

**FOUNDATION INVESTIGATION AND DESIGN REPORT
FIVE RETAINING WALLS
HIGHWAY 7 WIDENING, FROM BROCK ROAD TO HIGHWAY 12
CITY OF PICKERING, ONTARIO
G.W.P. No. 2075-08-00**

GEOCRES Number: 30M14-320

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the sites of five retaining walls to be constructed as part of the widening of Highway 7, in Pickering and Whitby, Ontario.

Highway 7 will be widened from two to four lanes from Brock Road in Pickering, Ontario easterly to Highway 12 in Whitby, Ontario. The retaining walls are located from between approximate Stations 24+670 to 24+710, 25+975 to 26+060, 25+025 to 25+120, 10+890 to 10+930 and 14+155 to 14+185.

The purpose of the investigation was to explore the subsurface conditions at the sites and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profiles, laboratory test results, and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained during the course of the investigation.

Thurber Engineering Ltd. (Thurber) was retained by MMM Group Ltd. (MMM) to carry out the foundation investigation at these sites under the Ministry of Transportation Ontario (MTO) Agreement Number 2006-E-0064.

2 SITE DESCRIPTION

It is proposed to construct five retaining walls as part of the widening of Highway 7 from Brock Road to Highway 12.

- The first retaining wall (RET 1) is located on the south side of Highway 7, approximately 200 m east of 4th Sideline and extending approximately 40 m east, between approximate Stations 24+670 to 24+710;

- The second retaining wall (RET 2) is located at the southwest corner of Highway 7 and Lake Ridge Road and is proposed to extend approximately 85 m west of the intersection, between approximate Stations 25+975 to 26+060;
- The third retaining wall (RET 3) is located on the north side of Highway 7, approximately 125 m west of Kinsale/Audley Road and extends approximately 95 m west, between approximate Stations 25+025 to 25+120;
- The fourth retaining wall (RET 4) is located on the south side of Highway 7, approximately 325 m west of Coronation Road and extends approximately 40 m west, between approximate Stations 10+890 to 10+930; and
- The fifth and final retaining wall (RET 5) is located on the south side of Highway 7, across from Ferguson Avenue approximately 850 m west of Ashburn Road and is approximately 30 m long, between approximate Stations 14+155 to 14+185.

The sites for retaining walls 1 to 3 (RET 1 to 3) are located within the City of Pickering, Ontario, while retaining walls 4 and 5 (RET 4 and 5) are located within the City of Whitby, Ontario.

The existing Highway 7 at the retaining walls RET 1 and 3 is a two-lane paved road with paved shoulders. The highway at retaining walls RET 2, 4 and 5 is a three-lane paved road with paved shoulders.

Areas surrounding the sites are predominantly agricultural with occasional residential dwellings. The southern properties adjacent to the highway at RET 1 and RET 4 are occupied by residential dwellings, while the south side of RET 2 is occupied by a school, and the south side of RET 5 is occupied by a gas station and car wash. The property north of RET 3 is currently occupied by an auto garage.

The site is situated in the Physiographic area known as the South Slope, which lies between the Oak Ridges Moraine and the Iroquois Plain and typically is characterized by overburden composed of sand and silt, overlying glacial till sheets. Lacustrine clay deposited by Lake Iroquois, is often encountered overlying the till sheets. The bedrock is composed of black bituminous shale of the Whitby formation.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried out between October 14 and 15, 2008, and March 23 to 25, 2009 and consisted of drilling and sampling thirteen boreholes (numbered RET 1-A, B and C; RET 2-A, B and C; RET 3-A, B and C; RET 4-A and B and RET 5-A and B). Boreholes RET 1-A, B and C were drilled between Sta. 24+670 to 24+710 and were advanced to depths ranging from 6.1 to 6.4 m (El. 151.7 and 152.4 m). Boreholes RET 2-A, B and C were drilled between Sta. 25+975 to 26+060 and were advanced to depths ranging between 6.2 to 6.5 m (El. 165.9 to 166.6 m). Boreholes RET 3-A, B and C were drilled between Sta. 25+025 to 25+120 and were advanced to depths ranging between 6.1 to 6.3 m (El. 162.6 to 164.1 m). Boreholes RET 4-A and B

were drilled between Sta. 10+890 to 10+930 and were respectively advanced to depths of 6.5 and 6.3 m (El. 155.3 and 154 m). Boreholes RET 5-A and B were drilled between Sta. 14+155 to 14+185 and were each advanced to a depth of 6.7 m (El. 162.2 and 162.1 m).

Prior to the start of drilling, the borehole locations were marked in the field and utility clearances were obtained by Thurber.

A truck mounted drill rig was used to drill and sample the boreholes. Solid stem augers were used to advance the boreholes through the overburden soils. Soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT).

Groundwater conditions in the open boreholes were observed throughout the drilling operations. A standpipe piezometer consisting of a 19 mm PVC pipe with a slotted screen was installed and enclosed in sand in Boreholes RET 1-B and RET 2-B. The piezometers were installed to monitor the longer-term groundwater levels at the two retaining wall locations. The location and completion details of the piezometers are shown below in Table 3.1.

Table 3.1
Borehole Completion and Piezometer Installation Details

Borehole ID	Total Depth (m)	Piezometer Tip Details			Backfill
		Depth (m)	El. (m)	Stratum	
RET 1-A	6.1	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, concrete cement to surface
RET 1-B	6.2	4.5	154.0	Sand & Silt Till	Sand filter from 4.6 to 2.7 m, holeplug from 2.7 m to surface.
RET 1-C	6.4	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, concrete cement to surface
RET 2-A	6.2	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, concrete cement to surface
RET 2-B	6.2	6.1	166.4	Sand & Silt Till	Sand filter from 6.2 to 4.2 m, bentonite holeplug from 4.2 m to surface.
RET 2-C	6.5	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, concrete cement to surface
RET 3-A	6.3	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, asphalt to surface
RET 3-B	6.2	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, asphalt to surface
RET 3-C	6.1	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, asphalt to surface
RET 4-A	6.5	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, asphalt to surface

Borehole ID	Total Depth (m)	Piezometer Tip Details			Backfill
		Depth (m)	El. (m)	Stratum	
RET 4-B	6.3	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, asphalt to surface
RET 5-A	6.7	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, concrete cement to surface
RET 5-B	6.7	None Installed			Bentonite holeplug mixed with cuttings to 0.2 m, concrete cement to surface

Results of field drilling and sampling are presented on the Record of Borehole Sheets in Appendix A.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, secured the recovered samples in labelled containers, and transported the samples to Thurber's laboratory.

4 LABORATORY TESTING

All 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.

A minimum of 25% of the recovered samples were subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing when appropriate. The results of this testing program are shown on the Record of Borehole Sheets in Appendix A and on the charts in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole Sheets in Appendix A for details of the encountered soil stratigraphy. A stratigraphic profile is presented on the Borehole Locations and Soil Strata Drawing, Appendix C, for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the borehole logs governs any interpretation of the site conditions.

The soil stratigraphy encountered at the borehole locations typically consists of fill composed of sand and clayey silt overlying layers of native cohesionless glacial tills which are occasionally interbedded with wet granular materials. In some of the locations, topsoil was encountered immediately below the fill and above the glacial till deposits. More detailed descriptions of the individual stratum are presented below.

5.2 Pavement

In Boreholes RET 1-A to C, RET 2-A to C and RET 4-A and B, a 50 to 150 mm thick layer of asphalt surface was encountered. The asphalt was then underlain by a granular fill. The depth of the granular fill ranged from 0.6 to 1.7 m (El. 156.3 to 157.9 m) at RET 1; from 0.8 to 1.1 m (El. 171.3 to 172.0 m) at RET 2; and 1.4 m (El. 158.8 and 160.3 m) at RET 4. The granular fill consists of a brown sand to silty sand containing trace to some silt and trace to some gravel.

SPT N-values recorded in the granular fill layer ranged from 13 to 72 blows for 0.3 m of penetration indicating a relative density of compact to very dense.

Moisture content in the granular fill deposits varied from 3 to 10%.

5.3 Topsoil

A layer of topsoil measuring approximately 300 mm in thickness was encountered immediately below the granular fill in RET 2-B and RET 2-C. The topsoil was observed to contain traces of sand, silt and organic matter.

Moisture contents of the two samples recovered from the topsoil layer were measured as 24 and 6% in RET 2-B and RET 2-C respectively.

5.4 Fill

A clayey silt fill of variable thickness was encountered below the granular fill in Boreholes RET 1-A and RET 1-C. The fill consists predominantly of a dark brown clayey silt with some sand and traces of gravel. The cohesive fill was found to extend to depths ranging from 2.3 to 2.4 m below the ground surface (El. 155.6 and 156.3 m).

A cohesionless fill consisting of a silty sand to sand and silt with trace to some clay and trace gravel was encountered below the pavement structure in Boreholes RET 1-B, from the ground surface in RET 3-C and from the ground surface in Boreholes RET 5-A and B. The fill was found to extend to a depth of 2.2 m (El. 156.3 and 166.6 m) in Boreholes RET 1-B and RET 3-C respectively. The lower boundary of the fill was contacted at a depth of 4.0 m (El. 165.0 and 164.9 m) in Boreholes RET 5-A and B respectively.

Grain size analyses conducted on eight (8) samples retrieved from the fill layers are presented on the Record of Borehole Sheets and Figures B1 and B2 of Appendix B. Atterberg limits testing on two (2) samples indicated that the cohesive fill is a low to intermediate plasticity clay (CL - CI). The results of the Atterberg limits testing may be found on the Record of Borehole Sheets and Figure B8 in Appendix B. The results of laboratory tests carried out on the fill deposit were as follows:

<u>Clayey Silt Fill</u>		<u>Silty Sand Fill</u>	
Gravel %	0 to 3	Gravel %	2 to 3
Sand %	26 to 32	Sand %	42 to 54
Silt %	49 to 57	Silt %	29 to 47
Clay %	15 to 17	Clay %	7 to 14
Liquid Limit %	29 to 38		
Plastic Limit %	19 to 24		

SPT N-values obtained in the cohesionless fill ranged from 5 to 45 blows per 0.3 m of penetration, indicating a loose to dense relative density. SPT N-values obtained in the cohesive fill ranged from 2 to 11 blows per 0.3 m of penetration, indicating a soft to stiff consistency.

The moisture content of all fill samples ranged from 7% to 31%.

5.5 Silty Sand

Below the fill in Boreholes RET 5-A and 5-B, a layer of silty sand with some clay and trace gravel was encountered. The cohesionless layer was contacted at a depth of 4.0 m (El. 165.0 and 164.9 m) in Boreholes RET 5-A and B respectively. Both of the boreholes were terminated in the silty sand at a depth of 6.7 m (El. 162.2 and 162.1 m).

SPT N-values recorded in the cohesionless layer ranged from 7 to 19 blows for 0.3 m of penetration indicating a loose to compact relative density. The moisture content of the silty sand ranged from 10 to 18%.

The result of grain size distribution analyses conducted on one (1) sample is presented on the Record of Borehole Log Sheets and Figure B3. The results of the geotechnical laboratory testing are summarized below.

Gravel %	2
Sand %	50
Silt %	37
Clay %	10

5.6 Sand and Silt Till to Silty Sand Till

In all boreholes but RET 5-A and B, a cohesionless glacial till was encountered. The till is comprised of a brown sand and silt till to silty sand till with some clay. The cohesionless till was encountered immediately below the topsoil in Boreholes RET 2-B and RET 2-C and below the fill in all other borehole locations.

The surface of the sand and silt till to silty sand till was encountered at depths ranging from 2.2 to 2.4 m, below the ground surface (El. 155.6 to 156.3 m) in the boreholes drilled at RET 1. In the boreholes drilled at RET 2, the surface of the cohesionless till was encountered at

depths ranging from 0.8 to 1.4 m (El. 171.0 to 172.0 m). In the boreholes drilled at RET 3, the cohesionless till was initially contacted at depths ranging from 0.2 to 2.2 m (El. 166.6 to 170.2 m) and at a depth of 1.4 m (El. 158.8 to 160.3 m) in the boreholes drilled at RET 4.

Boreholes RET 3-B and C were interbedded with a layer of sand and gravel which is described in more detail in a subsequent section. In general, the sand and gravel interbed was initially contacted at depths of 2.2 and 3.0 m (El. 167.5 and 165.8 m) and the lower boundary was encountered at depths of 3.0 and 4.1 m (El. 166.7 and 164.7 m).

SPT test results conducted in the silt/sand till deposit varied widely from 16 to greater than 50 blows for 0.05 m of penetration indicating a compact to very dense condition. The compact portion of the till was encountered in the upper 1 to 1.5 m of the till below which the till was dense to very dense.

Moisture contents from this deposit ranged from 5 to 16%.

The results of grain size distribution analyses conducted on fifteen (15) samples are presented on the Record of Borehole Log Sheets and Figures B4 to B6. The results of the geotechnical laboratory testing are summarized below.

Gravel %	0 to 12
Sand %	37 to 49
Silt %	33 to 42
Clay %	9 to 22

5.7 Sand and Gravel

Interbedded in the cohesionless till, a thin layer of sand and gravel was encountered in Boreholes RET 3-B and C. The sand and gravel was initially contacted at a depth of 2.2 and 3.0 m (El. 167.5 and 165.8 m) in Boreholes RET 3-B and C respectively, and the lower boundary was correspondingly encountered at depths of 3.0 and 4.1 m (El. 166.7 and 164.7 m).

SPT N-values in the sand and gravel interbeds ranged from 74 to 77 blows for 0.3 m of penetration indicating a very dense relative density. Moisture contents in the two recovered samples were observed as 12 to 15%.

The results of grain size distribution analyses conducted on two (2) samples are presented on the Record of Borehole Log Sheets and Figure B7. The results of the geotechnical laboratory testing are summarized below.

Gravel %	40 to 44
Sand %	41 to 49
Silt and Clay%	11 to 15

5.8 Groundwater Conditions

All boreholes drilled at retaining walls RET 2 and 4 were observed to be open and dry following completion of drilling. The water levels in the boreholes drilled at retaining wall upon completion were as shown below in Table 5.1.

The groundwater levels at RET 3 ranged from 1.5 to 2.7 m below the ground surface (El. 167.3 to 167.7 m). The groundwater levels in the open boreholes at RET 5 were measured at 4.9 and 2.7 m (El. 164.0 and 166.1 m).

19 mm diameter standpipe type piezometers were installed into one borehole drilled at the sites of RET 1 and RET 2. Details of the standpipe piezometer construction are indicated above in Table 3.1.

The water levels measured in the piezometers are summarized in Table 5.1.

Table 5.1 – Measured Groundwater Levels

Borehole	Date	Water Level (m)		Measured In
		Depth	El.	
RET 1-A	Oct 14, 2008	2.7	155.1	Open Borehole
RET 1-B	Feb 11, 2009	3.26	155.2	Piezometer
RET 1-C	Oct 14, 2008	3.3	155.5	Open Borehole
RET 2-A	Oct 15, 2008	Dry	N/A	Open Borehole
RET 2-B	Feb 11, 2009	3.98	168.6	Piezometer
RET 2-C	Oct 15, 2008	Dry	N/A	Open Borehole
RET 3-A	Mar 24, 2009	2.7	167.7	Open Borehole
RET 3-B	Mar 24, 2009	2.1	167.6	Open Borehole
RET 3-C	Mar 24, 2009	1.5	167.3	Open Borehole
RET 4-A	Mar 25, 2009	Dry	N/A	Open Borehole
RET 4-B	Mar 25, 2009	Dry	N/A	Open Borehole
RET 5-A	Mar 23, 2009	4.9	164.0	Open Borehole
RET 5-B	Mar 23, 2009	2.7	166.1	Open Borehole

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

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. MMM surveyed the as-drilled locations, and provided northing and easting coordinates and ground surface elevations.

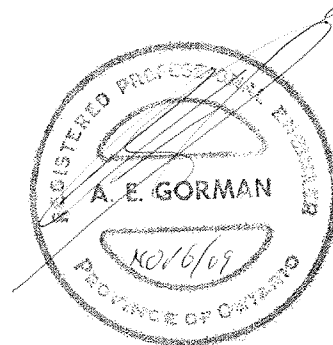
Groundwork Drilling Inc. of Etobicoke, Ontario supplied and operated a truck-mounted BOA 5-M drill rig to conduct the drilling and sampling operations for RET 1 and 2. DBW Drilling Inc. of Ajax, Ontario supplied and operated a truck-mounted Diederichs D50 drill rig to conduct the drilling and sampling operations at RET 3, 4 and 5.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Stephane Loranger and Mr. Will Ball of Thurber.

Laboratory testing was carried out by Thurber Engineering Ltd. in its MTO-approved Oakville laboratory.

Interpretation of the field data and preparation of the investigation report was completed by Mr. David Elwood, P.Eng and Mr. Alastair E. Gorman, P. Eng. Overall supervision of the field program was performed by Mr. David Elwood, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Alastair E. Gorman, P.Eng.,
Associate, Senior Project Engineer

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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 geotechnical design recommendations related to the detail design of suitable foundation systems for the construction of five retaining walls associated with the widening of Highway 7 in Pickering and Whitby, Ontario.

The proposed walls will support the highway widening and right turn lanes at RET 1 and RET 2 respectively, which at these locations are situated at a higher level than adjacent properties to the south. The grade difference between the adjacent properties was estimated from topographic data provided by MMM and is anticipated to range from between 0.8 to 1.0 m at RET 1 and from between 0.4 to 0.8 m at RET 2. At RET 3, 4 and 5 the proposed retaining wall will support the existing property adjacent to the proposed highway widening. The grade difference at RET 3 is estimated to range from 0.5 to 1.0 m, while at RET 4 the anticipated cut is expected to range from 3 to 4 m to match the existing highway alignment. Finally at RET 5, the separation is anticipated to be around 0.3 to 0.5 m above the proposed highway grade.

At the time of the report, details regarding the design and construction of the various retaining walls were not available for review.

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

After preparation of this report we were advised that MTO has acquired a sufficient width of right-of-way to eliminate the retaining walls. Accordingly, the foundation recommendations have not been further reviewed or developed.

8 RETAINING WALL FOUNDATIONS

Four alternative wall types were initially considered during preparation of this report:

- A concrete cantilever wall supported on spread footings;
- An RSS wall;
- A concrete toe wall; and
- A soldier pile and lagging wall.

However, considering the low height of the retaining walls, the soldier pile wall option was deemed impractical and uneconomical. Foundation recommendations for a concrete cantilever wall, an RSS type wall and toe walls are presented below.

8.1 Cantilever Retaining Wall

The subsurface stratigraphy along the wall alignment generally consists of a shoulder pavement structure overlying a heterogeneous fill which is underlain by a compact to very dense sand and silt till / silty sand till to silty sand.

New retaining wall footings should be founded on native undisturbed, compact to very dense, cohesionless till a minimum 1.2 m below finished grade. Footings should not be founded on the fill indicated in the boreholes. The highest recommended founding levels at the borehole locations are summarized in Table 8.1.

Table 8.1 – Highest Recommended Founding Levels

Borehole ID	Highest Founding Level Depth (El.) (m)	Founding Material
RET 1-A	2.3 (155.5)	Sand and Silt Till
RET 1-B	2.3 (156.2)	Sand and Silt Till
RET 1-C	2.6 (156.2)	Silty Sand Till
RET 2-A	1.2 (171.6)	Sand and Silt Till
RET 2-B	1.5 (171.1)	Sand and Silt Till
RET 2-C	1.5 (170.9)	Sand and Silt Till
RET 3-A	1.2 (169.2)	Sand and Silt Till
RET 3-B	1.2 (168.5)	Sand and Silt Till
RET 3-C	2.3 (166.5)	Sand and Silt Till
RET 4-A	1.5 (160.2)	Sand and Silt Till
RET 4-B	1.5 (158.8)	Sand and Silt Till
RET 5-A	See paragraph below	Silty Sand
RET 5-B	See paragraph below	Silty Sand

Up to 4.0 m of fill has been identified in Boreholes RET 5-A and 5-B, it is recommended that this fill be excavated to a minimum of 2.1 m depth, which is a minimum of 0.9 m below the design level (1.2 m below the ground surface) and replaced with a well compacted Granular A or unshrinkable fill to re-establish the founding level. The granular/unshrinkable fill should extend at least 300 mm beyond the front and back edges of the wall footing.

The footing bases at RET 1 and 3 may be brought up to a depth of 1.2 m below the finished grade by excavating to the recommended founding level on native soils and replacing the existing fill material with compacted Granular A or unshrinkable fill to re-establish the founding level. The granular/unshrinkable fill should extend a minimum of 300 mm beyond the edge of the footing at the footing base level and project outwards below this level at an inclination of 1H:1V to the native surface beyond the front and back edges of the wall footing. The longitudinal extent of the fill along the wall should be defined by close examination during construction.

It has been assumed that the footing will be bearing on the compact to very dense cohesionless till at or below the levels indicated in Table 8.1. The footings should be designed for a Factored Geotechnical Resistance at ULS of 300 kPa and a Geotechnical Resistance at SLS of 200 kPa.

The resistance values are for vertical, concentric loads. In accordance with the CHBDC Clauses 6.7.3 and 6.7.4, the design must also account for the effects of the eccentric and inclined loads applied to the wall and the foundation.

The lateral resistance of the footings founded on cohesionless till may be computed using an unfactored friction coefficient of 0.5. This is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance.

The contract documents must specify that the contractor’s Q.V.E. staff include a qualified geotechnical engineer to inspect the footing bases and confirm that the exposed surface conforms to the design requirements, has been adequately prepared to receive concrete, and consists of the compact to very dense native glacial till below the level of all fill or loosened/softened material or consists of engineered fill constructed in accordance with the recommendations contained in this report.

All footings must be provided with a minimum of 1.2 m of earth cover over the footing base as protection against frost action.

8.2 Retained soil Systems

Retained soil system (RSS) walls may be used subject to the requirements presented in this section. RSS walls should be specified to be “High Performance” and “High Appearance”. The contract drawings must include information on the longitudinal alignment of the wall in

plan, the top and base elevations of the wall in profile, cross-sectional space constraints and an NSSP for the RSS wall.

The performance of an RSS is dependent on, among other factors, the characteristics of its foundation. Failure to provide an adequate foundation may lead to settlement and distortion of the RSS and, in severe cases, to possible failure of the system. The foundation of the entire RSS mass must be considered, i.e. from the face of the wall to the furthest extent of the reinforcement.

To provide an acceptable foundation performance, the RSS mass must be founded on the compact to very dense cohesionless till at or below the levels indicated in Table 8.1. For RET 5-A and RET 5-B, partial removal of fill and placement of a minimum of 0.9 m of engineered fill below the RSS wall may be used. A wall founded on this material should be designed for a factored bearing resistance of 300 kPa at ULS and a bearing resistance of 200 kPa at SLS.

Topsoil, loose fill, and any soft/wet native material should be stripped from the footprint of the RSS. Fill placed under the RSS mass to achieve the design founding level must be placed as engineered fill, consisting of OPSS Granular A compacted to 100% of its SPMDD at a moisture content within 2% of optimum.

The entire block of reinforced earth must be designed against various modes of failure including sliding and overturning. Sliding resistance along the base of the wall on engineered granular fill, native silty sand or sand and silt till may be estimated using an ultimate friction coefficient of 0.55, 0.45 and 0.5 respectively.

If an RSS wall system is selected, the global stability must be analyzed after the design details of the wall is known. The global stability of the RSS wall is dependent on the characteristics of the embankment fill and the foundation soils, the geometry of the embankment and location of the RSS within the embankment. Typically global stability should not be a concern for an RSS wall founded on the compact to dense cohesionless till however the stability of the wall should be reviewed by a qualified geotechnical engineer once the design has been finalized.

8.3 Toe Wall

Toe wall design should be in accordance with OPSD 3120.100. A toe wall set approximately 450 mm below the finished road grade as per the OPSD will be founded on compact to dense cohesionless fill or glacial till. All temporary excavations for the construction of the retaining walls should follow the recommendations provided in Section 10.

All retaining walls subgrade should be sub-excavated to the elevations recommended below in Table 8.2. The subgrade beneath the retaining walls should be uniformly competent and carefully prepared. The retaining wall subgrade should be proof rolled and inspected by a qualified geotechnical engineer. If any topsoil, organics, debris, soft soils or other deleterious

materials are identified during the inspection, these areas should be sub-excavated and replaced with OPSS Granular A or Granular B Type II and compacted to 100% SPMDD at $\pm 2\%$ OMC or mass concrete.

For a Type II and Type III wall as per OPSD 3120.100, a minimum bearing capacity at ultimate limit states of 300 kPa is required. The loose to compact heterogeneous silty sand to clayey silt fill subgrade at this site will not be able to support this bearing capacity without causing uneven settlement of the wall. Table 8.2 recommends a depth of subexcavation of existing fill and thicknesses of engineered fill below the retaining wall base. Engineered fill should consist of Granular A or Granular B Type II compacted to 100% SPMDD at $\pm 2\%$ of OMC. The width of the engineered fill pad should be at least twice the footing width.

Table 8.2 – Toe Wall Foundation Preparation

Borehole ID	Elevation of Base of Sub-Excavation (m)	Recommended Thickness of Engineered Fill Below Retaining Wall Base (m)
RET 1-A	156.9	0.45
RET 1-B	156.3	1.75
RET 1-C	156.3	1.95
RET 2-A	171.9	0.45
RET 2-B	171.2	0.95
RET 2-C	171.0	0.95
RET 3-A	169.9	On dense native till
RET 3-B	168.8	0.45
RET 3-C	167.9	0.45
RET 4-A	160.8	0.45
RET 4-B	159.4	0.45
RET 5-A	168.0	0.45
RET 5-B	167.9	0.45

The bearing capacity value of 300 kPa is for vertical concentric loads only. Effects of load inclination and eccentricity should be taken into account as per OHBDC or CHBDC. Resistance to lateral forces/sliding between the concrete and the granular pad below the wall may be calculated using an ultimate friction factor of 0.6.

9 BACKFILL AND LATERAL EARTH PRESSURES

The retaining wall backfill should consist of Granular A or Granular B material. The backfill must be in accordance with OPSS 902 as amended by Special Provision 902S01, and placed to the extents shown in OPSD 3121.150 where applicable.

The design of the retaining walls must incorporate a subdrain as shown in OPSD 3121.150 and 3190.100, or as per the supplier specifications.

Earth pressures acting on the walls may be assumed to be triangular and to be governed by the characteristics of the backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC (2006) but generally are given by the expression:

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

where: p_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see Table 9.1)

γ = unit weight of retained soil (see Table 9.1)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the retaining wall are dependent on the material used as backfill. Typical values for granular backfill are shown in Table 9.1.

Table 9.1 – Earth Pressure Coefficients (K)

Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.40	0.31	0.43
At rest (Restrained Wall)	0.43	-	0.47	-
Passive (Movement Towards Soil Mass)	3.7	2.1	3.3	1.7

The factors in Table 9.1 above are “ultimate” values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the Canadian Highway Bridge Design Code.

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or 1.7 m for Granular A or Granular B Type II.

Compaction equipment to be used adjacent to retaining structures must be restricted in accordance with OPSS 501.07.

10 EXCAVATION AND DEWATERING

Excavation and backfilling for retaining wall construction must be carried out in accordance with SP 902S01 and the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the cohesionless till at these sites are classified as Type 2 soils above the water level and Type 3 soils below the water level. All existing fills are classified as Type 3 soils.

Temporary excavation slopes should not exceed 1V:1H. Where this cannot be accommodated, a shored and braced excavation should be used. Roadway protection should be supplied where required in accordance with SP 105S19 and designed for Performance Level 2. The design of roadway protection should be the responsibility of the Contractor.

Selection of the appropriate excavation procedures and dewatering system is the responsibility of the Contractor. The Contract documents should alert him to the requirement to maintain a stable excavation and a dry, sound base on which to work. Any shoring system should be designed by a shoring specialist.

Based on the borehole information, excavation for foundation construction is not expected to extend below the groundwater level at the retaining walls except at RET 3-C. However, seepage may be experienced from perched zones in the fill and from the sand and gravel layers at these locations. Removal of this water from the excavation using sumps and pumps is considered feasible. The design of any dewatering system that may be required is the responsibility of the Contractor.

11 SEISMIC CONSIDERATIONS

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 1
- Zonal Acceleration Ratio 0.05
- Peak Horizontal Acceleration 0.08

The soil profile type at this site has been classified as Type I. Therefore, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient “S” (ground motion amplification factor) of 1.0 should be used in seismic design.

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. The seismic earth pressure coefficients to be used in design at this site are shown in Table 14.1.

Table 11.1 – Earth Pressure Coefficients (K) for Seismic Design

Condition	Earth Pressure Coefficient (K) for Earthquake Loading			
	OPSS Granular A or OPSS Granular B $\phi = 35^\circ, \delta = 0^\circ$		OPSS Granular B Type I $\phi = 32^\circ, \delta = 0^\circ$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active*, K_{AE} (Unrestrained Wall)	0.28	0.47	0.32	0.59
At rest**, K_{OE} (Restrained Wall)	0.54	-	0.58	-
Passive*, K_{PE} (Movement Towards Soil Mass)	3.6	-	3.1	-

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

** After Woods

The potential for liquefaction of the foundation soils has been assessed using the Seed and Idriss (1971) method. The footings are anticipated to be constructed above the groundwater level and are not considered to be in danger of undergoing liquefaction.

12 CONSTRUCTION CONCERNS

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

- The till soils may contain cobbles and boulders that must be penetrated or removed during excavation activities;
- Removal of buried topsoil;
- Care must be taken during excavation to avoid disturbing the retaining wall subgrade. The exposed subgrade should be protected from physical disturbance and the granular bedding and/or mud slab must be placed on the approved subgrade expeditiously following excavation;
- Confirmation that the retaining wall backfills are adequately placed and compacted to specifications;
- Groundwater infiltration at the retaining walls may require the use of filtered sumps and pumps.

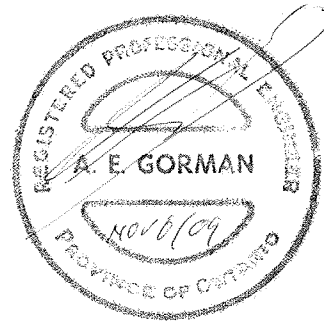
The successful performance of the retaining walls will depend largely upon good workmanship and quality control during construction. Subgrade examination and field density testing should be carried out by qualified geotechnical personnel during construction to confirm that the foundation recommendations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

13 CLOSURE

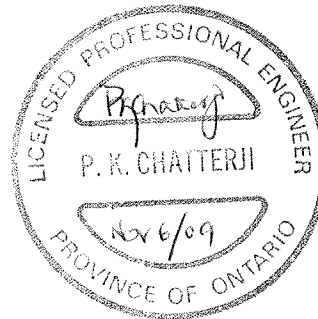
Engineering analysis and preparation of this preliminary foundation design report was carried out by Mr. David Elwood, P.Eng. and Mr. Alastair E. Gorman, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Alastair E. Gorman, P.Eng.,
Associate, Senior Project Engineer



Report Reviewed by:
P. K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact



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

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

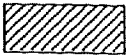
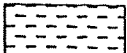



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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

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

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>		
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa) (psi)	Field Estimation of Hardness*
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

<u>TERMS</u>	
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 RET1-A

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 348.44 E 342 250.19 ORIGINATED BY SLL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.10.14 - 2008.10.14 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								20 40 60 80 100		PLASTIC LIMIT w _p		NATURAL MOISTURE CONTENT w			LIQUID LIMIT w _L		
157.8	Geodetic																
0.0 0.1	ASPHALT 50 mm																
	SAND, some silt, trace gravel Very Dense to Compact Light Brown Moist (FILL)		1	SS	72												
			2	SS	29												
156.3																	
1.5	Clayey SILT, some sand Stiff Dark Brown Moist (FILL)		3	SS	11									0 26 57 17			
155.6																	
2.3	SAND and SILT, some clay, some gravel Dense to Very Dense Brown to Grey Moist (TILL)		4	SS	31												
			5	SS	40									12 45 34 9			
			6	SS	50/ .100												
			7	SS	50/ .075												
151.7																	
6.1	END OF BOREHOLE AT 6.1m. WATER LEVEL AT 2.7m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE TO 0.2 m, CONCRETE CEMENT TO GROUND SURFACE.		8	SS	50/ .050												

+ 3 . x 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET1-B

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 353.56 E 342 267.77 ORIGINATED BY SLL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.10.14 - 2008.10.14 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
158.5	Geodetic							20 40 60 80 100					
0.0 0.1	ASPHALT 50 mm							o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
157.9	SAND, trace silt, trace gravel Very Dense Brown Moist (FILL)		1	SS	63								
0.6	Silty SAND, some clay, trace gravel Compact to Loose Dark Brown Moist (FILL)		2	SS	22								3 54 29 14
156.3			3	SS	5								
2.2	SAND and SILT, some clay, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		4	SS	23								0 40 39 21
			5	SS	73								
			6	SS	86								
			7	SS	50/ .150								
152.3			8	SS	50/ .150								
6.2	END OF BOREHOLE AT 6.1m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 11-Feb-09 3.26 155.22												

+ ³ . ³ × ³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET1-C

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 355.83 E 342 275.87 ORIGINATED BY SLL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.10.14 - 2008.10.14 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
158.8	Geodetic							20 40 60 80 100						
0.0 0.1	ASPHALT (50 mm)							40 80 120 160 200						
	SAND, trace silt, trace gravel Dense to Compact Brown Moist (FILL)		1	SS	38		158							
			2	SS	13									
157.1														
1.7	Clayey SILT, some sand, trace gravel Soft Dark Brown Moist (FILL)		3	SS	2		157							3 32 49 15
156.3														
2.4	Silty SAND some clay, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		4	SS	20		156							
			5	SS	28		155							3 49 33 14
			6	SS	77									
			7	SS	50/ .075		154							
							153							
152.4			8	SS	50/ .150									
6.4	END OF BOREHOLE AT 6.4m. WATER LEVEL AT 3.3m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE TO 0.2 m, CONCRETE CEMENT TO GROUND SURFACE.													

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

RECORD OF BOREHOLE No RET2-A

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 762.37 E 343 476.84 ORIGINATED BY SLL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.10.15 - 2008.10.15 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
172.8	Geodetic													
0.0	ASPHALT 50 mm													
0.1	SAND, some gravel, trace silt Dense Brown Moist (FILL)		1	SS	43									
172.0							172							
0.8	SAND and SILT, some clay, trace gravel, occasional sand layers Compact to Very Dense Brown to Grey Moist (TILL)		2	SS	16									2 38 38 22
			3	SS	31		171							
			4	SS	91									3 44 37 16
							170							
			5	SS	50/ .150									
			6	SS	50/ .150		169							
			7	SS	50/ .150		168							
							167							
166.6														
6.2	END OF BOREHOLE AT 6.2m. BOREHOLE DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE TO 0.2 m, CONCRETE CEMENT TO GROUND SURFACE.		8	SS	50/ .150									

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15
10

















(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET2-B

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 776.22 E 343 518.02 ORIGINATED BY SLL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.10.15 - 2008.10.15 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100						
								SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
							WATER CONTENT (%)							
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L							
172.6	Geodetic													
0.0 0.1	ASPHALT 50 mm													
	SAND, trace silt, trace gravel Dense Brown Moist (FILL)		1	SS	40									
171.5							172							
1.1	TOPSOIL		2	SS	10									
171.2														
1.4	SAND and SILT, some clay, trace gravel Compact to Very Dense Moist (TILL)													
			3	SS	21		171							3 37 40 19
														
			4	SS	50/ .150		170							
														
			5	SS	50/ .150									
														
			6	SS	50/ .150		169							2 46 33 19
														
			7	SS	50/ .125		168							
														
			8	SS	50/ .125		167							
166.3														
6.2	END OF BOREHOLE AT 6.2m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 11-Feb-09 3.98 168.58				.125									

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET2-C

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 785.19 E 343 543.04 ORIGINATED BY SLL
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2008.10.15 - 2008.10.15 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						40	80	120	160	200	20
172.4	Geodetic																						
0.0	ASPHALT 50 mm																						
0.2	SAND, trace to some silt, trace gravel Dense Brown Moist (FILL)		1	SS	37																		
171.3																							
1.1	TOPSOIL		2	SS	38																		
171.0																							
1.4	SAND and SILT, some clay, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		3	SS	21																		
			4	SS	45																		
			5	SS	41																		
			6	SS	72																		
			7	SS	73																		

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET3-A

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 476.34 E 342 591.82 ORIGINATED BY WB
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.03.24 - 2009.03.24 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	100 200 300 400 500	600 800 1000 1200 1400 1600 1800 2000	20 40 60 80 100	100 200 300 400 500		
170.4	Geodetic													
0.0	SAND (150mm) (FILL)	✕												GR SA SI CL
0.2	SAND and SILT, some clay, trace gravel Dense to Very Dense Brown to Grey Moist (TILL)	o	1	SS	43		170							2 49 35 14
		o	2	SS	78		169							
		o	3	SS	36		168							
		o	4	SS	64		167							
		o	5	SS	100/ 0.175		166							
		o	6	SS	100/ 0.200		165							0 46 41 12
164.1		o												
6.3	END OF BOREHOLE AT 6.3m. WATER LEVEL AT 2.7m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOI FPLUG AND CUTTINGS TO SURFACE.													

+ 3 . x 3 : Numbers refer to
Sensitivity

20
15
10



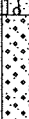
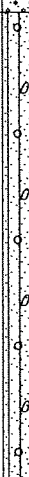
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET3-B

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 866 490.81 E 342 633.45 ORIGINATED BY WB
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.03.24 - 2009.03.24 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L			
169.7	Geodetic													
0.0	Gravelly SAND (FILL)													
169.0														
0.7	SAND and SILT, some clay, some gravel Compact Grey Moist (TILL)		1	SS	16		169							
			2	SS	26		168							
167.5														
2.2	SAND and GRAVEL, trace silt Very Dense Brown Wet		3	SS	77		167						40 49 11 (SI+CL)	
166.7														
3.0	SAND and SILT, some clay, some gravel Very Dense Brown to Grey Moist (TILL)		4	SS	60		166							
			5	SS	100/ 0.200		165						1 45 38 16	
							164							
163.5			6	SS	100/ 0.075									
6.2	END OF BOREHOLE AT 6.2m. WATER LEVEL AT 2.1m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS, HOLEPLUG AND THEN CAPPED WITH ASPHALT TO SURFACE.													

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15 10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET3-C

1 OF 1

METRIC

G.W.P. 2075-08-00

LOCATION N 4 866 501.89 E 342 667.01

ORIGINATED BY WB

HWY 7 - Brock Rd. to Hwy 12

BOREHOLE TYPE Solid Stem Augers

COMPILED BY AN

DATUM Geodetic

DATE 2009.03.24 - 2009.03.24

CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
168.8	Geodetic							20 40 60 80 100						
0.0	Gravelly SAND Compact Brown Moist (FILL)							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
			1	SS	24		168							
			2	SS	25		167							26 66 8 (SI+CL)
166.6														
2.2	SAND and SILT, some clay, some gravel Dense Brown Moist (TILL)		3	SS	37		166							
165.8														
3.0	SAND and GRAVEL, trace silt Very Dense Brown Wet		4	SS	74		165							44 41 15 (SI+CL)
164.7														
4.1	SAND and SILT, some clay, some gravel Very Dense Brown to Grey Moist (TILL)		5	SS	100/ 0.100		164							
							163							
162.6			6	SS	100/ 0.050									
6.1	END OF BOREHOLE AT 6.1m. WATER LEVEL AT 1.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS, HOLEPLUG AND THEN CAPPED WITH ASPHALT TO SURFACE.													

+ 3. × 3.

Numbers refer to
Sensitivity

20
15 10 5

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET4-A

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 088.61 E 344 421.00 ORIGINATED BY WB
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.03.25 - 2009.03.25 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE		● QUICK TRIAXIAL × LAB VANE				W _P	W	W _L
161.7	Geodetic						20	40	60	80	100					
0.0	ASPHALT (150mm)						40	80	120	160	200					
0.2	SAND, some gravel, trace silt Dense Brown Moist (FILL)		1	SS	40											
160.3																
1.4	SAND and SILT, some clay, some gravel Very Dense Brown Moist (TILL)		2	SS	85											
			3	SS	79											
			4	SS	100/ 0.075											
			5	SS	100/ 0.225											
			</													

ONTMT4S 6126.GPJ 14/8/09

+ 3 . x 3 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET4-B

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 867 098.81 E 344 452.13 ORIGINATED BY WB
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.03.25 - 2009.03.25 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
							20 40 60 80 100					WATER CONTENT (%) 20 40 60				
160.3	Geodetic															
0.0	ASPHALT (150mm)															
0.2	SAND, some gravel Dense Brown Moist (FILL)		1	SS	42											0 57 31 12
158.8							160									
1.4	SAND and SILT, some clay, trace gravel Very Dense Brown Moist (TILL)		2	SS	100/ 0.275											
			3	SS	100/ 0.200		159									
			4	SS	100/ 0.200		158									
			5	SS	100/ 0.225		157									0 47 41 13
							156									
154.0			6	SS	100/ 0.200		155									
6.3	END OF BOREHOLE AT 6.3m. BOREHOLE DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS AND THEN CAPPED WITH ASPHALT TO SURFACE.				0.200		154									

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

RECORD OF BOREHOLE No RET5-A

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 868 132.44 E 347 514.36 ORIGINATED BY WB
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.03.23 - 2009.03.23 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								20 40 60 80 100		PLASTIC LIMIT w _p NATURAL MOISTURE CONTENT w LIQUID LIMIT w _L							
168.9	Geodetic																
0.0	SAND and SILT, some clay, trace gravel Compact Brown Moist (FILL)		1	SS	29		168							2 44 47 7			
			2	SS	39		167										
			3	SS	23		166										
			4	SS	22		165										
165.0	Silty SAND, some clay, trace gravel Compact Grey Moist		5	SS	19	▽	164							2 50 37 10			
			6	SS	12		163										
162.2	END OF BOREHOLE AT 6.7m. WATER LEVEL AT 4.9m UPON COMEPLATION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS, HOLEPLUG AND CONCRETE TO SURFACE.																
6.7																	

+³ x³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RET5-B

1 OF 1

METRIC

G.W.P. 2075-08-00 LOCATION N 4 868 140.05 E 347 536.28 ORIGINATED BY WB
 HWY 7 - Brock Rd. to Hwy 12 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.03.23 - 2009.03.23 CHECKED BY DE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
168.8	Geodetic						20 40 60 80 100								
0.0	SAND and SILT , some clay, trace gravel Dense Brown Moist to Wet (FILL)		1	SS	45										3 42 43 12
			2	SS	21										
			3	SS	17										
			4	SS	15										3 52 35 11
164.9															
4.0	Silty SAND , some clay, trace gravel Loose to Compact Grey Moist		5	SS	7										
			6	SS	14										
162.1															
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL AT 2.7m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG, CUTTINGS AND THEN CAPPED WITH CONCRETE TO SURFACE.														

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

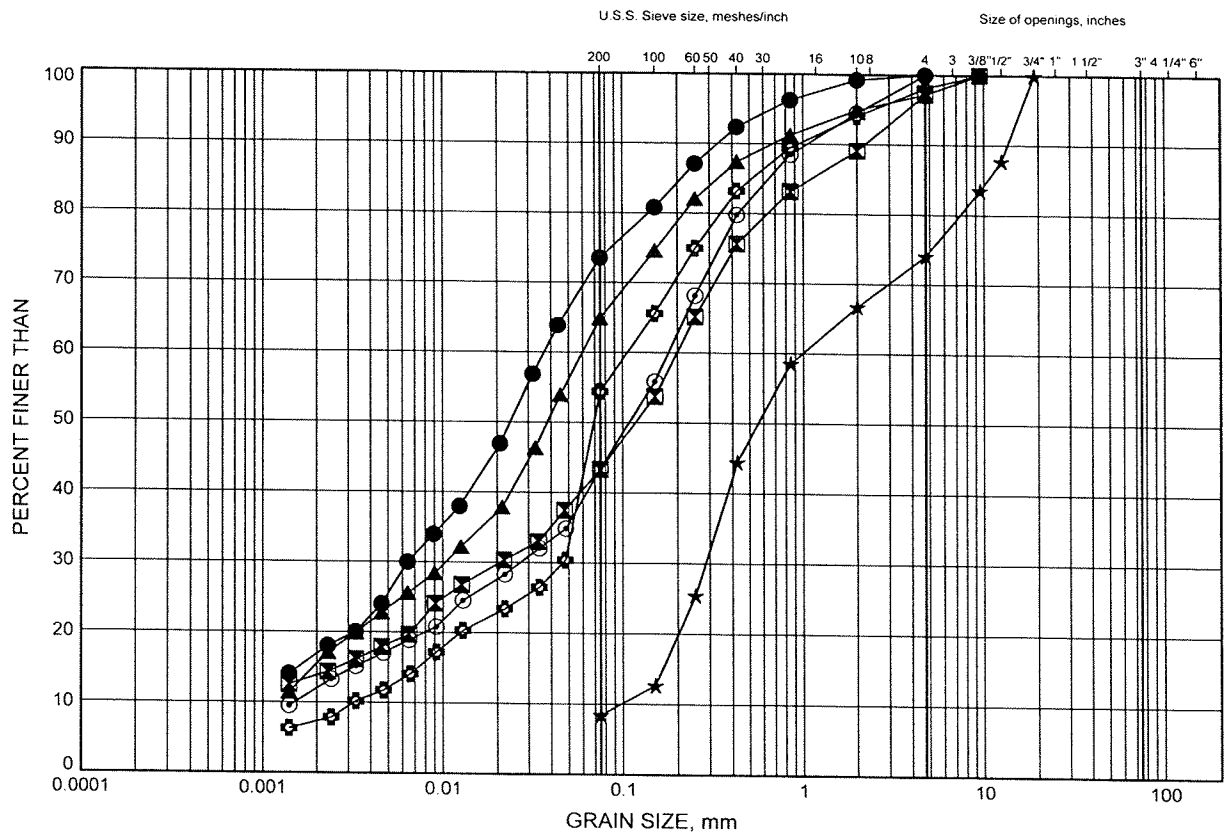
Appendix B

Geotechnical Laboratory Test Results

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B1

SURFICIAL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RET1-A	1.83	156.02
⊠	RET1-B	1.07	157.42
▲	RET1-C	1.83	156.95
★	RET3-C	1.83	166.96
⊙	RET4-B	1.07	159.19
⊕	RET5-A	1.83	167.11

GRAIN SIZE DISTRIBUTION - THURBER 6126 GPJ 23/6/09

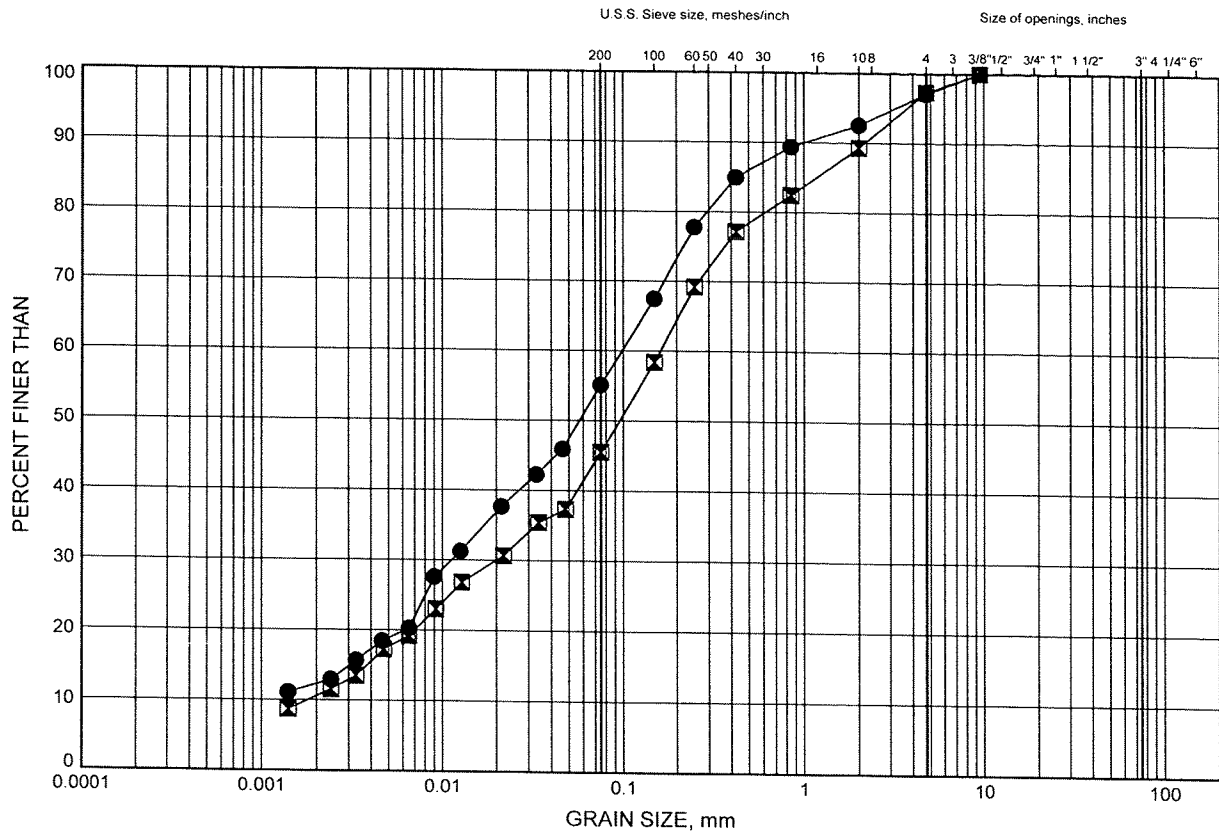
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Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B2

SURFICIAL FILL



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

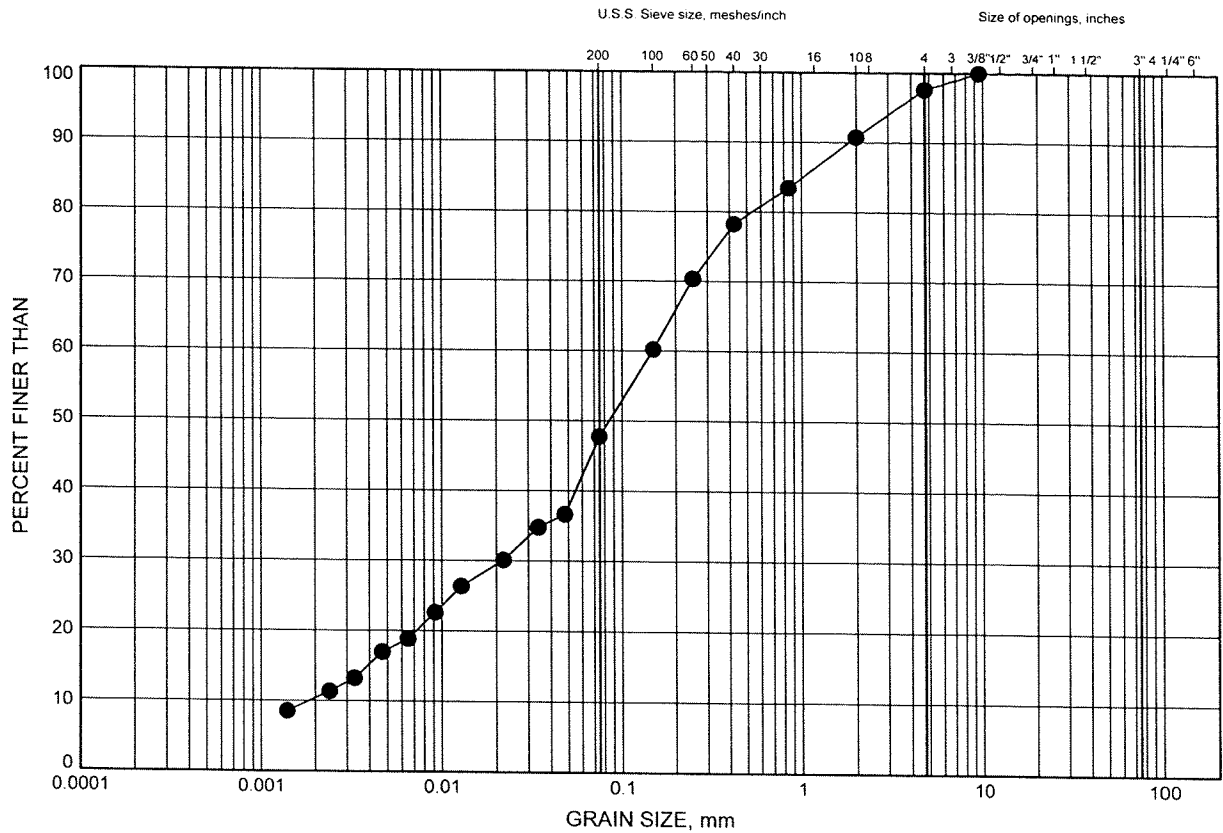
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RET5-B	1.07	167.75
◻	RET5-B	3.35	165.46

Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RET5-A	6.40	162.54

GRAIN SIZE DISTRIBUTION - THURBER 6126.GPJ 23/6/09

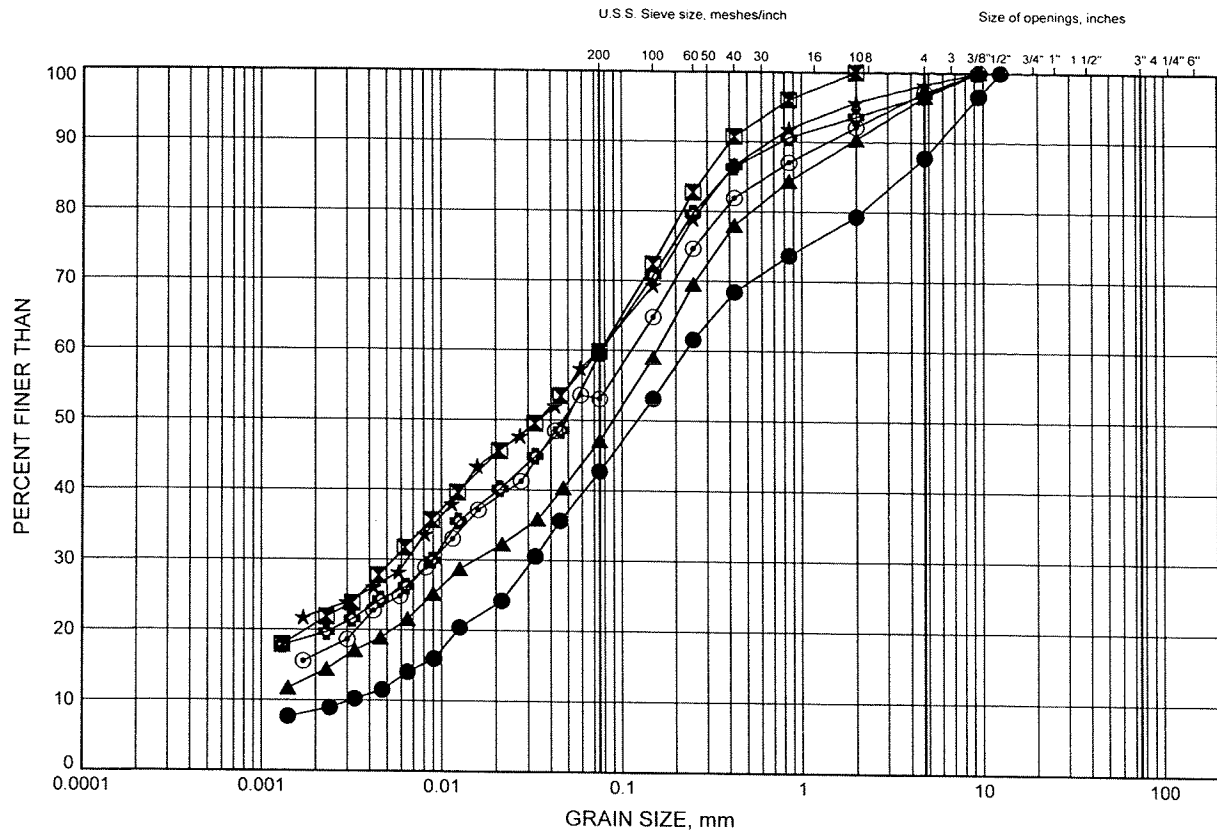
W.P.# 2075-08-00
Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RET1-A	3.35	154.50
⊠	RET1-B	2.59	155.89
▲	RET1-C	4.03	154.76
★	RET2-A	1.37	171.41
⊙	RET2-A	2.50	170.28
⊕	RET2-B	1.83	170.73

GRAIN SIZE DISTRIBUTION - THURBER 6126.GPJ 23/6/09

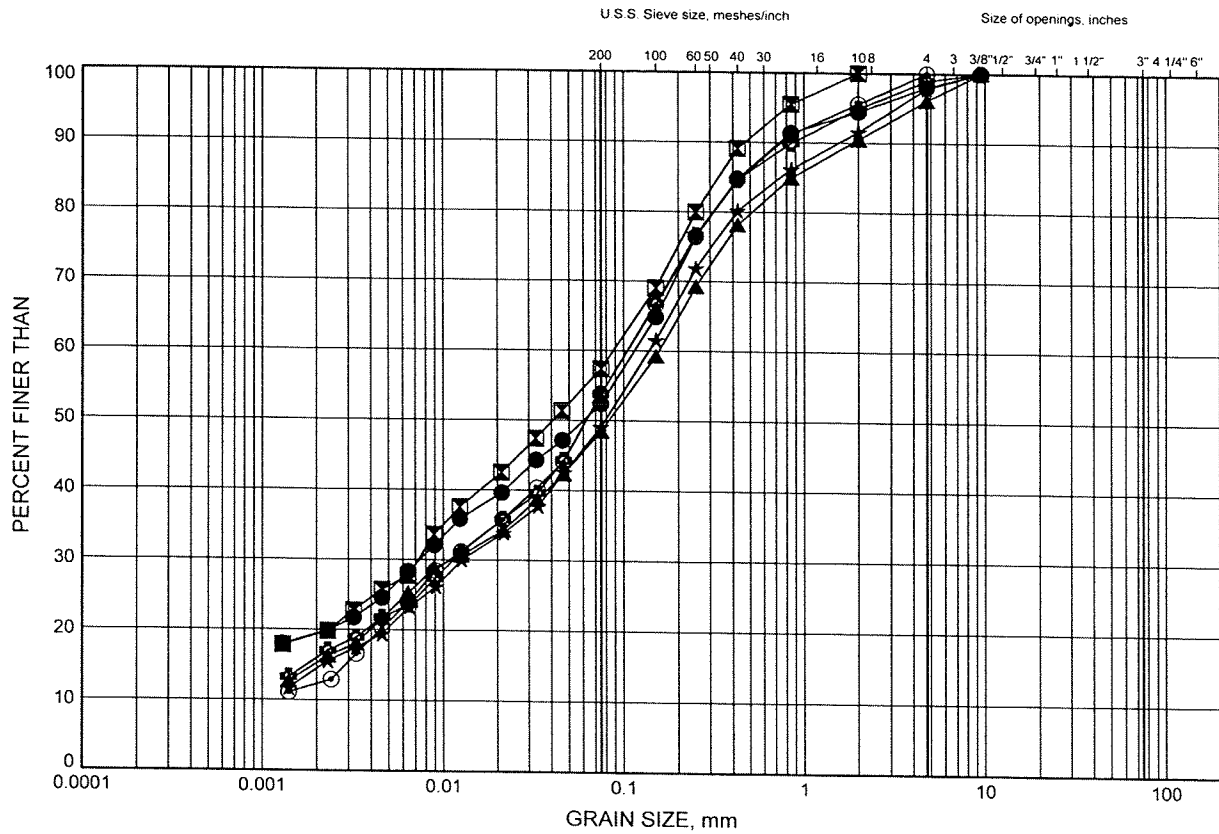
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Prepared By MFA
Checked By DEE



Hwy 7 Brock to Hwy 12 GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RET2-B	3.96	168.60
⊠	RET2-C	2.59	169.82
▲	RET2-C	4.80	167.61
★	RET3-A	1.07	169.30
⊙	RET3-A	6.20	164.17
⊕	RET3-B	4.75	164.96

GRAIN SIZE DISTRIBUTION - THURBER 6126 GPJ 23/6/09

W.P.# 2075-08-00
Prepared By MFA
Checked By DEE

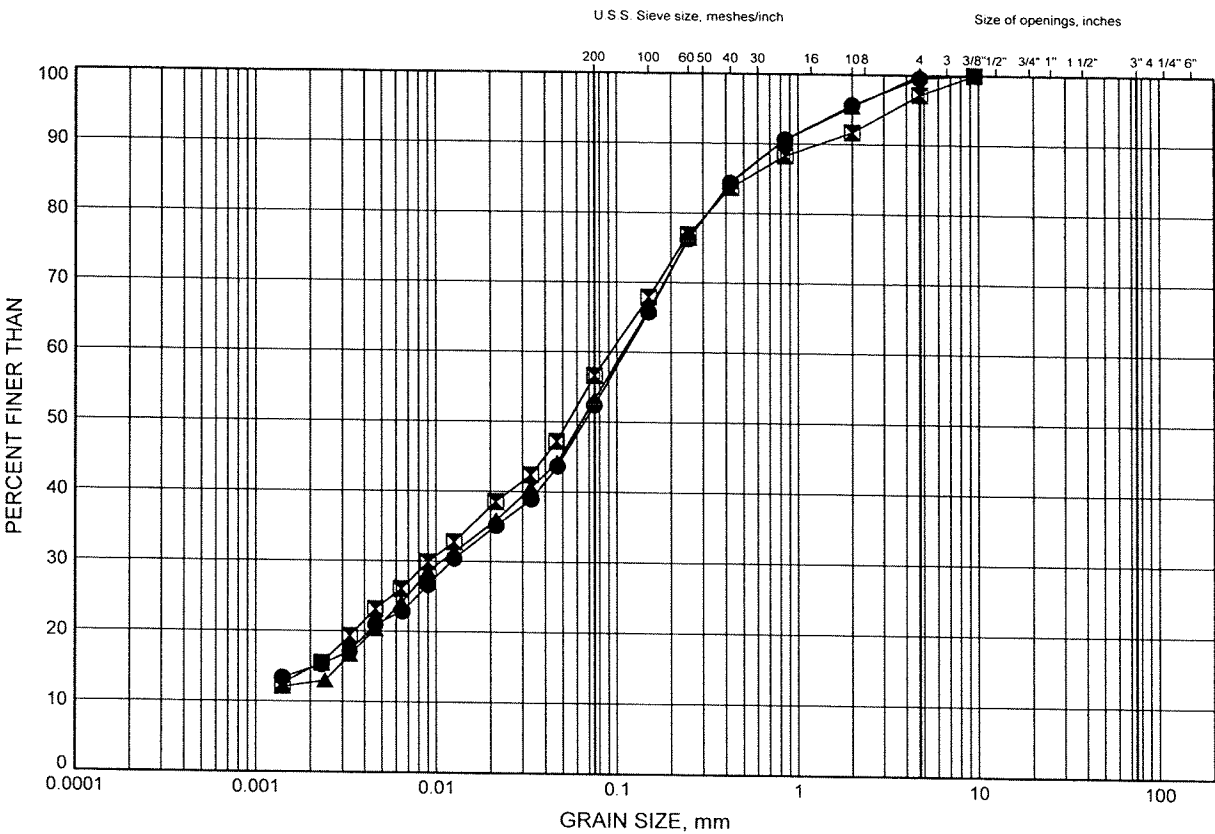


Hwy 7 Brock to Hwy 12

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RET4-A	1.83	159.92
⊠	RET4-A	4.69	157.06
▲	RET4-B	4.76	155.49



GRAIN SIZE DISTRIBUTION - THURBER 6126 GPJ 23/6/09

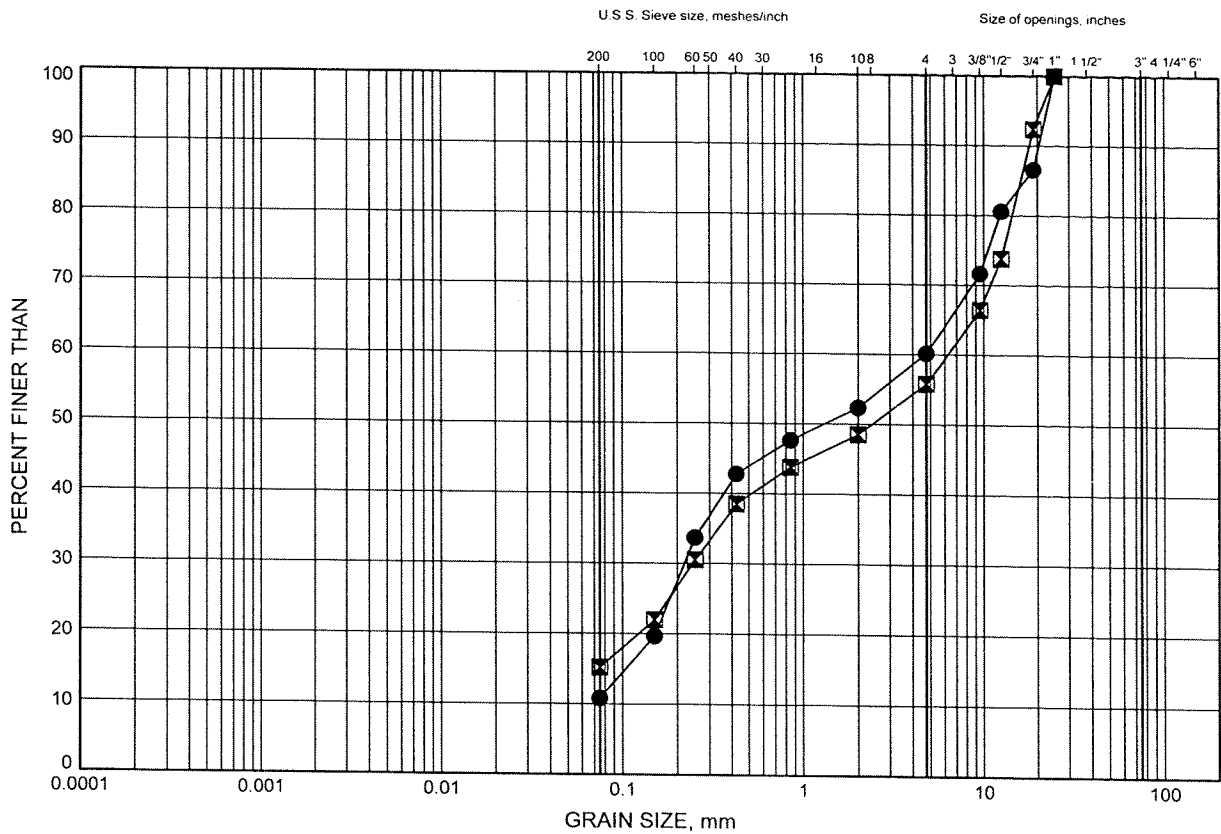
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 Prepared By MFA.....
 Checked By DEE.....

Hwy 7 Brock to Hwy 12

GRAIN SIZE DISTRIBUTION

FIGURE B7

SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RET3-B	2.59	167.12
⊠	RET3-C	3.35	165.44

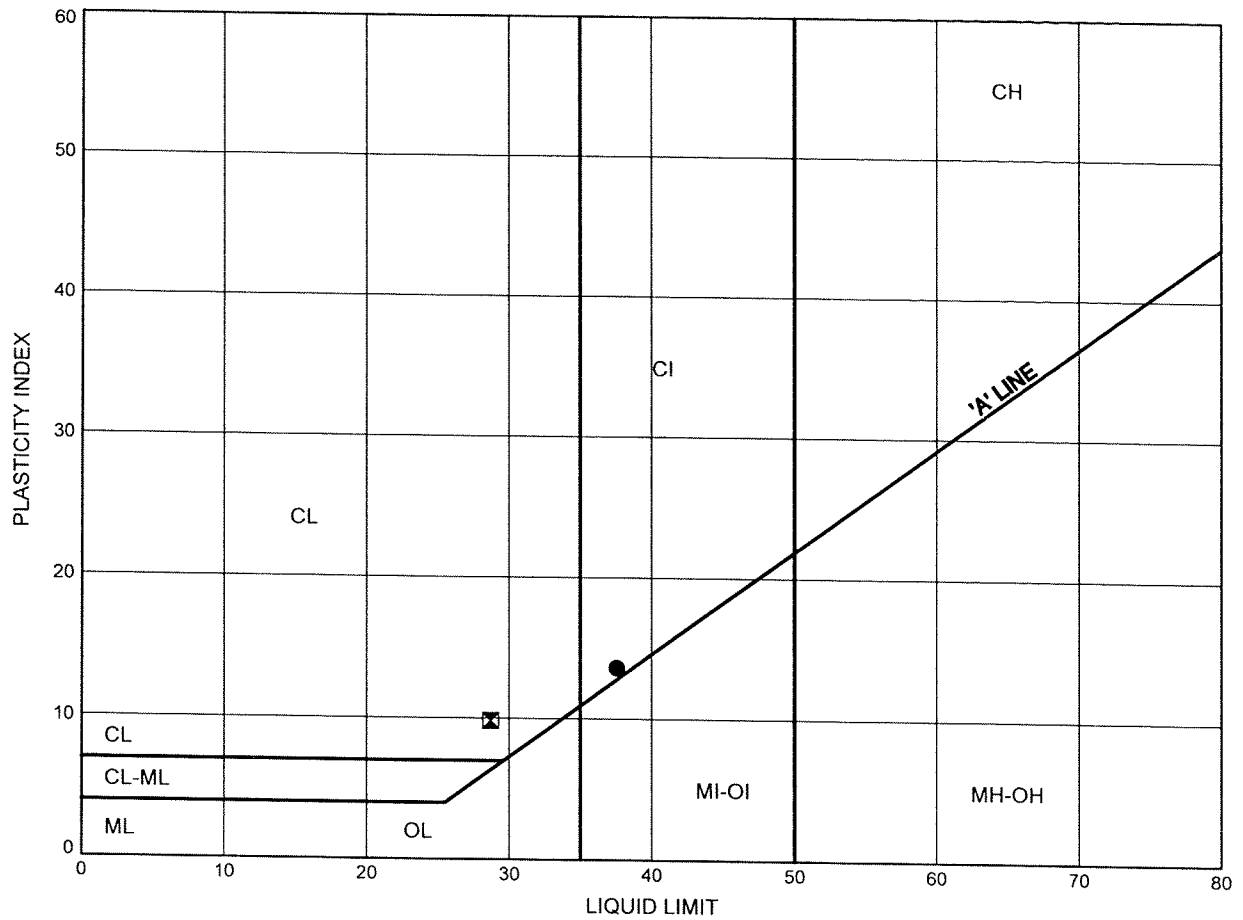


W.P.# 2075-08-00
 Prepared By MFA
 Checked By DEE

Hwy 7 Brock to Hwy 12 ATTERBERG LIMITS TEST RESULTS

FIGURE B8

SURFICIAL FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	RET1-A	1.83	156.02
⊠	RET1-C	1.83	156.95

Date June 2009

Project 2075-08-00

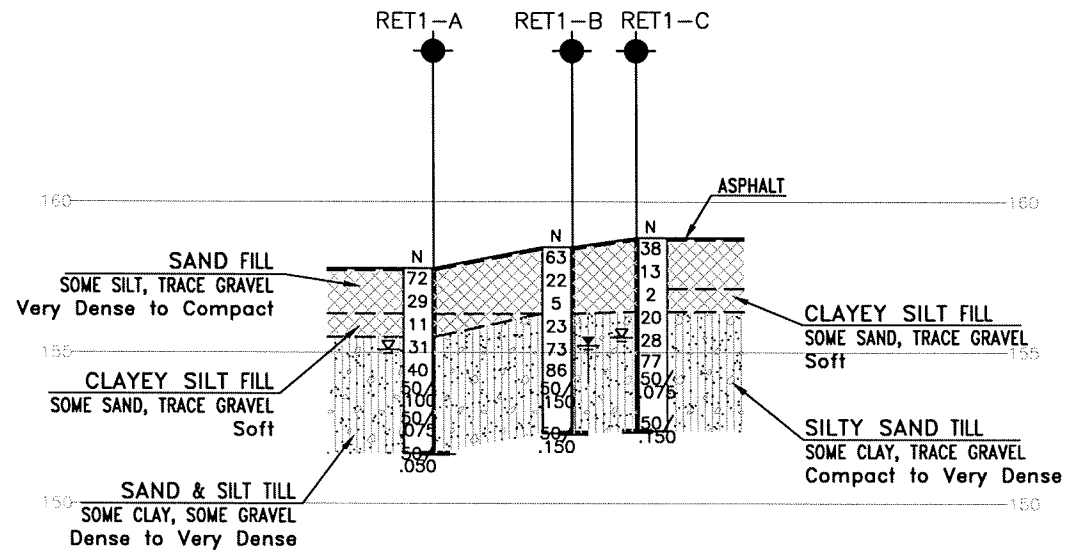
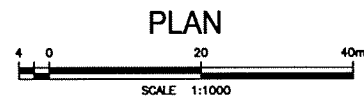
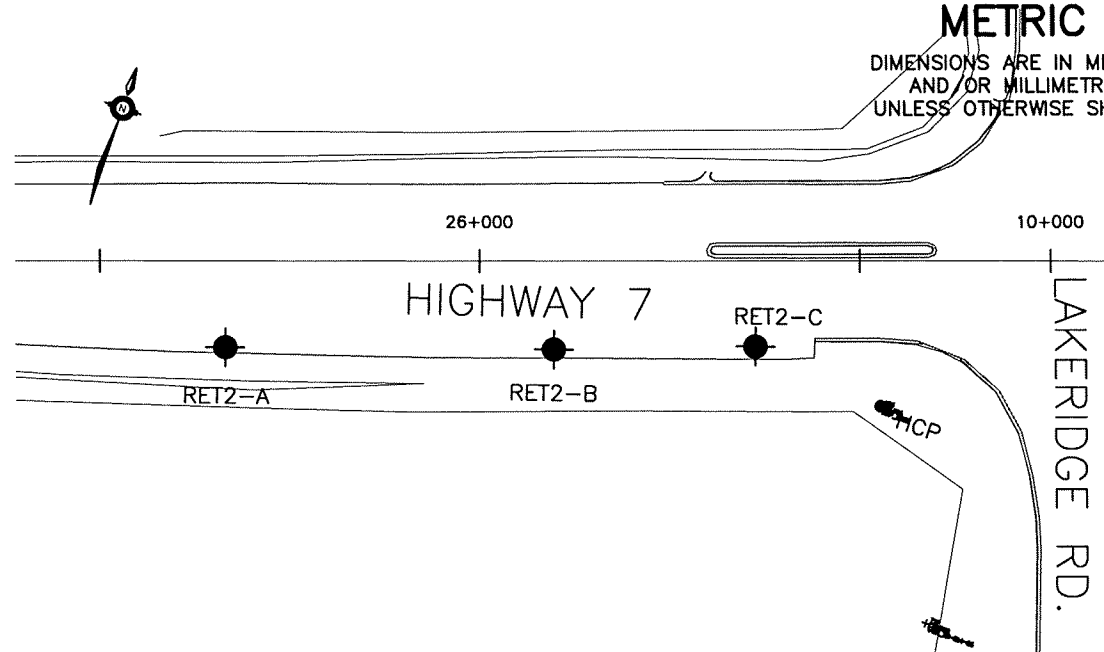
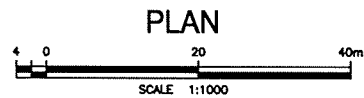
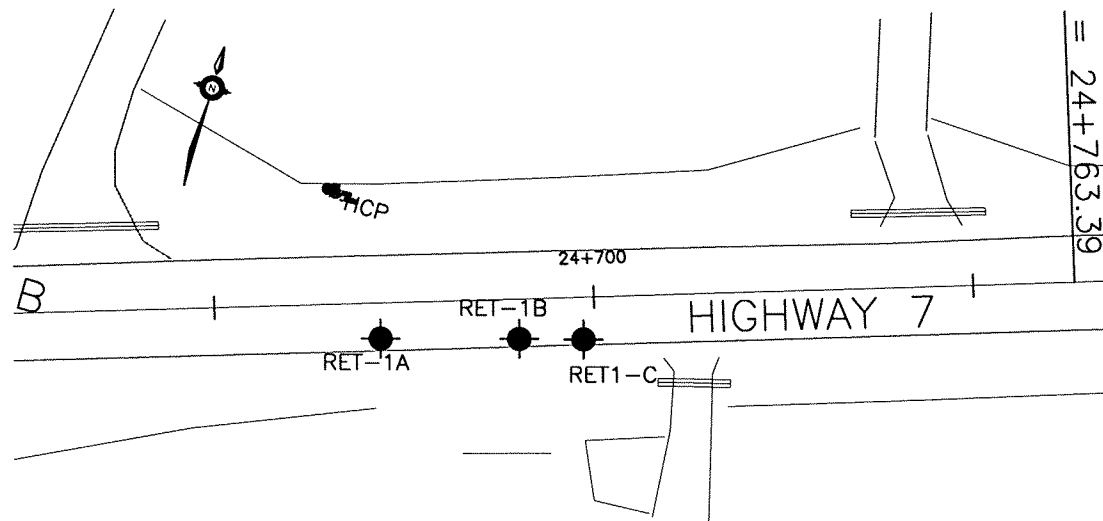


Prep'd MFA

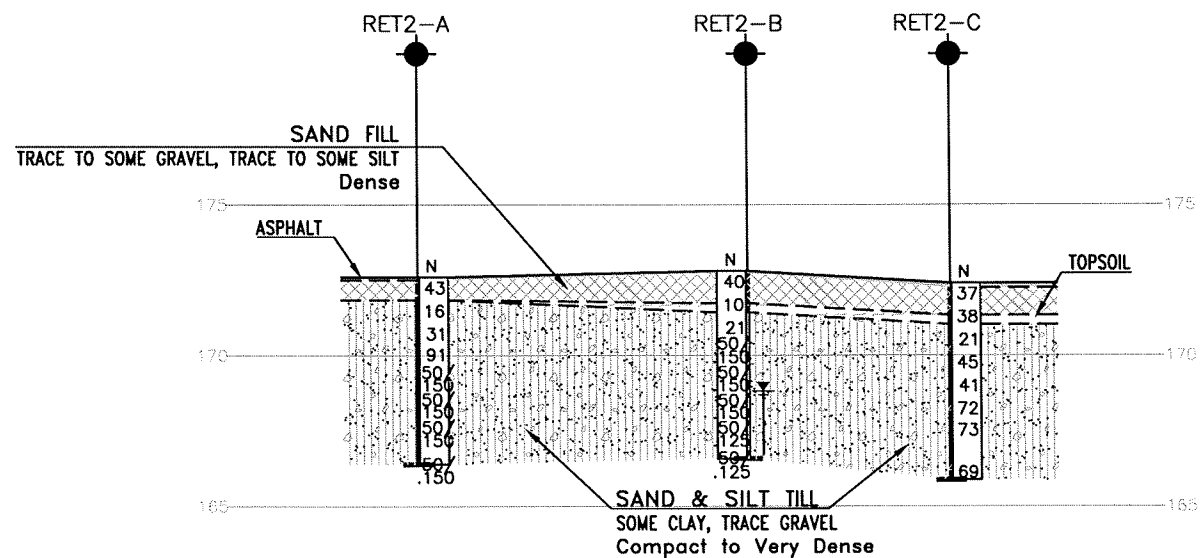
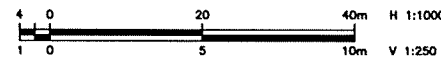
Chkd. DEE

Appendix C

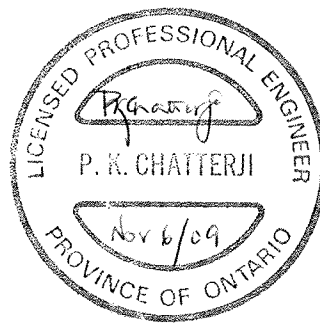
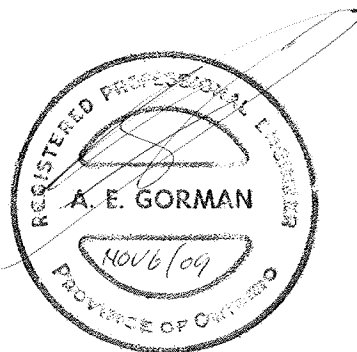
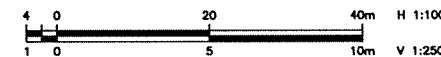
Borehole Locations and Soil Strata Drawing



PROFILE RETAINING WALL RET-1



PROFILE RETAINING WALL RET-2



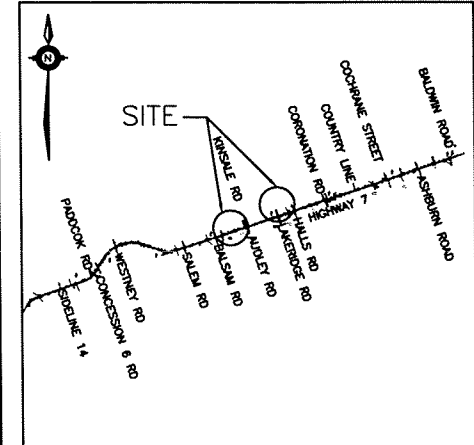
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HIGHWAY 7
CONT No
GWP No 2075-08-00



HWY 7
BROCK STREET TO HWY 12
RETAINING WALL RET-1&2
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

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

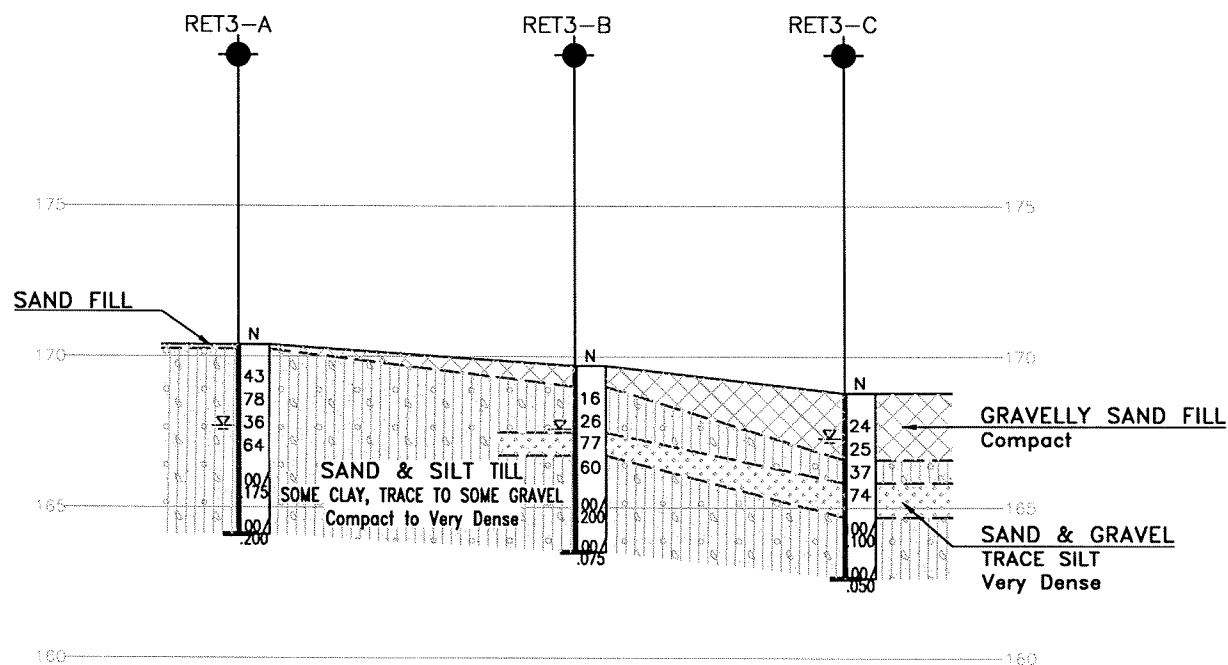
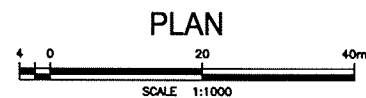
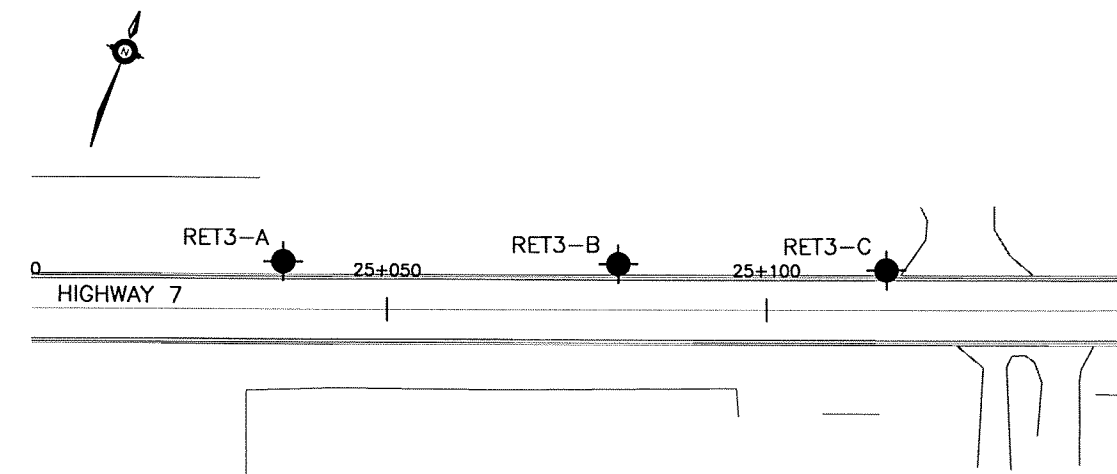
NO	ELEVATION	NORTHING	EASTING
RET1-A	157.8	4 866 348.4	342 250.2
RET1-B	158.5	4 866 353.8	342 267.8
RET1-C	158.8	4 866 355.8	342 275.9
RET2-A	172.8	4 866 762.4	343 476.8
RET2-B	172.6	4 866 776.2	343 518.0
RET2-C	172.4	4 866 785.2	343 543.0

-NOTES-

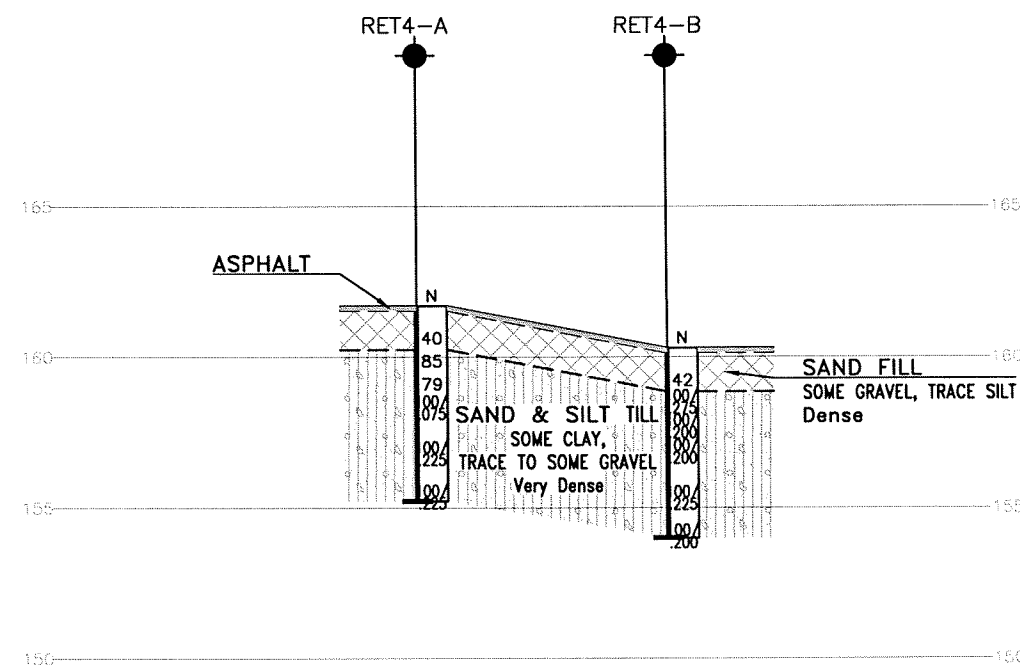
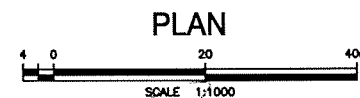
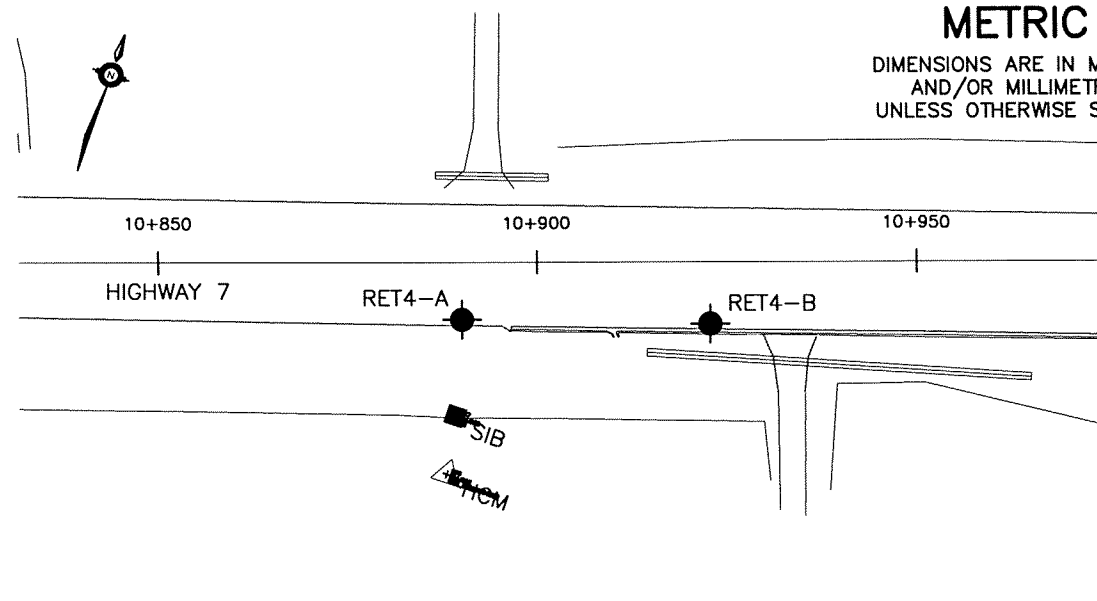
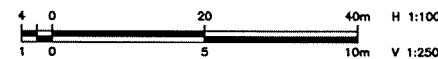
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 30M14-320

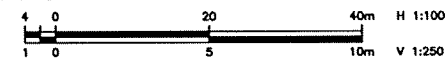
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DEE	CHK PKC	CODE
DRAWN	MFA	CHK AEG	SITE
			STRUCT
			DATE
			NOV. 2009
			DWG 8



PROFILE RETAINING WALL RET-3



PROFILE RETAINING WALL RET-4



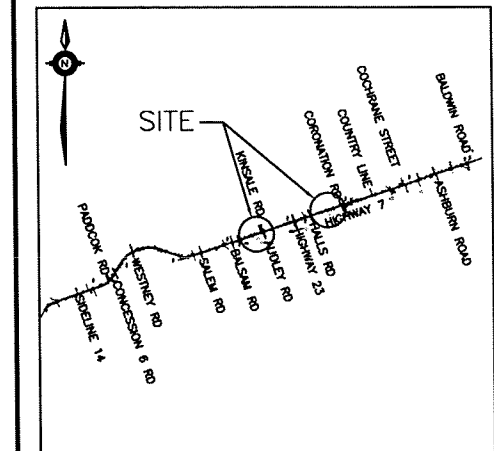
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HIGHWAY 7
CONT No
GWP No 2075-08-00

HWY 7
BROCK STREET TO HWY 12
RETAINING WALL RET-3&4
BOREHOLE LOCATIONS AND SOIL STRATA

MMM GROUP

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

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

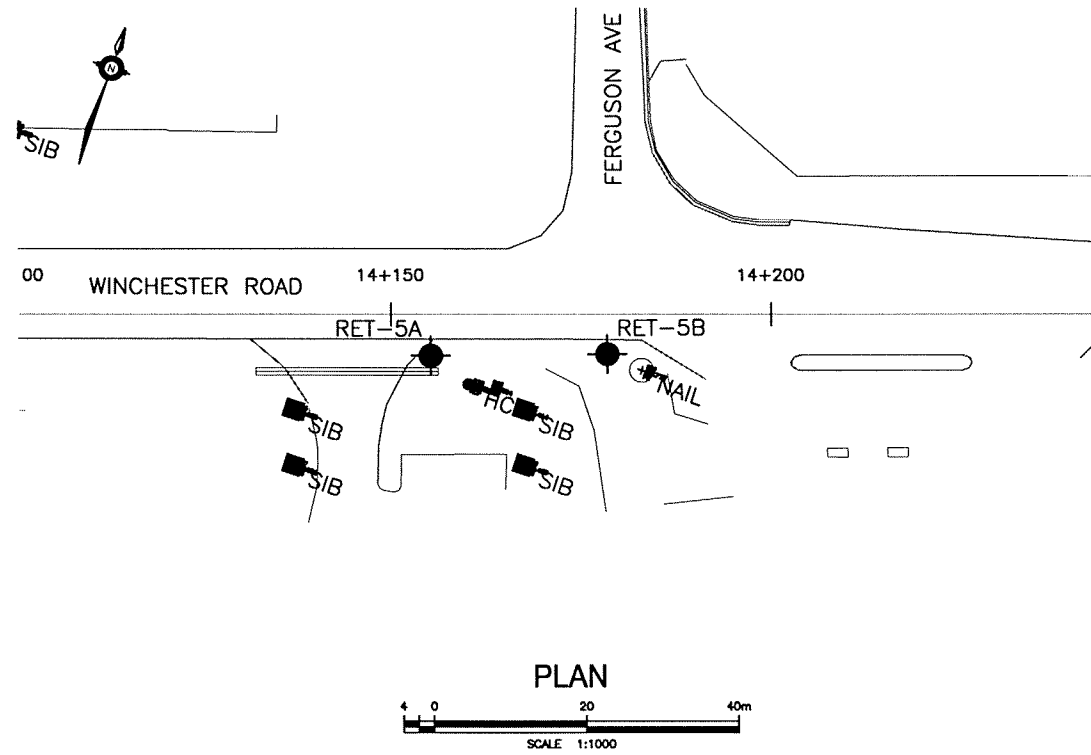
NO	ELEVATION	NORTHING	EASTING
RET3-A	170.4	4 866 476.3	342 591.8
RET3-B	169.7	4 866 490.8	342 633.5
RET3-C	168.8	4 866 501.9	342 667.0
RET4-A	161.7	4 867 088.6	344 421.0
RET4-B	160.3	4 867 098.8	344 452.1

-NOTES-

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

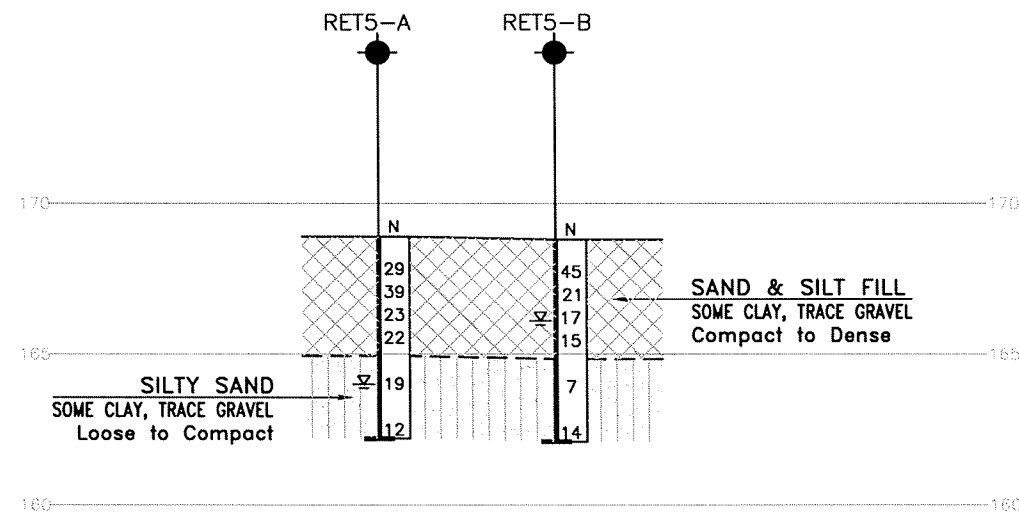
GEOCREs No. 30M14-320

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	DEE	CHK PKC	CODE
DRAWN	MFA	CHK AEG	SITE
			LOAD
			DATE
			NOV. 2009
			DWG 9

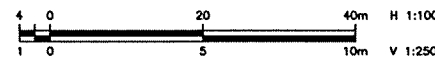


PLAN

SCALE 1:100

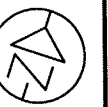


PROFILE RETAINING WALL RET-5

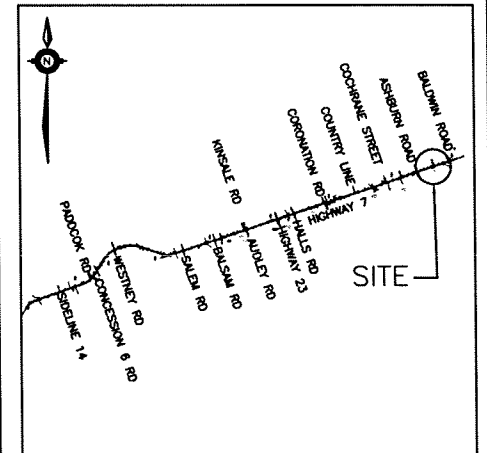


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HIGHWAY 7
CONT No
GWP No 2075-08-00








SHEET



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

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
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GEOCRES No. 30M14-320

[illegible]