FOUNDATION INVESTIGATION AND DESIGN REPORT

HIGHWAY 407/BROCK ROAD INTERCHANGE CONNECTION

STRUCTURE M-7 (SITE 102)

REALIGNED BROCK ROAD

OVER BROUGHAM CREEK TRIBUTARY 'A'

Contract No.: E2-2012

Report to

MMM Group Limited

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January 18, 2013
File: 19-5161-130A

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This section of the report presents the factual findings obtained from a foundation investigation conducted at the proposed location of a new culvert (Structure M-7) that will carry Brougham Creek Tributary ‘A’ under the proposed realigned Brock Road north of Highway 7, in Pickering, Ontario. The new culvert (and realigned Brock Road) is planned as part of the Highway 407/Brock Road Interchange Connection project.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, a stratigraphic profile, laboratory test results and written descriptions of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited, under the Highway 407 ETR Contract Number E2-2012 (Design).

2 SITE DESCRIPTION

The proposed culvert runs approximately north to south and is located approximately 200 m east of Brook Road and 450 m north of Highway 7. The community of Brougham is located approximately 575 m southwest of the proposed culvert site.

At the location of the proposed culvert, Brougham Creek Tributary ‘A’ flows from north to south. Lands surrounding the culvert site consist of shrubs and primarily of agricultural fields. A photograph showing the existing condition is provided in Appendix C.

The site is situated in the physiographic region known as the South Slope, which lies between the Oak Ridges Moraine and the Iroquois Plain and typically is characterized by overburden deposits consisting of sand and silt, overlying glacial till sheets. Lacustrine clay deposited by Lake Iroquois, is often encountered between or overlying the till sheets. ‘Surficial Geology of Southern Ontario’, as produced by The Ontario Geological Survey, shows that the culvert site is located in an area covered by sandy silt to silty sand till.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this structure were completed on December 14, 2012. One borehole, identified as SM7-01, was drilled and sampled at this site. A borehole drilled by Peto MacCallum Ltd. in December 2010 (identified as M7-2) has been included in this report. The boreholes were advanced to depths of 6.2 and 5.5 m (Elevation 195.8 and 199.6 m). The Record of Borehole sheets are included in Appendix A. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata drawing included in Appendix E.

An additional borehole (identified as M7-1) was also previously drilled by Peto MacCallum Ltd. However, since this borehole is not located along the proposed structure alignment, the data collected in this borehole is not summarized in this report.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling. Permission to Enter was obtained by way of a Memorandum of Understanding between Transport Canada (who owns the land) and MTO.

The borehole drilled during the current investigation was completed using a CME 55 track-mounted drill rig and the borehole was advanced with solid stem augers. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The boreholes were logged in the field and the recovered soil samples were transported to Thurber's laboratory in Oakville, Ontario for further examination and testing.

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. A standpipe piezometer, consisting of 25 mm diameter PVC pipe with a 1.5 m long slotted screen, was installed for subsequent monitoring of groundwater levels. The completion details of the piezometer and borehole are summarized in Table 3-1.

Table 3-1. Borehole Completion and Piezometer Installation Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Completion/Installation Details
SM7-01	6.2 / 195.8	Piezometer with 1.5 m slotted screen installed with filter sand to 4.3 m and bentonite holeplug to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis (sieve and hydrometer) testing, where appropriate. The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figure included in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy along the proposed culvert alignment are presented on the Record of Borehole sheets included in Appendix A and on the Borehole Locations and Soil Strata drawing included in Appendix E. An overall description of the stratigraphy encountered at the proposed culvert site 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, the subsurface stratigraphy encountered at the site consists of a surficial layer of topsoil overlying a layer varying from sandy silt to sand and silt which was underlain by a layer of silty sand till. At the outlet end of the culvert, a layer of silty clay was encountered above the silty sand till. More detailed descriptions of the individual strata are presented below.

5.1 Topsoil

A layer of topsoil was encountered at the ground surface in both of the boreholes. The thickness of the topsoil varied between 150 to 300 mm. The thickness of topsoil may vary between the boreholes and in other areas of the site.

5.2 Sandy Silt to Sand and Silt

A layer of sandy silt to sand and silt was encountered directly below the topsoil layer. The layer was brown and contained trace to some clay. Trace rootlets were noted in borehole SM7-01. The thickness of this layer ranged from 0.4 to 0.6 m. The layer had an underside depth between 0.7 and 0.8 m below the ground surface and an underside elevation ranging from 201.2 to 204.4 m.

A SPT N-value of 15 blows for 0.3 m penetration, indicating a compact relative density, was recorded in the sandy silt layer. A single moisture content of 24% was obtained in this layer.

5.3 Silty Clay

A layer of silty clay with some sand and trace gravel was encountered below the sandy silt within borehole SM7-01. The thickness of the layer was 0.7 m with an underside depth of 1.5 m (elev. 200.5 m) below the ground surface.

A SPT N-value of 20 blows for 0.3 m penetration, indicating very stiff consistency, was recorded in the clay layer. A single moisture content of 28% was obtained in this layer.

5.4 Silty Sand Till

Underlying the above layers was a deposit of silty sand till with trace to some gravel and trace to some clay. The till was encountered at depths ranging from 0.7 to 1.5 m and the boreholes were terminated in this layer at depths of 5.5 to 6.2 m (elev. 195.8 to 199.6 m).

SPT N-values recorded in the till ranged from 44 blows for 0.3 m penetration to greater than 100 blows for 0.13 m penetration, indicating a dense to very dense relative density. In general, N-values were greater than 100 blows for 0.3 m penetration (very dense). Moisture contents ranged from 5 to 10%.

Grain size analysis testing was performed on two samples of the silty sand till. The results of these tests are presented on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figures B1 of Appendix B. The results of the grain size analysis tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	9 to 10
Sand	45 to 49
Silt	32 to 36
Clay	8 to 10

It should be noted that glacial tills inherently contain cobbles and boulders.

5.5 Groundwater Conditions

Where present, water level was observed in the open borehole during and upon completion of drilling. One standpipe piezometer was installed at this site, in Borehole SM7-01, to monitor water levels after completion of drilling. The water level measured in the piezometer is summarized in Table 5-1, along with the measurements in the open boreholes upon completion of drilling.

Table 5-1. Measured Groundwater Levels

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
SM7-01	Dec. 14, 2012 Dec. 19, 2012 Jan. 3, 2013 Jan. 9, 2013	Dry 2.8 1.7 1.7	- 199.2 200.3 200.3	Open borehole Piezometer Piezometer Piezometer
M7-2	Dec.3, 2010	Dry		Open borehole

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 periods of significant or prolonged precipitation events.

6 MISCELLANEOUS

The borehole location was selected by Thurber Engineering Ltd. and staked in the field by an experienced Thurber staff member using a Trimble Pathfinder ProXRT differential GPS. The coordinates and ground surface elevations at the boreholes were surveyed by MMM upon completion of drilling.

DBW Drilling of Ajax, Ontario supplied a track-mounted drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. George Azzopardi. of Thurber.

Routine geotechnical laboratory testing was carried out by Thurber. Overall supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T. Interpretation of the data and preparation of the report were carried out by Mr. Stephen Peters, P.Eng(MB) and Mr. Alastair Gorman, P.Eng.

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

Thurber Engineering Ltd.

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This section of the report provides an interpretation of the factual data and also presents geotechnical recommendations for the design of the culvert that will carry Brougham Creek Tributary 'A' under the realigned Brock Road. These recommendations are based on the factual information and our understanding of the project. The plans and profiles used for preparation of this report were provided by MMM Group.

Based on the General Arrangement (GA) drawing for this proposed culvert, dated January 2013, the structure will be a concrete box culvert 2.4 m wide and height of 1.2 m with a total length of 48.8 m. The box culvert is shown to be located at approximate Sta. 9+229. The inlet and outlet elevations, as shown on the drawing, are 202.56 and 201.75 m. The embankment height above the box culvert at the centreline of the realigned Brock road is approximately 3.0 m.

In general, the subsurface stratigraphy encountered at the site consists of a surficial layer of topsoil overlying a layer varying from sandy silt to sand and silt which was underlain by a deposit of very dense silty sand till. The short term groundwater level at the site was measured at approximate elevation 200.3 m within the standpipe installed at the outlet end of the culvert.

8 CULVERT FOUNDATION

Foundation recommendations for the proposed culvert are provided in the following section. The culvert must be designed, at a minimum, to resist frost forces, lateral earth forces, hydrostatic pressures, weight of embankment fill, traffic loading and surcharge due to construction equipment.

8.1 Culvert Subgrade

In general, surface vegetation, topsoil, organic deposits, disturbed material or otherwise loose/soft soils must be stripped from the culvert area and embankment footprint prior to culvert installation. Based on the boreholes drilled, the highest permissible founding elevations for the box culvert are as follows:

Table 8-1. Highest Permissible Founding Elevation

Borehole Location	Borehole	Elevation (m)
Outlet	SM7-1	201.2
Inlet	M7-2	202.8

Following subexcavation to the design base level of the culvert, any remaining fill, topsoil, peat, streambed deposits or soft soils within the culvert footprint must be subexcavated to the undisturbed native soils at, or below, the elevations shown in Table 8-1. The exposed subgrade must be inspected to confirm that the subgrade is uniformly competent.

If a higher subgrade elevation is required, the area must be excavated as described above and brought up using Granular A compacted in accordance with OPSS 501 and OPSD 803.010. In all cases, a precast culvert must have a minimum of 300 mm of Granular A bedding below it. The bedding material must be placed as soon as practical following inspection and approval of the final subgrade as protection from disturbance during construction. The Granular A bedding must be compacted in accordance with OPSS 501. The bedding must extend a minimum of 0.5 m beyond the footprint of the culvert.

8.2 Bearing Resistance

The bearing resistance below a culvert founded on a subgrade prepared as described above will be 250 kPa at SLS and 375 kPa at ULS_f. However, the performance of a box culvert within an embankment is not governed by bearing resistance but by the settlement of the embankment. Settlement of the culverts will be governed by compression of the foundation soils under the weight of the road embankment fill.

The horizontal resistance against sliding between cast-in-place concrete founded on engineered granular fill can be computed using an ultimate friction factor of 0.60.

8.3 Settlement

The actual settlement of the culvert is expected to be controlled primarily by the settlement of the subgrade under the weight of road embankment fill. The settlement at the culvert foundation level due to the embankment loads is estimated to be less than 25 mm.

Settlement within the fill mass is estimated to be as high as 0.5% of the embankment height, approximately 20 mm. This settlement is expected to be essentially complete at the end of construction.

8.4 Frost Cover

Frost tapers must be included in accordance with the requirements of OPSD 803.030 or 803.031, as appropriate. The design depth of frost penetration is 1.2 m.

9 EXCAVATION AND GROUNDWATER CONTROL

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of assessing excavation slope requirements in compliance with the OHSA, the native soils above the recommended culvert founding elevations in Table 8-1 are classified as Type 3 soils. The underlying foundation soils are classified as Type 2 soil.

The sides of temporary excavations must be sloped in accordance with the requirements of OHSA. Where space does not permit the sides to be sloped, temporary shoring must be used.

Selection of the equipment and methodology to excavate and prepare the founding surface is the responsibility of the Contractor. Based on the preliminary GA and recorded ground water levels, excavation below the groundwater level to construct the culvert may occur. Therefore, the Contractor should be prepared to pump from sumps to remove any remaining seepage water or surface water collecting in an excavation. Placement of the culvert must be done in the dry. Unwatering must remain operational and effective until the culvert is installed and backfilled.

Furthermore, the excavation and backfilling for foundations must be carried out in accordance with OPSS 902.

10 SCOUR PROTECTION AND EROSION CONTROL

Culvert foundations must be provided with scour protection. Erosion control should be provided at the culvert inlet and outlet areas as applicable. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in this field.

Typically, rock protection should be provided over all surfaces with which creek flow is likely to be in contact. Treatment at the outlets should be in accordance with OPSD 810.010. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion, in accordance with OPSS 804

It is recommended that a clay seal or a concrete cut-off wall be used to minimize the potential for flow of water through the granular backfill around the culvert and accompanying risk of erosion. The clay seal should extend at least 0.3 m above the high water level and laterally for the width of the granular material, and have a minimum thickness parallel to the culvert of 0.5 m. The material requirements should be in accordance with OPSS 1205. A prefabricated geosynthetic clay liner, such as Bentofix NSL, may be used as an alternative to a clay seal.

11 CULVERT BACKFILL

The culvert backfill must consist of free-draining granular material conforming to OPSS Granular A or B Type II meeting the requirements of Special Provisions 110S13 "Amendment to OPSS 1010, April 2004". The granular material should be placed at least to the general extents shown in OPSD 803.010.

Backfill must be placed and compacted in simultaneous equal lifts on both sides of the culvert, and the top of backfill elevation should be within 400 mm on both sides of the culvert at all times. Heavy compaction equipment should not be used adjacent to the walls and roof of the culvert. Compaction equipment to be used adjacent to the culvert must be restricted in accordance with OPSS 501. Compaction must be carried out in accordance with OPSS 501.

12 LATERAL EARTH PRESSURE

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

$$p = K(\gamma h + q)$$

where:
- p = horizontal pressure on the wall at depth h (kPa)
- K = earth pressure coefficient (see table below)
- γ = unit weight of retained soil (see table below)
- h = depth below top of fill where pressure is computed (m)
- q = value of any surcharge (kPa)

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 the 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.

Earth pressure coefficients for backfill to the culvert are dependent on the material used as backfill. Recommended unfactored values are shown in Table 12-1. The at-rest coefficients should be employed for closed box culvert walls. Active pressures should be used for any wingwalls or unrestrained walls.

The active and passive earth pressure coefficients in Table 12-1 are "ultimate" values and require certain movements for the respective conditions to be mobilized. The values to be used in design can be estimated from Figure C6.16 in the Commentary to the CHBDC.

The design of the culvert must incorporate measures such as weepholes or subdrains to permit drainage of the culvert backfill or alternatively the culvert walls should be designed to withstand the potential build-up of hydrostatic pressures behind the walls.

Table 12-1. Earth Pressure Coefficients

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

* For wing walls, if employed.

13 SEISMIC CONSIDERATIONS

13.1 Seismic Design Parameters

The following seismic parameters should be used for design:

Velocity Related Seismic Zone	1
Zonal Velocity Ratio	0.05
Acceleration Related Seismic Zone	1
Zonal Acceleration Ratio	0.05
Peak Horizontal Acceleration	0.08

The soil profile type at this site has been classified as Type II. Thus, according to Table 4.4 of the CHBDC, a Site Coefficient "S" (ground motion amplification factor) of 1.2 should be used in seismic design.

13.2 Dynamic Earth Pressures

In accordance with Clause 4.6.4 of the CHBDC, structures should be designed using earth pressure coefficients that incorporate the effects of earthquake loading. The seismic earth pressure coefficients for active (K_{AE}) and passive (K_{PE}) conditions for seismic loading are shown in Table 13-1.

Table 13-1. Earth Pressure Coefficients for Seismic Design

Condition	Earth Pressure Coefficient (K) for Earthquake Loading			
	OPSS Granular A or 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 Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active*, K_{AE} (Unrestrained Wall)	0.30	0.47	0.34	0.58
At rest**, K_{OE} (Restrained Wall)	0.53	-	0.58	-
Passive*, K_{PE} (Movement Towards Soil Mass)	3.6	-	3.2	-

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

13.3 Liquefaction Potential

The foundation soils under the embankment are not in danger of undergoing liquefaction. Some toe failure may occur but it is expected to be of limited nature and readily repairable.

14 EMBANKMENT

Embankment construction must be carried out in accordance with OPSS 206. The embankment material should consist of Select Subgrade Material (SSM).

In general, surface vegetation, topsoil, organic matter, disturbed material or other loose/soft soils must be stripped from the new culvert and embankment footprint. Inspection and approval of the foundation surfaces by qualified geotechnical personnel is recommended.

Provided that the SSM is placed as recommended, it is anticipated that a slope inclination of 2H:1V or flatter should remain stable.

15 TEMPORARY SHORING

If temporary shoring is required, it must be implemented in accordance with OPSS 539 and designed for Performance Level 2.

Trench boxes or conventional steel soldier piles and timber lagging walls may be considered to provide temporary support to the soils during excavation. Timber lagging boards should be installed as soon as the soil face is exposed and properly prepared.

The design of a temporary shoring is the responsibility of the Contractor. 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 must be designed by a licensed Professional Engineer experienced in such designs, who will determine an appropriate support system.

Temporary surface water control measures will be required during construction. Although the responsibility for selecting appropriate dewatering methods remains the responsibility of the Contractor, it is anticipated that pumping from properly filtered sumps will be adequate to handle groundwater on this project.

Decisions regarding dewatering, shoring methods and sequencing should be made by the contractor and submitted to the Contract Administrator for information purposes.

16 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- Care must be exercised during excavation to avoid disturbing the founding subgrade. The exposed subgrade should be protected from physical disturbance, and the granular bedding must be placed on the approved subgrade expeditiously following excavation.
- Sump pumping, as required, is essential to maintaining a reasonably dry excavation.

The successful performance of the culverts will depend largely upon good workmanship and quality control during construction. Subgrade examination and field density testing should be carried out by qualified geotechnical personnel during construction to confirm that foundation recommendations are correctly implemented and material specifications are met.

17 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Stephen Peters P.Eng(MB) and Mr. Alastair E. Gorman, P.Eng.

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

Thurber Engineering Ltd.

Jan 18/13

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Appendix A
Record of Borehole Sheets

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No SM7-01

METRIC

WP#	E2-2012	LOCATION	N 4 864 894.6 E 336 566.7	ORIGINATED BY	GA
HWY	407	BOREHOLE TYPE	Solid Stem Augers	COMPILED BY	AN
DATUM	Geodetic	DATE	2012.12.14 - 2012.12.14	CHECKED BY	LRB

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
202.0	
0.0	**TOPSOIL:** (150mm)
0.2	Sandy **SILT**, some clay, trace rootlets Compact Brown Dry
201.2 / 0.8	Silty **CLAY**, some sand, trace gravel Very Stiff Brown Damp
200.5 / 1.5	Silty **SAND**, trace clay, some gravel Very Dense Brown to Grey with depth Dry (TILL)
195.8 / 6.2	END OF BOREHOLE AT 6.2m. BOREHOLE OPEN TO 6.1m AND DRY. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
Jan. 03/13	1.7	200.3
Jan. 09/13	1.7	200.3

SAMPLES

NUMBER	TYPE	"N" VALUES	WATER CONTENT (%) (approx., from plot)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	15	~22	
2	SS	20	~24	
3	SS	84	~9	10 45 36 8
4	SS	116	~7	
5	SS	107/ 0.150	~7	
6	SS	121/ 0.150	~7	9 49 32 10
7	SS	102/ 0.150	~7	

Column headings: GROUND WATER CONDITIONS; ELEVATION SCALE (202, 201, 200, 199, 198, 197, 196); 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.

+³, ×³: Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No M7-2

METRIC

G.W.P. 07-20015 LOCATION Coords: 4 864 933.1 N; 336 578.1 E ORIGINATED BY Z.I

DIST Central HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.

DATUM Geodetic DATE December 03, 2010 CHECKED BY G.D.

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)
205.1	Ground Surface				205	
0.0	Topsoil	1	SS	5		
204.8 / 0.3	Sand and silt, trace clay; Compact Brown Moist					
204.4 / 0.7	Silty sand some clay, trace gravel; Dense to very dense Grey Moist (TILL)	2	SS	96	204	o
		3	SS	44		o
		4	SS	100/15cm	203	o
		5	SS	102/20cm	202	o
	some gravel, trace clay	6	SS	100/13cm	201	o
		7	SS	100/13cm		o
199.6 / 5.5	End of borehole	8	SS	100/13cm	200	o

Column headings: SOIL PROFILE (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 (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)

Samples 4, 5, 6, 7 & 8: Sampler bouncing

* Borehole dry

+7, ×5: Numbers refer to Sensitivity

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

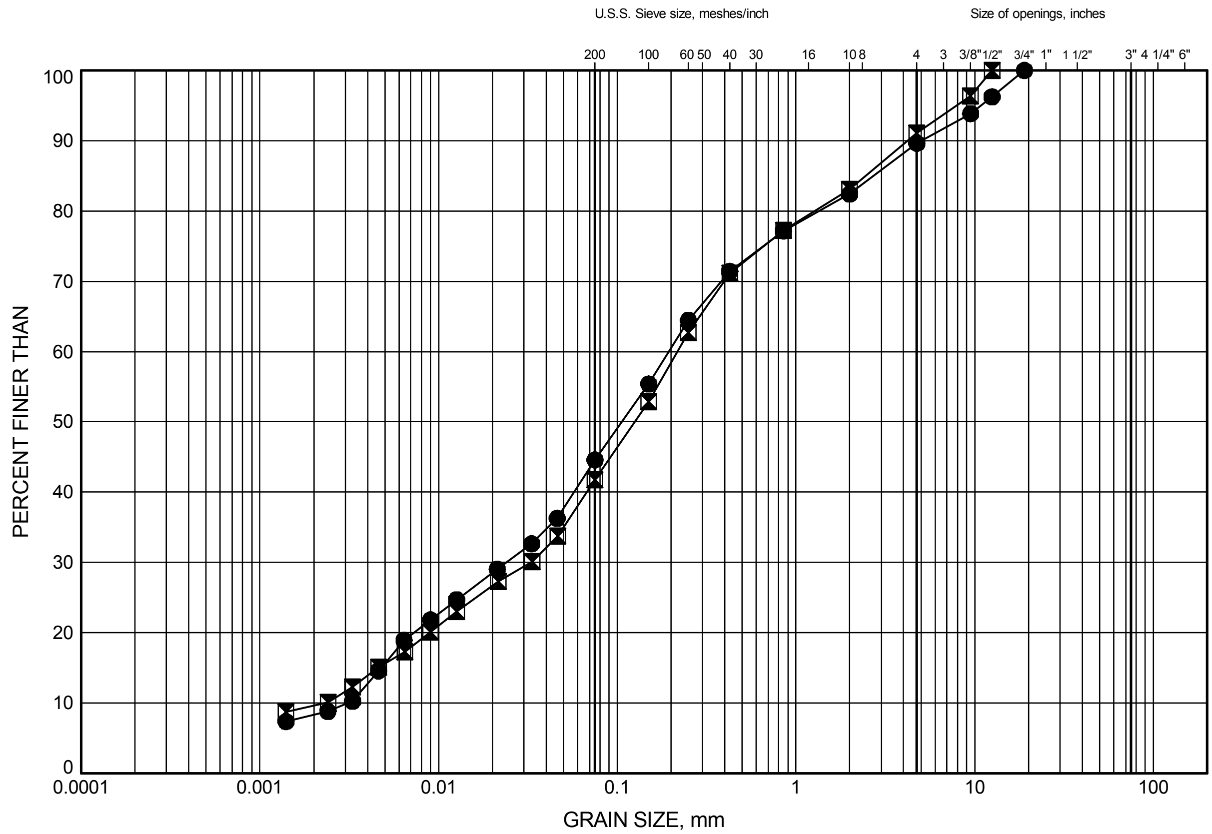
Appendix B
Laboratory Test Results

Hwy 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty Sand Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SM7-01	1.83	200.17
⧗	SM7-01	4.64	197.36

Date January 2013

WP# E2-2012

THURBER

Prep'd SBP

Chkd.

GRAIN SIZE DISTRIBUTION - THURBER 1130A.GPJ 8/1/13

Appendix C
Site Photograph

Photograph 1: Looking north, toward culvert outlet

Appendix D
List of SP’s and OPSS

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

- OPSS 206
- OPSS 501
- OPSS 539
- OPSS 804
- OPSS 902
- OPSS 1205
- OPSD 803.010
- OPSD 803.030
- OPSD 810.010
- Special Provisions 110S13

Appendix E
Borehole Locations and Soils Strata Drawing

NO.	DATE	REVISIONS	BY	CHK	LEAD DISC	PROJ MAN.

CONTRACT No. E2-2012

HWY 407/BROCK ROAD INTERCHANGE

STRUCTURE M-7 (SITE 102)
REALIGNED BROCK ROAD OVER
BROUGHAM CREEK TRIBUTARY 'A'
BOREHOLE LOCATIONS AND SOIL STRATA

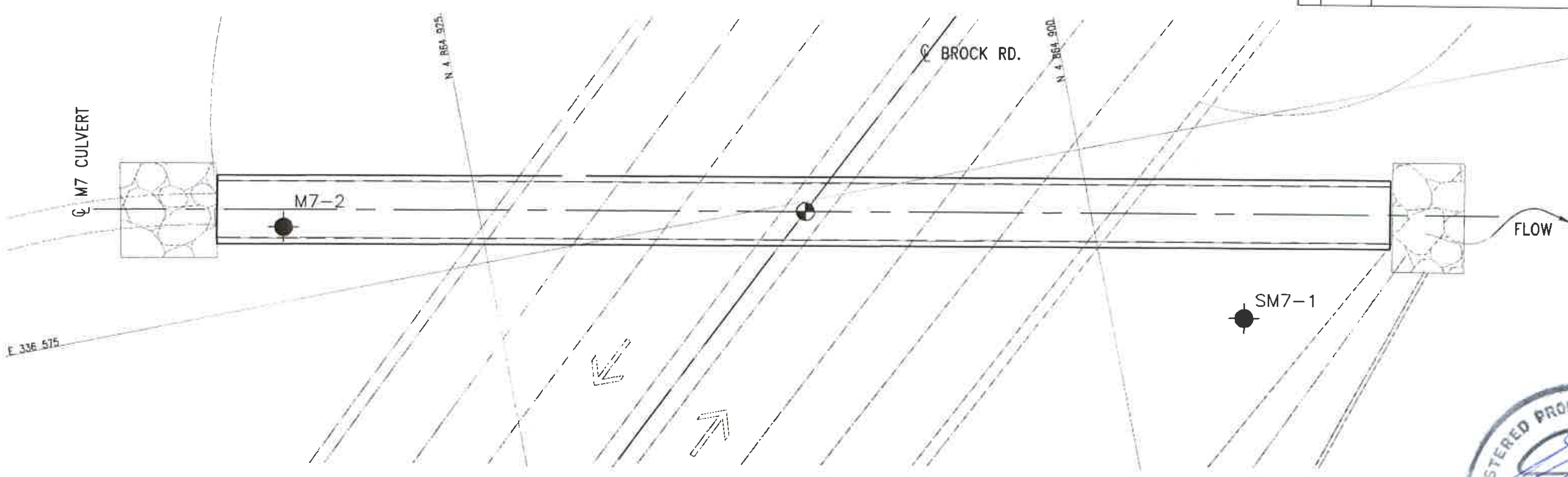
SHEET

407 ETR Express Toll Route

MMM GROUP

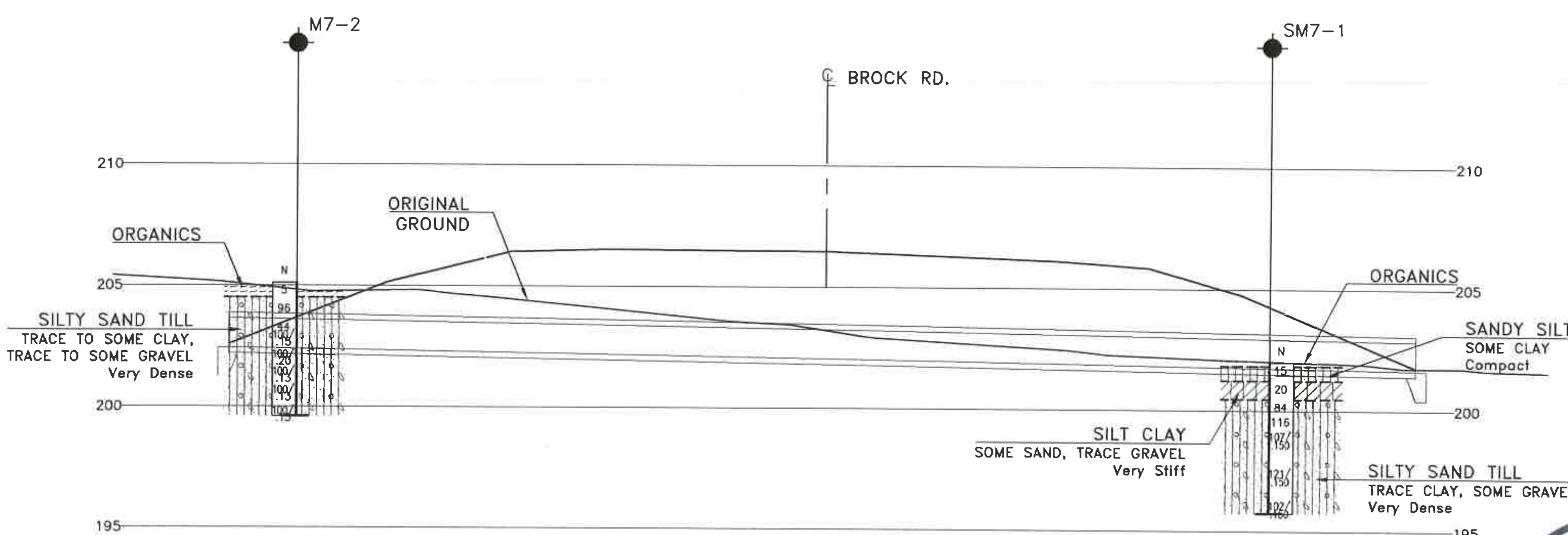
THURBER ENGINEERING LTD.

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



PLAN

SCALE 1:250

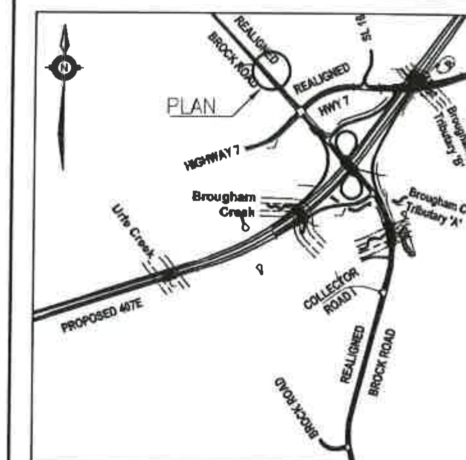


PROFILE ALONG ℄ M-7 CULVERT

SCALE 1:250

REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
JAN 18/13
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
Jan 18/13
PROVINCE OF ONTARIO



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
SM7-1	202.0	4 864 894.6	336 566.7
M7-2	205.1	4 864 933.1	336 578.1

-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.

DESIGN SBP	CHK AEG	CODE		LOAD	DATE JAN. 2013
DRAWN AN	CHK SBP	SITE 102	STRUCT M-7		DWG 1

DRAWING NAME: H:\Drafting\19\5161\130\ted1130A-M7-BoreholePlan&Profile.dwg
CREATED: January 7, 2013 MODIFIED: January 23, 2013