FOUNDATION INVESTIGATION AND DESIGN REPORT
RETAINING WALLS AND PRIVACY WALL
QEW WIDENING, THIRD LINE TO BURLOAK DRIVE
G.W.P. 169-00-00

Geocres Number: 30M5-251

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed retaining walls and privacy wall to be constructed in connection with the widening of the QEW between Third Line and Burloak Drive 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 plan, borehole logs, stratigraphic profiles, and written description of the subsurface conditions. A model of the subsurface conditions was developed to describe the geotechnical conditions influencing design and construction of the foundations for the proposed retaining walls and privacy wall.

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 project area is located near 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 contain shale and limestone fragments. Wave action in the glacial lake modified the original ground moraine and lacustrine/beach deposits in the form of stratified silts and sands are present at locations along the shoreline of the glacial lake.

The proposed retaining walls will be located between the Bronte Road and Third Line interchanges. In general, the ground surface in the project area slopes downward from north to south: road grades on North Service Road adjacent to the QEW generally range from near elevation 117 to 113 m, falling to the east; grades along the QEW range from approximate elevation 112.5 to 114.5 m; and grades on South Service Road are typically near elevation 112.5 m. Within the area enclosed by the N/S-E ramp of the Bronte Road interchange (on the north side of the QEW), the terrain is largely flat with the ground surface varying between elevations 121 and 122 m, then drops in the order of 4 m to 5 m towards the QEW at approximate elevation 117 m.

Drainage at the site appears to flow southerly and towards the Bronte Creek valley, situated immediately west of Bronte Road and incised approximately 28 m below the surrounding tableland. The valley slopes are steep and cut into shale bedrock. Bronte Creek flows southward to Lake Ontario.

Immediately south of the QEW, the land has been developed for commercial uses, principally a car dealerships 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. A pioneer cemetery exists between the QEW and North Service Road between Third Line and Bronte Road.

3 SITE INVESTIGATION AND FIELD TESTING

Site investigation and field testing at the locations of the proposed retaining walls and privacy wall were carried out during the period November 3 to December 9, 2006. The site investigation consisted of drilling and sampling two to six boreholes along each wall alignment, for a total of 25 boreholes. Several of the boreholes were drilled in conjunction with concurrent fieldwork for deep cuts, high mast lights, overhead signs and utility crossings. The boreholes were terminated in shale bedrock at depths of 1.6 to 9.2 m.

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings in Appendix D. The coordinates and elevations of the boreholes are given on these drawings and on the individual Record of Borehole Sheets in Appendix A.

Prior to the start of drilling, utility clearances were obtained for all borehole locations. Encroachment permits and road occupancy permits were also obtained.

Solid stem augers were used to advance the boreholes in overburden and into shale. Samples were obtained using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). NQ rock coring equipment was used to recover core samples of the underlying bedrock.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The inspector logged the boreholes, visually examined the recovered samples, and transported them to Thurber's laboratory for further examination and testing. The recovered rock core was described in the field, packaged in core boxes with moist towels and parafilm wrap, and returned to our laboratory for examination and testing.

Standpipe piezometers, consisting of 19 mm PVC pipes with slotted tip, were installed in selected boreholes to monitor groundwater levels. The completion details are shown in Table 3.1.

Table 3.1 – Piezometer Details

Piezometer Location	Tip (Sand Filter) Details			Backfill
	Depth	Elevation	Stratum	
NWC2	2.6 – 4.6	119.3 – 117.3	Clayey Silt, Shale	Bentonite to surface
NWC3	7.0 – 9.2	114.8 – 112.6	Shale	Bentonite to surface
NW2	4.0 – 6.2	117.6 – 115.4	Shale	Bentonite to 0.9 m, cuttings to surface
NSR2	2.7 – 4.7	113.8 – 111.8	Silty Clay Till, Sand, Shale	Bentonite to 0.6 m, concrete to surface
WBT1	1.2 – 3.2	112.2 – 110.2	Silty Clay Till, Shale	Bentonite to 0.3 m, concrete to surface
WBT4	0.6 – 2.4	112.7 – 110.9	Silty Clay Till, Shale	Bentonite to 0.3 m, concrete to surface
EBT2	4.3 – 6.2	108.6 – 106.7	Shale	Bentonite to 0.6 m, concrete to surface
EBT5	1.2 – 3.1	111.1 – 109.2	Silty Clay Fill, Silty Clay Till, Shale	Bentonite to 0.3 m, concrete to surface

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A.

Approximately 25% of the recovered samples were subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing. The results are shown on the Record of Borehole sheets in Appendix A and on the charts in Appendix B.

Selected rock core samples were subjected to Point Load Testing to assist evaluation of the compressive strength of the bedrock.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A and the Borehole Locations and Soil Strata Drawings in Appendix D for details of the encountered soil stratigraphy. An overall description of the stratigraphy is given in the following paragraphs however the factual data presented in the borehole logs governs any interpretation of the site conditions.

5.1 Retaining Wall 1: N-W Ramp of QEW/Bronte Road Interchange

Boreholes designated NW1, NW2, NWC2 and NWC3 (Drawing 1) were drilled along or adjacent to the proposed alignment of Retaining Wall 1. The stratigraphy encountered in these boreholes generally consists of a topsoil layer overlying silty clay, underlain by a unit of silty sand to sandy silt, followed by silty clay and silty clay till. Weathered shale bedrock was contacted below the silty clay/till deposits. More detailed descriptions of the individual strata are presented below.

5.1.1 Topsoil

A 100 to 125 mm thick topsoil layer was identified surficially in all boreholes. The topsoil thickness was established only at the borehole locations and may vary between and beyond the borehole locations.

5.1.2 Silty Clay

A layer of silty clay, extending to depths of 0.7 to 1.5 m (elevation 120.1 to 121.2 m), was encountered below the topsoil in the boreholes. Standard penetration test (SPT) N-values obtained in this layer ranged from 8 to 27 blows/0.3 m of penetration, indicating a stiff to very stiff consistency. Moisture contents varied from 11 to 27%.

5.1.3 Silty Sand to Sandy Silt

A non-cohesive unit grading from silty sand to sandy silt was encountered below the silty clay layer. The sand/silt unit ranged in thickness from 0.7 to 1.5 m and has a lower boundary at 2.2 m depth (elevation 119.4 to 119.7 m). SPT N-values obtained in the silty sand to sandy silt typically ranged from 19 to 26 blows/0.3 m, indicating a compact condition. An N-value of 40 (dense) was recorded for one sample in borehole NW1.

Grain size distribution results for the sand/silt are presented on Figure B2 of Appendix B. Moisture contents ranged from about 11 to 21%.

5.1.4 Silty Clay and Silty Clay Till

Cohesive silty clay to silty clay till was encountered below the sand/silt unit. The upper boundary of the clay was contacted at 2.2 m depth (elevation 119.4 to 119.7 m), and the lower boundary was encountered at depths of 3.9 to 4.0 m (elevation 117.7 to 117.9 m). SPT N-values of 15 to 28 blows/0.3 m indicate that the consistency of the silty clay is very stiff. A value of 65 was obtained at one location (borehole NW1) when a shale fragment was encountered.

Grain size distribution results for the silty clay/till are presented on the Record of Borehole sheets and Figures B2 and B3 of Appendix B. Atterberg Limits testing, Figure B5, indicates that the silty clay is of low plasticity. Moisture contents ranged from about 12 to 20%. Although not encountered, glacial till may contain cobbles, boulders and rock slabs.

5.1.5 Shale Bedrock

Shale bedrock was contacted in the boreholes at the following depths and elevations:

Table 5.1 – Depth to Shale

Borehole	Shale	
	Depth (m)	Elevation (m)
NWC2	4.0	117.9
NW1	3.9	117.7
NWC3	4.0	117.8
NW2	3.9	117.7

Boreholes NW1, NW2 and NWC2 were terminated in the shale at depths of 4.6 to 6.2 m. A 4.4 m length of shale core was recovered from borehole NWC3 as part of the deep cut investigation. The bedrock consists of reddish brown, thinly bedded shale of the Queenston Formation with hard limestone interbeds (ranging from 50 to over 300 mm in thickness) and clay seams. In general, the bedrock is highly weathered in the upper 1 to 2 m and becomes moderately weathered and harder below this depth.

Total core recovery (TCR) of the bedrock cores was 100%. The Rock Quality Designation (RQD) of the shale core ranged from 50 to 90%, indicating a fair to good rock quality. An RQD value of 0% was obtained in the initial 150 mm core run. Point Load tests conducted on the cores were generally not representative because the cores would easily split along the bedding planes at very low loads. Where valid tests were completed, the estimated unconfined compressive strengths of the cores varied from 4 to 19 MPa. Compressive strengths of 50 to 100 MPa have been measured in the hard interbedded limestone layers elsewhere on this project.

5.1.6 Water Levels

Water was measured in the open boreholes and piezometers installed in selected boreholes at the levels shown in Table 5.2.

Table 5.2 – Measured Groundwater Levels

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
NWC2	10-Nov-2006	4.1	117.8	In piezometer
	08-Dec-2006	3.4	118.5	In piezometer
NW1	03-Nov-2006	2.5	119.1	Upon completion
NWC3	10-Nov-2006	4.8	117.0	In piezometer
	08-Dec-2006	4.2	117.6	In piezometer
NW2	10-Nov-2006	3.6	118.0	In piezometer
	08-Dec-2006	3.4	118.2	In piezometer

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

5.2 Retaining Wall 2: North Service Road

Boreholes designated NSR1 to NSR4, WBT1 and WBT2 (Drawing 2) were drilled along the proposed alignment of Retaining Wall 2. The stratigraphy encountered in the boreholes generally consists of a crushed stone layer forming the shoulder of North Service Road or a pavement structure on the E-N/S ramp, overlying silty clay fill and/or till, underlain by weathered shale bedrock. More detailed descriptions of the individual strata are presented below.

5.2.1 Shoulder and Pavement Structure

Boreholes NSR1 to NSR3, WBT1 and WBT2 were drilled on the south shoulder of North Service Road and encountered 600 to 800 mm of crusher run limestone. SPT N-values of 15 to 23 blows/0.3 m were obtained in the crushed stone, indicating a compact condition.

Borehole NSR4 was drilled on the E-N/S ramp of the Bronte Road interchange. The pavement structure encountered in the borehole consisted of 200 mm of asphalt over 1100 mm of crusher run limestone. The results of gradation analyses conducted on samples of the granular material are presented on Figure B1, Appendix B.

5.2.2 Silty Clay Fill

Silty clay fill was encountered in boreholes NSR2 and NSR3 located on an elevated section of North Service Road. The fill extended to depths of 2.3 and 1.5 m (elevation 114.2 and 114.9 m). SPT N-values of 6 to 8 blows/0.3 m (firm) were recorded, and moisture contents of 13 to 20% were determined in the fill.

5.2.3 Silty Clay Till

A layer of cohesive silty clay was encountered below the granular material and silty clay fill in all boreholes except WBT2. The till layer was 0.3 to 1.5 m thick, with an upper boundary at depths of 0.6 to 2.3 m (elevation 112.8 to 114.9 m) and lower boundary at depths of 1.5 to 3.0 m (elevation 111.9 to 114.7 m). The consistency of the clay is typically firm to stiff with SPT N-values of 5 to 14 blows/0.3 m obtained where completed in this unit.

Grain size distribution results for the clay till are presented on Figure B4 of Appendix B. Atterberg Limits testing, Figure B8, indicates that the clay till is of low to medium plasticity. Moisture contents ranged from 14 to 22%. Although not encountered, glacial till may contain cobbles, boulders and rock slabs.

5.2.4 Isolated Silt and Sand Layers

A layer of compact (N=16) sand was encountered between the till and shale at 3.0 to 3.8 m depth (elevation 113.4 to 112.7 m), in borehole NSR2 only. Similarly, a layer of hard (N=41) silt was encountered only in borehole NSR3, between the till and bedrock at a depth of 3.0 to 3.7 m (elevation 113.3 to 112.7 m). Moisture contents ranged from 15 to 18%.

5.2.5 Shale Bedrock

Shale bedrock was contacted in the boreholes at the following depths and elevations:

Table 5.3 – Depth to Shale

Borehole	Shale	
	Depth (m)	Elevation (m)
NSR4	1.6	114.7
NSR3	3.7	112.7
NSR2	3.8	112.7
NSR1	1.8	112.6
WBT1	1.5	111.9
WBT2	0.8	112.3

The bedrock consists of reddish brown, thinly bedded shale of the Queenston Formation with hard limestone interbeds and clay seams. The boreholes were terminated in the shale at depths of 2.3 to 4.8 m, approximately 0.7 to 1.7 m below the shale surface. Within this depth, the bedrock is highly weathered. The rock is known to get less weathered and harder with depth. The results of particle size distribution analyses conducted on the shale material are presented on Figure B6.

5.2.6 Water Levels

Water was not observed in the boreholes during or upon completion of drilling. Water was measured in the piezometers installed in two boreholes at the levels shown in Table 5.4.

Table 5.4 – Measured Groundwater Levels

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
NSR2	08-Dec-2006	3.2	113.3	In piezometer
	14-Dec-2006	3.5	113.0	In piezometer
WBT1	08-Dec-2006	2.5	110.9	In piezometer

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

5.3 QEW Westbound Toe Wall

Boreholes designated WBT3 to WBT7 (Drawing 2) were drilled along the proposed alignment of a toe wall on the north side of the QEW. The stratigraphy encountered in the boreholes consists of a crushed stone layer forming the shoulder of North Service Road or a pavement structure on the QEW shoulder, overlying silty clay till, underlain by weathered shale bedrock. More detailed descriptions of the individual strata are presented below.

5.3.1 Shoulder and Pavement Structure

Boreholes WBT3 to WBT6 were drilled on the south shoulder of North Service Road and encountered 600 mm of crusher run limestone. SPT N-values of 14 to 34 blows/0.3 m were obtained in the crushed stone, indicating a compact to dense condition.

Borehole WBT7 was drilled on the paved shoulder of the QEW. The pavement structure encountered in the borehole consisted of 150 mm of asphalt over 650 mm of dense crusher run limestone.

5.3.2 Silty Clay Till

Cohesive silty clay till was encountered below the granular material. The till layer has an upper boundary at 0.6 to 0.8 m depth (elevation 112.5 to 113.0 m), is 0.4 to 0.5 m thick, and is underlain by shale bedrock. SPT N-values obtained in the till and partially into the underlying shale ranged from 10 to 36 blows/0.3 m, indicating a stiff to hard consistency. Moisture contents ranged from about 15 to 18%. Although not encountered, glacial till may contain cobbles, boulders and rock slabs.

5.3.3 Shale Bedrock

Shale bedrock was contacted in the boreholes at the following depths and elevations:

Table 5.5 – Depth to Shale

Borehole	Shale	
	Depth (m)	Elevation (m)
WBT3	1.1	112.0
WBT4	1.1	112.3
WBT5	1.1	112.3
WBT6	1.1	112.5
WBT7	1.2	112.5

The bedrock consists of reddish brown, thinly bedded shale of the Queenston Formation with hard limestone interbeds and clay seams. The boreholes were terminated in the shale at depths of 1.8 to 2.4 m, approximately 0.6 to 1.3 m below the shale surface. Within this depth, the bedrock is highly weathered. The rock is known to get less weathered and harder with depth. The results of particle size analyses (Figure B6) and Atterberg Limits testing (Figure B10) conducted on the shale material classify it as silty clay with low plasticity.

5.3.4 Water Levels

Water was not observed in the boreholes during or upon completion of drilling. On December 8, 2006, no water was detected in the piezometer installed in borehole WBT4. The water level observations are short-term and seasonal fluctuations of the groundwater level are to be expected.

5.4 Retaining Wall 3: Westbound QEW at Cemetery

Boreholes designated WBC1 to WBC3 (Drawing 3) were drilled along the proposed alignment of Retaining Wall 3. The stratigraphy encountered in the boreholes consists of a pavement structure on the QEW shoulder, overlying silty clay till, underlain by weathered shale bedrock. More detailed descriptions of the individual strata are presented below.

5.4.1 Shoulder and Pavement Structure

The pavement structure encountered on the QEW shoulder consisted of 125 to 150 mm of asphalt over 575 to 675 mm of compact to very dense crusher run limestone. The results of sieve analyses on the granular material are presented on Figure B1.

5.4.2 Silty Clay Till

Cohesive silty clay till was encountered below the pavement structure. The till layer has an upper boundary at 0.7 to 0.8 m depth (elevation 113.7 to 114.0 m), is 0.2 to 0.7 m thick, and is underlain by shale bedrock. SPT N-values obtained in the till and partially into the underlying shale ranged from 24 to 55 blows/0.3 m, indicating a very stiff to hard consistency.

A grain size distribution curve for one sample of the silty clay till is presented on Figure B4 of Appendix B. Atterberg Limits testing of this sample, Figure B9, indicates that the silty clay is of low plasticity. Moisture contents ranged from about 8 to 11%.

5.4.3 Shale Bedrock

Shale bedrock was contacted in the boreholes at the following depths and elevations:

Table 5.6 – Depth to Shale

Borehole	Shale	
	Depth (m)	Elevation (m)
WBC1	1.5	113.3
WBC2	0.9	113.8
WBC3	1.0	113.5

Boreholes WBC1 and WBC3 were terminated in the shale at depths of 2.3 and 1.6 m. A 3.0 m length of shale core was recovered from borehole WBC2. The bedrock consists of reddish brown, thinly bedded shale of the Queenston Formation with hard limestone interbeds and clay seams. In general, the bedrock is highly to moderately weathered in the upper 1 to 2 m and becomes slightly weathered and harder below this depth.

Total core recovery (TCR) of the bedrock cores was 100%. The Rock Quality Designation (RQD) of the shale core was 24 and 78%, indicating a very poor to good rock quality. Point Load tests conducted on the cores were generally not representative because the cores would easily split along the bedding planes at very low loads. Where valid tests were completed, the unconfined compressive strengths of the shale were estimated at 6 and

14 MPa. Compressive strengths of 50 to 100 MPa have been measured in the hard interbedded limestone layers elsewhere on this project.

5.4.4 Water Levels

Water was not observed in the boreholes during or upon completion of drilling. Water was introduced into borehole WBC2 during coring and therefore the presence of water in the shale was not investigated. The water level observations are short-term and seasonal fluctuations of the groundwater level are to be expected.

5.5 Retaining Wall 4: QEW Westbound

Boreholes designated EBT1 to EBT5 (Drawing 4) were drilled along the proposed alignment of Retaining Wall 4. The stratigraphy encountered in the boreholes generally consists of a granular shoulder or pavement structure on South Service Road, overlying a discontinuous silty clay fill unit and silty clay till, underlain by weathered shale bedrock. More detailed descriptions of the individual strata are presented below.

5.5.1 Shoulder and Pavement Structure

Boreholes EBT4 and EBT5 were drilled on the north shoulder of South Service Road. The shoulder structure consisted of 1.5 and 0.6 m of sand and gravel. SPT N-values of 13 to 27 blows/0.3 m were obtained in the granular material, indicating a compact condition.

Boreholes EBT1 to EBT3 were drilled through the pavement on South Service Road. The pavement structure encountered in the boreholes consisted of 100 mm of asphalt over 500 mm of compact sand and gravel. The results of a sieve analysis conducted on the granular material are presented on Figure B1.

5.5.2 Silty Clay Fill

Silty clay fill was encountered below the pavement and shoulder structure in boreholes EBT2, EBT3 and EBT5. The fill extended to 1.5 m depth (elevation 110.8 to 111.4 m). STP N-values of 5 to 18 blows/0.3 m (firm to very stiff) were recorded, and moisture contents of 13 to 18% were determined in the fill.

5.5.3 Silty Clay Till

A layer of cohesive silty clay till was encountered below the granular material and silty clay fill in all boreholes. The till layer was 0.8 to 0.9 m thick, with an upper boundary at depths of 0.6 to 1.5 m (elevation 110.8 to 111.8 m) and lower boundary at depths of 1.5 to 2.4 m (elevation 110.0 to 110.9 m). The consistency of the clay till is firm to very stiff with SPT N-values ranging from 6 to 22 blows/0.3 m in this unit.

Grain size distribution results for the clay till are presented on Figure B4 of Appendix B. Atterberg Limits testing, Figure B9, indicates that the plasticity of the clay till ranges from low to high. Moisture contents ranged from 11 to 17%, with one value of 31% measured in a sample from borehole EBT3.

5.5.4 Shale Bedrock

Shale bedrock was contacted in the boreholes at the following depths and elevations:

Table 5.7 – Depth to Shale

Borehole	Shale	
	Depth (m)	Elevation (m)
EBT1	1.5	110.9
EBT2	2.4	110.4
EBT3	2.3	110.4
EBT4	2.3	110.3
EBT5	2.3	110.0

Boreholes EBT1 and EBT3 to EBT5 were terminated in the shale at depths of 2.4 to 3.2 m. A 2.9 m length of shale core was recovered from borehole EBT2 as part of the HML foundation investigation. The bedrock consists of reddish brown, thinly bedded shale of the Queenston Formation with hard limestone interbeds and clay seams. In general, the bedrock is highly weathered in the upper 1 to 2 m and becomes moderately weathered and harder below this depth.

Total core recovery (TCR) of the two bedrock core runs was 80 and 100%. The Rock Quality Designation (RQD) of the shale core was 45 and 61%, indicating a poor to fair rock quality. Point Load tests conducted on the cores were generally not representative because the cores would easily split along the bedding planes at very low loads. The results of particle size analyses (Figure B7) and Atterberg Limits testing (Figure B10) conducted on the shale material classify it as silty clay with low to medium plasticity.

5.5.5 Water Levels

Water was not observed in the boreholes during or upon completion of drilling. Water was measured in the piezometers installed in selected boreholes at the levels shown in Table 5.8.

Table 5.8 – Measured Groundwater Levels

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
EBT2	08-Dec-2006	4.4	108.5	In piezometer
EBT5	08-Dec-2006	Dry	-	In piezometer

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

5.6 Privacy Wall

Boreholes designated PW1 and PW2 (Drawing 1) were drilled along the proposed alignment of the privacy wall. The stratigraphy encountered in the boreholes consists of a fill or topsoil layer overlying sand and silt deposits, underlain by silty clay till and weathered shale bedrock. More detailed descriptions of the individual strata are presented below.

5.6.1 Granular Fill

A 800 mm thick layer of crusher run limestone was encountered in borehole PW1 located on secondary residential driveway. An SPT N-value of 12 blows/0.3 m was obtained in the granular material, indicating a compact condition.

5.6.2 Topsoil

A 75 mm thick topsoil layer was identified surficially in borehole PW2. The topsoil thickness was established only at the borehole location and may vary at other locations.

5.6.3 Sand

A 1.2 to 1.5 m thick layer of sand was encountered below the fill and topsoil. SPT N-values obtained in the sand ranged from 4 to 6 blows/0.3 m, indicating a loose condition. Moisture contents of about 16 to 18% were obtained in the sand.

5.6.4 Silt to Sandy Silt

A non-cohesive unit of silt, grading to sandy silt in the upper 0.8 m of this unit, was encountered below the sand. The silt unit was 2.6 to 2.8 m thick, with an upper boundary at depths of 2.0 and 1.5 m (elevation 123.5 and 122.5 m) and a lower boundary at 4.6 and 4.3 m (elevation 120.9 and 119.7 m). SPT N-values obtained in the silt ranged from 12 to 34 blows/0.3 m, indicating a compact to dense condition.

Grain size distribution results for the silt are presented on Figure B2 of Appendix B. Moisture contents ranged from about 16 to 21%.

5.6.5 Silty Clay Till

Cohesive silty clay till was encountered below the silt unit. The upper boundary of the clay was contacted at depths of 4.6 and 4.3 m (elevation 120.9 and 119.7 m), and the lower boundary was encountered at depths of 5.8 and 5.2 m (elevation 119.7 and 118.8 m). SPT N-values of 19 and 30 blows/0.3 m indicate that the consistency of the till is very stiff to hard.

Grain size distribution results for the silty clay till are presented on the Record of Borehole sheets and Figure B5 of Appendix B. Atterberg Limits testing, Figure B9, indicates that the till is of low plasticity. Moisture contents of about 10 and 14% were obtained.

5.6.6 Shale Bedrock

Shale bedrock was contacted in the boreholes at the following depths and elevations:

Table 5.9 – Depth to Shale

Borehole	Shale	
	Depth (m)	Elevation (m)
PW1	5.8	119.7
PW2	5.2	118.8

The bedrock consists of reddish brown, thinly bedded shale of the Queenston Formation with hard limestone interbeds and clay seams. The boreholes were terminated in the shale at depths of 6.2 and 5.5 m, approximately 0.4 and 0.3 m below the shale surface. Within this depth, the bedrock is highly weathered. The rock is known to get less weathered and harder with depth.

5.6.7 Water Levels

Water was measured in borehole PW2 at 4.6 m depth (elevation 119.4 m) upon completion of drilling. Water was not observed in borehole PW1 during or upon completion of drilling. The water level observations are short-term and seasonal fluctuations of the groundwater level are to be expected.

6 MISCELLANEOUS

J.D. Barnes Limited completed field layout for the site investigation and provided borehole coordinates and ground surface elevations.

DBW Drilling Limited supplied and operated the drilling and sampling equipment used for the investigation. Full time supervision of the field activities, including obtaining utility clearances, was carried out by Mr. Stephane Loranger, Mr. George Azzopardi, and Ms. Jessica Lee of Thurber.

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

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FOUNDATION INVESTIGATION AND DESIGN REPORT
RETAINING WALLS AND PRIVACY WALL
QEW WIDENING, THIRD LINE TO BURLOAK DRIVE
G.W.P. 169-00-00

Geocres Number: 30M5-251

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team to select and design a suitable foundation system for the proposed retaining walls and privacy wall.

At present, four retaining walls, a toe wall and a privacy wall are proposed in connection with this project. Preliminary drawings showing the proposed wall type and design were provided by the Prime Consultant during preparation of this report. The proposed type, length and height of each wall shown on the drawings are as follows:

Facility	Location	Length (m)	Maximum Retained Height (m)	Type
Retaining Wall 1	QEW-Bronte Road Interchange, N-W Ramp	65	2.5	RSS
Retaining Wall 2	North Service Road	268	4.0	Reinforced Concrete
Toe Wall	QEW Westbound	200	1.6	OPSD 3120.100
Retaining Wall 3	QEW Westbound at Cemetery	80	2.1	Soldier Pile
Retaining Wall 4	QEW Eastbound	182	1.8	Reinforced Concrete
Privacy Wall	Bronte Road	60	-	-

Based on the results of the exploratory boreholes drilled at the proposed wall locations, the stratigraphy at the site generally consists of pavement/shoulder structures and fill associated with the existing roadworks, a discontinuous layer of glaciolacustrine sands/silts, and silty clay to silty clay till. The site is underlain by shale bedrock at depths of 0.8 to 5.8 m.

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 the investigation.

8 RETAINING WALL FOUNDATIONS

Recommendations and corresponding geotechnical design parameters for each proposed wall are presented in this section. Initially, consideration was given to the following foundation types:

- Spread footings on native soil
- Spread footings on shale bedrock
- Spread footings on engineered fill
- Caissons (drilled shaft piles)
- Driven steel H-piles.

A comparison of the advantages and disadvantages of the different foundations schemes for each individual wall is presented in Table C1 of Appendix C.

In consideration of the proposed wall types prescribed by the Prime Consultant, and the subsurface conditions encountered in the boreholes, spread footings on shale were selected as the most practical design for support of all retaining walls except Retaining Wall 3, which was specified by the designer to be a soldier pile wall. Native soil was either not present at the design level or considered too variable for support of the footings. Driven pile foundations were eliminated from further consideration for all walls in view of the shallow depth to bedrock and the higher cost than footings. Similarly, caisson foundations were not considered further for all but Retaining Wall 3.

The recommendations presented in this section address the design of the preferred foundation schemes, as well as alternative systems where practical.

8.1 Retaining Wall 1

The proposed retaining wall design consists of a retained soil system (RSS) with a maximum height of 2.6 m. The base of the wall will be at elevation 113.4 to 114.15 m, which is approximately 3.2 to 4.4 m below the bedrock surface encountered in the boreholes. Therefore, it is anticipated that this wall will be founded on shale bedrock.

The RSS wall must meet the Ministry's specifications for "High Performance" and "High Appearance" systems. Therefore it is critical that the RSS wall is not subject to settlement due to compression of the foundation soils. An RSS system is considered suitable for the subsurface conditions at this site and is expected to meet the aesthetic and structural requirements.

The shale bedrock at the proposed founding level is considered capable of supporting a concentric, vertical geotechnical resistance of 1,000 kPa at factored ULS. The bearing resistance at SLS (25 mm of settlement) will not govern design of spread footings on shale bedrock.

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

The lateral resistance of the footings founded on shale may be computed using an unfactored friction coefficient of 0.55. This is an "ultimate" value and requires a degree of sliding movement to occur to fully mobilize the resistance.

Global stability of the RSS wall founded on shale bedrock is not a concern.

All foundation excavation should be carried out in accordance with SP 902S01. Shale is prone to rapid deterioration upon exposure to water and air, and therefore a 100 mm thick mat of concrete should be placed over the founding surfaces within 24 hours of excavation, inspection and approval. The mat concrete should be of the same class as the footing concrete.

Alternate Wall Design

The proposed top of pavement level behind the wall will be near elevation 117.2 m, which is approximately 0.5 m below the shale surface encountered in the boreholes. Therefore the material behind the full height of the wall will consist of shale bedrock. To limit the quantity of rock excavation, consideration may be given to constructing a near-vertical rock cut protected by a concrete facing instead of an RSS wall.

Typically, this facing should be poured neat against the rock face, except for the provision of drainage. To maintain contact between the concrete and the rock mass, "passive" rock anchors such as rock dowels that are grouted but not prestressed or resin grouted rock bolts should be used.

The rock dowels/bolts should be fully grouted a minimum length of 2 m into the rock mass and designed using an ultimate bond resistance of 400 kPa. Due to the presence of horizontal bedding planes in the shale, it is recommended that the dowels/bolts be installed sub-horizontally to minimize the unlikely event of "pull-out". The suppliers of the proprietary system should be consulted for further details of such application of their products.

Prior to placing the concrete facing, the exposed rock slopes should be scaled and any loose rock fragments should be removed as per OPSS 206. Anchor installation should be carried out in accordance with OPSS 942.

Some form of drainage should be provided behind the concrete facing. Consideration may be given to placing proprietary strip drains at a spacing of 1.5 m, connected to a header pipe, on the rock face prior to forming the concrete facing.

8.2 Retaining Wall 2

The preliminary design drawings provided by the Prime Consultant indicate that the proposed retaining wall will consist of a reinforced concrete structure with a maximum height of approximately 4.0 m. The proposed founding level will range from elevation 111.2 to 112.5 m for all of the wall length except the western 40 m, where it will rise to elevation 114.7 m. These levels are approximately 0.0 to 1.1 m below the bedrock surface encountered in the boreholes. Therefore, it is anticipated that the wall will be supported on footings placed on shale bedrock.

The shale bedrock at the proposed founding level is considered capable of supporting a concentric, vertical geotechnical resistance of 750 kPa at factored ULS. The bearing resistance at SLS (25 mm of settlement) will not govern design of spread footings on shale bedrock.

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

The potential exists that the design founding level may be above the bedrock surface locally, notably at the west end of the wall where the founding level rises and the wall extends over the existing E-N/S Ramp. For consistency of performance, it is recommended that all footings extend to rock and that any difference between the rock elevation and design founding level be made up with mass concrete. The mass concrete should extend a minimum 0.5 m beyond the edge of footing and be of the same class as the footing concrete.

The lateral resistance of the footings founded on shale may be computed using an unfactored friction coefficient of 0.55. This is an "ultimate" value and requires a degree of sliding movement to occur to fully mobilize the resistance.

All foundation excavation should be carried out in accordance with SP 902S01. Shale is prone to rapid deterioration upon exposure to water and air, and therefore a 100 mm thick mat of concrete should be placed over the founding surfaces within 24 hours of excavation, inspection and approval. The mat concrete should be of the same class as the footing concrete.

A storm sewer will be installed along the outside of the QEW shoulder immediately in front of the wall. The toe of the retaining wall might extend over the sewer trench backfill. It is recommended that the trench backfill in this area comprise mass concrete of the same class as the footing concrete. The concrete backfill should be placed within 72 hours of trench excavation.

8.3 Toe Wall

Toe wall design should be in accordance with OPSD 3120.100. A toe wall set approximately 450 mm below the finished road grade as per the OPSD will be founded on compacted granular materials, overlying stiff to hard silty clay till or compacted fill placed to establish the widened road platform, underlain by shale bedrock at shallow depth. Provided the toe wall is placed on compacted granular fill, the toe wall may be designed using factored ULS resistances of 200 kPa for a Type I wall and 300 kPa for Type II and Type III walls as specified in the standard drawing.

Fill placed under the wall must consist of OPSS Granular A compacted in accordance with OPSS 501. The base of the engineered fill must extend laterally beyond the base of the wall a distance at least equivalent to the depth of fill.

8.4 Retaining Wall 3

The preliminary design drawings provided by the Prime Consultant indicate that the proposed retaining wall will consist of a soldier pile and lagging system with a maximum height of 2.1 m. The foundation concept calls for steel W-piles installed in 600 mm diameter pre-augered holes and filled with concrete (caisson). The top of the caisson will range from elevation 113.2 to 113.8 m, which is approximately 1.0 m below, to 0.3 m above, the bedrock surface encountered in the boreholes.

Resistance to lateral movement of a soldier pile retaining wall will be provided by the passive earth pressure developed on the face of the socket embedded in the shale bedrock below the frost depth. Resistance within the fill and silty clay above the shale surface should be neglected.

The lateral resistance that can be mobilized in front of the pile socket may be computed using the coefficient of horizontal subgrade reaction k_s and ultimate lateral resistance p_{ult} estimated as follows:

k_s = $67\ s_u / D$ (kN/m^3)

p_{ult} = $2\ s_u$ (kPa) at bedrock surface, increasing linearly to
$9\ s_u$ (kPa) at a depth of 3 caisson diameters (D) and below

where s_u = undrained shear strength
= 500 kPa for the upper 2 m of weathered shale
= 1,000 kPa for shale at least 2 m below the shale surface

The recommended parameters may be used for numerical analysis of the interaction between the caisson and surrounding soil. The lateral pressures obtained by the numerical analysis should not exceed the ultimate lateral resistance.

The spring constant K_s and ultimate spring load P_{ult} values for numerical analysis can be obtained by multiplying the k_s and p_{ult} values by the caisson diameter and the vertical distance between nodal points of the numerical model mesh along the caisson. The ultimate lateral resistance of a 0.6 m diameter caisson should not exceed a total of 300 kN.

8.5 Retaining Wall 4

The preliminary design drawings provided by the Prime Consultant indicate that the proposed retaining wall will consist of a reinforced concrete structure with a maximum height of approximately 1.8 m. The proposed founding level will range from elevation 111.6 to 112.1 m, which is approximately 1.2 to 1.6 m above the bedrock surface encountered in the boreholes. Construction of footings on the silty clay till or fill overlying the bedrock is not recommended due to the relatively low bearing resistance available and variability of this material.

It is recommended that the fill and silty clay below the founding level be excavated to the bedrock surface and replaced with mass concrete, or that the footings be extended down to penetrate the silty clay and founded on the underlying shale bedrock. The mass concrete should extend at least 0.5 m beyond the edge of footing and be of the same class as the footing concrete. The recommended design founding levels for mass concrete or deepened footings are as follows:

Sta. 12+390 to 12+420	El. 110.5 m
Sta. 12+420 to 12+520	El. 110.2 m
Sta. 12+520 to 12+572	El. 109.9 m

Footings constructed on mass concrete or the shale bedrock may be designed using a concentric, vertical geotechnical resistance of 750 kPa at factored ULS. The bearing resistance at SLS (25 mm of settlement) will not govern design of spread footings on shale bedrock.

Alternatively, the footings may be founded on engineered fill constructed by excavation of the silty clay fill/till and replacement with compacted granular material. The underside of the engineered fill should be placed on bedrock at the elevations indicated above for mass concrete. The engineered fill must consist of OPSS Granular A placed in accordance with OPSS 501, and to the limits illustrated in Figure 1 of Appendix C.

Provided a minimum footing width of 2 m is maintained, a footing bearing on the engineered fill may be designed for a concentric, vertical geotechnical resistance of 900 kPa at factored ULS and a resistance of 350 kPa at SLS.

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

The lateral resistance of the footings may be computed using an unfactored friction coefficient of 0.55 when founded on shale or 0.7 on engineered fill. This is an "ultimate" value and requires a degree of sliding movement to occur to fully mobilize the resistance.

All foundation excavation should be carried out in accordance with SP 902S01. Shale is prone to rapid deterioration upon exposure to water and air, and therefore a 100 mm thick mat of concrete should be placed over the founding surfaces within 24 hours of excavation, inspection and approval. The mat concrete should be of the same class as the footing concrete.

8.6 Frost Protection

The depth of earth cover required to provide frost protection for footings at this site is 1.2 m. Although the shale is geologically defined as rock, protection against frost action must also be provided for the bedrock.

It is possible to reduce the thickness of earth cover by the substitution of synthetic insulation. A 25 mm thickness of rigid, extruded polystyrene insulation is equivalent to 600 mm of earth cover. Synthetic insulation must be covered to provide protection where it is used.

9 PRIVACY WALL

The privacy wall will consist of a noise and visual barrier supported on augered caisson posts (Durisol wall or equivalent). Recommended geotechnical parameters for the design of the caisson foundations are presented in Table 9.1.

Table 9.1 – Privacy Wall Foundation Design Parameters

Borehole Number	Subsurface Stratigraphy			Foundation Design Parameters			
	Material	Depth* (m)	Elevation	q_u (kPa)	ϕ (deg.)	γ (kN/m^3)	Depth to Groundwater (m)
PW1	Sand, loose	1.2 – 2.0	124.3 – 123.5	-	30	20	4.6
	Silt, compact	2.0 – 4.6	123.5 – 120.9	-	30	20	
	Clay till, hard	4.6 – 5.8	120.9 – 119.7	200	-	20	
	Shale	5.8 –	119.7 –	-	40	23	
PW2	Sand, loose	1.2 – 1.5	122.8 – 122.5	-	30	20	4.6
	Silt, compact	1.5 – 4.3	122.5 – 119.7	-	30	20	
	Clay till, very stiff	4.3 – 5.2	119.7 – 118.8	150	-	20	
	Shale	5.2 –	118.8 –	-	40	23	

* Ignore resistance in upper 1.2 m due to frost effects.

The geotechnical parameters presented in Table 9.1 are defined as follows:

For cohesionless soil:

ϕ = angle of internal friction of soil (degrees)

γ = unit weight of soil (kN/m^3)
below water table, use submerged unit weight: $\gamma' = \gamma - 9.8$ kN/m^3

For cohesive soil:

q_u = unconfined compressive strength (kPa)
= 2 x undrained shear strength, c_u

The passive earth pressure coefficient, K_p, for cohesionless soils may be calculated using the following equations:

For a horizontal ground surface:

$$K_p = \frac{1 + \sin\phi}{1 - \sin\phi}$$

For a sloping ground surface:

$$K_p = \left[\frac{\cos\phi}{1 - \sqrt{\sin\phi\,(\sin\phi - \cos\phi\,\tan\beta\,)}}\right]^2$$

where β = slope inclination from horizontal (degrees)

The lateral resistance within the upper 1.2 m below final grade should be neglected in the foundation design to account for frost effects and potential surficial disturbance. Any sloping ground surface or berm slope in front of the caisson will reduce the lateral passive resistance to be considered in design. The length of caisson should be sufficient to withstand all lateral loads including wind loads, and to counteract frost jacking forces.

Load factors and geotechnical resistance factors should be applied for caisson design as per the CHBDC (2000).

The fill and till soils are likely to contain shale and limestone fragments, and possibly cobbles and boulders, that must be penetrated or removed during caisson installation. The shale contains hard interbeds of limestone, siltstone or calcareous shale that may slow production and/or require the use of coring or breaking equipment to penetrate.

10 EXCAVATION

All excavation must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the fill, native sand/silt and firm to very stiff silty clay at this site may be classed as Type 3 soil. The hard clay till may be classed as Type 2 soil. Near vertical sideslopes may be employed for temporary excavation in the shale.

Roadway protection should be supplied in accordance with OPSS 539 and designed for Performance Level 2. Soil parameters for design are given in a subsequent section of this report.

Use of a hydraulic excavator should be suitable for excavation in the overburden. Provision should be made for handling of the pavement materials, possible obstructions in the fill, and cobbles, boulders, and slabs/fragments of shale and limestone in the clay or fill during excavation.

Excavation of the upper 1 to 2 m of the shale should be possible using heavy excavation equipment supplemented by rippers or pneumatic rock breakers to penetrate layers of hard material. The shale becomes less weathered and harder with depth and intensive use of pneumatic/hydraulic breakers will likely be required. The contract documents should contain an NSSP alerting the contract bidders that rock excavation may require the use of such equipment. Suggested wording for this NSSP is provided in Appendix C.

11 UNWATERING

Water was not observed in the majority of the boreholes during or upon completion of drilling. Water was measured at depths of 2.5 to 4.8 m in selected piezometers at the locations of Retaining Walls 1, 2 and 4 and the privacy wall. In all cases except borehole NSR2 drilled at Retaining Wall 2, the water levels were measured within silty clay, silty clay till or shale units. Considering the consistency and relatively low permeability of the soils and shale on site, dewatering using sumps and pumps is considered feasible.

Perched water may be encountered in the fill or sand/silt deposits of glaciolacustrine origin encountered north of the QEW (borehole NSR2 or within the N/S-W ramp), particularly if wet weather conditions persist prior to construction. As well, concentrated seepage may be experienced from seams or fractures in the shale bedrock. Assuming that the deep cuts for the realignment of Bronte Road and the interchange ramps will be carried out prior to retaining wall construction, seepage should be minimal.

The design of any dewatering system that may be required is the responsibility of the Contractor.

12 BACKFILL AND LATERAL EARTH PRESSURES

Backfill to the retaining walls should consist of Granular A or Granular B material. The backfill must be in accordance with OPSS 902 as amended by Special Provision 902S01, and placed to the extents shown in OPSD 3121.150. Backfill to the toe walls should be in accordance with OPSD 3120.100.

The design of the retaining walls must incorporate a subdrain as shown in OPSD 3190.100.

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

Earth pressures acting on the walls may be assumed to be triangular and to be governed by the characteristics of the backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC (2000) but generally are given by the expression:

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

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

K = earth pressure coefficient (see Table below)

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

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

q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the retaining wall are dependent on the material used as backfill. Typical values for granular backfill are shown in Table 12.1.

Where space restrictions do not allow excavation and backfilling with granular material to the extents shown in the OPSD, geotechnical parameters for on-site silty clay fill and silty clay till, also shown in Table 12.1, should be employed. In this case, full hydrostatic pressure should be assumed to act on the wall.

Table 12.1 – Earth Pressure Coefficients (K)

Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35°$, $\gamma = 22.8$ kN/m^3		OPSS Granular B Type I $\phi = 32°$, $\gamma = 21.2$ kN/m^3		Firm to Stiff Silty Clay Fill or Till $\phi = 28°$, $\gamma = 20.0$ kN/m^3	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.40	0.31	0.43	0.36	-
At rest (Restrained Wall)	0.43	-	0.47	-	0.53	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	2.8	-

In conventional design, the use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) might be preferred as it results in lower earth pressures acting on the wall.

The factors in Table 12.1 above are "ultimate" values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the Canadian Highway Bridge Design Code.

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

13 CONSTRUCTION CONCERNS

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

- The fill and till soils may contain shale and limestone slabs/fragments, and possibly cobbles and boulders, that must be penetrated or removed during excavation or post installation.
- Undulations in the shale surface may be encountered, requiring additional rock excavation or sub-excavation of additional fill/soil to follow the bedrock surface between borehole locations.
- The upper part of the shale bedrock is highly weathered and often resembles a till soil. Therefore precise definition of the shale surface in the boreholes is difficult. The bedrock surface elevation determined in a large open excavation may vary from that defined in the boreholes.
- The shale contains hard interbeds of limestone, siltstone or calcareous shale that may slow production and/or require the use of coring or breaking equipment to penetrate. Excavation of the shale bedrock may require the use of rock excavation methods such as pneumatic rock breakers to penetrate hard limestone interbeds

- To prevent softening and degradation of the shale, exposed bearing surfaces must be protected by placement of a mud slab within 24 hours of completion.
- Perched water may be encountered in the fill or sand/silt deposits on site. As well, concentrated seepage may be experienced from seams or fractures in the shale bedrock.

14 CLOSURE

Engineering analysis and preparation of the foundation design report was conducted by Mr. Murray Anderson, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT(1) 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS	Split Spoon Sample
WS	Wash Sample
AS	Auger (Grab) Sample
TW	Thin Wall Shelby Tube Sample
TP	Thin Wall Piston Sample
PH	Sampler Advanced by Hydraulic Pressure
PM	Sampler Advanced by Manual Pressure
WH	Sampler Advanced by Self Static Weight
RC	Rock Core
SC	Soil Core

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

▽ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

SYMBOLS

▨	CLAYSTONE
┅	SILTSTONE
░	SANDSTONE
■	COAL
▩	Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

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

STRENGTH CLASSIFICATION

Rock Strength	**Approximate Uniaxial Compressive Strength**		**Field Estimation of Hardness***
	(MPa)	(psi)	
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

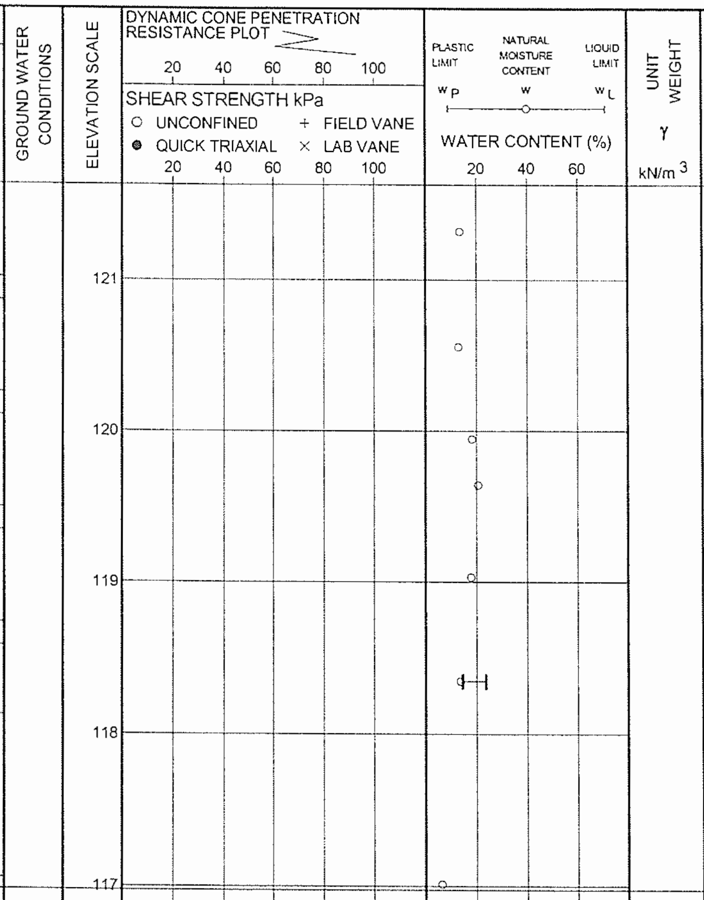
THURBER

RECORD OF BOREHOLE No 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	NUMBER	TYPE	"N" VALUES	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 0.7	Silty **SAND**, with clayey silt layers, some gravel Dense to Compact Brown Wet	2	SS	40	6	72	22 (SI+CL)	
		3	SS	21				
119.4 2.2	Silty **CLAY** Very Stiff Brown to Grey Wet	4	SS	18				
118.6 3.0	Silty **CLAY**, some sand, with approximate 100mm thick shale layer Hard Reddish Brown	5	SS	65	0	12	67	21
117.7 3.9	Highly weathered, thinly bedded, **SHALE**							
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.	6	SS	50/ .075				



+3, ×3: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 19/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NW2

1 OF 1 **METRIC**

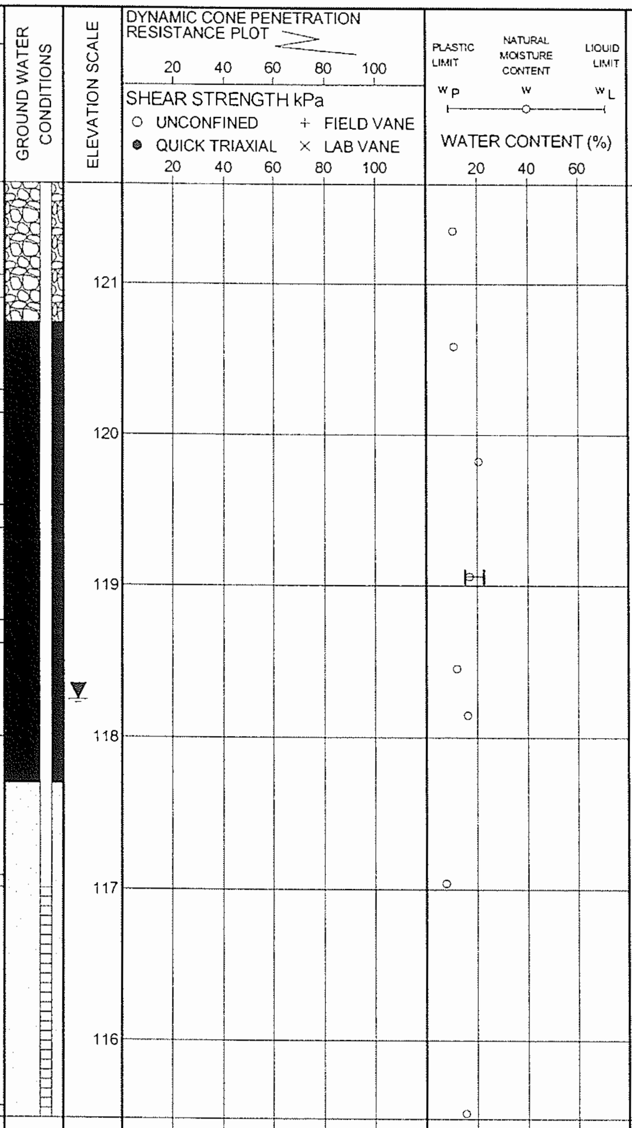
G.W.P. 169-00-00	LOCATION QEW, Third Line to Burloak Drive N 4 807 893.63 E 285 295.84		ORIGINATED BY SLL
HWY QEW	BOREHOLE TYPE Solid Stem Auger		COMPILED BY JHL
DATUM Geodetic	DATE 03.11.06 - 03.11.06		CHECKED BY MEF

SOIL PROFILE

ELEV DEPTH	DESCRIPTION
121.6	
0.0	TOPSOIL: (100 mm)
0.1	Silty **CLAY**, some sand, trace shale fragments, with topsoil staining Very Stiff Brown
120.1 1.5	Sandy **SILT**, trace clay Compact Brown Wet
119.5 2.1	Silty **CLAY**, trace sand seams Very Stiff Brown (TILL)
117.7 3.9	Highly weathered, thinly bedded, reddish brown, **SHALE**, with greenish grey limestone interbeds Hard
115.4 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.

SAMPLES

NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	17				
2	SS	27				
3	SS	24				
4	SS	17	0	1	75	23
5	SS	22				
6	SS	50/ .075				
7	SS	50/ .075				



UNIT WEIGHT γ kN/m³

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
10.11.06	3.58	118.02
08.12.06	3.41	118.19

ONTMT4S 5127A.GPJ 18/12/06

+ 3, × 3: Numbers refer to Sensitivity

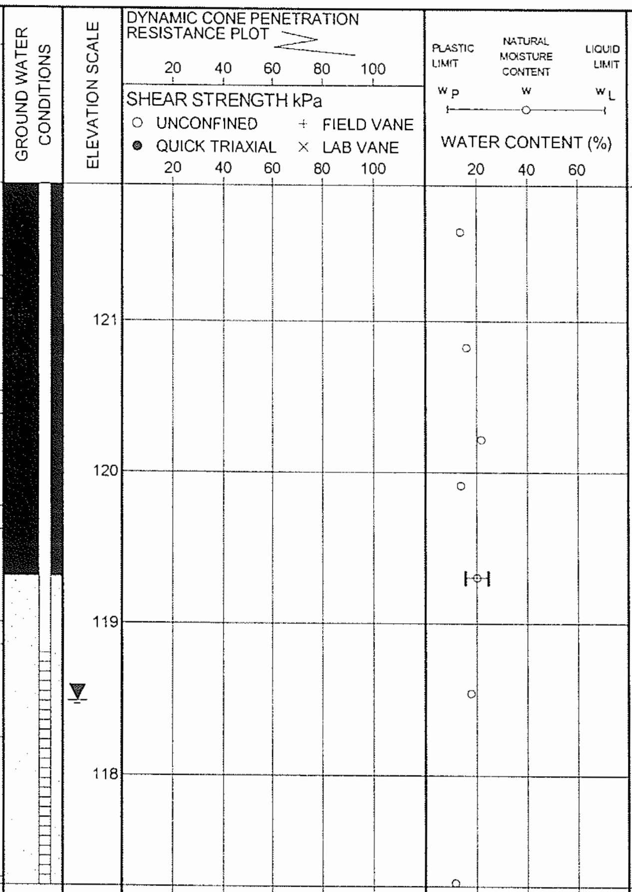
20
15 5
10
(%) STRAIN AT FAILURE

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

SOIL PROFILE		SAMPLES			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
121.9								
0.0	TOPSOIL: (125 mm)							
0.1	Silty **CLAY**, trace sand Stiff Brown	1	SS	10				
121.2 0.7	**SAND**, some silt to silty, trace clay, trace shale fragments Compact Brown Wet	2	SS	21	7	66	19	9
		3	SS	19				
120.0 1.8	Sandy **SILT**, trace clay Compact Brown Moist							
119.7 2.2	Silty **CLAY**, trace sand Very Stiff Grey (CL)	4	SS	15	0	1	74	25
		5	SS	17				
117.9 4.0	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard							
117.2 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				



UNIT WEIGHT γ kN/m³

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

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

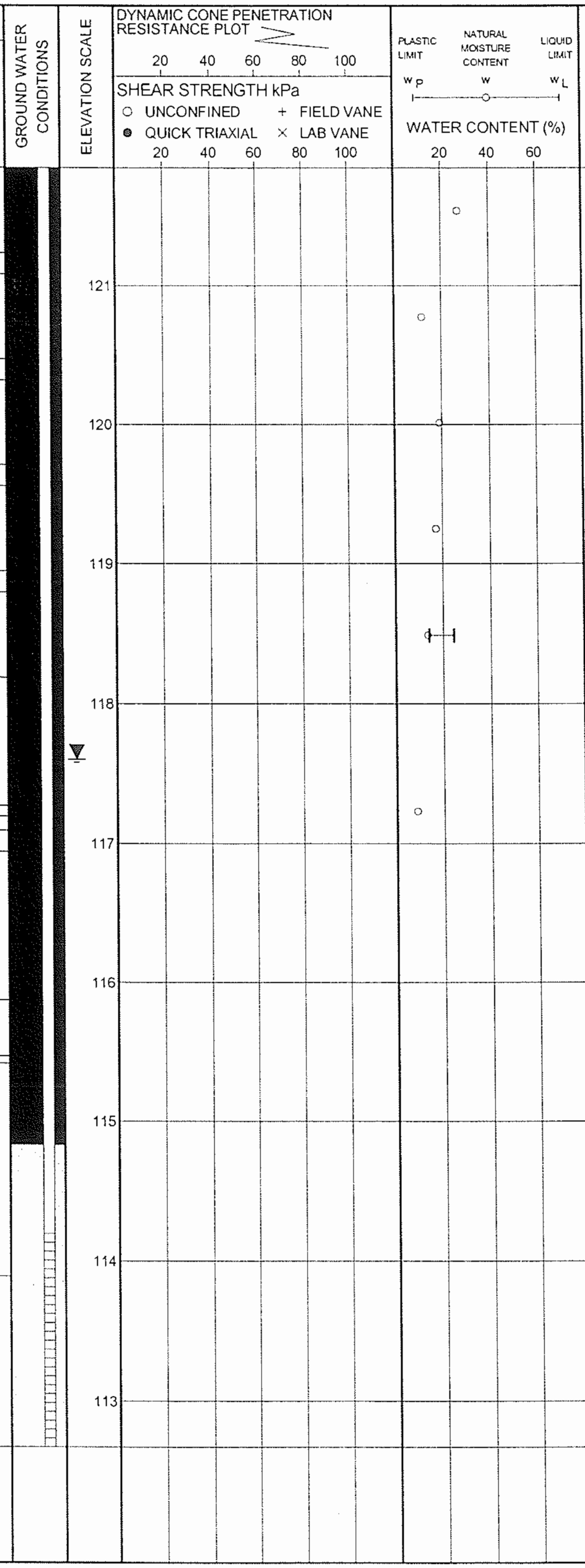
RECORD OF BOREHOLE No NWC3

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

SOIL PROFILE		SAMPLES			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	kN/m3	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 0.7	Silty **SAND**, trace to some gravel, trace clay Compact Brown Wet	2	SS	20		14	54	24	8
120.5 1.3	Sandy SILT, trace clay Compact Brown Wet	3	SS	26					
119.6 2.2	Silty **CLAY**, some sand Very Stiff Brown (CL)	4	SS	28					
		5	SS	28		0	20	50	27
117.8 4.0	Highly to moderately weathered, thinly bedded, reddish brown, very weak to weak, **SHALE**, with greenish grey limestone interbeds	6	SS	50/ .075	FI				
		1	RUN		8 6	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		5 1 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 3	RUN 3# TCR=100%, SCR=100%, RQD=88%			
	Limestone interbeds at 6.50 to 6.57, and 6.63 to 6.79 m Clay seams at 7.45 to 7.52, and 7.75 to 7.77 m Vertical joint at 7.52 to 7.60 m	4	RUN		4 3 3	RUN 4# TCR=100%, SCR=100%, RQD=50%, UCS=4MPa			
113.9 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 2 1 3	RUN 5# TCR=100%, SCR=100%, RQD=90%, UCS=10MPa			
112.6 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.				0				



Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

20 15 ⊕ 5 10 (%) STRAIN AT FAILURE

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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					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	GROUND WATER CONDITIONS	ELEVATION SCALE				
	WATER LEVEL READINGS:										

DATE	DEPTH(m)	ELEV.(m)
10.11.06	4.76	117.04
08.12.06	4.24	117.56

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

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

Ministry of Transportation
Ontario

THURBER

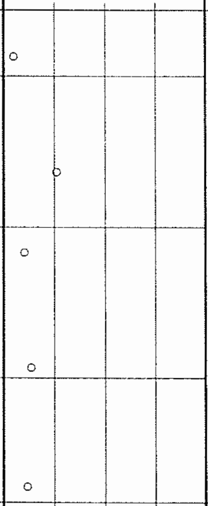
RECORD OF BOREHOLE No NSR1

1 OF 1

METRIC

G.W.P. 169-00-00	LOCATION QEW, Third Line to Burloak Drive N 4 808 251.52 E 285 627.44	ORIGINATED BY GA
HWY QEW	BOREHOLE TYPE Solid Stem Auger	COMPILED BY MFA
DATUM Geodetic	DATE 21.11.06 - 21.11.06	CHECKED BY MEF

SOIL PROFILE		SAMPLES									REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	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	STRAT PLOT	GR	SA	SI	CL
114.4														
0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)	1	SS	23		114								
113.8 0.6	Silty **CLAY**, trace to some sand, trace gravel Stiff Brown (TILL)	2	SS	8		113								
112.6 1.8	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard	3	SS	25							0	0	76	23
		4	SS	50/ .125		112								
		5	SS	50/ .050										
111.2 3.3	END OF BOREHOLE AT 3.25 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.													



+ 3, × 3: Numbers refer to Sensitivity

20 15 ⊕ 5 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NSR2

1 OF 1 **METRIC**

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 210.61 E 285 590.69
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Auger
COMPILED BY MFA
DATUM Geodetic
DATE 21.11.06 - 21.11.06
CHECKED BY MEF

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

SOIL PROFILE		SAMPLES				REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	GR	SA	SI	CL
116.5									
0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)	1	SS	15	116	51	39	10 (SI+CL)	
115.9 0.6	Silty **CLAY**, some sand, trace gravel, occasion shale fragments Firm to Stiff Reddish Brown (FILL)(CI)	2	SS	8	115				
		3	SS	6					
114.2 2.3	Silty **CLAY**, trace rootlets and wood fibres Firm to Stiff Dark Brown (TILL)	4	SS	8	114	0	20	53	28
113.4 3.0	**SAND**, trace silt Compact Brown Moist	5	SS	16	▼ 113				
112.7 3.8	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard	6	SS	50/ .150	112				
111.7 4.7	END OF BOREHOLE AT 4.72 m. BOREHOLE OPEN AND DRY TO BOTTOM ON 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)
08.12.06	3.22	113.28
14.12.06	3.52	112.98

+ 3, × 3: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NSR3

1 OF 1

METRIC

G.W.P. 169-00-00	LOCATION QEW, Third Line to Burloak Drive N 4 808 177.62 E 285 555.63		ORIGINATED BY GA
HWY QEW	BOREHOLE TYPE Solid Stem Auger		COMPILED BY MFA
DATUM Geodetic	DATE 21.11.06 - 21.11.06		CHECKED BY MEF

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
116.4											
0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)		1	SS	20		116				
115.7 0.6	Silty **CLAY**, trace to some sand, trace gravel, occasional shale fragments Firm to Stiff Reddish Brown (FILL)		2	SS	6						
114.8 1.5	Silty **CLAY**, trace to some sand, trace gravel, occasional shale fragments Firm to Stiff Reddish Brown (TILL)		3	SS	5		115	10	12	47	29
			4	SS	11		114				
113.3 3.0	**SILT**, trace clay, trace shale fragments Hard Reddish Brown		5	SS	41		113				
112.7 3.7	Highly weathered, thinnly bedded, reddish brown, **SHALE** Hard		6	SS	50/ .075		112				
111.6 4.8	END OF BOREHOLE AT 4.77 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.										

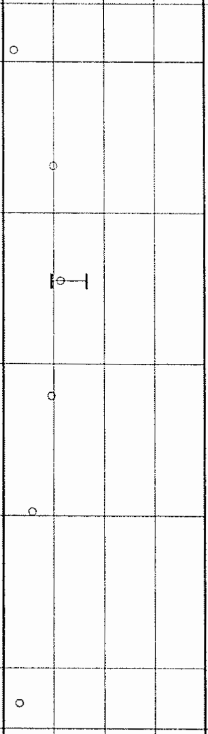
DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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



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

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 19/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NSR4

1 OF 1 **METRIC**

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 144.22 E 285 511.91
ORIGINATED BY SLL
HWY QEW
BOREHOLE TYPE Solid Stem Auger
COMPILED BY MFA
DATUM Geodetic
DATE 28.11.06 - 28.11.06
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
116.3														
0.0	**ASPHALT**: (200 mm)	■												
0.2	**CRUSHER RUN LIMESTONE** Dense Brown Moist (FILL)	▨					116							
			1	SS	41				○		31	53	16 (SI+CL)	
			2	SS	43				○					
114.9 1.3	Silty **CLAY**, occasional shale fragments	▥					115							
114.7 1.6	Hard Brown Moist (TILL)	▨	3	SS	50/ .075				○					
113.9 2.3	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard		4	SS	50/ .050		114		○					
	END OF BOREHOLE AT 2.33 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND PATCHED WITH ASPHALT AT SURFACE.													

+ 3, × 3: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WBT1

1 OF 1

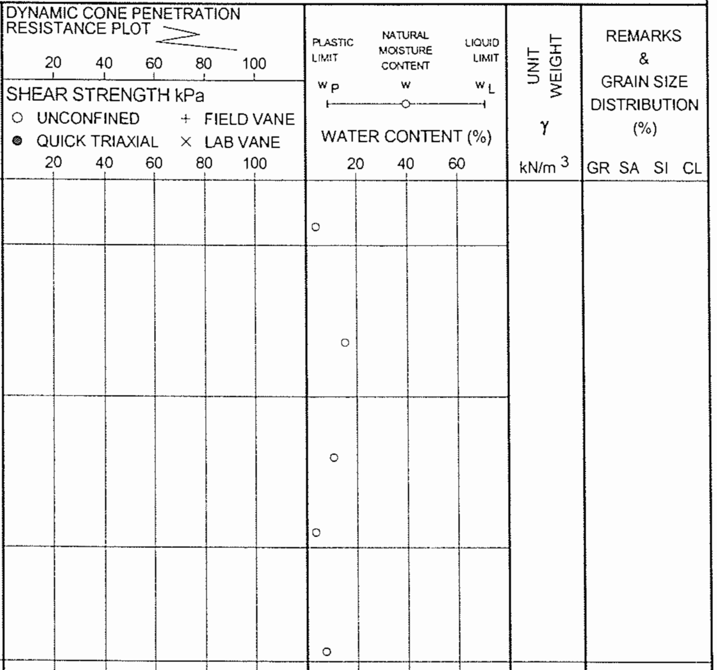
METRIC

G.W.P.	169-00-00	LOCATION	QEW, Third Line to Burloak Drive N 4 808 282.64 E 285 653.06	ORIGINATED BY	GA
HWY	QEW	BOREHOLE TYPE	Solid Stem Augers	COMPILED BY	MFA
DATUM	Geodetic	DATE	21.11.06 - 21.11.06	CHECKED BY	MEF

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS / ELEVATION SCALE
113.4					
0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)	1	SS	15	113
112.8 0.6	Silty **CLAY**, trace to some sand, trace gravel Stiff Reddish brown (TILL)	2	SS	14	112
111.9 1.5	Highly weathered, thinly bedded, reddish brown, **SHALE**, with greenish grey limestone interbeds Hard	3	SS	52	
		4	SS	50/ .100	▽ 111
110.2 3.2	END OF BOREHOLE AT 3.18 m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.	5	SS	50/ .125	

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
08.12.06	2.48	110.92



+ 3, × 3: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 18/12/06

Ministry of
Transportation
Ontario

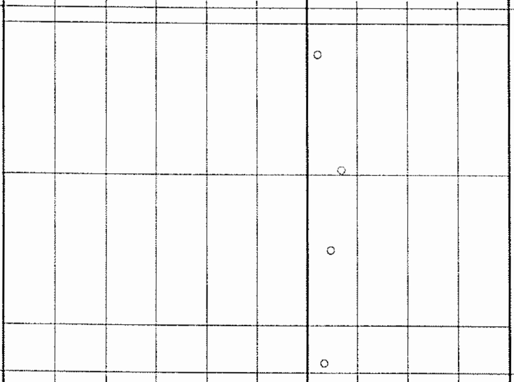
THURBER

RECORD OF BOREHOLE No WBT2

1 OF 1 **METRIC**

G.W.P. 169-00-00	LOCATION QEW, Third Line to Burloak Drive N 4 808 316.65 E 285 682.57		ORIGINATED BY GA
HWY QEW	BOREHOLE TYPE Solid Stem Augers		COMPILED BY MFA
DATUM Geodetic	DATE 21.11.06 - 21.11.06		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
113.1 0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)		1	SS	20		113		○		51	40	9 (SI+CL)	
112.3 0.8	Highly weathered, thinly bedded, reddish brown, **SHALE** Very Stiff to Hard		2	SS	20		112		○					
			3	SS	50/ .150				○		0	0	69	31
							111							
			4	SS	50/ .125				○					
110.7 2.4	END OF BOREHOLE AT 2.41 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.													



+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5127A.GPJ 19/12/06

Ministry of Transportation
Ontario

THURBER

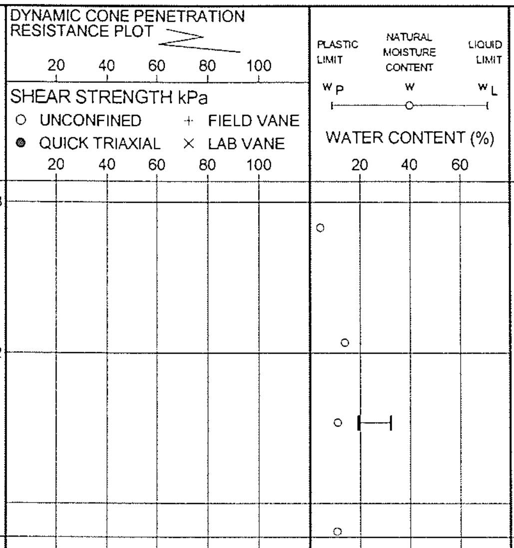
RECORD OF BOREHOLE No WBT3

1 OF 1

METRIC

W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 359.56 E 285 716.88
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Augers
COMPILED BY MFA
DATUM Geodetic
DATE 21.11.06 - 21.11.06
CHECKED BY MEF

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	GR	SA	SI	CL
113.1 0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)		1	SS	14		113					
112.5 0.6	Silty **CLAY**, trace sand, trace gravel Very Stiff to Hard Reddish Brown Dry (TILL)(CL)		2	SS	22		112					
112.0 1.1	Highly weathered, thinnly bedded, reddish brown, **SHALE** Hard		3	SS	50/ .150				0	0	75	25
			4	SS	50/ .075		111					
110.7 2.4	END OF BOREHOLE AT 2.36 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.											



+3, ×3: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 14/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WBT4

1 OF 1 **METRIC**

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 386.27 E 285 738.21
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Augers
COMPILED BY MFA
DATUM Geodetic
DATE 21.11.06 - 21.11.06
CHECKED BY MEF

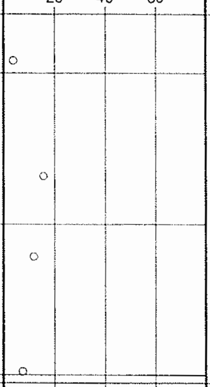
ELEV DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	TYPE	"N" VALUES	ELEVATION SCALE
113.4 0.0	**CRUSHER RUN LIMESTONE** Dense Brown Dry (FILL)	1	SS	34	113
112.7 0.6	Silty **CLAY**, trace to some sand, trace gravel Very Stiff Reddish Brown (TILL)(CL)	2	SS	24	112
112.3 1.1	Highly weathered, thinly bedded, very weak, reddish brown, **SHALE** Hard	3	SS	50/ .150	
		4	SS	50/ .150	111
110.9 2.4	END OF BOREHOLE AT 2.44 m. BOREHOLE OPEN AND DRY TO BOTTOM ON 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) 08.12.06 Dry				

STRAT PLOT — GROUND WATER CONDITIONS

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



UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

ONTMT4S 5127A.GPJ 19/12/06

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

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

Ministry of Transportation
Ontario

THURBER

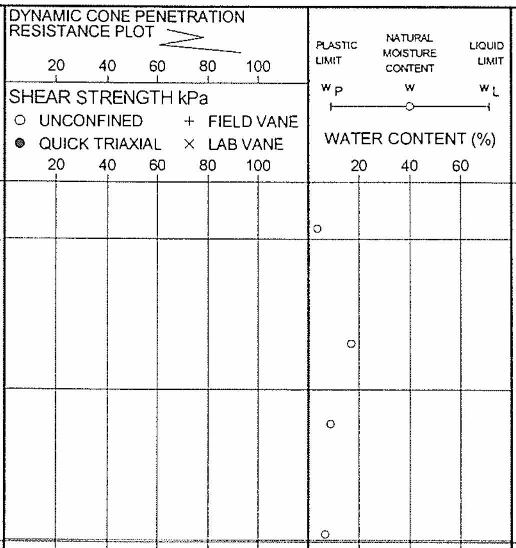
RECORD OF BOREHOLE No WBT5

1 OF 1

METRIC

W.P.	169-00-00	LOCATION	QEW, Third Line to Burloak Drive N 4 808 422.09 E 285 766.83	ORIGINATED BY	GA
HWY	QEW	BOREHOLE TYPE	Solid Stem Augers	COMPILED BY	MFA
DATUM	Geodetic	DATE	21.11.06 - 21.11.06	CHECKED BY	MEF

SOIL PROFILE		SAMPLES						
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.3								
0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)	1	SS	23		113		
112.7 0.6	Silty **CLAY**, trace to some sand, trace gravel Hard Reddish Brown (TILL)	2	SS	36		112		
112.3 1.1	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard	3	SS	50/ .150				0 0 78 22
		4	SS	50/ .100				
111.0 2.4	END OF BOREHOLE AT 2.39 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.					111		



+ 3, × 3: Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

ONTMT4S 5127A.GPJ 14/12/06

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WBT6

1 OF 1 **METRIC**

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 457.33 E 285 794.87
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Augers
COMPILED BY MFA
DATUM Geodetic
DATE 22.11.06 - 22.11.06
CHECKED BY MEF

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

SOIL PROFILE			SAMPLES								REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	GR	SA	SI	CL
113.6 0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)		1	SS	16				○					
113.0 0.6	Silty **CLAY**, trace to some sand, trace gravel Stiff Reddish Brown (TILL)		2	SS	10		113		○					
112.5 1.1	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard		3	SS	41		112		○		0	0	77	22
111.3 2.4	END OF BOREHOLE AT 2.36 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.		4	SS	50/ .075				○					

ONTMT4S 5127A.GPJ 19/12/06

+ 3, × 3: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WBT7

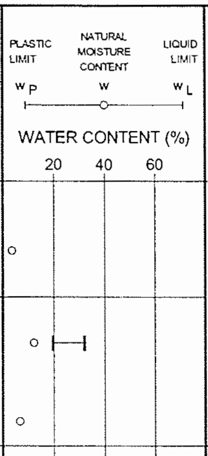
1 OF 1

METRIC

W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 489.44 E 285 825.22
ORIGINATED BY SLL
HWY QEW
BOREHOLE TYPE Solid Stem Augers
COMPILED BY MFA
DATUM Geodetic
DATE 14.11.06 - 14.11.06
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	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES								
113.7												
0.0	**ASPHALT**: (150 mm)											
0.2	**CRUSHER RUN LIMESTONE** Dense Brown Moist	1	SS	32								
112.9 0.8	(FILL) Silty **CLAY**, trace to some sand, trace gravel Hard Reddish Brown	2	SS	31		113			0	0	79	21
112.5 1.2	(TILL)											
112.0 1.8	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard	3	SS	50/ .075								

END OF BOREHOLE AT 1.75 m.
BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION.
BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO 0.2m THEN ASPHALT TO SURFACE.



+ ³, × ³ : Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

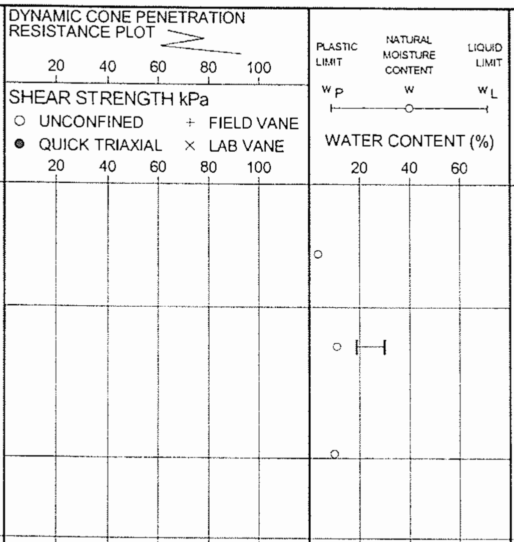
RECORD OF BOREHOLE No WBC1

1 OF 1 **METRIC**

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 565.95 E 285 889.49
ORIGINATED BY SLL
HWY QEW
BOREHOLE TYPE Solid Stem Auger
COMPILED BY JHL
DATUM Geodetic
DATE 14.11.06 - 14.11.06
CHECKED BY MEF

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	GR	SA	SI	CL
114.8												
0.0	**ASPHALT**: (150 mm)											
0.2	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)		1	SS	26							
114.0 0.8	Silty **CLAY**, trace shale fragments Very Stiff Brown (TILL)		2	SS	24		114		1	3	73	23
113.3 1.5	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard		3	SS	67		113					
112.4 2.3	END OF BOREHOLE AT 2.34 m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND PATCHED WITH ASPHALT AT SURFACE.		4	SS	50/ .050							

DYNAMIC CONE PENETRATION RESISTANCE PLOT
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE



REMARKS & GRAIN SIZE DISTRIBUTION (%)

+ 3, × 3: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WBC2

1 OF 1

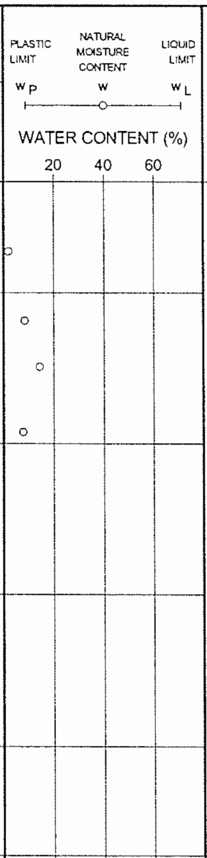
METRIC

G.W.P.	169-00-00	LOCATION	QEW, Third Line to Burloak Drive N 4 808 592.04 E 285 914.59	ORIGINATED BY	SLL
HWY	QEW	BOREHOLE TYPE	Solid Stem Auger/NQ Core Barrel	COMPILED BY	MFA
DATUM	Geodetic	DATE	14.11.06 - 14.11.06	CHECKED BY	MEF

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES				
114.7								
0.0	**ASPHALT**: (125 mm)							
0.1	**CRUSHER RUN LIMESTONE** Very Dense Brown Moist (FILL)	1 1	SS AS	50/ .075				33 54 13 (SI+CL)
114.0 0.7						114		
113.8 0.9	Silty **CLAY**, trace shale fragments Hard Brown (TILL)	2	SS	33				
	Highly to moderately weathered, thinly bedded, reddish brown, weak, **SHALE**, with greenish grey limestone interbeds Limestone interbeds at 1.88 to 2.00, 2.42 to 2.49, and 2.88 to 2.92 m Rubble zone from 2.49 to 2.54 m	1	RUN			113 112	FI 5 7 9 10	RUN 1# TCR=100%, SCR=96%, RQD=24%, UCS=6MPa
111.8 2.9	Becoming slightly weathered Limestone interbeds at 2.92 to 3.15, 3.20 to 3.25, 3.74 to 3.79, 4.01 to 4.04, and 4.27 to 4.32 m	2	RUN			111	6 1 4 2 5 0	RUN 2# TCR=100%, SCR=100%, RQD=78%, UCS=14MPa
110.3 4.4	END OF BOREHOLE AT 4.44 m.							

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



+ 3, × 3: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WBC3

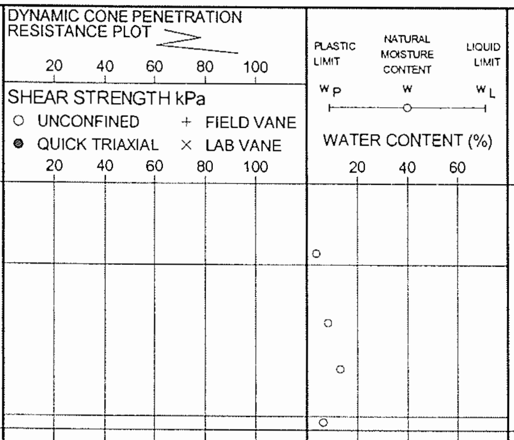
1 OF 1

METRIC

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 623.31 E 285 939.54
ORIGINATED BY SLL
HWY QEW
BOREHOLE TYPE Solid Stem Augers
COMPILED BY MFA
DATUM Geodetic
DATE 13.11.06 - 14.11.06
CHECKED BY MEF

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
114.5 0.0	**ASPHALT**: (125 mm)							
0.1 113.7	**CRUSHER RUN LIMESTONE** Very Dense Brown Moist (FILL)		1	SS	66		114	21 51 19 (SI+CL)
0.8 113.5 1.0	Silty **CLAY** Hard Brown (TILL)		2	SS	55			
112.9 1.6	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard		3	SS	50/ .100		113	

END OF BOREHOLE AT 1.62 m.
BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION.
BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND PATCHED WITH ASPHALT AT SURFACE.



UNIT WEIGHT γ kN/m^3

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No EBT1

1 OF 1

METRIC

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 028.42 E 285 541.61
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Auger
COMPILED BY MFA
DATUM Geodetic
DATE 22.11.06 - 22.11.06
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
112.4														
0.0	**ASPHALT**: (100 mm)													
0.1	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)		1	SS	24		112				39	46	15 (SI+CL)	
111.8 0.6	Silty **CLAY**, trace to some sand, occasional gravel, occasional rootlets Stiff Grey to Reddish Brown (TILL)		2	SS	14		111							
110.9 1.5	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard		3	SS	35						0	0	72	28
			4	SS	50/ .150									
110.0 2.4	END OF BOREHOLE AT 2.44 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND PATCHED WITH ASPHALT AT SURFACE.													

ONTMT4S 5127A.GPJ 19/12/06

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

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

Ministry of Transportation
Ontario

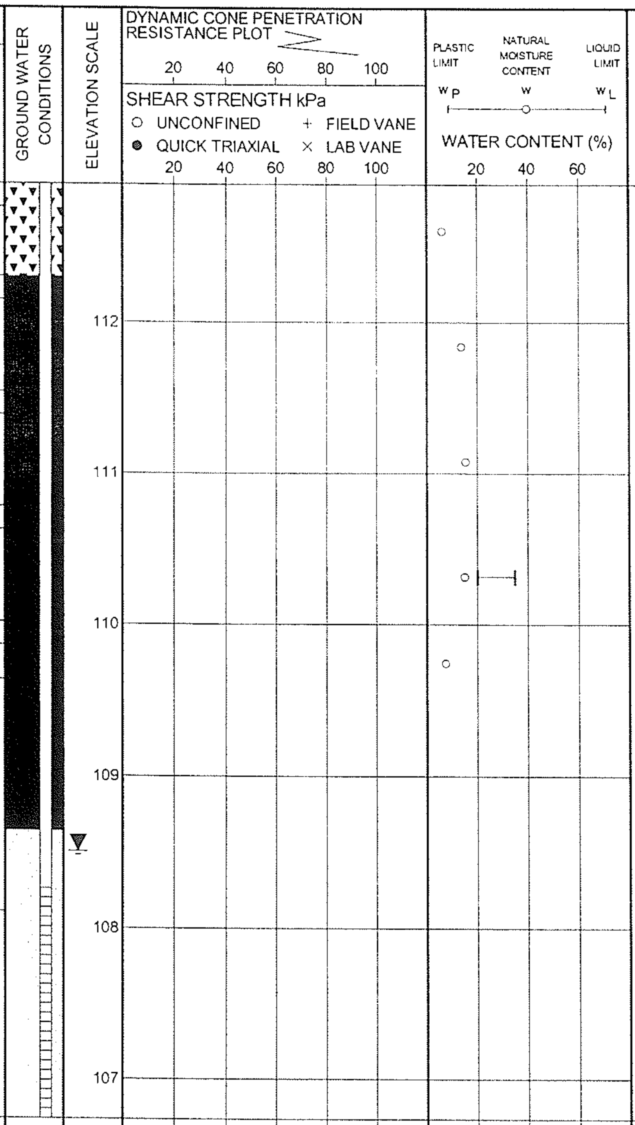
THURBER

RECORD OF BOREHOLE No EBT2

1 OF 1 **METRIC**

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 087.45 E 285 569.95
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel
COMPILED BY MFA
DATUM Geodetic
DATE 22.11.06 - 22.11.06
CHECKED BY MEF

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
112.9						
0.0	ASPHALT: (100 mm)					
0.1	**SAND and GRAVEL** Compact Brown Dry (FILL)	1	SS	19		
112.3 0.6	Silty **CLAY**, trace sand, occasional shale fragments Very Stiff Reddish Brown (FILL)	2	SS	18		
111.4 1.5	Silty **CLAY**, some sand, occasional shale fragments Firm Reddish Brown (TILL)	3	SS	6		
110.4 2.4	Highly to moderately weathered, thinly bedded, reddish brown, very weak to weak, **SHALE**, with greenish grey limestone interbeds	4	SS	25		0 1 69 29
		5	SS	50/ .075	FI	
	Clay seam at 3.28 to 3.31 m Rubble zone from 3.73 to 3.81 m Limestone interbeds at 4.21 to 4.24	1	RUN		0 5 2 3 2	RUN 1# TCR=80%, SCR=65%, RQD=45%, UCS=MPa
	Limestone interbeds at 4.82 to 4.88, 5.02 to 5.05, 6.15 to 6.22 m Clay seam at 5.38 to 5.43 m Limestone interbeds at 5.57 to 5.62, and 5.67 to 5.72 m	2	RUN		3 3 5 2	RUN 2# TCR=100%, SCR=100%, RQD=61%, UCS=21MPa
106.7 6.2	END OF BOREHOLE AT 6.18 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.				0	



WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
08.12.06	4.40	108.50

ONTMT4S 5127A.GPJ 19/12/06

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

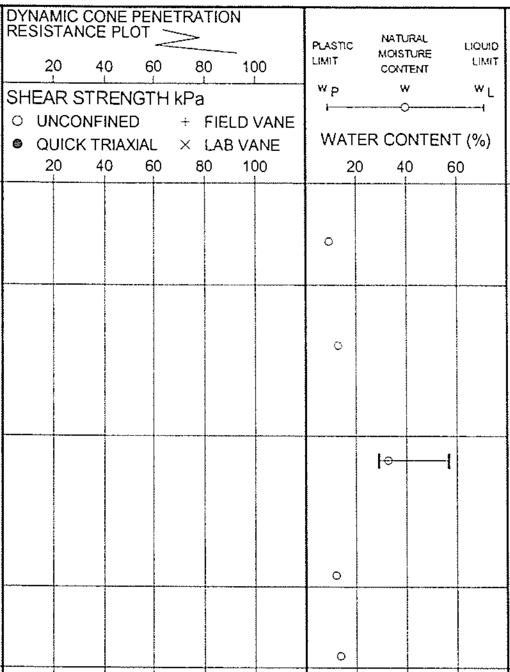
RECORD OF BOREHOLE No EBT3

1 OF 1

METRIC

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 113.06 E 285 590.37
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Auger
COMPILED BY MFA
DATUM Geodetic
DATE 22.11.06 - 22.11.06
CHECKED BY MEF

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
112.6								
0.0	ASPHALT: (100 mm)							
0.1	**SAND and GRAVEL** Compact Brown Dry (FILL)	1	SS	20				
112.0 0.6	Silty **CLAY**, trace sand Firm Reddish Brown (FILL)	2	SS	5				
111.1 1.5	Silty **CLAY**, trace sand Stiff Reddish Brown (TILL)	3	SS	10	0	2	46	52
110.4 2.3	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard	4	SS	80				
		5	SS	50/.150				
109.4 3.2	END OF BOREHOLE AT 3.20 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND PATCHED WITH ASPHALT AT SURFACE.							



Column headings: STRAT PLOT; GROUND WATER CONDITIONS; ELEVATION SCALE; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%)

ONTMT4S 5127A.GPJ 19/12/06

+ 3, × 3: Numbers refer to Sensitivity
$15\underset{10}{\overset{20}{\oplus}}5$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

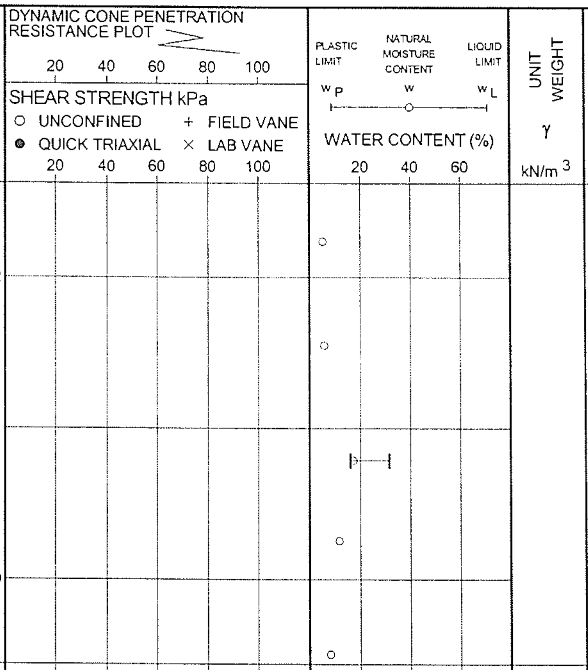
THURBER

RECORD OF BOREHOLE No EBT4

1 OF 1 **METRIC**

G.W.P.	169-00-00	LOCATION	QEW, Third Line to Burloak Drive N 4 808 146.61 E 285 617.13	ORIGINATED BY	GA
HWY	QEW	BOREHOLE TYPE	Solid Stem Auger	COMPILED BY	JHL
DATUM	Geodetic	DATE	23.11.06 - 23.11.06	CHECKED BY	MEF

SOIL PROFILE			SAMPLES					REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	GR	SA	SI	CL
112.6 0.0	**SAND and GRAVEL**, trace silt Compact Brown Dry (FILL)		1	SS	27						
			2	SS	13		112				
111.1 1.5	Silty **CLAY**, sandy Very Stiff Brown (TILL)(CL)		3	SS	22		111	0	33	33	34
110.3 2.3	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard		4	SS	50/ .150		110				
109.4			5	SS	50/ .125						
3.2	END OF BOREHOLE AT 3.17 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.										



+ 3, × 3 : Numbers refer to Sensitivity

15 ⊕ 5 (20, 10) (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EBT5

1 OF 1

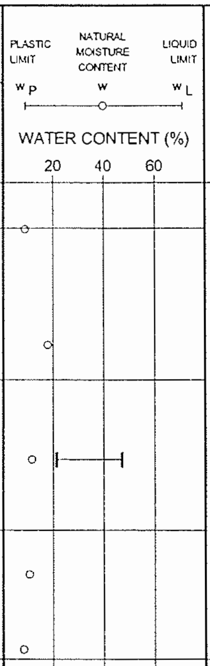
METRIC

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 182.11 E 285 646.12
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Auger
COMPILED BY MFA
DATUM Geodetic
DATE 23.11.06 - 23.11.06
CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	GR	SA	SI	CL
112.3									
0.0	SAND and GRAVEL Compact Brown Dry (FILL)	1	SS	19	112				
111.7 0.6	Silty CLAY, some sand, trace gravel Firm Reddish Brown (FILL)(CI)	2	SS	5	111				
110.7 1.5	Silty CLAY, some sand, trace gravel Stiff Reddish Brown (TILL)	3	SS	13		1	12	44	43
110.0 2.3	Highly weathered, thinly bedded, reddish brown, SHALE Hard	4	SS	50/ .150	110				
		5	SS	50/ .100					
109.1 3.1	END OF BOREHOLE AT 3.15 m. BOREHOLE OPEN AND DRY TO BOTTOM ON 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) 08.12.06 Dry								

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



UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

+ 3, × 3: Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

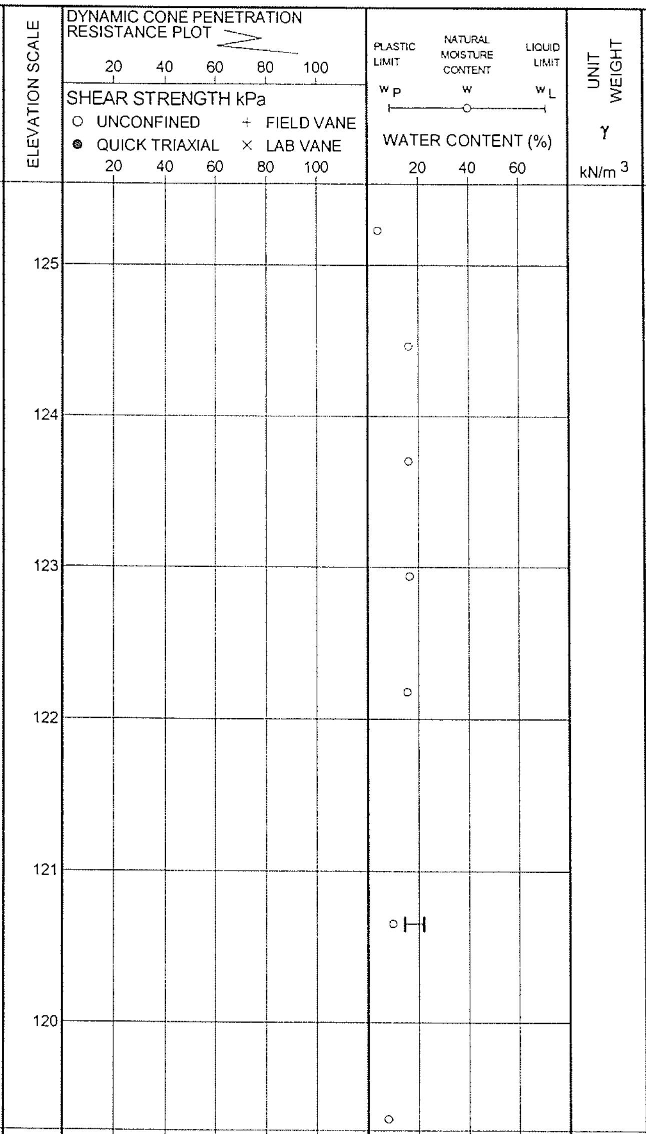
RECORD OF BOREHOLE No PW1

1 OF 1

METRIC

G.W.P. 169-00-00
LOCATION QEW, Third Line to Burloak Drive N 4 808 146.61 E 284 950.28
ORIGINATED BY GA
HWY QEW
BOREHOLE TYPE Solid Stem Augers
COMPILED BY WM
DATUM Geodetic
DATE 09.12.06 - 09.12.06
CHECKED BY MEF

ELEV DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
125.5								
0.0	**CRUSHER RUN LIMESTONE** Compact Brown Dry (FILL)	1	SS	12				
124.7 0.8	**SAND**, trace silt Loose Brown Damp to Moist	2	SS	4				
		3	SS	6				
123.5 2.0	**SILT**, trace sand, some clay, occasional iron oxide staining Compact to Dense Brown Moist	4	SS	22				
		5	SS	34	0	6	78	16
120.9 4.6	Silty **CLAY**, trace to some sand, trace gravel Hard Reddish Brown (TILL)	6	SS	30	0	10	68	22
119.7 5.8	Highly weathered, thinly bedded, reddish brown, **SHALE** Hard	7	SS	50/ .150				
119.3 6.2	END OF BOREHOLE AT 6.25 m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.							



REMARKS & GRAIN SIZE DISTRIBUTION (%)

+ 3, × 3: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

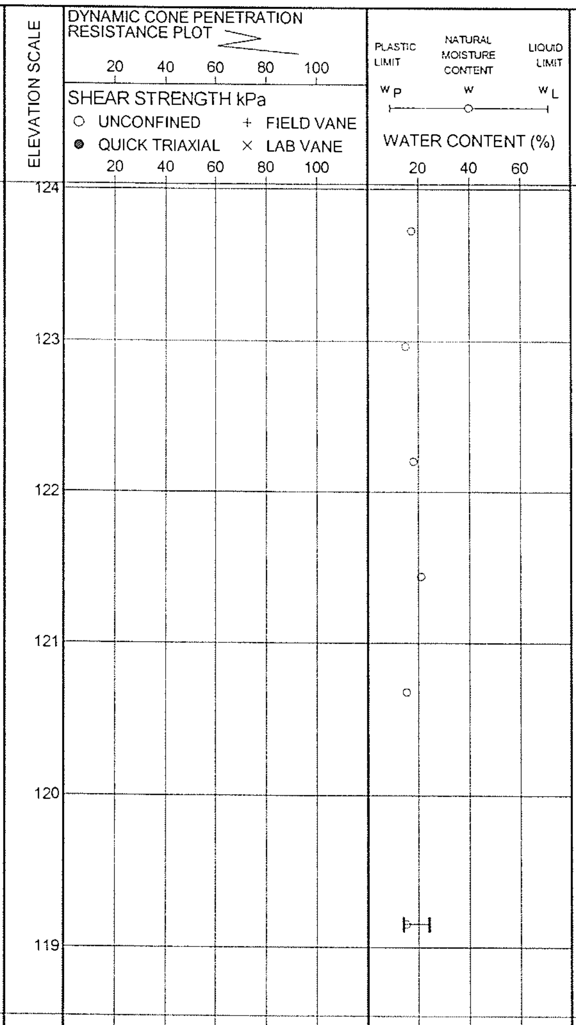
THURBER

RECORD OF BOREHOLE No PW2

1 OF 1 **METRIC**

G.W.P.	169-00-00	LOCATION	QEW, Third Line to Burloak Drive N 4 808 095.69 E 284 998.63	ORIGINATED BY	GA
HWY	QEW	BOREHOLE TYPE	Solid Stem Augers	COMPILED BY	WM
DATUM	Geodetic	DATE	05.12.06 - 05.12.06	CHECKED BY	MEF

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			GR	SA	SI	CL
124.0										
0.0	**TOPSOIL**: (75 mm)									
0.1	**SAND**, trace silt, trace rootlets Loose Brown Wet	1	SS	4						
		2	SS	6						
122.5 / 1.5	Sandy **SILT**, occasional iron oxide staining Compact Brown Wet	3	SS	12			2	28	61	9
121.7 / 2.3	**SILT**, trace to some sand Compact Brown Damp to Moist	4	SS	23						
		5	SS	20						
119.7 / 4.3	Silty **CLAY**, some sand to sandy, trace gravel Very Stiff Reddish Brown **(TILL)**	6	SS	19			0	28	45	27
118.8 / 5.2	Highly weathered, thinly bedded, reddish brown, very weak **SHALE**									
118.5 / 5.5	END OF BOREHOLE AT 5.48 m. BOREHOLE OPEN TO 5.48 m AND WATER LEVEL AT 4.57 m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.									



+ 3 , × 3 : Numbers refer to Sensitivity

20 15 ⊕ 5 10 (%) STRAIN AT FAILURE

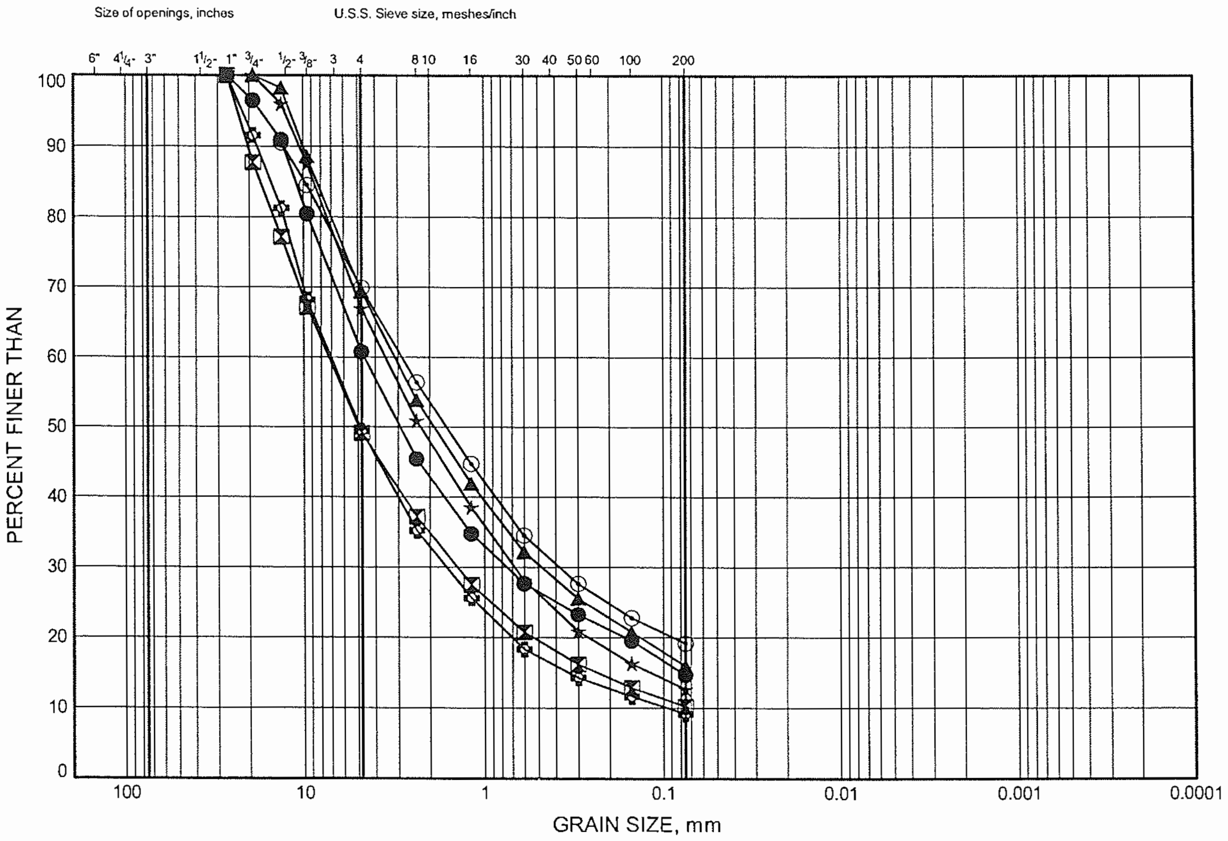
Appendix B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

GRANULAR MATERIAL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	EBT1	0.38	112.05
☒	NSR2	0.30	116.16
▲	NSR4	0.53	115.73
★	WBC2	0.46	114.99
⊙	WBC3	0.46	114.05
✪	WBT2	0.30	112.77

Date December 2006

Project 169-00-00

THURBER

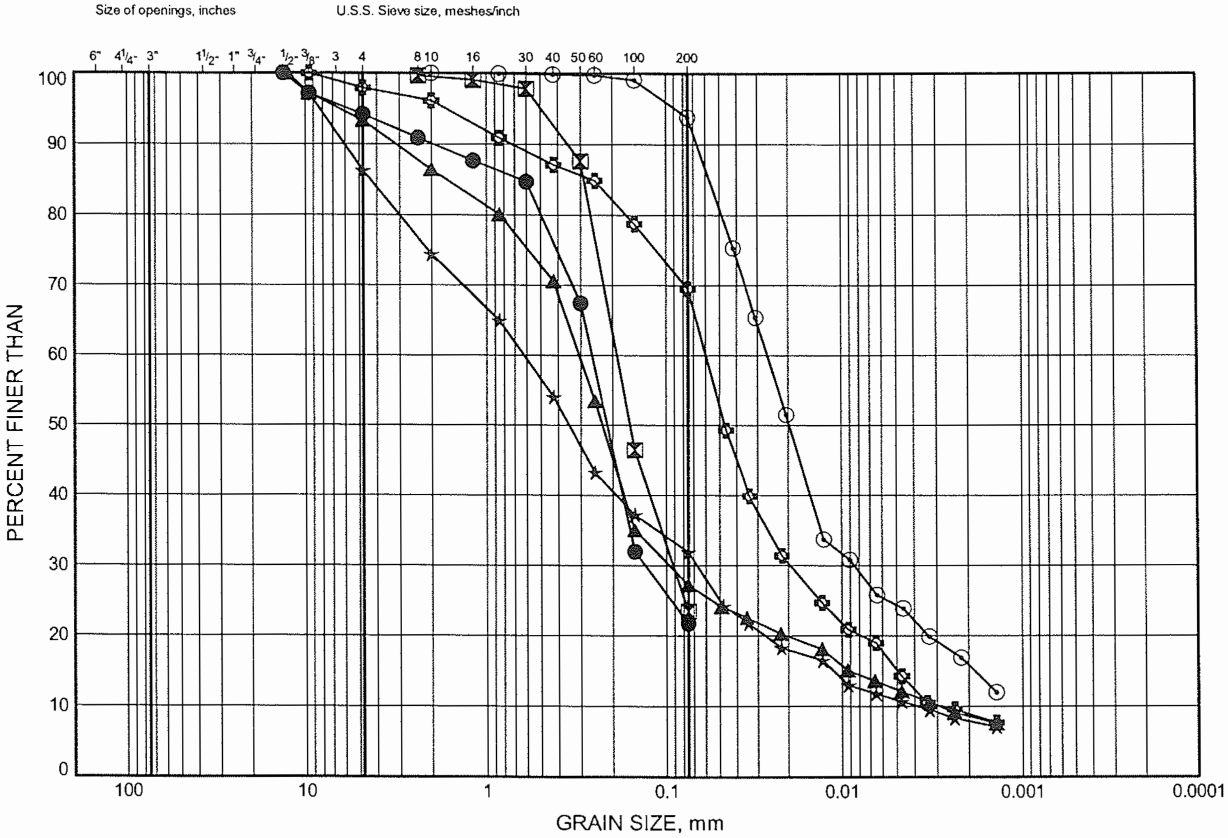
Prep'd WM

Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY SAND TO SANDY SILT, SILT



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
⊙	PW1	3.35	122.15
✿	PW2	1.83	122.17

THURBGSD 5127A.GPJ 19/12/06

Date December 2006

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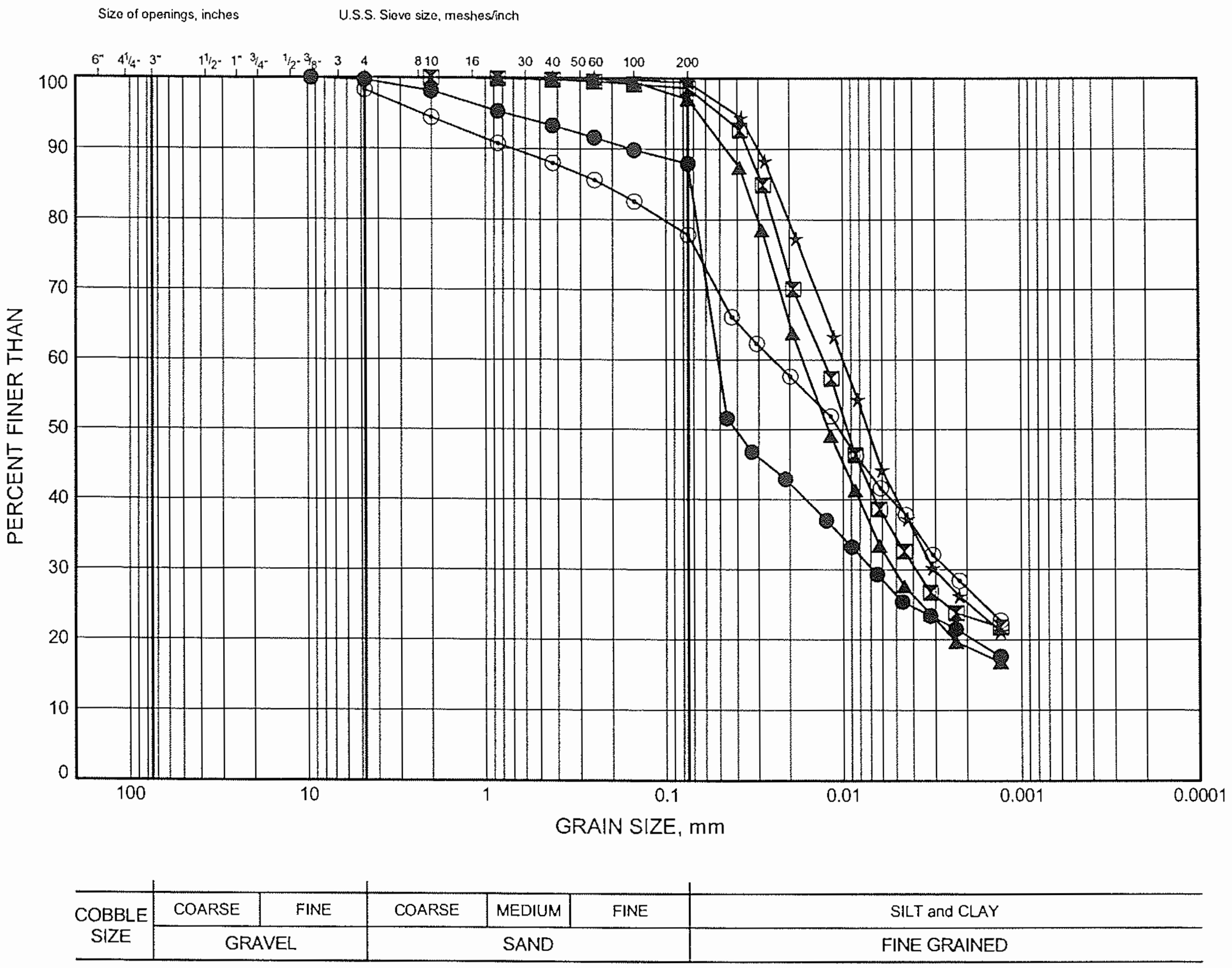
Prep'd WM

Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY TO SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NW1	3.28	118.32
☒	NW2	2.59	119.03
▲	NWC1	3.35	118.90
★	NWC2	2.59	119.27
⊙	NWC3	3.35	118.46

Date December 2006

Project 169-00-00

THURBER

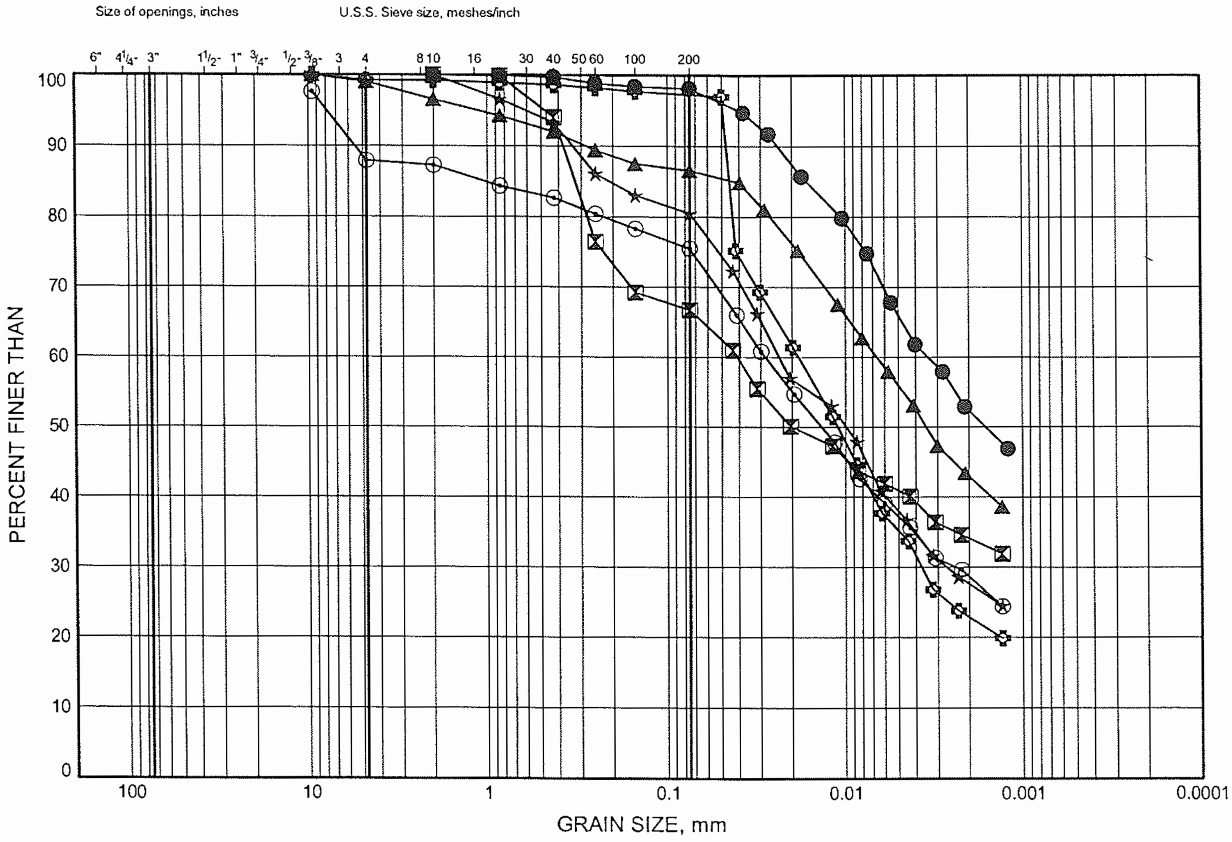
Prep'd WM

Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY TO SILTY CLAY TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	EBT3	1.83	110.81
☒	EBT4	1.83	110.76
▲	EBT5	1.83	110.44
★	NSR2	2.59	113.87
⊙	NSR3	1.83	114.52
✿	WBC1	1.07	113.71

THURBGSD 5127A.GPJ 18/12/06

Date December 2006

Project 169-00-00

THURBER

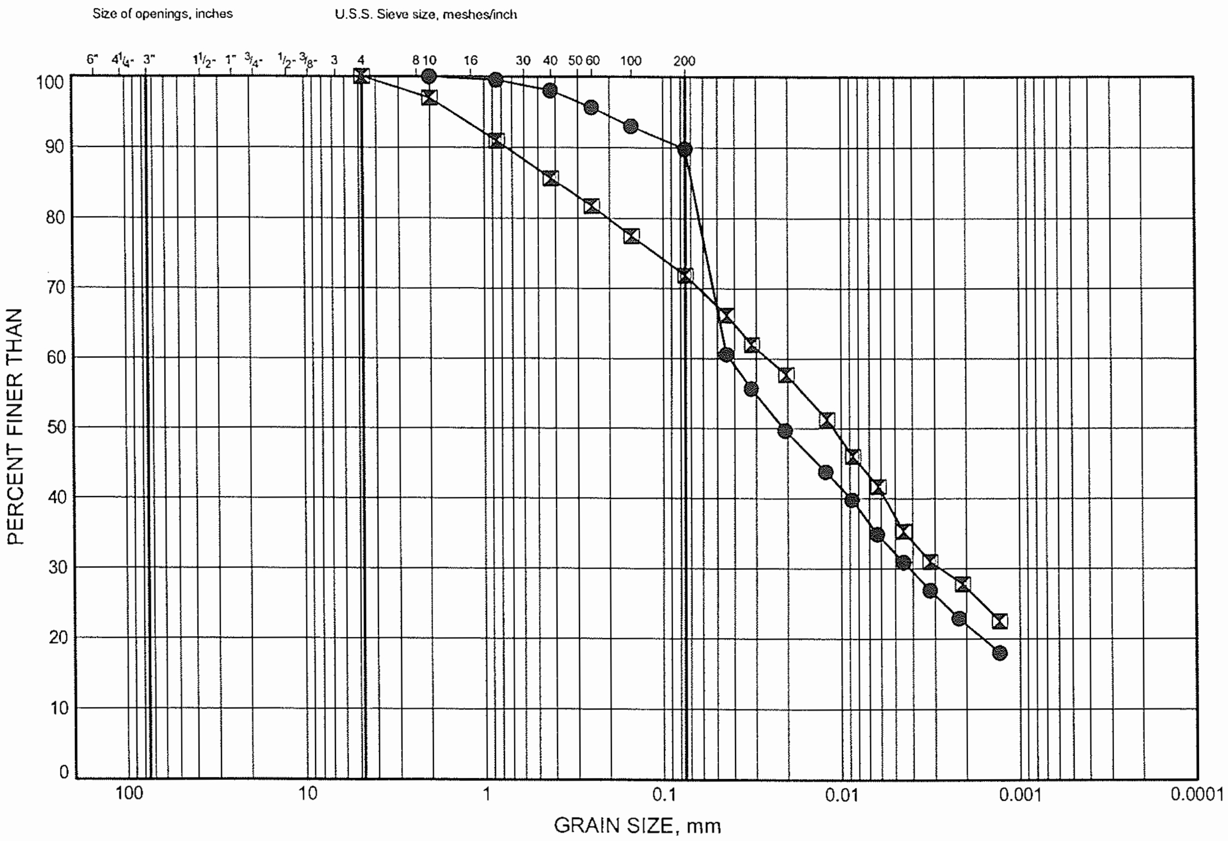
Prep'd WM

Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY CLAY TO SILTY CLAY TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PW1	4.88	119.97
☒	PW2	4.88	120.55

Date December 2006

Project 169-00-00

THURBER

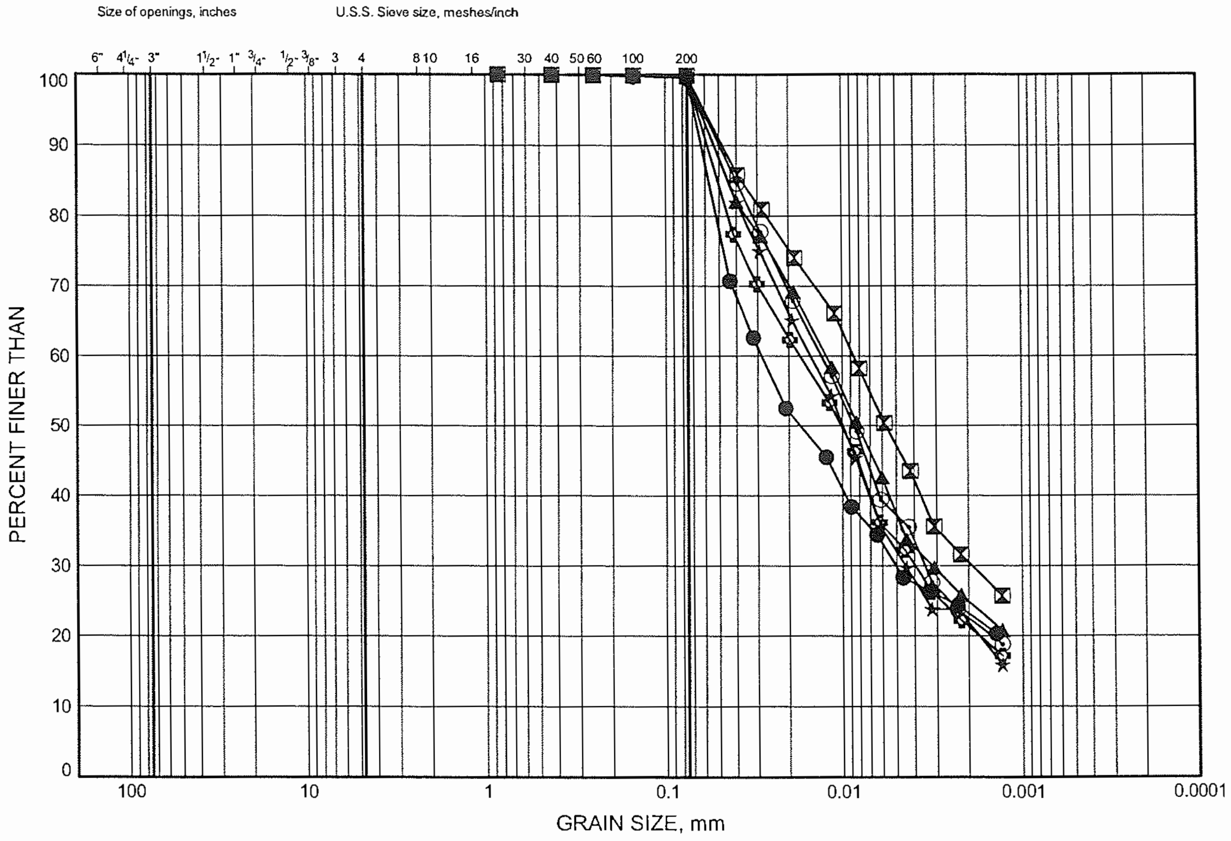
Prep'd WM

Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE B6

SHALE



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NSR1	1.60	112.80
☒	WBT2	1.60	111.47
▲	WBT3	1.60	111.51
★	WBT5	1.60	111.74
⊙	WBT6	1.83	111.78
✪	WBT7	1.07	112.67

Date December 2006

Project 169-00-00

THURBER

Prep'd WM

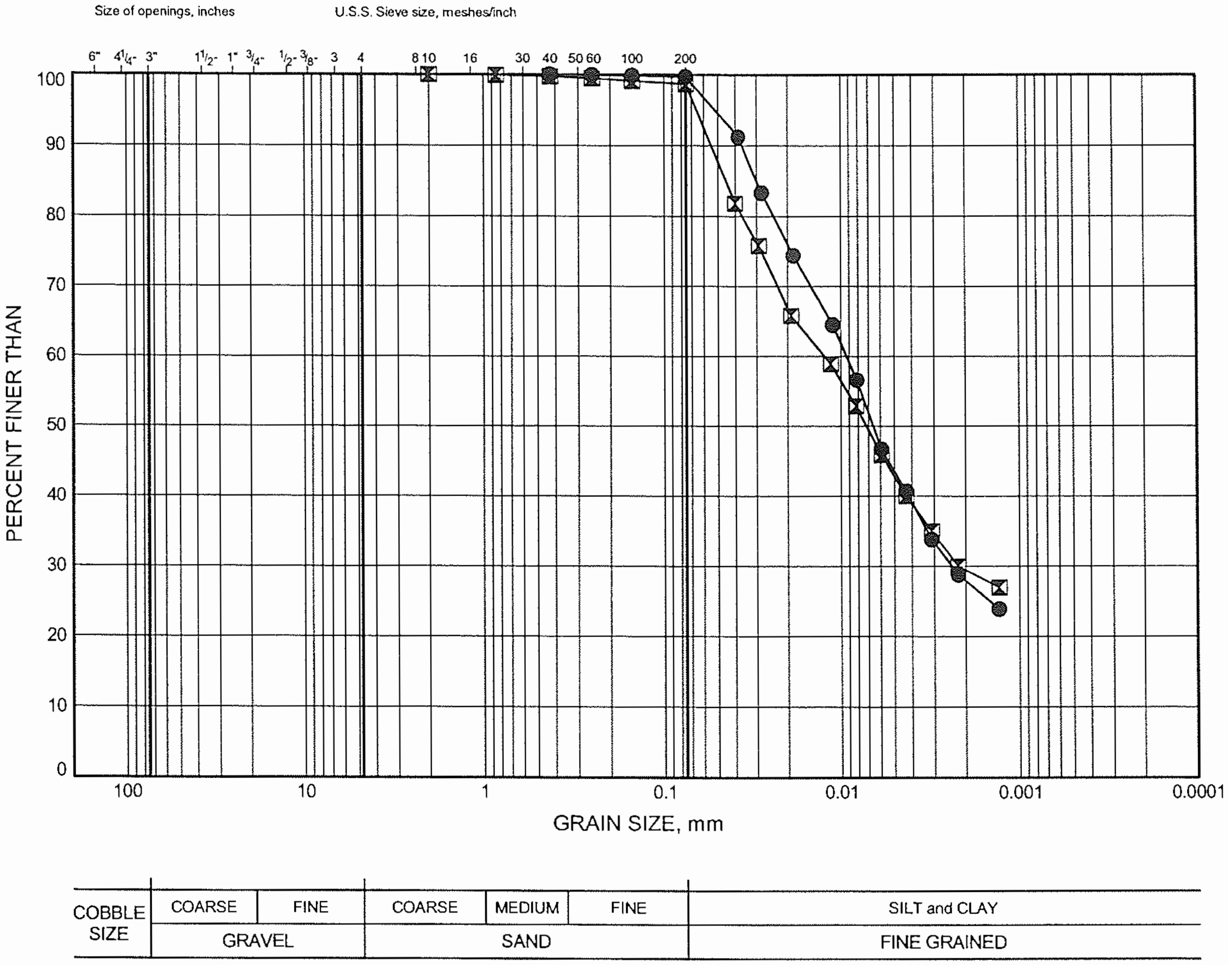
Chkd. MRA

THURBGSD 5127A.GPJ 19/12/06

GRAIN SIZE DISTRIBUTION

FIGURE B7

SHALE



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	EBT1	1.83	110.60
☒	EBT2	2.59	110.29

Date December 2006

Project 169-00-00

THURBER

Prep'd WM

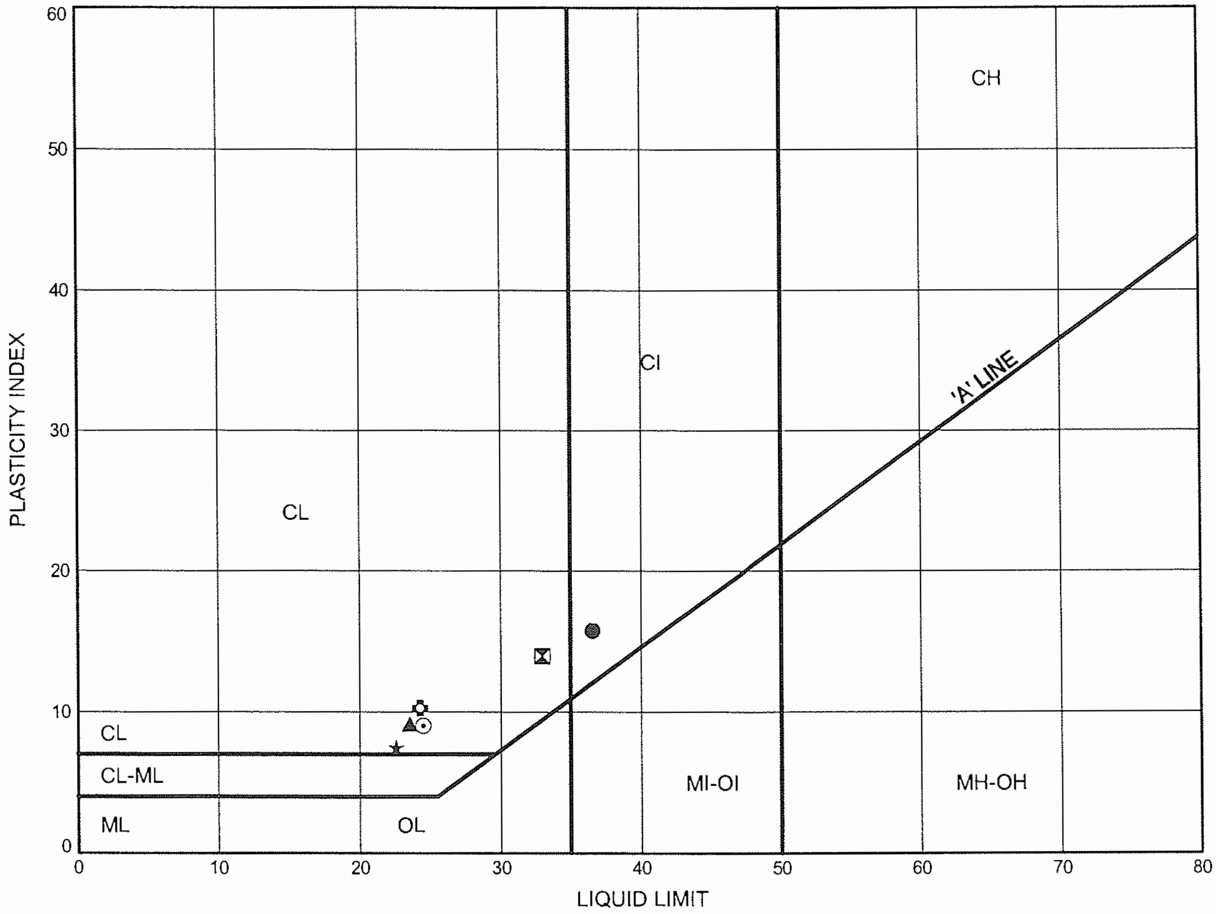
Chkd. MRA

THURBGSD 5127A.GPJ 18/12/06

ATTERBERG LIMITS TEST RESULTS

FIGURE B8

SILTY CLAY TO SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NSR2	2.59	113.87
⊠	NSR3	1.83	114.52
▲	NW1	3.28	118.32
★	NW2	2.59	119.03
⊙	NWC2	2.59	119.27
✪	NWC3	3.35	118.46

Date December 2006

Project 169-00-00

THURBER

Prep'd WM

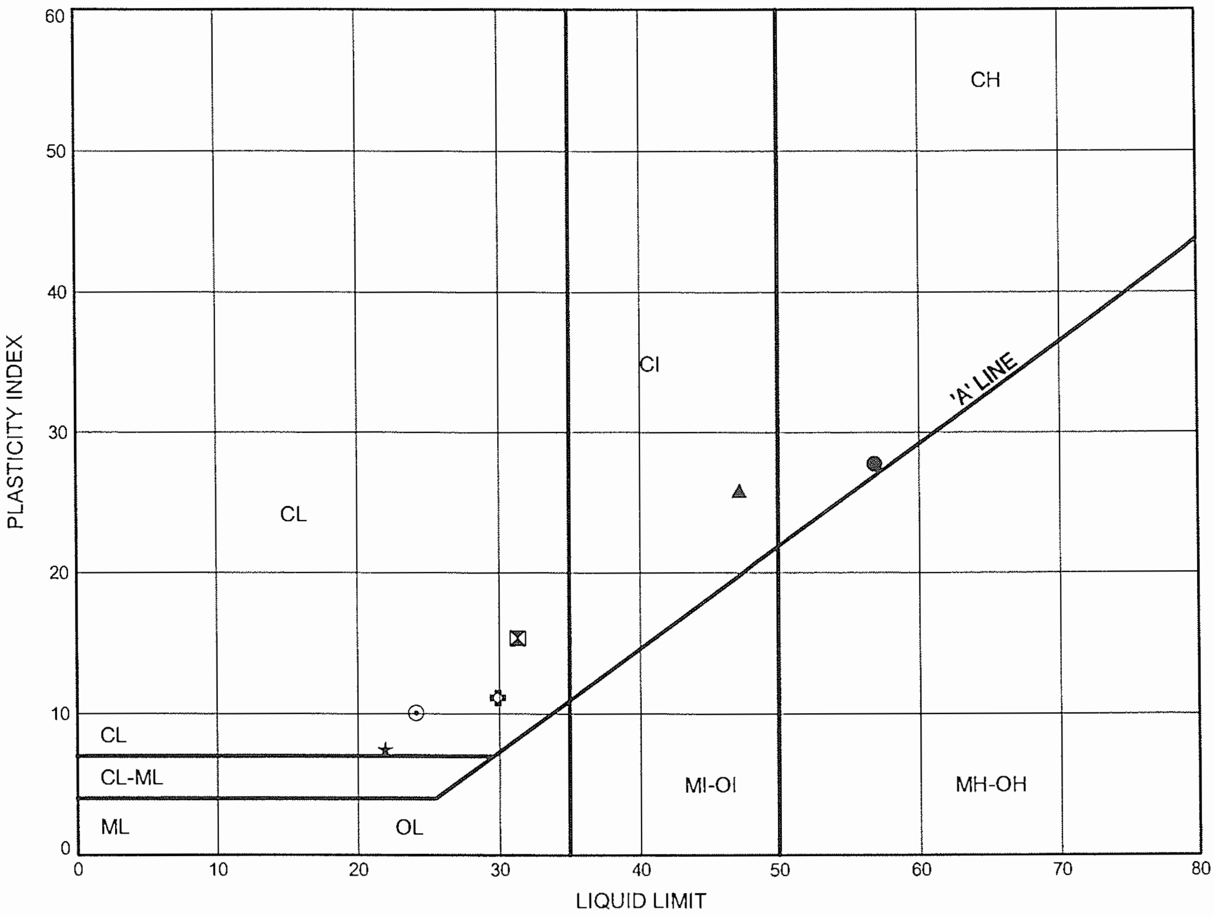
Chkd. MRA

THURBALT 5127A.GPJ 18/12/06

ATTERBERG LIMITS TEST RESULTS

FIGURE B9

SILTY CLAY TO SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	EBT3	1.83	110.81
☒	EBT4	1.83	110.76
▲	EBT5	1.83	110.44
★	PW1	4.88	119.97
⊙	PW2	4.88	120.55
✪	WBC1	1.07	113.71

THURBALT 5127A.GPJ 18/12/06

Date December 2006

Project 169-00-00

THURBER

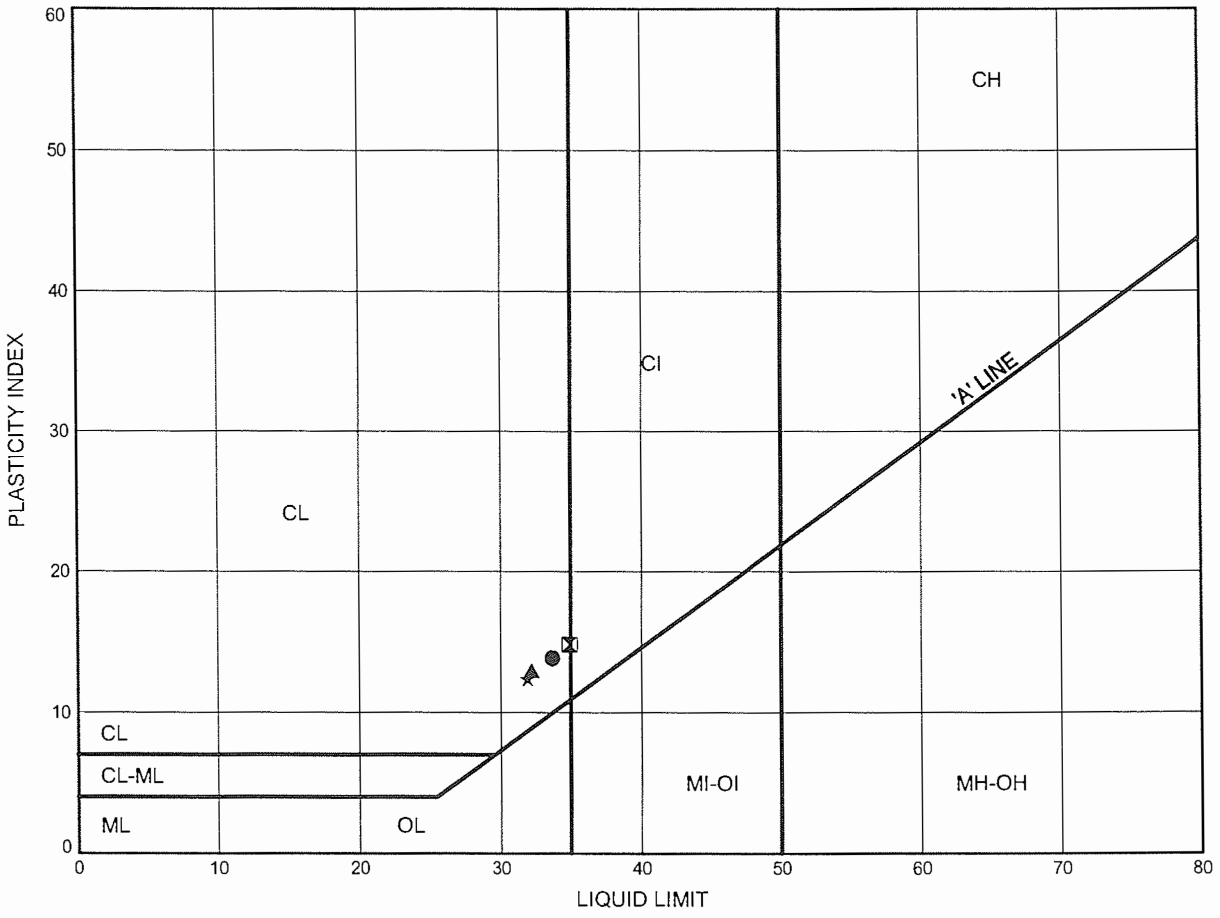
Prep'd WM

Chkd. MRA

ATTERBERG LIMITS TEST RESULTS

FIGURE B10

SHALE



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	EBT1	1.83	110.60
⊠	EBT2	2.59	110.29
▲	WBT3	1.60	111.51
★	WBT7	1.07	112.67

THURBALT 5127A.GPJ 18/12/06

Date December 2006

Project 169-00-00

THURBER

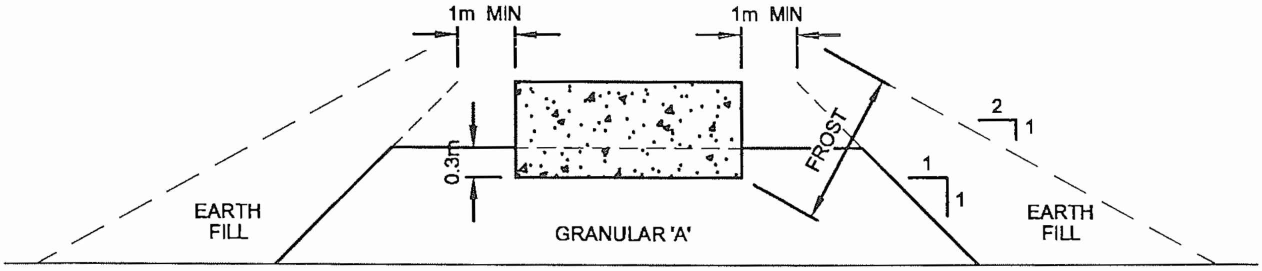
Prep'd WM

Chkd. MRA

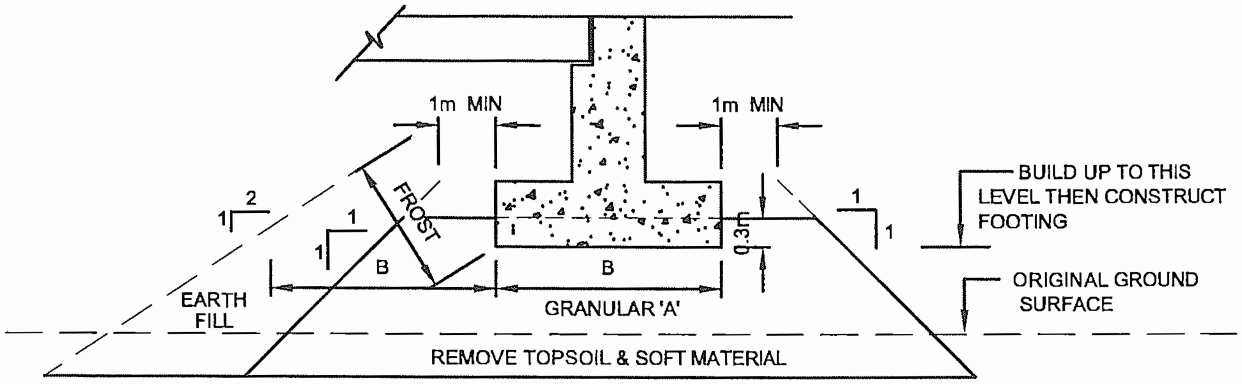
Appendix C

Figures, Tables and NSSPs

March , 2004



CROSS-SECTION



LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

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

ENGINEER SKP
DRAWN SS
DATE JAN. 2006
APPROVED PKC
SCALE NTS

ABUTMENT ON COMPACTED FILL SHOWING GRANULAR A CORE

THURBER

DWG. NO. FIGURE 1

TED35146 .DWG

TABLE C1
COMPARISON OF FOUNDATION ALTERNATIVES

Retaining Wall No.	Footings on Native Clay Till or Shale	Footings on Engineered Fill	Driven Piles	Caissons
1.	*Advantages:* i. Relatively high bearing resistance available on shale at design founding level. ii. Ease of construction. iii. Lower cost than deep foundations. *Disadvantages:* i. Native clay till is either not present or too variable for support of footings.	*Advantages:* i. Lower cost than deep foundations. *Disadvantages:* i. No increase in resistance compared to shale. ii. Excavation of shale required. iii. Cost of constructing engineered fill.	*Advantages:* i. Piles will develop high geotechnical resistance in rock. *Disadvantages:* i. Higher unit costs than footings. ii. Shallow depth to shale. Need to pre-auger or core shale to install.	*Advantages:* i. High resistance is available for caissons socketed in shale. *Disadvantages:* i. Higher cost than spread footings. ii. Potential difficulties in cleaning and inspecting bases. iii. Augering and/or coring of shale required. Potential difficulties penetrating hard limestone layers in shale.
2.	*Advantages:* i. Relatively high bearing resistance available on shale at design founding level. ii. Ease of construction. iii. Lower cost than deep foundations. *Disadvantages:* i. Possible need for local subexcavation below design level to contact shale.	*Advantages:* i. Lower cost than deep foundations. *Disadvantages:* i. No increase in resistance compared to shale. ii. Excavation of shale required. iii. Cost of constructing engineered fill.	*Advantages:* i. Piles will develop high geotechnical resistance in rock. *Disadvantages:* i. Higher unit costs than footings. ii. Shallow depth to shale. Need to pre-auger or core shale to install.	*Advantages:* i. High resistance is available for caissons socketed in shale. *Disadvantages:* i. Higher cost than spread footings. ii. Potential difficulties in cleaning and inspecting bases. iii. Augering and/or coring of shale required. Potential difficulties penetrating hard limestone layers in shale.

TABLE C1
COMPARISON OF FOUNDATION ALTERNATIVES

Retaining Wall No.	Footings on Native Clay Till or Shale	Footings on Engineered Fill	Driven Piles	Caissons
3.	*Advantages:* i. Relatively high bearing resistance available on shale. ii. Ease of construction. iii. Lower cost than deep foundations. *Disadvantages:* i. Not compatible with proposed soldier pile design. ii. Possible need for local subexcavation below design level to contact shale.	*Advantages:* i. Lower cost than deep foundations. *Disadvantages:* i. No increase in resistance compared to shale. ii. Not compatible with proposed soldier pile design. iii. Excavation of shale required. iv. Cost of constructing engineered fill.	*Advantages:* i. Piles will develop high geotechnical resistance in rock. ii. Compatible with proposed wall design. *Disadvantages:* i. Higher unit costs than footings. ii. Shallow depth to shale. Need to pre-auger or core shale to install.	*Advantages:* i. High resistance is available for caissons socketed in shale. ii. Compatible with proposed wall design. *Disadvantages:* i. Higher cost than spread footings. ii. Potential difficulties in cleaning and inspecting bases. iii. Augering/coring of shale required. Potential difficulties penetrating hard limestone layers in shale.
4.	*Advantages:* i. Relatively high bearing resistance available on shale. ii. Ease of construction. iii. Lower cost than deep foundations. *Disadvantages:* i. Native till is considered unsuitable. Founding on shale will require subexcavation below design level. ii. Mass concrete is needed to re-establish founding level.	*Advantages:* i. Lower cost than deep foundations. ii. Permits footing construction at design level without need for mass concrete. *Disadvantages:* i. No significant increase in resistance compared to shale. ii. Cost of constructing engineered fill.	*Advantages:* i. Piles will develop high geotechnical resistance in rock. *Disadvantages:* i. Higher unit costs than footings. ii. Shallow depth to shale. Need to pre-auger or core shale to install.	*Advantages:* i. High resistance is available for caissons socketed in shale. *Disadvantages:* i. Higher cost than spread footings. ii. Potential difficulties in cleaning and inspecting bases. iii. Augering/coring of shale required. Potential difficulties penetrating hard limestone layers in shale.

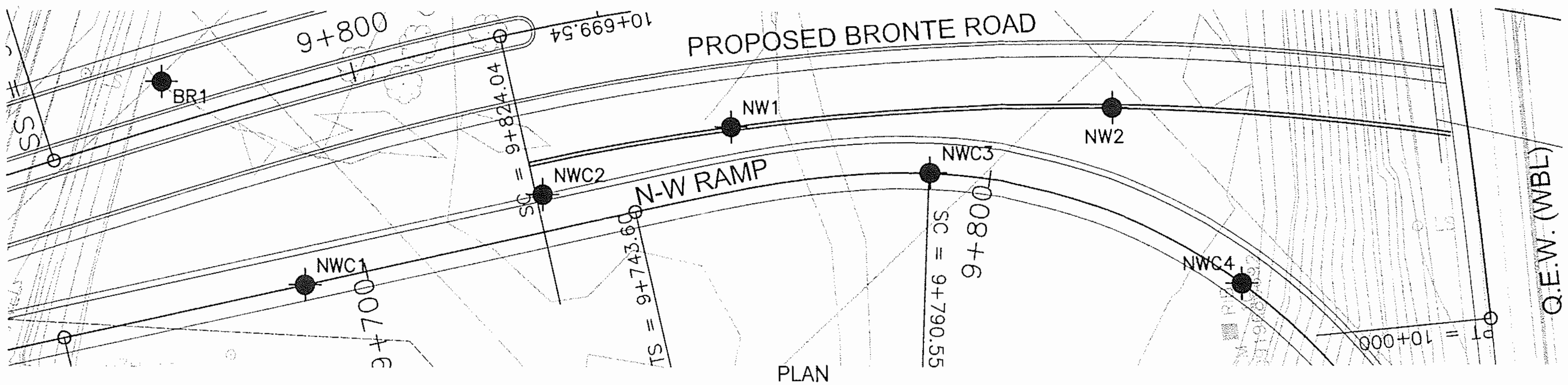
Suggested Text for NSSP on "Rock Excavation and Dewatering"

The upper 1.0 to 2.0 m of the shale bedrock is typically highly weathered and excavation should generally be possible using heavy excavation equipment and rippers, supplemented by pneumatic rock breakers where thick layers of hard material are encountered. The strength and quality of the shale bedrock increases with depth and very hard limestone and/or siltstone interbeds are present. As such, intensive use of pneumatic/hydraulic breakers or other methods of loosening the bedrock may be required and should be available on site to assist in excavation.

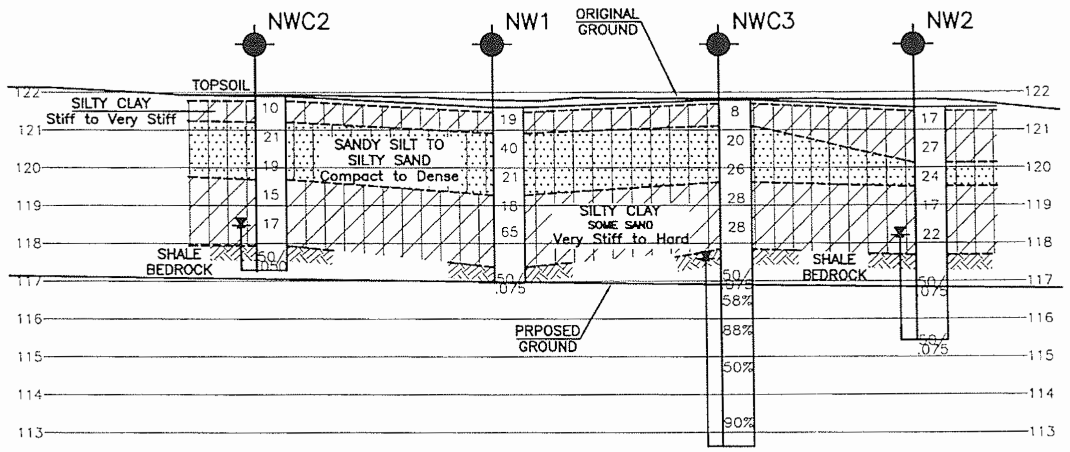
Although shale bedrock is intrinsically of low permeability, the possibility exists that concentrated seepage may be experienced from localized seams or fractures in the rock. Means to handle this seepage, such as additional pumps, should be made available.

Appendix D

Borehole Locations and Soil Strata Drawings

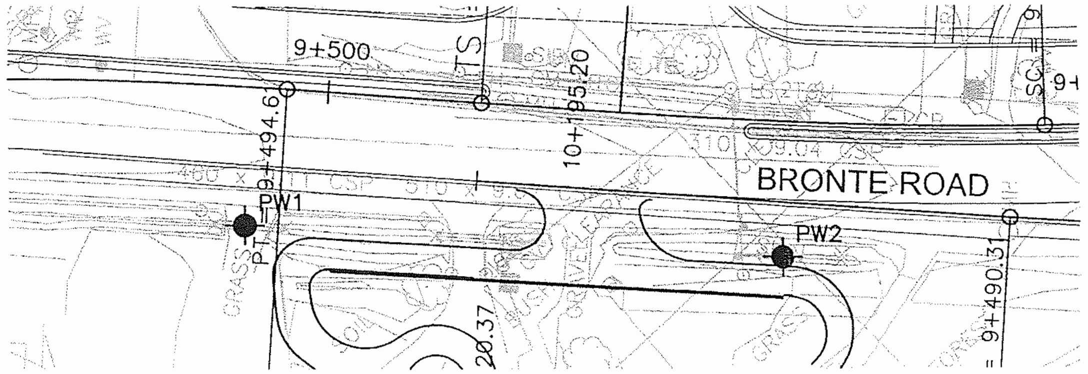


PLAN

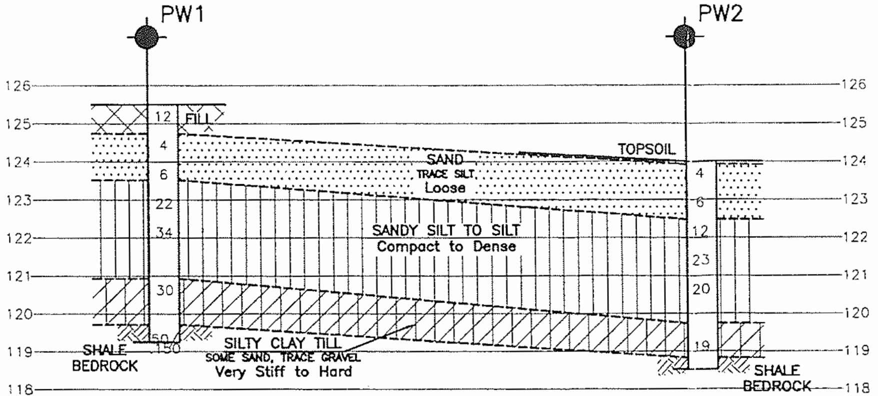


PROFILE OF RETAINING WALL 1

1 0 2 4m VERT 1:200
5 0 10 20m HORT 1:1000



PLAN



PROFILE OF PRIVACY WALL

1 0 2 4m VERT 1:200
5 0 10 20m HORT 1:1000

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

M. R. ANDERSON
Jan 18/07

A. E. GORMAN
Jan 18/07

P. K. CHATTERJI
Jan 18/07

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

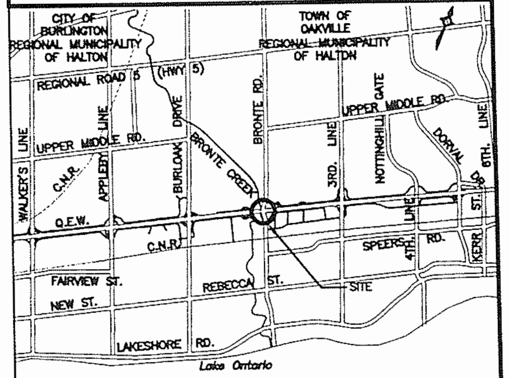
CONT No 2007-2026
WP No.169-00-08

QEW-BRONTE ROAD
RETAINING WALL 1(RAMP N-W)
AND PRIVACY WALL
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
589

McCORMICK RANKIN
CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

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

NO	ELEVATION	NORTHING	EASTING
NWC2	121.9	4 807 945.13	285 220.84
NWC3	121.8	4 807 905.91	285 267.79
NW1	121.6	4 807 932.53	285 249.91
NW2	121.6	4 807 893.63	285 295.84
PW1	125.5	4 808 146.61	284 950.28
PW2	124.0	4 808 095.69	284 998.63

-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 MRA	CHK PKC	CODE		LOAD	DATE	DEC 2006
DRAWN JHL	CHK MEF	SITE		STRUCT	DWG	1

DRAWING NAME: TED5127Report1-RetainingWall1
CREATED: DEC 06
MODIFIED:

FILENAME: D:\Job Files\19\1351\27 QEW-Bronte Creek\ted5127Report1-RetainingWall1.dwg
PLOTDATE: Jan 29, 2007 - 1:28pm

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

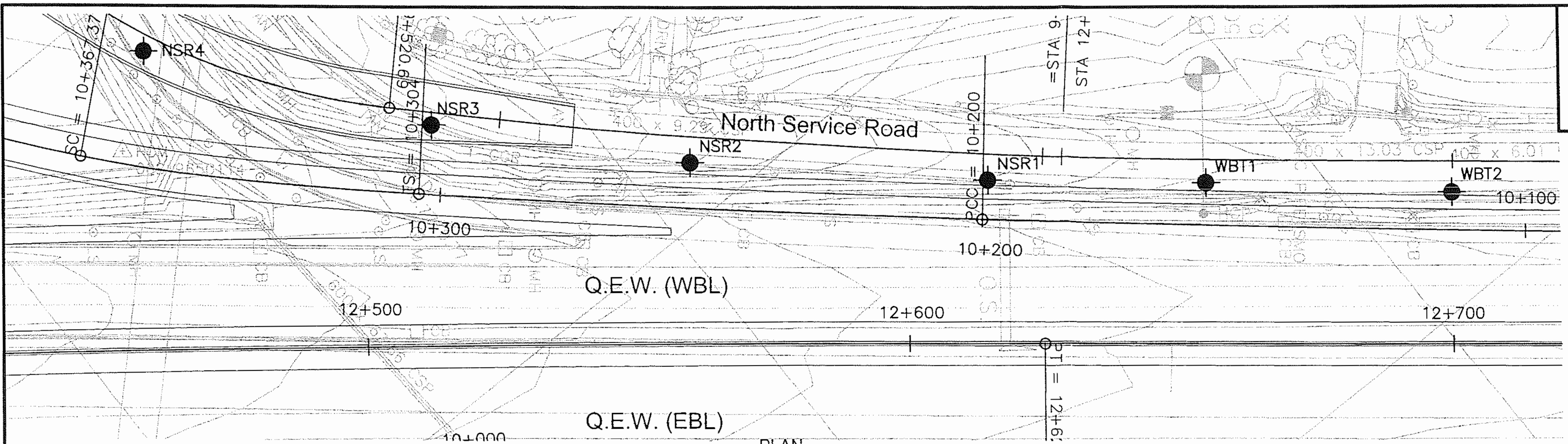
CONT No 2007–2026
WP No.169–00–09

QEW–BRONTE ROAD
RETAINING WALL 2 AND TOE WALL
BOREHOLE LOCATIONS AND SOIL STRATA

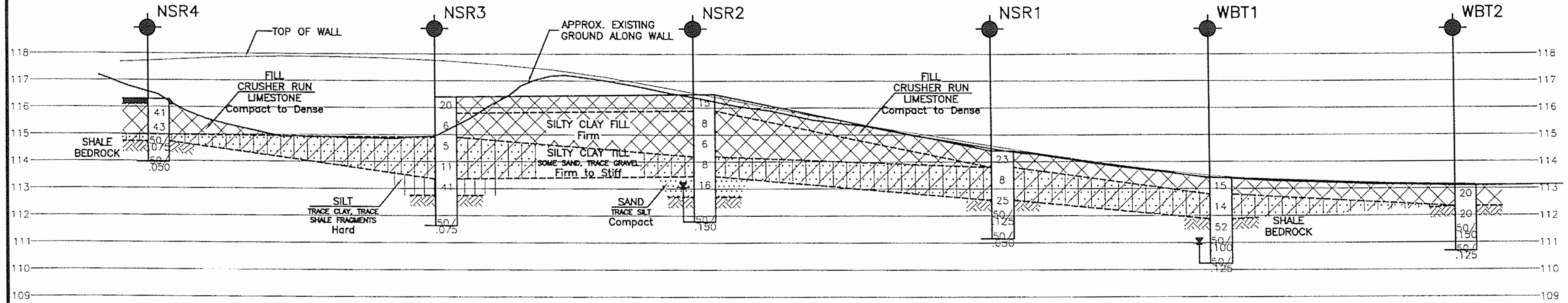
SHEET
592

McCORMICK RANKIN CORPORATION

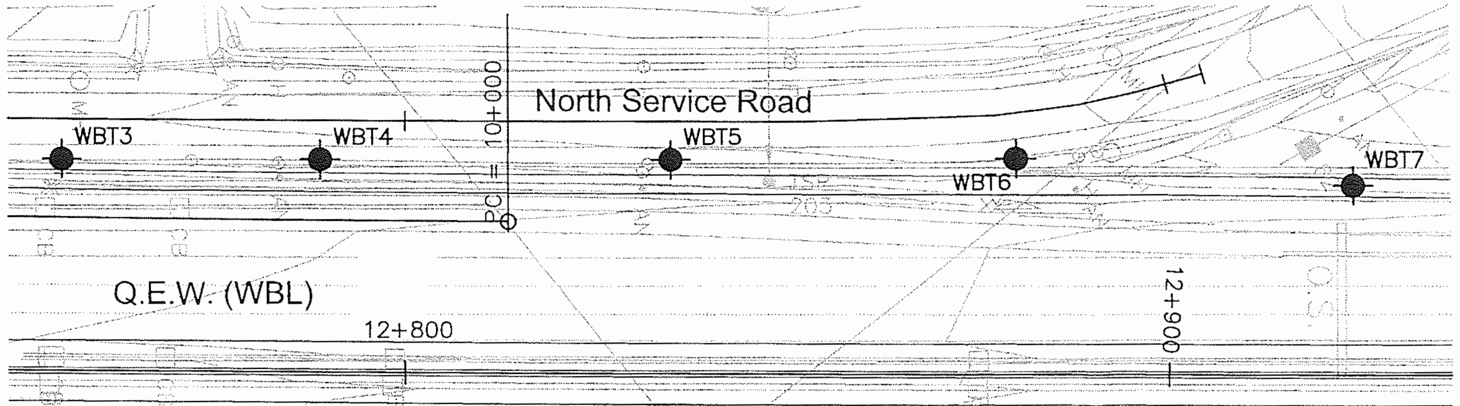
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



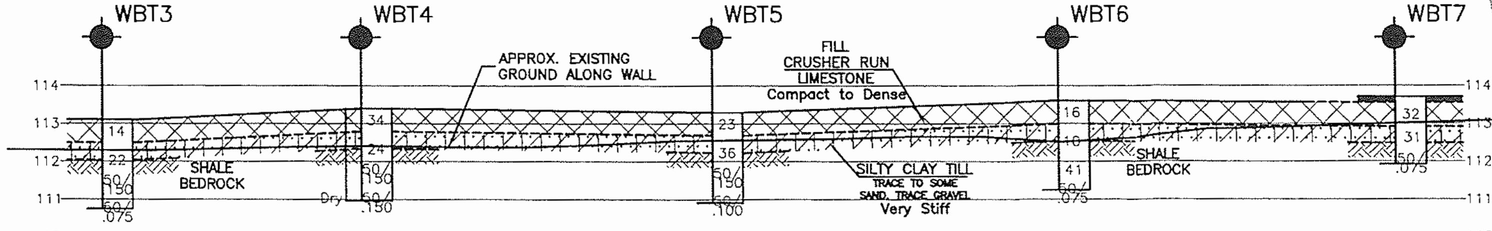
PLAN
5 0 10 20m



PROFILE OF RETAINING WALL 2
1 0 2 4m VERT 1:200
5 0 10 20m HORT 1:1000



PLAN
5 0 10 20m

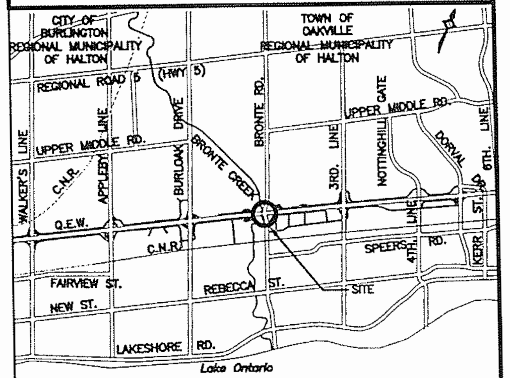


PROFILE OF TOE WALL
1 0 2 4m VERT 1:200
5 0 10 20m HORT 1:1000

M. R. ANDERSON
Jan 18/07

A. E. GORMAN
JAN 18/07

P. K. CHATTERJI
Jan 18/07



KEYPLAN

L E G E N D

●	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
NSR1	114.4	4 808 251.52	285 627.44
NSR2	116.5	4 808 210.61	285 590.69
NSR3	116.4	4 808 177.62	285 555.63
NSR4	116.3	4 808 144.22	285 511.91
WBT1	113.4	4 808 282.64	285 653.06
WBT2	113.1	4 808 316.65	285 682.57
WBT3	113.1	4 808 359.56	285 716.88
WBT4	113.4	4 808 386.27	285 738.21
WBT5	113.4	4 808 422.09	285 766.83
WBT6	113.6	4 808 457.33	285 794.87
WBT7	113.7	4 808 489.44	285 825.22

-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 MRA	CHK PKC	CODE	LOAD	DATE DEC 2006
DRAWN JHL	CHK MEF	SITE	STRUCT	DWG 2

DRAWING NAME: TED5198Bsofty
CREATED: DEC 06
MODIFIED:

FILENAME: D:\Job Files\19\1351\27 QEW-Bronte Creek\ted5127Report1-RetainingWall2.dwg
PLOTDATE: Jan 29, 2007 – 1:28pm

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

CONT No 2007-2026
WP No.169-00-10

QEW-BRONTE ROAD
RETAINING WALL 3
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
597

McCORMICK RANKIN
CORPORATION

THURBER ENGINEERING LTD.
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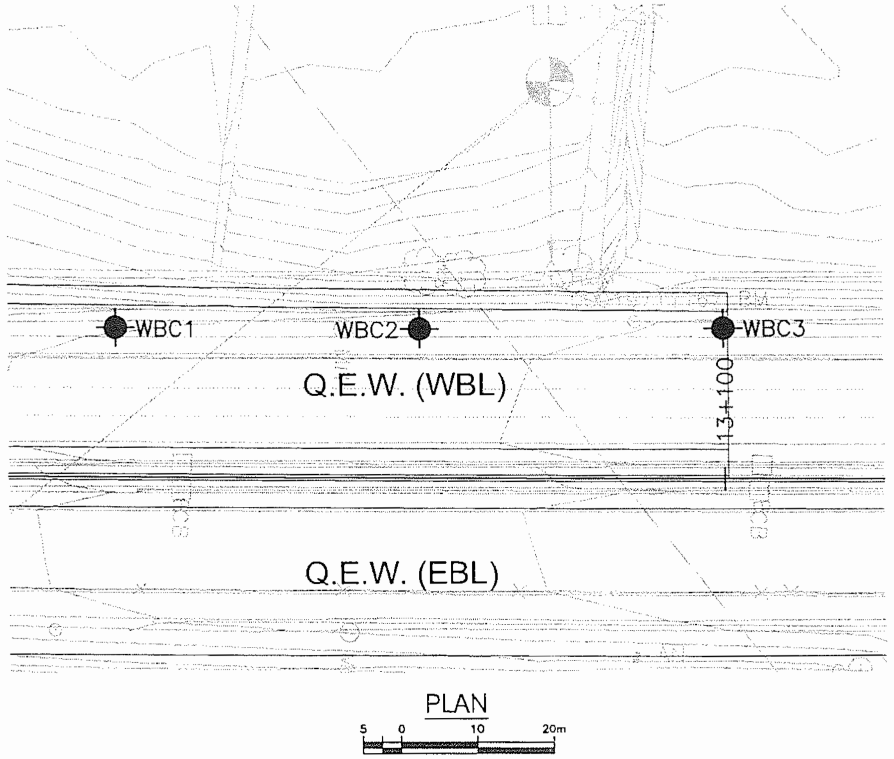
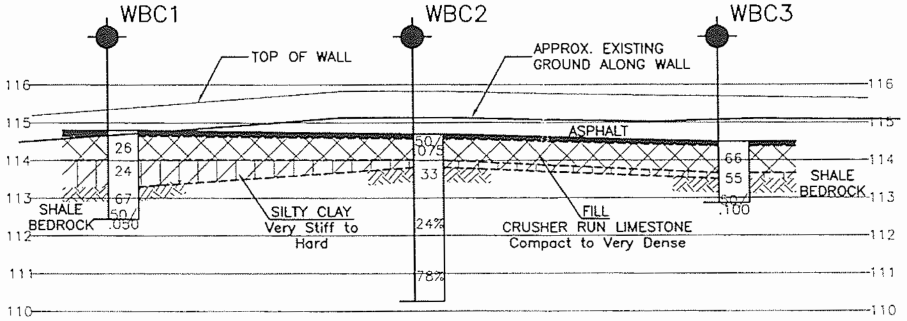


PLAN



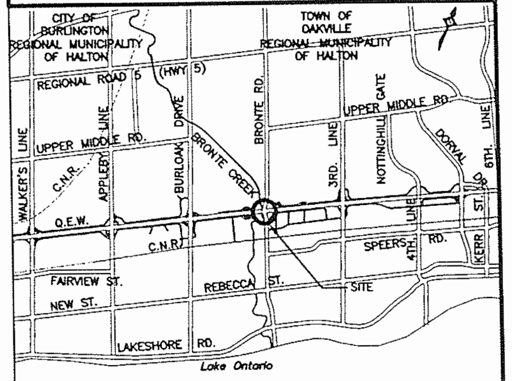
PROFILE OF RETAINING WALL 3

1 0 2 4m VERT 1:200
5 0 10 20m HORT 1:1000

M. R. ANDERSON
Jan 18/07

A. E. GORMAN
JAN 18/07

P. K. CHATTERJI
Jan 18/07



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
WBC1	114.8	4 808 565.95	285 889.49
WBC2	114.7	4 808 592.04	285 914.59
WBC3	114.5	4 808 623.31	285 939.54

-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 MRA	CHK PKC	CODE	LOAD	DATE DEC 2006	
DRAWN JHL	CHK MEF	SITE	STRUCT	DWG 3	

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

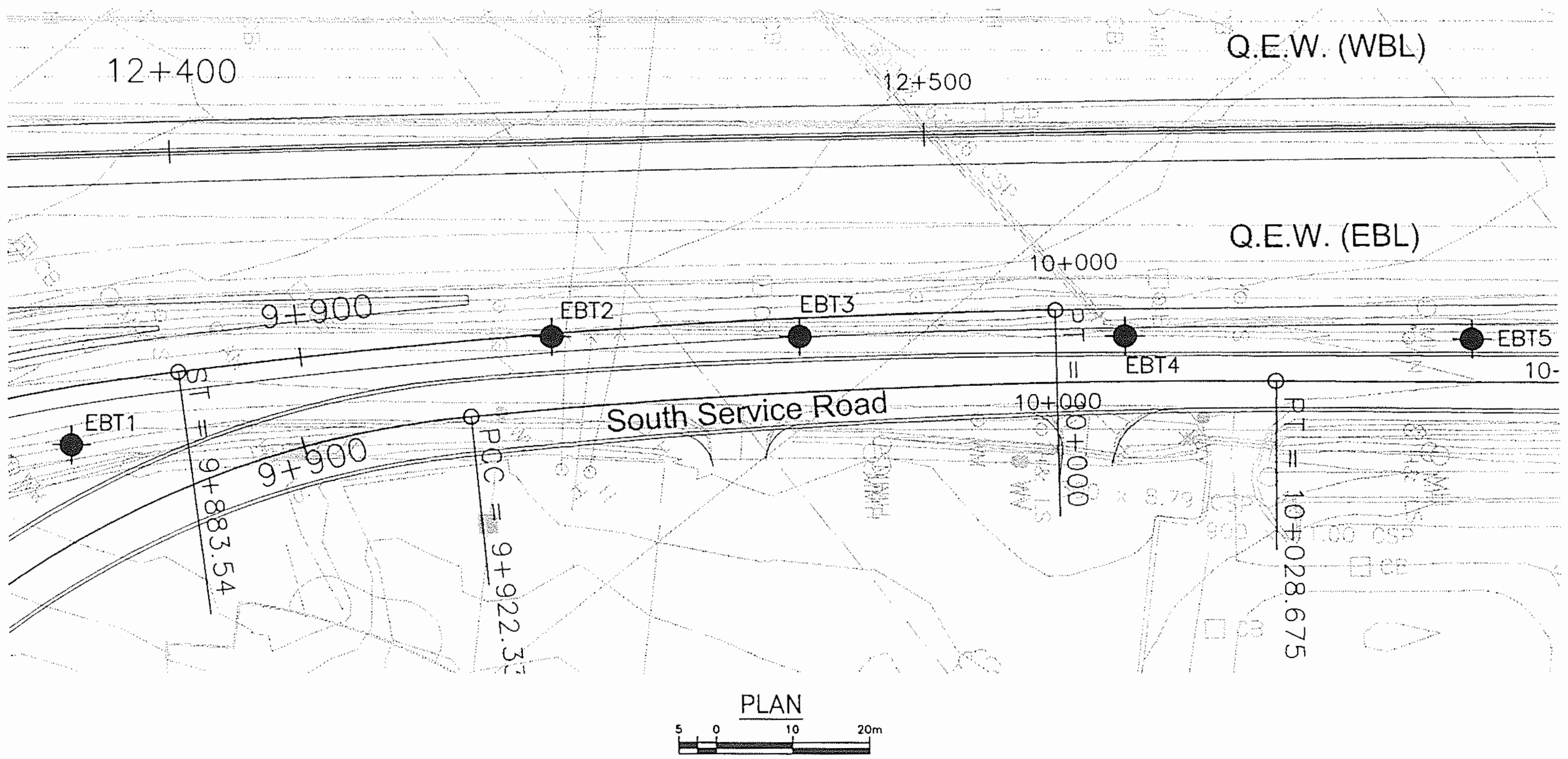
CONT No 2007–2026
WP No.169–00–11

QEW–BRONTE ROAD
RETAINING WALL 4
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
600

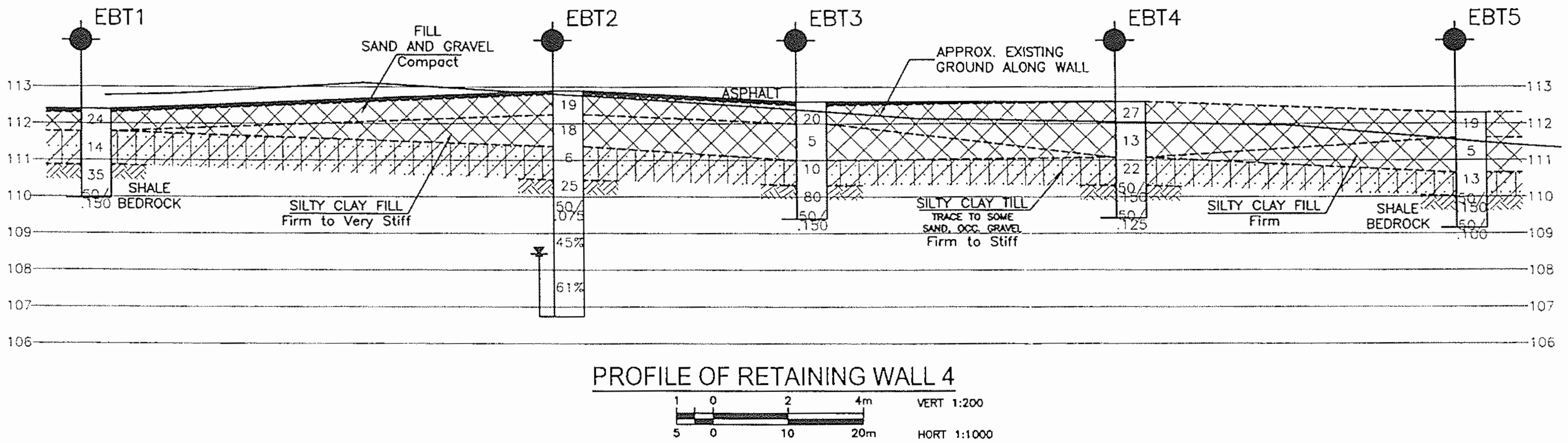
McCORMICK RANKIN
CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



PLAN

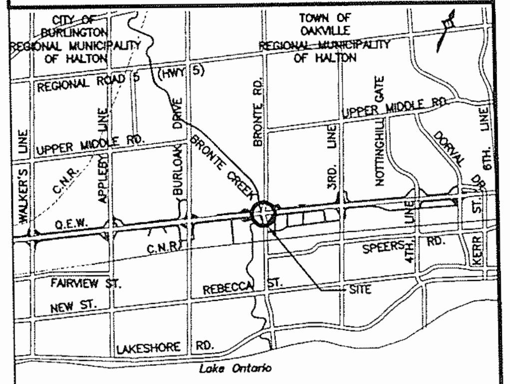
M. R. ANDERSON
Jan 18/07



PROFILE OF RETAINING WALL 4

A. E. GORMAN
JAN 18/07

P. K. CHATTERJI
Jan 18/07



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
EBT1	112.4	4 808 028.42	285 541.61
EBT2	112.9	4 808 087.45	285 569.95
EBT3	112.6	4 808 113.06	285 590.37
EBT4	112.6	4 808 146.61	285 617.13
EBT5	112.3	4 808 182.11	285 646.12

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DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS DATE	BY	DESCRIPTION			
DESIGN MRA	CHK PKC	CODE	LOAD	DATE DEC 2006	
DRAWN JHL	CHK MEF	SITE	STRUCT	DWG 4	