

**FOUNDATION INVESTIGATION REPORT
QUEENSVILLE SIDEROAD UNDERPASS
HIGHWAY 404 EXTENSION
FROM GREEN LANE TO WOODBINE AVENUE/RAVENSHOE ROAD
ONTARIO
G.W.P. 2109-05-00**

Geocres Number: 31D-449

Report to

Philips Engineering / Hatch Mott MacDonald Joint Venture

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

August 27, 2009
File: 19-1605-96

\\Torserver1\Projects\19\1605\96 Hwy404
Foundations\Reports & Memos\Queensville
Underpass\19160596 Queensville FIR-Final.doc

TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

1	INTRODUCTION	1
2	SITE DESCRIPTION	2
3	SITE INVESTIGATION AND FIELD TESTING.....	2
4	LABORATORY TESTING	4
5	DESCRIPTION OF SUBSURFACE CONDITIONS	4
5.1	Pavement Structure	4
5.2	Fill	4
5.3	Sand.....	5
5.4	Clayey Silt.....	5
5.5	Sand and Silt Till.....	6
5.6	Gravelly Sand.....	7
5.7	Clayey Silt Till.....	8
5.8	Silty Sand	9
5.9	Silt Till and Silt.....	10
5.10	Water Levels	10
6	MISCELLANEOUS	11

Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Record of Borehole Sheets and Laboratory Results (previous investigation)
Appendix D	Site Photographs
Appendix E	Drawing titled "Borehole Locations and Soil Strata"

**FOUNDATION INVESTIGATION REPORT
QUEENSVILLE SIDEROAD UNDERPASS
HIGHWAY 404 EXTENSION
FROM GREEN LANE TO WOODBINE AVENUE/RAVENSHOE ROAD
ONTARIO
G.W.P. 2109-05-00**

Geocres Number: 31D-449

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of a proposed underpass carrying Queensville Sideroad over the proposed Highway 404 extension in the Regional Municipality of York, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile and cross-sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the present investigation.

Thurber carried out the investigation as a sub-consultant to Philips Engineering/Hatch Mott MacDonald Joint Venture under the Ministry of Transportation Ontario (MTO) Agreement Number 2007-E-0027.

In the preparation of this report and in addition to the boreholes drilled under the current assignment, reference has been made to information on subsurface conditions contained in an earlier preliminary foundation report. The title of this report is listed as follows:

- Preliminary Foundation Investigation Report, Queensville Sideroad Underpass, Highway 404 Extension from Green Lane to Highway 12/48, Agreement No. 2005-A-000585, dated October 2006, prepared by Golder Associates. Report Reference No. 04-1111-016-3 (Reference 1).

2 SITE DESCRIPTION

The site is located on the existing Queensville Sideroad, approximately 750 m west of the intersection of Queensville Sideroad and Woodbine Avenue (York Regional Road 8), in the Town of East Gwillimbury, in the Regional Municipality of York.

Currently, the topography along Queensville Sideroad, east and west of the proposed site is a rolling/undulating terrain varying in elevation as follows:

Location	Station	Elevation
West of site	9+350 to 9+625	270 to 284.9
	9+625 to 10+075	284.9 to 257.1
Proposed Hwy 404 alignment & Queensville Sideroad intersection	10+000	259.1
East of site	10+075 to 10+280	257.1 to 264.5

The site location is within a low point/valley and the natural ground surface within the valley has a relatively flat to gently rolling/undulating topography. The underpass is on the east flank of a drumlin.

A small tributary of the Maskinonge River flows through a CSP culvert under Queensville Sideroad, near Station 9+790. The tributary flows south to north.

The lands around the site are generally undeveloped and/or agricultural. Vegetation consists mainly of tall grass, shrubs and a few mature trees. There are farmsteads to the north and south of Queensville Sideroad.

The site lies within the physiographic region known as The Peterborough Drumlin Field, characterized by drumlinized till. The till is typically sandy with shallow coverings of silt and fine sand.

Photographs in Appendix D show:

1. A view looking north of Queensville Sideroad at the proposed Highway 404 location.
2. View of the site looking northwest of Queensville Sideroad over proposed west approach to the future structure.
3. A view looking south of Queensville Sideroad at the proposed Highway 404 location.
4. A view east along existing Queensville Sideroad over the future east approach and east abutment location.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between March 11 and April 3, 2008 and consisted of drilling and sampling a total of five boreholes (numbered 08-43 to

08-47). Three boreholes (Boreholes 08-44, 08-45 and 08-46) were drilled at the foundation elements to depths ranging from 12.3 m to 23.1 m (Elevations 233.6 to 246.8 m). One borehole was drilled at each approach embankment. Termination depths for the west and east approach embankment boreholes (Boreholes 08-43 and 08-47) were 4.7 m and 27.7 m (Elevations 259.2 and 229.7 m), respectively.

The approximate borehole locations of the current and the previous investigations are shown on the Borehole Locations and Soil Strata Drawing in Appendix I. The coordinates and elevations of the current boreholes are given on the drawing and on the individual Record of Borehole Sheets in Appendix A.

Records of Boreholes 301, 301A, 302 and 303 drilled during the previous investigation (Reference 1) and their respective laboratory test results are enclosed in Appendix C.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

Drilling was carried out using track mounted CME 75 and D90 drill rigs. A combination of solid and hollow stem auger drilling techniques were used to advance the boreholes. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Standpipe piezometers consisting of 19 mm diameter PVC pipe with slotted screens were installed and enclosed in filter sand in two boreholes to permit longer term groundwater level monitoring. The locations and completion details of the piezometers are shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
West Approach	08-43	None installed	Borehole backfilled to surface with bentonite holeplug.
West Abutment	08-44	12.3/246.8	Sand from 12.3 m to 10.2 m. Borehole caved in from 10.2 m to 7.0 m, bentonite holeplug from 7.0 m to surface.
Pier	08-45	21.4/236.9	Sand from 21.4 m to 19.6 m, bentonite holeplug from 19.6 m to 0.3 m, cold patch from 0.3 m to surface.
East Abutment	08-46	None installed	Borehole backfilled to surface with bentonite holeplug.
East Approach	08-47	None installed	Borehole backfilled with bentonite holeplug to 0.2 m and asphalt to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendices A and C. Details of the encountered soil stratigraphy are presented in these sheets and on the "Borehole Locations and Soil Strata Drawing" and "Stratigraphic Sections" in Appendix E. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the soil stratigraphy encountered across the site consists of fill of variable composition (sand, sand and gravel, silty sand and clayey silt) overlying native deposits of dense to very dense sand and silt till and silt till, and stiff to hard clayey silt till. Fill thickness ranged from 1.5 m to 4.4 m. Interbedded layers of sand, silty sand and gravelly sand were observed within the till deposits. Asphalt was encountered at the surface in boreholes drilled on Queensville Sideroad. More detailed descriptions of the individual strata are presented below.

5.1 Pavement Structure

Pavement structure consisting of approximately 125 mm to 200 mm of asphalt overlying granular (sand and gravel fill) road base was encountered in Boreholes 08-43, 08-45 and 08-47 drilled on existing Queensville Sideroad lanes and shoulders.

5.2 Fill

Fill was contacted across the site in all the boreholes. Fill was encountered below the pavement structure in Boreholes 08-43, 08-45 and 08-47 and surficially in Boreholes 08-44, 08-46 and 301 to 303. The fill generally consists of various cohesionless soil layers such as dark brown to brown sand and gravel, sand and silty sand containing some gravel, trace of silt, trace of clay and occasional wood fibres and rootlets.

Dark brown to brown clayey silt fill was contacted surficially in Borehole 08-44 and at 0.7 m (Elevation 258.3) depth in Borehole 302.

Thickness of the fill ranged from 1.5 m to 4.2 m. The fill extended to depths ranging from 1.5 m to 2.9 m (Elevations 253.8 to 261.8) at the locations of proposed west approach, both abutments and pier. At the east approach (Borehole 08-47), fill extended to depth of 4.4 m (Elevation 253.0).

SPT 'N' values recorded in the cohesionless fill (sand and gravel and silty sand) ranged from 4 to 41 blows per 0.3 m penetration indicating a loose to dense relative density. In the clayey silt fill layer, the SPT 'N' values were 2 and 6 blows per 0.3 m of penetration, indicating a soft to firm consistency. The moisture content of the fill ranged from 2% to 21%.

Grain size distribution curves for the cohesionless fill samples of the current investigation tested are presented on the Record of Borehole sheets and on Figure B1 in Appendix B. The results of the laboratory tests are summarized as follows:

Soil	(%)
Gravel	3 to 12
Sand	55 to 57
Silt	26 to 33
Clay	7

5.3 Sand

A 0.8-m thick layer of brown sand with trace silt and trace gravel was contacted at 2.2 m depth (Elevation 256.9) in Borehole 08-44.

The depth to the base of the sand was 3.0 m (Elevation 256.0).

SPT-N value measured in the sand was 34 blows per 0.3 m of penetration, indicating a dense relative density. Moisture content was 18%.

5.4 Clayey Silt

Layers of native brown clayey silt with some sand and trace gravel were encountered below the fill in Boreholes 301 to 303. The thickness of the clayey silt layer ranged from 0.7 m to 1.5m.

The depth to the base of the clayey silt layer ranges from 2.2 m to 3.7 m (Elevations 253.8 to 258.8).

SPT-N values measured in the clayey silt ranged from 5 to 11 blows per 0.3 m of penetration, indicating a firm to stiff consistency. Moisture content ranged from 11% to 25%.

Grain size distribution curves and Atterberg Limit tests results for clayey silt samples conducted during the previous investigation are presented in Appendix C.

The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 3
Sand	21 to 28
Silt	43 to 65
Clay	7 to 33

Index Property	(%)
Liquid Limit	24 to 28
Plastic Limit	13 to 17

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

5.5 Sand and Silt Till

Layers of native brown sand and silt till containing trace to some clay and trace to some gravel were observed across the site in Boreholes 08-43 to 08-46, 302 and 303 at depths and elevations as indicated in Table 5.1.

Table 5.1 – Locations of Native Sand and Silt Till

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
West Approach	08-43	2.1 to 4.7 (borehole termination depth)	261.8 to 259.2	At least 2.6
West Abutment	08-44	3.0 to 12.3 (borehole termination depth)	256.0 to 246.8	At least 9.3
	303	3.0 to 13.9 (borehole termination depth)	258.0 to 247.1	At least 10.9
Pier	08-45	2.4 to 21.4 (borehole termination depth)*	255.8 to 236.9	At least 19.0
	302	3.0 to 18.5 (borehole termination depth)	256.0 to 240.5	At least 15.5
East Abutment	08-46	2.9 to 7.2	253.8 to 249.5	4.3

* A gravelly sand layer was intersected between 8.7 m to 11.0 m depth

Standard Penetration tests in this deposit gave SPT 'N' values ranging from 10 blows per 0.3 m of penetration to greater than 100 blows for 0.10 m of penetration, indicating that the soil was in compact to very dense state. An SPT 'N' value measured at 3.1 m depth (Elevation 255.2) in Borehole 08-45 was 9 blows per 0.3 m of penetration, indicating a

loose relative density. The high SPT 'N' values measured at the west abutment were generally encountered below Elevations 250.0 and 253.0 in Boreholes 08-44 and 303, respectively. At the pier, the high SPT 'N' values were measured below Elevations 240.0 and 243.0 in Boreholes 08-45 and 302, respectively. At the east abutment, high SPT 'N' values were encountered below Elevation 234.0. The moisture content of samples from the sand and silt till deposit varies between 5% and 18%.

Grain size distribution curves for the sand and silt till samples tested for the current investigation are presented on the Record of Borehole sheet and on Figures B2 and B3. Atterberg Limit test results are presented on Figure B9 of Appendix B.

Laboratory test results of previous investigation are presented in Appendix C.

The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 32
Sand	28 to 50
Silt	35 to 54
Clay	5 to 17

Index Property	(%)
Liquid Limit	12 to 19
Plastic Limit	9 to 11

The above results show that the clayey zone in the sand and silt till are typically of low plasticity with group symbols of CL-ML.

Although not encountered in the boreholes, glacial tills inherently contain cobbles and boulders which may account for some high blow counts and resistance to augering.

5.6 Gravelly Sand

A layer of grey gravelly sand was contacted in Borehole 08-45 at 8.7 m depth (Elevation 249.6), within the sand and silt till deposit.

The layer was 2.3 m thick. The depth to the base of the gravelly sand was 11.0 m (Elevation 247.3).

SPT-N values measured in the gravelly sand layer were 49 blows per 0.3 m of penetration and 100 blows per 0.1 m of penetration, indicating a dense to very dense relative density. The moisture content ranged from 9% to 11%.

Grain size distribution curve for a gravelly sand sample tested is presented on the Record of Borehole sheets and on Figure B4. The results of the laboratory test are summarized as follows:

Soil Particles	Gravelly Sand (%)
Gravel	22
Sand	71
Silt & Clay	7

5.7 Clayey Silt Till

Layers of native brown to grey clayey silt till containing some sand to sandy and trace gravel were observed in Boreholes 08-46, 08-47, 301 and 301A, drilled at the east abutment and east approach, at depths and elevations indicated in Table 5.2.

Table 5.2 – Depths and Elevations of Native Clayey Silt Till

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
East Abutment	08-46	7.2 to 10.3	249.5 to 246.4	3.1
		11.8 to 23.1 (borehole termination depth)	244.9 to 233.6	At least 11.3
	301	3.7 to 9.6	253.8 to 247.9	5.9
		11.6 to 15.7	245.9 to 241.8	At least 4.1
	301A	12.2 to 17.1	243.8 to 238.9	4.9
East Approach	08-47	4.4 to 21.8	253.0 to 235.6	17.4

Standard Penetration tests in these deposits gave SPT 'N' values ranging from 11 to 77 blows per 0.3 m of penetration, indicating a stiff to hard consistency. SPT 'N' values of 149 and 160 blows per 0.275 m of penetration were measured in Boreholes 08-46 and 08-47 at 23.1 m and 6.1 m depth (Elevations 233.6 and 251.3). The moisture content of samples from this deposit varies between 10% and 18%.

Grain size distribution curves for the samples tested for the current investigation are presented on the Record of Borehole sheet and on Figures B5 and B6. Atterberg Limit test results are presented on Figure B10 of Appendix B.

Laboratory test results of previous investigation are presented in Appendix C.

The results of gradation and Atterberg Limit Tests conducted on samples of clayey silt till are summarized below:

Soil Particles	(%)
Gravel	0 to 4
Sand	11 to 36
Silt	47 to 70
Clay	13 to 23

Index Property	(%)
Liquid Limit	12 to 20
Plastic Limit	10 to 19

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

Although not encountered in the boreholes, glacial tills inherently contain cobbles and boulders which may account for some high blow counts and resistance to augering.

5.8 Silty Sand

Layers of native brown to grey silty sand were encountered within clayey silt till in Boreholes 08-46 and 301 (east abutment) and below the clayey silt in Borehole 303. Thickness of the silty sand layers ranged from 0.8 m to 2.0 m.

The depths to the base of the silty sand were 3.0 m, 11.6 m and 11.8 m (Elevations 258.0, 245.9 and 244.9) in Boreholes 303, 301 and 08-46, respectively.

SPT-N values measured in the silty sand ranged from 10 to 33 blows per 0.3 m of penetration, indicating a compact to dense relative density. Moisture content ranged from 10% to 18%.

Grain size distribution curve for a silty sand sample tested for the current investigation is presented on the Record of Borehole sheet and on Figure B7. The results of the laboratory test are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	64
Silt	31
Clay	5

5.9 Silt Till and Silt

Grey silt till containing trace of gravel, sand and clay was encountered in Borehole 08-47 at 21.8 m depth (Elevation 235.6), extending to borehole termination depth, 27.7 m (Elevation 229.7).

Grey silt layer with interlayered clayey silt was contacted in Borehole 301A at 17.1 m depth (Elevation 238.9), extending to borehole termination depth.

SPT 'N' values ranging from 59 to higher than 100 blows for under 0.1 m penetration were measured within the silt and silt till layer, indicating a very dense relative density.

The natural moisture content of samples recovered from the silt till and silt layers were 17% to 21%.

Grain size distribution curve for silt and silty till samples tested for the current investigation are presented on the Record of Borehole sheets and on Figure B8.

Laboratory test results of previous investigation are presented in Appendix C.

The result of the laboratory tests are summarized below:

Soil Particles	(%)
Gravel	0
Sand	1 to 2
Silt	89 to 92
Clay	6 to 10

Index Property	(%)
Liquid Limit	19 to 28
Plastic Limit	15

The above results show that the clayey zone in the silt till and silt are typically of low plasticity with group symbols of CL-ML.

5.10 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in two boreholes during the current investigation to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.3, along with the measurements in the boreholes upon completion of drilling.

Table 5.3 – Water Level Measurements

Foundation Unit	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
West Approach	08-43	March 28, 2008	4.1	259.8	Open borehole
West Abutment	08-44	April 18, 2008	1.4	257.7	In piezometer
		June 30, 2008	2.1	257.0	
		July 29, 2008	1.9	257.2	
		October 24, 2008	1.1	258.0	
		March 20, 2009	0.5*	259.6*	
		April 22, 2009	0.5*	259.6*	
		May 15, 2009	0.5	258.6	
		June 5, 2009	1.0	258.1	
		July 10, 2009	2.1	257.0	
	303	September 29, 2004	9.1	251.9	Open borehole
Pier	08-45	April 18, 2008	2.4	255.9	In piezometer
		April 21, 2008	2.4	255.9	
	302	September 29, 2004	10.7	248.3	In piezometer
East Abutment	08-46	March 18, 2008	0.9	255.8	Open borehole
	301	June 11, 2004	4.9	252.6	Open borehole
	301A	September 28, 2004	2.7	253.3	In piezometer
		October 7, 2004	0.7*	256.7*	
East Approach	08-47	March 11, 2008	2.6	254.8	Open borehole

Water level above ground surface (artesian condition)

The piezometric readings of the current investigation indicate that the groundwater level is high and the water level decreases from west to east from Elevations 257.0 to 255.9.

At the location of Borehole 08-44, during the winter season, a relatively low artesian head was encountered at 0.5 m (Elevation 259.6) above the ground surface.

Previous geotechnical investigation (Reference 1) indicates that a relatively low artesian head was encountered in Borehole 301A, where water level was measured at 0.7 m (Elevation 256.7) above the ground surface.

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

6 MISCELLANEOUS

Borehole locations were selected by Thurber Engineering Ltd. Surveyors from J. D. Barnes obtained the co-ordinates and the ground surface elevations at each borehole.

Thurber obtained utility clearances for the borehole locations prior to drilling.

DBW Drilling of Ajax Ontario supplied track mounted CME 75 and D90 drill rigs and conducted the drilling, sampling and in-situ testing operations.

The field program was supervised on a full time basis by Ms. Eckie Siu of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

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

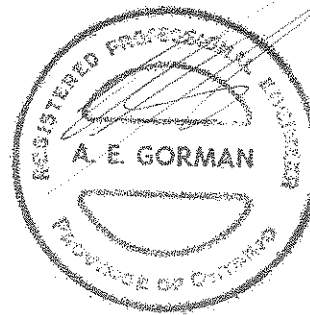
The report was reviewed by Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd

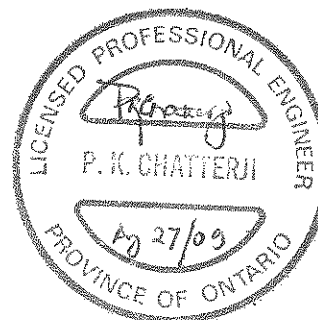
Rocio Palomeque Reyna, P.Eng.
Geotechnical Engineer



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



P. K. Chatterji, P.Eng.
Review Principal



Queensville Sideroad Underpass
Highway 404 Extension from Green Lane to Woodbine Avenue/Ravenshoe Rd.

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

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.

TERMS					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
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.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No 08-43

1 OF 1

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 051.2 E 309 710.3, Station 9+820, Left Shoulder ORIGINATED BY ES
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.03.28 - 2008.03.28 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
263.9								20 40 60 80 100						
0.0	ASPHALT: (200mm)							○ UNCONFINED + FIELD VANE						
0.2	SAND, some gravel, trace to some silt							● QUICK TRIAXIAL X LAB VANE						
263.1	Dark Brown													
0.8	Moist (FILL)		1	SS	41		263							12 56 26 7
	Silty SAND, some gravel, trace clay													
	Dense to Compact		2	SS	16		262							
	Brown													
	Moist (FILL)													
261.8														
2.1	SAND and SILT, trace gravel, trace clay		3	SS	24		261							
	Compact to Very Dense													
	Brown		4	SS	37		260							1 40 52 8
	Moist (TILL)													
259.2			5	SS	100/									
4.7	END OF BOREHOLE AT 4.7m. BOREHOLE OPEN AND WATER LEVEL AT 4.1m ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLE PLUG.				.125									

METRIC

DATUM Geodetic DATE 2008.03.28 - 2008.04.02 CHECKED BY AEF

Continued Next Page

+³, X³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 08-44

2 OF 2

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 053.5 E 309 751.4, Station 9+960, 10m Rt ORIGINATED BY ES
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.03.28 - 2008.04.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE			w _p	w	w _L
								20 40 60 80 100								
	Continued From Previous Page															
	SAND and SILT, trace clay Very Dense Grey (TILL)		10	SS	100/ .125		249							0 42 49 9		
							248									
246.8			11	SS	100/ .100		247									
12.3	END OF BOREHOLE AT 12.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.04.18 1.4 257.7 2008.06.30 2.1 257.0 2008.07.29 1.9 257.2 2008.10.24 1.1 258.0 2009.03.20 0.5* 259.6 2009.04.22 0.5* 259.6 2009.05.15 0.5 258.6 2009.06.05 1.0 258.1 2009.07.10 2.1 257.0 2009.07.16 at ground level * (above ground surface)															

RECORD OF BOREHOLE No 08-45

1 OF 3

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 070.2 E 309 788.1, Station 10+000, 5m Rt ORIGINATED BY ES
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.04.03 - 2008.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
								UNCONFINED + FIELD VANE QUICK TRIAXIAL X LAB VANE					
								WATER CONTENT (%)					
258.3													
0.0	ASPHALT: (125mm)												
0.1	SAND, some gravel, trace to some silt Dark Brown to Brown Compact Moist (FILL)		1	SS	25								
	fine grained Loose		2	SS	6								
255.8													
2.4	SAND and SILT, some clay, occasional oxide staining Loose Brown (TILL)		3	SS	9								
			4	SS	9								
	Compact Grey		5	SS	16								
			6	SS	21								
	Very Dense		7	SS	58								
249.6													
8.7	Gravelly SAND, medium to coarse grained, trace silt and clay Very Dense Grey Wet		8	SS	100/ .100								

Continued Next Page

+ 3. X 3. Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

ORIGINATED BY ES

COMPILED BY WM

CHECKED BY AEG

Continued Next Page

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-45

3 OF 3

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 070.2 E 309 788.1, Station 10+000, 5m Rt ORIGINATED BY ES
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.04.03 - 2008.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
	Continued From Previous Page							20 40 60 80 100					w _p w w _L			kN/m ³	GR SA SI CL		
								40 80 120 160 200					20 40 60						

+ 3 x 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-46

1 OF 3

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 096.4 E 309 821.8, Station 10+060, 10m R1 ORIGINATED BY ES
 HWY 404 BOREHOLE TYPE Solid Stem Augers / Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.03.17 - 2008.03.18 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE		
256.7							20	40	60	80	100		
0.0	SAND, medium to coarse grained, some gravel, some silt, trace rootlets Loose to Compact Dark Brown Moist (FILL)		1	SS	5								
			2	SS	19								
254.7			3	SS	6								
2.0	Silty SAND, some gravel, occasional wood fibres Loose Brown Moist (FILL)		4	SS	7								
253.8			5	SS	10								
2.9	SAND and SILT, some clay, trace gravel, occasional oxide staining Compact Brown to Grey Moist (TILL)		6	SS	22								
			7	SS	120								
	Dense to Very Dense												
249.5			8	SS	77								
7.2	Clayey SILT, sandy Hard Grey (TILL)		9	SS	45								

Continued Next Page

+ 3, x 3 Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

METRIC

[illegible]

Numbers refer to Sensitivity

RECORD OF BOREHOLE No 08-46

3 OF 3

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 096.4 E 309 821.8, Station 10+060, 10m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Solid Stem Augers / Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.17 - 2008.03.18 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _P	W	W _L		
	Continued From Previous Page																
	Clayey SILT, sandy, trace gravel Hard Grey (TILL)		16	SS	35											1 36 48 15	
233.6			17	SS	149/												
23.1	END OF BOREHOLE AT 23.1m. BOREHOLE OPEN TO 5.2m AND WATER LEVEL AT 0.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.				.275												

RECORD OF BOREHOLE No 08-47

1 OF 3

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 092.8 E 309 843.9, Station 10+040, Right Shoulder ORIGINATED BY ES
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.03.11 - 2008.03.12 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)	
								20	40	60	80			100	PLASTIC LIMIT w _p
257.4															
0.0	ASPHALT: (150mm)														
0.2	SAND and GRAVEL, some silt Compact to Dense Dark brown Moist (FILL)		1	SS	41										
			2	SS	18										
			3	SS	10										
255.2															
2.1	Silty SAND, trace gravel, trace clay Compact Brown Moist (FILL)		4	SS	19										
254.1															
3.3	SAND and GRAVEL, trace clay, occasional cobbles Compact Brown Moist (FILL)		5	SS	21										
253.0															
4.4	Clayey SILT, sandy, trace gravel, oxide staining Very Stiff Brown (TILL)		6	SS	18										
	Hard Grey		7	SS	160/ 275										

Continued Next Page

+ 3 x 3 Numbers refer to
Sensitivity 20
15-45 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 08-47

2 OF 3

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 092.8 E 309 843.9, Station 10+040, Right Shoulder ORIGINATED BY ES
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.03.11 - 2008.03.12 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								20 40 60 80 100							
								40 80 120 160 200							
Continued From Previous Page							o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L WATER CONTENT (%)				
	Clayey SILT, sandy, trace gravel Hard Grey (TILL)		10	SS	50		247								
							246								
	Auger grinding at 11.6 to 11.9m		11	SS	59		245								1 13 64 23
							244								
			12	SS	65		243								
							242								
			13	SS	64		241								
							240								
			14	SS	73		239								1 34 46 17
							238								
			15	SS	37										

Continued Next Page

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

RECORD OF BOREHOLE No 08-47

3 OF 3

METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 092.8 E 309 843.9, Station 10+040, Right Shoulder
 HWY 404 BOREHOLE TYPE Hollow Stem Augers
 DATUM Geodetic DATE 2008.03.11 - 2008.03.12
 ORIGINATED BY ES
 COMPILED BY WM
 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL x LAB VANE									
							WATER CONTENT (%)										
							20	40	60	80	100						
							40	80	120	160	200	20	40	60			
	Continued From Previous Page		16	SS	36											0 11 70 19	
	Clayey SILT, trace to some sand Hard Grey (TILL)						237										
							236										
235.6							235										
21.8	SILT, trace sand, trace gravel, trace clay Very Dense Grey Moist (TILL)		17	SS	100/ .100		234										
			18	SS	100/ .100		233									0 2 92 6	
							232										
			19	SS	100/ .140		231										
229.7			20	SS	100/ .100		230										
27.7	END OF BOREHOLE AT 27.7m. BOREHOLE OPEN AND WATER LEVEL AT 2.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.2m THEN ASPHALT TO SURFACE.																

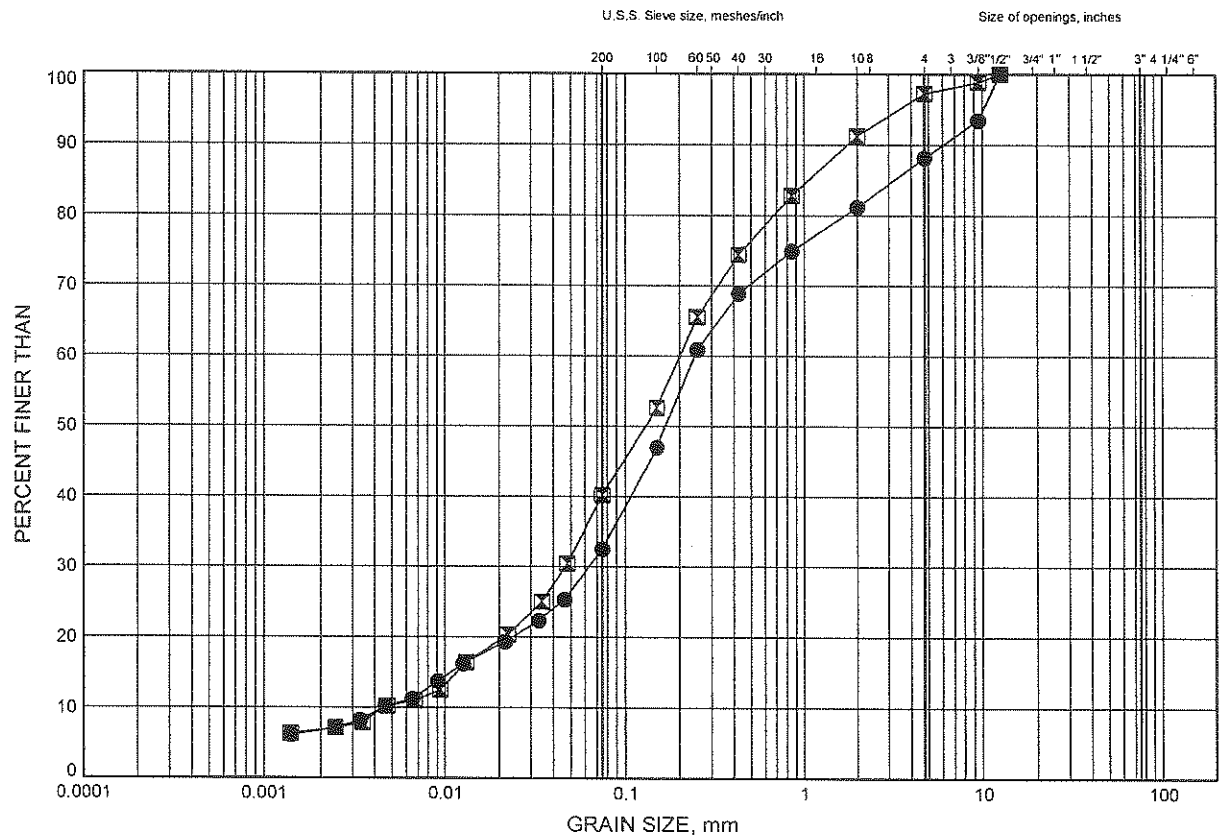
Appendix B

Laboratory Test Results

Hwy 404 Extension GRAIN SIZE DISTRIBUTION

FIGURE B1

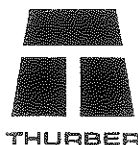
SILTY SAND (FILL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-43	0.99	262.87
◻	08-47	2.82	254.56

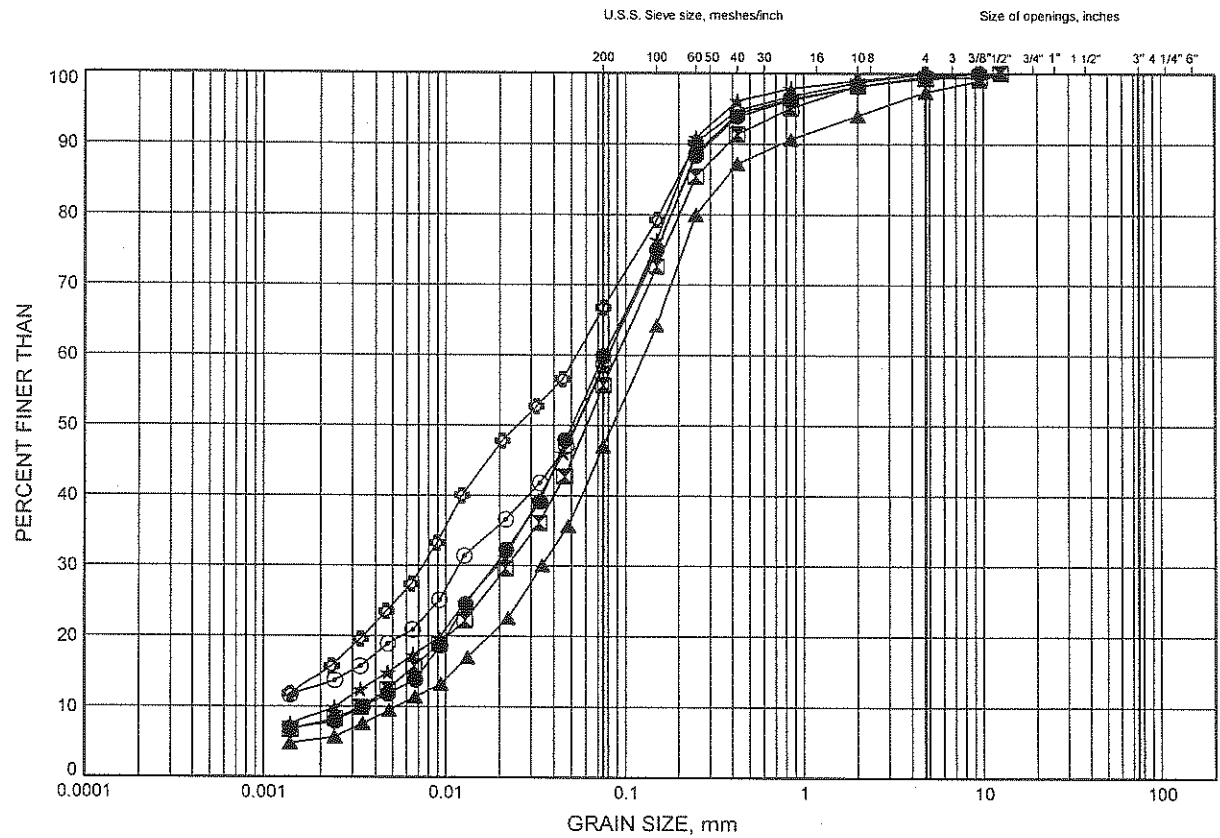


W.P.#
Prepared By MFA
Checked By RPR

Hwy 404 Extension GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND AND SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-43	3.28	260.58
⊠	08-44	4.80	254.29
▲	08-44	7.85	251.24
☆	08-44	10.73	248.36
⊙	08-45	3.28	254.99
⊗	08-45	7.85	250.42

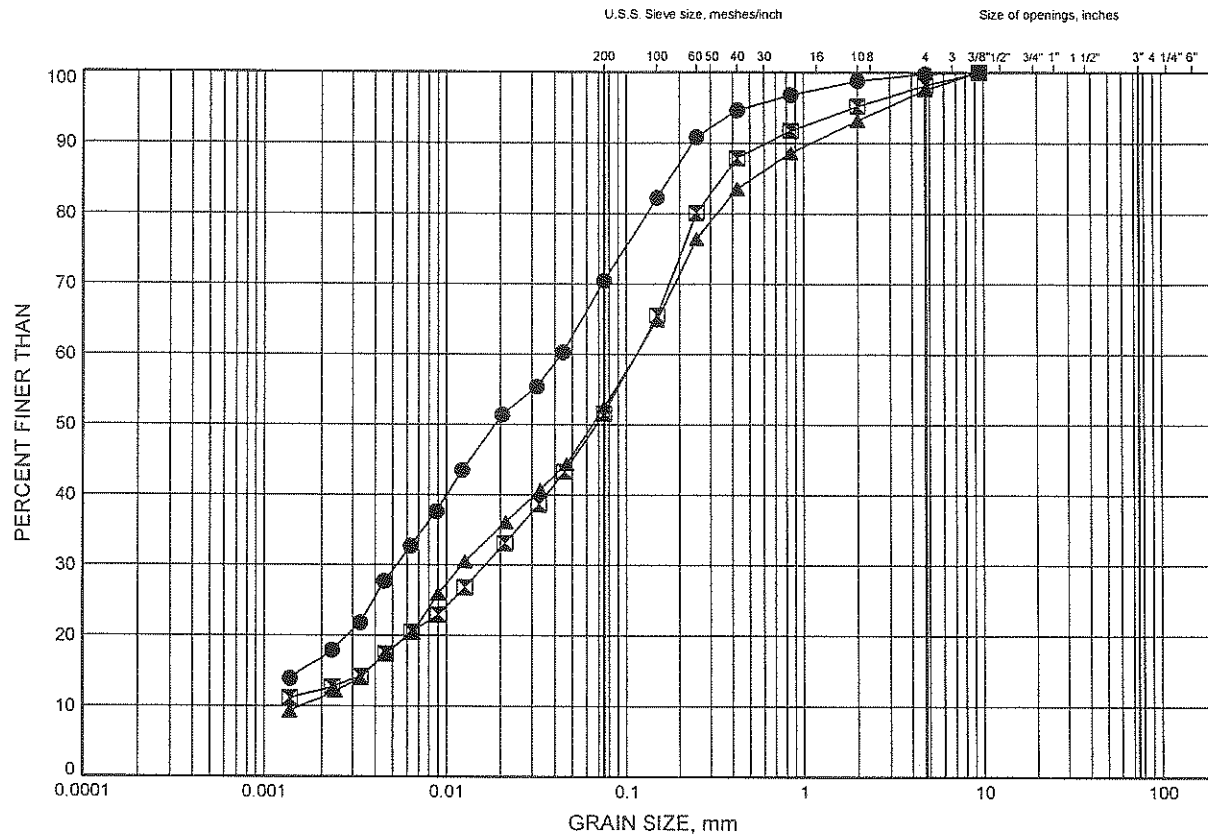


W.P.#
Prepared By MFA.....
Checked By RPR.....

Hwy 404 Extension GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND AND SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-45	15.47	242.80
⊠	08-45	19.87	238.40
▲	08-46	4.88	251.82

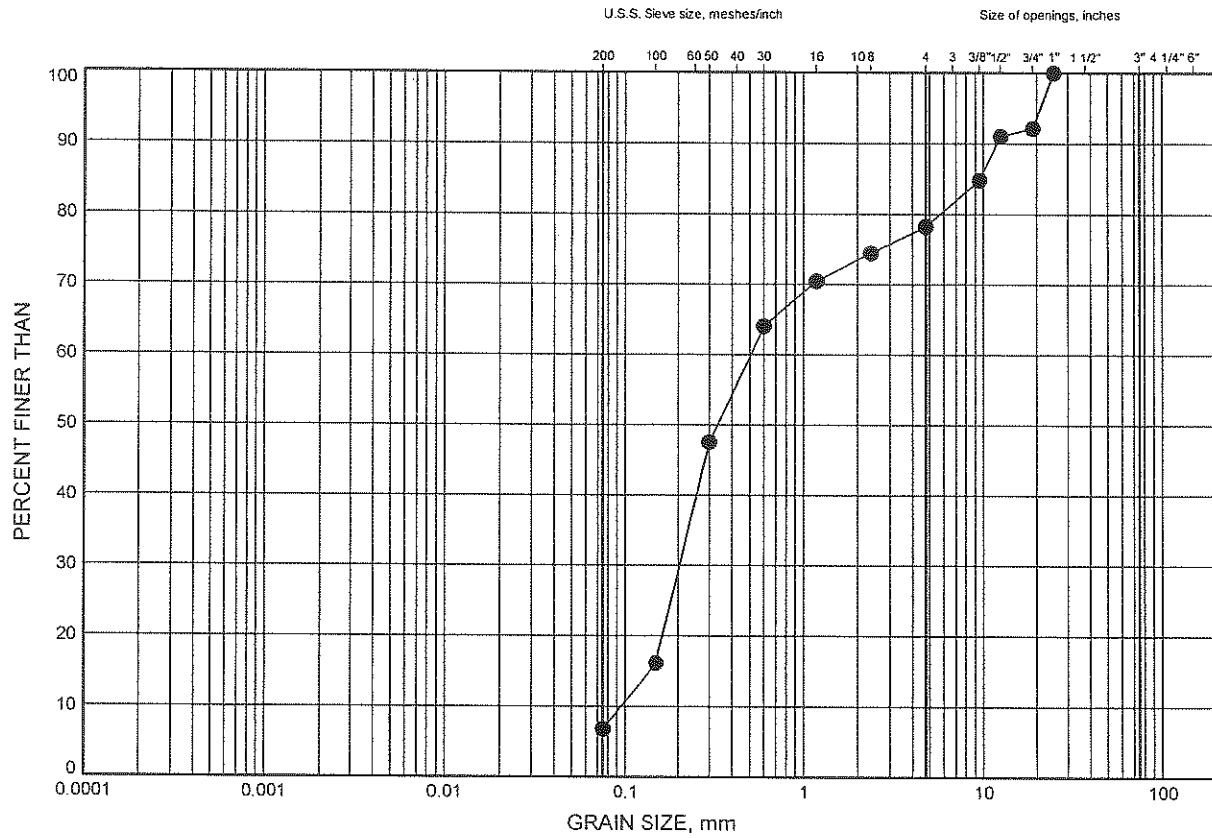


W.P.#
Prepared By MFA.....
Checked By RPR.....

Hwy 404 Extension GRAIN SIZE DISTRIBUTION

FIGURE B4

GRAVELLY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-45	10.79	247.48

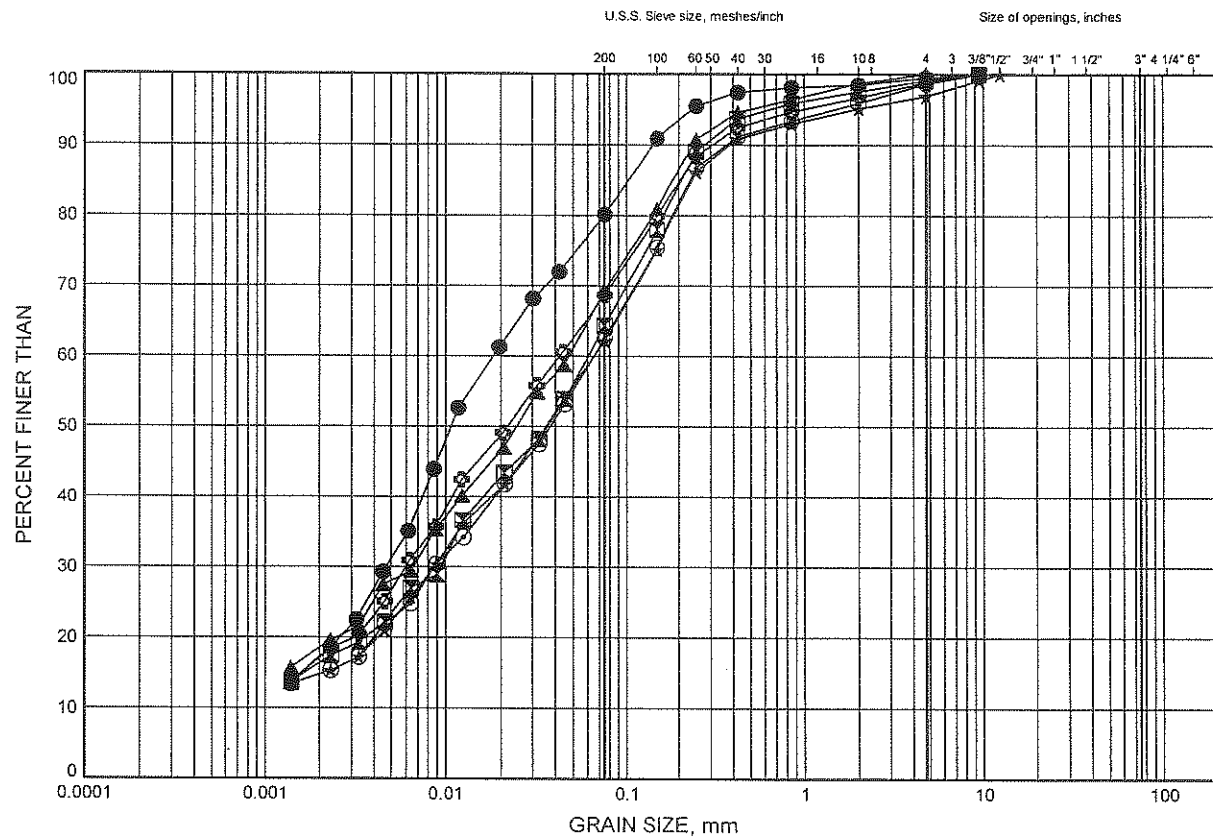


W.P.#
Prepared By MFA
Checked By RPR

Hwy 404 Extension GRAIN SIZE DISTRIBUTION

FIGURE B5

CLAYEY SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-46	7.92	248.78
⊠	08-46	14.02	242.68
▲	08-46	17.07	239.63
☆	08-46	18.52	238.18
⊙	08-46	20.12	236.58
⊗	08-47	6.32	251.06

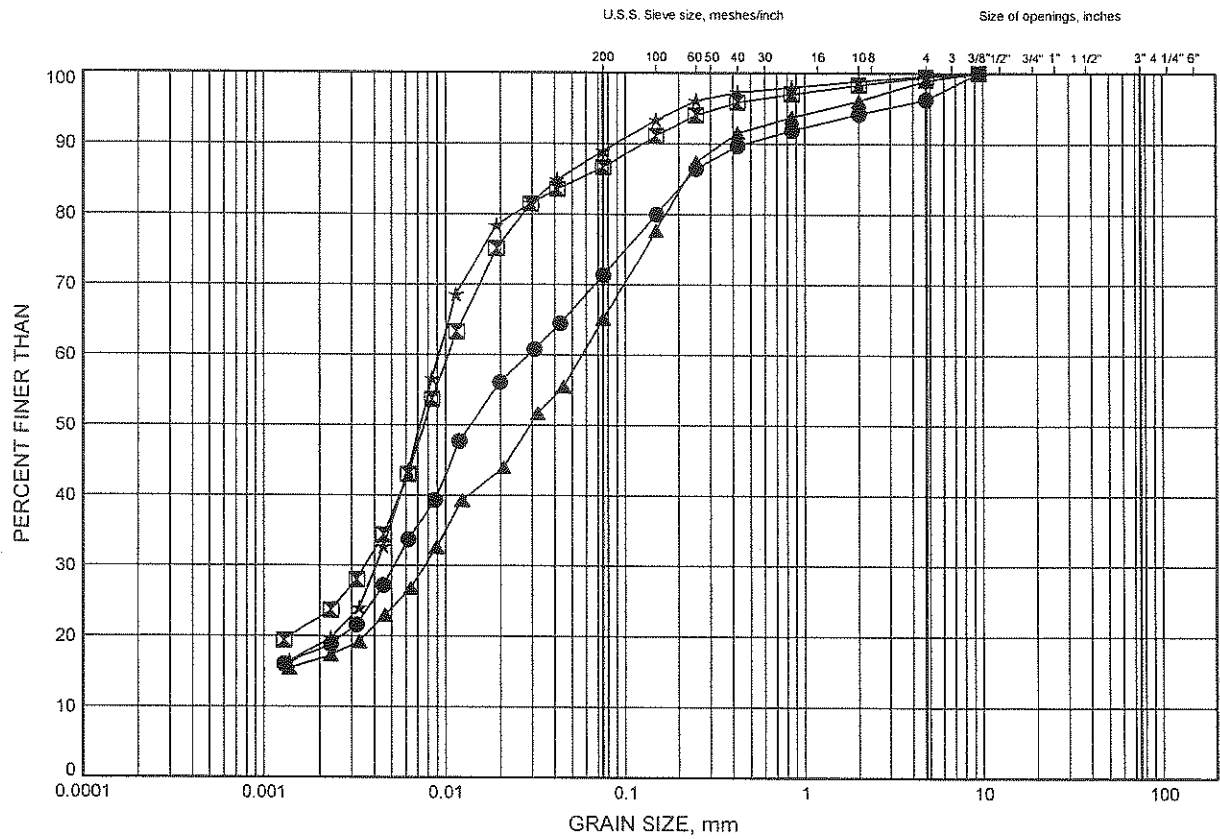


W.P.#
Prepared By MFA
Checked By RPR

Hwy 404 Extension GRAIN SIZE DISTRIBUTION

FIGURE B6

CLAYEY SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-47	7.92	249.46
◻	08-47	12.50	244.88
▲	08-47	17.07	240.31
☆	08-47	20.12	237.26

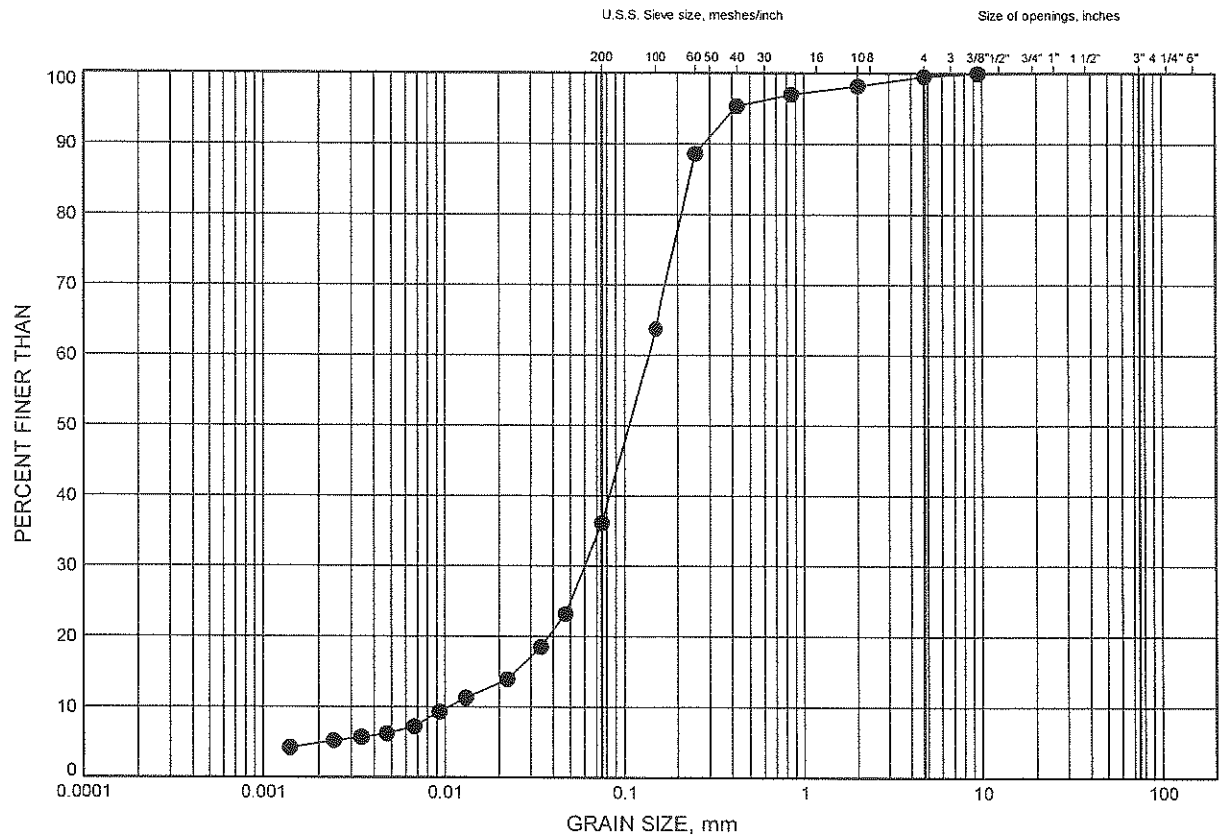


W.P.#
Prepared By MFA.....
Checked By RPR.....

Hwy 404 Extension GRAIN SIZE DISTRIBUTION

FIGURE B7

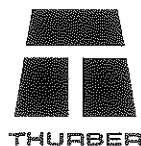
SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-46	10.97	245.73

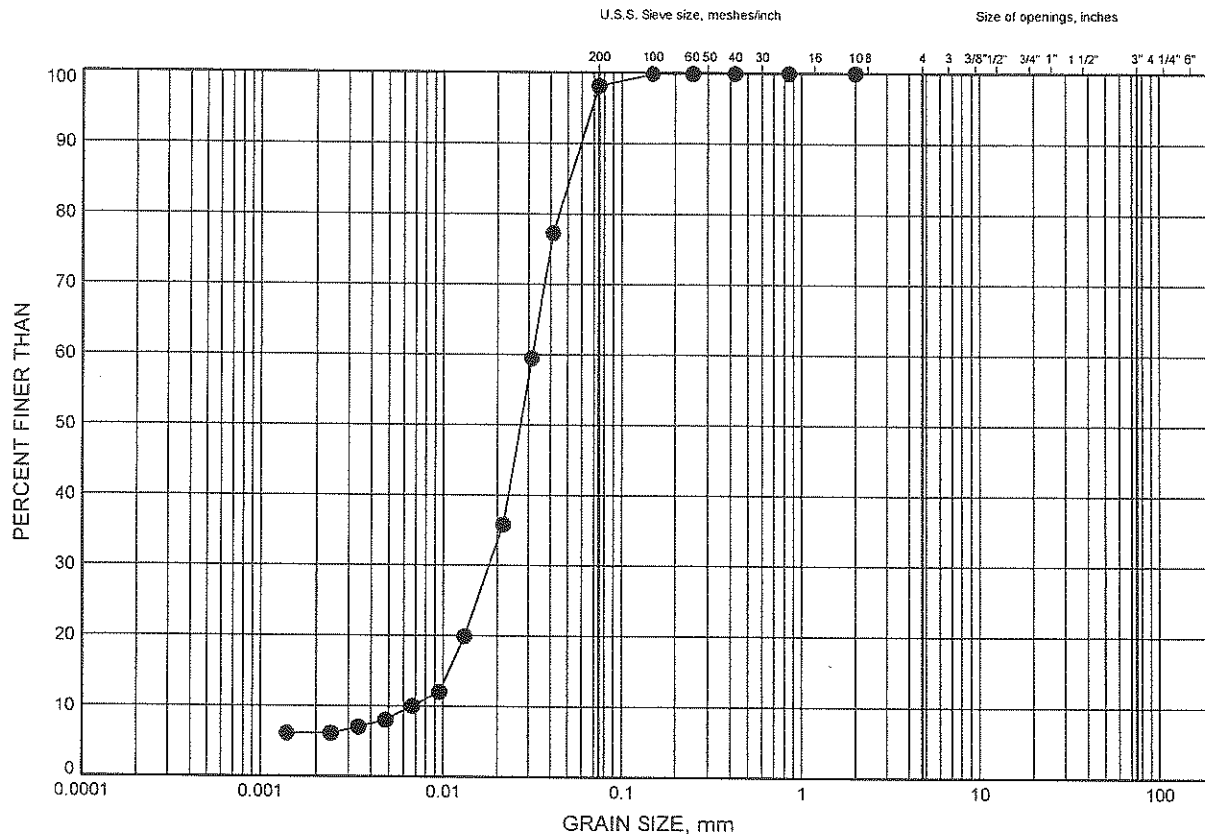


W.P.#
Prepared By MFA
Checked By RPR

Hwy 404 Extension GRAIN SIZE DISTRIBUTION

FIGURE B8

SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-47	24.52	232.86

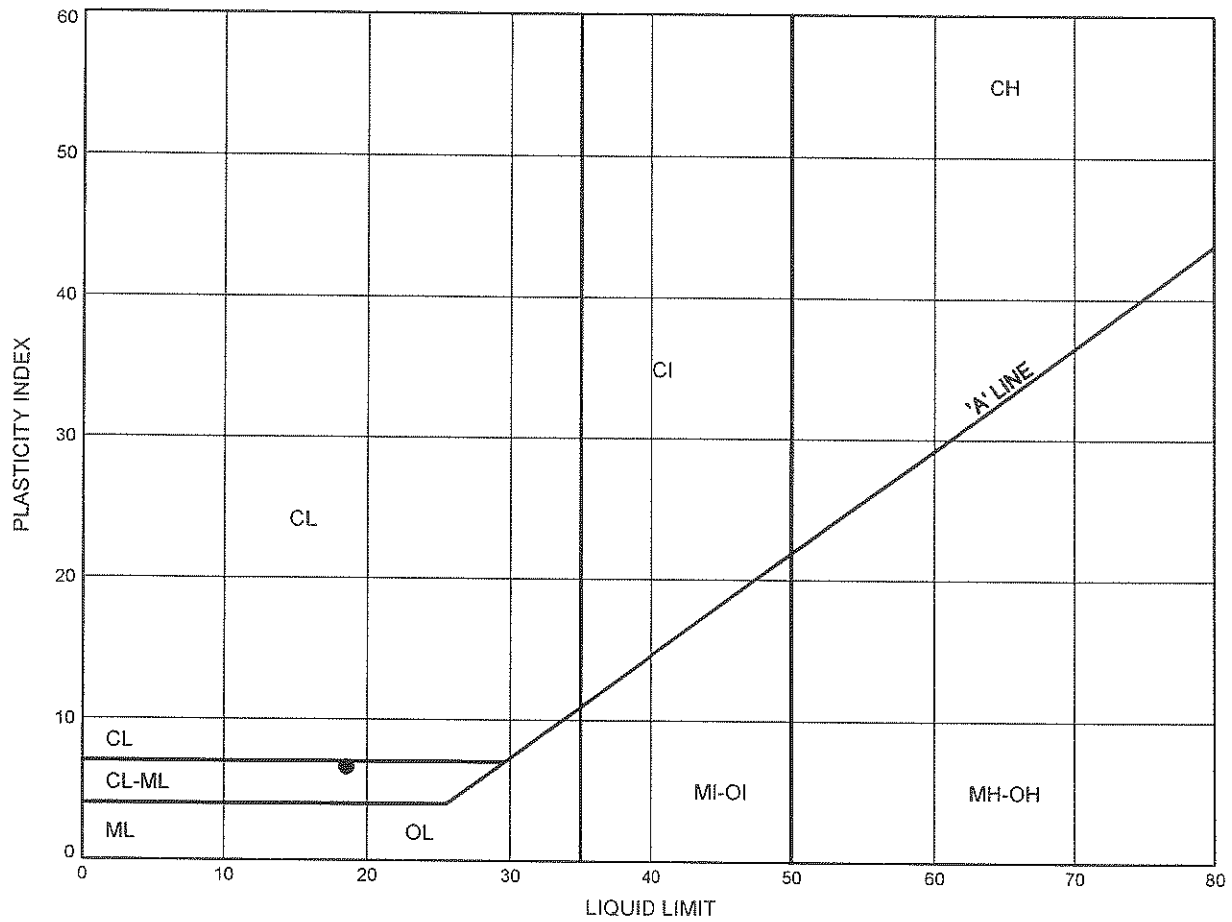


W.P.#
Prepared By MFA
Checked By RPR

Hwy 404 Extension
ATTERBERG LIMITS TEST RESULTS

FIGURE B9

SAND AND SILT TILL

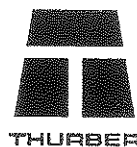


SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-45	15.47	242.80

THURBALT 0596.GPJ 8/26/08

Date August 2008

Project



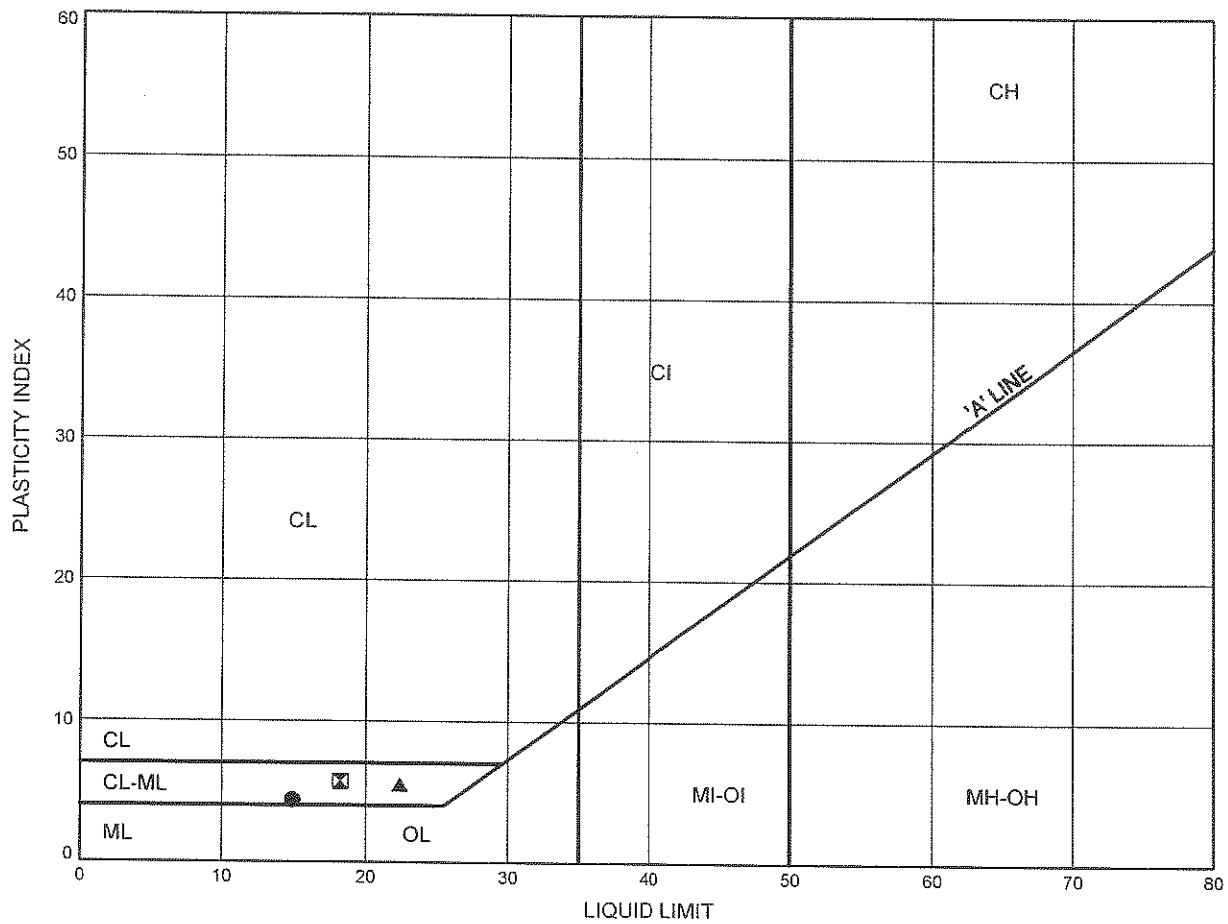
Prep'd MFA

Chkd. RPR

Hwy 404 Extension
ATTERBERG LIMITS TEST RESULTS

FIGURE B10

CLAYEY SILT TILL

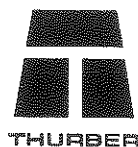


SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-46	17.07	239.63
⊠	08-47	7.92	249.46
▲	08-47	20.12	237.26

THURBALT 0596 GPJ 8/25/08

Date August 2008

Project



Prep'd MFA

Chkd. RPR

Appendix C

Record of Borehole Sheets and Laboratory Results (previous investigation)

PROJECT 04-1111-016

RECORD OF BOREHOLE No BH 301

1 OF 2 **METRIC**

W.P. LOCATION N 4889092.6 ; E 309821.8

ORIGINATED BY PKS

DIST Central HWY 404 BOREHOLE TYPE 108 mm Diameter Solid Stem Augers

COMPILED BY DD

DATUM Geodetic DATE JUNE 11, 2004

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x REMOULDED						
257.5	GROUND SURFACE							20 40 60 80 100							
0.0	Sand and gravel (FILL) Compact Brown Moist		1	SS	14		257								
256.9	Silty sand, some gravel, trace clay (FILL) Compact to loose Brown Moist		2	SS	14		256								
0.6			3	SS	7										
255.3															
2.2	Clayey Silt with sand, trace gravel Firm to stiff Brown Wet		4	SS	5		255								
			5	SS	8										
253.8															
3.7	Clayey Silt, some sand, trace gravel (TILL) Stiff to hard Brown Wet		6	SS	11		254							0 28 65 7	
			7	SS	15		253								
			8	SS	40		252								
							251								
	Becoming gray below 7.6 m depth		9	SS	56		250							1 15 68 16	
247.9			10	SS	45	249									
9.6	Silty Sand, trace gravel Compact Grey Wet					248									
			11	SS	14	247									
245.9						246									
11.6	Clayey Silt, some sand, trace gravel (TILL) Hard Grey Moist		12	SS	33	245									
			13	SS	39	244									
						243									

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

MIS-MTD 001 041111016AAMTO.GPJ GAL-MISS.GDT 26/4/06

PROJECT 04-1111-016		RECORD OF BOREHOLE No BH 301				2 OF 2 METRIC											
W.P. _____		LOCATION N 4889092.6 ; E 309821.8				ORIGINATED BY PKS											
DIST Central HWY 404		BOREHOLE TYPE 108 mm Diameter Solid Stem Augers				COMPILED BY DP											
DATUM Geodetic		DATE JUNE 11, 2004				CHECKED BY LCC											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	Y	GR	SA	SI	CL
--- CONTINUED FROM PREVIOUS PAGE ---																	
241.8			14	SS	32		242										
15.7	End of Borehole Note: Water level at 4.9 m depth (Elevation 252.6 m) upon completion of drilling																

+3, X3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>04-1111-016</u>		RECORD OF BOREHOLE No BH 301A		2 OF 2 METRIC	
W.P. _____		LOCATION <u>N 4889107.0 ; E 309821.9</u>		ORIGINATED BY <u>PKS</u>	
DIST <u>Central</u> HWY <u>404</u>		BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>		COMPILED BY <u>DD</u>	
DATUM <u>Geodetic</u>		DATE <u>SEPTEMBER 27, 28, 2004</u>		CHECKED BY <u>LCC</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED						
--- CONTINUED FROM PREVIOUS PAGE ---															
238.9 17.1	Clayey Silt, some sand, trace gravel (TILL) Stiff to hard Grey Moist to wet		3	SS	12										
	Interlayered Clayey Silt, trace sand, and Silt, trace clay and sand, containing clay seams Hard/Very dense Grey Moist to wet		4	SS	59										
			5	SS	100										
			6	SS	121										
			7	SS	108										
			8	SS	100/16										
			9	SS	76										
231.0 25.0	End of Borehole														
Notes: 1. Water level in piezometer measured at 2.7 m depth (Elevation 253.3 m) on September 28, 2004 and at 0.7m above ground surface. (Elevation 256.7m) on October 7, 2004.															

MIS-MTO 001 041111016AAMTO.GPJ GAL-MISS.GDT 26/4/06

PROJECT 04-1111-016		RECORD OF BOREHOLE No BH 302		1 OF 2 METRIC	
W.P. _____		LOCATION N 4889084.1 E 309781.5		ORIGINATED BY PKS	
DIST Central HWY 404		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers		COMPILED BY DD	
DATUM Geodetic		DATE SEPTEMBER 28, 2004		CHECKED BY LCC	


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x REMOULDED							
259.0	GROUND SURFACE						20 40 60 80 100				10 20 30					
0.0	Topsoil		1	SS	6											
258.3	Silty sand (FILL) Loose Brown Moist		2	SS	6											
0.7	Clayey silt, some sand, trace gravel, trace asphalt fragments (FILL)		3	SS	10											
257.5	Firm Dark brown Moist		4	SS	9											
1.5	Clayey Silt, some sand, trace gravel Stiff Mottled brown Moist		5	SS	14								3 21 43 33			
256.0	Sand and Silt, trace gravel, trace clay, containing lenses/interlayers of sand and gravel (TILL) Compact to very dense Brown to grey Moist		6	SS	23											
3.0			7	SS	23											
			8	SS	32											
			9	SS	38								2 38 53 7			
			10	SS	39											
			11	SS	39											
			12	SS	74											
			13	SS	81											

Continued Next Page

+ 3 X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

PROJECT <u>04-1111-016</u>		RECORD OF BOREHOLE No BH 302		2 OF 2 METRIC	
W.P. _____		LOCATION <u>N 4889084.1 ; E 309781.5</u>		ORIGINATED BY <u>PKS</u>	
DIST <u>Central</u> HWY <u>404</u>		BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>		COMPILED BY <u>DD</u>	
DATUM <u>Geodetic</u>		DATE <u>SEPTEMBER 28, 2004</u>		CHECKED BY <u>LCC</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						x REMOULDED		

	-- CONTINUED FROM PREVIOUS PAGE --																		
	Sand and Silt, trace gravel, trace clay, containing lenses/interlayers of sand and gravel (TILL) Compact to very dense Brown to grey Moist		14	SS	102												1 34 54 11		
			15	SS	100/23														
240.5							243												
							242												
							241												
18.5	End of Borehole		16	SS	100/16														
	Note: Water level in piezometer measured at 10.7 m depth (Elevation 248.3 m) on September 29, 2004.																		

MIS-MTO 001 041111016AAMTO.GPJ GAL-MISS.GDT 26/4/06

PROJECT 04-1111-016

RECORD OF BOREHOLE No BH 303

1 OF 1 **METRIC**

W.P. _____ LOCATION N 4889071.0 ; E 309743.7

ORIGINATED BY PKS

DIST Central HWY 404 BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers

COMPILED BY DD

DATUM Geodetic DATE SEPTEMBER 29, 2004

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20 40 60 80 100										10 20 30		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED												
261.0	GROUND SURFACE																			
0.0	Silty Sand, some organics (FILL) Very loose to loose Brown Moist		1	SS	4															
			2	SS	6															
259.5							260													
1.5	Clayey Silt, some sand, trace gravel, trace organics Stiff Brown Moist		3	SS	11															
258.8							259													
2.2	Silty Sand, trace clay, trace gravel, trace organics Dense Brown Moist		4	SS	33															
258.0							258													
3.0	Sand and Silt, trace clay, some gravel (TILL) Dense to very dense Brown, becoming grey below 9.1 m depth Moist to wet below 3.7 m depth		5	SS	36															
			6	SS	33		257													
			7	SS	40		256									32 28 35 5				
							255													
			8	SS	67		254													
							253													
			9	SS	100/23		252													
							251													
			10	SS	100/23		250													
							249													
			11	SS	100/13		248													
			12	SS	100/18															
247.1			13	SS	100/19															
13.9	End of Borehole																			
	Note: Water level at 9.1 m depth (Elevation 250.9 m) upon completion of drilling.																			

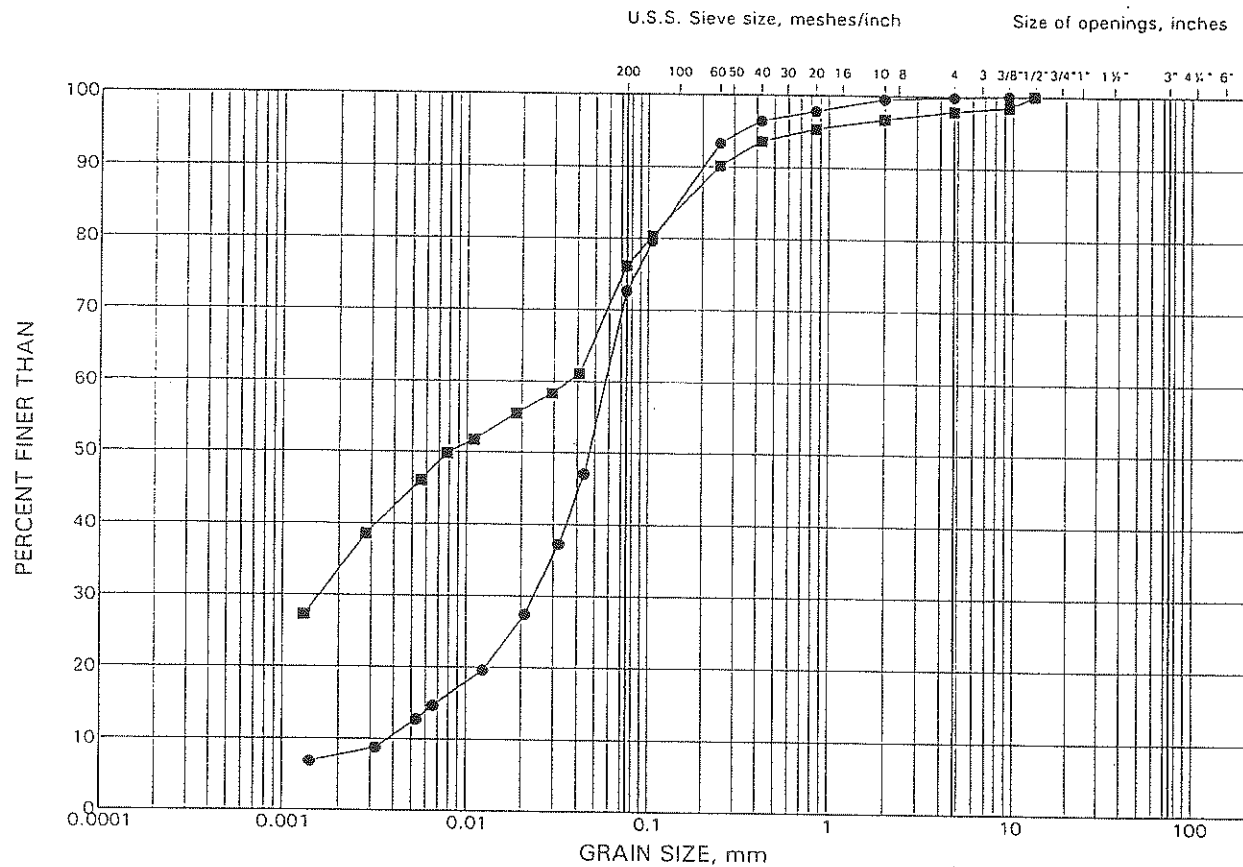
+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

MIS-MTO 001 041111016AAMTO.GPJ GAL-MISS.GDT 26/4/06

GRAIN SIZE DISTRIBUTION TEST RESULTS

Surficial Clayey Silt

FIGURE 1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	301	5	254.3
■	302	3	257.2

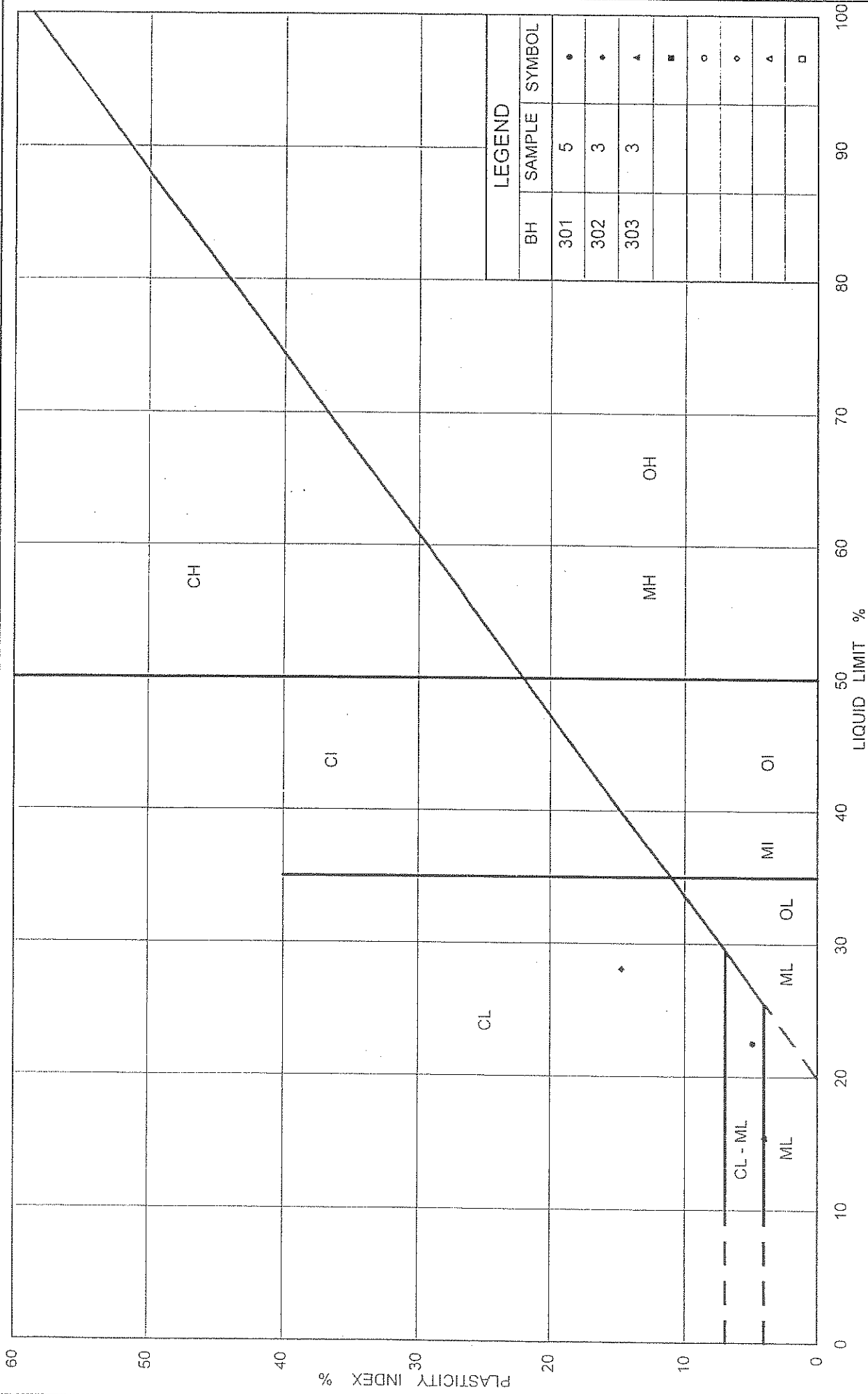


FIG No. 2

PLASTICITY CHART Surficial Clayey Silt

Ministry of Transportation

Project No. 04-1111-016

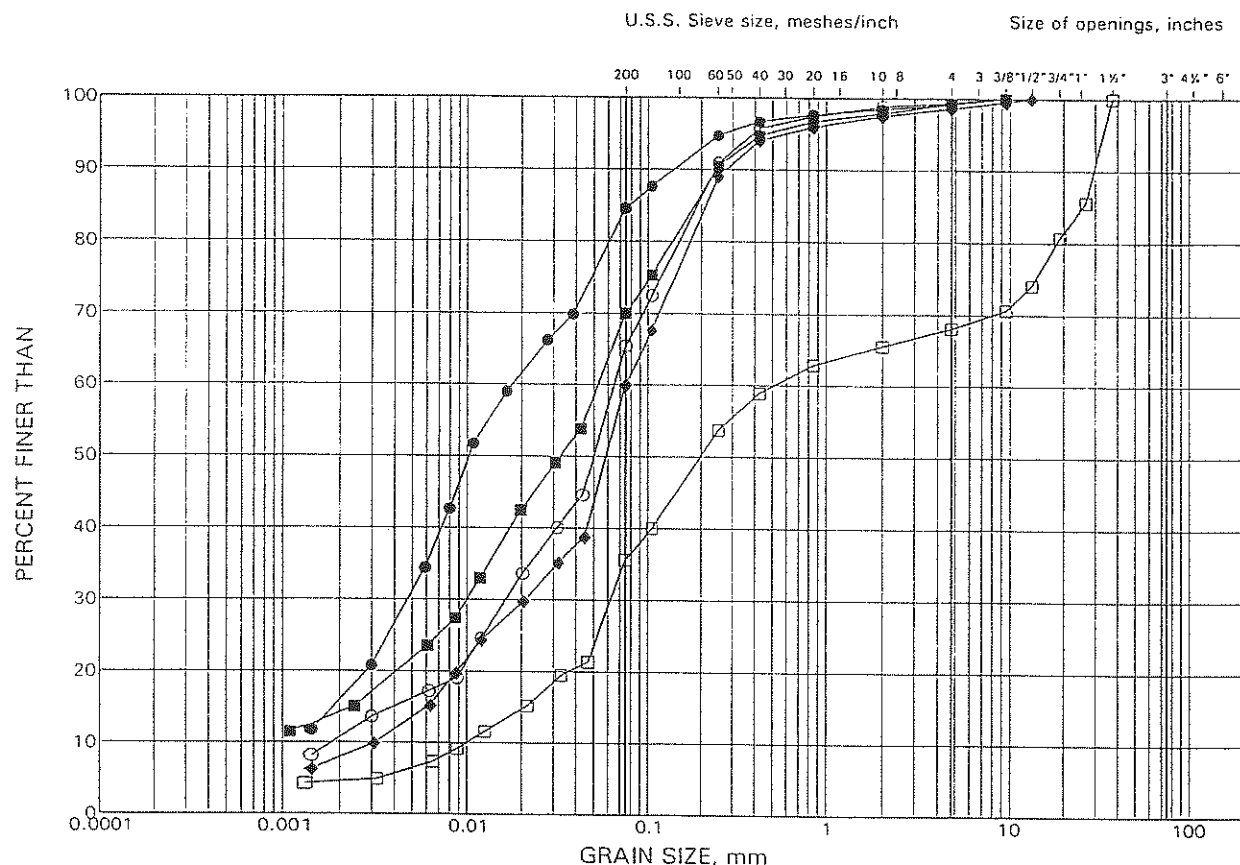


Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till / Sand and Silt Till

FIGURE 3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	301	9	249.6
■	301A	2	242.0
◆	302	9	251.1
○	302	14	243.5
□	303	7	256.2

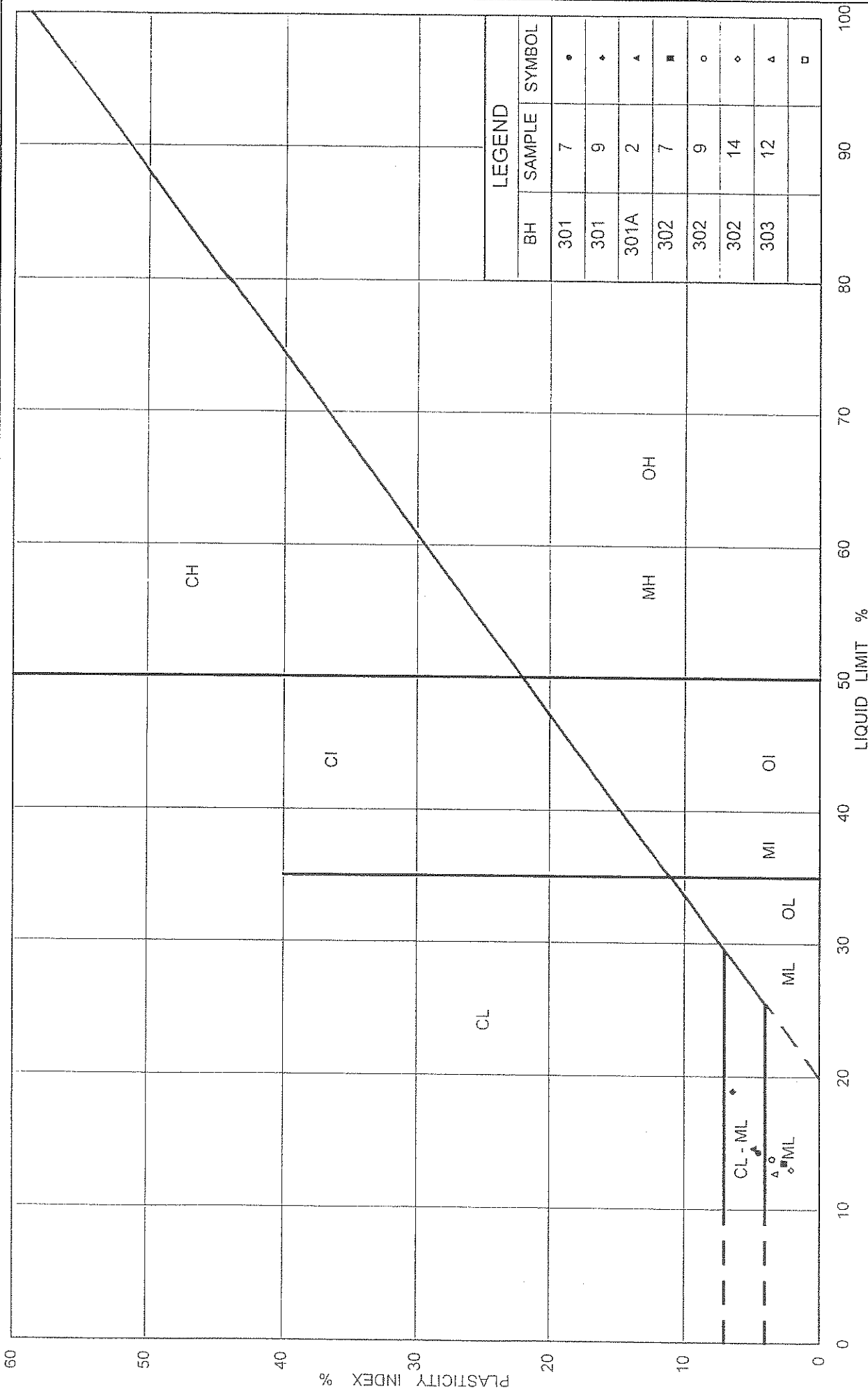


FIG No. 4

PLASTICITY CHART Clayey Silt Till / Sand and Silt Till

Ministry of Transportation



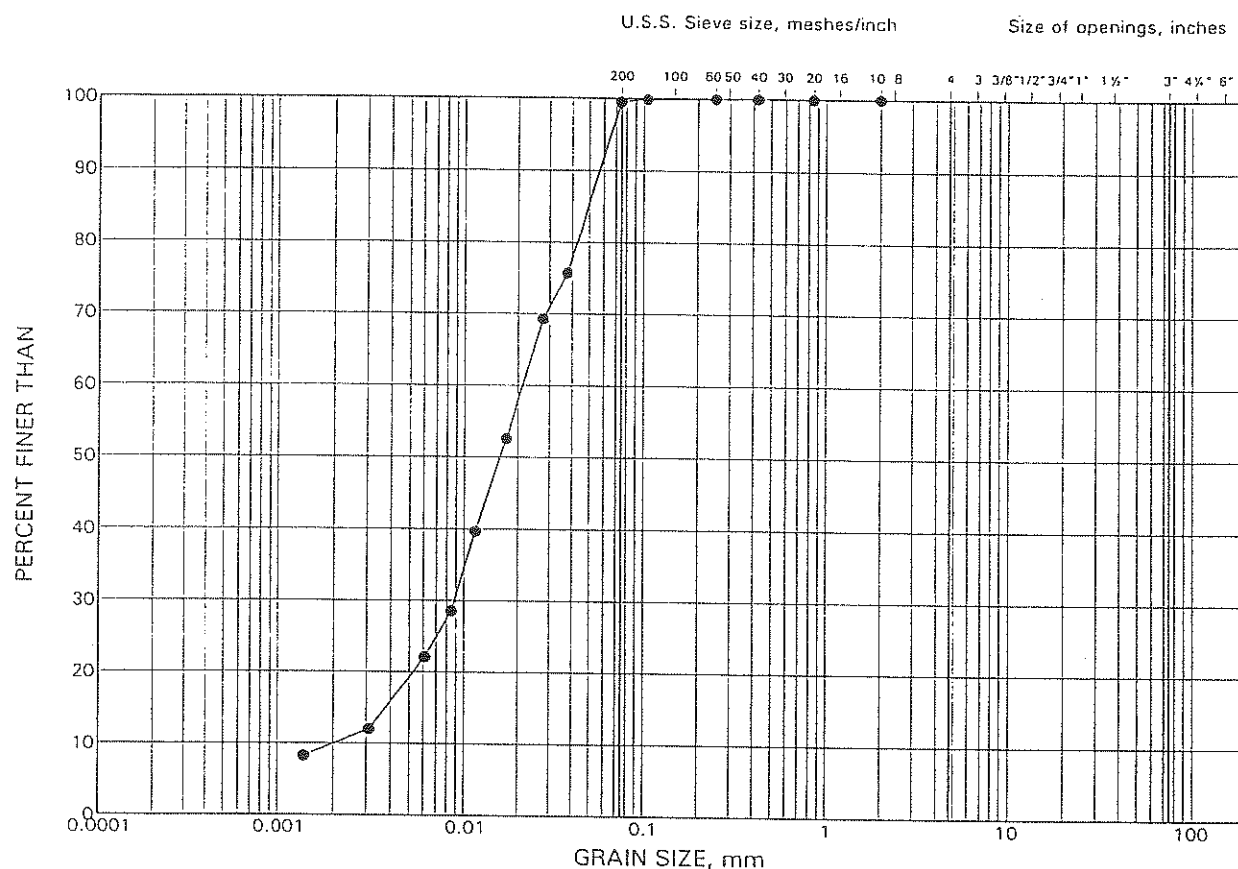
Ontario

Project No. 04-1111-016

GRAIN SIZE DISTRIBUTION TEST RESULT

Interlayered Clayey Silt and Silt

FIGURE 5



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	301A	7	234.5

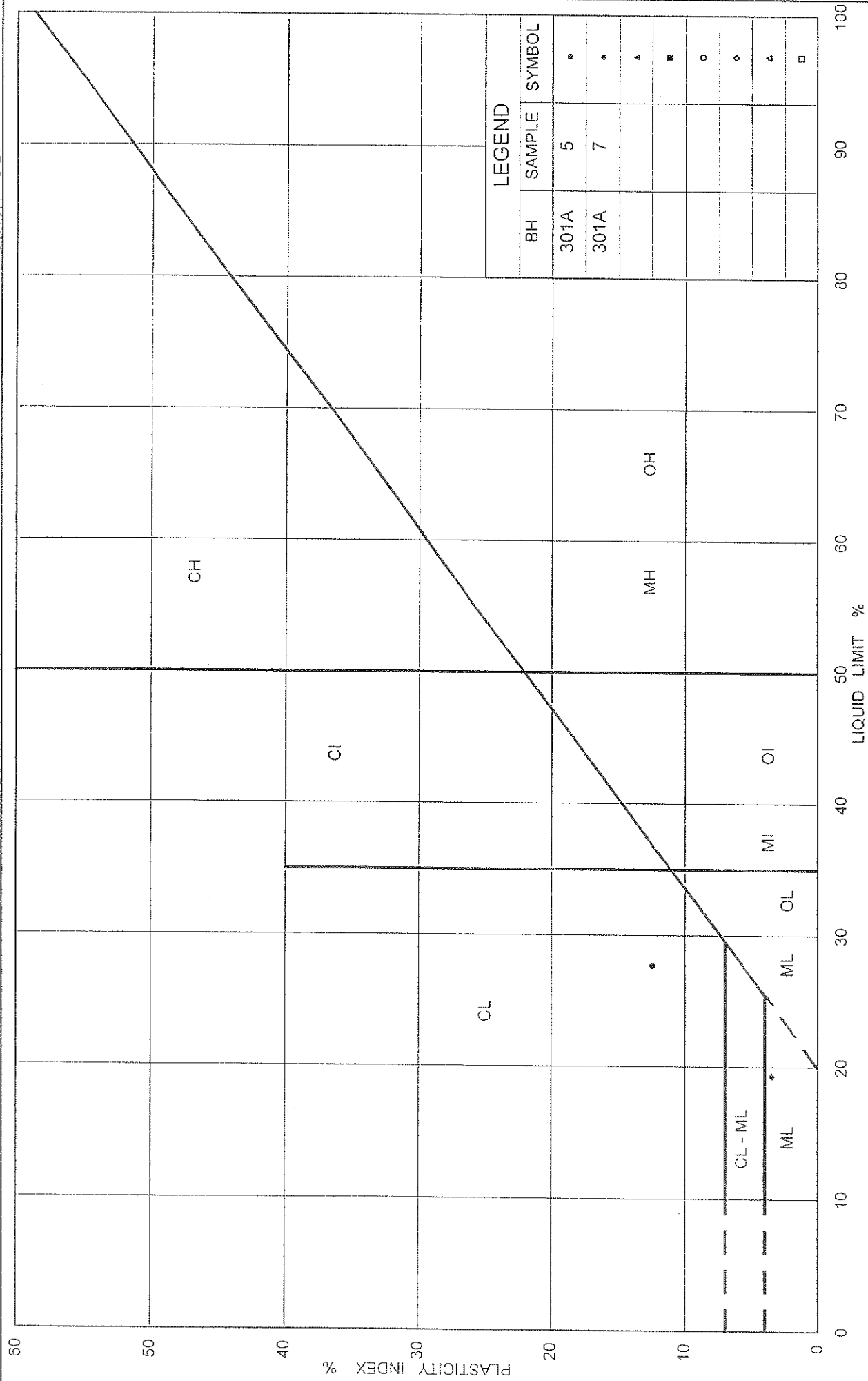


FIG No. 6

PLASTICITY CHART
Interlayered Clayey Silt and Silt

Ministry of Transportation



Ontario

Appendix D

Site Photographs

Queensville Sideroad Underpass
Highway 404 Extension from Green Lane to Woodbine Avenue/Ravenshoe Rd.



Photograph 1 – View of the site looking north of Queensville Sideroad



Photograph 2 – View of the site looking northwest of Queensville Sideroad

Queensville Sideroad Underpass
Highway 404 Extension from Green Lane to Woodbine Avenue/Ravenshoe Rd.



Photograph 3 – Looking south of Queensville Sideroad



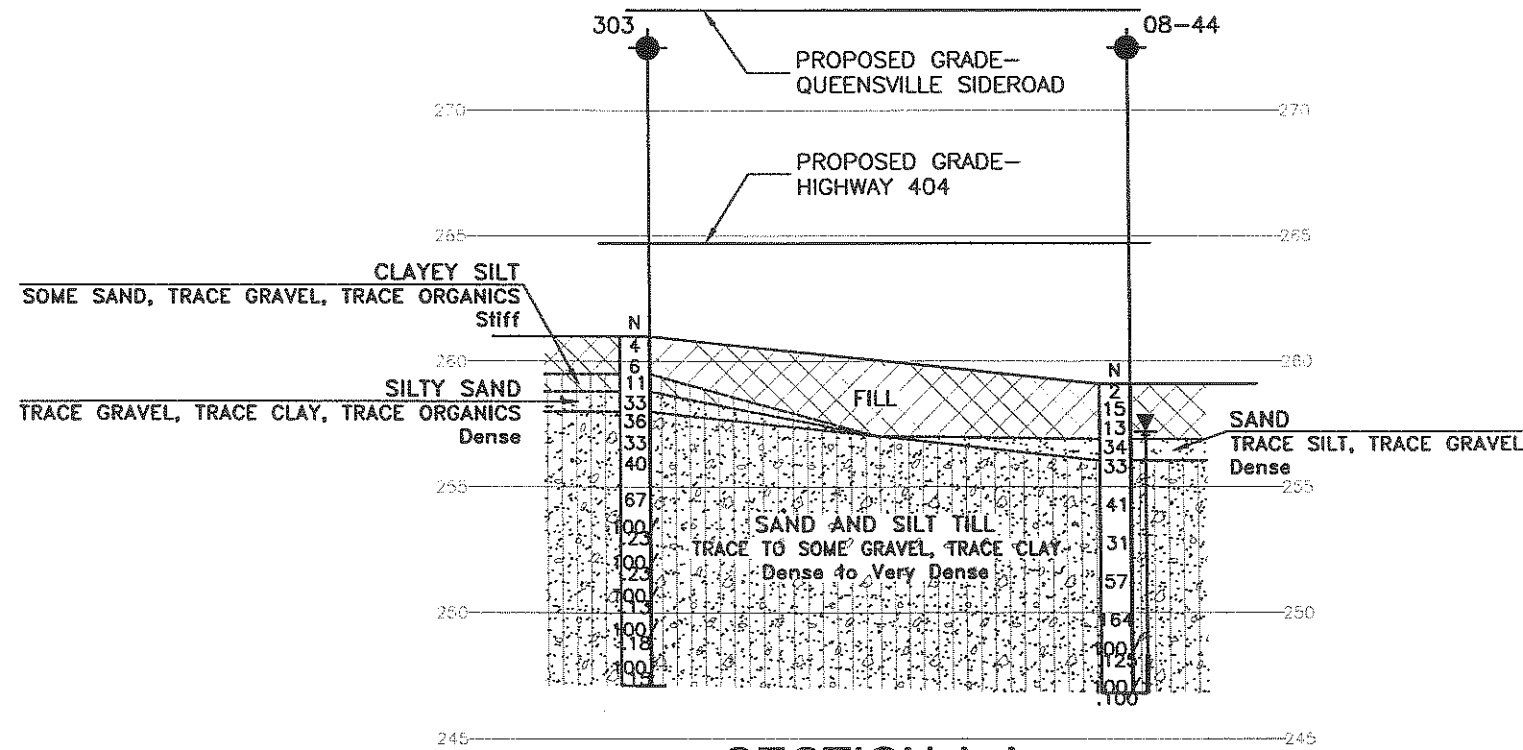
Photograph 4 – Looking west along Queensville Sideroad

Queensville Sideroad Underpass
Highway 404 Extension from Green Lane to Woodbine Avenue/Ravenshoe Rd.

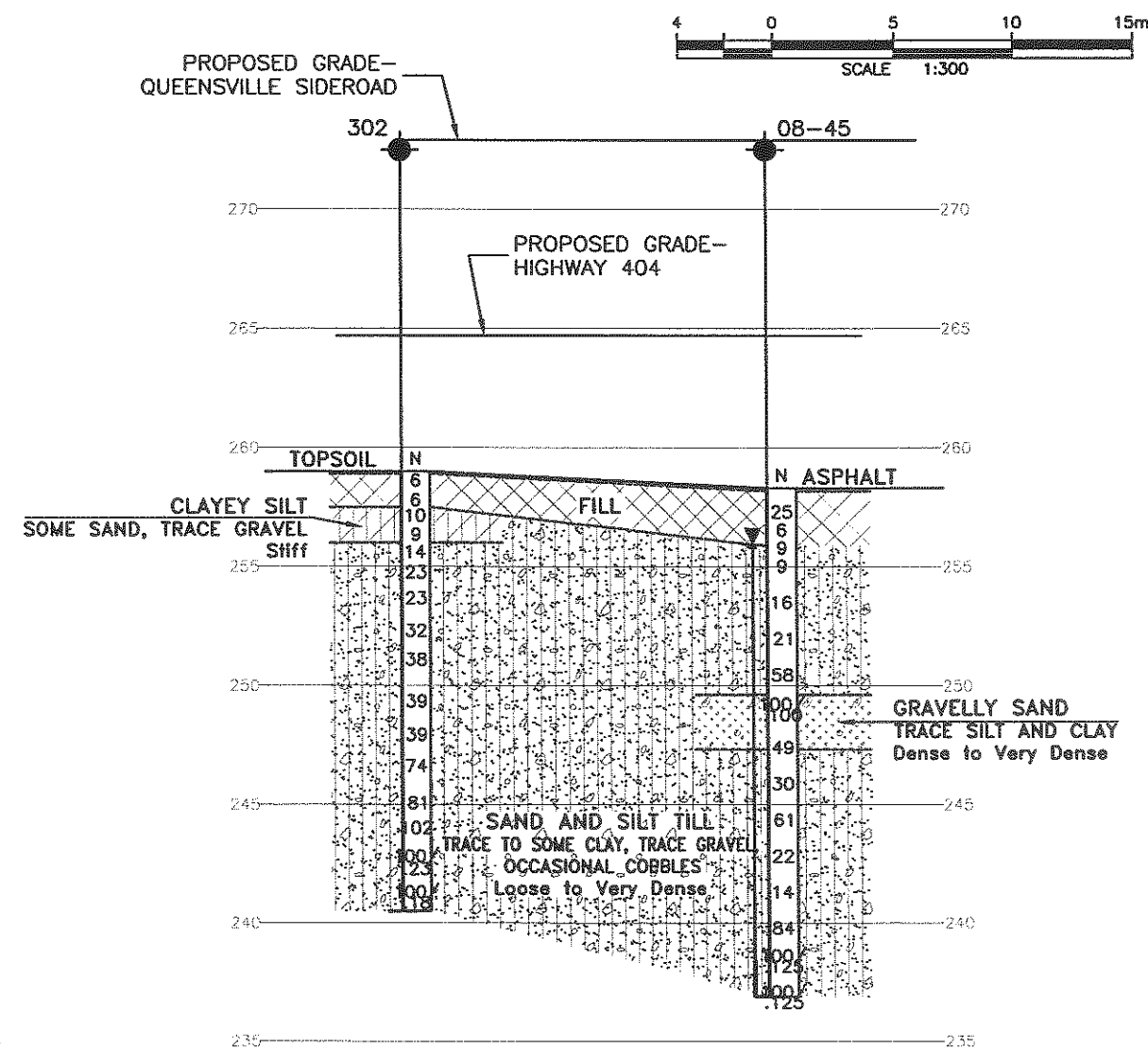
Appendix E

Drawing

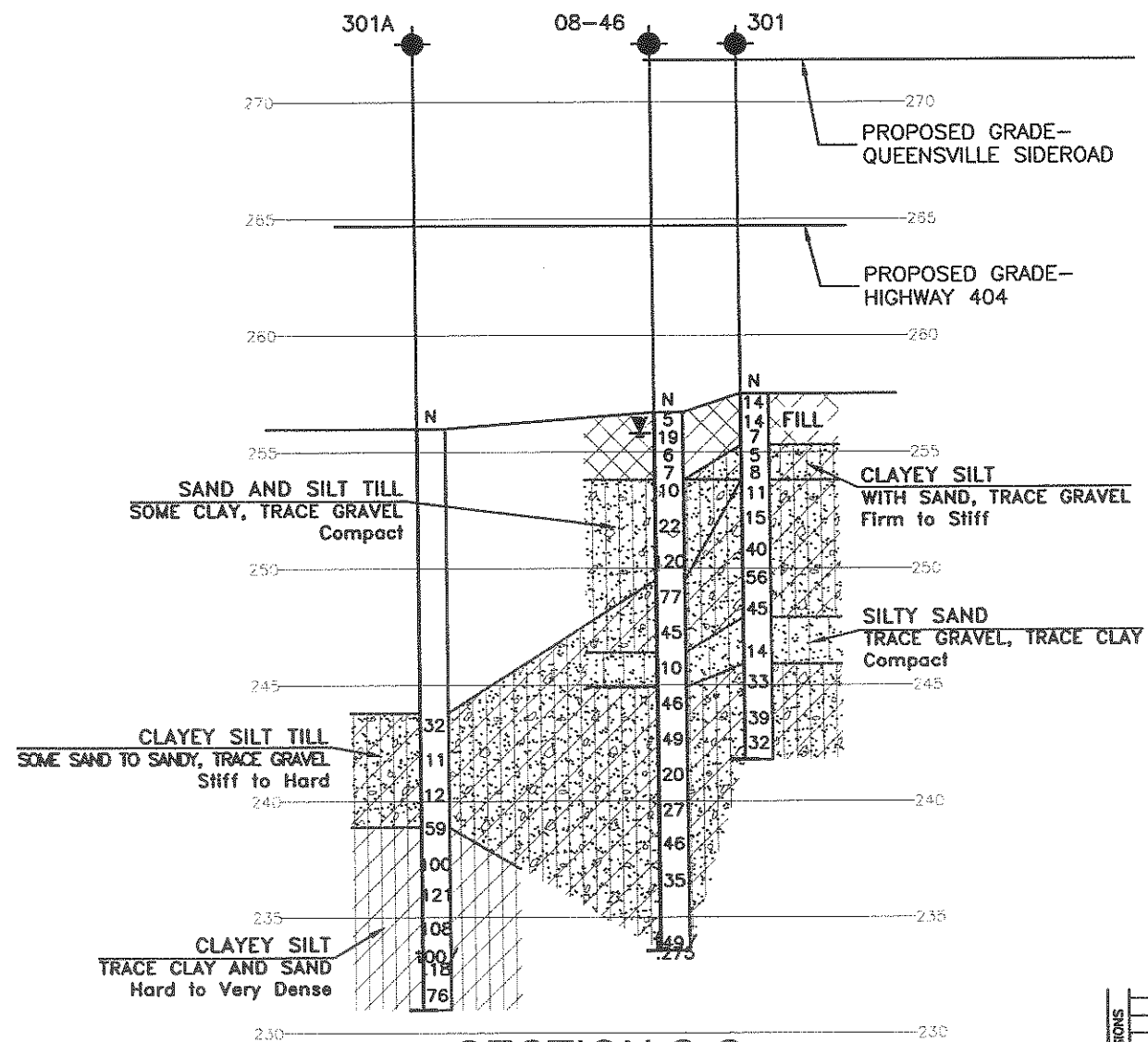
Borehole Locations and Soil Strata



SECTION A-A



SECTION B-B



SECTION C-C

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

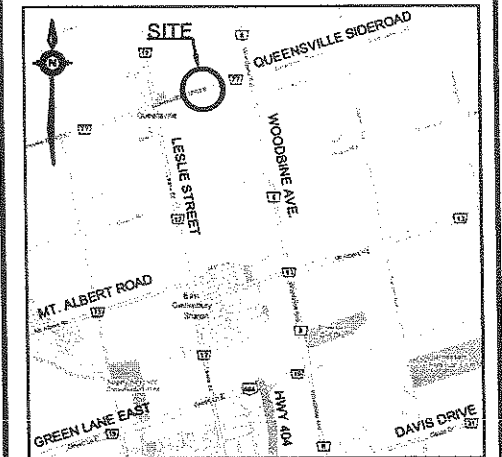
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No

HIGHWAY 404 EXTENSION
QUEENSVILLE UNDERPASS






SHEET 1

BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
08-43	263.9	4 889 051.2	309 710.3
08-44	259.1	4 889 053.5	309 751.4
08-45	258.3	4 889 070.2	309 788.1
08-46	256.7	4 889 096.4	309 821.8
08-47	257.4	4 889 092.8	309 843.9
301	257.5	4 889 092.6	309 821.8
301A	256.0	4 889 107.0	309 821.9
302	259.0	4 889 084.1	309 781.5
303	261.0	4 889 071.0	309 743.7

-NOTES-

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

GEOCRES No. 31D-449

REVISIONS									
	DATE	BY	DESCRIPTION						
DESIGN			CHK	AEQ	CODE		LOAD	DATE	AUG. 2009
DRAWN	MFA		CHK	RPR	SITE		STRUCT	LDWG	