FOUNDATION INVESTIGATION AND DESIGN REPORT
HURONTARIO STREET SOUTH ACCESS ROAD STRUCTURE AND RETAINING WALLS
HWY 401 WIDENING, HWY 410 TO CREDIT RIVER
MISSISSAUGA, ONTARIO
G.W.P. 2107-05-00, WP 2107-05-03, SITE 24-758

Geocres Number: 30M12-270

Report to

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March 20, 2008
File: 19-1423-11

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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 Hurontario Street South Access Road under the existing Hurontario Street at the Highway 401-Hurontario Street interchange in Mississauga, Ontario. The proposed structure and associated RSS walls will be located on the south side of Highway 401.

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, as well as for associated retaining walls.

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.

2 SITE DESCRIPTION

The site is located to the southeast of the Highway 401 underpass bridge at Hurontario Street in Mississauga, Ontario. Currently two ramps are located on the north side of the proposed road: Highway 10 N-Highway 401 E ramp and Highway 401 W – Highway 10 N/S ramp.

The lands at the northwest quadrant of Highway 401 and Hurontario Street are generally vacant, undeveloped and/or agricultural. Vegetation is moderate consisting 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. At the site, the ground surface elevation increases towards the east.

The general site area is located within the physiographic region known as the Peel Plain, characterized by a level to undulating cohesive glacial till plain underlain by reddish brown shale of the Queenston Formation with limestone layers.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation was carried out during the period of September 10 to 14 and October 10 to 22, 2007, and consisted of drilling and sampling a total of twenty-five boreholes. Boreholes for the proposed grade separation structure were numbered HAR-1 to HAR-18 and boreholes for the proposed RSS walls were numbered RW3-1, RW3-2 and RW4-1 to RW4-5. Boreholes were drilled at the structure abutments, approaches and retaining walls along the alignment of the proposed Hurontario Street South Access Road.

Nineteen boreholes were terminated upon auger refusal in shale bedrock at depths of 3.7 m to 10.7 m (elevations 182.7 m to 189.0 m). Six boreholes were further advanced into shale bedrock by coring to depths of 8.5 m to 13.7 m (elevations 183.3 m to 185.3 m), with a minimum 3.0 m of rock cores recovered in each borehole.

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

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

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. Eight standpipe piezometers consisting of 19 mm PVC pipes with screens were installed in selected boreholes to permit monitoring of groundwater levels. Details of the piezometer installations and other borehole completion details are as shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
North Abutment			
West	HAR-02	None installed	Bentonite grout to surface.
	HAR-03	6.1/187.6	Cuttings from 7.3 m to 6.1 m, sand from 6.1 m to 4.3 m, bentonite grout to surface.
Centre	HAR-04	None installed	Bentonite grout to surface.
	HAR-05	11.6/185.1	Sand from 11.6 m to 9.8 m, bentonite grout to surface.
East	HAR-06	None installed	Bentonite grout to 0.9 m, concrete to 0.3 m and cold patch to surface.
	HAR-07	None installed	Bentonite grout to 0.9 m, concrete to 0.15 m and cold patch to surface.
South Abutment			
West	HAR-10	None installed	Bentonite grout to surface.
	HAR-11	None installed	Bentonite grout to surface.
Centre	HAR-12	None installed	Bentonite grout to surface.
	HAR-13	None installed	Bentonite grout to surface.
East	HAR-14	None installed	Bentonite grout to 0.9 m, concrete to 0.15 m and cold patch to surface.
	HAR-15	None installed	Bentonite grout to 0.9 m, concrete to 0.15 m and cold patch to surface.
North Approach	HAR-17	8.2/188.8	Sand from 8.2 m to 6.4 m, bentonite grout to surface.
South Approach	HAR-18	None installed	Bentonite grout to surface.
Retaining Wall			
Northeast	HAR-08	10.7/185.8	Sand from 10.7 m to 8.8 m, bentonite grout to surface.
Northwest	HAR-01	None installed	Bentonite holeplug to surface.
	RW3-1	4.6/186.3	Sand from 4.6 m to 2.7 m, bentonite grout to surface.
	RW3-2	None installed	Bentonite grout to surface.
Southeast	HAR-16	7.6/188.5	Sand from 7.6 m to 5.8 m, bentonite grout to surface.
Southwest	HAR-09	4.3/187.9	Sand from 4.3 m to 2.4 m, bentonite grout to surface.
	RW4-1	4.6/182.6	Sand from 4.6 m to 2.7 m, bentonite grout to surface.
	RW4-2	None installed	Bentonite grout to surface.
	RW4-3	None installed	Bentonite grout to surface.
	RW4-4	None installed	Bentonite grout to surface.
	RW4-5	None installed	Bentonite grout to surface.

4 LABORATORY TESTING

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

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, siltstone and limestone interbeds upon arrival at the laboratory to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the selected rock core samples are shown in Table 1 immediately following the text.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

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

In general terms, the soil stratigraphy encountered at this site comprises surficial topsoil or pavement structure overlying fill underlain by native silty clay/clayey silt till and occasional layers of sand and silt till. Weathered shale bedrock was contacted below the till deposits. More detailed descriptions of the individual strata are presented below.

5.1 Proposed Overpass Structure

Boreholes drilled for the proposed structure were numbered HAR-1 to HAR-18.

5.1.1 Pavement Structure

Pavement structure consisting of approximately 110 to 125 mm of asphalt overlying granular (sand and gravel fill) road base was encountered in Boreholes HAR-06, HAR-07 and HAR-13 to HAR-15 drilled on Hurontario Street lanes. The thickness of granular fill measured in the boreholes ranged from 1.1 to 1.4 m and the pavement structure underside is at elevations 195.2 m to 196.0 m.

5.1.2 Topsoil

Topsoil was identified surficially at the locations of boreholes that were drilled outside of existing Hurontario Street lanes. The topsoil thickness generally ranged from 80 mm to 150 mm. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.1.3 Fill

Fill was encountered below the topsoil and pavement structure in all the boreholes. The fill generally consists of intermixed layers of various soils:

- Brown, grey and reddish brown silty clay and clayey silt with trace to some sand trace of gravel,
- Brown sand and gravel with trace of silt and clay;
- Brown fine to medium sand with some gravel to gravelly, trace of silt and trace of clay;
- Brown silt with some sand, trace of clay and trace of gravel;
- Reddish brown highly weathered shale fill was contacted in Boreholes HAR-06, HAR-07, HAR-08, HAR-14 and HAR-15, drilled on the east side of the proposed north and south abutments. The shale fill was 0.7 m to 2.3 m thick.

Based on recorded SPT values ranging from 8 to 51 blows for 0.3 m of penetration, the silty clay/clayey silt fill is described as stiff to hard. SPT values of 65 and 80 blows per 0.3 m penetration and greater than 50 blows per 0.15 m penetration and were observed within the clay fill in Boreholes HAR-02, HAR-04 and HAR-18.

SPT values measured in the cohesionless fill were 10 to 79 blows per 0.3 m penetration indicating a compact to very dense density. SPT values greater than 50 blows per 0.15 m penetration and were observed within the sand fill in Boreholes HAR-12 and HAR-15.

The natural moisture content of the samples obtained from the fill layer ranged from 2% to 19%.

Grain size distribution curves for the cohesionless fill samples tested are presented on the Record of Borehole sheets and on Figures B1 to B3 in Appendix B. Grain size distribution results of the cohesive fill are presented on the Record of Borehole sheets and on Figure B4 in Appendix B. Atterberg Limit test results are presented on Figure B10 of Appendix B.

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

Soil	Cohesive Fill (%)	Cohesionless Fill (%)
Gravel	1 to 9	0 to 46
Sand	16 to 39	44 to 86
Silt and Clay	-	9 to 43
Silt	40 to 68	-
Clay	15 to 25	-

Liquid Limit	22 to 28
Plastic Limit	13 to 15

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

In general the fill extended to depths varying from 0.6 m to 6.1 m (elevations 189.2 m to 193.2 m). Thickness of fill ranged from 0.4 m to 6.0 m.

5.1.4 Silty Clay Till

Native reddish brown, brown to grey silty clay till with sand to some sand, trace gravel and occasional shale fragments was encountered below the fill in all the boreholes. Locally in Borehole HAR-09, a 400 mm thick layer of clayey silt till was contacted at 2.3 m depth.

Based on SPT values ranging from 17 blows for 0.3 m of penetration to greater than 50 and 100 blows per 0.15 m penetration, the silty clay till is described as being predominantly very stiff to hard. Occasional blow counts of 6 to 11 are also noted in the till.

The natural moisture contents of the samples recovered from the silty clay/clayey silt till layer ranged from 10 to 28%. Locally in Borehole HAR-06 moisture content was 3% at 7.6 m depth.

Grain size distribution curves for the sample tested are presented on the Record of Borehole sheets and on Figures B5 to B9 of Appendix B. Atterberg Limit test results are presented on Figures B11 to B13 of Appendix B.

The results of laboratory tests carried out on nineteen soil samples were as follows:

Soil Particles	(%)
Gravel	0 to 16
Sand	8 to 40
Silt	41 to 68
Clay	13 to 29

Liquid Limit	23 to 36
Plastic Limit	12 to 21

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

The depth to the base of the silty clay till layer ranged from 2.3 m to 9.9 m (Elevations 186.6 m to 190.0 m).

Although not encountered in the boreholes, glacial tills inherently contain cobbles and boulders and the lower part of the till may contain pieces and slabs of bedrock which may account for some high blow counts and resistance to augering.

5.1.5 Silt Till

Silt till with trace of gravel and sand, was contacted at 2.3 m depth in Boreholes HAR-01 and HAR-03, which were located on the northwest side of the proposed structure. The layer thickness ranged from 0.7 m to 1.1 m.

Based on SPT values ranging from 36 to 86 blows for 0.3 m of penetration, the silt till is described as being very dense to dense.

The natural moisture content of the samples obtained from the sand layer ranged from 10 to 19%.

5.1.6 Bedrock

The soils described above were found to be underlain by shale bedrock of the Queenston Formation. The shale encountered in the boreholes is described as thinly bedded and contains numerous hard interbedded siltstone and limestone layers. The shale bedrock is highly to moderately weathered within the upper 2 m below which the degree of weathering decreases with depth. SPT N-values obtained in the upper part of the shale bedrock ranged from 32 to greater than 100 blows per 0.125 m penetration. Moisture contents ranged from 6 to 10%. Depth and elevations of the top of weathered bedrock are shown in Table 5.1.

Table 5.1 – Depth and elevation of Top of Weathered Bedrock

Foundation Element	Borehole	Depth to Weathered Bedrock (m)	Top of Weathered Bedrock Elevation (m)
North Abutment			
West	HAR-02	5.2*	188.7*
	HAR-03	5.2	188.5
Centre	HAR-04	6.1*	189.8*
	HAR-05	6.7*	190.0*
East	HAR-06	8.1	189.1
	HAR-07	9.4*	187.6*
South Abutment			
West	HAR-10	4.9*	188.8*
	HAR-11	5.2	188.8
Centre	HAR-12	6.7	189.1
	HAR-13	7.6	189.1
East	HAR-14	7.9	188.9
	HAR-15	7.3*	189.3*
North Approach	HAR-17	8.2	188.8
South Approach	HAR-18	5.8	189.2
Retaining Wall			
Northeast	HAR-08	9.9	186.6
Northwest	HAR-01	3.0	189.1
Southeast	HAR-16	6.7	189.4
Southwest	HAR-09	2.7	189.4

* Proved by coring below augered depth.

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

RQD values recorded for six of the core runs ranged from 20% to 65% in the upper zones of the shale (elevations 188.3 m to 184.8 m) of initial core runs, indicate poor to fair rock quality. Higher RQD values were obtained in subsequent core runs, generally 50% to 100%, indicating a fair to excellent rock quality. Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 10.

Results of the point load tests conducted on the rock core samples are presented in Table 1 immediately following the text. Average values are also shown on the Record of Borehole

sheets. The typical ranges of inferred UCS for various types of rock cores are summarized in Table 5.2.

Table 5.2 – Inferred Unconfined Compressive Strength

Rock Type	Unconfined Compressive Strength (UCS) (MPa)
Shale	3 to 36
Shale/siltstone	12 to 72
Siltstone	40 to 105
Limestone	80 to 130

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

The shale bedrock typically contains layers of siltstone and limestone that can be significantly harder than the shale itself. The distribution, thickness and strength of these layers vary from location to location, and these layers typically exhibit less pronounced weathering than the shale. The record of boreholes indicate that within the depths investigated, these hard interbeds range from 20 to 200 mm in thickness. Sampling and interpretation from small diameter boreholes may underestimate the frequency, thickness and strength of the strong layers and therefore geological expertise and past experience must be applied in any decision making process regarding the bedrock.

5.1.7 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in six boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.3, along with the measurements in the boreholes upon completion of drilling.

Table 5.3 – Measured Groundwater Levels

Foundation Element	Borehole	Date (2007)	Water Level (m)		Comment
			Depth (m)	Elevation (m)	
North Abutment					
West	HAR-02	October 16	4.2	189.6	In open borehole
	HAR-03	October 18 November 15	4.2 4.2	189.5 189.5	In piezometer
Centre	HAR-04	October 15	1.8	194.1	In open borehole
	HAR-05	November 10 November 15	5.8 5.7	190.9 191.0	In piezometer
East	HAR-06	November 18	Dry	-	-
	HAR-07	October 19	Dry	-	-
South Abutment					
West	HAR-10	October 16	7.5	186.2	In open borehole
	HAR-11	October 10	Dry	-	-
Centre	HAR-12	October 10	Dry	-	-
	HAR-13	October 22	Dry	-	-
East	HAR-14	October 18	Dry	-	-
	HAR-15	October 17	4.8	191.8	In open borehole
North Approach	HAR-17	October 18 November 1 November 15	4.3 4.5 4.4	192.8 192.6 192.7	In piezometer
South Approach	HAR-18	0ctober 9	Dry	-	-
Retaining Wall					
Northeast	HAR-08	September 19 September 28 October 5 October 18 November 1 November 15	5.9 6.1 6.1 6.2 5.9 6.1	190.6 190.4 190.4 190.3 190.6 190.4	In piezometer
Northwest	HAR-01	October 10	Dry	-	-
Southeast	HAR-16	September 19 September 28 October 5 October 18 November 1 November 15	4.8 4.5 4.6 4.2 4.5 4.7	191.3 191.6 191.5 191.9 191.6 191.4	In piezometer
Southwest	HAR-09	October 18 November 15	1.9 1.9	190.3 190.3	In piezometer

The groundwater levels measured in the piezometers range from elevations 189.5 m to 192.8 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.

5.2 Proposed Retaining Walls 3 and 4

Boreholes for the proposed Retaining Walls 3 and 4, located on the west side of the proposed overpass structure, were numbered RW3-1, RW3-2 and RW4-1 to RW4-5.

5.2.1 Topsoil

Topsoil was identified at ground surface in all the boreholes drilled along the proposed retaining walls. The topsoil thickness generally ranged from 50 mm to 100 mm. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.2.2 Fill

Fill was encountered below topsoil in Boreholes RW3-1, RW3-2, RW4-1 and RW4-5 drilled along the proposed Retaining Walls 3 and 4. The fill generally consists of brown to grey silty clay with some sand to sandy, trace gravel, occasional shale and asphalt fragments and rootlets. Thickness of the cohesive fill layer varies from 1.4 m to 3.9 m.

A 0.7-m thick layer of shale fill was noted at the surface in Borehole RW4-5.

Based on SPT values ranging from 15 blows for 0.3 m of penetration to greater than 50 blows per 0.10 m penetration, the silty clay fill is described as being very stiff to hard.

The natural moisture contents of the samples recovered from the silty clay till layer ranged from 7 to 21%.

Grain size distribution curves for the fill samples tested are presented on the Record of Borehole sheets and on Figure C1 of Appendix C. Atterberg Limit tests results are presented on Figure C3 of Appendix C.

The results of laboratory tests carried out on three soil samples were as follows:

Soil Particles	(%)
Gravel	0 to 3
Sand	16 to 31
Silt	45 to 54
Clay	22 to 30

Liquid Limit	27 to 38
Plastic Limit	15 to 19

The results of Atterberg limit testing indicate that the silty clay fill is low to medium plastic with group symbol of CL and CI.

The depth to the base of the silty clay fill layer ranged from 1.5 m to 4.0 m (Elevations 185.7 m to 190.1 m).

5.2.3 Silty Clay Till

Native brown, mottled brown and grey silt clay till with sand to some sand, trace gravel and occasional shale fragments and rootlets was encountered below the fill in Borehole RW4-1 and below the topsoil in Boreholes RW4-2 to RW4-4.

Based on SPT values ranging from 10 blows for 0.3 m of penetration to greater than 50 blows per 0.15 m penetration, the silty clay till is described as being stiff to hard.

The natural moisture contents of the samples recovered from the silty clay till layer ranged from 9 to 19%.

Grain size distribution curves for the sample tested are presented on the Record of Borehole sheets and on Figure C2 of Appendix C. The results of Atterberg limit testing are shown on Figure C4 of Appendix C.

The results of laboratory tests carried out on three samples were as follows:

Soil Particles	(%)
Gravel	0 to 6
Sand	22 to 28
Silt	47 to 49
Clay	23 to 26

Liquid Limit	31
Plastic Limit	16

The results of Atterberg limit testing indicate that the silty clay till is low plastic with group symbol of CL.

The depth to the base of the silty clay till layer ranged from 0.6 m to 2.1 m (Elevations 185.1 m to 188.7 m).

Although not encountered in the boreholes, glacial tills inherently contain cobbles and boulders which may account for some high N-values.

5.2.4 Bedrock

The soils described above were found to be underlain by shale bedrock of the Queenston Formation. The shale encountered in the boreholes is described as thinly bedded and contains numerous hard interbedded siltstone and limestone layers. The shale bedrock is highly to moderately weathered within the upper 2 m below which the degree of weathering decreases with depth. SPT N-values obtained in the upper part of the shale bedrock ranged from 42 to greater than 100 blows per 0.1 m penetration. Moisture contents ranged from 5 to 15%.

Depth and elevations of the top of weathered bedrock are shown in Table 5.4.

Table 5.4 – Depth and elevation of Top of Weathered Bedrock

Foundation Element	Borehole	Depth to Weathered Bedrock (m)	Top of Weathered Bedrock Elevation (m)
Retaining Wall			
Northwest	RW3-1	1.5	189.4
	RW3-2	3.1	190.1
Southwest	RW4-1	2.1	185.1
	RW4-2	0.8	186.1
	RW4-3	0.6	187.2
	RW4-4	1.2	188.7
	RW4-5	4.0	188.2

The shale bedrock typically contains layers of siltstone and limestone that can be significantly harder than the shale itself. The distribution, thickness and strength of these layers vary from location to location, and these layers typically exhibit less pronounced weathering than the shale.

5.2.5 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 5.5, along with the measurements in the boreholes upon completion of drilling.

Table 5.5 – Measured Groundwater Levels

Foundation Element	Borehole	Date (2007)	Water Level (m)		Comment
			Depth (m)	Elevation (m)	
Retaining Wall					
Northwest	RW3-1	October 18 October 15	Dry 2.7	- 188.2	In piezometer
	RW3-2	October 11	Dry	-	In open borehole
Southwest	RW4-1	October 18 October 15	Dry 2.7	- 184.5	In piezometer
	RW4-2	October 11	Dry	-	In open borehole
	RW4-3	October 11	Dry	-	In open borehole
	RW4-4	October 11	Dry	-	In open borehole
	RW4-5	October 11	Dry	-	In open borehole

The groundwater levels measured in the piezometers ranged from elevations 184.5 to 188.2 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

Borehole locations and 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 of Thurber Engineering Ltd.

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

Supervision of the field program, interpretation of the field data and preparation of the investigation report was conducted by Dr. Sydney Pang, 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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PART 2: ENGINEERING DISCUSSIONS AND RECOMMENDATIONS

7 INTRODUCTION

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team to select and design a suitable foundation system and approach fills for the proposed overpass and associated RSS walls.

It is understood that the proposed structure is to carry a section of Hurontario Street located south of Highway 401 over a new Hurontario Street South Access Road. The new road under Hurontario Street will be formed in a cut varying in depth from approximately 0.4 m to 6.9 m, generally increasing from west to east of the structure. Four RSS walls also included in the design, will extend parallel to the proposed access road, adjacent to each corner of the rigid frame structure. Two of these retaining walls (Retaining Walls 3 and 4) are longer and extend from the north and south abutments in a westerly direction along the proposed access road.

The preliminary General Arrangement (GA) drawing provided by MMM indicates that the proposed structure is a single-span, concrete, rigid frame with a clear span of 11.5 m (perpendicular to existing Hurontario Street alignment) and an approximate length of 40 m (along the Hurontario St. South Access Road alignment). Finished lane grades of existing Hurontario Street and proposed Hurontario Street South Access Road decrease in elevation toward the east as follows:

	Approximate Grade Elevations (m)	
	West	East
Hurontario Street	197.1	196.6
Proposed Hurontario Street South Access Road	191.7	190.2

The proposed elevations of the underside of the rigid frame footings vary from approximate elevation 190.5 m to 189.2 m (west to east).

At the north approach, the original ground lies between Elevations 193.7 m and 197.2 m, resulting in a proposed approach fill up to 3.4 m high. At the south approach, the original ground varies from approximate Elevations 193.7 m to 196.8 m, resulting in an approach fill up to 3.4 m high.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of the investigation.

8 FOUNDATION DESIGN

Consideration was given to various alternate foundations systems, taking account of the site stratigraphy and the structure General Arrangement. In general terms, the stratigraphy encountered at the site consists of topsoil or pavement structure overlying the fill of the Hurontario Street approaches which is underlain by native stiff to hard silty clay/clayey silt till and occasional silt layers. Fill thickness varies from 2.3 m to 6.0 m at the approaches. Weathered shale bedrock was contacted below the till deposits at depth varying from 2.7 m to 9.9 m (elevations 186.6 m to 190.0 m). Piezometers installed in boreholes revealed that groundwater level is anticipated to be near 1.9 m to 6.1 m depth (elevations 189.5 m to 192.8 m) although perched water may be encountered at higher levels within the till and overlying fill.

Initial consideration was given to the following foundation types:

- Spread footings on native soil
- Spread footings on shale bedrock
- Augered Caissons (drilled shafts)
- Driven steel H-piles

A comparison of these foundation alternatives based on advantages and disadvantages of each is included in Appendix D.

Given the presence of competent tills overlying relatively shallow bedrock at this site, use of deep foundations such as steel piles and caissons are not practical or cost effective at this site. If these are to be used, both the piles and the caissons would need to be socketted into the shale bedrock. Pre-augering will likely be required to achieve adequate pile embedment into the shale.

From a geotechnical perspective and based on the subsurface conditions, spread footings founded on the native hard till immediately overlying bedrock is considered the most cost effective foundation option for supporting the rigid frame structure at this site. If a higher bearing capacity is required, spread footings founded on shale bedrock may be considered although this will extend the footing excavation up to 3.2 m below the proposed access road grade for foundation construction.

Excavation at the location of Borehole HAR-07 will extend to 4.1 m below proposed access road grade.

General Arrangement Drawing indicates that the proposed foundation system for the new structure consists of spread footings founded below the final grade of the access road. Founding levels indicated in the drawing will generally lie in hard silty clay till or shale bedrock.

8.1 Spread Footings on Native Soil

Spread footings can be founded on the hard native undisturbed silty clay till. The highest permitted founding elevations for spread footings are given in Table 8.1.

Provided a minimum footing width of 2 m is maintained footings founded on the above recommended strata may be designed for the following values:

- Factored geotechnical resistance of 600 kPa at Ultimate Limit States (ULS)
- Geotechnical resistance of 400 kPa at Serviceability Limit States (SLS)

The geotechnical resistances quoted above are for concentric, vertical loads only. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHBDC Clause 6.7.3 and Clause 6.7.4.

Table 8.1 – Highest Permitted Founding Elevations

Foundation Element	Borehole	Recommended Founding Level Depth in Native Hard Till (m)	Recommended Footing Base Elevation in Native Hard Till (m)	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
North Abutment					
West	HAR-02	4.5	189.3	5.2	188.7
	HAR-03	4.5	189.2	5.2	188.5
Centre	HAR-04	4.6	191.3	6.1	189.8
	HAR-05	6.1	190.6	6.7	190.0
East	HAR-06	6.2	191.0	8.1	189.1
	HAR-07	6.0	191.0	9.4	187.6
South Abutment					
West	HAR-10	4.5	189.2	4.9	188.8
	HAR-11	4.6	189.4	5.2	188.8
Centre	HAR-12	6.0	189.8	6.7	189.1
	HAR-13	6.1	190.6	7.6	189.1
East	HAR-14	6.0	190.8	7.9	188.9
	HAR-15	6.0	190.6	7.3	189.3
North Approach	HAR-17	7.6	189.5	8.2	188.8
South Approach	HAR-18	-	-	5.8	189.2

The geotechnical SLS resistance values given above are based on an estimated total settlement not exceeding 25 mm. This settlement is expected to be substantially complete by the end of construction. Differential settlement is not expected to exceed 10 mm across the width of the structure. Footings must not be placed on fill. Sub-excavation will be required to expose the underlying undisturbed hard native till in areas where the existing fill extends below the desired footing founding elevations.

The sliding resistance of mass concrete poured on the native till may be computed on the basis of an ultimate coefficient of friction of 0.5. This is an "ultimate" value and requires a degree of sliding movement to occur to fully mobilize the resistance.

Temporary excavations required to construct these footings will extend below the water table. Local groundwater control will be required to construct the footing in the dry and to prevent disturbance of the footing base.

The bases of the foundation excavations should be inspected by geotechnical personnel to confirm that the exposed surface conforms to the design requirements and has been adequately prepared to receive concrete. Where subexcavation is required to remove unsuitable material from below the design founding level, the founding surface should be re-established using engineered fill or concrete of the same class as the footing. The engineered fill must consist of OPSS Granular "A" placed in 150 mm lifts, compacted to 100% of its SPMDD at ±2% of optimum moisture content.

8.2 Spread Footings on Shale Bedrock

Based on the subsurface stratigraphy encountered and the proposed road grade, the additional depth of excavation below the recommended native hard till founding levels to top of bedrock varies from 0.4 m to 1.9 m. The excavation will extend to 3.4 m in Borehole HAR-07.

Sub-excavation below the proposed road grade to top of bedrock varies from 0.2 m to 4.1 m.

Spread footings bearing on undisturbed weathered shale bedrock may be designed for the following geotechnical resistances:

- Factored geotechnical resistance of 750 kPa at Ultimate Limit States (ULS)

The SLS condition will not govern design for footings founded on shale bedrock.

The highest permissible bearing elevations for spread footings on bedrock are given in Table 8.1.

These resistance values are for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance used in design must be reduced in accordance with the CHBDC Clause 6.7.3 and Clause 6.7.4.

The lateral resistance of the footings founded on shale may be computed using an unfactored friction coefficient of 0.55. This is an "ultimate" value and requires a degree of sliding movement to occur to fully mobilize the resistance.

The bearing surface should be prepared by removing all loose/disturbed material and shattered rock, and protecting the shale from deterioration by placing a working mat of concrete of the same class as the footing within 4 hours of completing excavation. Areas requiring subexcavation beneath the underside of footing should be backfilled with the same class of concrete as used in the footing. A mud slab should have a minimum thickness of 100 mm. Also, if the bedrock surface lies below the required footing base, any difference between the underside of the footing and the top of bedrock may be made up using the same class of concrete as used in the footing. In this case, the geotechnical resistance of 750 kPa may still be used for footing design.

The mass concrete fill must extend beyond the footing perimeter by sufficient distance to distribute the shear stresses from the footing and prevent stress concentrations under the edge

of the footing. This condition must be checked structurally but extension of the mass concrete to 200 mm beyond the edge of the footing is typically sufficient. Similarly, the maximum depth of mass concrete that may be permitted below the footing is a function of the structural behaviour of the concrete and is not an issue of geotechnical resistance. Where the bedrock slopes within the foundation footprint, the foundation shall be prepared by excavation of a horizontal surface in bedrock, though stepping of the footing base is permissible.

8.3 Frost Protection

The design depth of frost penetration at this site through overburden soils is 1.2 m.

Although the shale is geologically defined as bedrock, it is susceptible to frost action. Therefore, all footings must be provided with a minimum of 1.2 m of earth cover as frost protection. It is possible to reduce the thickness of earth cover by the substitution of synthetic insulation and typically 25 mm of Styrofoam is equivalent to 600 mm of earth cover. Synthetic insulation must be covered to provide protection where it is used.

9 PERMANENT CUT

9.1 Cuts in Fill and Native Soil

Permanent earth cuts are required to construct the access road at this site. The cut will be formed predominantly through about 0.4 m to 6.9 m (from west to east) of the existing silty clay and sand fill, native stiff to hard silty clay till and possible extending to bedrock at some locations. Based on this stratigraphy, cuts through the cohesive and cohesionless fills, native soils and shale bedrock are expected to be stable at inclinations not steeper than 2H : 1V. It is anticipated that the base of the cut will generally consist of sand and gravel and clay fill or stiff to hard native silty clay till and weathered shale bedrock.

At some locations, the ground water level is about 2.2 m above the base of the cut. The cohesive fills and native soils that will be exposed within the cut are considered to be of generally low permeability and consequently seepage from the sides of the cut is expected to be of low volume. Much of the water is anticipated to originate from surface runoff and perched water within the fill. During excavation, drainage ditches supplemented by pumping from filtered sumps can be used to control groundwater seepage, surface runoff and precipitation. Surface runoff should be diverted away from the cut at all times.

The detailed design of a permanent drainage system is beyond the scope of this investigation. A drainage measure that is considered feasible for this site includes longitudinal sub-drains running along the side(s) of the new road that are connected to positive drainage outlets.

The design of temporary unwatering systems that will be required during construction must remain the responsibility of the Contractor.

Vegetative cover should be established on all exposed earth slopes to protect against surficial erosion. Reference may be made to special provision SP572S01 for more detailed requirements, where applicable.

10 TEMPORARY EXCAVATION

10.1 General

All excavations must be carried out in accordance with the requirements of the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the soils within the likely depth of excavation at this site may be classed as Type 3 soils for fills and Type 2 for native stiff to hard silty clay till; sands and silts below the groundwater level may be classed as Type 3. The upper 2 m of the shale (weathered zone) may be classed as a Type 2 material.

The selection of the method of excavation is the responsibility of the contractor and must be based on his equipment, experience and interpretation of the site conditions. Excavations should be inspected regularly for evidence of instability if they have been left open for extended periods of time and following periods of heavy rain or thawing. If required, remedial actions must be taken to ensure the stability of the excavation and the safety of workers.

The requirements for unwatering during excavation are discussed in Section 12.

10.2 Foundations

The excavation and backfilling for foundations must be carried out in accordance with SP 902S01.

10.3 Earth Excavation

Earth excavations required at this site will penetrate through a variety of overburden soils including fills, native silty clay till and silt till. The soils, especially the tills, may contain cobbles, boulders and slabs of rock. It is anticipated that temporary excavations through a majority of soils at this site may be formed with side slopes not steeper than 1H : 1V. Flatter slopes may be required at locations where the soils are less competent than what is assumed during design or where water seepage affects surficial stability.

Excavations should be inspected regularly for evidence of instability if they have been left open for extended periods of time and following periods of heavy rain or thawing. If

required, remedial actions must be taken to ensure the stability of the excavation and the safety of workers.

A NSSP should be included in the contract alerting the Contractor to the possible presence of cobbles, boulders and bedrock fragments in the overburden, particularly in the very dense silty sand till layer above the bedrock.

The NSSP should also alert the contractor to the fact that some of the fill may have originated from excavated shale, including limestone interbeds, which has softened as a result of exposure to weathering.

10.4 Rock Excavation

Any rock excavation should be carried out in accordance with the Special Provision (SP), Amendment to OPSS 120, 1994.

For foundation construction at some locations such as within the proposed Retaining Walls 3 and 4, the excavation will extend through the upper weathered shale and possible into the relatively sound shale with hard limestone and siltstone interbeds.

The selection of the method of excavating and removing the bedrock is the responsibility of the contractor and the contractor is solely responsible for assessing the type, size and power rating of the required equipment. However, from the point of view of assessing constructability, the following points should be taken into consideration:

- The silty clay till grades into weathered bedrock and there is often not a distinct boundary between the two and, accordingly, excavation of the upper, more weathered layers of the bedrock may be similar to excavation of the overburden.
- If rock excavation is required at this site, bidders must be alerted to the fact that the shale bedrock gets stronger with depth and contains frequent very strong interbeds, and rock-breaking equipment must be provided for rock excavation.
- Excavation of the bedrock will become more arduous with increasing depth into the deposit and the contractor may have to employ specialized methods such as ripping, and pneumatic breaking to dislodge the rock.

The contract documents should contain a Non Standard Special Provision (NSSP) alerting the contract bidders that rock excavation may require the use of such equipment. Suggested wording for this NSSP is provided in Appendix E.

11 ROADWAY PROTECTION

It is anticipated that roadway protection will be required during construction. An item titled "Protection System" as per SP 105S19 should be included in the contract documents. It is

recommended that Performance Level 2 as per Clause 539.04.02.01 and the alignment of the shoring be specified on the contract drawings.

The design of roadway protection should be the responsibility of the Contractor. However, one option that is considered to be suitable for use as temporary shoring at this site is a soldier pile and lagging wall. It is anticipated that the soldier piles will need to be socketted into the very stiff to hard silty clay till or bedrock to develop the required toe resistance. It is anticipated that the shoring system may be stiffened by cross bracings, where applicable.

A temporary braced soldier pile and lagging wall may be designed using the parameters given below:

γ	=	20 kN/m^3
γ_w	=	10 kN/m^3
K_a	=	0.35 (existing fill)
	=	0.33 (silty clay till)
K_p	=	3.0 (road embankment fill)
	=	3.0 (silty clay till)
h_w	=	0 (assuming no hydrostatic pressure build-up behind a presumably permeable wall)
H	=	depth to base of excavation (rock surface) (m)

For rock sockets formed within the shale bedrock, the ultimate passive force that can be mobilized by the embedded portion of a pile is given by:

$$P_p = 6 \cdot c \cdot D \cdot L$$

where c = 150 kPa (equivalent Mohr-Coulomb cohesion based on Hoek and Brown rock mass classification)
D = diameter of socket, m
L = depth of socket in rock, m

The designer of the roadway protection system should check whether the socket is sufficiently deep to provide base fixity.

The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system. All shoring systems should be designed by a Professional Engineer experienced in such designs.

12 UNWATERING

Temporary excavations for footing construction in the native till are anticipated to extend up to 1.5 m to 3.5 m below the groundwater level. If footings are founded in bedrock, temporary excavation will extend up to 1.0 m to 5.2 m below the groundwater level. Considering the consistency and low permeability of the clayey soils, groundwater control measures such as perimeter ditches and

pumping from filtered sumps should be implemented to remove any accumulation of water from the footing base prior to placing concrete. The possibility exists that additional pumps may be required if localized zones of perched water are encountered in the fill, or if concentrated seepage is experienced from seams or fractures in the shale bedrock. If footings are founded on shale bedrock, they must be constructed in the dry as shale is prone to rapid deterioration upon exposure to water and air. All footings must be constructed in the dry.

The design of the unwatering systems is the responsibility of the Contractor.

13 APPROACH EMBANKMENTS

The foundation soils governing stability of the approach embankments consist of existing stiff to hard and compact to dense fill, overlying native stiff to hard silty clay till underlain by shale bedrock. The proposed embankment heights are approximately 3.4 m at the north and south approaches.

Embankment construction should be in accordance with OPSS 206, as amended by Special Provision "Amendment to OPSS 206, December 1993", dated November 2002. It is recommended that earth fill should consist of SSM or granular materials in compliance with Special Provision 110F13, "Amendment to OPSS 1010 March 1993". Any existing fill slopes must be benched in accordance with OPSD 208.010 prior to placing new fill. Excavated shale bedrock must not be used for approach embankment construction.

The embankment foundation soils are considered to provide adequate stability to new earth fills inclined at 2H:1V or flatter.

Considering the embankment height and consistency of the foundation soils, post construction settlement induced by embankment loading will be less than 25 mm. Completing embankment construction three months in advance of road paving is recommended as a good construction practice to minimize any time-dependent settlement due to consolidation or particle re-organization in the embankment fill itself.

All topsoil and organic soils should be stripped from the footprint of the approach fills. Particular attention should be paid to removing all softened material from existing ditches that fall within the footprint of the new embankment.

Earth fill embankment slopes must be provided with erosion protection in accordance with SP572S01.

14 BACKFILL TO ABUTMENTS

Backfill to the abutments should consist of Granular A or Granular B Type II material meeting the requirements of Special Provision 110F13 "Amendment to OPSS 1010, March 1993". The backfill must be in accordance with OPSS 902 as amended by Special Provision 902S01, and placed to the extents shown in OPSD 3101.150.

Excavated shale is prone to deterioration and is difficult to compact adequately. Therefore, excavated shale must not be used as backfill to the abutments.

Compaction equipment to be used adjacent to retaining structures must be restricted in accordance with SP105S01. The design of the abutment must include a subdrain as shown in OPSD 3102.100.

15 STATIC EARTH PRESSURE

Earth pressures acting on the structure may be assumed to be triangular and to be governed by the characteristics of the abutment backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC but generally are given by the expression:

$P_h = K^*(\gamma h + q)$

Where:

P_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see Table 15.1)

γ = unit weight of retained soil (see Table 15.1)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the abutment wall are dependent on the material used as backfill. Typical values are shown in Table 15.1.

Table 15.1 – Earth Pressure Coefficients (K)

Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A $\phi = 35°, \gamma = 22.8$ kN/m^3		OPSS Granular B Type II $\phi = 35°, \gamma = 22.8$ kN/m^3		OPSS Granular B Type I $\phi = 32°, \gamma = 21.2$ kN/m^3	
	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)
Active (Unrestrained Wall)	0.27	0.40*	0.27	0.40*	0.31	0.48*
At rest (Restrained Wall)	0.43	-	0.43	-	0.47	-
Passive	3.7	-	3.7	-	3.3	-

* For wing walls.

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or 1.7 m for Granular A or Granular B Type II.

In conventional design, the use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) might be preferred as it results in lower earth pressures acting on the wall.

The factors in Table 15.1 are "ultimate" values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the Canadian Highway Bridge Design Code.

16 RETAINED SOIL SYSTEMS

It is understood that Retained Soil System (RSS) walls are proposed to support the north and south approaches. Details of the proposed RSS are as follows:

Retaining Walls	Location (relative to proposed rigid frame)	Location	Start Station	End Station	Length (m)	Max. Height (m)
Retaining Wall 3	Northeast	-			16	-
	Northwest	HWY 401 W-Hurontario St. Ramp, Right Side	19+060	19+165	111	± 6.7
Retaining Wall 4	Southeast	-			16	-
	Southwest	Hurontario St. South Access Road, Right side	18+905	9+984	288	± 6.8

The borehole information indicates that the foundation conditions at the wall locations are comprised of approximately 0.7 m to 4.5 m of stiff to very stiff silty clay fill and compact to dense sand fill overlying very stiff to hard silty clay till and weathered shale bedrock.

The soil conditions encountered on site are generally suitable for the support of RSS walls. RSS walls used in conjunction with new road abutments must be "High Performance" and "High Appearance". The contract drawings should include information on the longitudinal alignment of the wall in plan, the top and base elevations of the wall in profile, cross-sectional space constraints and an NSSP for the RSS wall.

The performance of a RSS is dependent on, among other factors, the characteristics of its foundation. Failure to provide an adequate foundation may lead to settlement and distortion of the RSS and, in severe cases, to possible failure of the system. It is critical that the RSS walls are not subject to settlement due to compression of the foundation soils and embankment fill. The foundation of the entire RSS mass must be considered, i.e. from the face of the wall to the furthest extent of the reinforcement.

To provide an acceptable foundation performance, the RSS mass must be founded on the native undisturbed hard clay, dense sand/silt or shale bedrock. The highest base levels for the underside of the wall are indicated in Table 16.1.

Table 16.1 – Maximum Elevation at Underside of Wall Base or Granular A Fill

Foundation Element	Borehole	Depth to Hard/Dense Native Till (m)	Native Hard/ Dense Till Elevation (m)	Depth to Weathered Bedrock (m)	Top of Weathered Bedrock Elevation (m)
Retaining Wall					
Northeast	HAR-08	7.6	188.9	9.9	186.6
Northwest	HAR-01	0.8	191.3	3.0	189.1
	RW3-1	-	-	1.5	189.4
	RW3-2	-	-	3.1	190.1
Southeast	HAR-16	4.5	191.6	6.7	189.4
Southwest	HAR-09	0.6	191.6	2.7	189.4
	RW4-1	1.5	185.7	2.1	185.1
	RW4-2	-	-	0.8	186.1
	RW4-3	-	-	0.6	187.2
	RW4-4	0.8	189.1	1.2	188.7
	RW4-5	-	-	4.0	188.2

A wall founded on native very stiff to hard silty clay till at or below elevations shown in Table 16.1 should be designed for a factored bearing resistance of 400 kPa at ULS and a bearing resistance of 250 kPa at SLS.

For an RSS wall founded on shale bedrock, detailed design recommendations on vertical and horizontal geotechnical resistances, stepped footings, eccentric and inclined loads are similar to those for the rigid frame structure footings (see previous Section 8.2, Spread Footings on Bedrock).

Alternatively, the RSS may be founded on engineered fill founded on the native very stiff to hard silty clay till contacted at the above elevations. Engineered fill placed under the RSS mass to achieve the design founding level should consists of OPSS Granular "A" compacted to 100% of its SPMDD at a moisture content within 2% of optimum. The engineered pad must extend at least 500 mm beyond the limits of the RSS mass and levelling strip.

The geotechnical resistances provided above are for concentric, vertical loading. The effects of load inclination and eccentricity need to be taken into account according to the CHBDC 2006 Section 6.7.

The entire block of reinforced earth must be designed against various modes of failure including sliding and overturning. Sliding resistance along the base of the wall on engineered granular fill may

be estimated using an ultimate friction coefficient of 0.55. For an RSS block founded on hard native till or shale bedrock, coefficients of sliding friction of 0.45 and 0.5, respectively may be used.

Topsoil, loose fill, and any soft/wet native material should be stripped from the footprint of the RSS. The native soil under the RSS foundation should be proofrolled to detect and replace any soft areas.

The proprietary RSS system must meet the Ministry's specifications for performance and appearance. The RSS supplier/designer may specify more stringent criteria or other requirements related to the particular design. The internal stability of the RSS wall should be analyzed by the supplier/designer of the proprietary product selected for this site.

If a RSS wall system is selected, the global stability must be analyzed after the location of the wall is known. The global stability of the RSS wall is dependent on the characteristics of the embankment fill and the foundation soils, the geometry of the embankment and location of the RSS within the embankment. Typically, global stability should not be a major concern for a RSS wall founded on the very stiff to hard till at this site.

17 SEISMIC CONSIDERATIONS

17.1 Seismic Design Parameters

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 1
- Zonal Acceleration Ratio 0.05
- Peak Horizontal Acceleration 0.04

The soil profile type at this site has been classified as Type I. Therefore, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient "S" (ground motion amplification factor) of 1.0 should be used in seismic design.

17.2 Liquefaction Potential

The potential for liquefaction of the foundations soils was assessed using the Seed and Idriss (1971) method[1].

Using this method, the foundation soils at the site are assessed as not being prone to liquefaction.

[1] Seed, H.B. and Idriss, I.M. 1971, "Simplified Procedure for Evaluating Soil Liquefaction Potential" *Journal of Soil Mechanics and Foundations Division,* ASCE, Vol. 101, No. SM9, September, pp. 1249-1273.

17.3 Retaining Wall Dynamic Earth Pressures

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading.

In calculating the active, passive and at rest earth pressure coefficients the angle of friction between the wall and backfill material is assumed to be 0.5 ϕ. For the design of retaining walls, the coefficients of horizontal earth pressure in Table 17.1 may be used:

Table 17.1 – Earth Pressure Coefficient for Earthquake Loading

	Earth Pressure Coefficient (K) for Earthquake Loading			
	Granular A or Granular B Type II $\phi = 35°$; $\delta = 17.5°$ $\gamma = 22.8$ kN/m^3		**OPSS Granular B Type I $\phi = 32°$; $\delta = 16°$ $\gamma = 21.2$ kN/m^3**	
Wall Condition	**Horizontal Surface Behind Wall**	**Sloping Surface Behind Wall (2H:1V)**	**Horizontal Surface Behind Wall**	**Sloping Surface Behind Wall (2H:1V)**
Active (K_{AE})*	0.3	0.45	0.33	0.54
Passive (K_{PE})	6.3	6.3	5.4	5.4
At Rest (K_{OE})**	0.59		0.63	

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.
** After Woods

18 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not limited to:

1. Excavations

Care must be exercised during excavation to avoid disturbing the founding subgrade. The exposed subgrade soils should be expeditiously inspected, approved and protected from disturbance.

2. Perched groundwater

Perched water may be encountered within the sand, silt and till soils. The impact of this perched groundwater is not expected to be significant. However, the Contractor's unwatering plan must be available for rapid implementation should the need arise. All footings must be placed in the dry.

19 CLOSURE

Engineering analysis and preparation of the foundation design report was conducted by and Dr. Sydney Pang, P.Eng. and Ms. R. Palomeque Reyna, P.Eng. The report was reviewed by P. K. Chatteriji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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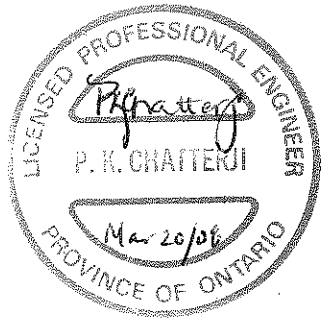

TABLE 1 -Point Load and Unconfined Compression Test Results

Hurontario Street South Access Road

HAR-02	DEPTH			Is (MPa)	Is50 (MPa)	Inferred UCS (MPa)	Rock Type
	FT.	IN.	(m)				
RUN #1	18	6	5.64	2.321	1.969	47.26	siltstone
	20	11	6.38	0.000	0.000	3.00	shale
	23	5	7.14	0.428	0.463	11.12	shale, siltstone
	22	9	6.93	0.000	0.000	3.00	shale
RUN #2	23	9	7.24	0.674	0.750	18.01	shale, siltstone
	24	11	7.59	0.000	0.000	3.00	shale, siltstone
	25	11	7.90	0.557	0.528	12.68	shale, siltstone
	26	4.5	8.04	0.000	0.000	3.00	shale
	27	9	8.46	1.509	1.810	43.45	siltstone
	24	9	7.54	5.000	3.873	92.95	limestone

Inferred UC Test Average

RUN #1:			
	AVERAGE	MAX	MIN
Shale	3.00	3.00	3.00
Siltstone	47.26	47.26	47.26
Shale/Siltstone	11.12	11.12	11.12
Limestone			

RUN #2:			
Shale	3.00	3.00	3.00
Siltstone	43.45	43.45	43.45
Shale/Siltstone	11.23	18.01	3.00
Limestone	92.95	92.95	92.95

SUMMARY	AVERAGE	MAX	MIN
Shale	3.00	3.00	3.00
Siltstone	45.36	47.26	43.45
Shale/Siltstone	11.20	18.01	3.00
Limestone	92.95	92.95	92.95

HAR-04	DEPTH			Is (MPa)	Is50 (MPa)	Inferred UCS (MPa)	Rock Type
	FT.	IN.	(m)				
RUN #1	20	6	6.25	0.000	0.000	3.00	shale
RUN #2	30	5	9.27	1.039	0.906	21.73	limestone
	30	9	9.37	1.451	1.487	35.69	shale
	30	11	9.42	7.798	6.041	144.97	shale, siltstone
	32	2	9.80	0.380	0.356	8.55	shale, siltstone
	33	6	10.21	0.288	0.310	7.45	limestone
	34	8	10.57	0.326	0.404	9.70	limestone

Inferred UC Test Average

RUN #1:			
	AVERAGE	MAX	MIN
Shale	3.00	3.00	3.00
Siltstone			
Shale/Siltstone			
Limestone			

RUN #2:			
Shale	35.69	35.69	35.69
Siltstone			
Shale/Siltstone	76.76	144.97	8.55
Limestone	12.96	21.73	7.45

SUMMARY	AVERAGE	MAX	MIN
Shale	19.35	35.69	3.00
Siltstone			
Shale/Siltstone	76.76	144.97	8.55
Limestone	12.96	21.73	7.45

TABLE 1 -Point Load and Unconfined Compression Test Results

Hurontario Street South Access Road

HAR-05	DEPTH			Is (MPa)	Is50 (MPa)	Inferred UCS (MPa)	Rock Type
	FT.	IN.	(m)				
RUN #1	1	32	10.00	0.501	0.501	12.03	shale, siltstone
RUN #2	33	9	10.29	0.844	0.840	20.15	shale
	34	10	10.62	7.200	5.091	122.19	limestone
	34	11	10.64	4.085	3.875	93.00	limestone
	35	11	10.95	0.000	0.000	3.00	shale, siltstone
	37	7	11.46	0.401	0.448	10.76	shale, siltstone

Inferred UC Test Average

RUN #1:			
	AVERAGE	MAX	MIN
Shale			
Siltstone			
Shale/Siltstone	12.03	12.03	0.00
Limestone			

RUN #2:			
Shale	20.15	20.15	20.15
Siltstone			
Shale/Siltstone	6.88	10.76	3.00
Limestone	107.60	122.19	93.00

SUMMARY	AVERAGE	MAX	MIN
Shale	20.15	20.15	20.15
Siltstone			
Shale/Siltstone	8.60	12.03	3.00
Limestone	107.60	122.19	93.00

HAR-07	DEPTH			Is (MPa)	Is50 (MPa)	Inferred UCS (MPa)	Rock Type
	FT.	IN.	(m)				
RUN #1	36	1	11.00	0.800	0.566	13.58	limestone
	37	5	11.40	0.000	0.000	3.00	shale, siltstone
	38	4	11.68	0.000	0.000	3.00	shale, siltstone
	39	4	11.99	0.000	0.000	3.00	shale, siltstone
	38	2	11.63	2.600	2.600	62.40	siltstone
RUN #2	40	0	12.19	0.000	0.000	3.00	siltstone
	41	4	12.60	1.176	1.182	28.37	siltstone
	41	10	12.75	1.319	1.626	39.04	siltstone
	42	7	12.98	0.000	0.000	3.00	shale, siltstone
	43	3	13.18	0.000	0.000	3.00	shale, siltstone
	44	8	13.61	0.119	0.141	3.38	shale, siltstone

Inferred UC Test Average

RUN #1:			
	AVERAGE	MAX	MIN
Shale			
Siltstone	62.40	62.40	62.40
Shale/Siltstone	3.00	3.00	3.00
Limestone	13.58	13.58	13.58

RUN #2:			
Shale			
Siltstone	23.47	39.04	3.00
Shale/Siltstone	3.13	3.38	3.00
Limestone			

SUMMARY	AVERAGE	MAX	MIN
Shale			
Siltstone	33.20	62.40	3.00
Shale/Siltstone	3.06	3.38	3.00
Limestone	13.58	13.58	13.58

TABLE 1 -Point Load and Unconfined Compression Test Results

Hurontario Street South Access Road

HAR-10	DEPTH			Is (MPa)	Is50 (MPa)	Inferred UCS (MPa)	Rock Type
	FT.	IN.	(m)				
RUN #1	22	6	6.86	1.044	0.934	22.42	siltstone
RUN #2	24	7	7.49	5.212	5.442	130.61	limestone
	26	3	8.00	0.557	0.528	12.68	shale, siltstone
	26	5	8.05	0.000	0.000	3.00	shale
	27	4	8.33	0.000	0.000	3.00	shale

Inferred UC Test Average			
RUN #1:			
	AVERAGE	MAX	MIN
Shale			
Siltstone	22.42	22.42	22.42
Shale/Siltstone			
Limestone			
RUN #2:			
Shale	3.00	3.00	3.00
Siltstone			
Shale/Siltstone	12.68	12.68	12.68
Limestone	130.61	130.61	130.61
SUMMARY	AVERAGE	MAX	MIN
Shale	3.00	3.00	3.00
Siltstone	22.42	22.42	22.42
Shale/Siltstone	12.68	12.68	12.68
Limestone	130.61	130.61	130.61

HAR-15	DEPTH			Is (MPa)	Is50 (MPa)	Inferred UCS (MPa)	Rock Type
	FT.	IN.	(m)				
RUN #1	30		9.14	0.418	0.458	10.98	shale, siltstone
	30	11	9.42	0.000	0.000	3.00	shale
	31	8	9.65	1.129	0.971	23.31	shale, siltstone
	32	10.5	10.02	2.961	2.632	63.17	siltstone
RUN #2	33	6	10.21	0.000	0.000	3.00	shale, siltstone
	34	4	10.46	4.082	3.415	81.96	limestone/shale
	35	15	11.05	4.832	4.402	105.65	siltstone
	36	5	11.10	0.339	0.412	9.89	shale, siltstone
	37	6	11.43	3.008	3.008	72.19	shale, siltstone
	37	8	11.48	3.501	3.588	86.11	limestone

Inferred UC Test Average			
RUN #1:			
	AVERAGE	MAX	MIN
Shale	3.00	3.00	3.00
Siltstone	63.17	63.17	63.17
Shale/Siltstone	17.15	23.31	23.31
Limestone			
RUN #2:			
Shale			
Siltstone	105.65	105.65	105.65
Shale/Siltstone	28.36	72.19	3.00
Limestone	86.11	86.11	86.11
SUMMARY	AVERAGE	MAX	MIN
Shale	3.00	3.00	3.00
Siltstone	84.41	105.65	63.17
Shale/Siltstone	23.87	72.19	3.00
Limestone	86.11	86.11	86.11

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

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

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

∇ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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

UNIFIED SOILS CLASSIFICATION

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-01 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 071.981 E 290 010.469 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-11-10 - 2007-11-10 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.1											
0.0 / 0.1	**TOPSOIL:** (80mm)						192				
	Silty **CLAY**, trace to some sand, trace gravel, occasional rootlets Very Stiff Brown to Mottled Brown-Grey (FILL)		1	SS	24				○		
191.3 / 0.8											
	Silty **CLAY**, some sand, trace gravel Hard Mottled Brown-Grey (TILL)		2	SS	69		191		○		
			3	SS	50/ .150				○		1 17 53 29
189.8							190				
2.3	**SILT**, some sand to sandy, trace gravel, trace clay Very Dense Brown (TILL)		4	SS	86				○		
189.1							189				
3.0	Highly weathered, thinly bedded, reddish brown **SHALE**		5	SS	50/ .150				○		
			6	SS	100/ .150		188		○		0 8 68 24
186.3							187				
5.8	END OF BOREHOLE AT 5.79m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTM4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-02 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 082.073 E 290 015.967 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-16 - 2007-10-16 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.8											
0.0	**TOPSOIL:** (80mm)										
0.1	Silty **CLAY**, trace sand, trace gravel, occasional rootlets Hard (FILL)		1	SS	65/300				○		
193.1											
0.8	**SAND** and **GRAVEL**, trace silt, trace clay Compact to Very Dense Brown Moist (FILL)		2	SS	79		193		○		39 47 14 (SI+CL)
			3	SS	18		192		○		
			4	SS	38		191		○		
190.8											
3.0	Silty **CLAY**, some sand, occasional rootlets Very Stiff to Hard Dark Grey to Brown (TILL)		5	SS	20	▼	190		⊖—I		0 18 58 24
			6	SS	100		189		○		
188.7											
5.2	Highly to moderately weathered, thinly bedded, reddish brown **SHALE** with occasional green siltstone and limestone interbeds Coring started at 5.5m Green siltstone interbeds at 5.66 to 5.72, 5.87, 6.22, 6.45 to 6.65, 6.73 to 6.78 and 6.88 to 6.93m Limestone interbeds at 6.20 and 6.65m Highly broken zones at 5.99 to 6.10, 6.45 to 6.65 and 6.73 to 6.78m Horizontal joints at 5.69 to 5.72, 5.84, 5.87, 5.97, 6.05, 6.07, 6.12, 6.17, 6.22, 6.35, 6.45, 6.65, 6.68, 6.71, 6.73 and 6.91m Weak to strong Siltstone interbeds at 7.16, 7.29, 7.54, 7.62, 7.70, 7.85, 7.87, 8.00, 8.13, 8.23, 8.26, 8.31 and 8.46 to 8.53m Limestone interbeds at 7.11, 7.24, 7.34, 7.54 and 7.90m		1	RUN			188			FI 2 5 5 10	RUN 1# TCR=100%, SCR=45%, RQD=20%, UCS=10MPa (Shale/Siltstone) UCS = 47 MPa (Siltstone)
							187			5	
			2	RUN			186			0 0 0 0 0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=10MPa (Shale/Siltstone) UCS = 43 MPa (Siltstone) UCS = 92 MPa (Limestone)
185.3											
8.5	END OF BOREHOLE AT 8.53m. BOREHOLE OPEN AND WATER LEVEL AT 4.27m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.										

+³, ×³: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-03 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 080.604 E 290 021.551 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-10 - 2007-10-10 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.7											
0.0 / 0.1	**TOPSOIL:** (80mm)										
	SAND, trace silt, trace gravel, occasional rootlets, occasional asphalt at 0.61m Dense Brown (FILL)		1	SS	42				○		
192.9 / 0.8											
	SILT, trace to some sand, trace gravel Compact Brown (FILL)		2	SS	30				○		
192.2 / 1.5											
	SAND, fine to medium grained, some silt, trace clay, trace gravel Compact Brown (FILL)		3	SS	19				○		5 83 12 (SI+CL)
191.4 / 2.3											
	SILT, trace sand, trace gravel Compact to Dense Brown (TILL)		4	SS	36				○		
190.3			5	SS	17						
3.4	Silty **CLAY**, some sand, occasional rootlets Very Stiff to Hard Dark Grey to Mottled Brown-Grey (TILL)					▼					
188.5			6	SS	74				⊢○		1 20 60 19
5.2	Highly weathered, thinly bedded, reddish brown **SHALE**		7	SS	100/.150				○		
186.4											
7.3	END OF BOREHOLE AT 7.32m UPON AUGER REFUSAL. BOREHOLE DRY AND OPEN TO 6.10m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule PVC pipe. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Oct 18/07 4.2 189.5 Nov 15/07 4.2 189.5										

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-04 1 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 092.354 E 290 026.159 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-15 - 2007-10-15 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.9											
0.0	**TOPSOIL:** (100mm)										
0.1	Silty **CLAY**, trace to some sand, trace gravel, occasional rootlets Hard Brown (FILL)		1	SS	80				o		
			2	SS	51		195		o		
194.3											
1.5	**SAND**, fine to medium, trace silt, trace clay Dense Brown (FILL)		3	SS	38	▼	194		o		
			4	SS	30				o		0 86 14 (SI+CL)
			5	SS	31		193		o		
191.3							192				
4.6	Silty **CLAY**, some sand, trace gravel Hard Mottled Greenish Brown-Grey (TILL)		6	SS	50/.150		191		o		0 19 52 29
189.8	Reddish Brown						190				
6.1	Highly to moderately weathered, thinly bedded, reddish brown **SHALE** with occasional green siltstone and clay seams Limestone interbeds at 9.37 to 9.40, 9.55, 9.78 and 10.26m		7	SS	50/.150		189		o		
	Coring started at 7.6m Siltstone interbeds at 7.67, 8.00, 8.23, 8.38, 8.43, 8.53, 8.56, 8.76 and 8.81m Clay seams at 8.18 and 8.61m Highly broken zones at 7.62 to 7.75 and 9.04 to 9.14m Horizontal joints at 7.75, 7.82, 7.87, 7.90, 7.98, 8.03, 8.28, 8.36, 8.41, 8.43 and 8.46m		1	RUN			188			FI 5 3 4	RUN 1# TCR=100%, SCR=67%, RQD=38%, UCS=3MPa (Shale)
							187			6	
	Grey limestone interbeds Weak to strong									5	RUN 2# TCR=100%, SCR=90%, RQD=90%, UCS=8MPa Average
	Siltstone interbeds at 9.25 to 9.32,		2	RUN			186			2 0 0	

Continued Next Page

+³ ×³ Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-04 2 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 092.354 E 290 026.159 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-15 - 2007-10-15 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	9.40 to 9.47, 9.80, 9.98, 10.06 to 10.13, 10.16, 10.19 and 10.21									0	(Shale/Siltstone) UCS = 83 MPa (Siltstone) UCS = 36 MPa (Limestone)
185.2											
10.6	END OF BOREHOLE AT 10.64m. BOREHOLE OPEN TO 10.64m AND WATER LEVEL AT 1.83m. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.						185			0	

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

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

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-05 1 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 098.165 E 290 038.959 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-16 - 2007-10-16 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.7								20 40 60 80 100	20 40 60		
0.0 / 0.1	**TOPSOIL:** (80mm)										
	SAND, some silt, trace clay, trace gravel, occasional rootlets Dense Brown Moist (FILL)		1	SS	35		196				
			2	SS	35						
195.2							195				
1.5	**SILT**, clayey, some sand Very stiff to hard Brown Moist (FILL)		3	SS	46						
			4	SS	19		194				1 16 68 15
193.6											
3.0	**SAND**, fine to medium grained Compact Brown Moist (FILL)		5	SS	18		193				
192.1											
4.6	Silty **CLAY**, some sand, trace gravel, occasional rootlets Stiff Dark Grey to Reddish Brown (FILL)		6	SS	14		192				
191.5											
5.2	Silty **CLAY**, some sand, trace gravel Hard Mottled Brown-Grey (TILL)						191				
	cobbles		7	SS	50/.150						4 25 50 21
190.0							190				
6.7	Highly to moderately weathered, thinly bedded, reddish brown **SHALE** with occasional green siltstone interbeds, occasional limestone interbeds and clay seams		8	SS	100/.150		189				
	Coring started at 8.5m						188				FI 1 3 0 5 5 RUN 1# TCR=100%, SCR=58%, RQD=52%, UCS=12MPa (Shale/Siltstone)
	Siltstone interbeds at 8.94, 9.12, 9.25, 9.32, 9.65, 9.80 and 10.01m Limestone interbeds at 9.37, 9.60 to 9.63 and 9.75m Clay seam at 9.96m Highly broken zones at 9.60 to 9.65		1	RUN			187				

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-05 2 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 098.165 E 290 038.959 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-16 - 2007-10-16 CHECKED BY RPR

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	and 9.80 to 9.86m Horizontal joints at 8.56, 8.94, 8.97, 9.02, 9.60, 9.63, 9.70, 9.75, 9.78, 9.83, 9.86 and 9.91m Sightly weathered to fresh, thinly bedded, weak, reddish brown **SHALE** occasional silt stone and limestone interbeds Siltstone interbeds at 10.06, 10.11, 10.36, 10.74 to 10.77, 11.07 to 11.13 and 11.56 to 11.58m		2	RUN			186			0 0 0 0 0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=20MPa (Shale) UCS = 8 MPa (Shale/Siltstone) UCS = 107 MPa (Limestone)
185.1 11.6	Limestone interbeds at 10.46, 10.62, 10.72 and 11.13m										
	END OF BOREHOLE AT 11.58m. BOREHOLE OPEN AND WATER LEVEL AT 2.74m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule PVC pipe. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Nov 01/07 5.8 190.9 Nov 15/07 5.7 191.0										

+ ³ . × ³ : Numbers refer to Sensitivity

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

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-06 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 110.692 E 290 044.337 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-18 - 2007-10-18 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.2											
0.0	**ASPHALT:** (125mm)										
0.1	**SAND** and **GRAVEL**, trace clay Dense to Compact Brown Moist (FILL)		1	SS	43		197				
195.9			2	SS	27		196				46 45 9 (SI+CL)
1.2	**SHALE**, highly weathered, very stiff, reddish brown (FILL)		3	SS	20		195				
194.1			4	SS	17						
3.0	Silty **CLAY**, some sand, trace gravel Stiff Mottled Reddish Brown to Brown (FILL)		5	SS	12		194				
192.6							193				
4.6	Silty **CLAY**, some sand, trace gravel Hard Brown to Mottled Brown-Grey (TILL)		6	SS	35		192				4 21 47 28
			7	SS	44		191				
							190				
189.1			8	SS	35						
188.9	Highly weathered, thinly bedded, reddish brown **SHALE**						189				
8.2	END OF BOREHOLE AT 8.23m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 0.9m, CONCRETE TO 0.3m AND COLD PATCH TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-07 1 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 107.251 E 290 047.966 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-19 - 2007-10-19 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.0											
0.0	**ASPHALT:** (110mm)						197				
0.1	**SAND** and **GRAVEL** Dense Brown (FILL)		1	SS	41				o		
196.0			2	SS	16		196		o		
1.1	Silty **CLAY**, trace to some sand, trace gravel Very Stiff to Stiff Reddish Brown (FILL) Layer of highly weathered, reddish brown **SHALE** (1.5m thick)		3	SS	27				o		
			4	SS	11		195		o		
	sand, occasional shale fragment		5	SS	12		194		⊕		2 25 57 16
192.5							193				
4.6	Silty **CLAY**, some sand Hard Brown (TILL)		6	SS	46				o		
	Occasional silt seam Occasional iron oxidized staining Brown to Mottled Brown-Grey		7	SS	61		192				
							191		⊕		2 17 54 27
			8	SS	96/.225		190		o		
							189				
187.6	Possible sand seam at 9.1m		9	SS	100/.100		188				
9.4	Moderately weathered to fresh, thinly bedded, weak to strong, reddish brown **SHALE** with occasional green siltstone interbeds and grey limestone										

Continued Next Page

+ ³, × ³ Numbers refer to Sensitivity

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

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-07 2 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 107.251 E 290 047.966 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-19 - 2007-10-19 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
	Continued From Previous Page										
	Highly weathered, thinly bedded, very weak, reddish brown SHALE						187			FI	
	Coring started at 10.7m									5	RUN 1# TCR=100%, SCR=65%, RQD=65%, UCS=3MPa (Shale/Siltstone) UCS = 62.4 MPa (Siltstone) UCS = 13 MPa (Limestone)
	Siltstone interbeds at 10.67, 11.00 to 11.05, 11.13, 11.18, 11.23, 11.25, 11.30, 11.38, 11.53 to 11.58, 11.68, 12.02 and 12.19m Limestone interbeds at 11.15, 11.30 and 11.63 to 11.68m Highly broken zones at 10.67 to 10.97m Horizontal joints at 11.00, 11.07, 11.13, 11.20 and 11.25m		1	RUN			186			5	
										0	
										0	
							185			0	
	Siltstone interbeds at 12.19 to 12.29, 12.40, 12.42, 12.55 to 12.65, 12.73 to 12.83, 12.83 to 12.88, 13.01 to 13.11, 13.18, 13.36 and 13.39m Limestone interbeds at 12.50 and 12.88m		2	RUN						0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=3MPa (Shale/Siltstone) UCS = 33.2 MPa (Siltstone) UCS = 13 MPa (Limestone)
										0	
										0	
							184			0	
183.3										0	
13.7	END OF BOREHOLE AT 13.72m. BOREHOLE OPEN UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 0.9m, CONCRETE TO 0.15m AND COLD PATCH TO SURFACE.										

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

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

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-08 1 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 118.929 E 290 057.007 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
DATUM Geodetic DATE 2007-09-14 - 2007-09-14 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.5											
0.0	**TOPSOIL:** (100mm)										
0.1	Fine grained **SAND**, occasional silt, occasional gravel Compact Brown Moist (FILL)		1	SS	16		196				
195.9											
0.7	Silty **CLAY**, trace sand, occasional rootlets Very Stiff to Stiff Dark Grey (FILL)		2	SS	15						
	Layer of highly weathered, reddish brown **SHALE** (700mm)		3	SS	16		195				
	sand, occasional shale fragments Reddish Brown to Brown		4	SS	8		194				1 21 55 23
	Occasional iron oxidized stains		5	SS	8		193				2 39 40 19
192.0											
4.6	Silty **CLAY**, with sand, trace gravel Stiff to Hard Brown (TILL)		6	SS	11		192				2 40 45 13
			7	SS	24	▼	191				
	Brown to Reddish Brown		8	SS	57		190				2 30 46 22
			9	SS	80		189				16 26 43 15
							188				
186.6							187				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-08 2 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 118.929 E 290 057.007 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
DATUM Geodetic DATE 2007-09-14 - 2007-09-14 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
9.9 185.9	Highly weathered, thinly bedded, reddish brown **SHALE**						186				
10.7	END OF BOREHOLE AT 10.7m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY TO 10.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
Sep 19/07	5.9	190.6
Sep 28/07	6.1	190.4
Oct 05/07	6.1	190.4
Oct 18/07	6.2	190.3
Nov 01/07	5.9	190.6
Nov 15/07	6.1	190.4

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

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

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-09 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 067.557 E 290 023.701 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-11 - 2007-10-11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.2												
0.0	**TOPSOIL:** (150mm)											
0.2	Silty **CLAY**, trace to some sand, trace gravel, occasional shale fragments, occasional rootlets		1	SS	20		192			○		
191.6	Very Stiff											
0.6	Reddish Brown											
	(FILL)		2	SS	57					○		
	Silty **CLAY**, trace to some sand, trace gravel						191					
	Hard											
	Mottled Brown-Grey		3	SS	50/ .150	▼				○		
	(TILL)											
189.9							190					
2.3	Clayey **SILT**, with sand		4	SS	50/ .150					○		0 32 52 16
	Hard											
189.4	Brown											
2.7	(TILL)											
	Highly weathered, thinly bedded, reddish brown **SHALE**		5	SS	100/ .150		189			○		
							188					
187.3			6	SS	100/ .175					○		
4.9	END OF BOREHOLE AT 4.93m UPON AUGER REFUSAL . BOREHOLE DRY AND OPEN TO 4.27m											

Piezometer installation consists of 19mm diameter schedule pipe.

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
Oct 18/07	1.9	190.3
Nov 15/07	1.9	190.3

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

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-10 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 077.987 E 290 031.489 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-15 - 2007-10-16 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.7											
0.0 / 0.1	**TOPSOIL:** (80mm)										
	SAND, gravelly, some silt, some clay Compact to Very Dense Brown (FILL)		1	SS	66						
			2	SS	42		193				28 44 28 (SI+CL)
			3	SS	10		192				
191.4											
2.3	Silty **CLAY**, trace to some sand, trace gravel Very Stiff to Hard Mottled Brown-Grey to Reddish Brown (FILL)		4	SS	29		191				7 17 58 18
			5	SS	25		190				
189.6											
4.1	Silty **CLAY**, trace to some sand, trace gravel Hard Brown (TILL)		6	SS	50/.100		189				
188.8											
4.9	Highly to moderately weathered, thinly bedded, reddish brown **SHALE** with occasional green siltstone interbeds										
	Coring started at 5.5m									FI	RUN 1#
	Siltstone interbeds at 5.49 to 5.54, 5.66, 5.94, 6.86 to 6.88 and 6.93m Highly broken zones at 5.49 to 5.56, 5.69 to 5.72, 5.82 to 6.00 and 6.58 to 6.65m Horizontal joints at 5.56, 5.64, 5.69, 5.72, 5.79, 5.92, 5.94, 5.97, 6.10, 6.43, 6.50, 6.55 and 6.76m		1	RUN			188			5 5 0 5	TCR=100%, SCR=56%, RQD=35%, UCS=22MPa (Siltstone)
							187			1	RUN 2#
	Siltstone interbeds at 7.09, 7.21, 7.34 to 7.42, 7.49 to 7.57, 7.62 to 7.64, 7.72 to 7.77, 7.85 to 7.87, 8.03 to 8.08 and 8.41 to 8.46m Clay seams at 8.15 to 8.21m Highly broken zones at 7.37, 7.49 and 7.67 to 7.75m Horizontal joints at 7.21, 7.26, 7.34, 7.52, 7.57, 7.62, 7.67, 7.75, 7.80, 7.85, 8.18 and 8.25m		2	RUN		▼	186			1 5 5 0 2	TCR=100%, SCR=73%, RQD=50%, UCS=3MPa (Shale) UCS = 12 MPa (Shale/Siltstone) UCS the 130 MPa (Limestone)
185.2											
8.5	END OF BOREHOLE AT 8.46m. BOREHOLE OPEN AND WATER LEVEL AT 7.54m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.										

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-11 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 076.517 E 290 037.072 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-10 - 2007-10-10 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.0							194				
0.0	**TOPSOIL:** (100mm)										
0.1	**SAND**, otrace silt, trace to some gravel Dense Brown Moist (FILL)		1	SS	37				○		
193.4											
0.6	Clayey **SILT**, some sand, trace gravel Hard Brown (FILL)		2	SS	48		193		○		
192.5											
1.5	Silty **CLAY**, trace to some sand, trace gravel Stiff to Very Stiff Dark Grey (FILL) Mottled Brown-Grey to Reddish Brown		3	SS	11		192		○		
			4	SS	23				○		
191.0											
3.0	Silty **CLAY**, trace sand, trace gravel, occasional rootlets Very Stiff to Hard Dark Grey to Mottled Reddish Brown (TILL)		5	SS	28		191		○		
			6	SS	100/.125		190		○⊢		1 20 56 23
188.8							189				
5.2	Highly weathered, thinly bedded, reddish brown **SHALE**		7	SS	100/.125		188		○		
	Highly to moderately weathered						187				
			8	SS	100/.100				○		
185.5							186				
8.5	END OF BOREHOLE AT 8.53m UPON AUGER REFUSAL. BOREHOLE DRY AND OPEN UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

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

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-12 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 086.283 E 290 039.712 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-10 - 2007-10-10 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.8											
0.0	TOPSOIL: (100mm)										
0.1	SAND, fine to medium grained, trace silt, trace gravel, trace clay Compact to Very Dense Brown (FILL)		1	SS	25						
			2	SS	46		195				
			3	SS	50/.150		194				4 82 14 (SI+CL)
193.5											
2.3	Silty CLAY, trace to some sand, trace gravel, occasional shale fragments Very Stiff Mottled Reddish Brown to Brown (FILL)		4	SS	15		193				
192.7											
3.0	SILT, trace clay, some sand, trace gravel Dense Brown (FILL)		5	SS	35		192				
191.2											
4.6	Silty CLAY, with sand, occasional rootlets Hard Dark Grey to Brown (TILL)		6	SS	35		191				
			7	SS	100/.150		190				1 32 41 26
189.1											
6.7	Highly weathered, thinly bedded, reddish brown SHALE		8	SS	100/.125		189				
							188				
186.9											
8.8	END OF BOREHOLE AT 8.84m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.						187				

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-13 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 093.367 E 290 050.225 ORIGINATED BY VS

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-22 - 2007-10-22 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.7											
0.0	**ASPHALT:** (110mm)										
0.1	**SAND** and **GRAVEL**, trace silt, trace clay Compact to Dense Brown Damp to Moist (FILL)		1	SS	16				o		
			2	SS	47		196		o		45 44 11 (SI+CL)
195.2											
1.5	**SAND**, some silt, some clay Compact to Very Dense Brown Moist (FILL)		3	SS	58		195		o		
			4	SS	27		194		o		
			5	SS	21				o		0 81 19 (SI+CL)
192.1							193				
4.6	Silty **CLAY**, with sand, trace gravel Firm to Hard Brown to Grey (TILL)		6	SS	6		192		o		
			7	SS	58		191		⊣		2 23 49 26
189.1							190				
188.6			8	SS	32				o		
7.7	Highly weathered, very thinly bedded, reddish brown **SHALE**										
	END OF BOREHOLE AT 7.72m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-14 1 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 101.263 E 290 054.562 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-18 - 2007-10-18 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.8											
0.0	**ASPHALT:** (125mm)										
0.1	**SAND** and **GRAVEL** Dense Brown Damp (FILL)		1	SS	32						51 38 11 (SI+CL)
			2	SS	34		196				
195.4											
1.4	**SHALE**, highly weathered, thinly bedded Stiff to Hard Reddish Brown Damp (FILL)		3	SS	44		195				
			4	SS	12		194				
193.7											
3.0	Silty **CLAY**, trace to some sand, trace gravel, occasional shale fragments Stiff Reddish Brown (FILL)		5	SS	14		193				
192.2											
4.6	Silty **CLAY**, some sand, some gravel, occasional iron oxidized stains Hard Mottled Brown-Grey (TILL)		6	SS	35		192				
			7	SS	60		191				1 19 56 24
188.9			8	SS	100/.150		190				
7.9	Highly weathered, thinly bedded, reddish brown **SHALE**						189				
187.6							188				
9.1	END OF BOREHOLE AT 9.15m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 0.9m, CONCRETE										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-14 2 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 101.263 E 290 054.562 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-18 - 2007-10-18 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
	Continued From Previous Page										
	TO 0.15m AND COLD PATCH TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-15 1 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 097.821 E 290 058.189 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-17 - 2007-10-17 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.6											
0.0	**ASPHALT:** (125mm)										
0.1	**SAND** and **GRAVEL** Dense to Very Dense Brown (FILL)		1	SS	33						
			2	SS	50/ .150						
195.3											
1.4	Silty **CLAY**, some sand, trace gravel, occasional shale fragments Very Stiff Reddish Brown (FILL)		3	SS	20						1 22 52 25
194.4											
2.3	**SHALE**, highly weathered, thinly bedded Stiff to Hard Reddish Brown (FILL)		4	SS	30						
			5	SS	14						
192.1											
4.6	Silty **CLAY**, with sand, trace gravel Hard Mottled Brown and Grey (TILL)		6	SS	33						
			7	SS	60						1 25 51 23
189.3											
7.3	Highly weathered to fresh, thinly bedded, reddish brown **SHALE** with occasional green siltstones and grey limestone interbeds		8	SS	70/ .150						
	Coring started at 8.5m.										
	Green siltstone interbeds at 8.66, 8.74, 8.94, 9.11, 9.22, 9.25 to 9.30, 9.58, 9.81, 9.85, 9.98 and 10.03m Limestone interbeds at 9.02, 9.09, 9.63, 9.81 and 10.03m Highly broken zones at 8.56 to 8.69,		1	RUN						FI >5 >5 >5 4 0	RUN 1# TCR=100%, SCR=48%, RQD=48%, UCS=17.5MPa (Shale/Siltstone) UCS=63MPa (Siltstone)

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-15 2 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 097.821 E 290 058.189 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-17 - 2007-10-17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100	WATER CONTENT (%) 20 40 60	kN/m³	GR SA SI CL
	Continued From Previous Page										
	8.81 to 8.99 and 9.20 to 9.32m Weak to strong									0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=28MPa (Shale/Siltstone) UCS=105MPa (Siltstone) UCS=86MPa (Limestone)
	Green siltstone interbeds at 10.08 to 10.11, 10.90, 10.97, 11.15 to 11.20, 11.25 to 11.28, 11.30 to 11.41 and 11.56 to 11.58m		2	RUN			186			0	
	Grey limestone interbeds at 10.26, 10.49 to 10.52, 11.33 and 11.51 to 11.56m									0	
185.1 / 11.6										0	
	END OF BOREHOLE AT 11.58m. BOREHOLE OPEN AND WATER LEVEL AT 4.88m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 0.9m, CONCRETE to 0.15m AND COLD PATCH TO SURFACE.										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-16 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 110.129 E 290 065.885 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA

DATUM Geodetic DATE 2007-09-14 - 2007-09-14 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.1											
0.0	TOPSOIL: (100mm)										
0.1	SAND, some silt, trace clay, trace gravel Compact to Dense Brown (FILL)		1	SS	40		196	○			
			2	SS	16		195	○			
	Loose		3	SS	9			○			0 86 14 (SI+CL)
193.9							194				
2.2	Silty CLAY, trace to some sand, trace gravel Stiff Brown to Reddish Brown (FILL)		4	SS	12			○			
193.2							193				
3.0	Silty CLAY, with sand, trace gravel, occasional iron oxidized stains Hard Mottled Brown and Grey (TILL)		5	SS	16			○			
			6	SS	49	▼	192	⊖			1 29 50 20
	Brown to Reddish Brown		7	SS	60/.150		191				
189.4							190	○			
6.7	Highly weathered, thinly bedded, reddish brown SHALE										
188.5							189				
7.6	END OF BOREHOLE AND AUGER REFUSAL AT 7.6m. BOREHOLE OPEN AND DRY TO 7.6m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Sep 19/07 4.8 191.3 Sep 28/07 4.5 191.6 Oct 05/07 4.6 191.5 Oct 18/07 4.2 191.9 Nov 01/07 4.5 191.6 Nov 15/07 4.7 191.4		8	SS	50/.000						

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

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-17 1 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 109.067 E 290 014.565 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-10 - 2007-10-10 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.1											
0.0	**TOPSOIL:** (100mm)										
0.1	**SILT**, some sand, trace gravel, occasional rootlets		1	SS	31						
196.4	Dense										
0.6	Brown										
	(FILL)										
	Silty **CLAY**, trace to some sand, trace gravel, occasional rootlets		2	SS	25						
	Very Stiff to Hard										
	Brown										
	(FILL)		3	SS	30						
194.8											
2.3	**SAND**, fine grained, occasional gravel		4	SS	16						
	Compact										
	Brown										
	Moist										
	(FILL)		5	SS	18						
	Some silt, some clay		6	SS	10						1 56 43 (SI+CL)
191.0											
6.1	Silty **CLAY**, some sand, trace gravel		7	SS	25						
	Very Stiff										
	Reddish Brown to Brown										
	(TILL)										
			8	SS	50/.150						0 15 61 24
188.8											
8.2	Highly weathered, thinly bedded, reddish brown **SHALE**		9	SS	100/.150						

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+³, ×³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 2/5/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HAR-17 2 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 109.067 E 290 014.565 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-10 - 2007-10-10 CHECKED BY RPR

SOIL PROFILE			SAMPLES						DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60					GR SA SI CL
187.0	Continued From Previous Page													
10.1	END OF BOREHOLE AT 10.06m UPON AUGER REFUSAL. BOREHOLE OPEN TO 10.06m AND WATER LEVEL AT 8.23m. Piezometer installation consists of 19mm diameter schedule PVC pipe. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Oct 18/07 4.3 192.8 Nov 01/07 4.5 192.6 Nov 15/07 4.4 192.7						187							

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

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

ONTMT4S 2311.GPJ 12/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No HAR-18 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 069.279 E 290 058.058 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-09-10 - 2007-09-10 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.0							195				
0.0	TOPSOIL: (100mm)										
0.1	SAND, trace clay, trace silt, trace gravel, occasional rootlets Compact Brown (FILL)		1	SS	24						
194.2							194				
0.8	Silty CLAY, with sand, trace gravel Very Stiff Mottled Dark Grey-Brown (FILL)		2	SS	16						
			3	SS	18		193				
			4	SS	13						9 33 43 15
	Brown to Mottled Brown-Reddish		5	SS	19		192				
							191				
	Hard		6	SS	50/ .150						
189.2							190				
5.8	Highly weathered, thinly bedded, reddish brown SHALE with occasional sand seams		7	SS	100/ .150		189				
187.4							188				
7.6	END OF BOREHOLE AT 7.62m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 19/11/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No RW3-1 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 020.551 E 289 930.652 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-11 - 2007-10-11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.9											
0.0	**TOPSOIL:** (100mm)										
0.1	Silty **CLAY**, some sand, occasional rootlets Very Stiff to Hard Brown (FILL)		1	SS	16				○		0 16 54 30
			2	SS	50/.100		190		○		
189.4											
1.5	Highly to moderately weathered, thinly bedded, reddish brown **SHALE**		3	SS	42		189		○		
			4	SS	50/.150				○		
			5	SS	109		188		○		
	Grinding at 3.66m to 4.27m										
			6	SS	100/.150		187		○		
185.4							186				
5.5	END OF BOREHOLE AT 5.49m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule PVC pipe. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Oct 18/07 Dry - Nov 15/07 2.7 188.2										

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 19/11/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No RW3-2 1 OF 1 METRIC

G.W.P. 2107-05-02 LOCATION Hurontario St. South Access Road N 4 832 040.894 E 289 977.204 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-11 - 2007-10-11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.2											
0.0	**TOPSOIL:** (100mm)										
0.1	Silty **CLAY**, with sand, trace gravel, occasional rootlets Very Stiff Brown (FILL)		1	SS	27		193		o		
			2	SS	20		192		o		
	oxidized stains Brown to Grey		3	SS	15						1 31 45 24
			4	SS	19		191		o		
190.1											
3.1	Highly weathered, thinly bedded, reddish brown **SHALE**		5	SS	50/.075		190		o		
			6	SS	100/.150		189		o		
			7	SS	100/.125		188				
							187		o		
			8	SS	100/.100		186		o		
							185				
184.3											
8.9	END OF BOREHOLE AT 8.89m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 7/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No RW4-1 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 017.434 E 289 808.441 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-12 - 2007-10-12 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.2											
0.0	TOPSOIL: (100mm)										
0.1	Silty CLAY, trace to some sand, trace gravel, occasional rootlets Very Stiff to Hard Brown (FILL)		1	SS	16		187				
			2	SS	36						
185.7							186				
1.5	Silty CLAY, with sand, trace gravel Hard Brown		3	SS	50/.150						
185.1	(TILL)										6 22 47 25
2.1	Highly weathered, thinly bedded, reddish brown SHALE		4	SS	100/.150		185				
	Highly to moderately weathered		5	SS	100/.150		184				
182.7							183				
4.6	END OF BOREHOLE AT 4.57m. BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule PVC pipe. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) Oct 18/07 Dry - Nov 15/07 2.7 184.5										

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

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 19/11/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No RW4-2 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 015.087 E 289 854.780 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-11 - 2007-10-11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.8											
0.0 / 0.1	TOPSOIL: (80mm)										
	Silty CLAY, some sand, occasional rootlets Stiff		1	SS	12				o		0 28 49 23
186.1 / 0.8	Brown to Mottled Brown-Grey (TILL)										
	Highly weathered, thinly bedded, reddish brown SHALE		2	SS	50/ .125		186		o		
			3	SS	115				o		
	Highly to moderately weathered						185				
			4	SS	100/ .125				o		
							184				
183.2			5	SS	100/ .100				o		
3.7	END OF BOREHOLE AT 3.66m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 19/11/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No RW4-3 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION Hurontario St. South Access Road N 4 832 007.315 E 289 904.253 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-11 - 2007-10-11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.8											
0.0	TOPSOIL: (80mm)										
0.1	Silty CLAY, some sand, trace gravel, occasional rootlets Stiff Brown (TILL)		1	SS	10						
187.2											
0.6	Highly to moderately weathered, thinly bedded, reddish brown SHALE		2	SS	50/ .100		187				
			3	SS	100/ .225		186				
			4	SS	100/ .100		185				
			5	SS	100/ .125		184				
183.9											
4.0	END OF BOREHOLE AT 3.96m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 19/11/07

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No RW4-4 1 OF 1 METRIC

G.W.P. 2107-05-02 LOCATION Hurontario St. South Access Road N 4 832 015.970 E 289 955.559 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007-10-11 - 2007-10-11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.9											
0.0 / 0.1	**TOPSOIL:** (50mm)										
	Silty **CLAY**, some sand, occasional rootlets Very Stiff to Hard Brown, Mottled Brown/Grey to Reddish (TILL)		1	SS	29				o		
			2	SS	50/.150		189		o		
188.7 / 1.2	Highly weathered, thinly bedded, reddish brown **SHALE**		3	SS	118		188		o		0 26 48 26
	Highly to moderately weathered		4	SS	100/.150				o		
			5	SS	100/.150		187		o		
185.9 / 4.0	END OF BOREHOLE AT 4.01m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.						186				

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

(%) STRAIN AT FAILURE

ONTMT4S 2311.GPJ 7/12/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No RW4-5 1 OF 1 METRIC

G.W.P. 2107-05-02 LOCATION Hurontario St. South Access Road N 4 832 042.246 E 289 996.052 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007-10-11 - 2007-10-11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.1											
0.0 / 0.1	**TOPSOIL:** (80mm)										
	Highly weathered, thinly bedded, compact, reddish brown **SHALE**, trace gravel (FILL)		1	SS	25		192				
191.4 / 0.8	Silty **CLAY**, sandy, trace gravel, occasional rootlets, occasional asphalt fragments Very Stiff to Hard Brown (FILL)		2	SS	16		191				
			3	SS	28						
	Mottled Brown-Grey to Reddish Brown		4	SS	41		190				
			5	SS	50/.150		189				3 30 45 22
188.2 / 4.0	Highly weathered, thinly bedded, reddish brown **SHALE** with limestone and siltstone layers		6	SS	143		188				
			7	SS	100/.150		187				
			8	SS	100/.125		186				
183.6 / 8.5	END OF BOREHOLE AT 8.53m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.						185				
							184				

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

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

ONTMT4S 2311.GPJ 7/12/07

Appendix B

Laboratory Test Results

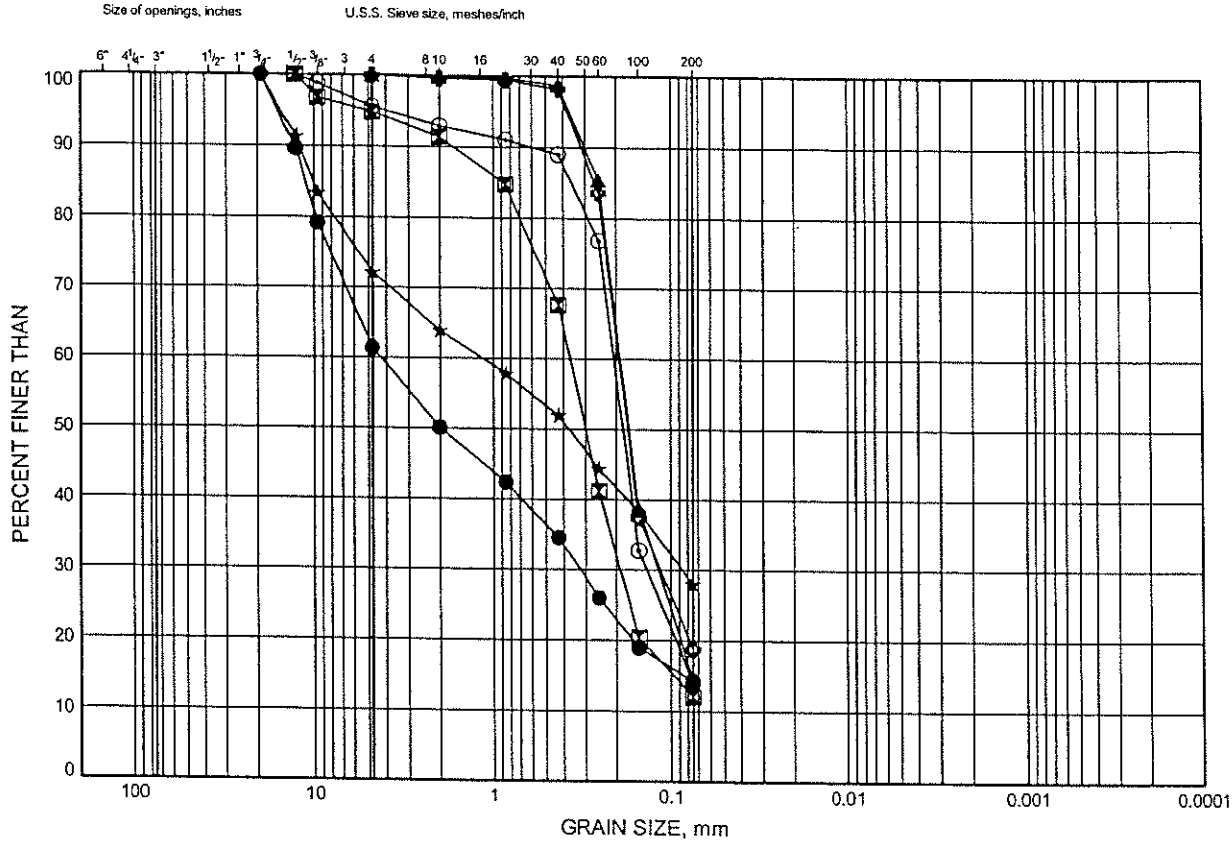
(Proposed Grade Separation)

Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B1

Sand Fill



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-02	1.07	192.77
⊠	HAR-03	1.83	191.86
▲	HAR-04	2.68	193.17
★	HAR-10	1.07	192.63
⊙	HAR-12	1.83	193.95
✿	HAR-13	3.26	193.42

Date November 2007

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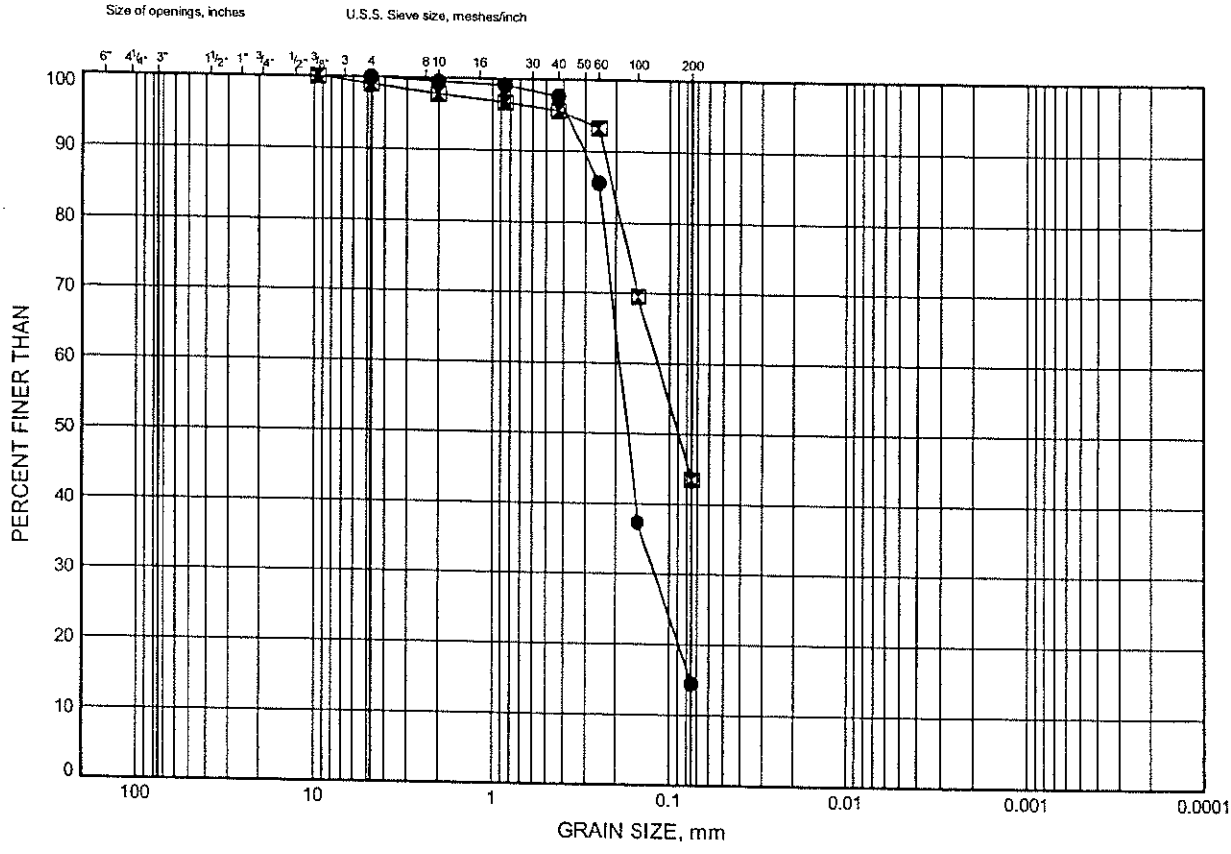
Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B2

Sand Fill



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-16	1.83	194.32
⊠	HAR-17	4.88	192.18

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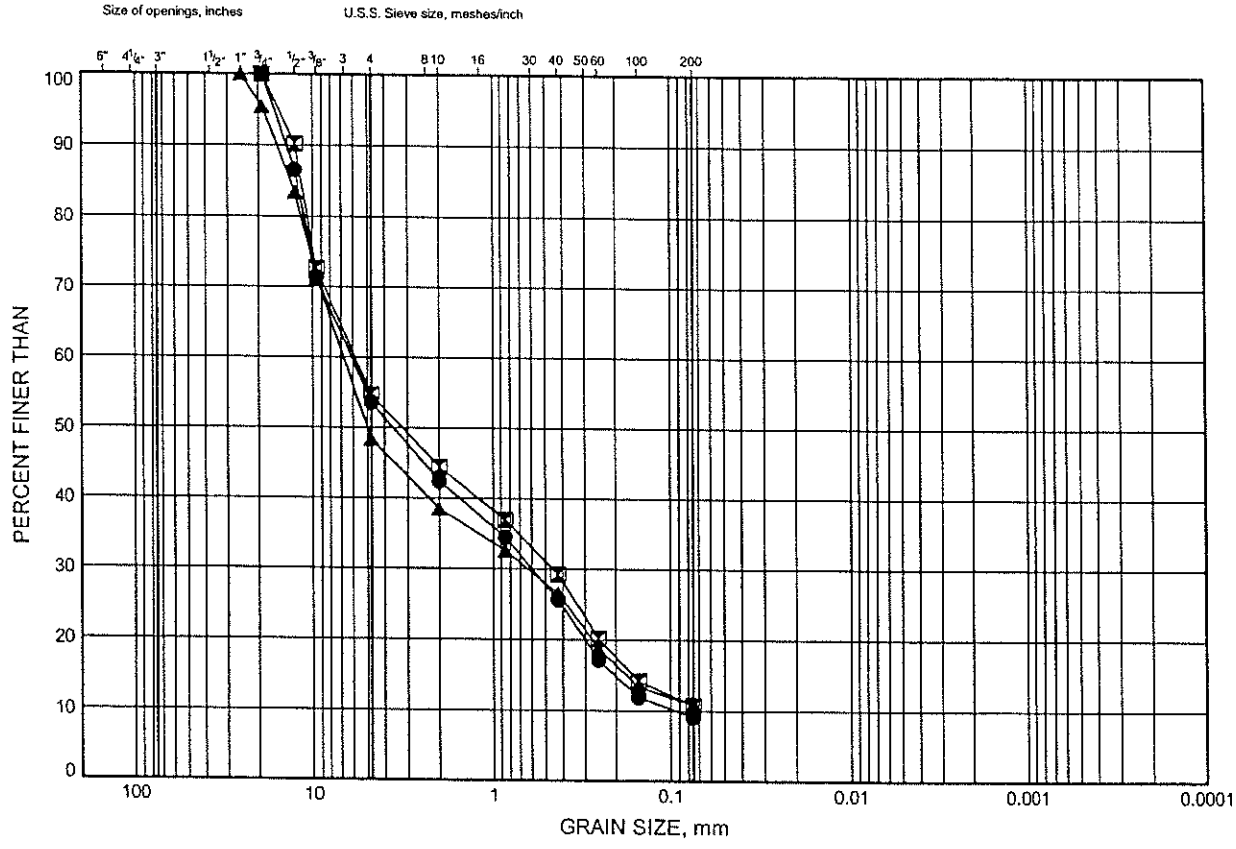
Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B3

Sand and Gravel Fill



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-06	1.07	196.08
⊠	HAR-13	0.84	195.84
▲	HAR-14	0.38	196.40

Date November 2007

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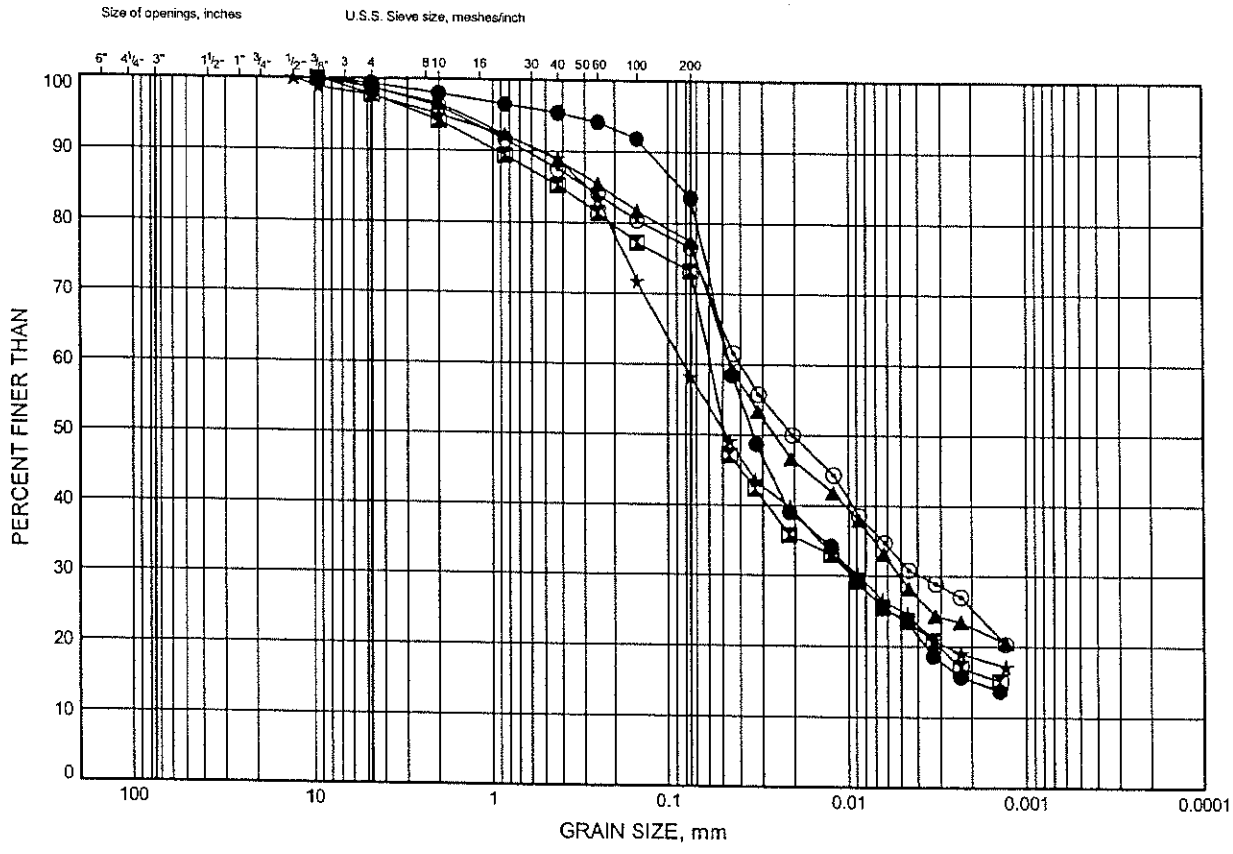
Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B4

Clayey Silt / Silty Clay Fill



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-05	2.59	194.09
⊠	HAR-07	3.35	193.67
▲	HAR-08	2.59	193.96
★	HAR-08	3.35	193.20
⊙	HAR-15	1.83	194.82

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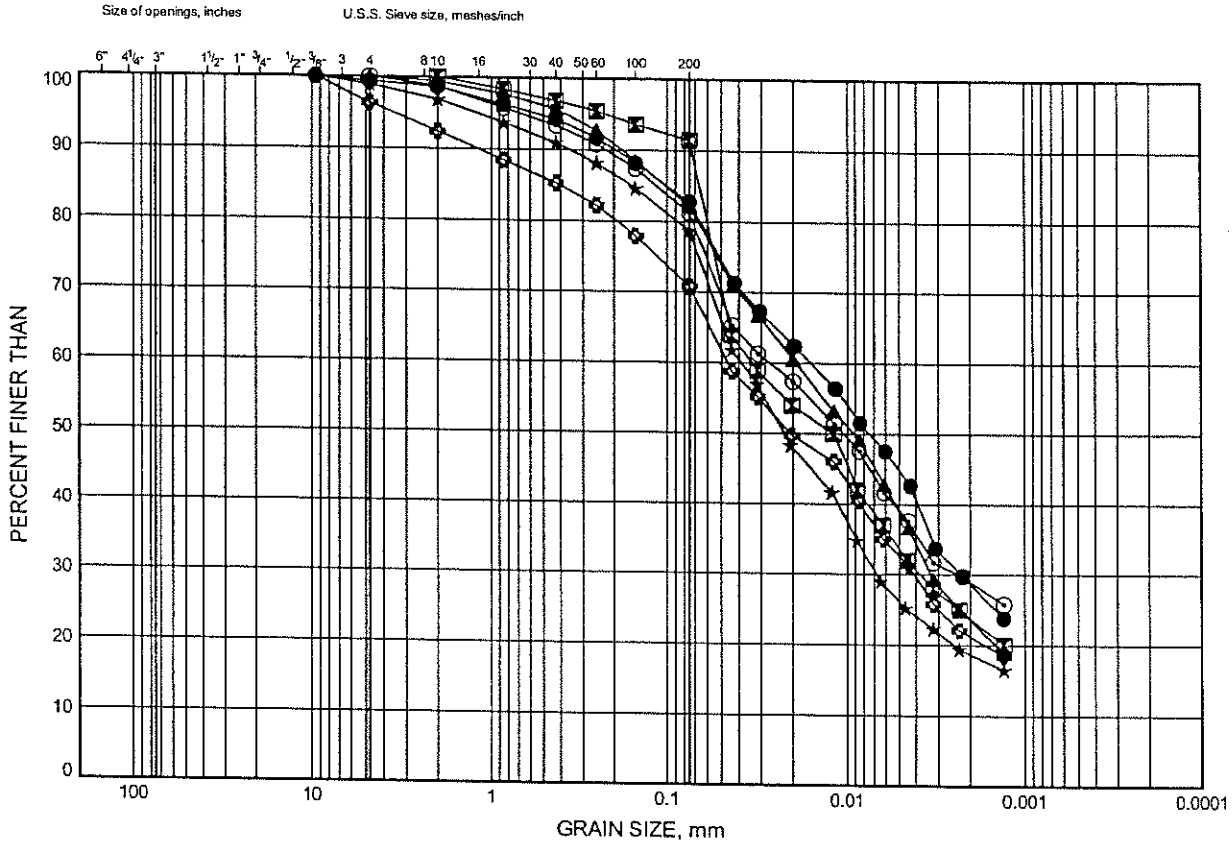
Hwy 401/410 to Credit River

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)
●	HAR-01	1.60	190.45
⊠	HAR-01	4.65	187.41
▲	HAR-02	3.35	190.49
★	HAR-03	4.88	188.81
⊙	HAR-04	4.88	190.98
✿	HAR-05	6.25	190.43

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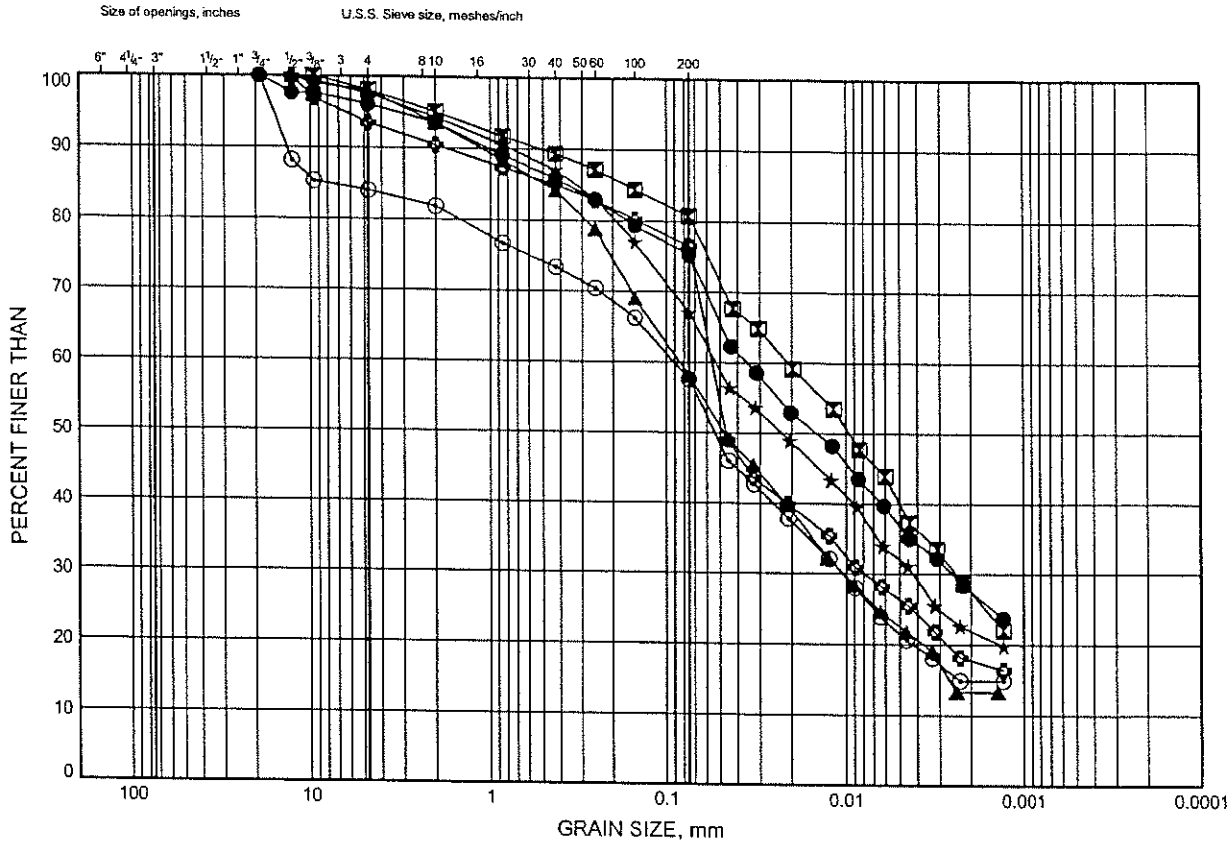
Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B6

Silty Clay Till



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-06	4.88	192.27
⊠	HAR-07	6.40	190.63
▲	HAR-08	4.88	191.67
★	HAR-08	6.40	190.15
⊙	HAR-08	7.92	188.62
✪	HAR-10	2.59	191.10

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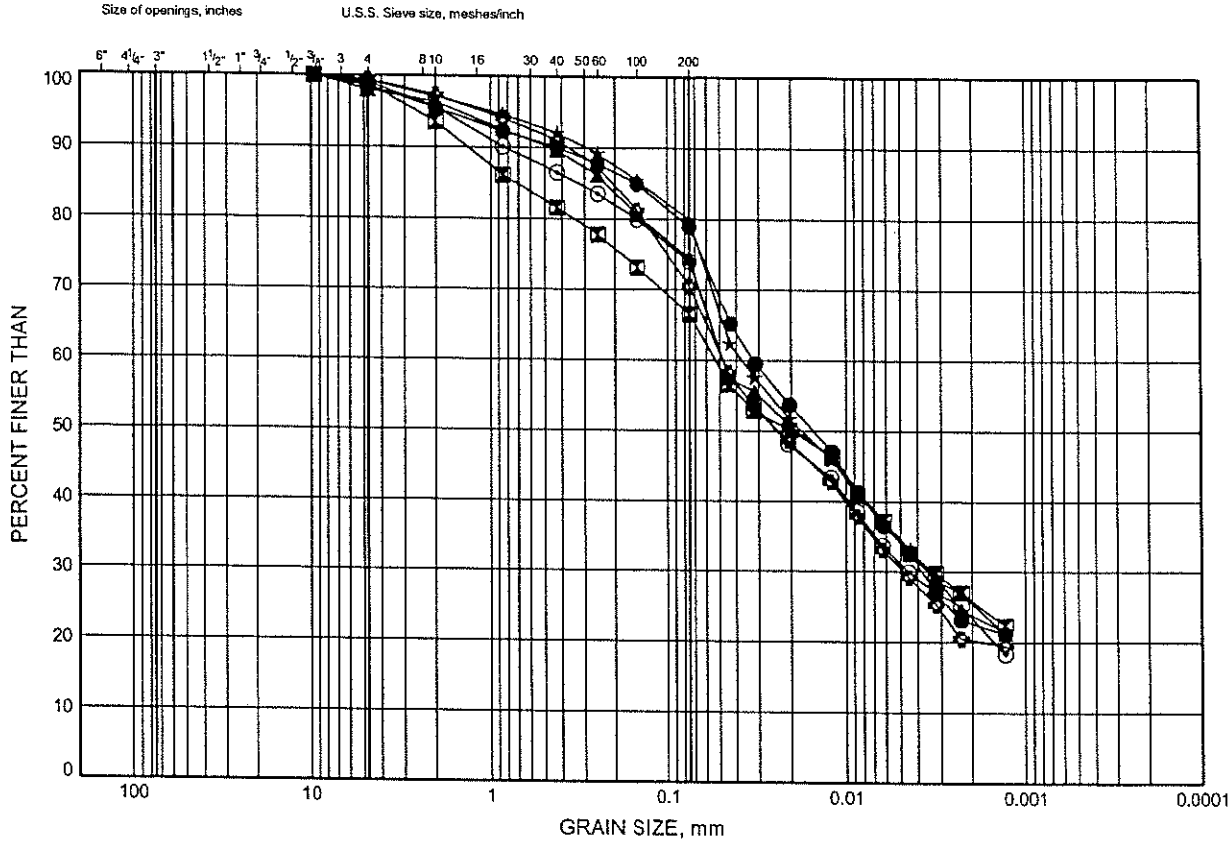
Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B7

Silty Clay Till



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-11	4.64	189.37
⊠	HAR-12	6.17	189.60
▲	HAR-13	6.40	190.28
★	HAR-14	6.40	190.38
⊙	HAR-15	6.40	190.25
✿	HAR-16	4.88	191.27

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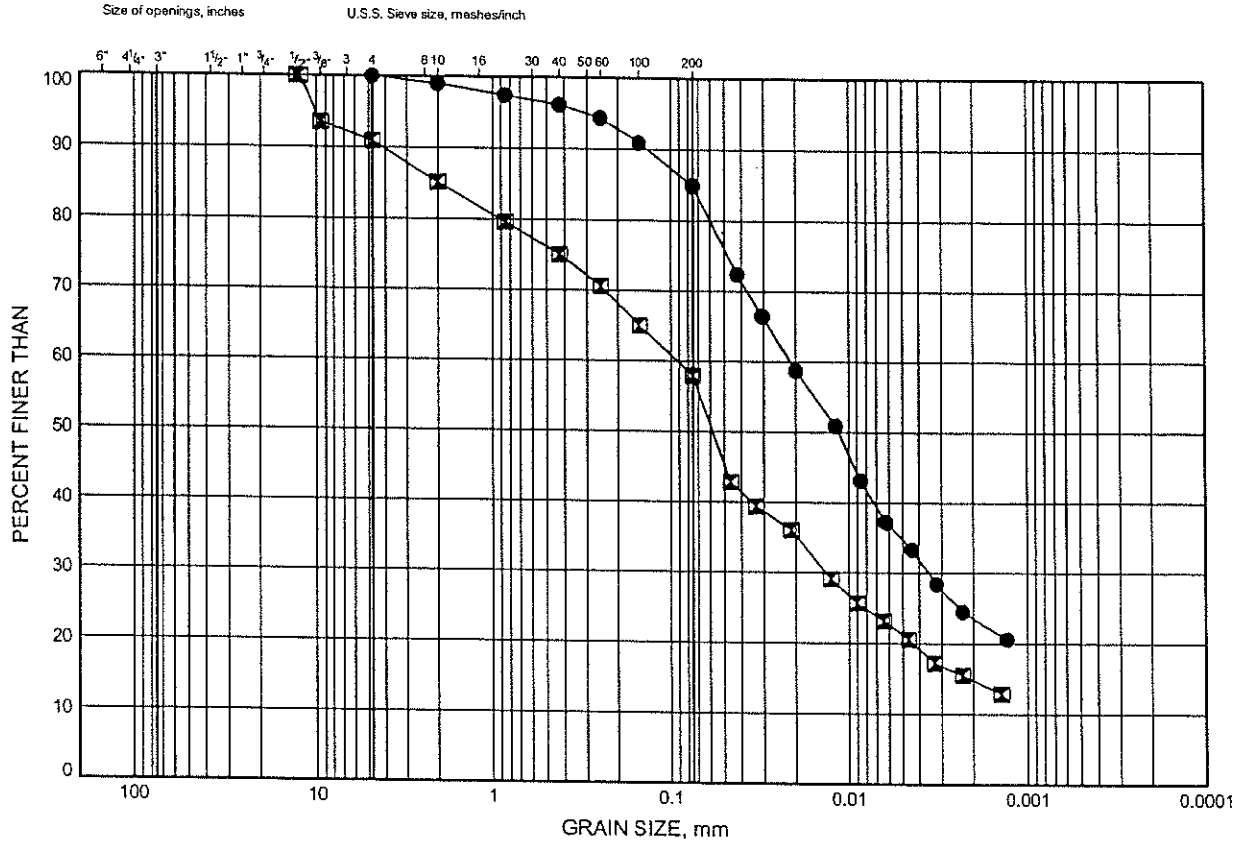
Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B8

Silty Clay Till



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-17	7.92	189.13
⊠	HAR-18	2.59	192.41

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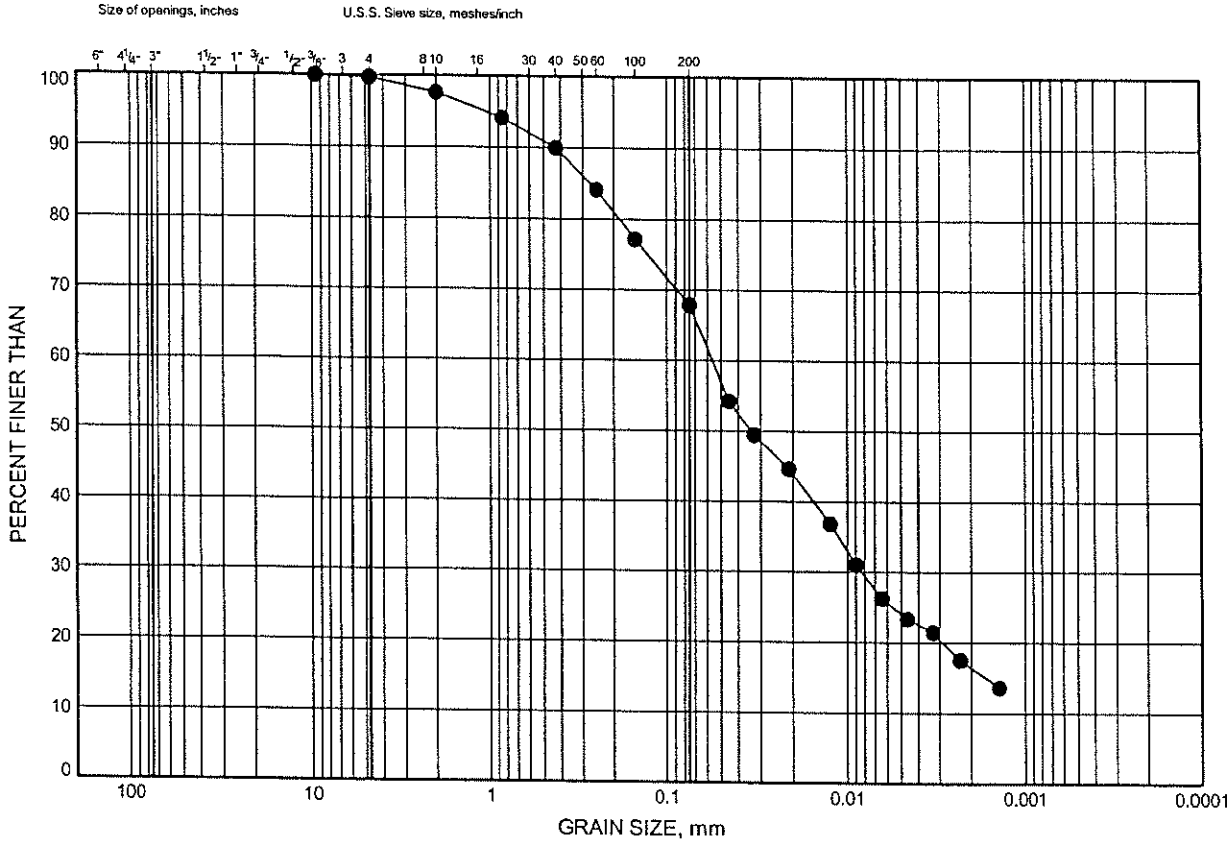
Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE B9

Clayey Silt Till



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-09	2.36	189.83

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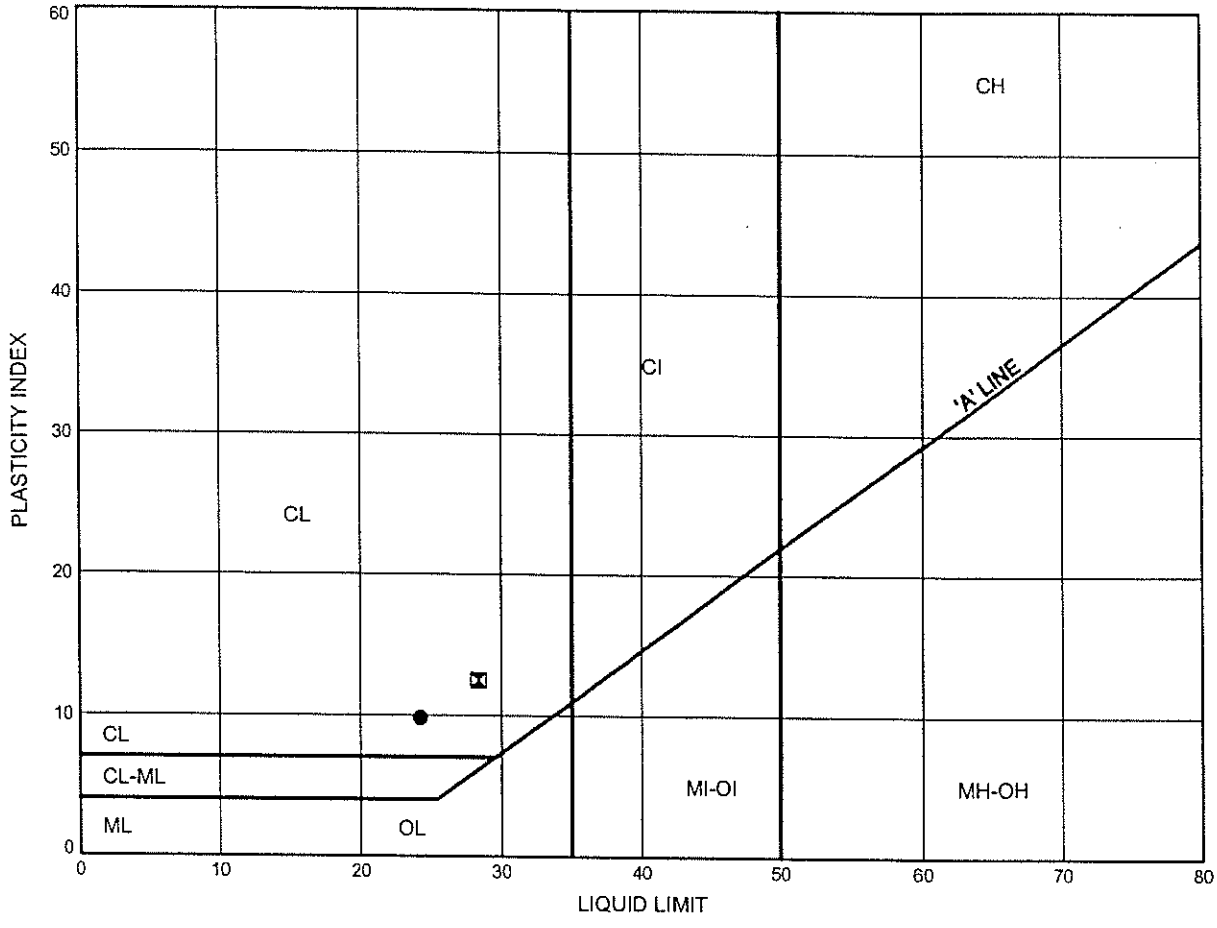
Hwy 401/410 to Credit River

ATTERBERG LIMITS TEST RESULTS

FIGURE B10

Silty Clay Fill



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-07	3.35	193.67
⊠	HAR-15	1.83	194.82

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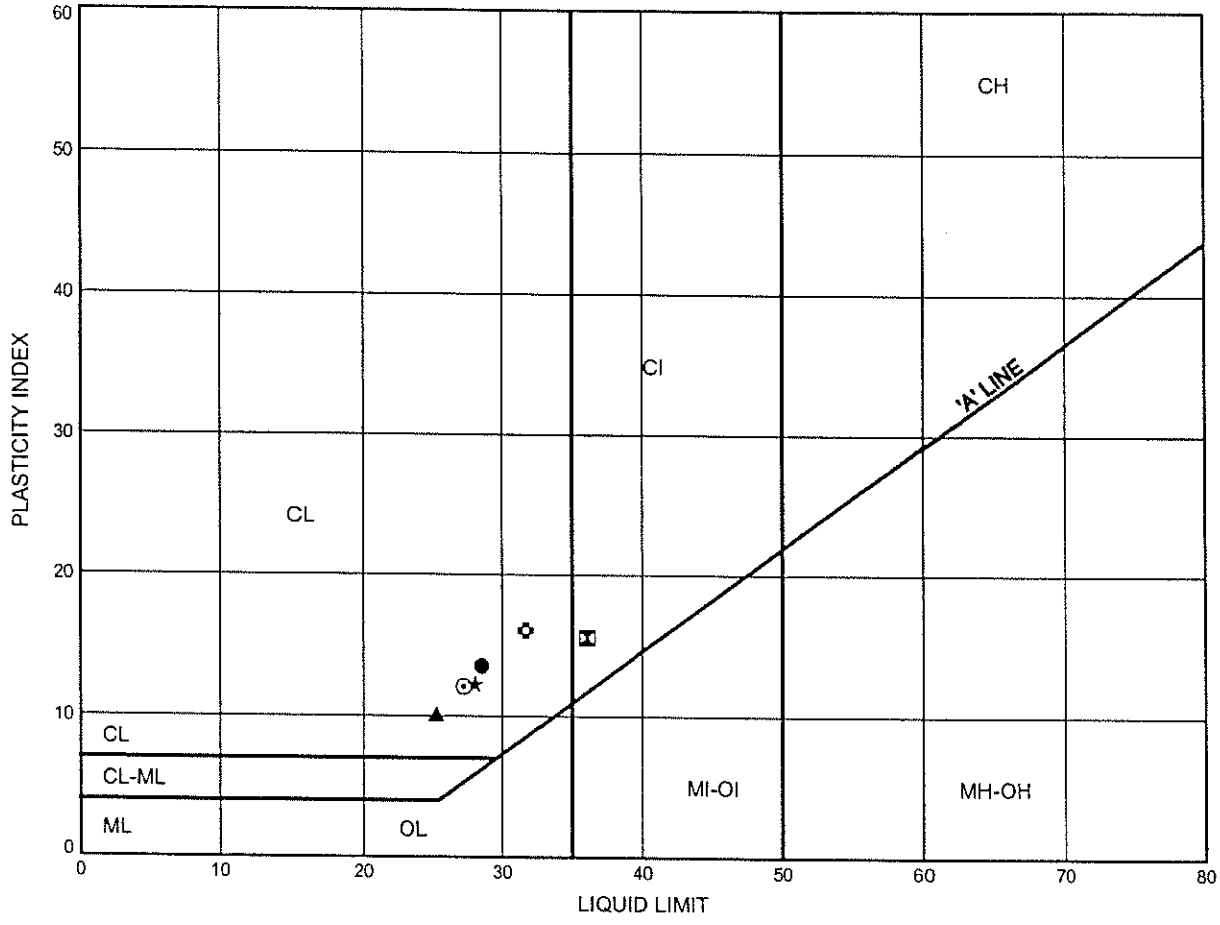
THURBALT 2311.GPJ 17/12/07

Hwy 401/410 to Credit River

ATTERBERG LIMITS TEST RESULTS

FIGURE B11

Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-01	1.60	190.45
⊠	HAR-02	3.35	190.49
▲	HAR-03	4.88	188.81
★	HAR-04	4.88	190.98
⊙	HAR-05	6.25	190.43
✿	HAR-06	4.88	192.27

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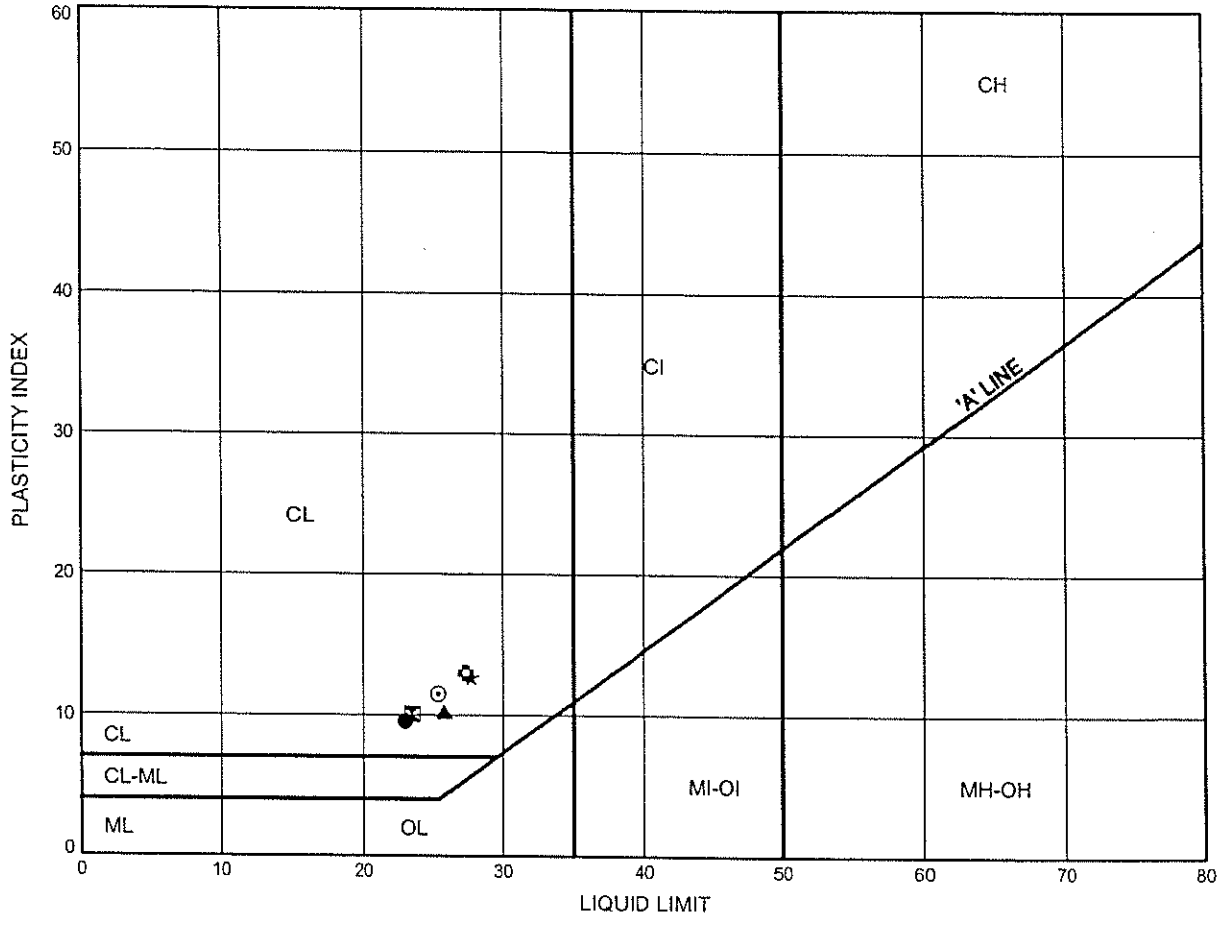
Hwy 401/410 to Credit River

ATTERBERG LIMITS TEST RESULTS

FIGURE B12

Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-08	4.88	191.67
⊠	HAR-08	7.92	188.62
▲	HAR-10	2.59	191.10
★	HAR-11	4.64	189.37
⊙	HAR-13	6.40	190.28
✿	HAR-14	6.40	190.38

Date December 2007

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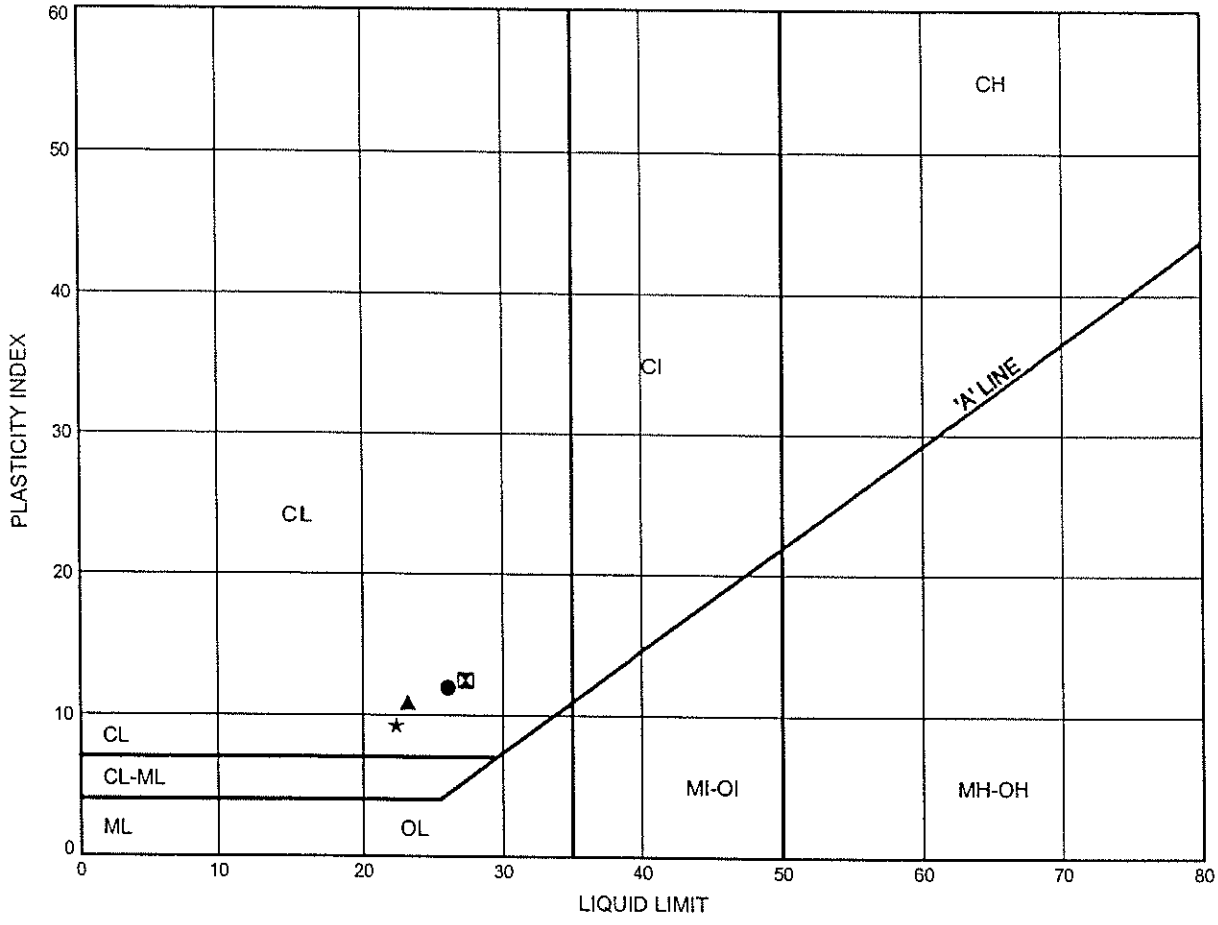
Hwy 401/410 to Credit River

ATTERBERG LIMITS TEST RESULTS

FIGURE B13

Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HAR-15	6.40	190.25
⊠	HAR-16	4.88	191.27
▲	HAR-17	7.92	189.13
★	HAR-18	2.59	192.41

Date December 2007

Project 2107-05-00

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THURBALT 2311.GPJ 17/12/07

Appendix C

Laboratory Test Results

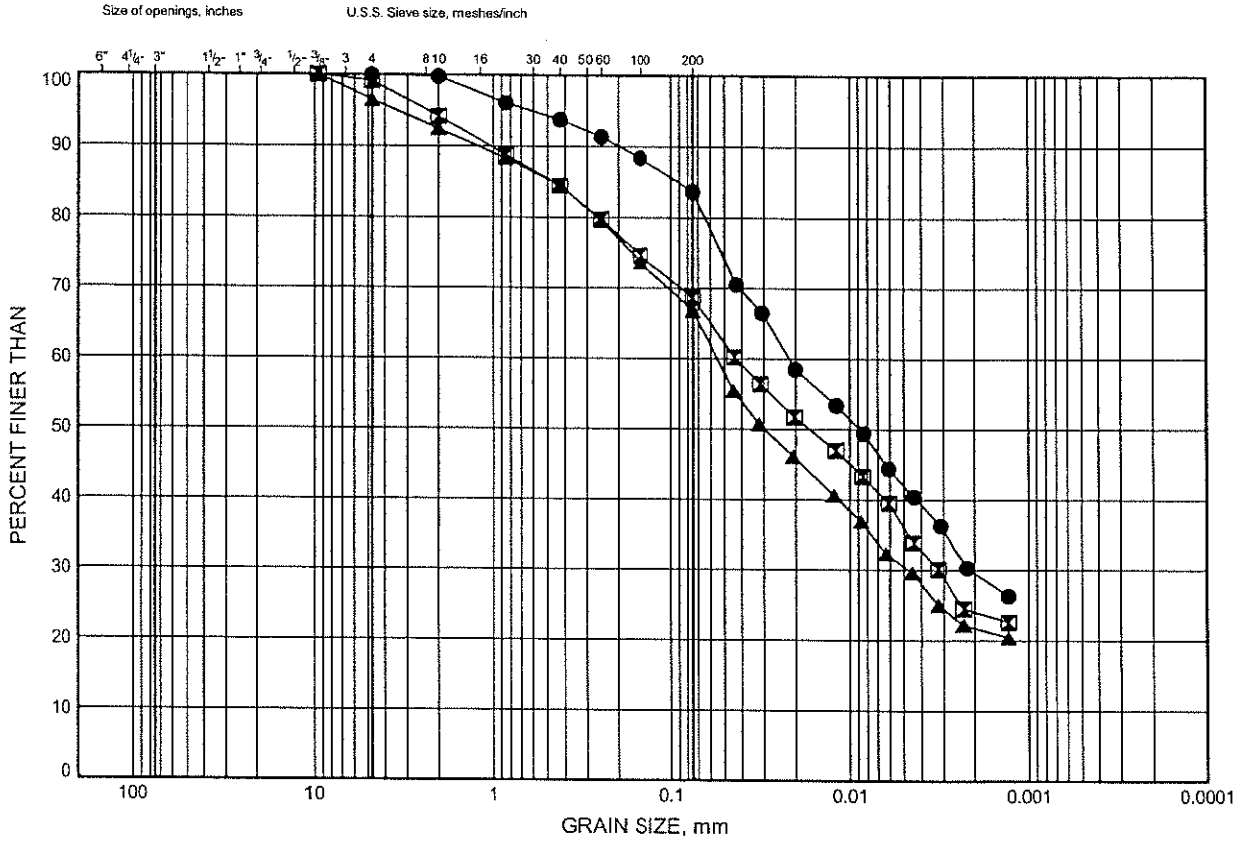
(Proposed Retaining Walls)

Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE C1

Silty Clay Fill



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	RW3-1	0.30	190.62
⊠	RW3-2	1.83	191.35
▲	RW4-5	3.35	188.76

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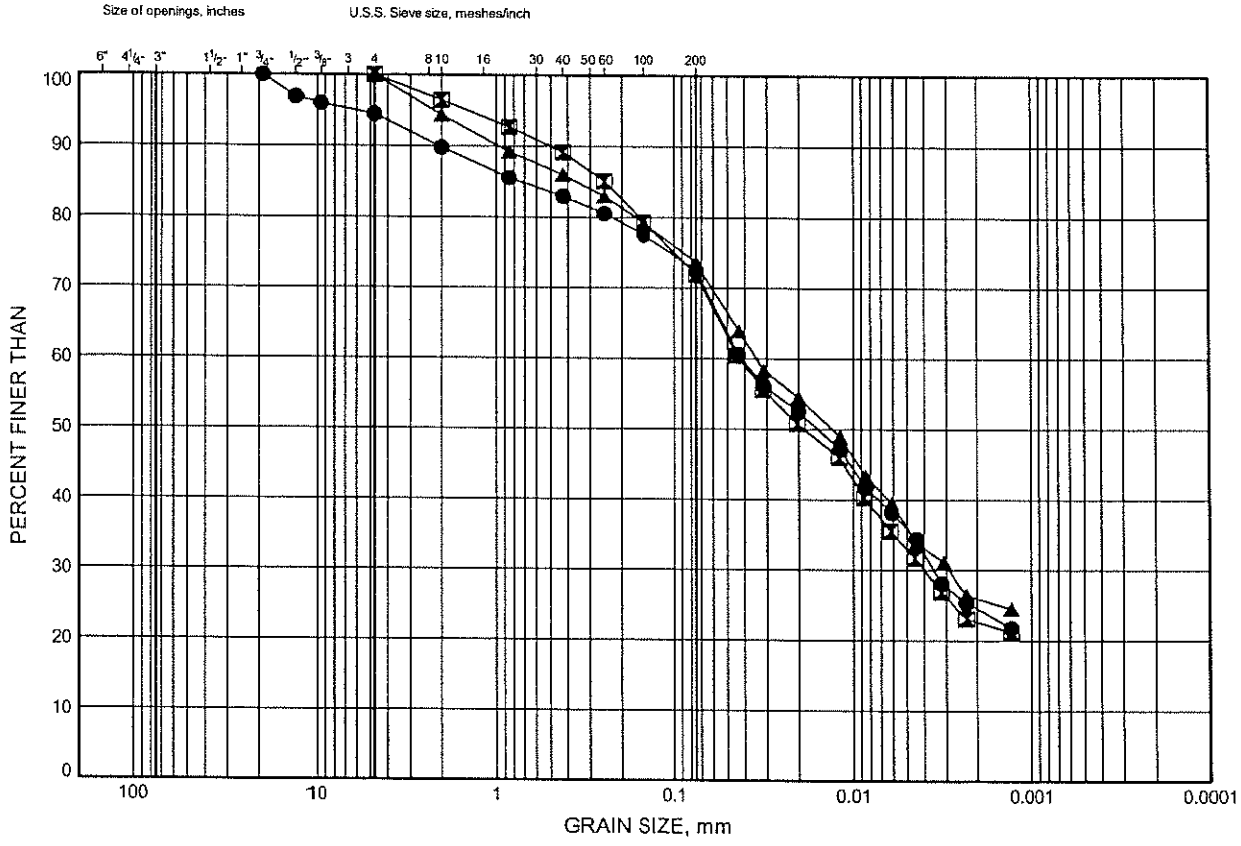
Hwy 401/410 to Credit River

GRAIN SIZE DISTRIBUTION

FIGURE C2

Silty Clay Till



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	RW4-1	1.83	185.40
⊠	RW4-2	0.30	186.53
▲	RW4-4	1.07	188.83

Date December 2007

Project 2107-05-00

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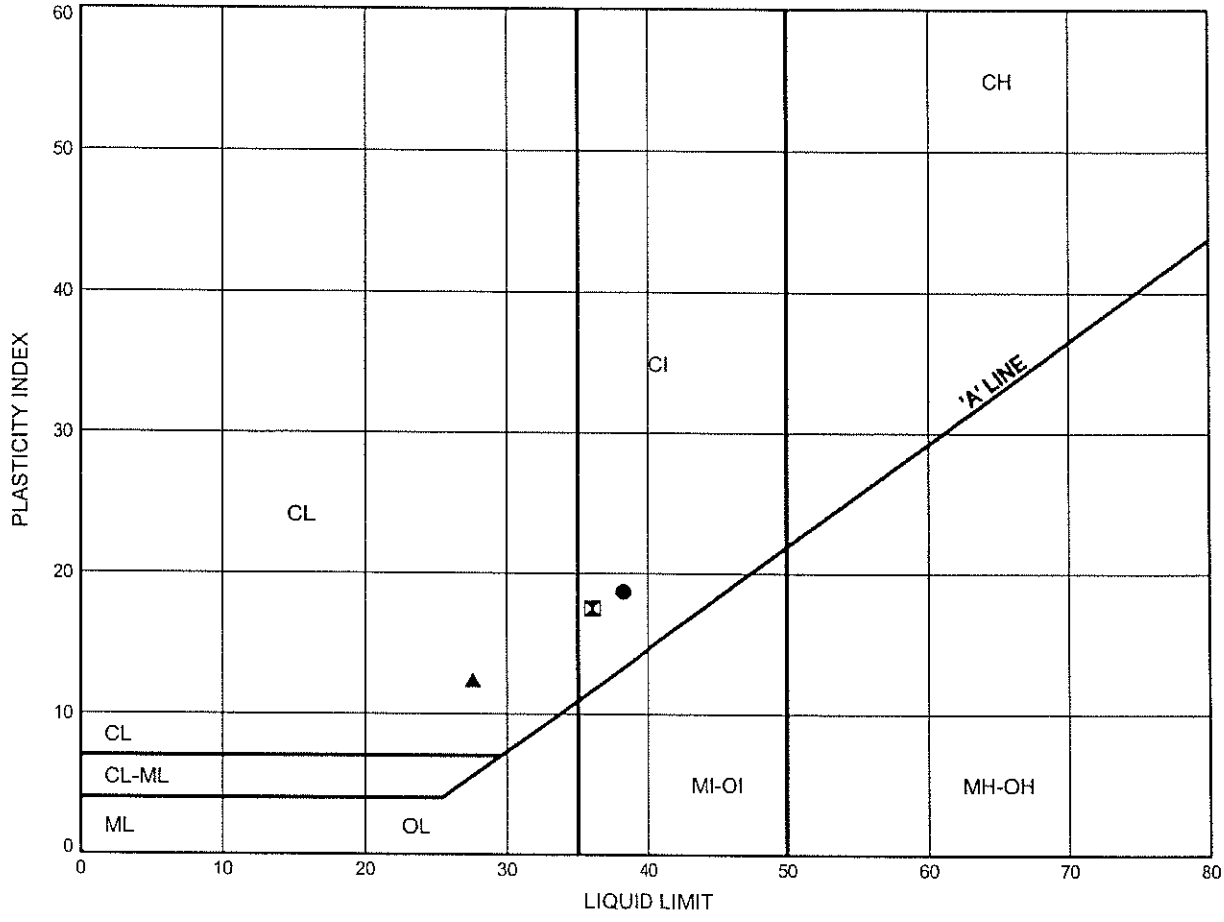
Hwy 401/410 to Credit River

ATTERBERG LIMITS TEST RESULTS

FIGURE C3

Silty Clay Fill



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	RW3-1	0.30	190.62
⊠	RW3-2	1.83	191.35
▲	RW4-5	3.35	188.76

Date December 2007

Project 2107-05-00

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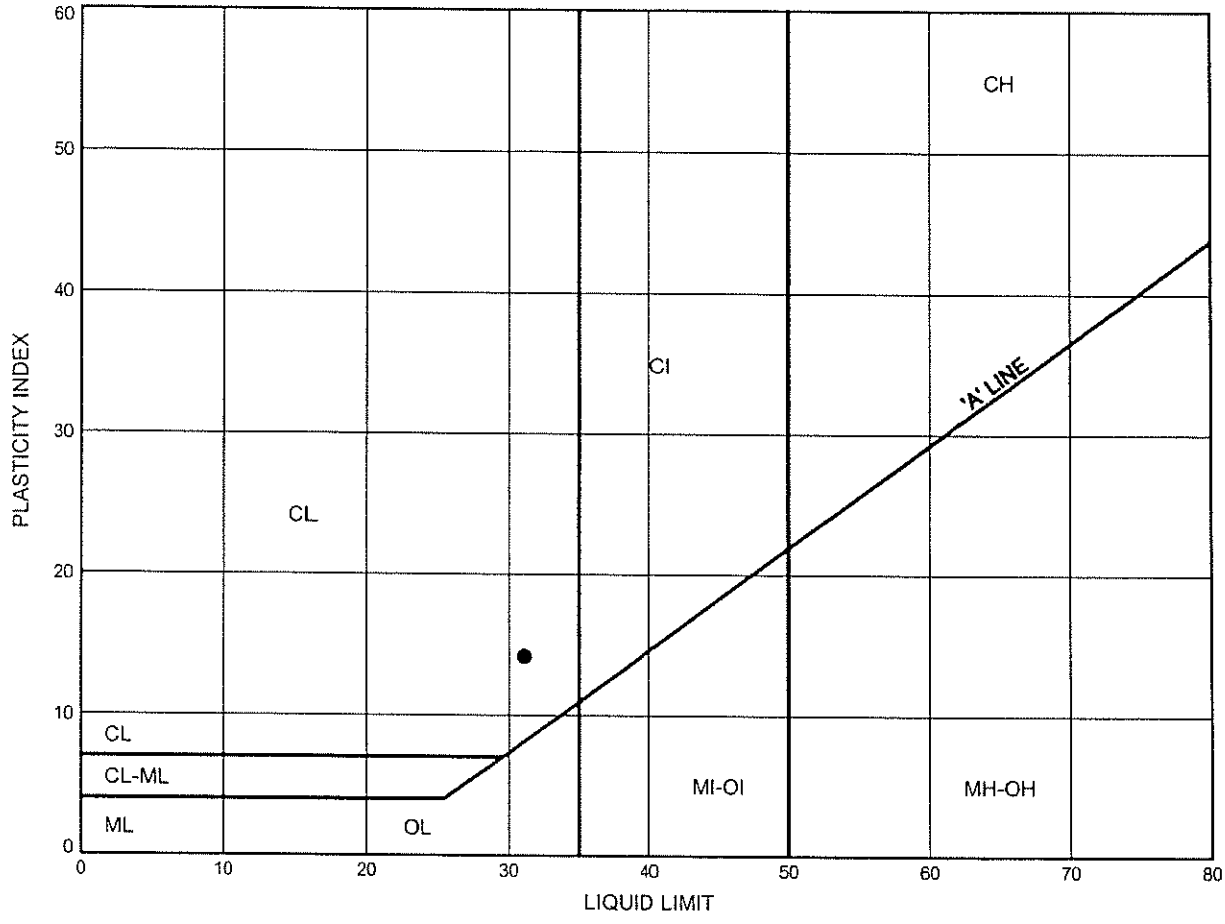
THURBALT 2311.GPJ 17/12/07

Hwy 401/410 to Credit River

ATTERBERG LIMITS TEST RESULTS

FIGURE C4

Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	RW4-2	0.30	186.53

Date December 2007

Project 2107-05-00

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Prep'd MFA

Chkd. RPR

THURBALT 2311.GPJ 17/12/07

Appendix D

Foundation Comparison

Highway 401 Widening – Hurontario Street South Access Road

COMPARISON OF FOUNDATION ALTERNATIVES

Footings on Native Soil	Footings on Shale	Driven Piles	Caissons
Advantages: i. Ease of construction. ii. Good geotechnical resistance is available on the till deposits. iii. Lower cost than deep foundations. *Disadvantages:* i. Subexcavation might be required to penetrate fill. ii. Lower geotechnical resistance in soil than in bedrock iii. Mass concrete fill may be required to raise the founding subgrade level. **RECOMMENDED**	*Advantages:* i. High values of geotechnical resistance are available on the bedrock. ii. Relatively simple construction method *Disadvantages:* i. Mass concrete fill may be required to raise the founding subgrade level. ii. Stepped footing may be required to accommodate undulation of bedrock. iii. Higher cost of excavation to bedrock. **RECOMMENDED**	*Advantages:* i. Piles will develop high geotechnical resistance in hard/dense soils. ii. Installation of piles could continue in freezing weather. iii. Readily installed. iv. Foundation construction requires less volume of excavation than footings *Disadvantages:* i. Higher unit costs than footings. ii. Possibility that cobbles and boulders may be encountered in till. iii. Not practical to drive piles into shale bedrock. **NOT RECOMMENDED**	*Advantages:* i. High resistance is available for caissons founded in dense till/bedrock. ii. Construction of caissons could continue in freezing weather. iii. Subexcavation of fill and variable material not required. *Disadvantages:* i. Higher cost than spread footings ii. Possibility of boulders being encountered during augering. iii. Potential difficulties penetrating hard limestone layers in shale. iv. More likely to encounter groundwater. v. Potential difficulty in cleaning and inspecting bases. **NOT RECOMMENDED**

THURBER

Appendix E

List of SPs and OPSS

Suggested Text for Selected NSSP

1. List of Special Provisions and OPSS Documents Referenced in this Report

- SP 902 S01.
- SP 572 S01
- OPSS 120, 1994
- SP 105S19
- OPSS 206
- OPSS 1010
- OPSD 208.010
- OPSS 902
- Special Provision 902S01
- OPSD 3101.150.
- OPSD 3102.100

OPSS 206, as amended by Special Provision "Amendment to OPSS 206, December 1993", dated November 2002.

All granular material should meet the specifications of Special Provision 110F13 "Amendment to OPSS 1010, March 1993".

2. Suggested Text for NSSP on "Native Hard Till" and "Rock Excavation"

Cobbles and boulders should be expected within the silty clay till layer. The silty clay till grades into weathered bedrock, accordingly, excavation of the lower zones of the till may be difficult.

The strength of the shale bedrock increases with depth and there is presence of very hard limestone and/or siltstone interbeds within the shale bedrock. Bulk excavation through the sound shale and the hard interbeds may be difficult. As such, rock coring equipment, pneumatic rock splitting/breaking equipment and ripping machinery should be available on site to assist in excavation and drilling.

Although shale bedrock is intrinsically of low permeability, the possibility exists that concentrated seepage may be experienced from localized seams or fractures in the rock. Means to handle this seepage, such as additional pumps, should be made available.

Appendix F

Borehole Locations and Soil Strata Drawing

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

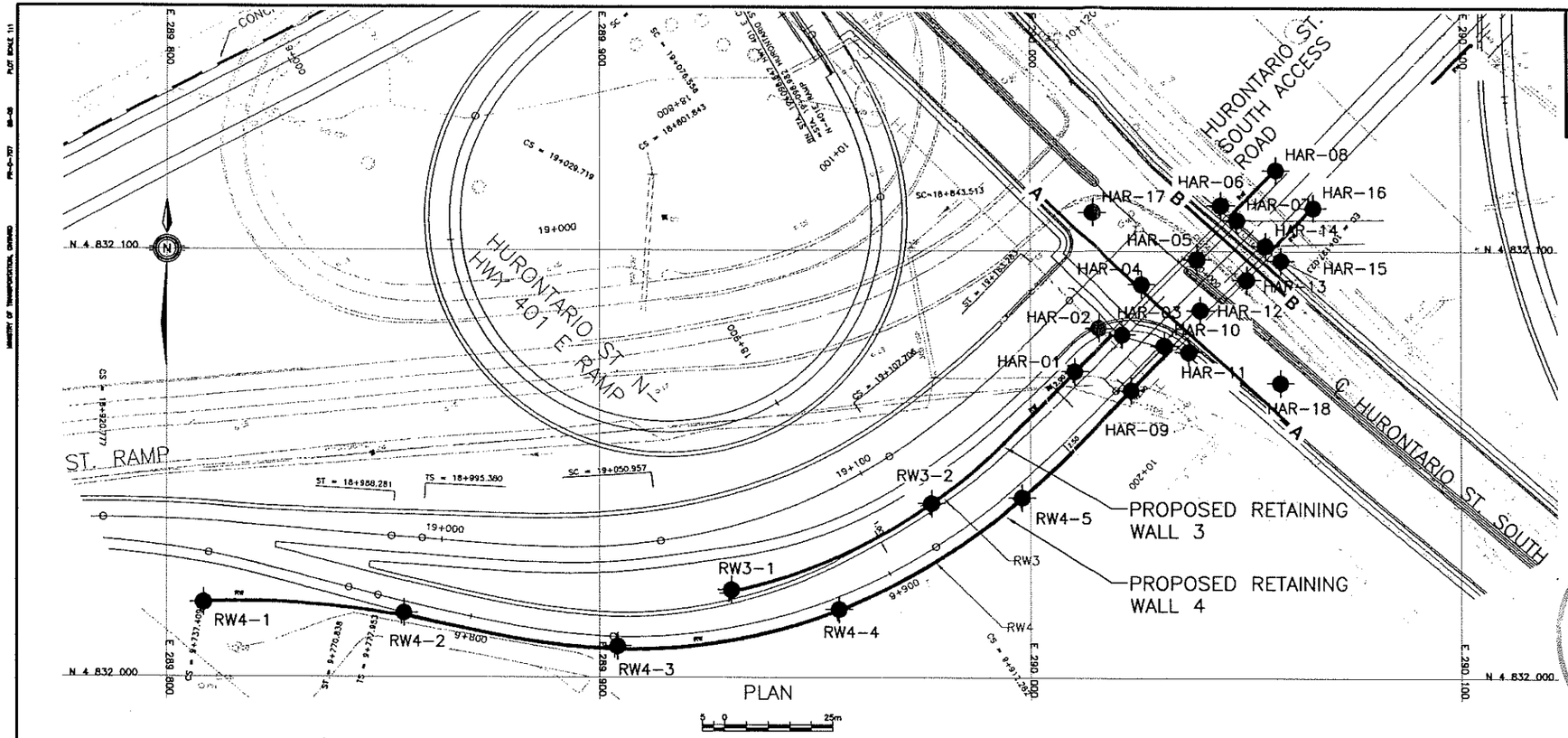
HWY 401
SITE No 24-758
GWP No 2107-05-00

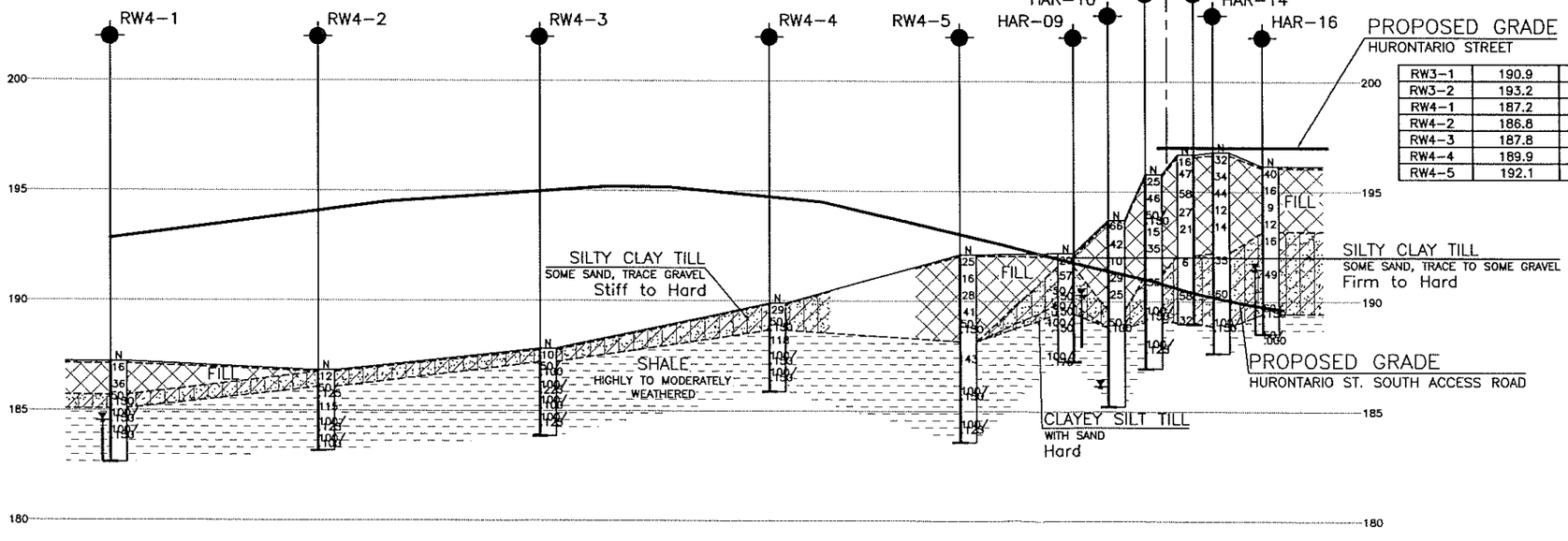
HURONTARIO STREET
SOUTH ACCESS ROAD
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

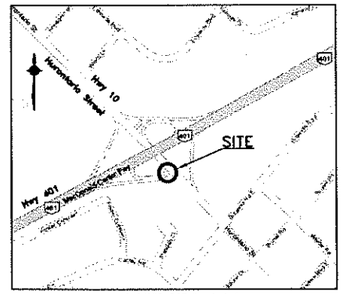
Marshall Macklin Monaghan
PROJECT MANAGERS • ENGINEERS • SURVEYORS • PLANNERS

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS





RW3-1	190.9	4 832 020.6	289 930.7
RW3-2	193.2	4 832 0040.9	289 977.2
RW4-1	187.2	4 832 0017.4	289 808.4
RW4-2	186.8	4 832 0015.1	289 854.8
RW4-3	187.8	4 832 0007.3	289 904.3
RW4-4	189.9	4 832 016.0	289 955.6
RW4-5	192.1	4 832 0042.2	289 998.1



KEYPLAN

LEGEND

✦	Borehole (Present Investigation, 2007)
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
⧗	Water Level
↑	Head Artesian Water
|	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HAR-01	192.1	4 832 072.0	290 010.5
HAR-02	193.8	4 832 082.1	290 016.0
HAR-03	193.7	4 832 080.6	290 021.6
HAR-04	195.9	4 832 092.4	290 026.2
HAR-05	196.7	4 832 098.2	290 039.0
HAR-06	197.2	4 832 110.7	290 044.3
HAR-07	197.0	4 832 107.3	290 048.0
HAR-08	196.5	4 832 118.9	290 057.0
HAR-09	192.2	4 832 067.6	290 023.7
HAR-10	193.7	4 832 078.0	290 031.5
HAR-11	194.0	4 832 076.5	290 037.1
HAR-12	195.8	4 832 086.3	290 039.7
HAR-13	196.7	4 832 093.4	290 050.3
HAR-14	196.8	4 832 101.3	290 054.6
HAR-15	196.6	4 832 097.8	290 058.2
HAR-16	196.1	4 832 110.1	290 065.9
HAR-17	197.1	4 832 109.1	290 014.6
HAR-18	195.0	4 832 069.3	290 058.1

-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.

Refer to DWG 2 for Sections A-A and B-B.

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN RPR	CHK PKC	CODE	LOAD DATE DEC 2007
DRAWN MFA	CHK PKC	SITE	STRUCT. SCHEME. DWG 1

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CREATED:

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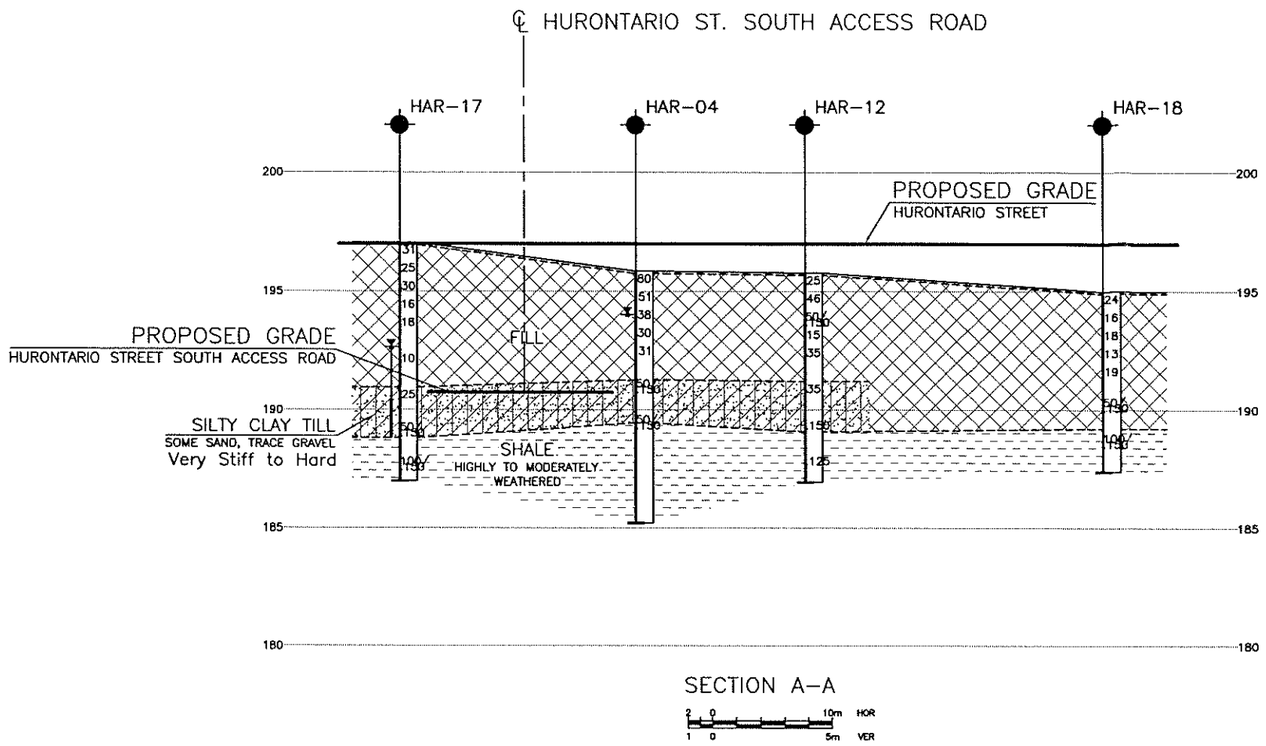
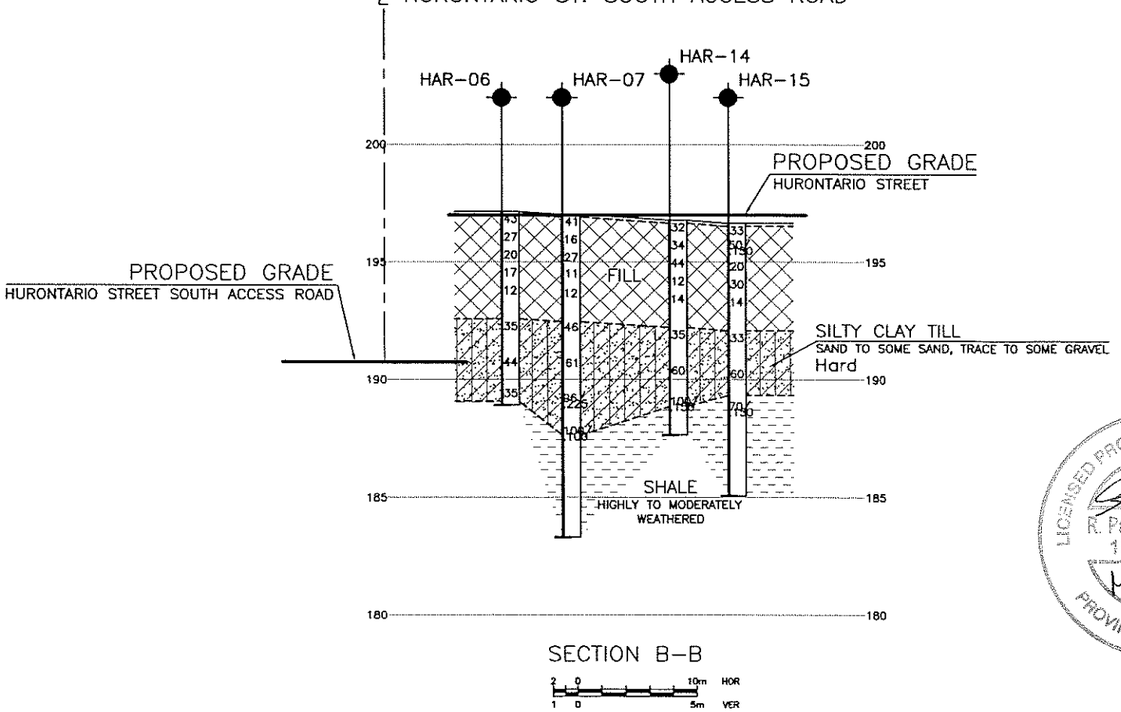


SECTION A-A

2 0 10m HOR
1 0 5m VER



SECTION B-B

2 0 10m HOR
1 0 5m VER

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

HWY 401
SITE No 24-758
GWP No 2107-05-00

HURONTARIO STREET
SOUTH ACCESS ROAD
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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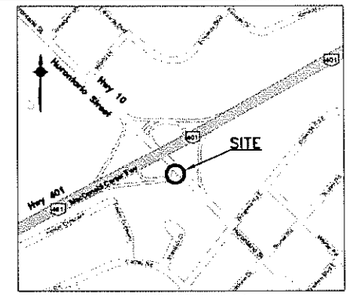

KEYPLAN

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	Piezometer
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HAR-05	196.7	4 832 098.2	290 039.0
HAR-06	197.2	4 832 110.7	290 044.3
HAR-07	197.0	4 832 107.3	290 048.0
HAR-08	196.5	4 832 118.9	290 057.0
HAR-09	192.2	4 832 067.6	290 023.7
HAR-10	193.7	4 832 078.0	290 031.5
HAR-11	194.0	4 832 076.5	290 037.1
HAR-12	195.8	4 832 086.3	290 039.7
HAR-13	196.7	4 832 093.4	290 050.3
HAR-14	196.8	4 832 101.3	290 054.6
HAR-15	196.6	4 832 097.8	290 058.2
HAR-16	196.1	4 832 110.1	290 065.9
HAR-17	197.1	4 832 109.1	290 014.6
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RW4-4	189.9	4 832 016.0	289 955.6
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GEOCRES No.

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
March 20, 2008
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 20/08
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	AEC	CHK	PKC	CODE	LOAD	DATE	DEC 2007
DRAWN	MFA	CHK	PKC	SITE	STRUCT.	SCHEME.	DWG 2

MINISTRY OF TRANSPORTATION, ONTARIO — PLOT SCALE 1:1 — PLOT DATE 08-03-27

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