FOUNDATION INVESTIGATION REPORT
STORM SEWER AND WATERMAIN CROSSINGS
UNDER HURONTARIO STREET
MISSISSAUGA BUS RAPID TRANSIT (BRT) PROJECT
MISSISSAUGA, ONTARIO

Geocres Number: 30M12-308

Report to

McCormick Rankin Corporation

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H:\19\1351\160 Mississauga BRT Detailed Design\Reports & Memos\Structures\Pipe Crossings\BRT Hurontario Tunnels FIR Final.doc

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for a proposed storm sewer and watermain crossing under Hurontario Street at the W-N/S Ramp / Sherwoodtowne Boulevard intersection in Mississauga, Ontario. Installation of the sewer and watermain by trenchless methods is planned. The work is part of the Mississauga Bus Rapid Transit (BRT) project.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profiles, and written description of the subsurface conditions. A model of the subsurface conditions was developed to describe the geotechnical conditions influencing design and construction of the proposed crossings.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation under their Sub-consultant Agreement for Project Number 7493.

2 PROJECT AND SITE DESCRIPTION

The BRT project involves a fully grade-separated, two-lane bus-only roadway located in the City of Mississauga, extending from the City Centre Station (Highway 403 at Hurontario Street) to the Renforth Drive Station (Renforth Drive at Eglinton Avenue). The total length is approximately 9.5 km.

As part of the project, a storm sewer and watermain will be installed under Hurontario Street at the intersection with the W-N/S Ramp and Sherwoodtowne Boulevard. The proposed storm sewer will have a diameter of 1350 mm and an invert level approximately 9 m below the pavement surface. The watermain will have a diameter of 300 mm and invert level near 7 m depth. The trenchless portions of the crossings will be approximately 85 and 75 m in length, respectively.

The site is situated within the South Slope physiographic region. The geology generally comprises a till plain consisting of clayey silt to silty clay till (Halton Till) overlying bedrock at relatively shallow depth. The bedrock consists of grey shale, siltstone and limestone of the Georgian Bay Formation.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation was carried out on April 6 to 8, 2010, and consisted of drilling and sampling three boreholes along the proposed crossing alignment. Two boreholes drilled near the proposed entrance and exit pits were extended by augering in the overburden and coring of shale bedrock to depths of 9.1 and 11.0 m. A third borehole (borehole 10-02) located near the middle of Hurontario Street was terminated in shale at 4.8 m depth.

The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawings in Appendix C. The coordinates and elevations of the boreholes are given on the drawing and on the individual Record of Borehole Sheets in Appendix A.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

Solid stem augers were used to advance the boreholes in the overburden and into the shale. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). NQ rock coring equipment was used to recover core samples of the underlying bedrock in boreholes 10-01 and 10-03.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, visually examined the recovered samples, and transported them to Thurber's laboratory for further examination and testing.

All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Standpipe piezometers consisting of 25 mm PVC pipes with screens were installed in two boreholes to permit monitoring of groundwater levels. Details of the piezometer installations and other borehole completion details are as shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
10-01	9.1/149.3	Piezometer with 1.5 m slotted screen installed with sand filter to 7.3 m, bentonite from 7.3 m to ground surface.
10-02	None installed	Backfilled with bentonite to 0.15 m, asphalt at ground surface.
10-03	11.0/150.1	Piezometer with 1.5 m slotted screen installed with sand filter to 9.2 m, bentonite from 9.2 m to ground surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and rock samples to geological logging. At least 25% of the recovered samples of soil were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. Moisture content determinations were carried out on all soil samples. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

Core samples of the shale bedrock were carefully protected to prevent drying during transport to the laboratory. Point load tests were carried out on selected samples of intact limestone interbeds upon arrival at the laboratory to assist in evaluation of the compressive strength of the bedrock. The results of the point load tests are shown on the borehole log.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil and rock stratigraphy are presented in this appendix and on the Borehole Locations and Soil Strata Drawing in Appendix C. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general terms, the soil stratigraphy encountered at this site comprises fill overlying native silty clay till, which is in turn underlain by weathered shale bedrock. A pavement structure was encountered on Hurontario Street. More detailed descriptions of the individual strata are presented below.

5.1 Pavement Structure

The pavement structure encountered in borehole 10-02 drilled on Hurontario Street consisted of 150 mm of asphalt overlying 550 mm of sand and gravel (crushed limestone). The results of a grain size distribution analysis conducted on the granular material are shown in Figure B1, Appendix B.

5.2 Silty Clay, Shale, and Sand and Gravel Fill

Fill consisting of silty clay mixed with zones of broken shale and locally grading to clayey sand and silt was encountered in each borehole. In boreholes 10-01 and 10-03, the fill was 2.3 m thick with a lower boundary at elevation 156.1 and 158.7 m, respectively. In borehole 10-02, a possible buried pavement structure was encountered below the clay/shale fill at 2.4 m depth (elevation 158.7 m).

The buried pavement structure in borehole 10-02 consisted of approximately 200 mm of asphalt overlying 1.4 m of sand and gravel fill. The lower boundary of the fill was encountered at 4.0 m depth (elevation 157.1 m).

SPT 'N' values obtained in the fill typically ranged from 11 to 40 blows/0.3 m, indicating a stiff to hard/compact to dense condition. An 'N' value of 77 blows/0.3 m was obtained in a zone of shale fill in borehole 10-01, and a value of 50 blows/0.15 m of penetration was recorded when the sampler encountered the buried asphalt layer in borehole 10-02.

The natural moisture contents of the fill samples generally ranged from 9 to 17%.

Grain size distribution curves for two samples of the clay/clayey fill and one sample of the sand and gravel fill are presented on Figures B2 and B1 of Appendix B, respectively. Atterberg Limit test results are presented on Figure B4. The results of the laboratory tests are summarized as follows:

Soil Particles	Silty Clay	Sand and Gravel
Gravel %	8 to 12	41
Sand %	31 to 39	47
Silt %	29 to 39	12
Clay %	20 to 22	

Liquid Limit	33
Plastic Limit	20

The above results show that the clay fill is of low plasticity with a group symbol of CL.

5.3 Silty Clay Till

Native brown to grey silty clay till was contacted at 2.3 m depth in boreholes 10-01 and 10-03. The lower boundary of the till was encountered at 3.8 m depth (elevation 154.6 and 157.3 m, indicating a layer thickness of 1.5 m.

SPT 'N' values of 12 and 16 blows/0.3 m were obtained in the clay till in borehole 10-01, indicating a stiff to very stiff consistency. In borehole 10-03, SPT 'N' values of 30 blows/0.3 m and 50 blows/0.1 m were obtained, indicating a hard consistency. The natural moisture content of the silty clay till ranged from 15 to 24%.

Grain size distribution curves for the clay till are presented on the Record of Borehole sheets and on Figure B3 of Appendix B. Atterberg Limit test results are included on Figure B4. The results of the laboratory tests are summarized as follows:

Gravel %	1 to 7
Sand %	19 to 23
Silt %	44 to 44
Clay %	26 to 36

Liquid Limit	27 to 39
Plastic Limit	16 to 22

The above results show that the silty clay till is typically of low to medium plasticity with group symbols of CL-CI.

Glacial tills inherently contain cobbles and boulders and the lower part of the till may contain pieces and slabs of bedrock which may account for some high blow counts.

5.4 Bedrock

Shale bedrock was encountered below the fill and clay till at 3.8 to 4.0 m depth. The depths and elevations of the bedrock surface are summarized in Table 5.1.

Table 5.1 – Depth and Elevation of Bedrock Surface

Borehole	Depth to Bedrock (m)	Bedrock Surface Elevation (m)
10-01	3.8	154.6
10-02	4.0	157.1
10-03	3.8	157.3

The shale recovered in the rock cores is described as thinly bedded with hard limestone interbeds. The shale bedrock is highly weathered within the upper 1.0 to 2.5 m below which it becomes slightly weathered to fresh and stronger. SPT 'N' values of 50 blows per 25 to 100 mm penetration were obtained in the upper part of the shale bedrock.

Total core recovery (TCR) in the bedrock was 100% in all core runs except the initial run in borehole 10-03 where it was 32%. RQD values typically increased with depth, ranging from 48% to 100%, indicating a generally fair to excellent rock quality. An RQD value of 0% was recorded in the initial run in borehole 10-03, indicating a very poor rock quality in the upper part of the shale.

In general, the Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, exceeded 5 in the upper 1.2 to 2.5 m of the shale, and was 0 to 1 below this level. Highly broken/rubble zones were observed within the cores at several depths.

The unconfined compressive strength of the limestone interbeds assessed from Point Load testing on recovered rock cores ranged from 74 to 251 MPa, indicating a strong to very strong rock. Point load tests were possible only on the limestone interbed samples as the more typical weathered shale cores tended to split along bedding planes and were not suitable for testing. Based on point load and unconfined compression testing carried out on shale cores from other areas of the BRT project, the shale strength ranges from about 3 to 30 MPa, indicating a very weak to medium strong rock.

5.5 Water Levels

Water was measured at depths of 0.4 and 0.1 m in boreholes 10-01 and 10-03 upon completion of coring. These levels reflect the presence of core water introduced into the

boreholes as part of the coring operations and do not indicate natural groundwater levels. Water was not observed in borehole 10-02 during drilling.

Standpipe piezometers were installed in boreholes 10-01 and 10-03 to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.2.

Table 5.2 – Measured Groundwater Levels

Borehole	Date	Water Level	
		Depth (m)	Elevation (m)
10-01	30-Apr-10	4.3	154.1
10-03	30-Apr-10	5.1	156.0

The above values 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.

6 MISCELLANEOUS

The locations and ground surface elevations at the boreholes were established by Thurber Engineering using a Trimble Pathfinder ProXRT GPS unit with a precision of 0.3 m.

The drilling and sampling equipment was supplied and operated by DBW Drilling of Ajax, Ontario. The fieldwork was supervised on a full time basis by Mr. George Azzopardi of Thurber Engineering Ltd. Overall supervision of the field program was conducted by Mr. Mark Farrant, P. Eng.

Laboratory testing was carried out at Thurber's laboratory in Oakville, Ontario.

Interpretation of the data and preparation of the report were carried out by Mr. Murray R. Anderson, P.Eng. Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects, reviewed the report.

THURBER ENGINEERING LTD.

Murray R. Anderson, P.Eng., M.Eng.
Senior Foundations Engineer

P.K. Chatterji, P.Eng., Ph.D.
Review Principal

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

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

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

$\underline{\blacktriangledown}$ 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

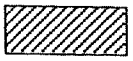
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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			

EXPLANATION OF ROCK LOGGING TERMS

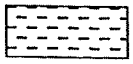
ROCK WEATHERING CLASSIFICATION

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

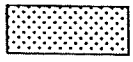
SYMBOLS



CLAYSTONE



SILTSTONE



SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

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

STRENGTH CLASSIFICATION

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

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RECORD OF BOREHOLE No 10-01 1 OF 2 METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 232.9 E 609 537.9 ORIGINATED BY GA
HWY 403 / BRT BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY AN
DATUM DATE 2010.04.06 - 2010.04.06 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	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
158.4											
0.0 / 0.1 / 158.0	**TOPSOIL:** (75mm)										
0.5	Silty **CLAY**, trace sand, trace rootlets Very Stiff Brown Damp (FILL)		1	SS	19		158		o		
156.9	**SHALE**, grey (FILL)		2	SS	77		157		o		
1.5 / 156.1	Clayey **SAND** and **SILT**, some gravel, trace shale fragments, trace organics Very Stiff Grey (FILL)		3	SS	22				o		12 39 29 20
2.3	Silty **CLAY**, some sand, trace gravel, occasional rootlets Stiff to Very Stiff Grey Damp (TILL)		4	SS	16		156		o		
154.6			5	SS	12		155		o		7 23 44 26
3.8	**SHALE**, highly weathered, thinly bedded, weak, grey, occasional strong to very strong limestone interbeds		6	SS	50/ 0.100				o		
	Slightly weathered to fresh Highly broken zones (50mm or more): 75mm at 4.6m 100mm at 4.8m 75mm at 5.0m		1	RUN			154			FI 2 >5 >10 0	RUN 1# TCR=100%, SCR=82%, RQD=48% UCS=111MPa (Limestone)
	Limestone interbeds (50mm or more): 150mm at 4.3m 125mm at 4.5m 125mm at 6.1m 125mm at 6.6m 175mm at 7.5m 150mm at 8.1m 75mm at 8.9m		2	RUN			153 152			0 0 3 0 0	RUN 2# TCR=100%, SCR=90%, RQD=83% UCS=114MPa (Limestone)
	100mm vertical joint at 7.5m		3	RUN			151 150			1 0 1 0 1	RUN 3# TCR=100%, SCR=100%, RQD=100% UCS=103MPa (Limestone)
149.3			4	RUN						0 0	RUN 4# TCR=100%, SCR=100%,
9.1	END OF BOREHOLE AT 9.1m. BOREHOLE OPEN TO 9.1m AND WATER LEVEL AT 0.4m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe										RQD=100% UCS=74MPa (Limestone)

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1160(MTO).GPJ 5/18/10

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RECORD OF BOREHOLE No 10-01 2 OF 2 METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 232.9 E 609 537.9 ORIGINATED BY GA
HWY 403 / BRT BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY AN
DATUM DATE 2010.04.06 - 2010.04.06 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O 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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.04.30 4.3 154.1										

+ ³, × ³: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 1160(MTO).GPJ 5/18/10

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No 10-02 1 OF 1 METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 277.5 E 609 538.6 ORIGINATED BY GA

HWY 403 / BRT BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM DATE 2010.04.07 - 2010.04.07 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / 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
161.1											
0.0	**ASPHALT:** (150mm)						161				
0.2	**SAND** and **GRAVEL**, some silt Dense Brown Dry (FILL)		1	SS	40				○		27 53 20 (SI+CL)
160.4											
0.7	Silty **CLAY**, trace sand, trace gravel, occasional shale fragments Hard Grey		2	SS	36		160		○		
159.6											
1.5	Dry (FILL)		3	SS	22				○		
	SHALE, highly weathered Grey Dry						159				
158.7	(FILL)										
2.4 158.5	**ASPHALT**		4	SS	50/ 0.150				○		
2.6	**SAND** and **GRAVEL**, some silt to silty Compact Brown Dry (FILL)						158				
			5	SS	18				○		41 47 12 (SI+CL)
157.1											
4.0	**SHALE**, highly weathered Grey Dry		6	SS	50/ 0.025		157		○		
156.3			7	SS	50/				○		
4.8	END OF BOREHOLE AT 4.8m UPON AUGER REFUSAL. BOREHOLE OPEN TO 4.7m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 0.15m, THEN ASPHALT PATCH TO SURFACE.				0.050						

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 1160(MTO).GPJ 5/6/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 10-03 1 OF 2 METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 323.4 E 609 536.3 ORIGINATED BY GA
HWY 403 / BRT BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY AN
DATUM DATE 2010.04.07 - 2010.04.08 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
161.1											
0.0	Silty **CLAY**, some sand, trace gravel, occasional rootlets Stiff to Very Stiff Brown to Grey (FILL)		1	SS	12		161				
	with shale fragments and slabs		2	SS	11		160				
			3	SS	21		159				8 31 39 22
158.7											
2.3	Silty **CLAY**, some sand, trace gravel Hard Brown to Grey Dry (TILL)		4	SS	30		158				1 19 44 36
			5	SS	50/ 0.100						
157.3							157				
3.8	**SHALE**, highly weathered, grey, thinly bedded, very weak to weak, with strong to very strong limestone interbeds Highly broken zones (50mm or more): 325mm at 5.8m 175mm at 6.1m 200mm at 7.3m Limestone interbeds (50mm or more): 100mm at 6.5m 125mm at 6.7m 100mm at 9.1m 50mm at 9.4m 50mm at 9.6m 50mm at 9.9m 100mm at 10.2m Slightly weathered to fresh		6	SS	50/ 0.075						
			1	RUN		▼	156			FI >10	RUN 1# TCR=32%, SCR=12%, RQD=0%
			2	RUN			155			>10 >5 0	RUN 2# TCR=100%, SCR=60%, RQD=58% UCS=251MPa (Limestone)
							154			0 >5	
			3	RUN			153			0 0 0 0	RUN 3# TCR=100%, SCR=100%, RQD=100%
			4	RUN			152			0 0 0	RUN 4# TCR=100%, SCR=100%, RQD=100% UCS=120MPa (Limestone)

Continued Next Page

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 10-03 2 OF 2 METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 323.4 E 609 536.3 ORIGINATED BY GA
HWY 403 / BRT BOREHOLE TYPE Solid Stem Augers / NQ Coring COMPILED BY AN
DATUM DATE 2010.04.07 - 2010.04.08 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						151			0	
										0	
150.1			5	RUN						0	RUN 5# TCR=100%, SCR=100%, RQD=100% UCS=166MPa (Limestone)
11.0	END OF BOREHOLE AT 11.0m. BOREHOLE OPEN TO 11.0m AND WATER LEVEL AT 0.12m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2010.04.30	5.1	156.0

SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE

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

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

ONTMT4S 1160(MTO).GPJ 5/18/10

Appendix B

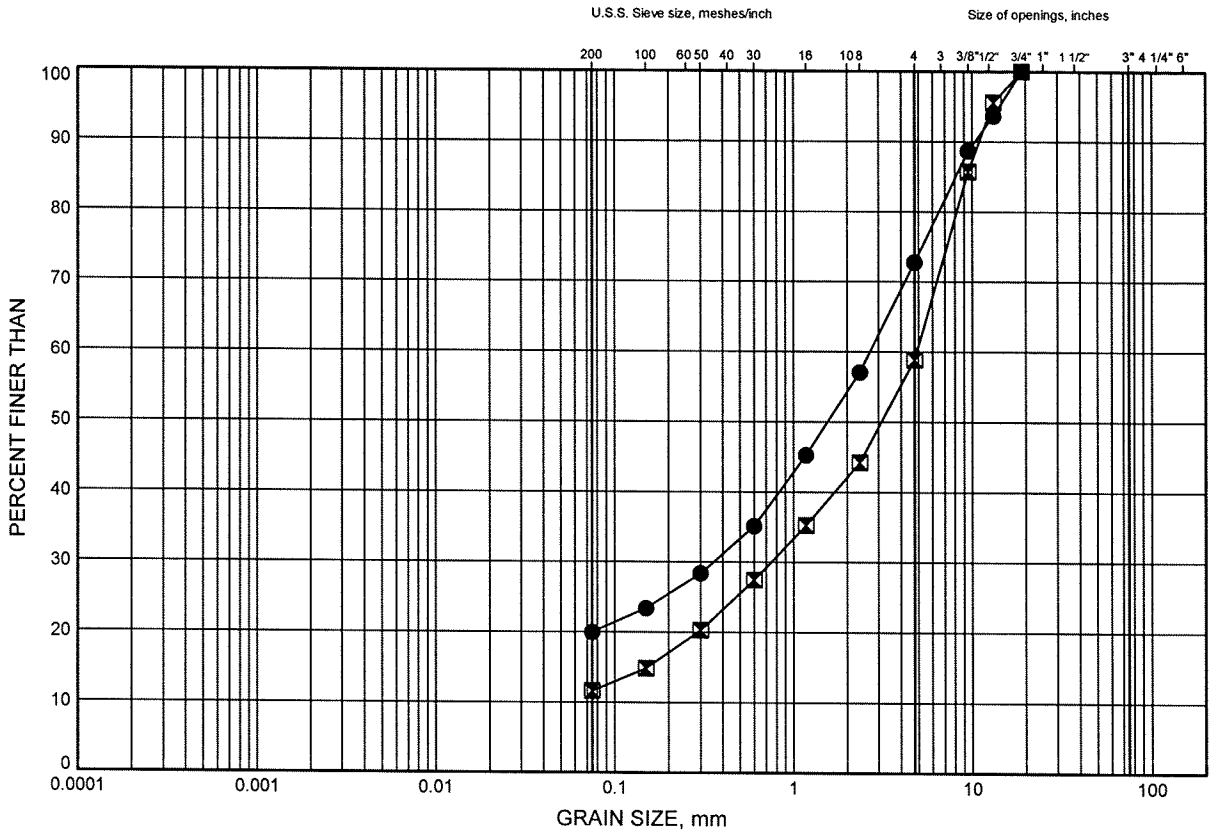
Laboratory Test Results

Mississauga BRT East

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND AND GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-02	0.46	160.64
⊠	10-02	3.35	157.74

W.P.# 19-1351-160

Prepared By MFA

Checked By MRA

THURBER

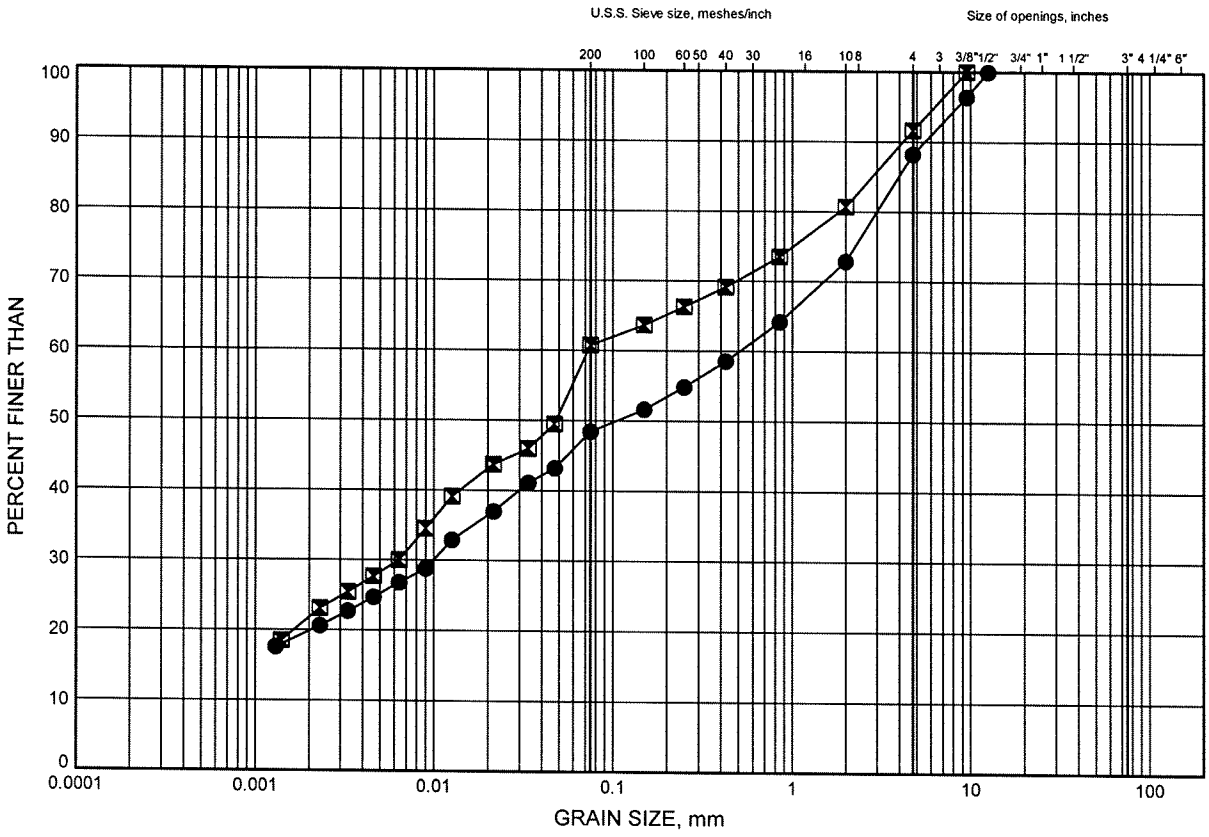
GRAIN SIZE DISTRIBUTION - THURBER 1160(MTO).GPJ 5/6/10

Mississauga BRT East

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY TO CLAYEY SAND AND SILT FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-01	1.83	156.61
⊠	10-03	1.83	159.24

W.P.# 19-1351-160
Prepared By MFA
Checked By MRA

THURBER

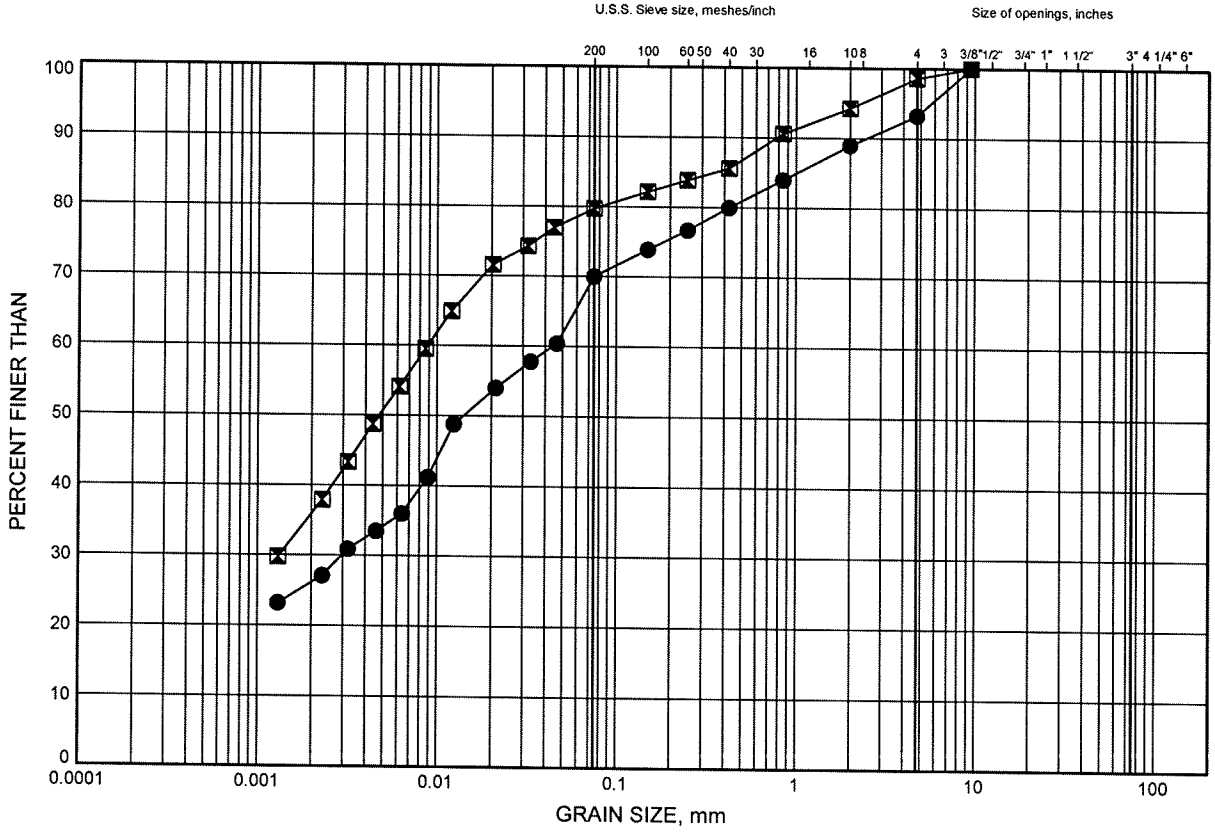
GRAIN SIZE DISTRIBUTION - THURBER 1160(MTO).GPJ 5/6/10

Mississauga BRT East

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-01	3.35	155.08
⊠	10-03	2.59	158.48

W.P.# 19-1351-160
Prepared By MFA
Checked By MRA

THURBER

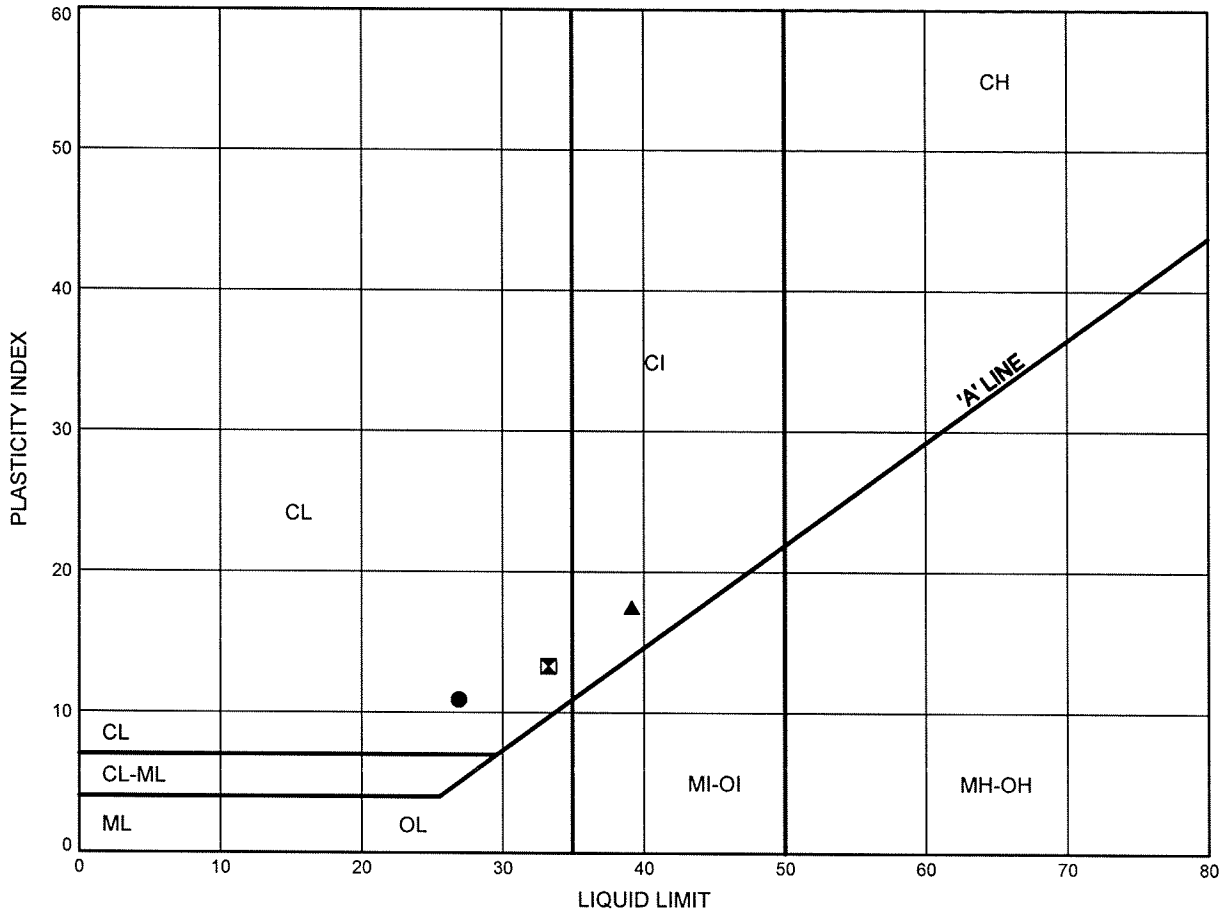
GRAIN SIZE DISTRIBUTION - THURBER 1160(MTO).GPJ 5/6/10

Mississauga BRT East

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

SILTY CLAY FILL AND SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	10-01	3.35	155.08
⊠	10-03	1.83	159.24
▲	10-03	2.59	158.48

Date May 2010

Project 19-1351-160

THURBER

Prep'd MFA

Chkd. MRA

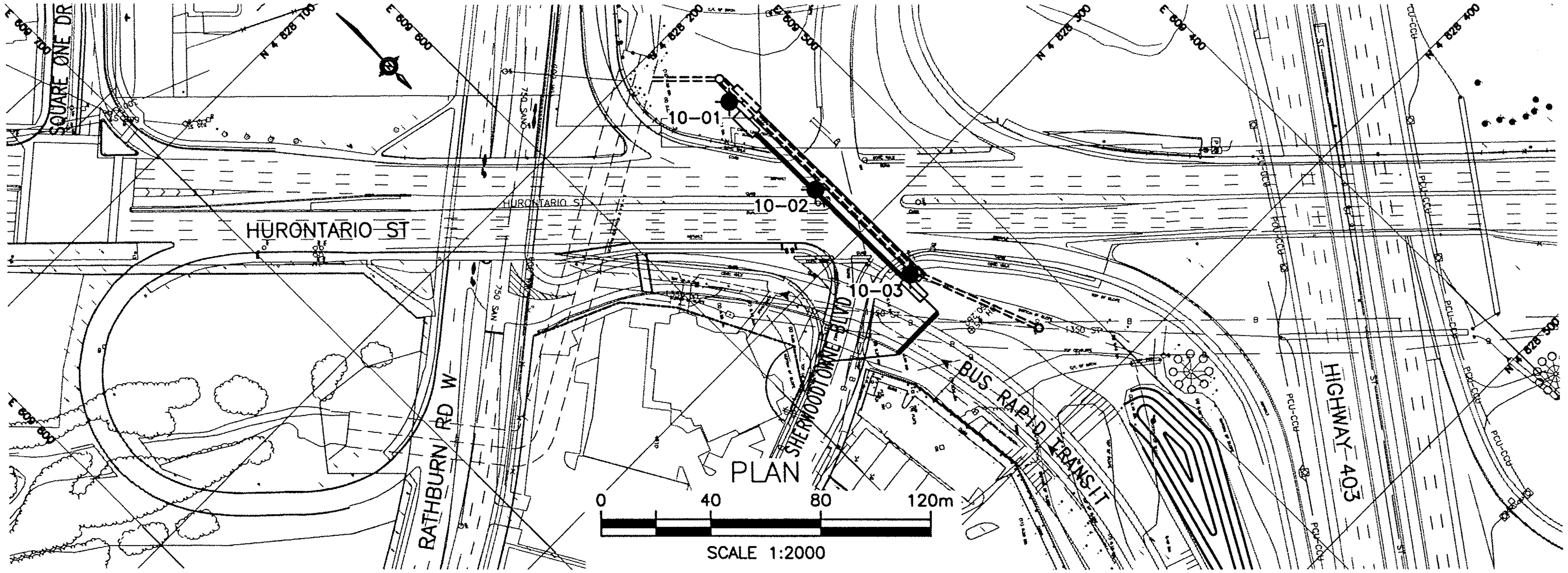
THURBALT 1160(MTO).GPJ 5/6/10

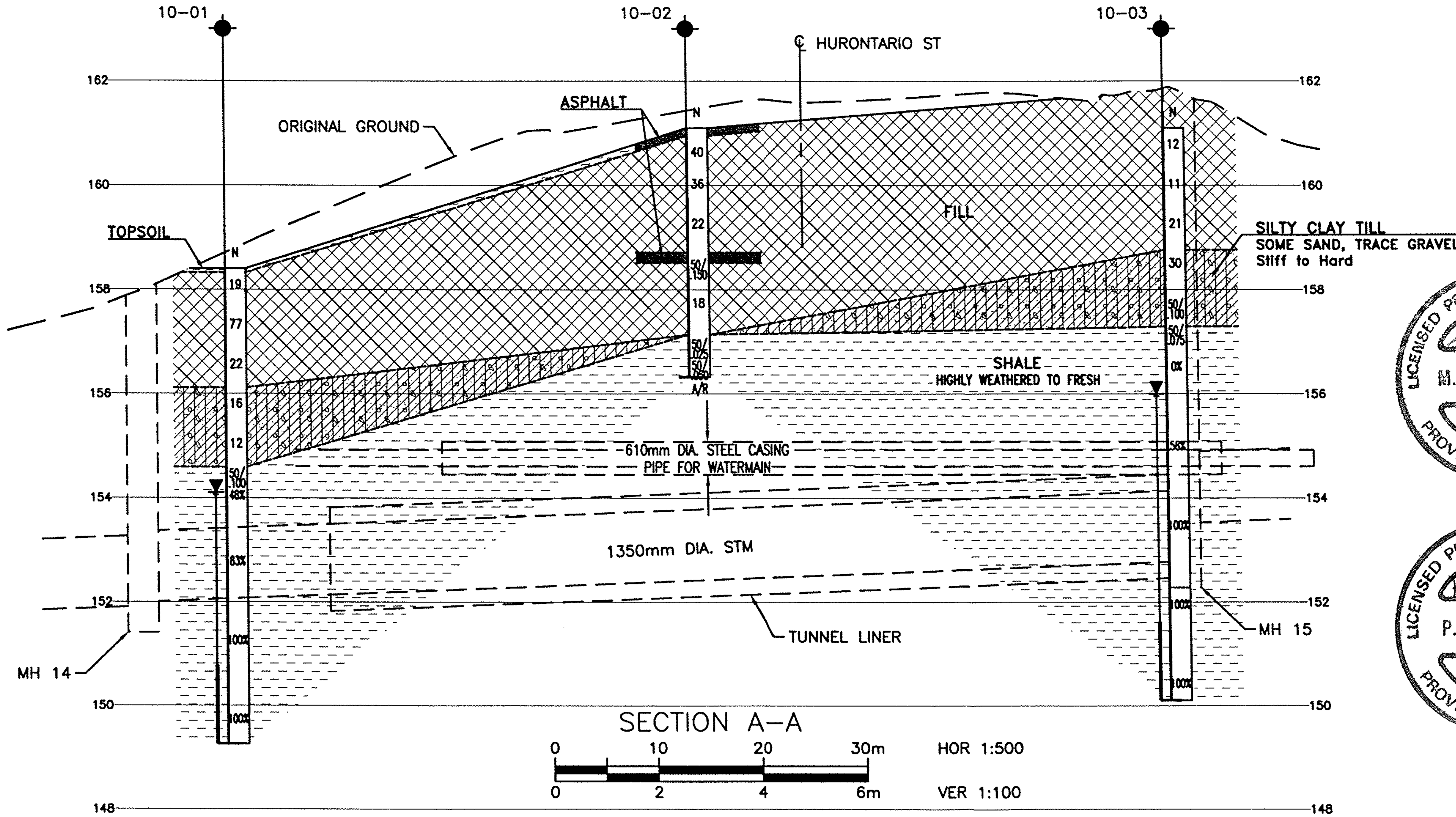
Appendix C

Borehole Locations and Soil Strata Drawing

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN





CONT No

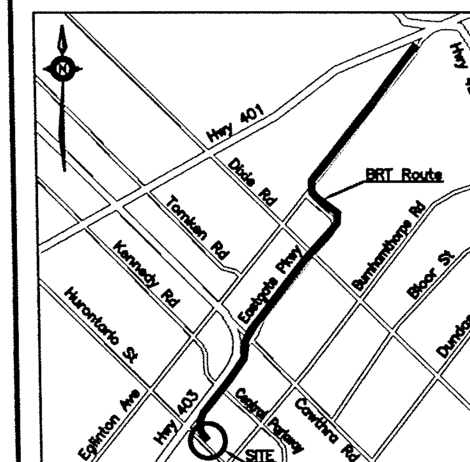
GWP No

MISSISSAUGA BRT EAST
PIPE CROSSING AT
HURONTARIO ST AND SHERWOODTOWNE BLVD
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

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
10-01	158.400	4828232.900	609537.900
10-02	161.100	4828277.500	609538.600
10-03	161.100	4828323.400	609536.300

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
July 2/10
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
July 2/10
PROVINCE OF ONTARIO

-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. 30M12-308

REVISIONS	DATE	BY	DESCRIPTION

DESIGN MRA	CHK PKC	CODE	LOAD	DATE JUN. 2010
DRAWN MFA	CHK AEG	SITE	STRUCT	DWG 1