

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

**Geocres Number: 30M12-286**

**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 Cawthra Road in Mississauga, Ontario. The proposed structure will be located adjacent to the north side of the Cawthra Road and Eastgate Parkway intersection, east of Highway 403.

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 and approach embankments 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 Cawthra Road will include the construction of a bus station and a grade separation structure to carry the proposed BRT under Cawthra Road.

The site is located on the north side of the Cawthra Road and Eastgate Parkway intersection; approximately 250 m east of Highway 403.

Currently, the lands adjacent to the Cawthra Road and Eastgate Parkway intersection comprise utility corridors with overhead transmission lines and buried pipelines. Vegetation consists mainly of tall grass and shrubs.

Lands located on the west and east sides of Cawthra Road, approximately 150 m south of the intersection, are generally residential and commercial.

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 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 from March 11 to 13, 2009. The field program consisted of drilling and sampling four boreholes (numbered 09-52 to 09-55) for the proposed grade separation structure.

Boreholes 09-052 to 09-054 were terminated at depths ranging from 12.6 m to 15.4 m (Elevations 135.9 to 138.9). Borehole 09-055 encountered auger refusal in silty clay till at 15.3 m depth on a possible boulder or slab of hard limestone and was advanced below this depth by coring to 19.8 m depth (Elevation 131.5).

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. For this report, Cawthra Road was considered to be running in a north-south direction.

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. 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 advance Borehole 09-055 when auger refusal was encountered on a rock slab within the silty clay till.

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.

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 (Boreholes 09-052 and 09-055) 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**

<b>Foundation Unit</b>	<b>Borehole</b>	<b>Piezometer Tip Depth/ Elevation (m)</b>	<b>Completion Details</b>
North Abutment	09-052	12.2/139.3	Piezometer with 1.5 m slotted screen installed with sand filter to 7.6 m, bentonite from 7.6 m to ground surface.
	09-053	None installed	Bentonite to surface.
South Abutment	09-054	None installed	Bentonite to 0.1 m, then asphalt to surface.
	09-055	19.8/131.5	Piezometer with 1.5 m slotted screen installed with sand filter to 16.8 m, then bentonite from 16.8 m to ground surface.

#### **4 LABORATORY TESTING**

All recovered soil samples were subjected to Visual Identification (VI) and moisture content determinations. At least 25% of the recovered samples of soil were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limit testing where appropriate. 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.

#### **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil 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 pavement structure overlying fill which is underlain by native silty clay till and sand and silt till. More detailed descriptions of the individual strata are presented below.

##### **5.1 Pavement Structure**

Pavement structure consisting of approximately 50 mm to 100 mm of asphalt overlying granular (sand and gravel) road base was encountered surficially in Boreholes 09-052 to 09-054 drilled on Cawthra Road. The thickness of granular fill measured in the boreholes ranged from 0.5 m to 0.75 m and the underside lay at elevations ranging from 150.6 to 150.7.

##### **5.2 Fill**

A 600-mm thick layer of sand and gravel fill was contacted surficially in Borehole 09-055.

Fill consisting of silty clay containing some sand, trace gravel and occasional rootlets was encountered below the sand and gravel fill in Borehole 09-055 and below the granular road base in Boreholes 09-052 to 09-054.

The thickness of the silty clay fill ranged from 1.4 m to 2.4 m.

The depth to the base of the silty clay fill ranges from 2.2 m to 3.0 m (Elevations 148.3 to 149.3).

Based on SPT 'N' values ranging from 6 to 17 blows for 0.3 m of penetration, the silty clay fill is described as firm to very stiff in consistency. The natural moisture contents of the samples recovered from the silty clay fill layer ranged from 8% to 19%. Moisture contents measured in the sand and gravel fill samples ranged from 2% to 9%.

### 5.3 Silty Clay Till

Native brown to grey silty clay till was contacted below silty clay fill in all the boreholes. The silty clay till is sandy and contains trace gravel, occasional rock pieces and cobbles. The thickness of the silty clay till ranged from 7.7 m to 8.5 m.

In Borehole 09-055, a second silty clay till unit was contacted at 15.3 m depth (Elevation 136.0).

The depth to the base of the silty clay till was 10.7 m (Elevations 140.6 to 140.8).

Based on SPT 'N' values ranging from 7 to 15 blows per 0.3 m of penetration, the upper 1.5 m of silty clay till is described as firm to very stiff in consistency. Below the upper 1.5 m, the silty clay till is described as very stiff to hard in consistency, based on SPT 'N' values ranging from 18 to 71 blows for 0.3 m of penetration. An SPT 'N' value of 50 blows per 0.075 m of penetration was measured near elevation 142.3 in Borehole 09-052.

The natural moisture contents of the samples recovered from the silty clay till layer ranged from 8% to 22%.

Grain size distribution curves for the samples tested are presented on the Record of Borehole sheets and on Figures B1 and B2 of Appendix B. Atterberg Limit test results are presented on Figures B4 and B5 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 5
Sand	24 to 39
Silt	42 to 54
Clay	12 to 30

Liquid Limit	20 to 37
Plastic Limit	13 to 18

The above results show that the silty clay till is typically of low plasticity with group symbols of CL and CL-ML. One tested sample is of medium plasticity with a group symbol of CI.

Visual assessment and a high SPT 'N' value measured in the sample recovered at 15.3 m depth (Elevation 136.0) in Borehole 09-055, indicated the possible presence of bedrock. Therefore, coring was conducted below 15.3 m depth (Elevation 136.0). The cores recovered consisted of silty clay till with rock fragments and occasional cobbles and boulders. Coring was terminated at 19.8 m depth (Elevation 131.5).

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

#### 5.4 Sand and Silt Till

Native grey sand and silt till containing trace to some clay, trace gravel and occasional cobbles and sand seams was contacted below the silty clay till at 10.7 m depth (Elevations 140.6 to 140.8) in all the boreholes. Boreholes 09-052 to 09-054 were terminated within the sand and silt till at depths ranging from 12.6 m to 15.4 m (Elevations 135.9 to 138.9). The thickness of the sand and silt till was 4.6 m in Borehole 09-055.

The depth to the base of the sand and silt till in Borehole 09-055 was 15.3 m (Elevation 136.0).

Based on SPT 'N' values of 50 to 100 blows per 0.025 m to 0.25 m of penetration, the sand and silt till is described as very dense in relative density. An SPT 'N' value of 21 blows per 0.3 m of penetration, indicating compact relative density was measured near elevation 140.3 in Borehole 09-055.

The natural moisture contents of the samples recovered from the sand and silt till layer ranged from 5% to 15%.

Grain size distribution curves for the sand and silt till samples tested are presented on the Record of Borehole sheets and on Figure B3 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	4 to 13
Sand	37 to 49
Silt	31 to 49
Clay	5 to 10

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

## 5.5 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 5.1, along with the measurements in the boreholes upon completion of drilling.

**Table 5.1 – Measured Groundwater Levels**

Foundation Element	Borehole	Date (2009)	Water Level (m)		Comment
			Depth (m)	Elevation (m)	
North Abutment	09-052	May 21	3.5	148.0	In piezometer
	09-053	March 12	15.4	135.9	Open borehole
South Abutment	09-055	May 5	3.4	147.9	In piezometer
		May 21	3.6	147.7	

The groundwater levels measured in the piezometers are typically near elevation 148.0.

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. 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 Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario. The field work was supervised on a full time basis by Mr. Luke Gilarski 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.

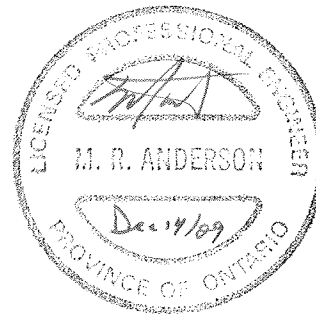


THURBER ENGINEERING LTD.

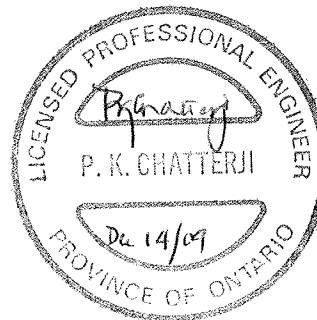
Rocio Palomeque Reyna, P.Eng.  
Geotechnical Engineer



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 <sup>(1)</sup> '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


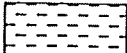



C<sub>pen</sub> Shear Strength Determination by Pocket Penetrometer

- (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.
		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

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.

# RECORD OF BOREHOLE No 09-052

1 OF 2

METRIC

G.W.P. 19-1351-160 LOCATION N 4 830 140.1 E 610 596.5 ORIGINATED BY LG  
 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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
151.5								20 40 60 80 100						
0.0	ASPHALT (100mm)							○ UNCONFINED + FIELD VANE						
0.1	SAND and GRAVEL, some silt Brown (FILL)		1	AS			151	● QUICK TRIAXIAL × LAB VANE						
150.7														
0.8	Silty CLAY, some sand, trace gravel Very Stiff Brown Moist (FILL)		1	SS	15		150							
			2	SS	17									
149.3														
2.2	Silty CLAY, sandy, trace gravel, occasional cobbles Stiff to Firm Brown (TILL)		3	SS	8		149							1 26 47 26
			4	SS	7		148							
	Becoming hard		5	SS	39		147							3 24 54 19
			6	SS	28		146							
							145							
			7	SS	37		144							5 26 45 24
							143							
			8	SS	50/ .075		142							

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+ 3 . × 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 09-053

1 OF 2

METRIC

G.W.P. 19-1351-160 LOCATION N 4 830 164.4 E 610 612.2 ORIGINATED BY LG  
 HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM DATE 2009.03.12 - 2009.03.12 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
151.3							20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT					
0.0	ASPHALT (50mm)		1	AS				w <sub>p</sub> w w <sub>L</sub>					
150.6	SAND and GRAVEL Brown Moist (FILL)							○ UNCONFINED + FIELD VANE					
0.8	Silty CLAY, some sand, trace gravel Stiff to Firm Mottled Brown Grey (FILL)		1	SS	10			● QUICK TRIAXIAL × LAB VANE					
			2	SS	14			WATER CONTENT (%)					
			3	SS	6			40 80 120 160 200	20 40 60				
148.4	Silty CLAY, sandy, trace gravel Very Stiff to Hard Brown (TILL)		4	SS	15								
3.0			5	SS	35								
			6	SS	42								
			7	SS	28								
			8	SS	53								
	Occasional rock pieces												

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+<sup>3</sup> ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE





# RECORD OF BOREHOLE No 09-054

1 OF 2

METRIC

G.W.P. 19-1351-160 LOCATION N 4 830 125.6 E 610 610.8 ORIGINATED BY LG  
 HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM DATE 2009.03.12 - 2009.03.12 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
151.3								20	40	60	80	100		
0.0	ASPHALT (100mm)													
0.1	SAND and GRAVEL		1	AS			151							
150.7	Brown Moist (FILL)													
0.6	Silty CLAY, some sand, occasional rootlets Stiff Mottled Brown (FILL)		1	SS	12		150							
			2	SS	13									
149.1														
2.2	Silty CLAY, sandy, trace gravel Stiff to Very Stiff Mottled Brown (TILL)(CI to CL)		3	SS	8		149							
			4	SS	15		148							0 39 45 16
			5	SS	27		147							
							146							
	Becoming grey		6	SS	18		145							
							144							
	Becoming hard		7	SS	52		143							5 37 42 16
							142							
			8	SS	71									

Continued Next Page

+ <sup>3</sup> . X <sup>3</sup> : Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 09-054

2 OF 2

METRIC

G.W.P. 19-1351-160 LOCATION N 4 830 125.6 E 610 610.8 ORIGINATED BY LG  
HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM DATE 2009.03.12 - 2009.03.12 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL X LAB VANE						
								WATER CONTENT (%)						
								40 80 120 160 200						
								PLASTIC LIMIT W P W L						
								NATURAL MOISTURE CONTENT W						
								LIQUID LIMIT W L						
140.7	Silty <b>CLAY</b> , sandy, trace gravel Hard Grey (TILL)(CI to CL)						141							
10.7	<b>SAND</b> and <b>SILT</b> , some gravel, trace clay Very Dense Grey Moist (TILL)		9	SS	100/ .250		140							
			10	SS	50/ .125		139							13 48 31 8
137.4			11	SS	50/ .075		138							
13.9	END OF BOREHOLE AT 13.9m. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE TO 0.1m THEN ASPHALT TO SURFACE.													

# RECORD OF BOREHOLE No 09-055

1 OF 3

METRIC

G.W.P. 19-1351-160 LOCATION N 4 830 149.3 E 610 626.1 ORIGINATED BY LG  
 HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN  
 DATUM DATE 2009.03.11 - 2009.03.11 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								20	40	60						
151.3																
0.0	<b>SAND and GRAVEL</b> Brown Wet (FILL)		1	AS												
150.7																
0.6	Silty <b>CLAY</b> , some sand, trace gravel Firm to Stiff Mottled Brown (FILL)		1	SS	8											
	Some gravel		2	SS	10											
			3	SS	14											
148.3																
3.0	Silty <b>CLAY</b> , sandy, trace gravel Stiff to Hard Mottled Grey Brown (TILL)(CL)		4	SS	11											
				5	SS	38										
				6	SS	35										

Continued Next Page

+ <sup>3</sup> . X <sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 09-055

3 OF 3

METRIC

G.W.P. 19-1351-160 LOCATION N 4 830 149.3 E 610 626.1 ORIGINATED BY LG  
 HWY 403 / BRT BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN  
 DATUM DATE 2009.03.11 - 2009.03.11 CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.05.09 3.4 147.9 2009.05.21 3.6 147.7													

ONTMT4S 1160(MTO),GPJ 12/1/09

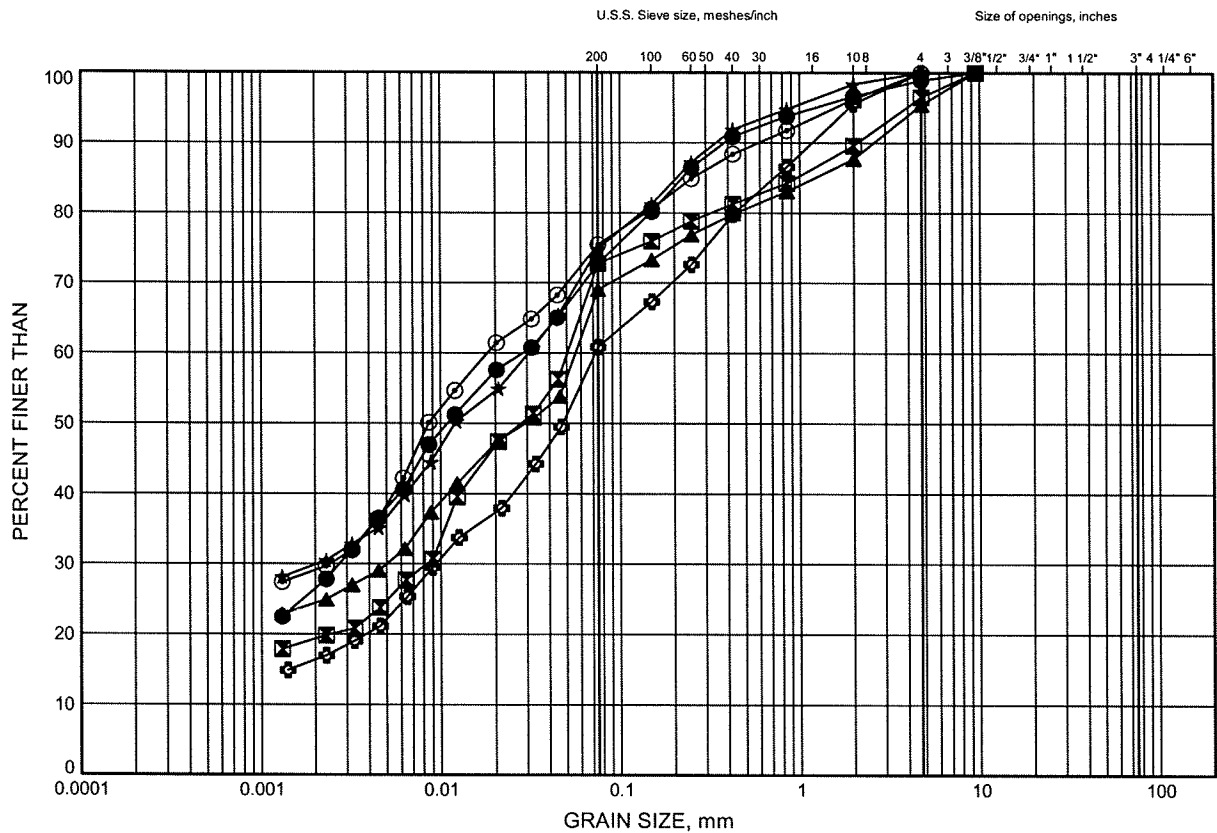
## **Appendix B**

### **Laboratory Test Results**

# Mississauga BRT East GRAIN SIZE DISTRIBUTION

FIGURE B1

## SILTY CLAY TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-052	2.59	148.89
⊠	09-052	4.88	146.61
▲	09-052	7.92	143.56
★	09-053	3.35	147.99
⊙	09-053	7.92	143.41
⊕	09-054	3.35	147.99



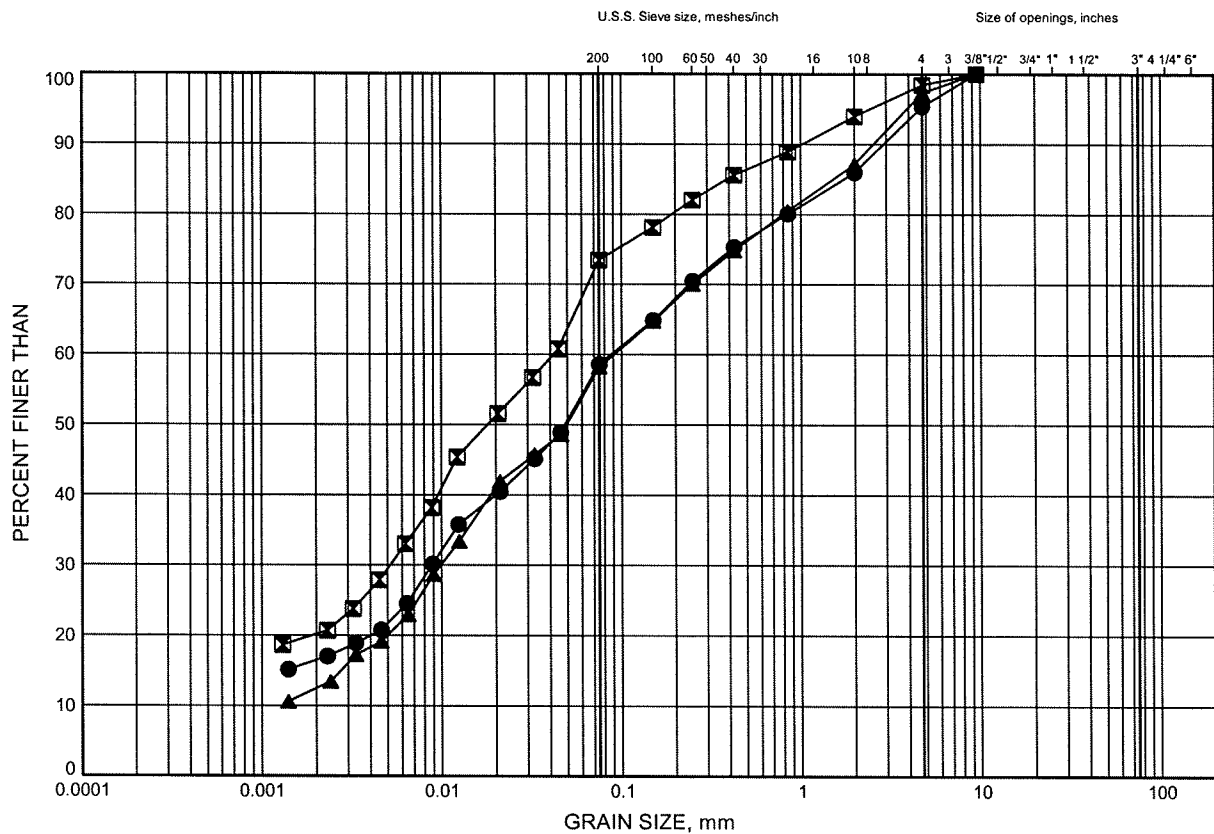
W.P.# 19-1351-160.....  
Prepared By .AN.....  
Checked By .RPR.....



# Mississauga BRT East GRAIN SIZE DISTRIBUTION

FIGURE B2

## SILTY CLAY TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-054	7.92	143.42
⊠	09-055	4.88	146.41
▲	09-055	9.45	141.84

GRAIN SIZE DISTRIBUTION - THURBER 1160.GPJ 5/21/09

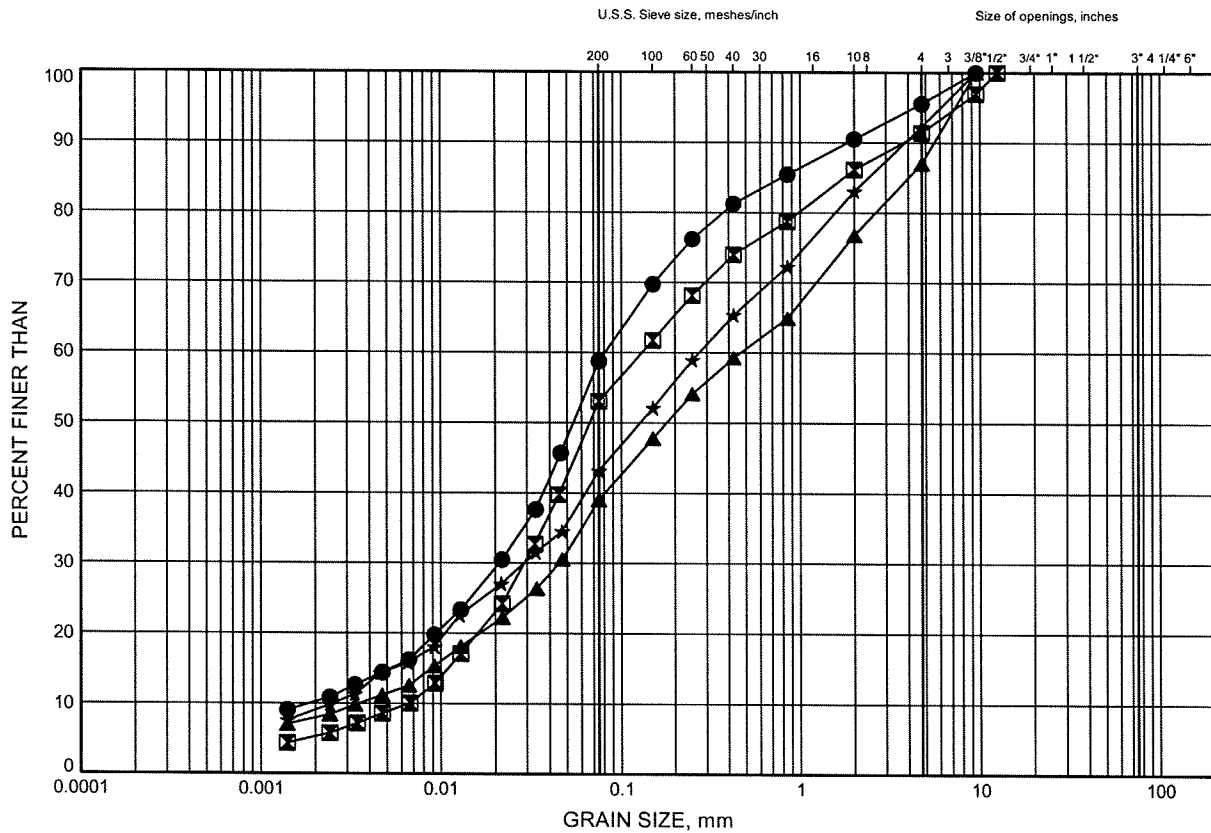
W.P.# 19-1351-160.....  
Prepared By AN.....  
Checked By RPR.....



Mississauga BRT East  
GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-052	10.80	140.69
⊠	09-053	13.83	137.51
▲	09-054	12.26	139.09
★	09-055	12.33	138.96

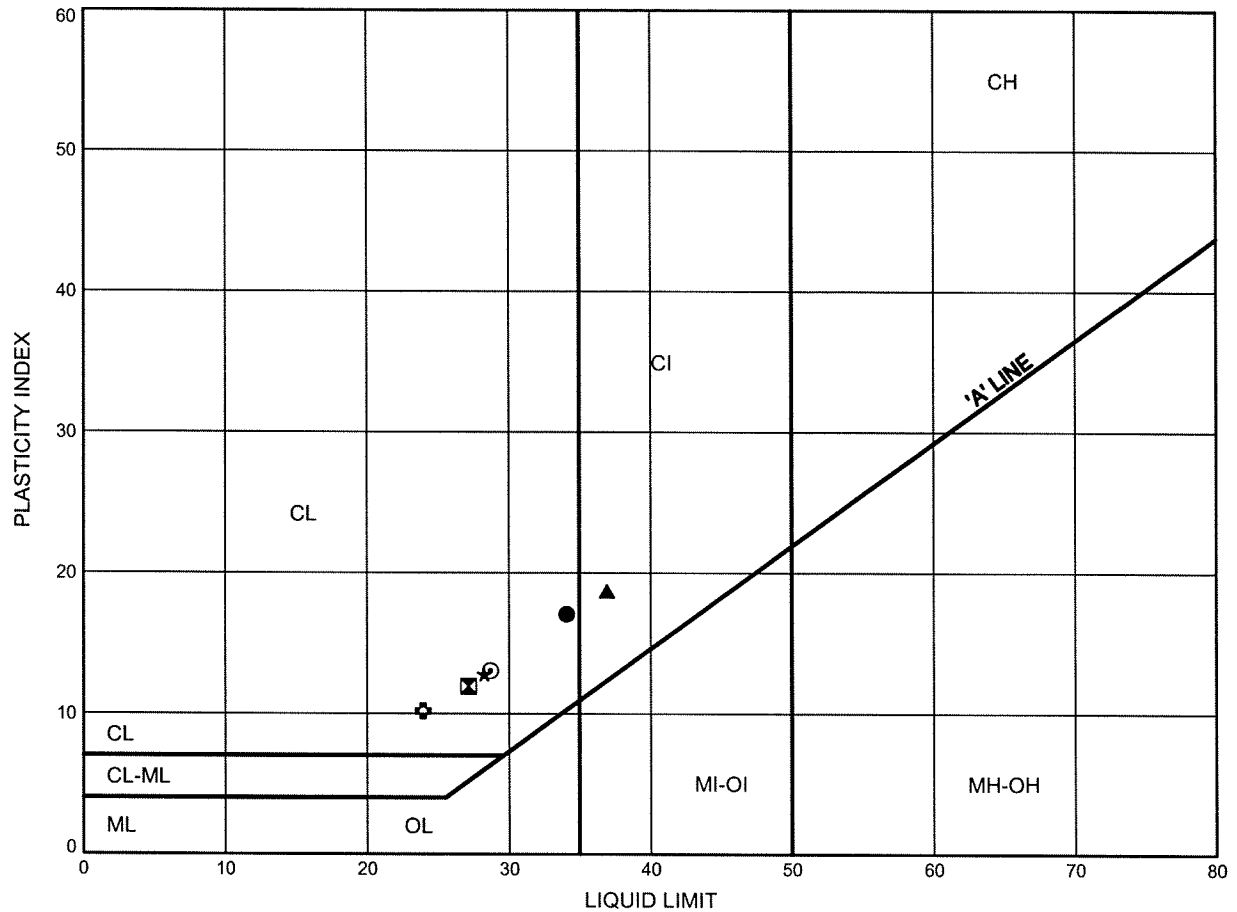


W.P.# 19-1351-160.....  
Prepared By AN.....  
Checked By RPR.....

Mississauga BRT East  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B4

**SILTY CLAY TILL**



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	09-052	2.59	148.89
⊠	09-052	7.92	143.56
▲	09-053	3.35	147.99
★	09-053	7.92	143.41
⊙	09-054	3.35	147.99
⊕	09-054	7.92	143.42

Date May 2009  
 Project 19-1351-160

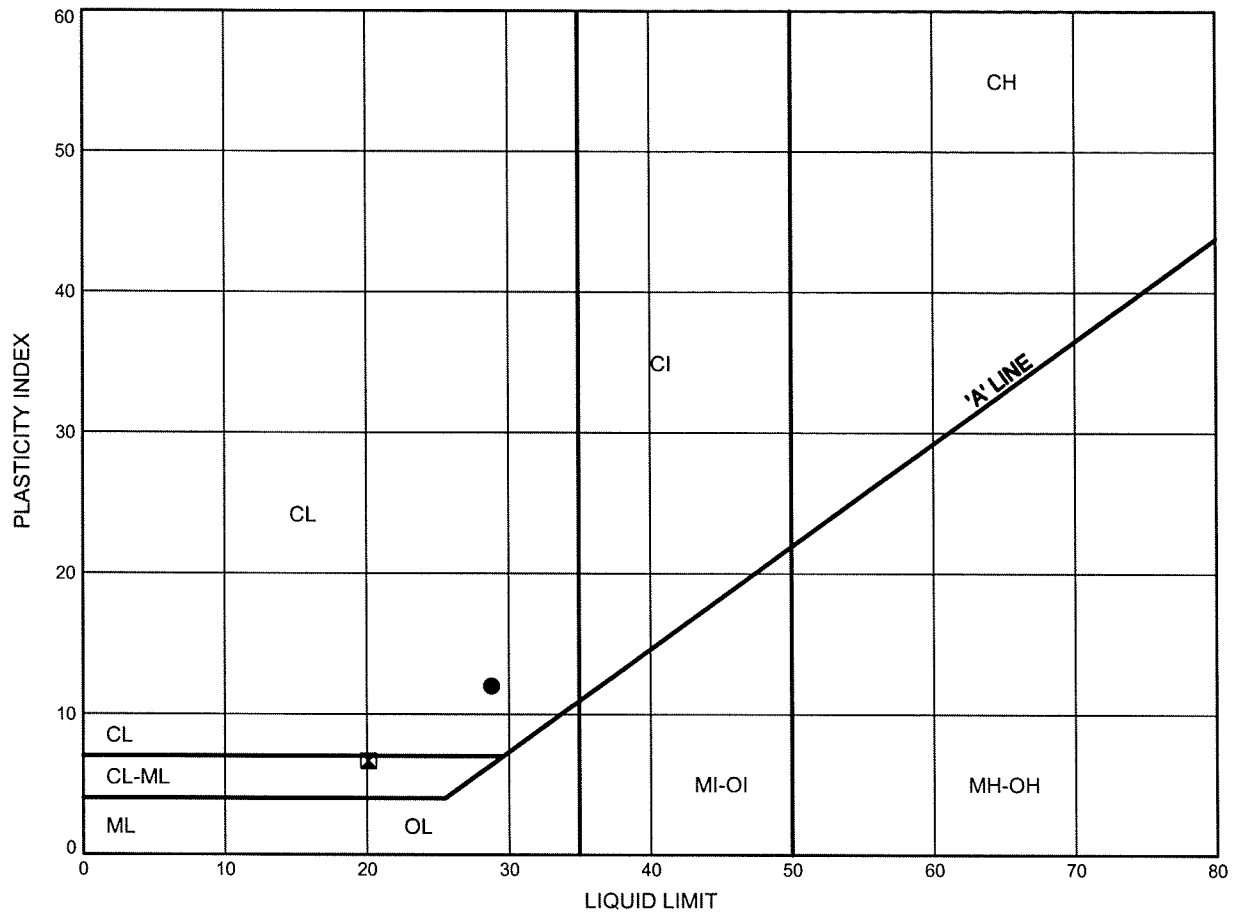


Prep'd AN  
 Chkd. RPR

Mississauga BRT East  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B5

**SILTY CLAY TILL**



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	09-055	4.88	146.41
☒	09-055	9.45	141.84

## **Appendix C**

### **Site Photographs**

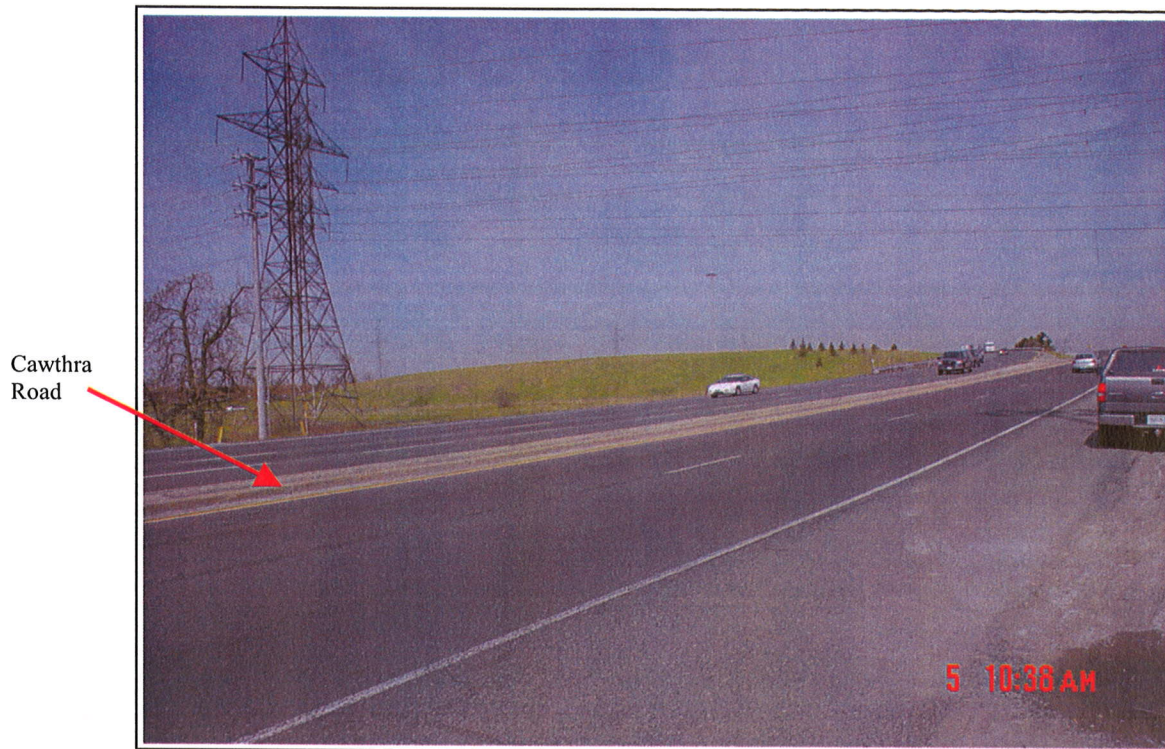


Photo 1. Cawthra Road just north of Eastgate Parkway, facing north



Photo 2. Cawthra Road and Eastgate Parkway intersection, facing south

## **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  
GRADE SEPARATION STRUCTURE AT CAWTHRA RD  
BOREHOLE LOCATIONS AND SOIL STRATA



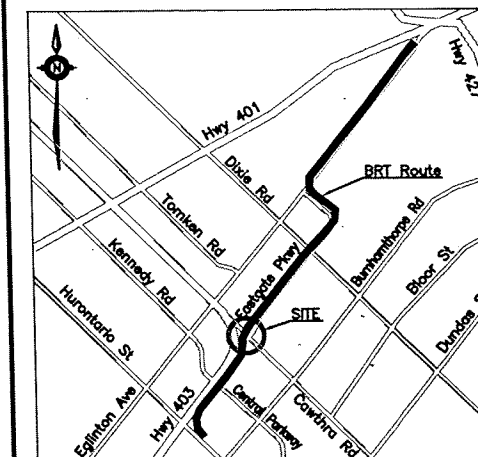
**MCCORMICK RANKIN  
CORPORATION**



**THURBER ENGINEERING LTD.**  
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



SHEET



**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
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

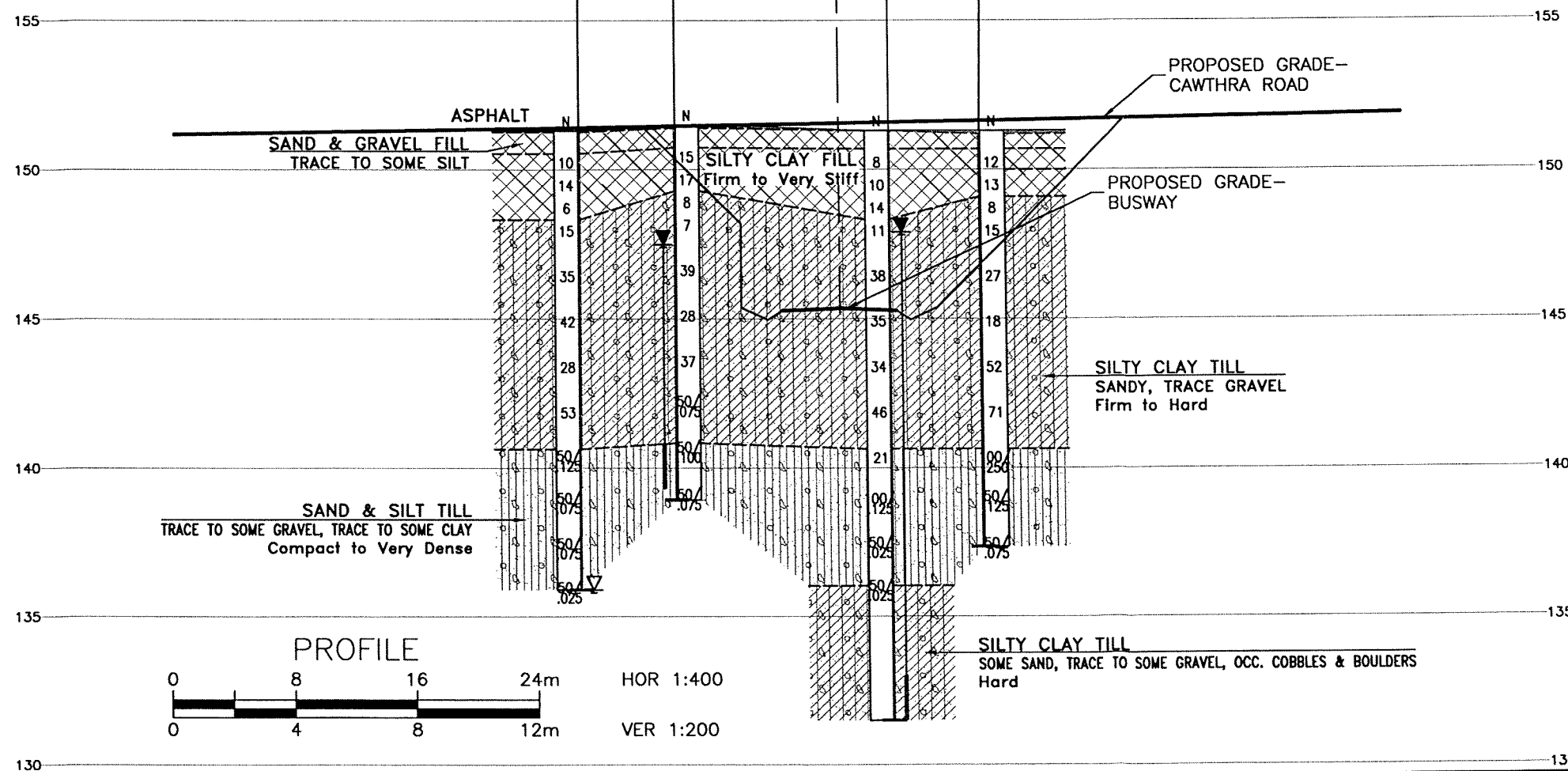
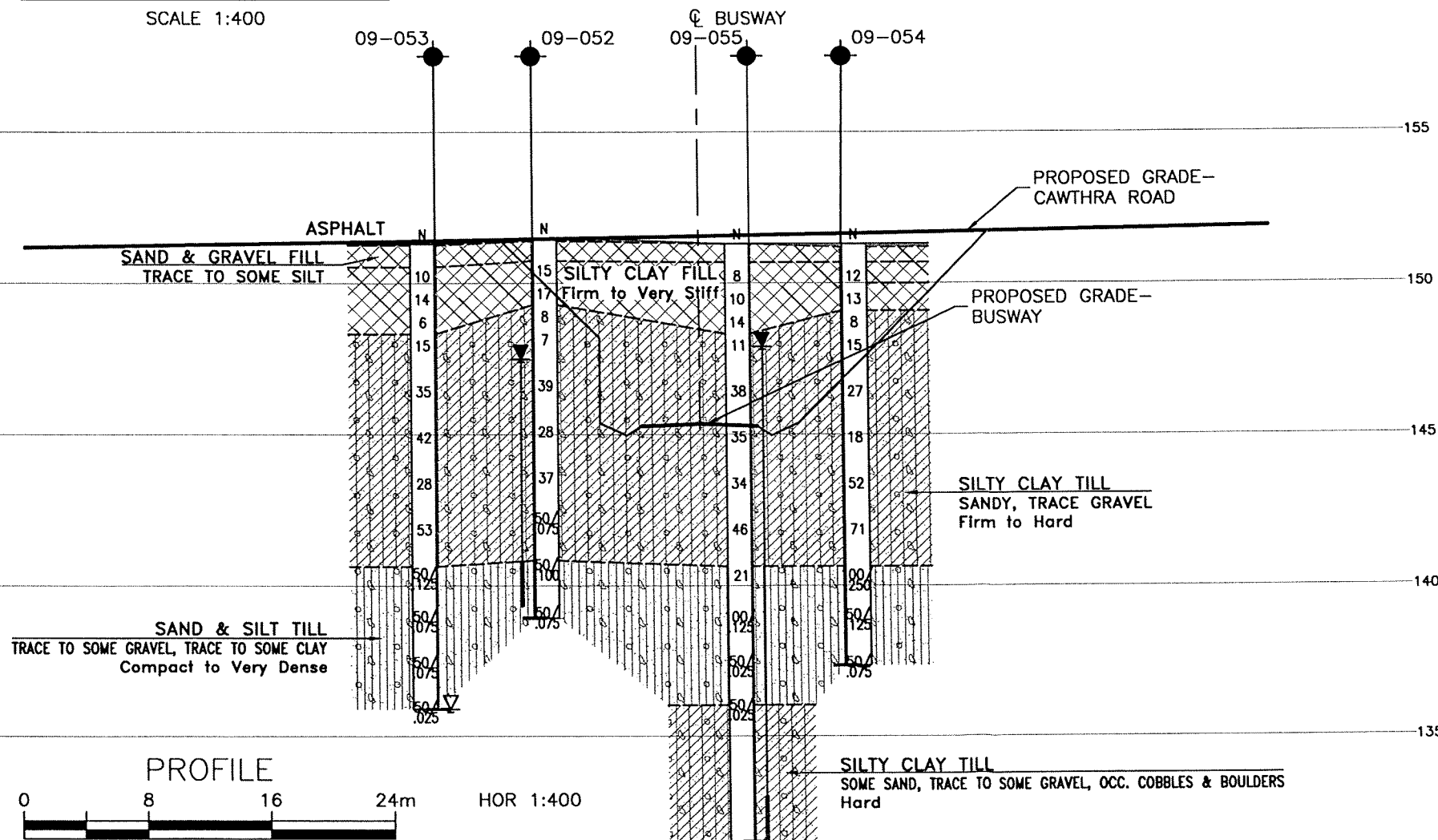
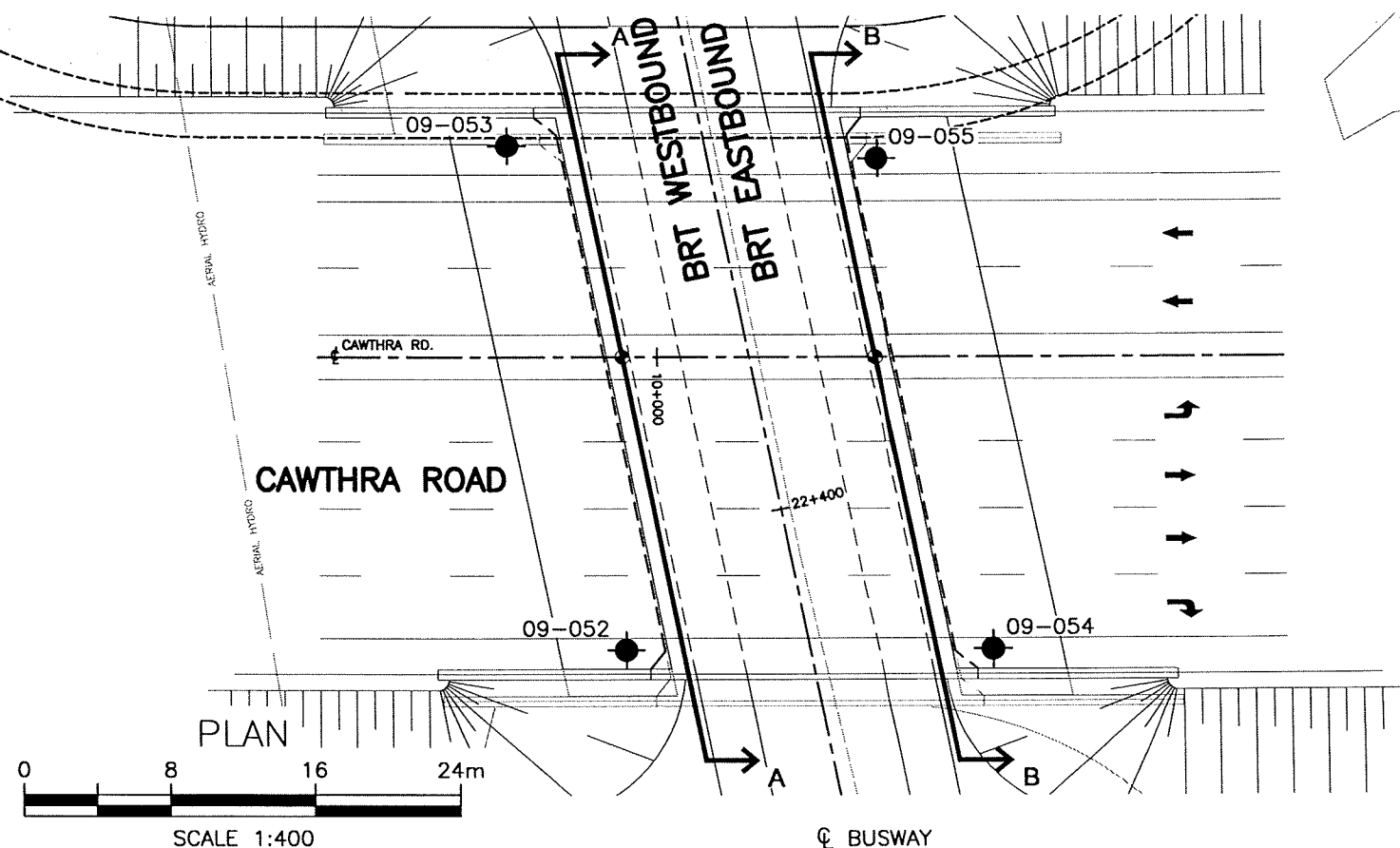
NO	ELEVATION	NORTHING	EASTING
09-052	151.5	4 830 140.1	610 596.5
09-053	151.3	4 830 164.4	610 612.2
09-054	151.3	4 830 125.6	610 610.8
09-055	151.3	4 830 149.3	610 626.1

**NOTES**

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

**GEOCRES No. 30M12-286**

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MEF	CHK	PKC
DRAWN	MFA	CHK	MEF
CODE	LOAD	DATE	DEC. 2009
SITE	STRUCT	DWG	1





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

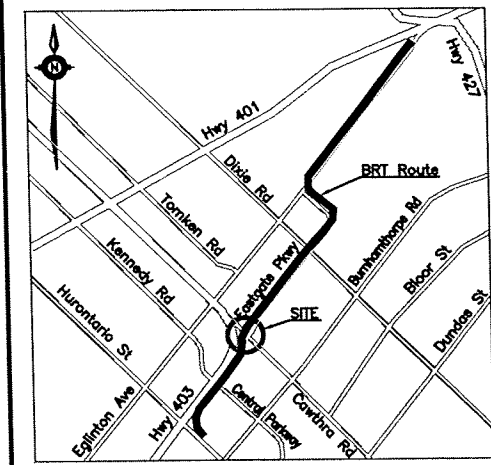
CONT No  
GWP No

MISSISSAUGA BRT EAST  
DETAILED DESIGN  
GRADE SEPARATION STRUCTURE AT CAWTHRA RD  
SOIL STRATA

**MRC** McCORMICK RANKIN  
CORPORATION

**SHEET**

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**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
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

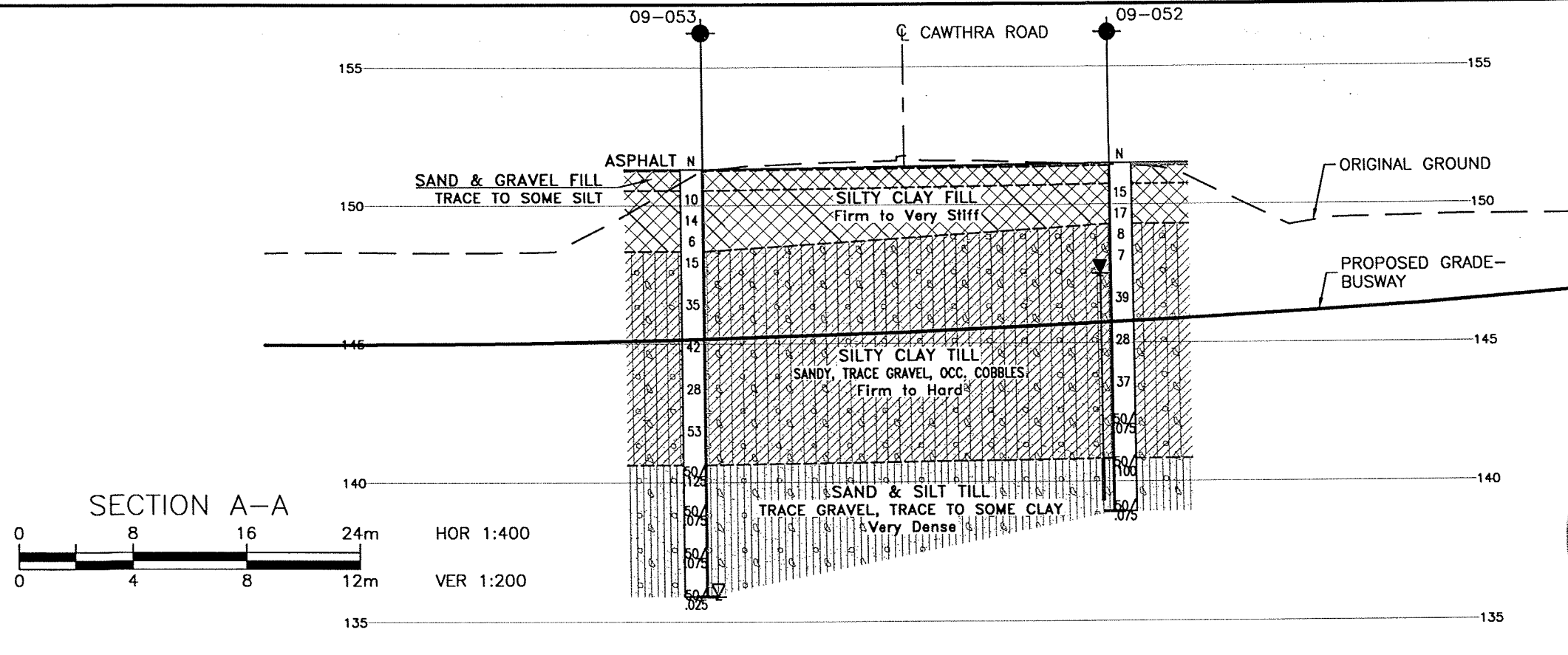
NO	ELEVATION	NORTHING	EASTING
09-052	151.5	4 830 140.1	610 596.5
09-053	151.3	4 830 164.4	610 612.2
09-054	151.3	4 830 125.6	610 610.8
09-055	151.3	4 830 149.3	610 626.1

**-NOTES-**

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
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**GEOCRES No. 30M12-286**

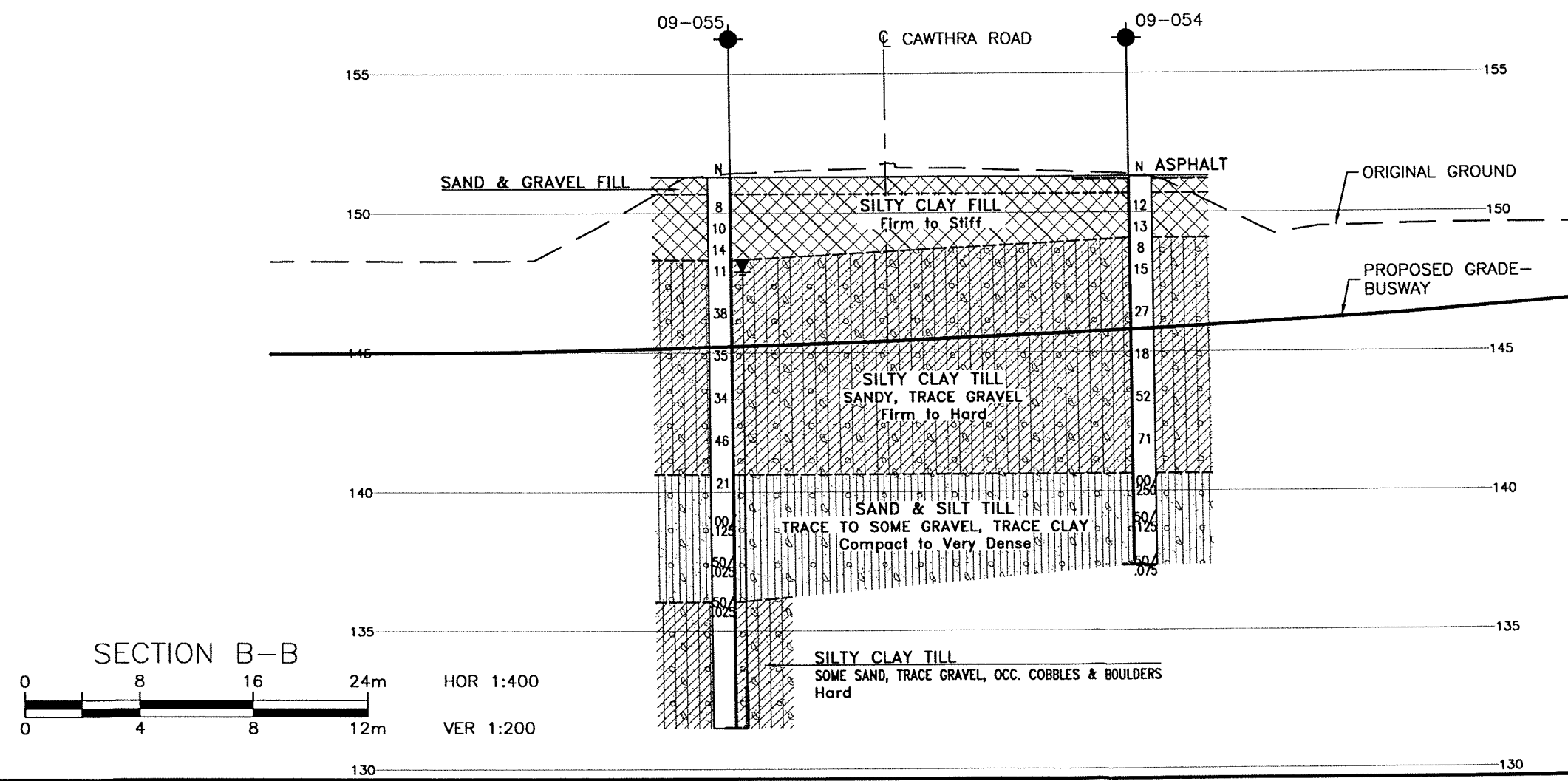
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MEF	CHK PKC	CODE
DRAWN	MFA	CHK MEF	SITE
			LOAD
			STRUCT
			DWG 2



**SECTION A-A**

0 8 16 24m  
0 4 8 12m

HOR 1:400  
VER 1:200



**SECTION B-B**

0 8 16 24m  
0 4 8 12m

HOR 1:400  
VER 1:200