The elevation at the centreline of the highway was surveyed by MPCE at Elevation 182.82 m. The elevation of the top of the culvert was surveyed by Thurber at Elevation 181.29 m and Elevation 181.08 m at the inlet and outlet respectively. The maximum height of the road embankment from shoulder to the top of the culvert is approximately 1.8 m. The invert was measured at an elevation ranging from 179.86 m and 179.64 m at the inlet and outlet respectively.

The lands surrounding the project limits are mainly forested and partially developed with some residential and commercial developments. The terrain in the vicinity of the inlet and outlet of the culvert is generally flat. Select site photographs illustrating existing conditions at the site are presented in Appendix D.

3 SITE INVESTIGATION AND FIELD TESTING

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to provide utility locate clearances for the intended borehole locations.

The field investigation for this site included advancing four boreholes drilled between April 11, 2016 and April 19, 2016. The location and ground surface elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and are summarized in Table 3-1.

Table 3-1: Borehole Summary

Borehole	Location	Drilling Equipment	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Depth (m)
16-1	Inlet	ATV mount CME55 / HAS	4 950 954.9	292 931.5	180.5	15.8
16-2	West shoulder	ATV mount CME55 / HSA	4 950 948.4	292 944.0	182.4	18.9
16-3	East shoulder	Truck mount CME75 / HSA	4 950 957.4	292 950.4	183.0	18.9
16-4	Outlet	ATV mount CME55 / HSA	4 950 952.0	292 966.4	180.3	15.8

The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in the boreholes via the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. In-situ shear vane testing was carried out within cohesive strata. A DCPT cone was also advanced to refusal in Borehole 16-2. All soil samples recovered from the boreholes were placed in moisture-proof containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing.

A 25 mm inside diameter PVC piezometer was installed in Borehole 16-1 to measure the groundwater level at the site. Construction details for the piezometer are illustrated on the Record of Borehole sheet for Borehole 16-1, provided in Appendix B.

The boreholes without a piezometer were backfilled with a low-permeability mixture of auger cuttings and bentonite pellets in general accordance with the intent of Ontario MOE Regulation 903. The piezometer was decommissioned April 19, 2016.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by Thurber between April 14 and 19, 2016. The vertical datum used was temporary benchmark (TBM) BM1484 provided by MPCE and had a geodetic elevation of 180.448 m. The location of the TBM is indicated on Drawing No. 1 in Appendix A.

3.1 LABORATORY TESTING

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size distribution analyses, and Atterberg Limits testing were also carried out on selected samples to MTO and ASTM standards.

The laboratory test results are presented on the Record of Borehole sheets in Appendix B and are illustrated on the figures provided in Appendix C.

4 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 Overview / General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the culvert area is presented on Drawing No. 1 in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions.

For reference, the stratigraphy in the area of the boreholes through the embankment is generally characterized by sand fill with varying amounts of silt and gravel, overlying organic clay, overlying clay, overlying silt and underlain by probable bedrock.

More detailed descriptions of the individual strata are presented below.

4.2 Topsoil

A 50 to 75 mm thick topsoil layer was encountered in the inlet and outlet boreholes respectively.

4.3 Embankment Fill

A fill layer consisting predominantly of sand, with varying amounts of silt and gravel was encountered from surface in both embankment boreholes. This layer has a top elevation of 183.0 m and 182.4 m and has a thickness of 4.3 m and 3.7 m. The SPT ‘N’ values ranged from 1 to 45 blows per 0.3 m of penetration; indicating a very loose to dense condition; but typically loose to compact. Occasional cobbles were noted in this layer.

The moisture content for the samples tested ranged from 2% to 13%. The results of two grain size analysis conducted on samples of this material are summarized in Table 4-1 and are illustrated on Figure 1 in Appendix C.

Table 4-1: Gradation Results for Embankment Fill

Soil Particles	%
Gravel	9 to 11
Sand	74 to 77
Silt and Clay	14 to 15

4.4 Clay Fill

A clay fill layer with varying amounts of organics was encountered just below the ground surface in both the inlet and outlet boreholes. This layer has a top elevation ranging from 180.4 m to 180.2 m and has a thickness 0.7 m. The SPT 'N' values ranged from 3 to 6 blows per 0.3 m of penetration, indicating a soft to firm consistency.

The moisture content for the samples tested ranged from 32% to 55%.

4.5 Organic Silt (MH-OH) to Organic Clay (CH-OH)

A dark grey organic silt to clay layer was encountered below the clay fill in Boreholes 16-1 and 16-4 and below the embankment fill in Boreholes 16-2 and 16-3. This stratum has a top elevation ranging from 178.7 m to 179.7 m and a thickness ranging from 2.4 m to 2.7 m. In-situ shear vane test results indicated undrained shear strengths ranging from 22 kPa to 77 kPa; indicating a soft to stiff consistency; but typically soft to firm. A 50 mm thick peat layer was observed within this unit in Boreholes 16-2 and 16-3.

The moisture content of the samples tested ranged from 25% to 87%. The results of grain size analysis including hydrometer analysis conducted on three samples of this material are summarized in Table 4-2 and are illustrated on Figure 2 in Appendix C.

Table 4-2: Gradation Results for Organic Silt and Clay

Soil Particles	%
Gravel	0
Sand	1 to 3
Silt	51 to 57
Clay	41 to 46

The results of Atterberg Limits testing completed on three samples of this material are summarized in Table 4-3 and are illustrated on Figure 6 in Appendix C. The results indicate an organic silt to clay of high plasticity.

Table 4-3: Atterberg Limits Test Results

Liquid Limit	65 to 75
Plastic Limit	30 to 36
Plasticity Index	35 to 41

4.6 Clay (CL to CI) with Interlayered Silty Clay (CL-ML)

A clay layer was encountered below the organic silt to clay layer in all boreholes. This stratum has a top elevation ranging from 176.0 m to 177.1 m and has a thickness ranging from 9.6 m to 11.4 m. In-situ shear vane test results indicated undrained shear strengths ranging from 15 kPa to 50 kPa; indicating a soft to stiff consistency; but typically firm. A silty clay layer 1.9 m to 3.4 m thick was noted interlayered within the clay layer.

The moisture content for the samples tested ranged from was 32% to 64%. The results of grain size analysis conducted on five samples of this material are summarized in Table 4-4 and are illustrated on Figures 3 and 4 in Appendix C.

Table 4-4: Gradation Results for Clay

Soil Particles	%
Gravel	0
Sand	1 to 35
Silt	43 to 67
Clay	14 to 53

The results of Atterberg Limits testing completed on five samples of this material are summarized in Table 4-5 and are illustrated on Figures 6 and 7 in Appendix C. The results indicate a clay of low to intermediate plasticity.

Table 4-5: Atterberg Limits Test Results

Liquid Limit	17 to 47
Plastic Limit	13 to 21
Plasticity Index	4 to 27

4.7 Silt (ML)

A silt layer was encountered in all boreholes. This stratum lies below the clay layer and has a top elevation ranging from 165.5 m to 166.7 m. All boreholes were terminated within this layer. A dynamic cone was driven in Borehole 16-2. It reached refusal at a depth of 22.5 m (elevation 159.9 m). The SPT 'N' values were all weight of hammer per 0.3 m of penetration; indicating a very loose condition. This may indicate hydraulic disturbance of the silt layer.

The moisture content for the samples tested ranged from 20% to 30%. The results of grain size analysis conducted on four samples of this material are summarized in Table 4-6 and are illustrated on Figure 5 in Appendix C.

Table 4-6: Gradation Results for Sandy Silt to Silt

Soil Particles	%
Gravel	0
Sand	1
Silt	89 to 93
Clay	6 to 10

Based on the results of Atterberg limit testing, this material was classified as non-plastic.

4.8 Refusal on Probable Bedrock

Refusal on probable bedrock was encountered at 22.5 m in Borehole 16-2.

4.9 Groundwater

The groundwater level in the piezometer installed in Borehole 16-1 was recorded on April 19, 2016, at least 0.85 m above existing grade indicating an artesian condition and corresponding to an elevation of 181.35 m.

Immediately after this reading the well was decommissioned by packing the well full of bentonite pellets to seal off the artesian flow at the source and decommissioned in accordance with Ontario MOE Regulation 903.

Slight artesian conditions were also noted during drilling of Borehole 16-3 at a depth of 7.6 m to 11.0 m. Additional drilling depth cut off the artesian flow and the water level completion of drilling was noted to be 11.3 m (elevation 171.7 m). Free water was noted at 7.6 m and 0.6 m depth within Boreholes 16-2 and 16-4 respectively at completion of drilling, corresponding to elevation 174.8 m and 179.7 m.

The water level in the culvert was measured at the time of Thurber's field investigation at an elevation ranging from 179.7 m to 180.1 m. The groundwater level in the area of the culvert is expected to reflect the creek water level.

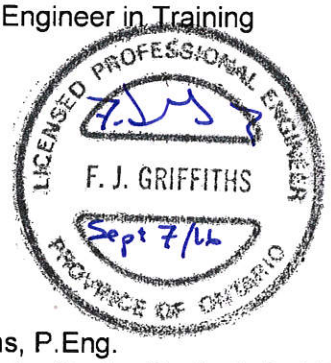
These observations are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level and/or artesian conditions may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

5 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber surveyed the borehole locations, and determined the ground surface elevations based on contract drawings provided by McIntosh Perry Consulting Engineers. Terex Drilling Solutions of Concord, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, and in-situ testing. The drilling, and sampling operations in the field were supervised on a full time basis by Mr. Christopher Murray of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa, Ontario.

Overall project management and direction of the field program was provided by Kenton Power, P.Eng. Interpretation of the field data and preparation of this report was completed by Christopher Murray. The report was reviewed by Fred J. Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.

Christopher Murray, M.A.Sc.
Geotechnical Engineer in Training

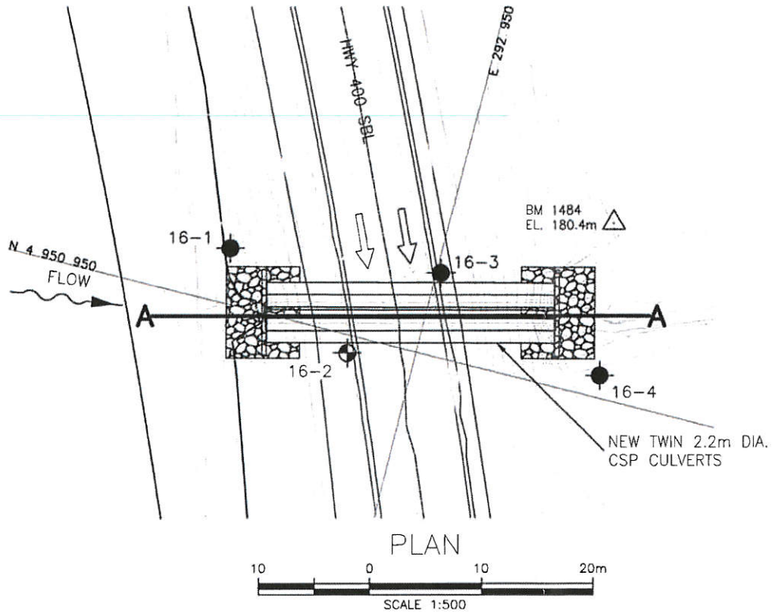


Fred J. Griffiths, P.Eng.
Senior Associate, Senior Geotechnical Engineer

P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

APPENDIX A

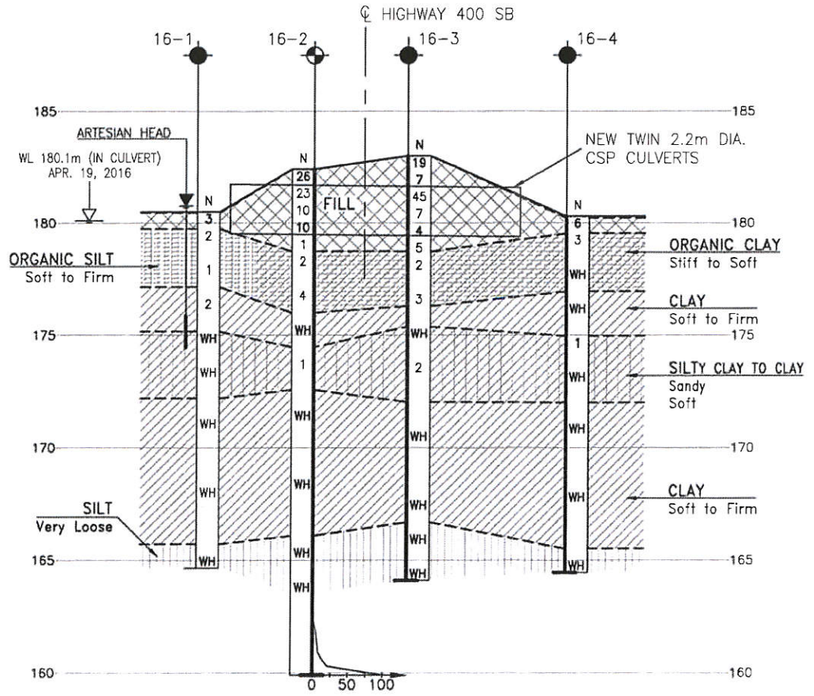
BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS



PLAN

10 0 10 20m

SCALE 1:500



SECTION A-A

10 0 10 20m H 1:500

5 0 5 10m V 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

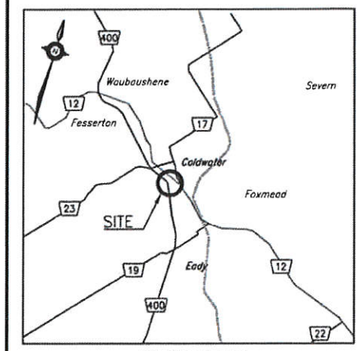
CONT No
WP No 2183-13-00

HIGHWAY 400 SB
COLDWATER CULVERT
CV-0252-0400-0076
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

McINTOSH PERRY

THURBER ENGINEERING LTD



KEYPLAN

LEGEND

●	Borehole
⊕	Borehole & Cone
△	Benchmark
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
WH	Weight of Hammer
⧖	Water Level
⧗	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
16-1	180.5	4 950 954.9	292 931.5
16-2	182.4	4 950 948.4	292 944.0
16-3	183.0	4 950 957.4	292 950.4
16-4	180.3	4 950 952.0	292 966.4

-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) Borehole locations are shown in MTM Zone 10 coordinates.

GEOCRES No. 31D-662

LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
Sept 7/16
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Sep 6/16
PROVINCE OF ONTARIO

REVISIONS

DATE	BY	DESCRIPTION

DESIGN	CM	CHK	PC	CODE	LOAD
DRAWN	MFA	CHK	FG	SITE	STRUCT

DATE AUG 2016
DWG 1

FILENAME: H:\Drafting\19\3405\31\ted4055-PlanAProfile(Culvert).dwg
PLOTDATE: 8/26/2016 10:46 AM

MINISTRY OF TRANSPORTATION, ONTARIO

APPENDIX B

SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS
RECORD OF BOREHOLE SHEETS

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SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an “A” size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

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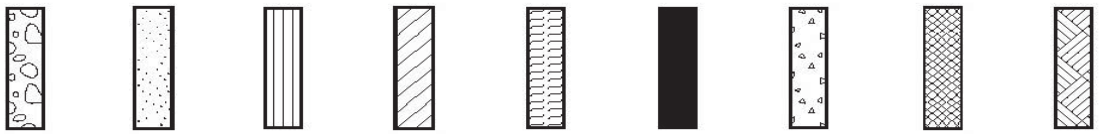
STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel

Sand

Silt

Clay

Organics

Asphalt

Concrete

Fill

Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

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MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L= Liquid Limit

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EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
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 structures are preserved.

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 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-1

1 OF 2

METRIC

GWP# 2041-13-00 | LOCATION Highway 400 SB Severn, ON N 4 950 954.9 E 292 931.5 | ORIGINATED BY CAM

HWY Highway 400 | BOREHOLE TYPE Hollow Stem Auger | COMPILED BY CAM

DATUM Geodetic | DATE 2016.04.18 - 2016.04.18 | CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
180.5							
0.0 / 0.1	**Rootmat (50mm)**						
	CLAY, trace wood **FILL** Stiff Brown		1	SS	3		
179.7							
0.8	**ORGANIC SILT (MH-OH)** Soft to Firm Dark Grey		2	SS	2		
	-Thin Topsoil / Silty Sand Layers around 2.4 m		3	SS	1		
177.1							
3.4	**CLAY (CI)** Firm Grey		4	SS	2		
175.1							
5.3	**SILTY CLAY (CL-ML) to CLAY (CL)**, Sandy Soft Grey **Artesian**		5	SS	WH		
			6	SS	WH		
172.2							
8.3	**CLAY (CI)** Soft to Firm Grey		7	SS	WH		

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/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	0	1	55	44
	0	2	60	38
	0	35	51	14
	0	1	46	53

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 16-1 2 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 SB Severn, ON N 4 950 954.9 E 292 931.5 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.18 - 2016.04.18 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	CLAY (CI) Soft to Firm Grey						170 169 168 167 166	4.4 6.4 3.0 4.4	○ 168		
165.7 14.8	**SILT (ML)** Very Loose Grey		8 9	SS SS	WH WH		165	○ 165			0 1 93 6
164.6 15.8	End of Borehole at 15.8 m A water level of at least 0.85 m above ground level was measured on April 19, 2016, just prior to decommissioning										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

$^{20}_{15}$⊕$^{5}_{10}$ (%) STRAIN AT FAILURE

ONTMT4S 19-3405-5 HWY 400 CULVERTS.GPJ 2012TEMPLATE(MTO).GDT 9/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-2 1 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 SB Severn, ON N 4 950 948.4 E 292 944.0 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.18 - 2016.04.18 CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (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
182.4											
0.0 / 182.1	SAND with Gravel **FILL** Compact Grey		1	SS	26		182				
0.3	SILTY SAND **FILL** Compact to Very Loose Brown		2	SS	23						
			3	SS	10		181				
			4	SS	10		180				9 77 14 (SI+CL)
	-with Gravel		5	SS	1		179				
178.8 / 3.7	**ORGANIC CLAY (CH-OH)** Stiff Dark Grey		6	SS	2						0 2 57 41
							178	3.8, 3.5			
	-50mm Peat Layer around 5.6 m		7	SS	4		177	6.0			
176.0 / 6.4	**CLAY (CL)** Firm Grey		8	SS	WH	▽	176	4.4			0 5 63 32
174.5 / 7.9	**SILTY CLAY (CL-ML) to CLAY (CL)** with Sand Soft to Firm Grey **Artesian**		9	SS	1		175	2.0, 4.5			0 15 67 18
							174				
							173	2.0, 3.1			
172.6 / 9.8											

Continued Next Page

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-2 2 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 SB Severn, ON N 4 950 948.4 E 292 944.0 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.18 - 2016.04.18 CHECKED BY KCP

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)	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										
	CLAY (CI) Soft to Firm Grey						172				
			10	SS	WH		171		o		
							170	2.7 3.4			
							169				
			11	SS	WH		168		o		0 4 45 51
166.1							167	2.4 4.2			
16.3	**SILT (ML)** Very Loose Grey						166				
			12	SS	WH		165		o		0 1 92 7
			13	SS	WH		164		o		
163.5							163				
18.9	End of Borehole at 18.9 m DCPT driven from 18.9 m to refusal on probable bedrock at 22.5 m Water at 7.6 m on completion of drilling										

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-2 3 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 SB Severn, ON N 4 950 948.4 E 292 944.0 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.18 - 2016.04.18 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

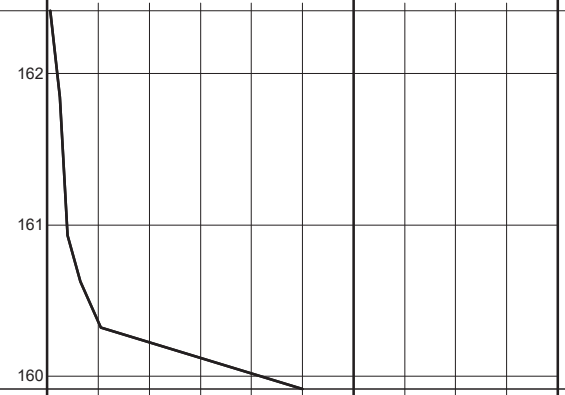
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

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



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

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

ONTMT4S 19-3405-5 HWY 400 CULVERTS.GPJ 2012TEMPLATE(MTO).GDT 9/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-3 1 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 SB Severn, ON N 4 950 957.4 E 292 950.4 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.19 - 2016.04.19 CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.0									
0.0 / 182.7	SAND with Gravel **FILL** Compact Grey		1	SS	19				
0.3	SILTY SAND **FILL** Loose to Dense Brown		2	SS	7		182		
			3	SS	45		181		
			4	SS	7		180		
			5	SS	4				11 74 15 (SI+CL)
178.7			6	SS	5		179		
4.3	**ORGANIC CLAY (CH-OH)** Firm to Stiff Dark Grey		7	SS	2		178		0 3 51 46
	-50mm Peat Layer around 6.2 m		8	SS	3		177		
176.3									
6.7	**CLAY (CL)** Soft to Firm Grey						176		
175.4									
7.6	**SILTY CLAY (CL-ML) to CLAY (CL)** with Sand Soft Grey **Artesian**		9	SS	WH		175		0 24 43 33
			10	SS	2		174		
							173		

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

2.6 3.9 3.1 3.7 2.6

Continued Next Page

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

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

ONTMT4S 19-3405-5 HWY 400 CULVERTS.GPJ 2012TEMPLATE(MTO).GDT 9/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-3 2 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 SB Severn, ON N 4 950 957.4 E 292 950.4 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.19 - 2016.04.19 CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (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										
172.0											
11.0	**CLAY (CI)** Soft to Firm Grey					▽	172	2.0 3.4			
			11	SS	WH		171				
							170				
							169	3.3 4.0			
			12	SS	WH		168				
166.7							167				
16.3	**SILT (ML)** Very Loose Grey										
			13	SS	WH		166				0 1 89 10
			14	SS	WH		165				
164.1											
18.9	End of Borehole at 18.9 m Water at 11.3 m on completion of drilling										

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

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

ONTMT4S 19-3405-5 HWY 400 CULVERTS.GPJ 2012TEMPLATE(MTO).GDT 9/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-4 1 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 SB Severn, ON N 4 950 952.0 E 292 966.4 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.14 - 2016.04.15 CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.3											
0.0 / 0.1	**Rootmat (75mm)**										
	CLAY **FILL** Stiff Grey		1	SS	6	▽	180				
179.6											
0.8	**ORGANIC CLAY (CH-OH)** Stiff to Soft Dark Grey		2	SS	3		179	4.0, 3.0			
			3	SS	WH		178	4.0			
177.0							177	7.0			
3.4	**CLAY (CL)** Soft to Firm Grey		4	SS	WH						0 4 63 33
175.0							176	7.3, 5.2			
5.3	**SILTY CLAY (CL-ML) to CLAY (CL)**, Sandy Soft Grey **Artesian**		5	SS	1		175	2.0			0 30 54 16
			6	SS	WH		174	2.0			
172.0							173	3.8, 5.0			
8.3	**CLAY (CI)** Soft to Firm Grey		7	SS	WH		172				
							171				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

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

ONTMT4S 19-3405-5 HWY 400 CULVERTS.GPJ 2012TEMPLATE(MTO).GDT 9/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-4 2 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 SB Severn, ON N 4 950 952.0 E 292 966.4 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.14 - 2016.04.15 CHECKED BY KCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (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										
	CLAY (CI) Soft to Firm Grey						170	2.0 3.5			
							169				
			8	SS	WH		168				
							167	1.9 1.8			
165.5							166				
14.8	**SILT (ML)** Very Loose Grey										
			9	SS	WH		165				0 1 91 8
164.5											
15.8	End of Borehole at 15.8 m Water at 0.6 m on completion of drilling										

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

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

ONTMT4S 19-3405-5 HWY 400 CULVERTS.GPJ 2012TEMPLATE(MTO).GDT 9/2/16

APPENDIX C

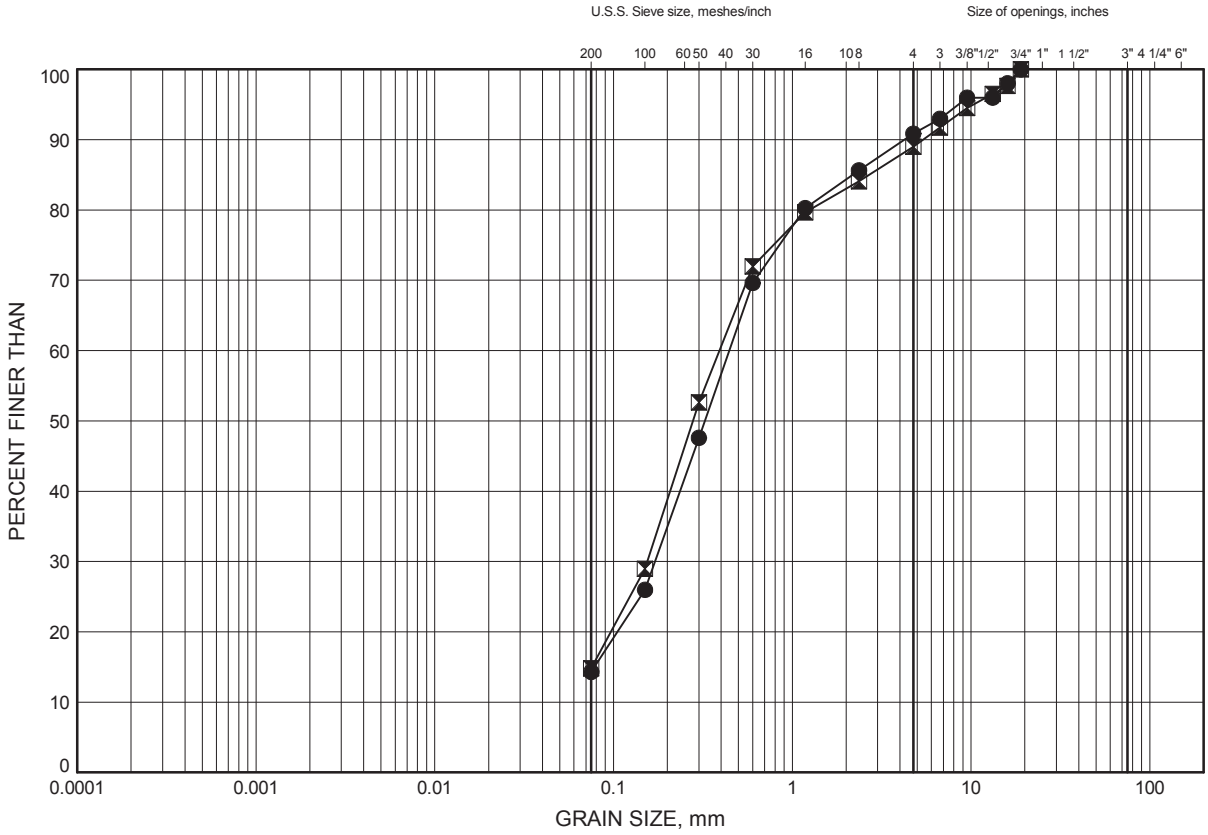
LABORATORY TEST RESULTS

Highway 400 SB near Coldwater, ON

GRAIN SIZE DISTRIBUTION

FIGURE 1

Embankment Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-2	2.59	179.83
⧓	16-3	3.35	179.65

Date May 2016

GWP# 2013-E-0053

THURBER

Prep'd CM

Chkd. FJG

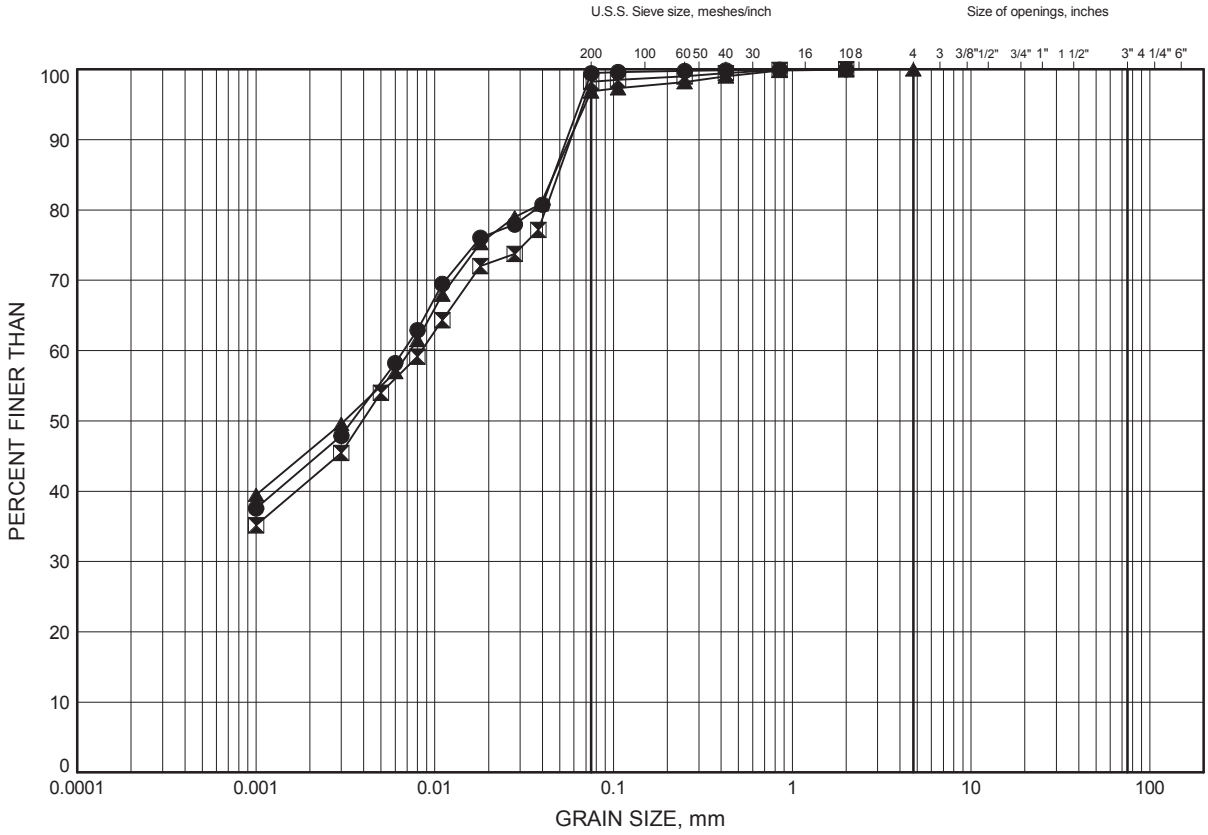
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 17/5/16

Highway 400 SB near Coldwater, ON

GRAIN SIZE DISTRIBUTION

FIGURE 2

Organic Silt (MH-OH) to Organic Clay (CH-OH)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	1.07	179.41
⊠	16-2	4.11	178.30
▲	16-3	4.88	178.12

Date May 2016

GWP# 2013-E-0053

THURBER

Prep'd CM

Chkd. FJG

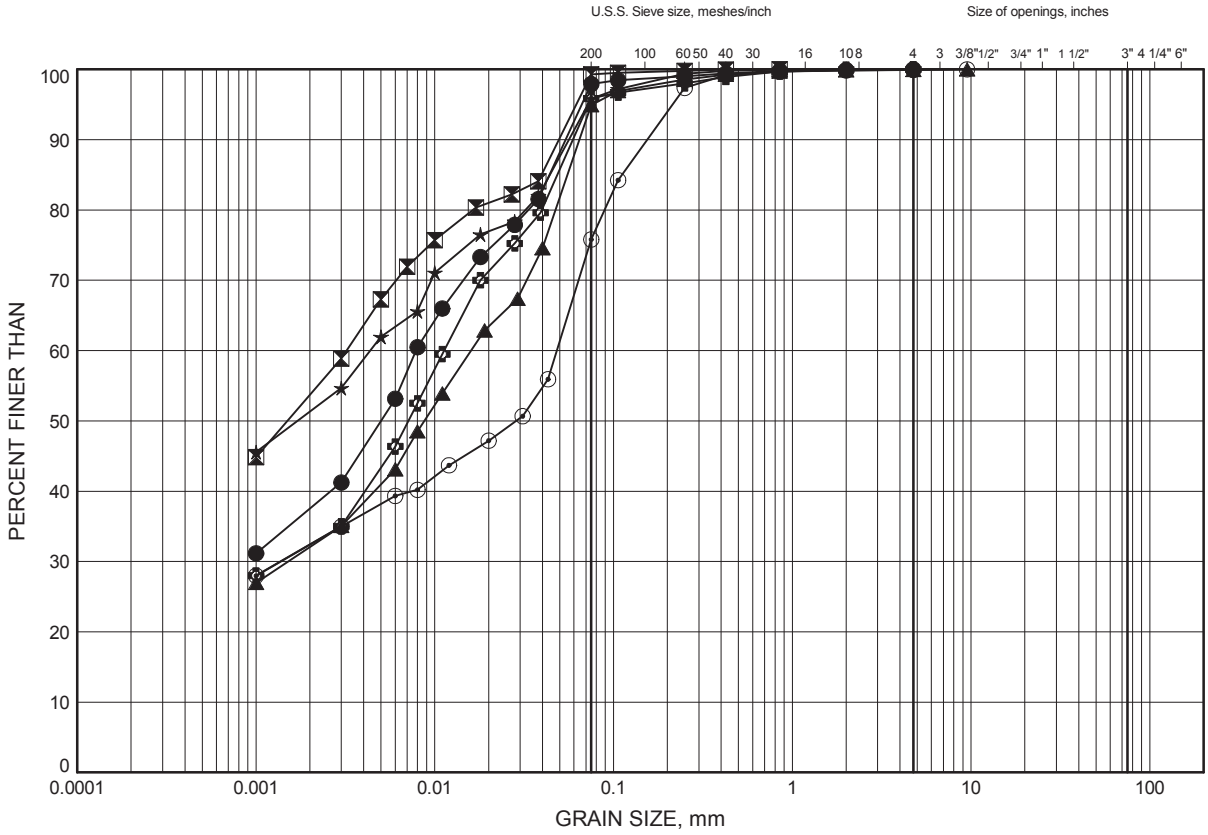
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 17/5/16

Highway 400 Southbound Culvert Replacements

GRAIN SIZE DISTRIBUTION

FIGURE 3

Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	4.11	176.36
⊠	16-1	9.45	171.03
▲	16-2	7.16	175.26
★	16-2	14.02	168.40
⊙	16-3	7.92	175.07
✿	16-4	4.11	176.21

Date June 2016

GWP# 2013-E-0053

THURBER

Prep'd KCP

Chkd. FG

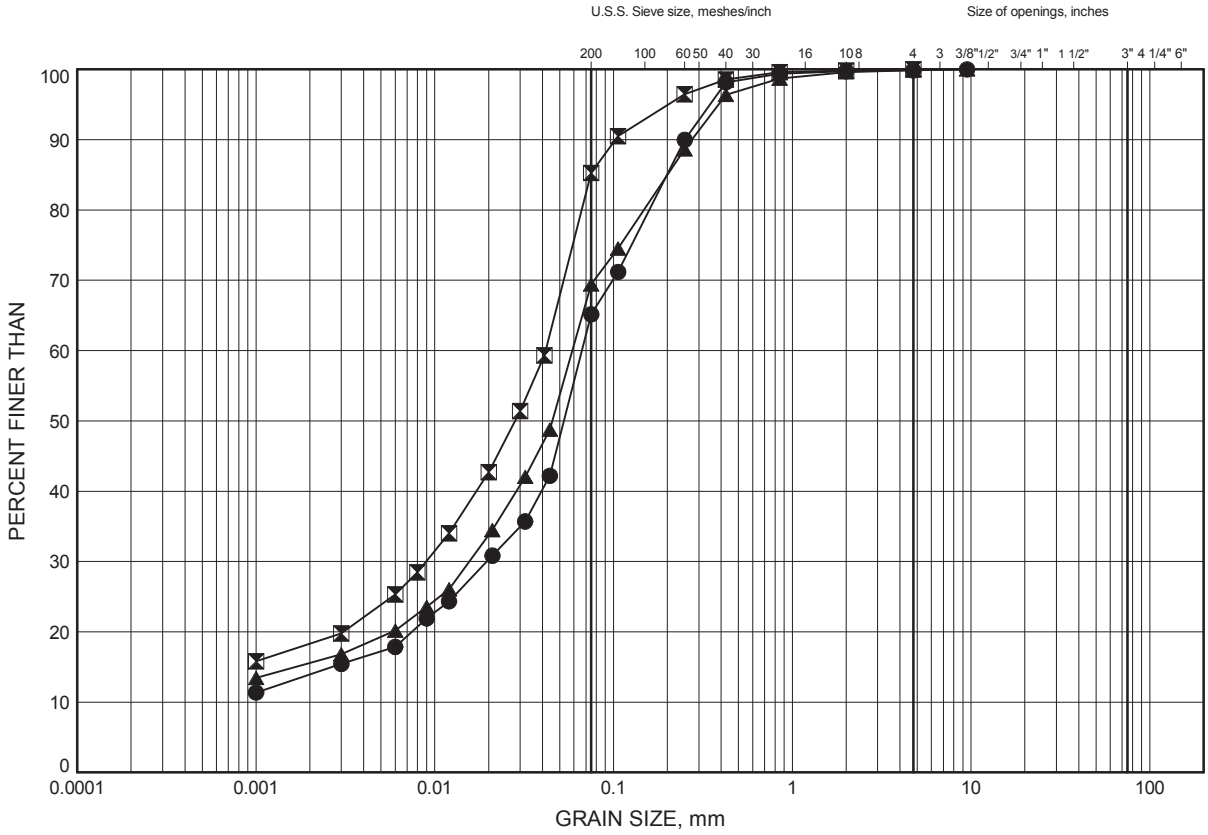
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 2/6/16

Highway 400 Southbound Culvert Replacements

GRAIN SIZE DISTRIBUTION

FIGURE 4

Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	5.64	174.84
⊠	16-2	8.69	173.73
▲	16-4	5.64	174.68

Date June 2016

GWP# 2013-E-0053

THURBER

Prep'd KCP

Chkd. FG

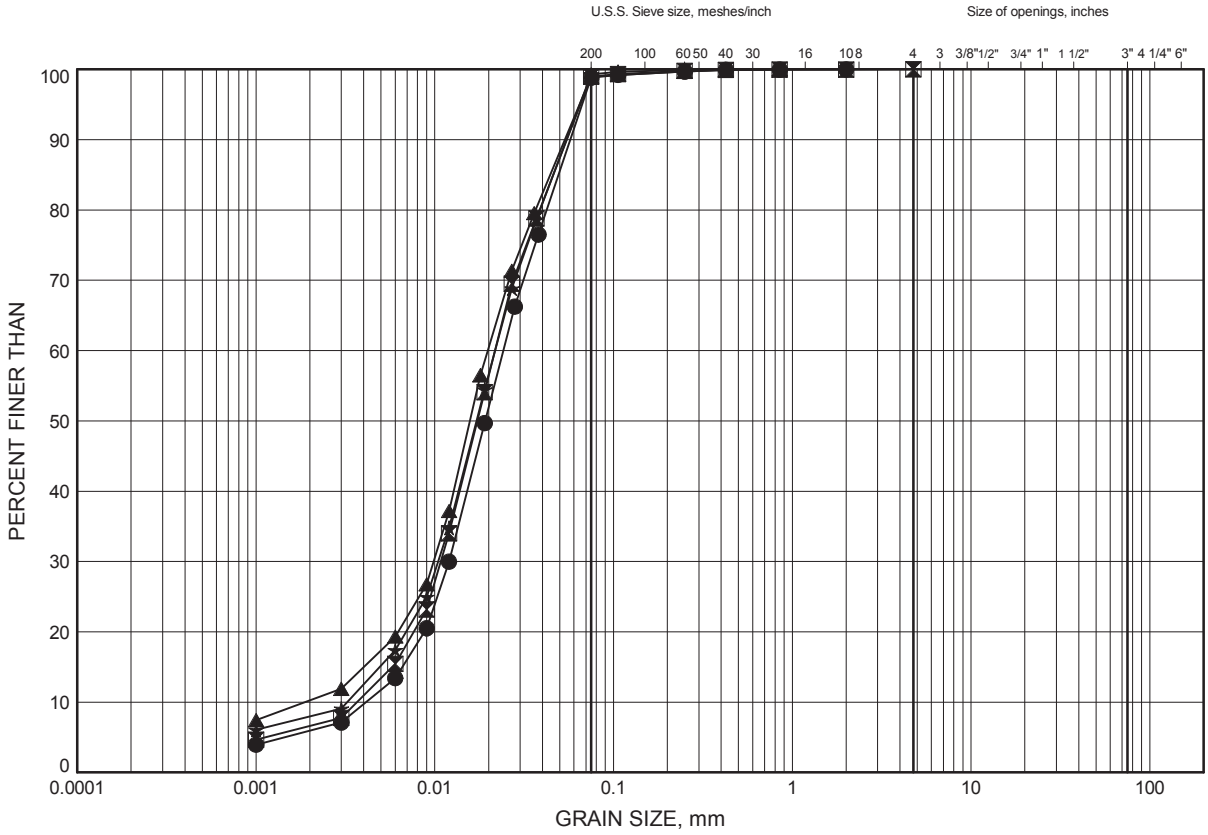
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 2/6/16

Highway 400 SB near Coldwater, ON

GRAIN SIZE DISTRIBUTION

FIGURE 5

Silt (ML)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	15.54	164.93
⊠	16-2	17.07	165.35
▲	16-3	17.07	165.93
★	16-4	15.54	164.78

Date May 2016

GWP# 2013-E-0053

THURBER

Prep'd CM

Chkd. FJG

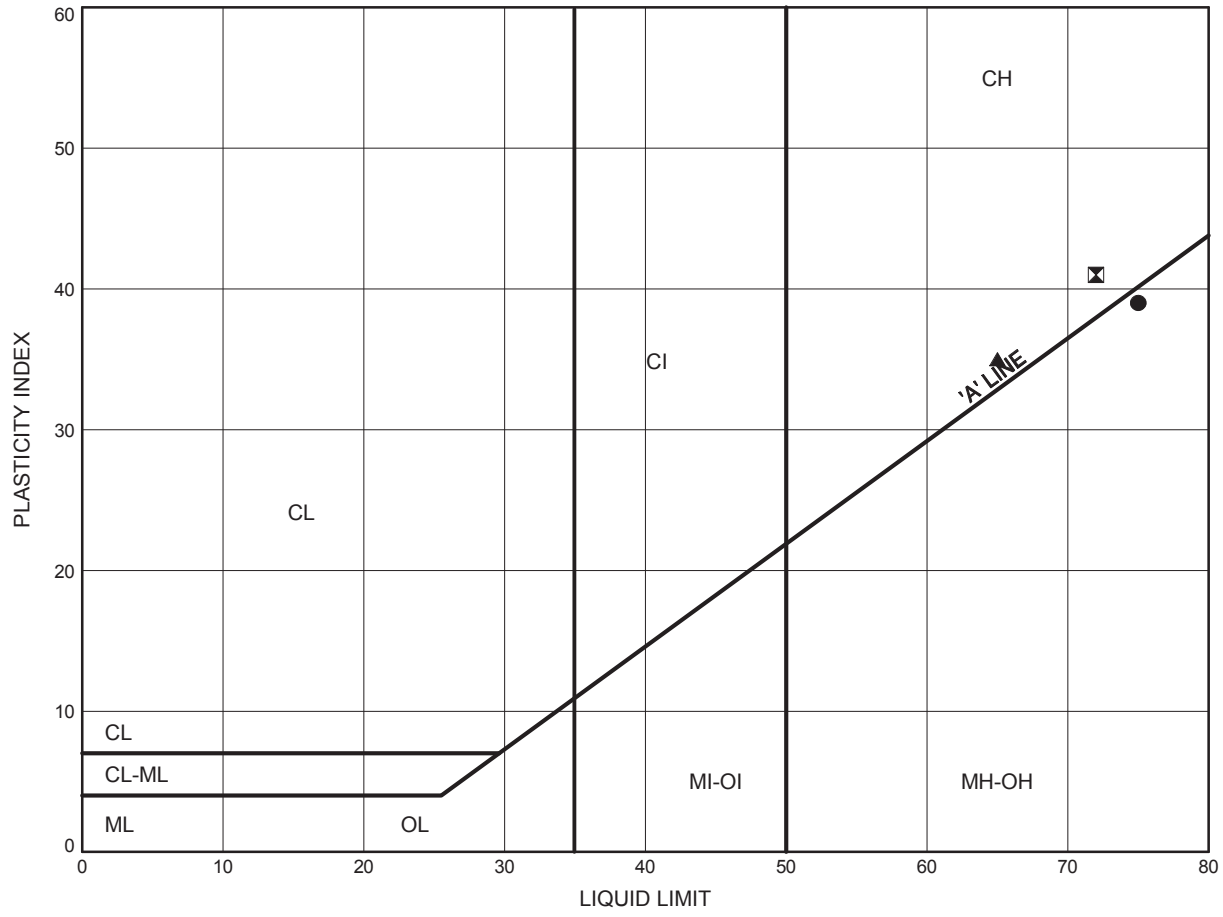
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 17/5/16

Highway 400 SB near Coldwater, ON

ATTERBERG LIMITS TEST RESULTS

FIGURE 6

Organic Silt (MH-OH) to Organic Clay (CH-OH)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	1.07	179.41
⊠	16-2	4.11	178.30
▲	16-3	4.88	178.12

Date May 2016

GWP# 2013-E-0053

THURBER

Prep'd CM

Chkd. FJG

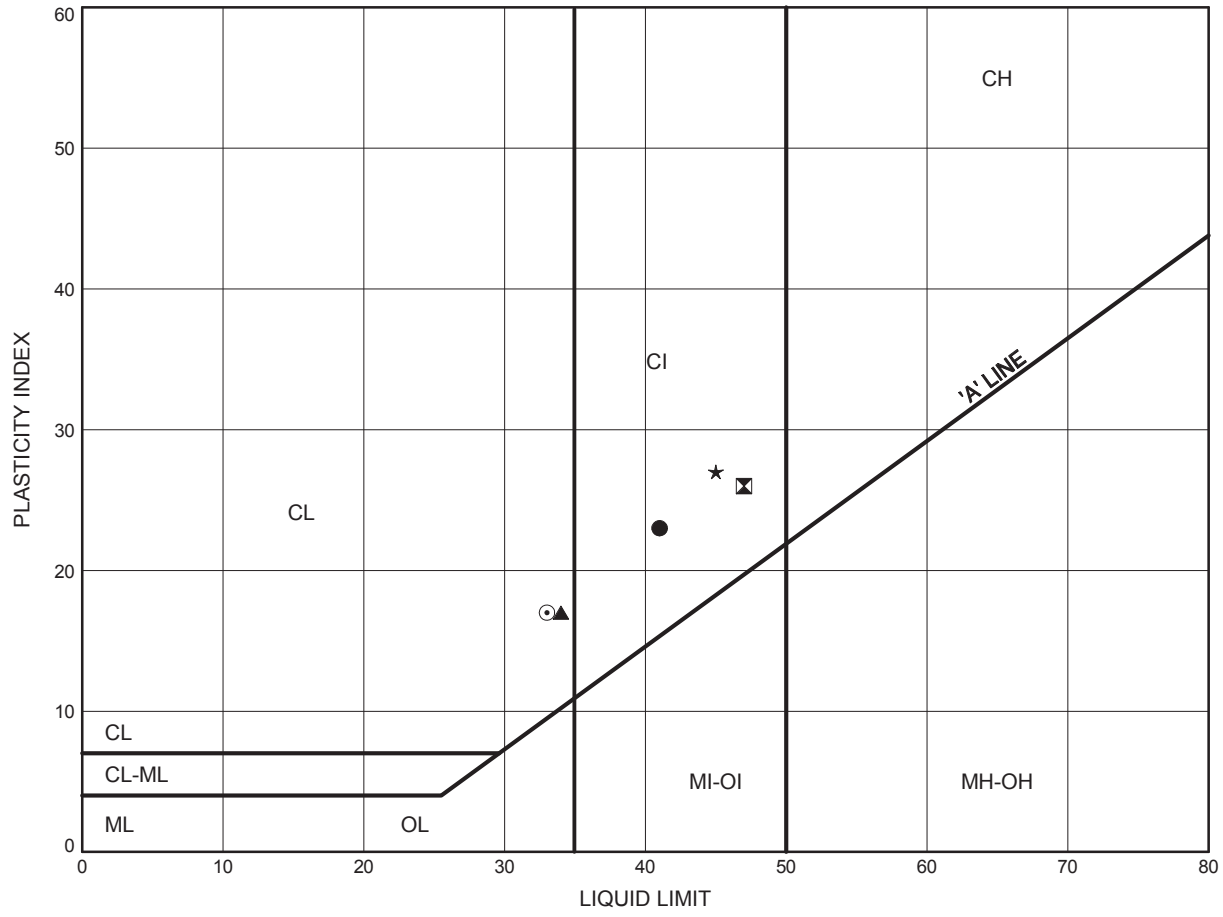
THURBALT 19-3405-5 HWY 400 CULVERTS.GPJ 17/5/16

Highway 400 SB near Coldwater, ON

ATTERBERG LIMITS TEST RESULTS

FIGURE 7

Clay (CL) to Clay (CI)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	4.11	176.36
⊠	16-1	9.45	171.03
▲	16-2	7.16	175.26
★	16-2	14.02	168.40
⊙	16-4	4.11	176.21

Date May 2016

GWP# 2013-E-0053

THURBER

Prep'd CM

Chkd. FJG

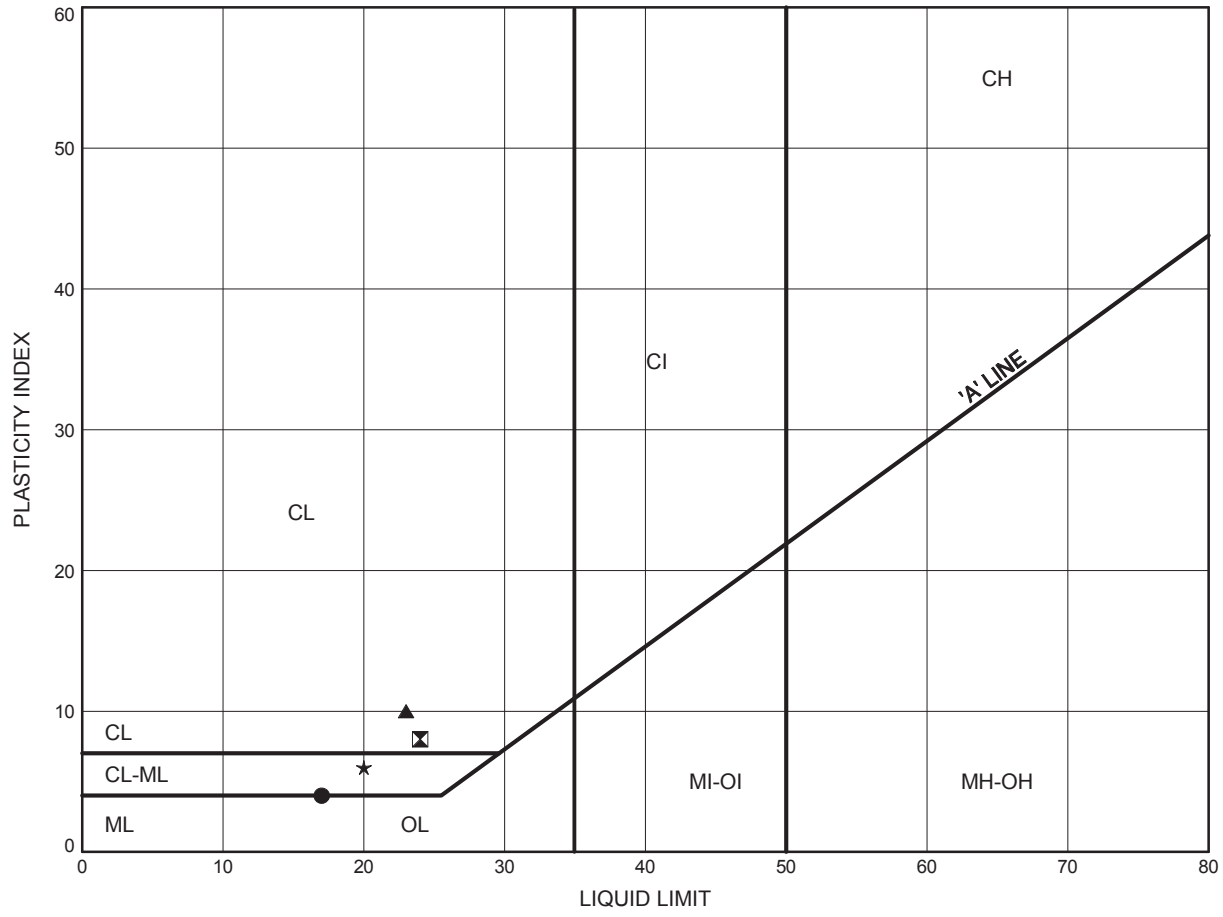
THURBALT 19-3405-5 HWY 400 CULVERTS.GPJ 17/5/16

Highway 400 SB near Coldwater, ON

ATTERBERG LIMITS TEST RESULTS

FIGURE 8

Silty Clay (CL-ML) to Clay (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	5.64	174.84
⊠	16-2	8.69	173.73
▲	16-3	7.92	175.07
★	16-4	5.64	174.68

Date May 2016

GWP# 2013-E-0053

THURBER

Prep'd CM

Chkd. FJG

THURBALT 19-3405-5 HWY 400 CULVERTS.GPJ 17/5/16

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Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Unit 107
Ottawa, ON K1B4S5
Attn: Kenton Power

Client PO:
Project: 19-3405-5
Custody: 27348

Report Date: 5-May-2016
Order Date: 2-May-2016

Order #: 1619039

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1619039-01	BH16-4 SS3 (7'6"-9'6")
1619039-02	BH16-3 SS3 (5'-7')
1619039-03	BH16-8 SS3 (5'-7')
1619039-04	BH16-6 SS4 (7'6-9'6)

Approved By:

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-May-2016
Order Date: 2-May-2016
Project Description: 19-3405-5

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	3-May-16	3-May-16
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	2-May-16	3-May-16
Resistivity	EPA 120.1 - probe, water extraction	5-May-16	5-May-16
Solids, %	Gravimetric, calculation	3-May-16	3-May-16

Certificate of Analysis

Client: Thurber Engineering Ltd.

Client PO:

Report Date: 05-May-2016

Order Date: 2-May-2016

Project Description: 19-3405-5

	Client ID:	BH16-4 SS3 (7'6"-9'6")	BH16-3 SS3 (5'-7')	BH16-8 SS3 (5'-7')	BH16-6 SS4 (7'6-9'6)
	Sample Date:	14-Apr-16	18-Apr-16	13-Apr-16	16-Apr-16
	Sample ID:	1619039-01	1619039-02	1619039-03	1619039-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	58.2	92.5	54.2	87.9
General Inorganics					
pH	0.05 pH Units	6.93	7.74	7.85	6.90
Resistivity	0.10 Ohm.m	18.4	38.9	6.20	8.99
Anions					
Chloride	5 ug/g dry	235	64	952	656
Sulphate	5 ug/g dry	56	21	88	36

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-May-2016
Order Date: 2-May-2016
Project Description: 19-3405-5

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
General Inorganics									
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-May-2016
Order Date: 2-May-2016
Project Description: 19-3405-5

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	22.3	5	ug/g dry	21.5			3.7	20	
Sulphate	40.6	5	ug/g dry	39.9			1.9	20	
General Inorganics									
pH	7.70	0.05	pH Units	7.72			0.3	10	
Resistivity	39.4	0.10	Ohm.m	38.9			1.2	20	
Physical Characteristics									
% Solids	82.3	0.1	% by Wt.	82.0			0.4	25	

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 05-May-2016
Order Date: 2-May-2016
Project Description: 19-3405-5

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	121	5	ug/g	21.5	99.1	78-113			
Sulphate	146	5	ug/g	39.9	106	78-111			

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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Chain of Custody
(Lab Use Only)

№ 27348

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Client Name: Thurber Engineering
Contact Name: Kenton Power
Address: 104-2460 Lancaster Rd Ottawa, ON K1B 4S5
Telephone:

Project Reference: 19-3405-5
Quote #
PO #
Email Address: kpower@thurber.ca

TAT: [X] Regular [ ] 3 Day [ ] 2 Day [ ] 1 Day
Date Required: _____

Criteria: [ ] O. Reg. 153/04 (As Amended) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Paracel Order Number: 1619039

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	Required Analyses: pH	Sulphate	Chloride	Resistivity							
1	BH16-4 SS3 (7'6"-9'6")				2016/04/14	10:34AM	✓	✓	✓	✓			Ziplock				
2	BH16-3 SS3 (5'-7')				2016/04/18	12:43PM	✓	✓	✓	✓			↓				
3	BH16-8 SS3 (5-7')				2016/04/13	3:35PM	✓	✓	✓	✓							
4	BH16-6 SS4 (7'6"-9'6")				2016/04/16	8:45AM	✓	✓	✓	✓			✓				
5																	
6																	
7																	
8																	
9																	
10																	

Comments:

Method of Delivery: Walk-in

Relinquished By (Sign):	Received by Driver/Depot:	Received at Lab:	Verified By:
Relinquished By (Print): Kenton Power	Date/Time:	Date/Time: May 2/16	Date/Time: May 2/16 1:25
Date/Time: 2016/05/02	Temperature: ____ °C	Temperature: ____ °C 12:39p	pH Verified [X] By: NA

APPENDIX D

SELECTED PHOTOGRAPHS OF CULVERT LOCATION

Figure 1: Roadway Platform at southbound Culvert Site looking north

Figure 2: Looking east downstream from culvert outlet

Figure 3: Existing condition of culverts and embankment at outlet

Figure 4: Looking towards the west upstream from culvert inlets

Figure 5: Existing condition of culverts and embankment at inlet