FOUNDATION INVESTIGATION REPORT
PRELIMINARY DESIGN AND ENVIRONMENTAL ASSESSMENT
QEW MISSISSAUGA ROAD OVERPASS
MISSISSAUGA, ONTARIO
W.O. 08-20008, ASSIGNMENT NO. 2008-E-0025

GEOCRES Number: 30M12-342

Report to

McCormick Rankin Corporation

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H:\19\1351\174 QEW at Credit River\Reports and Memos\191351174 QEW Mississauga Road Interchange FIR FINAL Rep may 12.doc

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a preliminary foundation investigation carried out for the proposed replacement of the QEW/Mississauga Road overpass. This investigation was carried out to support the preliminary design of the QEW from West of Hurontario Street to West of Mississauga Road in Mississauga, Ontario.

The purpose of the investigation was to explore the subsurface conditions near the foundation elements and, based on the data obtained, to provide a borehole locations and soil strata drawing, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained during the course of the present investigation.

Information contained in the following report for a previous investigation was reviewed as part of the current investigation.

- Racey, MacCallum and Associates Limited report titled "Soils Investigation, Queen Elizabeth Way Overpass at Mississauga Road", GEOCRES No. 30M12-116, Report No.: S-500-516/55/T-103-1, dated June 20, 1955 (Reference 1).

Thurber was retained by McCormick Rankin Corporation (MRC) to carry out the foundation investigation at this site on behalf of the Ministry of Transportation Ontario (MTO) under W.O. 08-20008 and Consultant Assignment No. 2008-E-0025.

2 SITE DESCRIPTION

The existing QEW/Mississauga Road overpass is located 500 m south-west of the QEW/Credit River crossing on a flat landscaped area of small trees and shrubs close to residential housings.

The existing QEW/Mississauga Road interchange structure is a single span overpass that is currently proposed to be replaced by a new structure of sufficient width to accommodate extra lanes on the

QEW as a result of widening works at Credit River Bridge, located north-east of the interchange structure.

From published geological information, the site is situated within the physiographic region known as the Iroquois Plain. In this area, soil deposits are relatively thin and typically consist of cohesive soils (some tills) overlying shale bedrock of the Georgian Bay Formation. The till is known to contain fragments of shale and limestone.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried on September 17, 2011. Two boreholes were drilled and sampled. The boreholes were drilled within the Mississauga Road cut and were numbered MR11-01 and MR11-02. Borehole MR11-01 was drilled to the west and borehole MR11-02 was drilled to the east of the overpass. Details of borehole depth are summarised below:

Borehole Number	Ground Elevation	Borehole Termination Elevation	Borehole Termination Depth (m)
MR11-01	94.3	90.7	3.6
MR11-02	93.3	85.6	7.7

The borehole locations were staked and/or marked in the field by Thurber. Utility clearance was obtained at all borehole locations prior to drilling. The northing and easting co-ordinates and ground surface elevations of the completed boreholes were provided by MRC.

A track mounted CME 55 drill rig was used to conduct the drilling, sampling and in-situ testing. Auger drilling techniques were used to advance the boreholes through soils and weathered bedrock. Soil and weathered bedrock samples were obtained at selected intervals using a split spoon sampler in conjunction with the Standard Penetration Testing (SPT). These boreholes were further advanced into bedrock by NQ size rotary coring techniques to recover core samples. All rock cores were logged, and properties including the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined where applicable.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's laboratory for further examination and testing.

Standpipe piezometer was installed in borehole MR11-02 to monitor groundwater level. The piezometer comprises a 25 mm diameter Schedule 40 PVC pipes with 1.52 m long slotted screens. The sand screen surrounding the pipe extends above the slotted portion of the pipe. Bentonite holeplug seals were placed above the sand screen in the piezometer installation. The completion details of the boreholes and piezometer installation are summarised in Table 1 attached after the text

of the report. On completion of drilling and sampling, boreholes without piezometer installation were backfilled with bentonite holeplug and then concreted to surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A. Selected soil samples were subjected to grain size distribution analysis. The results of this testing program are presented on the Record of Borehole sheets in Appendix A and on the figures in Appendix B.

Point Load Tests (PLT) were carried out on selected rock core samples and the results are shown in Table 2 attached after the text of the report and on the Records of Boreholes in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil and rock stratigraphy are presented in these records and on the "Borehole Locations and Soil Strata" drawing in Appendix C. General description of the stratigraphy is given in the following paragraphs. The factual information established at the borehole locations governs any interpretation of site conditions.

The stratigraphy at the Mississauga Road Interchange overpass typically consists of pavement structure overlying fill. Shale bedrock is encountered below the fill.

5.1 Pavement Structure

Pavement structure typically consists of 100 to 250 mm of asphalt overlying 400 mm of brown sand with some gravel. Moisture content between 3% and 3.5% was measured in the sand.

A SPT 'N' value of 53 blows per 0.3 m penetration was recorded within the granular layer of the pavement structure.

5.2 Gravelly Sand and Sand Fill

Fill was encountered below the pavement structure in both boreholes. In Borehole MR11-01, the fill comprises brown sand containing some gravel, some silt and trace of clay. In Borehole MR11-02, the fill consists of brown gravelly sand overlying sand with trace silt. Trace of organics was noted in the gravelly sand fill, whereas limestone and shale fragments were noted in the underlying sand fill.

The fill is 1.0 m thick in Borehole 11-01 and the underside of the fill is at 1.1 m depth (Elevation 93.2 m). In Borehole MR11-02, the fill below the road granular is 2.1 m thick and extends to 2.8 m depth (Elevation 90.5 m). Within the upper 1.1 to 1.3 m, the SPT 'N' values of the fill ranged from 47 to 63 blows per 0.3 m penetration indicating a dense to

very dense condition. Below 1.3 m depth in Borehole 11-02, 'N' values of 12 and 18 blows indicate a compact condition. The moisture content of the fill ranged from about 4% to 10%.

Grain size analysis was conducted on a sand fill sample from Borehole MR11-01. Results of the test is plotted in Figure B1 in Appendix B and summarized below.

Gravel %	17
Sand %	62
Silt %	16
Clay %	5

Grain size analysis was conducted on another sand fill sample from Borehole MR 11-02. Results of the test are presented in Figures B2 and summarised below.

Gravel %	49
Sand %	37
Silt & Clay %	14

Visual inspection of the sample used for the above test indicates high content of shale fragments and occasional limestone fragments in the sand fill above the bedrock in Borehole MR11-02. The 49% of gravel indicated by the grain size analysis test results comprised mainly of shale fragments.

5.3 Shale Bedrock

Weathered shale bedrock was encountered below the fill described above and proven by coring in boreholes MR11-01 and MR11-02. The depths and elevations of the bedrock surface are summarised below:

Borehole Number	Depth to Weathered Shale (m)	Top of Weathered Shale Elevation (m)
MR11-01	1.1	93.2
MR11-02	2.8	90.5

The bedrock was described as grey, fine grained, thinly bedded shale with hard limestone interbeds throughout. The shale is completely to highly weathered in Borehole MR11-01 and highly to moderately weathered in Borehole MR11-02. The degree of weathering generally decreases with depth. Clay seams were noted at depths of 1.9 to 2.2 m within the shale in borehole MR11-01. A hard limestone interbed at depths of 5.7 to 5.8 m and vertical joints at depths of 6.6 to 7 m were noted in borehole MR11-02.

Total Core Recovery (TCR) of the bedrock was generally between 55% and 100%. The Rock Quality Designation (RQD) values typically ranged between 30% and 70%, indicating

rock quality to be poor to fair. In borehole MR11-01, the first run of the core returned a RQD value of zero. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, is typically greater than 20 and occasionally ranged from 0 to 15.

The estimated unconfined compressive strength (UCS) of the shale, interpreted from point load tests conducted on intact rock cores, ranged from 2 to 16 MPa, indicating a very weak to weak rock. A point load test on a limestone interbed in Borehole MR11-02 gives a UCS value of 190 MPa indicating a very strong rock.

5.4 Groundwater Conditions

A standpipe piezometer was installed in Borehole MR11-02. The piezometric reading obtained on September 30, 2011 is presented below.

Borehole	Date	Ground Surface Elevation (m)	Groundwater	
			Depth (m)	Elevation (m)
MR11-02	September 30, 2011	93.3	2.3	91.0

The groundwater reading at this site is a short term observation. 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.

6 MISCELLANEOUS

Borehole locations and ground surface elevations were provided to Thurber by MRC.

The drilling and sampling equipment was supplied and operated by DBW Drilling Limited of Ajax, Ontario. The field work was supervised on a full time basis by Mr. David Ametrano of Thurber Engineering Ltd.

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

Overall supervision of the field program was conducted by Dr. Sydney Pang, P.Eng. Compilation of data and preparation of the report were carried out by Miss Mei Cheong. The report was reviewed by Dr. Pang.

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

THURBER ENGINEERING LTD.

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

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

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

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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

UNIFIED SOILS CLASSIFICATION

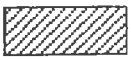
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

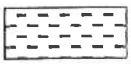
EXPLANATION OF ROCK LOGGING TERMS

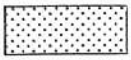
ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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Ontario

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RECORD OF BOREHOLE No MR11-01 1 OF 1 METRIC

W.P. W.O. 08-20008 LOCATION N 4 823 600.3 E 295 564.2 QEW Mississauga Road Overpass ORIGINATED BY DA

HWY QEW BOREHOLE TYPE Solid Stem Augers/NQ Core Barrel COMPILED BY AN

DATUM Geodetic DATE 2011.09.17 - 2011.09.17 CHECKED BY MEF

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
94.3											
0.0	**ASPHALT:** (100mm)		1	AS							
0.1	**SAND**, some gravel, some silt, trace clay Dense Brown Moist		1	SS	47		94				17 62 16 5
93.3	(FILL)		2	SS	62/						
1.1	Some limestone fragments				0.28						
92.8	**SHALE**, weathered, grey						93				
1.5	END OF SPT SAMPLING AT 1.2m. AUGER TO 1.5m AND START CORING. FOR ROCK DETAILS PLEASE REFER TO MR11-01R.										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 1174.GPJ 11/18/11

RECORD OF BOREHOLE MR11-01R

PROJECT : QEW Mississauga Rd. Overpass
LOCATION : Mississauga, ON
STARTED : September 17, 2011
COMPLETED : September 17, 2011

INCLINATION: Vertical AZIMUTH:

Project No. W.O. 08-20008

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER .3 m	DISCONTINUITY DATA DIP wrt Core Axis	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	Unconfined Compressive Strength (MPa)	FIELD/LABORATORY TESTING RESULTS
				92.8												
2	NQ Coring RUN	**SHALE**, completely to highly weathered, fine grained, thinly bedded, grey, weak with strong limestone interbeds: (GEORGIAN BAY FORMATION) Clay seams at 1.9m and 2.2m		1.5	1	0.15	-						Broken Core			
	NQ Coring RUN				2	0.10	-						Broken Core			
				90.7												
4		END OF BOREHOLE AT 3.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.		3.6												
6																
8																
10																

FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN
F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED
SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR
FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED

FIELD/LABORATORY TESTING RESULTS
● Point Load Test Diametral
▲ Point Load Test Axial
▣ Laboratory UCS Test

GROUNDWATER ELEVATIONS

SHALLOW/SINGLE INSTALLATION
WATER LEVEL (date)

DEEP/DUAL INSTALLATION
WATER LEVEL (date)

LOGGED : DA
CHECKED : MEF

ROCKM 1174.GPJ 11/11/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No MR11-02 1 OF 1 METRIC

W.P. W.O. 08-20008 LOCATION N 4 823 601.1 E 295 645.2 QEW Mississauga Road Overpass ORIGINATED BY DA

HWY QEW BOREHOLE TYPE Solid Stem Augers/NQ Core Barrel COMPILED BY AN

DATUM Geodetic DATE 2011.09.17 - 2011.09.17 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.3											
0.0 93.1	**ASPHALT:** (250mm)										
0.3 92.6	**SAND**, some gravel Very Dense Brown Moist (FILL)		1	SS	53		93		○		
0.7 92.0	Gravelly **SAND**, trace organics Very Dense Brown Moist (FILL)		2	SS	63		92		○		
1.3 90.5	**SAND**, fine grained, trace silt, some limestone fragments, trace shale fragments Compact Moist (FILL)		3	SS	12				○		
			4	SS	18		91		○		49 37 14 (SI+CL)
2.8 90.2	**SHALE**, weathered, grey		5	SS	50/ 0.100				○		
3.1	END OF SPT SAMPLING AT 3.1m AND START CORING. FOR ROCK DETAILS PLEASE REFER TO MR11-02R. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.30/11 2.3 91.0										

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

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

ONTMT4S 1174.GPJ 11/18/11

RECORD OF BOREHOLE MR11-02R

PROJECT : QEW Mississauga Rd. Overpass
LOCATION : Mississauga, ON
STARTED : September 17, 2011
COMPLETED : September 17, 2011

INCLINATION: Vertical AZIMUTH:

Project No. W.O. 08-20008

SHEET 1 OF 1
DATUM Geodetic

DEPTH SCALE (metres)	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER .3 m	DISCONTINUITY DATA DIP wrt Core Axis	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	Unconfined Compressive Strength (MPa)	FIELD/LABORATORY TESTING RESULTS
				93.31													
4	NQ Coring RUN	**SHALE**, highly to moderately weathered, fine grained, thinly bedded, grey, very weak to weak, with strong to very strong limestone interbeds: (GEORGIAN BAY FORMATION)		3.1	1	0.06	100							Broken Core			Slotted Screen
														Broken Core			
														Broken Core			88.74
	NQ Coring RUN	becoming slightly weathered			2	0.09	100							Broken Core (4.6m - 4.8m)			
		limestone interbeds from 5.7m to 5.8m															
6														Limestone			Sand
	NQ Coring RUN	vertical joint from 6.6m to 7.0m			3	0.07	100										
				85.6													85.59
		END OF BOREHOLE AT 7.7m.		7.7													
8																	
10																	
12																	

FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN
F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED
SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR
FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED

FIELD/LABORATORY TESTING RESULTS
● Point Load Test Diametral
▲ Point Load Test Axial
■ Laboratory UCS Test

GROUNDWATER ELEVATIONS

SHALLOW/SINGLE INSTALLATION
WATER LEVEL (date)

DEEP/DUAL INSTALLATION
WATER LEVEL (date)

LOGGED : DA
CHECKED : MEF

ROCKM 1174.GPJ 11/11/11

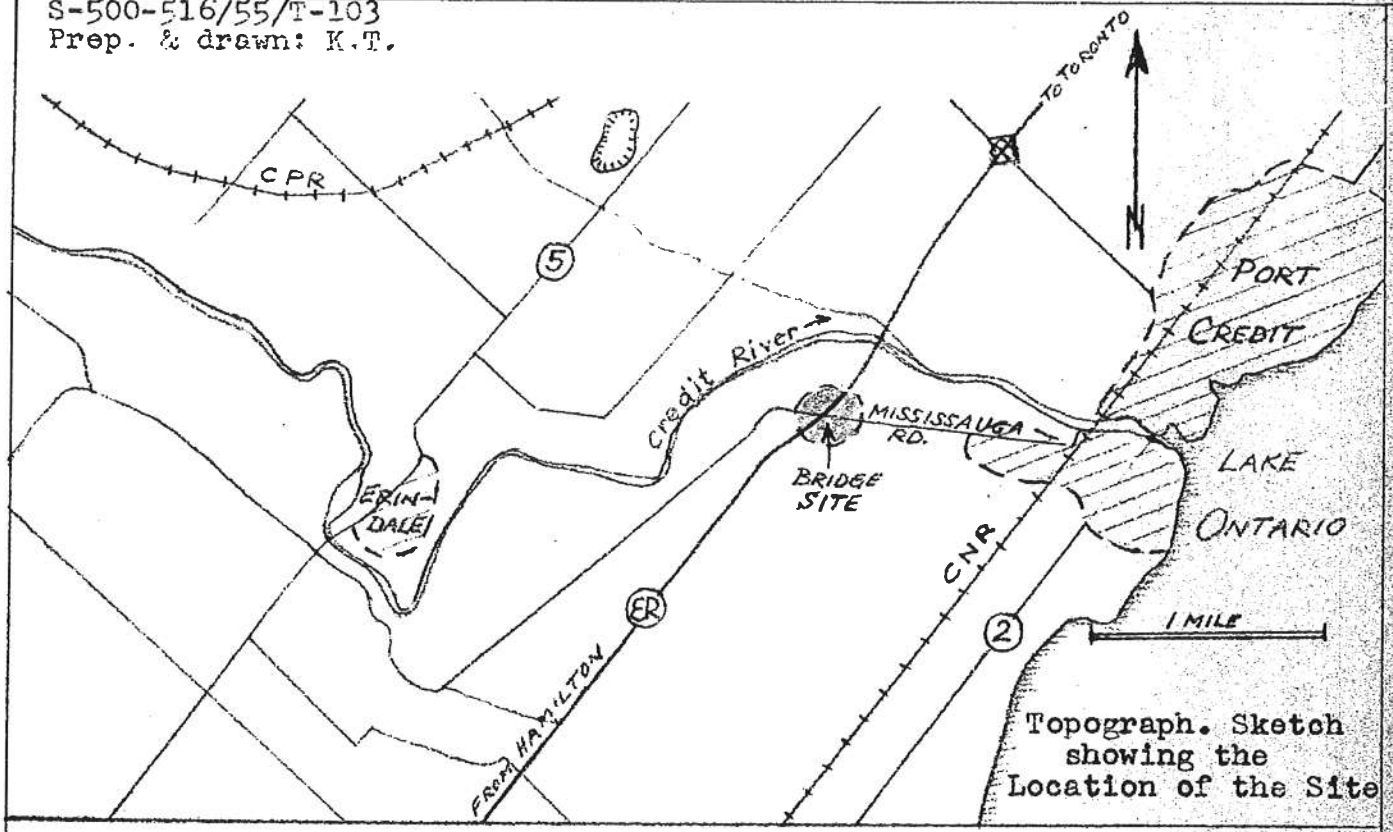
Table A1

Borehole Completion Details

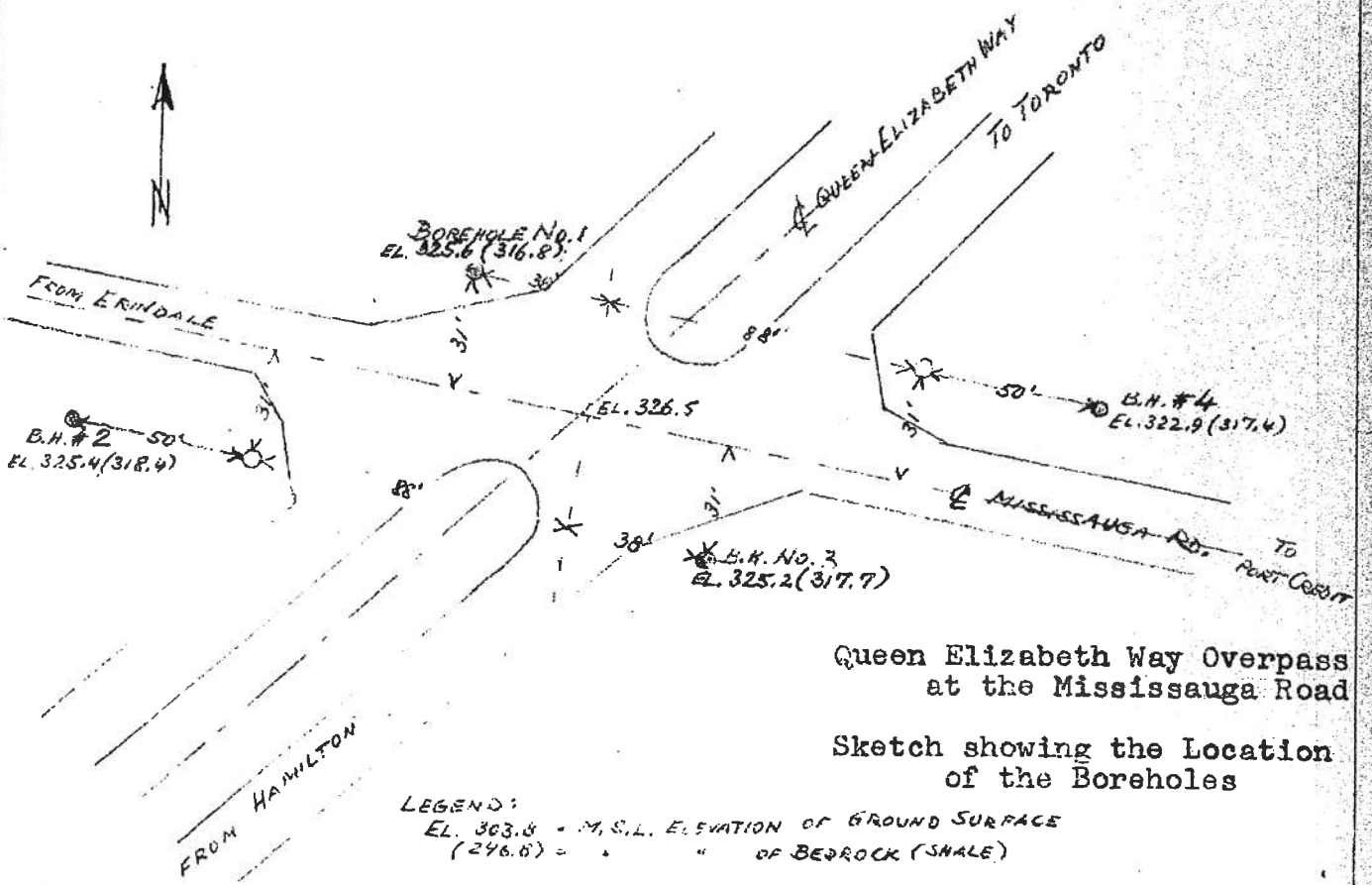
Borehole	Tip Position (m)		Completion Details
	Depth	Elev.	
MR11-01	None installed		Bentonite seal from 3.6 to 0.3 m, then concrete to surface.
MR11-02	4.6	88.7	Sand filter from 7.7 to 2.4 m, drill cuttings and bentonite holeplug from 2.4 to 0.3 m, then concrete to surface.

ENCOSURE No. 1

S-500-516/55/T-103
Prep. & drawn: K.T.



Topograph. Sketch showing the Location of the Site



Queen Elizabeth Way Overpass at the Mississauga Road

Sketch showing the Location of the Boreholes

LEGEND:
EL. 303.8 = M.S.L. ELEVATION OF GROUND SURFACE
(246.6) = " " OF BEDROCK (SHALE)

RACEY, MacCALLUM & ASSOCIATES, Ltd.

ENCLOSURE No. 2

Order No.: S-500-576/555/T-103 RACEY, MacCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

A. McCADDEN
Driller

Hole Begun 12/5/55

Hole Ended 12/5/55 **Engineering Data Sheet for Borehole:** /

Helper

Job Name: Queen Elizabeth Way Overpass at Mississauga Road

B.F.W. & K.T.
Checked by

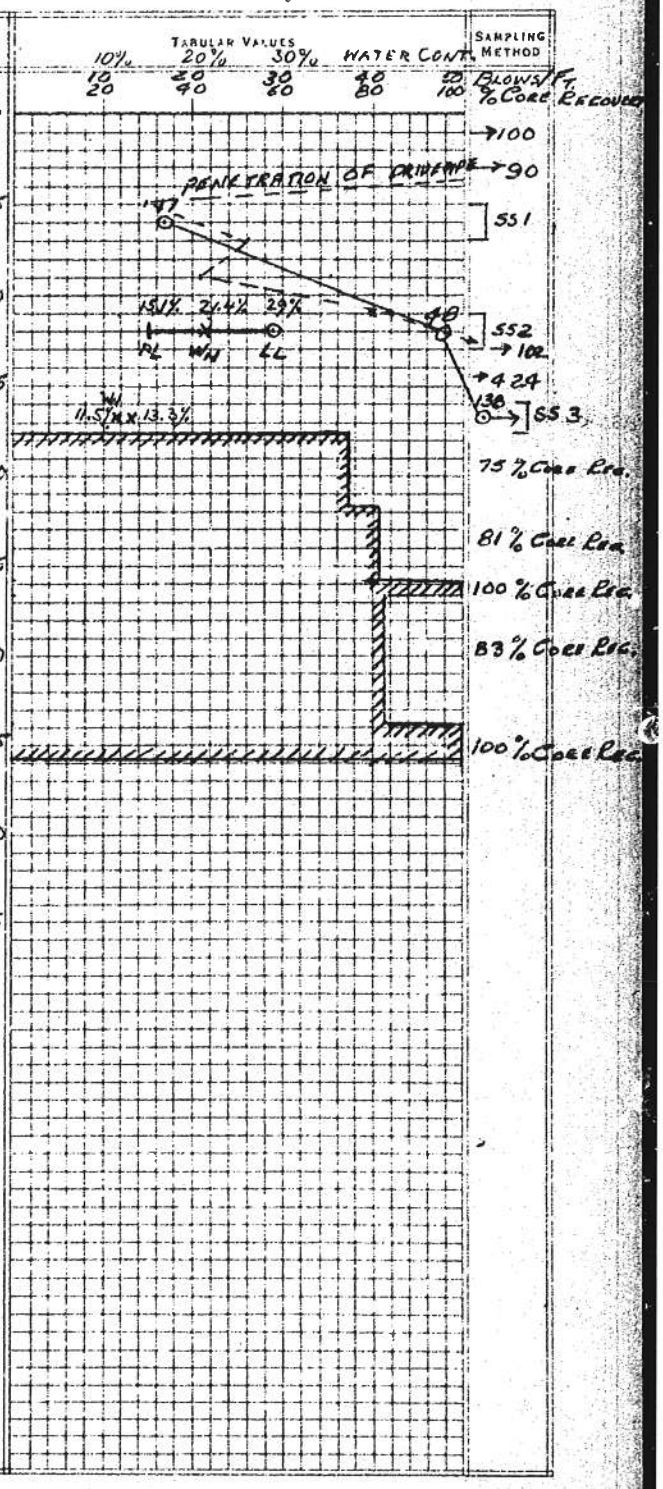
Job Located: ON QUEEN ELIZABETH HWY. AT MISSISSAUGA RD.

Hole Located: AS SHOWN ON ATTACHED SKETCH PLAN

Hole Elevation: 325.6 Datum: M.S.L.

6/6/55
Day / Month / Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0	325.6			GROUND SURFACE
				FAIRLY COMPACT, VERY FINE BROWN SAND, BROWN WITH TRACE OF SILT
				LIGHT BROWN, STIFF CLAY WITH FINE GRAVEL. CLAY OF LOW PLASTICITY.
8.8	316.8			REFUSAL ON BEDROCK
10.8				GREY CLAY SHALE SLIGHTLY CALCAREOUS, WITH OCCASIONAL SOLID MUDSTONE BEDS, UP TO ~6" THICK.
12.9				
13.3				
16.9				
17.2	307.7			END OF BOREHOLE



ENCLOSURE NO. 3

Order No.: 5-500-316/55/7-103 **RACEY, MacCALLUM AND ASSOCIATES LIMITED**

Foundation Engineering, Division

Hole Begun 14/5/55

Hole Ended 17/5/55

Engineering Data Sheet for Borehole: 2

Driller: A. McCADDEN

Helper:

Job Name: Queen Elizabeth Way Overpass at Mississauga Road

Job Located: ON QUEEN ELIZABETH HWY AT MISSISSAUGA RD.

Hole Located: AS SHOWN ON ATTACHED SKETCH PLAN

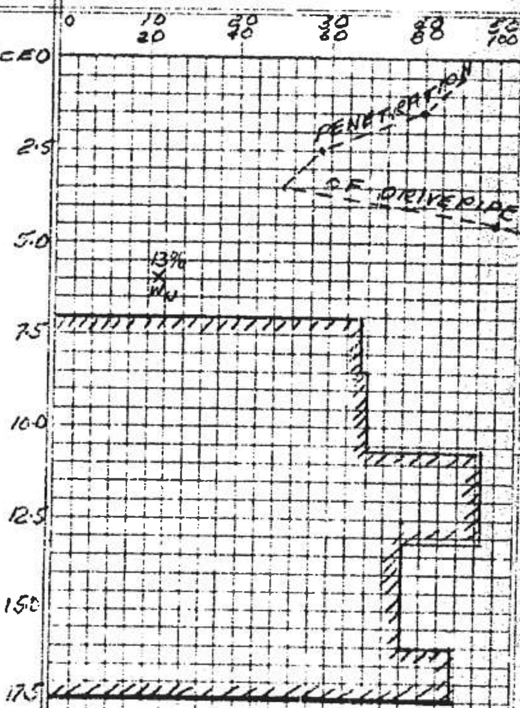
Hole Elevation: 325.4 Datum: M.S.L.

Checked by: B.F.W. & K.T.

Day / Month / Year: 6/6/55

DEPTH	EL	THICKNESS	SYMBOL	DESCRIPTION	SAMPLING METHOD (BLOWS/FT. / % CORE REC.)
0	325.4			GROUND SURFACE	
				EXTREMELY STIFF CLAY = WEATHERED CLAY SHALE	76 → 56, 331, 81
7.0	318.4			REFUSAL ON BEDROCK	
8.0					67% CORE REC.
8.5				GREY CLAY SHALE SLIGHTLY CALCAREOUS, WITH OCCASIONAL MUDSTONE BEDS. SOLID, UP TO ~6" THICK.	62% CORE REC.
13.2					93% CORE REC.
16.0					76% CORE REC.
17.4	308.0			END OF BOREHOLE	87% CORE REC.

TABULAR VALUES



W_N - NAT. WATER CONTENT

Order No.: S-500-5/6/55/T-103 RACEY, MacCALLUM AND ASSOCIATES LIMITED — *Foundation Engineering Division*

A. McCADDEN — Driller

Hole Begun 17/5/55

Helper

Hole Ended 18/5/55 **Engineering Data Sheet for Borehole:** 3

Job Name: Queen Elizabeth Way Overpass at Mississauga Road

B.F.W. & K.T. — Checked by

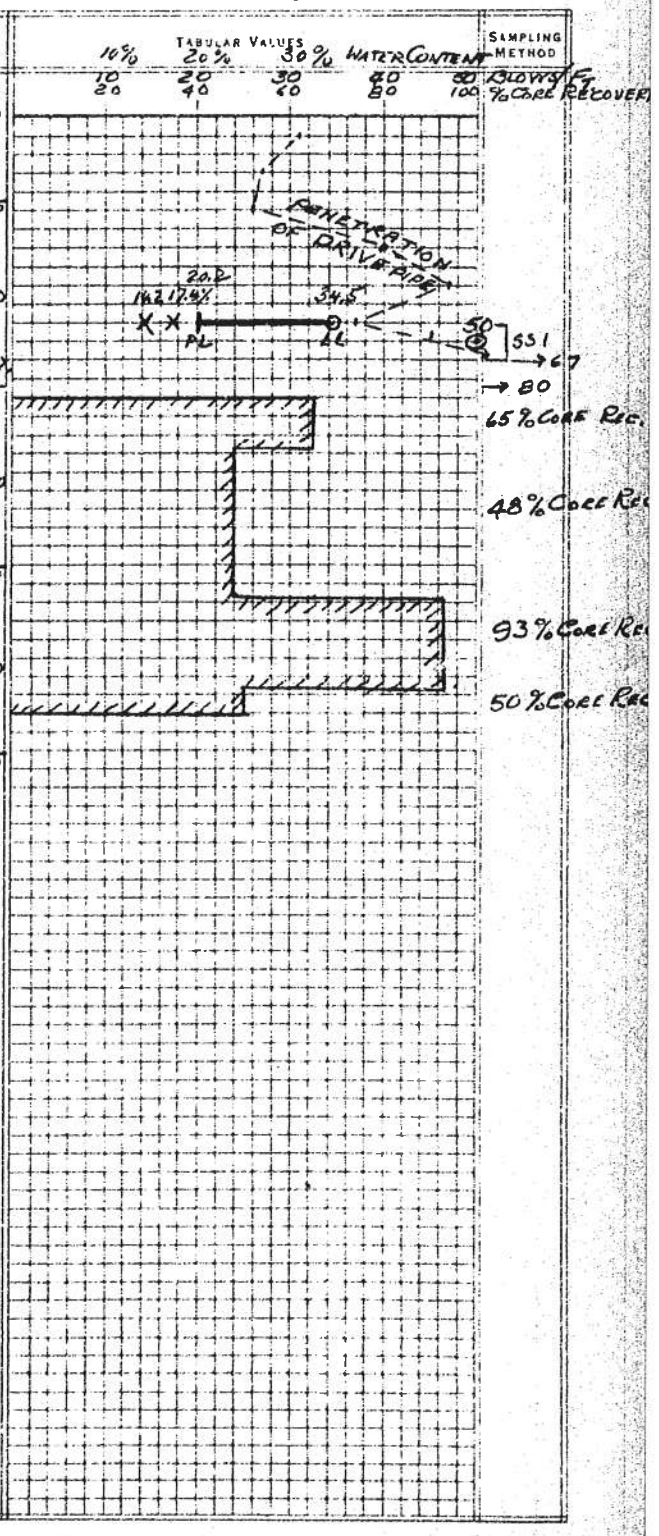
Job Located: ON QUEEN ELIZABETH HWY AT MISSISSAUGA RD.

Hole Located: AS SHOWN ON ATTACHED SKETCH PLAN

Hole Elevation: 325.2 Datum: M.S.L.

6/6/55 — Day / Month / Year

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION
0	325.2			GROUND SURFACE
				EXTREMELY STIFF CLAY = WEATHERED CLAYSHALE. CLAY OF MEDIUM PLASTICITY.
7.5	317.7			REFUSAL ON BEDROCK
8.8				GREY CLAY SHALE SLIGHTLY CALCAREOUS, WITH OCCASIONAL MUDSTONE BEDS, SOLID, UP TO ~6" THICK.
12.8				
15.3				
16.0	309.2			END OF BOREHOLE



ENCLOSURE NO. 5

Order No.: S-500-54/55/T-103 **RACEY, MACCALLUM AND ASSOCIATES LIMITED**

Foundation Engineering Division

Driller: A. McCADDEN

Hole Begun: 18/5/55

Hole Ended: 19/5/55

Engineering Data Sheet for Borehole: 4

Helper:

Job Name: Queen Elizabeth Way Overpass at Mississauga Road

Job Located: ON QUEEN ELIZABETH HWY AT MISSISSAUGA RD.

Hole Located: AS SHOWN ON ATTACHED SKETCH PLAN

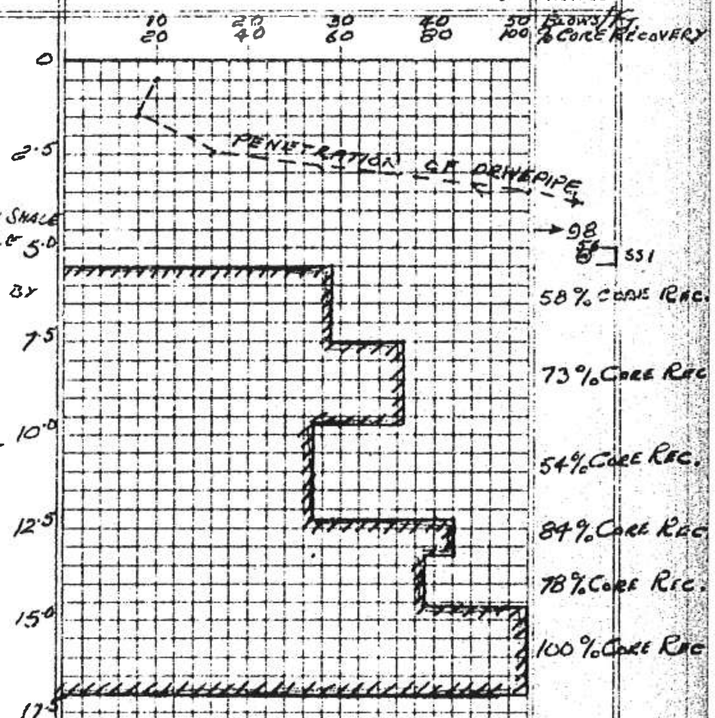
Hole Elevation: 322.9 Datum: M.S.L.

Checked by: B.F.W. & K.T.

Day / Month / Year: 6/6/55

DEPTH	EL.	THICKNESS	SYMBOL	DESCRIPTION	SAMPLING METHOD
0	322.9			GROUND SURFACE	
				EXTREMELY STIFF CLAY WITH CLAY SHALE FRAGMENTS + WEATHERED CLAY SHALE	98/6" SS1
5.5	317.4			REFUSAL ON BEDROCK	
				GREENISH-GREY CLAY SHALE, AFFECTED BY WEATHERING	58% CORE REC.
7.5				GREY CLAY SHALE, SLIGHTLY CALCAREOUS, WITH OCCASIONAL SOLID MUDSTONE BEDS, UP TO ~ 6" THICK.	73% CORE REC.
9.7					54% CORE REC.
12.3					84% CORE REC.
13.3					78% CORE REC.
14.6					100% CORE REC.
17.0	305.9			END OF BOREHOLE	

TABULAR VALUES



Appendix B

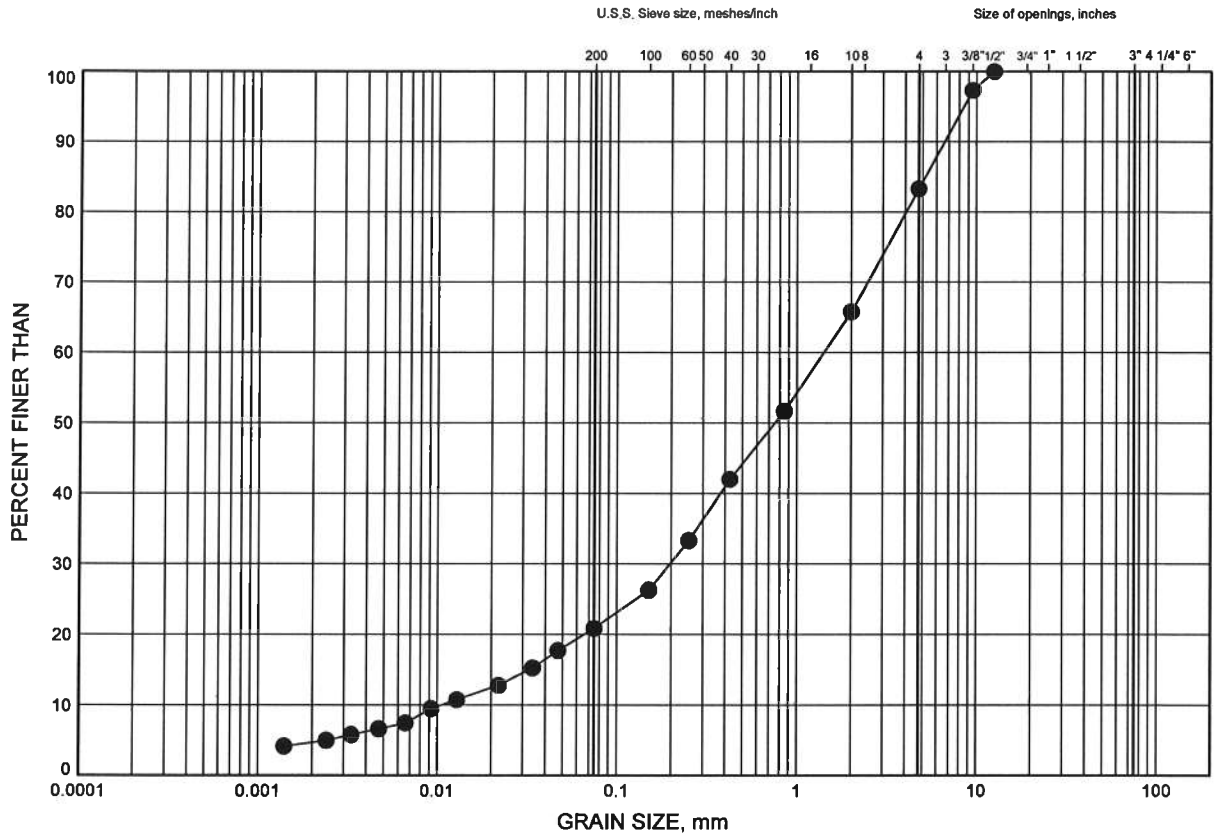
Laboratory Test Results

QEW Mississauga Rd. Overpass

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MR11-01	0.35	93.98

W.P.# W.O. 08-20008
Prepared By AN
Checked By SKP

THURBER

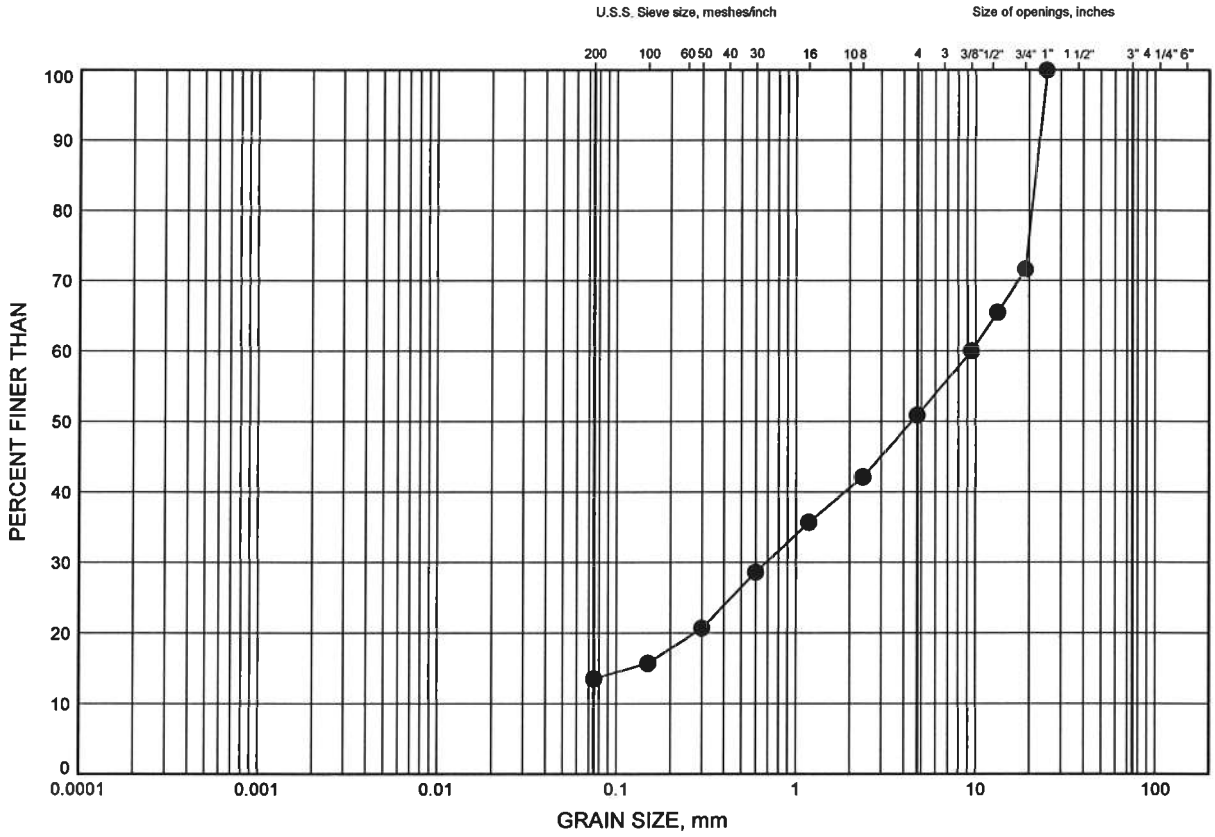
GRAIN SIZE DISTRIBUTION - THURBER 1174.GPJ 11/18/11

QEW Mississauga Rd. Overpass

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND FILL,With SHALE Fragments



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MR11-02	2.57	90.74

W.P.# W.O. 08-20008
Prepared By AN
Checked By SKP

THURBER

GRAIN SIZE DISTRIBUTION - THURBER 1174.GPJ 11/18/11

Table B1

Point Load Test Results

POINT LOAD TEST SHEET

Job No :	19-1351-174			**Client :**	MRC
				Date Drilled :	17/09/2011
Project Name :	Mississauga Road / QEW Bridge			**Date Tested :**	19/09/2011
Core Size :	NQ	**BH No :**	MR11-01	**Tester :**	DA

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (kPa)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	2	3.3	A	2240	47.0	56.2	16.2	shale	Weak
2	2	3.5	D	1560	47.0	72.5	15.6	shale	Weak
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
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21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.

THURBER

POINT LOAD TEST SHEET

Job No :	19-1351-174	**Client :**	MRC
		Date Drilled :	17/09/2011
Project Name :	Mississauga Road / QEW Bridge	**Date Tested :**	19/09/2011
Core Size :	NQ **BH No :** MR11-02	**Tester :**	DA

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (kPa)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	3.4	A	780	47.0	39.9	7.4	shale	Weak
2	1	3.5	D	180	47.0	60.6	1.8	shale	Very Weak
3	1	3.7	D	480	47.0	76.2	4.8	shale	Very Weak
4	1	3.9	A	1340	47.0	53.1	10.1	shale	Weak
5	2	4.8	D	580	47.0	79.9	5.8	shale	Weak
6	2	5.0	A	2240	47.0	63.4	14.8	shale	Weak
7	2	5.2	A	980	47.0	58.7	6.8	shale	Weak
8	2	5.6	D	1480	47.0	65.1	14.8	shale	Weak
9	2	5.7	D	19000	47.0	89.7	190.3	limestone	Very Strong
10	2	6.4	A	1500	47.0	55.3	11.0	shale	Weak
11	2	6.5	D	1400	47.0	80.9	14.0	shale	Weak
12	2	7.1	D	1640	47.0	70.4	16.4	shale	Weak
13	2	7.5	A	1740	47.0	59.9	12.0	shale	Weak
14									
15									
16									
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26									
27									
28									
29									
30									

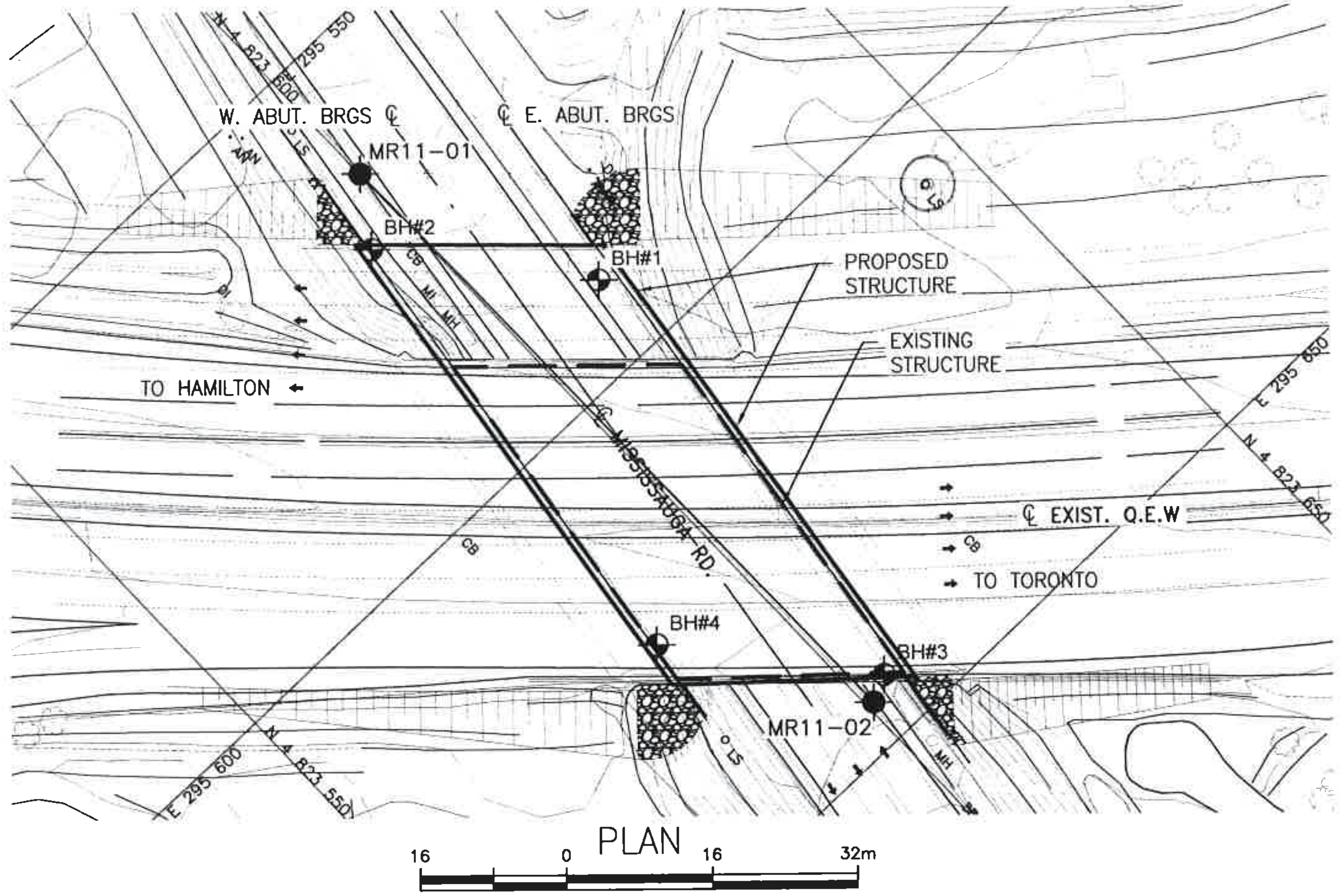
* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.

THURBER

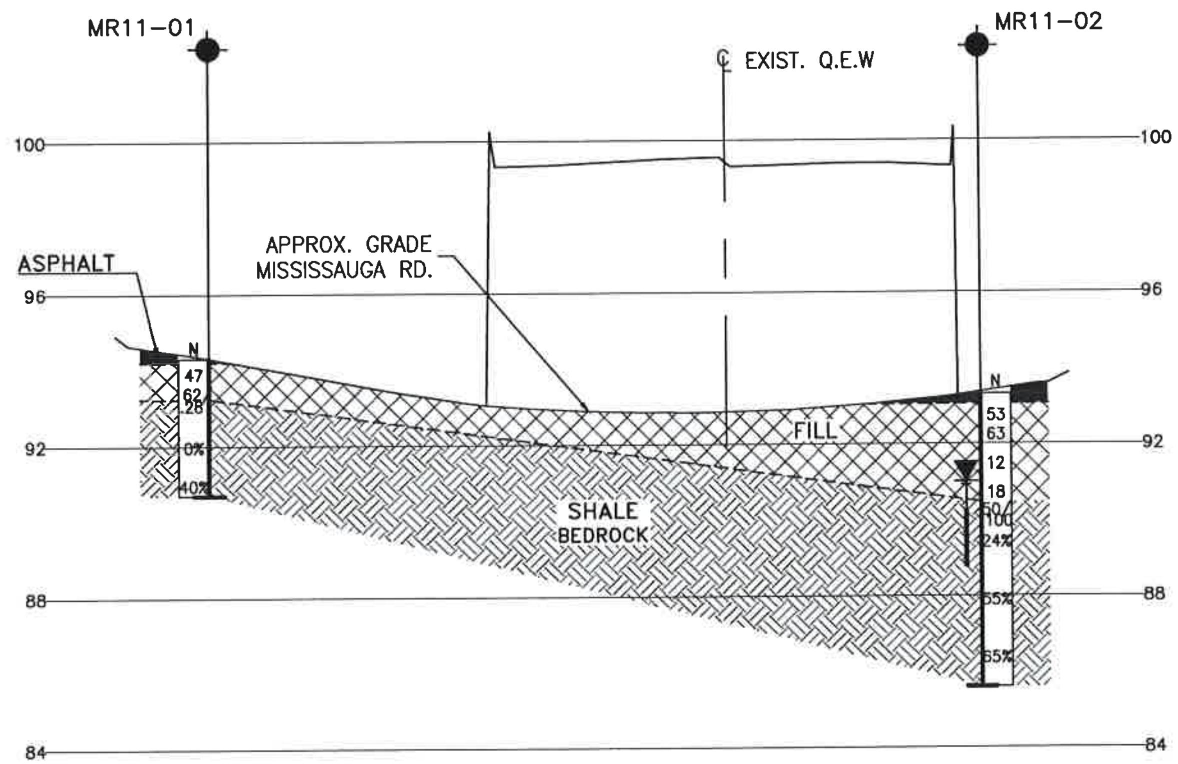
Appendix C

Drawings

THURBER



PLAN



PROFILE ALONG ℄ MISSISSAUGA RD.

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER — S. PANG — May 14/12 — PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER — P. K. CHATTERJI — May 14/12 — PROVINCE OF ONTARIO

CONT No

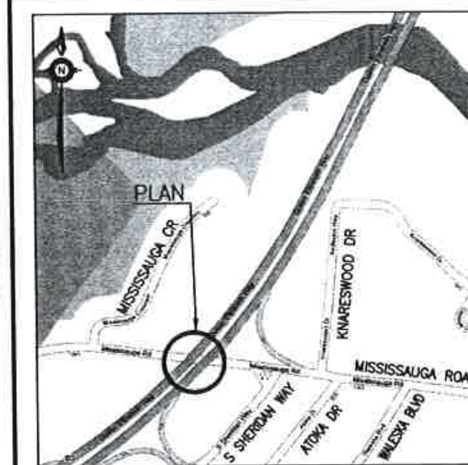
WP No 08-20008

QUEEN ELIZABETH WAY
MISSISSAUGA ROAD
INTERCHANGE OVERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MRC McCORMICK RANKIN A member of MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⯁	Borehole (Current Investigation)
⯁	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
*	Approx. Borehole Location (Survey Data Not Available)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
MR11-01	94.3	4 823 600.3	295 564.1
MR11-02	93.3	4 823 601.1	295 645.2
BH#1*		4 823 612.6	295 587.7
BH#2*		4 823 595.3	295 571.1
BH#3*		4 823 603.8	295 643.8
BH#4*		4 823 588.7	295 630.2

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 30M12-342

REVISIONS	DATE	BY	DESCRIPTION

DESIGN SKP	CHK SKP	CODE	LOAD	DATE MAY 2012	
DRAWN AN	CHK	SITE	STRUCT	DWG 1	