

**FOUNDATION INVESTIGATION REPORT  
HURONTARIO STREET UNDERPASS  
HWY 401 WIDENING, HWY 410 TO CREDIT RIVER  
MISSISSAUGA, ONTARIO  
G.W.P. 2149-01-00 & 2150-01-00, SITE 24-132**

**Geocres Number: 30M12-268**

**Report to**

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**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted at Highway 401 and Hurontario Street interchange in Mississauga, Ontario. The project involves widening of Highway 401 and replacement of the structure carrying Hurontario Street over Highway 401.

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 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 MMM Group Limited (MMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 2005-A-000347.

In the preparation of this report and in addition to the boreholes drilled under the current assignment, reference has been made to information on subsurface conditions contained in an earlier foundation report under G.W.P. 54-82-02. The title of this report is listed as follows:

- Engineering Materials Office, report titled “Foundation Design Section, Highway 10 Underpass, Highway 401, District 6, Toronto”, G.W.P. 54-82-02, Site 24-132, GEOCRETS No. 30M12-183, dated August 1994 (Reference 1).

**2 SITE DESCRIPTION**

The site is located on Hurontario Street at the Highway 401 and Hurontario Street interchange in Mississauga, Ontario.

The lands to the northwest quadrant of Highway 401 and Hurontario Street are generally vacant, undeveloped and/or agricultural. Vegetation consists mainly of tall grass and shrubs. To the east of Hurontario Street and south of Highway 401, lands have been developed for commercial and industrial uses. The topography is generally flat.

The general site area is located within the physiographic region known as Peel Plain, characterized by a level to undulating cohesive glacial till typically less than 3 m thick underlain by reddish brown shale or limestone of the Queenston Formation.

### **3 SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field testing for this project were carried out from October 30 to December 11, 2006 and consisted of drilling and sampling eight boreholes (numbered H1 to H8) at the site. Boreholes were drilled at the projected locations of foundations elements (piers and abutments) and approaches along the alignment of the Hurontario Street and Highway 401 interchange structure.

Borehole H2, H3 and H8 were terminated in shale bedrock at depths of 4.6 m to 15.3 m with SPT 'N' values of at least 100 blows for 0.3 m of penetration. Borehole H5 was terminated in the fill layer upon refusal to auger due to the presence of an obstruction at 6.1 m depth (elevation 194.0 m). Borehole H7 drilled at the north approach was terminated within the native silty clay till layer at 8.1 m depth (elevation 191.1 m). Boreholes H1, H4 and H6 drilled at or near the foundation elements were advanced into shale bedrock by coring to depths of 14.8 m to 19.8 m (elevations 180.2 m to 182.8 m), with a minimum 3.0 m rock core recovered in each borehole.

The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawing in Appendix G. The coordinates and elevations of the boreholes are given on these drawings and on the individual Record of Borehole Sheets in Appendix A. Records of boreholes drilled during the previous investigation (1983) are enclosed in Appendix C.

The survey for this earlier investigation was apparently carried out using the NAD 27 datum. The coordinates have been converted to NAD 83 and the boreholes (numbered 1 to 8) have been plotted on the Borehole Locations and Soil Strata drawing on the basis of the converted coordinates.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations. Road occupancy and lane closure permits were also obtained.

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 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 and standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen were installed in five of the boreholes to permit longer term groundwater level monitoring. The boreholes in which no piezometers were installed were grouted with bentonite. Details of the piezometer installations and other borehole completion details are as shown in Table 3.1.

**Table 3.1 – Borehole Completion Details**

Foundation Element	Borehole	Piezometer Tip (Sand Filter) Details			Backfill
		Depth (m)	Elevation (m)	Stratum	
North Approach	H7	None installed			Bentonite grout for full depth
North abutment	H1	None installed			Bentonite grout for full depth
	H2	13.5 – 15.3	186.3 – 184.5	Shale Bedrock	Bentonite to 0.3 m and concrete to surface.
Pier 1	H3	2.8 – 4.6	191.7 – 189.8	Shale Bedrock/Till	Bentonite to surface.
	H4	16.7 – 19.8	183.3 – 180.2	Shale Bedrock	Bentonite to surface.
Pier 2	H5	None installed			Bentonite grout for full depth
South Abutment	H6	15.0 – 16.8	184.6 – 182.9	Shale Bedrock	Bentonite to 14.0 m, grout to 2.4 m, bentonite to 0.3 m and concrete to surface.
South Approach	H8	7.6 – 9.4	190.4 – 188.6	Shale Bedrock/Till	Bentonite to surface.

#### 4 LABORATORY TESTING

All recovered samples were subjected to Visual Identification (VI) and geological logging. More than 25% of the recovered samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing. 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 shale upon arrival at the Thurber laboratory to assist evaluation of the compressive strength of the bedrock. Two shale samples (Borehole H4, Run 1 and Borehole H6, Run 2) were subjected to unconfined compression

tests. The results of point load and unconfined compression tests on rock cores retrieved from the boreholes are shown on the Record of Borehole sheets in Appendix A and also in Appendix B.

## **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole sheets in Appendices A and C. Details of the encountered soil and rock stratigraphy are presented in these appendices and on the “Borehole Locations and Soil Strata” drawing in Appendix G. 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 consists of topsoil or pavement structure overlying fill which is underlain by native silty clay till and occasional silty sand. Weathered shale bedrock was contacted below the till deposits. More detailed descriptions of the individual strata are presented below.

### **5.1 Pavement Structure**

Pavement structure consisting of approximately 100 to 150 mm of asphalt overlying granular (sand and gravel fill) road base was encountered in Boreholes H2, H5 to H7 drilled on Hurontario Street lanes. The thickness of granular fill measured in the boreholes ranged from 0.6 to 1.4 m and the underside lay at elevations 198.2 m to 198.9 m.

### **5.2 Topsoil**

Topsoil was identified surficially at the proposed locations of North Abutment, Pier 1 and South Approach (Boreholes H1, H3, H4 and H8). The topsoil thickness generally ranged from 50 mm to 225 mm. 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**

A layer of soil was encountered that was identified as fill on the basis of its composition and disturbed appearance. The fill was encountered in all the boreholes drilled along the entire project area: North and South Approaches, North and South Abutments and Piers 1 and 2.

Fill was contacted below the topsoil or below the pavement structure in Boreholes H1 to H8 from the current investigation and surficially in Boreholes 1 to 8 from the previous investigation (1983). The fill generally consists of cohesionless layers of brown sand and gravel with some silt, trace of clay and occasional shale fragments and cohesive layers of brown to reddish brown silty clay fill with some sand and trace of gravel. Cobbles were also observed within the fill.

Fill extended to depths ranging from 4.4 m to 9.4 m (elevations 192.2 m to 189.7 m) at the locations of proposed approaches, east side of piers and both abutments. Locally in

Boreholes 2, 7, 8 and H3 drilled from the level of Highway 401, the fill extended to depths ranging from 0.6 m to 1.4 m (elevations 193.8 m to 191.1 m).

After several attempts, borehole H5, located on the east side of Pier 2 was terminated within the fill layer at 6.1 m (elevation 194.0 m) upon consistent auger refusal.

The results of gradation and Atterberg Limit Tests conducted on samples of fill are summarized below:

Soil	(%)
Gravel	0 to 73
Sand	27 to 69
Silt	9 to 53
Clay	9 to 27

Liquid Limit	22 to 39
Plastic Limit	13 to 21

The grain size distribution of the cohesionless fill is represented by the data plotted in Figures B3 and B4 in Appendix B. The grain size distribution results of the cohesive fill are presented in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figure B8 of Appendix B, indicate that the clay is low to medium plastic.

SPT N-values collected in the silty clay fill ranged from 5 to 56 blows per 0.3 m penetration indicating a firm to hard consistency. SPT N-values of the sand and gravel fill ranged from 5 to 85 blows per 0.3 m penetration indicating a loose to very dense relative density. Locally in Borehole H4, very loose silty sand fill was apparently contacted at 6.1 m depth (elevation 193.9 m) possibly due to some disturbance by groundwater. SPT N-values greater than 50 blows per 0.15 m penetration were observed in Borehole H2, possibly due to the presence of limestone fragments. The moisture content of samples collected ranged from 2% to 21%.

Although not directly encountered in the boreholes, the existing fill may contain cobbles and boulders. Borehole H5 was terminated on an obstruction and other obstructions such as limestone slabs or concrete slabs or building rubble may be encountered in the fill during construction.

#### 5.4 Silty Clay Till

A deposit of native, brown to grey silty clay till with trace to some sand, trace to some gravel and occasional shale fragments was contacted below the fill in all the boreholes, except in Boreholes H1, H5 and 1, drilled on the west side of the North Abutment, Pier 2 and South Abutment, respectively.

The till deposit extended to depths of at least 8.1 m and 8.8 m (elevations 191.1 m and 189.2 m) at the North and South Approaches, respectively. At the North and South Abutments, the till extended to depths ranging from 13.7 m to 10.9 m (elevations 186.1 m to 188.9 m). Boreholes drilled in close proximity to Piers 1 and 2 revealed till extending to depths ranging from 4.0 m to 10.7 m (elevations 188.3 m to 190.5 m). Locally the till extended to 15.2 m depth (elevation 184.8 m) in Borehole H4 drilled at the proposed Pier 1. The silty clay till extended to depths ranging from 3.5 m to 2.5 m (elevations 189.0 m to 190.1 m) in boreholes drilled on Highway 401 centreline (Boreholes 7 and 8).

The results of gradation and Atterberg Limit Tests carried out on samples of the till are summarized below:

Soil	(%)
Gravel	0 to 7
Sand	21 to 44
Silt	36 to 46
Clay	9 to 37

Liquid Limit	23 to 35
Plastic Limit	14 to 19

Grain size distribution results from the silty clay till are presented on the Record of Borehole sheets and Figures B5 and B6 of Appendix B. Atterberg Limit testing result is presented in Figure B9 of Appendix B.

Based on SPT N-values generally ranging from 14 blows for 0.3 m of penetration to higher than 50 blows per 0.1 m, the deposit is classified as stiff to hard in consistency. The measured natural moisture contents range from 3% to 18% and locally 22% in Borehole BH7.

Although not encountered in the boreholes, glacial till may contain cobbles and boulders.

## 5.5 Silty Sand

A 1.5 m thick layer of native silty sand with trace to some clay was contacted below the silty clay fill and extending to 9.1 m depth (elevation 188.1 m) at the North Abutment (Borehole H1).

The results of gradation tests carried out the silty sand are summarized below:

Soil	(%)
Gravel	0
Sand	50
Silt & Clay	50



Laboratory results are presented in Figure B7 of Appendix B.

SPT N-value was 50 blows per 0.15 m penetration, indicating a very dense relative density. Moisture content was 18%.

## 5.6 Bedrock

The soils described above were found to be underlain by reddish brown weathered shale bedrock. The shale encountered in the boreholes is described as thinly bedded and contains numerous very strong interbedded siltstone and limestone layers. Rubble zones were contacted within the bedrock at depth ranging from 14.1 m to 14.6 m (elevations 185.6 m to 185.1 m) in Borehole H6 and at 11.9 m and 13.3 m depth (elevations 185.4 and 184.0) in Borehole H1.

SPT N-values obtained in the shale bedrock were 85 blows per 0.3 m penetration to greater than 50 blows per 0.10 m penetration. Moisture contents ranged from 5% to 14%.

At the locations of Boreholes H2 and H4 (east side of North Abutment and Pier 1), bedrock was contacted 4 to 5 m deeper than other current and previous boreholes drilled in the vicinity of Boreholes H2 and H4.

Elevations of the top of bedrock are shown in Table 5.1.

**Table 5.1 – Elevation of Top of Bedrock**

Foundation Element	Borehole	Depth (m)	Bedrock Elevation (m)
North Approach	H7	-	-
North abutment	H1	9.1	188.1
	H2	13.7	186.1
Pier 1	H3	4.0	190.5
	H4	15.2	184.8
	3	7.0	188.7
	4	9.8	190.1
Highway 401 Centreline	7	3.5	189.0
	8	2.5	190.1
Pier 2	H5	-	-
	2	4.4	188.3
	5	10.7	189.3
South Abutment	H6	11.7	187.9
	1	4.4	190.3
	6	10.9	188.9
South Approach	H8	8.8	189.2

Bedrock core was collected using NQ sized coring equipment in three boreholes. Total core recovery (TCR) in the bedrock was 100% in most core runs. TCR value of 70% was observed in Borehole H1, Run 1.

The RQD values recorded for seven of the eight core runs ranged from 20 to 58% indicating poor to fair rock quality. Lower RQD value of 7% was obtained in Borehole H1 Run 1, cored near elevation 186.6 m, indicating a very poor quality rock. Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, generally ranged from 2 to greater than 10. In Run 1 and Run 2 of Borehole H6 values were generally low, except in the upper section of each run, where FI was greater than 5.

The results of Point Load tests conducted on bedrock samples indicated unconfined compressive strength (UCS) values of 44 to 105 MPa (estimated from point load tests on intact samples) indicating that the samples tested were medium strong to strong. Low UCS values of 3 MPa were observed in Borehole H1, Runs 2 and 3, which represents weak rock.

Two bedrock samples were subjected to unconfined compression tests. Results indicated that the UCS values were 9.5 MPa and 29 MPa, in samples from Borehole H4, Run 1 and Borehole H6, Run 2, respectively. UCS results for Boreholes H4 and H6 are attached in Appendix B. The samples tested will be classified as weak to medium strong rock.

It must be noted however that point load tests were possible only on less weathered shale or higher strength limestone samples as the more typical weathered shale cores tended to disintegrate under point loading.

The shale bedrock typically contains layers of 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. Thickness of hard layers generally ranges from 30 to 200 mm. Sampling and interpretation from small diameter boreholes may underestimate the frequency and strength of the strong layers and therefore geological expertise and past experience must be applied in any decision making process regarding the bedrock.

## **5.7 Water Levels**

Upon completion of drilling, water was measured at depths of 9.1 m and 13.1 m (elevations 188.2 m and 186.7 m) in open Boreholes H1 and H2. Standpipe piezometers were installed in five boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.2, along with the measurements in the boreholes upon completion of drilling.

**Table 5.2 – Measured Groundwater Levels**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
H1	15-Nov-2006	9.1	188.2	In open borehole
H2	3-Nov-2006	13.1	186.7	In open borehole
	13-Nov-2006	6.0	193.8	In piezometer
H3	29-Jan-2007	1.6	192.8	In piezometer
H4	14-Nov-2006	8.1	191.9	In piezometer
H6	14-Nov-2006	7.1	192.6	In piezometer
H8	13-Nov-2006	7.7	190.3	In piezometer
	12-Dec-2006	7.1	190.9	
	29-Jan-2007	7.4	190.6	

Based on these observations, local groundwater levels exist at Elevations 190.6 m to 193.8 m.

Water levels were observed on the site during previous investigation (Reference 1) indicated that groundwater level varying from elevations 187.2 m to 190.6 m.

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

The borehole locations were staked on site and the ground surface elevations were supplied to Thurber by MMM Group Limited.

The drilling and sampling equipment was supplied and operated by DBW Drilling of Ajax Ontario. The field work was supervised on a full time basis by Mr. George Azzopardi and Mr. Stephane Loranger, C.E.T. of Thurber Engineering Ltd.

Laboratory testing was carried out at Thurber's Laboratory in Oakville and Golder's Laboratory in Mississauga.

Supervision of the field program, interpretation of the field data and preparation of the Foundation Investigation Report were conducted by Mr. A. E. Gorman, 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.

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**Appendix A**

**Record of Borehole Sheets  
(present investigation)**

## 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  
 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 (MPa) (psi)	Field Estimation of Hardness*	
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 H1

1 OF 2

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 263.1 E 289 857.2 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY JHL  
 DATUM Geodetic DATE 2006-11-15 - 2006-11-15 CHECKED BY RPR

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			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
197.3 0.0 0.1	TOPSOIL: (75 mm)  Silty CLAY, some sand, trace gravel Firm to Stiff Reddish Brown (FILL)		1	SS	10		197							
			2	SS	15		196							
	occasional shale fragments		3	SS	13		195							
	Becoming Brown to Grey		4	SS	7		194							5 32 47 16
			5	SS	5		193							
			6	SS	10		192							
	occasional rootlets Very Stiff		7	SS	16		191							0 20 53 27
189.7 7.6	Silty SAND, fine grained, trace to some clay Very Dense Brown Moist to Wet		8	SS	50/ .150		190							0 50 50 (SI+CL)
188.1 9.1	SHALE, highly weathered, thinly bedded, reddish brown, frequent rubble zones		9	SS	85		188							

Continued Next Page

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

20  
15 5  
10 (%) STRAIN AT FAILURE

ONTM4S 2311.GPJ 3/4/08

# RECORD OF BOREHOLE No H1

2 OF 2

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 263.1 E 289 857.2 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY JHL  
 DATUM Geodetic DATE 2006-11-15 - 2006-11-15 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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								
								○ UNCONFINED      + FIELD VANE								
								● QUICK TRIAXIAL      × LAB VANE								
								20   40   60   80   100			PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT W <sub>p</sub> W      W <sub>L</sub>			WATER CONTENT (%) 20   40   60		
Continued From Previous Page																
182.5   																

# RECORD OF BOREHOLE No H2

1 OF 2

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 276.4 E 289 882.0 ORIGINATED BY GA/JHL  
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JHL  
DATUM Geodetic DATE 2006-10-30 - 2006-11-03 CHECKED BY RPR

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			20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>		
199.8													
0.0	ASPHALT: (100 mm)		1	SS	50/ .075								
0.1	Gravelly SAND, some silt, occasional shale fragments Very Dense Brown Damp (FILL)		2	SS	85		199						
198.2													
1.5	Silty CLAY, some sand, trace gravel, some shale fragments Very Stiff to Hard Brown to Reddish Brown (FILL)		3	SS	50		198						5 31 46 18
			4	SS	23		197						
	some limestone fragments												
			5	SS	50/ .150		196						
			6	SS	22		195						
							194						
	black staining		7	SS	20		193						11 37 35 17
			8	SS	35		192						
							191						
			9	SS	50/ .025		190						
190.3													
9.4	Silty CLAY, some sand, trace gravel, occasional siltstone and limestone fragments												

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No H2

2 OF 2

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 276.4 E 289 882.0 ORIGINATED BY GA/JHL  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JHL  
 DATUM Geodetic DATE 2006-10-30 - 2006-11-03 CHECKED BY RPR

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			20	40	60	80	100		
	Continued From Previous Page													
	Silty CLAY, some sand, trace gravel, occasional siltstone and limestone fragments Hard Grey (TILL)		10	SS	50/ .125		189						o	7 43 36 14
			11	SS	50/ .125		188						o	
							187							
186.1														
13.7	SHALE, highly weathered, thinly bedded, reddish brown, grey limestone layers		12	SS	126		186						o	
							185							
184.5			13	SS	100/ .075								o	
15.3	END OF BOREHOLE AT 15.32 m. BOREHOLE OPEN AND WATER LEVEL AT 13.1 m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 13.11.06 6.0 193.8													

+ 3 X 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No H3

1 OF 1

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 235.7 E 289 881.3 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JHL  
 DATUM Geodetic DATE 2006-11-12 - 2006-11-12 CHECKED BY RPR

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			20	40	60	80	100		
194.4	TOPSOIL: (50 mm)		1	SS	8		194							
193.8	Sandy SILT, trace clay, trace gravel Brown Damp (FILL)		2	SS	34		193							
190.5	Silty CLAY, some sand, trace gravel Hard Brown (TILL)		3	SS	48		192							3 33 44 20
			4	SS	50/ .125		191							
			5	SS	50/ .075		190							2 44 45 9
189.9	SHALE, highly weathered, thinly bedded, reddish brown, grey limestone layers		6	SS	50/ .100									
4.6	END OF BOREHOLE AT 4.57 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 29.01.07 1.6 192.8													

+ 3 . X 3 : Numbers refer to 20  
Sensitivity 15-5 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No H4

1 OF 3

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 249.1 E 289 906.0 ORIGINATED BY JHL  
 HWY 401 BOREHOLE TYPE Solid Stem Augers/NO Coring COMPILED BY JHL  
 DATUM Geodetic DATE 2006-10-31 - 2006-11-01 CHECKED BY RPR

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			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
200.0 0.0 0.1	TOPSOIL: (100 mm)						200						
	SAND, trace silt, trace to some gravel, occasional shale fragments Compact Brown Moist (FILL)		1	SS	28								
			2	SS	29								
							199						
			3	SS	13								
							198						
	occasional cobbles		4	SS	13								
197.0 3.0	SAND AND GRAVEL, trace silt, trace clay, occasional cobbles Compact Brown Moist (FILL)		5	SS	14		197						37 54 9 (SH+CL)
							196						
			6	SS									
							195						
193.9 6.1	Silty SAND, some clay, trace gravel, occasional cobbles Very Loose Brown Wet (FILL)		7	SS	0		194						4 47 33 16
							193						
192.3 7.8	Silty CLAY, some sand, trace gravel, trace rootlets, occasional shale fragments, occasional oxide staining Very Stiff to Hard Grey (TILL)		8	SS	22		192						
							191						
			9	SS	63								1 35 42 22

Continued Next Page

+ 3. X 3. Numbers refer to  
Sensitivity

20  
15 5  
10

(%) STRAIN AT FAILURE

## METRIC

CHECKED BY RPR

CONTMT4S 2311.GPJ 3/4/08

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No H4

3 OF 3

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 249.1 E 289 906.0 ORIGINATED BY JHL  
 HWY 401 BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY JHL  
 DATUM Geodetic DATE 2006-10-31 - 2006-11-01 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
	Continued From Previous Page													
	END OF BOREHOLE AT 19.81 m. BOREHOLE GROUTED WITH BENTONITE. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 14.11.06 8.1 191.9													



# RECORD OF BOREHOLE No H5

1 OF 1

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 211.2 E 289 940.2 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JHL  
 DATUM Geodetic DATE 2006-11-03 - 2006-11-03 CHECKED BY RPR

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  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 ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x LAB VANE								
200.1								20	40	60	80	100				
0.0	ASPHALT: (150 mm)						200									
0.2	SAND AND GRAVEL, trace silt Dense to Very Dense Brown Damp (FILL)		1	SS	30											
			2	SS	48		199									
198.6																
1.5	SAND, some gravel, trace silt, trace clay Loose to Compact Brown Damp (FILL)		3	SS	8		198									
			4	SS	8											16 67 17 (SI+CL)
			5	SS	7		197									
							196									
			6	SS	6											
							195									
194.0			7	S	16											12 69 19 (SI+CL)
6.1	END OF BOREHOLE AT 6.10 m. AUGER REFUSAL AT 6.10 m ON OBSTRUCTION. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.															

+ 3, X 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No H6

1 OF 2

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 190.6 E 289 977.1 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY JHL  
 DATUM Geodetic DATE 2006-11-06 - 2006-11-07 CHECKED BY RPR

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					
199.7							20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT					
0.0	ASPHALT: (150 mm)							WATER CONTENT (%)					
0.2	SAND AND GRAVEL Dense Brown Moist (FILL)		1	SS	32			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE					
198.9							199						
0.8	Sandy SILT, trace gravel, occasional shale fragments Dense Brown (FILL)		2	SS	32								
198.1							198						
1.5	Silty CLAY, some sand to sandy, trace gravel Stiff to Very Stiff Reddish Brown (FILL)		3	SS	12								
			4	SS	16		197						1 28 47 24
			5	SS	13								
							196						
			6	SS	10		195						
							194						
			7	SS	15		193						
							192						
	occasional asphalt fragments Hard		8	SS	45								
191.1							191						
8.5	Silty CLAY, some sand, trace gravel Hard Brown (TILL)		9	SS	57		190						1 32 46 21

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 H6

2 OF 2

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 190.6 E 289 977.1 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY JHL  
 DATUM Geodetic DATE 2006-11-06 - 2006-11-07 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  Y  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100					
								SHEAR STRENGTH kPa					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
							WATER CONTENT (%)						
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
							W <sub>p</sub> W W <sub>L</sub>						
							20 40 60						
	Continued From Previous Page												
	Silty CLAY, some sand, trace gravel Hard Brown (TILL)		10	SS	144		189						
187.9													
11.7	SHALE, highly to moderately weathered, thinly bedded, reddish brown, grey limestone layers		11	SS	106		188						
							187						
			12	SS	100/ .125		186						
	Rubble zones from 14.10m to 14.14m, 14.53m to 14.56m												
	Limestone interbeds at 14.51m to 14.56m, 14.68m to 14.71m, 14.75m to 14.80m, 14.99m to 15.04m		1	RUN			185						
	Limestone interbeds at 15.73m to 15.80m, 16.00m to 16.05m		2	RUN			184						
182.8							183						
16.8	END OF BOREHOLE AT 16.84 m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 14.11.06 7.1 192.6												

ONTMT4S 2311.GPJ 3/4/06

+ 3 . X 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No H7

1 OF 1

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 287.0 E 289 859.4 ORIGINATED BY JHL  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JHL  
 DATUM Geodetic DATE 2006-10-31 - 2006-10-31 CHECKED BY RPR

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						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
							WATER CONTENT (%)							
							20 40 60							
199.2														
0.0	ASPHALT: (100 mm)													
0.1	SAND, trace silt Very Dense Brown Moist (FILL)		1	SS	56									
198.3			2	SS	56									
0.9	Silty CLAY, some sand, trace gravel, occasional shale fragments Firm to Hard Brown (FILL)													
			3	SS	18									
			4	SS	21									
	occasional rock fragments Becoming Reddish Brown to Brown		5	SS	8									
			6	SS	11									
193.1														
6.1	Silty CLAY, some sand, trace gravel Stiff to Very Stiff Grey (TILL)		7	SS	14									
			8	SS	28									
191.1														
8.1	END OF BOREHOLE AT 8.08 m. BOREHOLE GROUTED WITH BENTONITE TO SURFACE. WATER NOT OBSERVED IN BOREHOLE UPON COMPLETION OF DRILLING.													

ONTMT4S 2311.GPJ 3/4/08

# RECORD OF BOREHOLE No H8

1 OF 2

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 133.0 E 289 989.3 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JHL  
 DATUM Geodetic DATE 2006-11-09 - 2006-11-09 CHECKED BY RPR

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 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA St CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
198.0								20 40 60 80 100						
0.0	TOPSOIL: (225 mm)													
0.2	Silty CLAY, some sand, some asphalt fragments, organics and rootlets Firm to Very Stiff Brown to Reddish Brown (FILL)		1	SS	8									
			2	SS	7									
			3	SS	15									
			4	SS	14									
			5	SS	10									
			6	SS	11									
			7	SS	20									
191.0														
7.0	Silty CLAY, some sand, trace gravel Hard Brown (TILL)													
			8	SS	42									
189.2														
8.8	SHALE, highly weathered, thinly bedded, reddish brown, grey limestone layers													
188.6			9	SS	106									
9.4	END OF BOREHOLE AT 9.45 m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION.													

Continued Next Page

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

20  
15 5  
10 (%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 3/4/08

# RECORD OF BOREHOLE No H8

2 OF 2

METRIC

G.W.P. 2149-01-00 & 2150-01-00 LOCATION Proposed Hurontario St. Underpass N 4 832 133.0 E 289 989.3 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JHL  
 DATUM Geodetic DATE 2006-11-09 - 2006-11-09 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
	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) 13.11.06 7.7 190.3 12.12.06 7.1 190.9 29.01.07 7.4 190.6																

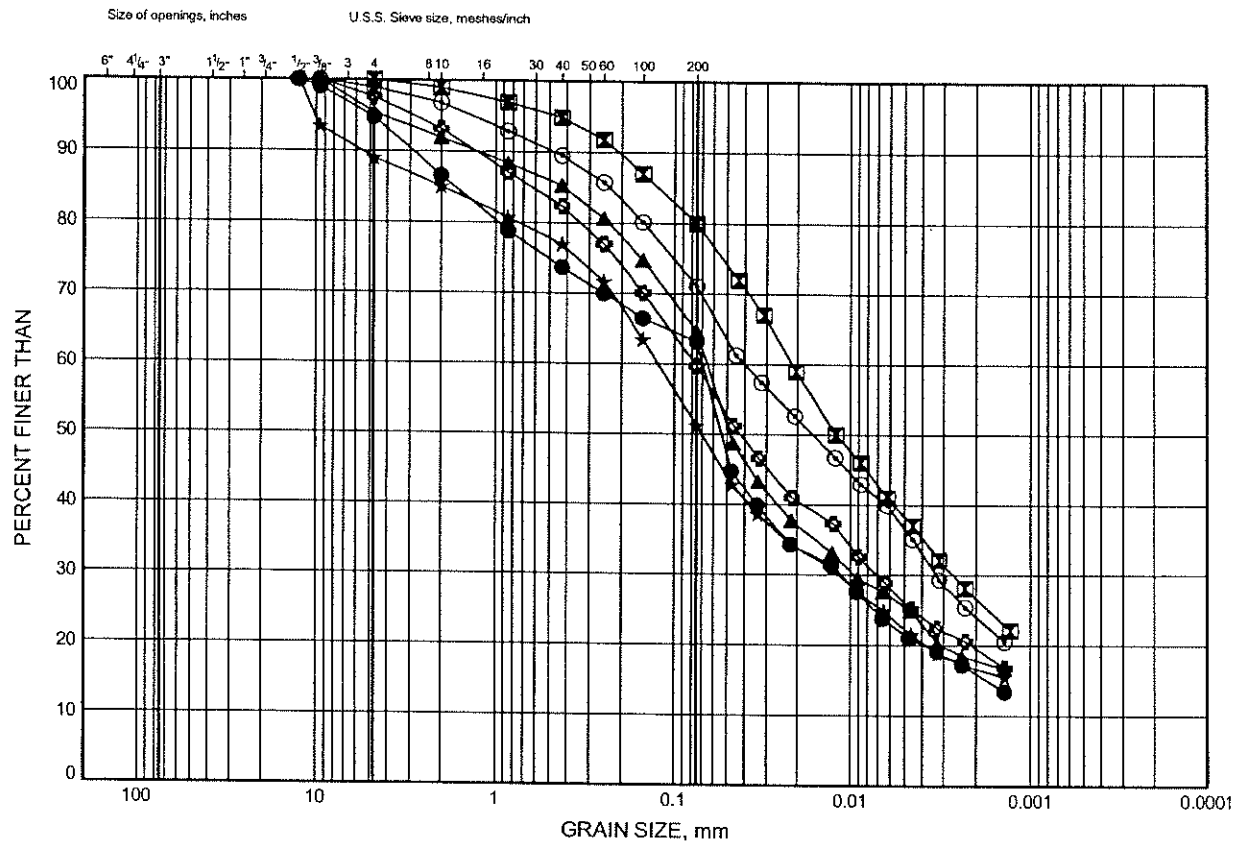
## **Appendix B**

### **Laboratory Test Results**

Hwy 401/410 to Credit River  
GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY CLAY / CLAYEY SILT FILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	H1	2.59	194.70
⊠	H1	6.40	190.89
▲	H2	1.75	198.01
★	H2	6.32	193.44
⊙	H6	2.59	197.08
⊕	H7	3.28	195.90

Date February 2008

Project 2149-01-00 & 2150-01-00



Prep'd MFA

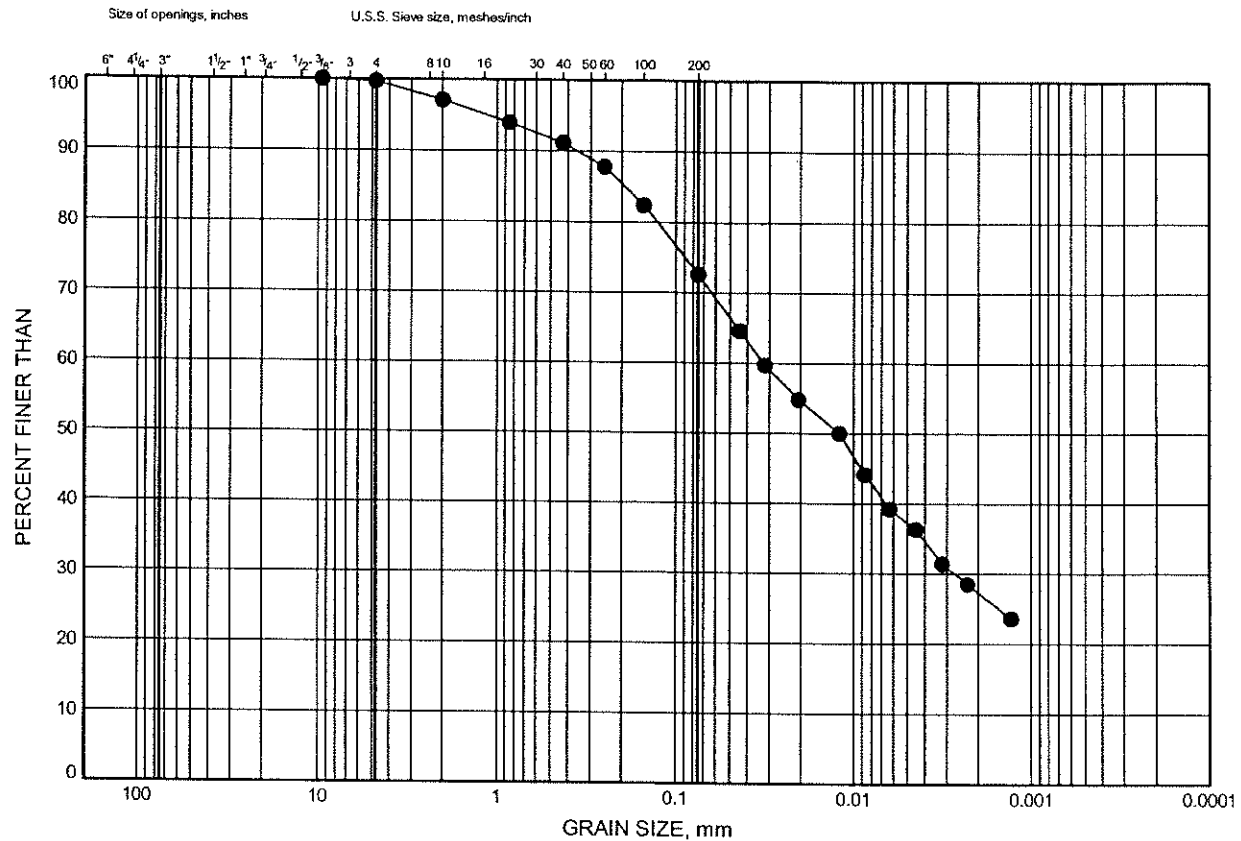
Chkd. RPR



Hwy 401/410 to Credit River  
GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY / CLAYEY SILT FILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	H8	4.88	193.15

Date February 2008

Project 2149-01-00 & 2150-01-00



Prep'd MFA

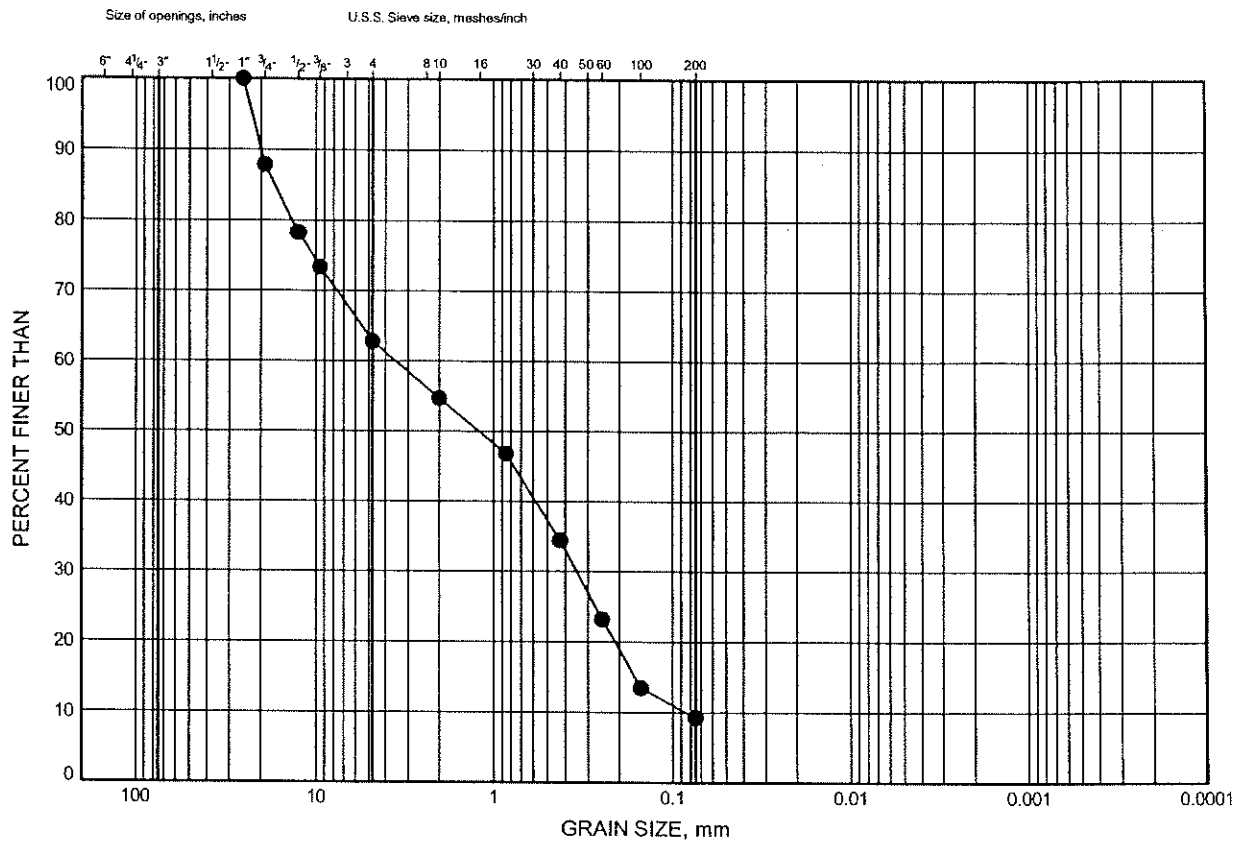
Chkd. RPR



Hwy 401/410 to Credit River  
**GRAIN SIZE DISTRIBUTION**

FIGURE B4

**SAND AND GRAVEL FILL**

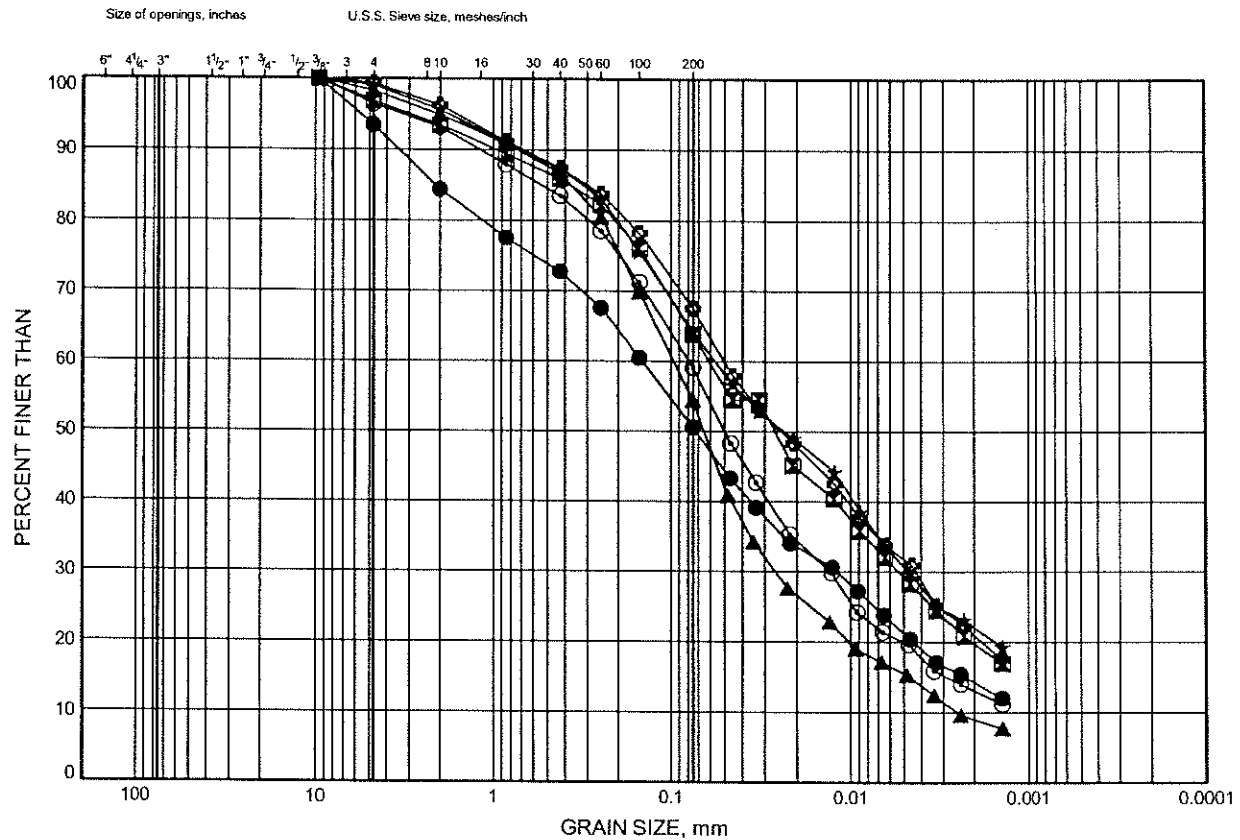


# Hwy 401/410 to Credit River

## GRAIN SIZE DISTRIBUTION

FIGURE B5

### SILTY CLAY TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	H2	10.73	189.04
⊠	H3	1.83	192.61
▲	H3	3.16	191.28
★	H4	9.37	190.67
⊙	H4	10.77	189.28
⊗	H6	9.45	190.22

Date February 2008

Project 2149-01-00 & 2150-01-00



Prep'd MFA

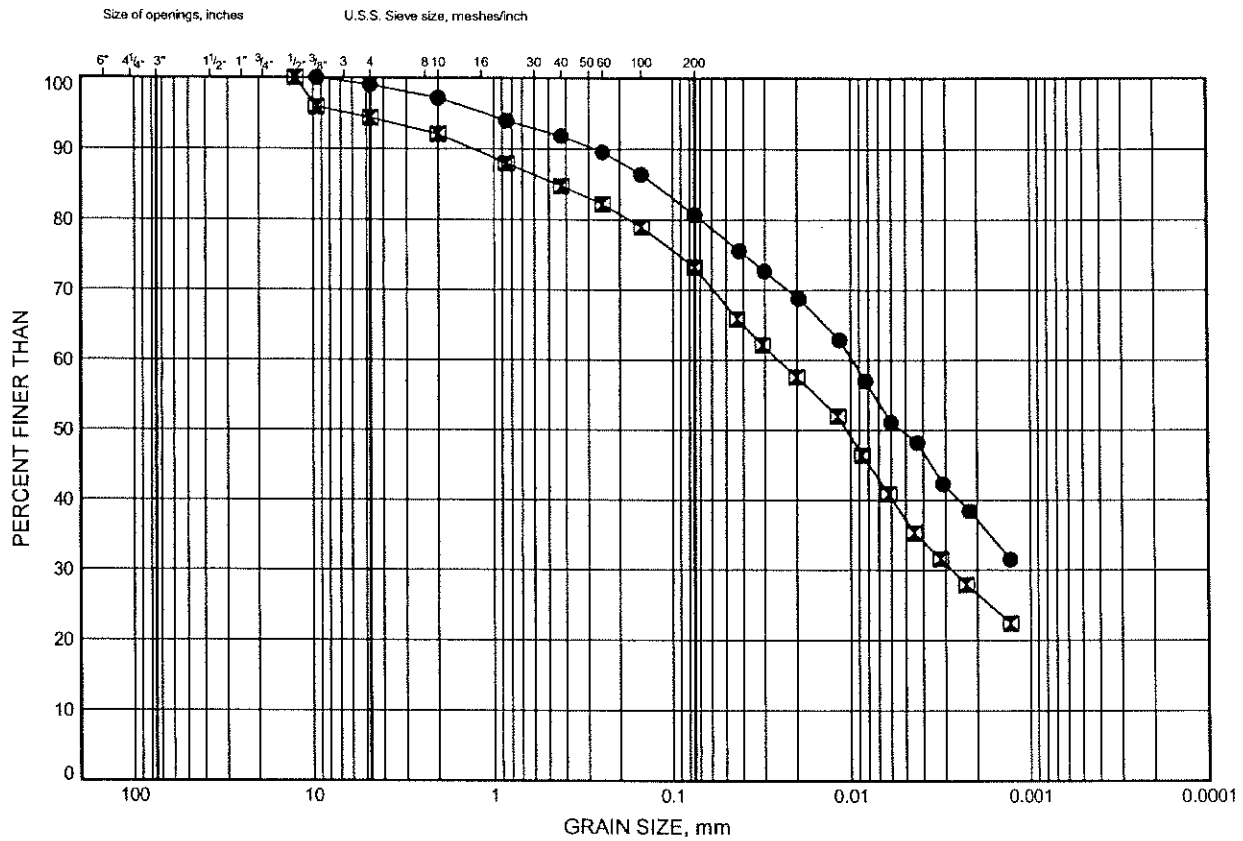
Chkd. RPR

# Hwy 401/410 to Credit River

## GRAIN SIZE DISTRIBUTION

FIGURE B6

### SILTY CLAY TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	H7	6.32	192.85
☒	H8	7.92	190.10

Date February 2008

Project 2149-01-00 & 2150-01-00



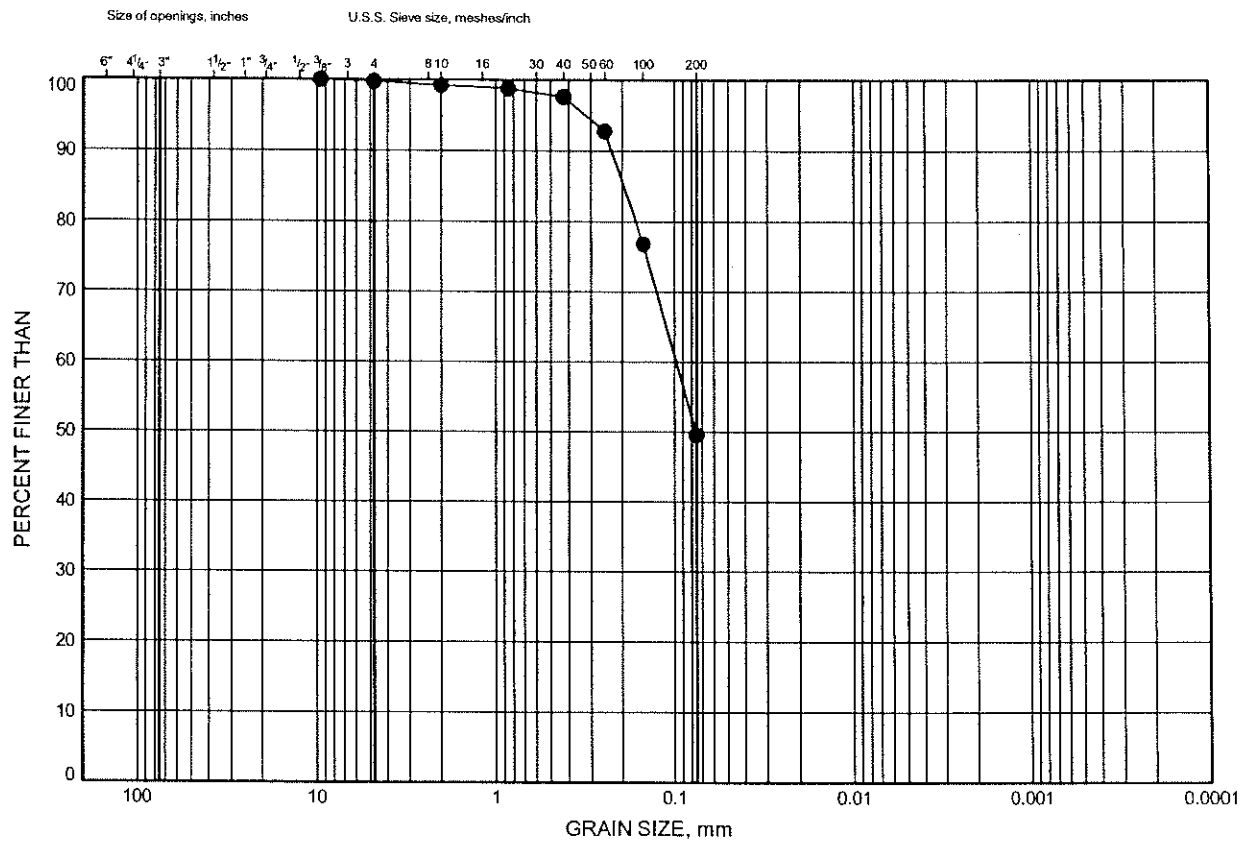
Prep'd MFA

Chkd. RPR

# Hwy 401/410 to Credit River GRAIN SIZE DISTRIBUTION

FIGURE B7

## SILTY SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	H1	7.92	189.36

Date February 2008

Project 2149-01-00 & 2150-01-00



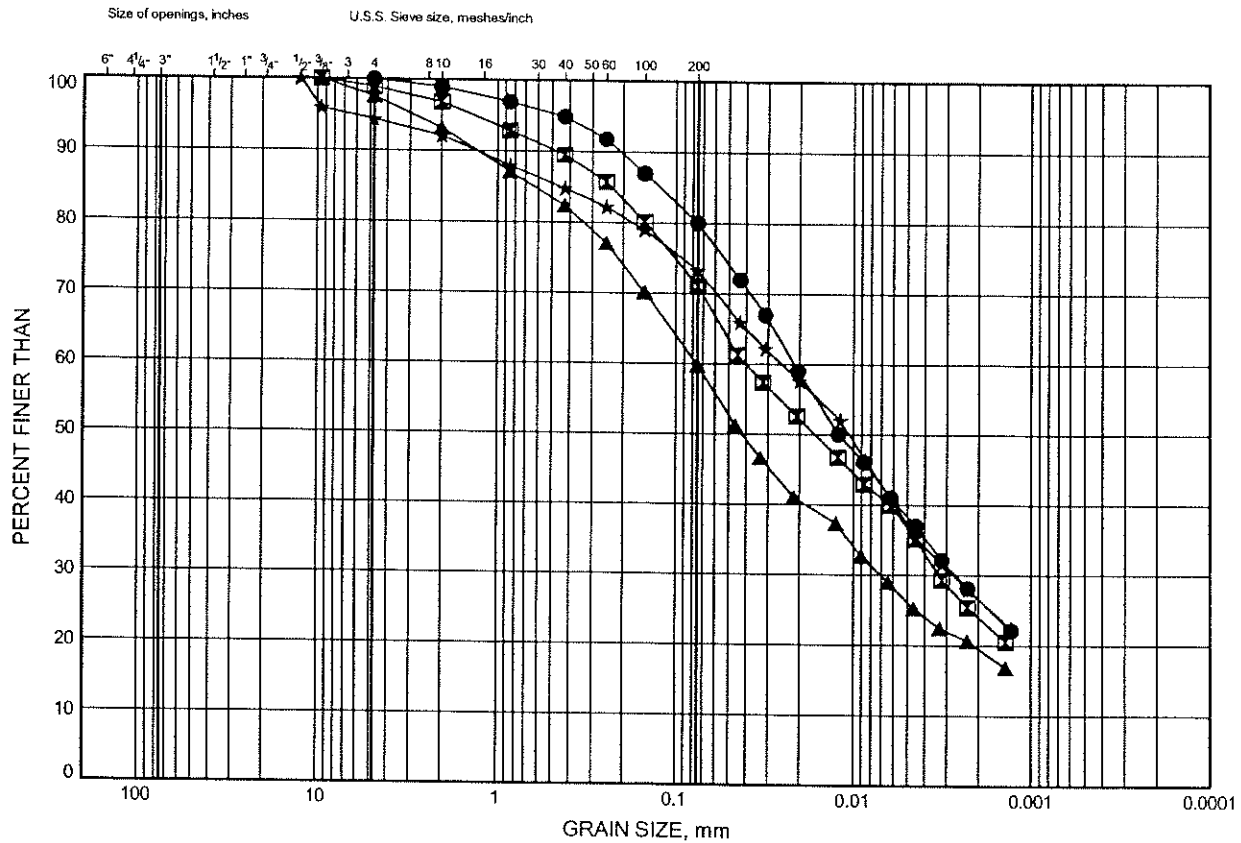
Prep'd MFA

Chkd. RPR

Hwy 401/410 to Credit River  
GRAIN SIZE DISTRIBUTION

FIGURE B8

SILTY CLAY FILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	H1	6.40	190.89
⊠	H6	2.59	197.08
▲	H7	3.28	195.90
★	H8	7.92	190.10

Date February 2008  
Project 2149-01-00 & 2150-01-00

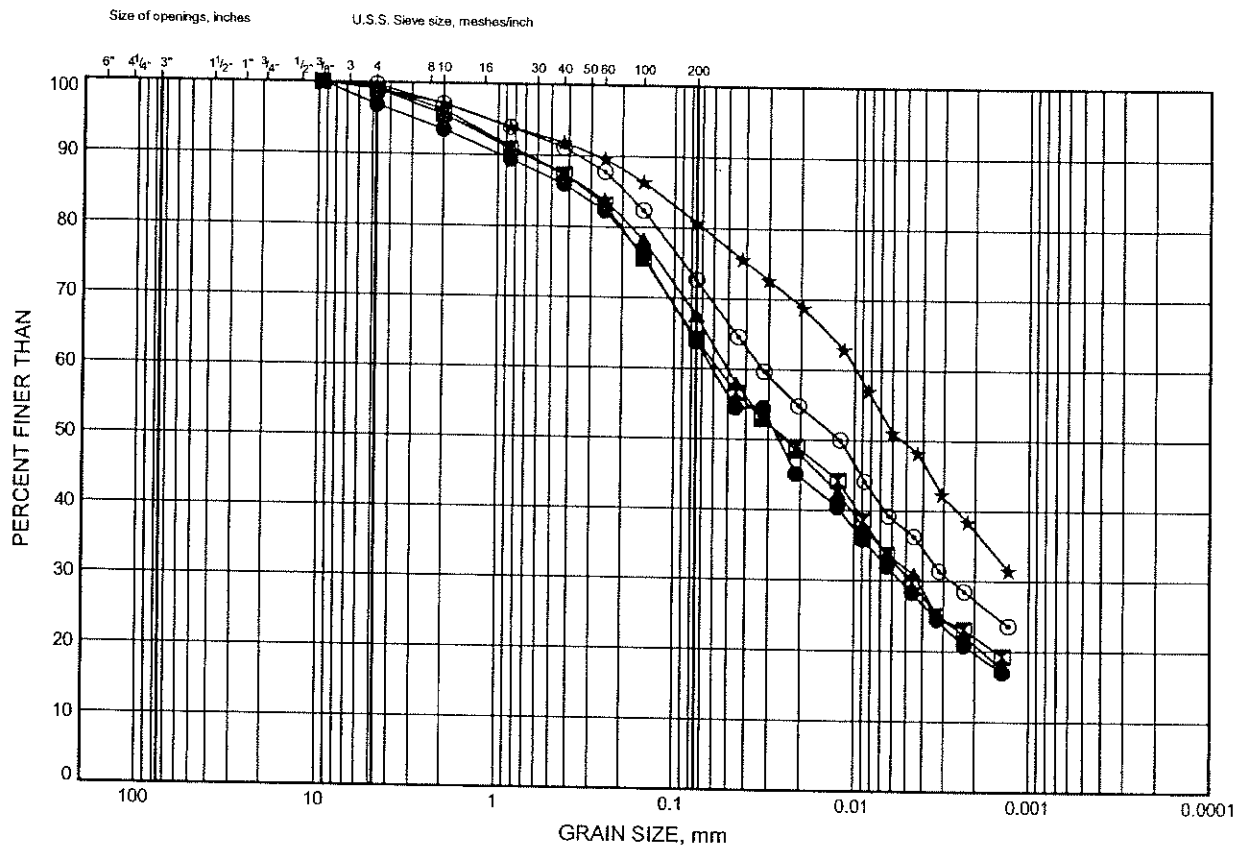


Prep'd MFA  
Chkd. RPR

# Hwy 401/410 to Credit River GRAIN SIZE DISTRIBUTION

FIGURE B9

## SILTY CLAY TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	H3	1.83	192.61
⊠	H4	9.37	190.67
▲	H6	9.45	190.22
★	H7	6.32	192.85
⊙	H8	4.88	193.15

Date February 2008

Project 2149-01-00 & 2150-01-00



Prep'd MFA

Chkd. RPR



# UNCONFINED COMPRESSION TEST (UC)

## SAMPLE IDENTIFICATION

PROJECT NUMBER	06-1116-040	SAMPLE NUMBER	NQ Run 1
BOREHOLE NUMBER	H4	SAMPLE DEPTH, m	17.2-17.3

## TEST CONDITIONS

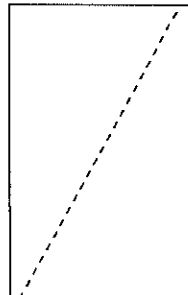
MACHINE SPEED, mm/min	0.00	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	1.90

## SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	8.92	WATER CONTENT, (specimen) %	3.00
SAMPLE DIAMETER, cm	4.70	UNIT WEIGHT, kN/m <sup>3</sup>	24.62
SAMPLE AREA, cm <sup>2</sup>	17.35	DRY UNIT WT., kN/m <sup>3</sup>	23.90
SAMPLE VOLUME, cm <sup>3</sup>	154.76	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	388.66	VOID RATIO	0.11
DRY WEIGHT, g	377.34		

## VISUAL INSPECTION

## FAILURE SKETCH



## TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	9.5
----------------------	---	-------------------------	-----

REMARKS: Sample cracked horizontally through  
middle of sample before test.

DATE:

11/16/2006



# UNCONFINED COMPRESSION TEST (UC)

## SAMPLE IDENTIFICATION

PROJECT NUMBER	06-1116-040	SAMPLE NUMBER	NQ Run 2
BOREHOLE NUMBER	H6	SAMPLE DEPTH, m	16.2-16.4

## TEST CONDITIONS

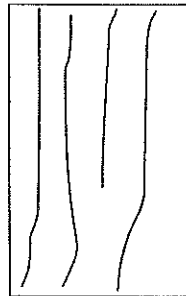
MACHINE SPEED, mm/min	0.00	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.27

## SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.69	WATER CONTENT, (specimen) %	2.10
SAMPLE DIAMETER, cm	4.71	UNIT WEIGHT, kN/m <sup>3</sup>	25.03
SAMPLE AREA, cm <sup>2</sup>	17.42	DRY UNIT WT., kN/m <sup>3</sup>	24.52
SAMPLE VOLUME, cm <sup>3</sup>	186.26	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	475.58	VOID RATIO	0.08
DRY WEIGHT, g	465.80		

## VISUAL INSPECTION

## FAILURE SKETCH



## TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	29.7
----------------------	---	-------------------------	------

REMARKS: Sample cracked horizontally through middle of sample before test.

DATE:

11/16/2006

**Appendix C**

**Record of Borehole Sheets  
And  
Laboratory Test Results  
(previous investigation)**

# RECORD OF BOREHOLE No 1

METRIC

W P 54-82-02 LOCATION Co-ords. N 4 831 951.5; E 289 917.2 ORIGINATED BY RM  
 DIST 6 HWY 10 & 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RM  
 DATUM Geodetic DATE 1983 08 24 CHECKED BY [Signature]

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
194.7 0.0	Ground Surface												
	Fill Silty Clay, some sand, trace gravel trace organics Stiff to Very Sciff		1	SS	37								
			2	SS	14								
			3	SS	21								
			4	SS	18								
			5	SS	25								
190.3 4.4	Shale Bedrock Very Weathered Red		6	SS	80	12 cm							
			7	SS	115	15 cm							
			8	SS	100	10 cm							
187.8 6.9	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 2

METRIC

W P 54-82-02 LOCATION Co-ords. N 4 831 975.5; E 289 898.5 ORIGINATED BY RM  
 DIST 6 HWY 10 & 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RM  
 DATUM Geodetic DATE 1983 08 24 CHECKED BY [Signature]

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			20	40	60	80	100					
192.7	Ground Surface																GR SA SI CL
0.0	Fill Silty Clay, some sand, trace gravel		1	SS	17		192										
191.3	Very Stiff																
1.4	Heterogenous Mixture Silty Clay some sand and gravel (Glacial Till) Hard		2	SS	45												
			3	SS	90/	10 cm											
			4	SS	70/	8 cm	190										22 20 45 13
188.3			5	SS	112												
4.4	Shale Bedrock Very Weathered Red		6	SS	71/	12 cm	188										17 39 39 5
186.2																	
6.5	End of Borehole		7	SS	70/	8 cm											

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 3

METRIC

W P 54-82-02 LOCATION Co-ords. N 4 832 022.5; E 289 852.5 ORIGINATED BY RM  
 DIST 6 HWY 10 & 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RM  
 DATUM Geodetic DATE 1983 08 24 CHECKED BY *CP*

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			20	40	60	80	100				
195.7	Ground Surface															
0.0	Fill		1	SS	12											
	Silty Clay with sand some gravel		2	SS	19											
	Stiff to Very Stiff		3	SS	35											
	Asphaltic Concrete		4	SS	17											
			5	SS	24											
191.0	Organic Matter		6	SS	30											
4.7	Heterogenous Mixture		7	SS	100	10 cm									0m 2%	2 28 54 16
	Silty Clay															
	some sand and gravel															
188.7	Hard															16 38 39 7
7.0	Shale Bedrock		8	SS	100	8 cm										
	Very Weathered															
	Red															
186.3			9	SS	80	8 cm										
9.4	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 4

METRIC

W P 54-82-02 LOCATION Co-ords. N 4 832 029.2; E 289 870.5 ORIGINATED BY RM  
 DIST 6 HWY 10 & 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RM  
 DATUM Geodetic DATE 1983 08 25 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20 40 60 80 100							W <sub>p</sub>	W	W <sub>L</sub>
								SHEAR STRENGTH									
					</												

OFFICE REPORT ON SOIL EXPLORATION

## METRIC

W P 54-82-02 LOCATION Co-ords. N 4 831 977.2; E 289 922.2 ORIGINATED BY RM  
DIST 6 HWY 10 & 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RM  
DATUM Geodetic DATE 1983 08 25 & 26 CHECKED BY ep

[illegible]

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 6

METRIC

W P 54-82-02 LOCATION Co-ords. N 4 831 960.0; E 289 939.2 ORIGINATED BY RM  
 DIST 6 HWY 10 & 401 BOREHOLE TYPE Solid Sem Augers COMPILED BY RM  
 DATUM Geodetic DATE 1983 08 26 CHECKED BY CP

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			20	40	60	80	100				
199.8	Ground Surface															
0.0	Fill															
	Fine to Medium		1	SS	15											
	Sand		2	SS	22											
	some silt		3	SS	6											
	silt		4	SS	13											
	Compact		5	SS	13											
	Stiff		6	SS	9											
	Silty Sand		7	SS	12											
	Silty Clay															
	with sand															
	some gravel															
192.0			8	SS	26											
7.8	Heterogenous Mixture		9	SS	117											
	of Silty Clay,															
	some sand and gravel															
	(Glacial Till)															
	Hard		10	SS	100											
188.9																
10.9	Shale Bedrock															
187.8	Very Weathered															
	Red		11	SS	125											
12.0	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 7

METRIC

W P 54-82-02

LOCATION

Co-ords. N 4 831 998.4; E 289 899.5

ORIGINATED BY RM

DIST 6 HWY 10 & 401

BOREHOLE TYPE

Solid Stem Auger

COMPILED BY RM

DATUM Geodetic

DATE

1983 08 29

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES						
192.5	Ground Surface										
0.0	Fill - Silty Clay with sand some gravel		1	SS	16		192				
191.1	Stiff		2	SS	31						
1.4	Het. Mixture of Silty Clay, some sand and gravel (Glacial Till)		3	SS	58		190				2 32 49 17
189.0	Hard		4	SS	70	5 cm					13 38 40 9
3.5	Shale Bedrock Very Weathered Red		5	SS	72		188				
			6	SS	50	8 cm					
185.9			7	SS	100	13 cm	186				
6.6	End of Borehole		8	SS	100	8 cm					

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 8

METRIC

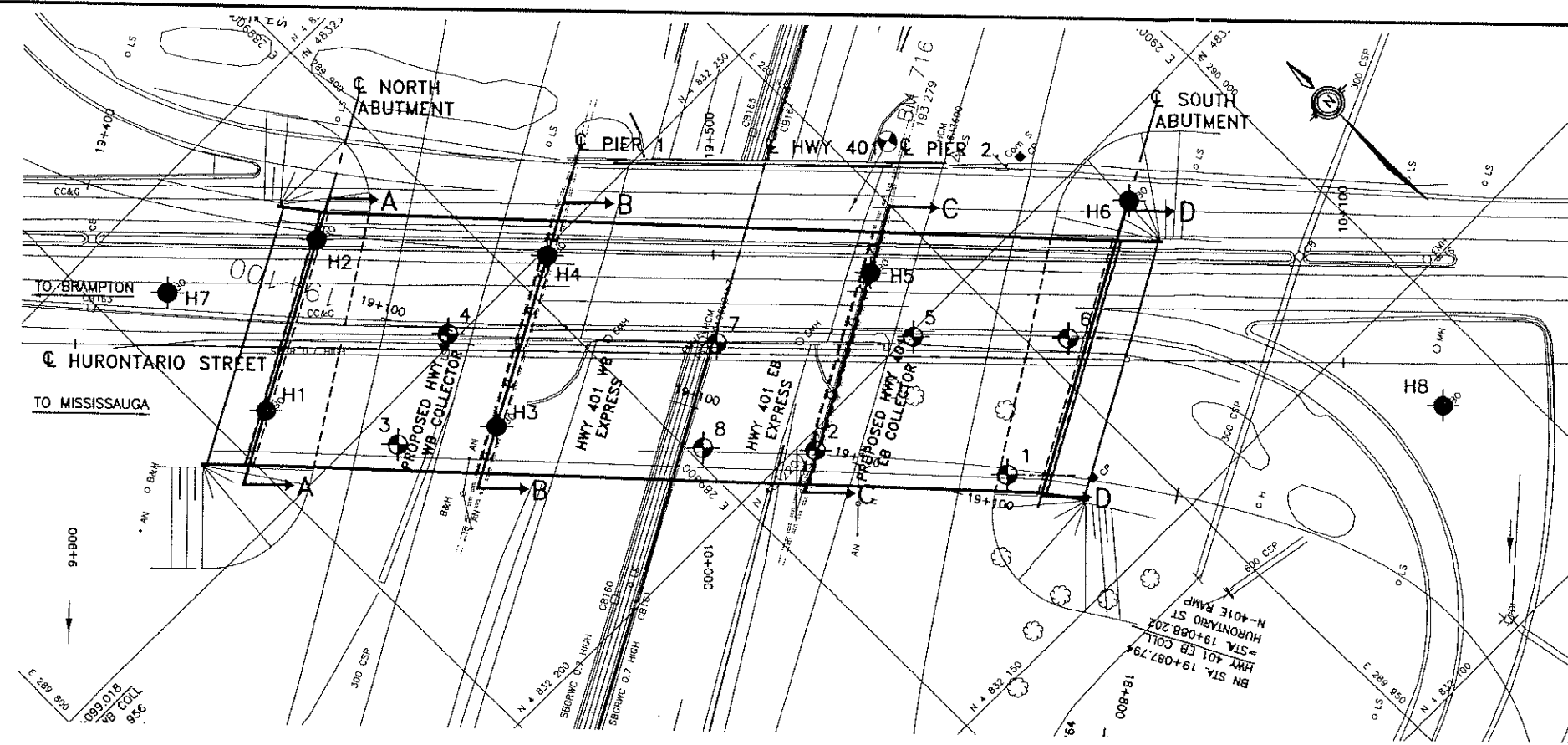
W P 54-82-02 LOCATION Co-ords. N 4 831 988.3; E 289 886.2 ORIGINATED BY RM  
 DIST 6 HWY 10 & 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RM  
 DATUM Geodetic DATE 1983 08 29 CHECKED BY [Signature]

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			20	40	60	80					
192.6	Ground Surface															
0.0	Fill															
	Fine to Medium Sand trace clay		1	SS	29											
191.2	Compact															
1.4	Silty Clay, some sand and gravel		2	SS	64											
190.1	(Glacial Till) Hard		3	SS	151											
2.5	Shale Bedrock		4	SS	50	5 cm										
	Very Weathered															
188.2	Red		5	SS	100	13 cm										
4.4	End of Borehole															
Note: Groundwater Level not Established																

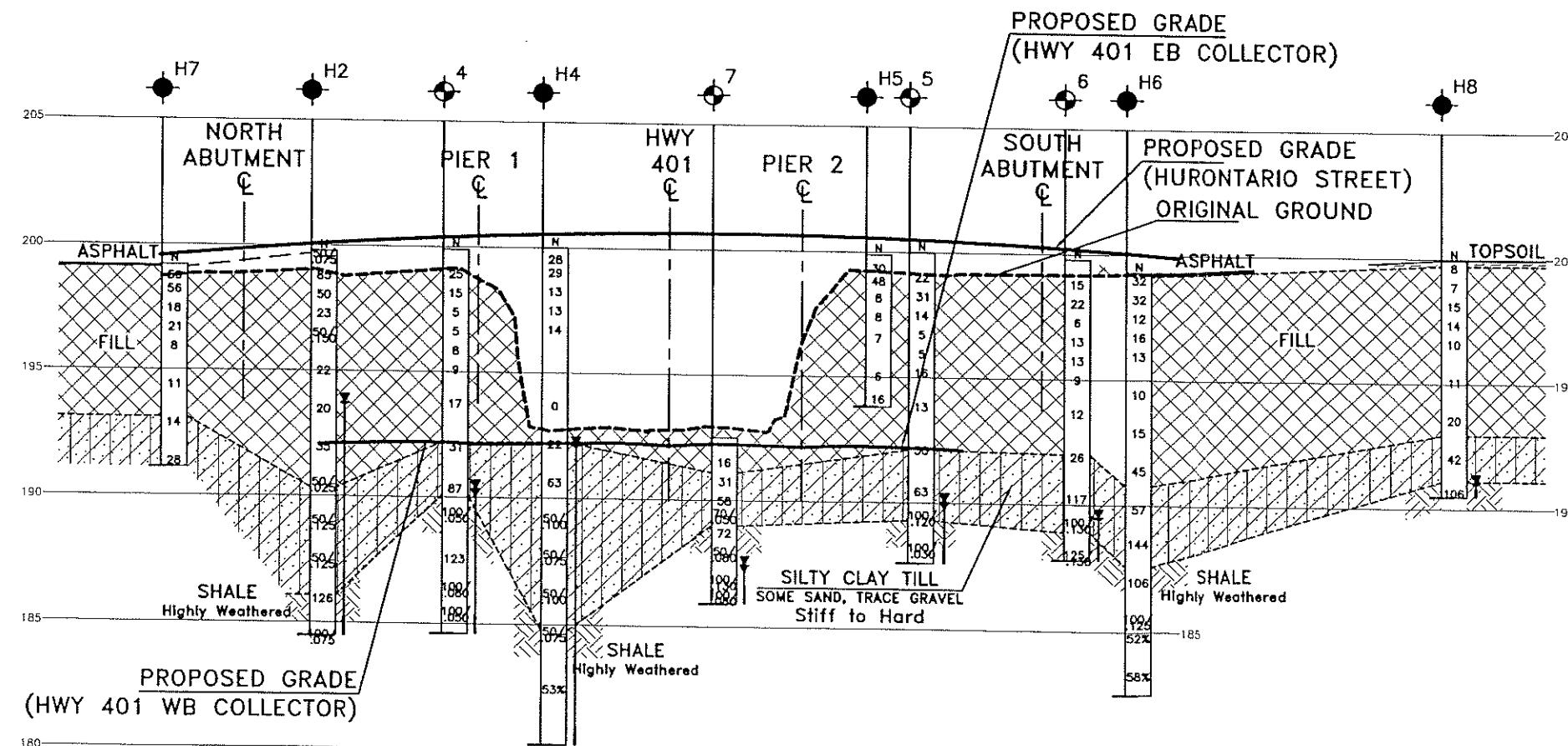
OFFICE REPORT ON SOIL EXPLORATION

## **Appendix D**

### **Borehole Locations and Soil Strata Drawing**



PLAN



PROFILE OF HURONTARIO STREET

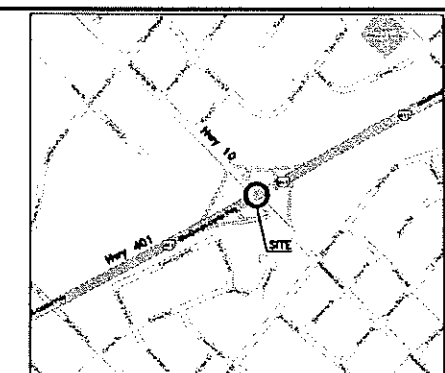
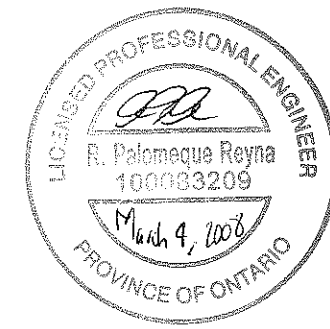
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

HWY 401  
CONT No  
CWP No 2149-01-00 & 2150-01-00

HWY 10  
IC UNDERPASS  
BOREHOLE LOCATIONS AND SOIL STRATA

**Marshall Macklin Monaghan**  
PROJECT MANAGERS • ENGINEERS • SURVEYORS • PLANNERS

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



KEYPLAN

LEGEND

- BoreHole
- Previous BoreHole
- 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
H1	197.3	4 832 263.1	289 857.2
H2	199.8	4 832 276.4	289 882.0
H3	194.4	4 832 235.7	289 881.3
H4	200.0	4 832 249.1	289 906.0
H5	200.1	4 832 211.2	289 940.2
H6	199.7	4 832 190.6	289 977.1
H7	199.2	4 832 287.0	289 859.4
H8	198.0	4 832 133.0	289 989.3
1	194.7	4 832 173.7	289 933.0
2	192.7	4 832 197.7	289 914.3
3	195.7	4 832 244.7	289 868.2
4	199.9	4 832 251.4	289 886.2
5	200.0	4 832 199.4	289 938.0
6	199.8	4 832 182.2	289 955.0
7	192.5	4 832 220.6	289 915.3
8	192.6	4 832 210.5	289 902.0

N.B. COORDINATES FOR  
BOREHOLES 1 TO 8 HAVE  
BEEN CONVERTED FROM  
AN EARLIER DATUM.

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. 30M12-268

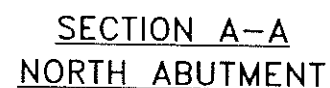
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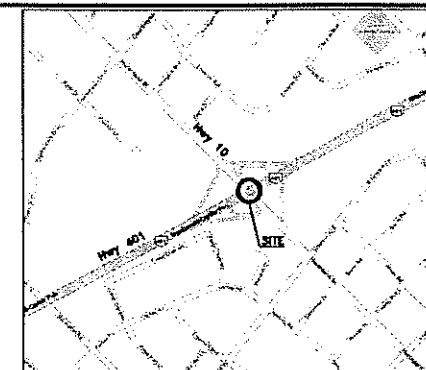
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**Marshall  
Macklin  
Monaghan**  
PROJECT MANAGERS • ENGINEERS • SURVEYORS • PLANNERS








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



## KEYPLAN

### LEGEND

- |   |                                       |
|---|---------------------------------------|
|    | BoreHole                              |
|    | Previous BoreHole                     |
| 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
H1	197.3	4 832 263.1	289 857.2
H2	199.8	4 832 276.4	289 882.0
H3	194.4	4 832 235.7	289 881.3
H4	200.0	4 832 249.1	289 906.6
H5	200.1	4 832 211.2	289 940.2
H6	199.7	4 832 190.6	289 977.7
H7	199.2	4 832 287.0	289 859.4
H8	198.0	4 832 133.0	289 989.3
1	194.7	4 832 173.7	289 933.6
2	192.7	4 832 197.7	289 914.3
3	195.7	4 832 244.7	289 868.2
4	199.9	4 832 251.4	289 886.2
5	200.0	4 832 199.4	289 938.0
6	199.8	4 832 182.2	289 955.6
7	192.5	4 832 220.6	289 915.3
8	192.6	4 832 210.5	289 902.0

-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. 30M12-268

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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