PRELIMINARY

FOUNDATION INVESTIGATION AND DESIGN REPORT

PROPOSED HIGHWAY 7 BRIDGE OVER WOODLAWN ROAD

HIGHWAY 7-NEW, KITCHENER TO GUELPH

G.W.P. 408-88-00

Geocres Number: 40P9-46

Report to

Ministry of Transportation Ontario

Southwestern Region

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October 8, 2008
File: 15-64-17

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a preliminary foundation investigation conducted at the site of the proposed bridge structures to carry the eastbound lanes (EBL) and westbound lanes (WBL) of proposed Highway 7 over existing Woodlawn Road in the City of Guelph, Ontario.

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, records of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions under the potential foundation footprint was developed from the data obtained in the course of the investigation.

The information collected in the course of the investigation and presented in this report is intended for preliminary design purposes only. Additional site investigation, field testing and engineering analysis will be required at the detail design stage. The extent of the additional investigation will depend, in part, on the final location and General Arrangement of the structure.

Thurber carried out the investigation for the Ministry of Transportation Ontario, Southwestern Region (MTO) under Purchase Order Number 3006-E-0123.

2 SITE DESCRIPTION

The site is located at the intersection of Woodlawn Road (existing Highway 7) and the Hanlon Expressway (Highway 6). The site is at the northwest end of the City of Guelph.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within an area referred to as the Guelph Drumlin Field, an area of drumlinized till plain, also mapped as containing eskers. The till is described as stony and the occurrence of surface boulders is noted. Chapman and Putnam give a typical gradation of the till as being 50% sand, 35% silt and 15% clay. Swampy valleys are reported to occur between the drumlins and associated gravel terraces.

Lands adjacent to the site generally consist of commercial developments.

A photograph of the site, looking east along Woodlawn Road is included in Appendix D and shows the general nature of the surrounding land.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing at this site was carried out from June 18 to 20, 2008. Four boreholes, 08-236 to 08-239 were drilled for the proposed WBL and EBL bridges. One borehole was drilled at each bridge abutment of possible one-span structure arrangements.

Boreholes 08-237 and 08-238 were terminated upon auger refusal on possible bedrock at 3.7 m and 5.3 m depth (Elevations 335.8 and 335.7), respectively. Two boreholes (Boreholes 08-236 and 08-239) were further advanced into dolostone bedrock by coring to depths of 7.8 m and 8.5 m (333.7 and 331.5), with a minimum 3.0 m of rock cores recovered in each borehole.

The Record of Borehole sheets for the boreholes are included in Appendix A. The approximate locations of the four boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix E.

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area.

The boreholes were drilled using hollow stem auger equipment mounted on a CME-75 truck-mounted drill rig. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils. NQ rock coring equipment was used to recover core samples of the underlying bedrock in selected boreholes.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Standpipe piezometers were installed in Boreholes 08-237 (WBL, South abutment) and 08-238 (EBL, North abutment). The standpipe piezometers consist of 25 mm diameter PVC pipe with a slotted screen and enclosed in filter sand to permit longer term groundwater level monitoring. The locations and completion details of the piezometers are shown in Table 3.1. Boreholes without piezometer installations were grouted with bentonite upon completion. The borehole completion details are also shown in Table 3.1.

The completion of the boreholes and the standpipe piezometer was carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07).

Table 3.1 – Borehole Completion Details

Foundation Unit		Borehole Location	Piezometer Tip Depth/ Elevation (m)	Completion Details
WBL	North Abutment	08-236	No Installation	Borehole backfilled with holeplug to 4.6 m, bentonite seal from 4.6 m to 0.6 m, then grout to surface.
	South Abutment	08-237	3.7/335.8	Piezometer with 1.5 m slotted screen installed with sand filter to 1.8 m, holeplug from 1.8 m to 0.9 m, bentonite seal from 0.9 m to 0.6 m, sand from 0.6 m to 0.5 m, then concrete to ground surface.
EBL	North Abutment	08-238	5.1/335.9	Piezometer with 1.5 m slotted screen installed with sand filter to 3.3 m, holeplug from 3.3 m to 2.4 m, bentonite seal from 2.4 m to 0.4 m, sand from 0.4 m to 0.3 m, then holeplug to ground surface.
	South Abutment	08-239	No Installation	Borehole backfilled with holeplug to 5.2 m, bentonite seal to 0.6 m, then holeplug to surface.

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

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

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 (sieve and hydrometer tests). The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

Core samples of the dolostone bedrock were carefully protected during transport to the laboratory. Point load tests were carried out on selected samples of intact dolostone to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the selected rock core samples are shown in Table B1 in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy along the proposed alignment are presented in this appendix and on the "Borehole Locations and Soil Strata" drawing in Appendix E. 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 granular fill overlying native silty sand, sand and sandy silt till. Slightly to moderately weathered dolostone bedrock was contacted below the till deposit.

5.1 Fill

Fill was encountered surficially at all four exploration locations at this site. The fill consists of an upper layer of dark brown silt mixed with topsoil followed by a layer of brown sand and gravel with numerous cobbles. Presence of organics and gas odour were noted in Boreholes 08-237 and 08-239.

The depth to the base of the fill was 3.0 m and 3.7 m (Elevations 338.4 to 335.8) at the WBL bridge location, and 1.5 m and 2.6 m (Elevation 338.4) at the EBL bridge location.

The fill is classified as compact to very dense, based on SPT 'N' values ranging from 25 to 92 blows for 0.3 m of penetration. In Borehole 08-237, an SPT 'N' value of 50 blows per 0.1 m of penetration was measured at 0.8 m depth. Loose relative density was observed in the surficial silt fill layer in Borehole 08-236. Moisture content ranged from 4% to 23%.

Grain size distribution curves for several samples of granular fill tested are presented on the Record of Borehole sheet and on Figure B1 of Appendix B. The results of laboratory tests are summarized below:

Soil Particles	(%)
Gravel	32 to 41
Sand	43 to 46
Silt & Clay	13 to 25

5.2 Silty Sand and Sand

Layers of native brown silty sand and sand containing some gravel and numerous cobbles were contacted below the fill at 1.5 m depth in Borehole 08-239. Gas odour was noted within the silty sand layer.

Thicknesses of the silty sand and sand layers were 0.6 m and 1.6 m, respectively.

SPT 'N' values varied from 13 to 43 blows per 0.3 m of penetration, indicating a compact to dense relative density. The natural moisture contents generally lay in the range of 16% to 19%.

Grain size distribution curves for 2 samples tested are presented on the Record of Borehole sheets and on Figures B2 and B3 of Appendix B. The results of laboratory tests are summarized as follows:

Soil Particles	Silty Sand (%)	Sand (%)
Gravel	1	20
Sand	49	58
Silt	39	-
Clay	11	-
Silt & Clay	-	22

5.3 Sandy Silt Till

Sandy silt till containing trace of gravel, trace to some clay and numerous cobbles and possible boulders was contacted in Boreholes 08-236, 08-238 and 08-239 at depths ranging from 2.6 m to 3.7 m (338.4 to 336.3). Thickness of the sandy silt till ranged from 1.6 m to 2.7 m.

SPT ‘N’ values ranged from 58 blows per 0.3 m of penetration to 103 blows per 0.125 m of penetration, indicating a very dense relative density. The natural moisture contents generally lay in the range of 5 to 18%.

Grain size distribution curves for 3 samples tested are presented on the Record of Borehole sheets and on Figure B4 of Appendix B. The results of laboratory tests carried out on sandy silt till samples were as follows:

Soil Particles	(%)
Gravel	0 to 3
Sand	31 to 45
Silt	48 to 55
Clay	7 to 11

Although not specifically identified in the boreholes, this layer may contain boulders and cobbles which may account for some high SPT ‘N’ values and resistance to augering.

5.4 Bedrock

The soils described above were found to be underlain by dolostone bedrock of the Guelph Formation. The dolostone encountered in the boreholes is described as white in colour and slightly to moderately weathered. Depth and elevations of the top of weathered bedrock are shown in Table 5.1.

Table 5.1 – Depth and elevation of Top of Weathered Bedrock

Foundation Unit		Borehole	Depth to Weathered Bedrock (m)	Top of Weathered Bedrock Elevation (m)
WBL	North Abutment	08-236	4.6	336.8
	South Abutment	08-237	3.7*	335.8
EBL	North Abutment	08-238	5.3*	335.7
	South Abutment	08-239	5.3	334.6

* Inferred from auger refusal

Bedrock cores were collected using NQ sized coring equipment. Total core recovery (TCR) in the bedrock was 100% in all core runs, except in Borehole 08-236 Run 3 where TCR was 86%.

RQD values recorded for rock cores in both boreholes ranged from 33% to 100%. In Borehole 08-236 Run 3 and Borehole 08-239 Run 4, RQD values were 26% and 25%, respectively. Based on RQD values, rock quality is described as poor to excellent.

Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 1 to higher than 10.

Results of the point load tests conducted on the rock core samples are presented in Table 1 immediately following the text. Average values are shown on the Record of Borehole sheets. The typical ranges of inferred UCS for various types of rock cores were 88 to 176 MPa, indicating a strong to very strong rock.

5.5 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Two standpipe piezometers were installed to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.2, along with the measurements in the boreholes upon completion of drilling.

Table 5.2 – Water Level Measurements

Foundation Unit		Borehole	Date (2008)	Water Level (m)		Comment
				Depth	Elevation	
WBL	North Abutment	08-236	June 18	4.0	337.4	During drilling
	South Abutment	08-237	June 20 July 15	2.4 2.3	337.1 337.2	During drilling In piezometer
EBL	North Abutment	08-238	June 20 July 15	2.7 2.9	338.1 338.1	During drilling In piezometer
	South Abutment	08-239	June 19	2.1	337.8	During drilling

The piezometric reading indicates that the groundwater level is near Elevation 338.0 m.

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

All-Terrain Drilling of Waterloo, Ontario supplied a CME 75 truck-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. Stephane Loranger, C.E.T. of Thurber, under the direction of Mr. Alastair E. Gorman, P.Eng.

The coordinates for the boreholes and the ground surface elevations were obtained by Thurber Engineering Ltd. using GPS equipment.

Overall supervision of the field program was conducted by Mr. Alastair E. Gorman, P.Eng and Mr. Mark Farrant, P. Eng. Interpretation of the data and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng and Ms. R. Palomeque Reyna, P.Eng.

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

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents preliminary geotechnical design recommendations to assist the design team to select and design a suitable foundation system for the new structures.

Based on the Plate 23 of the E.A:

- Existing Woodlawn Road (Highway 7) grade will be at Elevation 341.0.
- The finished grade at the proposed Highway 7 structures will be about Elevation 348.8 m and the original ground surface varies from Elevation 339.5 to 341.4, resulting in approach embankments of 7.3 m to 9.3 m high.

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

8 STRUCTURE FOUNDATIONS

The stratigraphy identified in the preliminary investigation consisted primarily of a sand and gravel fill overlying native silty sand, sand and silty sand till. Slightly to moderately weathered dolostone bedrock was contacted below the till deposit at depths varying from 3.7 m to 5.3 m (Elevations 334.6 to 336.8). Piezometers installed in boreholes revealed that groundwater level is anticipated to be near 2.0 m to 3.0 m depth (Elevation 338.0).

In the preparation of the preliminary geotechnical design recommendations, consideration was given to the following foundation types:

- Spread footings bearing on native soil
- Spread footings on bedrock
- Augered Caissons in bedrock (drilled shafts)
- Steel H-piles driven to bedrock

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

8.1 Spread Footings on Native Soil

Spread footings bearing on native soil generally are the least expensive form of construction.

The existing fill is not considered to be suitable for the support of spread footings and the footings must be placed on the underlying undisturbed native soils.

The design of spread footings bearing on native dense to very dense sand and sandy silt till soil must be in accordance with the elevations and bearing resistances given in Table 8.1.

Table 8.1 – Bearing Resistances for Spread Footings

Foundation Unit		Borehole	Depth (m)	Elev.	ULS_f (kPa)	SLS (kPa)
WBL	North Abutment	08-236	3.0	338.4	750	500
	South Abutment	08-237	Footings, caissons or piles on bedrock			
EBL	North Abutment	08-238	3.0	338.0	750	500
	South Abutment	08-239	2.4	337.5	600	450
			Below 3.7	Below 336.2	750	500

The bearing resistances in Table 8.1 are for vertical, concentric loading. In the case of eccentric or inclined loading, the bearing resistance must be adjusted as shown in the CHBDC (2006) Clause 6.7.3 and Clause 6.7.4.

The geotechnical SLS resistance values given above are based on an estimated total settlement not exceeding 25 mm. This settlement is expected to be substantially complete by the end of construction. Differential settlements are not expected to exceed 20 mm across the width of the structure or between foundation elements.

Founding elevations at the abutments presented in Table 8.1 are generally at or a short distance below the groundwater level observed during the site investigation.

If temporary excavations required to construct these footings extend in cohesionless soils below the water table, local groundwater control will be required prior to excavation to construct the footing in the dry, to prevent sloughing of the sides and to prevent disturbance of the footing base due to the inflow of groundwater.

8.2 Spread Footings on Bedrock

Spread footings bearing on bedrock is another foundation alternative at this site.

Based on the subsurface stratigraphy, the additional depth of excavation below the recommended native till founding levels to top of bedrock varies from 1.6 m to 3.0 m. The excavation will extend to 3.7 m in Borehole 08-237.

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

- Factored geotechnical resistance of 2,000 kPa at Ultimate Limit States (ULS)

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

The highest permissible bearing elevations for spread footings on bedrock are given in Table 5.1.

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

The bearing surface should be prepared by removing all loose/disturbed material and shattered rock. Areas requiring subexcavation beneath the underside of footing should be backfilled with the same class of concrete as used in the footing.

Forming and unwatering an excavation to bedrock will be problematic and accordingly this option is not recommended.

8.3 Augered Caissons in Bedrock (Drilled Shafts)

Drilled shaft foundations are also suitable for the support of structural loads at this site. The caissons must be founded in the bedrock at depths and elevations indicated in Table 5.1. The base of the caissons would be about 1.0 m to 2.7 m plus depth of socket below the groundwater level.

Geotechnical resistance has been calculated for a range of probable caisson diameters and for a range of socket depths and the values are shown in Table 8.2.

The vertical geotechnical resistance for caisson foundations has been calculated assuming contributions from factored sidewall resistance in the sockets.

Table 8.2 – Vertical Geotechnical Resistance (Factored ULS) for Caisson Foundations

Caisson Diameter 0.9 m		Caisson Diameter 1.2 m	
Socket Depth* (m)	**Geotechnical Resistance (kN)**	**Socket Depth* (m)**	**Geotechnical Resistance (kN)**
2.0	8,000	2.0	10,000
3.0	12,000	3.0	16,000
5.0	21,000	5.0	29,000

* Depth of penetration into bedrock from elevation given in Table 5.1.

Caisson installation should be in accordance with Special Provision No. 903S01.

The caisson installation equipment should be able to dislodge and remove any obstructions in the fill or cobbles and boulders in the till.

The overburden soil at this site is predominantly permeable cohesionless soils under water table and contains cobbles and boulders. These conditions will make caisson installation difficult and sealing of caisson liners into the founding stratum to exclude groundwater will also be difficult. Installation of caisson to bedrock is also expected to be a more expensive option than driven piles. For these reasons, the use of a caisson foundation is not recommended.

8.4 Steel H-Piles

The soil stratigraphy encountered at this site is considered to be suitable for the support of foundations on driven steel piles.

It is recommended that the H-piles be driven to achieve resistance in the dolostone bedrock encountered at this site. The elevations at which the H-piles are expected to develop the required resistance are given in Table 8.3.

Table 8.3 – Estimated Pile Tip Elevation

Foundation Unit		Borehole	Highest Pile Tip Elevation
WBL	North Abutment	08-236	336.8
	South Abutment	08-237	335.8
EBL	North Abutment	08-238	335.7
	South Abutment	08-239	334.6

8.4.1 Axial Resistance

For preliminary design, the vertical, axial, factored geotechnical resistance at Ultimate Limit States (ULS) for two pile sections when founded on the dolostone bedrock are presented in Tables 8.4.

Table 8.4 – Axial Resistance of Two Pile Sections Founded on Bedrock

Pile Section	Geotechnical Resistance (kN)
	Factored ULS
HP 310 X 110	2,000
HP 360 X 132	2,400

The SLS condition will not govern for piles founded on the bedrock. The structural resistance of the pile must be checked by the structural designer.

These are preliminary recommendations and may change during detail design based on the final alignment, final bridge arrangement and the results of the site investigation and field testing to be completed at that time.

At the locations of Boreholes 08-237 (WBL south abutment) and 08-238 (EBL north abutment), greater depth of exploration is required to confirm bedrock by coring and that must be addressed during the detail design phase.

Due to the presence of cobbles and boulders in the till and the fact that piles will be driven to relatively strong bedrock, it is recommended that the pile tips be fitted with cast steel, H-Section rock points from an approved manufacturer such as Titus Steel (Standard H-point).

8.4.2 Downdrag

Downdrag on the piles is not an issue at this site.

8.5 Abutment Design Considerations

From a geotechnical perspective, the conditions at this site are considered to be suitable for the design of conventional, semi-integral or integral abutments. Depending on final grades, integral abutment design may require drilling into bedrock to install the piles and achieve the flexibility required in the upper 3 m.

8.6 Frost Cover

The design depth of frost penetration for this site is 1.4 m. All footing bases and undersides of pile caps/abutment stems must be provided with at least 1.4 m of soil cover, or an equivalent combination of soil cover and extruded polystyrene (EPS) insulation. A 25 mm thickness of EPS is equivalent to 600 mm of soil cover.

8.7 Recommended Foundation

From a geotechnical perspective, and based on current information, the recommended abutment foundation consists of steel H-piles driven to bedrock

9 BRIDGE APPROACHES AND EMBANKMENTS

Based on the four boreholes drilled at the site, the approach embankments will be constructed over compact to dense existing fill and non-cohesive sandy silt till overlying bedrock.

Preliminary analysis indicates that at the abutments, settlement in the order of 50 to 60 mm is estimated in the foundation soils under the loading imposed by approximately 9.0 m of the approach fill. Due to the non cohesive nature of the foundation soils, these settlements will be immediate and essentially completed when construction of the fill is completed. Further analysis should be conducted during the detail phase design.

The 7 to 9 m high embankments likely to be constructed will be stable at side slopes of 2H:1V if constructed using SSM or granular fill. Where earth fill embankments are higher than 8 m, mid-height berms should be incorporated in the design. The berms should:

- extend for the length through which the embankment height exceeds 8 m
- be at least 2 m wide
- have 2% positive grade to shed run-off water.

The global, internal and surficial stability of the approach embankment fills are not expected to be an issue, but should be evaluated during the detail design phase.

10 CONSTRUCTION CONCERNS

Based on the Recommended Alignment and the preliminary geotechnical information, potential construction concerns include, but are not necessarily limited to:

1. Excavation

   If excavations advance below the existing groundwater level, groundwater control measures may have to be implemented in order to maintain stables sides and base in the excavation.

11 INVESTIGATION FOR DETAIL DESIGN

During the detail design phase of the project, additional site investigation and field testing will be required. The following minimum program is recommended:

1. Boreholes for structure foundations.

   Additional boreholes will be required for the structure foundations. Coring of bedrock is required for WBL south abutment and EBL north abutment.

2. Subsurface investigation

   Further investigation will be required to delineate the extent of fill on this site, especially at the WBL South abutment.

3. Boreholes for approaches.

   A minimum of one borehole is recommended in each approach fill.

4. Groundwater impacts.

   The need to apply for an MOE Permit to Take Water must be evaluated.

12 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng and Ms. R. Palomeque Reyna, P.Eng.

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

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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

THURBER

RECORD OF BOREHOLE No 08-236

METRIC

G.W.P. 408-88-00	LOCATION N 4 823 685.76 E 240 320.65	ORIGINATED BY SA
HWY 7	BOREHOLE TYPE Hollow Stem Augers	COMPILED BY ES
DATUM Geodetic	DATE 2008.06.18 - 2008.06.18	CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³ (FI)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
341.4 / 0.0	SILT, mixed with topsoil, occasional roots; Loose; Dark brown; Moist (FILL)	1	SS	2			
340.6 / 0.8	SAND and GRAVEL, some silt, trace clay; Compact to very dense; Brown; Moist (FILL); Cobbles	2	SS	25			
		3	SS	53			33 43 24 (SI+CL)
	Auger grinding, split spoon bouncing	4	SS	75			
338.4 / 3.0	Sandy SILT, numerous cobbles; Very dense; Grey; Moist (TILL)	5	SS	88	▼ (approx. 4.0 m)		0 45 48 7
336.8 / 4.6	Coring started at 4.62m. DOLOSTONE; Slightly to moderately weathered; White	1	RUN			FI 0	RUN 1# TCR=100%, SCR=100%, RQD=33%
		2	RUN			10, 10, 10	
		3	RUN			12, 1, 1	RUN 2# TCR=100%, SCR=100%, RQD=46%
		4	RUN			1, 3, 2, 4	RUN 3# TCR=86%, SCR=86%, RQD=26%, UCS=130MPa; RUN 4# TCR=100%, SCR=100%, RQD=90%, UCS=130MPa
333.7 / 7.8	END OF BOREHOLE AT 7.8m. WATER OBSERVED AT 4.0m DURING DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO 4.6m THEN BENTONITE SEAL TO 0.6m THEN GROUT TO SURFACE.						

Plot columns: 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); ELEVATION SCALE 341 – 334; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60.

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No 08-237

METRIC

G.W.P. 408-88-00	LOCATION N 4 823 653.07 E 240 355.32	ORIGINATED BY SA
HWY 7	BOREHOLE TYPE Hollow Stem Augers	COMPILED BY ES
DATUM Geodetic	DATE 2008.06.20 - 2008.06.20	CHECKED BY RPR

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	GR	SA	SI	CL
339.5 0.0	**SAND** and **GRAVEL**, silty, trace clay, numerous cobbles Dense to very dense Brown Moist (FILL) Possible boulders					o				
		1	SS	50/ .100	339					
	Wet, gas odour	2	SS	37	338	o	32	43	25 (SI+CL)	
		3	SS	63	337	o				
335.8 3.7		4	SS	57	336	o	38	43	19 (SI+CL)	

END OF BOREHOLE AT 3.66m UPON AUGER REFUSAL ON POSSIBLE BEDROCK. WATER OBSERVED AT 2.4m DURING DRILLING.
Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.
WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2008.07.15	2.3	337.2

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; 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 (%)

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No 08-238

METRIC

G.W.P. 408-88-00 | LOCATION N 4 823 655.45 E 240 290.22 | ORIGINATED BY SA

HWY 7 | BOREHOLE TYPE Hollow Stem Augers | COMPILED BY ES

DATUM Geodetic | DATE 2008.06.18 - 2008.06.20 | CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
341.0 / 0.0	**SILT**, some gravel, trace sand, mixed with topsoil Dark brown Moist (FILL)	1	AS		
340.2 / 0.8	**SAND** and **GRAVEL**, some silt, trace clay, numerous cobbles Compact to very dense Brown Moist (FILL)	1	SS	23	
		2	SS	92	41 46 13 (SI+CL)
	Possible boulder at 2.5m				
338.4 / 2.6	Sandy **SILT**, trace gravel, some clay Very dense Brown Moist to wet (TILL)	3	SS	50	3 31 55 11
		4	SS	120	
		5	SS	103/.125	
335.7 / 5.3	END OF BOREHOLE AT 5.3m UPON AUGER REFUSAL ON POSSIBLE BEDROCK. WATER OBSERVED AT 2.7m DURING DRILLING. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.07.15 2.9 338.1				

Column headings: SOIL PROFILE (ELEV DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE (341, 340, 339, 338, 337, 336); 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   15-⊕-5 (20, 10) (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 08-239

METRIC

G.W.P. 408-88-00	LOCATION N 4 823 617.26 E 240 315.41		ORIGINATED BY SLL
HWY 7	BOREHOLE TYPE Hollow Stem Augers		COMPILED BY ES
DATUM Geodetic	DATE 2008.06.19 - 2008.06.19		CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT γ kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
339.9 / 0.0						340			
0.1	SILT, mixed with topsoil, roots. Dark brown. Moist (FILL)	1	SS	35					
	SAND and GRAVEL, trace silt. Dense. Brown. Moist (FILL). Silty, organic, gas odour. Dark brown	2	SS	46		339			
338.4 / 1.5	Silty SAND, trace gravel, some clay, gas odour. Compact. Brown. Moist	3	SS	13	▼	338			1 49 39 11
337.8 / 2.1	SAND, fine grained, some gravel, trace silt, trace clay, numerous cobbles. Dense. Brown. Wet	4	SS	42		337			
		5	SS	43					20 58 22 (SI+CL)
336.3 / 3.7	Sandy SILT, trace gravel, trace clay. Very dense. Brown. Wet (TILL)					336			
		6	SS	58		335			3 34 54 9
334.6 / 5.3	DOLOSTONE. Coring started at 5.3m. Slightly to moderately weathered. White	1	RUN					FI 2	RUN 1# TCR=100%, SCR=100%, RQD=100%
		2	RUN			334		10, 10	
		3	RUN			333		2, 10, 10, 2	RUN 2# TCR=100%, SCR=100%, RQD=80%, UCS=140MPa; RUN 3# TCR=100%, SCR=100%, RQD=69%, UCS=130MPa
		4	RUN			332		>10, >10, 5, 4	RUN 4# TCR=100%, SCR=100%, RQD=25%, UCS=105MPa
331.5 / 8.5	END OF BOREHOLE AT 8.46m. WATER OBSERVED AT 2.1m DURING DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO 5.2m, BENTONITE BENSEAL TO 0.6m THAN HOLEPLUG TO SURFACE.								

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.

$+^3, \times^3$: Numbers refer to Sensitivity — 20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Appendix B

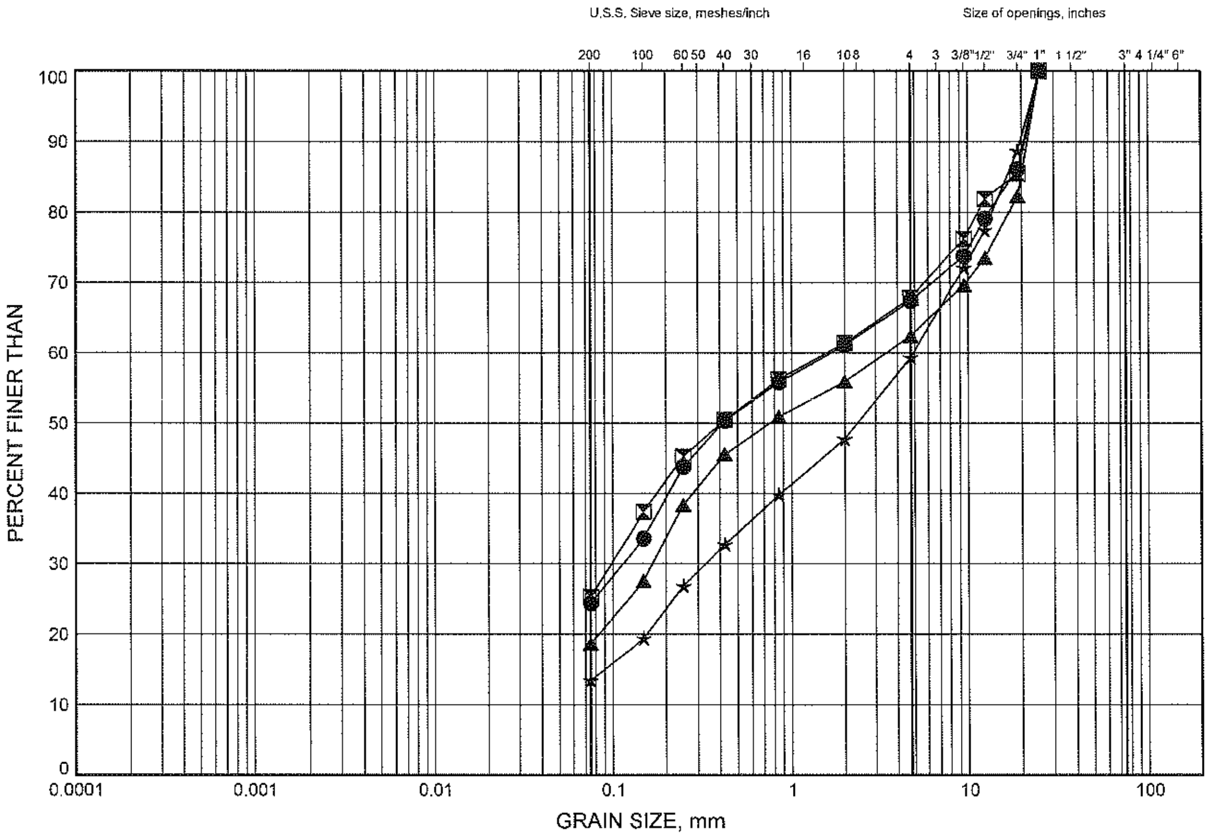
Laboratory Test Results

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B1

Sand and Gravel Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-236	1.83	339.61
⊠	08-237	1.83	357.71
▲	08-237	3.35	356.19
☆	08-238	1.83	339.21

W.P.# 408-88-00

Prepared By SA

Checked By RPR

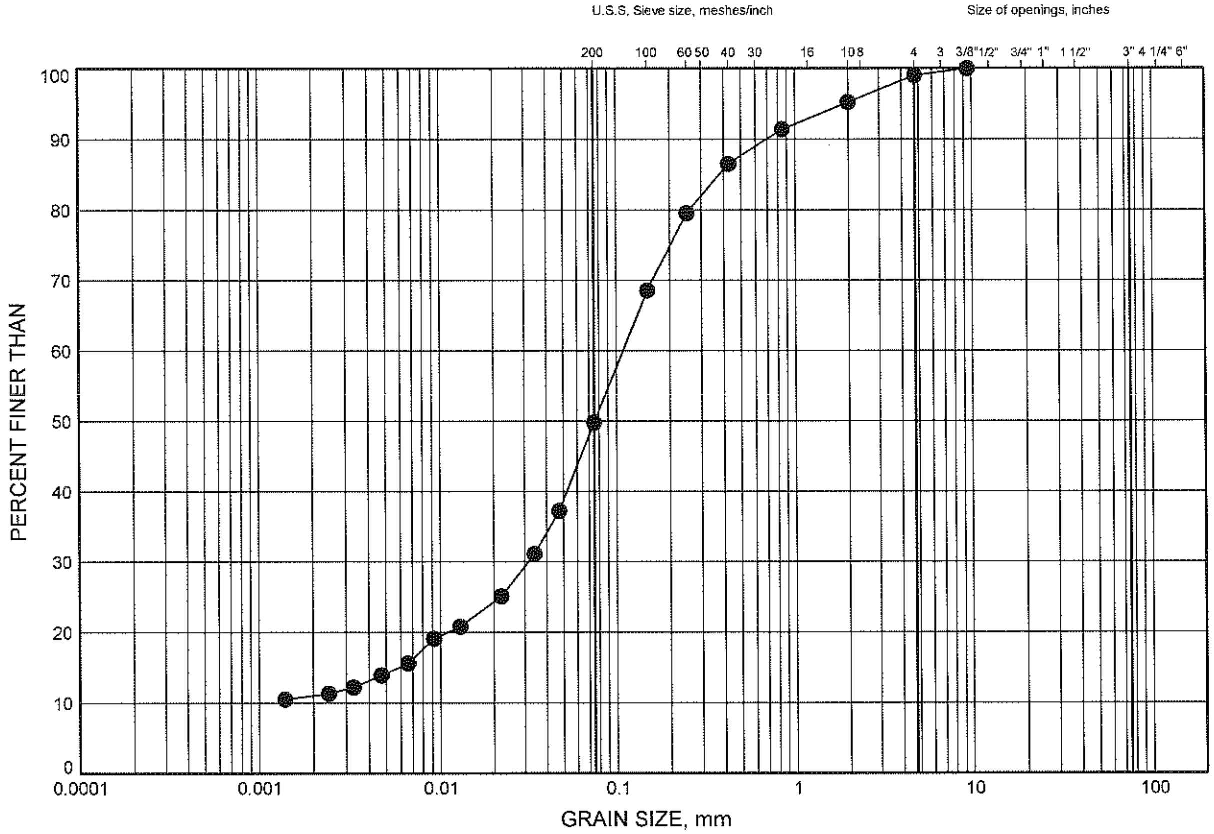
THURBER

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-239	1.83	338.09

W.P.# 408-88-00

Prepared By SA

Checked By RPR

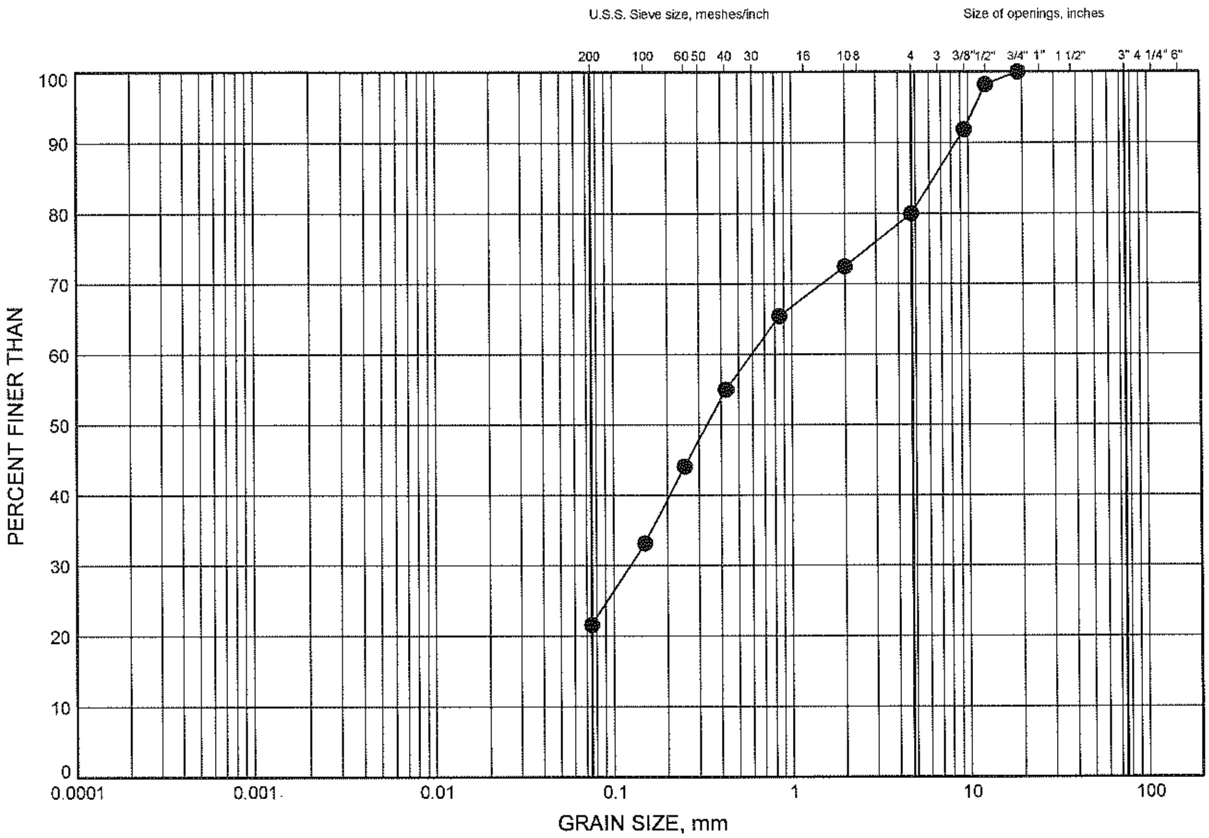
THURBER

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B3

Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-239	3.35	336.57

W.P.# 408-88-00

Prepared By SA

Checked By RPR

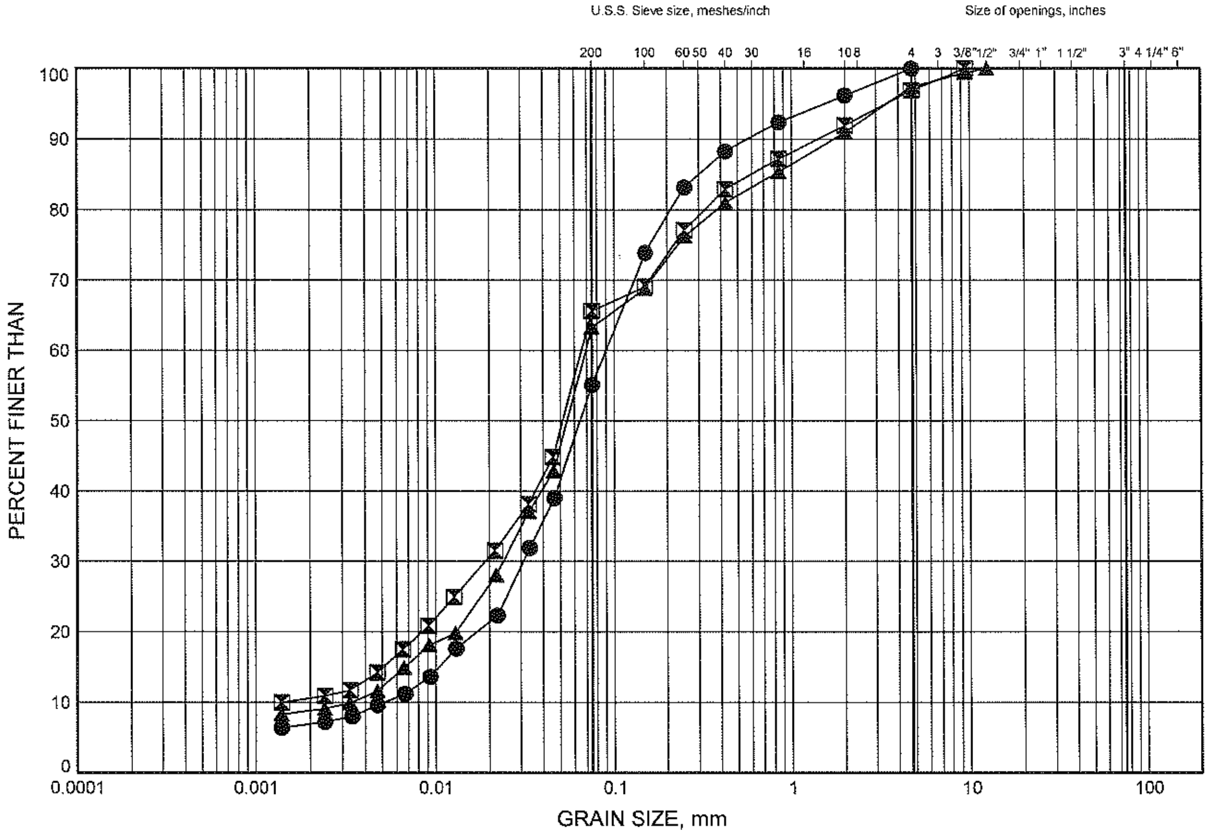
THURBER

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 7/23/08

Highway 7 - New
GRAIN SIZE DISTRIBUTION

FIGURE B4

Sandy Silt Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-236	3.16	338.27
⧗	08-238	2.51	338.52
▲	08-239	4.88	335.04

W.P.# 408-88-00
Prepared By SA
Checked By RPR

THURBER

TABLE B1 -Point Load Results

Highway 7 New

	DEPTH			Is (MPa)	Is50 (MPa)	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS							
	BH 08-236									
RUN #3	20	0	6.10	6.205	6.048	145.15				
	20	2	6.15	4.925	4.801	115.21	**RUN #3:**	130.18	145.15	115.21
RUN #4	20	6	6.25	7.535	7.344	176.25		**AVERAGE**	**MAX**	**MIN**
	20	8	6.30	4.046	3.943	94.64	**RUN #4:**	129.99	176.25	94.64
	23	0	7.01	6.648	6.480	155.52				
	24	0	7.32	6.205	6.048	145.15				
	24	6	7.47	5.101	4.972	119.33				
	25	0	7.62	5.319	5.184	124.41				
	25	3	7.70	4.046	3.943	94.64				
	BH 08-239									
RUN #2	17	4	5.28	5.277	5.143	123.44				
	18	0	5.49	5.097	4.968	119.23				
	18	6	5.64	7.535	7.344	176.25				
	19	2	5.84	5.857	5.769	138.45				
RUN #3	20	2	6.15	4.432	4.320	103.68		**AVERAGE**	**MAX**	**MIN**
	21	6	6.55	7.036	6.858	164.59	**RUN #1:**	139.34	176.25	119.23
	23	1	7.04	5.319	5.184	124.41	**RUN #2:**	130.89	164.59	103.68
							RUN #3:	104.78	119.23	88.13
RUN #4	24	5	7.44	3.767	3.672	88.13				
	25	2	7.67	4.573	4.458	106.98				
	26	6	8.08	5.097	4.968	119.23				

Appendix C

Foundation Comparison

COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Foundation Element	Spread Footings on Native Soil	Spread Footings on Bedrock	Caissons	Driven Piles
Abutments	***Advantages:*** i. Generally less costly construction than deep foundation elements. ii. Ease of construction. ***Disadvantages:*** i. Lower geotechnical resistance on native soils than bedrock. ii. Dewatering may be required, depending on depth of excavation. **FEASIBLE**	***Advantages:*** i. Generally less costly construction than deep foundation elements. ii. High geotechnical resistance available on the bedrock. ***Disadvantages:*** i. Dewatering may be required, depending on depth of excavation. ii. More excavation required. iii. Mass concrete fill may be required to raise the founding subgrade level. **NOT RECOMMENDED**	***Advantages:*** i. High resistance is available for caissons socketed in bedrock. ii. Subexcavation of fill or variable material is not required. iii. Construction of caissons could continue in freezing weather. ***Disadvantages:*** i. Higher cost than spread footings. ii. Dewatering may be required. iii. Possibility of boulders being encountered during augering. iv. Potential difficulty in cleaning and inspecting bases. **FEASIBLE**	***Advantages:*** i. High geotechnical resistance may be developed by driving the piles into bedrock. ii. Comparatively short abutment stem possible. iii. Permits integral abutment design. iv. Readily installed. v. Foundation construction requires less excavation than footings. ***Disadvantages:*** i. Higher unit cost compared to footings. ii. Possibility that cobbles and boulders may be encountered in the till. iii. Bedrock at shallow depth will limit length of pile and geotechnical resistance that can be developed. **RECOMMENDED**

Appendix D

Site Photograph

Photo 1. Looking east along Woodlawn Road

Appendix E

Drawing titled "Borehole Locations and Soil Strata"

METRIC

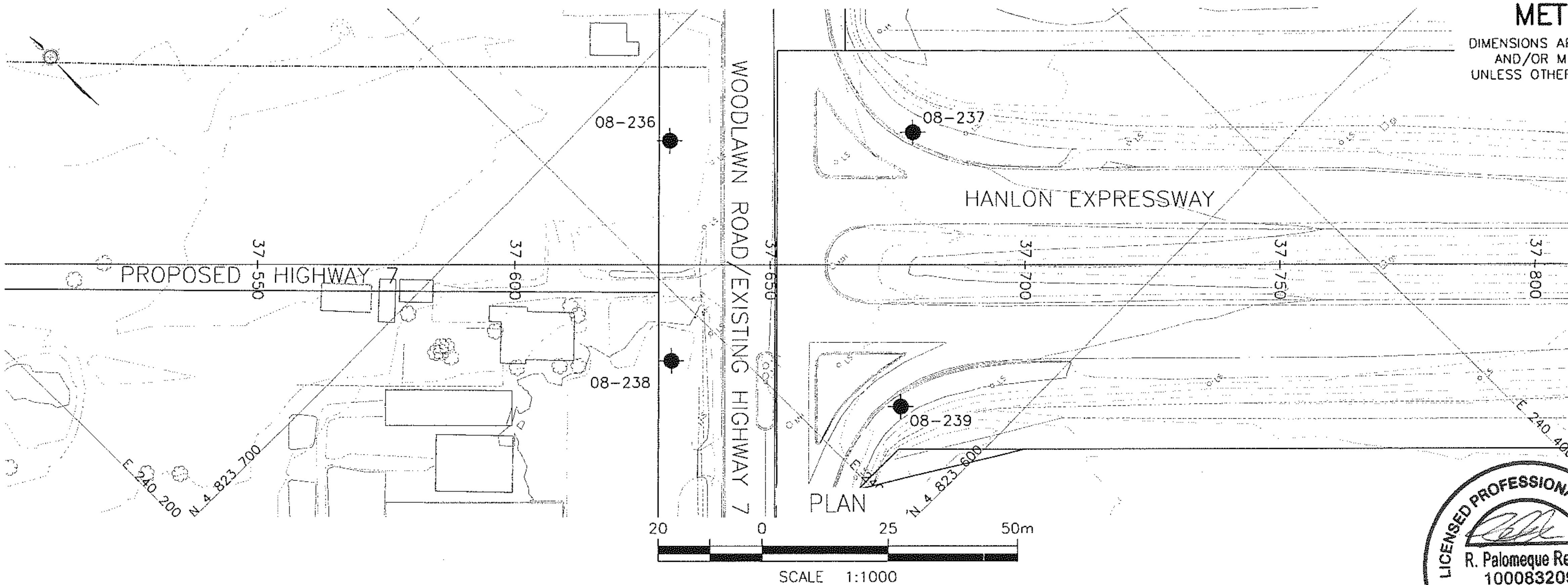
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

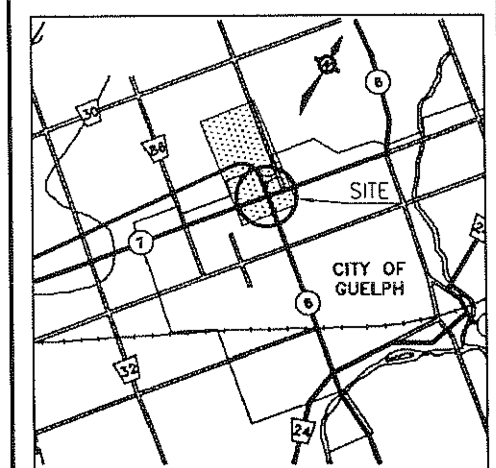
CONT No
GWP No 408-88-00

HIGHWAY 7
RECOMMENDED ROUTE
WOODLAWN ROAD
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS





KEYPLAN

LEGEND

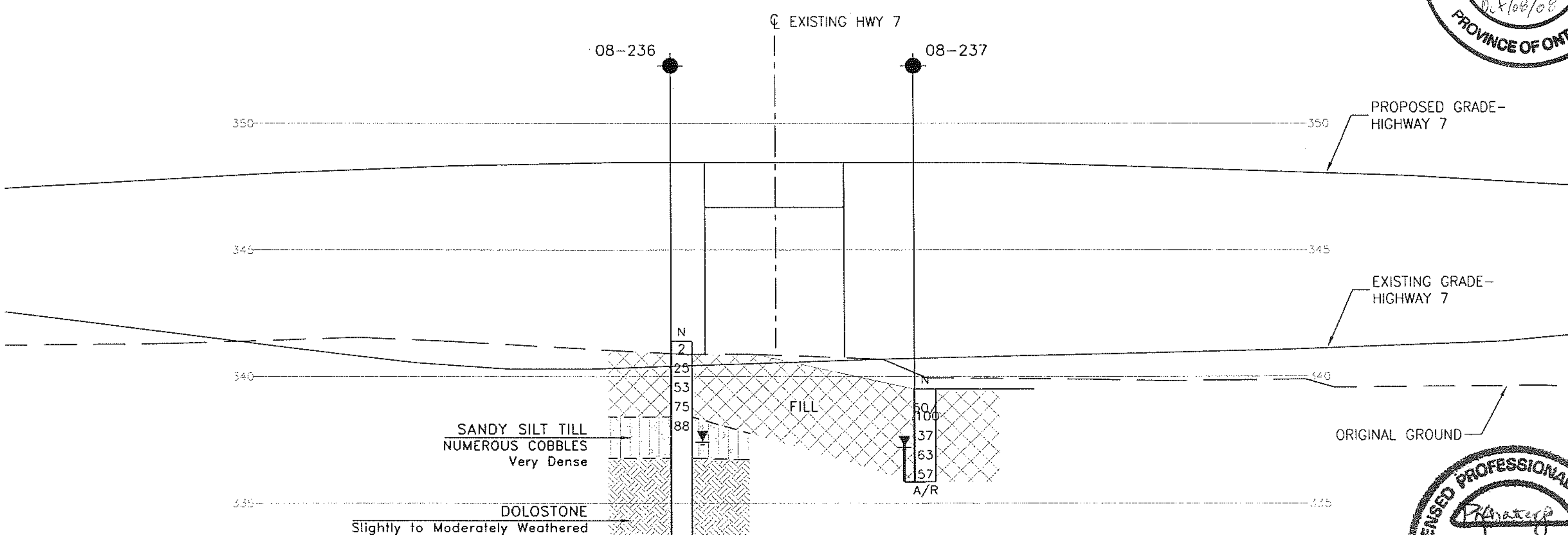
●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
08-236	341.4	4 823 685.8	240 320.6
08-237	339.5	4 823 653.1	240 355.3
08-238	341.0	4 823 655.5	240 290.2
08-239	339.9	4 823 617.3	240 315.4

-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.
3) Proposed grades are from Plate 15 of the E.A. Study.

GEOCRES No. 40P9-46



PROFILE ALONG ℄ OF PROPOSED HIGHWAY 7 WBL/HANLON EXPRESSWAY

20 0 25 50m HOR 1:1000

4 0 5 10m VER 1:200

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Oct/08/08
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 8/08
PROVINCE OF ONTARIO

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN AEG	CHK PKC	CODE	LOAD	DATE OCT. 2008
DRAWN MFA	CHK AEG	SITE	STRUCT	DWG

FILENAME: H:\Drafting\15\64\17\led6417-WoodlawnRoad.dwg
PLOTDATE: Oct 08, 2008 - 2:36pm

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 408-88-00

HIGHWAY 7
RECOMMENDED ROUTE
WOODLAWN ROAD
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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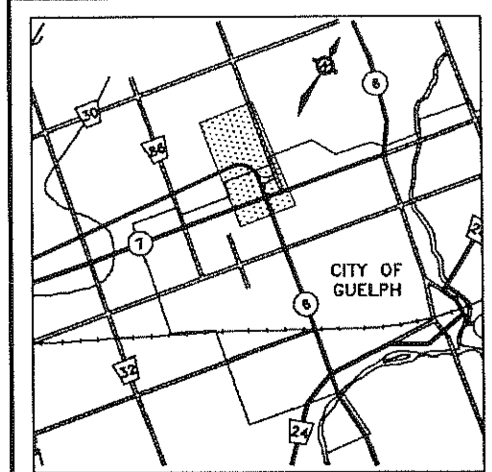
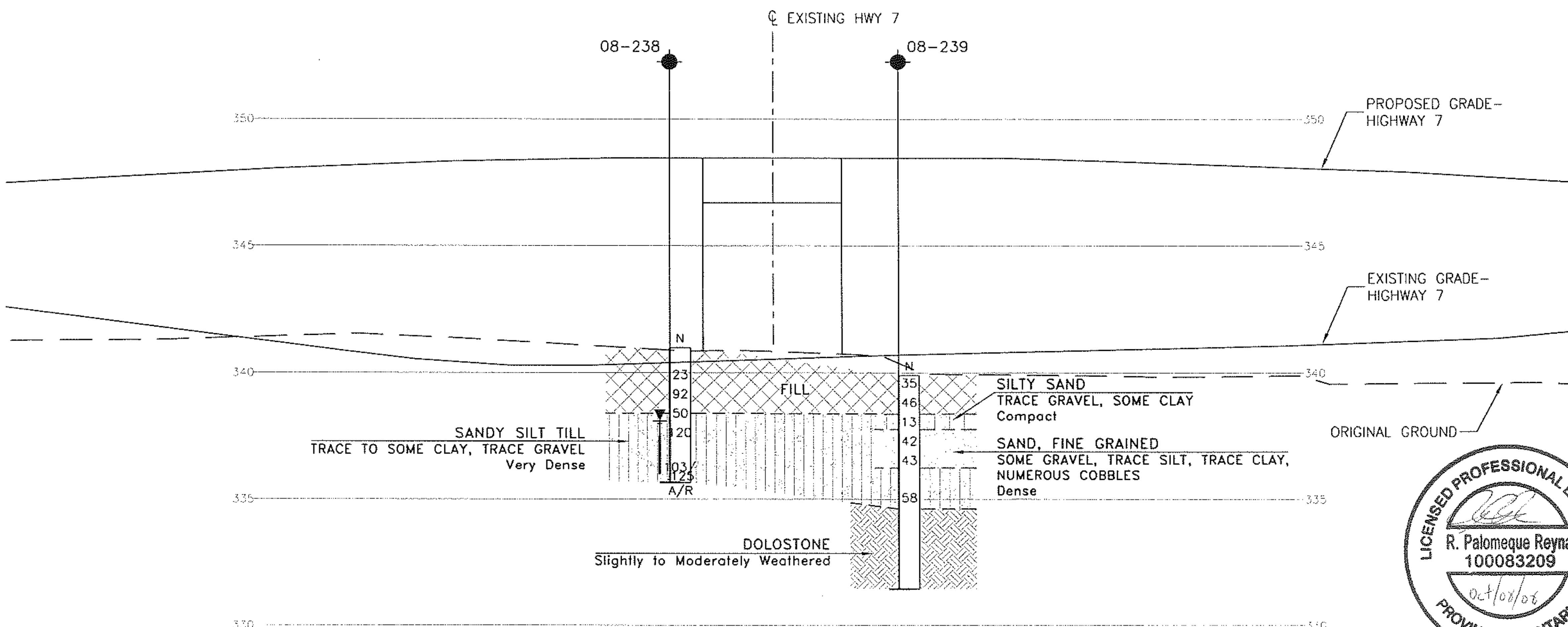
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN



PROFILE ALONG ℄ OF PROPOSED HIGHWAY 7 EBL/HANLON EXPRESSWAY

20 0 25 50m HOR 1:1000

4 0 5 10m VER 1:200

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Oct/08/08
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 8/08
PROVINCE OF ONTARIO

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
08-236	341.4	4 823 685.8	240 320.6
08-237	339.5	4 823 653.1	240 355.3
08-238	341.0	4 823 655.5	240 290.2
08-239	339.9	4 823 617.3	240 315.4

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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.

3) Proposed grades are from Plate 15 of the E.A. Study.

GEOCRES No. 40P9-46

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN AEG	CHK PKC	CODE	LOAD	DATE OCT. 2008
DRAWN MFA	CHK AEG	SITE	STRUCT	DWG

PLOTDATE: Oct 06, 2008 - 2:56pm