FOUNDATION INVESTIGATION AND DESIGN REPORT
BRONTE ROAD DEEP CUTS
QEW WIDENING, THIRD LINE TO BURLOAK
G.W.P. 169-00-00

Geocres Number: 30M5 - 254

Report to

McCormick Rankin Corporation

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

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of deep cuts associated with the proposed interchange between QEW and realigned Bronte Road in Oakville, 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 plans, records of boreholes, 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 in the course of the present and previous investigations.

A previous foundation investigation was carried out by Thurber Engineering Ltd. for a proposed bridge structure at this site. The factual data from that earlier investigation has been incorporated in the preparation of this report.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 2005-A-000346.

2 SITE DESCRIPTION

The deep cuts are located on the tableland just east of the Bronte Creek valley. The creek valley is incised up to approximately 28 m below the surrounding tableland. The valley slopes are steep and are formed into shale bedrock. On the tableland, shale is also present underneath overburden soils or fill (under the existing QEW roadway) at shallow depth. It appears that drainage at the site flows towards Bronte Creek, which flows southward to Lake Ontario.

On the north side of the site (north of QEW), the terrain is largely flat with the ground surface varying between Elevations 121 m and 122 m. The ground surface then drops in the order of 4 m to 5 m towards the QEW at approximate Elevation 117 m. On the south side (south of QEW), the terrain is slightly undulating but generally slopes downward towards the southerly portion of Bronte Road situated at about Elevation 108 m. Vegetation is moderate consisting mainly of tall grass, shrubs and occasional small trees.

The project area appears to be located adjacent to the shoreline of the glacial Lake Iroquois. From published geological information, this area is situated at the border between a physiographic region known as the Peel Plain to the north and Iroquois Plain to the south. In this area, the relatively thin native soil deposits typically consist of cohesive soils (some tills) overlying shale bedrock of the Queenston Formation. The till is known to consist of shale and limestone fragments. Wave action in the glacial lake modified the original ground moraine and lacustrine deposits in the form of stratified silts and sands are present at locations along the shoreline of the glacial lake.

Immediately south of the QEW, the land has been developed for commercial uses, principally a car dealership and a hotel. A short distance to the north of the QEW, the land has been developed for the Region of Halton Municipal Headquarters Complex. To the east of the complex lies open space and a golf course, while to the west is the Bronte Creek valley and Bronte Creek Provincial Park.

Photographs of the site are included in Appendix E.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing used to describe the stratigraphy in the area of the deep cuts was carried out in two phases. Investigation was conducted for the deep cuts in the period November 3 to November 30, 2006. Borehole data obtained in an earlier investigation for the QEW/Bronte Road Interchange structure was also used. These boreholes were drilled in the period June 12 to June 19, 2006. A total of twenty two boreholes were considered in the preparation of the stratigraphic description of the site. The approximate locations of all of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix D.

A combination of hollow-stem auger drilling and diamond coring techniques were used to advance the boreholes. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils. Since Queenston shale bedrock occurs at shallow depth across the site, all boreholes were taken to bedrock, or inferred bedrock. Eleven of the boreholes were terminated after SPT sampling showed that the top of the bedrock had been reached. In three of the boreholes, bedrock was proved by coring for depths ranging from 3.1 to 4.4 m. In the remaining eight boreholes, the bedrock was cored for depths ranging between 5.2 and 8.4 m in order to obtain a stratigraphic profile to the full depth of excavation of the road cuts.

Groundwater conditions in the open boreholes were observed throughout the drilling operations and standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen were installed in nine of the boreholes to permit longer term groundwater level monitoring. The locations and completion details of the piezometers are shown in Table 3.1. The boreholes in which no piezometers were installed were grouted with bentonite or backfilled with cuttings when the boreholes were less than 3.0 m deep. The borehole completion details are shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Location	Piezometer Tip Depth/ Elevation (m)	Completion Details
EN-1	None installed	Bentonite grout for full depth
EN-2	4.6/116.5	Sand from 4.6 to 2.6, bentonite grout to 0.9, cuttings to surface
EN-3	9.4/112.2	Sand from 9.4 to 6.7, bentonite grout to 0.2, cuttings to surface
EN-4	None installed	Bentonite grout and drill cuttings to surface
SW-1	None installed	Bentonite grout for full depth
SW-2	None installed	Bentonite grout to surface
SW-3	None installed	Bentonite grout for full depth
SW-4	None installed	Backfilled with drill cuttings to surface
NW-1	None installed	Bentonite grout to surface
NW-2	6.2/115.4	Sand from 6.2 to 4.0, bentonite grout to 0.9, cuttings to surface
NWC-1	9.2/113.0	Sand from 9.2 to 6.7, bentonite grout to surface
NWC-2	4.6/117.2	Sand from 4.6 to 2.6, bentonite grout to surface
NWC-3	9.2/112.6	Sand from 9.2 to 6.9, bentonite grout to surface
NWC-4	None installed	Bentonite grout and drill cuttings to surface
BR-1	None installed	Bentonite grout for full depth
BR-2	12.2/109.6	Sand from 12.2 to 10.1, bentonite grout to surface
BR-3	None installed	Bentonite grout and drill cuttings to surface
BR-4	12.0/109.2	Sand from 12.0 to 10.1, bentonite grout to surface
BR-5	7.6/105.4	Sand from 7.6 to 5.8, bentonite grout to surface
06-2	None installed	Bentonite grout for full depth
06-4	None installed	Bentonite grout for full depth
06-14	None installed	Backfilled with drill cuttings to surface

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

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

4 LABORATORY TESTING

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

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil and rock stratigraphy are presented in that appendix and on the "Borehole Locations and Soil

Strata" drawing in Appendix D. 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 silty clay, sand, lower silty clay and clay till overlying Queenston Shale bedrock. Topsoil and fill were also encountered at the surface.

5.1 Bronte Road

The interpretation of the subsurface conditions along Bronte Road was based on Boreholes BR1, BR2, BR3, BR4, BR5, 06-2, 06-4 and 06-14.

Along the alignment of Bronte Road north of QEW, the stratigraphy consists of topsoil and minor fill, silty clay, silty sand, a lower silty clay and silty clay till, all overlying Queenston Shale bedrock.

Under existing QEW, the pavement structure overlay Queenston Shale Bedrock.

South of the existing QEW, the stratigraphy consisted of silty clay or fill overlying Queenston Shale bedrock.

5.1.1 Topsoil

Reference should be made to Table 5.1 for the thicknesses of topsoil in Boreholes BR1, BR2, BR3, BR4 and BR5.

Topsoil thickness may vary between and beyond the boreholes.

5.1.2 Asphalt and Concrete

As part of the existing pavement structure, asphalt was encountered in the two boreholes drilled on the QEW and concrete was encountered below the asphalt in one of the boreholes. The asphalt thickness ranged between 175 and 190 mm, and the concrete thickness was 140 mm as shown below.

Borehole	Asphalt Thickness (mm)	Concrete Thickness (mm)
06-4	190	140
06-14	175	-

5.1.3 Fill

Fill was encountered below the asphalt and/or concrete, and immediately above shale in the two boreholes located on the QEW. The fill grading is sand and gravel, and is visually classified as a 19 mm crusher run limestone. The thickness of the fill ranges from 0.4 m to 0.7 m. The fill is largely in a compact state.

A further pocket of loose sand fill was encountered on the new Bronte Road alignment, in Borehole BR-2. This fill was 600 mm thick and underlay 150 mm of topsoil.

South of the QEW, on the new Bronte Road alignment, Borehole BR-5 encountered fill underlying 50 mm of topsoil. The fill consisted of firm to very stiff silty clay. On the deep cut alignment south of QEW, the fill is identified as lying directly on the shale bedrock. The measured moisture contents in this fill ranged from 15 to 19%.

5.1.4 Silty Clay

From Sta 9+770 to Sta 9+880, the silty clay is approximately 0.6 m thick and the base elevation varies from 121.0 to 121.2. From Sta 9+880 to 9+940, the thickness of the clay layer increases to approximately 2 m and the elevation of the underside of the layer lies at approximately 119.0.

The clay is firm to stiff, brown and the natural moisture content ranges from 10 to 22%.

The grain size distribution of the silty clay is represented by the data plotted in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figures B8 to B10 show that soil to be low plasticity.

5.1.5 Silty Sand

The silty clay is underlain by a layer of silty sand that varies in thickness from 0.7 to 1.5 m, with the base of the layer at Elevation 118.2 to 120.5.

The silty sand is in a compact state, based on SPT values ranging from 16 to 22 blows for 0.3 m of penetration. The silty sand is described as brown, moist, with the natural moisture content ranging from 10 to 19%.

The grain size distribution of the sand is plotted in Figure B5.

5.1.6 Lower Silty Clay

A lower deposit of silty clay, similar to the upper layer, lies below the silty sand. About Sta 9+770, the silty clay layer is approximately 1.5 m thick but the thickness decreases with increasing chainage until it has pinched out by Sta 9+940. The base of this layer lies between Elevation 118.3 and 118.9.

The clay is stiff to very stiff, brown to grey and the natural moisture content ranges from 19 to 21%.

The grain size distribution of the silty clay is represented by the data plotted in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figure B8 show that soil to be low plasticity.

5.1.7 Silty Clay Till

Below the lower layer of silty clay the boreholes encountered silty clay till. It should be noted that the transition between the two soil types is gradual and no distinct boundary may be observable in the field. This layer is approximately 1.1 to 1.6 m thick and the base of the layer lies at Elevation 116.7 to 117.7.

The silty clay till is stiff to very stiff, reddish brown to brown to grey and the natural moisture content ranges from 15 to 19%.

The till may contain cobbles, boulders or rock slabs.

The grain size distribution is represented by the data plotted in Figure B6 in Appendix B. The results of Atterberg limit testing, as plotted in Figure B7 show that soil to be low plasticity.

5.1.8 Bedrock

The soils described above are underlain by Queenston Shale bedrock. A general description of the shale bedrock, with layers of siltstone and limestone is presented later in this section and the bedrock elevations are presented in Table 5.1.

5.2 Ramp S – W

The interpretation of the subsurface conditions along the Ramp S – W. is based on Boreholes BR4, SW1, SW2, SW3, and SW4.

Along the alignment of Ramp S - W, the stratigraphy consists of topsoil and minor fill, silty clay, silty sand, a lower silty clay and silty clay till, all overlying Queenston Shale bedrock.

5.2.1 Topsoil

Reference should be made to Table 5.1 for the thicknesses of topsoil in Boreholes SW1, SW2, SW3, SW4 and BR4.

Topsoil thickness may vary between and beyond the boreholes.

5.2.2 Silty Clay

The thickness of the silty clay varied from approximately 2 m near Sta 9+570 to 0.6 m further round the ramp until it pinched out about Sta 9+800 and the base elevation varies from 119.0 to 120.8.

The clay is stiff to hard, brown and the natural moisture content ranges from 10 to 21%.

The grain size distribution of the silty clay is represented by the data plotted in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figures B8 to B10 show that soil to be low plasticity.

5.2.3 Silty Sand

The silty clay is underlain by a layer of silty sand that varies in thickness from 0.5 to 0.7 m, with the base of the layer at Elevation 118.2 to 120.3.

The silty sand is in a compact state, based on SPT values ranging from 11 to 25 blows for 0.3 m of penetration. The silty sand is described as brown, moist, with the natural moisture content ranging from 15 to 20%.

The grain size distribution of the sand is plotted in Figure B5.

5.2.4 Lower Silty Clay

A lower deposit of silty clay, similar to the upper layer, lies below the silty sand for part of the length of the ramp. From the start of the ramp to about Sta 9+600, the lower silty clay is absent. From Sta 9+600 to beyond Sta 9+800 the silty clay layer is approximately 0.8 to 1.6 m thick. The base of this layer lies between Elevation 118.6 and 119.0.

The clay is stiff to hard, brown and the natural moisture content ranges from 19 to 21%.

The grain size distribution of the silty clay is represented by the data plotted in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figure B10 show that soil to be low plasticity.

5.2.5 Silty Clay Till

Below the lower layer of silty clay or the silty sand, the boreholes encountered silty clay till. It should be noted that the transition between the two soil types is gradual and no distinct boundary may be observable in the field. This layer is approximately 0.4 to 2.6 m thick, though it is pinched out by Sta 9+800, and the base of the layer lies at Elevation 116.7 to 118.6.

The silty clay till is very stiff to hard, reddish brown to brown to grey and the natural moisture content ranges from 12 to 19%.

The till may contain cobbles, boulders or rock slabs.

The grain size distribution is represented by the data plotted in Figure B7 in Appendix B. The results of Atterberg limit testing, as plotted in Figure B10 show that soil to be low plasticity.

5.2.6 Bedrock

The soils described above are underlain by Queenston Shale bedrock. A general description of the shale bedrock, with layers of siltstone and limestone is presented later in this section and the bedrock elevations are presented in Table 5.1.

5.3 Ramp E – N/S

The interpretation of the subsurface conditions along the Ramp E – N/S is based on Boreholes BR2, EN1, EN2, EN3 and EN4.

The predominant soil type encountered along this ramp is silty clay. This soil is partially overlain by silty sand, upper silty clay and fill. The main silty clay stratum is underlain by silty clay till, followed by Queenston Shale bedrock.

5.3.1 Topsoil

Reference should be made to Table 5.1 for the thicknesses of topsoil in Boreholes EN1, EN2, EN3, EN4 and BR2.

Topsoil thickness may vary between and beyond the boreholes.

5.3.2 Fill

A minor pocket of loose to compact sand fill was encountered around Sta 10+700.

5.3.3 Silty Clay

A small pocket of silty clay was encountered below the topsoil in Borehole EN4, around Sta 10+660.

The clay is firm, brown and the natural moisture content is 21%.

The grain size distribution of the silty clay is represented by the data plotted in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figures B8 to B10 show that soil to be low plasticity.

5.3.4 Silty Sand

The silty clay is underlain by a layer of silty sand from Sta 10+550 to beyond Sta 10+700. The thickness of the layer ranges from 0.5 to 1.0 m until it pinches out close to Sta 10+550. The base of the layer lies at Elevation 120.1 to 121.0.

The silty sand is in a loose to compact state, based on SPT values ranging from 6 to 30 blows for 0.3 m of penetration. The silty sand is described as brown, moist, with the natural moisture content ranging from 15 to 19%.

The grain size distribution of the sand is plotted in Figure B5.

5.3.5 Lower Silty Clay

A deposit of silty clay was encountered under the silty sand and upper silty clay for the entire length of the ramp. The thickness of this layer ranges from 1.3 to 2.2 m and the base of the layer lies between Elevation 118.1 and 119.2.

The clay is firm to very stiff, brown to grey and the natural moisture content ranges from 16 to 23%.

The grain size distribution of the silty clay is represented by the data plotted in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figure B7 show that soil to be low plasticity.

5.3.6 Silty Clay Till

The silty clay is underlain by silty clay till from Sta 10+600, approximately, to beyond Sta 10+700. It should be noted that the transition between the two soil types is gradual and no distinct boundary may be observable in the field. This layer is approximately 1.0 to 1.4 m thick, though it is pinched out by Sta 10+600, and the base of the layer lies at Elevation 117.5 to 117.9.

The silty clay till is stiff to very stiff, reddish brown to grey and the natural moisture content ranges from 15 to 16%.

The grain size distribution is represented by the data plotted in Figure B6 in Appendix B. The results of Atterberg limit testing, as plotted in Figure B9 show that soil to be low plasticity.

5.3.7 Bedrock

The soils described above are underlain by Queenston Shale bedrock. A general description of the shale bedrock, with layers of siltstone and limestone is presented later in this section.

5.4 Ramp N – W

The interpretation of the subsurface conditions along Ramp N – W is based on Boreholes NW1, NW2, NWC1 NWC2, NWC3 and NWC4.

Along the alignment of Ramp N - W, the stratigraphy consists of topsoil, silty clay, silty sand, a lower silty clay and a pocket of silty clay till, all overlying Queenston Shale bedrock.

5.4.1 Topsoil

Reference should be made to Table 5.1 for the thicknesses of topsoil in Boreholes NW1, NW2, NWC1, NWC2, NWC3 and NWC4.

Topsoil thickness may vary between and beyond the boreholes.

5.4.2 Silty Clay

The thickness of the silty clay underlying the topsoil varied from 0.6 to 1.4 m and the base elevation varies from 120.1 to 121.6.

The clay is stiff to very stiff, brown and the natural moisture content is 10 to 23%.

The grain size distribution of the silty clay is represented by the data plotted in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figures B8 to B9 show that soil to be low plasticity.

5.4.3 Silty Sand and Sandy Silt

The silty clay is underlain by a layer of silty sand and sandy silt that varies in thickness from 0.6 to 1.5 m. The base of the layer lies at Elevation 119.4 to 120.0.

The silty sand is in a compact to dense state, based on SPT values ranging from 14 to 40 blows for 0.3 m of penetration. The silty sand is described as brown, moist, with the natural moisture content ranging from 15 to 21%.

The grain size distribution of the sand is plotted in Figure B5.

5.4.4 Lower Silty Clay

A deposit of silty clay was encountered under the silty sand and upper silty clay for the entire length of the ramp. The thickness of this layer ranges from 1.7 to 1.9 m and the base of the layer lies between Elevation 117.5 and 118.4.

The clay is very stiff to hard, brown to grey and the natural moisture content ranges from 15 to 20%.

The grain size distribution of the silty clay is represented by the data plotted in Figures B1 and B2 in Appendix B. The results of Atterberg limit testing, as plotted in Figures B8 and B9 show that soil to be low plasticity.

5.4.5 Silty Clay Till

The silty clay is underlain by silty clay till only in the vicinity of Borehole NWC1. It should be noted that the transition between the two soil types is gradual and no distinct boundary may be observable in the field. This layer is approximately 0.9 m thick and the base of the layer lies at Elevation 117.4.

The silty clay till is hard, brown and the natural moisture content ranges from 10 to 12%.

The till may contain cobbles, boulders and rock slabs.

The grain size distribution is represented by the data plotted in Figure B6 in Appendix B. The results of Atterberg limit testing, as plotted in Figures B8 and B9 show that soil to be low plasticity.

5.4.6 Bedrock

The soils described above are underlain by Queenston Shale bedrock. A general description of the shale bedrock, with layers of siltstone and limestone is presented later in this section and the bedrock elevations are presented in table 5.1.

5.5 Shale Bedrock

The overburden soils described above are underlain by weathered shale bedrock. In the boreholes outside of the QEW, the weathered shale was encountered at depths of between 1 m and 4 m below existing ground surface. On the QEW, the weathered shale was present immediately below the pavement structure at between 0.7 m and 0.9 m. Bedrock was proven by coring beyond the augered depth in Boreholes EN1, EN3, SW1, SW3, NWC1, NWC3, BR2, BR4, BR5, 06-2 and 06-4. The depth and elevation of the shale are summarized in Table 5.1.

Total core recovery in the bedrock was generally 100%, with only occasional values down to 91%. The RQD values generally ranged from 43% to 100% indicating poor to excellent rock quality. Parts of the Ramp E – N had RQD values down to 0%, indicating very poor quality rock. This range of values is typical is near surface Queenston Shale and reflects the variation between highly weathered shale and relatively unweathered limestone or siltstone stringers.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to >10. This range in the value of the Fracture Index is typical of the Queenston Shale and represents the contrast between the relatively fissile shale and the limestone and siltstone stringers.

The unconfined compressive strength of most of the rock cores is estimated to range between 1 and 39 MPa indicating very weak weathered shale to medium strong intact limestone and siltstone. These estimated rock strength values are based on point load tests that were conducted on rock cores recovered from the boreholes.

The sampling and testing conducted for this project have indicated that the bedrock is Queenston Shale. This deposit typically contains layers of siltstone and limestone that can be significantly harder than the shale itself, with unconfined compressive strengths in excess of 100 MPa being measured at some locations.

The results of the investigation indicate that the shale is moderately to highly weathered near the overburden contact and generally becomes less weathered and stronger with depth. The distribution, thickness and strength of the siltstone and limestone layers vary from location to location and these layers typically exhibit less pronounced weathering than the shale. This means that layers of strong to very strong siltstone or limestone may be encountered at or near the top of the bedrock deposit.

The Record of Borehole sheets indicate where siltstone or limestone layers were identified in the investigation. However, sampling and interpretation from small diameter boreholes may underestimate the frequency and strength of the strong layers within the rock mass and geological expertise and past experience must be applied in any decision making process regarding the bedrock.

Table 5.1

Borehole	Topsoil Thickness (mm)	Depth to Bedrock (m)	Bedrock Elevation
EN-1	100	1.5	119.2
EN-2	75	2.3	118.9
EN-3	75	3.6	118.1
EN-4	100	4.0	117.9
SW-1	100	3.8	117.7
SW-2	100	3.6	118.0
SW-3	200	2.7	118.6
SW-4	75	1.5	119.2
NW-1	125	3.9	117.7
NW-2	100	3.9	117.7
NWC-1	125	4.8	117.4
NWC-2	125	4.0	117.9
NWC-3	100	4.0	117.8
NWC-4	75	3.7	117.5
BR-1	150	4.3	117.7
BR-2	150	4.3	117.5
BR-3	100	4.5	117.2
BR-4	150	4.6	116.7
BR-5	50	2.3	110.7
06-2	50	1.0	112.5
06-4	(QEW)	0.7	116.6
06-14	(QEW)	0.9	115.9

5.6 Water Levels

Standpipe piezometers were installed in selected boreholes and water levels were measured on completion of drilling and shortly thereafter. The water level readings are presented in Table 5.2.

Based on these observations, local groundwater levels exist at Elevations 106.82 m to 120.10. All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

Table 5.2: Water Level Measurements

Date	November 10, 2006		December 8, 2006	
Borehole	Depth (m)	Elev. (m)	Depth (m)	Elev. (m)
EN2	3.56	117.64	2.00	119.20
EN3	4.05	117.65	3.24	118.46
NW2	3.58	118.02	3.41	118.19
NWC1	2.52	119.68	2.10	120.10
NWC2	4.10	117.80	3.41	118.49
NWC3	4.76	117.04	4.24	117.56
BR2	-	-	1.93	119.87
BR4	-	-	4.09	117.11
BR5	-	-	6.18	106.82

6 MISCELLANEOUS

The borehole locations were marked in the field by surveyors from J.D. Barnes Ltd. who also provided Thurber with the coordinates and geodetic elevations. Thurber obtained utility clearances prior to drilling.

DBW Drilling Limited of Ajax, Ontario, supplied the 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 of Thurber.

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

Mr. Murray Anderson, P.Eng. and Mr. Mark E. Farrant, P.Eng. directed the field operations.

The report was prepared by Mr. Alastair E. Gorman, P.Eng.

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

Thurber Engineering Ltd.

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

Report Reviewed by:
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 geotechnical design recommendations to assist the design team to design the deep cuts required as part of the project.

It is understood that QEW will be maintained at existing grade and that Bronte Road will be depressed under the QEW. At the north edge of the QEW, the Bronte Road grade will be as low as 11 to 12 m below existing ground level and rising towards the north.

The Ramp S – W will match the elevation of Bronte Road at the north edge of QEW and will spiral upward to the east and south to match the grade of QEW.

The Ramp E – N/S will exit from QEW and fall to meet Bronte Road in the cut section.

The Ramp N – W will exit Bronte Road in the cut section and run more-or-less at constant grades to meet the QEW.

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 and the previous investigation carried out for the bridge foundations.

Stability analysis has been carried out for selected critical sections in each cut using G-Slope, a computer program developed by Mitre Software, and using Bishop's method of analysis. The bedrock was assigned a mass shear strength of 500 kPa, which is considered to be a conservative value.

8 CUT SLOPES

All excavations to form the cut slopes must be carried out in accordance with the Occupation Health and Safety Act (OHSA). For the purposes of OHSA, the fill and silty sand at this site are classified as Type 3 soils. The silty clay and silty clay till are classified as Type 2 soils.

Short term excavations of moderate depth in the Queenston shale will generally be stable with near-vertical faces. However, the Queenston Shale is prone to weathering and on the longer term

steep slopes are expected to slough and ravel. Taking account of the properties of the shale, permanent slopes cut at 2H:1V are considered to be stable at heights of up to 15 m.

The design and construction of temporary slopes is the responsibility of the contractor but, typically, vertical slopes on Queenston shale up to 6 m high will be stable in the short term, e.g. for up to 1 month, depending on the time of year and the weather.

Vegetation cover should be established on all exposed soil and shale bedrock slopes to protect against surficial erosion. Reference may be made to the latest revision of OPSS 572 and related special provision(s) for more detailed requirements, where applicable.

8.1 Bronte Road

8.1.1 General

North of the QEW, the stratigraphy in the cut for Bronte Road consists of 4 to 5 m of fill, silty clay, silty sand and silty clay till overlying shale bedrock. The deep cut will fully penetrate the overburden and will cut up to 7 m into the underlying shale. South of the QEW, the cut will penetrate through 2 to 3 m of silty clay fill overlying the shale bedrock.

The greatest depth of cut and the least favourable stratigraphy, i.e. maximum depth of overburden, occur immediately north of the QEW, in the area represented by Borehole BR4. At this section, the cut face will consist of approximately 2 m of silty clay over 1 m of silty sand over 2.5 m of silty clay till over bedrock. The cut penetrates approximately 7 m into the shale. This section has been selected as the critical section for stability analysis.

8.1.2 Stability

The stability analysis output is included as Figure C1 in Appendix C and shows that for a cut slope of 2H:1V the factor of safety against failure is 1.3.

8.1.3 Recommended Geometry

The recommended slope geometry for the Bronte Road cut, to maximum height of 12.5 m, is a slope of 2H:1V for both the soil and the Queenston Shale bedrock.

8.2 Ramp S – W

8.2.1 General

The Ramp S –W exits from Bronte Road NB at the north of the QEW and the grade climbs to match that of QEW. The stratigraphy consists of 4 to 5 m of fill, silty clay, silty sand and silty clay till overlying shale bedrock. The deep cut will fully penetrate the overburden and will cut up to 7 m into the underlying shale.

The greatest depth of cut and the least favourable stratigraphy, i.e. maximum depth of overburden, occur immediately north of the QEW, in the area represented by

Borehole BR4. At this section, the cut face will consist of approximately 2 m of silty clay over 1 m of silty sand over 2.5 m of silty clay till over bedrock. The cut penetrates approximately 7 m into the shale. This section has been selected as the critical section for stability analysis and is the same section selected for Bronte Road analysis.

8.2.2 Stability

The same stability analysis conducted for Bronte Road is considered to apply to the Ramp S – W.

The stability analysis output is included as Figure C1 in Appendix C and shows that for a cut slope of 2H:1V the factor of safety against failure is 1.3.

8.2.3 Recommended Geometry

The recommended slope geometry for the Ramp S - W cut, to maximum height of 12.5 m, is a slope of 2H:1V for both the soil and the Queenston Shale bedrock.

8.3 Ramp E – N/S

8.3.1 General

Ramp E – N/S exits QEW and runs in an increasingly deep cut to intersect the Bronte Road cut in the vicinity of Borehole BR2. The stratigraphy consists of fill, silty clay, silty sand and silty clay till overlying shale bedrock. The deep cut will fully penetrate the overburden and will cut up to 4 m into the underlying shale.

The greatest depth of cut and the least favourable stratigraphy, in terms of maximum depth of overburden and highest groundwater level, occur at the intersection with Bronte Road, in the area represented by Borehole BR2. At this section, the cut face will consist of approximately 1.5 m of fill and sand over 1.4 m of silty clay over 1.4 m of silty clay till over bedrock. The cut penetrates approximately 4 m into the shale. This section has been selected as the critical section for stability analysis.

8.3.2 Stability

The stability analysis output is included as Figure C2 in Appendix C. When failure surface is forced into the 2H:1V slope, the calculated minimum factor of safety is 2.7. Otherwise, when the analysis runs without constraints, the results indicate only surficial ravelling.

8.3.3 Recommended Geometry

The recommended slope geometry for the Ramp S - W cut, to maximum height of 12.5 m, is a slope of 2H:1V for both the soil and the Queenston Shale bedrock.

8.4 Ramp N – W

8.4.1 General

The profile of Ramp N – W runs at a more-or-less constant elevation from Bronte Road to QEW. The required cut will fully penetrate the overburden and penetrate as much as 1 m into the bedrock. The maximum depth of cut is in the order of 5 m.

The greatest depth of cut and the least favourable stratigraphy, in terms of maximum depth of overburden and highest groundwater level, occur in the vicinity of Borehole NWC1. At this section, the cut face will consist of approximately 0.7 m of silty clay over 1.5 m of silty sand over 1.7 m of silty clay and 0.9 m of silty clay till over bedrock. The cut penetrates only nominally into the shale. This section has been selected as the critical section for stability analysis.

8.4.2 Stability

The stability analysis output is shown in Figure C3 in Appendix C. This results shows that for a cut slope of 2H:1V the minimum factor of safety in the analysis was 1.5.

8.4.3 Recommended Geometry

The recommended slope geometry for the Ramp N - W cut, to maximum height of 12.5 m, is a slope of 2H:1V for both the soil and the Queenston Shale bedrock.

9 EXCAVATION

9.1 General

All excavations must be carried out in accordance with the requirements of the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the silty clay and silty clay till may be classed as Type 2 soils. The fill and silty sand are classed as Type 3 soils.

Rock excavation must also be carried out in accordance with the most recent Special Provision amending OPSS 120. The bedrock at this site may contain hard layers and the Contractor must alerted to this fact. Suggested wording for inclusion in a NSSP is included in Appendix F.

9.2 Overburden

The excavations required at these sites will penetrate through a variety of overburden soils including fill, existing pavement, silty clay, silty sand and silty clay till. The soils, especially the silty clay till, may contain cobbles, boulders and slabs of rock.

The selection of the method of excavation is the responsibility of the contractor and must be based on his equipment, experience and interpretation of the site conditions. However,

from the point of view of assessing constructability, excavation by backhoes or by bulldozers and rippers is considered to be feasible.

9.3 Bedrock

The deep cuts described in this report will generally penetrate into the Queenston Shale bedrock.

The selection of the method of excavating and removing the bedrock is the responsibility of the contractor and the contractor is solely responsible for assessing the type, size and power rating of the required equipment. However, from the point of view of assessing constructability, the following points should be taken into consideration:

- The silty clay till grades into weathered bedrock and there is often not a distinct boundary between the two and, accordingly, excavation of the upper, more weathered layers of the bedrock may be similar to excavation of the overburden
- Notwithstanding the above, the bedrock becomes stronger with depth and contains numerous siltstone and limestone layers, as described on the Record of Borehole sheets, and these stronger layers may occur immediately below the overburden
- Excavation of the bedrock will become more arduous with increasing depth into the deposit and the contractor may have to employ specialized methods such as ripping, and pneumatic breaking to dislodge the rock
- Blasting may be considered by some contractors to be a desirable option to dislodge and loosen the bedrock and this is acceptable from a geotechnical point of view provided the blasts are of sufficiently low energy as not to loosen the rock that will form the final cut slope face
- The use of blasting may be limited, or prohibited, by the presence of buried utilities (especially the Halton Region feedermain), the proximity of highways, residences, businesses and institutional occupancies, or by the policies of agencies having jurisdiction.

9.4 Roadway Protection

If roadway protection will be required during construction, an item titled "Protection System" as per SP 105S19 should be included in the contract documents. It is recommended that Performance Level 2 as per Clause 539.04.02.01 and the alignment of the shoring be specified for this site.

The design of roadway protection should be the responsibility of the Contractor. However, one option that is considered to be suitable for use as temporary shoring at this site is a soldier pile and lagging wall. Due to the presence of shallow bedrock, the soldier piles will need to be installed through pre-drilled holes and socketted into bedrock in order to

develop the required fixity. It is anticipated that the shoring system may be stiffened by cross bracings, where applicable. Anchors may also be required at some locations and a maximum bond strength of 125 kPa may be assumed for pull-out design.

For a temporary braced soldier pile and lagging wall, the lateral pressure diagram as shown in Figure D1 in Appendix D may be used for design using the parameter values shown below.

γ	=	20 kN/m^3
γ_w	=	10 kN/m^3
K_a	=	0.31 (road embankment fill)
	=	0.33 (sandy silt to silty sand)
	=	0.37 (silty clay and clayey silt till, and weathered shale)
h_w	=	0 (assuming no hydrostatic pressure build-up behind a presumably permeable wall)
H	=	depth to base of excavation (rock surface) (m)

For rock sockets formed within the shale bedrock, the ultimate passive force that can be mobilized by the embedded portion of a pile is given by :

$$P_p = 6 \cdot c \cdot D \cdot L$$

where	c	=	300 kPa (equivalent Mohr-Coulomb cohesion based on Hoek and Brown rock mass classification)
	D	=	diameter of socket, m
	L	=	depth of socket in rock, m

The designer of the roadway protection system should check whether the socket is sufficiently deep to provide base fixity.

It should be pointed out that the actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall. These factors should also be considered when designing the shoring system. All shoring systems should be designed by a Professional Engineer experienced in such designs.

10 GROUNDWATER CONTROL AND DRAINAGE

Short term groundwater levels were recorded at depths of 2.0 to 6.2 m below ground surface. The recorded elevations of the groundwater ranged from 119.9 at the north (Borehole BR2) to 106.8 at the south (Borehole BR5). The elevations at intermediate points confirm that groundwater levels fall from north to south across the site and that groundwater flow is towards the south.

North of the QEW, the groundwater levels lie at or 1 m above the bedrock surface, with the exception of Borehole BR2 where the level is 2.4 m above the bedrock. South of the QEW, along the new Bronte Road alignment, the water level lies approximately 3 m below the top of bedrock.

10.1 Bronte Road

The proposed grade of Bronte Road will lie below the observed groundwater level from near the north end of the cut to a point just south of the existing QEW. Close to the north edge of QEW, the base of the cut will lie approximately 7 m below the observed groundwater level. Groundwater seepage will occur into the cut as excavation proceeds. It is expected that seepage will be gradual and will not impede excavation, but the water will accumulate in the low points in the excavation. Accordingly, gravity drainage or unwatering systems must be installed to allow work to continue in the dry.

The rate of seepage is expected to decrease over time as the local groundwater table is drawn down. However, some continuing seepage is expected in the long term and permanent drainage must be designed.

10.2 Ramp S – W

This ramp starts under the structure in the deep part of the Bronte Road cut and rises as it spirals east and south to the QEW. The proposed grade will be below the groundwater table for most of its length and seepage will occur into the cut as excavation proceeds. The depth below groundwater will be 6 to 7 m where the ramp exits from Bronte Road, diminishing as the ramp spirals up to meet QEW. It is expected that seepage will be gradual and will not impede excavation, but the water will accumulate in the low points in the excavation. Accordingly, gravity drainage or unwatering systems must be installed to allow work to continue in the dry.

The rate of seepage is expected to decrease over time as the local groundwater table is drawn down. However, some continuing seepage is expected in the long term and permanent drainage must be designed.

Short term drainage during construction could be accomplished by draining the water into a common system with the Bronte Road cut.

10.3 Ramp E – N/S

From a crest near QEW, this ramp slopes down into the Bronte Road cut at a maximum depth of more than 8 m. From the crest down to Bronte Road, the grade of this ramp will lie below the groundwater table observed during the investigation by 2 to 7 m and seepage will occur into the cut as excavation proceeds. It is expected that seepage will be gradual and will not impede excavation, but the water will accumulate in the low points in the excavation. Accordingly, gravity drainage or unwatering systems must be installed to allow work to continue in the dry.

The rate of seepage is expected to decrease over time as the local groundwater table is drawn down. However, some continuing seepage is expected in the long term and permanent drainage must be designed.

Short term drainage during construction could be accomplished by draining the water into a common system with the Bronte Road cut.

10.4 Ramp N – W

The Ramp N – W has a relatively flat proposed grade running approximately 5 m below the existing ground surface. The grade will be typically 1.0 to 3.0 m below the groundwater levels observed during the investigation. Some seepage will occur into the cut as excavation proceeds but it is expected to be less in this cut than in the other deeper cuts associated with the QEW/ Bronte Road Interchange. Gravity drainage back into the Bronte Road cut may be adequate, or the contractor may elect to use sumps and pumps to handle the inflow.

The rate of seepage is expected to decrease over time as the local groundwater table is drawn down. However, some continuing seepage is expected in the long term and permanent drainage must be designed.

10.5 Construction Drainage

Prior dewatering of the site is not considered necessary but groundwater seepage is expected to enter the open excavation, which may have to be unwatered to allow construction to proceed in the dry.

The design of the groundwater control system is the responsibility of the Contractor. However, suitable systems that might be considered include:

- Constructing the permanent outlet from the low point in the Bronte Road cut and excavating the remainder of the cuts from that point and utilizing gravity drainage
- pumping from sumps excavated at intervals in the base of the excavations.

In either case, the drainage/unwatering system design must take account of all MOE/MNR requirements regarding, among other things, taking water, discharging water and the turbidity of the discharge.

10.6 Permanent Drainage

Permanent drainage will be required to remove groundwater seeping from the cut slopes and from the subgrade.

Assuming an urban cross-section, this drainage may be achieved by means of longitudinal subdrains leading to a suitable gravity outlet or to a pump station. Due to the fact that the subgrade will generally be below the original groundwater table, it is recommended that drains be installed on both sides of the roadways.

If seepage occurs from the silty sand layer and causes sloughing of the surface soils, provision should be made in the contract quantities for the application of gravel sheeting.

11 SEISMIC CONSIDERATIONS

11.1 Seismic Design Parameters

The site is treated as lying in Seismic Zone 1. 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

11.2 Liquefaction Potential

The stratigraphy at the deep cuts consists essentially of silty clay, silty clay till and silty sand overlying the shale bedrock. The silty sand is generally above the observed groundwater level.

Based on the observed stratigraphy and groundwater conditions, there is not considered to be any potential for liquefaction of the deep cut slopes at this site under a seismic event.

12 CONSTRUCTION CONCERNS

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

1. Excavation difficulties

The shale bedrock encountered at this site typically contains layers of strong (> 50 MPa strength) or very strong (> 100 MPa strength) limestone or siltstone. The hard layers can cause problems in excavating the bedrock or in maintaining alignment of bored or driven installations.

The contract documents must contain a NSSP or other warning to alert the Contractor to this possibility and alert him to the fact that the provision of suitable equipment must be included in his bid. Some suggested wording is included in Appendix F.

2. Control of groundwater seepage during construction

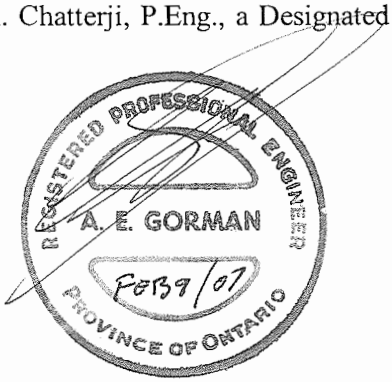
Groundwater is expected to seep into the excavation during the course of construction. The Contractor must be alerted to the expected seepage. Accordingly the contract documents must reference OPSS 902 and 902SP01.

13 CLOSURE

Engineering analysis and preparation of the report were carried out by 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.,
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[(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

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

$\underline{\nabla}$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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

UNIFIED SOILS CLASSIFICATION

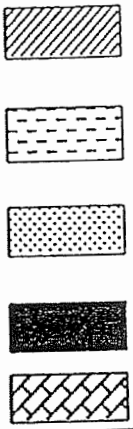
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

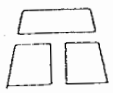
Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

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

STRENGTH CLASSIFICATION

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



Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BR1 1 OF 1 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 999.17 E 285 188.78 ORIGINATED BY GA

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 29.11.06 - 29.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
122.0							122				
0.0	TOPSOIL: (150 mm)										
0.2	Silty **CLAY**, sandy, trace gravel, occasional rootlets Firm		1	SS	5			○	○		
121.2	Reddish Brown										
0.8	**SAND**, some gravel, trace silt Compact Brown Damp to Moist		2	SS	17		121	○	○		
120.5											
1.5	Silty **CLAY**, trace sand Stiff Brown (CL)		3	SS	11			○	○		0 1 63 36
2.1	Sand layer at 2.13 to 2.36 m						120				
119.6											
2.4			4	SS	8			⊣●⊢	⊣●⊢		0 4 74 21
118.9											
3.0	Silty **CLAY**, trace to some sand, trace gravel Stiff Brown (TILL)		5	SS	12		119	○	○		0 4 77 20
117.7							118				
4.3	Highly weathered, thinly bedded, reddish brown, **SHALE**										
117.3	Hard		6	SS	50/			○	○		
4.7	END OF BOREHOLE AT 4.70 m. BOREHOLE OPEN TO 4.70 AND WATER LEVEL AT 1.07 UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				.125						

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

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BR2 1 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 973.11 E 285 243.69 ORIGINATED BY GA

HWY QEW BOREHOLE TYPE Solid Stem Auger/HQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 29.11.06 - 29.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.8											
0.0	**TOPSOIL** (150mm)										
0.2	**SAND**, trace silt, occasional rootlets, Loose, Brown, Moist		1	SS	6				○		
121.0	(FILL)						121				
0.8	**SAND**, some gravel, trace silt, Compact, Brown, Moist		2	SS	22				○		
120.2											
1.5	Silty **CLAY**, trace sand, Very Stiff, Brown, (CL)		3	SS	22		120		○		0 4 76 20
			4	SS	17				⊢●		0 2 74 25
118.9							119				
2.9	Silty **CLAY**, some sand to sandy, trace gravel, Very Stiff, Reddish brown, (TILL)		5	SS	25				○		2 12 58 28
117.5							118				
4.3	Highly to Moderately weathered, thinly bedded, reddish brown, very weak, **SHALE**, with greenish grey limestone interbeds		6	SS	50/.050				○		FI
	Limestone interbeds at 4.62 to 4.82, and 5.39 to 5.46 m		1	RUN			117				>10 0
	Rubble zones at 4.62 to 4.80, and 5.26 to 5.33 m										>10 2
115.7							116				
6.1	Becoming slightly weathered to fresh, weak to medium strong		2	RUN							0 0 0 1 2
	Limestone interbeds at 6.14 to 6.17, 6.20 to 6.25, 6.30 to 6.35, 6.65 to 6.71, 6.86 to 6.91, and 6.99 to 7.04 m						115				
	Rubble zones at 7.67 to 7.72, and 7.85 to 7.90 m		3	RUN			114				1 >10 1 1 1
	Limestone interbeds at 7.87 to 7.92, 8.33 to 8.38, 8.51 to 8.56, 8.66 to 8.69, 8.79 to 8.84, and 8.94 to 8.99 m										
	Limestone interbeds at 9.12 to 9.24, 9.80 to 9.85, and 10.13 to 10.21 m		4	RUN			113				0 0 0
							112				0

RUN 1# TCR=100%, SCR=84%, RQD=70%

RUN 2# TCR=100%, SCR=100%, RQD=88%, UCS=29MPa

RUN 3# TCR=100%, SCR=97%, RQD=93%, UCS=12MPa

RUN 4# TCR=100%, SCR=100%, RQD=100%, UCS=8MPa

Continued Next Page

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

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BR2 2 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 973.11 E 285 243.69 ORIGINATED BY GA

HWY QEW BOREHOLE TYPE Solid Stem Auger/HQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 29.11.06 - 29.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60		GR SA SI CL
										0	
										0	
							111			0	RUN 5# TCR=100%, SCR=100%, RQD=100%, UCS=14MPa
	Limestone interbeds at 10.97 to 11.00, 11.07 to 11.18, 11.28 to 11.30, 11.45 to 11.48, 11.73 to 11.76, and 12.02 to 12.17 m		5	RUN						0	
							110			0	
109.6										0	
12.2	END OF BOREHOLE AT 12.17 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 08.12.06 1.93 119.87										

+ 3 , × 3 Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BR3 1 OF 1 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 936.05 E 285 279.08 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 03.11.06 - 03.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.7											
0.0	TOPSOIL: (100 mm)										
0.1	Silty **CLAY** mixed with **TOPSOIL** Firm Brown		1	SS	6				○		
121.0							121				
0.7	**SAND**, some silt, trace gravel Compact Brown Wet		2	SS	22				○		
119.5			3	SS	16		120		○		
2.2	Silty **CLAY**, trace sand Stiff Grey (CL)		4	SS	14		119		○		0 2 79 19
118.3			5	SS	21				⊢⊣		
3.4	Silty **CLAY**, some sand to sandy, trace gravel Very Stiff Grey (TILL)						118				
117.2											
4.5	Highly weathered, thinly bedded,										
116.9	reddish brown, **SHALE**		6	SS	50/		117		○		
4.8	Hard				.075						
	END OF BOREHOLE AT 4.79 m. BOREHOLE OPEN TO 4.79 m AND WATER LEVEL AT 3.58 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9 m AND DRILL CUTTINGS TO SURFACE.										

+ 3, × 3 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BR4 1 OF 2 METRIC

G.W.P. 169-00-00 | LOCATION QEW, Third Line to Burloak Drive N 4 807 910.06 E 285 323.10 | ORIGINATED BY GA
HWY QEW | BOREHOLE TYPE Solid Stem Auger/HQ Core Barrel | COMPILED BY MFA
DATUM Geodetic | DATE 29.11.06 - 29.11.06 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.2											
0.0	**TOPSOIL**: (150 mm)										
0.2	Silty **CLAY**, some sand, trace gravel Stiff Brown (CL)		1	SS	9		121				
			2	SS	9		120				
			3	SS	11						0 3 70 27
119.0							119				
2.3	**SAND**, trace silt, trace gravel Compact Brown Damp to Moist		4	SS	17						
118.2							118				
3.0	Silty **CLAY**, some sand to sandy, trace gravel Very Stiff Reddish Brown (TILL)(CL)		5	SS	27	▼					6 18 53 22
116.7							117				
4.6	Highly weathered, thinly bedded, reddish brown, very weak to weak, **SHALE**, with greenish grey limestone interbeds		6	SS	50/.075		116				
115.1			7	SS	50/.075		115			FI	
6.1	Becoming moderately to slightly weathered, weak to medium strong Rubble zone from 6.17 to 6.22 m Limestone interbeds at 6.22 to 6.25, 6.30 to 6.32, 6.38 to 6.47, and 7.30 to 7.32 m		1	RUN						>10 3 2 3 3	RUN 1# TCR=100%, SCR=90%, RQD=75%, UCS=20MPa
	Limestone interbeds at 7.94 to 8.08, 8.15 to 8.21, 8.25 to 8.27, 8.33 to 8.43, and 8.79 to 8.84 m		2	RUN			114			2 1 1 1	RUN 2# TCR=100%, SCR=96%, RQD=96%, UCS=32MPa
112.2							113			0	
9.1	Becoming fresh									0	RUN 3# TCR=100%, SCR=100%, RQD=100%, UCS=22MPa
	Limestone interbeds at 9.77 to 9.85.		3	RUN			112			1 0	

Continued Next Page

+ ³, × ³ : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BR4 2 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 910.06 E 285 323.10 ORIGINATED BY GA
HWY QEW BOREHOLE TYPE Solid Stem Auger/HQ Core Barrel COMPILED BY MFA
DATUM Geodetic DATE 29.11.06 - 29.11.06 CHECKED BY MEF

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	10.38 to 10.40, 10.43 to 10.46, and 10.54 to 10.59 m						111			0	
										0	
	Limestone interbeds at 10.59 to 10.61, 10.65 to 10.67, 10.87 to 10.92, and 11.45 to 11.60 m		4	RUN			110			0	RUN 4# TCR=100%, SCR=100%, RQD=100%, UCS=7MPa
109.2										0	
										0	
12.0	END OF BOREHOLE AT 12.02 m. BOREHOLE OPEN TO 12.02m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 08.12.06 4.09 117.11										

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

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BR5 1 OF 1 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 779.54 E 285 403.30 ORIGINATED BY GA

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 28.11.06 - 28.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.0											
0.0	**TOPSOIL**: (50 mm)						113				
	Silty **CLAY**, trace to some sand, trace gravel, occasional rootlets Firm to Very Stiff Brown to Reddish Brown (FILL)		1	SS	5						
			2	SS	24		112				
			3	SS	13						
110.7							111				
2.3	Highly to moderately weathered, thinly bedded, reddish brown, very weak to weak, **SHALE**, with greenish grey limestone interbeds		4	SS	25						
			5	SS	50/.150		110				
							109				
	Limestone interbeds at 4.90 to 4.93, 5.21 to 5.24, and 5.89 to 5.97 m		1	RUN			108			FI >10 >10	RUN 1# TCR=100%, SCR=85%, RQD=63%
	Rubble zones at 4.57 to 4.70, 4.93 to 4.98, and 5.51 to 5.56 m									>10 3	
106.9										2	
6.1	Becoming moderately to slightly weathered Limetone interbeds at 6.35 to 6.40m, 6.70 to 6.73m, 7.60 to 7.63m Rubble zone at 6.78 to 6.81 m		2	RUN		▽	107			2 1 >10	RUN 2# TCR=100%, SCR=97%, RQD=75%, UCS=5MPa
							106			1	
105.4										3	
7.6	END OF BOREHOLE AT 7.62 m. BOREHOLE OPEN TO 7.62 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 08.12.06 6.18 106.82										

ONTMT4S 5127A.GPJ 15/12/06

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-2 1 OF 1 METRIC

W.P. 169-00-00 LOCATION N 4 807 834.0 E 285 390.6 (Bronte) ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Rock Coring COMPILED BY JHL

DATUM Geodetic DATE 12.06.06 - 12.06.06 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.4											
0.0 / 0.0	**TOPSOIL**: (50 mm)										
	Silty **CLAY**, trace sand seams, topsoil stained, trace roots and rootlets Firm Dark Brown Moist		1	SS	5		113		○		
112.5											
1.0	**SHALE**, weathered, with grey siltstone layer Reddish Brown		2	SS	27		112		○		
			3	SS	97/ .275				○		
111.1			4	SS	50/ .075		111		○		
2.4	**SHALE BEDROCK**, moderately to slightly weathered, fine grained, thinly bedded, reddish brown, with frequent grey strong **LIMESTONE** interbeds, and occasional clay seams Silt seam (50 mm) at 3.23 m Clay seam (50 mm) at 3.51 m Limestone layer (25 mm) at 3.71 m		1	RUN			110				RUN 1# TCR=100%, SCR=97%, RQD=68%
	Limestone layer (25 mm) at 4.27 m Siltstone layer (125 mm) at 4.32 m Limestone layer (25 mm) at 4.88 m		2	RUN			109				RUN 2# TCR=97%, SCR=97%, RQD=76%
107.9	Limestone layer (125 mm) at 5.47 m						108				
5.6	END OF BOREHOLE AT 5.59 m. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.										

+ 3, × 3 : Numbers refer to Sensitivity

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

ONTMT4S 5163.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-4 1 OF 1 METRIC

W.P. 169-00-00 LOCATION N 4 807 873.7 E 285 359.9 (Bronte) ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Rock Coring COMPILED BY JHL

DATUM Geodetic DATE 18.06.06 - 18.06.06 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
117.3											
0.0	**ASPHALT**: (190 mm)										
116.9	**CONCRETE**: (140 mm)						117				
0.3	**SAND and GRAVEL**: (19 mm CRUSHER RUN LIMESTONE) Brown (FILL)										
116.6			1	SS	50/.050						
0.7	**SHALE**, weathered, with limestone fragments Reddish Brown										
115.9			2	SS	50/.050		116				
1.4	**SHALE BEDROCK**, moderately to slightly weathered, fine grained, thinly bedded, reddish brown, with frequent grey strong LIMESTONE interbeds and occasional clay seams Limestone layer (25 mm) at 2.08 m Limestone layer (50 mm) at 2.32, 2.44 m		1	RUN							RUN 1# TCR=100%, SCR=88%, RQD=67%
							115				
			2	RUN			114				RUN 2# TCR=100%, SCR=100%, RQD=49%
	Limestone layer (50 mm)at 4.04, 4.21 m Clay seam (<25mm) at 4.0m										
112.8							113				
4.5	Limestone layer (140 mm) at 4.32 m END OF BOREHOLE AT 4.50 m. BOREHOLE GROUTED WITH BENTONITE AND PATCHED WITH ASPHALT TO SURFACE.										

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

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

ONTMT4S 5163.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-14 1 OF 1 METRIC

W.P. 169-00-00 LOCATION N 4 807 888.4 E 285 354.0 (Bronte) ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY JHL

DATUM Geodetic DATE 19.06.06 - 19.06.06 CHECKED BY SKP

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
116.8											
0.0	**ASPHALT**: (175 mm)										
0.2	**SAND and GRAVEL**: (19 mm CRUSHER RUN LIMESTONE) Compact Brown (FILL)		1	AS					○		
115.9											
0.9	**SHALE**, weathered Reddish Brown		1	SS	50/.075		116		○		
115.3			2	SS	50/.025				○		
1.5	AUGER REFUSAL AT 1.47 m. END OF BOREHOLE AT 1.47 m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND PATCHED WITH ASPHALT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5163.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SW1 1 OF 2 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 963.49 E 285 299.96 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 08.11.06 - 08.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.5									
0.0	**TOPSOIL**: (100 mm)								
0.1	Sandy **SILT**, trace clay, trace rootlets Loose Brown Moist		1	SS	9		121		
120.8	(FILL)								
0.7	**SAND**, trace gravel Compact Brown Wet		2	SS	13				
120.3									
1.2	Silty **CLAY**, sandy Very Stiff Grey (TILL)		3	SS	23		120		
			4	SS	24		119		0 26 58 16
118.5									
3.0	Silty **CLAY**, with weathered shale fragments Very Stiff Brown		5	SS	16		118		
117.7									
3.8	Highly to moderately weathered, thinly bedded, reddish brown, very weak to weak, **SHALE**, with greenish grey limestone interbeds		6	SS	50/.050		117	FI	
	Limestone interbeds at 4.65 to 4.67, 5.59 to 5.69, 5.94 to 6.01, and 6.10 to 6.12 m		1	RUN				4 6 5	RUN 1# TCR=100%, SCR=97%, RQD=43%
							116	5 4	
	Limestone interbeds at 6.20 to 6.27, 7.47 to 7.52, 7.55 to 7.57, and 7.60 to 7.67 m		2	RUN			115	2 2 2 1	RUN 2# TCR=100%, SCR=100%, RQD=80%, UCS=4MPa
							114	2	
	Limestone interbeds at 7.67 to 7.75, 8.10 to 8.15, and 8.33 to 8.38 m Rubble zone from 8.38 to 8.40 m		3	RUN			113	2 0 >10 0	RUN 3# TCR=100%, SCR=100%, RQD=85%, UCS=8MPa
112.3								2	
9.2	Becoming slightly weathered to fresh Limestone interbeds at 9.19 to 9.21, 9.28 to 9.30, 9.32 to 9.34, 9.60 to 9.63, and 10.11 to 10.14,		4	RUN			112	1 2	RUN 4# TCR=100%, SCR=95%, RQD=80%, UCS=4MPa

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa 20 40 60 80 100
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SW1 2 OF 2 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 963.49 E 285 299.96 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 08.11.06 - 08.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Rubble zone from 10.03 to 10.11 m									>10	
										1	
							111			1	
	Limestone interbeds at 10.72 to 10.77, and 11.28 to 11.43 m									0	RUN 5# TCR=100%, SCR=90%, RQD=82%, UCS=1MPa
			5	RUN						1	
							110			1	
	Vertical joint from 11.66 to 11.73 m									2	
109.3										3	
12.2	END OF BOREHOLE AT 12.24 m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.										

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

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

ONTMT4S 5127A.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SW2 1 OF 1 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 010.95 E 285 306.03 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 08.11.06 - 08.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.5											
0.0	TOPSOIL: (100 mm)										
0.1	Silty **CLAY**, some shale fragments, trace roots Stiff Brown (CI)		1	SS	9						0 3 47 50
120.8							121				
0.7	**SAND**, trace gravel Compact Brown Wet		2	SS	25						
120.2							120				
1.3	Silty **CLAY**, trace sand Very Stiff Brown (CL)		3	SS	27						0 1 66 32
			4	SS	29		119				
118.6											
2.9	Silty **CLAY**, sandy, trace gravel Hard Grey (TILL)		5	SS	43						2 26 51 18
118.0							118				
3.6	Highly weathered, thinly bedded, reddish brown, **SHALE**										
117.6	Hard		6	SS	50/.100						
3.9	END OF BOREHOLE AT 3.91 m. BOREHOLE OPEN TO 3.05 m AND WATER LEVEL AT 1.11 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SW3 1 OF 1 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 036.05 E 285 347.89 ORIGINATED BY GA

HWY QEW BOREHOLE TYPE Solid Stem Auger/HQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 30.11.06 - 30.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.3											
0.0	**TOPSOIL** (200mm)										
0.2	**CRUSHER RUN LIMESTONE**, trace silt, occasional asphalt fragments Compact Brown Dry		1	SS	18		121		○		
120.6											
0.8	(FILL) **SAND**, trace silt Compact Brown Dry		2	SS	11		120		○		
119.8											
1.5	Silty **CLAY** Very Stiff Brown		3	SS	16				⊢○⊣		0 3 64 33
119.0											
2.3	Silty **CLAY**, sandy, trace gravel Hard Reddish Brown (TILL)		4	SS	70/.300		119		○		
118.6											
2.7	Highly to moderately weathered, thinly bedded, reddish brown, very weak to medium strong, **SHALE**, with greenish limestone interbeds Limestone interbeds at 3.25 to 3.28 m, 4.01 to 4.04 m, 4.11 to 4.14 m, 4.19 to 4.24, and 4.29 to 4.32 m Sub vertical joint from 3.56 to 3.71 m		5	SS	50/.050		118		○		FI 7 5 3 0 0 RUN 1# TCR=100%, SCR=93%, RQD=43%
116.9			1	RUN			117				
4.5	Becoming slightly weathered to fresh Limestone interbeds at 5.08 to 5.16, 5.23 to 5.26, 5.51 to 5.54, 5.64 to 5.67, and 5.84 to 5.94 m		2	RUN			116				4 3 1 0 RUN 2# TCR=100%, SCR=95%, RQD=58%, UCS=39MPa
	Limestone interbeds at 6.81 to 6.83, 7.16 to 7.19, 7.28 to 7.34, and 7.42 to 7.52 m		3	RUN			115				2 1 1 1 1 0 RUN 3# TCR=100%, SCR=100%, RQD=88%
	Limestone interbed at 7.80 to 8.02m		4	RUN			114 113				0 0 0 0 0 0 RUN 4# TCR=100%, SCR=100%, RQD=100%
112.3											
9.1	END OF BOREHOLE AT 9.07 m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.										

+ 3, × 3 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SW4 1 OF 1 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 017.52 E 285 392.87 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY WM

DATUM Geodetic DATE 03.11.06 - 03.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
120.6											
0.0											
0.1	**TOPSOIL**: (75 mm)										
	Silty **CLAY**, some sand, some shale fragments Stiff to Hard Brown (CI)		1	SS	12				○		
			2	SS	65		120		○		0 1 65 34
119.2											
1.5	Highly weathered, thinly bedded, reddish brown, **SHALE**, with greenish grey limestone interbeds Hard		3	SS	87/ .225		119		○		
			4	SS	50/ .075				○		
117.5							118				
3.1	END OF BOREHOLE AT 3.13 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.		5	SS	50/ .075				○		

ONTMT4S 5127A.GPJ 15/12/06

+ 3, × 3 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No EN1 1 OF 1 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 066.47 E 285 401.04 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 06.11.06 - 06.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
120.7											
0.0	**TOPSOIL**: (100 mm)										
0.1	Silty **CLAY**, trace sand, trace roots Firm to Very Stiff Brown		1	SS	7				○		
			2	SS	21		120		○		
119.2											
1.5	Highly weathered, thinly bedded, reddish brown, very weak to weak, **SHALE**, with greenish grey limestone interbeds		3	SS	50/.175		119		○		0 4 83 12
			4	SS	50/.125				○		
							118			FI	
	Limestone interbeds at 3.12 to 3.18, 3.37 to 3.42 m		1	RUN						>10	RUN 1# TCR=100%, SCR=68%, RQD=0%, UCS=9MPa
116.8							117			9	
3.9	Becoming moderately weathered Limestone interbeds at 3.86 to 3.99, 4.13 to 4.19, 4.34 to 4.40, 4.55 to 4.62, and 4.72 to 4.77 m		2	RUN						9	RUN 2# TCR=100%, SCR=98%, RQD=57%
										7	
							116			7	
	Limestone interbeds at 5.16 to 2.20, 5.51 to 5.59, and 6.12 to 6.14 m		3	RUN						4	
										0	RUN 3# TCR=100%, SCR=93%, RQD=68%, UCS=6MPa
	Clay seam at 5.92 to 5.94 m Vertical joint at 6.12 to 6.38 m Rubble zone at 6.27 to 6.39 m						115			4	
114.2										2	
6.5	Becoming slightly weathered to fresh, weak to medium strong Limestone interbeds at 6.55 to 6.57, 6.69 to 6.79, 7.21 to 7.23, 7.47 to 7.49, 7.64 to 7.67, and 7.97 to 8.03 m		4	RUN						1	
										2	
							114			>10	RUN 4# TCR=100%, SCR=100%, RQD=75%, UCS=27MPa
										3	
										5	
										4	
							113			1	
										1	
	Limestone interbeds at 8.10 to 8.12, 8.69 to 8.79, 8.94 to 8.96, 9.12 to 9.14m		5	RUN						3	RUN 5# TCR=100%, SCR=100%, RQD=96%, UCS=21MPa
							112			1	
111.3										2	
										3	
9.4	END OF BOREHOLE AT 9.43 m. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5127A.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No EN2 1 OF 1 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 057.68 E 285 352.20 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 03.11.06 - 03.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.2												
0.0	**TOPSOIL**: (75 mm)											
0.1	Silty **CLAY**, trace sand, trace roots, occasional iron oxide staining Firm to Very Stiff Brown		1	SS	6		121					
			2	SS	18		120					
			3	SS	29	▼						0 3 73 24
118.9							119					
2.3	Highly weathered, thinly bedded, reddish brown, **SHALE**, with greenish grey limestone interbeds Hard		4	SS	50/.150							
			5	SS	50/.050		118					
116.5							117					
4.6	END OF BOREHOLE AT 4.62 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		6	SS	50/.050							

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
10.11.06	3.56	117.64
08.12.06	2.00	119.20

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

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

ONTMT4S 5127A.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No EN3 1 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burtoak Drive N 4 808 036.73 E 285 308.29 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 07.11.06 - 07.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.7											
0.0	**TOPSOIL**: (75 mm)										
0.1	Silty **CLAY**										
0.2	Brown		1	SS	30						
121.0	**SAND**, some gravel, trace silt										
0.7	Compact										
	Brown										
	Moist										
	Silty **CLAY**, topsoil stained		2	SS	21		121				
	Very Stiff										
120.2	Dark Brown										
1.5	Silty **CLAY**, some sand layers										
	Very Stiff		3	SS	15		120				0 6 64 30
	Brown to Grey										
	(CL)		4	SS	26		119				
			5	SS	25						0 9 66 25
118.1							118				
3.6	Highly to moderately weathered, thinly bedded, reddish brown, very weak to weak, **SHALE**, with greenish grey limestone interbeds		6	SS	50/ 025						
			1	RUN			117			FI	RUN 1#
										10	TCR=100%,
										3	SCR=75%,
	Limestone interbeds at 5.18 to 5.38, 5.66 to 5.69, 5.72 to 5.77, 5.94 to 5.99, and 6.04 to 6.10 m									1	RQD=0%,
			2	RUN			116				UCS=MPa
										5	RUN 2#
											TCR=100%,
										1	SCR=94%,
											RQD=73%,
										6	UCS=MPa
	Rubble zones at 6.50 to 6.55, and 6.99 to 7.04 m										RUN 3#
	Sub vertical joint at 6.76 to 6.89 m						115			>10	TCR=91%,
											SCR=82%,
	Clay seams at 7.06 to 7.14 and 7.24 to 7.26 m		3	RUN						>10	RQD=40%,
											UCS=10MPa
114.1										1	
7.6	Becoming slightly weathered to fresh						114			1	
	Limestone interbeds at 7.67 to 7.87, and 7.95 to 7.97 m									0	RUN 4#
										3	TCR=100%,
											SCR=100%,
	Limestone interbeds at 8.02 to 8.18, and 9.09 to 9.14 m		4	RUN			113			0	RQD=91%,
											UCS=16MPa
112.1										2	
										1	
9.5	END OF BOREHOLE AT 9.55 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 27/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No EN3 2 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 036.73 E 285 308.29 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 07.11.06 - 07.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 10.11.06 4.05 117.65 08.12.06 3.24 118.46										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 5127A.GPJ 27/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No EN4 1 OF 1 METRIC

W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 000.60 E 285 273.42 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 03.11.06 - 03.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.8											
0.0	TOPSOIL: (100 mm)										
0.1 / 121.1	Silty **CLAY**, mixed with **TOPSOIL** Firm Brown		1	SS	5						
0.7 / 120.1	**SAND**, some gravel, trace silt Loose Brown Wet		2	SS	6		121				
1.7 / 118.9	Silty **CLAY**, trace sand Stiff Grey		3	SS	14		120				
			4	SS	13		119				0 2 69 29
3.0 / 117.9	Silty **CLAY**, some sand, trace gravel Very Stiff Grey (TILL)		5	SS	21		118				1 34 45 20
4.0 / 117.2	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard		6	SS	50/.075						
4.6	END OF BOREHOLE AT 4.65 m. BOREHOLE OPEN TO 4.65 m AND WATER LEVEL AT 1.22 m UPON COMPLETION. BOREHOLE BACKFILLED BENTONITE HOLEPLUG TO 0.6 m AND DRILL CUTTINGS TO SURFACE.										

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

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 15/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NWC1 1 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 960.56 E 285 183.56 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 09.11.06 - 09.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
122.2											
0.0	TOPSOIL: (125 mm)										
0.1	Silty **CLAY**, some shale fragments Very Stiff Brown		1	SS	23		122	○			
121.6											
0.7	Silty **SAND**, trace gravel Compact to Dense Brown Moist to Wet		2	SS	22		121	○			
			3	SS	38	▼		○			0 76 23 (SI+CL)
120.0							120				
2.2	Silty **CLAY**, trace sand Very Stiff Grey (CL)		4	SS	17			○			
			5	SS	16		119	⊖			0 3 78 19
118.4											
3.9	Silty **CLAY**, sandy, trace gravel, trace shale fragments Hard Brown (TILL)						118				
117.4			6	SS	68/ -200			○ ○			
4.8	Highly to moderately weathered, thinly bedded, reddish brown, very weak, **SHALE**, with greenish grey limestone interbeds						117			FI	
	Limestone interbeds at 5.84 to 5.87, 6.52 to 6.65 m		1	RUN						4	RUN 1# TCR=100%, SCR=92%, RQD=60%, UCS=4MPa
	Sub vertical joint at 6.45 to 6.50 m						116			5 4	
	Limestone interbeds at 6.94 to 6.98, 7.11 t 7.24, and 8.11 to 8.13 m		2	RUN						1 2	RUN 2# TCR=100%, SCR=97%, RQD=58%
	Sub vertical joint at 7.97 to 8.12 m						115			5 2 6	
	Limestone interbeds at 8.48 to 8.53, 8.61 to 8.77, 8.89 to 8.97, and 9.19 to 9.22 m		3	RUN			114			3 2 2	RUN 3# TCR=100%, SCR=100%, RQD=90%, UCS=2MPa
113.0											
9.2	END OF BOREHOLE AT 9.22 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

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+ 3, × 3 Numbers refer to Sensitivity

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NWC1 2 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 960.56 E 285 183.56 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 09.11.06 - 09.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 10.11.06 2.52 119.68 08.12.06 2.10 120.10										

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

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NWC2 1 OF 1 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 945.13 E 285 220.84 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 09.11.06 - 09.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.9											
0.0	TOPSOIL: (125 mm)										
0.1 / 121.2	Silty **CLAY**, trace sand Stiff Brown		1	SS	10				○		
0.7 / 120.0	**SAND**, some silt to silty, trace clay, trace shale fragments Compact Brown Wet		2	SS	21		121		○		7 66 19 9
			3	SS	19				○		
1.8 / 119.7	Sandy **SILT**, trace clay Compact Brown						120		○		
2.2	Moist										
	Silty **CLAY**, trace sand Very Stiff Grey (CL)		4	SS	15		119		⊢○⊣		0 1 74 25
			5	SS	17	▼			○		
4.0 / 117.2	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard						118				
			6	SS	50/.050				○		
4.6	END OF BOREHOLE AT 4.62 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
10.11.06	4.10	117.80
08.12.06	3.41	118.49

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

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NWC3 1 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 905.91 E 285 267.79 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 08.11.06 - 08.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.8											
0.0	**TOPSOIL**: (100 mm)										
0.1	Silty **CLAY**, trace roots, trace shale and limestone fragments Stiff Brown		1	SS	8				○		
121.1							121				
0.7	Silty **SAND**, trace to some gravel, trace clay Compact Brown		2	SS	20				○		14 54 24 8
120.5							120				
1.3	Wet Sandy **SILT**, trace clay Compact Brown Wet		3	SS	26				○		
119.6							119				
2.2	Silty **CLAY**, some sand Very Stiff Brown (CL)		4	SS	28				○		
			5	SS	28				⊢		0 20 50 27
117.8							118				
4.0	Highly to moderately weathered, thinly bedded, reddish brown, very weak to weak, **SHALE**, with greenish grey limestone interbeds		6	SS	50/				○		FI
			1	RUN	.075		117				8 RUN 1# TCR=100%, SCR=83%, RQD=0%
	Limestone interbeds at 4.93 to 4.98, and 5.13 to 5.15 m		2	RUN							6
							116				5 RUN 2# TCR=100%, SCR=98%, RQD=58%, UCS=19MPa
	Limestone interbeds at 5.97 to 6.04, and 6.37 to 6.42 m		3	RUN							1 5
	Limestone interbeds at 6.50 to 6.57, and 6.63 to 6.79 m		4	RUN			115				1 RUN 3# TCR=100%, SCR=100%, RQD=88%
	Clay seams at 7.45 to 7.52, and 7.75 to 7.77 m										3 4 RUN 4# TCR=100%, SCR=100%, RQD=50%, UCS=4MPa
113.9	Vertical joint at 7.52 to 7.60 m						114				3 2 RUN 5# TCR=100%, SCR=100%, RQD=90%, UCS=10MPa
7.9	Becoming slightly weathered, weak Limestone interbeds at 8.02 to 8.08, 8.23 to 8.33, 8.66 to 8.72, and 8.87 to 8.92 m		5	RUN							2 1
							113				3
112.6											0
9.2	END OF BOREHOLE AT 9.17 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

Continued Next Page

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

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NWC3 2 OF 2 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 905.91 E 285 267.79 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA

DATUM Geodetic DATE 08.11.06 - 08.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 10.11.06 4.76 117.04 08.12.06 4.24 117.56										

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

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NWC4 1 OF 1 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 859.69 E 285 291.80 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 03.11.06 - 03.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.2								20 40 60 80 100	20 40 60		
0.0	**TOPSOIL**: (75 mm)										
0.1	Silty **CLAY**, some sand, some topsoil Stiff Brown		1	SS	8		121	○	○		
120.5											
0.7	**SAND** and **SILT**, some clay Compact Brown Moist to Wet		2	SS	14		120	○	○		0 52 36 13
119.4			3	SS	20			○	○		
1.8	Silty **CLAY**, some sand Very Stiff to Hard Brown (CL)		4	SS	23		119		○		
117.5			5	SS	38		118		○⊣		3 11 68 18
3.7	Highly weathered, thinly bedded, reddish brown, **SHALE**						117				
116.6			6	SS	50/.050				○		
4.6	END OF BOREHOLE AT 5.02 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6 m AND DRILL CUTTINGS TO SURFACE.										

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NW1 1 OF 1 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 932.53 E 285 249.91 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY JHL

DATUM Geodetic DATE 03.11.06 - 03.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.6											
0.0	**TOPSOIL**: (125 mm)										
0.1	Silty **CLAY**, some sand, trace gravel Very Stiff Brown		1	SS	19				○		
120.9							121				
0.7	Silty **SAND**, with clayey silt layers, some gravel Dense to Compact Brown Wet		2	SS	40				○		6 72 22 (SI+CL)
119.4			3	SS	21		120		○		
2.2	Silty **CLAY** Very Stiff Brown to Grey Wet		4	SS	18		119		○		
118.6											
3.0	Silty **CLAY**, some sand, with approximate 100mm thick shale layer Hard Reddish Brown		5	SS	65		118		⊣●⊢		0 12 67 21
117.7											
3.9	Highly weathered, thinly bedded, **SHALE**		6	SS	50/.075		117		○		
116.9											
4.6	END OF BOREHOLE AT 4.65 m. BOREHOLE OPEN TO 4.65 m AND WATER LEVEL AT 2.52 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.										

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

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

ONTMT4S 5127A.GPJ 21/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NW2 1 OF 1 METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 893.63 E 285 295.84 ORIGINATED BY SLL

HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY JHL

DATUM Geodetic DATE 03.11.06 - 03.11.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.6											
0.0	**TOPSOIL**: (100 mm)										
0.1	Silty **CLAY**, some sand, trace shale fragments, with topsoil staining Very Stiff Brown		1	SS	17		121				
120.1			2	SS	27						
1.5	Sandy **SILT**, trace clay Compact Brown Wet		3	SS	24		120				
119.5											
2.1	Silty **CLAY**, trace sand seams Very Stiff Brown		4	SS	17		119				0 1 75 23
			5	SS	22	▼	118				
117.7											
3.9	Highly weathered, thinly bedded, reddish brown, **SHALE**, with greenish grey limestone interbeds Hard		6	SS	50/.075		117				
115.4			7	SS	50/.075		116				
6.2	END OF BOREHOLE AT 6.18 m. BOREHOLE OPEN AND WATER LEVEL AT 1.57 m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 10.11.06 3.58 118.02 08.12.06 3.41 118.19										

+ ³, × ³: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 22/12/06

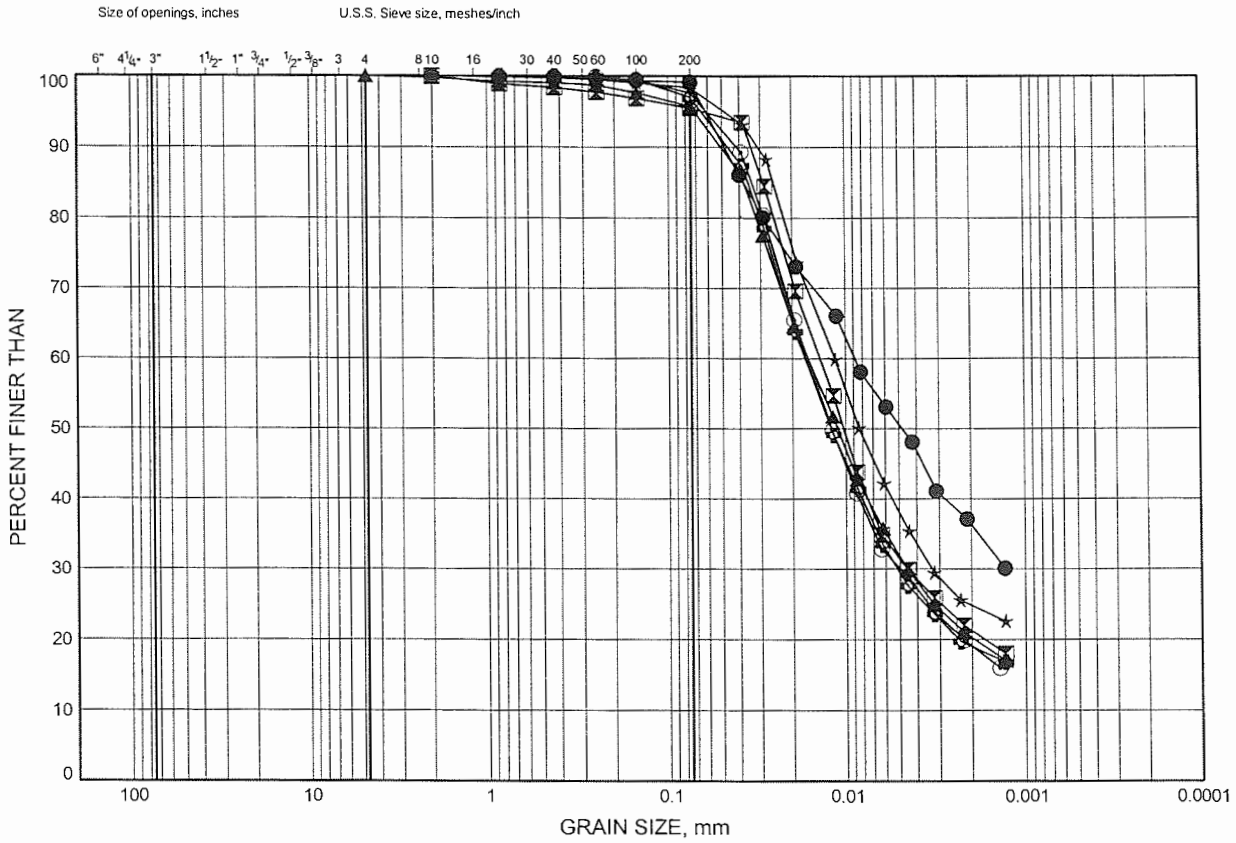
Appendix B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BR1	1.83	120.15
⊠	BR1	2.59	119.38
▲	BR2	1.83	119.93
★	BR2	2.59	119.16
⊙	BR3	2.59	119.11
✪	NWC1	3.35	118.90

Date December 2006

Project 169-00-00

THURBER

Prep'd JHL

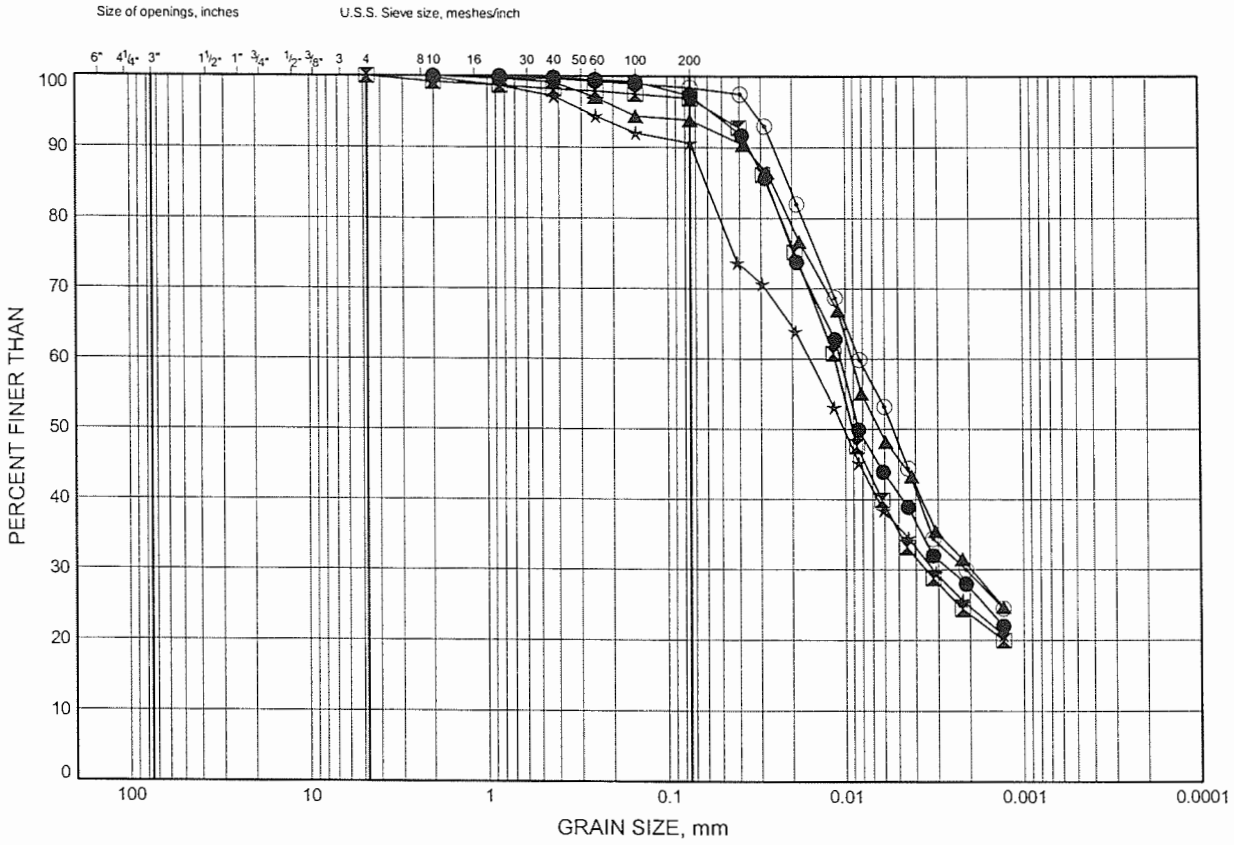
Chkd. AEG

THURBGSD 5127A.GPJ 22/12/06

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BR4	1.83	119.42
⊠	EN2	1.83	119.33
▲	EN3	1.83	119.84
★	EN3	3.35	118.32
⊙	EN4	2.59	119.23

Date December 2006

Project 169-00-00

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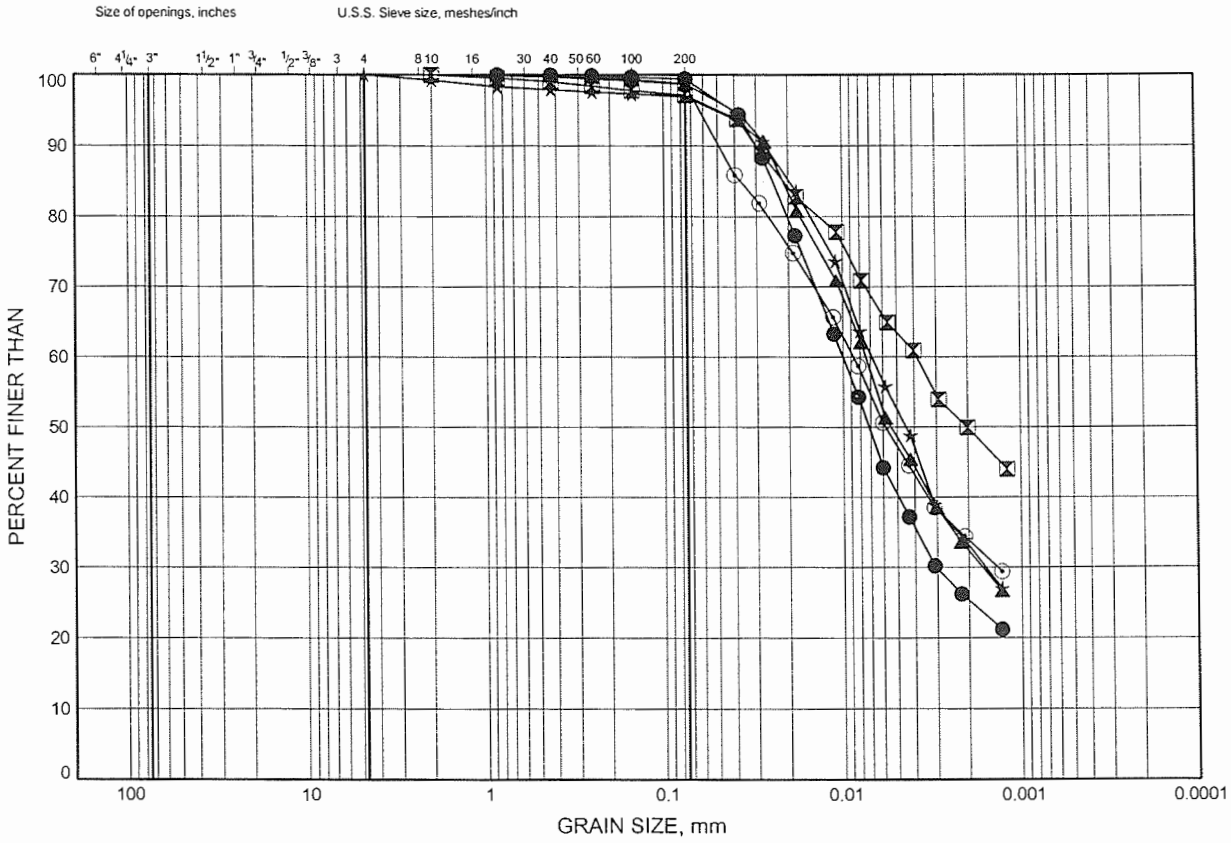
Chkd. AEG

THURBGSD 5127A.GPJ 22/12/06

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NWC2	2.59	119.27
⊠	SW2	0.30	121.20
▲	SW2	1.83	119.68
★	SW3	1.83	119.51
⊙	SW4	0.99	119.65

Date December 2006

Project 169-00-00

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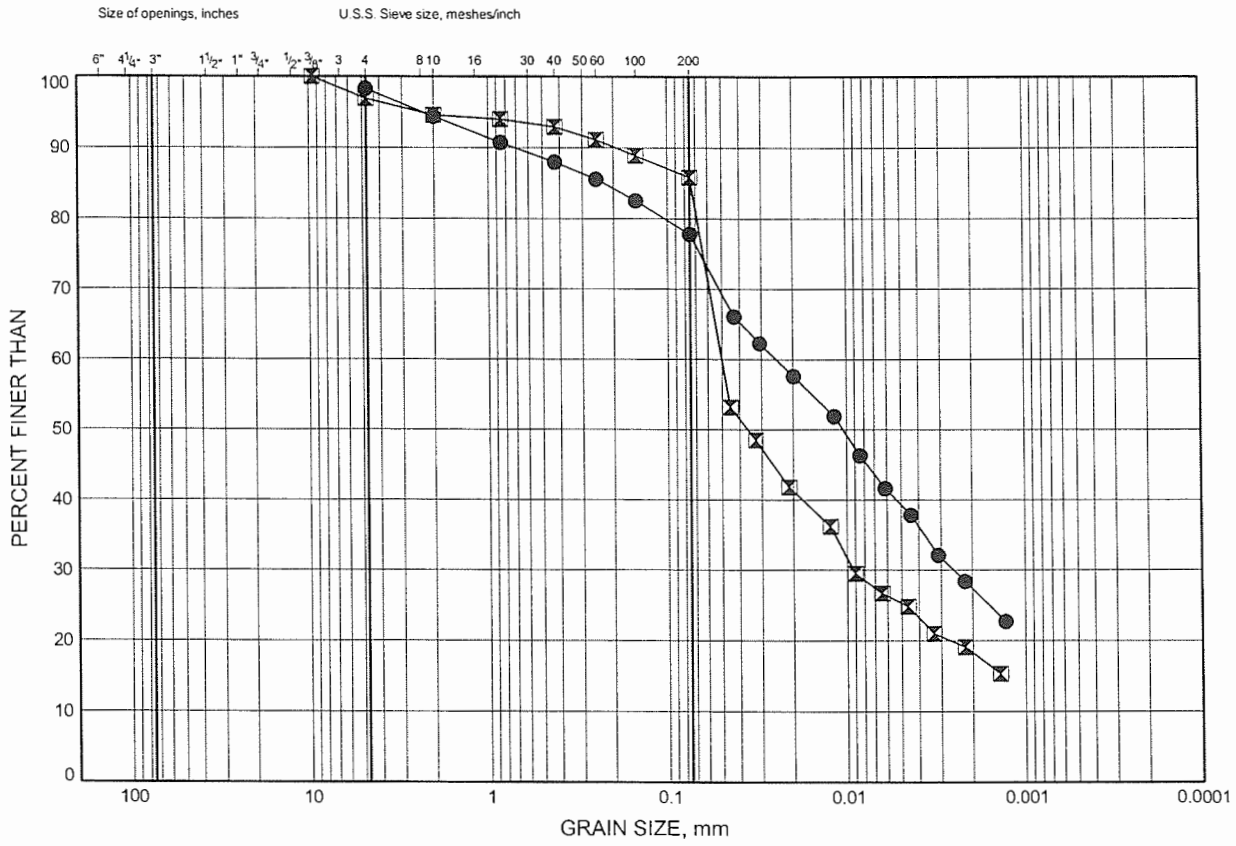
GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NWC3	3.35	118.46
⊠	NWC4	3.35	117.85

Date December 2006

Project 169-00-00

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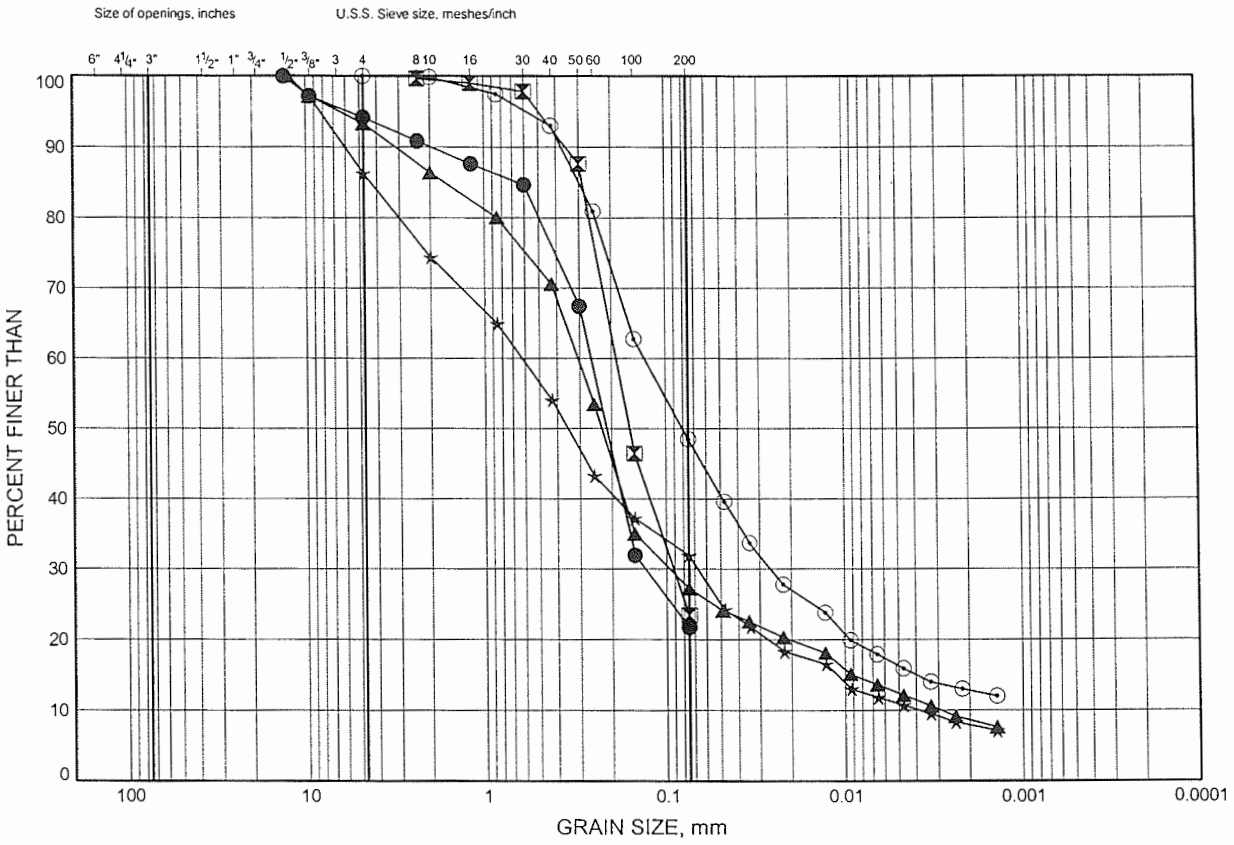
THURBGSD 5127A.GPJ 22/12/06

GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NW1	1.07	120.53
⊠	NWC1	1.83	120.42
▲	NWC2	1.07	120.80
★	NWC3	1.07	120.74
⊙	NWC4	1.07	120.14

Date December 2006

Project 169-00-00

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Prep'd JHL

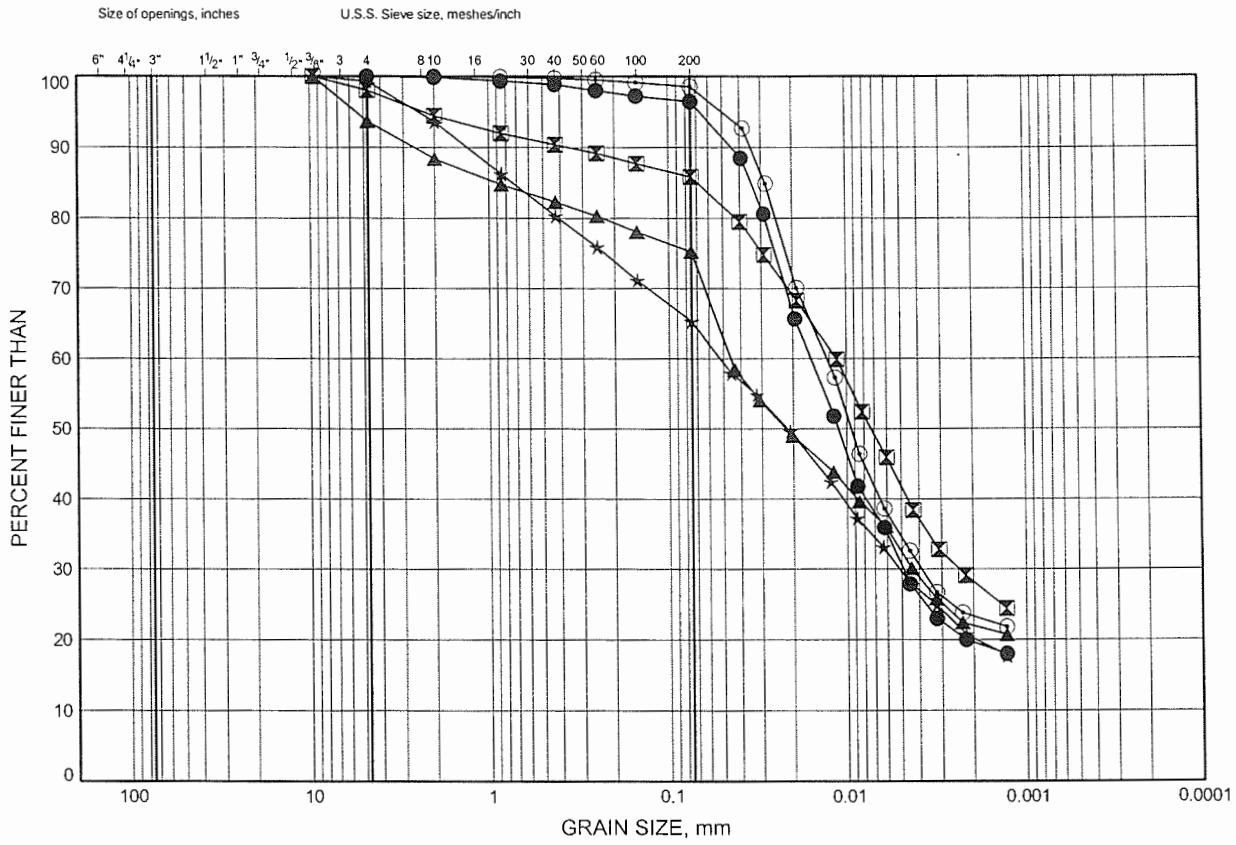
Chkd. AEG

THURBGSD 5127A.GPJ 22/12/06

GRAIN SIZE DISTRIBUTION

FIGURE B6

SILTY CLAY TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BR1	3.35	118.62
⊠	BR2	3.35	118.40
▲	BR4	3.35	117.90
★	EN4	3.35	118.47
⊙	NW2	2.59	119.03

Date December 2006

Project 169-00-00

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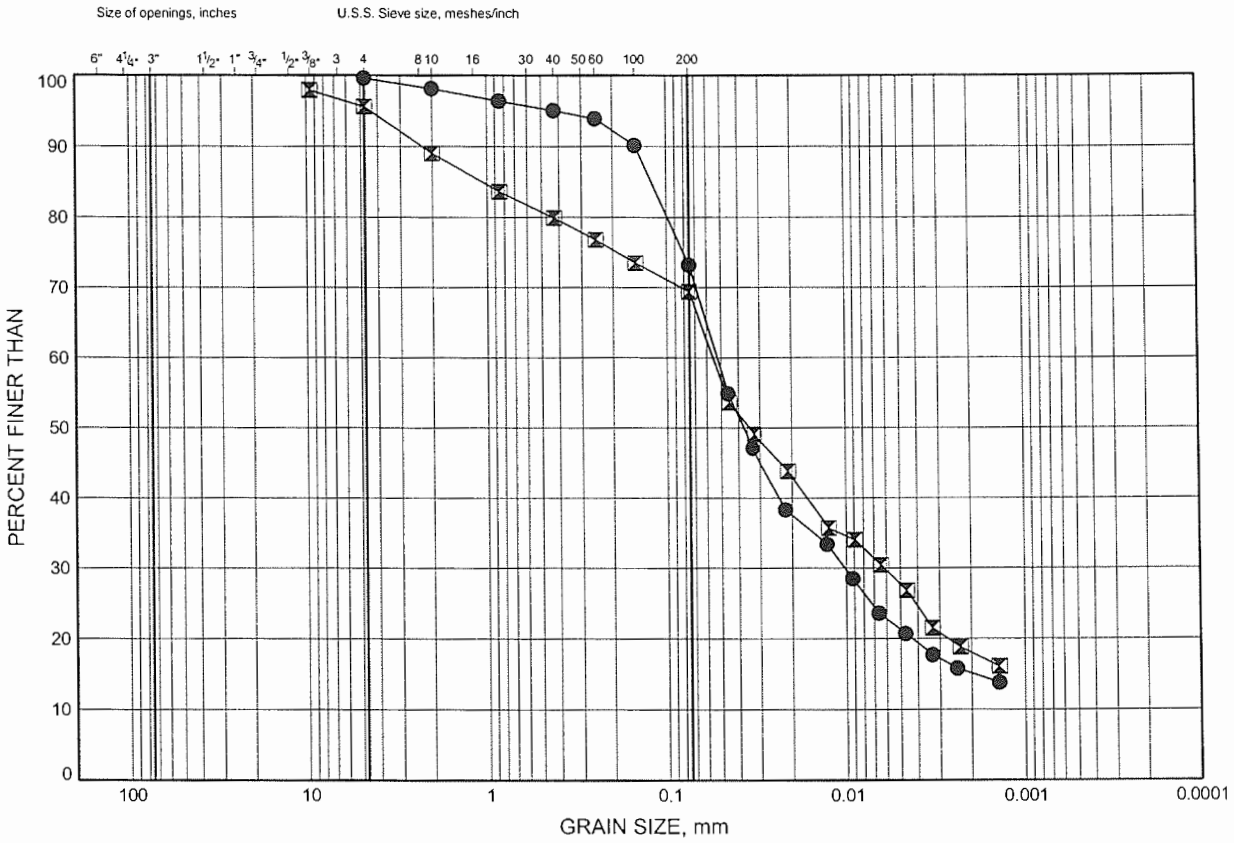
THURBGSD 5127A.GPJ 22/12/06

GRAIN SIZE DISTRIBUTION

FIGURE B7

SILTY CLAY TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SW1	2.59	118.90
⊠	SW2	3.34	118.17

Date December 2006

Project 169-00-00

THURBER

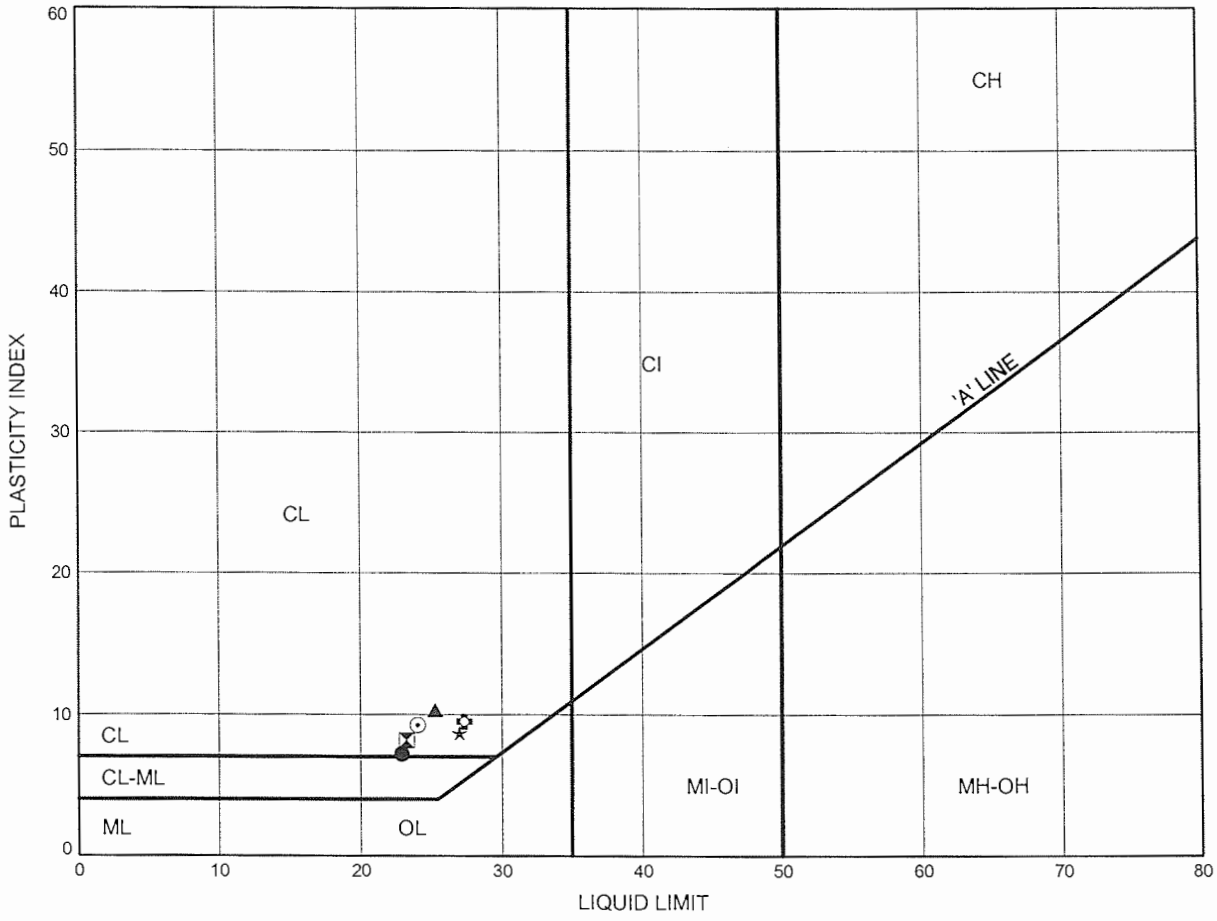
Prep'd JHL

Chkd. AEG

THURBGSD 5127A.GPJ 22/12/06

ATTERBERG LIMITS TEST RESULTS

FIGURE B8



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BR1	2.59	119.38
⊠	BR2	2.59	119.16
▲	BR3	3.35	118.34
★	BR4	1.83	119.42
⊙	BR4	3.35	117.90
✿	EN2	1.83	119.33

Date December 2006

Project 169-00-00

THURBER

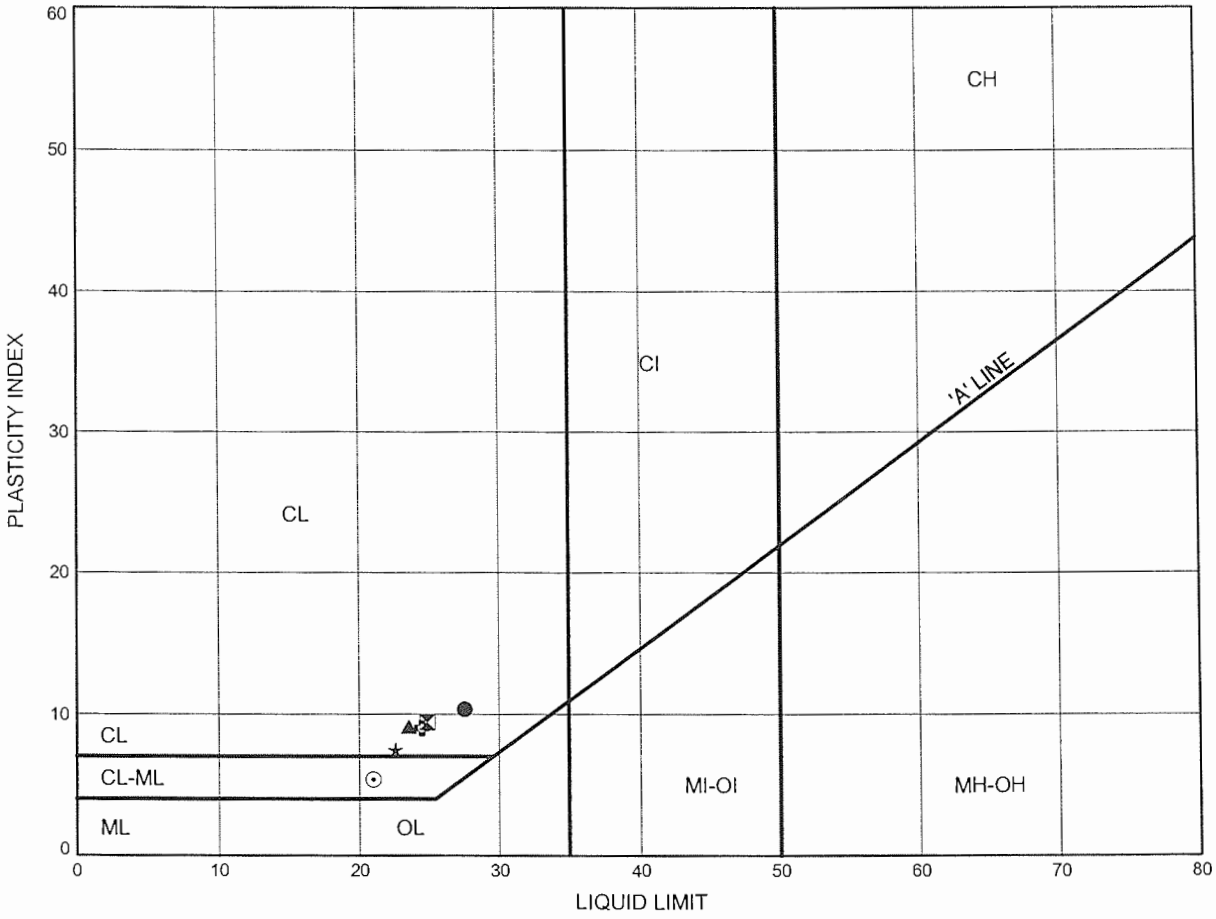
Prep'd WM

Chkd. AEG

THURBALT 5127A.GPJ 22/12/06

ATTERBERG LIMITS TEST RESULTS

FIGURE B9



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	EN3	1.83	119.84
⊠	EN4	2.59	119.23
▲	NW1	3.28	118.32
★	NW2	2.59	119.03
⊙	NWC1	3.35	118.90
✿	NWC2	2.59	119.27

Date December 2006

Project 169-00-00

THURBER

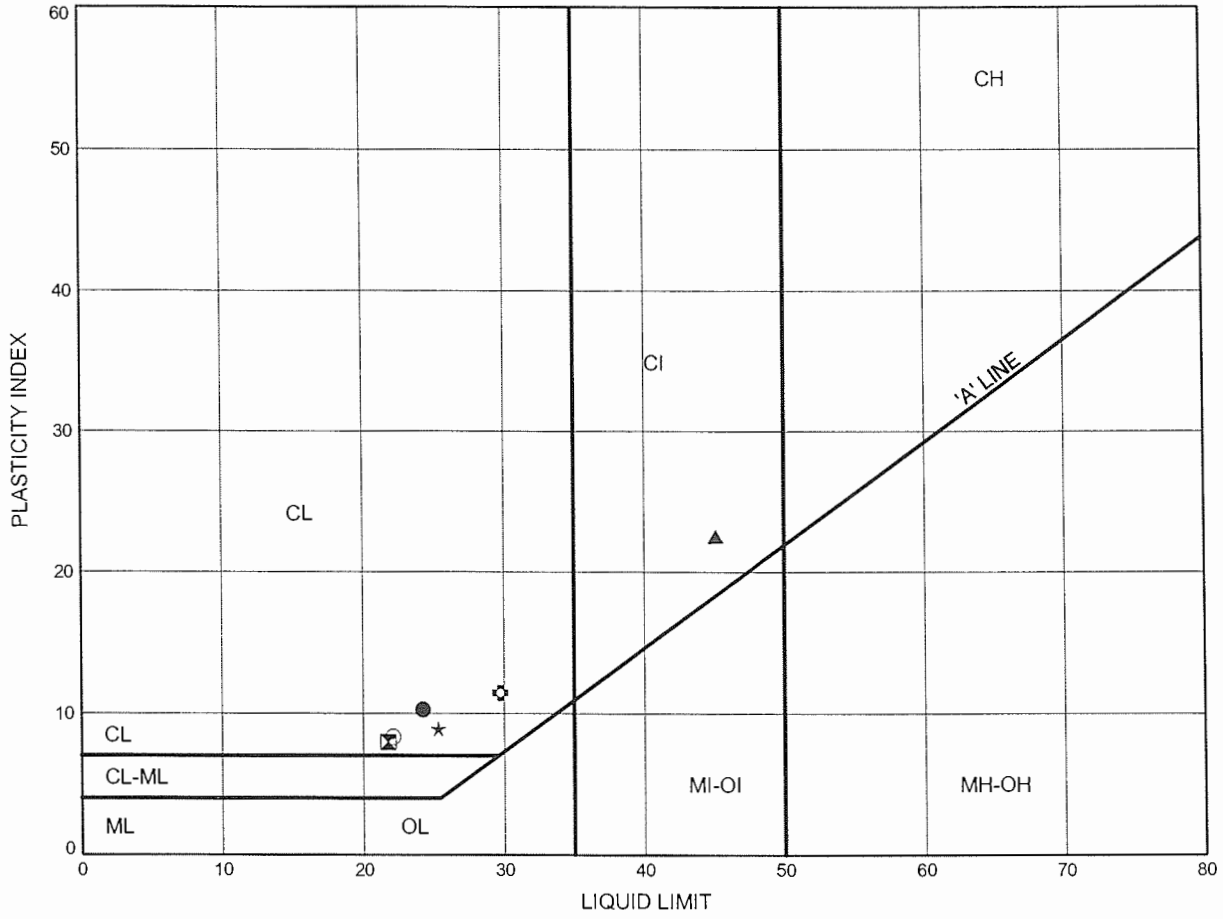
Prep'd WM

Chkd. AEG

THURBALT 5127A.GPJ 22/12/06

ATTERBERG LIMITS TEST RESULTS

FIGURE B10



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NWC3	3.35	118.46
⊠	NWC4	3.35	117.85
▲	SW2	0.30	121.20
★	SW2	1.83	119.68
⊙	SW2	3.34	118.17
✿	SW3	1.83	119.51

Date December 2006

Project 169-00-00

THURBER

Prep'd WM

Chkd. AEG

THURBALT 5127A.GPJ 22/12/06

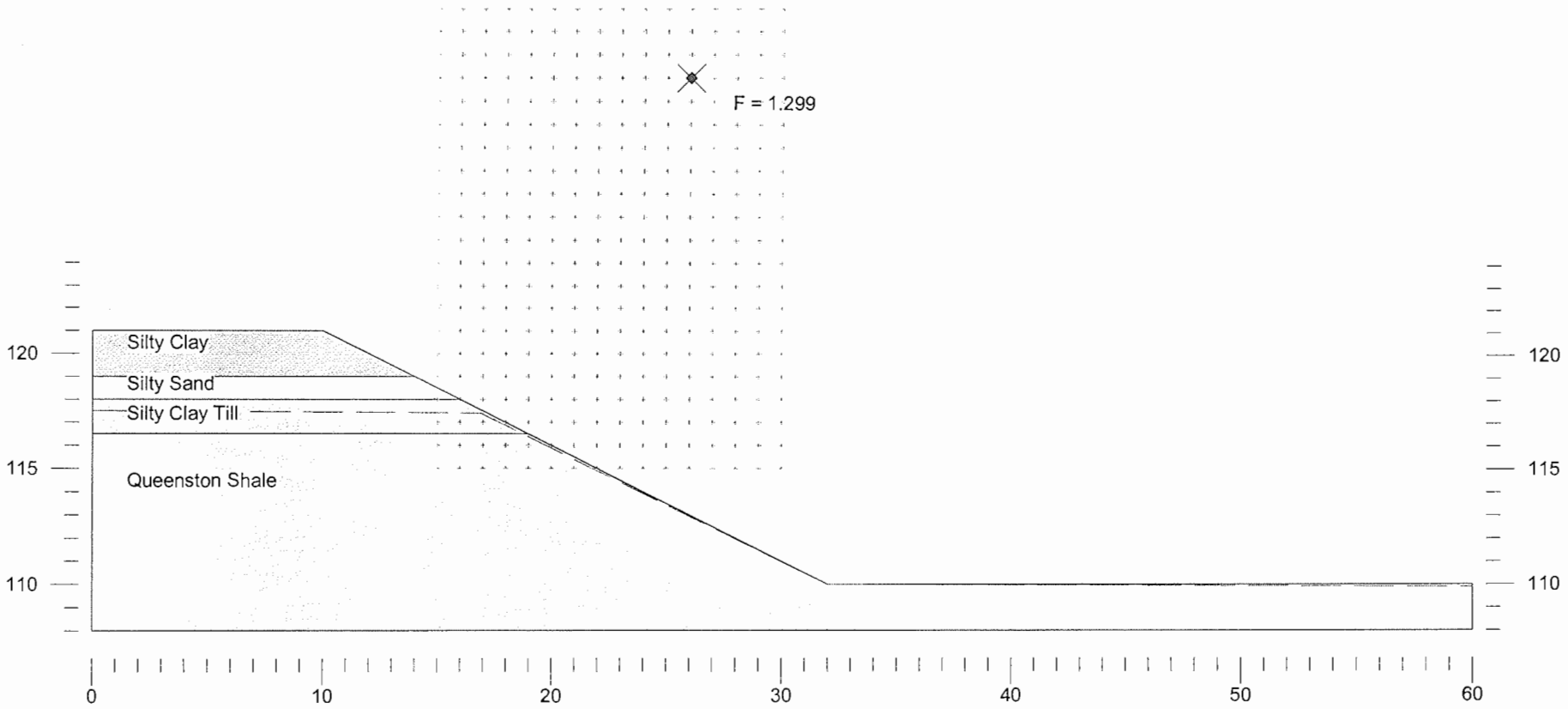
Appendix C

Stability Output

DRAFT

	Gamma	C	Phi	Min	Piezo
	kN/m3	kPa	deg	c/p	Surf.
Silty clay	20	80	0	0	1
Silty sand	21	0	30	0	1
Silty clay till	23	0	33	0	1
Shale	23	500	0	0	1

Thurber Engineering Ltd. - Toronto
19-1351-27
QEW Bronte Road Deep Cuts
December 19, 2006
Bronte Road 1

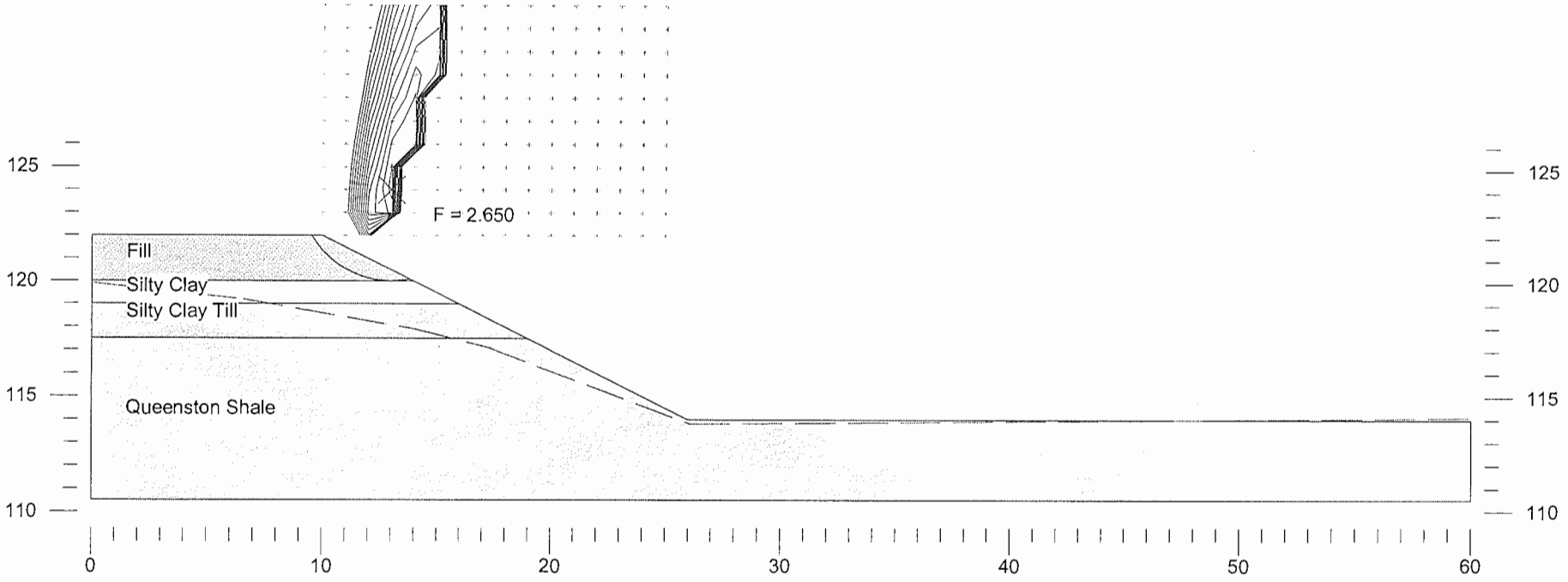


19/12/2006 3:48:36 PM H:\19\1351\27QEW-~1\VOL5DE~1\BR-1.GSL Thurber Engineering Ltd. - Toronto F = 1.299

Figure C1

	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.
Fill	22	5	32	1
Silty clay	21	200	0	1
Silty clay till	23	10	33	1
Shale	23	500	0	1

Thurber Engineering Ltd. - Toronto
19-1351-27
QEW Bronte Road Deep Cuts
December 20, 2006
Ramp E-N/S

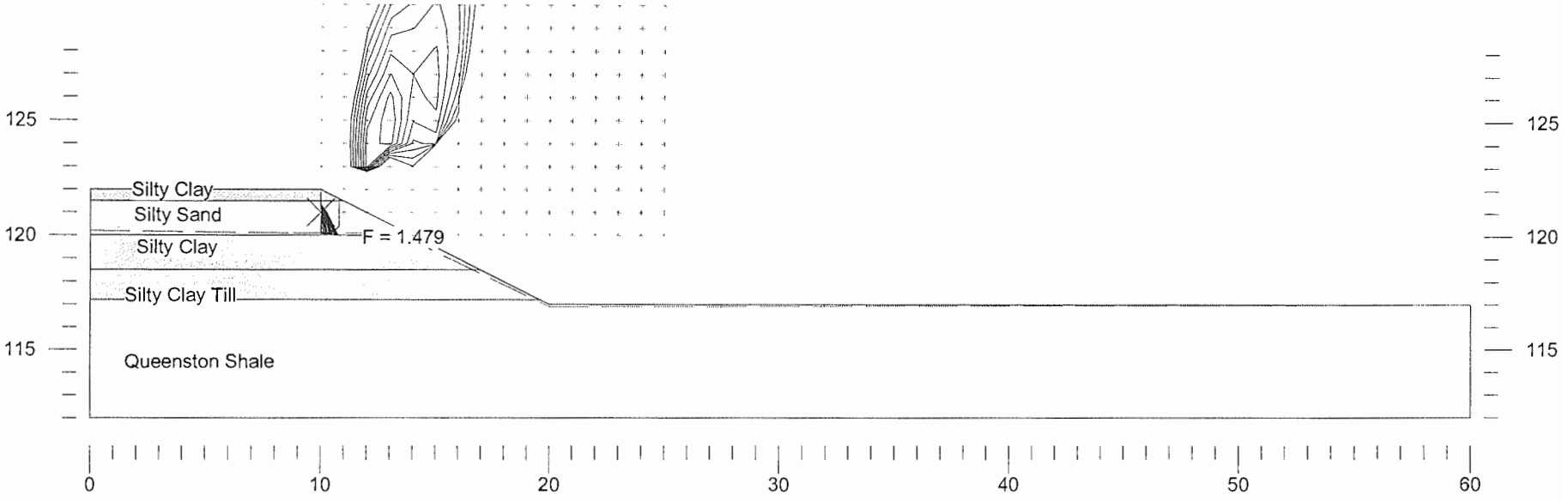


21/12/2006 5:25:20 PM H:\19\1351\27QEW-~1\VOL5DE~1\BR-3.GSL Thurber Engineering Ltd. - Toronto F = 2.650

Figure C2

	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.
Silty clay	20	60	0	1
Silty sand	21	0	30	1
Silty clay	20	80	0	1
Silty clay till	23	0	33	1
Shale	23	500	0	1

Thurber Engineering Ltd. - Toronto
19-1351-27
QEW Bronte Road Deep Cuts
December 21, 2006
Bronte Road N-W Ramp

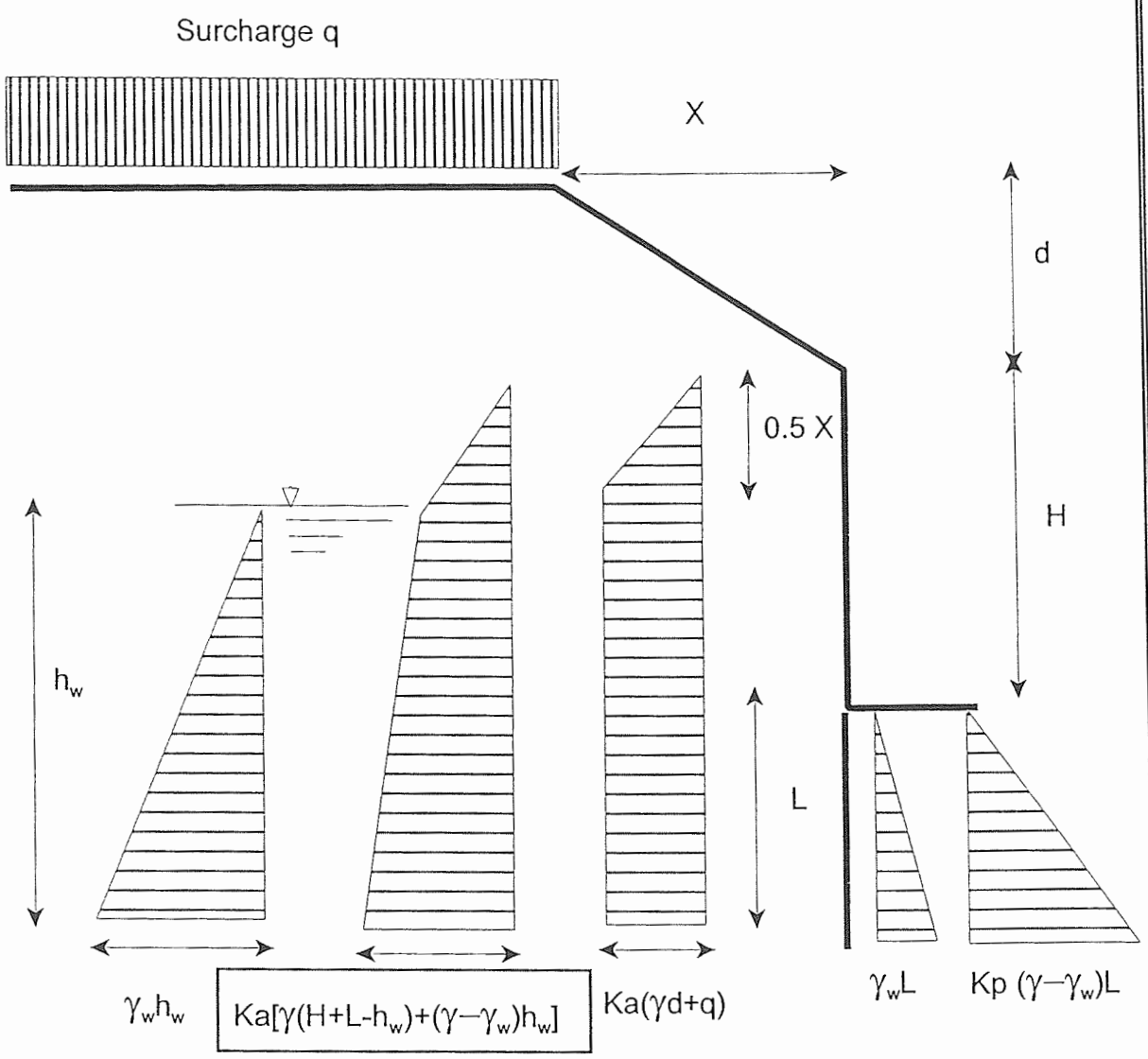


21/12/2006 5:57:16 PM H:\19\1351\27QEW-~1\VOL5DE~1\BR-4.GSL Thurber Engineering Ltd. - Toronto F = 1.479

Figure C3

Appendix D

Drawings



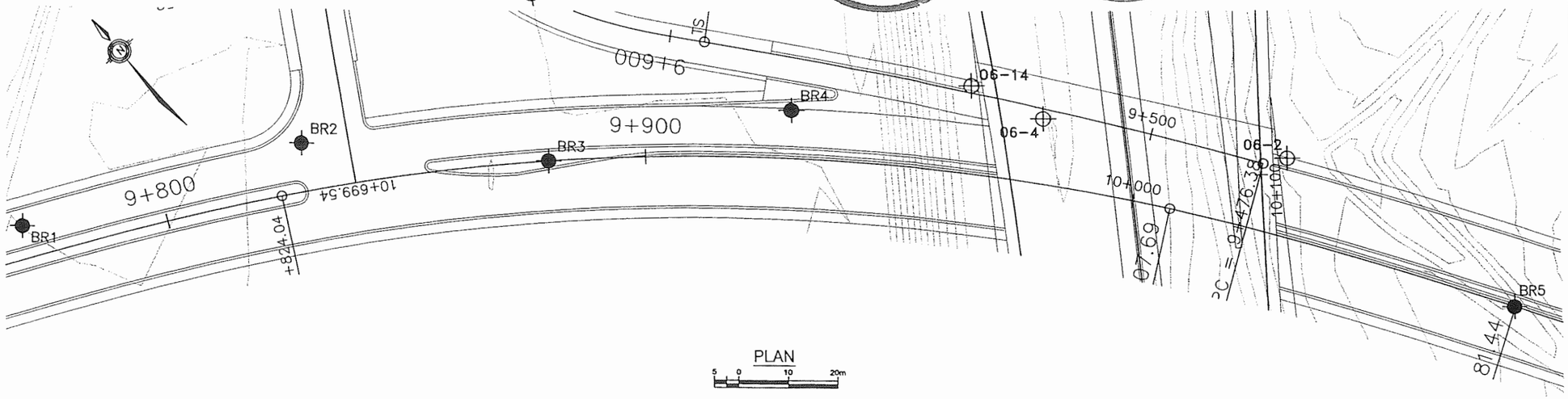
γ = unit weight of soil

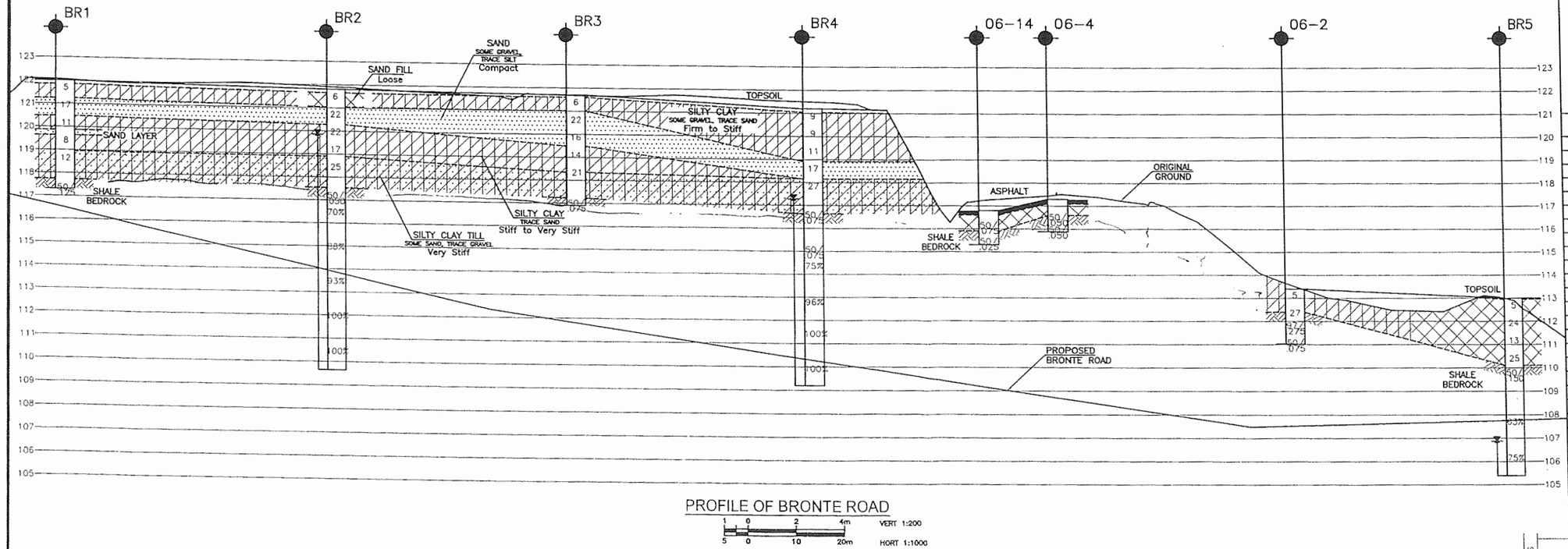
γ_w = unit weight of water

Ka = active earth pressure coefficient

Kp = passive earth pressure coefficient

THURBER	LATERAL PRESSURE DISTRIBUTION FOR ANCHORED WALL	FIGURE D1





METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No.169-00-00

BRONTE ROAD DEEP CUTS
BRONTE ROAD
BOREHOLE LOCATIONS AND SOIL STRATA

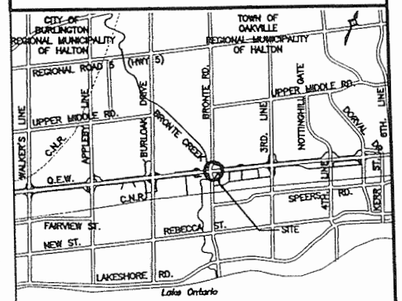
SHEET

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
FEB 9/07
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb 9/07
PROVINCE OF ONTARIO



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
BR1	122.0	4 807 999.17	285 188.78
BR2	121.8	4 807 973.11	285 243.69
BR3	121.7	4 807 936.05	285 279.08
BR4	121.2	4 807 910.06	285 323.10
BR5	113.0	4 807 779.54	285 403.30
06-2	113.4	4 807 833.96	285 390.64
06-4	117.3	4 807 873.68	285 359.85
06-14	116.8	4 807 888.38	285 353.96

-NOTE-

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	AEG	CHK	PKC	CODE		LOAD	DATE DEC 2006
DRAWN	JHL	CHK	PKC	SITE		STRUCT	DWG

MINISTRY OF TRANSPORTATION, ONTARIO PR-D-707 85-08 PLOT SCALE 1:1

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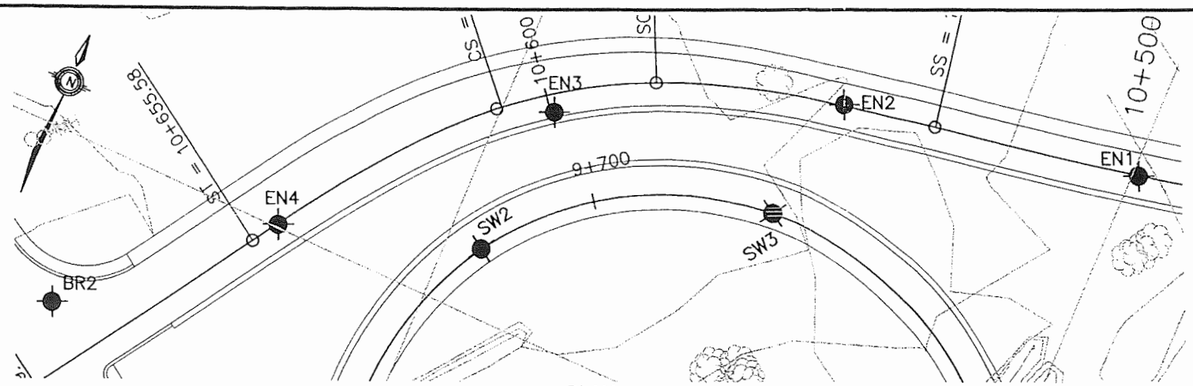

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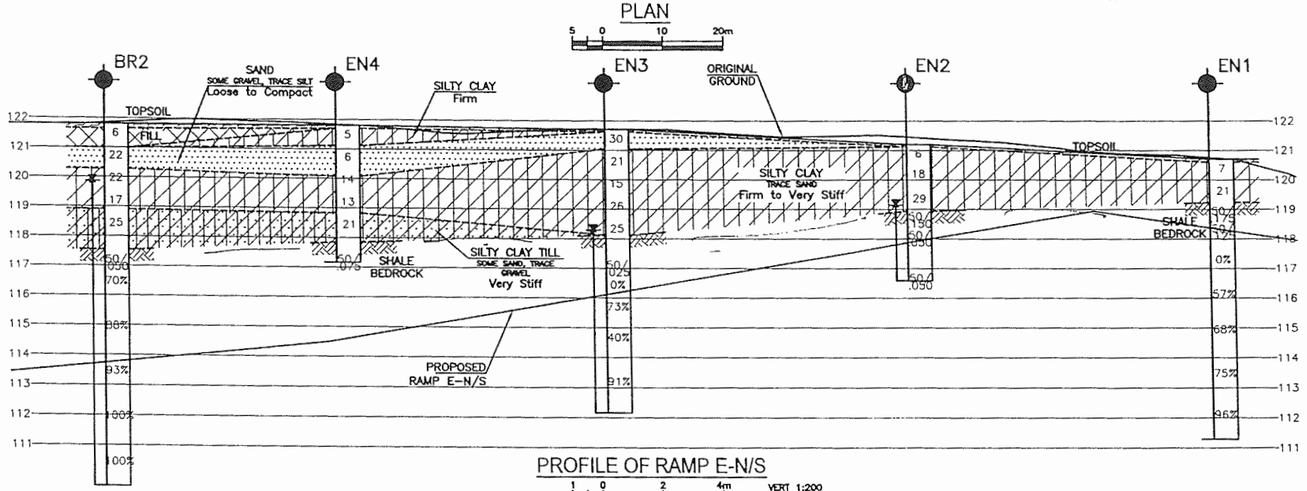

PROFILE OF RAMP E-N/S

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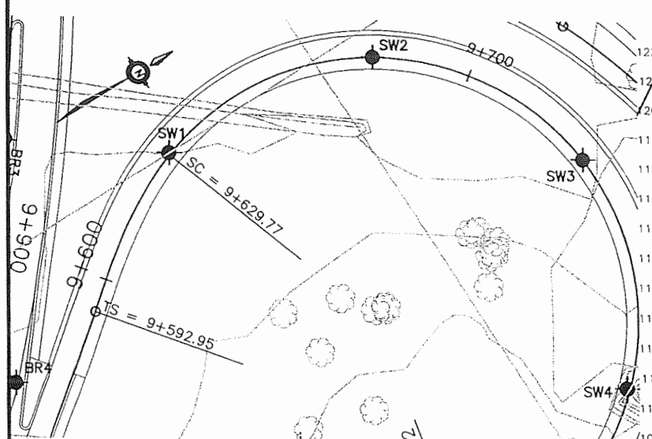
HORT 1:1000



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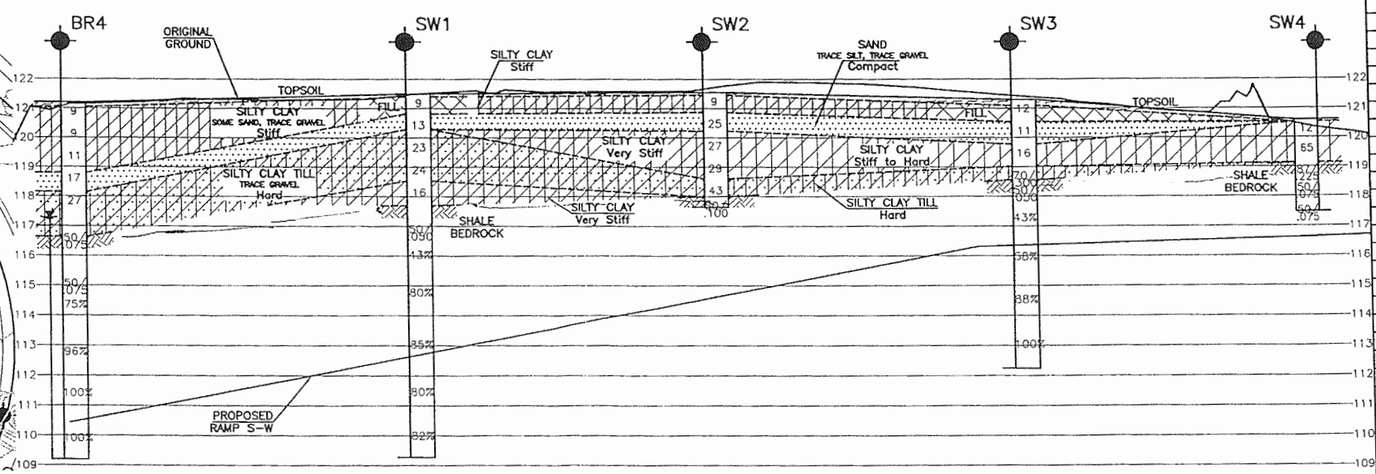

PROFILE OF RAMP S-W

VERT 1:200

HORT 1:1000

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No.169-00-00

BRONTE ROAD DEEP CUTS
RAMP E-N/S AND RAMP S-W
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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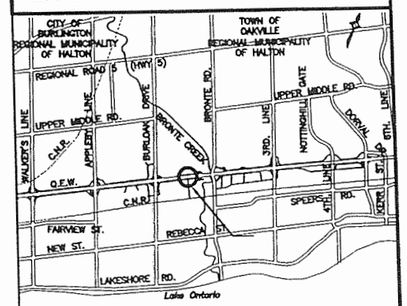
REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
Feb 9/07
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb 9/07
PROVINCE OF ONTARIO



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
EN1	120.7	4 808 066.47	285 401.04
EN2	121.2	4 808 057.68	285 352.20
EN3	121.7	4 808 036.73	285 308.29
EN4	121.8	4 808 000.60	285 273.42
SW1	121.5	4 807 963.49	285 299.96
SW2	121.5	4 808 010.95	285 306.03
SW3	121.3	4 808 036.05	285 347.89
SW4	120.6	4 808 017.52	285 392.87
BR2	121.8	4 807 973.12	285 243.69
BR4	121.3	4 807 910.06	285 323.10

-NOTE-

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS			
DATE	BY	DESCRIPTION	

DESIGN	AEG	CHK	PKC	CODE		LOAD	DATE DEC 2006
DRAWN	JHL	CHK	PKC	SITE		STRUCT	DWG

MINISTRY OF TRANSPORTATION ONTARIO — PR-A-707 — BS-GB — PLOT SCALE 1:1

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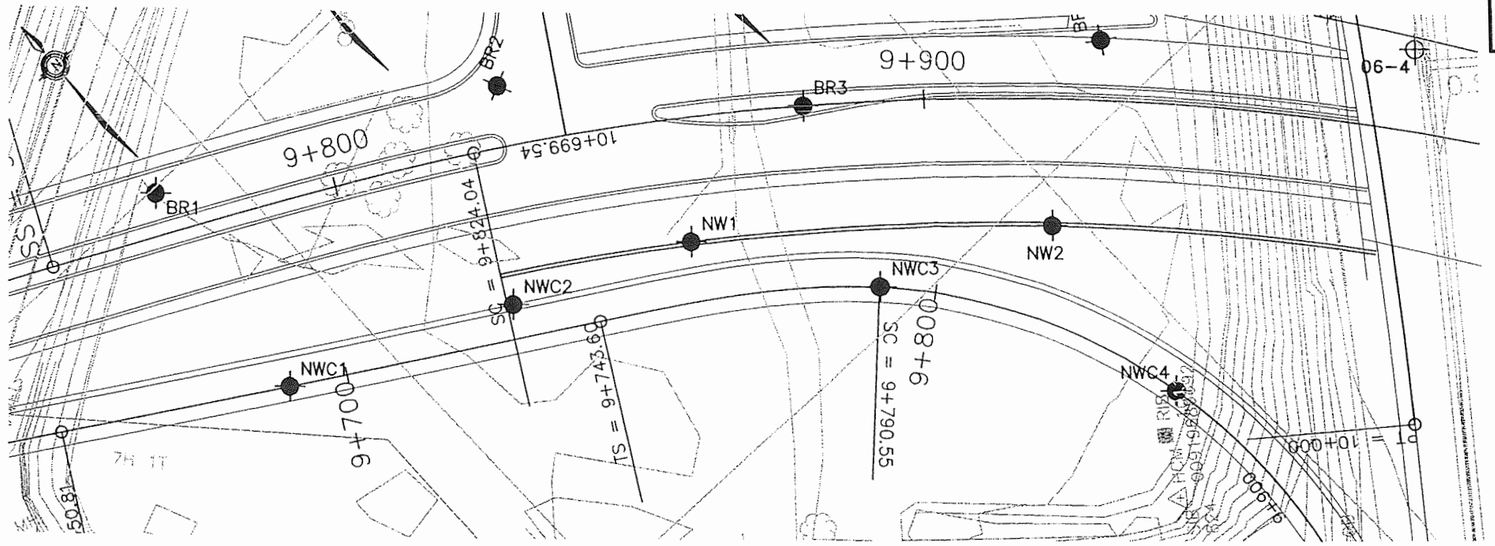
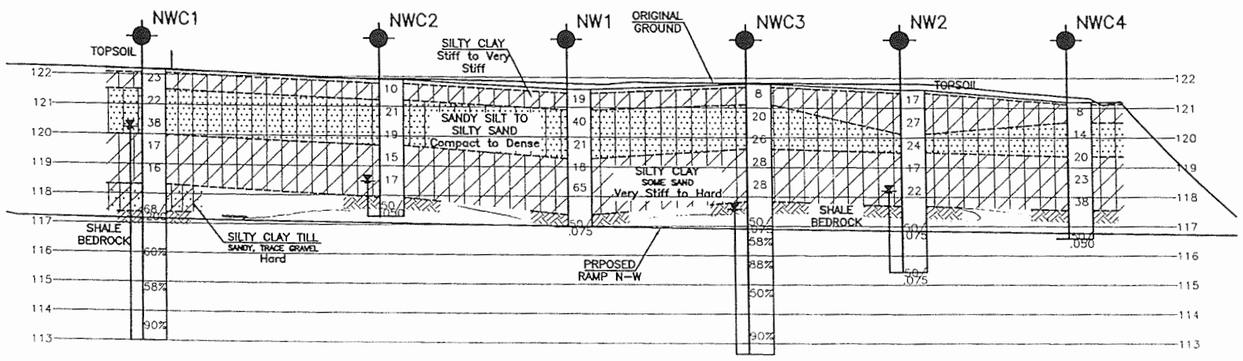


PLAN

5 0 10 20m



PROFILE OF RAMP N-W

1 0 2 4m VERT 1:200

5 0 10 20m HORT 1:1000

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No.169-00-00

SHEET

BRONTE ROAD DEEP CUTS
RAMP N-W
BOREHOLE LOCATIONS AND SOIL STRATA

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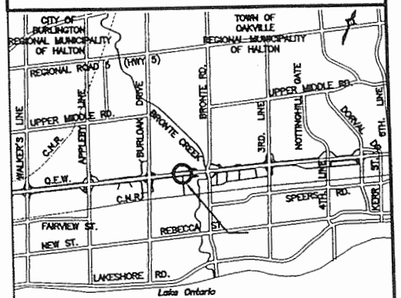

KEYPLAN

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 Refusol

NO	ELEVATION	NORTHING	EASTING
NWC1	122.2	4 807 960.56	285 183.56
NWC2	121.9	4 807 945.13	285 220.84
NWC3	121.8	4 807 905.91	285 267.79
NWC4	121.2	4 807 859.69	285 291.80
NW1	121.6	4 807 932.53	285 249.91
NW2	121.6	4 807 893.63	285 295.84

-NOTE-

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REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
Feb 9/07
PROVINCE OF ONTARIO

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DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN AEG	CHK PKC	CODE	LOAD
DRAWN JHL	CHK PKC	SITE	STRUCT

DATE DEC 2006
DWG

MINISTRY OF TRANSPORTATION, ONTARIO
PR-D-797 BR-28 PLOT SCALE 1:1

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CREATED: DEC 06
MODIFIED:

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PLOTDATE: Dec 21, 2006 - 1:43pm

Appendix E

Site Photographs

Photo 1, General Area of Bronte Road, Ramp S-W, Ramp E-N/S and Ramp N-W Cuts North of QEW

Photo 2, General Area of Bronte Road Cut South of QEW

Appendix F

Text for NSSP

Suggested Text for NSSP on "Rock Excavation"

The strength of the shale bedrock increases with depth and there is presence of very hard limestone and/or siltstone interbeds within the shale bedrock. Bulk excavation and pre-drilling through the sound shale and the hard interbeds may be difficult. As such, intensive use of pneumatic rock splitting/breaking equipment, ripping machinery or other methods of loosening the bedrock may be required and should be available on site to assist in rock excavation.