FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF CULVERT No. CV-0252-0400-0075
HIGHWAY 400 NORTHBOUND
TOWNSHIP OF SEVERN
G.W.P. 2041-13-00
2013-E-0053

GEOCRES NUMBER: - 31D-663

SUBMITTED TO

MCINTOSH PERRY CONSULTING ENGINEERS

September 2016
19-3405-5

Table of Contents

PART 1: FACTUAL INFORMATION

APPENDICES

FOUNDATION INVESTIGATION REPORT
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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-0252-0400-0075 (Site) located on Highway 400 northbound, within the Township of Severn. Thurber carried out the investigation as a sub-consultant to McIntosh Perry Consulting Engineers (MPCE) as part of 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 northbound 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 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 northbound consists two, 4.0 m wide lanes with a rural cross-section, and granular shoulders that are approximately 3.0 m and 1.5 m wide on the east and west side of the highway respectively. Based on the information provided by MPCE the existing twin CSP culverts have an internal diameter of 1.4 m and a length of 28.7 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 3.8H:1V (Horizontal:Vertical) and 3.3H: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 182.12 m. The elevation of the top of the culvert was surveyed by Thurber at Elevation 180.57 m and Elevation 180.55 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 top of streambed was measured at an elevation ranging from 179.35 m and 179.21 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)
16-5	Inlet	Portable / N casing	4 950 959.1	292 980.5	179.8	14.3
16-6	West shoulder	Truck mount CME75 / HSA	4 950 968.2	292 988.1	181.8	18.9
16-7	East shoulder	ATV mount CME55 / HSA	4 950 965.7	292 999.4	182.3	23.5
16-8	Outlet	ATV mount CME55 / HSA	4 950 966.6	293 010.5	180.4	24.8

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 16-7. 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 16-8 to measure the groundwater level at the site. Construction details for the piezometer are illustrated on the Record of Borehole sheet for Borehole 16-8, 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 a temporary benchmarks (TBM) BM1240 and BM1484 provided by MPCE. The geodetic elevations for the TBMs are 181.424 m and 180.448 m for BM1240 and BM1484 respectively. The location of the TBMs 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 with peat, overlying clay with a silty clay layer within it, overlying silt to sandy silt overlying silty sand, and underlain by probable bedrock.

More detailed descriptions of the individual strata are presented below.

4.2 Embankment Fill

A fill layer consisting predominantly of sand, with varying amounts of silt and gravel was encountered from surface in all boreholes. This material contained organics at the inlet and outlet boreholes. This layer has a top elevation ranging from 182.3 m to 179.8 m and has a thickness of 0.5 m to 3.8 m. The SPT ‘N’ values ranged from 3 to 23 blows per 0.3 m of penetration; indicating a loose to compact condition. Occasional cobbles were noted in this fill layer.

The moisture content for the samples tested ranged from 3% to 47%. The higher moisture content likely reflects the presence of organics in the sand fill. 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	12 and 13
Sand	75 and 73
Silt and Clay	13 and 14

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

A dark grey organic silt to clay layer was encountered below the embankment fill in all boreholes. This stratum has a top elevation ranging from 178.2 m to 179.6 m and a thickness ranging from 600 mm to 2.3 m. In-situ shear vane test results indicated undrained shear strengths of this

deposit ranging from 18 kPa to 77 kPa; indicating a soft to stiff consistency; but typically soft to firm.

The moisture content of the samples tested ranged from 27% to 87%. The results of a grain size analysis test conducted on a sample of this material indicates a gravel content of 0%, a sand content of 3%, a silt content of 55% and clay content of 42%.

The results of Atterberg Limits testing indicate a liquid limit of 59, a plastic limit of 31 and plasticity of 28 and are illustrated on Figure 8 in Appendix C.

4.4 Peat

A thin layer of peat was encountered beneath the organic clay strata in Borehole 16-6. This layer has a top elevation of 177.6 m and has a thickness of 300 mm. The moisture content for a sample tested was 336%. The results of organic content testing according to ASTM D2974 conducted on a sample of this material indicated an organic content of 42%.

4.5 Clay (CL to CH) with Interlayered Silty Clay (CL-ML)

A clay layer was encountered below the organic silt to clay layer in all boreholes except in Borehole 16-6 where it was encountered beneath the peat layer. This stratum has a top elevation ranging from 176.2 m to 177.9 m and has a thickness ranging from 8.7 m to 11.5 m. In-situ shear vane test results indicated undrained shear strengths ranging from 15 kPa to 82 kPa; indicating a soft to stiff consistency; but typically soft to firm. A silty clay layer was noted interlayered within the clay layer in Boreholes 16-5 and 106-7 with a thickness ranging from 3.2 m to 3.4 m.

The moisture content for the samples tested ranged from was 25% to 68%. The results of grain size analysis conducted on samples of this material are summarized in Table 4-2 and are illustrated on Figures 7 and 8 in Appendix C.

Table 4-2: Gradation Results for Clay

Soil Particles	%
Gravel	0
Sand	0 to 30
Silt	38 to 69
Clay	14 to 62

The results of Atterberg Limits testing completed on five samples of this material are summarized in Table 4-5 and are illustrated on Figures 7 and 8 in Appendix C. The results indicate a clay of low to high plasticity.

Table 4-3: Atterberg Limits Test Results

Liquid Limit	19 to 56
Plastic Limit	13 to 22
Plasticity Index	4 to 34

4.6 Silt to Sandy Silt (ML)

A stratum of silt with varying amounts of sand was encountered beneath the clay layer in all boreholes. This stratum has a top elevation ranging from 166.5 m to 167.5 m and has a thickness where completely penetrated ranging from 1.5 m to 6.1 m. Boreholes 16-5 was terminated in this material. The SPT 'N' values were weight of hammer to 17 blows per 0.3 m of penetration; indicating a very loose to compact condition; but typically very loose to loose. This may indicate a hydraulic disturbance of the silt layer.

The moisture content for the samples tested ranged from 28% to 45%. The results of grain size analysis including hydrometer analysis conducted on four samples of this material are summarized in Table 4-8 and are illustrated on Figure 5 in Appendix C.

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

Soil Particles	%
Gravel	0 to 10
Sand	1 to 41
Silt	89 to 93
Clay	6 to 10
Silt and Clay	49 to 61

Based on the results of Atterberg limit testing, this material was determined to be non plastic.

4.7 Silty Sand (SM) to Silty Sand (SM) with Gravel

A sand layer, with varying amounts of silt and gravel was encountered beneath the silt layer in all boreholes expect Borehole 16-5. This layer has a top elevation ranging from 165.5 m to 161.0 m and has a thickness where completely penetrated of 2.6 m to 5.4 m. Borehole 16-5 was terminated in this layer. The SPT 'N' values ranged from 1 to 22 blows per 0.3 m of penetration; indicating a very loose to compact condition; but typically compact.

The moisture content for the samples tested ranged from 10% to 23%. The results of grain size analysis conducted on samples of this material are summarized in Table 4-5 and are illustrated on Figure 6 in Appendix C.

Table 4-5: Gradation Results for Embankment Fill

Soil Particles	%
Gravel	0 and 36
Sand	38 and 75
Silt and Clay	18 and 50

4.8 Refusal on Probable Bedrock

Refusal on probable bedrock was encountered at 23.9 m and 24.8 m in Boreholes 16-7 and 16-8.

4.9 Groundwater

The groundwater level in the piezometer installed in Borehole 16-8 was recorded on April 19, 2016 at a depth of 0.82 m; corresponding to an elevation of 179.6 m.

The water level in the creek was measured at the time of Thurber's field investigation at an elevation ranging from 179.2 m to 179.5 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 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 and Walker Drilling Ltd of Utopia, Ontario and 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.

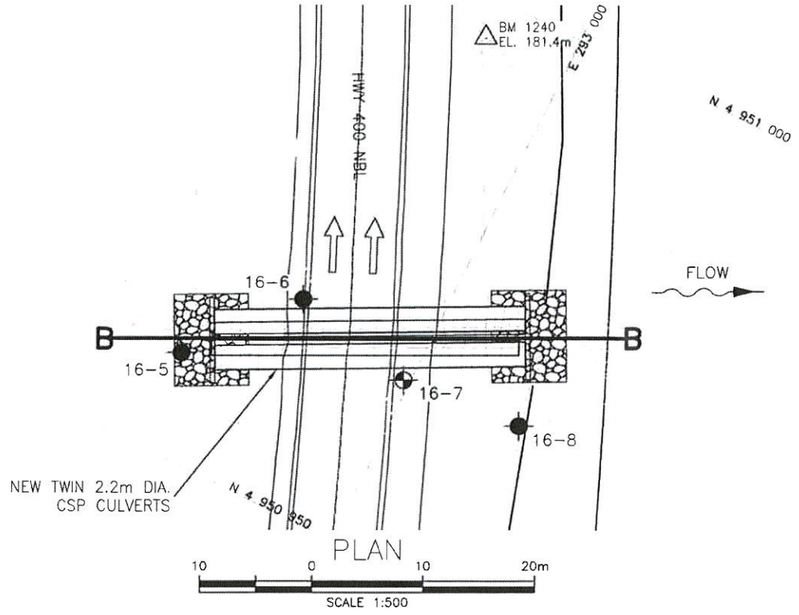
Overall project management and direction of the field program was provided by Kenton Power, P.Eng. Interpretation of the field data and preparation of this report was completed by Kenton Power, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations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

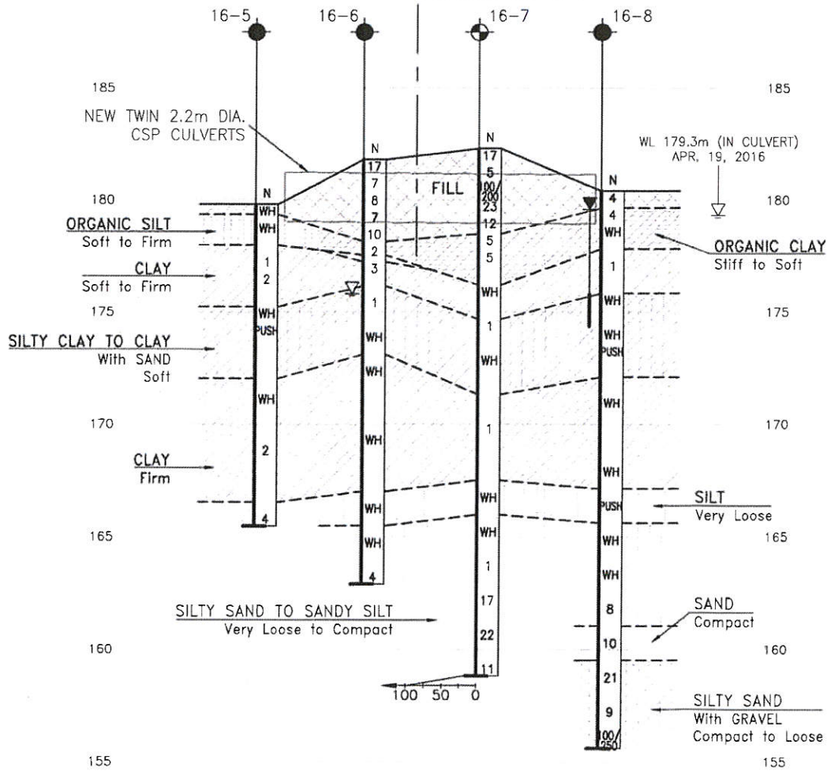
Kenton C. Power, P.Eng.
Geotechnical Engineer

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

APPENDIX A

BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS





SECTION B-B

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

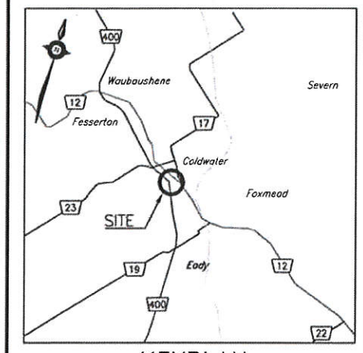
CONT No
WP No 2183-13-00

SHEET

HIGHWAY 400 NB
COLDWATER CULVERT
CV-0252-0400-0075
BOREHOLE LOCATIONS AND SOIL STRATA

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
16-5	179.8	4 950 959.1	292 980.5
16-6	181.8	4 950 968.2	292 986.1
16-7	182.3	4 950 965.7	292 999.4
16-8	180.4	4 950 966.6	293 010.5

-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-663

LICENSED PROFESSIONAL ENGINEER
K.T.C. POWER
100130652
Sept 6/2016
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\03\Ver4805-PlanProfile(Culvert).dwg
PLOTDATE: 8/26/2016 10:47 AM

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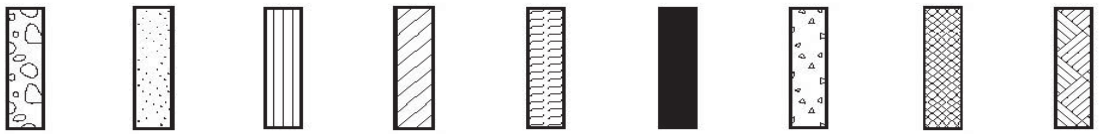
STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



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

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RECORD OF BOREHOLE No 16-5 1 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 959.1 E 292 980.5 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Portable / N-Casing COMPILED BY CAM

DATUM Geodetic DATE 2016.11.04 - 2016.12.04 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
179.8											
0.0	SAND with Organics Brown Very Loose		1	SS	WH						
179.3	**FILL**										
0.5	**ORGANIC SILT (MH-OH)** Soft to Firm Dark Grey		2	SS	WH		179				0 3 55 42
177.9							178	4.5 3.2			
1.8	**CLAY (CI)** Soft to Firm Grey		3	SS	1		177				0 2 59 39
			4	SS	2		176	6.0 5.1			
175.2											
4.6	**SILTY CLAY (CL-ML)** Soft Grey		5	SS	WH		175				0 14 69 17
			6	GS	PUSH		174				
							173	4.0 4.0			
172.0							172				
7.8	**CLAY (CI)** Firm Grey		7	SS	WH		171				0 0 38 62
							170	7.0 7.3			

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 16-5 2 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 959.1 E 292 980.5 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Portable / N-Casing COMPILED BY CAM

DATUM Geodetic DATE 2016.11.04 - 2016.12.04 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
	Continued From Previous Page										
	CLAY (CI) Firm Grey						169				
			8	SS	2				○		
							168				
								3.7 +			
								3.7 +			
166.5							167				
13.3	**SILT (ML)** Very Loose Grey										
			9	SS	4		166		○		
165.4											
14.3	End of Borehole at 14.3 m Water at 0 m on completion of drilling										

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

15 20 10 5 (%) STRAIN AT FAILURE

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

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THURBER

RECORD OF BOREHOLE No 16-6 1 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 968.2 E 292 988.1 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 (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
181.8								20 40 60 80 100	20 40 60		
0.0	SAND with Gravel Compact Brown		1	SS	17						
181.4 0.5	**FILL**										
	SILTY SAND Loose to Compact Brown **FILL**		2	SS	7		181				13 73 14 (SI+CL)
			3	SS	8		180				
			4	SS	7		179				
	- Cobbles from 3.0 m to 3.6 m		5	SS	10						
178.2 3.7	**ORGANIC CLAY (CH-OH)** Stiff Dark Grey		6	SS	2		178		336		
177.6 4.3	**PEAT**										42% organic content
177.3 4.6	Soft Black		7	SS	3		177	6.4			
	CLAY (CI) Stiff Grey							4.9			
176.2 5.6	**CLAY (CL)** with Sand Soft to Firm Grey		8	SS	1	▽	176				0 17 53 30
							175	7.5			
			9	SS	WH		174				0 6 67 27
173.1 8.7	**CLAY (CH)** Firm Grey						173				
			10	SS	WH		172				

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 16-6 2 OF 2 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 968.2 E 292 988.1 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 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 (%) GR SA SI CL
	Continued From Previous Page										
	CLAY (CH) Firm Grey						171	3.8 9.0			
							170				
			11	SS	WH				○		0 1 38 61
							169				
167.0							168	3.4 3.3			
14.8	**SILT (ML)** Very Loose Grey						167				
			12	SS	WH				○		0 1 93 6
165.5							166				
16.3	**SILTY SAND (SM)** Very Loose to Loose Grey						165				
			13	SS	WH						
							164				
			14	SS	4				○		0 50 50 (SI+CL)
162.9							163				
18.9	End of Borehole at 18.9 m Water at 6.0 m on completion of drilling										

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

(%) 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 16-7 1 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 965.7 E 292 999.4 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.13 - 2016.04.13 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
182.3								20 40 60 80 100	20 40 60		
0.0	SAND with Gravel Compact Brown **FILL**		1	SS	17		182				
181.5											
0.8	SILTY SAND, some gravel Loose to Compact Brown **FILL**		2	SS	5		181				
	- Cobbles from 1.8 m to 3.1 m		3	SS	100/ 200mm						
			4	SS	23		180				12 75 13 (SI+CL)
178.5			5	SS	12	▽	179				
3.8	**ORGANIC CLAY (CH-OH)** Stiff Dark Grey		6	SS	5		178				
			7	SS	5		177	5.5 3.0			
176.2											
6.1	**CLAY (CL)** Soft to Stiff Grey		8	SS	WH		176				0 2 61 37
174.7							175	2.5			
7.6	**SILTY CLAY (CL-ML)** with Sand Soft Grey		9	SS	1						0 30 56 14
							174	6.0			
			10	SS	WH		173				

Continued Next Page

+ ^{3}, × ^{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 16-7 2 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 965.7 E 292 999.4 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.13 - 2016.04.13 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
	Continued From Previous Page										
171.3							172				
11.0	**CLAY (CI)** Firm Grey						171	3.6			
			11	SS	1		170				
							169	6.0 3.1			
167.5							168				
14.8	**SILT (ML)** Very Loose Grey						167				
			12	SS	WH						0 1 92 7
166.0							166				
16.3	**Sandy SILT (ML)** Very Loose to Compact Grey										
			13	SS	WH		165				
							164				
			14	SS	1						10 41 49 (SI+CL)
							163				

Continued Next Page

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

$\frac{20}{15}$ 5 $\frac{}{10}$ (%) 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 16-7 3 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 965.7 E 292 999.4 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.13 - 2016.04.13 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) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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
	Continued From Previous Page		15	SS	17		162		○		
161.4											
20.9	**Silty SAND (SM)** Compact Grey		16	SS	22		161		○		7 75 18 (SI+CL)
							160				
158.8			17	SS	11		159		○		7 56 37 (SI+CL)
23.5	End of Borehole at 23.5 m DCPT driven from 23.5 m to refusal on probable bedrock at 23.9 m Water at 3.0 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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-8 1 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 966.6 E 293 010.5 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.13 - 2016.04.14 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
180.4											
0.0	SAND with Organics Loose Brown **FILL**		1	SS	4		180				
179.6											
0.8	**ORGANIC CLAY (CH-OH)** Stiff to Soft Dark Grey		2	SS	4		179				
			3	SS	WH				88		
177.8							178	3.5 2.8			
2.6	**CLAY (CI)**, occasional Peat seams Firm Grey		4	SS	1		177	6.2 3.6			
175.8							176				
4.6	**CLAY (CL)** with Sand Soft Grey		5	SS	WH						0 12 55 33
			6	SS	WH		175	1.9			
			7	GS	PUSH		174				
172.1							173	4.0 3.0			
8.3	**CLAY (CI)** Firm Grey		8	SS	WH		172				
							171				

Continued Next Page

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-8 2 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 966.6 E 293 010.5 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.13 - 2016.04.14 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
	Continued From Previous Page										
	CLAY (CI) Firm Grey						170	4.0 5.8			
							169				
			9	SS	WH		168				
167.1											
13.3	**SILT (ML)** Very Loose Grey						167				
			10	GS	PUSH		166				0 1 89 10
165.6											
14.8	**Sandy SILT (ML)** Very Loose to Loose Grey						165				
			11	SS	WH		164				
			12	SS	WH		163				0 39 61 (SI+CL)
							162				
			13	SS	8						
161.0							161				
19.4	**Silty SAND (SM)** Compact Grey										

Continued Next Page

$+^3$, $\times^3$: 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 16-8 3 OF 3 METRIC

GWP# 2041-13-00 LOCATION Highway 400 NB Severn, ON N 4 950 966.6 E 293 010.5 ORIGINATED BY CAM

HWY Highway 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CAM

DATUM Geodetic DATE 2016.04.13 - 2016.04.14 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
	Continued From Previous Page		14	SS	10		160		○		
159.5											
20.9	**SILTY SAND (SM)** with Gravel Compact to Loose Grey		15	SS	21		159		○		
							158				
			16	SS	9		157		○		
							156				
155.6			17	SS	100/250mm				○		36 38 26 (SI+CL)
24.8	End of Borehole at 24.8 m on probable Bedrock Groundwater level was measured at 0.82m BGS on April 19, 2016										

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

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

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

APPENDIX C

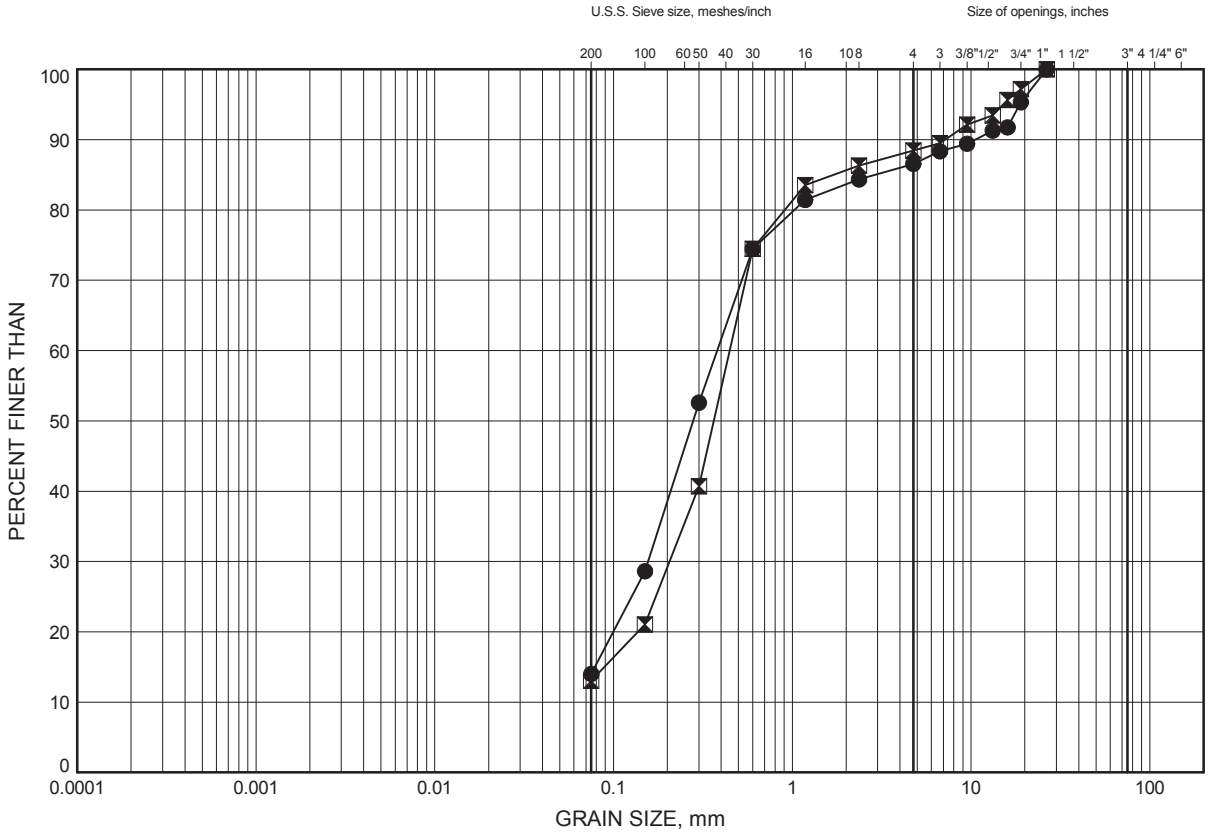
LABORATORY TEST RESULTS

Highway 400 Northbound Culvert Replacements

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)
●	16-6	1.07	180.76
⊠	16-7	2.59	179.71

Date July 2016

GWP# 2041-13-00

THURBER

Prep'd KCP

Chkd. PK

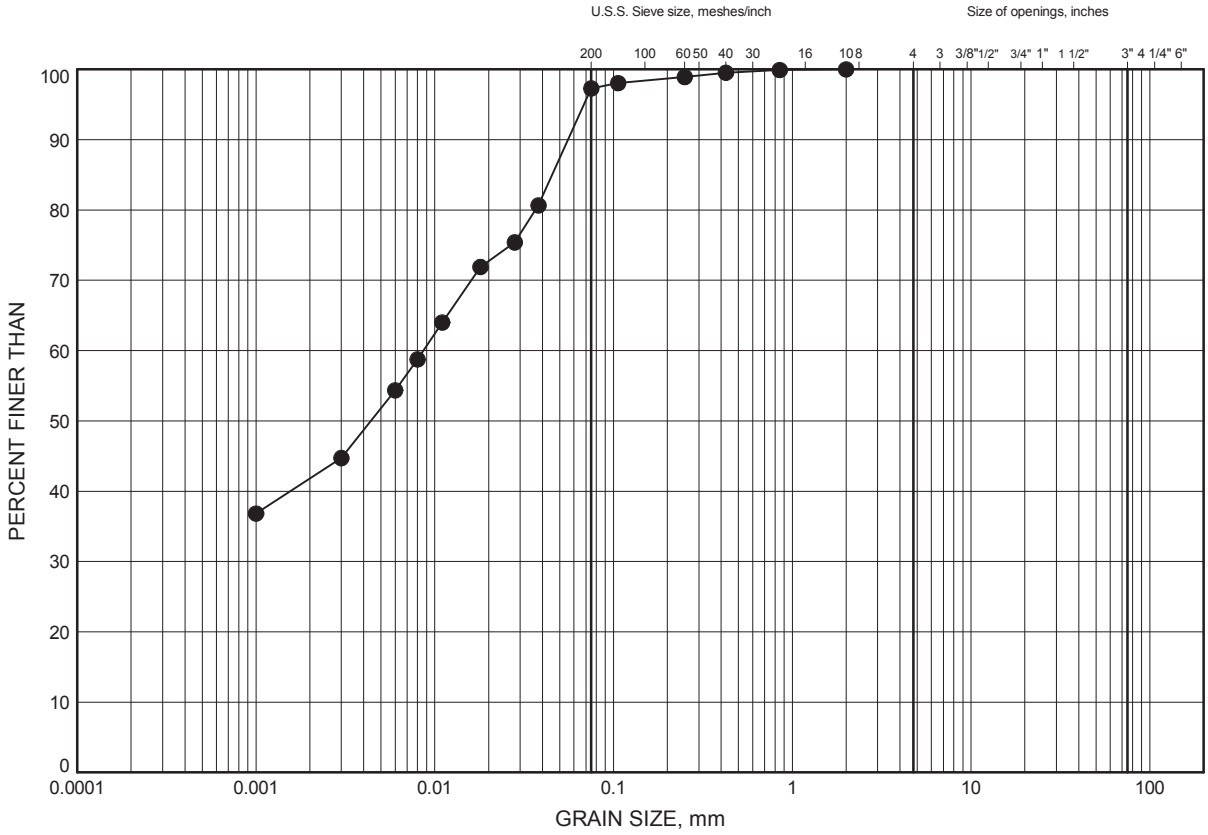
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 14/7/16

Highway 400 Northbound Culvert Replacements

GRAIN SIZE DISTRIBUTION

FIGURE 2

Organic Silt and Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-5	1.07	178.69

Date July 2016

GWP# 2041-13-00

THURBER

Prep'd KCP

Chkd. PK

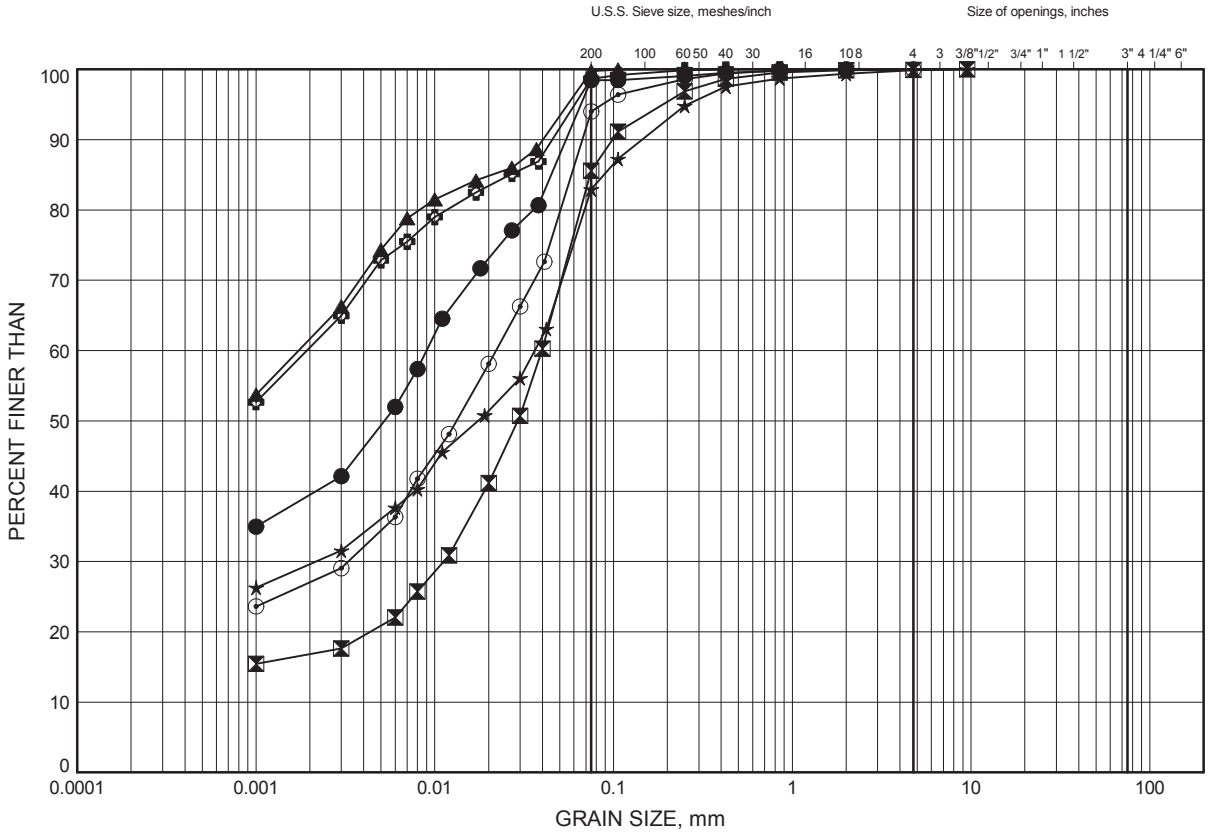
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 14/7/16

Highway 400 Northbound 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)
●	16-5	2.59	177.16
⊠	16-5	4.88	174.88
▲	16-5	8.69	171.07
★	16-6	6.40	175.42
⊙	16-6	7.92	173.90
✿	16-6	12.50	169.33

Date July 2016

GWP# 2041-13-00

THURBER

Prep'd KCP

Chkd. PK

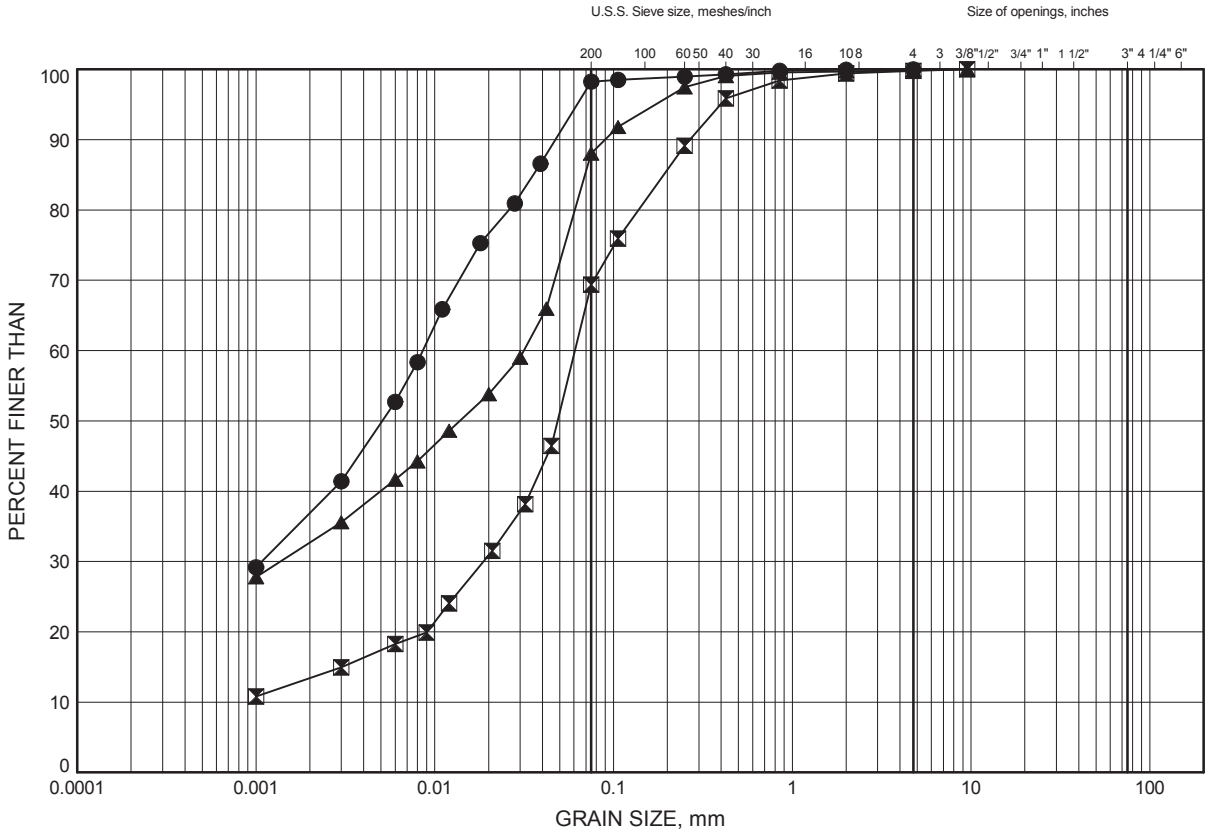
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 14/7/16

Highway 400 Northbound 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)
●	16-7	6.40	175.90
⊠	16-7	7.92	174.38
▲	16-8	4.88	175.48

Date July 2016

GWP# 2041-13-00

THURBER

Prep'd KCP

Chkd. PK

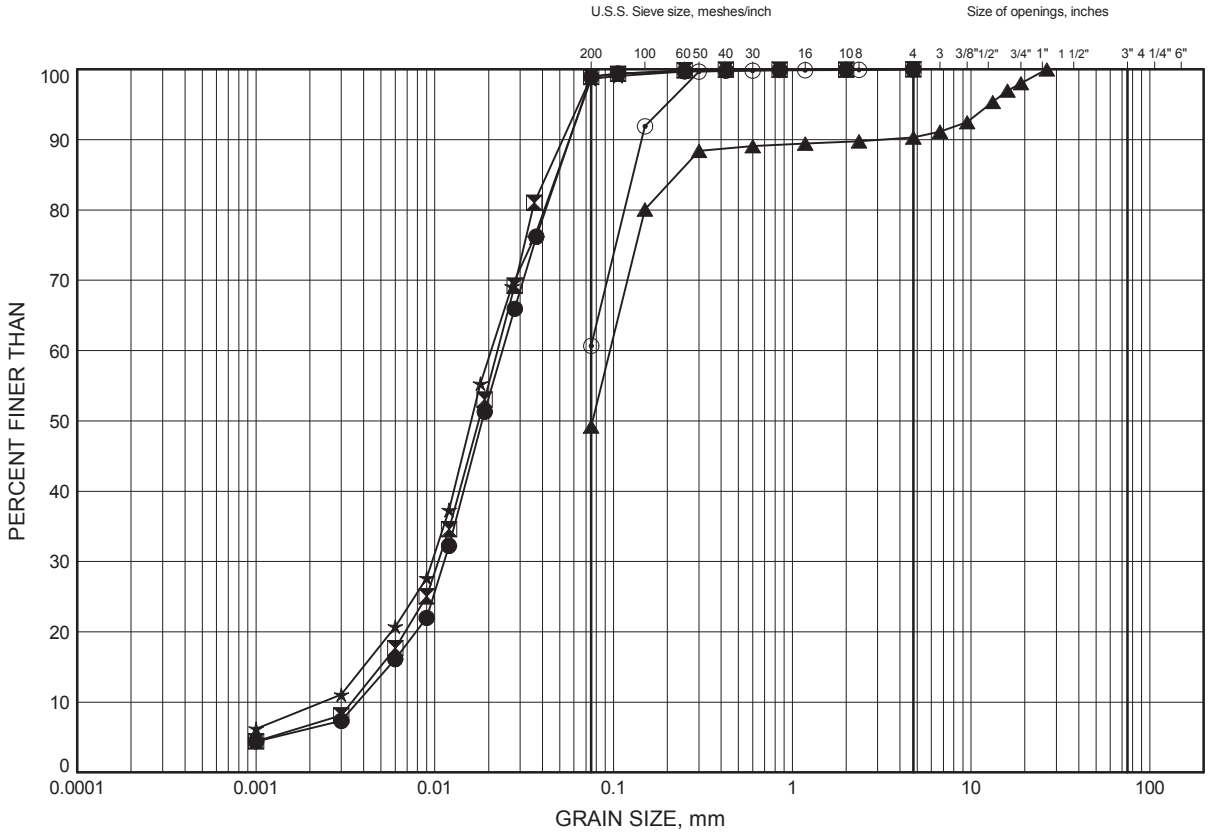
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 14/7/16

Highway 400 Northbound Culvert Replacements

GRAIN SIZE DISTRIBUTION

FIGURE 5

Silt to Sandy Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-6	15.54	166.28
⊠	16-7	15.54	166.76
▲	16-7	18.59	163.71
★	16-8	14.02	166.34
⊙	16-8	17.07	163.29

Date July 2016

GWP# 2041-13-00

THURBER

Prep'd KCP

Chkd. PK

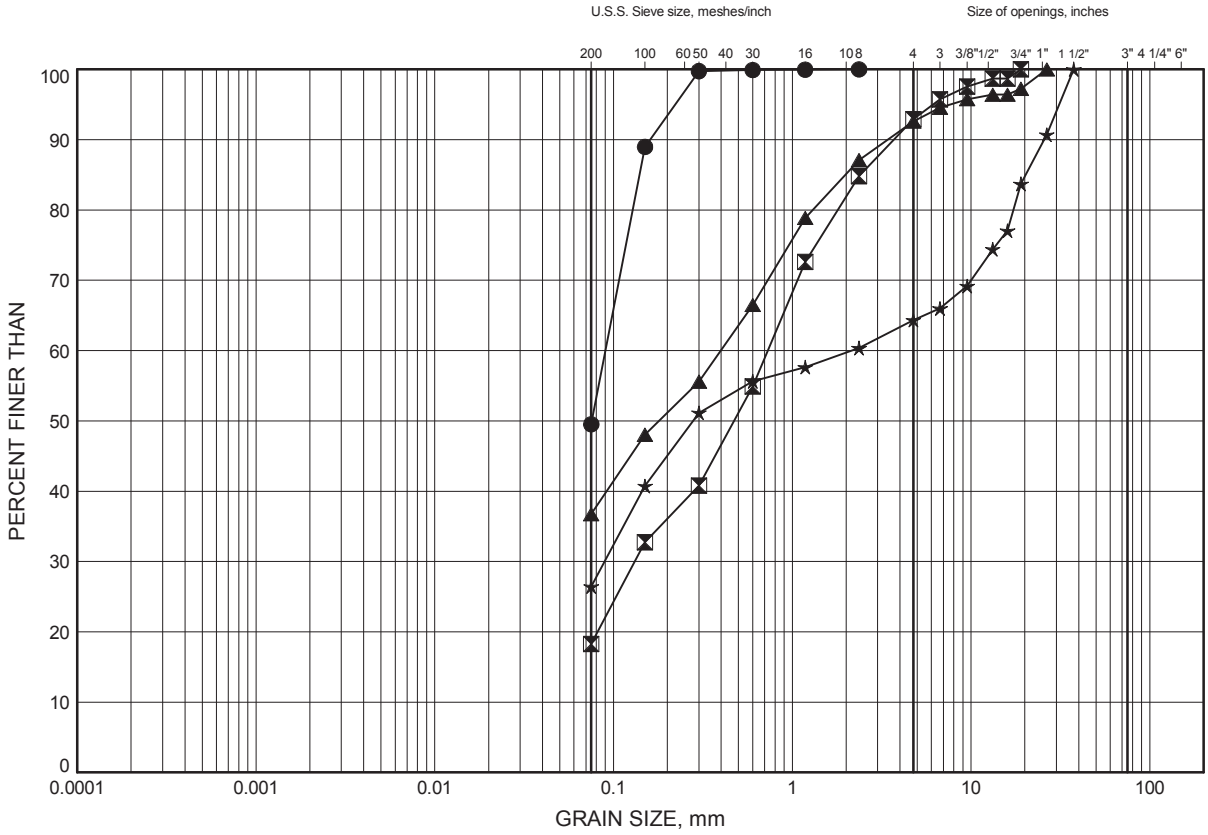
GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 14/7/16

Highway 400 Northbound Culvert Replacements

GRAIN SIZE DISTRIBUTION

FIGURE 6

Sand to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-6	18.59	163.23
⊠	16-7	21.64	160.66
▲	16-7	23.16	159.14
★	16-8	24.59	155.77

Date July 2016

GWP# 2041-13-00

THURBER

Prep'd KCP

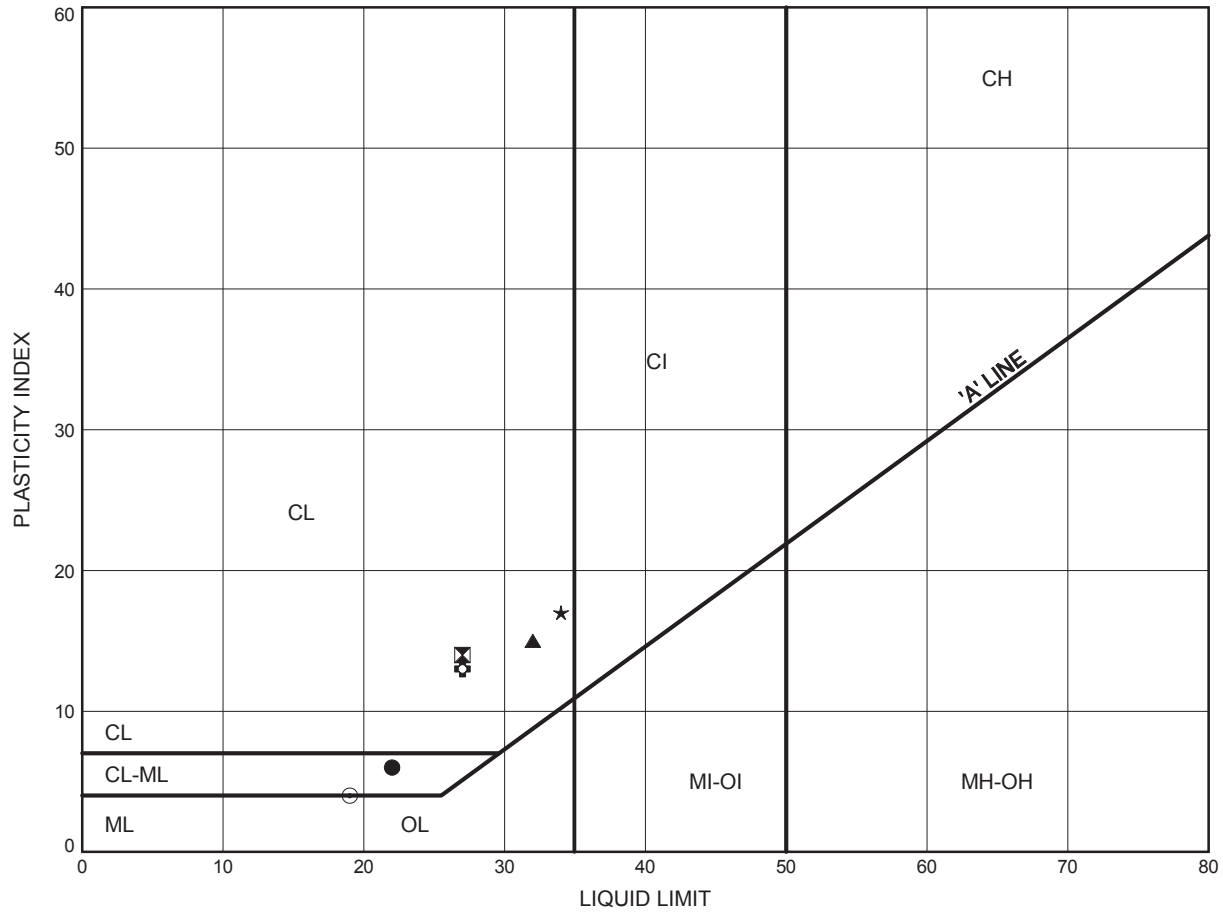
Chkd. PK

GRAIN SIZE DISTRIBUTION - THURBER 19-3405-5 HWY 400 CULVERTS.GPJ 14/7/16

Highway 400 Northbound Culvert Replacements

ATTERBERG LIMITS TEST RESULTS

FIGURE 7



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-5	4.88	174.88
⊠	16-6	6.40	175.42
▲	16-6	7.92	173.90
★	16-7	6.40	175.90
⊙	16-7	7.92	174.38
✿	16-8	4.88	175.48

Date July 2016

GWP# 2041-13-00

THURBER

Prep'd KCP

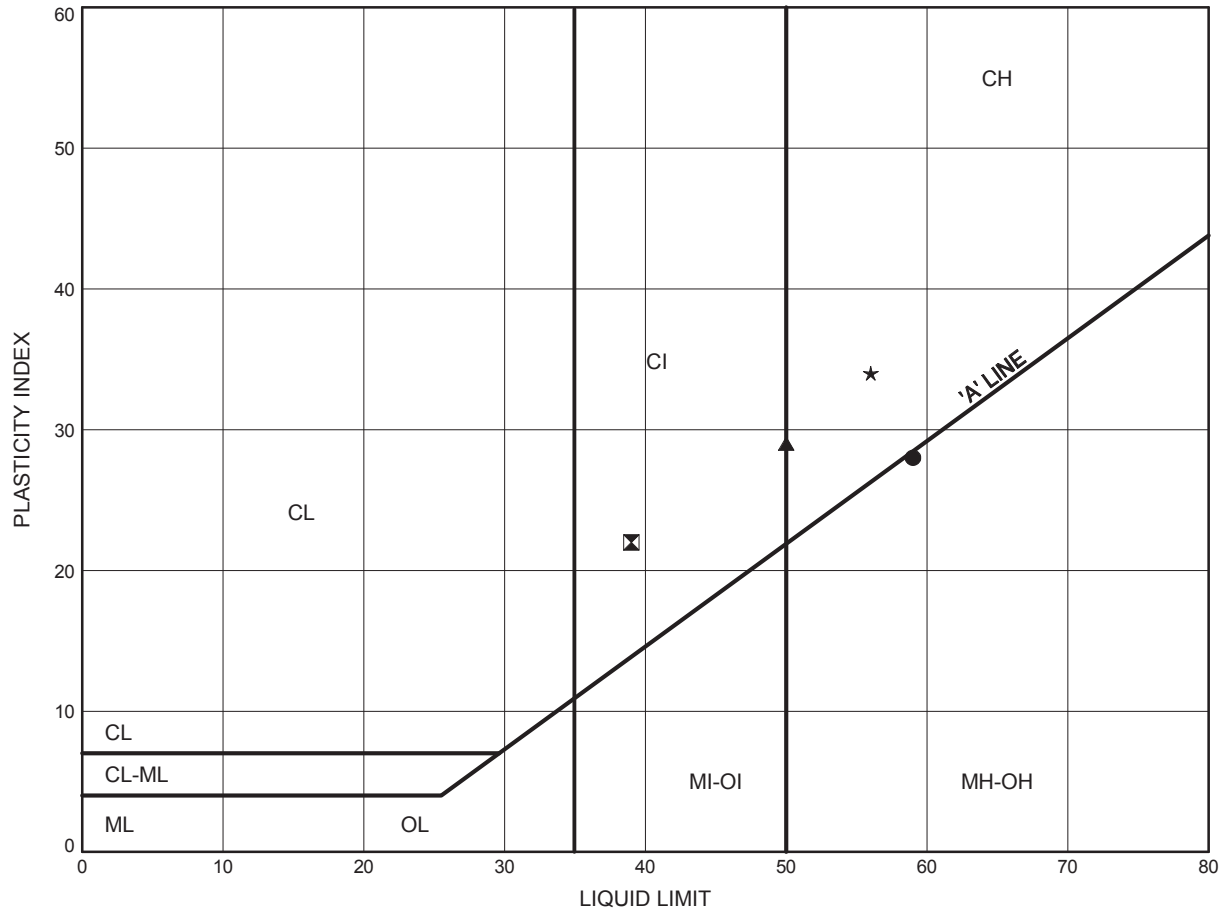
Chkd. PK

THURBALT 19-3405-5 HWY 400 CULVERTS.GPJ 14/7/16

Highway 400 Northbound Culvert Replacements

ATTERBERG LIMITS TEST RESULTS

FIGURE 8



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-5	1.07	178.69
⊠	16-5	2.59	177.16
▲	16-5	8.69	171.07
★	16-6	12.50	169.33

Date July 2016

GWP# 2041-13-00

THURBER

Prep'd KCP

Chkd. PK

THURBALT 19-3405-5 HWY 400 CULVERTS.GPJ 14/7/16

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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

Page __ of __

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 northbound 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 upstream from culvert inlets towards Highway 401 southbound

Figure 5: Existing condition of culverts and embankment at inlet