FOUNDATION INVESTIGATION REPORT
ROUNDABOUT SIGN SUPPORTS
HIGHWAY 401 AND HIGHWAY 19 INTERCHANGE
TOWN OF INGERSOLL, ONTARIO
G.W.P. 3079-09-00

GEOCRES No. 40P2-83

Submitted

to

MMM Group Limited

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1.0 INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the detailed design of the roundabout sign supports at the Highway 401 and Highway 19 Interchange in the Town of Ingersoll, Ontario.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (MMM) under the Ministry of Transportation Ontario (MTO) Agreement Number 3013-E-0027.

The purpose of this investigation was to explore the subsurface conditions at the selected locations of the new signs and, based on the data obtained, to provide a borehole location plan, records of boreholes, laboratory test results and a written description of the subsurface conditions.

The design parameters for the roundabout sign support have also been provided in Table 1, which follows the text of this report.

2.0 SITE DESCRIPTION

A total of six roundabout signs are intended to be installed at the Highway 401 and Highway 19 Interchange at the locations as follows:

Sign #1 - Station 9+446, Harris Street
Sign #2 - Station 10+065, Highway 19
Sign #3 - Station 10+560, Highway 19
Sign #4 - Station 9+941, Harris Street
Sign #5 - Station 10+152, Ramp W-N/S
Sign #6 - Station 10+180, Ramp E-N.

The locations of the signs are also shown on the Borehole Location Plan enclosed in Appendix C.

At the project site, Highway 401 runs approximately in the southwest-northeast direction, and for the purpose of this report, Highway 401 is assumed to run west-east. The site extends to the north and south of the Highway 401.

The surrounding land is gently undulating. The land use generally consists of a mixed agricultural land with a commercial property to the north and a parking lot directly west of the existing underpass structure. The developed area of the Town of Ingersoll lies a short distance to the north of Highway 401.

Based on the Quaternary Geology Map, the site is situated in the till plain characterized by the Tavistock Till (Huron-Georgian Bay lobe) consisting of sandy silt to silt matrix with variable amounts of clay and sand and moderate to high carbonate content. Bedrock of the Detroit River Group, Onondaga Formation consisting of limestone, dolostone and shale underlies the site, although bedrock was not encountered during this investigation.

3.0 INVESTIGATION PROCEDURES

3.1 Field Investigation and Testing

The field investigation for this project was carried out between December 16 and 21, 2015 when six (6) boreholes denoted as Borehole R-01 to R-06 were advanced at the locations of the proposed roundabout signs. The location of the boreholes were determined based on drawings provided by MMM, and the locations are shown on the Borehole Location Plan in Appendix C. The boreholes were advanced using hollow stem augers to depths ranging from 6.7 m to 7.7 m. Soil samples were obtained at selected intervals with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT).

Groundwater conditions were observed in the boreholes during and upon completion of drilling operations. Following the final water level reading, the boreholes were decommissioned and backfilled in general accordance with MOE Regulation 903. Information on the borehole depths, base elevations and completion are summarized in Table 3.1 below.

Table 3.1- Borehole Backfilling Details

Borehole	Borehole Depth/ Base Elevation (m)	Borehole Backfilling Details
R-01	6.7 / 284.8	Bentonite holeplug and cuttings to 0.3 m, concrete mix to 0.2 m and capped with cold mix to surface.
R-02	6.7 / 289.8	Bentonite holeplug and cuttings to surface.
R-03	7.7 / 284.8	Cuttings to 0.9 m, bentonite holeplug to 0.2 m and cuttings to surface.
R-04	6.7 / 288.8	Cuttings to 0.9 m, bentonite holeplug to 0.3 m, then cuttings to surface.

Borehole	Borehole Depth/ Base Elevation (m)	Borehole Backfilling Details
R-05	6.7 / 285.8	Bentonite holeplug and cuttings to 0.3 m, concrete mix to 0.1 m then capped with cold mix to surface.
R-06	6.7 / 282.8	Bentonite holeplug and cuttings to 0.3 m, concrete mix to 0.1 m then capped with cold mix to surface.

The field investigation was supervised on a full-time basis by a member of Thurber's technical staff who located the boreholes in the field, cleared borehole locations of underground utilities, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The supervisor processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing. Results of field sampling and testing are presented in the Record of Borehole sheet included in Appendix A.

Ground surface elevation and coordinates at the boreholes were obtained from the base drawing provided by MMM. Ground surface elevations at Boreholes R-01 and R-03 located on Highway 19 some distance from the roundabout ramps were interpolated from the available ground surface contours, and are approximate.

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 were also conducted on selected samples. The results of these laboratory tests are summarized on the Record of Borehole sheets included in Appendix A, and are illustrated on figures included in Appendix B.

4.0 SUBSURFACE CONDITIONS

4.1 General

This section presents a generalized summary of the subsurface conditions encountered in the boreholes. Detailed subsurface soil and groundwater conditions encountered in the boreholes are presented on the Record of Borehole sheet in Appendix A. The factual data presented in the record of borehole governs any interpretation of the site conditions. It should be recognized that the subsurface conditions may vary beyond the borehole locations.

The native soils encountered in the boreholes below the embankment fill materials consisted of predominantly glacial till deposit. The till deposit comprised of sand and gravel and silty sand interlayered at two locations with silty clay till. Five of the six boreholes drilled were dry on completion of drilling, and water level in Borehole R-06 was measured at a depth of 2.1m (Elev. 287.4).

4.2 Asphalt

Borehole R-01 was advanced from the shoulder of the Highway 19 and Boreholes R-05 and R-06 were advanced from the shoulders of W-NS Ramp and E-NS Ramp, respectively. The boreholes encountered some 75 mm to 150 mm of asphalt.

4.3 Road Base Fill

Underlying the asphalt, or extending from the ground surface, in all boreholes was a layer of fill that comprises the road base. The fill was classified as sand and gravel to gravelly sand with some silt and occasional cobbles. The fill varied in thickness from 0.4 m to 1.5 m. The underside of the sand and gravel/gravelly sand fill was encountered between 0.5 m and 1.5 m depth or between Elev. 288.3 and Elev. 295.7.

SPT 'N' values ranged from 12 blows per 0.3 m penetration to 51 blows per 0.3 m penetration, indicating a compact to very dense relative density of the fill. Although, the recorded higher N-values in the fill may reflect presence of cobbles.

Grain size analyses were completed on selected samples of the fill. The results are presented on the Record of Borehole sheets in Appendix A and are shown on Figure B1 in Appendix B.

The results of the grain size distribution tests are summarized below:

Soil Particles	Percentage (%)
Gravel	27 to 51
Sand	39 to 60
Silt and Clay	10 to 13

Moisture contents of 2% to 5% were measured on samples of this fill material.

4.4 Sand and Silt to Silty Sand Fill

Underlying the road base in Boreholes R-01 to R-04 is a layer of sand and silt to silty sand fill. Trace to some clay, trace to some gravel, occasional clay seams and occasional cobbles were noted in the fill material. The thickness of fill varied from 3.3 m in Borehole R-01 to 1.5 m in Borehole R-04. The underside of this fill was encountered between depths of 3.0 m and 3.8 m depths, or between Elev. 287.7 and Elev. 293.0.

SPT 'N' values ranged from 10 blows per 0.3 m penetration to 35 blows per 0.3 m penetration, indicating a compact to dense relative density of the fill.

Grain size analyses were completed on selected samples of the fill. The results are presented on the Record of Borehole sheets in Appendix A and are shown on Figure B2 in Appendix B.

The results of the grain size distribution tests are summarized below:

Soil Particles	Percentage (%)
Gravel	0 to 14
Sand	40 to 47
Silt	29 to 40
Clay	14 to 19
Silt and Clay	51

Moisture contents of 3% to 18% were measured on samples of this fill material.

4.5 Silty Clay

A layer of silty clay was encountered in Borehole R-06 underlying the road base material. The silty clay contained trace sand and trace gravel and was 1.8 m in thickness. The underside of the layer was found at 3.0 m depth or at Elev. 286.5.

SPT 'N' values of 6 and 8 blows per 0.3 m penetration were obtained in this deposit, indicating a firm consistency of the silty clay.

Grain size analysis was completed on a sample of the silty clay. The results are presented on the Record of Borehole sheet in Appendix A and are shown on Figure B3 in Appendix B.

The results of the grain size distribution tests are summarized below:

Soil Particles	Percentage (%)
Gravel	0
Sand	0
Silt	81
Clay	19

Moisture contents of 12% and 20% were measured on samples of the silty clay.

4.6 Cohesionless Till

A cohesionless till ranging in composition from sand and gravel to silty sand with trace to some clay, occasional cobble and occasional silty clay seams was encountered in Boreholes R-01 to R-05 underlying the fill, and in Borehole R-06 underlying the silty clay. The cohesionless till was encountered to the base of Boreholes R-01 and R-03 to R-05 at depths ranging from 6.7 m to 7.7 m (Elev. 284.8 to 288.8). In Borehole R-02, the layer of sand and gravel till was 1.8 m thick and extended to a depth of 5.3 m or Elev. 291.2. In Borehole R-06, a layer of silty sand till was 1.6 m thick and extended to 4.6 m depth or Elev. 284.9.

It should be noted that cobbles and boulders inherently occur in glacial deposits and they should be expected within the soil matrix.

SPT tests N-Values obtained in this till varied from 7 to in excess of 100 blows per 0.3 m of penetration, indicating a loose to very dense relative density.

Grain size analyses were completed on selected samples of the cohesionless till. The results are presented on the Record of Borehole sheets in Appendix A and are shown on Figures B4 and B5 in Appendix B.

The results of the grain size distribution tests are summarized below:

Soil Particles	Sand and Gravel	Silty Sand
	Percentage (%)	
Gravel	44 to 46	0 to 8
Sand	37 to 45	46 to 56
Silt	11 to 17	30 to 35
Clay		10 to 16

Moisture contents in the sand and gravel till ranged from 2 to 8%, and in the silty sand ranged from 2 to 20%.

4.7 Silty Clay Till

A till consisting of silty clay with trace to some sand and trace to some gravel was encountered underlying the sand and gravel till in Borehole R-02 and silty sand till in Borehole R-06. This cohesive till extended to the base of boreholes at 6.7 m depth or to Elev. 289.8 and Elev. 282.8, respectively in Boreholes R-02 and R-06.

SPT tests N-Values obtained in this till varied from 15 to 29 blows per 0.3 m of penetration, indicating a very stiff consistency of the deposit.

Moisture contents in the silty clay till ranged from 10 to 17%.

Glacial till inherently contains cobbles and boulders.

4.8 Groundwater Conditions

Groundwater conditions were observed during drilling operations and in the boreholes upon completion of drilling. The water levels are summarized in the table below.

Table 4.1 - Water Levels in Boreholes

Borehole Number	Depth /Elevation (m)	Comments
R-01	Dry to 3.8 m/Elev. 287.7	Upon borehole completion
R-02	Dry to 5.8 m / Elev. 290.7	Upon borehole completion
R-03	Dry to 7.7 m / Elev. 284.8	Upon borehole completion
R-04	Dry to 5.5 m / Elev. 290.0	Upon borehole completion
R-05	Dry to 6.7 m / Elev. 285.8	Upon borehole completion
R-06	2.1 m / Elev. 287.4	Upon borehole completion

It should be noted that the above are very short term observations and the actual long-term groundwater levels at the borehole locations may be higher. Moreover, the groundwater level is subject to seasonal fluctuations and severe climatic events.

5.0 GEOTECHNICAL PARAMETERS

The geotechnical parameters that may be used in the design of the sign support/foundation are presented in Table 1, which follows the text of this report.

6.0 MISCELLANEOUS

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

Altech Drilling and Investigative Services Ltd. of Elmira, Ontario, supplied and operated the drilling, sampling and in-situ testing equipment for the field program. The field investigation was supervised on a full time basis by Mr. Tim Craplewe of Thurber. Overall supervision of the investigation program was conducted by Mr. Stephane Loranger, C.E.T and Weiss Mehdawi, P.Eng.

Routine laboratory testing was carried out by Thurber’s geotechnical laboratory in Oakville, Ontario.

Interpretation of the data and preparation of this report was carried out by Ms. Anna Piascik, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng. and by Dr. P.K. Chatterji, P.Eng., who is a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

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TABLE 1
FOUNDATION DESIGN PARAMETERS
ROUNDABOUT SIGN SUPPORTS
HIGHWAY 401 AND HIGHWAY 19 INTERCHANGE, TOWN OF INGERSOLL
G.W.P. 3079-09-00

Sign No	Relevant Borehole	Simplified Stratigraphy	Ground Surface Elev. (m)	Depth Below Existing Grade (m)	Geotechnical Design Parameters						
					q_u (kPa)	ϕ' (deg.)	γ (kN/m^3)	γ' (kN/m^3)	n_h (MN/m^3)	K_p	Groundwater depth (m)
Sign #1	R-01	Sand and Gravel Fill	291.5	0.1 – 0.5	-	30	20	-	2.5	3.0	
		Sand and Silt Fill		0.5 – 3.8	-	30	20	-	2.5	3.0	Dry to 3.8 m
		Sand and Gravel Till		3.8 – 6.7	-	35	-	11	6.0	3.7	
Sign #2	R-02	Sand and Gravel Fill	296.5	0.0 - 0.8	-	30	20	-	2.5	3.0	
		Silty Sand Fill		0.8 – 3.5	-	30	20	-	2.5	3.0	
		Sand and Gravel Till		3.5 – 5.3	-	35	21	-	10	3.7	Dry to 5.8 m
		Silty Clay Till (above wl)		5.3 – 5.8	100	-	19	-	-	-	
		Silty Clay Till (below wl)		5.8 – 6.7	100	-	-	9	-	-	
Sign #3	R-03	Gravelly Sand Fill	292.5	0.0– 1.2	-	30	20	-	2.5	3.0	
		Sand and Silt Fill		1.2 – 3.0	-	30	20	-	2.5	3.0	Dry to 7.7 m
		Silty Sand Till (loose)		3.0 – 5.0	-	30	21	-	2.5	3.0	
		Silty Sand Till (very dense)		5.0 - 7.7	-	35	21	-	10.0	3.7	
Sign #4	R-04	Sand and Gravel Fill	295.5	0.0 – 1.5	-	30	20	-	2.5	3.0	
		Sand and Silt Fill		1.5 - 3.0	-	30	20	-	2.5	3.0	Dry to 5.5 m
		Silty Sand Till (above wl)		3.0 – 5.5	-	32	21	-	5.0	3.3	
		Silty Sand Till (below wl)		5.5 – 6.7	-	30	-	11	3.0	3.0	
Sign #5	R-05	Sand and Gravel Fill	292.5	0.2 – 1.4	-	30	20	-	2.5	3.0	Dry to 6.7 m
		Silty Sand Till		1.4 – 6.7	-	33	21	-	6.0	3.4	
Sign #6	R-06	Sand and Gravel Fill	289.5	0.2 – 1.2	-	30	20	-	2.5	3.0	
		Silty Clay (above wl)		1.2 – 2.1	40	-	18	-	-	-	Water level at 2.1 m / Elev. 287.4
		Silty Clay (below wl)		2.1 – 3.0	40	-	-	8	-	-	
		Silty Sand Till (below wl)		3.0 – 4.6	-	32	-	11	5.0	3.3	
		Silty Clay Till (below wl)		4.6 – 6.7	150	-	-	9	-	-	

Legend:

q_u	=	unconfined compressive strength	=	2 x c_u (undrained shear strength)
ϕ'	=	angle of internal friction		
γ	=	bulk unit weight		
γ'	=	submerged unit weight		
K_p	=	coefficient of passive earth pressure		

Note: The ultimate lateral resistance in front of the caisson within the upper 1.2 m below the final grade should be neglected to account for frost action and surficial disturbance.

Appendix A

Record of Borehole Sheet

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

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

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Ontario

THURBER

RECORD OF BOREHOLE No R-01 1 OF 1 METRIC

GWP# 3079-09-00 LOCATION N 4 766 579.3 E 194 066.0 ORIGINATED BY TIM

HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.12.16 - 2015.12.16 CHECKED BY AMP

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
291.5	GROUND SURFACE										
0.0 / 0.1	**ASPHALT:** (75mm)										
291.0 / 0.5	**SAND** and **GRAVEL**, some silt Compact Brown Moist (FILL)		1	SS	12		291		○		
	SAND and **SILT**, trace to some clay, trace gravel, occasional cobbles Compact Brown Moist (FILL)		2	SS	12				○		
			3	SS	12		290		○		
			4	SS	11		289		○		2 43 36 19
			5	SS	19		288		○		
287.7											
3.8	**SAND** and **GRAVEL**, some silt, occasional cobbles Very Dense Brown Moist (TILL)		6	SS	50/ 0.150		287		○		
			7	SS	79		286				
284.8							285		○		44 45 11 (SI+CL)
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 3.8m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.3m, CONCRETE MIX TO 0.2m AND CAPPED WITH COLD MIX.										

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

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

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 2/16/16

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No R-02 1 OF 1 METRIC

GWP# 3079-09-00 LOCATION N 4 766 126.4 E 194 484.7 ORIGINATED BY TIM

HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.12.18 - 2015.12.18 CHECKED BY AMP

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
296.5	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	**SAND** and **GRAVEL**, some silt Compact Brown Moist (FILL)		1	SS	15		296		○		
295.7											
0.8	Silty **SAND**, trace to some gravel, some clay, occasional silty clay seam Compact to Dense Brown Moist (FILL)		2	SS	25				○		
			3	SS	17		295		○		8 47 31 14
			4	SS	35		294		○		
293.0			5	SS	20				○		14 42 29 15
3.5	**SAND** and **GRAVEL**, some silt, trace clay, occasional cobbles Compact to Dense Brown Moist (TILL)						293				
			6	SS	39		292		○		46 37 17 (SI+CL)
291.2											
5.3	Silty **CLAY**, trace to some sand, trace gravel Very Stiff Brown Moist (TILL)						291				
			7	SS	15				○		
289.8							290				
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 5.8m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

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

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

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 2/16/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No R-03 1 OF 1 METRIC

GWP# 3079-09-00 LOCATION N 4 765 777.5 E 194 838.7 ORIGINATED BY TIM

HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.12.18 - 2015.12.18 CHECKED BY AMP

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
292.5	GROUND SURFACE										
0.0	Gravelly **SAND**, some silt Compact Brown Moist (FILL)		1	SS	29		292	○	○		27 60 13 (SI+CL)
291.3			2	SS	20			○			
1.2	**SAND** and **SILT**, some clay, trace gravel, slight organic odours Compact Brown Moist (FILL)		3	SS	10		291	○	○		0 44 40 16
289.5			4	SS	15		290	○	○		
3.0	Silty **SAND**, some clay, trace to some gravel, occasional cobbles Loose to Very Dense Brown Moist (TILL)		5	SS	7		289	○	○		
			6	SS	9		288	○	○		6 49 35 10
			7	SS	50/ 0.050		287	○	○		
284.8			8	SS	142/ 0.100		286				
7.7	END OF BOREHOLE AT 7.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, BENTONITE HOLEPLUG TO 0.2m, THEN CUTTINGS TO SURFACE.						285				

+ 3, × 3: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 2/16/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No R-04 1 OF 1 METRIC

GWP# 3079-09-00 LOCATION N 4 766 210.9 E 194 402.7 ORIGINATED BY TIM

HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.12.16 - 2015.12.16 CHECKED BY AMP

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
295.5	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, some silt Compact Brown Moist (FILL)		1	SS	24		295		○		
			2	SS	17				○		51 39 10 (SI+CL)
294.0							294				
1.5	**SAND** and **SILT**, trace to some clay, trace to some gravel Compact Brown Moist (FILL)		3	SS	16				○		
			4	SS	19		293		○		9 40 51 (SI+CL)
292.5											
3.0	Silty **SAND**, some clay, trace to some gravel, occasional silty clay seams, occasional cobbles Loose to Compact Brown Moist (TILL)		5	SS	13		292		○		
			6	SS	8		291		○ ⊢		8 46 30 16
			7	SS	9		290		○		
288.8							289				
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 5.5m AND DRY. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, BENTONITE HOLEPLUG TO 0.3m, THEN CUTTINGS TO SURFACE.										

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

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

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 2/16/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No R-05 1 OF 1 METRIC

GWP# 3079-09-00 LOCATION N 4 765 991.5 E 194 338.5 ORIGINATED BY TIM

HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.12.21 - 2015.12.21 CHECKED BY AMP

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
292.5	GROUND SURFACE										
0.0	**ASPHALT:** (150mm)										
0.2	**SAND** and **GRAVEL**, some silt, occasional cobbles Compact to Dense Brown Moist (FILL)		1	SS	41		292		○		
			2	SS	26				○		
291.1							291				
1.4	Silty **SAND**, some clay, trace to some gravel Compact Brown Moist (TILL)		3	SS	26				○		
			4	SS	27		290		○		
			5	SS	11		289		○		
			6	SS	19		288		○		
							287				
			7	SS	13		286		○		5 47 34 14
285.8											
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.3m, CONCRETE MIX TO 0.1m, THEN CAPPED WITH COLD MIX TO SURFACE.										

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

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

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 2/16/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No R-06 1 OF 1 METRIC

GWP# 3079-09-00 LOCATION N 4 766 362.0 E 194 511.7 ORIGINATED BY TIM

HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.12.21 - 2015.12.21 CHECKED BY AMP

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
289.5	GROUND SURFACE										
0.0	**ASPHALT:** (150mm)										
0.2	**SAND** and **GRAVEL**, some silt, occasional cobbles Dense Brown Moist (FILL)		1	SS	51		289		○		
288.3			2	SS	30				○		
1.2	Silty **CLAY**, trace sand, trace gravel Firm Brown Moist to Wet		3	SS	6	▽	288		○		0 0 81 19
286.5			4	SS	8		287		○		
3.0	Silty **SAND**, trace clay, trace gravel Compact Brown Moist (TILL)		5	SS	13		286		○		0 56 35 9
284.9							285				
4.6	Silty **CLAY**, trace sand, trace to some gravel, occasional cobbles Very Stiff Brown Moist (TILL)		6	SS	25		284		○		
282.8			7	SS	29		283		○		
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 5.5m AND WATER LEVEL AT 2.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.3m, CONCRETE MIX TO 0.1m, THEN COLD MIX TO SURFACE.										

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

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

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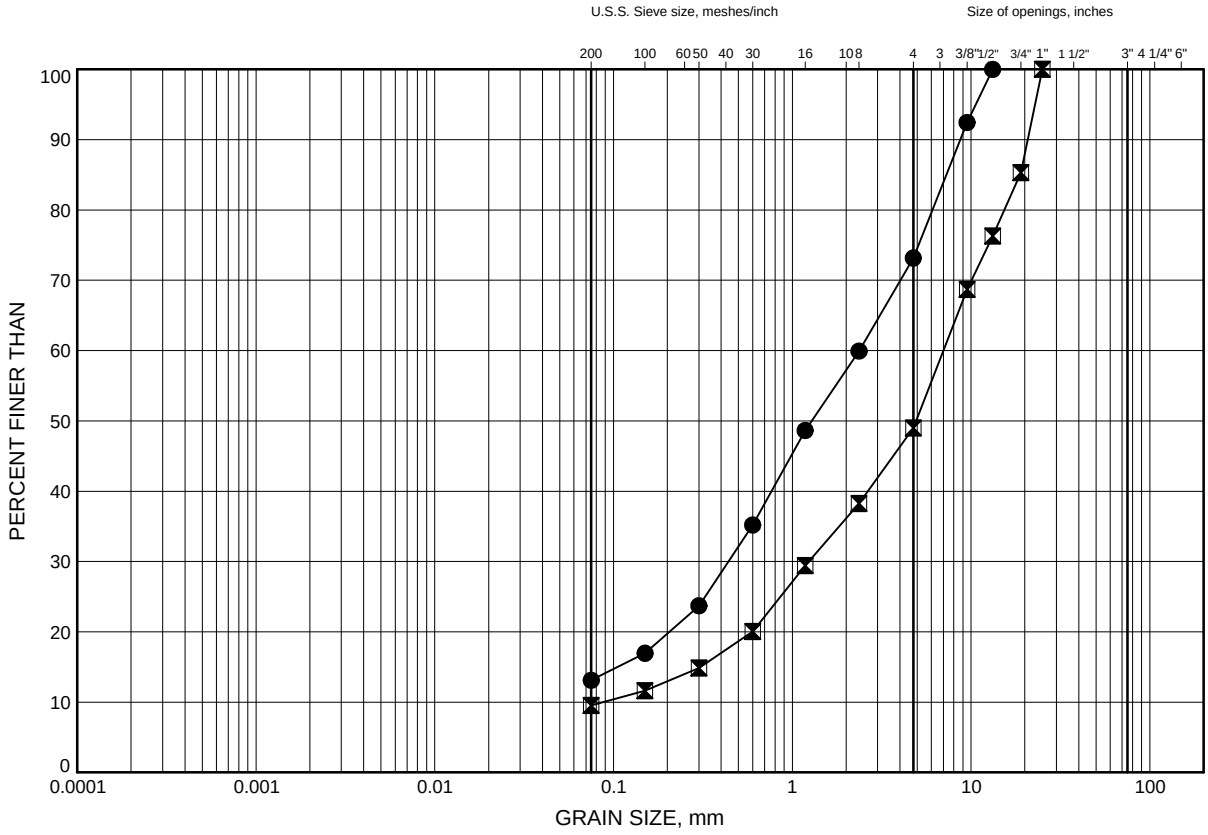
Appendix B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND & GRAVEL to Gravelly SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	R-03	0.30	292.20
⧓	R-04	1.07	294.43

Date February 2016

GWP# 3079-09-00

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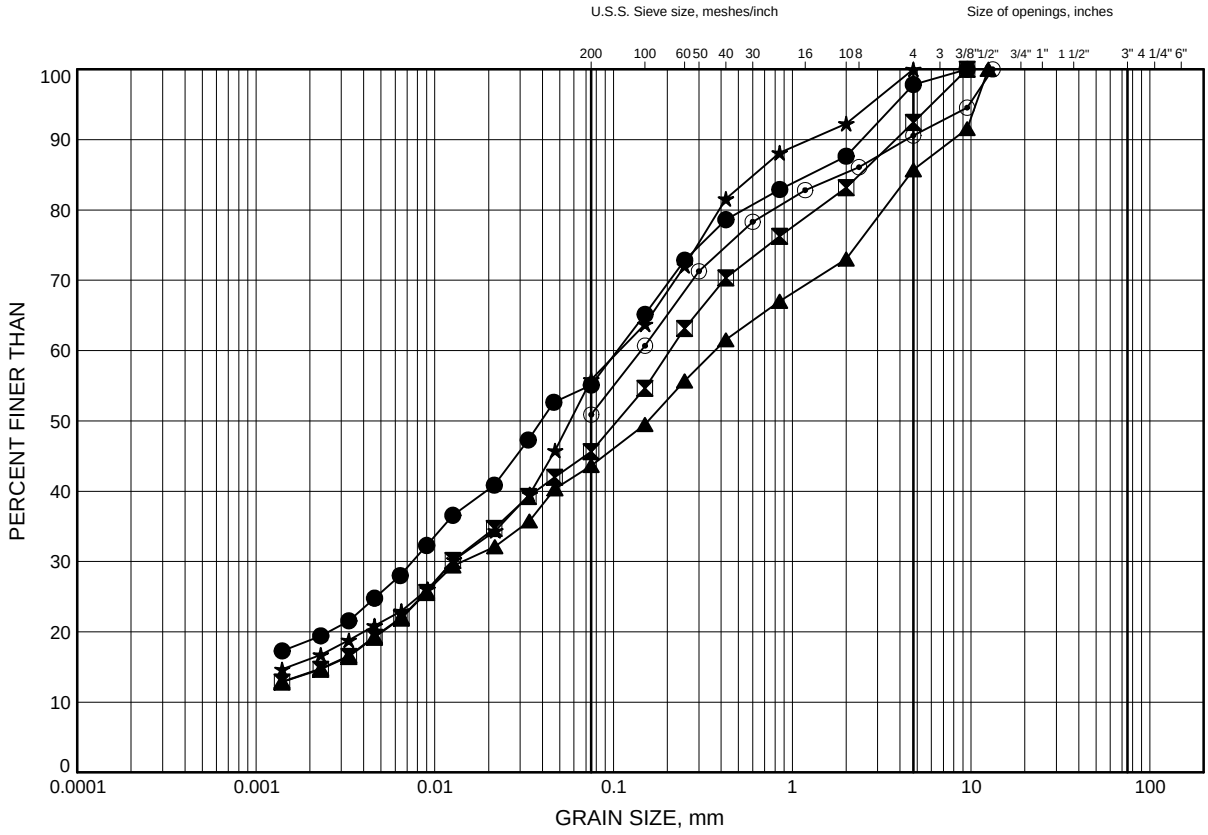
GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 2/16/16

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & SILT to Silty SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	R-01	2.59	288.91
⊠	R-02	1.83	294.67
▲	R-02	3.35	293.15
★	R-03	1.83	290.67
⊙	R-04	2.59	292.91

Date February 2016

GWP# 3079-09-00

THURBER

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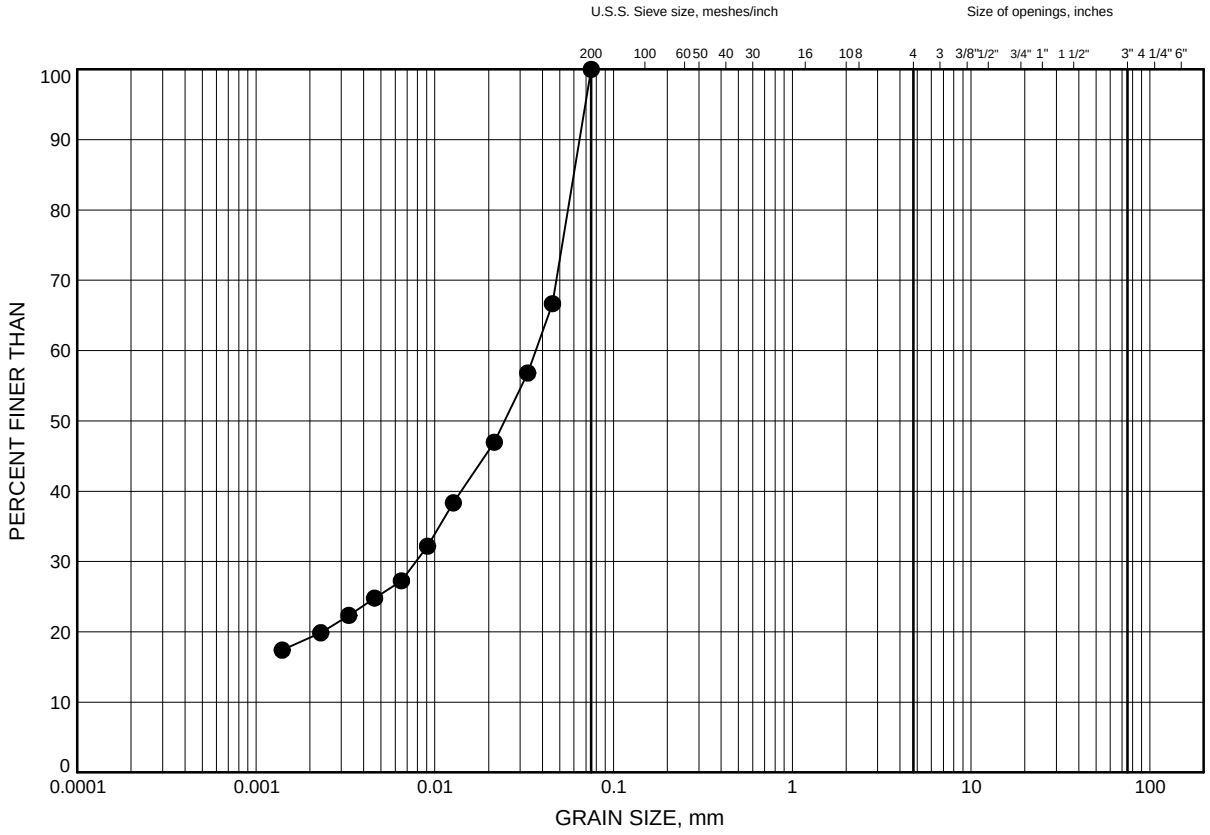
Chkd. AMP

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 2/16/16

GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	R-06	1.83	287.67

Date February 2016

GWP# 3079-09-00

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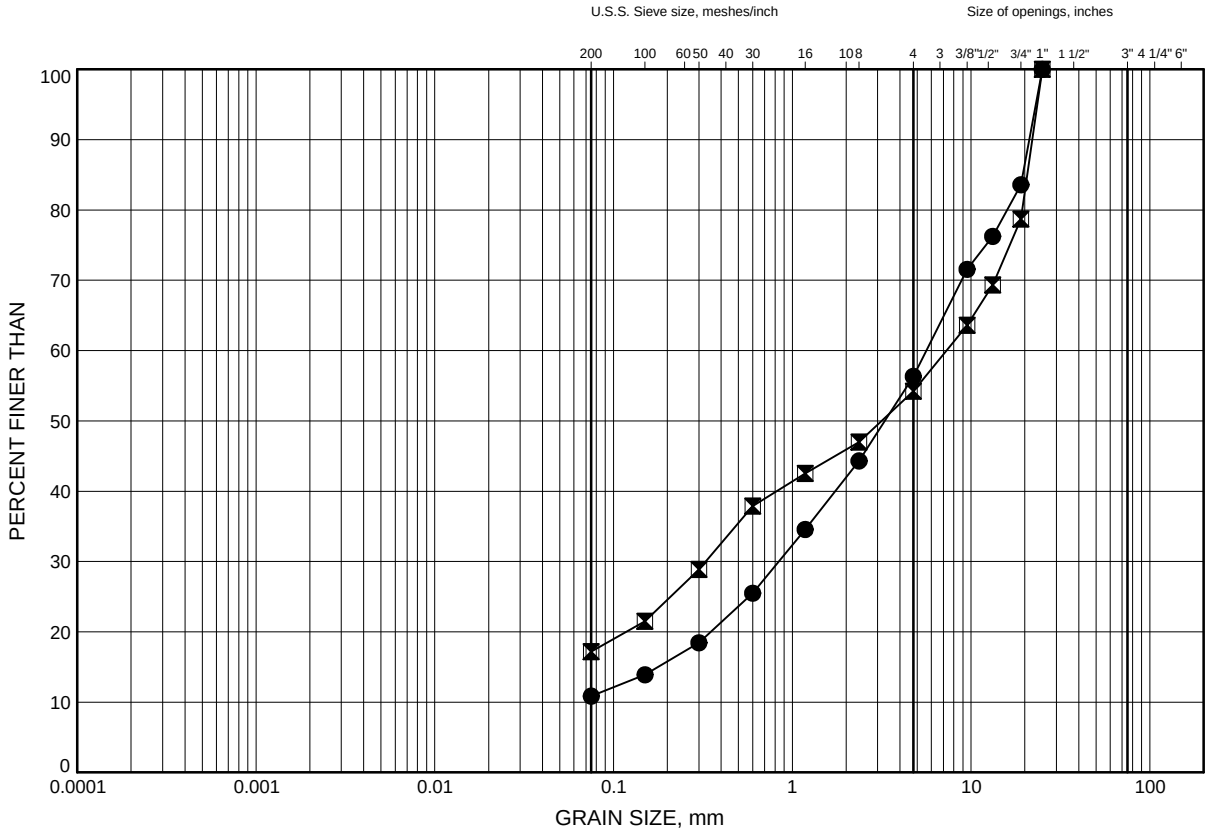
GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 2/16/16

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND & GRAVEL TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	R-01	6.40	285.10
⧓	R-02	4.88	291.62

Date February 2016

GWP# 3079-09-00

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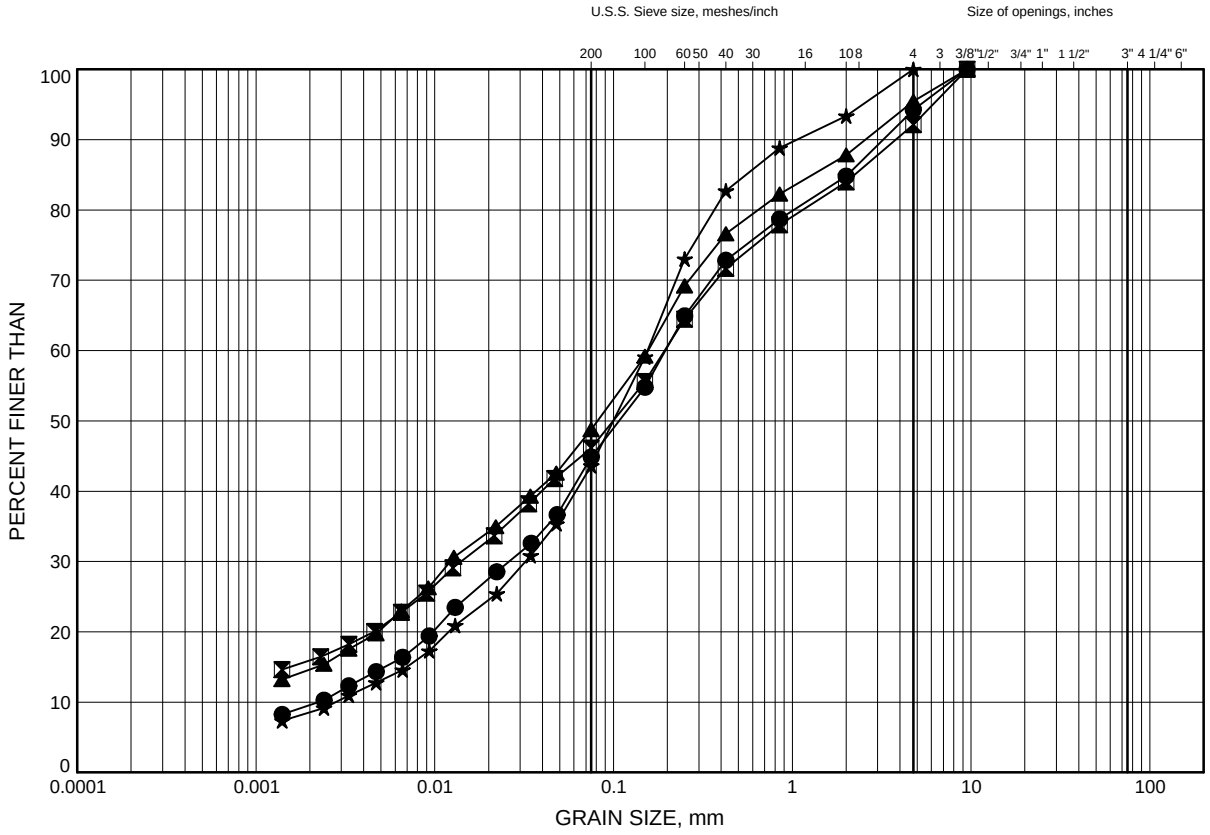
GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 2/16/16

GRAIN SIZE DISTRIBUTION

FIGURE B5

Silty SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	R-03	4.88	287.62
⊠	R-04	4.88	290.62
▲	R-05	6.40	286.10
★	R-06	3.35	286.15

Date February 2016

GWP# 3079-09-00

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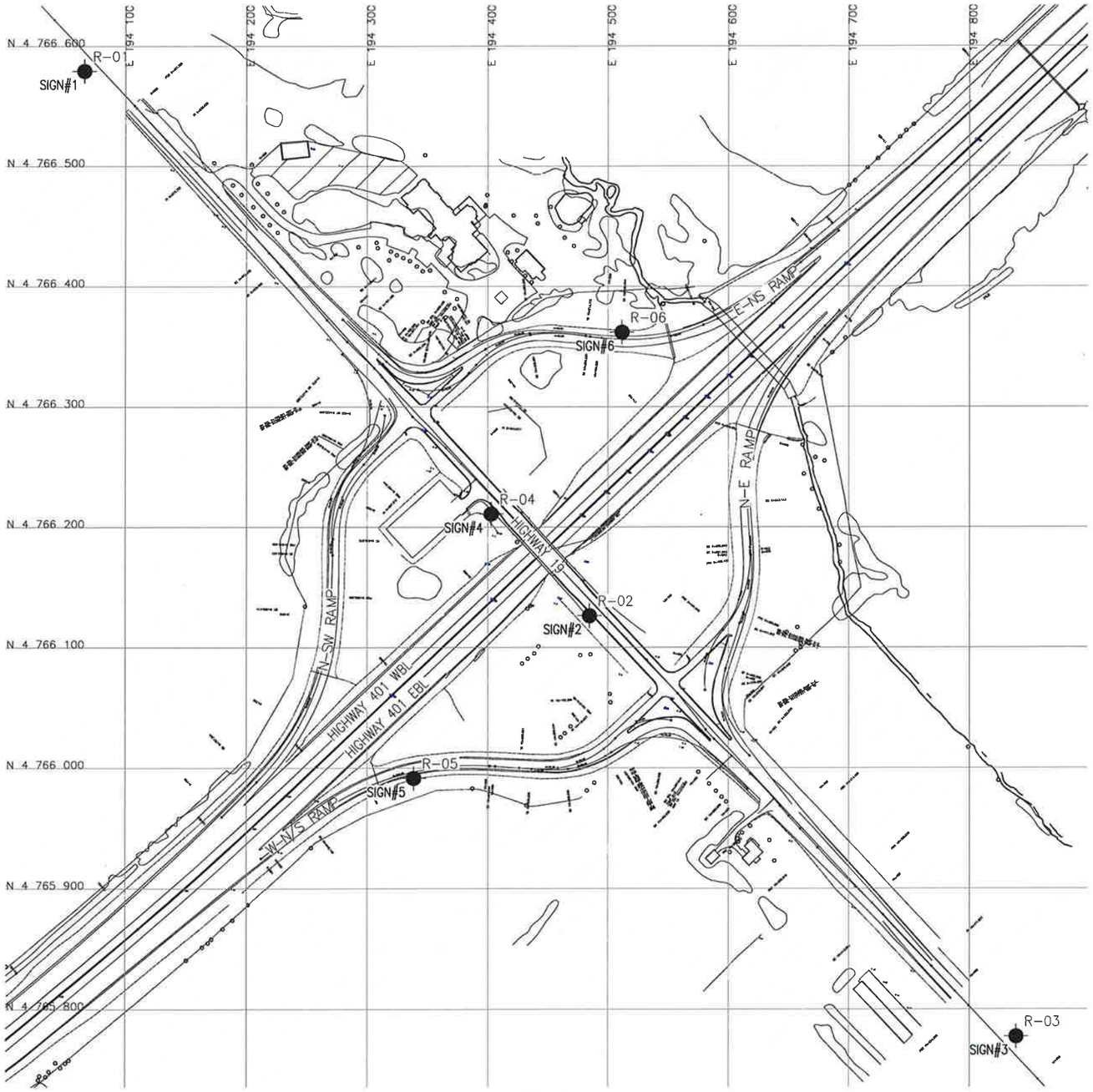
GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 2/16/16

Appendix C

Borehole Location Plan

THURBER



PLAN

80 0 80 160m

SCALE 1:4000

METRIC

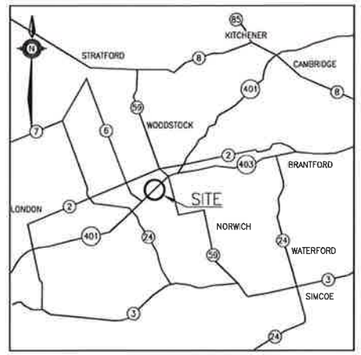
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 3079-09-00

SHEET

HIGHWAY 401 &
HIGHWAY 19
ROUNDABOUT SIGNS
BOREHOLE LOCATIONS PLAN

THURBER ENGINEERING LTD.



KEYPLAN

LICENSED PROFESSIONAL ENGINEER
A. PIASCIK
Mar 15/16
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 15/16
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
16+537	291.8	4 765 867.2	194 155.5
17+390	291.2	4 765 496.0	194 743.7
R-01	291.5	4 766 579.3	194 066.0
R-02	296.5	4 766 126.4	194 484.7
R-03	292.5	4 765 777.5	194 838.7
R-04	295.5	4 766 210.9	194 402.7
R-05	292.5	4 765 991.5	194 338.5
R-06	289.5	4 766 362.0	194 511.7

-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.

GEOCRES No. 40P2-83

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	AMP	CHK PKC	CODE	LOAD	DATE MAR 2016
DRAWN	AN	CHK AMP	SITE	STRUCT	DWG 1

FILENAME: H:\Drafting\15\5161\224\tec1224--BoreholePlan--HWY19(OverheadSigns).dwg
PLOTDATE: 3/15/2016 8:12 AM