

**PRELIMINARY  
FOUNDATION INVESTIGATION AND DESIGN REPORT  
GREENHOUSE ROAD UNDERPASS  
HIGHWAY 7-NEW, KITCHENER TO GUELPH  
G.W.P. 408-88-00**

**Geocres Number: 40P8-149**

**Report to**

**Ministry of Transportation Ontario  
Southwestern Region**

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

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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 underpass structure to carry Greenhouse Road over Highway 7-New in the Regional Municipality of Waterloo, 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**

At the site, the Highway 7-New alignment runs approximately parallel to the existing Highway 7 alignment and 420 m to the north. The site lies approximately 4.5 km northeast of a developed area of the City of Kitchener.

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.

The site lies within an area of farms and agricultural lands. There are farmsteads to the east and west of Greenhouse Road, north of the existing Highway 7 alignment.

A photograph of the site, looking north along Greenhouse Road is included in Appendix E and show 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 between May 28 and May 29, 2008. Three boreholes, 08-137, 08-138 and 08-139, were drilled approximately at the north abutment, pier and south abutment of a possible two-span structure arrangement. The depths of the boreholes ranged from 11.1 m to 20.0 m. The Record of Borehole sheets for the boreholes are included in Appendix A. The approximate locations of the three boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix F.

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area. Road occupancy permit was also obtained to complete site investigation.

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.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. In Borehole 08-138, drilled at the proposed pier location, a standpipe piezometer consisting of 25 mm diameter PVC pipe with a slotted screen was installed and enclosed in filter sand to permit longer term groundwater level monitoring. The locations and completion details of the piezometer 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**

<b>Foundation Unit</b>	<b>Borehole Location</b>	<b>Piezometer Tip Depth/ Elevation (m)</b>	<b>Completion Details</b>
North Abutment	08-137	No Installation	Bentonite grout from bottom of borehole to ground surface.
Pier	08-138	11.1/321.4	Piezometer with 1.5 m slotted screen installed with sand filter to 8.5 m, holeplug from 8.5 m to 8.2 m, bentonite mixed with auger cuttings from 8.2 m to 0.9 m, sand from 0.9 m to 0.3 m, then cement grout to ground surface.
South Abutment	08-139	No Installation	Bentonite grout and auger cuttings from bottom of borehole to 0.9 m, holeplug from 0.9 m to 0.6 m, then auger cuttings to ground 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.

#### **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) and Atterberg Limits testing where appropriate. 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.

#### **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 F. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by granular fill overlying two distinct, glacial till deposits within the depth of exploration: sandy silt till and silty clay till. Layers of sandy silt and silt were also encountered within the till deposits.

## 5.1 Fill

Fill was encountered surficially at all three exploration locations at this site. The fill consists of brown sand and gravel, sandy silt and silty sand presumably placed to construct the existing embankment for Greenhouse Road. A layer of silty clay fill was contacted in Borehole 08-137 at 0.6 m depth.

The depth to the base of the fill ranged from 1.4 m to 1.7 m (Elevations 330.0 to 331.6).

The fill is classified as loose, based on SPT 'N' values of 9 and 10 blows for 0.3 m of penetration. SPT 'N' value of 21 blows per 0.3 m of penetration was measured in the cohesive fill layer, indicating a very stiff consistency. The natural moisture content ranged from 3 to 20%.

Grain size distribution curve for a sample tested is presented on the Record of Borehole sheet and on Figure B1 of Appendix B. The result of laboratory test carried out on a sand and gravel sample was as follows:

Soil Particles	(%)
Gravel	37
Sand	49
Silt & Clay	14

## 5.2 Upper Sandy Silt Till

Native sandy silt till was contacted below the fill in all the boreholes. The sandy silt till generally contains trace gravel, trace to some clay and occasional cobbles and varies in colouration from brown to grey with depth.

Clayey zones were encountered within the sandy silt till in Boreholes 08-138 and 08-139 at approximately 6.0 m and 4.5 m depth (elevations 326.5 and 328.6), respectively.

Depths and elevations where native sandy silt till was encountered are indicated in Table 5.1.

**Table 5.1 – Depths and Elevations of Native Sandy Silt Till**

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
08-137	1.7 to 9.8	330.0 to 321.8	8.2
08-138	1.4 to 11.1 (borehole termination depth)	331.0 to 321.4	9.6
08-139	1.4 to 10.0	331.6 to 323.1	8.5

Above Elevation 327.3 (approximately), SPT 'N' values of the sandy silt till ranged from 8 to 38 blows per 0.3 m of penetration indicating a loose to dense relative density.

Below Elevation 327.3 (approximately), SPT 'N' values varied from 50 blows per 0.3 m of penetration to higher than 100 blows per 0.15 m of penetration, indicating a very dense relative density.

The natural moisture contents generally lay in the range of 6 to 19%.

Grain size distribution curves of sandy silt till samples tested are presented on the Record of Borehole sheets and on Figures B2 to B4 of Appendix B. Atterberg Limits test results are presented on Figures B7 and B8 of Appendix B. The results of laboratory tests carried out on sandy silt till samples were as follows:

Soil Particles	Sandy Silt Till trace clay to clayey (%)	Sandy Silt Till Clayey zone (%)
Gravel	0 to 6	1 to 2
Sand	21 to 53	8 to 36
Silt	33 to 61	41 to 57
Clay	9 to 17	21 to 34
Liquid Limit	-	15 to 28
Plastic Limit	-	9 to 14

The above results show that the clayey zone of the sandy silt till is of low plasticity with a group symbol of CL-ML.

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

### 5.3 Silty Clay Till

Brown to grey silty clay till containing some sand to sandy, trace gravel and occasional cobbles was encountered below the upper sandy silt till layer at depths and elevations indicated in Table 5.2.

**Table 5.2 – Depths and Elevations of Native Silty Clay Till**

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
08-137	9.8 to 14.8	321.8 to 316.9	5.0
08-139	10.0 to 16.3	323.1 to 316.8	6.3

Brown to grey silt seams were encountered within the silty clay till in Boreholes 08-137 and 08-139 at 11.8 m and 13.3 m depth (Elevation 319.8), respectively.

SPT 'N' values in the silty clay till ranged from 55 to 100 blows per 0.3 m of penetration, indicating a hard consistency. The natural moisture contents generally lay in the range of 8 to 19%.



Grain size distribution curves for samples tested are presented on the Record of Borehole sheets and on Figure B5 of Appendix B. Grain size distribution curve for the silt tested is presented on the Record of Borehole sheet and on Figure B6 of Appendix B. Atterberg Limits test results are presented on Figure B9 of Appendix B.

The results of laboratory tests carried out on four silty clay till samples and one silt sample were as follows:

Soil Particles	Silty Clay Till (%)	Silt (%)
Gravel	0 to 2	0
Sand	13 to 37	4
Silt	42 to 52	85
Clay	19 to 35	11

Liquid Limit	18 to 30	-
Plastic Limit	11 to 14	-

The above results show that the silty clay till is of low plasticity with a group symbol of CL. Although not specifically identified in the boreholes, glacial tills are known to contain cobbles and boulders.

#### 5.4 Lower Sandy Silt Till

A lower layer of sandy silt till containing trace to some gravel, trace clay to some clay and occasional cobbles was contacted in Boreholes 08-137 and 08-139 at 14.8 and 16.3 m depth (Elevations 316.9 and 316.8), respectively. Both boreholes were terminated within the lower sandy silt till.

SPT 'N' values were higher than 100 blows per 0.15 m of penetration, indicating a very dense relative density. The natural moisture contents generally lay in the range of 5 to 8%.

Grain size distribution curves for 5 samples tested are presented on the Record of Borehole sheets and on Figures B2 and B3 of Appendix B. Atterberg Limits test results are presented on Figure B7 of Appendix B. The results of laboratory tests carried out on the lower sandy silt till samples were as follows:

Soil Particles	(%)
Gravel	6 to 10
Sand	35 to 43
Silt	40 to 43
Clay	9 to 15

Liquid Limit	16
Plastic Limit	10

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

### 5.5 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. A standpipe piezometer was installed in Borehole 08-138 (at the proposed pier) to monitor water levels after completion of drilling. The water levels measured in the piezometer are summarized in Table 5.4, along with the measurements in the boreholes upon completion of drilling.

**Table 5.4 – Water Level Measurements**

Foundation Unit	Borehole	Date (2008)	Water Level (m)		Comment
			Depth	Elevation	
North Abutment	08-137	May 28	17.3	314.3	Open borehole
Pier	08-138	May 28	5.9	326.6	In piezometer
		July 23	1.6	330.9	
South Abutment	08-139	May 29	19.0	314.1	Open borehole

The piezometric reading indicates that the groundwater level lies at Elevation 330.9.

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. 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.

Thurber Engineering Ltd



Rocío Palomeque Reyna, P.Eng.  
Geotechnical Engineer



Alastair E. Gorman, P.Eng.,  
Senior Foundations Engineer



P.K. Chatterji, P.Eng.,  
Review Principal, Designated MTO Contact

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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 structure.

Based on the Plate 9 of the E.A:

- The mainline (proposed Highway 7) will be in a cut 6 m to 7 m deep with the base of the cut at Elevation 325.0.
- Greenhouse Road will be at Elevation 333.0 with approach embankments of 1.0 to 1.5 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 two layer system of glacial till: an upper sandy silt till over silty clay till, underlain by a lower sandy silt till. The natural soils are overlain by sand and gravel fill, presumably placed during construction of Greenhouse Road. The groundwater level measured in the piezometer is 1.6 m (Elevation 330.9) below the ground surface.

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 engineered fill
- Steel H-piles driven into the very dense glacial till soil

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 compact to very dense upper sandy silt till must be in accordance with the elevations and bearing resistances given in Table 8.1.

**Table 8.1 – Bearing Resistances for Spread Footings**

Element	Depth (m)	Elev.	ULS <sub>r</sub> (kPa)	SLS (kPa)
North Abutment (BH 08-137)	2.3	329.3	300	200
	Below 4.6	Below 327.0	750	500
Pier (BH 08-138)	1.6	330.9	300	200
	3.0	329.5	450	300
	Below 4.6	Below 327.9	750	500
South Abutment (BH 08-139)	1.6	331.5	300	200
	4.5	328.6	450	300
	Below 6.1	Below 327.0	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 settlement is 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 below the groundwater level of 330.9 measured in the piezometer. Based on proposed Highway 7 profile, the pier footing will be below elevation 322.0 ± and hence below ground water table.

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

## 8.2 Spread Footings on Engineered Fill

Spread footings can also be founded on Granular “A” engineered fill pads. These would probably be most useful in the case of perched abutments on footings.

If an engineered fill pad is used, all topsoil, or other deleterious materials must be stripped from the footprint of the foundation to expose competent native subgrade material. Subexcavation of existing surficial fill soils and native loose sands will be required. The engineered fill should bear on compact or very dense sandy silt till and the highest permitted founding/base elevations at which engineered fill pads may be placed, are given in Table 8.2.

**Table 8.2 – Founding Elevations for Engineered Fill Pads**

<b>North Abutment (BH 08-137)</b>	<b>South Abutment (BH 08-139)</b>
329.5	331.5

Typically, spread footings on pads of engineered granular fill at least 2 m thick may be designed for the following geotechnical resistances:

- Factored ULS 900 kPa
- SLS 350 kPa

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

For footings designed on the basis of the geotechnical resistance values given above, total settlement under a footing is expected to not exceed 25 mm. Differential settlements are not expected to exceed 20 mm across the width of the structure or between foundation elements.

The Granular A pad must be compacted to 100% Standard proctor maximum dry density (SPMDD) at optimum moisture content  $\pm 2\%$ . The geometry of the fill pad must conform to the general requirements shown in Figure 1 in Appendix D.

## 8.3 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 very dense sandy silt till encountered at this site. Based on an HP 310 X 110 pile, a minimum embedment depth of 6 m is required. The preliminary information in EA Plate 9 indicates that this

depth of embedment should be achievable at the abutments. At the pier, pile installation would probably require pre-augering to achieve sufficient embedment.

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	Anticipated Pile length below original ground (m)	Highest Pile Tip Elevation	Comments
North Abutment (BH 08-137)	8.3	323.3	Depending on final design, pre-augering may be required.
Pier (BH 08-138)	6.0	319.0 <sup>1,2</sup>	A minimum pile length of 6 m must be maintained. Pre-augering will most probably be required at the pier.
South Abutment (BH 08-139)	8.0	325.1	A minimum pile length of 6 m must be achieved. Depending on final design, pre-augering may be required.

1 Elevation based on proposed Highway 7 grade (Elevation 325.0).

2 Below depth of exploration

### 8.3.1 Axial Resistance

For preliminary design, the vertical, axial, factored geotechnical resistance at Ultimate Limit States (ULS) and geotechnical resistance at Serviceability Limit States (SLS) for a pile section when driven into the very dense sandy silt till are presented in Tables 8.4 .

**Table 8.4 – Axial Resistance of Two Pile Sections Founded on Very Dense Soils  
(For a minimum pile embedment of 6.0 m)**

Pile Section	Geotechnical Resistance (kN)	
	Factored ULS	SLS
HP 310 X 110	1,600	1,400
HP 360 X 132	1,800	1,600

The structural resistance of the pile must be checked by the structural designer.

Installation of the piles must be in accordance with SP 903S01 and must be controlled using the Hiley Formula and an ultimate resistance of 3,200 kN for an HP 310 X 110 pile and 3,600 kN for the HP 360 X 132 pile.

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.

Due to the possible presence of cobbles and boulders in the glacial till layers at the expected founding layer, the tips of all driven piles should be fitted with steel H-Pile driving shoes in accordance with OPSD 3000.100.

Higher geotechnical resistances may be achieved by installing the piles to greater depth but this will require pre-augering. For piles extending below Elevations 321.0 at the pier and 313.0 at the abutments, a greater depth of exploration is required and must be addressed during the detail design phase. This analysis must also address the drivability of the piles.

### **8.3.2 Downdrag**

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

### **8.4 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 pre-augering to install the piles and achieve the flexibility required in the upper 3 m.

### **8.5 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.

### **8.6 Recommended Foundation**

From a geotechnical perspective, and based on current information, the recommended abutment foundation consists of steel H-piles driven into the very dense native sandy silt till, despite the higher cost noted in Appendix C. The recommended foundation at the pier is a spread footing on very dense sandy silt till.

## **9 BRIDGE APPROACHES AND EMBANKMENTS**

Based on the three boreholes drilled at the site, the approach embankments will be constructed over compact, non-cohesive sandy silt till and may incorporate the sand and gravel fill of the existing embankment.

No long term settlement or global stability issues are anticipated for approach embankments built at this site. The 1 to 2 m high embankments likely to be constructed will be stable at side slopes of 2H:1V if constructed using SSM or granular fill.



The mainline cut shown on EA Plate 9 may penetrate approximately 6.0 m below the groundwater table. During detail design, when the grade has been finalized, permanent drainage and slope protection requirements must be addressed. Subject to depressing the groundwater level below the base of the cut and implementing permanent drainage, the cut slopes will be stable at slopes with a maximum inclination of 2H: 1V. MTO policy requires a mid-height bench in cut slopes higher than 6.0 m.

## **10 CONSTRUCTION CONCERNS**

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

### **1. Pile Installation**

The presence of very dense soil at comparatively shallow depth will limit the length of pile that can be driven, especially at the proposed pier location. If design requires longer piles, pre-augering will be required.

### **2. Excavation**

Hydraulic equipment is expected to be capable of excavating to the required depths at this site. If excavations advance below the existing groundwater level, groundwater control measures will be required in order to maintain stable 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 may be required for the structure foundations, especially if the structure is built off the current Greenhouse Road alignment and thus removed from the alignment of the current investigation. Particular attention should be paid to groundwater levels and exploration off the existing road embankment is recommended.

### **2. Pile Design**

For piles extending below Elevations 321.0 and 313.0 (approximately) at the pier and at the abutments, respectively, a greater depth of exploration is required and must be addressed during the detail design phase.

### **3. Boreholes for approaches.**

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

4. Cut stability

At least one borehole is required in the mainline cut to either side of the structure. The boreholes in the cut must include piezometers for groundwater monitoring. Stability of cuts must be investigated during detail design phase.

5. Groundwater impacts.

The potential impact of drainage of the cuts on the local groundwater table must be addressed by a hydrogeologist, who should also consider the need to apply for an MOE Permit to Take Water.

## 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.

Thurber Engineering Ltd.

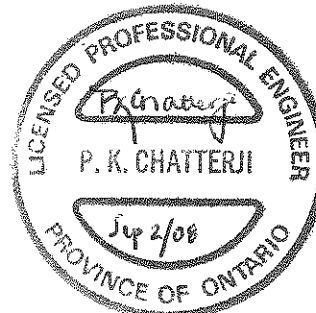
Rocío Palomeque Reyna, P.Eng., M.Eng.  
Geotechnical Engineer



Alastair E. Gorman, P.Eng.,  
Senior Foundations Engineer



P. K. Chatterji, P.Eng.,  
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 <sup>(1)</sup> '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<sub>pen</sub> 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		SYMBOLS	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	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

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.

# RECORD OF BOREHOLE No 08-137

1 OF 2

METRIC

G.W.P. 408-88-00 LOCATION N 4 818 114.44 E 231 823.85 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM  
 DATUM Geodetic DATE 2008.05.28 - 2008.05.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
331.6	SAND and GRAVEL, trace silt Brown Moist (FILL)		1	AS								
331.0												
0.6	Silty CLAY, trace sand, trace gravel, trace rootlets, topsoil stained Very Stiff Brown (FILL)		1	SS	21		331					
330.0												
1.7	Sandy SILT, trace gravel, trace to some clay, occasional cobbles Loose to Compact Brown Moist (TILL)		2	SS	8		330					
			3	SS	16		329					
			4	SS	22		328					
	Very Dense		5	SS	100/ .150		327					
							326					
	Grey		6	SS	90		325					
							324					
			7	SS	100/ .150							
							323					
			8	SS	100/ .175							
321.8							322					
9.8	Silty CLAY, sandy											

Continued Next Page

+<sup>3</sup> x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 08-137

2 OF 2

METRIC

G.W.P. 408-88-00 LOCATION N 4 818 114.44 E 231 823.85 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM  
 DATUM Geodetic DATE 2008.05.28 - 2008.05.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page											
	Silty CLAY, sandy, occasional cobbles Hard Grey (TILL.)		9	SS	80		321					0 25 51 24
	Wet silt seam		10	SS	55		320					
			11	SS	69		319					
							318					1 13 52 34
316.9							317					
14.8	Sandy SILT, trace to some clay, trace to some gravel Very Dense Grey Moist (TILL.)		12	SS	100/ .150		316					10 37 40 13
			13	SS	100/ .150		315					6 43 42 9
313.2			14	SS	100/ .150		314					
18.4	END OF BOREHOLE AT 18.4m. BOREHOLE OPEN TO 17.8m AND WATER LEVEL AT 17.3m ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.											

ONTMT4S 6417R.GPJ 8/7/08



# RECORD OF BOREHOLE No 08-138

1 OF 2

METRIC

G.W.P. 408-88-00 LOCATION N 4 818 075.48 E 231 835.90 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stern Augers COMPILED BY WM  
 DATUM Geodetic DATE 2008.05.28 - 2008.05.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	
332.5 0.0	SAND and GRAVEL, trace silt Brown Moist (FILL)		1	AS			332					37 49 14 (SI+CL)
331.9 0.6	Sandy SILT, trace clay, trace gravel, trace topsoil Compact Moist to Wet (FILL)		1	SS	10							
331.0 1.4	Sandy SILT, trace to some clay, trace gravel, occasional cobbles Compact to Dense Brown Moist to Wet (TILL)		2	SS	18		331					5 48 37 10
			3	SS	14		330					
			4	SS	38		329					
							328					
	Very Dense		5	SS	100/ .150		327					
							326					
	Clayey zone		6	SS	50/ .125		325					2 36 41 21
							324					
			7	SS	100/ .250		323					
			8	SS	100/ .125							

Continued Next Page

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

RECORD OF BOREHOLE No 08-138

2 OF 2

METRIC

G.W.P. 408-88-00 LOCATION N 4 818 075.48 E 231 835.90 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM  
 DATUM Geodetic DATE 2008.05.28 - 2008.05.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
321.4	Sandy SILT, some clay, trace gravel, occasional cobbles Very Dense Grey Moist (TILL)		9	SS	100/ 275		322							1 21 61 17
11.1	END OF BOREHOLE AT 11.1m. BOREHOLE DRY ON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2008.05.28 5.9 326.6 2008.07.23 1.6 330.9													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

## METRIC

[illegible]

(%) STRAIN AT FAILURE

## METRIC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT  W <sub>P</sub>	NATURAL MOISTURE CONTENT  W	LIQUID LIMIT  W <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES						20 40 60 80 100
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100						
Continued From Previous Page							WATER CONTENT (%) 20 40 60			kN/m <sup>3</sup>	GR SA SI LI		

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

ONTMT4S 6417R.GPJ 8/7/08

RECORD OF BOREHOLE No 08-139

3 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 818 040.27 E 231 856.64 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM  
 DATUM Geodetic DATE 2008.05.29 - 2008.05.29 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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	W <sub>P</sub>	W	W <sub>L</sub>		
20.0	Continued From Previous Page END OF BOREHOLE AT 20.0m. BOREHOLE OPEN TO 19.1m AND WATER LEVEL AT 19.0m ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS TO 0.9m, HOLEPLUG TO 0.6m, THEN CUTTINGS TO SURFACE.				175											

ONTMT4S 8417R.GPJ 8/7/08

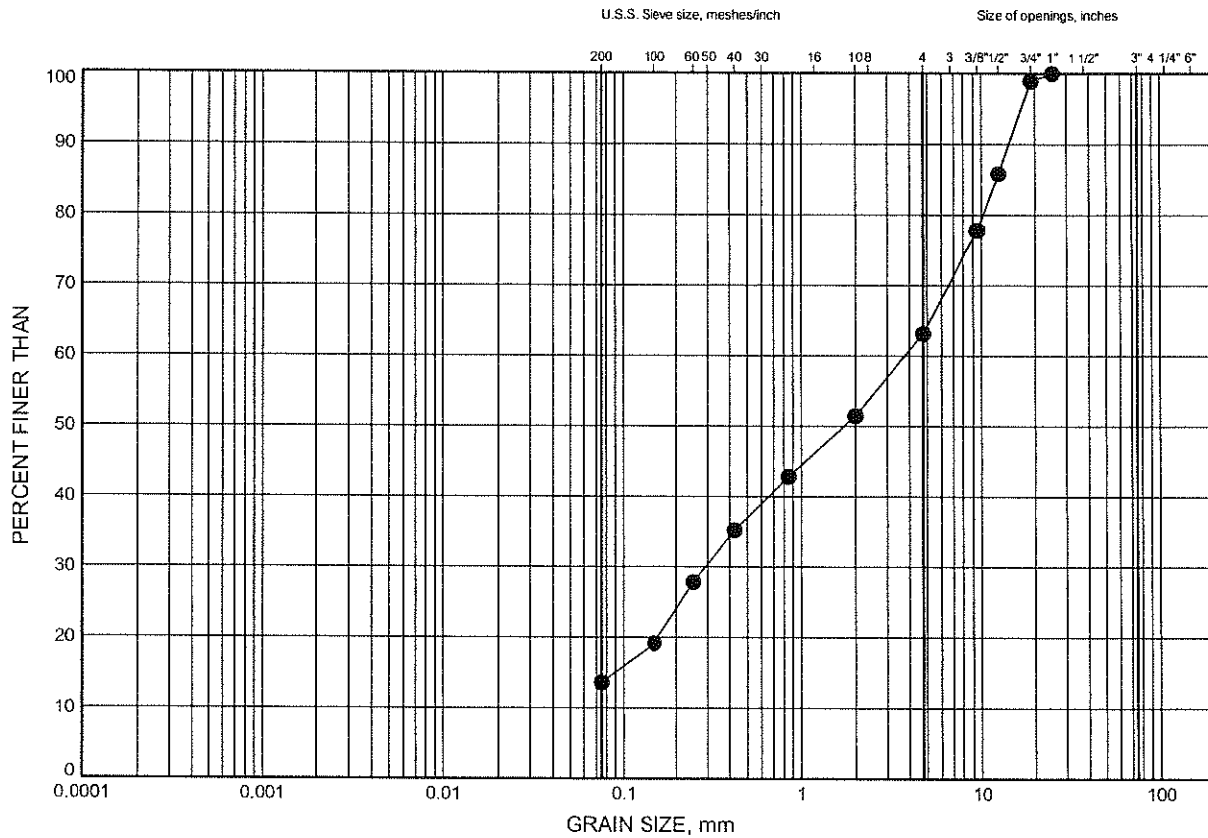
## **Appendix B**

### **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)
●	08-138	0.13	331.20

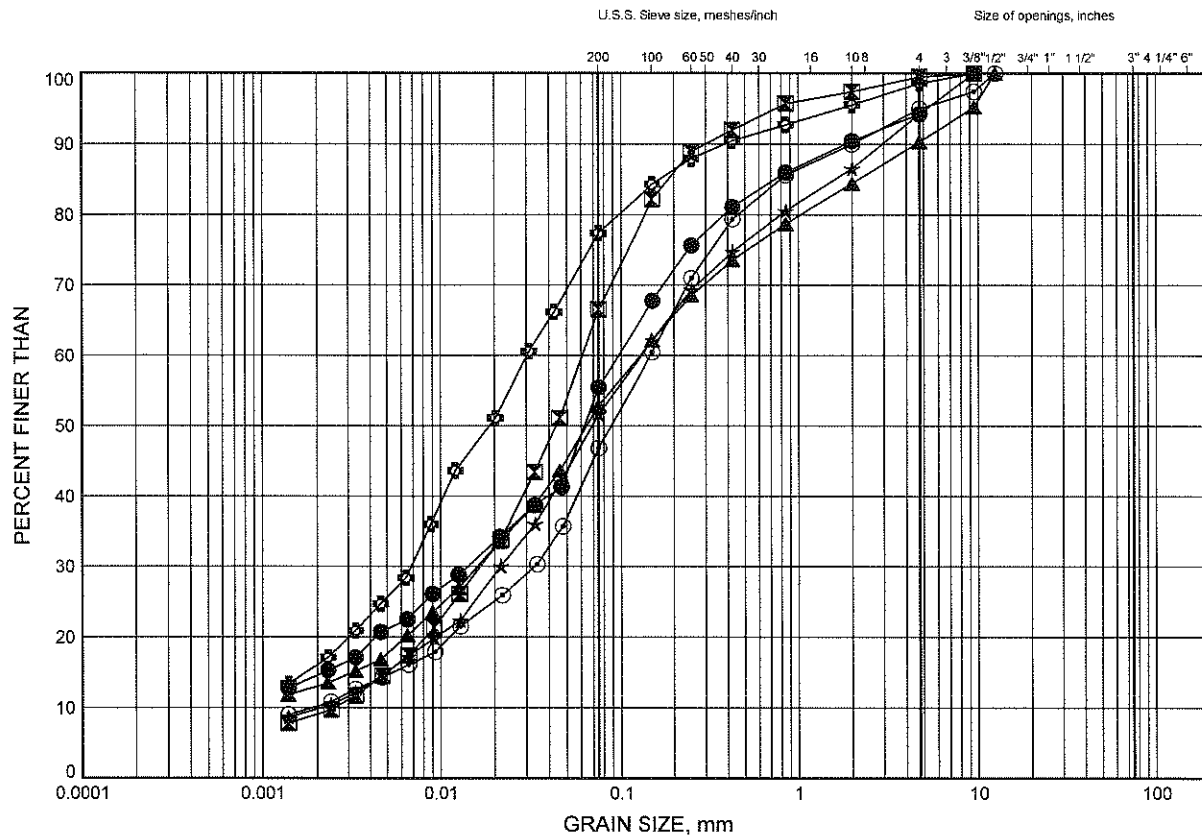


W.P.# 408-88-00  
Prepared By MFA  
Checked By RPR

# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B2

Sandy Silt Till (trace clay to clayey)



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-137	3.35	328.30
⊠	08-137	9.24	322.41
▲	08-137	15.32	316.33
☆	08-137	16.84	314.81
⊙	08-138	1.83	330.63
⊕	08-138	10.90	321.56



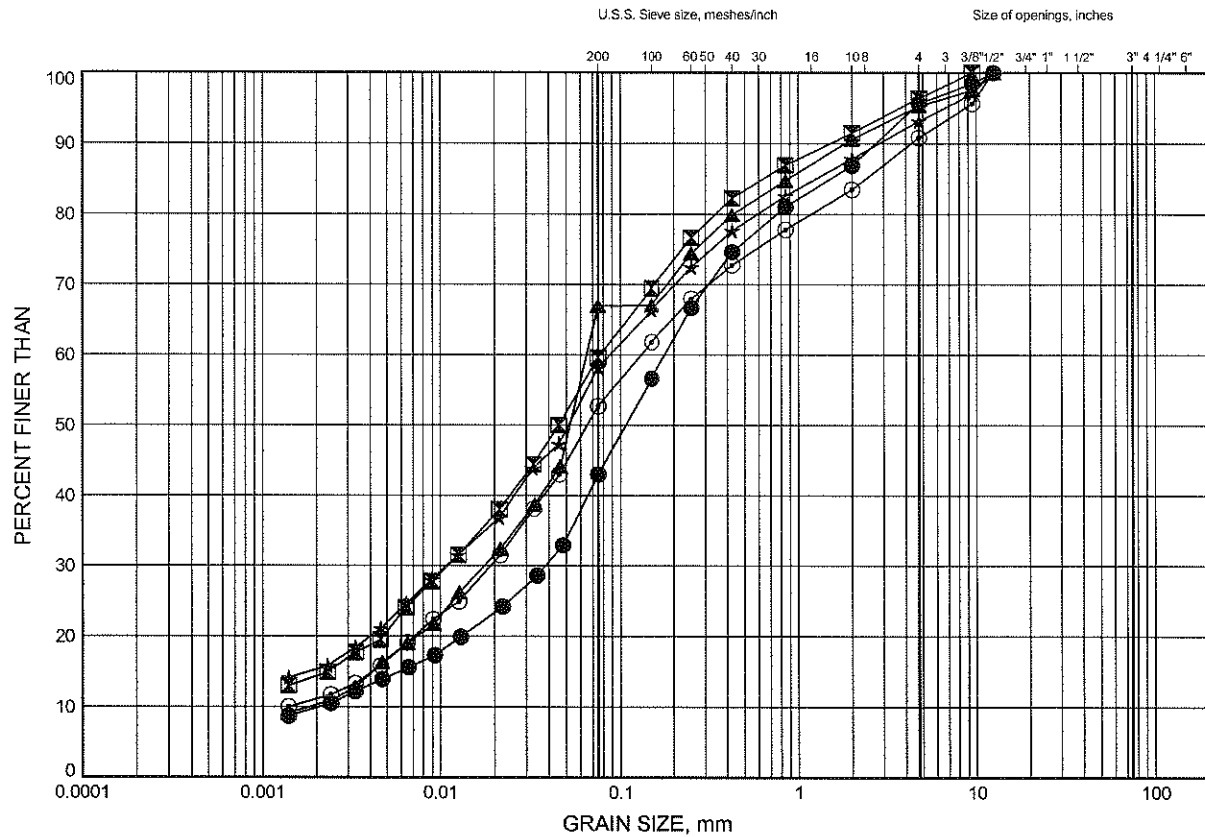
W.P.# 408-88-00  
Prepared By SA  
Checked By RPR



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B3

Sandy Silt Till (trace clay to clayey)



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-139	2.59	330.49
⊠	08-139	6.24	326.85
▲	08-139	7.84	325.25
☆	08-139	16.92	316.17
⊙	08-139	19.89	313.19

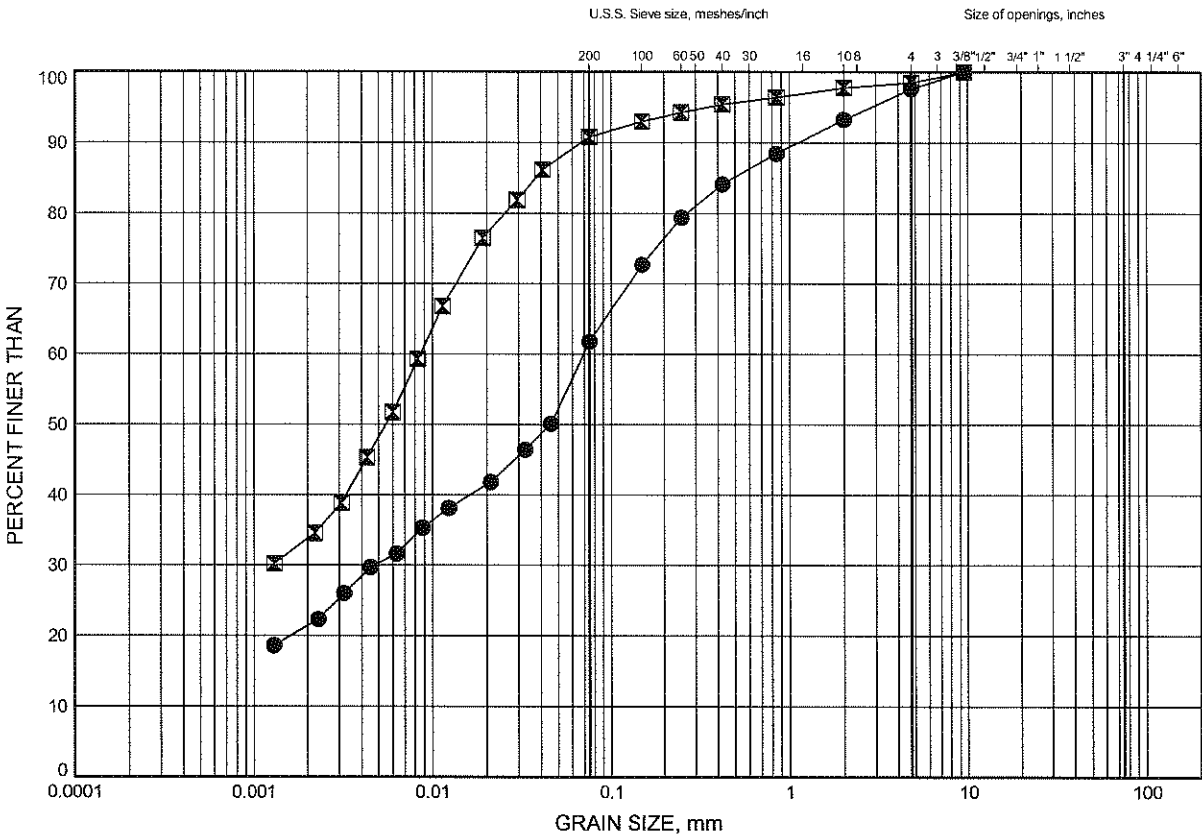


W.P.# 408-88-00  
Prepared By MFA  
Checked By RPR

Highway 7 - New  
GRAIN SIZE DISTRIBUTION

FIGURE B4

Sandy Silt Till (clayey zone)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-138	6.40	326.06
■	08-139	4.88	328.21

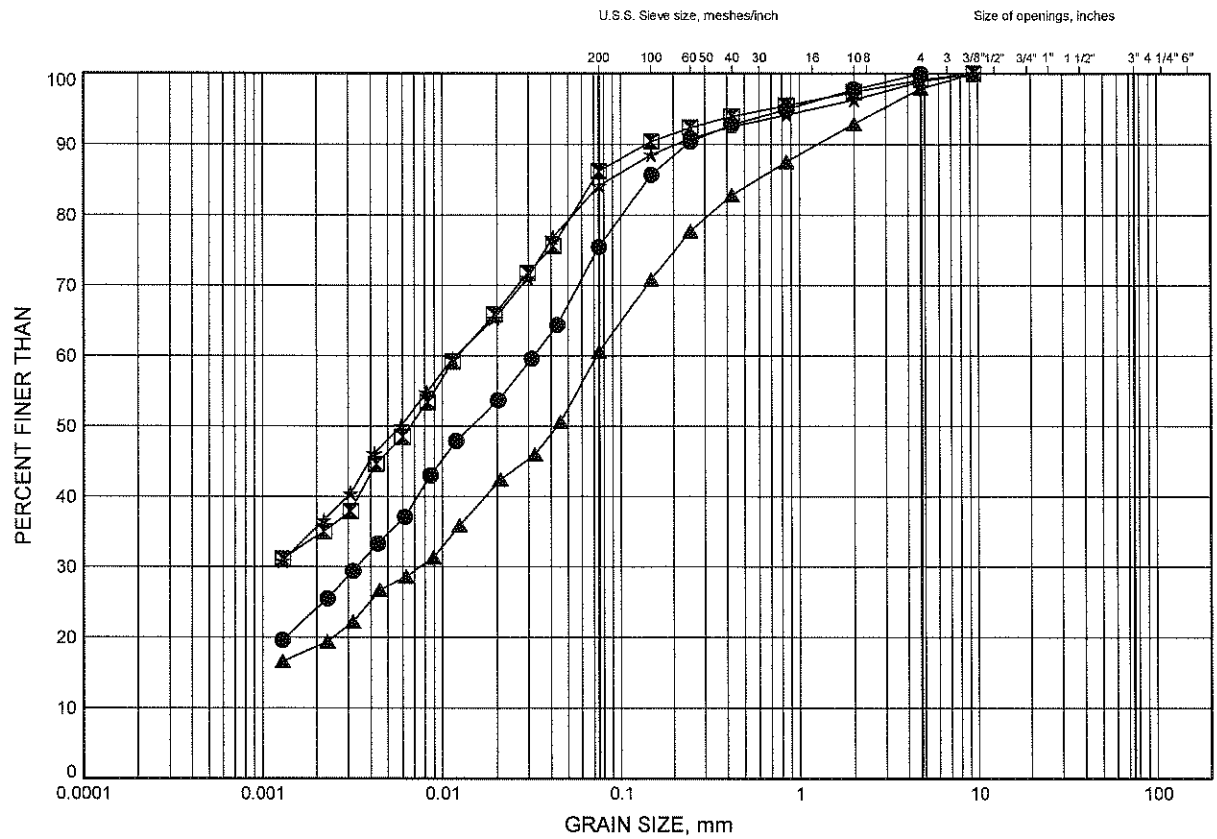


W.P.# 408-88-00  
Prepared By MFA  
Checked By RPR

# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B5

## Silty Clay Till



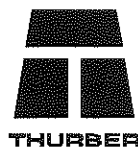
SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-137	10.97	321.16
⊠	08-137	14.02	318.11
▲	08-139	10.97	321.28
☆	08-139	15.54	316.71

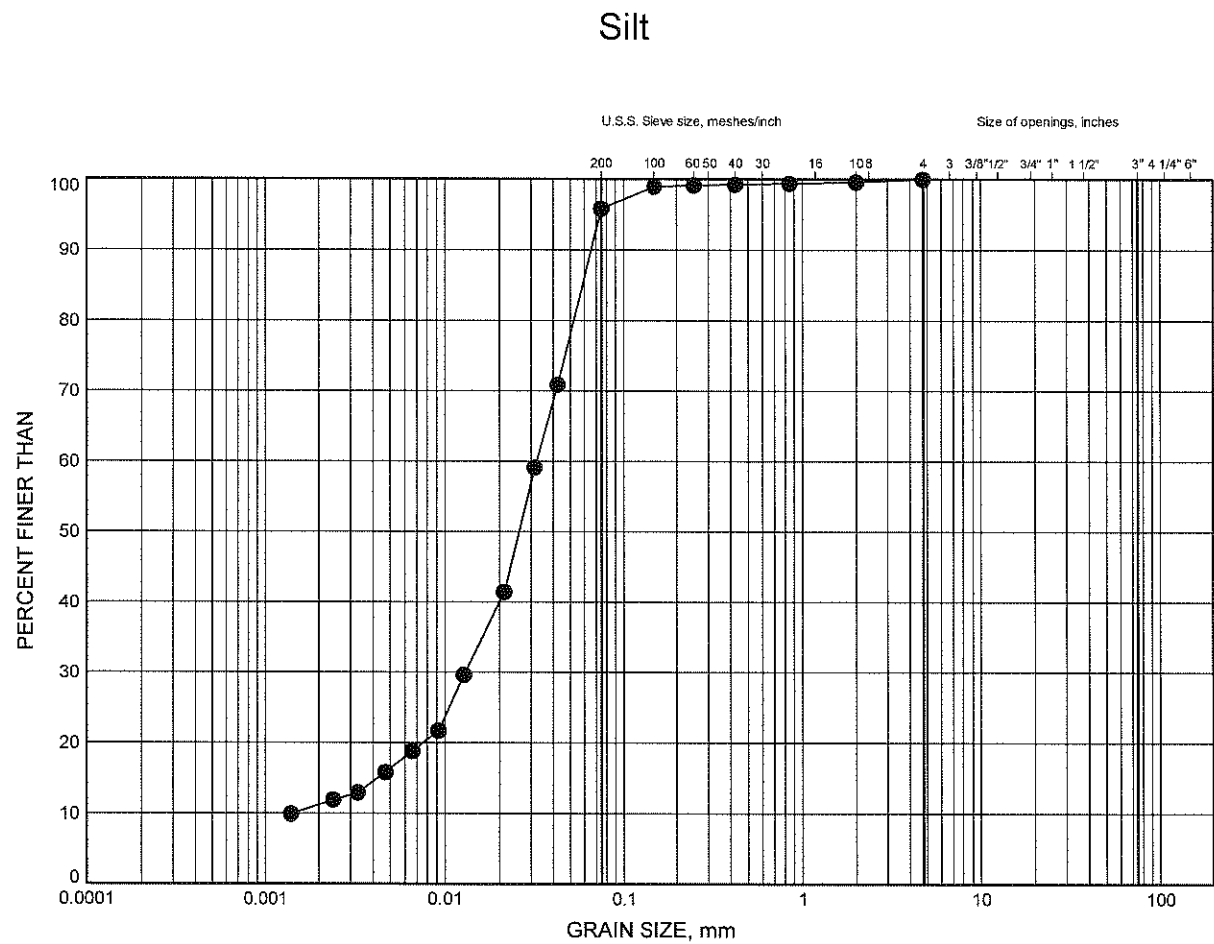
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 7/28/08

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



Highway 7 - New  
GRAIN SIZE DISTRIBUTION

FIGURE B6



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-139	13.84	318.41

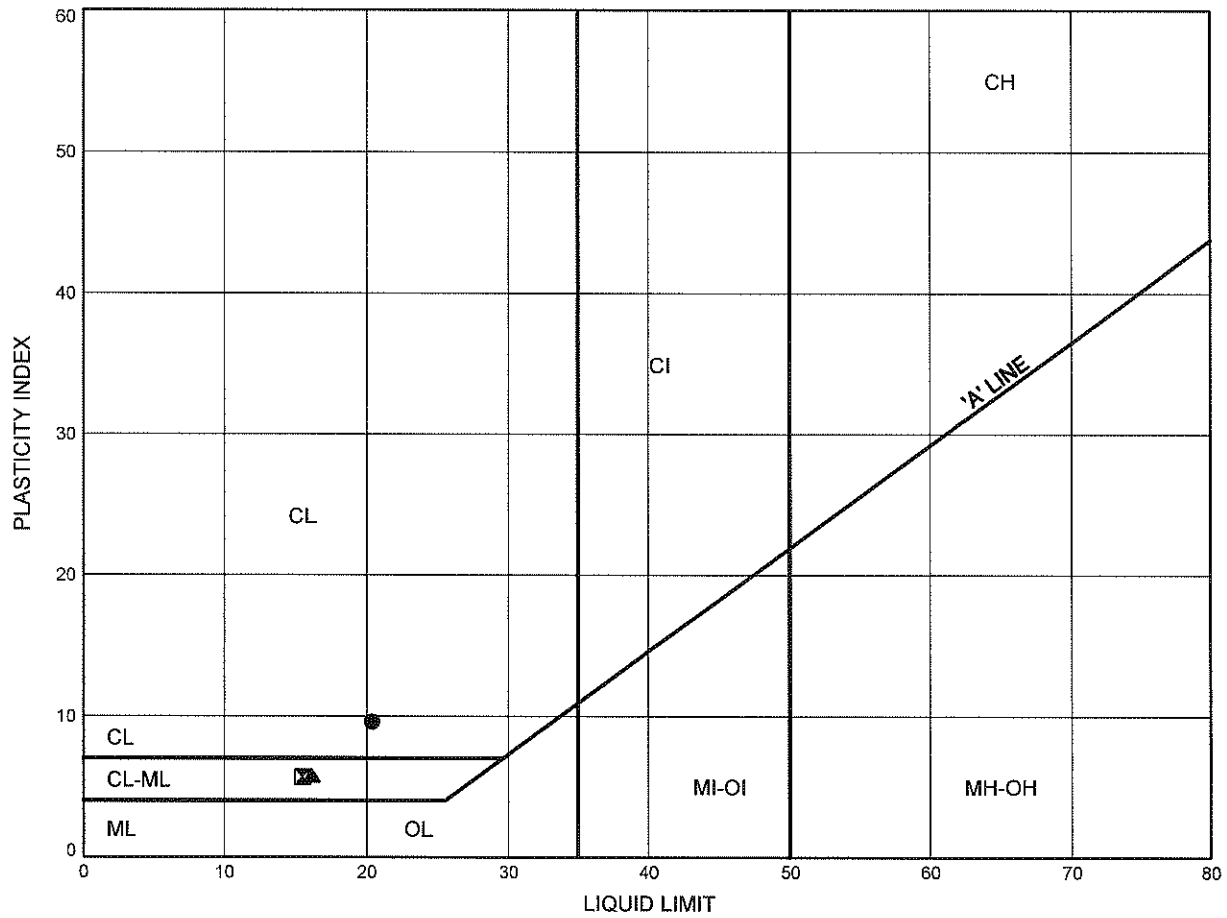


W.P.# 408-88-00  
Prepared By SA  
Checked By RPR

# Highway 7 - New ATTERBERG LIMITS TEST RESULTS

FIGURE B7

Sandy Silt Till (trace clay to clayey)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-138	6.39	324.94
⊠	08-139	6.24	326.01
▲	08-139	16.92	315.33



Date July 2008

Project 408-88-00

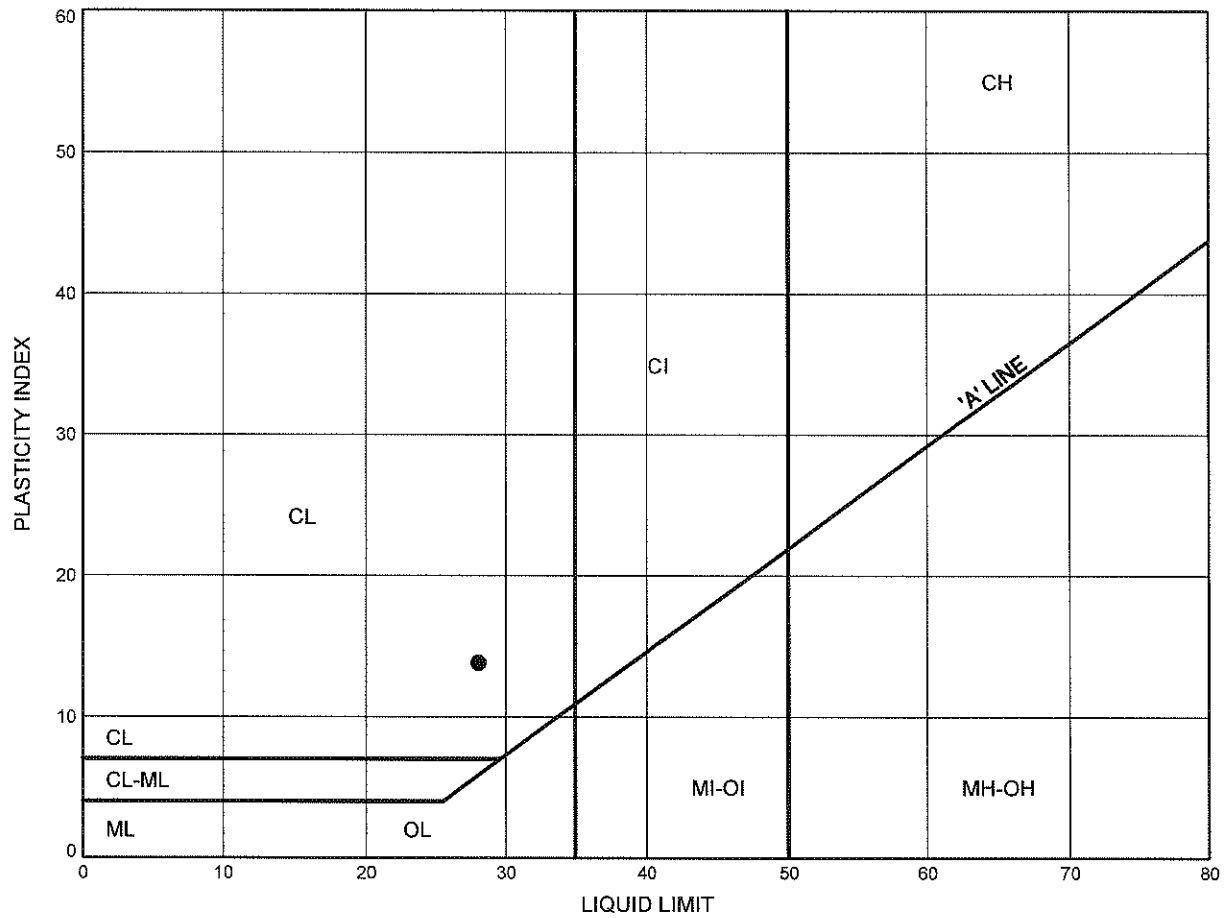
Prep'd SA

Chkd. RPR

# Highway 7 - New ATTERBERG LIMITS TEST RESULTS

FIGURE B8

Sandy Silt Till (clayey zone)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-139	4.88	327.37

Date July 2008

Project 408-88-00



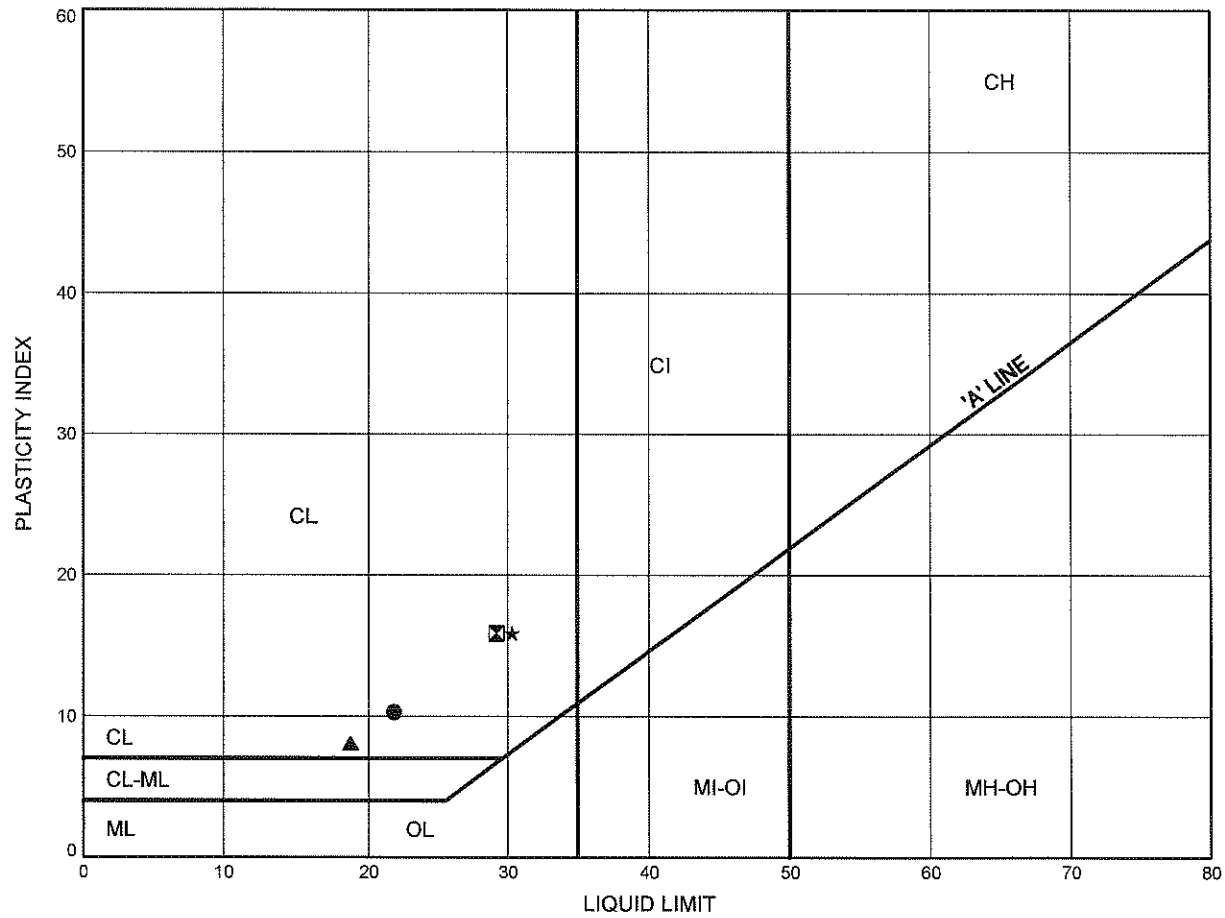
Prep'd SA

Chkd. RPR

# Highway 7 - New ATTERBERG LIMITS TEST RESULTS

FIGURE B9

Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-137	10.97	321.16
⊠	08-137	14.02	318.11
▲	08-139	10.97	321.28
★	08-139	15.54	316.71

Date July 2008

Project 408-88-00



Prep'd SA

Chkd. RPR

## **Appendix C**

### **Foundation Comparison**

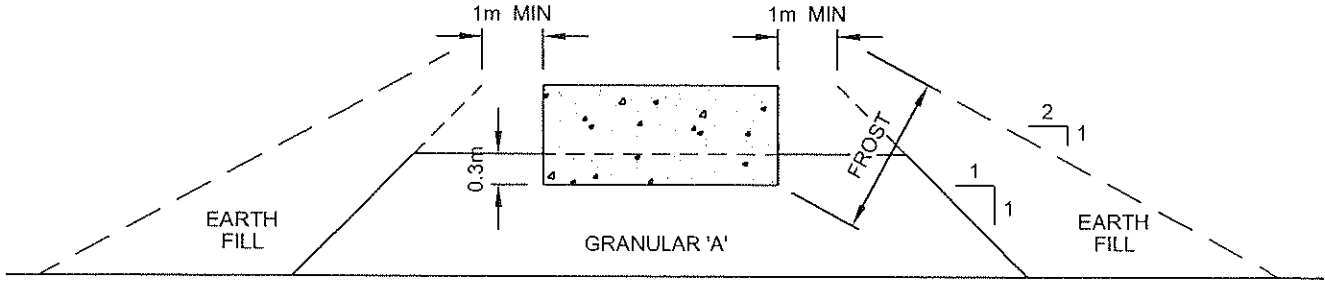


**COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT**

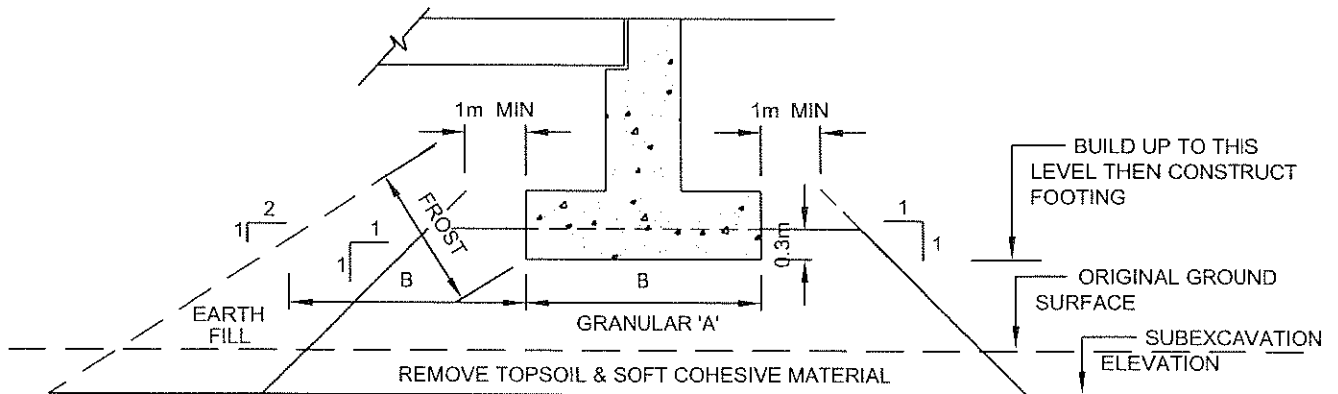
Foundation Element	Spread Footings	Spread Footings on Engineered Fill	Driven Piles
Abutments	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Generally less costly construction than deep foundation elements.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Lower geotechnical resistance available due to founding on compact soils near the surface.</li> <li>ii. Dewatering may be required, depending on depth of excavation.</li> </ul> <p><b>NOT RECOMMENDED</b></p>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Generally less costly construction than deep foundation elements.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Better geotechnical resistance than spread footings on native, but still influenced by the compact soils at the surface.</li> <li>ii. Dewatering may be required, depending on depth of excavation.</li> </ul> <p><b>NOT RECOMMENDED</b></p>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. High geotechnical resistance may be developed by driving the piles into very dense/hard soils.</li> <li>ii. Comparatively short abutment stem possible</li> <li>iii. Permits integral abutment design</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Higher unit cost compared to footings.</li> <li>ii. Very dense/hard soils at shallow depth will limit length of pile and geotechnical resistance that can be developed.</li> </ul> <p><b>RECOMMENDED</b></p>
Pier	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Generally less costly construction than deep foundation elements.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Dewatering may be required, depending on depth of excavation.</li> </ul> <p><b>RECOMMENDED</b></p>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Generally less costly construction than deep foundation elements.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Dewatering may be required, depending on depth of excavation.</li> </ul> <p><b>NOT RECOMMENDED</b></p>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. High geotechnical resistance may be developed by driving the piles into very dense/hard soils.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Higher unit cost compared to footings.</li> <li>ii. Very dense/hard soils at shallow depth will limit length of pile and geotechnical resistance that can be developed.</li> </ul> <p><b>NOT RECOMMENDED</b></p>

## Appendix D

### Figure



## CROSS-SECTION



## LONGITUDINAL SECTION

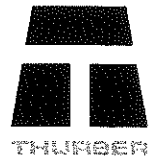
NOT TO SCALE

### NOTES:

1. REMOVE TOPSOIL AND SOFT SILTY CLAY SUBSOIL UNDER FOOTPRINT OF COMPACTED GRANULAR 'A'.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
3. CONSTRUCT CONCRETE FOOTING.
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
5. SOURCE M.T.C. 1982.

ENGINEER	AEG
DRAWN	SS
DATE	April , 2004
APPROVED	PKC
SCALE	NTS

ABUTMENT ON COMPACTED FILL SHOWING  
GRANULAR A CORE



DWG. NO.

FIGURE 1

## **Appendix E**

### **Site Photograph**

Greenhouse Road Underpass  
Highway 7-New, Kitchener to Guelph

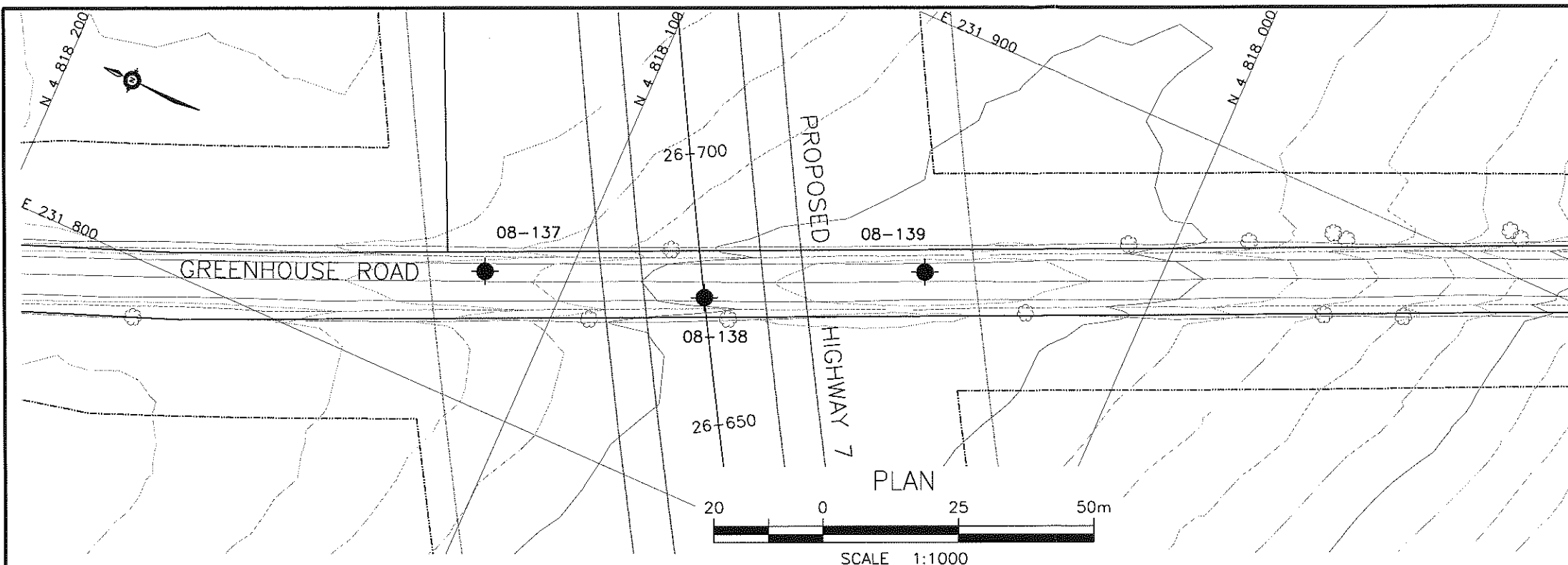
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Photo 1. Looking north along Greenhouse Road

## **Appendix F**

**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

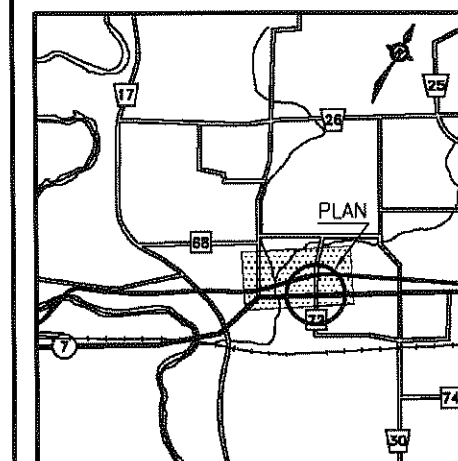


SHEET

HIGHWAY 7  
RECOMMENDED ROUTE  
GREENHOUSE ROAD  
BOREHOLE LOCATIONS AND SOIL STRATA








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## KEYPLAN

## LEGEND

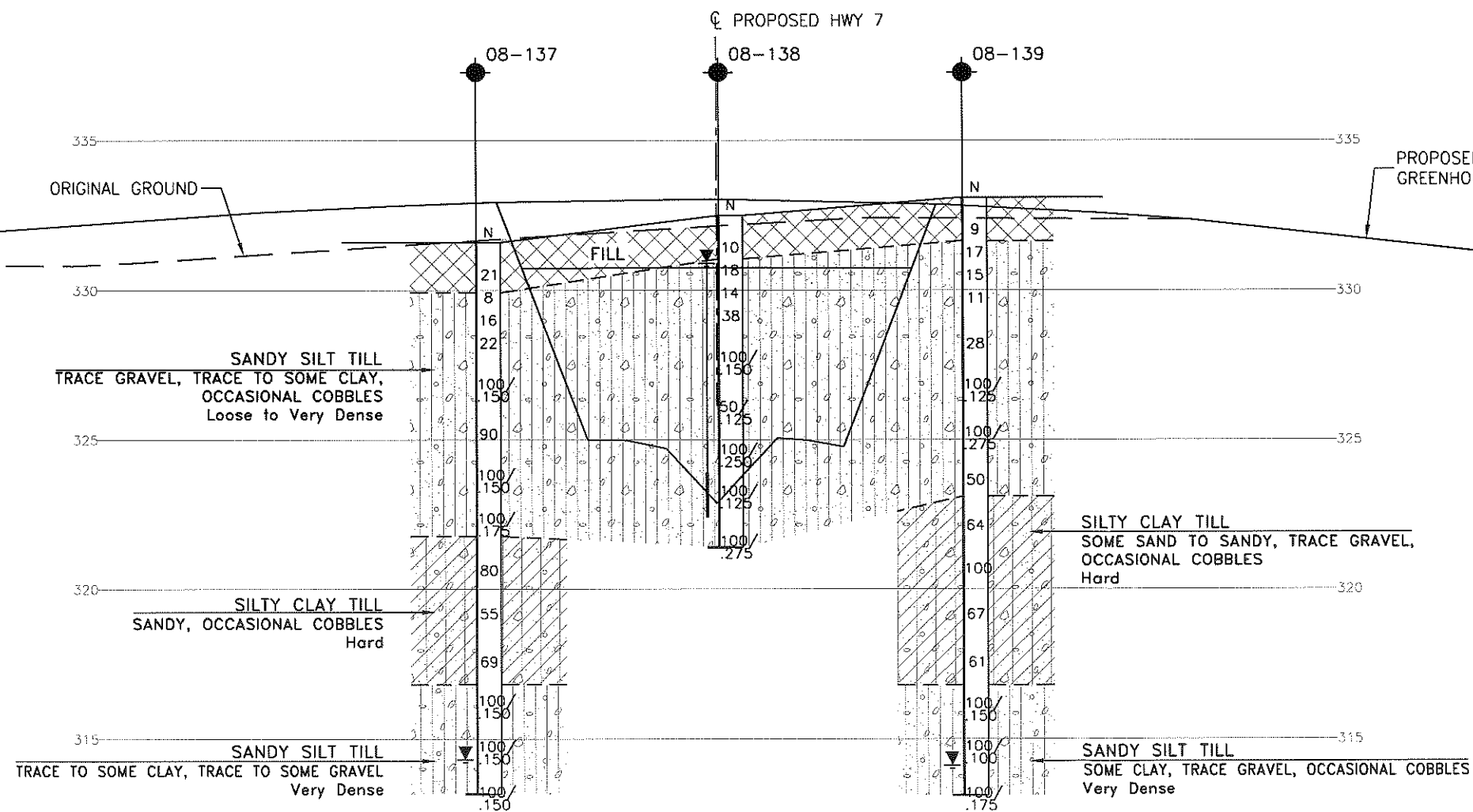
- |   |                                       |
|---|---------------------------------------|
|  | Borehole                              |
|  | Borehole and Cone                     |
| N   | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE  | Blows /0.3m (60° Cone, 475J/blow)     |
| PH  | Pressure, Hydraulic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

NO	ELEVATION	NORTHING	EASTING
08-137	331.6	4 818 114.4	231 823.9
08-138	332.5	4 818 075.5	231 835.9
08-139	333.1	4 818 040.3	231 856.6

-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.
- 3) Proposed grades are from Plate 9 of the E.A. Study.

GEOCRES No. 40P8-149



PROFILE ALONG C OF GREENHOUSE ROAD



HOR 1:1000

VER 1:200

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

	REVISIONS						
	DATE	BY					DESCRIPTION
DESIGN	AEG	CHK	PKC	CODE		LOAD	DATE JUNE 200
DRAWN	MFA	CHK	AFG	SITE		STRUCT	IDWG