

**FOUNDATION INVESTIGATION REPORT
SHERWOODTOWNE BOULEVARD GRADE SEPARATION STRUCTURE
MISSISSAUGA BUS RAPID TRANSIT (BRT) PROJECT
MISSISSAUGA, ONTARIO**

Geocres Number: 30M12-287

Report to

McCormick Rankin Corporation

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of a grade separation structure to carry the proposed Bus Rapid Transit way (BRT) under the existing Sherwoodtowne Boulevard in Mississauga, Ontario. The proposed structure will be located on the south side of Highway 403 adjacent to the east side of Hurontario Street.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, provide a borehole location plan, borehole logs, stratigraphic profile and cross-sections and a 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 foundations for the structure.

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.

The segment of the BRT at this site will include a grade separation structure to carry the proposed BRT under Sherwoodtowne Boulevard.

The site is located adjacent to the east side of Hurontario Street, approximately 250 m south of Highway 403 EBL and 120 m north of Rathburn Road in Mississauga, Ontario.

Lands adjacent to the site have been developed for residential and commercial uses.

Photographs of the site included in Appendix C, show the general nature of the site.

The site is situated within the South Slope physiographic region. The geology generally comprises a till plain consisting of clayey silt to silty clay (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 March 13 and 14, 2009. The field program consisted of drilling and sampling four boreholes (numbered 09-005 to 09-008) for the proposed grade separation structure.

All the boreholes were terminated in shale bedrock. Boreholes 09-006 and 09-007 were terminated at 6.1 m depth (Elevations 154.6 to 155.0). Boreholes 09-005 and 09-008 were advanced into the shale bedrock by coring to depths of 14.6 m and 13.6 m (Elevations 146.3 and 147.4), respectively, with 8.5 m and 9.5 m of rock core recovered.

The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawing in Appendix D. The coordinates and elevations of the boreholes are given on these drawings and on the individual Record of Borehole Sheets in Appendix A.

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

Hollow 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 selected boreholes.

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 19 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

Foundation Unit	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
East Abutment	09-005	None installed	Bentonite to surface.
	09-006	None installed	Bentonite to 3.0 m, auger cuttings from 3.0 m to 0.1 m, then asphalt to surface.
West Abutment	09-007	6.1/155.0	Piezometer with 1.5 m slotted screen installed with sand filter to 3.7 m, bentonite from 3.7 m to 2.1 m, auger cuttings from 2.1 m to 0.1 m, then asphalt to ground surface.
	09-008	13.0/148.0	Piezometer with 1.5 m slotted screen installed with sand filter to 9.9 m, bentonite from 9.9 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 and unconfined compression tests (UCS) were carried out on selected samples of intact shale, siltstone and limestone interbeds upon arrival at the laboratory to assist in evaluation of the compressive strength of the bedrock. The results of the point load and unconfined compression tests are shown on the Record of Borehole sheets, and the UCS results are also included in Appendix B.

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 D. 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 surficial topsoil or pavement structure overlying sand and gravel fill, sand fill and silty clay fill, underlain by native silty clay till at

the north end. Shale bedrock was contacted below the fill and till deposit. More detailed descriptions of the individual strata are presented below.

5.1 Pavement Structure

Pavement structure consisting of approximately 75 mm of asphalt overlying granular (sand and gravel) road base was encountered surficially in Borehole 09-006 drilled on Sherwoodtowne Boulevard. In Borehole 09-007 drilled on the boulevard, a 50 mm thick paving stone was encountered over granular base. The thickness of granular fill measured in the boreholes ranged from 625 mm to 650 mm and the underside lay at elevations 160.0 and 160.5. The moisture content of the granular material was 3 to 4%.

5.2 Topsoil

A 50-mm thick layer of topsoil was identified surficially in Borehole 09-005.

The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.3 Fill

Fill consisting of intermixed layers of various soils was encountered in all boreholes:

- Sand and gravel fill containing some clay and some silt was contacted below the topsoil in Borehole 09-005 and surficially in Borehole 09-008. The thickness of the sand and gravel fill was 650 mm and 700 mm.
- Gravelly sand fill was contacted at 1.2 m depth (Elevation 159.9) in Borehole 09-007. The thickness of the sand fill was 1.6 m.
- Silty clay fill containing some sand, trace gravel, occasional organics, occasional asphalt and limestone fragments and occasional cobbles was contacted below the granular road base in Boreholes 09-006 and 09-007 and below the sand and gravel fill in Boreholes 09-005 and 09-008. The thickness of the silty clay fill ranged from 0.5 m to 3.4 m.
- A second layer of clay fill was encountered below the sand fill in Borehole 09-007. This fill layer was 1.7 m thick.

The depths to the base of the fill ranged from 3.0 m to 4.5 m (Elevations 156.6 to 158.0).

Based on SPT 'N' values typically ranging from 6 to 25 blows for 0.3 m of penetration, the silty clay fill is generally described as firm to very stiff in consistency. SPT 'N' values of 42 blows per 0.3 m of penetration to 80 blows per 0.2 m (hard) recovered in the fill may reflect the presence of rock fragments or other obstructions. SPT 'N' values of 24 blows per 0.3 m of penetration and 75 blows per 0.225 m were measured within the sand fill, indicating a compact to very dense relative density.

The natural moisture contents of the fill samples recovered ranged from 4% to 21%.

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

Soil Particles	Silty Clay Fill	Sand/Gravel Fill
Gravel %	3 to 4	25 to 52
Sand %	19 to 26	31 to 52
Silt %	44 to 48	6 to 17
Clay %	27 to 27	
Liquid Limit	39 to 44	
Plastic Limit	20 to 22	

The above results show that the silty clay fill is typically of medium plasticity with a group symbol of CI.

5.4 Silty Clay Till

Native brown silty clay till containing some sand, trace gravel and occasional limestone and shale fragments was contacted below the fill in Boreholes 09-006 and 09-008. The thickness of the silty clay till was 0.8 m and 0.4 m.

The depth to the base of the silty clay till was 3.8 m and 3.4 m (Elevation 156.9 and 157.6) in Boreholes 09-006 and 09-008, respectively.

Based on SPT 'N' values of 25 and 35 blows for 0.3 m of penetration, the silty clay till is described as very stiff to hard in consistency.

The natural moisture contents of the samples recovered from the silty clay till layer ranged from 8% to 10%.

Grain size distribution curves for two samples of silty clay till are presented on the Record of Borehole sheets and on Figure B3 of Appendix B. Atterberg Limit test results are presented on Figure B5 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	4 to 5
Sand	14 to 16
Silt	54 to 61
Clay	21 to 25
Liquid Limit	41
Plastic Limit	22

The above results show that the silty clay till is typically of medium plasticity with a group symbol of 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.

5.5 Bedrock

The soils described above were underlain by shale bedrock. The shale encountered in the boreholes is described as thinly bedded and contains numerous hard interbedded siltstone and limestone layers. The shale bedrock is highly to moderately weathered within the upper 1.5 m to 2.5 m below which it becomes less weathered and stronger with depth. SPT 'N' values obtained in the upper part of the shale bedrock were 50 to 70 blows per 0.025 m to 0.175 m of penetration. Moisture contents ranged from 4% to 12%. The depths and elevations of the top of weathered bedrock are shown in Table 5.1.

Table 5.1 – Depths and Elevations of Top of Weathered Bedrock

Foundation Unit	Borehole	Depth to Weathered Bedrock (m)	Top of Weathered Bedrock Elevation (m)
East Abutment	09-005	4.1*	156.7
	09-006	3.8	156.9
West Abutment	09-007	4.5	156.6
	09-008	3.4*	157.6

* Proved by coring below augered depth.

Bedrock cores were collected using NQ sized coring equipment. Total core recovery (TCR) in the bedrock ranged from 90% to 100% in all core runs.

RQD values recorded in the core runs typically ranged from 83% to 100%, indicating a good to excellent rock quality. RQD values of 0% were recorded in Borehole 09-005 Run 1 and Borehole 09-008 Runs 1 to 3, indicating a very poor rock quality in the upper part of the shale. An RQD value of 50% was measured in Borehole 09-008 Run 4, indicating a fair to poor rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to greater than 25. Broken/rubble zones and clay seams were observed within the cores at several depths.

The unconfined compressive strength of the rock assessed from Point Load testing and Unconfined Compression tests conducted on recovered rock cores are presented on the Record of Borehole sheets in Appendix A. The UCS test reports are included in Appendix B. The compressive strength results ranged from 3 to 31 MPa (very weak to medium strong) for the shale and 26 to 189 MPa (medium strong to very strong) for the limestone interbeds.

It must be noted that point load tests were possible only on less weathered shale or higher strength limestone interbed samples as the more typical weathered shale cores tended to be not suitable for point load testing.

The shale bedrock typically contains layers of siltstone and limestone that can be significantly harder than the shale itself. The distribution, thickness and strength of these layers vary from location to location, and these layers typically exhibit less pronounced weathering than the shale. The records of boreholes indicate that within the depths investigated, these hard interbeds range up to 160 mm in thickness. Sampling and interpretation from small diameter boreholes may underestimate the frequency, thickness and strength of the strong layers and therefore geological expertise and past experience must be applied in any decision making process regarding the bedrock.

5.6 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in two boreholes 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

Foundation Unit	Borehole	Date (2009)	Water Level (m)		Comment
			Depth (m)	Elevation (m)	
West Abutment	09-007	April 14	5.9	155.2	In piezometer
		May 5	5.5	155.6	
		May 21	5.7	155.4	
	09-008	April 14	9.3	151.7	In piezometer
		May 5	6.6	154.4	
		May 21	8.5	152.5	

The most recent groundwater levels measured in the piezometers range from elevations 152.5 to 155.4.

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. Further, perched water may be encountered at higher levels in pockets or zones of more permeable sands and silts within the heterogeneous tills, or within the fill.

6 MISCELLANEOUS

Borehole locations and ground surface elevations were supplied to Thurber by McCormick Rankin Corporation.

The drilling and sampling equipment was supplied and operated by DBW Drilling of Ajax, Ontario and Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario. The field work was supervised on a full time basis by Mr. Luke Gilarski and Ms. Eckie Siu of Thurber Engineering Ltd. under the direction of Mr. Murray R. Anderson, P.Eng and Mr. Mark Farrant, P. Eng.

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

Overall supervision of the field program was conducted by Mr. Murray R. Anderson, P.Eng. and Mr. M. Farrant, P. Eng. Interpretation of the data and preparation of the report were carried out by Mr. Murray R. Anderson, P.Eng and Ms. R. Palomeque Reyna, P.Eng.

Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects, reviewed the report.

THURBER ENGINEERING LTD.

Rocio Palomeque Reyna, P.Eng.
Geotechnical Engineer



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



P.K. Chatterji, P.Eng.
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

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



Water Level

C_{pen}


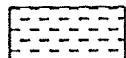
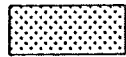

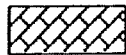
Shear Strength Determination by Pocket Penetrometer

- (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		SYMBOLS			
Fresh (FR)	No visible signs of weathering.				
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE		
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE		
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE		
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL		
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)		
DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
TERMS		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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.				



RECORD OF BOREHOLE No 09-005

1 OF 2

METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 307.9 E 609 577.0 ORIGINATED BY ES
 HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
 DATUM DATE 2009.03.13 - 2009.03.13 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
160.8							20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT			
0.9	TOPSOIL, trace roots and rootlets (50mm)		1	AS			40 80 120 160 200	W _p	W	W _L			
160.1	SAND and GRAVEL, some clay Brown Moist (FILL)												
0.7	Silty CLAY, some sand, trace gravel, occasional organics Firm to Stiff Brown (FILL) Layer of sand (200mm) Occasional brick fragments		1	SS	10								
			2	SS	6								
			3	SS	9								
			4	SS	12								
	Sandy zone		5	SS	80/ .200								
156.7	SHALE, highly weathered, thinly bedded, very weak to medium strong, with medium strong to very strong limestone interbeds Grey		6	SS	50/ .100								
4.1			7	SS	50/ .100								
	Limestone layer (greater than 50mm): 50mm at 6.6m 65mm at 6.9m Rubble zone (100mm) at 6.4m		1	RUN									
	Becoming slightly weathered		2	RUN									
	Clay seam ((25mm) at 8.1m		3	RUN									

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 09-006

1 OF 1

METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 327.0 E 609 564.9 ORIGINATED BY ES
 HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM DATE 2009.03.13 - 2009.03.13 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
160.7 0.0 0.1	ASPHALT (75mm)		1	AS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

ONTMT4S 1.160(MTO).GPJ 6/12/09

RECORD OF BOREHOLE No 09-007

1 OF 1

METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 304.2 E 609 558.7 ORIGINATED BY ES
 HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM DATE 2009.03.13 - 2009.03.13 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L			
161.1														
0.0	PAVING STONE (50mm)						161							
160.5	SAND and GRAVEL, some silt Brown Moist (FILL)		1	AS										
0.7														
159.9	Silty CLAY, some sand, trace gravel, occasional cobbles Very Stiff Brown (FILL)		1	SS	70/ .225		160							
1.2														
	SAND, trace gravel, occasional cobbles Very Dense to Compact Brown Moist (FILL)		2	SS	50/ .075									
							159							
158.3			3	SS	24									27 52 15 6
2.8	Silty CLAY, sandy, trace gravel Very Stiff to Hard Brown (FILL)													
			4	SS	20		158							
	Occasional oxide staining													
			5	SS	72		157							0 13 58 29
156.7														
4.5	SHALE, highly weathered, thinly bedded, occasional limestone interbeds Grey		6	SS	56/ .150		156							
155.0			7	SS	50/ .050									
6.1	END OF BOREHOLE AT 6.15m. BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter pipe. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.04.14 5.9 155.2 2009.05.05 5.5 155.6 2009.05.21 5.7 155.4													

+³ . X³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 09-008

1 OF 2

METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 323.4 E 609 551.5 ORIGINATED BY LG
HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
DATUM DATE 2009.03.14 - 2009.03.14 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
161.0														
0.0	SAND and GRAVEL, some silt Brown Moist (FILL)		1	AS									52 31 17 (SI+CL)	
160.3														
0.7	Silty CLAY, some sand, trace gravel, occasional limestone fragments Stiff to Hard Brown (FILL)		1	SS	12									
			2	SS	42									
			3	SS	13									
158.0														
3.0	Silty CLAY, some sand, trace gravel, occasional limestone and shale fragments Very Stiff to Hard Brown (TILL)		4	SS	25								0 10 69 21	
156.9			5	SS	50/									
4.1	SHALE, highly weathered, thinly bedded, weak to medium strong, with medium strong to very strong limestone interbeds, grey		1	RUN	.100							FI	RUN 1# TCR=94%, SCR=94%, RQD=0%, UCS=131MPa (Limestone)	
	Rubble zones: 300mm at 4.7m 50mm at 7.4m 50mm at 8.9m		2	RUN								8	RUN 2# TCR=100%, SCR=16%, RQD=0%	
	Clay seams: 50mm at 5.3m 100mm at 5.5m 50mm at 5.8m 50mm at 7.1m		3	RUN								10	RUN 3# TCR=100%, SCR=0%, RQD=0%, UCS=31MPa (Shale)	
	Becoming moderately weathered		4	RUN								>20	UCS=80 to 189MPa (Limestone)	
	Limestone layers (greater than 50mm): 150mm at 7.5m 50mm at 9.3m		5	RUN								>20	RUN 4# TCR=100%, SCR=53%, RQD=50%	
			6	RUN								12	RUN 5# TCR=100%, SCR=100%, RQD=83%, UCS=3MPa (Shale)	
												5	RUN 6# TCR=100%, SCR=97%, RQD=97%, UCS=75 to 120MPa (Limestone)	
												3		
												2		
												1		
												0		
												1		
												6		
												4		
												0		

Continued Next Page

+³, x³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 09-008

2 OF 2

METRIC

G.W.P. 19-1351-160 LOCATION N 4 828 323.4 E 609 551.5 ORIGINATED BY LG
HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
DATUM DATE 2009.03.14 - 2009.03.14 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
	SHALE, highly weathered, thinly bedded, weak to medium strong, grey							○ UNCONFINED + FIELD VANE						
	Clay zone (50mm) at 10.4m							● QUICK TRIAXIAL × LAB VANE						
	Limestone layers (greater than 50mm):							WATER CONTENT (%)						
	250mm at 10.5m							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
	50mm at 11.4m							W P W W L						
	50mm at 11.8m													
	150mm at 11.9m													
	250mm at 12.9m													
	220mm at 13.3m													
	50mm at 13.6m													
147.4			7	RUN			151							
							150							
							149							
			8	RUN			148							
13.6	END OF BOREHOLE AT 13.6m. Piezometer installation consists of 19mm diameter pipe. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.04.14 9.3 151.7 2009.05.05 6.6 154.4 2009.05.21 8.5 152.5													

ONTMT4S 1160(MTO),GPJ 12/14/09

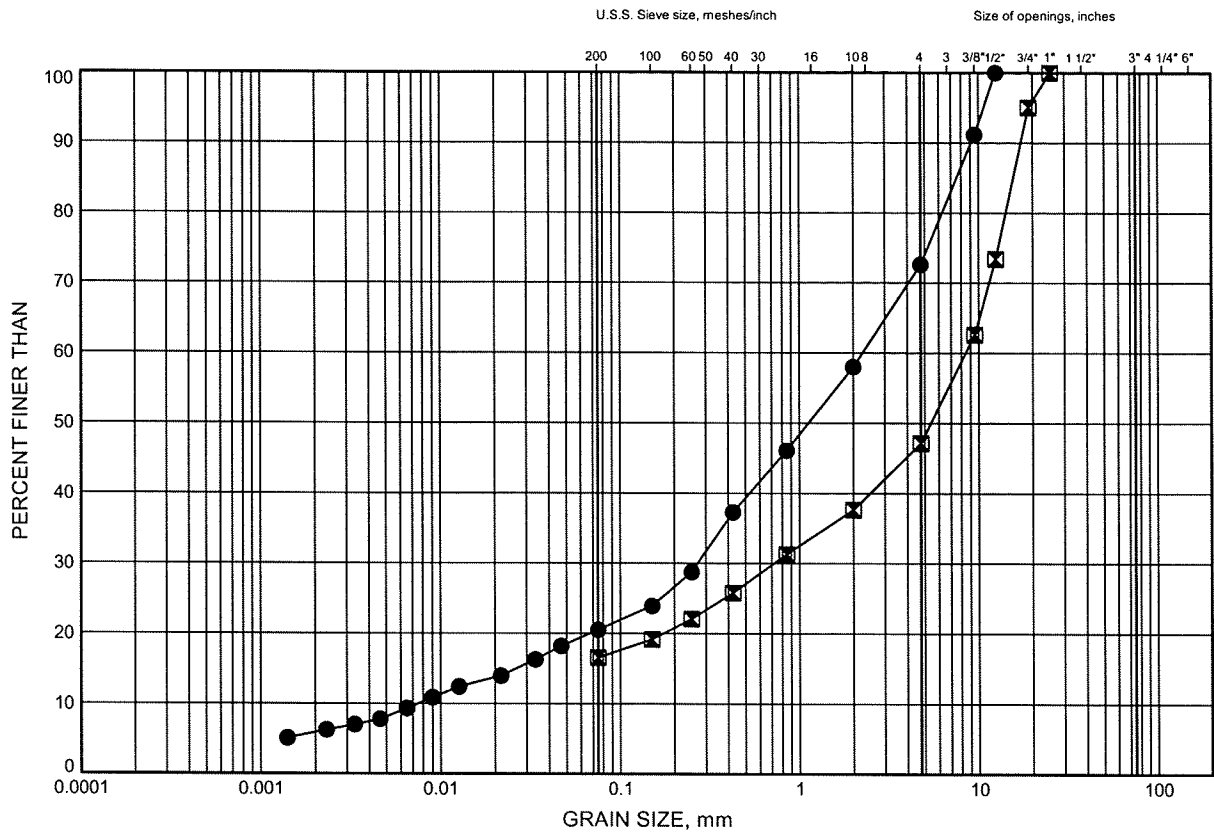
Appendix B

Laboratory Test Results

Mississauga BRT East
GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND/GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-007	2.55	158.60
☒	09-008	0.30	160.68

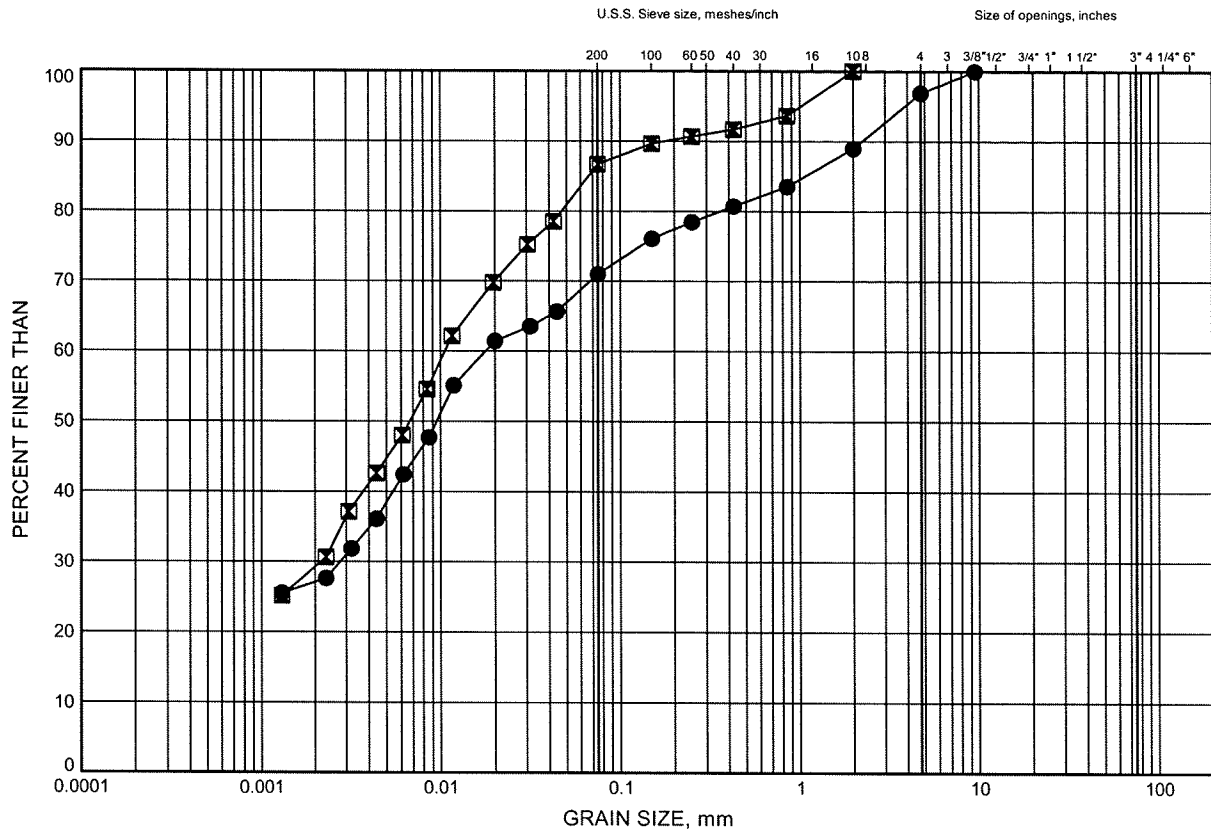


W.P.# 19-1351-160.....
Prepared By MFA.....
Checked By MRA.....

Mississauga BRT East GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-005	3.96	156.87
⊠	09-007	4.04	157.11

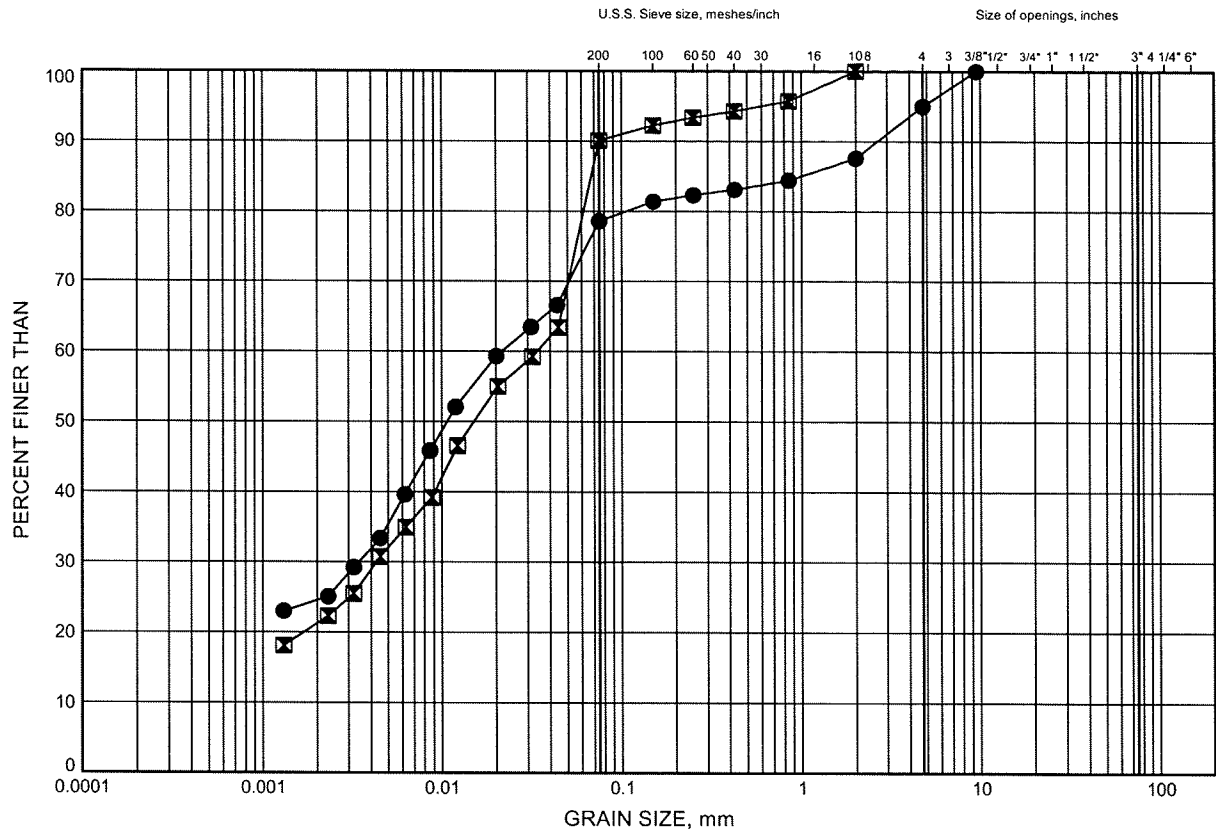


W.P.# 19-1351-160.....
Prepared By MFA.....
Checked By MRA.....

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)
●	09-006	3.35	157.36
◻	09-008	3.31	157.67

GRAIN SIZE DISTRIBUTION - THURBER 1160(MTO).GPJ 6/12/09

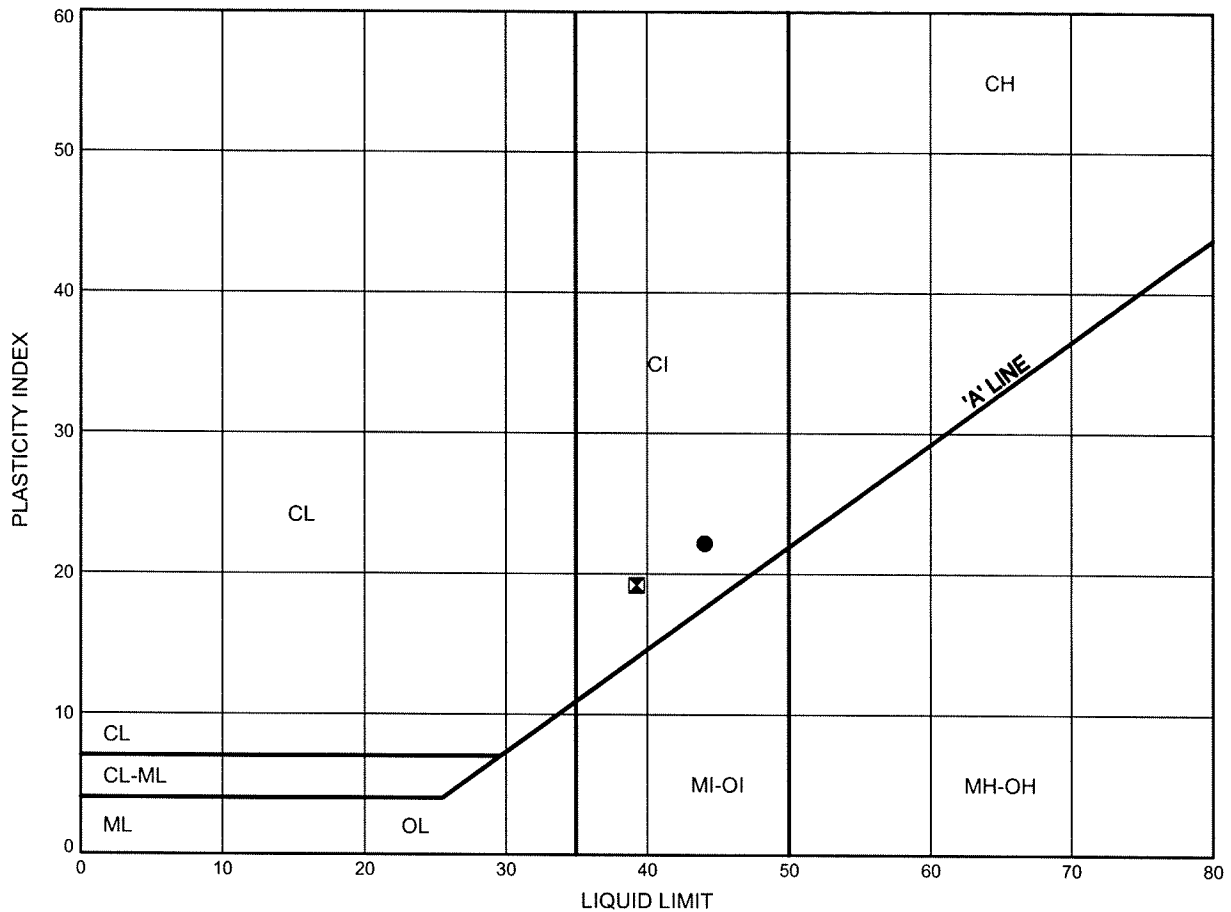
W.P.# 19-1351-160.....
Prepared By MFA.....
Checked By MRA.....



Mississauga BRT East
ATTERBERG LIMITS TEST RESULTS

FIGURE B4

Silty CLAY FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	09-005	3.99	156.84
⊠	09-007	4.19	156.96

Date June 2009
 Project 19-1351-160

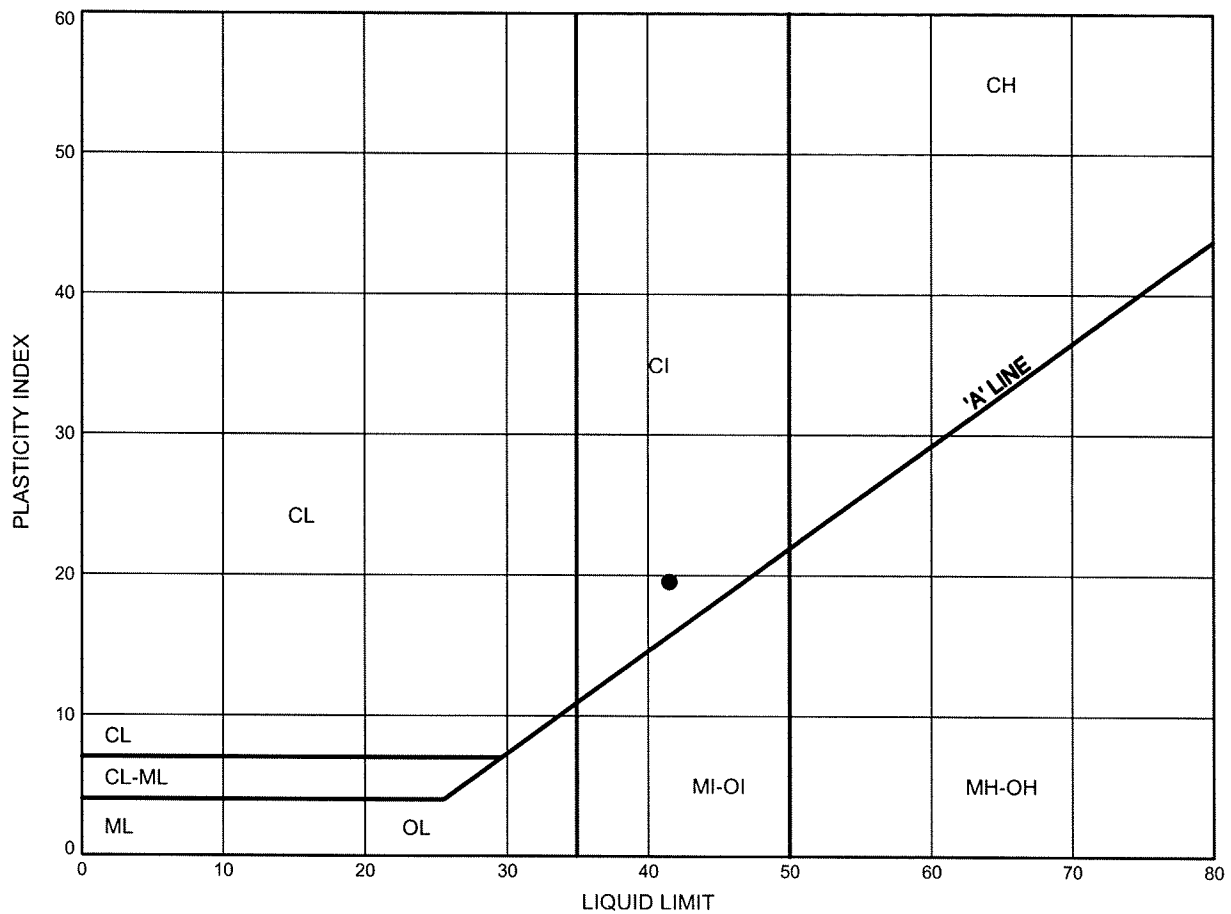


Prep'd MFA
 Chkd. MRA

Mississauga BRT East
ATTERBERG LIMITS TEST RESULTS

FIGURE B5

Silty CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	09-006	3.35	157.36

Date June 2009
 Project 19-1351-160



Prep'd MFA
 Chkd. MRA

UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0011	RUN NUMBER	6
BOREHOLE NUMBER	09-8	SAMPLE DEPTH, m	9.73-9.91

TEST CONDITIONS

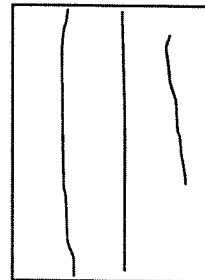
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.53

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	12.26	WATER CONTENT, (specimen) %	1.20
SAMPLE DIAMETER, cm	4.85	UNIT WEIGHT, kN/m ³	24.91
SAMPLE AREA, cm ²	18.47	DRY UNIT WT., kN/m ³	24.61
SAMPLE VOLUME, cm ³	226.50	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	575.54	VOID RATIO	0.08
DRY WEIGHT, g	568.72		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	74.6
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REMARKS:

DATE: 4/8/2009

Checked By: *ML*

Golder Associates

UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0011	RUN NUMBER	2
BOREHOLE NUMBER	09-5	SAMPLE DEPTH, m	7.90-8.05

TEST CONDITIONS

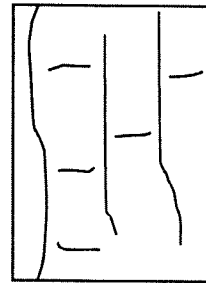
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.27

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.93	WATER CONTENT, (specimen) %	2.30
SAMPLE DIAMETER, cm	4.82	UNIT WEIGHT, kN/m ³	24.45
SAMPLE AREA, cm ²	18.25	DRY UNIT WT., kN/m ³	23.90
SAMPLE VOLUME, cm ³	199.44	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	497.33	VOID RATIO	0.11
DRY WEIGHT, g	486.15		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	51.2
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REMARKS:

DATE: 4/8/2009

Checked By: *YH*

Golder Associates

UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0011	RUN NUMBER	4
BOREHOLE NUMBER	09-5	SAMPLE DEPTH, m	10.79-10.90

TEST CONDITIONS

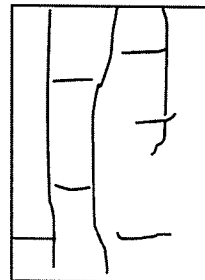
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.05

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	9.89	WATER CONTENT, (specimen) %	3.70
SAMPLE DIAMETER, cm	4.82	UNIT WEIGHT, kN/m ³	24.49
SAMPLE AREA, cm ²	18.21	DRY UNIT WT., kN/m ³	23.62
SAMPLE VOLUME, cm ³	180.09	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	449.94	VOID RATIO	0.12
DRY WEIGHT, g	433.89		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	9.0
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REMARKS: Sample broken upon arrival.

DATE: 4/8/2009

Checked By: *hli*

Golder Associates

Appendix C

Site Photographs

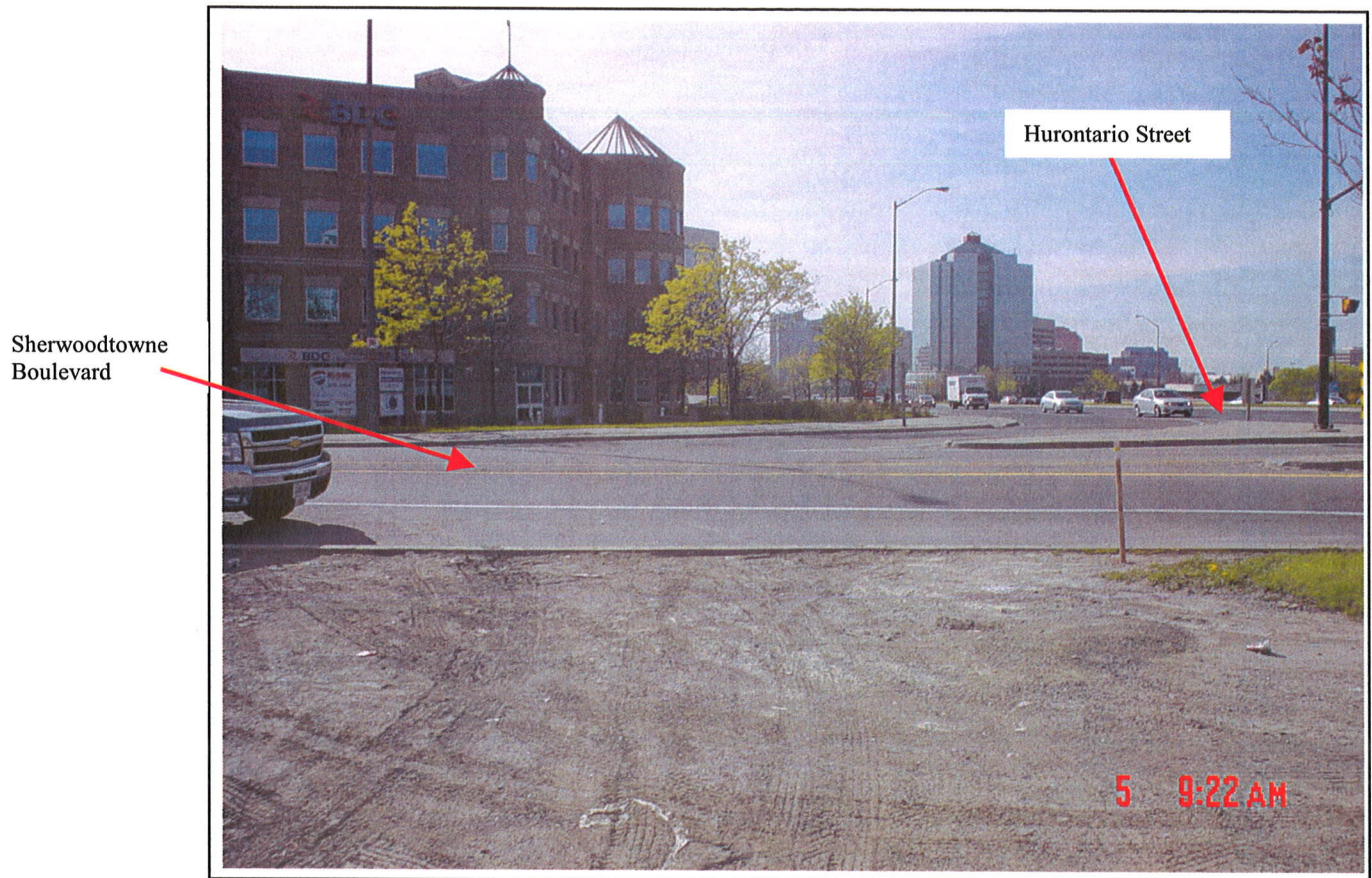


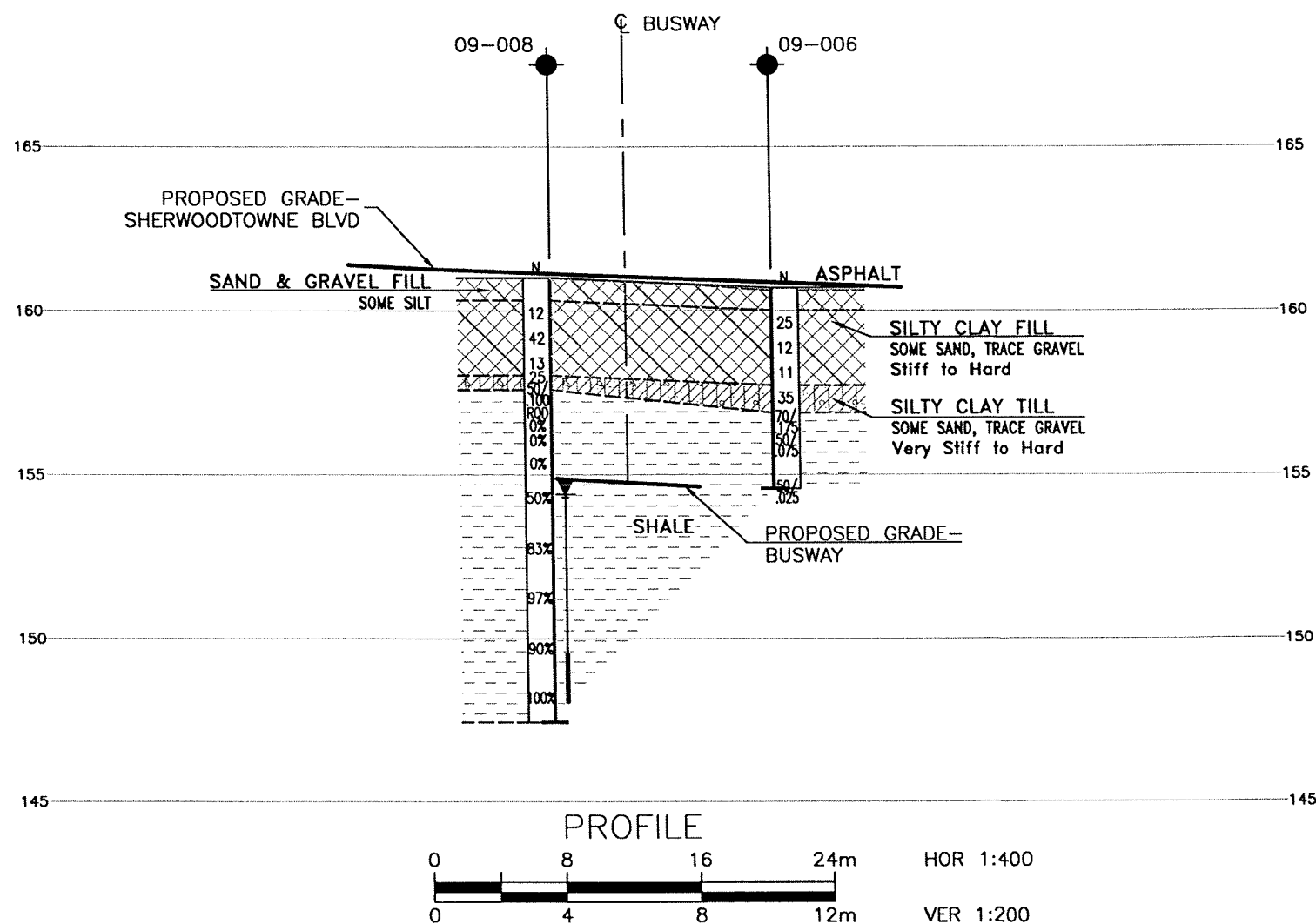
Photo 1. Looking south from the north side of Sherwoodtowne Boulevard, just east of Hurontario Street



Photo 2. Looking northwesterly from south side of Sherwoodtowne Boulevard just east of Hurontario Street.

Appendix D

Borehole Locations and Soil Strata Drawing



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No

MISSISSAUGA BRT EAST
DETAILED DESIGN
SHERWOODTOWNE BLVD
SOIL STRATA

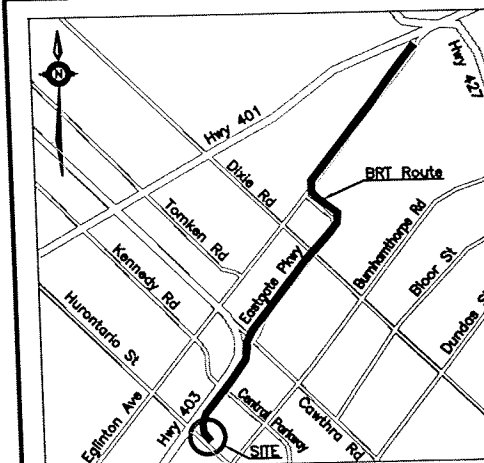
SHEET



**McCORMICK RANKIN
CORPORATION**








THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

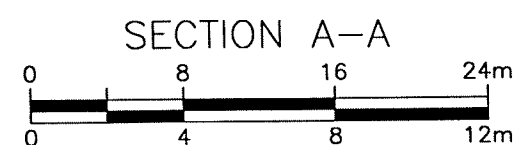
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
09-005	160.8	4 828 307.9	609 577.0
09-006	160.7	4 828 327.0	609 564.9
09-007	161.1	4 828 304.2	609 558.7
09-008	161.0	4 828 323.4	609 551.5

-NOTES-

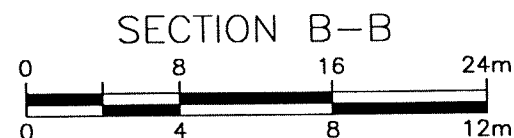
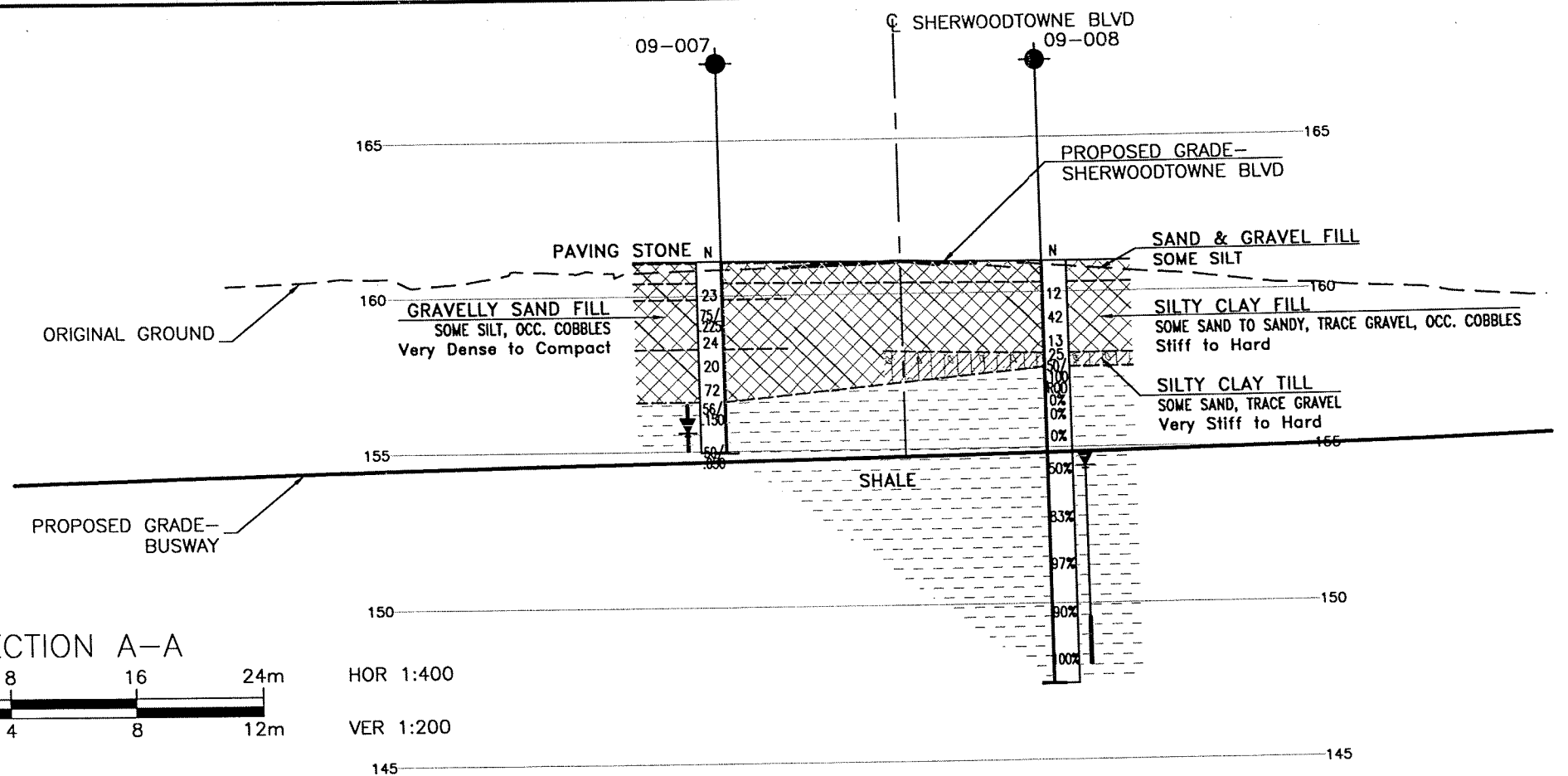
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 30M12-287

[illegible]

HOR 1:400

VER 1:200



HOR 1:400

VER 1:200

