THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
SITE 38S-126 – CENTRE LINE ROAD BRIDGE REPLACEMENT
SAULT STE. MARIE DISTRICT, ALGOMA COUNTY
G.W.P. 5149-13-00
ASSIGNMENT NUMBER: 5014-E-0032

GEOCRES NUMBER: - 41J-101

SUBMITTED TO
McINTOSH PERRY CONSULTING ENGINEERS

August 2016
10870

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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 the Centre Line Road Bridge crossing of the Thessalon River located within the Sault Ste. Marie district. Thurber carried out the investigation as a subconsultant to McIntosh Perry Consulting Engineers (MPCE) as part of Agreement No. 5014-E-0032.

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

Site 38S-126 is located on Centre Line Road, 2.2 km south of the Highway 638 Junction with Centre Line Road in Leeburn, Ontario. The location of the structure is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

The existing three-span, Pony truss structure carries a single lane of traffic over the Thessalon River. The bridge is approximately 46 m long, 4.0 m wide with approximate span lengths of 14 m, 18 m, 14 m. It is noted that for project orientation purposes, Centre Line Road, will be assumed to run north-south and the Thessalon River flow is from east to west.

Centre Line Road at this location has one lane in each direction with a rural cross-section and gravel shoulders. The lands surrounding the project limits are typically agricultural with some residential properties. Storm water drainage in the area is to existing ditches and culverts. Select site photographs are presented in Appendix D.

3 SITE INVESTIGATION

3.1 Field Investigation

The field investigation plan was finalized after discussion with the MTO Foundations Section. Approximate locations of boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 provided in Appendix A. The field investigation for this site included advancing four boreholes drilled between February 15, 2016 and February 17, 2016. The locations and elevations of the boreholes are shown Drawing No. 1 and are summarized in Table 3-1.

Table 3-1: Borehole Summary

Borehole	Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Depth (m)
201	North approach	5145430.8	319419.1	200.7	6.7
202	North abutment	5145424.3	319418.9	200.4	31.1
203	South abutment	5145372.3	319409.6	200.3	31.1
204	South approach	5145365.7	319407.2	200.1	6.7

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 boreholes were advanced with a CME truck mounted drill rig equipped with hollow stem augers and NW casing. 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 the firm to very soft cohesive strata. Thin-walled tube samples of soft to firm cohesive deposits were collected at selected locations. 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 203 to allow for measurement of the groundwater level at the site. Piezometer construction details are illustrated on the Record of Borehole sheet for Borehole 203, provided in Appendix B.

The boreholes without piezometer installations were backfilled with a low-permeability combination of auger cuttings, sand and bentonite pellets in general accordance with the intent of Ontario MOE Regulation 903. Boreholes advanced within paved areas were capped with 300 mm of cold patch asphalt.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by Thurber on February 16, 2016. The vertical datum used was a temporary benchmark (TBM) provided by MPCE, located at Station 2+035.2. The TBM has a geodetic elevation of 201.337 m. The location of the TBM is indicated on Drawing No. 1 in Appendix A.

3.2 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, Atterberg Limits testing and consolidation 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 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 site is presented on the Borehole Location and Soil Strata Drawing provided 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.

In general the stratigraphy in the area is characterized by an asphaltic surface, overlying sand with silt and gravel fill, overlying a clay fill material overlying clay, overlying a sandy silt underlain by a granular glacial till. The fill at the south abutment included some woody pieces between a depth of 2.3 and 3.8 m.

More detailed descriptions of the individual strata are presented below.

4.2 Granular Fill

All boreholes were advanced through Centre Line Road.

A granular fill layer consisting predominantly of sand and gravel with varying amounts of silt was encountered below the asphaltic surface. The top of this layer ranges from Elevation 200.6 m to Elevation 200.0 m and has a thickness ranging from 500 mm to 700 mm. At the time of the field investigation frost had penetrated to a depth of up to 2.0 m as such only auger samples could be obtained for the pavement structure.

The moisture content of the samples tested ranged from 3% to 4%. The results of grain size analysis conducted on two 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 Granular Fill

Soil Particles	%
Gravel	21 to 25
Sand	55 to 62
Silt and Clay	17 to 20

4.3 Clay Fill

A clay fill layer with varying amounts of sand and gravel was encountered beneath the granular fill in all boreholes. The top of this layer ranges from Elevation 200.1 m to Elevation 199.5 m and has a thickness ranging from 900 mm to 3.2 m. The SPT ‘N’ values ranged from 3 to 32 blows per 0.3 m of penetration indicating a soft to hard consistency. Some of the SPT ‘N’ values may be affected by the frozen condition of the fill.

The moisture content of the samples tested ranged from 24% to 42%. The results of grain size analysis conducted on samples this material are summarized in Table 4-2 and are illustrated on Figure 2 in Appendix C.

Table 4-2: Gradation Results for Clay Fill

Soil Particles	%
Gravel	0 to 22
Sand	8 to 35
Silt	44 to 50
Clay	21 to 31

The results of Atterberg Limits testing completed on samples of this material are summarized in Table 4-3 and are illustrated on Figures 7 and 8 in Appendix C.

Table 4-3: Atterberg Limits Test Results

Plastic Limit	15 to 23
Liquid Limit	28 to 41
Plasticity Index	13 to 18

4.4 Clay Crust

A brown native clay deposit was encountered beneath the clay fill materials in all boreholes expect Borehole 203. The top of this layer ranges from Elevation 199.2 m to Elevation 198.1 m and has a thickness ranging from 1.2 m to 1.5 m. In-situ shear vane test results indicated undrained shear strengths ranging from 64 kPa to 72 kPa indicating a stiff consistency. The moisture content of the samples tested ranged from 29% to 39%. The results of grain size analysis conducted on samples of this material are summarized in Table 4-4 and are illustrated on Figure 3 in Appendix C.

Table 4-4: Gradation Results for Clay

Soil Particles	%
Gravel	0
Sand	0
Silt	47 and 60
Clay	40 and 53

The results of Atterberg Limits testing completed on samples of this material are summarized in Table 4-5 and are illustrated on Figures 7 and 8 in Appendix C.

Table 4-5: Atterberg Limits Test Results

Plastic Limit	20
Liquid Limit	49 and 52
Plasticity Index	29 and 32

4.5 Clay

A grey clay deposit was encountered beneath the clay crust material in Boreholes 201, 202 and 204 and beneath the clay fill in Borehole 203. Boreholes 201 and 204 were terminated in this strata.

The top of this layer ranges from Elevation 197.6 m to Elevation 195.5 m and has a thickness where completely penetrated ranging from 11.5 m to 14.8 m. In-situ shear vane test results indicated undrained shear strengths ranging from 25 kPa to 65 kPa; indicating a firm to stiff

consistency; but typically firm. The moisture content of the samples tested ranged from 21% to 59%. The results of grain size analysis conducted on samples of this material are summarized in Table 4-6 and are illustrated on Figure 4 in Appendix C.

Table 4-6: Gradation Results for Clay

Soil Particles	%
Gravel	0
Sand	0 to 3
Silt	30 to 59
Clay	38 to 70

The results of Atterberg Limits testing completed on samples of this material are summarized in Table 4-7 and are illustrated on Figures 7 and 8 in Appendix C.

Table 4-7: Atterberg Limits Test Results

Plastic Limit	16 and 20
Liquid Limit	40 and 58
Plasticity Index	12 and 42

The results of oedometer (one-dimensional consolidation) tests carried out on an undisturbed clay sample are summarized in Table 4-8. A copy of the oedometer test results is provided in Appendix C. The results of the tests indicate that the clay is slightly over-consolidated.

Table 4-8: Consolidation Test Results

Parameter	Value
Borehole	202
Sample	ST-1
Depth / Elevation (m) (mid-sample)	4.0 / 196.4
Moisture Content, (%)	53
Unit Weight, (γ) (kN/m^3)	16.5
Specific Gravity (G_s)	2.737
Initial Void Ratio (e_o)	1.491
Pre-consolidation Pressure, (kPa)	120
Compression Index (C_c)	0.803
Recompression Index (C_r)	0.09

4.6 Silt to Sandy Silt

A silt layer with varying amounts of sand was encountered beneath the clay strata in Boreholes 202 and 203. The top of this layer ranges from Elevation 184.1 m to Elevation 182.1 m and has a thickness r**a**nging from 10.7 m to 12.8 m. The SPT 'N' values ranged from 5 to 16 blows per 0.3 m of penetration; indicating a loose to compact condition; but typically loose.

The moisture content of the samples tested ranged from 20% to 34%. The results of grain size analysis conducted on samples of this material are summarized in Table 4-9 and are illustrated on Figure 5 in Appendix C.

Table 4-9: Gradation Results for Silt

Soil Particles	%
Gravel	0
Sand	5 and 31
Silt	66 and 84
Clay	2 and 11

The results of Atterberg Limits testing completed on samples of this material indicated a non-plastic silt

4.7 Glacial Till

A stratum of granular glacial till consisting predominantly of sand with silt and gravel and occasional cobbles was encountered in Boreholes 202 and 203. Boreholes 202 and 203 were terminated in this material. The top of this layer ranges from Elevation 171.4 m to Elevation 171.3 m. The SPT 'N' values ranged from 53 to 98 blows per 0.3 m of penetration; indicating a very dense condition.

The moisture contents of the samples tested were 11% and 17%. The results of grain size analysis tests on samples of this material are summarized in Table 4-10 and are illustrated on Figure 6 in Appendix C.

Table 4-10: Gradation Results for Glacial Till

Soil Particles	%
Gravel	4
Sand	67 and 89
Silt and Clay	7 and 29

4.8 Groundwater Conditions

The groundwater level in the piezometer installed in Borehole 203 was recorded on February 19, 2016, at a depth of 3.2 m; corresponding to Elevation 197.1 m.

The water level in the Thessalon River was indicated on the base plan at Elevation 194.2 m on February 10, 2016. The high water mark was indicated at elevation 195.0 m.

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. Marathon Drilling of Greely, 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. Nick Weil of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa.

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

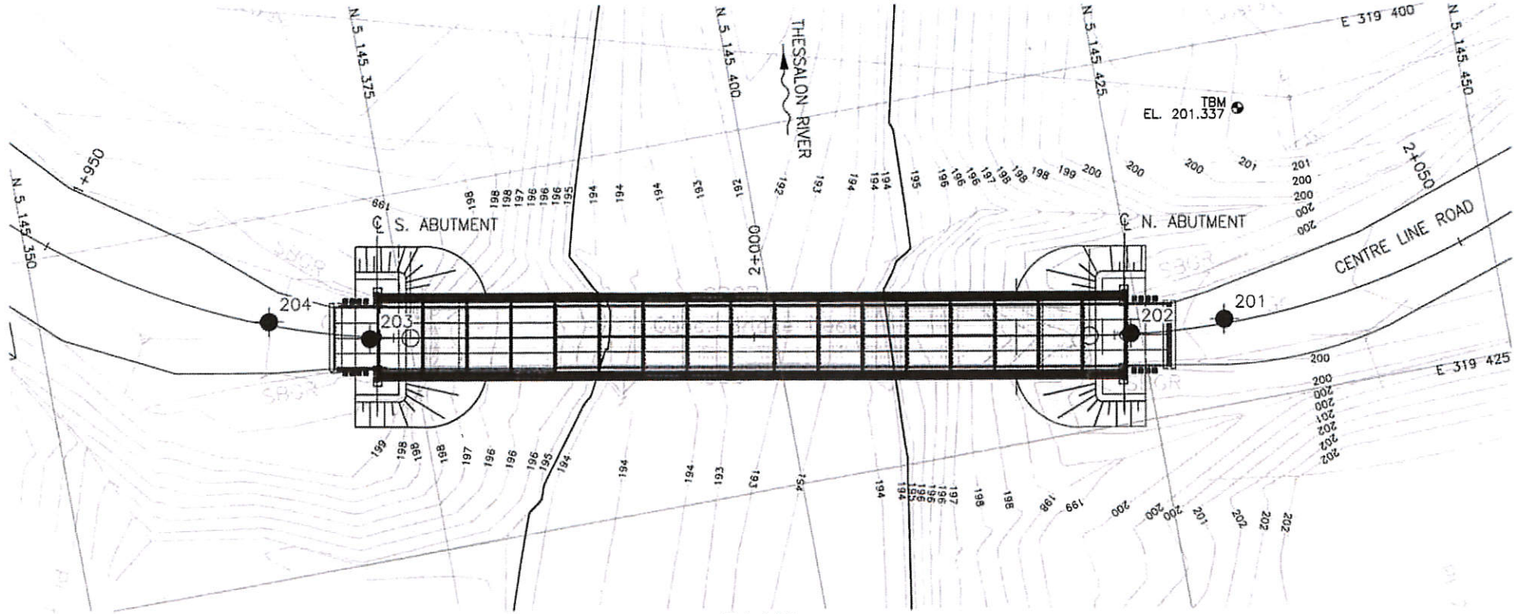
Kenton C. Power, P.Eng.
Geotechnical Engineer

Paul Carnaffan, P.Eng.
Associate, Senior Geotechnical Engineer

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

APPENDIX A

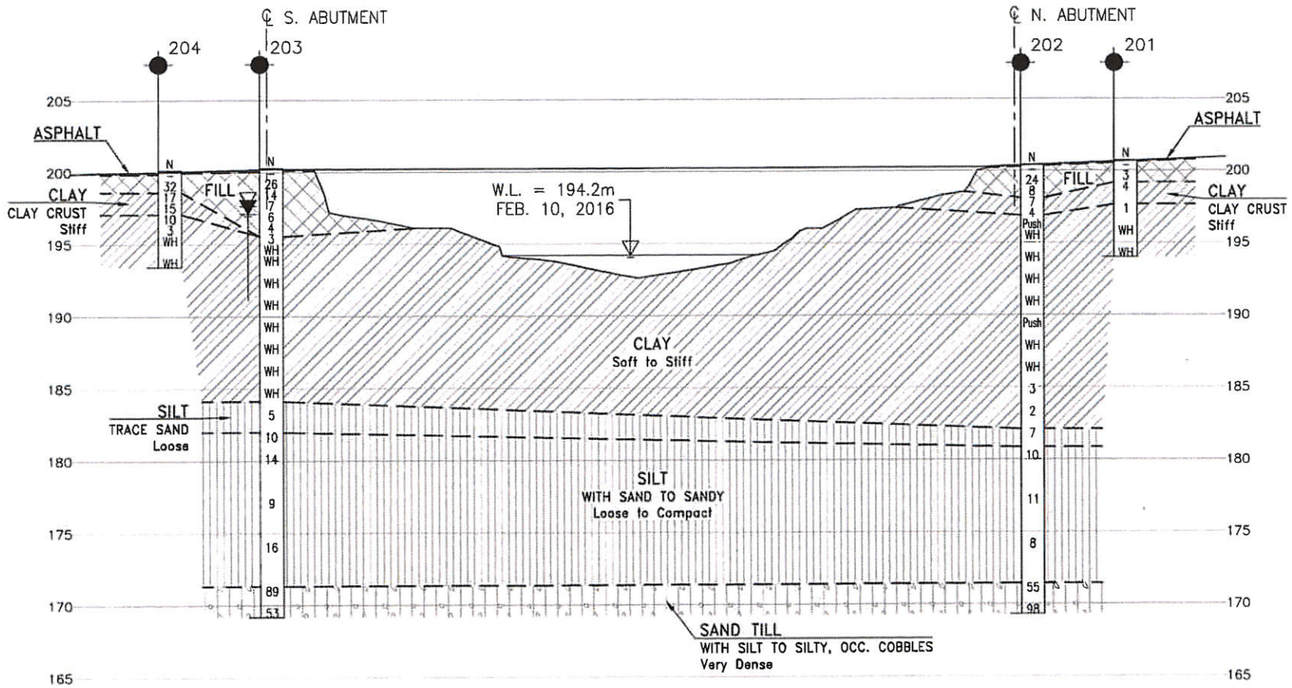
BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS



PLAN

8 0 8 16m

SCALE 1:400



PROFILE

8 0 8 16m

SCALE 1:400

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

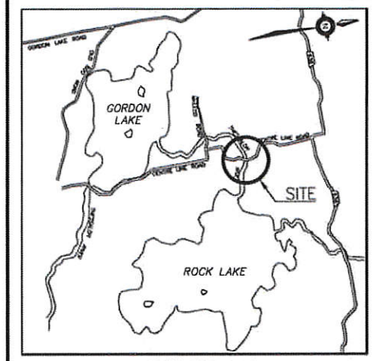
CONT No
GWP No 5149-13-00

SHEET

CENTRE LINE ROAD
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

McINTOSH PERRY

THURBER ENGINEERING LTD.



KEYPLAN

LICENSED PROFESSIONAL ENGINEER
K. T. C. POWER
100130652
2016/08/26
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 26/16
PROVINCE OF ONTARIO

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
201	200.7	5 145 430.8	319 419.1
202	200.4	5 145 424.3	319 418.9
203	200.3	5 145 372.3	319 409.6
204	200.1	5 145 365.7	319 407.2

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Borehole locations are shown in MTM Zone 13 coordinates.

GEOCRES No. 41J-101

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN KP	CHK –	CODE	LOAD
DRAWN MFA	CHK KP	SITE 38S-126	STRUCT

DATE JUL 2016
DWG 1

FILENAME: H:\Drafting\10000\10870\TED-10870-PLPR-CR.dwg
PLOTDATE: 7/26/2016 3:26 PM

APPENDIX B

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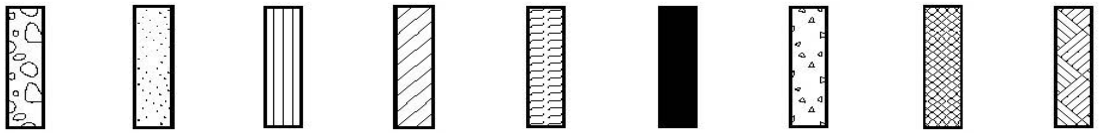
STRATA PLOT:
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



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 201 1 OF 1 METRIC

GWP# 5149-13-00 LOCATION 38S-126 Centre Line Road ORIGINATED BY NW

HWY Centre Line Road BOREHOLE TYPE HSA COMPILED BY KCP

DATUM Geodetic DATE 2016.02.17 - 2016.02.17 CHECKED BY PC

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
200.7								20 40 60 80 100	20 40 60		
0.0 / 0.1	50 mm **SURFACE TREATMENT**										
	Silty sand with gravel - frost to 1.5 m Compact Brown **FILL**		1	AS	-				○		
200.1 / 0.6											
	Silty clay Firm Brown		2	SS	3		200		○		
199.2 / 1.5	**FILL**										
	CLAY (CI) - clay crust Stiff Brown		3	SS	4		199	5.2	○		0 0 60 40
							198	4.3			
197.6 / 3.0	**CLAY** (CH) Firm Brown		4	SS	1		197	4.2 3.7	○		
			5	SS	WH		196	4.8	○		
							195	5.3			
194.0 / 6.7	Borehole terminated at 6.7 m		6	SS	WH		194		○		0 0 30 70

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

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

ONTMT4S 10870 CENTRE LINE RD.GPJ 2012TEMPLATE(MTO).GDT 3/5/16

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RECORD OF BOREHOLE No 202

1 OF 4

METRIC

GWP# 5149-13-00 | LOCATION 38S-126 Centre Line Road | ORIGINATED BY NW

HWY Centre Line Road | BOREHOLE TYPE HSA / NW casing | COMPILED BY KCP

DATUM Geodetic | DATE 2016.02.16 - 2016.02.17 | CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
200.4											
0.0 / 0.1	50 mm **SURFACE TREATMENT**										
	Silty sand with gravel - frost to 2.1 m Compact Brown		AS	SS	-		200		○		21 62 17 (SI+CL)
199.6 / 0.8	**FILL**										
	Silty clay Firm Brown **FILL**		2	SS	24		199		○		
			3	SS	8				○		
198.1 / 2.3	**CLAY** (CH) - clay crust Stiff Brown		4	SS	7		198		○		0 0 47 53
			5	SS	4		197		○		
196.9 / 3.5	**CLAY** (Cl) Firm Grey		1	TW	Push		196		○		
			6	SS	WH		195	6.3 4.4	○		
			7	SS	WH		194	5.3 5.3	○		
			8	SS	WH		193		○		
							192	5.3 4.6			
			9	SS	WH		191		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 202 2 OF 4 METRIC

GWP# 5149-13-00 LOCATION 38S-126 Centre Line Road ORIGINATED BY NW
HWY Centre Line Road BOREHOLE TYPE HSA / NW casing COMPILED BY KCP
DATUM Geodetic DATE 2016.02.16 - 2016.02.17 CHECKED BY PC

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 (Cl) Firm Grey						190	5.3 5.3			
			2	TW	Push						
							189	5.3 6.4			
			10	SS	WH		188				0 0 50 50
								5.3			
							187	6.7			
			11	SS	WH						
							186	10.0 3.6			
			12	SS	3		185				
	- becomes stiff							6.0			
182.1							184	6.0			
			13	SS	2						
18.3	**SILT (ML)** trace sand Loose Grey						183				
			14	SS	7		182				0 5 84 11
180.9											
19.5	**SILT (ML)** with sand Loose to compact Grey						181				

Continued Next Page

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

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

ONTMT4S 10870 CENTRE LINE RD.GPJ 2012TEMPLATE(MTO).GDT 3/5/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 202 — 3 OF 4 — METRIC

GWP# 5149-13-00 | LOCATION 38S-126 Centre Line Road | ORIGINATED BY NW
HWY Centre Line Road | BOREHOLE TYPE HSA / NW casing | COMPILED BY KCP
DATUM Geodetic | DATE 2016.02.16 - 2016.02.17 | CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT (ML) with sand Loose to compact Grey		15	SS	10		180		○		0 23 75 2
							179				
							178				
			16	SS	11		177		○		
							176				
							175				
			17	SS	8		174		○		
							173				
							172				
171.4 29.0	**SAND (SP-SM)** with silt **TILL** - ocassional cobbles Very dense Grey		18	SS	55		171		○		4 89 7 (SI+CL)

Continued Next Page

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

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

ONTMT4S 10870 CENTRE LINE RD.GPJ 2012TEMPLATE(MTO).GDT 3/5/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 202 4 OF 4 METRIC

GWP# 5149-13-00 LOCATION 38S-126 Centre Line Road ORIGINATED BY NW
HWY Centre Line Road BOREHOLE TYPE HSA / NW casing COMPILED BY KCP
DATUM Geodetic DATE 2016.02.16 - 2016.02.17 CHECKED BY PC

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										
	SAND (SP-SM) with silt **TILL** - ocassional cobbles Very dense Grey						170				
169.3			19	SS	98				○		
31.1	Borehole terminated at 31.1 m										

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

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

ONTMT4S 10870 CENTRE LINE RD.GPJ 2012TEMPLATE(MTO).GDT 3/5/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 203

1 OF 4

METRIC

GWP# 5149-13-00 | LOCATION 38S-126 Centre Line Road | ORIGINATED BY NW

HWY Centre Line Road | BOREHOLE TYPE HSA / NW casing | COMPILED BY KCP

DATUM Geodetic | DATE 2016.02.15 - 2016.02.16 | CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
200.3										
0.0 / 0.1	50 mm **SURFACE TREATMENT**									
	Silty sand with gravel - ocassional cobbles - frost to 1.5 m		1	AS	-					
199.7 / 0.6	Compact to dense Brown **FILL**		2	SS	26					
	Clay with gravel, trace sand Brown to grey Firm **FILL**		3	SS	14					22 8 45 25
	- wood pieces from 2.3 m to 3.8 m		4	SS	7	▽				
			5	SS	6	▼				
196.5 / 3.8	Sandy clay firm Grey **FILL**		6	SS	4					0 35 44 21
195.5 / 4.7	**CLAY** (CH to CI) - trace rootlets at 4.7 m Firm Grey		7	SS	3					
			8	SS	WH					
			9	SS	WH			5.0 +		
								14.0 +		
			10	SS	WH					0 1 40 59
								4.7 +		
								8.5 +		
			11	SS	WH					

ELEVATION SCALE: 200, 199, 198, 197, 196, 195, 194, 193, 192, 191

Continued Next Page

+ ³, × ³ : Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 203 2 OF 4 METRIC

GWP# 5149-13-00 LOCATION 38S-126 Centre Line Road ORIGINATED BY NW
HWY Centre Line Road BOREHOLE TYPE HSA / NW casing COMPILED BY KCP
DATUM Geodetic DATE 2016.02.15 - 2016.02.16 CHECKED BY PC

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 (CH to CI) Firm Grey						190	5.6, 6.8			
			12	SS	WH		189	5.4, 5.1			
			13	SS	WH		188	3.6			
			14	SS	WH		187	3.6			
	- becomes stiff						186	4.3			
			15	SS	WH		185				0 3 59 38
184.1											
16.2	**SILT (ML)**, trace sand Loose Grey		16	SS	5		184				
							183				
182.0											
18.3	**Sandy SILT (ML)** Loose to compact Grey		17	SS	10		182				
							181				

Continued Next Page

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

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

ONTMT4S 10870 CENTRE LINE RD.GPJ 2012TEMPLATE(MTO).GDT 3/5/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 203 3 OF 4 METRIC

GWP# 5149-13-00 LOCATION 38S-126 Centre Line Road ORIGINATED BY NW
HWY Centre Line Road BOREHOLE TYPE HSA / NW casing COMPILED BY KCP
DATUM Geodetic DATE 2016.02.15 - 2016.02.16 CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy **SILT** Loose to compact Grey		18	SS	14		180				0 31 66 3
							179				
							178				
			19	SS	9		177				
							176				
							175				
			20	SS	16		174				
							173				
							172				
171.3 29.0	Silty **SAND (SM) TILL** Very dense Grey		21	SS	89		171				4 67 29 (SI+CL)

Continued Next Page

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 10870 CENTRE LINE RD.GPJ 2012TEMPLATE(MTO).GDT 3/5/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 203 4 OF 4 METRIC

GWP# 5149-13-00 LOCATION 38S-126 Centre Line Road ORIGINATED BY NW

HWY Centre Line Road BOREHOLE TYPE HSA / NW casing COMPILED BY KCP

DATUM Geodetic DATE 2016.02.15 - 2016.02.16 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	Silty **SAND (SM) TILL** Very dense Grey						170				
169.2			22	SS	53				○		
31.1	Borehole terminated at 31.1 m										

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

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

ONTMT4S 10870 CENTRE LINE RD.GPJ 2012TEMPLATE(MTO).GDT 3/5/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 204 1 OF 1 METRIC

GWP# 5149-13-00 LOCATION 38S-126 Centre Line Road ORIGINATED BY NW

HWY Centre Line Road BOREHOLE TYPE HSA COMPILED BY KCP

DATUM Geodetic DATE 2016.02.17 - 2016.02.17 CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
200.1											
0.0 / 0.1	50 mm **SURFACE TREATMENT**										
	Silty sand with gravel - frost to 3.0 m Compact Brown **FILL**		1	AS	-						25 55 20 (SI+CL)
199.5 / 0.6											
	Clay with sand Firm Brown		2	SS	32						2 17 50 31
198.6 / 1.5	**FILL**										
	CLAY (CH) - clay crust Stiff Brown		3	SS	17						
			4	SS	15						
197.1 / 3.0	**CLAY (CI)** Firm to soft Grey		5	SS	10						
			6	SS	3						
			7	SS	WH						
			8	SS	WH						
193.4 / 6.7	Borehole terminated at 6.7 m										

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

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

ONTMT4S 10870 CENTRE LINE RD.GPJ 2012TEMPLATE(MTO).GDT 3/5/16

APPENDIX C

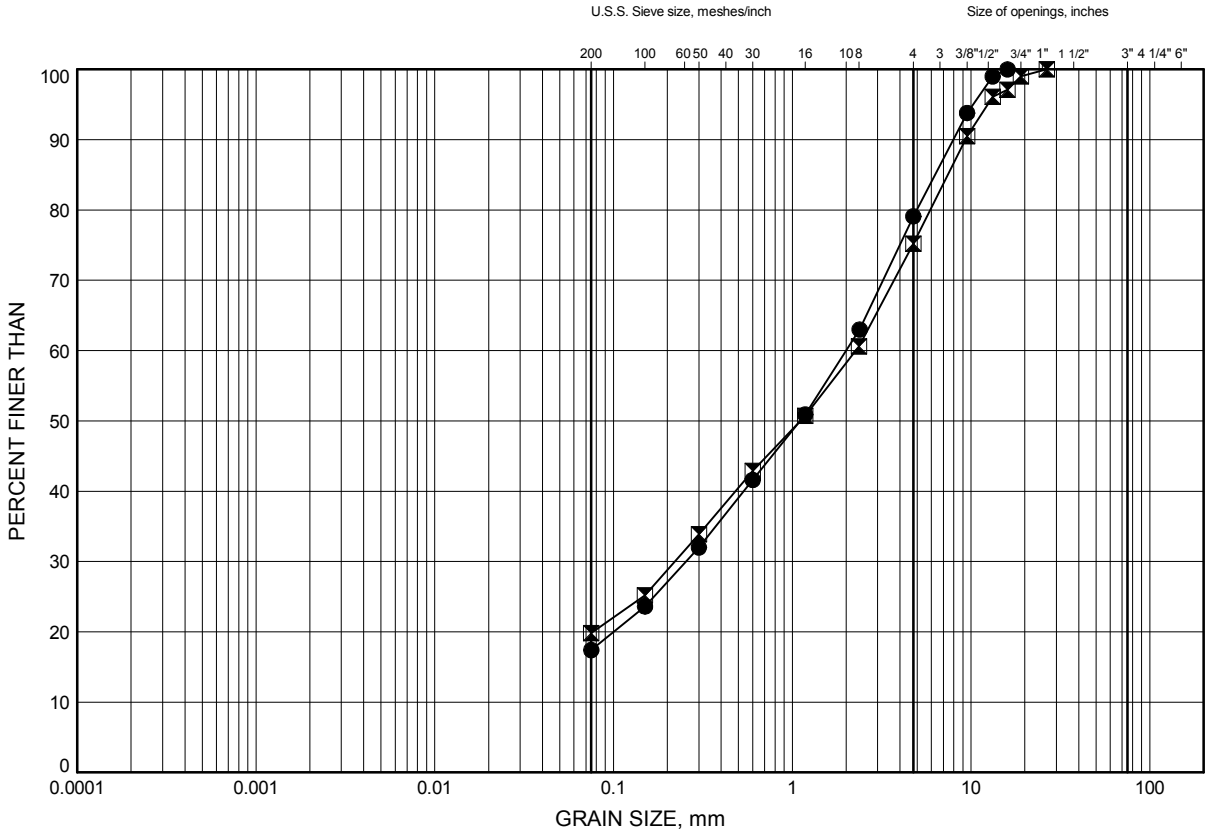
LABORATORY TEST RESULTS

38S-126 Centre Line Road

GRAIN SIZE DISTRIBUTION

FIGURE 1

Granular Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	202	0.30	200.09
⊠	204	0.30	199.83

Date May 2016

GWP# 5149-13-00

THURBER

Prep'd KCP

Chkd. PC

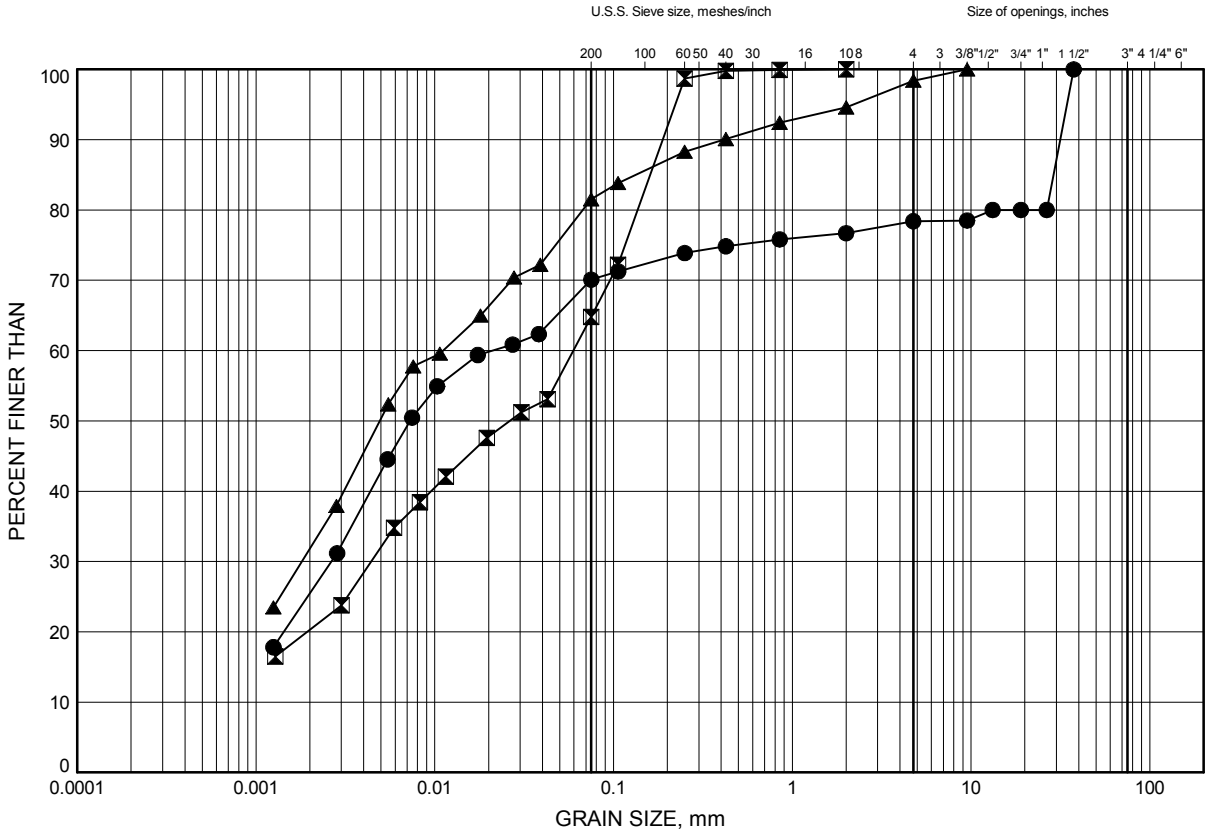
GRAIN SIZE DISTRIBUTION - THURBER 10870 CENTRE LINE RD.GPJ 25/5/16

38S-126 Centre Line Road

GRAIN SIZE DISTRIBUTION

FIGURE 2

Clay Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	203	1.83	198.44
⊠	203	4.11	196.16
▲	204	1.07	199.07

Date May 2016

GWP# 5149-13-00

THURBER

Prep'd KCP

Chkd. PC

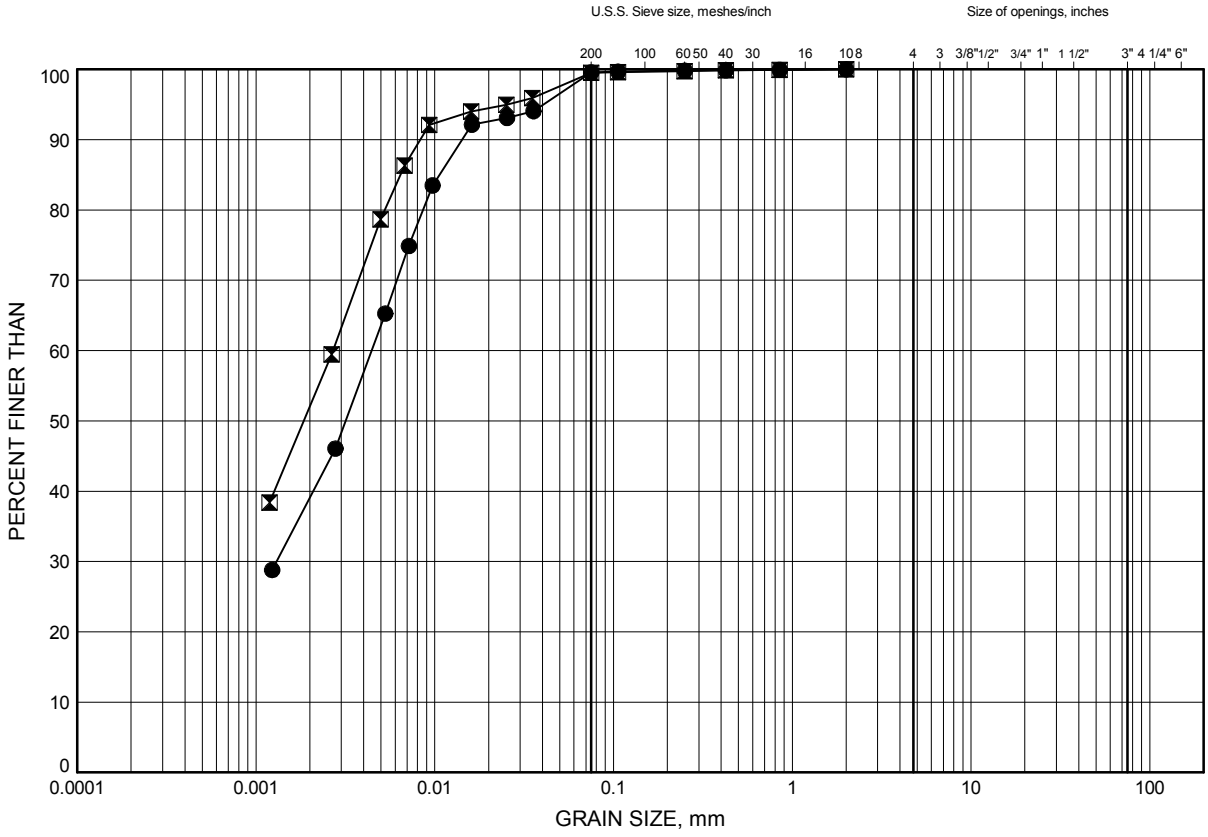
GRAIN SIZE DISTRIBUTION - THURBER 10870 CENTRE LINE RD.GPJ 3/5/16

38S-126 Centre Line Road

GRAIN SIZE DISTRIBUTION

FIGURE 3

Clay Crust



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	201	1.83	198.87
⧓	202	2.59	197.80

Date May 2016

GWP# 5149-13-00

THURBER

Prep'd KCP

Chkd. PC

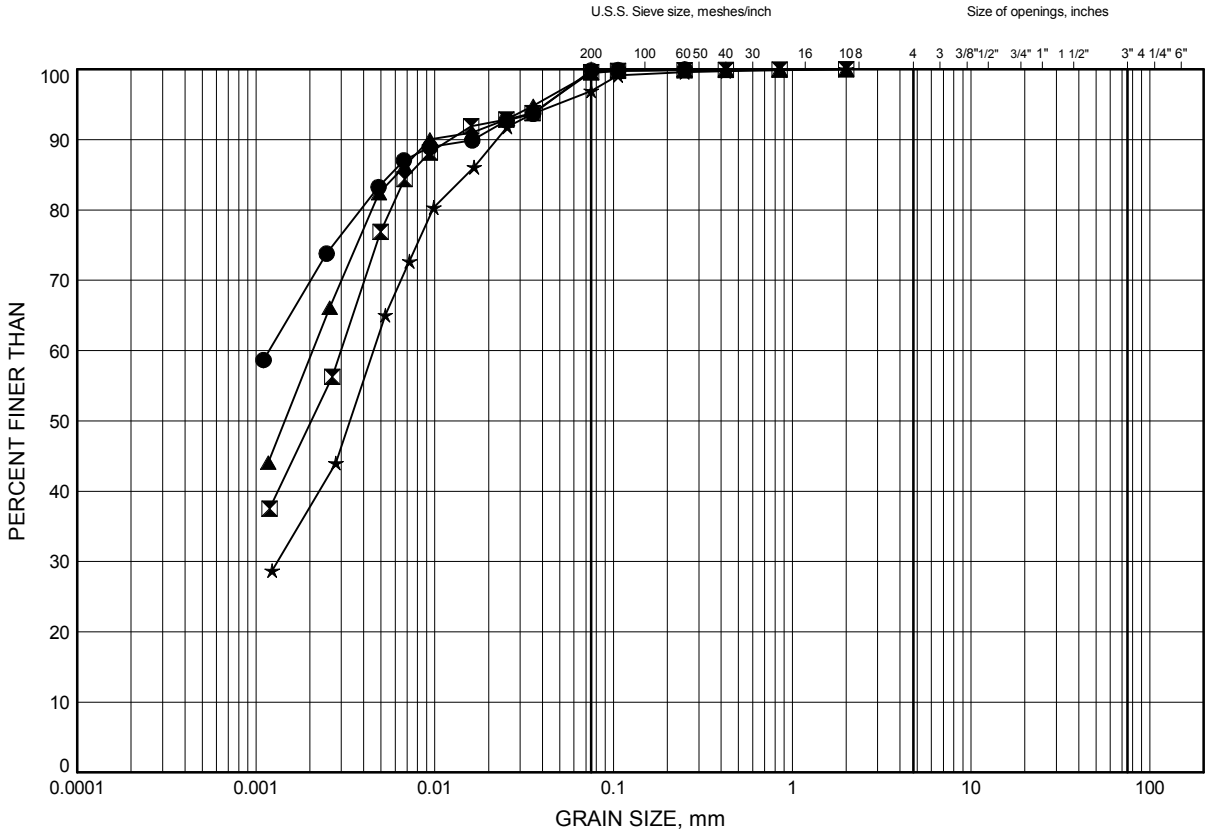
GRAIN SIZE DISTRIBUTION - THURBER 10870 CENTRE LINE RD.GPJ 3/5/16

38S-126 Centre Line Road

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)
●	201	6.40	194.30
⊠	202	12.50	187.90
▲	203	7.92	192.35
★	203	15.54	184.73

Date May 2016

GWP# 5149-13-00

THURBER

Prep'd KCP

Chkd. PC

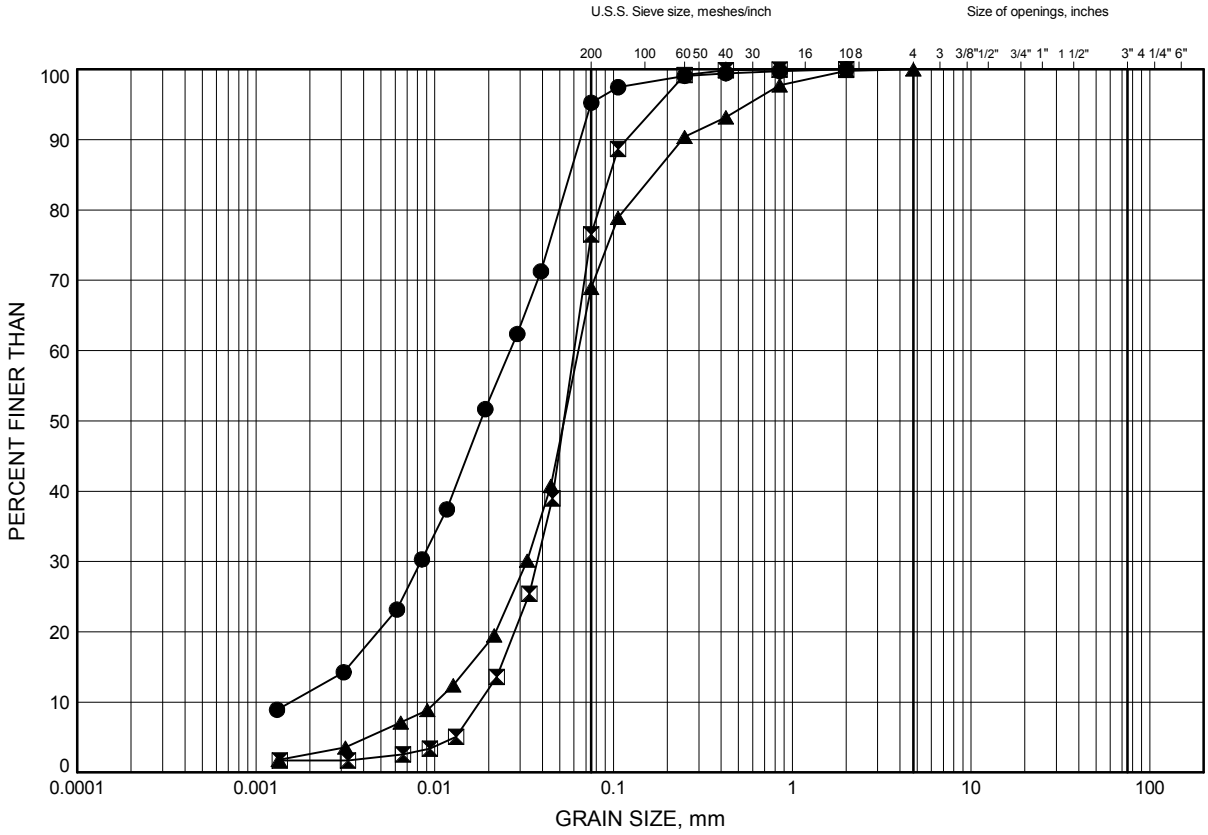
GRAIN SIZE DISTRIBUTION - THURBER 10870 CENTRE LINE RD.GPJ 3/5/16

38S-126 Centre Line Road

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)
●	202	18.59	181.80
⊠	202	20.12	180.28
▲	203	20.12	180.16

Date May 2016

GWP# 5149-13-00

THURBER

Prep'd KCP

Chkd. PC

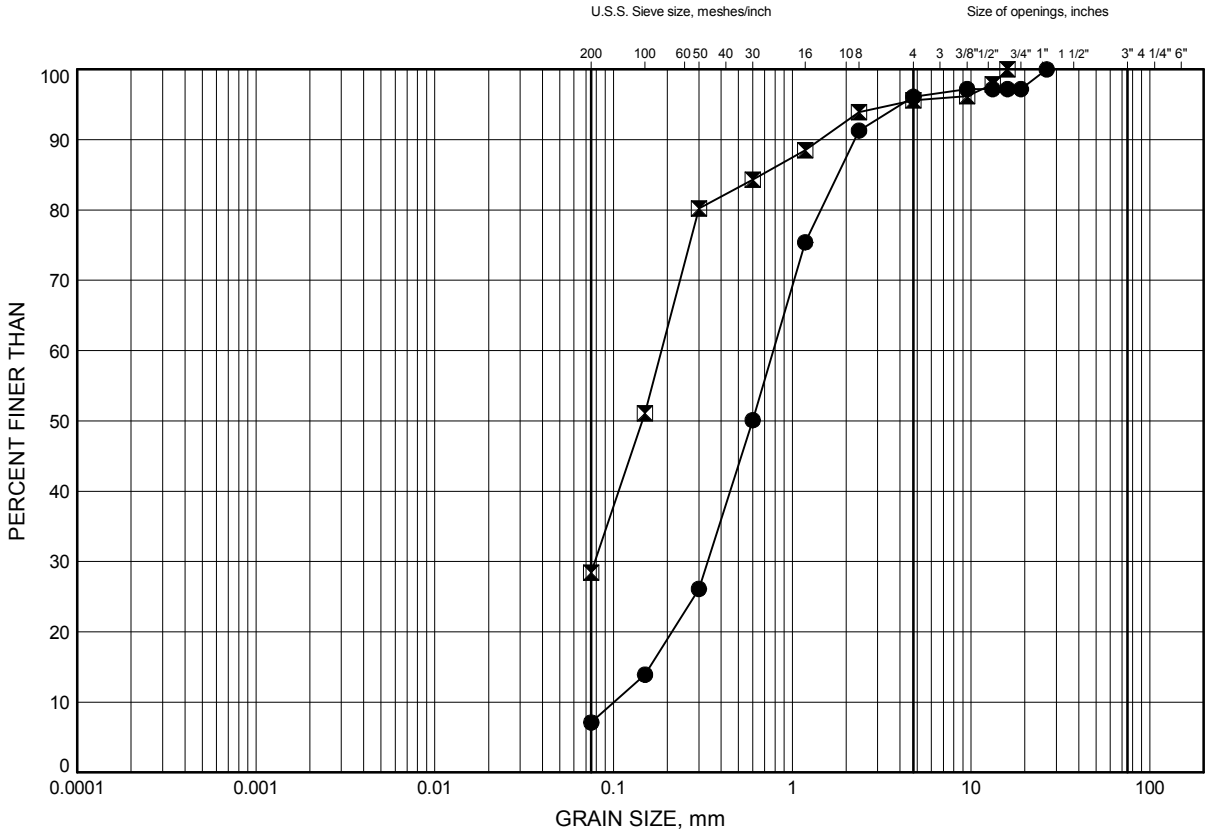
GRAIN SIZE DISTRIBUTION - THURBER 10870 CENTRE LINE RD.GPJ 3/5/16

38S-126 Centre Line Road

GRAIN SIZE DISTRIBUTION

FIGURE 6

Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	202	29.26	171.13
⧓	203	29.26	171.01

Date May 2016

GWP# 5149-13-00

THURBER

Prep'd KCP

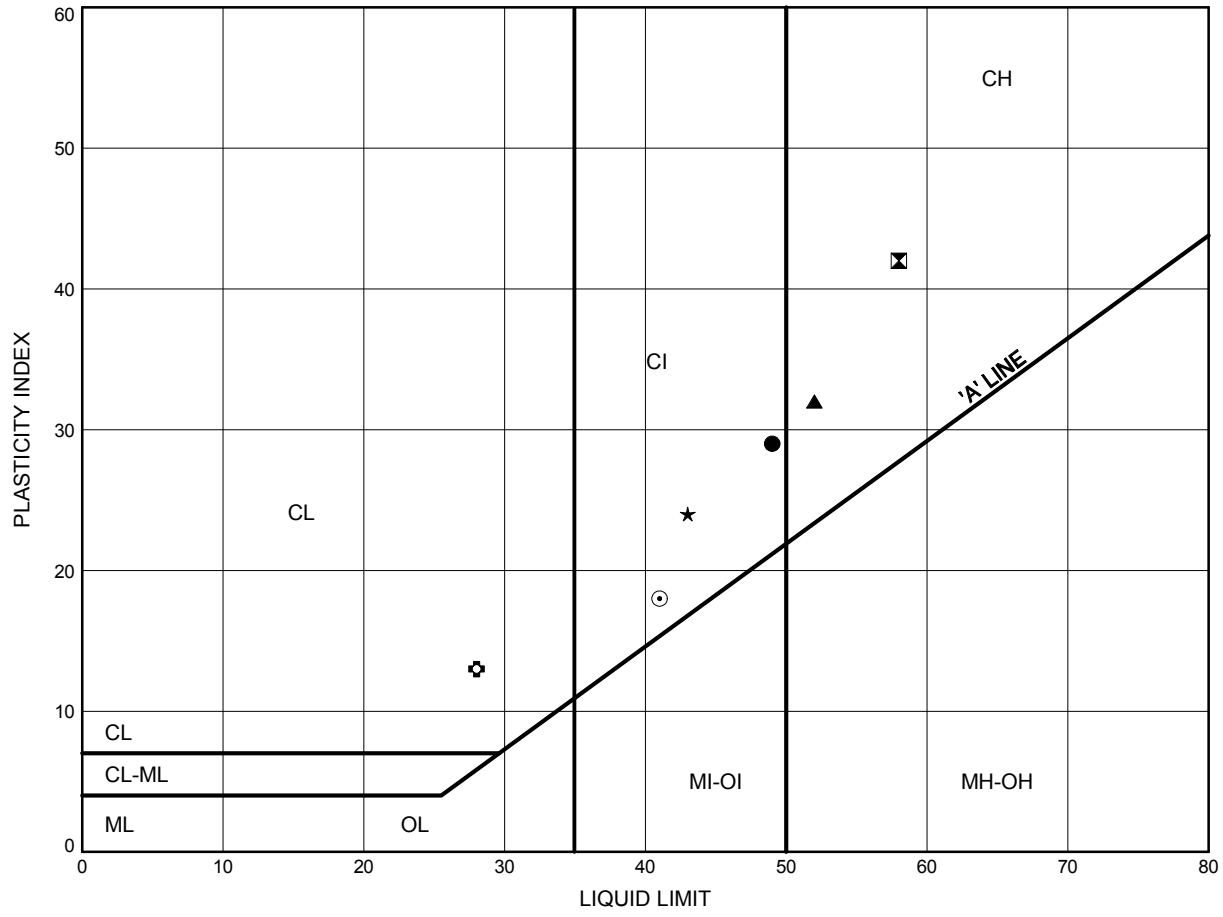
Chkd. PC

GRAIN SIZE DISTRIBUTION - THURBER 10870 CENTRE LINE RD.GPJ 3/5/16

38S-126 Centre Line Road

ATTERBERG LIMITS TEST RESULTS

FIGURE 7



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	201	1.83	198.87
⧓	201	6.40	194.30
▲	202	2.59	197.80
★	202	12.50	187.90
⊙	203	1.83	198.44
✿	203	4.11	196.16

Date May 2016

GWP# 5149-13-00

THURBER

Prep'd KCP

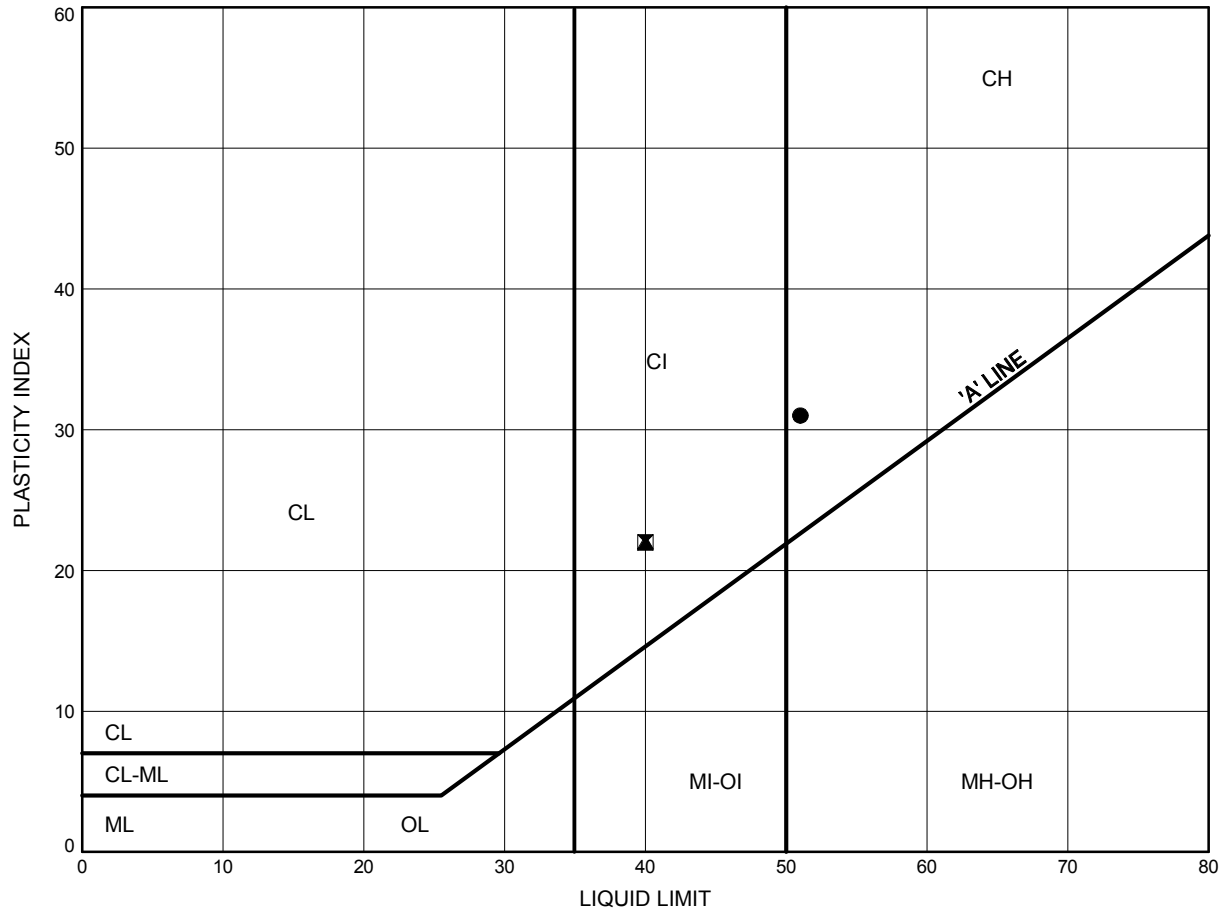
Chkd. PC

THURBALT 10870 CENTRE LINE RD.GPJ 3/5/16

38S-126 Centre Line Road

ATTERBERG LIMITS TEST RESULTS

FIGURE 8



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	203	7.92	192.35
⊠	203	15.54	184.73
▲	204	1.07	199.07

Date May 2016

GWP# 5149-13-00

THURBER

Prep'd KCP

Chkd. PC

THURBALT 10870 CENTRE LINE RD.GPJ 3/5/16

APPENDIX D

SELECT PHOTOGRAPHS OF THE BRIDGE LOCATION

Figure 1: Looking south across Centre Line Road Bridge

Figure 2: Existing Centre Line Bridge elevation looking west

Figure 3: Looking upstream from Centre Line Road Bridge

Figure 4: Looking downstream from Centre Line Road Bridge