

FOUNDATION INVESTIGATION REPORT
HYDRO ONE TOWER RELOCATION AT HODDER AVENUE
HIGHWAY 11/17 FOUR-LANING FROM 1.0 KM WEST OF
HODDER AVENUE/COPENHAGEN ROAD EASTERLY FOR 5.8 KM
THUNDER BAY, ONTARIO
W.P. 334-94-00

Geocres Number: 52A-145

Report to

McCormick Rankin Corporation

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

April 22, 2010
File: 19-1351-156

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Tower\Hydro Tower FIR FINAL.doc

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed relocation of a Hydro One tower in the southwest quadrant of the intersection of Hodder Avenue and Highway 11/17 in Thunder Bay, Ontario. An existing tower will be relocated 32 m to the west of the current tower location to accommodate construction of a new W-N/S ramp during interchange development.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, record of borehole sheets, laboratory test results 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 tower foundations.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 6008-E-0005.

2 SITE DESCRIPTION

The site lies on the southwest quadrant of the intersection of Highway 11/17 and Hodder Avenue at the northeast limit of the City of Thunder Bay. An existing Hydro One corridor runs east-west at the site, crossing Hodder Avenue to the east and Highway 11/17 to the west of the site.

The existing ground surface at the proposed tower location slopes down to the Current River situated approximately 200 m to the west. The hydro corridor is grass covered and bordered by trees on the north and south.

Geologically, the site area is located within the physiographic region known as the Canadian Shield, characterized by Pre-Cambrian bedrock typically occurring as rounded knobs and ridges where exposed. At this site, the bedrock consists of the Gunflint Formation, a sequence of limestone, chert-carbonate, graphitic shale, tuff, taconite and chert. Intrusions/sills of diorite are

present locally. The bedrock is overlain by a discontinuous layer of glacial till comprising a heterogeneous mixture of clayey silt, silt, sand and gravel.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation for the new tower foundations was carried out between January 9 and 13, 2010 and consisted of four boreholes, numbered 10-81 to 10-84, located near the corners of the proposed tower location. Five additional boreholes were drilled in the vicinity of the tower location, as follows:

- Boreholes 09-01 and 09-03 were drilled on June 29, 2009 in connection with the foundation investigation for the proposed W-N/S Ramp cut.
- Boreholes 10-86 and 10-87 were drilled to the north and east of the existing hydro tower to determine foundation parameters for a possible retaining wall along the W-N/S Ramp required if the existing tower were not relocated. These boreholes were drilled on January 6 and 14, 2010.
- Borehole 10-85 was drilled to the northwest of the proposed tower location on January 8 to 9, 2010 to confirm subsurface conditions downslope from the proposed tower location.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix C. The borehole elevations, locations and depths are summarized in Table 3.1. The boreholes were advanced to depths of 9.3 to 19.4 m, at least 3.0 m into bedrock in all but one of the boreholes.

Table 3.1 – Borehole Summary

Borehole	Ground Surface Elevation (m)	Location		Total Depth (m)	Length of Core in Bedrock (m)
		Northing	Easting		
09-01	260.4	5 371 905.0	365 060.4	9.3	-
09-03	263.1	5 371 893.1	365 081.2	10.7	3.1
10-81	256.9	5 371 883.6	365 036.8	17.9	3.7
10-82	258.6	5 371 883.1	365 043.8	18.0	3.1
10-83	256.8	5 371 875.9	365 036.6	19.4	4.5
10-84	258.4	5 371 876.5	365 043.0	17.5	4.1
10-85	255.4	5 371 889.1	365 032.3	14.8	3.0
10-86	261.8	5 371 898.8	365 071.6	10.9	3.6
10-87	264.4	5 371 883.3	365 102.6	10.4	3.5

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area. Hydro One was contacted to confirm the required clearance between the drilling equipment and overhead wires.

Hollow-stem augers were used to advance the boreholes to auger refusal encountered at depths of 2.7 to 6.3 m. Soil samples were obtained at selected intervals using a split spoon sampler in

conjunction with Standard Penetration Testing (SPT). Below the refusal depths, the boreholes were advanced a further 4.0 to 13.8 m, including 3.0 to 4.5 m into bedrock, by BQ and NQ size diamond coring techniques.

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.

All rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. In three boreholes (Nos. 09-03, 10-81 and 10-84), standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen were installed and enclosed in filter sand to permit longer term groundwater level monitoring. The completion details of the piezometers are shown in Table 3.2. Following the final water level reading, the piezometers were decommissioned in accordance with MOE Regulation 903.

The boreholes in which no piezometers were installed were backfilled with bentonite and cuttings. The borehole completion details are shown in Table 3.2.

Table 3.2 – Borehole Completion Details

Borehole	Piezometer Tip		Completion Details
	Depth (m)	Elevation (m)	
09-01	-	-	Borehole backfilled with bentonite to surface
09-03	10.7	252.4	Piezometer with 1.5 m slotted screen installed with sand filter below 5.6 m depth, and bentonite seal to ground surface.
10-81	10.7	246.2	Piezometer with 1.5 m slotted screen installed with sand filter below 4.9 m depth, and bentonite seal to ground surface.
10-82	-	-	Borehole backfilled with bentonite to surface
10-83	-	-	Borehole backfilled with bentonite to surface
10-84	13.7	244.7	Piezometer with 1.5 m slotted screen installed with sand filter below 9.0 m depth, and bentonite seal to ground surface.
10-85	-	-	Borehole backfilled with bentonite to surface
10-86	-	-	Borehole backfilled with bentonite to surface
10-87	-	-	Borehole backfilled with bentonite to surface

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A. Selected samples were also subjected to gradation analysis and the results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

Point load testing was conducted on rock core samples retrieved from the boreholes. The results of the point load tests are shown on the borehole logs 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 this appendix and on the “Borehole Locations and Soil Strata” drawings in Appendix C. 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, the site is underlain by compact to very dense sandy silt to silty sand till underlain by very dense sand and gravel with cobbles and boulders. The till, sand and gravel is underlain by bedrock. Surficial topsoil, clayey silt fill, sand and sandy silt layers were encountered in individual boreholes.

5.1 Silt Fill

Silt fill, trace clay to clayey, was encountered surficially in borehole 10-86 located northeast of the tower. The lower boundary of the fill was encountered at 2.1 m depth (elevation 259.7 m). The fill is firm to loose with SPT ‘N’ values of 7 and 3 blows/0.3 m recorded. Moisture contents ranged from 12 to 22% in the fill.

5.2 Topsoil

A 1.1 m thick layer of topsoil was encountered in borehole 09-01 located north of the proposed tower site. The topsoil thickness may vary beyond the borehole location and this data should not be used to estimate topsoil quantity.

5.3 Sand and Sandy Silt

A 0.3 m thick layer of dark brown sand with trace organics was encountered below the topsoil in borehole 09-01. An ‘N’ value of 21 blows/0.3 m (compact) and moisture content of 10% were obtained in this layer. The lower boundary of the sand was at 1.4 m depth (elevation 258.9 m).

A surficial sandy silt deposit was encountered in borehole 10-87 located east of the existing tower. An ‘N’ value of 8 blows/0.3 m indicates that the sandy silt is loose. A moisture content of 22% was obtained. The sandy silt layer was 1.4 m thick.

5.4 Sandy Silt to Silty Sand Till

A heterogeneous glacial till deposit consisting of sandy silt to silty sand with variable content of clay and gravel was encountered surficially or below the fill, sand or silt in all boreholes. The till contains frequent cobbles and boulders. The thickness of the till layer

varies from 1.7 to at least 7.9 m, and the lower boundary ranges from elevation 249.6 to 261.7 m.

The results of laboratory grain size distribution tests carried out on samples of the till are illustrated in Figures B1 to B3, Appendix B. The results for all but one sample are summarized below. A piece of gravel was included in the sample tested from borehole 10-85, resulting in a higher gravel content of 39%.

Gravel (%)	0 to 14
Sand (%)	17 to 57
Silt (%)	26 to 69
Clay (%)	5 to 15

The till is generally loose to dense with 'N' values of 5 to 44 blows/0.3 m in the upper 1.5 to 3.0 m of this deposit, and becomes dense to very dense below this level with 'N' values exceeding 40 blows/0.3 m penetration. Below 4.4 to 5.9 m depth in boreholes 09-01, 09-03 and 10-86, the till became very dense and/or bouldery, requiring coring procedures to penetrate.

The moisture content of samples from this deposit ranged from about 5 to 25%, typically 10 to 20%.

5.5 Silty Sand and Gravel

Further penetration by augering and split spoon sampling was refused at depths of 2.7 to 6.3 m in all boreholes. Below these depths, the boreholes were advanced using rock coring methods, resulting in limited recovery until bedrock was encountered at depths of 6.9 to 14.9 m.

Based on the limited samples recovered, the material penetrated during the coring operations was described as very dense silty sand and gravel with occasional to frequent cobbles and boulders. The sand and gravel is underlain by bedrock.

5.6 Bedrock

Bedrock was encountered below the silt/sand till and sand and gravel in all boreholes except borehole 09-01. The depths to bedrock proved by coring are summarized in Table 5.1.

Table 5.1 – Depth to Bedrock at Borehole Locations

Borehole	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
09-03	7.6	255.5
10-81	14.2	242.7
10-82	14.9	243.7
10-83	14.9	241.9
10-84	13.4	245.0
10-85	11.8	243.6
10-86	7.3	254.5
10-87	6.9	257.5

The bedrock recovered in the cores consisted of a complex interbedding of various rock types considered to be part of the Gunflint Formation. Varying with depth and location, the rock was described as chert carbonate, grainstone, calcareous siltstone, shale, and wackestone. Shale laminations, calcite veining, pyrite veining, chert nodules and fossiliferous bands were also noted.

The bedrock is typically described as thinly banded and fresh to slightly weathered. The colour is dark to charcoal grey with light grey bands.

Core recovery in the bedrock was between 80% and 100%. RQD values typically ranged from 77 to 100% indicating good to excellent rock quality. Lower RQD values of 35 to 60% were obtained in boreholes 10-84 and 10-87, indicating poor to fair quality. An RQD value of 0 (very poor quality) was recorded for one run of thinly bedded material recovered from borehole 10-82.

The unconfined compressive strength of the rock is highly variable depending upon the actual bedding layer of rock tested. Strength values estimated from the results of point load tests conducted on the core samples ranged from 31 to 302 MPa, indicating a medium strong to extremely strong intact rock. The point load test results are included on the borehole logs in Appendix A.

5.7 Groundwater

Groundwater was not observed in the boreholes while advancing using augers. Water was introduced into all boreholes as part of the coring operations and therefore groundwater levels could not be recorded immediately upon completion.

The groundwater depths and elevations measured in the piezometers two to five months subsequent to drilling are shown in Table 5.2.

Table 5.2 – Groundwater Depths and Elevations in Piezometers

Borehole	Installation Date	Groundwater Levels in Piezometers		
		Date	Depth (m)	Elevation (m)
09-03	29-Jun-09	23-Nov-09	10.4	252.7
10-81	10-Jan-10	01-Mar-10	9.8	247.1
10-84	13-Jan-10	01-Mar-10	11.2	247.2

The above water levels reflect the piezometric head at the level of the piezometer tips at the time of the readings. The measurements are short-term observations and seasonal fluctuations of the groundwater level are to be expected.

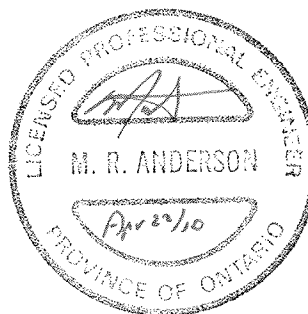
6 MISCELLANEOUS

J.D. Barnes Limited determined the co-ordinates and ground elevations at the boreholes following completion of the site investigation.

Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario supplied and operated the drilling and sampling equipment for the current field program. Full time supervision of the field activities, including obtaining utility clearances, was carried out by Mr. Stephane Loranger and Mr. Luke Gilarski of Thurber.

Supervision of the field program, interpretation of the field data, and preparation of the report was performed by Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.
Murray R. Anderson, P.Eng., M.Eng.
Senior Geotechnical Engineer



P.K. Chatterji, P.Eng., Ph.D.
Review Principal



Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽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
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 09-003

1 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 893.1 E 365 081.2 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/BQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2009.06.29 - 2009.06.29 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 09-003

2 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 893.1 E 365 081.2 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/BQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2009.06.29 - 2009.06.29 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
	Continued From Previous Page																
252.4							253								2		
10.7	END OF BOREHOLE AT 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) 2009.11.23 10.4 252.7														1		

ONTMT4S 1156.GPJ 3/17/10

RECORD OF BOREHOLE No 10-081

1 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 883.6 E 365 036.8 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.01.09 - 2010.01.10 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	×							LAB VANE
								● QUICK TRIAXIAL									
256.9							20	40	60	80	100						
0.0	SAND and SILT, trace clay, trace gravel Compact to Very Dense Brown Moist (TILL)		1	SS	11												
			2	SS	42												
			3	SS	27												
	Occasional cobble		4	SS	64										4 36 52 9		
			5	SS	44												
	Auger refusal at 5.8m. Began coring.																
251.1																	
5.8	Silty SAND and GRAVEL, with frequent cobbles		1	RUN											RUN 1# TCR=61%, SCR=9%, RQD=0%		
			2	RUN											RUN 2# TCR=58%, SCR=12%, RQD=0%		
			3	RUN											RUN 3# TCR=3%, SCR=0%, RQD=0%		

Continued Next Page




+³ ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10-081

2 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 883.6 E 365 036.8 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.01.09 - 2010.01.10 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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							
	Continued From Previous Page							20 40 60 80 100							
	Silty SAND and GRAVEL, with frequent cobbles		4	RUN			246								RUN 4# TCR=0%, SCR=0%, RQD=0%
			5	RUN			245								RUN 5# TCR=75%, SCR=5%, RQD=0%
			6	RUN			243								RUN 6# TCR=82%, SCR=45%, RQD=20%, UCS=186MPa
242.7															
14.2	GUNFLINT FORMATION, strong to extremely strong (grainstone), dark grey, slightly weathered		7	RUN			242								RUN 7# TCR=100%, SCR=97%, RQD=97%, UCS=175MPa
			8	RUN			240								RUN 8# TCR=100%, SCR=100%, RQD=100%, UCS=256MPa
239.0															
17.9	END OF BOREHOLE AT 17.9m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.03.01 9.8 247.1														

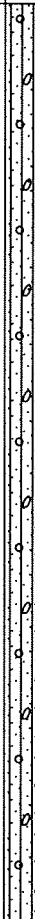
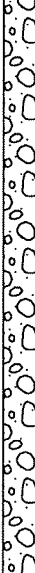
ONTMT4S 1156.GPJ 3/17/10

RECORD OF BOREHOLE No 10-082

1 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 883.1 E 365 043.8 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	W _P W W _L					
258.6							● QUICK TRIAXIAL × LAB VANE <td colspan="3"></td> <td colspan="3"></td> <td></td> <td></td>								
0.0	Sandy SILT , trace to some gravel, trace clay, occasional cobbles Compact to Very Dense Brown Moist (TILL)		1	SS	14										
			2	SS	22										
			3	SS	59										
			4	SS	78/ .225										
			5	SS	39										
252.5	Auger refusal at 6.1m. Began coring.														
6.1	Silty SAND and GRAVEL , frequent cobbles and boulders Very Dense Brown		1	RUN											
			2	RUN											
			3	RUN											

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10-082

2 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 883.1 E 365 043.8 ORIGINATED BY LG
HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			W _P	W	W _L		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%)						
	Continued From Previous Page						20 40 60 80 100				20 40 60			GR SA SI CL	
			4	RUN			248							RUN 4# TCR=68%, SCR=65%, RQD=0% UCS=217MPa	
							247								
			5	RUN			246							RUN 5# TCR=97%, SCR=17%, RQD=0%	
							245								
			6	RUN			244							RUN 6# TCR=53%, SCR=0%, RQD=0%	
243.7							243								
14.9	GUNFLINT FORMATION, very strong (grainstone), with interbedded calcareous siltstone shale at 15.9 to 16.6 and 17.1 to 17.4m, dark grey, some pyrite veining		7	RUN			242							RUN 7# TCR=84%, SCR=77%, RQD=77% UCS=194MPa	
							241								
			8	RUN											
			9	RUN										RUN 8# TCR=100%, SCR=76%, RQD=0% UCS=77MPa	
														RUN 9# TCR=100%, SCR=96%, RQD=96% UCS=222MPa	
240.6															
18.0	END OF BOREHOLE AT 18.0m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.														

ONTMT4S 1156.GPJ 3/22/10

RECORD OF BOREHOLE No 10-083

1 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 875.9 E 365 036.6 ORIGINATED BY LG
HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2010.01.10 - 2010.01.11 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE		● QUICK TRIAXIAL x LAB VANE						
256.8							20	40	60	80	100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
0.0	Sandy SILT, trace to some gravel, trace clay Compact to Very Dense Brown Moist (TILL) Occasional cobbles		1	SS	10											
			2	SS	34											
			3	SS	58											
			4	SS	41											
			5	SS	50											
					.075											
251.2	Auger refusal at 5.6m. Began coring.															
5.6	Silty SAND and GRAVEL, with occasional cobbles and boulders Very Dense Brown (TILL)		1	RUN												
			2	RUN												
			3	RUN												

Continued Next Page

+³ . X³ : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10-083

2 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 875.9 E 365 036.6 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.01.10 - 2010.01.11 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)		
								20 40 60 80 100							
								20 40 60 80 100							
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT								
							W P W W L								
							○ UNCONFINED + FIELD VANE								
							● QUICK TRIAXIAL x LAB VANE								
							20 40 60 80 100								
							20 40 60								
241.9	Continued From Previous Page											GR SA SI CL			
	Silty SAND and GRAVEL, with occasional cobbles		4	RUN			246					RUN 4# TCR=28%, SCR=0%, RQD=0%			
			5	RUN			245					RUN 5# TCR=50%, SCR=33%, RQD=33%			
			6	RUN			244					RUN 6# TCR=17%, SCR=0%, RQD=0%			
							243								
							242					RUN 7# TCR=80%, SCR=80%, RQD=80% UCS=129MPa			
			7	RUN			241								
			8	RUN			240					RUN 8# TCR=100%, SCR=100%, RQD=100% UCS=92MPa			
							239								
			9	RUN			238					RUN 9# TCR=100%, SCR=100%, RQD=100% UCS=63MPa			
237.4															
19.4	END OF BOREHOLE AT 19.4m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.														

ONTMT4S 1156.GPJ 3/17/10

+³, ×³: Numbers refer to Sensitivity
 20
 15 5
 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10-084

1 OF 2

METRIC

G.W.P. 334-94-00

LOCATION N 5 371 876.5 E 365 043.0

ORIGINATED BY LG

HWY 11/17

BOREHOLE TYPE Hollow Stem Augers/NQ Coring

COMPILED BY AN

DATUM Geodetic

DATE 2010.01.13 - 2010.01.13

CHECKED BY _____ TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		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							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE							
258.4 0.0	Sandy SILT, trace gravel, trace to some clay, occasional cobbles Compact to Very Dense Brown Moist (TILL)												kN/m ³	GR SA SI CL		
			1	SS	44											
			2	SS	13											
			3	SS	50/ .125									2 17 69 12		
			4	SS	77											
			5	SS	40									1 32 61 6		

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 1156.GPJ 3/17/10

METRIC

ORIGINATED BY LG

COMPILED BY AN

CHECKED BY TH

+³, ×³: Numbers refer to Sensitivity

METRIC

CHECKED BY TH

Continued Next Page

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10-085

2 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 889.1 E 365 032.3 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.01.08 - 2010.01.09 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
	Continued From Previous Page													
	Silty SAND and GRAVEL, frequent cobbles and boulders (TILL)		4	RUN			245							RUN 4# TCR=63%, SCR=42%, RQD=0%
243.6							244							
11.8	GUNFLINT FORMATION, strong (interbedded calcareous wackestone, siltstone and occasional shale laminations), light to dark grey, sub-horizontal fractures		5	RUN			243							RUN 5# TCR=100%, SCR=83%, RQD=83% UCS=54MPa
							242							RUN 6# TCR=100%, SCR=100%, RQD=100% UCS=73MPa
240.5			6	RUN			241							
14.8	END OF BOREHOLE AT 14.8m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.													

+³, X³: Numbers refer to
Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10-086

2 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 898.8 E 365 071.6 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.01.06 - 2010.01.06 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
	Continued From Previous Page							20	40	60	80	100					
250.9			5	RUN			251										RUN 5# TCR=100%, SCR=100%, RQD=100% UCS=31MPa
10.9	END OF BOREHOLE AT 10.9m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.																

RECORD OF BOREHOLE No 10-087

1 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 883.3 E 365 102.6 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.01.14 - 2010.01.14 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE						
								20	40	60	80						
264.4																	
0.0	Sandy SILT, trace gravel Loose Brown Moist		1	SS	8												
263.0																	
1.4	Silty SAND, some gravel, trace clay, occasional cobbles Compact to Very Dense Brown Moist (TILL)		2	SS	34											12 56 26 6	
	Auger refusal at 2.7m. Began coring.		3	SS	50/ 0.075												
261.7																	
2.7	Silty SAND and GRAVEL, frequent cobbles Very Dense Brown		1	RUN												RUN 1# TCR=29%, SCR=10%, RQD=0%	
			2	RUN												RUN 2# TCR=25%, SCR=0%, RQD=0%	
			3	RUN												RUN 3# TCR=77%, SCR=73%, RQD=73% UCS=302MPa	
257.5																	
6.9	GUNFLINT FORMATION, very strong to extremely strong (interbedded calcareous siltstone and fine grained wackestone), dark grey, sub-horizontal fractures		4	RUN												RUN 4# TCR=83%, SCR=52%, RQD=52% UCS=255MPa	
			5	RUN												RUN 5# TCR=100%, SCR=60%, RQD=60% UCS=243MPa	

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10-087

2 OF 2

METRIC

G.W.P. 334-94-00 LOCATION N 5 371 883.3 E 365 102.6 ORIGINATED BY LG
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.01.14 - 2010.01.14 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%) w _p w w _L				
	Continued From Previous Page							20	40	60	80	100	20	40	60	2	
254.0							254										
10.4	END OF BOREHOLE AT 10.4m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.																

ONTMT4S 1156.GPJ 3/22/10

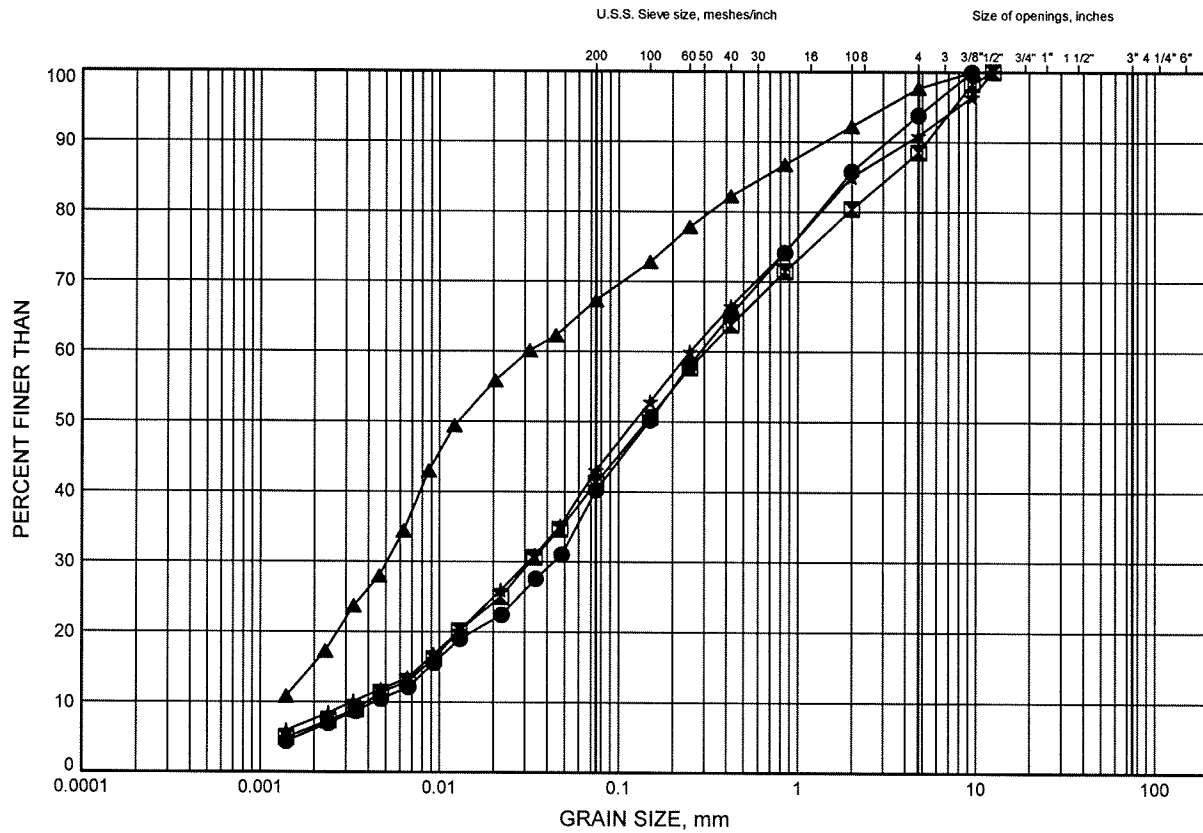
Appendix B

Laboratory Test Results

Hwy 11/17 Hodder Avenue
GRAIN SIZE DISTRIBUTION

FIGURE B1

SANDY SILT TO SILTY SAND TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	09-001	2.53	257.84
⊠	09-001	4.75	255.62
▲	09-003	1.07	262.00
★	09-003	3.35	259.72

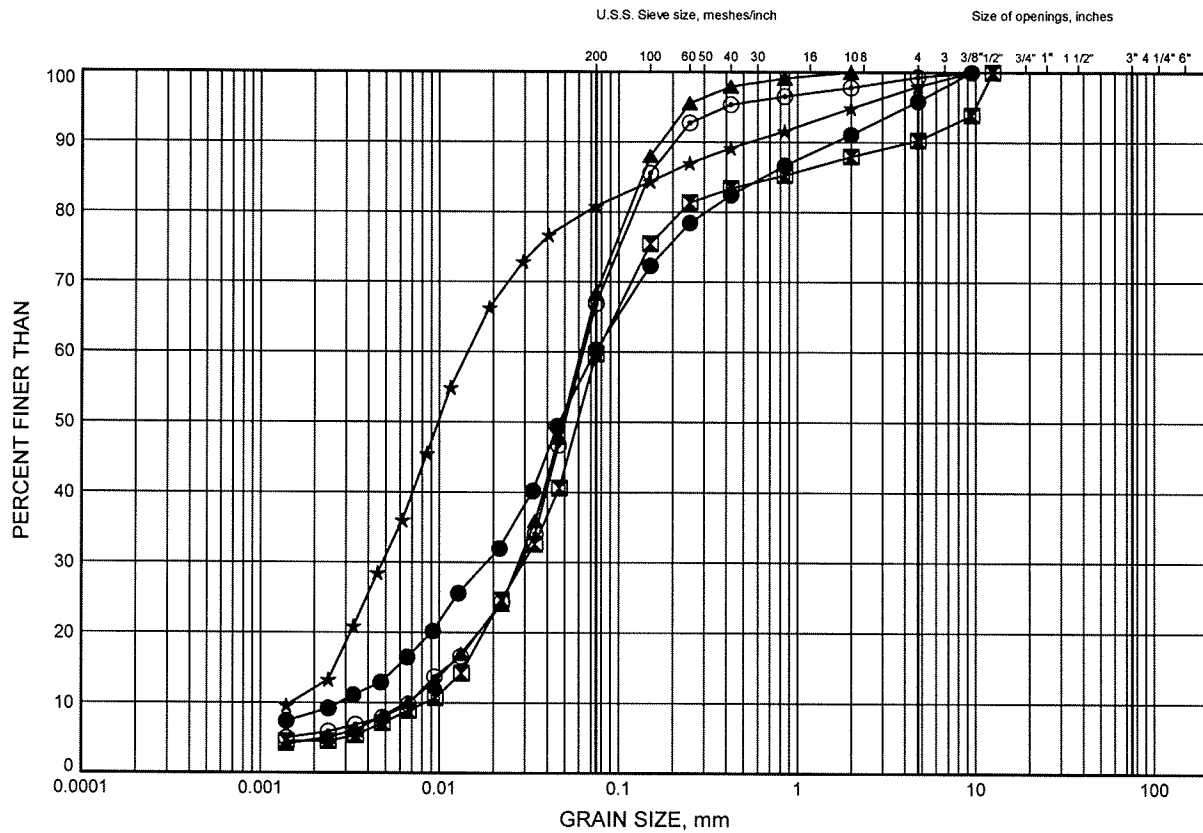


W.P.# 334-94-00
 Prepared By MFA
 Checked By MRA

Hwy 11/17 Hodder Avenue
GRAIN SIZE DISTRIBUTION

FIGURE B2

SANDY SILT TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-081	3.23	253.67
⊠	10-082	2.59	255.97
▲	10-082	4.88	253.68
★	10-084	1.83	256.60
⊙	10-084	4.88	253.55

GRAIN SIZE DISTRIBUTION - THURBER 1156.GPJ 3/12/10

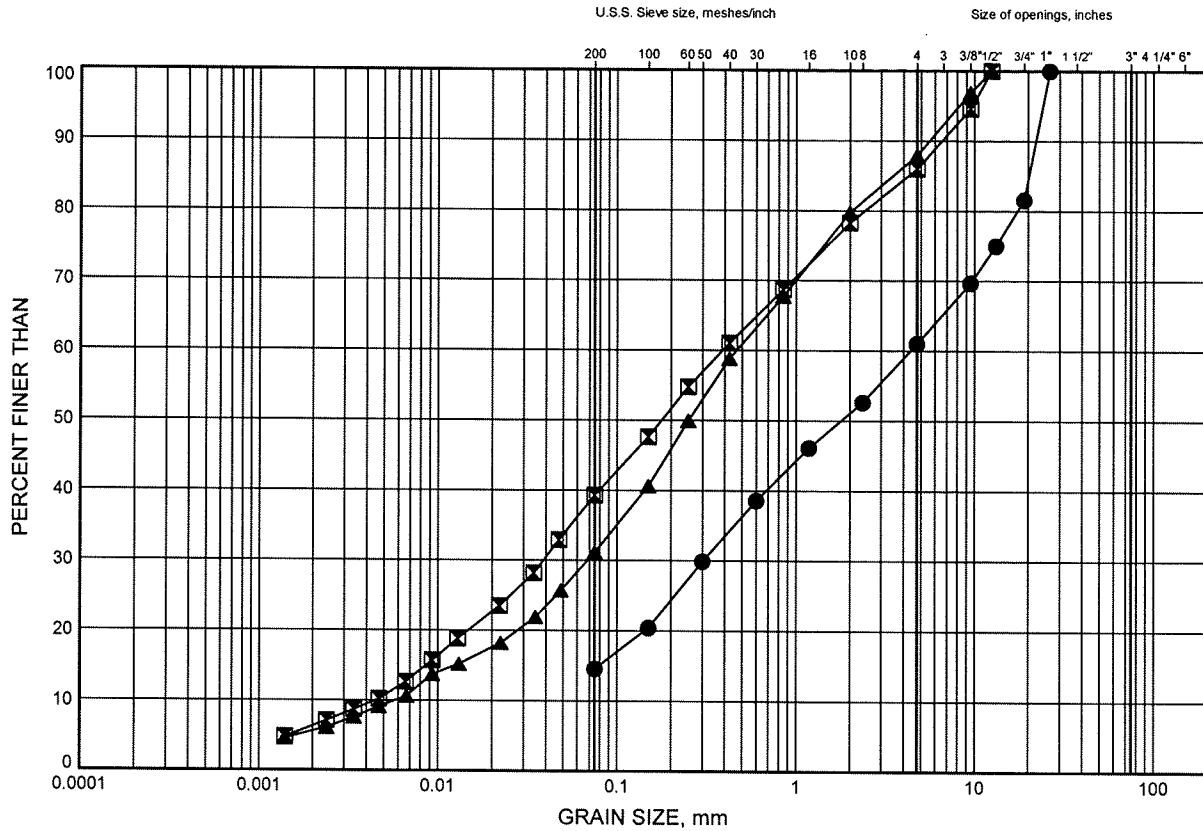
W.P.# 334-94-00
Prepared By MFA
Checked By MRA



Hwy 11/17 Hodder Avenue
GRAIN SIZE DISTRIBUTION

FIGURE B3

SANDY SILT TO SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-085	3.24	252.11
⊠	10-086	3.25	258.57
▲	10-087	1.83	262.57

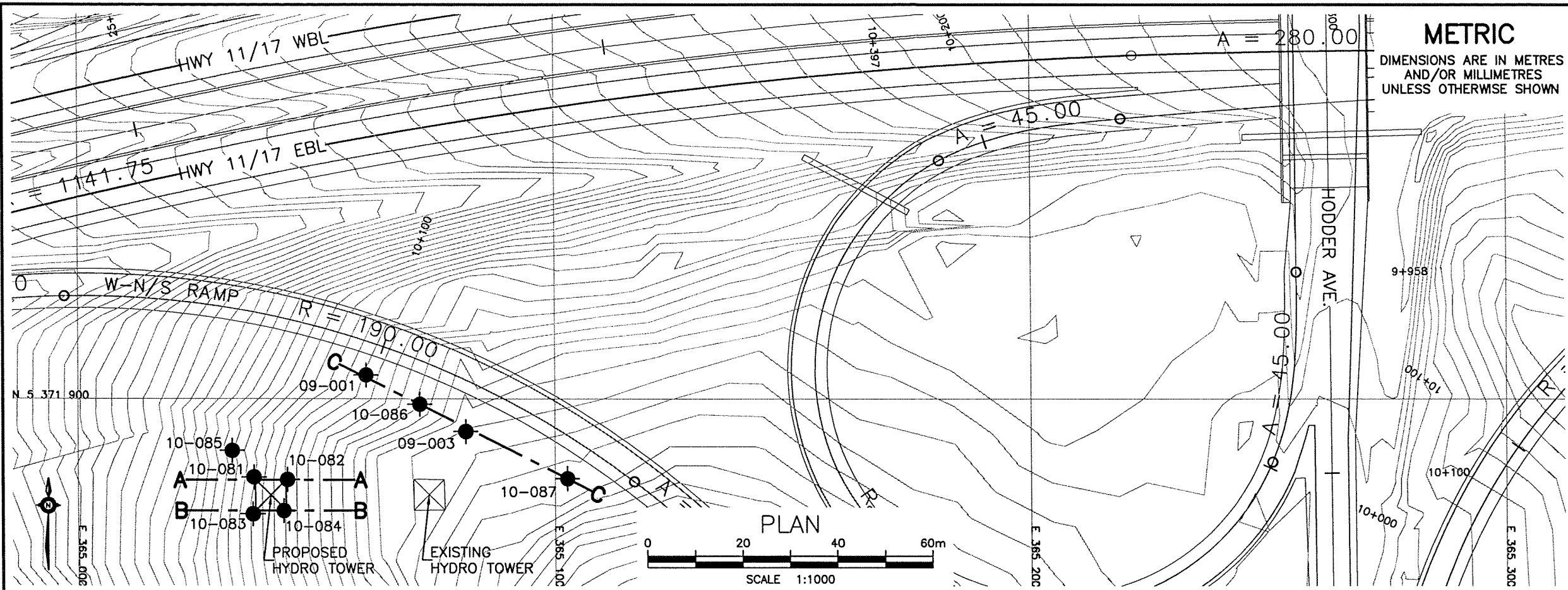


W.P.# 334-94-00
 Prepared By MFA
 Checked By MRA

Appendix C

Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



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

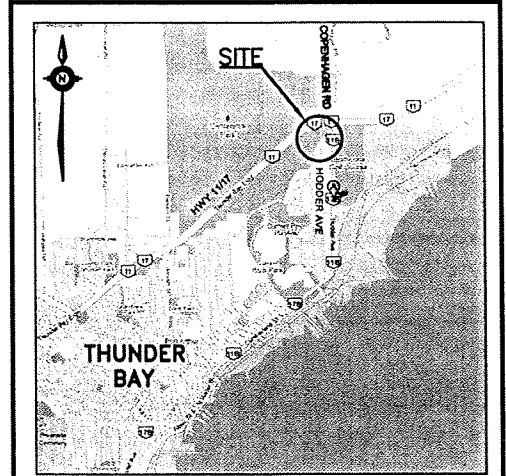
CONT No
GWP No

HIGHWAY 11/17
AT HODDER AVENUE
HYDRO TOWER AND RETAINING WALL
BOREHOLE LOCATIONS AND SOIL STRATA

MCCORMICK RANKIN CORPORATION

SHEET

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



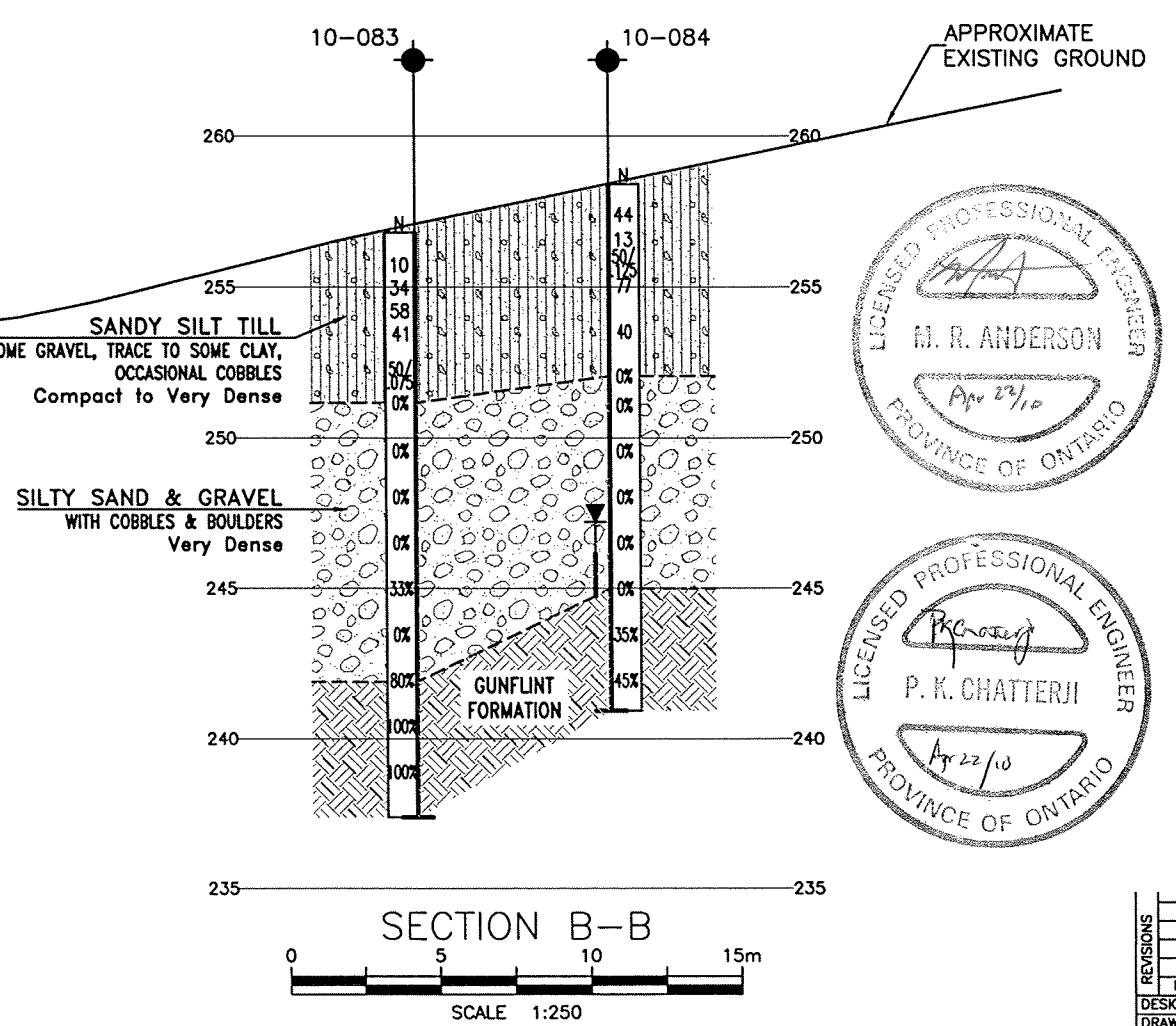
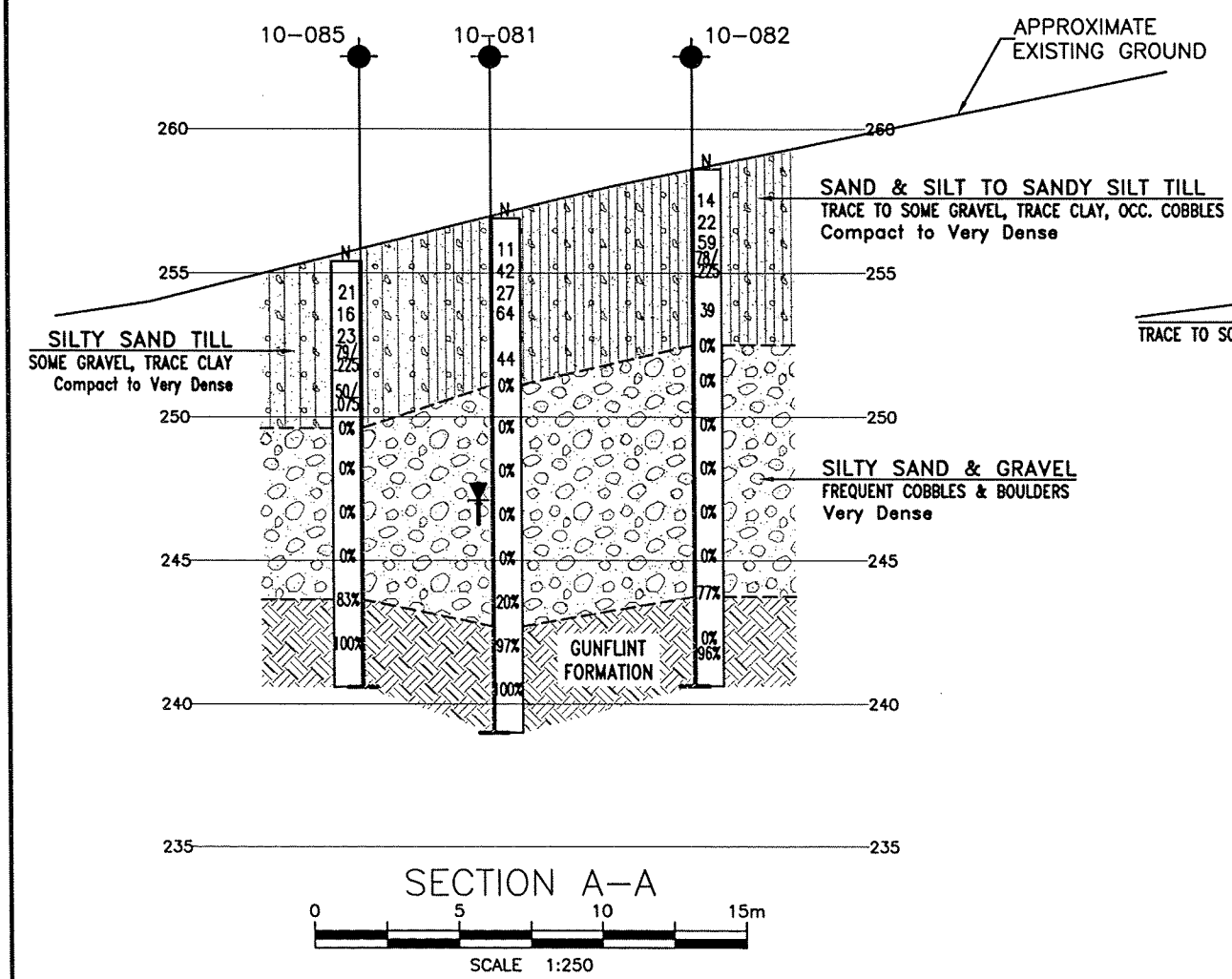
**KEYPLAN
LEGEND**

- Borehole
- Borehole and Cone
- Blows /0.3m (Std Pen Test, 475J/blow)
- Blows /0.3m (60' Cone, 475J/blow)
- Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- Rock Quality Designation (RQD)
- Auger Refusal

NO	ELEVATION	NORTHING	EASTING
09-001	260.4	5 371 905.0	365 060.4
09-003	263.1	5 371 893.1	365 081.2
10-081	256.9	5 371 883.6	365 036.8
10-082	258.6	5 371 883.1	365 043.8
10-083	256.8	5 371 875.9	365 036.6
10-084	258.4	5 371 876.5	365 043.0
10-085	255.4	5 371 889.1	365 032.3
10-086	261.8	5 371 898.8	365 071.6
10-087	264.4	5 371 883.3	365 102.6

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

GEOCREs No. 52A-145

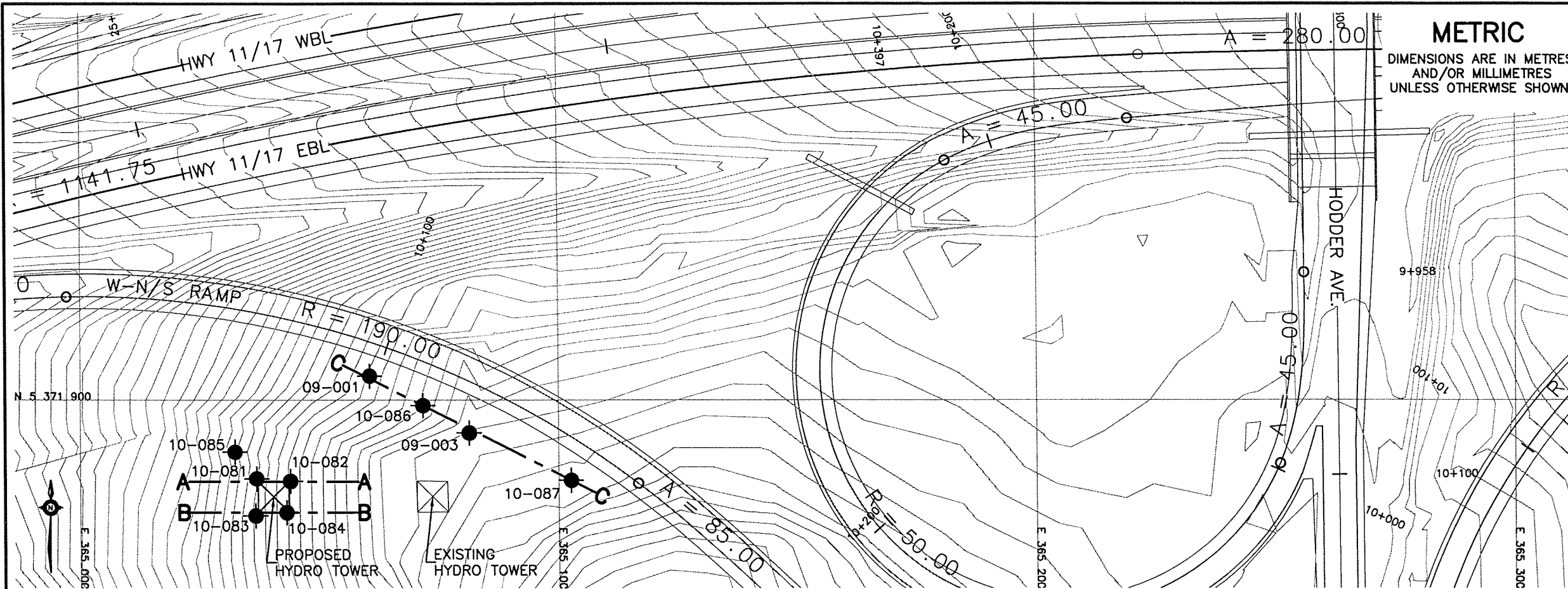


LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Apr 22/10
PROVINCE OF ONTARIO

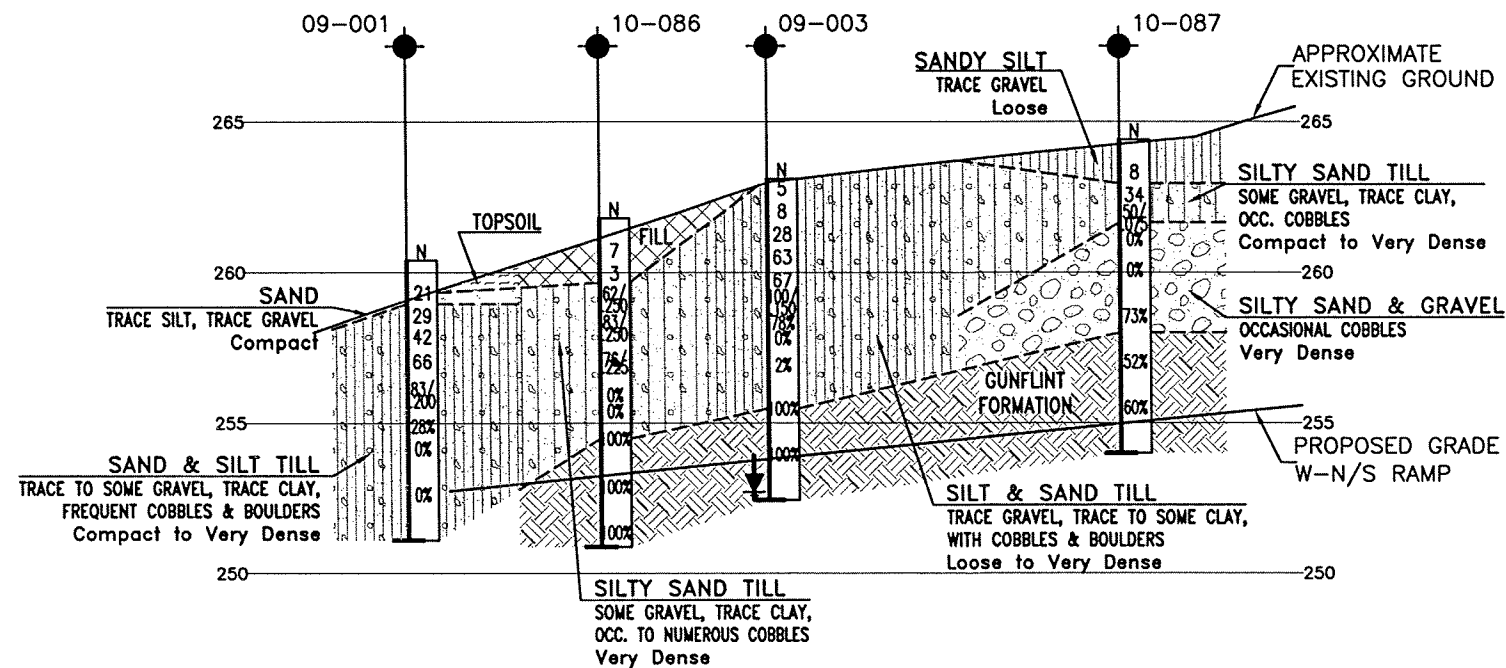
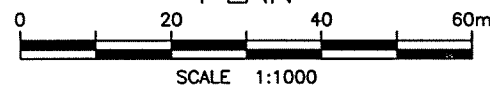
LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Apr 22/10
PROVINCE OF ONTARIO

REVISIONS	DATE	BY	DESCRIPTION
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DRAWN	MFA	CHK PKC	SITE
LOAD			
STRUCT			
DWG	1		
DATE	APR. 2010		

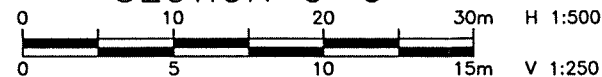
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PLAN



SECTION C-C



METRIC

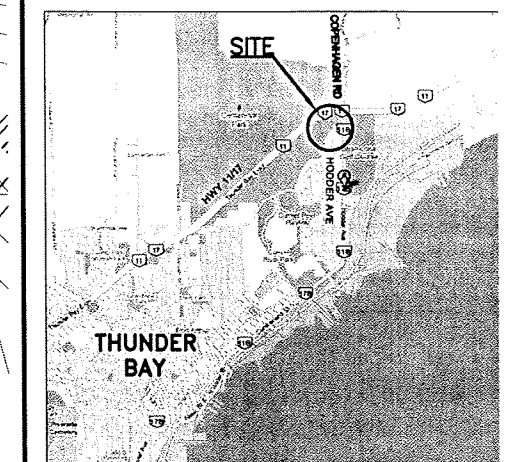
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No

HIGHWAY 11/17
AT HODDER AVENUE
HYDRO TOWER AND RETAINING WALL
BOREHOLE LOCATIONS AND SOIL STRATA

MRC McCORMICK RANKIN
CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

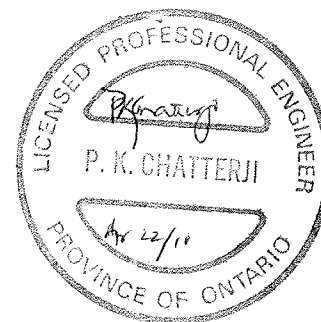
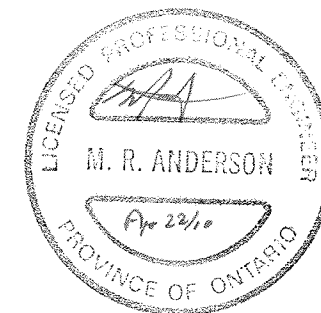
●	Borehole
⊙	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level
HA	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
09-001	260.4	5 371 905.0	365 060.4
09-003	263.1	5 371 893.1	365 081.2
10-081	256.9	5 371 883.6	365 036.8
10-082	258.6	5 371 883.1	365 043.8
10-083	256.8	5 371 875.9	365 036.6
10-084	258.4	5 371 876.5	365 043.0
10-085	255.4	5 371 889.1	365 032.3
10-086	261.8	5 371 898.8	365 071.6
10-087	264.4	5 371 883.3	365 102.6

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. 52A-145



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MRA	CHK AEG	CODE
DRAWN	MFA	CHK PKC	SITE
			LOAD
			DATE APR. 2010
			STRUCT
			DWG 2