FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 404 EXTENSION
FROM GREEN LANE TO QUEENSVILLE SIDEROAD
CULVERTS AT
Sta 30+300 Sta 30+430.5
Sta 32+903 Sta 10+075 QSR
QSR E/W – S Ramp N – E/W QSR
REGION OF YORK
G.W.P. 2109-05-00

GEOCRES Number: 31D-493

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the detail design of a total of six culverts to be installed at the proposed Highway 404 extension from Green Lane to Woodbine Avenue/Ravenshoe Road in the Town of East Gwillimbury, in the Regional Municipality of York. Four proposed culverts will be installed south of the Queensville Sideroad and two culverts south of Doane Road.

The purpose of the investigation was to explore the subsurface conditions at the various sites and, based on the data obtained, provide borehole location plans, borehole logs, stratigraphic profiles, cross-sections, laboratory test results and written descriptions of the subsurface conditions

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.

2 SITE AND PROJECT DESCRIPTIONS

2.1 Four proposed culverts at Queensville Sideroad and Highway 404 interchange (Culverts 1 to 4)

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

The natural ground surface at the site has a relatively gently rolling/undulating topography.

An existing CSP culvert carries a tributary of the Maskinonge River under Queensville Sideroad, near Station 10+080. The tributary flows north to south.

The lands surrounding 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 proposed culverts will be placed at specific locations along the proposed Highway 404 and Queensville Sideroad interchange to carry a small tributary of the Makinonge River under the proposed Highway 404 extension alignment, existing Queensville Sideroad and new ramps. The designations and approximate locations of the proposed culverts are as follows:

Culvert	Location
1	Queensville Sideroad East/West to Highway 404 South Ramp (E/W- S Ramp) (Site Number 37-1573/C)
2	Highway 404 North to Queensville Sideroad East/West Ramp (N-E/W Ramp) (Site Number 37-1574/C)
3	Highway 404 approximate Station 32+903 (Site Number 37-1575/C)
4	Queensville side Road, approximate Station 10+075 (Site Number 37-1576/C)

Photographs of the site included in Appendix C show the general nature of the surrounding land:

1. A view looking at the north end of existing CSP culvert (north of Queensville Sideroad).
2. View of the site looking south of Queensville Sideroad

2.2 Two proposed culverts south of Doane Road (Culverts 5 and 6)

The site is located approximately 450 m to 600 m south of Doane Road and approximately 450 m west of Woodbine Avenue (York Regional Road 8), in the Town of East Gwillimbury, in the Regional Municipality of York.

The site is currently a wooded area with mature trees, shrubs and long grass. Mount Albert creek is located within the site flowing southerly. A pond located northeast of the culverts has flooded the site of Culvert 6 with a water depth greater than 1.0 m. The pond is approximately 250 m long and 25 m wide.

The designations and approximate locations of the proposed culverts are as follows:

Culvert	Location
5	Proposed Highway 404 extension alignment, Station 30+300 Approx. 600 m south of Doane Road (Site Number 37-1571/C)
6	Proposed Highway 404 extension alignment, Station 30+450 to 30+412 Approx. 450 m south of Doane Road (proposed Highway 404 extension and Mount Albert creek crossing) (Site Number 37-1572/C)

The proposed culverts will carry Mount Albert creek under the proposed Highway 404 extension alignment.

Photographs of the site included in Appendix G show the general nature of the surrounding land:

1 and 2. Views looking at site location of proposed Culvert 5.

3 and 4. Views looking at site location of proposed Culvert 6.

The six culverts are located 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.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing at the locations of the proposed four culverts south of the Queensville Sideroad were carried out from February 25 to March 17, 2008. A total of 17 sampled boreholes were drilled for the proposed culverts.

Boreholes for the proposed Culvert 5, located south of Doane Road were drilled on August 26 and 27, 2009. A total of five sampled boreholes were drilled at this location.

Boreholes for the proposed Culvert 6, located south of Doane Road were drilled on February 17 and 18, 2010. A total of five sampled boreholes were drilled at this location.

A summary of the borehole locations, designations, termination depths and termination elevations drilled for each culvert is provided in Table 3.1. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets. Record of Borehole Sheets are included in Appendices A and E.

Table 3.1 – Borehole Designations

Culvert	Borehole	Station	Location Relative to the Culvert	Borehole Termination Depth (m)	Borehole Termination Elevation (m)	Appendix
1	QSR1-1	10+340	West of E/W-S Ramp	12.8	244.1	A
	QSR1-2	10+340	On E/W-S Ramp	12.8	244.2	
	QSR1-3	10+340	East of E/W-S Ramp	11.0	245.6	
2	QSR2-1	10+120	South of N-E/W Ramp	11.3	244.9	
	QSR2-2	10+115	South of N-E/W Ramp	12.8	243.6	
	QSR2-3	10+108	On N-E/W Ramp	12.8	244.0	
	QSR2-4	10+092	North of N-E/W Ramp	14.3	241.2	
3	QSR3-1	32+886	West of proposed Highway 404	14.3	241.0	
	QSR3-2	32+894	West of proposed Highway 404	12.8	242.7	
	QSR3-3	32+900	Proposed Highway 404	14.3	241.5	
	QSR3-4	32+908	Proposed Highway 404	14.3	241.3	
	QSR3-5	32+915	East of proposed Highway 404	11.1	243.9	
4	QSR4-1	10+095	North of Queensville Sideroad	12.8	240.9	
	QSR4-2	10+090	North of Queensville Sideroad	11.3	243.6	
	QSR4-3	10+080	On Queensville Sideroad	11.3	245.9	
	QSR4-4	10+078	South of Queensville Sideroad	11.3	244.2	
	QSR4-5	10+075	South of Queensville Sideroad	10.7	244.7	
5	08-1	30+300	On proposed Hwy 404 alignment	11.3	245.9	E
	08-2	30+300	West side of proposed Hwy 404 alignment	11.3	245.9	
	08-3	30+302		11.3	246.2	
	08-4	30+300	East side proposed Hwy 404 alignment	11.3	251.5	
	08-5	30+298		11.1	249.7	
6	08-10	30+435	On proposed Hwy 404 alignment	8.2	249.2	E
	08-11	30+441	East side of proposed Hwy 404 alignment	9.1	247.9	
	08-12	30+456		8.5	249.8	
	08-13	30+424	West side of proposed Hwy 404 alignment	9.1	247.8	
	08-14	30+412		9.1	247.9	

The approximate locations of all the boreholes drilled for culverts south of Queensville Sideroad and Doane Road are shown on the Borehole Location Drawings in Appendices D and H, respectively.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

Hollow and solid stem augering, and continuous split spoon sampling techniques were used to advance the boreholes in the overburden. Samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT).

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, visually examined the recovered samples, and transported them to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. A total of eleven standpipe piezometers consisting of 19 mm PVC pipes with screens were installed in selected boreholes to permit monitoring of groundwater levels. Details of the piezometer installations and other borehole completion details are shown in Table 3.2.

Table 3.2 – Borehole Completion Details

Culvert	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
1	QSR1-1	None installed	Borehole backfilled with holeplug to surface.
	QSR1-2	11.9/245.1	Sand from 11.9 m to 10.1 m, holeplug from 10.1 m to surface.
	QSR1-3	None installed	Borehole backfilled with holeplug to surface.
2	QSR2-1	11.3/244.9	Sand from 11.3 m to 9.4 m, holeplug from 9.4 m to 1.5 m, cuttings from 1.5 m to surface.
	QSR2-2	None installed	Borehole backfilled with holeplug to surface.
	QSR2-3	11.9/244.9	Sand from 11.9 m to 10.1 m, holeplug from 10.1 m to surface.
	QSR2-4	None installed	Borehole backfilled with holeplug to surface.
3	QSR3-1	13.5/241.9	Sand from 13.5 m to 11.7 m, holeplug to surface.
	QSR3-2	None installed	Holeplug to surface.
	QSR3-3	14.3/241.5	Sand from 14.3 m to 12.5 m, holeplug to surface.
	QSR3-4	None installed	Holeplug to 0.6 m then auger cutting to surface.
	QSR3-5	11.1/243.9	Sand from 11.1 m to 9.0 m, bentonite grout from 9.0 m to 0.6 m, and then cuttings to surface.
4	QSR4-1	None installed	Borehole backfilled with holeplug to surface.
	QSR4-2	11.3/243.6	Sand from 11.3 m to 9.4 m, bentonite grout from 9.4 m to 0.6 then cuttings to surface.
	QSR4-3	None installed	Holeplug to 0.2 m then asphalt/cold patch to surface.
	QSR4-4	10.7/244.7	Sand from 10.7 m to 8.5 m, bentonite grout from 8.5 m to surface.

	QSR4-5	None installed	Holeplug to 1.2 m then auger cuttings to surface.
5	08-1	None installed	Borehole backfilled with holeplug to surface.
	08-2	10.7/246.4	Sand from 10.7 m to 8.8 m, holeplug from 8.8 m to surface.
	08-3	None installed	Borehole backfilled with holeplug to surface.
	08-4	11.3/251.5	Sand from 11.3 m to 9.4 m, holeplug from 9.4 m to surface.
	08-5	None installed	Borehole backfilled with holeplug to surface.
6	08-10	None installed	Borehole backfilled with holeplug to surface.
	08-11	None installed	Borehole backfilled with holeplug to surface.
	08-12	8.5/249.8	Sand from 8.5 m to 5.5 m, holeplug from 5.5 m to surface.
	08-13	None installed	Borehole backfilled with holeplug to surface.
	08-14	None installed	Borehole backfilled with holeplug 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 for boreholes drilled south of the Queensville Sideroad and Doane Road are shown on the Record of Borehole sheets in Appendices A and E and on the figures contained in Appendices B and F, respectively.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendices A and E for details of the encountered soil stratigraphy in boreholes drilled south of Queensville Sideroad and Doane Road, respectively. Stratigraphic profiles are presented on the Borehole Locations and Soil Strata Drawings in Appendices D and H, for illustrative purposes. Overall descriptions of the stratigraphy are given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

5.1 Four proposed culverts at Queensville Sideroad and Highway 404 interchange (Culverts 1 to 4 - Boreholes QSR1-1 to QSR1-3, QSR2-1 to QSR2-4, QSR3-1 to QSR3-5 and QSR4-1 to QSR4-5)

The soil stratigraphy encountered at the borehole locations typically consists of topsoil or fill underlain by native clayey silt, silty clay and occasional silty sand layers overlying an extensive deposit of sand and silt till.

5.1.1 Topsoil

Topsoil was identified at ground surface in Boreholes QSR2-1 to QSR2-4 and QSR3-1 to QSR3-5 drilled at the proposed locations of Culverts 2 and 3. The topsoil thickness ranged from 300 mm to 500 mm. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.1.2 Pavement Structure

Pavement structure consisting of approximately 150 mm of asphalt overlying granular (gravelly sand fill) road base was encountered in Borehole QSR4-3 drilled on Queensville Sideroad. The thickness of granular fill was 0.9 m and the underside lay at elevation 256.1 m. The gravelly sand fill is in a dense state with SPT 'N' values of 46 blows per 0.3 m of penetration.

5.1.3 Fill

Fill was encountered surficially in Boreholes QSR4-1 to QSR4-5, drilled in close proximity to Queensville Sideroad. Fill was presumably placed to construct the existing embankment for Queensville Sideroad.

Fill consists of layers of dark brown to brown silty clay and sandy silt containing trace gravel to gravelly and occasional topsoil, organics, rootlets and wood fibres.

The thickness as well as the depth to the base of the fill ranged from 0.6 m to 4.1 m (Elevations 252.2 to 254.2).

Based on recorded SPT 'N' values ranging from 1 to 6 blows for 0.3 m of penetration, the silty clay fill is described as being very soft to firm in consistency. SPT 'N' values of 2 to 46 blows per 0.3 m of penetration, indicating a very loose to compact relative density, were measured in the sandy silt fill in Borehole QSR4-3 and QSR4-5.

The natural moisture content of the samples obtained from the fill layer ranged from 5% to 50%.

5.1.4 Clayey Silt and Silty Clay

Layers of native dark brown to brown clayey silt and silty clay containing trace to some sand, trace gravel and occasional roots, rootlets and topsoil were observed surficially in Boreholes QSR1-1 to QSR1-3. Brown clayey silt containing trace sand to sandy, trace gravel and occasional rootlets was contacted below the topsoil in Boreholes QSR2-2 to QSR2-4 and QSR1-3 to QSR3-5.

Thickness and depth to the base of the clayey silt and silty clay ranged from 1.2 m to 2.3 m (Elevations 254.3 to 255.8) in Boreholes QSR1-1 to QSR1-3.

In Boreholes QSR2-2 to QSR2-4 and QSR3-1 to QSR3-5, thickness of the clayey silt ranged from 0.3 m to 1.1 m. The depth to the base of the clayey silt varied from 0.8 m to 1.4 m (Elevations 253.8 to 256.1).

Based on recorded SPT 'N' values ranging from 3 to 13 blows for 0.3 m of penetration, the native silty clay and clayey silt are described as being soft to stiff in consistency.

The natural moisture content of the samples obtained from the clayey silt and silty clay layers ranged from 18% to 45%.

5.1.5 Silty Sand

Layers of silty sand were contacted in Borehole QSR1-3 at 2.3 m depth (Elevation 254.3) and in Boreholes QSR3-2 and QSR3-3 at 10.6 m depth (Elevations 244.9 and 245.2). Thickness of the silty sand layers ranged from 600 mm to 700 mm.

SPT 'N' values in the silty sand layers were 19 and 40 blows for 0.3 m of penetration, indicating a compact to dense relative density. Moisture content ranged from 10% to 19%.

Grain size distribution curves for three silty sand samples are presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 14
Sand	58 to 66
Silt	21
Clay	9
Silt & Clay	28 to 38

5.1.6 Sand and Silt till

An extensive deposit of brown to grey sand and silt till containing trace clay to clayey and trace gravel was observed in all boreholes at depths varying from 0.5 m to 4.1 m (Elevations 252.2 to 256.1).

Boreholes were terminated within the sand and silt till at depths ranging from 10.7 m to 14.3 m (Elevations 240.9 to 245.9).

The SPT 'N' values measured in the sand and silt till ranged from 8 to 107 blows per 0.3 m of penetration, indicating a loose to dense density. The deposit is generally in a compact to dense state. SPT 'N' values higher than 100 blows per 0.15 m of penetration were measured

in the sand and silt till near borehole termination depths in Boreholes QSR1-3, QSR3-5, QSR4-1 and QSR4-5. An SPT 'N' value of 50 blows per 0.15 m of penetration was measured in Borehole QSR3-3 near 3.0 m depth, Elevation 252.8. In Boreholes QSR3-2 and QSR3-3, SPT 'N' values of 0 and 1, indicating a very loose relative density, were measured at 7.7 m and 9.3 m (Elevations 247.8 and 246.5).

The moisture content of samples from this deposit ranges from 10% to 22%.

Grain size distribution curves for several sand and silt till samples are presented on the Record of Borehole sheets and on Figure B2 to B10 of Appendix B. Atterberg Limits test results are presented on Figures B11 to B16 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 7
Sand	13 to 53
Silt	35 to 78
Clay	3 to 36

Index Property	(%)
Liquid Limit	14 to 23
Plastic Limit	10 to 15

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

Glacial tills inherently contain cobbles and boulders which may account for some high blow counts.

5.1.7 Groundwater Conditions

Water level was observed in the boreholes during and upon completion of drilling. Eight standpipe piezometers were installed to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.1, along with the measurements in the boreholes upon completion of drilling.

Table 5.1 – Measured Groundwater Levels

Culvert	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
1	QSR1-1	March 5, 2008	1.5	255.4	In open borehole
	QSR1-2	March 5, 2008	1.7	255.3	In open borehole
		March 7, 2008	3.1	253.9	In piezometer
		March 20, 2008	2.2	254.8	In piezometer
		April 18, 2008	Ground surface	257.0	In piezometer
		June 30, 2008	1.1	255.9	In piezometer
		July 29, 2008	1.1	255.9	In piezometer
		October 24, 2008	1.2	255.8	In piezometer
		November 28, 2008	1.3	255.7	In piezometer
		February 6, 2009	1.2	255.8	In piezometer
		February 20, 2009	1.2	255.8	In piezometer
		March 20, 2009	1.1	255.9	In piezometer
		April 22, 2009	1.0	256.0	In piezometer
		May 15, 2009	1.1	255.9	In piezometer
		June 5, 2009	1.4	255.6	In piezometer
		July 29, 2009	0.2	256.8	In piezometer
		August 5, 2009	0.5*	257.5	In piezometer
		September 2, 2009	0.5	256.5	In piezometer
	QSR1-3	March 4, 2008	1.2	255.4	In open borehole

* Water level above ground surface (artesian condition)

Table 5.1 – Measured Groundwater Levels (Cont'd)

Culvert	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
2	QSR2-1	March 4, 2008	Ground surface	256.2	In open borehole
		March 7, 2008	3.3	252.9	In piezometer
		March 20, 2008	2.2	254.0	In piezometer
		April 18, 2008	0.3	255.9	In piezometer
		June 30, 2008	0.7	255.5	In piezometer
		July 29,2008	0.7	255.5	In piezometer
		October 24, 208	0.7	255.5	In piezometer
		November 28, 2008	0.7	255.5	In piezometer
		February 6, 2009	0.7	255.5	In piezometer
		February 20, 2009	0.6	255.6	In piezometer
		March 20, 2009	0.6	255.6	In piezometer
		April 22, 2009	0.7	255.5	In piezometer
		May 15, 2009	0.7	255.5	In piezometer
		June 5, 2009	1.1	255.1	In piezometer
		July 29, 2009	0.2*	256.4	In piezometer
		August 5, 2009	0.4*	256.6	In piezometer
	QSR2-2	February 28, 2008	5.2	251.2	In open borehole
	QSR2-3	February 28, 2008	5.7	251.1	In open borehole
		March 7, 2008	2.7	254.1	In piezometer
		March 20, 2008	1.1	255.7	In piezometer
		April 18, 2008	Ground surface	256.8	In piezometer
		June 3, 2008	0.7	256.1	In piezometer
		July 29, 2008	0.7	256.1	In piezometer
		October 24, 208	0.7	256.1	In piezometer
		November 28, 2008	0.8	256.0	In piezometer
		February 6, 2009	0.7	256.1	In piezometer
		February 20, 2009	0.7	256.1	In piezometer
		March 20, 2009	0.7	256.1	In piezometer
		April 22, 2009	0.6	256.2	In piezometer
		May 15, 2009	0.7	256.1	In piezometer
		June 5, 2009	1.0	255.8	In piezometer
		July 29, 2009	0.2*	257.0	In piezometer
		August 5, 2009	0.9*	257.7	In piezometer
	QSR2-4	March 3, 2008	1.0	254.5	In open borehole

* Water level above ground surface (artesian condition

Table 5.1 – Measured Groundwater Levels (Cont'd)

Culvert	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
3	QSR3-1	March 3, 2008	2.0	253.4	In open borehole
		March 7, 2008	2.5	252.9	In piezometer
		March 20, 2008	1.5	253.9	In piezometer
		April 18, 2008	Ground surface	255.4	In piezometer
		June 30, 2008	0.8	254.6	In piezometer
		July 29, 2008	0.8	254.6	In piezometer
		October 24, 208	0.8	254.6	In piezometer
		November 28, 2008	0.8	254.6	In piezometer
		February 6, 2009	0.8	254.6	In piezometer
		February 20, 2009	0.7	254.5	In piezometer
		March 20, 2009	0.7	254.5	In piezometer
		April 22, 2009	0.7	254.5	In piezometer
		May 15, 2009	0.7	254.5	In piezometer
		June 5, 2009	1.1	254.3	In piezometer
		July 29, 2009	0.2*	255.6	In piezometer
		August 5, 2009	0.9*	256.3	In piezometer
		September 2, 2009	0.9*	256.3	In piezometer
	QSR3-2	February 27, 2008	0.6	254.9	In open borehole
	QSR3-3	February 26, 2008	0.9	254.9	In open borehole
		February 28, 2008	3.2	252.6	In piezometer
		March 3, 2008	2.9	252.9	In piezometer
		March 7, 2008	0.3	255.5	In piezometer
		April 18, 2008	Ground surface	255.8	In piezometer
		June 30, 2008	0.9	254.9	In piezometer
		July 29, 2008	0.5	255.3	In piezometer
		October 24, 208	1.3	254.5	In piezometer
		November 28, 2008	1.4	254.4	In piezometer
		February 6, 2009	1.2	254.6	In piezometer
		February 20, 2009	1.2	254.6	In piezometer
		March 20, 2009	1.1	254.7	In piezometer
		April 22, 2009	1.0	254.8	In piezometer
		May 15, 2009	1.1	254.7	In piezometer
		June 5, 2009	1.6	254.2	In piezometer
		July 29, 2009	0.4*	256.2	In piezometer
		August 5, 2009	0.9*	256.7	In piezometer
		September 2, 2009	0.8*	256.6	In piezometer
	QSR3-4	February 26, 2008	2.0	253.7	In open borehole

* Water level above ground surface (artesian condition)

Table 5.1 – Measured Groundwater Levels (Cont'd)

Culvert	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
3	QSR3-5	February 25, 2008	0.8	254.2	In open borehole
		February 28, 2008	3.0	252.0	In piezometer
		March 7, 2008	2.5	252.5	In piezometer
		March 20, 2008	0.9	254.1	In piezometer
		April 18, 2008	Ground surface	255.0	In piezometer
		June 30, 2008	1.2	253.8	In piezometer
		July 29, 2008	1.2	253.8	In piezometer
		October 24, 208	1.8	253.2	In piezometer
		November 28, 2008	1.8	253.2	In piezometer
		February 6, 2009	1.7	253.3	In piezometer
		February 20, 2009	1.6	253.4	In piezometer
		March 20, 2009	1.4	253.6	In piezometer
		April 22, 2009	1.2	253.8	In piezometer
		May 15, 2009	1.3	253.7	In piezometer
		June 5, 2009	1.8	253.2	In piezometer
		July 29, 2009	0.3*	255.3	In piezometer
		August 5, 2009	0.9*	255.9	In piezometer
		September 2, 2009	1.0*	256.0	In piezometer
4	QSR4-1	March 7, 2008	1.1	252.6	In open borehole
	QSR4-2	March 20, 2008	3.3	251.6	In piezometer
		April 18, 2008	2.5	252.4	In piezometer
		June 30, 2008	1.0	253.9	In piezometer
		July 29, 2008	0.8	254.1	In piezometer
		October 24, 208	0.9	254.0	In piezometer
		November 28, 2008	1.0	253.9	In piezometer
		February 6, 2009	0.9	254.0	In piezometer
		February 20, 2009	0.9	254.0	In piezometer
		March 20, 2009	0.8	254.1	In piezometer
		April 22, 2009	0.8	254.1	In piezometer
		May 15, 2009	0.9	254.0	In piezometer
		June 5, 2009	1.3	253.6	In piezometer
		July 29, 2009	0.1*	255.0	In piezometer
		August 5, 2009	1.0*	255.9	In piezometer
		September 2, 2009	0.5*	255.4	In piezometer

* Water level above ground surface (artesian condition)

Table 5.1 – Measured Groundwater Levels (Cont'd)

Culvert	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
4	QSR4-3	March 17, 2008	1.5	255.7	In open borehole
	QSR4-4	February 25, 2008	0.8	254.6	In open borehole
		February 28, 2008	3.4	252.0	In piezometer
		March 7, 2008	3.0	252.4	In piezometer
		March 20, 2008	0.6	254.8	In piezometer
		April 18, 2008	Ground surface	255.4	In piezometer
		June 30, 2008	1.0	254.4	In piezometer
		July 10, 2009	0.8	254.6	In piezometer
		July 29, 2008	Ground surface	255.4	In piezometer
		August 5, 2009	0.8*	256.2	In piezometer
		September 2, 2009	0.9*	256.3	In piezometer
	QSR4-5	February 25, 2008	0.8	254.6	In open borehole

* Water level above ground surface (artesian condition)

Monitoring of water levels has been conducted from February 2008 to September 2009. The piezometric readings indicate that the groundwater level at the site is high.

Water level was observed at ground surface in April 2008 at the four culvert locations. Also, water levels were measured approximately 0.2 m to 1.0 m above the existing ground surface (artesian conditions) and at ground surface during the summer season (July to September)

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 Proposed culvert south of Doane Road (Culvert 5 – Boreholes 08-01 to 08-05)

The soil stratigraphy encountered at the borehole locations typically consists of topsoil underlain by native sandy silt and overlying a deposit of silty clay. Layers of silt were encountered within the silty clay. A layer of silty clay till was contacted below the silty clay in Borehole 08-05.

Boreholes at the proposed location of Culvert 6 have not been drilled at the time of preparation of this report, due to flooded site conditions and difficult access for drilling equipment.

5.2.1 Topsoil

Topsoil was identified at the ground surface in all the boreholes drilled at the proposed location of Culvert 5. The topsoil thickness ranged from 75 mm to 200 mm. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.2.2 Sandy Silt

Native brown sandy silt containing some clay and trace gravel was contacted below the topsoil in Boreholes 08-03 to 08-05. The thickness of the sandy silt varies from 0.8 m to 1.5 m.

The depth to the base of the sandy silt layer varies from 0.9 m to 1.6 m (Elevations 255.8 to 261.3).

SPT 'N' values measured in the sandy silt ranged from 3 to 10 blows per 0.3 m of penetration, indicating a very loose to compact relative density. The moisture content of samples from this layer ranges from 19% to 28%.

5.2.3 Silty Clay

A deposit of brown to grey silty clay was contacted below the topsoil in Boreholes 08-01 and 08-02 and below the sandy silt layer in Boreholes 08-03 to 08-05. Layers of silt containing some clay were encountered within the silty clay deposit. The thickness of the silty clay was 9.7 m in Borehole 08-05.

The depth to the base of the silty clay was contacted at 10.6 m (Elevation 250.2) in Borehole 08-05.

Boreholes 08-01 to 08-04 were terminated within the silty clay at 11.3 m depth (Elevations 245.9 to 251.5).

SPT 'N' values measured in the silty clay ranged from 3 to 47 blows per 0.3 m of penetration, indicating a soft to hard consistency. In general, the clay is stiff to very stiff. The moisture content of samples from this deposit ranges from 17% to 42%.

Grain size distribution curves for several silty clay samples are presented on the Record of Borehole sheets and on Figures F1 to F3 of Appendix F. Grain size distribution curves for

the silt samples are presented on the Record of Borehole sheets and on Figure F4 of Appendix F. Atterberg Limits test results are presented on Figures F5 and F6 of Appendix F. The results of the laboratory tests are summarized as follows:

Soil Particles	Silty Clay (%)	Silt (%)
Gravel	0	0
Sand	0 to 9	0 to 4
Silt	33 to 79	81 to 85
Clay	21 to 66	13 to 19

Liquid Limit	20 to 51	-
Plastic Limit	13 to 21	-

The above results show that the silty clay is typically of medium plasticity with a group symbol of CI. Two samples were classified as low plastic with a group symbol of CL. One sample was medium to high plastic with group symbols of CI-CH.

5.2.4 Silty Clay Till

Grey silty clay till was contacted below the silty clay at 10.6 m (Elevation 250.2) in Borehole 08-05.

Borehole 08-05 was terminated within the silty clay till at 11.1 m depth (Elevation 249.7).

An SPT 'N' value measured in the silty clay till was 84 blows per 0.3 m of penetration, indicating a hard consistency. The moisture content of was 18%.

5.2.5 Groundwater Conditions

Water level was observed in the boreholes during and upon completion of drilling. Two standpipe piezometers were installed to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.2, along with the measurements in the boreholes upon completion of drilling.

Table 5.2 – Measured Groundwater Levels

Culvert	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
5	08-01	August 27, 2009	1.6	255.6	In open borehole
	08-02	August 26, 2009 September 2, 2009	0.6 6.2	256.5 250.9	In open borehole In piezometer
	08-03	August 26, 2009	4.8	252.6	In open borehole
	08-04	August 27,2009 September 2, 2009	1.5 5.9	261.3 256.9	In open borehole In piezometer
	08-05	August 27, 2009	4.3	256.5	In open borehole

Piezometric readings indicate that water level ranged from elevation 250.9 to 261.3.

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 Proposed culvert south of Doane Road (Culvert 6 – Boreholes 08-10 to 08-14)

Boreholes 08-10 to 08-14 were advanced with light weight tripod drilling equipment to facilitate access to the flooded area. The lightweight tripod drilling method employed continuous split spoon sampling.

The soil stratigraphy encountered at the borehole locations typically consists of peat underlain by native silty clay till.

5.3.1 Peat

Peat was identified at the ground surface in all the boreholes drilled at the proposed location of Culvert 6. The peat thickness ranged from 10 mm to 1100 mm. The peat thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities. The peat is in a loose state and the moisture content ranges from 20% to 95%.

5.3.2 Silty Clay

Native brown silty clay was contacted below the peat in Borehole 08-13 at 0.6 m. The layer was 0.3 m thick with an underside elevation of 256.0 m.

The SPT 'N' value in the silty clay was 28 blows per 0.3 m penetration, indicating the clay layer to be in a very stiff state. The moisture content of the layer is 19%.

5.3.3 Silty Sand

Native silty sand was encountered in Boreholes 08-12 and 08-13. The layer ranged in thickness from 0.3 m to 0.7 m, with an underside elevation between 255.9 and 255.7 m. The SPT 'N' values in the sand layer ranged from 11 to 20 blows per 0.3 m penetration, indicating that the layer is in a compact state. The moisture content of the layer is in the order of 21%.

The results of a grain size distribution test for a sample of the silty sand from Borehole 08-12 is presented on the Record of Borehole sheet and on Figure F11 of Appendix F. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	60
Silt	26
Clay	14

5.3.4 Silty Clay Till

An extensive deposit of brown to grey silty clay till containing trace sand was observed in all boreholes at depths varying from 1.1 m to 2.4 m (Elevations 255.3 to 256.2).

Boreholes were terminated within the silty clay till at depths ranging from 8.2 m to 9.1 m (Elevations 247.8 to 249.8).

The SPT 'N' values measured in the silty clay till ranged from 6 to 50 blows per 0.15 m of penetration. The deposit is generally in a stiff to very stiff state.

The moisture content of samples from this deposit ranged from 18% to 35%.

Grain size distribution curves for the silty clay till samples are presented on the Record of Borehole sheets and on Figure F7 to F10 of Appendix F. Atterberg Limits test results are presented on Figures F12 to F15 of Appendix F. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	0 to 6
Silt	32 to 82
Clay	17 to 66

Index Property	(%)
Liquid Limit	23 to 39
Plastic Limit	7 to 20

The above results show that the silty clay till is typically of low to medium plasticity with group symbol of CL-CI.

Glacial tills inherently contain cobbles and boulders.

5.3.5 Groundwater Conditions

One standpipe piezometer was installed in Borehole 08-12 to monitor water levels after completion of drilling. The water level measured in the piezometer is summarized in Table 5.3.

Table 5.3 – Measured Groundwater Levels

Culvert	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
6	08-12	March 4, 2010	5.7	252.6	In piezometer
		March 9, 2010	6.2	252.1	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.

Groundwater was also observed at the surface of the site due to flooding from the pond to the northeast of the culvert.

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 and Walker Drilling Ltd. from Utopia, Ontario supplied track mounted CME 75 and D90 drill rigs and conducted the drilling, sampling and in-situ testing operations for Culverts 1 to 5. OGS Drilling Inc. from Almonte, Ontario supplied a lightweight tripod mounted drill rig and conducted the drilling, sampling and in-situ testing operations for Culvert 6.

The field program was supervised on a full time basis by Ms. Eckie Siu, Mr. George Azzopardi and Mr. Luke Gilarski 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., Mr. Weiss Medhawi, P.Eng., Ms. R. Palomeque Reyna, P.Eng., and Mr. Tony Harte.

Interpretation of the data and preparation of the report were carried out by Ms. R. Palomeque Reyna, P.Eng., and Mr. Tony Harte.

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

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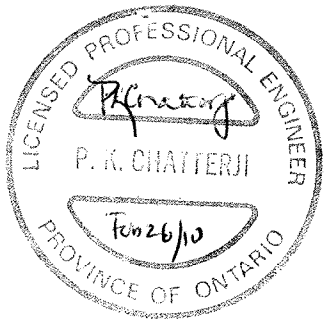


P.K. Chatterji, P.Eng.
Review Principal

FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 404 EXTENSION
FROM GREEN LANE TO QUEENSVILLE SIDEROAD
CULVERTS AT
Sta 30+300 Sta 30+430.5
Sta 32+903 Sta 10+075 QSR
QSR E/W – S Ramp N – E/W QSR
REGION OF YORK
G.W.P. 2109-05-00,

GEOCRES Number: 31D-493

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This report presents interpretation of the geotechnical data in the factual report and presents foundation design recommendations for the design of suitable foundation systems for six proposed culverts.

The project involves construction of a total of six culverts. Four culverts (Culverts 1 to 4) will be installed at the location of the proposed Highway 404 and Queensville Sideroad interchange. The culverts will carry a branch of the Maskinonge River under Highway 404, Queensville Sideroad and the new ramps.

Two culverts (Culverts 5 and 6) will be installed south of Doane Road to carry Mount Albert creek.

A general description of the proposed culverts, as provided by the designers, is presented in Table 7.1.

Table 7.1 – Proposed Culverts

Culvert	Location	Type	Culvert Size (m)	Proposed length (m)
1	Queensville Sideroad East/West to Highway 404 South Ramp	Conspan culvert	7.1 x 2.8	50
2	Highway 404 North to Queensville Sideroad East/West Ramp			70
3	Highway 404 approximate Station 32+900			105
4	Queensville side Road, approximate Station 10+075			140
5	Proposed Highway 404 extension alignment, Station 30+300	Conspan equalization culvert	8.5 x 3.1	95
6	Proposed Highway 404 extension alignment, Station 30+435 to 30+415 (Mount Albert creek crossing)	Conspan culvert	10.9 x 3.1	96

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained during the course of the investigation. The plans and profiles (plates) used for preparation of this report were provided by Philips Engineering/Hatch Mott MacDonald Joint Venture.

8 CULVERT FOUNDATIONS

8.1 General

The subsurface stratigraphy revealed in the boreholes drilled at the proposed locations of Culverts 1 to 4 consists of surficial topsoil and/or fill underlain by layers of native soft to stiff clayey silt/silty clay and compact to dense silty sand and an extensive deposit of compact to dense silty sand till. Clayey zones were observed within the silty sand till.

The subsurface stratigraphy at the proposed locations of Culverts 5 and 6 consisted of topsoil or peat overlying loose to compact sandy silt to silty sand and deposits of stiff to very stiff silty clay and silty clay till. Layers of silt were encountered within the silty clay.

A summary of the groundwater levels measured in the piezometers installed at selected boreholes at the proposed culvert is shown in Table 8.1.

Table 8.1 – Summary of Measured Groundwater Elevations

Culvert	Measured Groundwater Depth (m)	Measured Groundwater Elevation (m)	Comments
1	0.5* to 3.4	253.6 to 257.5	Groundwater observed at surface during Spring season. Artesian conditions during the rain/Summer season.
2	0.9* to 5.7	251.1 to 257.7	
3	1.0* to 3.9	251.1 to 256.0	
4	1.0* to 3.5	251.4 to 256.0	
5	5.9 to 6.2	250.9 to 261.3	-
6	5.7 to 6.2	252.1 to 252.6	The site is in a flooded condition.

* Above ground surface (artesian conditions)

8.2 Foundation Design

Foundation design issues for culverts are subgrade conditions, bearing resistances, settlement of foundation soils under the weight of the new roadway embankment fill, and stability of the new embankments adjacent to the culverts.

The following types of culvert have been considered in this report:

- Concrete open frame culvert with spread footings on native soil
- Concrete open frame culvert with spread footings on engineered fill
- Concrete closed box culvert supported on native soil
- Deep foundations (driven steel H-piles)

A comparison of the technical advantages and disadvantages of different foundation schemes is presented in Appendix I.

Based on the borehole data, it is anticipated that the native undisturbed sandy silty till or silty clay / silty clay till encountered at the proposed culvert locations are suitable for supporting the shallow foundations for open frame culverts or the base of precast box culverts.

A deep foundation system is not recommended as this foundation type is not required and the cost is expected to be high compared to shallow foundations.

Both pre-cast and cast-in place culvert options were considered. It is preferable to use precast concrete sections rather than cast-in-place construction for the culvert, since this type can be installed in a shorter time span and with less potential for disturbance of the founding soils. The designers have indicated that Conspan culverts will be specified at these sites.

Where head walls or wing walls are required, the site is considered to be suitable for:

- Cast-in-place construction
- Pre-cast units
- RSS walls

All walls, including the base of a RSS, must follow the foundation recommendation provided for the culverts.

Consideration could also be given to lengthening the culverts to remove the requirement for head walls.

The culverts must be designed to resist frost forces, lateral earth pressures, hydrostatic pressure including uplift, weight of embankment fill, traffic loading and surcharge due to construction equipment.

8.3 Open Frame Concrete Culvert on Spread Footings

Spread footings for a concrete open frame culvert and adjacent wingwall/headwall footings must be founded on undisturbed, native compact sand and silt till or very stiff silty clay. Existing fill is not acceptable as a bearing stratum.

Based on the borehole data, it is anticipated that compact to dense sand and silt till or very stiff silty clay / silty clay till will be present at depths and elevations shown in Table 8.2.

Table 8.2 –Highest Recommended Founding Levels for Spread Footings

Culvert	Borehole	Depth (m)	Elevation (m)	Soil Type
1	QSR1-1 QSR1-2 QSR1-3	2.6 2.7 2.3	254.3	Compact to dense silty sand and sand and silt till
2	QSR2-1 QSR2-3	1.2 1.8	255.0	Compact sand and silt till
	QSR2-2 QSR2-4	2.4 1.5	254.0	
3	QSR3-1 QSR3-2 QSR3-3 QSR3-4	1.4 1.5 1.8 1.7	254.0	Compact sand and silt till
	QSR3-5	1.5	253.5	
4	QSR4-1 QSR4-3	2.2 5.7	251.5	Compact sand and silt till

	QSR4-2 QSR4-4 QSR4-5	1.9 2.4 2.4	253.0	
5	08-01 08-03	1.7 1.9	255.5	Very stiff silty clay
	08-02	2.1	255.0	
	08-04	1.8	261.0	
	08-05	1.8	259.0	
6	08-10	1.6	255.0	Very stiff silty clay till
	08-11	1.9	254.5	
	08-12	1.6	255.0	
	08-13	1.9	255.0	
	08-14	2.3	254.5	

Assuming the footing width is 1.5 m, the following geotechnical resistances are recommended for design of spread footings founded on the native compact sand and silt till or very stiff silty clay / silty clay till at or below the elevations recommended in Table 8.2:

Culvert	**Factored geotechnical resistance Ultimate Limit States (ULS) (kPa)**	**Geotechnical resistance Serviceability Limit States (SLS) (kPa)**
1, 2, 4, 5 and 6	300	200
3	250	150

The above values are for vertical, concentric loads only. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHDBC 2006 Clauses 6.7.3 and 6.7.4.

The geotechnical resistance at SLS was computed on the basis of limiting the settlement of an individual culvert footing to 25 mm under the applied load. The actual settlement of the culvert will be governed by compression of the foundation soils under the weight of the road embankment fill. Comments on this regard are presented in Section 8.6 of this report.

The sliding resistance of concrete poured on the native sandy silty till and silty clay / silty clay till may be computed on the basis of an ultimate coefficient of friction of 0.4 and 0.35, respectively. This is an "ultimate" value and requires a degree of sliding movement to occur to fully mobilize the resistance.

Following excavation to the design founding level, any remaining fill, topsoil, loose streambed deposits or soft soils at the bearing surface should be subexcavated and replaced with a concrete working slab or compacted Granular A or Granular B Type II material. All foundation excavation should be carried out in accordance with SP 902S01. A 100 mm thick mat of concrete should be placed over the approved founding surfaces within 24 hours of excavation, inspection and approval to protect the surface from disturbance during construction.

The Contractor's QVE must verify that the bearing surfaces for the foundation have been prepared on undisturbed, native soil and are free of topsoil, peat, fill or other deleterious materials.

Based on piezometric readings, water levels are above founding levels as indicated in Tables 8.1 and 8.2. Groundwater levels were observed 0.5 m to 1.0 m above ground surface during the summer season, indicating artesian conditions at the locations of Culverts 1 to 4. Water was observed at ground surface during the spring season. A flooded condition was encountered at the site of Culvert 6.

An effective dewatering plan must be in place prior to the start of footing excavation so that the concrete footings are poured in the dry and to prevent sloughing of the sides or disturbance of the base of the excavation due to the inflow of groundwater. The dewatering plan must be able to lower the groundwater level at least 0.5 m below the base of the footing excavation and must maintain a stable, unwatered excavation throughout the footing construction. Dewatering must remain operational and effective until the footing is constructed and backfilled. Text for a NSSP is provided in Appendix K.

Consideration should be given to commencing the application process for a permit to take water (PTTW) prior to contract award.

Since these culverts are carrying Maskinonge River, the potential for scour to undermine the foundations must be taken into account and footings of the open frame culverts should be protected from scour. Design of scour protection must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in this field.

For frost protection purposes, the culvert design should incorporate 1.4 m of earth cover over the founding base.

8.4 Footings on Engineered Fill

Construction of spread footings on engineered fill may be considered to increase the available geotechnical resistance. The fill should be at least 1.5 m thick below the footing and it should be constructed over native undisturbed stiff to very stiff silty clay or compact to dense sand and silt till as indicated in Table 8.3.

The engineered fill must consist of OPSS Granular A (OPSS 1010) compacted according to OPSS 501 (Method A: Clause 501.08.02). The fill pad should conform to the geometry illustrated in Figure 1 in Appendix J.

Table 8.3 –Highest Recommended Founding Levels of Engineered Fill on Native Soils

Culvert	Borehole	Depth (m)	Elevation	Soil Type
1	QSR1-1 QSR1-2 QSR1-3	1.4 1.5 1.1	255.5	Stiff clayey silt Compact sand and silt till Stiff silty clay
2	QSR2-1 QSR2-2	0.7 0.9	255.5	Compact sand and silt till
	QSR2-3	0.8	256.0	
	QSR2-4	1.5	254.0	
3	QSR3-1 QSR3-3	1.0 1.4	254.4	Compact sand and silt till
	QSR3-2	1.5	254.0	Compact sand and silt till
	QSR3-4	1.5	254.2	
	QSR3-5	1.2	253.8	Dense sand and silt till
4	QSR4-1	2.2	251.5	Compact to dense sand and silt till
	QSR4-2	1.4	253.5	
	QSR4-3 QSR4-4 QSR4-5	4.2 2.4 2.4	253.0	
5	08-01	1.5	255.7	Stiff to very stiff silty clay
	08-02	2.1	255	
	08-03	1.4	256.0	
	08-04	1.5	261.3	
	08-05	1.3	259.5	
6	08-10	0.6	256.0	Very stiff silty clay till
	08-11	1.8	254.6	
	08-12	0.6	256.0	
	08-13	0.9	256.0	
	08-14	2.2	254.6	

Assuming a footing width of 1.5 and a 2 m minimum thickness of fill, footings bearing on the well compacted engineered fill may be designed for the following values:

- Factored geotechnical resistance of 900 kPa at Ultimate Limit States (ULS)
- Geotechnical resistance of 350 kPa at Serviceability Limit States (SLS)

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

The geotechnical resistance at SLS was computed on the basis of limiting the settlement of and individual culvert footing to 25 mm under the applied load. The actual settlement of the culvert will be governed by compression of the foundation soils under the weight of the road embankment fill. Comments on this regard are presented in Section 8.6 of this report.

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

Piezometric readings revealed that water levels are above the founding levels for culverts 1 to 5 as indicated in Table 8.3. High water level conditions including artesian conditions and water level at ground surface were also observed at the site in the wet seasons.

Unwatering must be carried out in accordance with SP902S01. The contract must include an NSSP alerting the contractor to the high water levels and the possibility of artesian conditions. The NSSP must also contain a provision that the groundwater level must be depressed to 0.5 m below the base of the excavation prior to commencing excavation.

The engineered fill pad should be protected against scour or erosion. Design of scour protection must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in this field.

A frost protection soil cover of 1.4 m or equivalent thickness of insulation should be used for foundation and backfill design to provide protection against frost action on the culvert base and foundations.

8.5 Concrete Box (Closed) Culvert

Consideration was also given to installation of concrete box culverts at these sites.

For closed concrete box culverts, the recommended highest subgrade elevations are the same as shown in Table 8.3 for engineered fill bases.

Following excavation to the design base level of the culvert, the Contractor's QVE must verify that the bearing surfaces for the foundation have been prepared on undisturbed, native compact to dense sand and silt till or stiff silty clay at or below elevations shown in Table 8.3, and that bearing surfaces are free of topsoil, peat, fill or other deleterious materials within the culvert footprint.

Any remaining fill, topsoil, loose streambed deposits or soft soils should be subexcavated to the native undisturbed compact to dense sand and silt till or stiff silty clay at or below

elevations shown in Table 8.3, as directed by the Contractor's QVE. Any soft areas should be subexcavated and replaced with well compacted granular fill. Any fill placed below the culvert to re-establish the founding level should consist of compacted Granular A or Granular B Type II material. This work should be carried in accordance with SP 902S01.

In order to provide a more uniform foundation subgrade condition, a 300 mm thick layer of bedding material conforming to OPSS Granular A requirements should be provided under the base of box culverts as per OPSD 803.010. The bedding material should be placed and compacted as soon as practical following inspection and approval of the final subgrade as protection from disturbance during construction.

Culverts founded on the native, undisturbed compact sand and silt till or very stiff silty clay at or below level indicated in Table 8.3, should be designed using a concentric, vertical geotechnical resistances as indicated below:

Culvert	Factored geotechnical resistance Ultimate Limit States (ULS) (kPa)	Geotechnical resistance Serviceability Limit States (SLS) (kPa)
1, 2, 4, 5 and 6	300	200
3	250	150

Settlement of the culvert will be governed by compression of the foundation soils under the weight of the road embankment fill. Therefore, the SLS resistance does not apply to the design of the box culvert. Comments in this regard are presented in Section 8.6 of this report.

8.6 Cast-in-place and Prefabricated Culvert Options

The foundation recommendations provided in the preceeding sections for the various culvert types apply to both cast-in-place and prefabricated culvert options.

The designers may select cast-in-place or prefabricated culverts on the basis of a number of considerations, including the required extent of excavation and site disturbance and on the duration of construction.

8.7 Settlement

The actual settlement of the culverts is expected to be controlled primarily by the settlement of the subgrade under the weight of the road embankment fill.

The estimated settlements at the culvert foundation level due to the embankment loads are presented in Table 8.4.

Table 8.4 –Foundation Settlements

Culvert	Approximate Embankment Height (m)	Estimated foundation settlement (mm)
1 to 3	6 to 7	10 to 15
4	13	45 to 50
5 and 6	7	15 to 20

Settlement within the fill mass is estimated to be as high as 0.5% of the embankment height, approximately 30 mm to 65 mm. This settlement is expected to be essentially complete at the end of construction.

Due to the non cohesive nature of the foundation soils at the Queensville Sideroad sites (Culverts 1 to 4), these settlements will be immediate and essentially completed when construction of the fill is completed.

Appropriate camber should be provided for the culverts to accommodate the above foundation settlements.

The embankments should be overbuilt in order to provide the required platform width after the indicated settlements have occurred.

8.8 Subgrade Preparation

A number of boreholes located near the culverts encountered topsoil, peat or fill with organic inclusions. The presence of alluvial and organic deposits should be expected in the vicinities of the watercourses. The combined thickness of topsoil, peat and fill at the various culvert sites was found to range from 75 mm to 4.2 m. The actual depths of topsoil, peat and fill are noted in Section 5 of this report.

Founding elevations have been selected with the intent of placing the foundations on suitable, undisturbed native soil. However, soil stratigraphy is inherently variable and the Contractor's QVE must verify that the base of the completed excavation is free of topsoil, peat, fill, disturbed soil or other deleterious materials.

Backfill to the sub-excavation for reinstating the founding elevation should consist of Granular A or B Type II material placed and compacted in accordance with SP 902S01. Lean mix concrete may be used as an alternative to compacted granular backfill.

9 BACKFILL AND LATERAL EARTH PRESSURES

Culvert backfill should consist of free-draining granular material conforming to OPSS Granular A or Granular B Type II specifications. The granular material should be placed to the extents shown in OPSD 803.010.

Backfill should be placed and compacted in simultaneous equal lifts on both sides of the culvert, and the top of backfill elevation should be within 400 mm on both sides of the culvert at all times. Heavy compaction equipment should not be used adjacent to the walls and roof of the culvert. Compaction should be carried out in accordance with SP 105S10.

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

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

where: p = horizontal pressure on the wall at depth h (kPa)
K = earth pressure coefficient (see table below)
γ = bulk 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 culvert are dependent on the material used as backfill. Recommended unfactored values are shown in Table 9.1. The at-rest coefficients should be employed for closed box culvert walls. Active pressures shall be used for any wingwalls or unrestrained walls.

Table 9.1 – Earth Pressure Coefficients (K)

Wall 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	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.40*	0.31	0.43*
At rest (Restrained Wall)	0.43	-	0.47	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-

* For wing walls, if employed.

The parameters in the table correspond to full mobilization of active and passive earth pressures, and require certain relative movements between the wall and adjacent soil to produce these conditions. The values to be used in design can be assessed from Figure C6.9.1 (a) of the Commentary to the CHBDC.

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.

The design of the culvert must incorporate measures such as weepholes or subdrains to permit drainage of the culvert backfill, or alternatively the culvert walls should be designed to withstand the potential build-up of hydrostatic pressures behind the walls.

10 SCOUR PROTECTION AND EROSION CONTROL

All culvert and head wall footings should be provided with scour protection. Erosion control should be provided at the culvert inlet and outlet areas as applicable. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in this field.

Typically, rock protection should be provided over all surfaces with which stream flow is likely to be in contact. Treatment at the outlets should be in accordance with OPSD 810.010. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion, in general accordance with SP 572S01.

It is recommended that a clay seal or a concrete cut-off wall be used to minimize the potential for erosion near the inlet area. The clay seal should extend at least 0.3 m above the high water level and laterally for the width of the granular material, and have a minimum thickness of 0.5 m. The material requirements should be in accordance with OPSS 1205.

11 EXCAVATION AND GROUNDWATER CONTROL

In general, surface vegetation, topsoil, peat, organic deposits, disturbed material or otherwise loose/soft soils should be stripped from the culvert area and embankment footprint prior to culvert installation.

Excavation is expected to be carried out through existing fills, native clayey silt/silty clay, silty sand, sand and silt till, and silty clay till.

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the native soils and fill within the probable depth of excavation at this site may be classed as Type 3 soils above the water table and Type 4 soils below the water table.

The excavation and backfilling for foundations must be carried out in accordance with SP 902S01.

The need for roadway protection is described in Section 13 of this report.

Based on piezometer readings, it is expected that excavation below the groundwater level will be required. The site of Culvert 6 was noted to be flooded. A cofferdam may be required to control this water. Surface and groundwater must be diverted away from any excavation at all times.

The Contractor must be prepared to control the groundwater and surface water to permit construction in the dry. The Contract Documents should also contain a NSSP alerting the Contractor to the risks associated with excavation of cohesionless soils submerged below the groundwater level without prior dewatering and specifying that an appropriate dewatering system must be provided to maintain a stable and reasonably dry excavation. Suggested wording is included in Appendix K.

The design of the dewatering system for foundation construction is the responsibility of the Contractor and the Contract Documents must alert him to this responsibility and the need to engage a dewatering specialist. While the responsibility for dewatering remains with the Contractor, suitable systems that might be employed include:

- Pumping from properly filtered sumps may be suitable to handle the groundwater on this project during the drier season when the excavations extend no more than 0.5 m below the groundwater level.
- The use of vacuum wellpoints for deeper penetration below the groundwater level.
- Sheetpiled cofferdam assisted by vacuum well points at locations near the creek and river.
- Temporary stream diversion measures, such as impervious dykes or cofferdams must be provided at Maskinonge River and Mount Albert Creek to divert surface water runoff and stream flow away from the culvert excavations in order to maintain dry excavations at all times during construction.

Dewatering and surface water diversion must remain operational and effective until each culvert footing is constructed and backfilled. Special attention should be given to the artesian conditions while selecting the dewatering system.

Decisions regarding dewatering, shoring methods and sequencing must be made by the contractor and submitted to the Contract Administrator for review.

It is recommended that culvert construction be conducted during the drier season.

Due to the presence of flooding at the site of Culvert 6, it may be necessary to place fill on both sides of the culvert to create a level working platform, and to build a cofferdam using steel sheet piles. All fill placed below the water surface should consist of rock fill, which should extend to a minimum of

150 mm above the water surface. The water level measured in Feb 2010 was at elevation 257.0, but this is variable. The surface of the rock fill should be chinked with rock fragments and spall and should be covered with a 300 mm layer of Granular B Type II to prevent loss of embankment fill into the voids in the rock fill. Inorganic embankment fill may be placed above the Granular B Type II layer. Text for a NSSP for culvert construction in the flooded area is provided in Appendix K. All peat should be removed from under the rockfill.

12 ROADWAY PROTECTION

Roadway protection will be required where excavations for culverts are located in close proximity to live traffic lanes or if there is insufficient clearance for an open cut. At the location of Culvert 4 near Queensville Sideroad, temporary shoring may be required to retain the embankment fill and native soils during culvert installation.

Temporary shoring in the form of steel sheet piles or soldier piles with timber lagging may be considered. Temporary shoring should be designed by a licensed Professional Engineer experienced in design of shoring with special consideration of traffic loads and any sloping retaining surfaces, taking account of the need to maintain the integrity of the existing culvert foundations.

If shoring is required during construction to retain excavations adjacent to existing roads, an item titled "Roadway Protection" as per SP539S01 should be included in the contract documents. Performance Level 2 is recommended as per Clause 539.04.02.01.

13 SEISMIC CONSIDERATIONS

13.1 Seismic Design Parameters

The following seismic parameters should be used for design:

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

The soil profile type at this site has been classified as Type II. Therefore, according to Table 4.4 of the CHBDC, a Site Coefficient "S" (ground motion amplification factor) of 1.2 should be used in seismic design.

13.2 Liquefaction Potential

The foundation soils at the abutments are not in danger of liquefaction under earthquake loading.

13.3 Retaining Wall Dynamic Earth Pressures

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading.

For the design of retaining walls, the coefficients of horizontal earth pressure in Table 14.1 may be used.

Table 14.1 – Earth Pressure Coefficient (K) for Earthquake Loading

Wall Condition	Granular A or 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	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (K_{AE})*	0.3	0.47	0.34	0.58
Passive (K_{PE})	3.6	-	3.2	-
At Rest (K_{OE})**	0.53	-	0.58	-

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

14 CONSTRUCTION CONCERNS

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

1. **Artesian water flow during excavation.**

   Groundwater levels were measured at the existing ground level in the piezometers. If artesian groundwater flow is observed during construction activities, the contractor or QVE must immediately advise the CA. If the CA agrees there are concerns regarding the artesian flow, the issue should be referred to the design team.

2. Destabilization of excavations

Groundwater was noted above the founding levels in Culverts 1 to 5, and the site of Culvert 6 was flooded. If excavation is carried out without prior implementation of adequate dewatering measures to control groundwater and surface water, there is a risk that the sides and or base of the excavation will be destabilized. This could lead to a risk to personnel work on site, or to a loss of bearing resistance in the soil.

Dewatering, in conjunction with temporary creek diversion might be required to maintain a reasonably dry excavation during the wet seasons.

Accordingly, it must be emphasized to the contractor that proper groundwater and surface water control measures must be in place prior to commencing excavation.

3. Founding subgrade

Care must be exercised during excavation to avoid disturbing the founding subgrade. The exposed subgrade soils should be expeditiously inspected, approved and protected from disturbance.

The successful performance of the culverts will depend largely upon good workmanship and quality control during construction. The Contractor's QVE must certify that the foundations have been constructed according to the drawings and specifications. However, it is recommended that the bases of the culvert foundation excavations be inspected by a qualified Geotechnical Engineer retained by the CA to confirm that the base of the excavation is free from inclusions of organic soils or loose, recent stream alluvium.

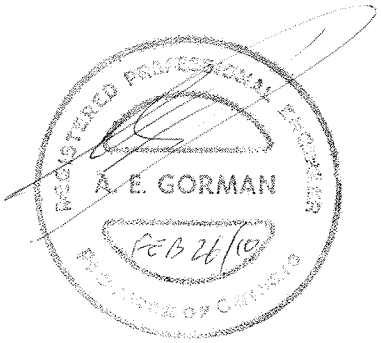
15 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng and Ms. R. Palomeque Reyna, P.Eng.

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

THURBER ENGINEERING LTD.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer



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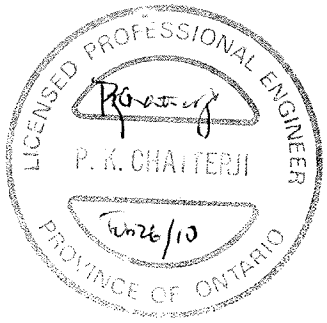
Senior Foundations Engineer



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

Appendix A

Record of Borehole Sheets (south of Queensville Sideroad)

Culverts 1 to 4

Boreholes QSR1-1 to QSR1-3, QSR2-1 to QSR2-4, QSR3-1 to QSR3-5 and QSR4-1 to QSR4-5

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

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

$\blacktriangledown$ 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			

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RECORD OF BOREHOLE No QSR1-1 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 726.4 E 309 717.9, Station 10+070, CL ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.05 - 2008.03.05 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.9											
0.0	Clayey **SILT**, trace sand, trace gravel, trace roots and rootlets Firm to Stiff Dark Brown		1	SS	5				○		
			2	SS	6	▽	256		○		
			3	SS	10		255		○		
254.6											
2.3	**SAND** and **SILT**, some clay, trace gravel Compact to Dense Brown Moist (TILL) occasional oxide staining		4	SS	41				○		1 30 53 16
			5	SS	39		254		○		
	Grey						253				
			6	SS	25		252		○		
	Loose Wet		7	SS	9		251		○		
			8	SS	10		250				
	Compact						249		○		
			9	SS	21		248		⊢		0 32 50 18
							247				

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Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No QSR1-1 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 726.4 E 309 717.9, Station 10+070, CL ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.05 - 2008.03.05 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay to clayey, trace gravel Dense to very Dense Grey Moist (TILL)										
			10	SS	66		246				
							245				
244.1			11	SS	41						0 19 61 20
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN AND WATER LEVEL AT 1.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

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

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RECORD OF BOREHOLE No QSR1-2 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 743.6 E 309 733.3, Station 10+070, 25m Lt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.03.05 - 2008.03.05 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
257.0										
0.0	Clayey **SILT**, trace to some sand, trace gravel, occasional roots Soft to Firm Dark Brown to Brown		1	SS	4		257			
255.8			2	SS	6		256			
1.2	**SAND** and **SILT**, some clay, trace gravel, occasional oxide staining Loose to Dense Brown Moist (TILL)		3	SS	12		255			
			4	SS	18		254			
			5	SS	37		253			0 28 53 19
			6	SS	24		252			
			7	SS	13		251			
	Wet						250			
			8	SS	20		249			2 32 48 18
	Grey		9	SS	29		248			

Continued Next Page

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

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

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THUNDER

RECORD OF BOREHOLE No QSR1-2 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 743.6 E 309 733.3, Station 10+070, 25m Lt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.03.05 - 2008.03.05 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay to clayey, trace gravel Very Dense Grey Moist (TILL)						247				
			10	SS	61		246		⊖		2 19 59 20
							245				
244.2			11	SS	69				o		0 31 53 16
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 11.9m AND WATER LEVEL AT 1.7m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.03.07 3.1 253.9 2008.03.20 2.2 254.8 2008.04.18 Ground surface 257.0 2008.06.30 1.1 255.9 2008.07.29 1.1 255.9 2008.10.24 1.2 255.8 2008.11.28 1.3 255.7 2009.02.06 1.2 255.8 2009.02.20 1.2 255.8 2009.03.20 1.1 255.9 2009.04.22 1.0 256.0 2009.05.15 1.1 255.9 2009.06.05 1.4 255.6 2009.07.29 0.2 256.8 2009.08.05 0.5* 257.5 2009.09.02 0.5 256.5 2009.09.21 0.1 256.9 * (above ground surface)										

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

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

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THURBER

RECORD OF BOREHOLE No QSR1-3 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 763.1 E 309 750.7, Station 10+070, 25m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.04 - 2008.03.04 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.6											
0.0	Silty **CLAY**, trace sand, trace gravel, trace roots, occasional topsoil Soft Dark Brown		1	SS	4						
	Layer of Sand		2	SS	13	▽	256				
	Stiff Brown		3	SS	12		255				
254.3											
2.3	Silty **SAND**, trace gravel, trace clay Compact Brown Wet		4	SS	19		254				4 66 21 9
253.6											
3.0	**SAND** and **SILT**, some clay, trace gravel Compact to Very Dense Grey Moist (TILL)		5	SS	27		253				1 26 55 18
			6	SS	43		252				
			7	SS	67		251				
			8	SS	107		250				0 29 60 11
			9	SS	29		249				
							248				
							247				

Continued Next Page

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR1-3 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 763.1 E 309 750.7, Station 10+070, 25m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.04 - 2008.03.04 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
245.6	**SAND** and **SILT**, some clay to clayey, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/.150		246				0 13 66 21
11.0	END OF BOREHOLE AT 10.9m. BOREHOLE OPEN AND WATER LEVEL AT 1.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

20
15 ⊕ 5
10 (%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR2-1 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 837.7 E 309 753.3, Station 10+120, 30m Lt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.04 - 2008.03.04 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
256.2 / 0.0	**TOPSOIL**: (500mm)	1	SS	3				
255.7 / 0.5	**SAND** and **SILT**, some clay, trace gravel, occasional oxide staining Compact to Dense Brown Moist (TILL)	2	SS	17				
		3	SS	20	0	33	54	13
		4	SS	40				
	Grey	5	SS	42				
	Clayey	6	SS	15	1	23	55	21
	Wet	7	SS	25				
		8	SS	32				
		9	SS	28	1	29	52	18

STRAT PLOT
GROUND WATER CONDITIONS
ELEVATION SCALE: 256, 255, 254, 253, 252, 251, 250, 249, 248, 247

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

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

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

Continued Next Page

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR2-1 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 837.7 E 309 753.3, Station 10+120, 30m Lt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.04 - 2008.03.04 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Compact Grey (TILL)						246				
			10	SS	26				o		
244.9							245				
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN AND WATER LEVEL AT SURFACE UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS:										

DATE	DEPTH (m)	ELEV. (m)
2008.03.07	3.3	252.9
2008.03.20	2.2	254.0
2008.04.18	0.3	255.9
2008.06.30	0.7	255.5
2008.07.29	0.7	255.5
2008.10.24	0.7	255.5
2008.11.28	0.7	255.5
2009.02.06	0.7	255.5
2009.02.20	0.6	255.6
2009.03.20	0.6	255.6
2009.04.22	0.7	255.5
2009.05.15	0.7	255.5
2009.06.05	1.1	255.1
2009.07.29	0.2*	256.4
2009.08.05	0.4*	256.6
2009.09.21	0.8*	257.0

* (above ground surface)

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

(%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 11/24/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR2-2 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 857.3 E 309 746.3, Station 10+115, 10m Lt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.28 - 2008.02.28 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.4											
0.0 / 255.9	**TOPSOIL:** (500mm)		1	SS	5		256				
0.5 / 255.6	Clayey **SILT**, some sand to sandy, trace gravel, occasional rootlets										
0.8	Stiff Brown		2	SS	10		255				
	SAND and **SILT**, trace to some clay, trace gravel, occasional oxide staining Compact Brown Moist (TILL)		3	SS	11		254				
	Wet		4	SS	20		253				
			5	SS	23		252				3 35 49 13
			6	SS	10	▽	251				
			7	SS	29		250				
			8	SS	11		249				3 30 63 4
			9	SS	21		248				
							247				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR2-2 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 857.3 E 309 746.3, Station 10+115, 10m Lt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.28 - 2008.02.28 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR	SA	SI	CL
	Continued From Previous Page														
	SAND and **SILT**, trace clay Compact to Very Dense Grey Moist (TILL)						246								
			10	SS	27		245		o		0	18	77	5
243.6			11	SS	51		244		o						
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 12.8m AND WATER LEVEL AT 5.2m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLE PLUG TO SURFACE.														

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

$\begin{matrix}20\\15\\10\end{matrix}$ 5 (%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR2-3 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 877.1 E 309 738.6, Station 10+108, 10m Rt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.28 - 2008.02.28 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.8											
0.0 / 256.4	**TOPSOIL:** (500mm)		1	SS	3				○		
0.5 / 256.1	Clayey **SILT**, some sand, trace gravel, occasional rootlets										
0.8	Soft Brown		2	SS	14		256		○		
	SAND and **SILT**, trace clay, trace gravel, occasional oxide lenses Compact Brown Moist (TILL)		3	SS	27		255		○		
			4	SS	18		254		○		
	Grey Moist		5	SS	11		253		⊢		1 17 78 4
	Loose		6	SS	8		252		○		
			7	SS	11		251		⊢		1 32 62 5
			8	SS	16		250 249		○		
	Wet		9	SS	19		248 247		○		

Continued Next Page

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR2-3 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 877.1 E 309 738.6, Station 10+108, 10m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.02.28 - 2008.02.28 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, trace gravel, trace clay Compact to Dense Grey Moist (TILL)										
			10	SS	17		246		O		0 42 54 4
							245				
244.0			11	SS	31				O		
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 12.8m AND WATER LEVEL AT 5.7m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE — DEPTH (m) — ELEV. (m) 2008.03.07 — 2.7 — 254.1 2008.03.20 — 1.1 — 255.7 2008.04.18 — Ground surface — 256.8 2008.06.30 — 0.7 — 256.1 2008.07.29 — 0.7 — 256.1 2008.10.24 — 0.7 — 256.1 2008.11.28 — 0.8 — 256.0 2009.02.06 — 0.7 — 256.1 2009.02.20 — 0.7 — 256.1 2009.03.20 — 0.7 — 256.1 2009.04.22 — 0.6 — 256.2 2009.05.15 — 0.7 — 256.1 2009.06.05 — 1.0 — 255.8 2009.07.29 — 0.2* — 257.0 2009.08.05 — 0.9* — 257.7 2009.09.21 — 0.2 — 256.6 * (above ground surface)										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 11/24/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR2-4 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 899.7 E 309 732.2, Station 10+092, 30m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.03 - 2008.03.03 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.5											
0.0 / 255.0	**TOPSOIL:** (500mm)		1	SS	5						
0.5 / 254.3	Clayey **SILT**, trace to some sand, occasional roots, oxide staining Firm Brown		2	SS	6	▽	255				
1.2	**SAND** and **SILT**, some clay, trace gravel Compact Brown Moist (TILL)		3	SS	17		254				
			4	SS	27		253				1 31 53 15
			5	SS	17						1 36 50 13
							252				
	Grey		6	SS	13		251				
							250				
			7	SS	18		249				1 28 55 16
							248				
			8	SS	16		247				
			9	SS	18		246				3 41 43 13

Continued Next Page

+ ³, × ³ Numbers refer to Sensitivity

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR2-4 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 899.7 E 309 732.2, Station 10+092, 30m Rt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.03.03 - 2008.03.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Compact Grey Wet (TILL)						245				
			10	SS	26				o		
							244				
			11	SS	27		243		⊳		1 15 66 18
							242				
241.2	Dense		12	SS	36				o		
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN AND WATER LEVEL AT 1.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR3-1 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 957.8 E 309 742.3, Station 32+786, 65m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.03 - 2008.03.03 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: UNCONFINED, FIELD VANE, QUICK TRIAXIAL, LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.4											
0.0 / 254.9	**TOPSOIL:** (500mm)		1	SS	5		255				
0.5 / 254.6	Clayey **SILT**, some sand, trace gravel, occasional oxide staining										
0.8	Stiff to Very Stiff Brown		2	SS	15		254				
	SAND and **SILT**, some clay, trace gravel Compact to Dense Brown Moist (TILL)		3	SS	20						
			4	SS	20		253				
			5	SS	11		252				
	Grey		6	SS	16		251				1 30 54 15
			7	SS	44		250				
			8	SS	13		249				1 34 52 13
			9	SS	22		248				0 53 40 7
							247				
							246				

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Continued Next Page

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR3-1 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 957.8 E 309 742.3, Station 32+786, 65m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.03 - 2008.03.03 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Dense Grey Moist (TILL)						245				
	Wet		10	SS	39		244		○		
			11	SS	37		243		○		
							242				
241.0			12	SS	32				⊢●		0 26 55 19
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN TO 13.5m AND WATER LEVEL AT 2.0m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.03.07 2.5 252.9 2008.03.20 1.5 253.9 2008.04.18 Ground surface 255.4 2008.06.30 0.8 254.6 2008.07.29 0.8 254.6 2008.10.24 0.8 254.6 2008.11.28 0.8 254.6 2009.02.06 0.8 254.6 2009.02.20 0.7 254.5 2009.03.20 0.7 254.5 2009.04.22 0.7 254.5 2009.05.15 0.7 254.5 2009.06.05 1.1 254.3 2009.07.29 0.2* 255.6 2009.08.05 0.9* 256.3 2009.09.02 0.9* 256.3 2009.09.21 0.4* 255.8 * (above ground surface)										

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

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

ONTMT4S 0596.GPJ 11/24/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR3-2 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 980.1 E 309 763.6, Station 32+794, 40m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.02.27 - 2008.02.27 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O 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
255.5											
0.0 / 255.2	**TOPSOIL:** (400mm)		1	SS	4	▽	255				
0.4 / 254.7	Clayey **SILT**, some sand, trace gravel Soft Brown										
0.8	**SAND** and **SILT**, some clay, trace gravel Loose to Compact Brown Moist (TILL)		2	SS	8		254				
			3	SS	13						1 32 50 17
			4	SS	13		253				
			5	SS	14		252				
	Grey		6	SS	28		251				
			7	SS	20		250				2 37 50 11
							249				
	Very Loose Wet		8	SS	0		248				
	Moist Dense		9	SS	36		247				
							246				

Continued Next Page

+³ ×³ Numbers refer to Sensitivity

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR3-2 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 980.1 E 309 763.6, Station 32+794, 40m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.02.27 - 2008.02.27 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O 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
	Continued From Previous Page										
	SAND and **SILT**, some gravel, some clay Dense Grey Moist (TILL) layer of silty sand (600mm)						245				
			10	SS	40				o		14 58 28 (SI+CL)
							244				
242.7	Compact		11	SS	21		243		ϕ		1 31 53 15
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN AND WATER LEVEL AT 0.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR3-3 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 988.6 E 309 787.5, Station 32+800, 15m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.02.26 - 2008.02.26 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (UNCONFINED, QUICK TRIAXIAL, FIELD VANE, LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.8								20 40 60 80 100	20 40 60		
0.0 / 255.5	**TOPSOIL:** (300mm)										
0.3	Clayey **SILT**, some sand, trace gravel, occasional roots Firm to Stiff Brown		1	SS	4						
			2	SS	7		255				
254.4											
1.4	**SAND** and **SILT**, some clay Compact Brown Moist (TILL)		3	SS	22		254				
			4	SS	27						
	Wet Very Dense		5	SS	50/.150		253				
							252				
	Clayey Compact Grey		6	SS	14		251				1 20 56 23
							250				
			7	SS	20						
							249				
			8	SS	26		248				0 19 61 20
							247				
	Very Loose		9	SS	1						
							246				

Continued Next Page

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR3-3 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 988.6 E 309 787.5, Station 32+800, 15m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.02.26 - 2008.02.26 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	SAND and **SILT**, trace to some clay, trace gravel Dense Grey Moist (TILL) Layer of silty sand (600mm)										0 62 38 (SI+CL)
			10	SS	40		245		○		
							244				
			11	SS	34				○		
							243				
							242				
241.5									○		1 39 49 11
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN AND WATER LEVEL AT 0.9m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.02.28 3.2 252.6 2008.03.07 2.9 252.9 2008.03.20 0.3 255.5 2008.04.18 Ground surface 255.8 2008.06.30 0.9 254.9 2008.07.29 0.5 255.3 2008.10.24 1.3 254.5 2008.11.28 1.4 254.4 2009.02.06 1.2 254.6 2009.02.20 1.2 254.6 2009.03.20 1.1 254.7 2009.04.22 1.0 254.8 2009.05.15 1.1 254.7 2009.06.05 1.6 254.2 2009.07.29 0.4* 256.2 2009.08.05 0.9* 256.7 2009.09.02 0.8* 256.6 2009.09.21 0.6* 256.4 * (above ground surface)										

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

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

ONTMT4S 0596.GPJ 11/24/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR3-4 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 993.1 E 309 812.0, Station 32+808, 10m Rt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.26 - 2008.02.26 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.7											
0.0 / 255.3	**TOPSOIL:** (300mm)										
0.3	Clayey **SILT**, trace gravel, occasional roots		1	SS	4				o		
254.9	Firm to Stiff						255				
0.8	Brown										
	SAND and **SILT**, some clay, trace gravel		2	SS	9				o		
	Loose to Compact										
	Brown										
	Moist										
	(TILL)		3	SS	12	▽	254		o		
			4	SS	11		253		o		
	Cobbles at 3.20 to 3.25m		5	SS	14		252		o		
	Grey		6	SS	13		251		o		
	Clayey						250				
	Wet		7	SS	20		249		⊕		3 24 51 22
			8	SS	12		248		o		
			9	SS	12		247		o		
							246				

Continued Next Page

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR3-4 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 888 993.1 E 309 812.0, Station 32+808, 10m Rt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.26 - 2008.02.26 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O 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
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Compact to Very Dense Grey Wet (TILL)						245				
			10	SS	18				o		
							244				
			11	SS	42				o		2 21 58 19
							243				
							242				
241.3			12	SS	59				o		
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN AND WATER LEVEL AT 2.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.6m THEN AUGER CUTTINGS TO SURFACE.										

$+^{3}$. $\times^{3}$. Numbers refer to Sensitivity

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR3-5 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 014.4 E 309 833.5, Station 32+815, 35m Lt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.25 - 2008.02.25 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.0											
0.0 / 254.6	**TOPSOIL:** (500mm)		1	SS	2						
0.5 / 253.8	Clayey **SILT**, trace gravel, occasional oxide staining Soft to Stiff Brown		2	SS	9						
1.2	**SAND** and **SILT**, some clay to clayey, trace gravel Compact to Dense Brown Moist (TILL)		3	SS	31						
			4	SS	11						2 25 53 20
			5	SS	18						
			6	SS	19						
			7	SS	16						2 26 54 18
	Grey Wet		8	SS	13						
	Very Stiff		9	SS	15						0 28 52 20

Continued Next Page

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

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

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No QSR3-5 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 014.4 E 309 833.5, Station 32+815, 35m Lt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.25 - 2008.02.25 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, trace gravel Grey Moist (TILL)						245				
243.9			10	SS	100/.150		244		o		
11.1	END OF BOREHOLE AT 11.1m. BOREHOLE OPEN AND WATER LEVEL AT 0.8m UPON COMPLETION. Piezometer installation consists of 19mm diameter schdule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS:										

DATE	DEPTH (m)	ELEV. (m)
2008.02.28	3.0	252.0
2008.03.07	2.5	252.5
2008.03.20	0.9	254.1
2008.04.18	Ground surface	255.0
2008.06.30	1.2	253.8
2008.07.29	1.2	253.8
2008.10.24	1.8	253.2
2008.11.28	1.8	253.2
2009.02.06	1.7	253.3
2009.02.20	1.6	253.4
2009.03.20	1.4	253.6
2009.04.22	1.2	253.8
2009.05.15	1.3	253.7
2009.06.05	1.8	253.2
2009.07.29	0.3*	255.3
2009.08.05	0.9*	255.9
2009.09.02	1.0*	256.0
2009.09.21	0.7*	255.7

* (above ground surface)

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

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

ONTMT4S 0596.GPJ 11/24/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR4-1 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 148.9 E 309 855.8, Station 10+088, 50m Lt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.07 - 2008.03.07 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
253.7											
0.0	Silty **CLAY**, trace sand, trace gravel, trace organics and topsoil Firm Dark Brown (FILL)		1	SS	4				○		
			2	SS	5	▽	253		○		
252.2											
1.5	**SAND** and **SILT**, some clay to clayey, trace gravel, occasional oxide staining Loose to Dense Brown Moist (TILL)		3	SS	8		252		○		
			4	SS	16				⊢○⊣		1 25 54 20
			5	SS	42		251		○		
	Grey		6	SS	34		250				
			7	SS	25		249		⊢○⊣		1 40 44 15
	Wet		8	SS	24		248		○		
	Very Dense Moist		9	SS	73		247		○		
							246				
							245				
							244				

Continued Next Page

+ ³ . × ³ : Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR4-1 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 148.9 E 309 855.8, Station 10+088, 50m Lt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.07 - 2008.03.07 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)						243				
			10	SS	100/ .150				o		1 22 60 17
							242				
240.9			11	SS	82				o		
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 12.8m AND WATER LEVEL AT 1.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLE PLUG TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR4-2 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 123.9 E 309 859.4, Station 10+084, 25m Lt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.03.07 - 2008.03.07 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
254.9											
0.0	Silty **CLAY**, trace sand, trace gravel, some topsoil, occasional rootlets Firm Dark Brown (FILL)		1	SS	6						
254.2											
0.6	**SAND** and **SILT**, some clay, trace gravel, occasional oxide staining Loose to Compact Brown Moist (TILL)		2	SS	9		254				
			3	SS	20		253				
	Dense to Compact		4	SS	50		252				1 29 52 18
			5	SS	25						
	Grey Wet						251				
			6	SS	26		250				
							249				
			7	SS	31						1 26 56 17
							248				
			8	SS	27		247				
	Moist						246				
			9	SS	42						2 35 52 11
							245				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR4-2 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 123.9 E 309 859.4, Station 10+084, 25m Lt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.03.07 - 2008.03.07 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Dense to Very Dense Grey Moist (TILL)										
			10	SS	50		244		○		
243.6											
11.3	END OF BOREHOLE AT 11.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2008.03.20	3.3	251.6
2008.04.18	2.5	252.4
2008.06.30	1.0	253.9
2008.07.29	0.8	254.1
2008.10.24	0.9	254.0
2008.11.28	1.0	253.9
2009.02.06	0.9	254.0
2009.02.20	0.9	254.0
2009.03.20	0.8	254.1
2009.04.22	0.8	254.1
2009.05.15	0.9	254.0
2009.06.05	1.3	253.6
2009.07.29	0.1*	255.0
2009.08.05	1.0*	255.9
2009.09.02	0.5*	255.4
2009.09.21	0.3	254.6

* (above ground surface)

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

15 20 5 10 (%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 11/24/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR4-3 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 098.8 E 309 863.0, Station 10+080, centreline ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.03.17 - 2008.03.17 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
257.2											
0.0	**ASPHALT:** (150mm)										
0.2	Gravelly **SAND** Dense Dark Brown Dry (FILL)		1	SS	46		257	o			
256.1			2	SS	19				o		
1.1	Sandy **SILT**, some clay, trace gravel Very Loose to Compact Brown Wet (FILL)					▽	256				
255.3			3a	SS	2				o		
1.8	Silty **CLAY**, some sand, trace gravel, some organics and topsoil Soft to Firm Brown (FILL)		3b	SS					o		
			4	SS	4		255				
	occasional wood fibres		5	SS	6		254		o		
253.0											
4.1	**SAND** and **SILT**, some clay to clayey, trace gravel, occasional oxide staining Compact Grey Moist (TILL)		6	SS	11		253		⊖		1 23 55 21
			7	SS	19		251		o		
	Very Dense		8	SS	74		250		o		7 48 35 10
			9	SS	84		248		o		

Continued Next Page

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR4-3 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 098.8 E 309 863.0, Station 10+080, centreline ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.03.17 - 2008.03.17 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Dense Grey (TILL)						247				
245.9			10	SS	38		246		⊢H		1 33 48 18
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 1.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.2m THEN ASPHALT/ COLD PATCH TO SURFACE.										

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR4-4 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 074.3 E 309 868.5, Station 10+078, 25m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.02.25 - 2008.02.25 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.4											
0.0	Silty **CLAY**, mixed with topsoil, trace sand, occasional rootlets Very soft to firm Brown Moist (FILL)		1	SS	1		255				
			2	SS	4						
	occasional wood fibres		3	SS	4		254				
253.3											
2.1	**SAND** and **SILT**, some clay, trace gravel Compact to Dense Grey Moist (TILL)		4	SS	32		253				
			5	SS	15		252				0 32 50 18
			6	SS	18		251				
			7	SS	37		250				
			8	SS	26		249				0 23 56 21
			9	SS	14		248				
							247				
							246				

Continued Next Page

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

$\begin{matrix}20\\15\oplus5\\10\end{matrix}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR4-4 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 074.3 E 309 868.5, Station 10+078, 25m Rt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.25 - 2008.02.25 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Compact Grey Moist (TILL)						245				
244.2			10	SS	27				H		2 31 49 18
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 10.7m AND WATER LEVEL AT 0.8m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.02.28 3.4 252.0 2008.03.07 3.0 252.4 2008.03.20 0.6 254.8 2008.04.18 Ground surface 255.4 2008.06.30 1.0 254.4 2008.07.10 0.8 254.6 2008.07.29 Ground surface 255.4 2008.08.05 0.8* 256.2 2008.09.02 0.9* 256.3 2008.09.21 0.8* 256.2 * (above ground surface)										

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No QSR4-5 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 049.6 E 309 873.1, Station 10+075, 50m Rt ORIGINATED BY ES
HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2008.02.25 - 2008.02.25 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	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
255.4											
0.0	Clayey **SILT**, mixed with topsoil, trace sand, occasional rootlets Soft to Stiff Brown (FILL)		1	SS	2		255				
254.8 / 0.6	Sandy **SILT**, some clay Loose to Compact Brown Moist (FILL)		2	SS	4	▽					
			3	SS	8		254				
253.0 / 2.4	**SAND** and **SILT**, some clay to clayey, trace gravel, occasional oxide staining Compact Grey (TILL)		4	SS	20		253				
			5	SS	11		252				0 20 58 22
			6	SS	12		251				2 18 44 36
			7	SS	17		250				
			8	SS	14		249				
			9	SS	15		248				
							247				
							246				2 31 49 18

Continued Next Page

+ ³, × ³. Numbers refer to Sensitivity

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No QSR4-5 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 889 049.6 E 309 873.1, Station 10+075, 50m Rt ORIGINATED BY ES

HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2008.02.25 - 2008.02.25 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
244.7	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/ .075		245		o		
10.7	END OF BOREHOLE AT 10.7m. BOREHOLE OPEN AND WATER LEVEL AT 0.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 1.2m THEN AUGER CUTTINGS TO SURFACE.										

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

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

ONTMT4S 0596.GPJ 10/5/09

Appendix B

Laboratory Test Results

(south of Queensville Sideroad)

Culverts 1 to 4

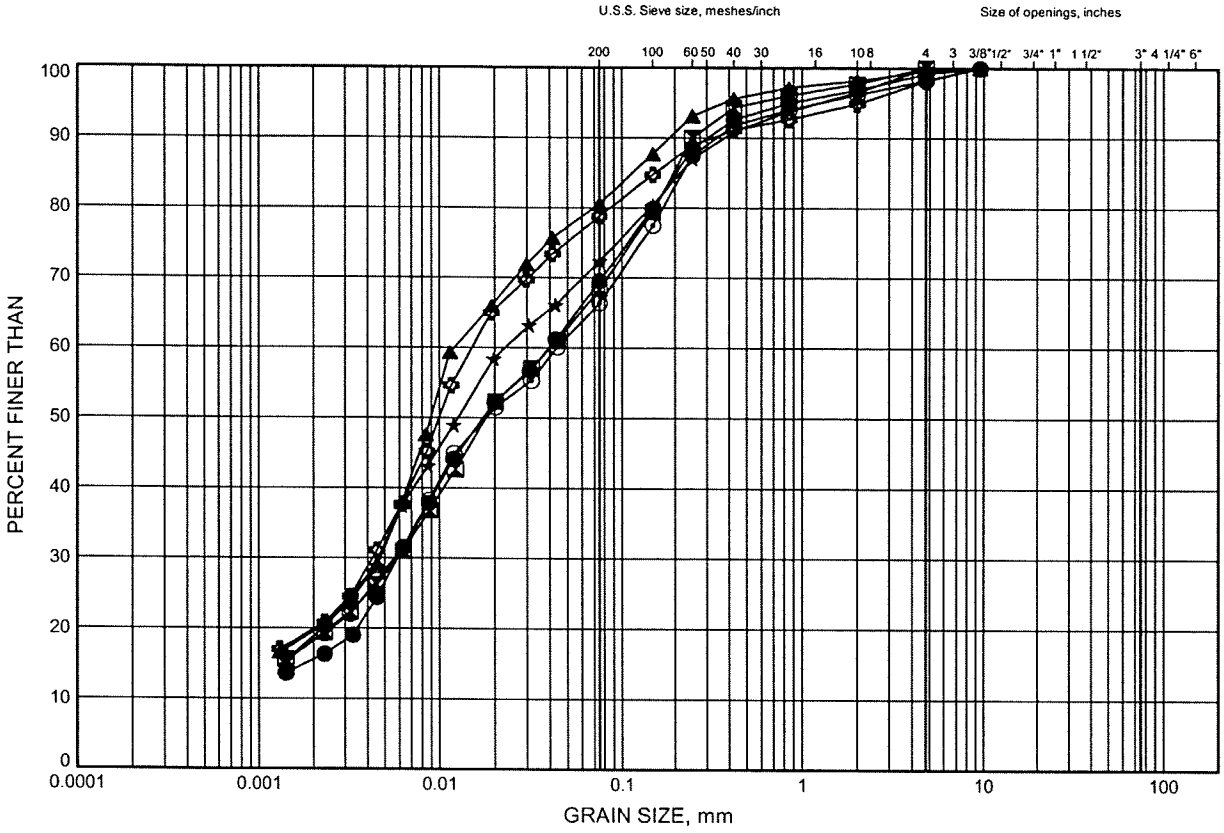
Boreholes QSR1-1 to QSR1-3, QSR2-1 to QSR2-4, QSR3-1 to QSR3-5 and QSR4-1 to QSR4-5

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR1-1	2.59	254.33
⊠	QSR1-1	9.45	247.47
▲	QSR1-1	12.50	244.42
★	QSR1-2	3.35	253.69
⊙	QSR1-2	7.92	249.12
✿	QSR1-2	10.97	246.07

W.P.# 2109-05-00

Prepared By AN

Checked By RPR

THURBER

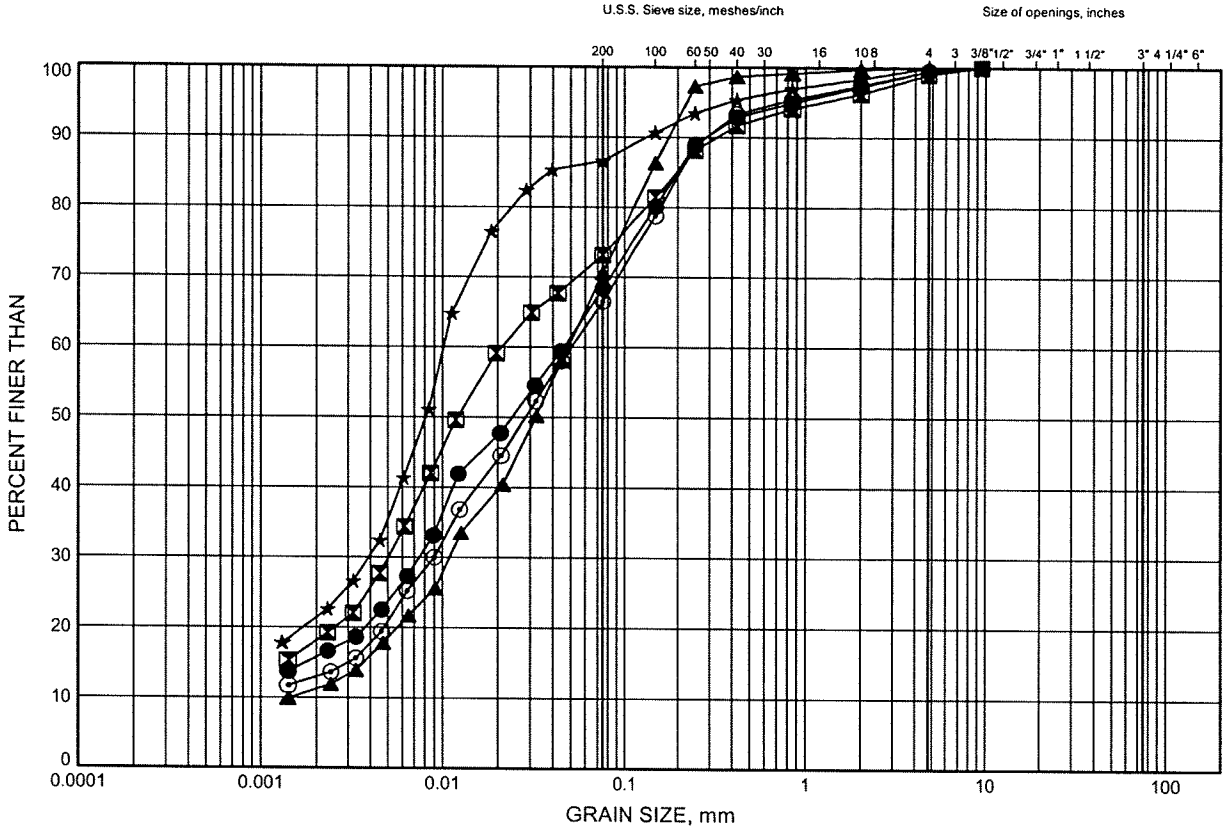
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 10/5/09

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR1-2	12.50	244.54
⊠	QSR1-3	3.35	253.26
▲	QSR1-3	7.92	248.69
★	QSR1-3	10.82	245.79
⊙	QSR2-1	1.83	254.37

W.P.# 2109-05-00

Prepared By AN

Checked By RPR

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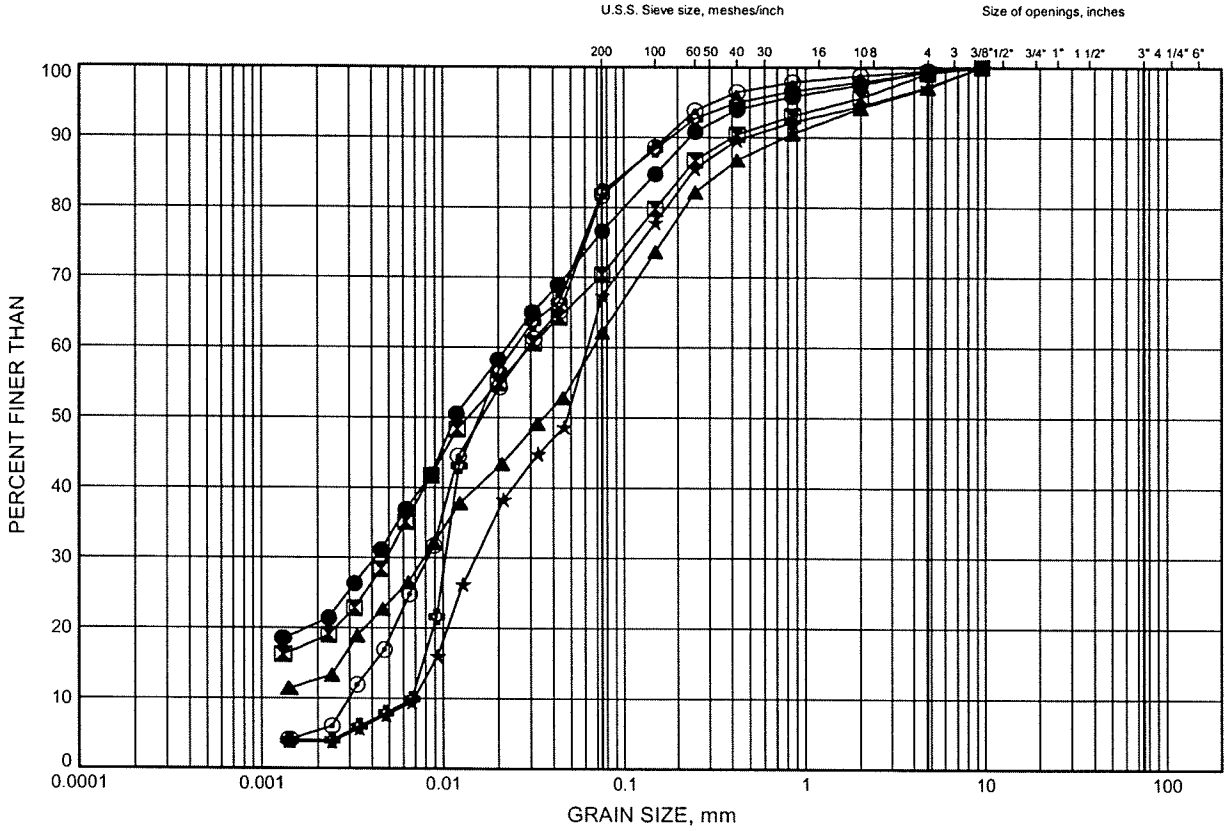
Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR2-1	4.88	251.32
⊠	QSR2-1	9.45	246.75
▲	QSR2-2	3.35	253.01
★	QSR2-2	7.92	248.44
⊙	QSR2-2	10.97	245.39
✿	QSR2-3	3.35	253.48

W.P.# 2109-05-00
Prepared By AN
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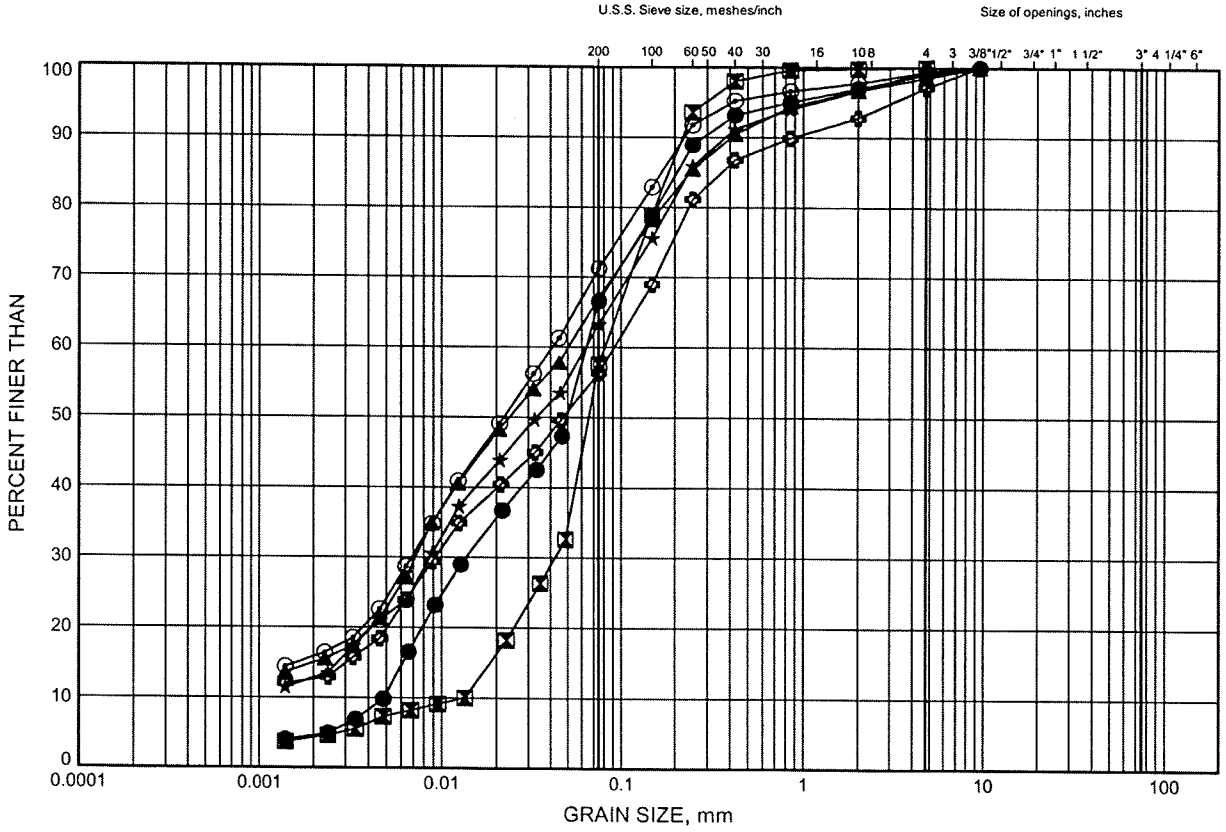
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 10/5/09

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR2-3	6.40	250.43
⊠	QSR2-3	10.97	245.86
▲	QSR2-4	2.59	252.91
★	QSR2-4	3.35	252.15
⊙	QSR2-4	6.40	249.10
✿	QSR2-4	9.45	246.05

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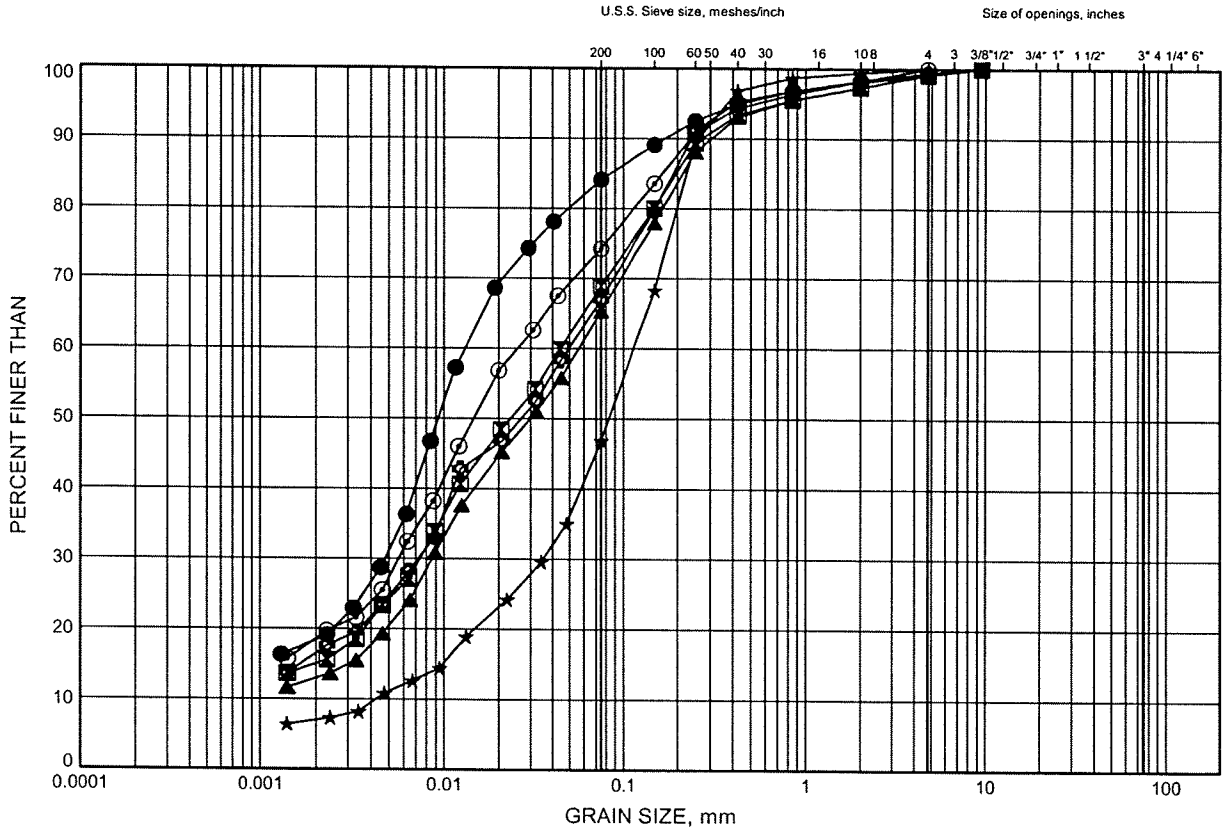
Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR2-4	12.50	243.00
⊠	QSR3-1	4.88	250.49
▲	QSR3-1	7.92	247.45
★	QSR3-1	9.45	245.92
⊙	QSR3-1	14.02	241.35
✿	QSR3-2	1.83	253.68

W.P.# 2109-05-00
Prepared By AN
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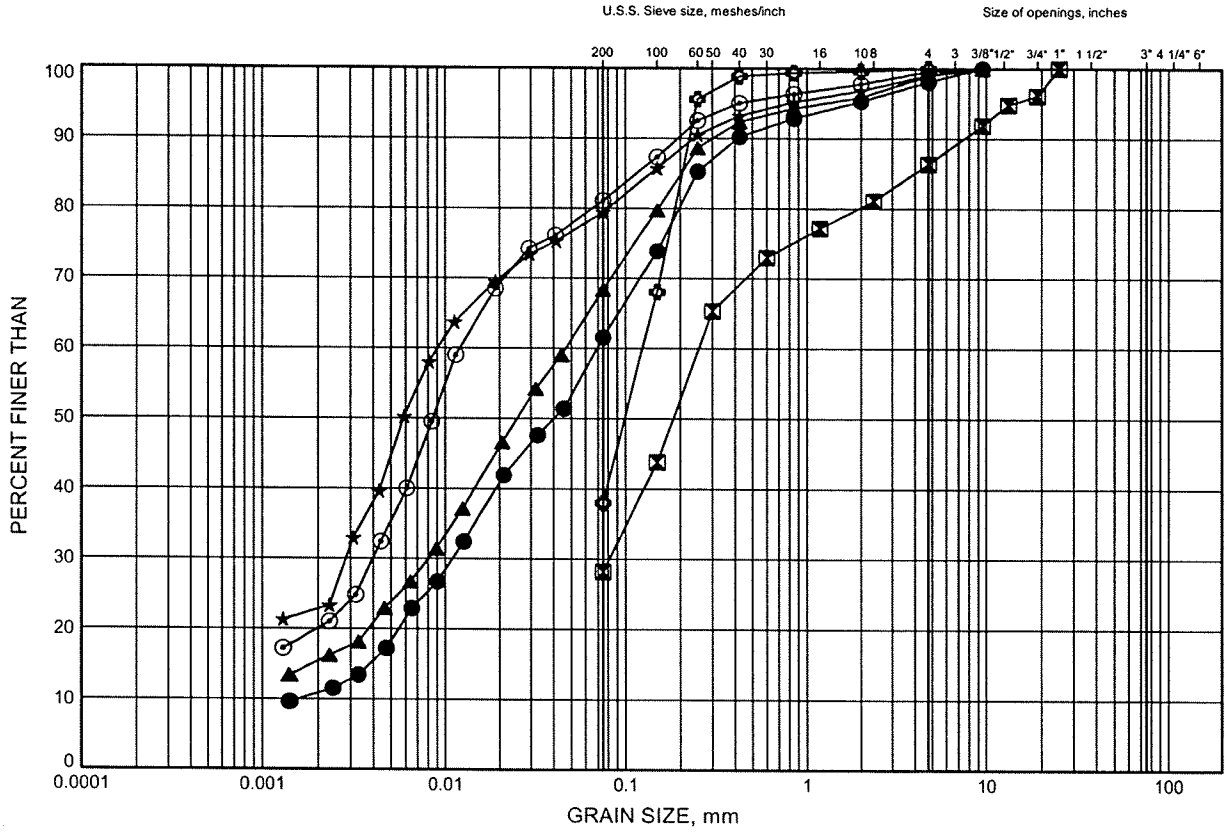
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 10/5/09

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR3-2	6.40	249.11
⊠	QSR3-2	10.60	244.91
▲	QSR3-2	12.50	243.01
★	QSR3-3	4.88	250.96
⊙	QSR3-3	7.92	247.92
✿	QSR3-3	10.60	245.24

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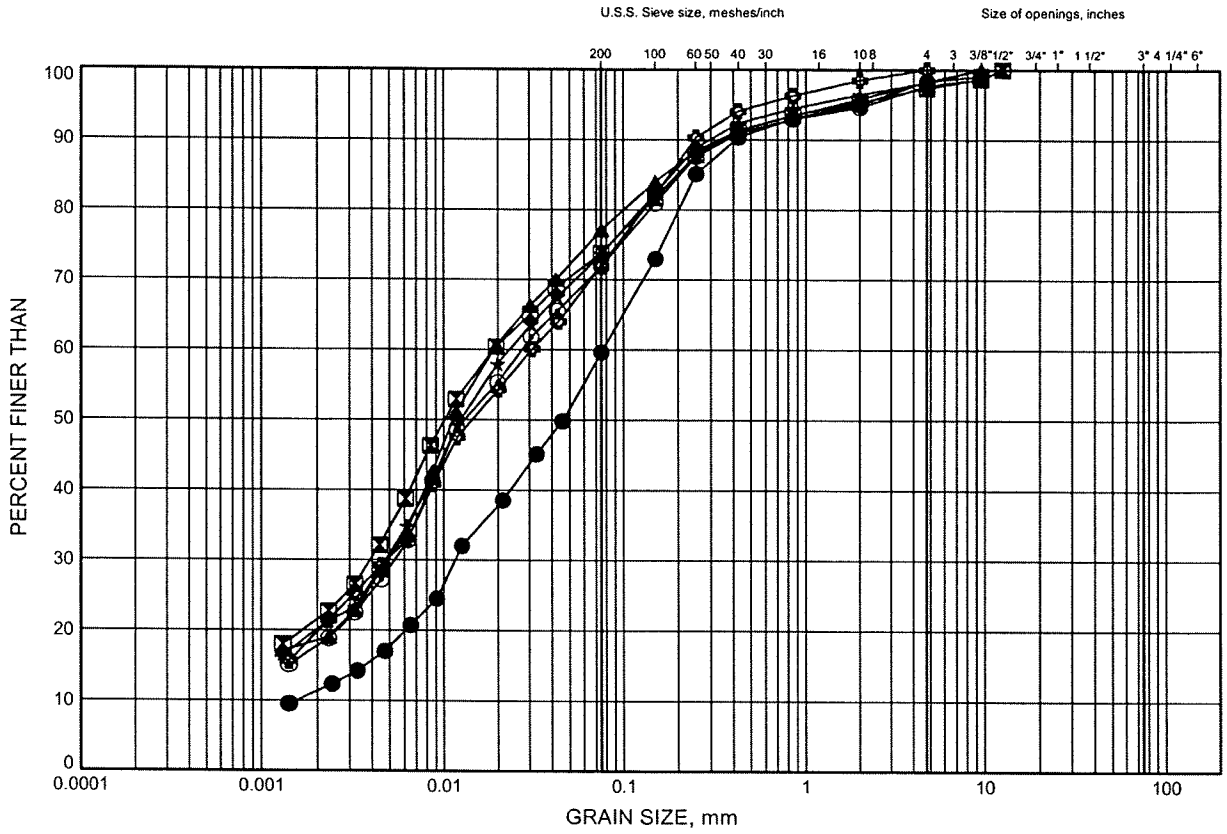
Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B7

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR3-3	14.02	241.82
⊠	QSR3-4	6.40	249.25
▲	QSR3-4	12.50	243.15
★	QSR3-5	2.59	252.44
⊙	QSR3-5	6.40	248.63
✿	QSR3-5	9.45	245.58

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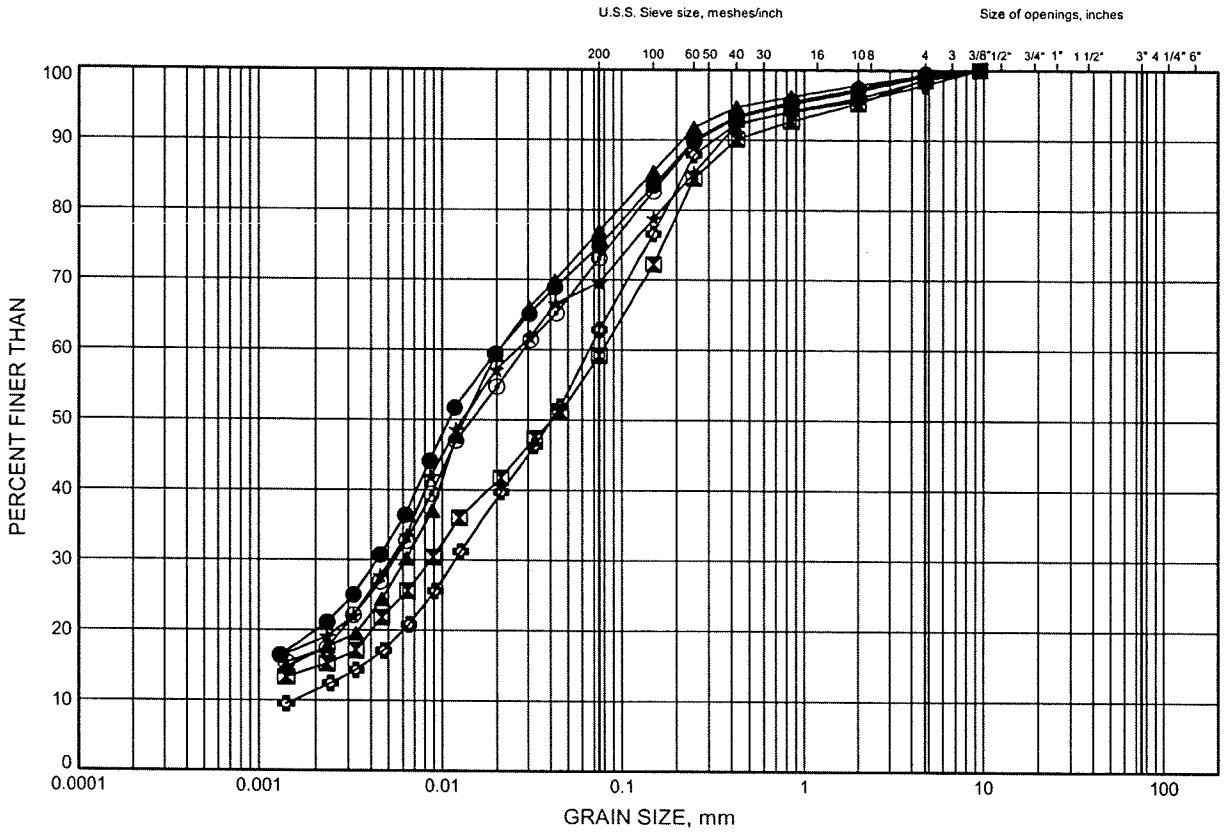
Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B8

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR4-1	2.59	251.15
⊠	QSR4-1	6.40	247.34
▲	QSR4-1	10.90	242.84
★	QSR4-2	2.59	252.26
⊙	QSR4-2	6.40	248.45
✿	QSR4-2	9.45	245.40

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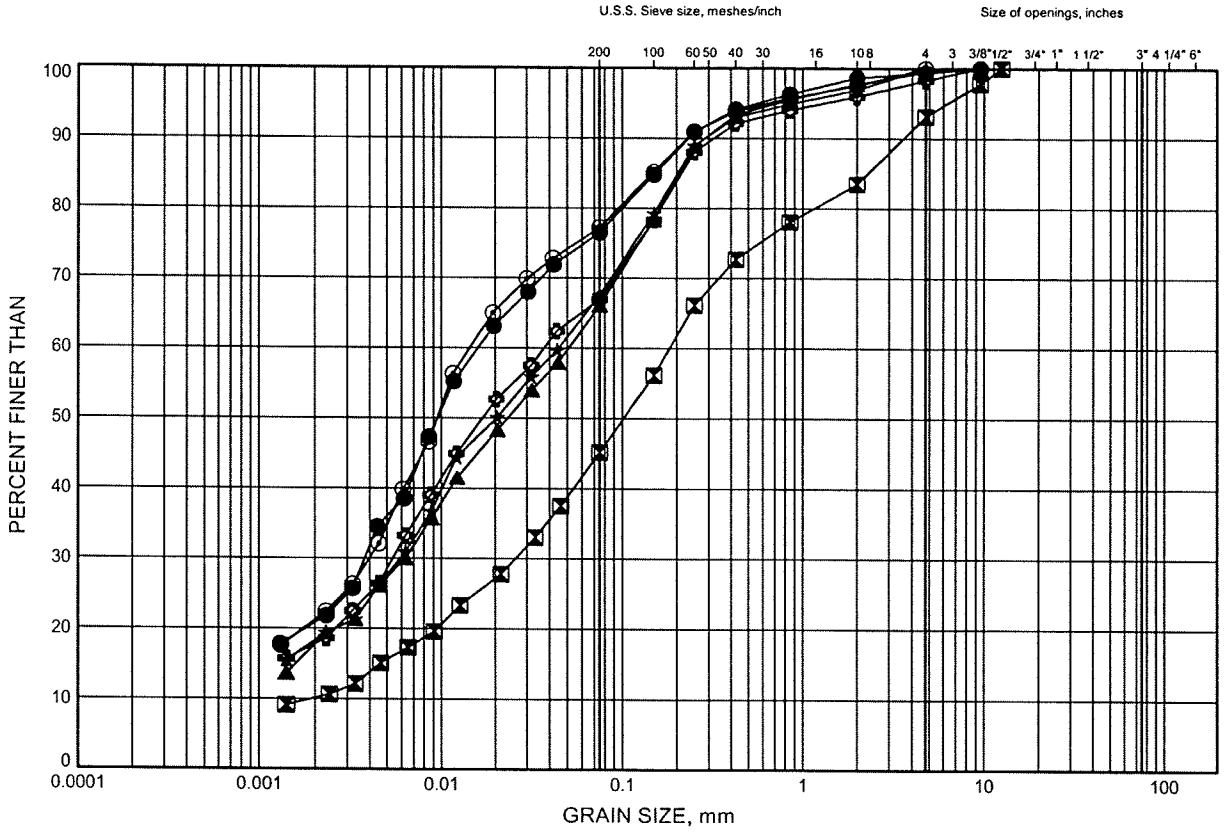
Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B9

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR4-3	4.88	252.27
⊠	QSR4-3	7.92	249.23
▲	QSR4-3	10.97	246.18
★	QSR4-4	3.35	252.08
⊙	QSR4-4	7.92	247.51
✿	QSR4-4	10.97	244.46

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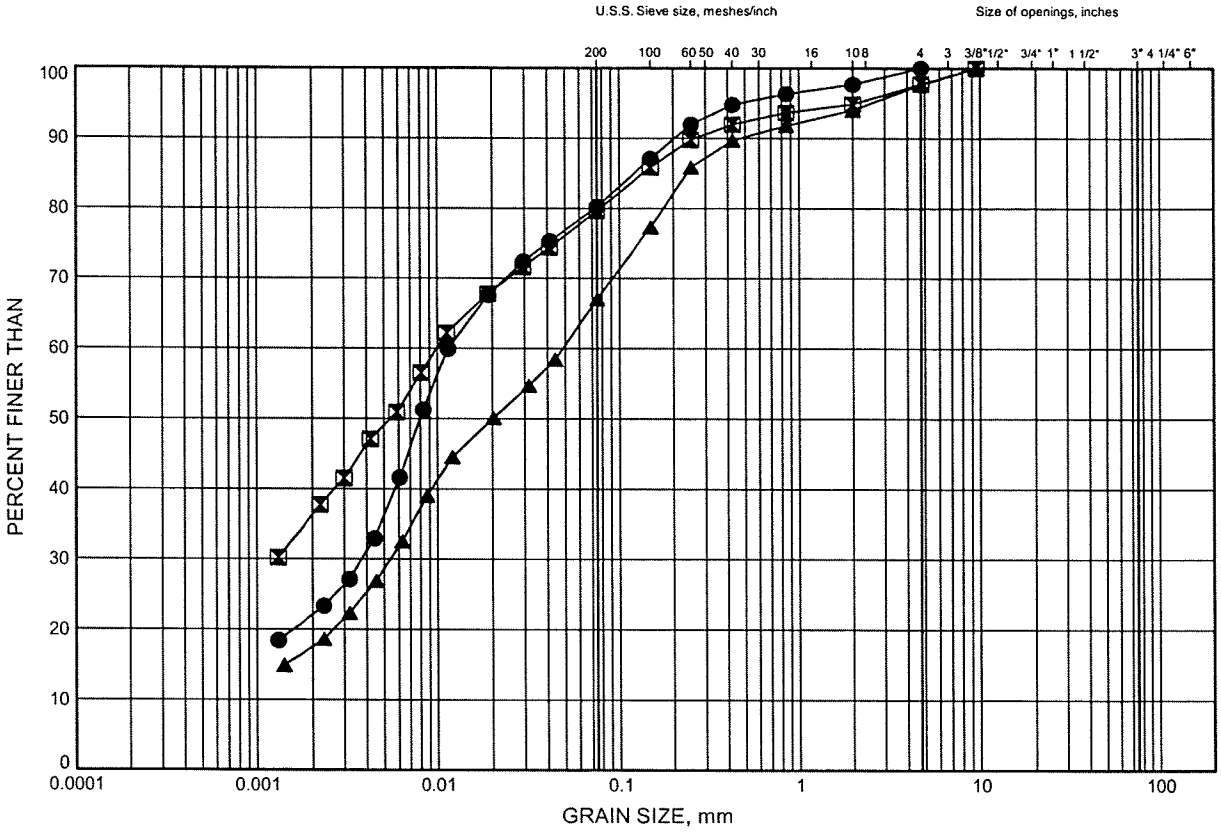
Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE B10

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR4-5	3.35	252.08
⊠	QSR4-5	4.88	250.55
▲	QSR4-5	9.45	245.98

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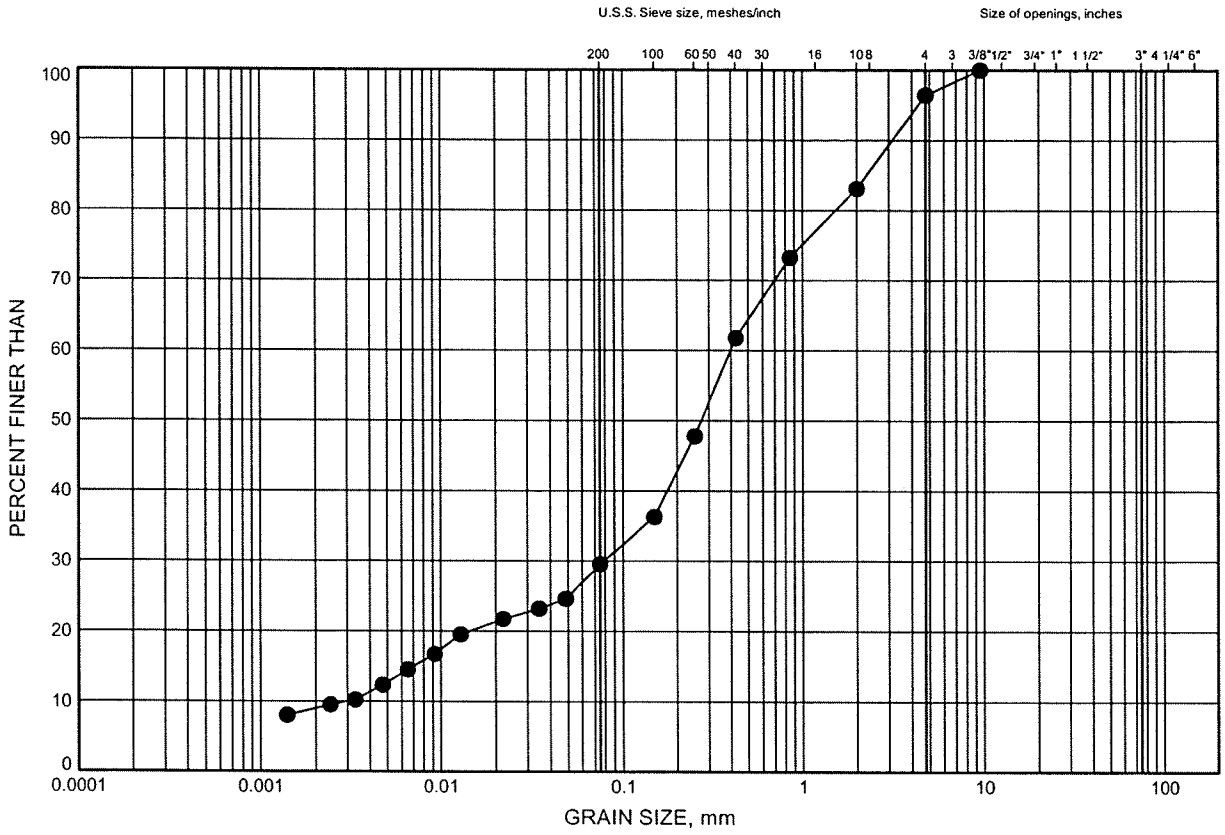
GRAIN SIZE DISTRIBUTION

FIGURE B11

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	QSR1-3	2.59	254.02

W.P.# 2109-05-00
Prepared By AN
Checked By RPR

THURBER

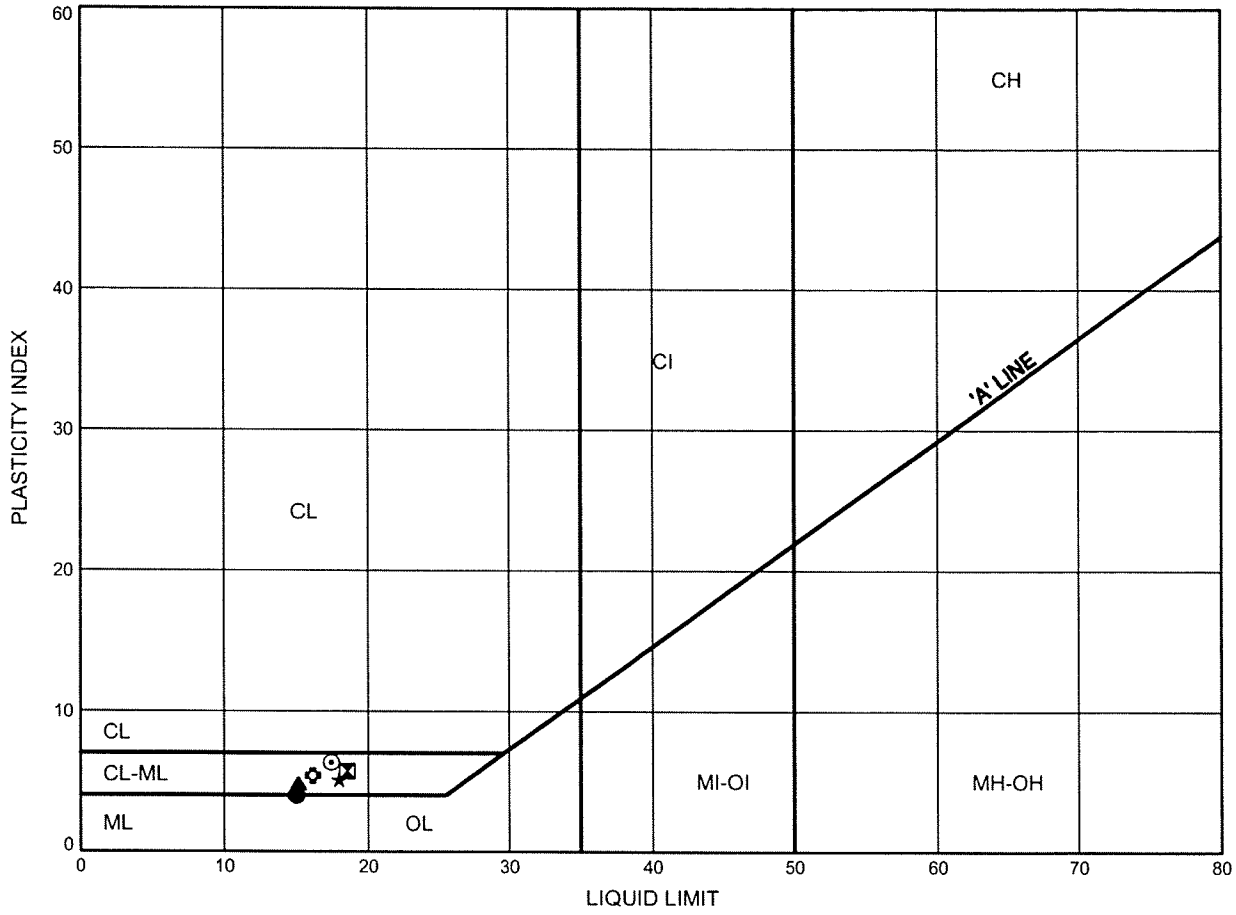
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 10/5/09

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE B12

SAND & SILT TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	QSR1-1	9.45	247.47
⊠	QSR1-2	3.35	253.69
▲	QSR1-2	7.92	249.12
★	QSR1-2	10.97	246.07
⊙	QSR2-1	4.88	251.32
✿	QSR2-1	9.45	246.75

Date October 2009

Project 2109-05-00

THURBER

Prep'd AN

Chkd. RPR

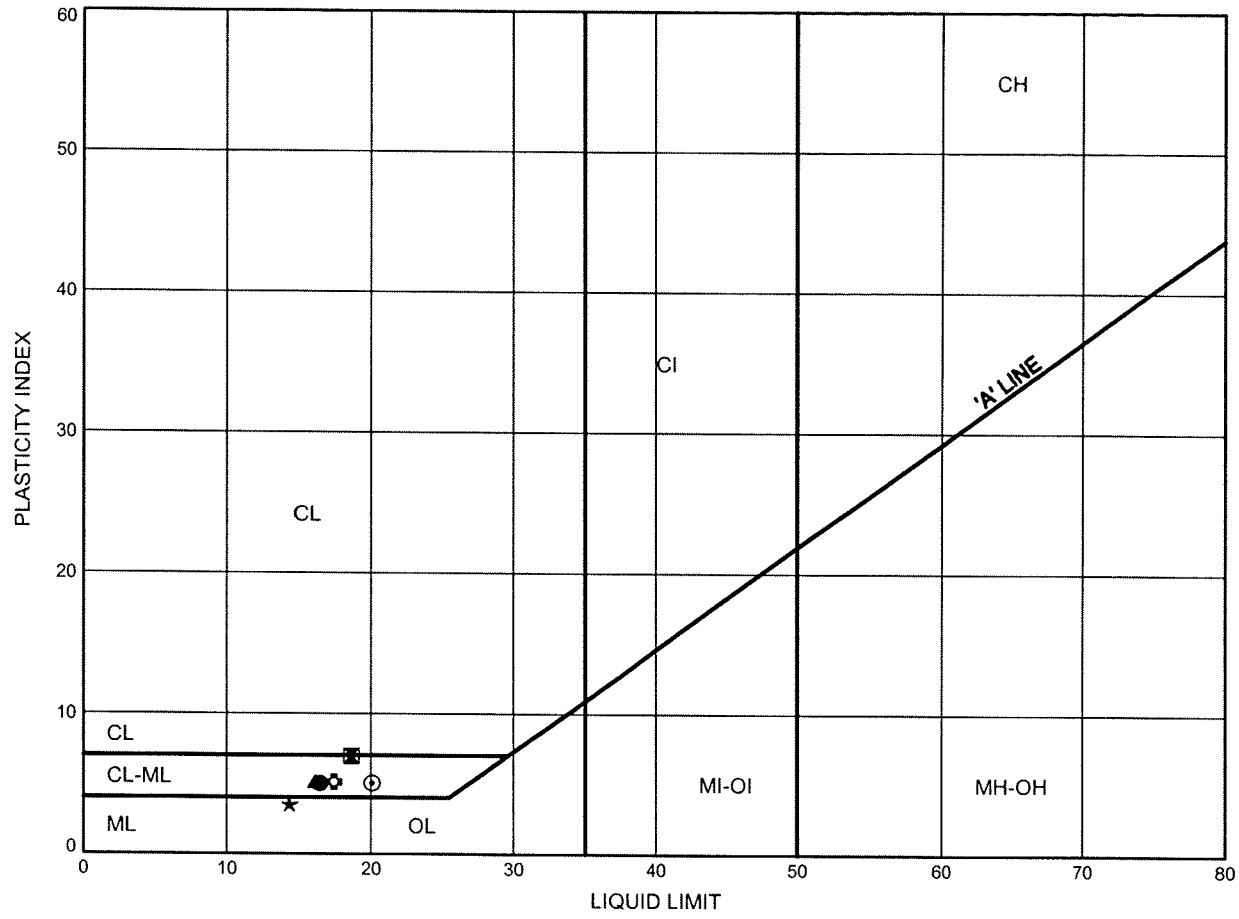
THURBALT 0596.GPJ 10/5/09

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE B13

SAND & SILT TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	QSR2-2	7.92	248.44
⊠	QSR2-3	3.35	253.48
▲	QSR2-3	6.40	250.43
★	QSR2-4	6.40	249.10
⊙	QSR2-4	12.50	243.00
✿	QSR3-1	3.35	252.02

Date October 2009

Project 2109-05-00

THURBER

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Chkd. RPR

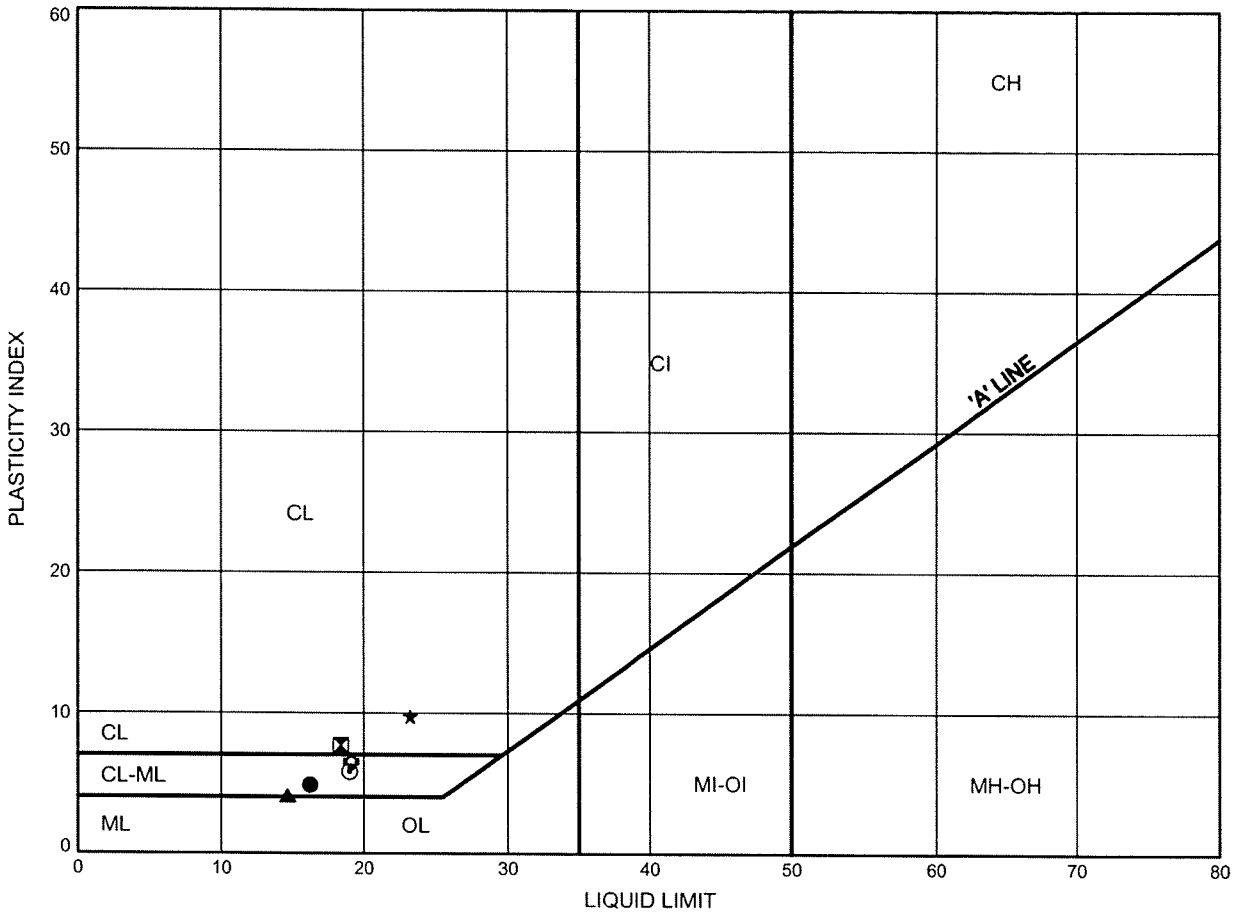
THURBALT 0596.GPJ 10/5/09

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE B14

SAND & SILT TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	QSR3-1	14.02	241.35
⊠	QSR3-2	1.83	253.68
▲	QSR3-2	12.50	243.01
★	QSR3-3	4.88	250.96
⊙	QSR3-3	7.92	247.92
✿	QSR3-4	6.40	249.25

Date October 2009

Project 2109-05-00

THURBER

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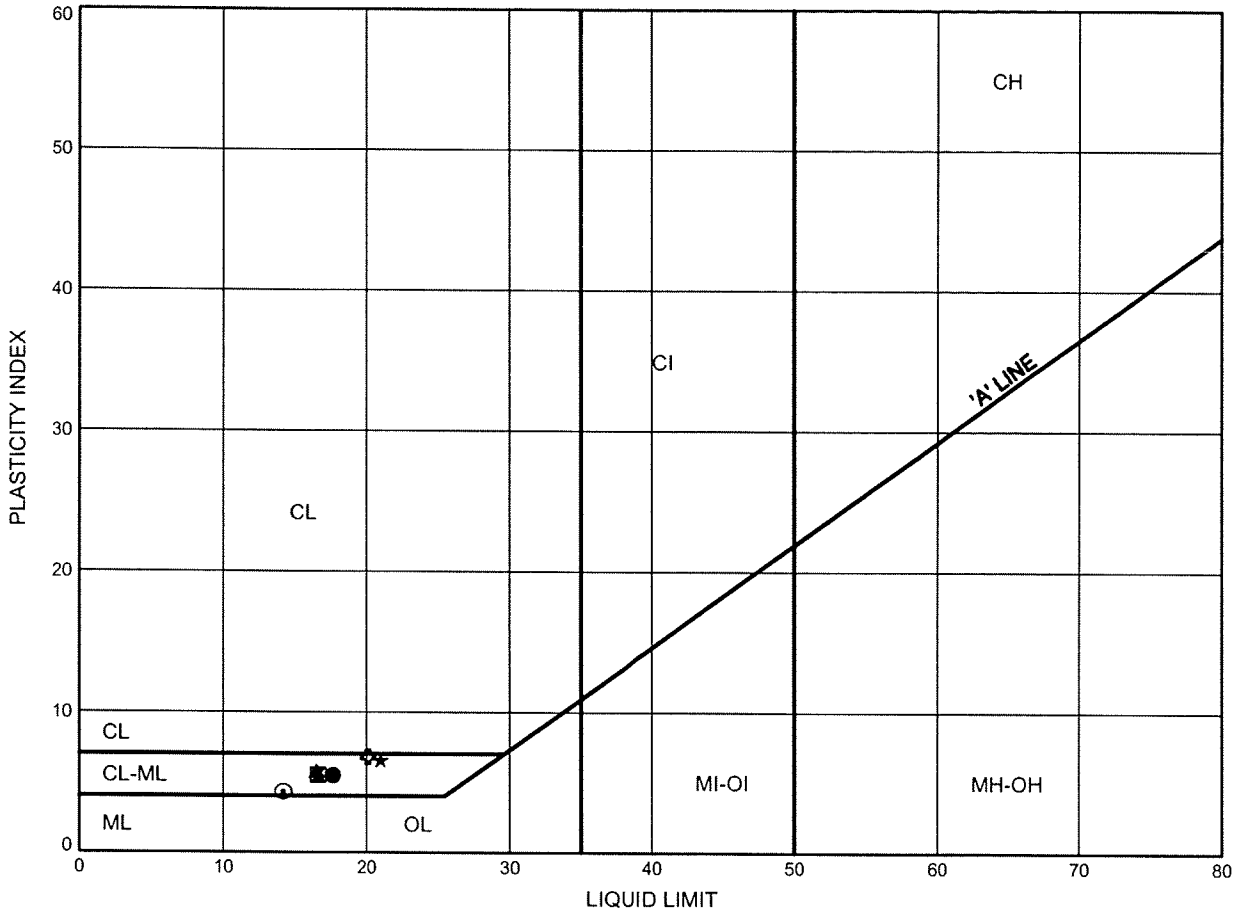
THURBALT 0596.GPJ 10/5/09

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE B15

SAND & SILT TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	QSR3-5	2.59	252.44
⊠	QSR3-5	6.40	248.63
▲	QSR3-5	9.45	245.58
★	QSR4-1	2.59	251.15
⊙	QSR4-1	6.40	247.34
✿	QSR4-2	2.59	252.26

Date October 2009

Project 2109-05-00

THURBER

Prep'd AN

Chkd. RPR

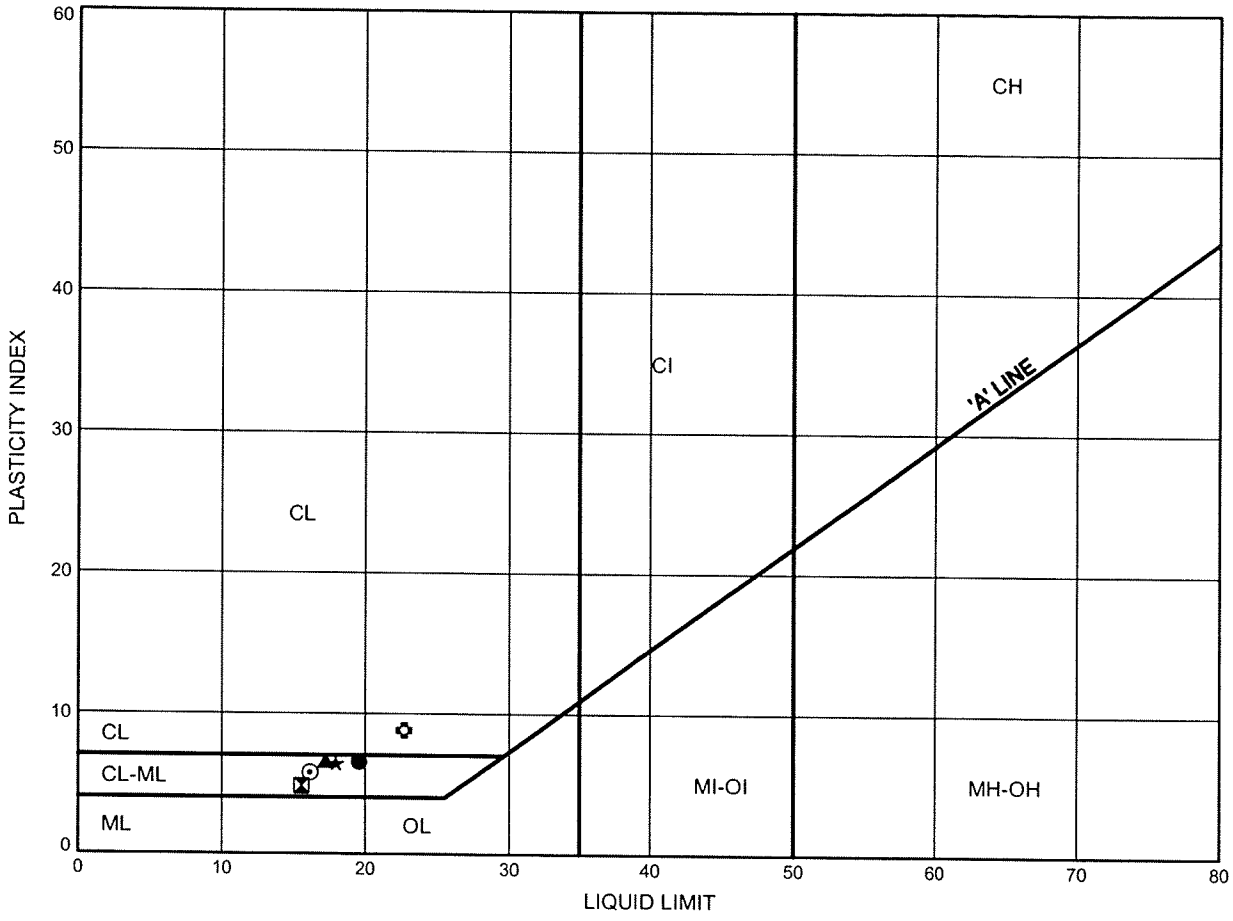
THURBALT 0596.GPJ 10/5/09

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE B16

SAND & SILT TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	QSR4-3	4.88	252.27
⊠	QSR4-3	10.97	246.18
▲	QSR4-4	3.35	252.08
★	QSR4-4	7.92	247.51
⊙	QSR4-4	10.97	244.46
✿	QSR4-5	3.35	252.08

Date October 2009

Project 2109-05-00

THURBER

Prep'd AN

Chkd. RPR

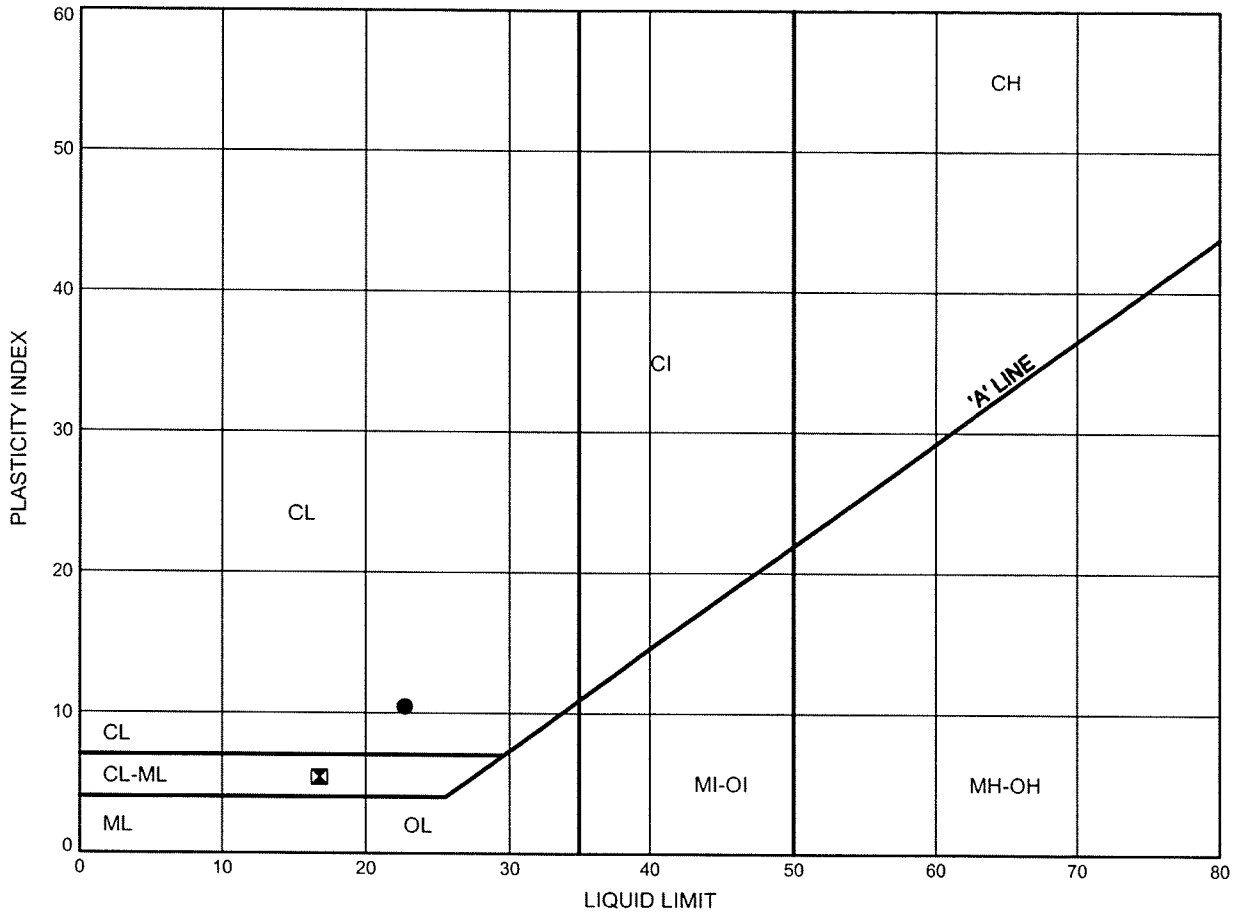
THURBALT 0596.GPJ 10/5/09

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE B17

SAND & SILT TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	QSR4-5	4.88	250.55
⊠	QSR4-5	9.45	245.98

Date October 2009

Project 2109-05-00

THURBER

Prep'd AN

Chkd. RPR

THURBALT 0596.GPJ 10/5/09

Appendix C

Site Photographs

(south of Queensville Sideroad)

Culverts 1 to 4

Boreholes QSR1-1 to QSR1-3, QSR2-1 to QSR2-4, QSR3-1 to QSR3-5 and QSR4-1 to QSR4-5

Photograph 1 – View of north end of existing CPS culvert (north of Queensville Sideroad)

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

Appendix D

Drawing titled "Borehole Locations and Soil Strata"

(south of Queensville Sideroad)

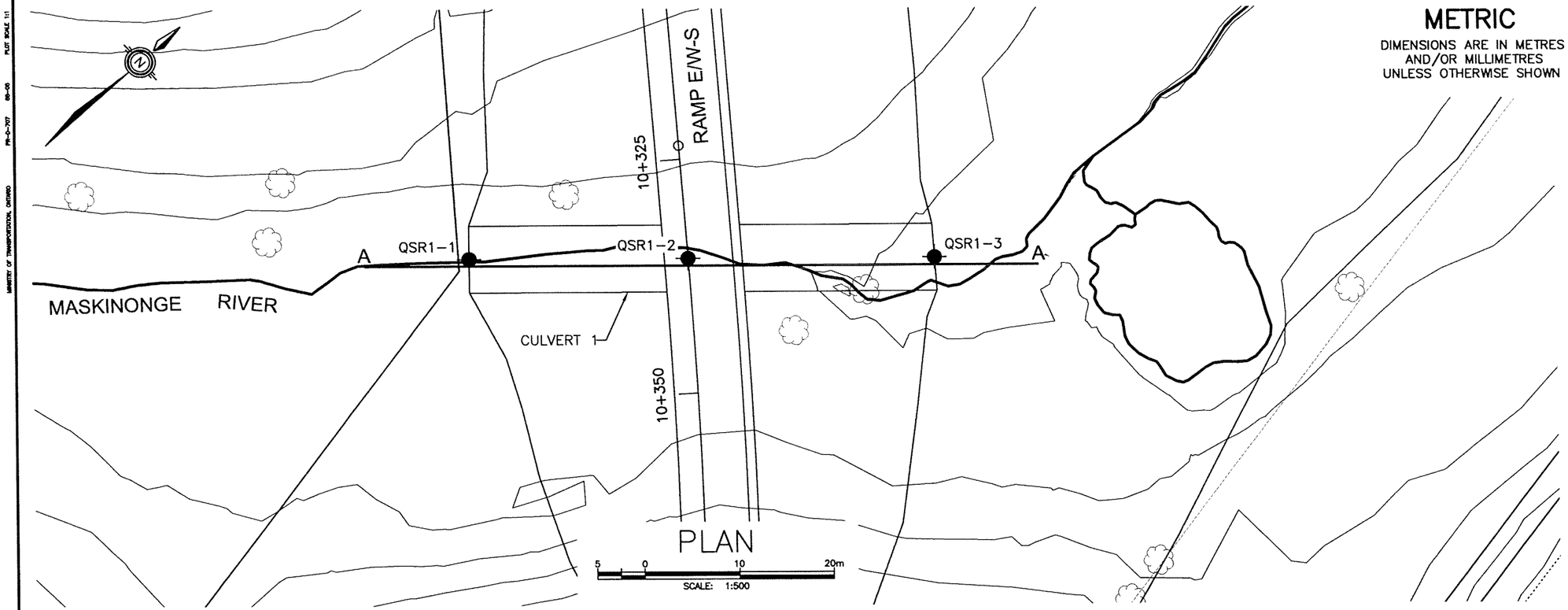
Culverts 1 to 4

Boreholes QSR1-1 to QSR1-3, QSR2-1 to QSR2-4, QSR3-1 to QSR3-5 and QSR4-1 to QSR4-5

MINISTRY OF TRANSPORTATION, ONTARIO
PR-A-707 05-06
PLOT SCALE 1:1

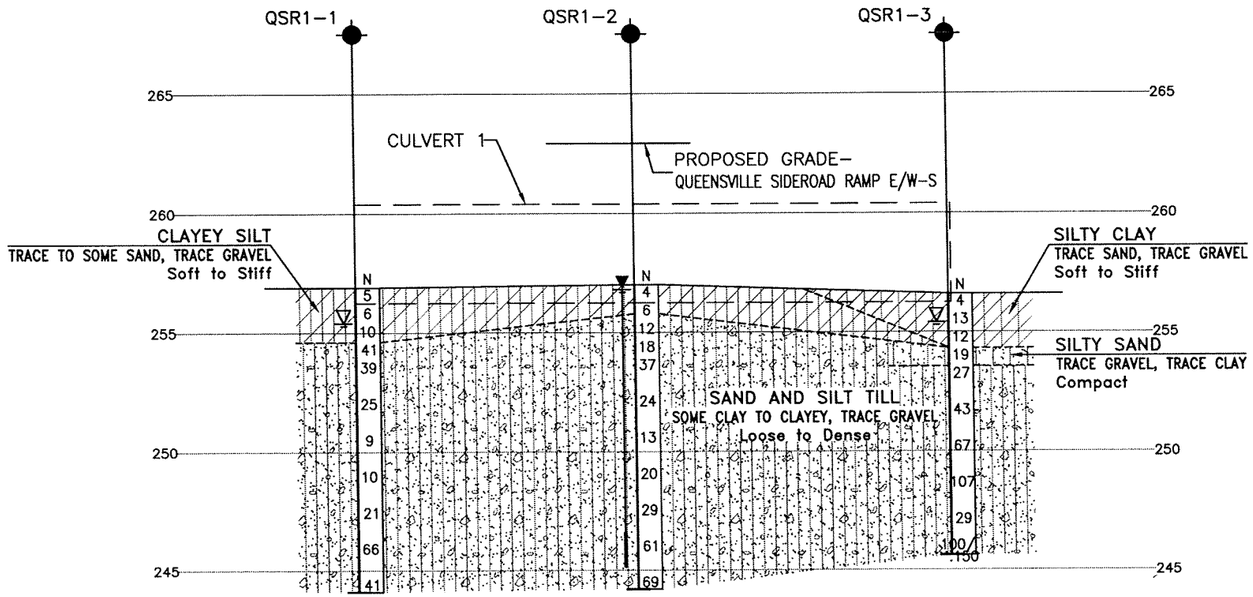
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

SCALE: 1:500



PROFILE

SCALE: V 1:500, H 1:250

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

CONT No
GWP No 2109-05-00

HIGHWAY 404 EXTENSION
CULVERT AT E/W-S RAMP
QUEENSVILLE INTERCHANGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 451

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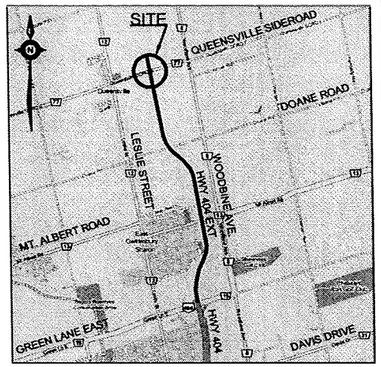


KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
QSR1-1	256.9	4 888 726.4	309 717.9
QSR1-2	257.0	4 888 743.6	309 733.3
QSR1-3	256.6	4 888 763.1	309 750.7

REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
Feb26/10
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb26/10
PROVINCE OF ONTARIO

-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-493

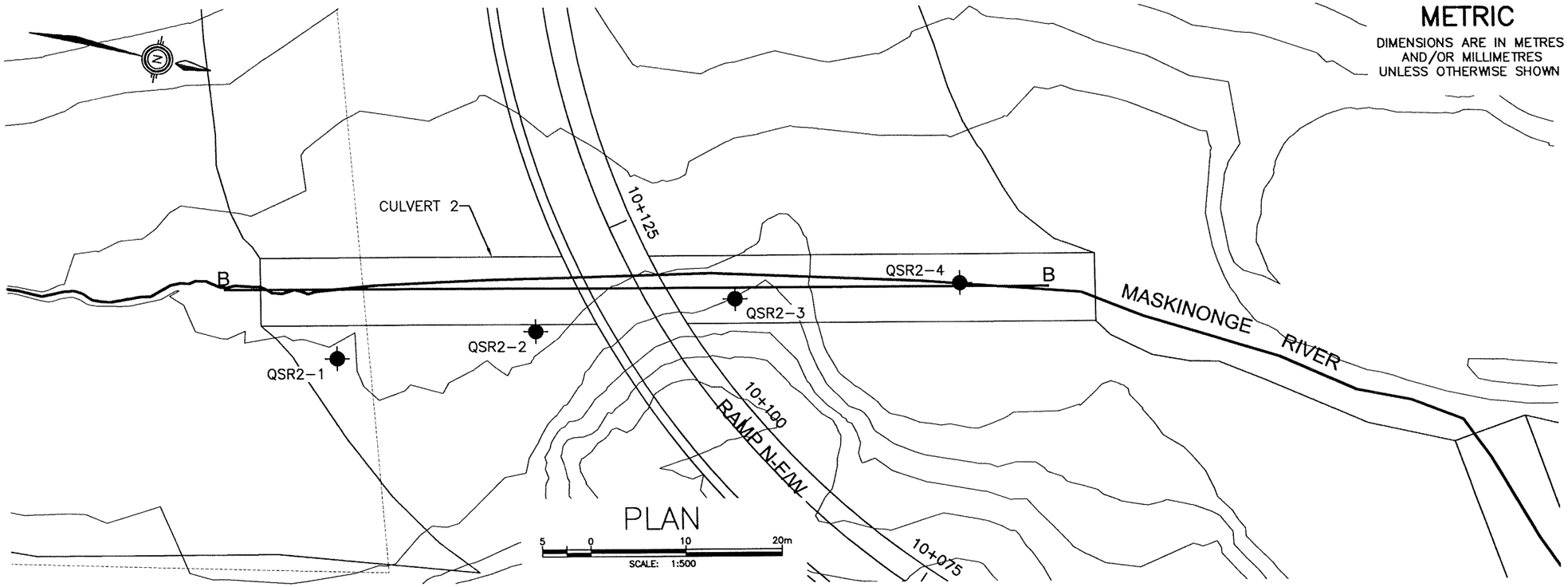
REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN RPR	CHK AEG	CODE	LOAD
DRAWN MFA	CHK RPR	SITE 37-1573/C	STRUCT
			DATE MAR. 2010
			DWG

FILENAME: G:\Drafting\19\1605\08\Iec0596-CulvertsatQSR(31D-493).dwg
PLOTDATE: Mar 08, 2010 - 11:12pm

PLOT SCALE 1:1
09-06
PW-D-707
MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

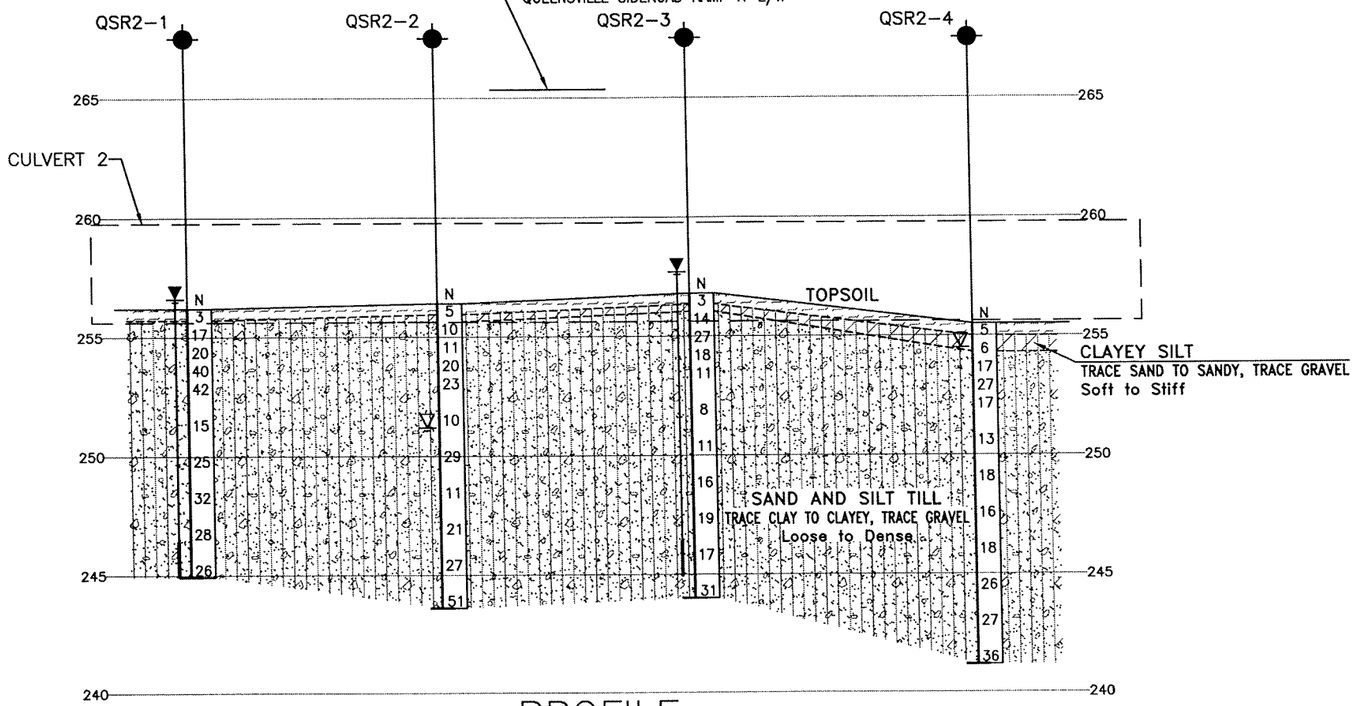
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

5 0 10 20m

SCALE: 1:500



PROFILE

5 0 10 20m V 1:500

2.5 0 5 10m H 1:250

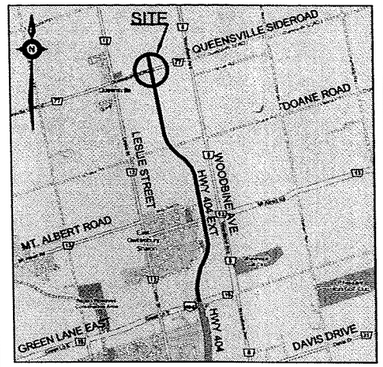
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

CONT No
GWP No 2109-05-00

HIGHWAY 404 EXTENSION
CULVERT AT N-E/W RAMP
QUEENSVILLE INTERCHANGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 447

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
QSR2-1	256.2	4 888 837.7	309 753.3
QSR2-2	256.4	4 888 857.3	309 746.3
QSR2-3	256.8	4 888 877.1	309 738.6
QSR2-4	255.5	4 888 899.7	309 732.2

-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-493

REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
PROVINCE OF ONTARIO

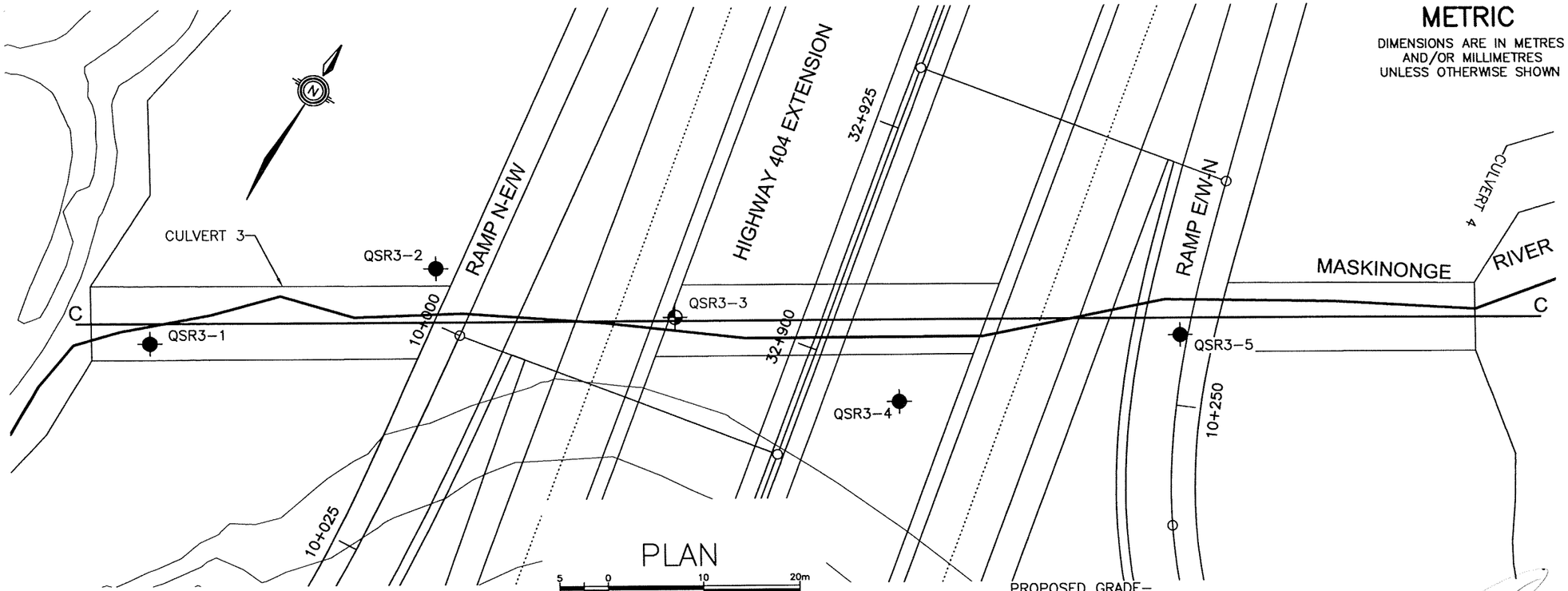
REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	AEG	CODE		LOAD	DATE MAR. 2010
DRAWN	MFA	CHK	RPR	SITE 37-1574/C	STRUCT	DWG	

FILENAME: D:\Drafting\101\1605\gb\1w60598-CulvertsatQSR(31D-493).dwg
PLOTDATE Mar 08, 2010 - 11:15pm

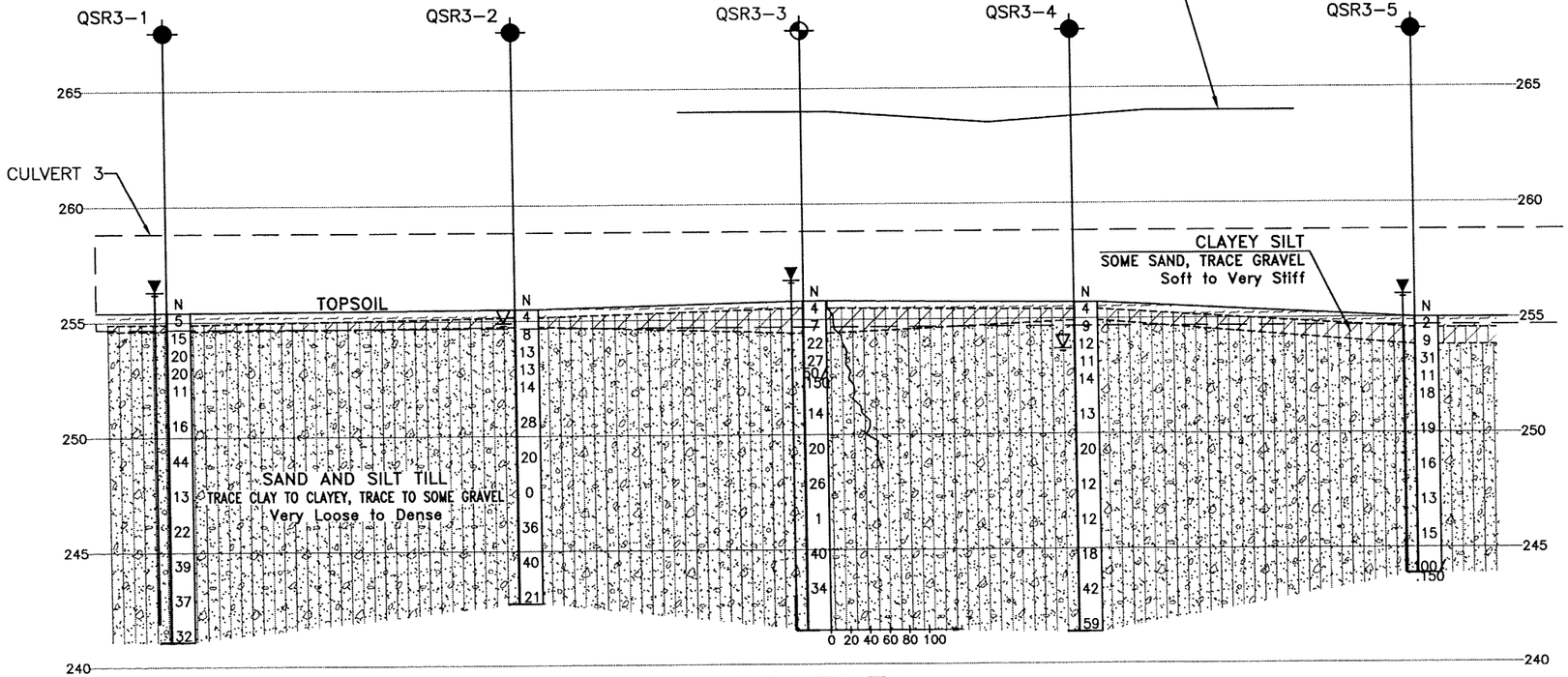
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

SCALE: 1:500



PROFILE

V 1:500
H 1:250

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

CONT No
GWP No 2109-05-00

HIGHWAY 404 EXTENSION
CULVERT AT STATION 32+903
QUEENSVILLE INTERCHANGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 463

THURBER ENGINEERING LTD.
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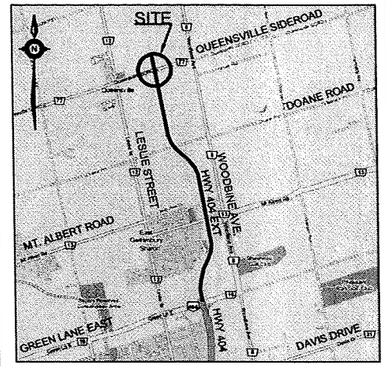

KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
QSR3-1	255.4	4 888 957.8	309 742.3
QSR3-2	255.5	4 888 980.1	309 763.6
QSR3-3	255.8	4 888 988.6	309 787.5
QSR3-4	255.7	4 888 993.1	309 812.0
QSR3-5	255.0	4 889 014.4	309 833.5

-NOTES-

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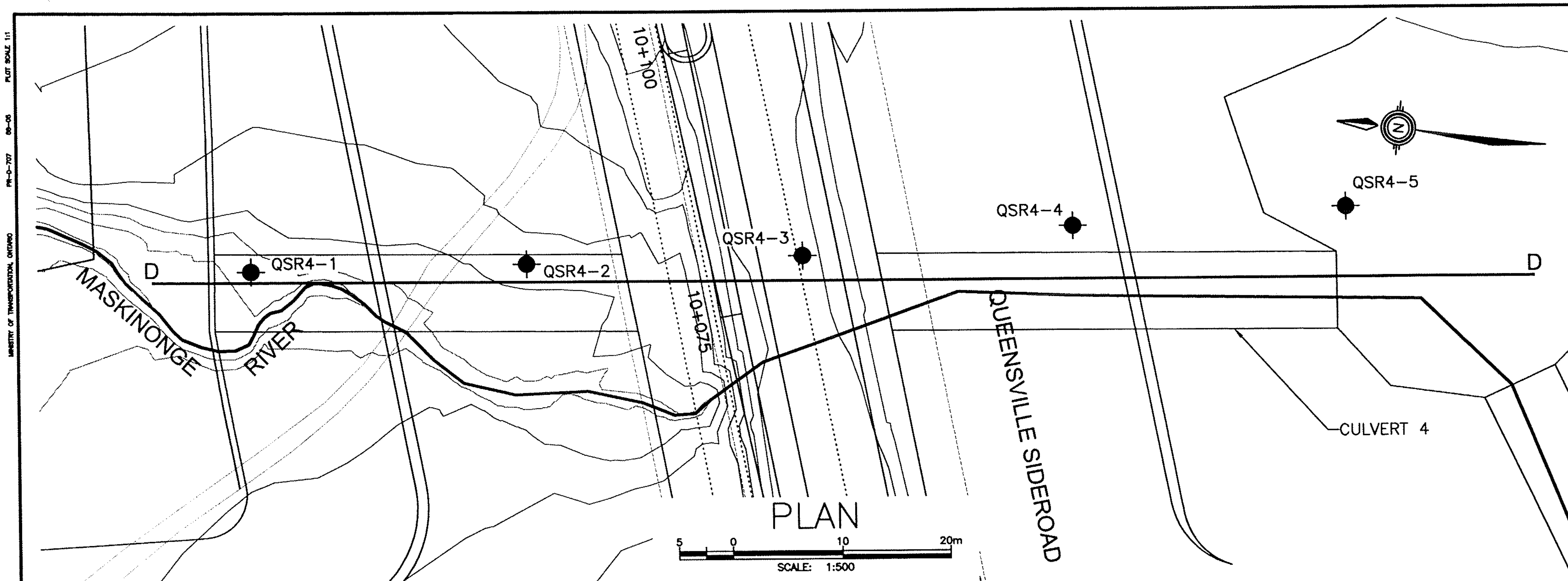
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-493

REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
Feb 26/10
PROVINCE OF ONTARIO

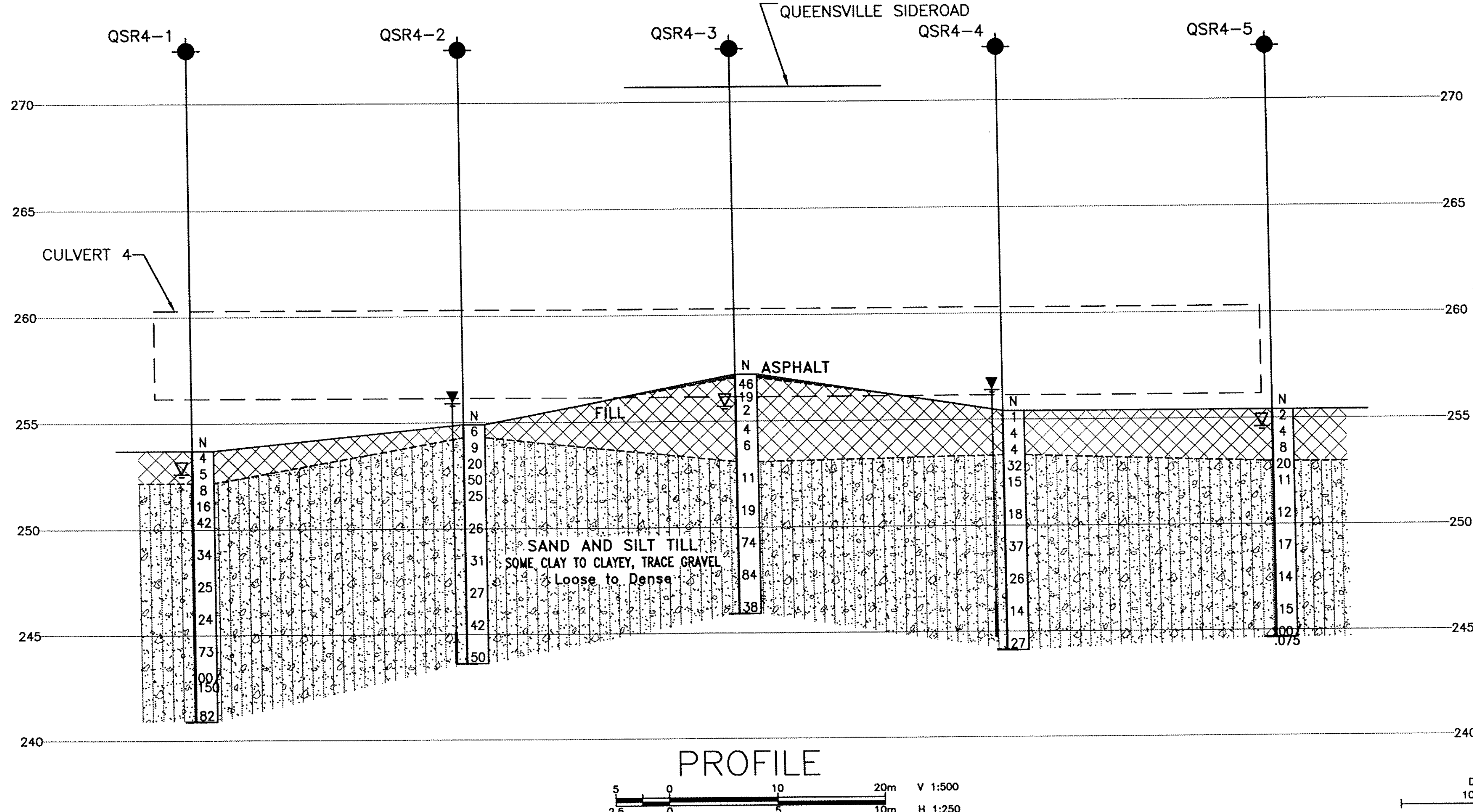
LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb 26/10
PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN RPR	CHK AEG	CODE	LOAD
DRAWN MFA	CHK RPR	SITE 37-1575/C	STRUCT
			DATE MAR. 2010
			DWG



METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



CONT No
GWP No 2109–05–00

HIGHWAY 404 EXTENSION
CULVERT AT QUEENSVILLE SIDEROAD
QUEENSVILLE INTERCHANGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 443

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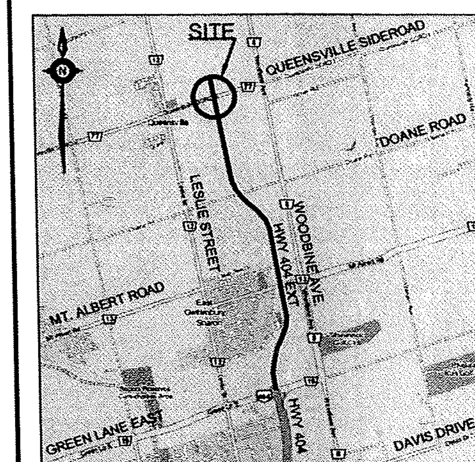

KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
QSR4–1	253.7	4 889 148.9	309 855.8
QSR4–2	254.9	4 889 123.9	309 859.4
QSR4–3	257.2	4 889 098.8	309 863.0
QSR4–4	255.4	4 889 074.3	309 868.5
QSR4–5	255.4	4 889 049.6	309 873.1

REGISTERED PROFESSIONAL ENGINEERS
A. E. GORMAN
Feb 26/10
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb 26/10
PROVINCE OF ONTARIO

-NOTES-

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2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-493

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION		
DESIGN RPR	CHK AEG	CODE	LOAD	DATE	MAR. 2010
DRAWN MFA	CHK RPR	SITE 37–1576/C	STRUCT	DWG	

FILENAME: D:\Drafting\19\1605\96\ted0595–Culvertat\QSR(31D–493).dwg
PLOTDATE: Mar 08, 2010 – 1:13pm

Appendix E

Record of Borehole Sheets

(south of Doane Road)

Culverts 5 and 6

Boreholes 08-01 to 08-05 and 08-10 to 08-14

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			

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-01 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 603.28 E 310 715.60 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.27 - 2009.08.27 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
257.2											
0.0	**TOPSOIL:** (200mm)										
0.2	Silty **CLAY**, trace sand, iron oxide staining Soft to Very Stiff Brown		1	SS	3		257	○	○		
			2	SS	4		256	○	○		
			3	SS	18			○	○		
			4	SS	17		255	○	○		0 2 50 48
	Occasional silt seams		5	SS	15		254	○	○		
			6	SS	15		253	○	○		0 1 46 53
	Grey		7	SS	17		252	○	○		0 0 79 21
			8	SS	21		251	○	○		
	Hard		9	SS	32		250	○	○		0 5 68 27
							249				
							248				

Continued Next Page

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-01 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 603.28 E 310 715.60 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.27 - 2009.08.27 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200): O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Hard Grey						247				
245.9			10	SS	43		246		O		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 10.6m AND WATER LEVEL AT 1.6m. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

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

ONTMT4S 0596.GPJ 9/10/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-02

1 OF 2

METRIC

G.W.P. 2109-05-00 | LOCATION N 4 886 589.18 E 310 694.94 | ORIGINATED BY GA
HWY 404 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.08.26 - 2009.08.26 | CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
257.1											
0.0 / 0.1	**TOPSOIL:** (75mm)										
	Silty **CLAY**, trace sand, iron oxide staining Soft to Firm Brown		1	SS	3		257				
			2	SS	3		256				
			3	SS	7						0 2 64 34
	Becoming stiff to very stiff		4	SS	16		255				
			5	SS	14		254				
							253				
			6	SS	15						0 1 33 66
							252				
	Grey		7	SS	13	▼	251				
							250				
	Layers of silt, some clay		8	SS	26						0 0 85 15
							249				
							248				
	Hard		9	SS	37						

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-02 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 589.18 E 310 694.94 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.26 - 2009.08.26 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 40 80 120 160 200	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace to some sand, trace gravel Very Stiff Grey						247				
245.9			10	SS	28		246		o		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN AND WATER LEVEL AT 0.6m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.09.02 6.2 250.9										

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

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

ONTMT4S 0596.GPJ 9/10/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-03 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 576.91 E 310 673.12 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.26 - 2009.08.26 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE, ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
257.4											
0.0	**TOPSOIL:** (100mm)										
0.1	Sandy **SILT**, some clay, iron oxide staining Loose to Compact Brown Wet		1	SS	4		257				
			2	SS	10						
255.8							256				
1.6	Silty **CLAY**, iron oxide staining Stiff to Very Stiff		3	SS	17						
			4	SS	17		255				0 0 52 48
			5	SS	14		254				
			6	SS	15	▽	253				
	Grey		7	SS	17		252				
							251				0 0 72 28
	Trace sand		8	SS	20		250				
							249				
			9	SS	19		248				0 9 68 23

Continued Next Page

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

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

ONTMT4S 0596.GPJ 10/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-03 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 576.91 E 310 673.12 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.26 - 2009.08.26 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 40 80 120 160 200	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	Silty **CLAY**, trace sand Hard Grey						247				
246.2			10	SS	42						
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN AND WATER LEVEL AT 4.8m. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 0596.GPJ 9/10/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-04 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 615.39 E 310 735.70 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.27 - 2009.08.27 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	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
262.8											
0.0	**TOPSOIL:** (100mm)										
0.1	Sandy **SILT**, some clay, trace gravel Loose Brown Wet		1	SS	4						
			2	SS	6		262				
261.3											
1.5	Silty **CLAY**, trace sand Stiff to Very Stiff Brown		3	SS	18		261				0 2 50 48
			4	SS	24		260				
	Occasional silt seams Grey		5	SS	12						0 2 38 60
							259				
			6	SS	11		258				
						▼	257				
			7	SS	14						
							256				
	Layers of silt, some clay		8	SS	24		255				0 4 83 13
							254				
			9	SS	29						
							253				

Continued Next Page

+ ³ , × ³ Numbers refer to Sensitivity

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

ONTMT4S 0596.GPJ 9/10/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-04 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 615.39 E 310 735.70 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.27 - 2009.08.27 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 40 80 120 160 200	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
251.5	Silty **CLAY**, trace sand Hard Grey		10	SS	47		252		o		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 10.6m AND WATER LEVEL AT 1.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.09.02 5.9 256.9										

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

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

ONTMT4S 0596.GPJ 9/10/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-05 1 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 625.73 E 310 761.36 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.27 - 2009.08.27 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (40 80 120 160 200)	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
260.8											
0.0	**TOPSOIL:** (100mm)										
0.1	Sandy **SILT**, some clay, iron oxide staining Very Loose Brown		1	SS	3						
259.9	Damp						260				
0.9	Silty **CLAY**, iron oxide staining Stiff to Very Stiff Brown		2	SS	8						0 0 59 41
			3	SS	24		259				
			4	SS	14		258				
	Occasional silt seams		5	SS	10						0 0 36 64
						▽	257				
			6	SS	16		256				
	Layers of silt, some clay Grey		7	SS	10		255				
							254				
	Layers of silt		8	SS	15		253				0 0 81 19
							252				
			9	SS	23		251				

Continued Next Page

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

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

ONTMT4S 0596.GPJ 9/14/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-05 2 OF 2 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 625.73 E 310 761.36 ORIGINATED BY GA
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.08.27 - 2009.08.27 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) O UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
250.2	Silty **CLAY** Very Stiff to Hard Grey										
10.6 249.7	Silty **CLAY**, trace to some sand, trace gravel Hard Grey (TILL)		10	SS	84		250		o		
11.1	END OF BOREHOLE AT 11.1m. BOREHOLE OPEN TO 10.6m AND WATER LEVEL AT 4.3m. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.										

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

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

ONTMT4S 0596.GPJ 9/14/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-10 1 OF 1 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 714.15 E 310 638.52 ORIGINATED BY LG

HWY 404 BOREHOLE TYPE Continuous Spoon Sampling with Tripod COMPILED BY AN

DATUM Geodetic DATE 2010.02.18 - 2010.02.18 CHECKED BY TH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ▲ Cpen × 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
257.4											
0.0	**ICE**										
0.2	**WATER**										
256.6							257				
0.8	**PEAT**		2	SS	2				96		
256.2											
1.2	Silty **CLAY**, trace sand Firm to Very Stiff Brown Wet (TILL)(CL-CI)		3	SS	11		256				
			4	SS	9						0 3 53 44
			5	SS	17		255				
			6	SS	24						
			7	SS	23		254				0 2 32 66
			8	SS	29		253				
			9	SS	27						
			10	SS	36		252				0 0 57 43
			11	SS	29		251				
			12	SS	28						
			13	SS	32		250				0 0 77 23
249.2			14	SS	50/ 0.150						
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S(CPEN) 0596.GPJ 3/11/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-11 1 OF 1 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 733.41 E 310 655.58 ORIGINATED BY LG

HWY 404 BOREHOLE TYPE Continuous Spoon Sampling with Tripod COMPILED BY AN

DATUM Geodetic DATE 2010.02.18 - 2010.02.18 CHECKED BY TH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
257.0							257				
0.0	**WATER**										
256.4							256				
0.6	**PEAT**, some sand		2	SS	2						
255.3			3	SS	3		255				
1.7	Silty **CLAY**, trace sand Firm to Very Stiff Brown Wet (TILL)(CL-CI)		4	SS	6						
			5	SS	19		254				0 4 36 60
			6	SS	17						
			7	SS	25		253				0 6 48 46
			8	SS	16						
			9	SS	27		252				
			10	SS	22						0 1 70 29
			11	SS	19		251				
			12	SS	23		250				
			13	SS	30						
			14	SS	23		249				0 1 73 26
			15	SS	53						
247.9							248				
9.1	END OF BOREHOLE AT 9.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

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

ONTMT4S(CPEN) 0596.GPJ 3/11/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-12 1 OF 1 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 759.24 E 310 668.13 ORIGINATED BY LG

HWY 404 BOREHOLE TYPE Continuous Spoon Sampling with Tripod COMPILED BY AN

DATUM Geodetic DATE 2010.02.18 - 2010.02.18 CHECKED BY TH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL ▲ Cpen × 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
258.3											
0.0	**ICE**										
0.2	**WATER**						258				
256.6							257				
256.6	**PEAT**										
1.7	Silty **SAND**, some clay Compact Brown		4	SS	11						0 60 26 14
255.9	Wet						256				
2.4	Silty **CLAY**, trace sand Stiff to Very Stiff Grey Moist (TILL)(CL-CI)		5	SS	27						
			6	SS	35		255				
			7	SS	39						0 4 41 55
			8	SS	42		254				
			9	SS	23						
			10	SS	33	▼	253				0 1 70 29
			11	SS	31		252				
			12	SS	39						0 1 82 17
			13	SS	30		251				
			14	SS	61						
249.8							250				
8.5	END OF BOREHOLE AT 8.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2010.03.04	5.7	252.6
2010.03.10	6.2	252.1

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

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

ONTMT4S(CPEN) 0596.GPJ 3/11/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-13 1 OF 1 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 691.28 E 310 623.35 ORIGINATED BY JM

HWY 404 BOREHOLE TYPE Continuous Spoon Sampling with Tripod COMPILED BY AN

DATUM Geodetic DATE 2010.02.17 - 2010.02.17 CHECKED BY TH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.9											
0.0	**PEAT**		1	SS	8						
256.3											
0.6	Silty **CLAY**										
256.0			2	SS	28		256				
0.9	Silty **SAND** Compact Brown Wet										
255.7			3	SS	22						0 3 69 28
1.2	Silty **CLAY**, trace sand Very Stiff to Hard Brown Wet (TILL)(CL)		4	SS	27		255				
			5	SS	54						
							254				
			6	SS	47						0 1 54 45
			7	SS	45		253				
			8	SS	28						
							252				
			9	SS	17						0 2 41 57
			10	SS	30						
							251				
			11	SS	31			>>			
			12	SS	28		250				0 0 61 39
			13	SS	31						
							249				
			14	SS	39						
			15	SS	47						
247.8							248				0 0 66 34
9.1	END OF BOREHOLE AT 9.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

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

ONTMT4S(CPEN) 0596.GPJ 3/9/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-14 1 OF 1 METRIC

G.W.P. 2109-05-00 LOCATION N 4 886 669.08 E 310 609.07 ORIGINATED BY JM

HWY 404 BOREHOLE TYPE Continuous Spoon Sampling with Tripod COMPILED BY AN

DATUM Geodetic DATE 2010.02.17 - 2010.02.17 CHECKED BY TH

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ▲ Cpen ● 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
257.0							257				
0.0	**ICE**										
0.2	**PEAT**		1	SS	1						
			2	SS	7		256				
255.9											
1.1	Silty **CLAY**, trace sand Firm to Very Stiff Brown Wet (TILL)(CL-CI)		3	SS	6						
			4	SS	7		255				
			5	SS	31						0 0 57 43
			6	SS	46		254				
			7	SS	47		253				
			8	SS	28						
			9	SS	20		252				0 0 38 62
			10	SS	14						
			11	SS	17		251				0 2 39 59
			12	SS	21		250				
			13	SS	26						
			14	SS	25		249				0 0 72 28
			15	SS	28						
247.9							248				
9.1	END OF BOREHOLE AT 9.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACCE.										

+ ³, × ³: Numbers refer to Sensitivity

20
15 10 5 (%) STRAIN AT FAILURE

ONTMT4S(CPEN) 0596.GPJ 3/9/10

Appendix F

Laboratory Test Results

(south of Doane Road)

Culverts 5 and 6

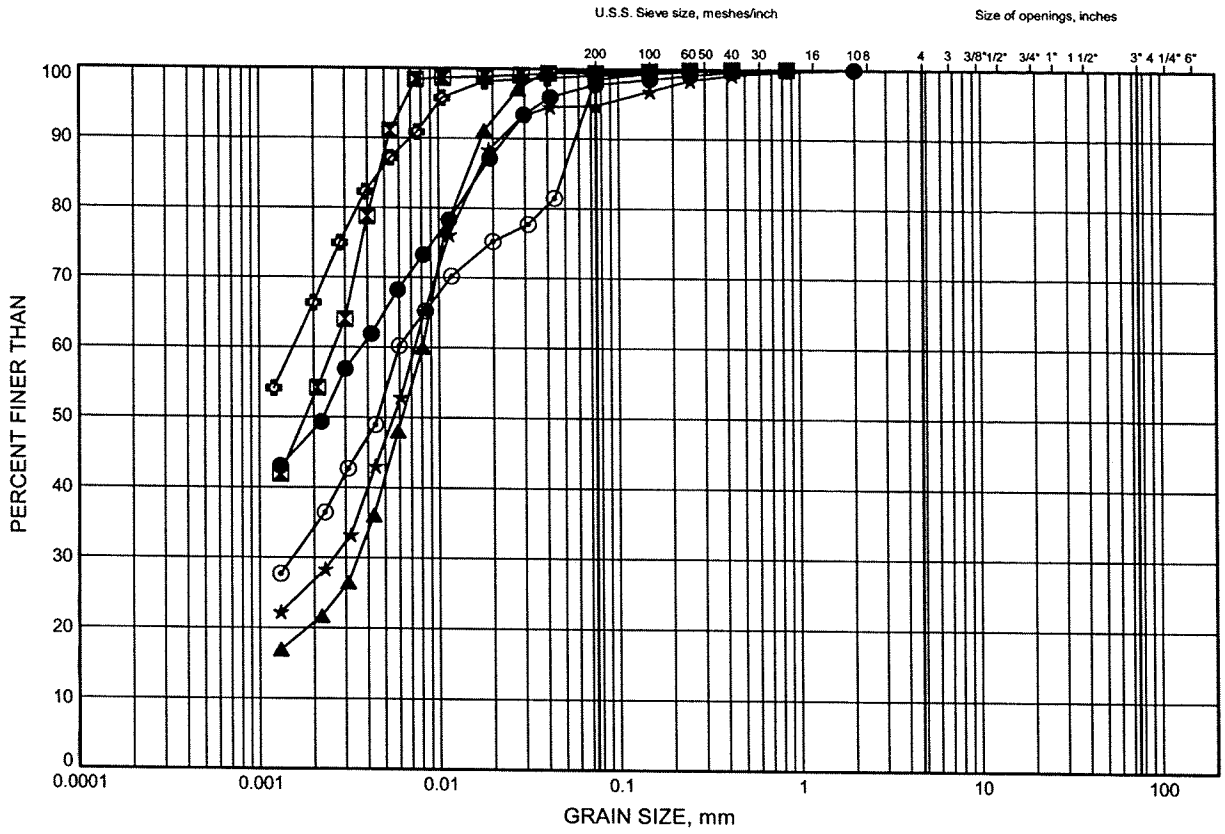
Boreholes 08-01 to 08-05 and 08-10 to 08-14

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F1

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-01	2.59	254.56
⊠	08-01	4.88	252.27
▲	08-01	6.40	250.75
★	08-01	9.45	247.70
⊙	08-02	1.83	255.30
✿	08-02	4.88	252.25

W.P.# 2109-05-00
Prepared By AN
Checked By RPR

THURBER

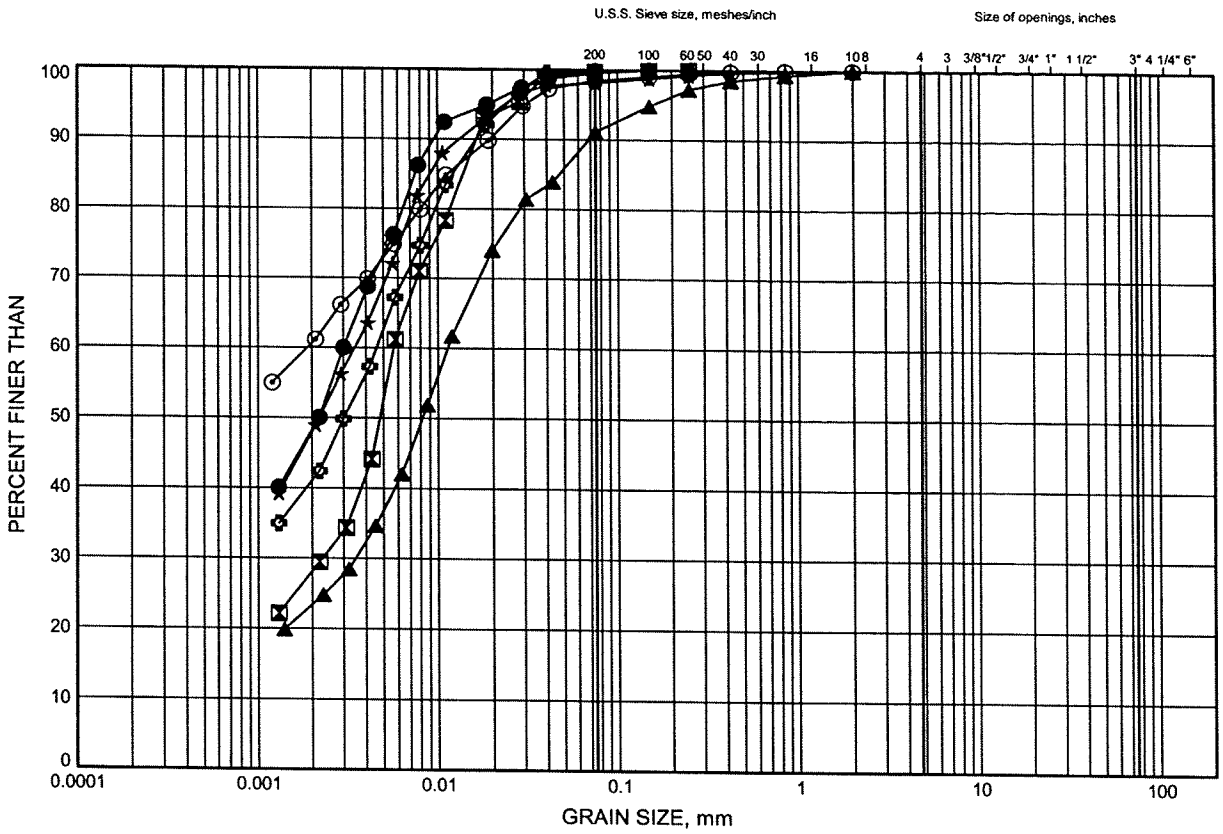
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 9/10/09

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F2

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-03	2.59	254.84
⊠	08-03	6.40	251.03
▲	08-03	9.45	247.98
★	08-04	1.83	260.97
⊙	08-04	3.35	259.45
✿	08-05	1.07	259.76

W.P.# 2109-05-00
Prepared By AN
Checked By RPR

THURBER

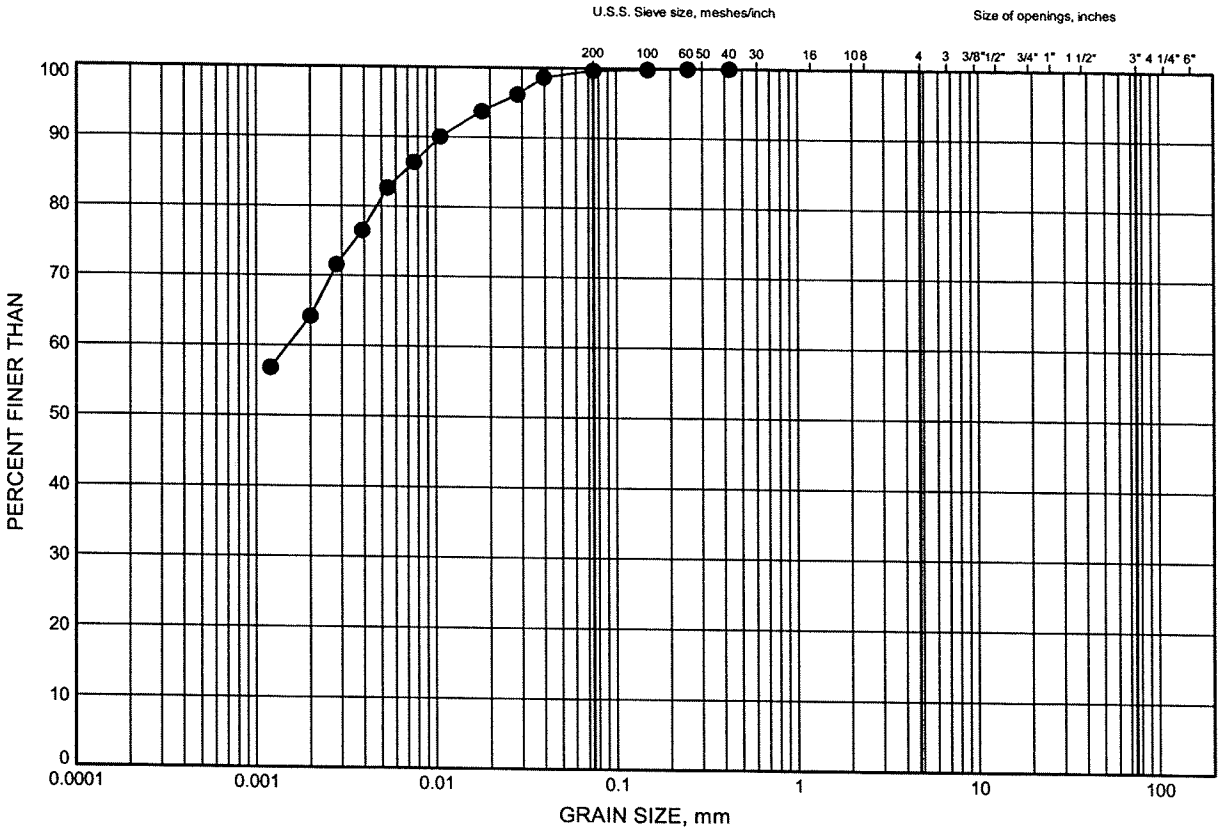
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 9/10/09

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F3

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-05	3.35	257.48

W.P.# 2109-05-00
Prepared By AN
Checked By RPR

THURBER

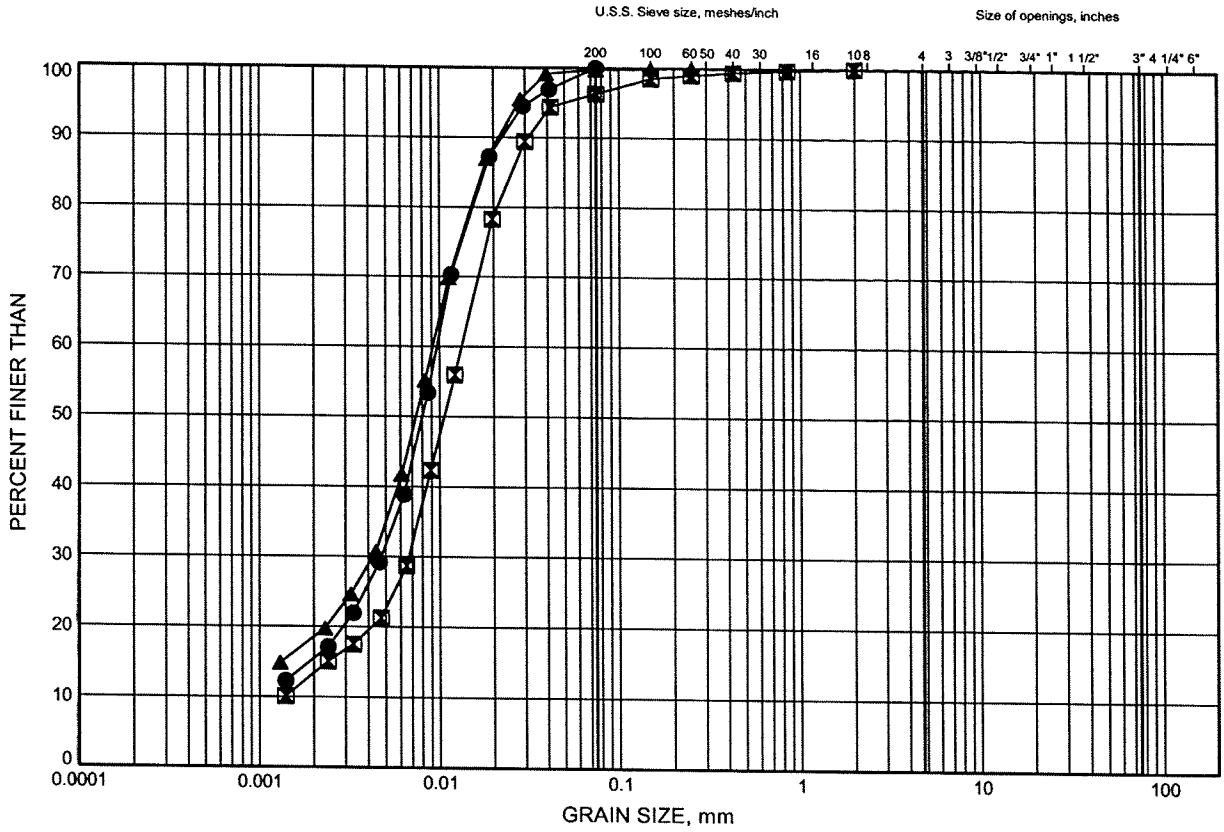
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 9/10/09

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F4

SILT (Some Clay)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-02	7.92	249.21
⊠	08-04	7.92	254.88
▲	08-05	7.92	252.91

W.P.# 2109-05-00
Prepared By AN
Checked By RPR

THURBER

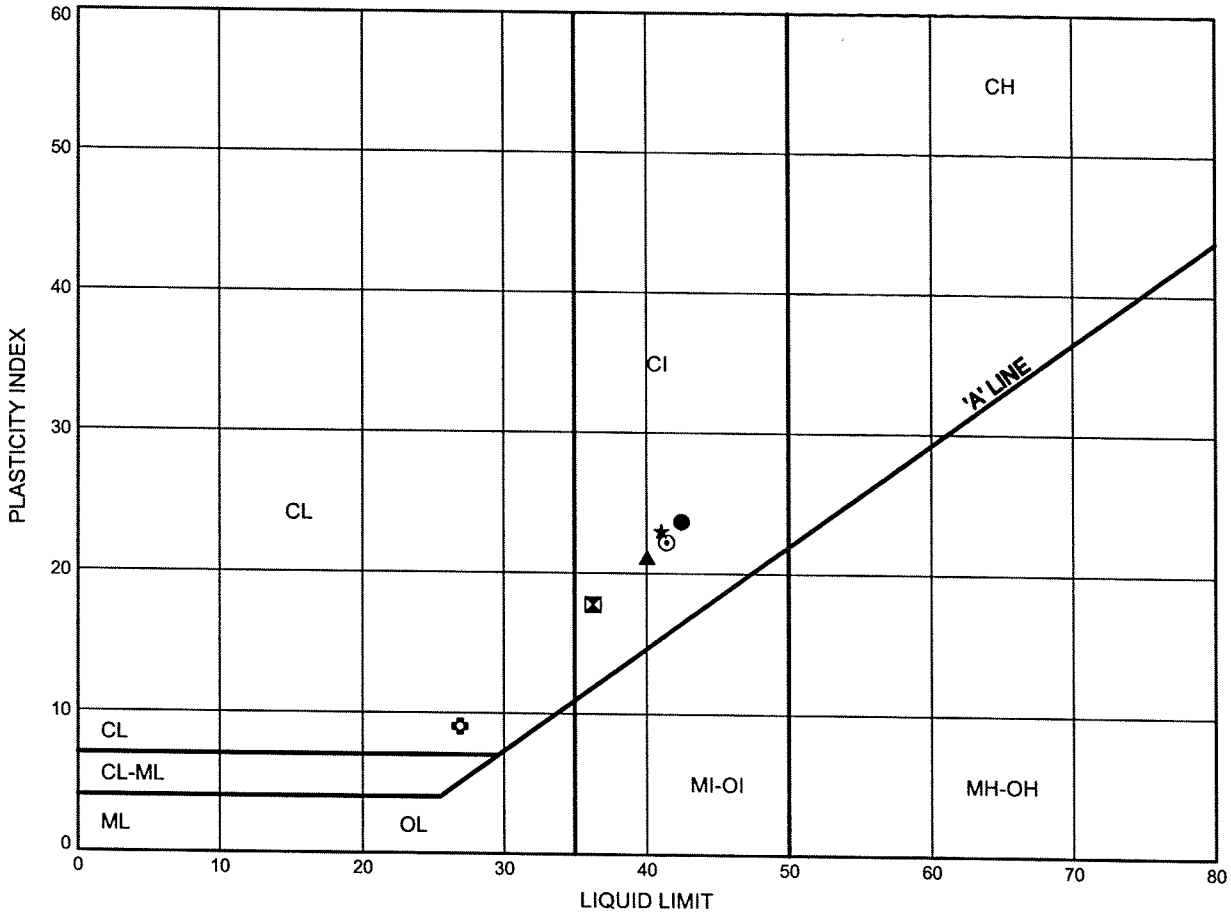
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 9/10/09

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE F5

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-01	2.59	254.56
⊠	08-01	4.88	252.27
▲	08-02	1.83	255.30
★	08-02	4.88	252.25
⊙	08-03	2.59	254.84
✿	08-03	6.40	251.03

Date September 2009

Project 2109-05-00

THURBER

Prep'd AN

Chkd. RPR

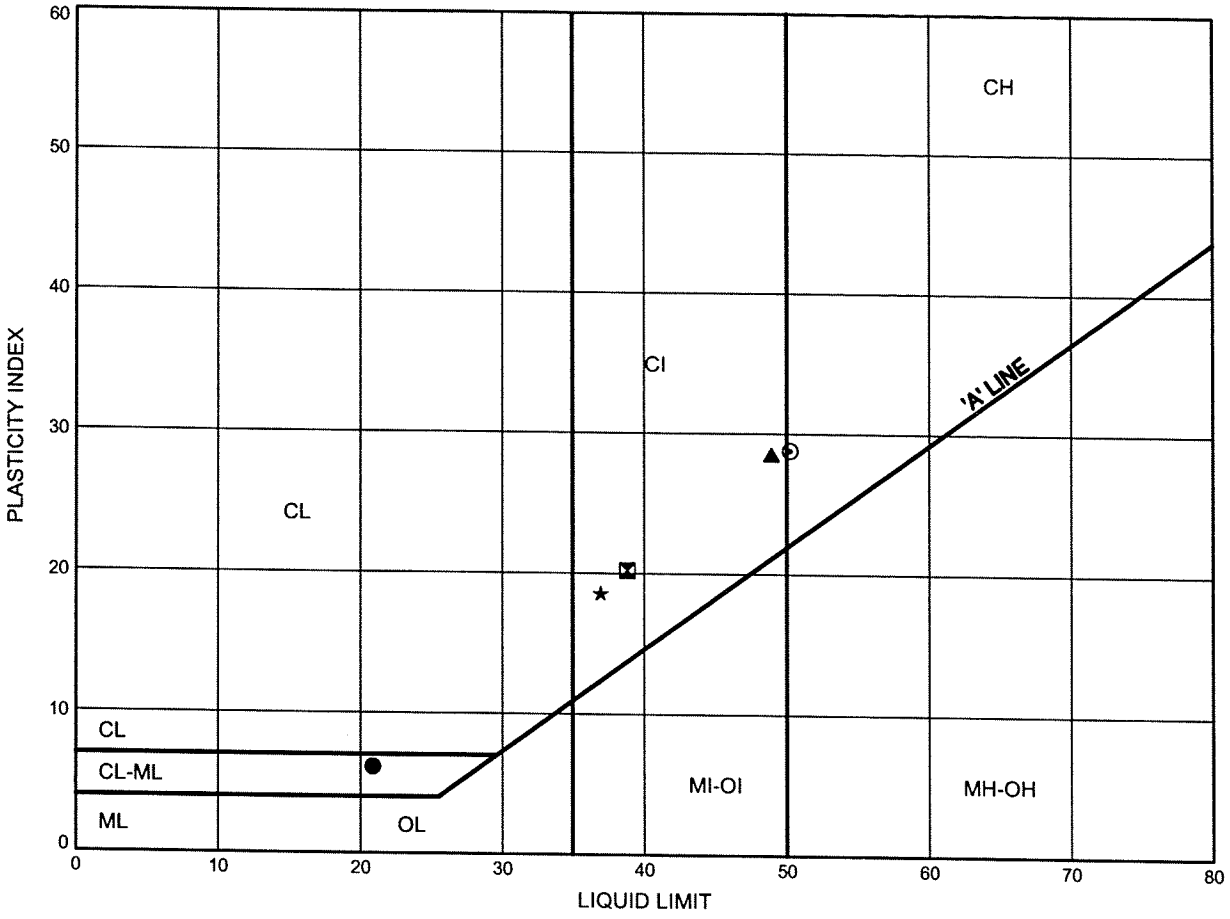
THURBALT 0596.GPJ 9/10/09

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE F6

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-03	9.45	247.98
⊠	08-04	1.83	260.97
▲	08-04	3.35	259.45
★	08-05	1.07	259.76
⊙	08-05	3.35	257.48

Date September 2009

Project 2109-05-00

THURBER

Prep'd AN

Chkd. RPR

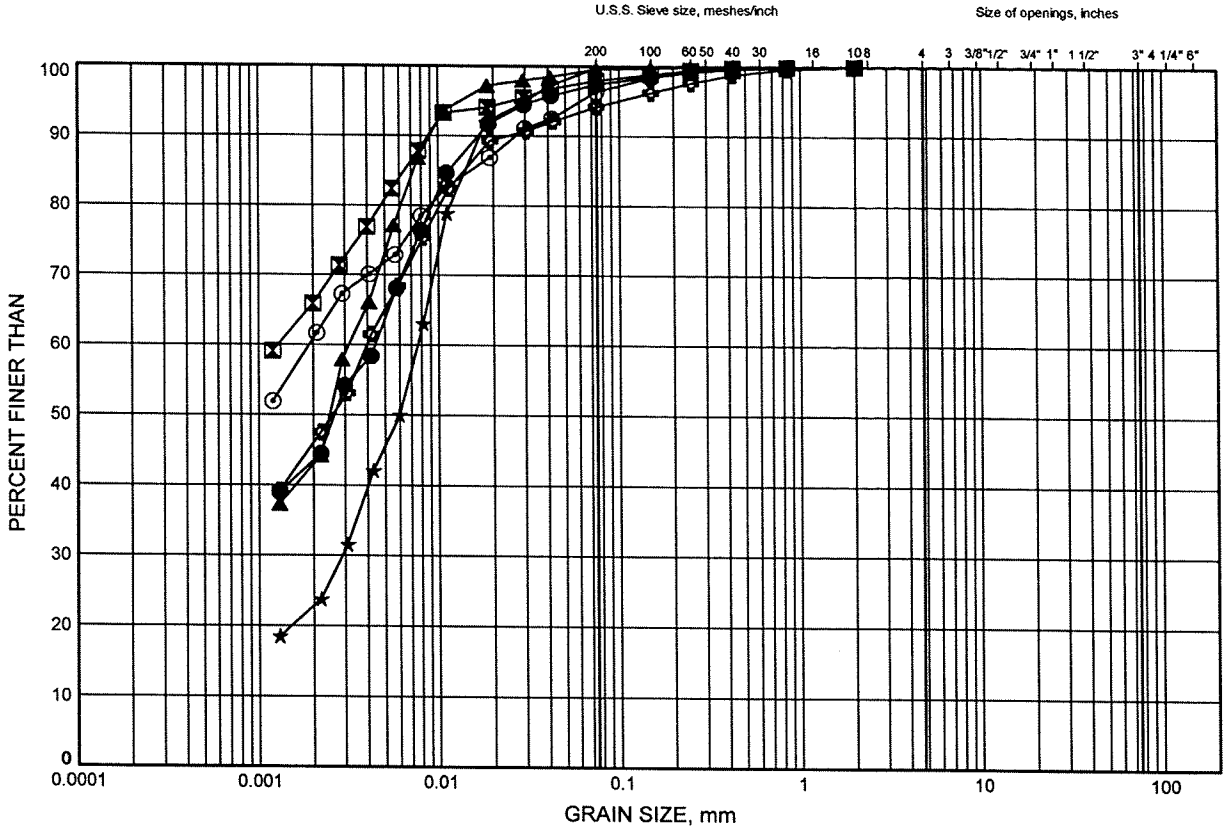
THURBALT 0596.GPJ 9/10/09

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F7

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-10	2.13	255.27
⊠	08-10	3.96	253.44
▲	08-10	5.79	251.61
★	08-10	7.62	249.78
⊙	08-11	2.74	254.26
✿	08-11	3.96	253.04

W.P.# 2109-05-00
Prepared By AN
Checked By TJH

THURBER

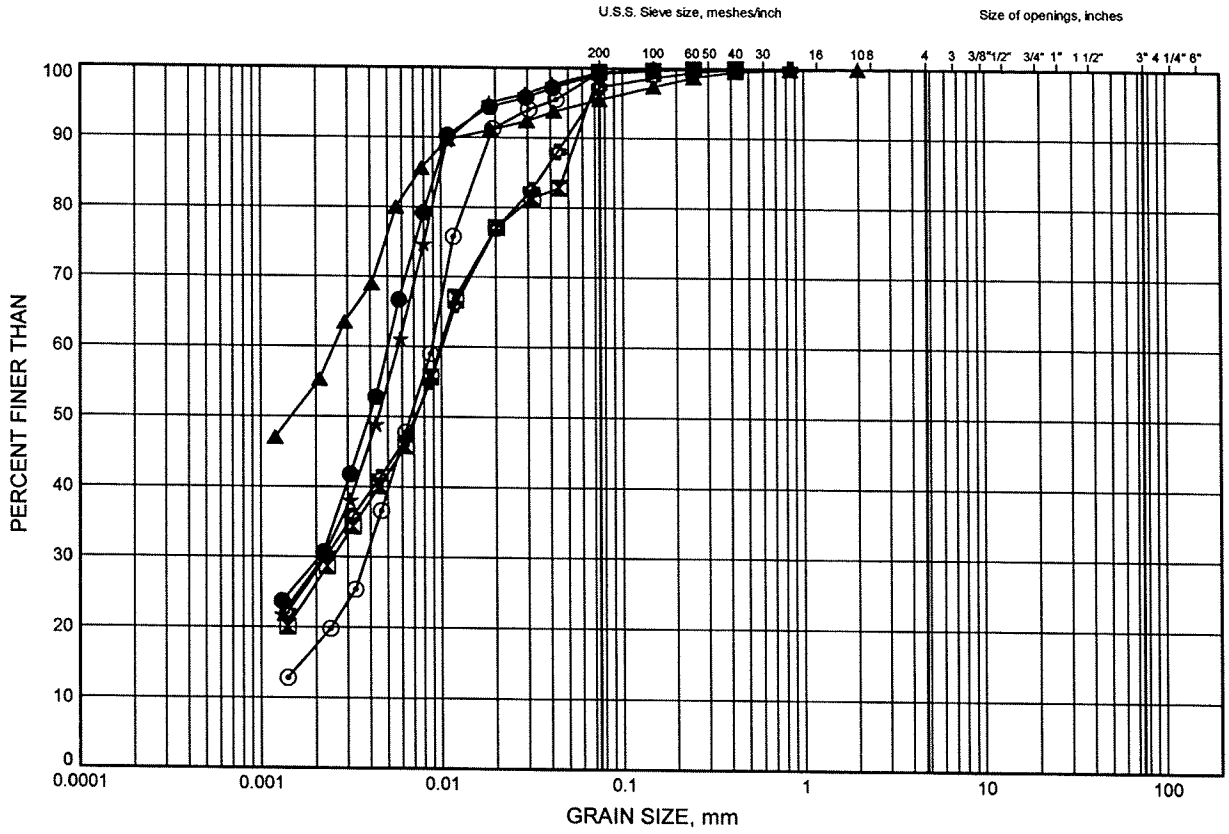
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 3/5/10

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F8

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-11	5.79	251.21
⊠	08-11	8.23	248.77
▲	08-12	3.96	254.34
★	08-12	5.79	252.51
⊙	08-12	7.01	251.29
✿	08-13	1.52	255.38

W.P.# 2109-05-00
Prepared By AN
Checked By TJH

THURBER

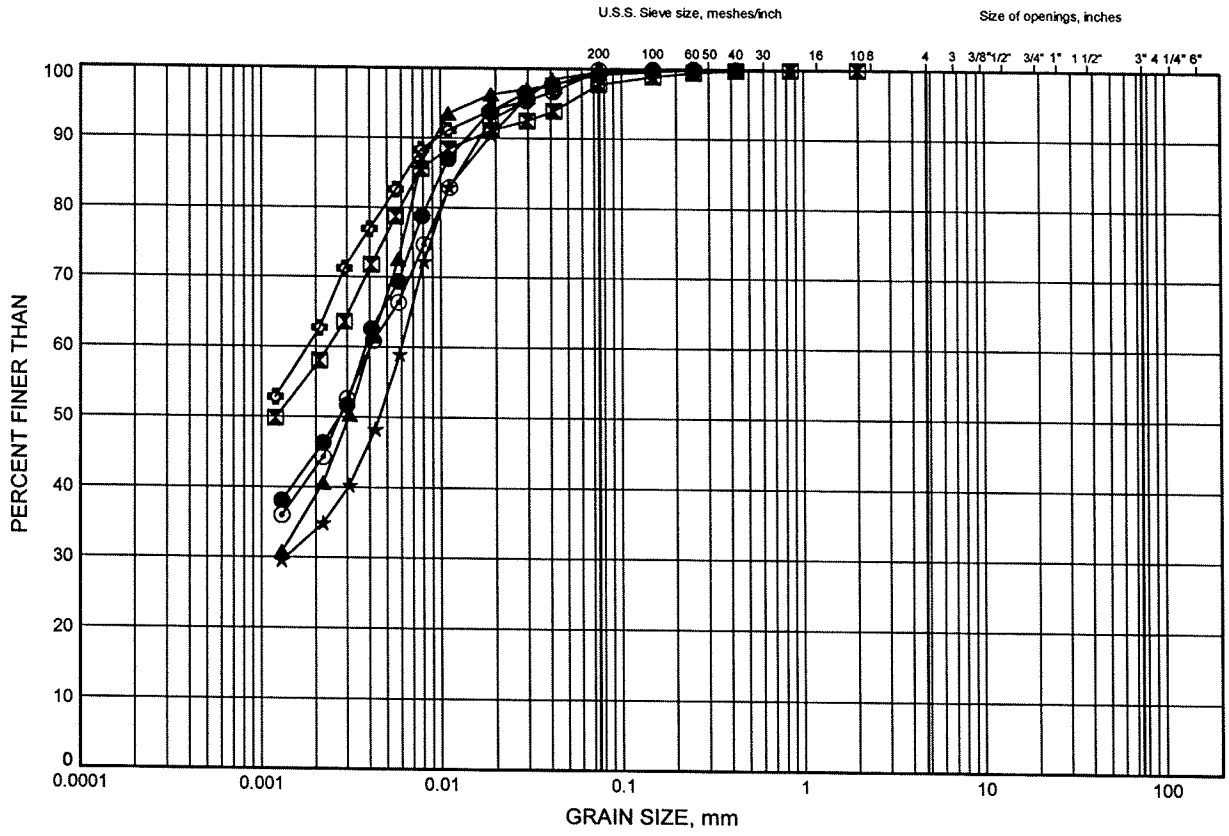
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 3/5/10

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F9

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-13	3.35	253.55
⊠	08-13	5.18	251.72
▲	08-13	7.01	249.89
★	08-13	8.84	248.06
⊙	08-14	2.74	254.26
✿	08-14	5.18	251.82

W.P.# 2109-05-00

Prepared By AN

Checked By TJH

THURBER

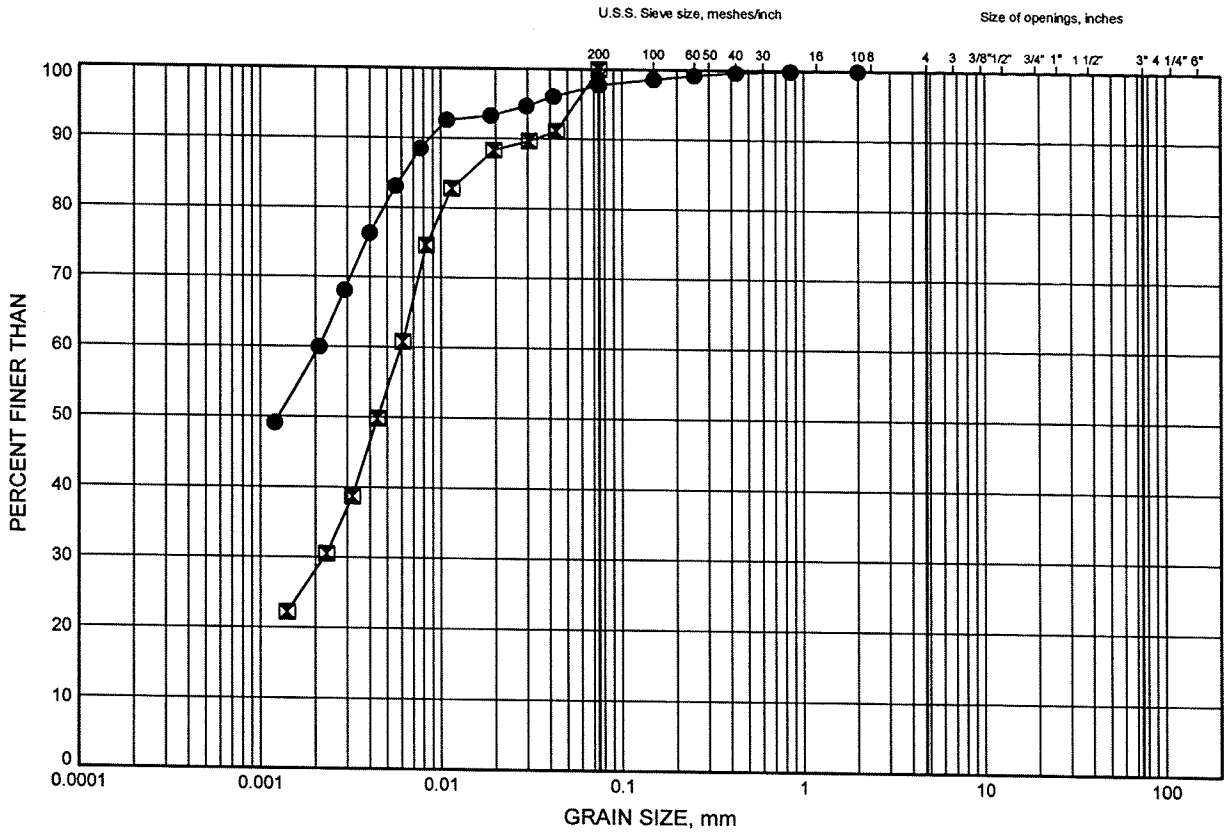
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 3/5/10

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F10

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-14	6.40	250.60
⊠	08-14	8.23	248.77

W.P.# 2109-05-00

Prepared By AN

Checked By TJH

THURBER

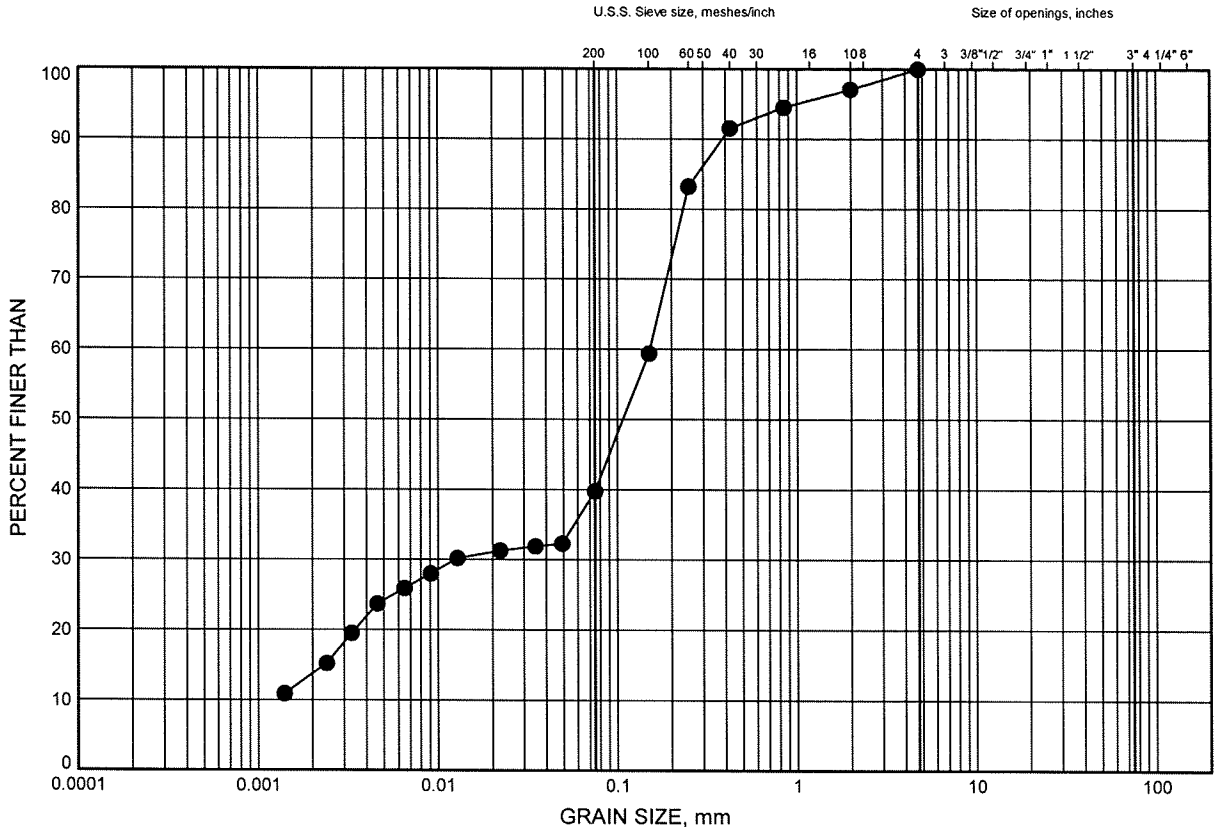
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 3/5/10

Hwy 404 Extension

GRAIN SIZE DISTRIBUTION

FIGURE F11

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-12	2.13	256.17

W.P.# 2109-05-00
Prepared By AN
Checked By TJH

THURBER

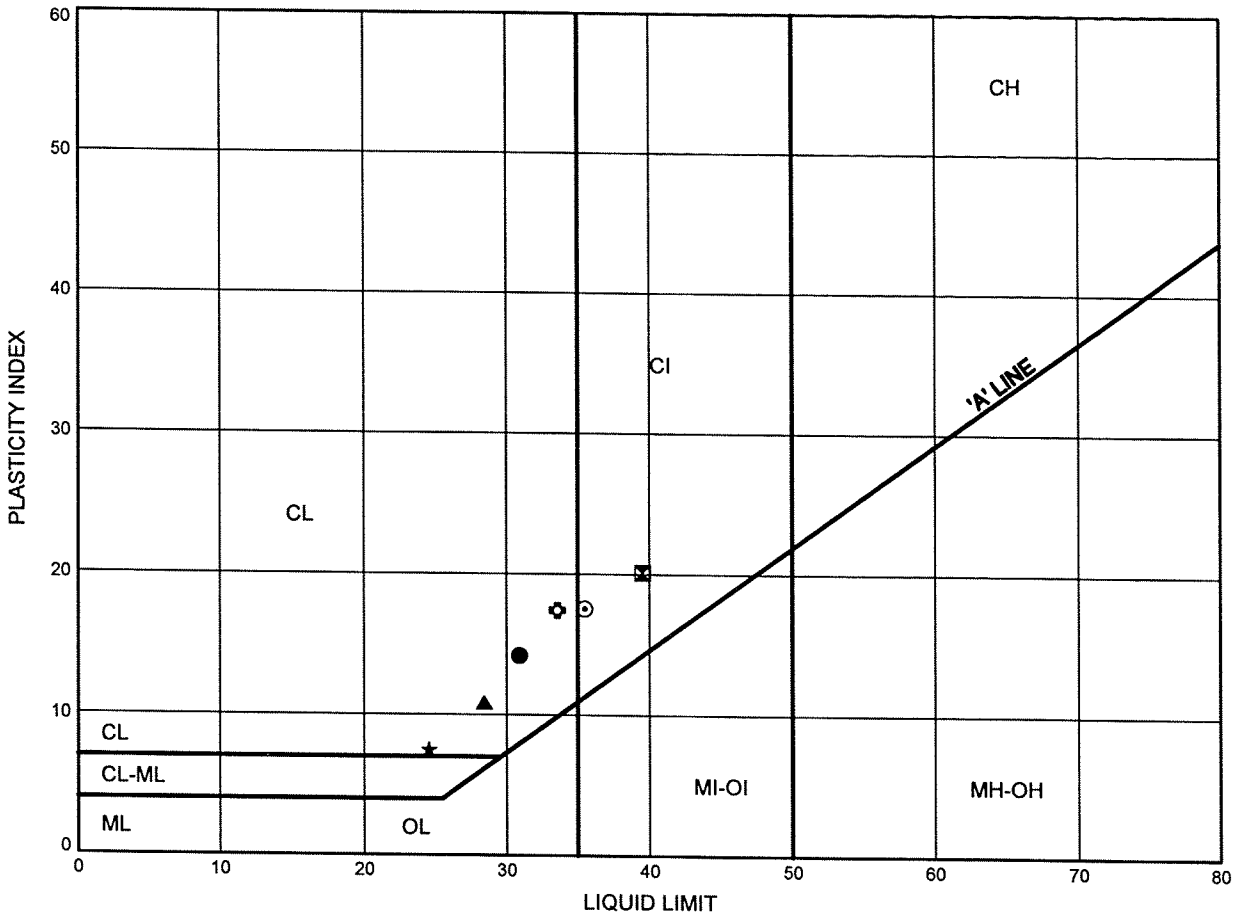
GRAIN SIZE DISTRIBUTION - THURBER 0596.GPJ 3/8/10

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE F12

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-10	2.13	255.27
⊠	08-10	3.96	253.44
▲	08-10	5.79	251.61
★	08-10	7.62	249.78
⊙	08-11	2.74	254.26
✿	08-11	3.96	253.04

Date March 2010

Project 2109-05-00

THURBER

Prep'd AN

Chkd. TJH

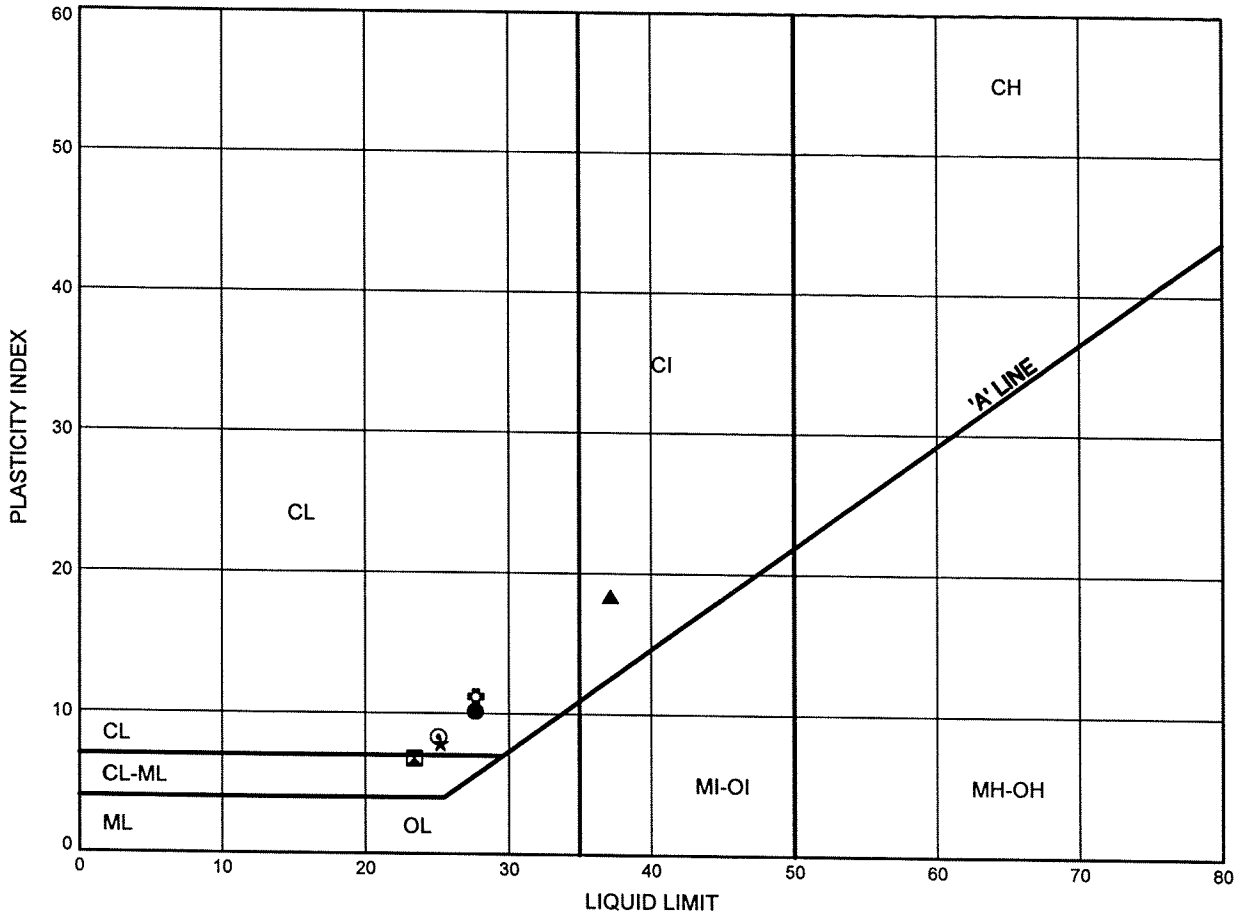
THURBALT 0596.GPJ 3/5/10

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE F13

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-11	5.79	251.21
⊠	08-11	8.23	248.77
▲	08-12	3.96	254.34
★	08-12	5.79	252.51
⊙	08-12	7.01	251.29
✿	08-13	1.52	255.38

Date March 2010

Project 2109-05-00

THURBER

Prep'd AN

Chkd. TJH

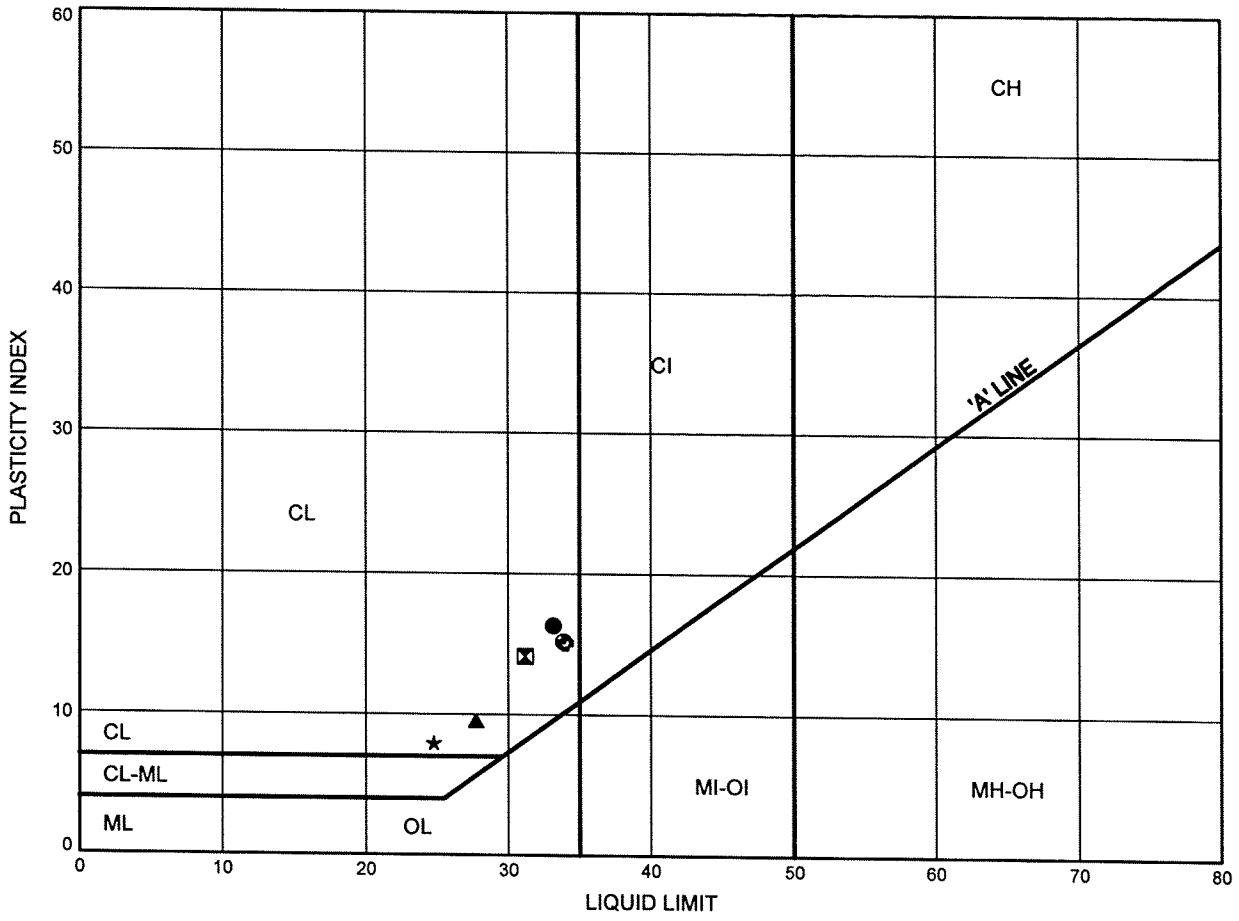
THURBALT 0596.GPJ 3/5/10

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE F14

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-13	3.35	253.55
⊠	08-13	5.18	251.72
▲	08-13	7.01	249.89
★	08-13	8.84	248.06
⊙	08-14	2.74	254.26
✿	08-14	5.18	251.82

Date March 2010

Project 2109-05-00

THURBER

Prep'd AN

Chkd. TJH

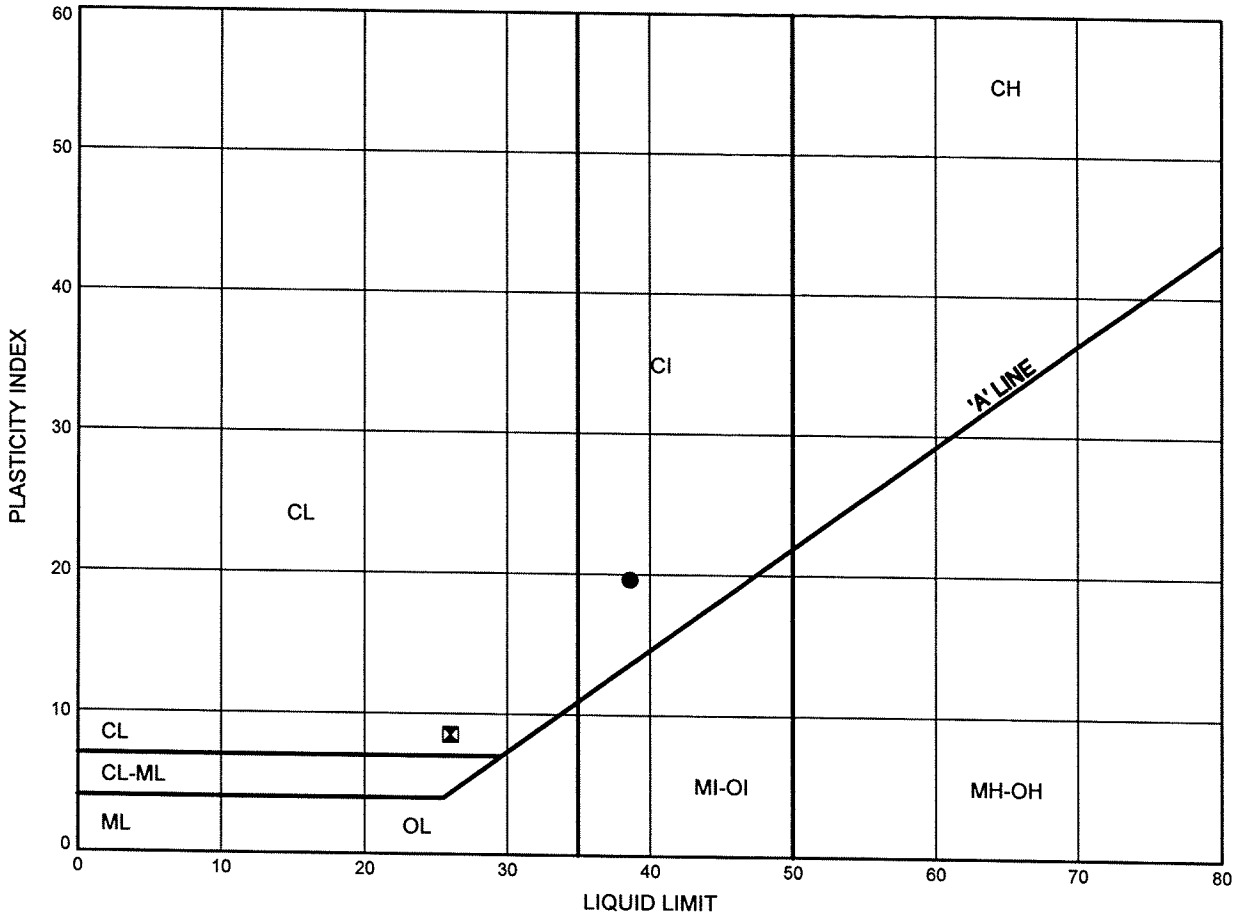
THURBALT 0596.GPJ 3/5/10

Hwy 404 Extension

ATTERBERG LIMITS TEST RESULTS

FIGURE F15

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-14	6.40	250.60
⊠	08-14	8.23	248.77

Date March 2010

Project 2109-05-00

THURBER

Prep'd AN

Chkd. TJH

THURBALT 0596.GPJ 3/5/10

Appendix G

Site Photographs

(south of Doane Road)

Culverts 5 and 6

Boreholes 08-01 to 08-05 and 08-10 to 08-14

Photograph 1 – Site location of Culvert 5

Photograph 2 – Site location of Culvert 5

Photograph 3 – Site location of Culvert 6

Photograph 4 – Site location of Culvert 6

Appendix H

Drawing titled "Borehole Locations and Soil Strata"

(south of Doane Road)

Culverts 5 and 6

Boreholes 08-01 to 08-05 and 08-10 to 08-14

METRIC

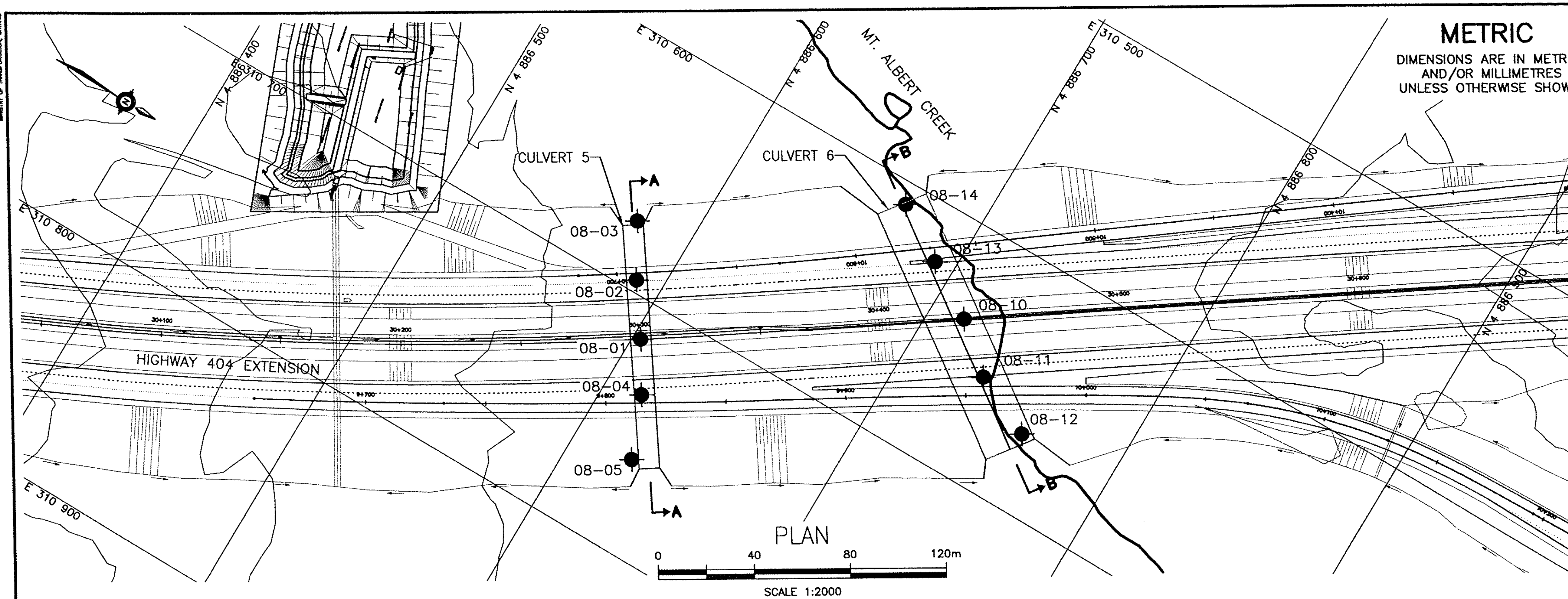
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 2109-05-00

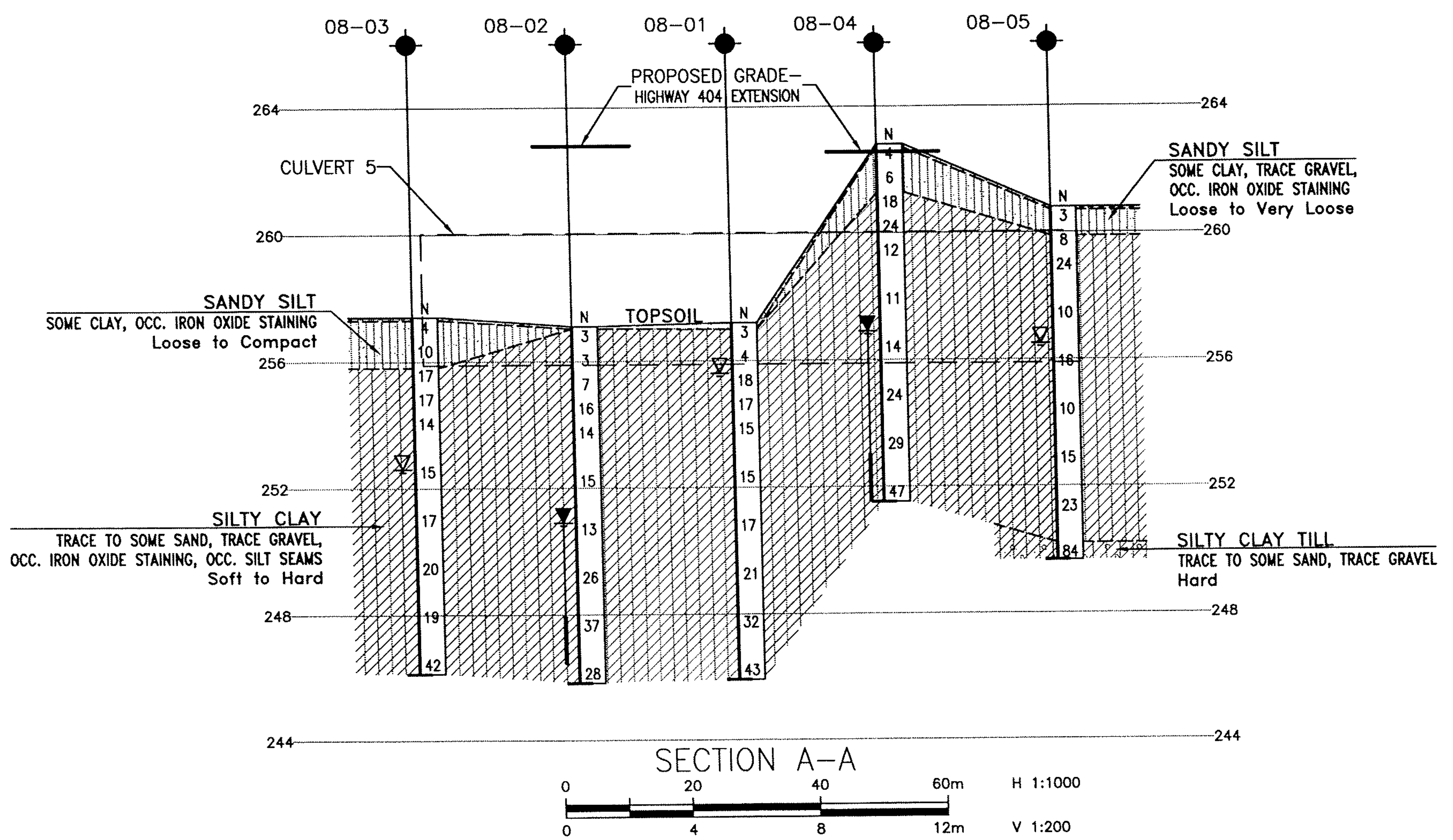
HIGHWAY 404 EXTENSION
CULVERT AT STATION 30+300
SOUTH OF DOANE ROAD
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 455

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



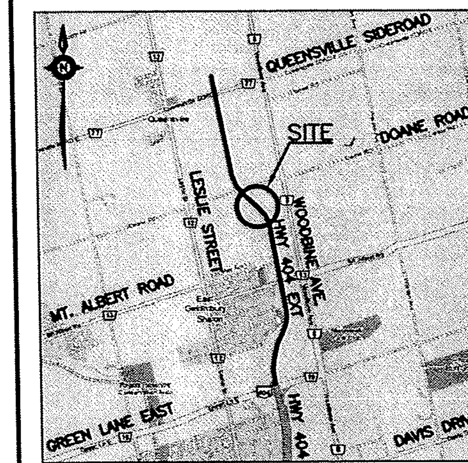
PLAN



SECTION A-A

A. E. GORMAN
REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
FEB 26/10

P. K. CHATTERJI
LICENSED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
08-01	257.2	4 886 603.3	310 715.6
08-02	257.1	4 886 589.2	310 694.9
08-03	257.4	4 886 576.9	310 673.1
08-04	262.8	4 886 615.4	310 735.7
08-05	260.8	4 886 625.7	310 761.4
08-10	257.4	4 886 714.2	310 638.6
08-11	257.0	4 886 733.4	310 655.6
08-12	258.3	4 886 759.2	310 668.1
08-13	256.9	4 886 691.6	310 623.8
08-14	257.0	4 886 669.1	310 609.1

-NOTES-

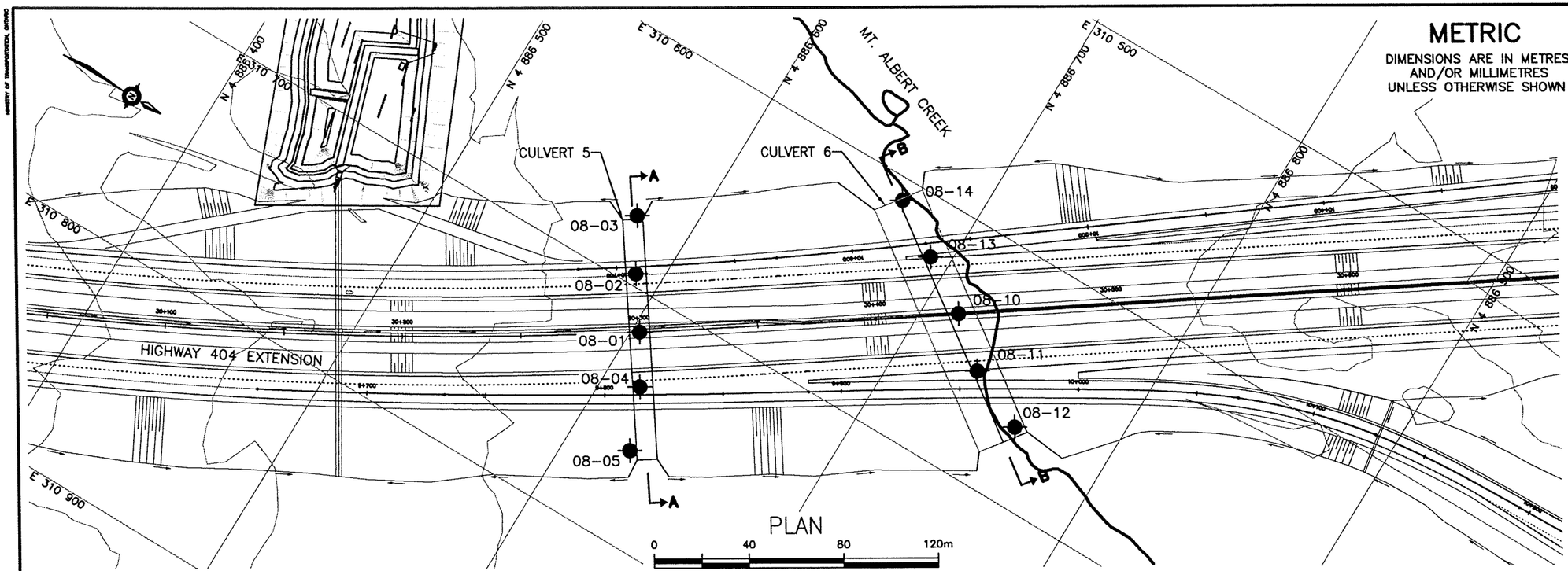
1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-493

REVISIONS	DATE	BY	DESCRIPTION		
DESIGN RPR	CHK PKC	CODE	LOAD	DATE MAR. 2010	
DRAWN MFA	CHK AEG	SITE 37-1571/C	STRUCT	DWG	

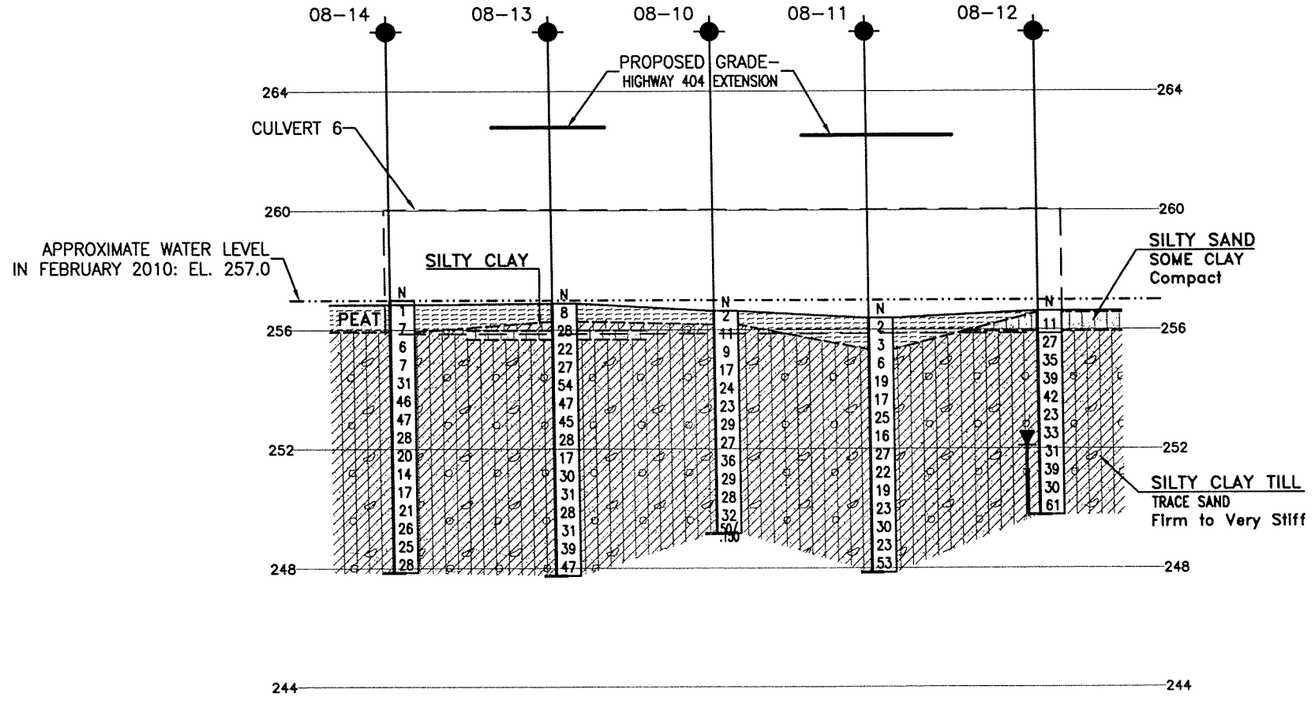
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

SCALE 1:2000



SECTION B-B

H 1:1000

V 1:200

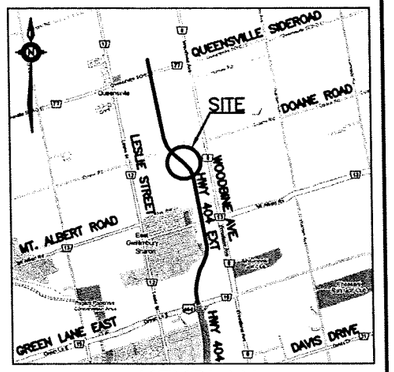
CONT No

GWP No 2109-05-00

HIGHWAY 404 EXTENSION
CULVERT AT STATION 30+430.5
SOUTH OF DOANE ROAD
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 458

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
08-01	257.2	4 886 603.3	310 715.6
08-02	257.1	4 886 589.2	310 694.9
08-03	257.4	4 886 576.9	310 673.1
08-04	262.8	4 886 615.4	310 735.7
08-05	260.8	4 886 625.7	310 761.4
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08-11	257.0	4 886 733.4	310 655.6
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08-13	256.9	4 886 691.6	310 623.8
08-14	257.0	4 886 669.1	310 609.1

REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
FEB 26/10
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Feb 26/10
PROVINCE OF ONTARIO

-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-493

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	PKC	CODE	LOAD
DRAWN	MFA	CHK	AEG	SITE 37-1572/G	STRUCT

DATE MAR. 2010

DWG

Appendix I

Foundation Comparison

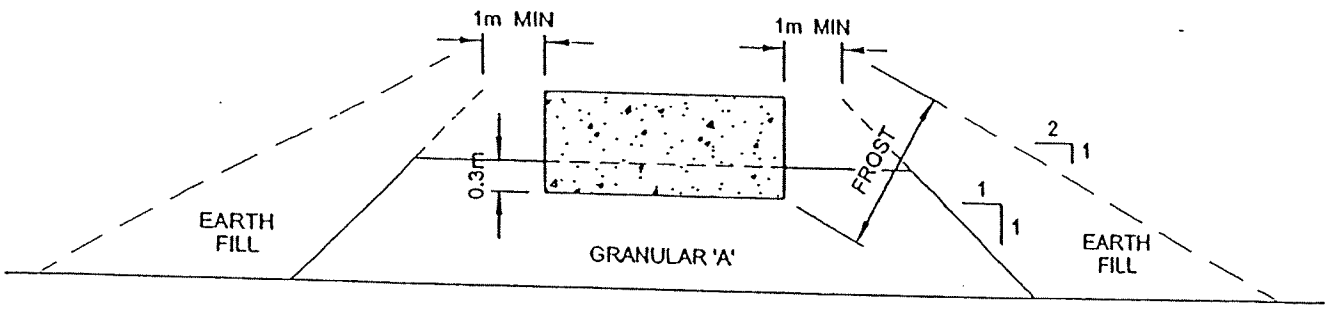
COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Open Footing Culvert on Native Soil	Footings on Engineered Fill	Closed Box Culvert
Advantages: i. Ease of construction. ii. Eliminates bedding requirement. iii. Potentially requires less excavation of creek bed iv. Consistent with the environmental requirements regarding the creek channel.	*Advantages:* i. Would permit use of higher geotechnical resistance than is available on the native soil. ii. Founding level is not governed by soil conditions. iii. Lower cost than deep foundations.	*Advantages:* i. Ease of construction. ii. Minimizes differential settlement. iii. Applies lower bearing pressures on foundation soils. iv. Lower cost than deep foundations.
Disadvantages: i. Potential settlement due to embankment loading. ii. Subexcavation may be required to penetrate soft or organic material if encountered. iii. Dewatering required prior to excavation. iv. Shallow foundations close to water would be at risk due to scour, erosion and undermining problems.	*Disadvantages:* i. Cost of construction engineered fill. ii. Potential for settlement in subgrade. iii. Subexcavation may be required to penetrate soft or organic material if encountered iv. Dewatering required prior to excavation. v. Shallow foundations close to water would be at risk due to scour, erosion and undermining problems.	*Disadvantages:* i. Requires subexcavation of soft or organic material from streambed if encountered. ii. Requires complete excavation of creek bed iii. May require dewatering prior to subexcavation at sites with cohesionless soils and high water table
RECOMMENDED	**FEASIBLE**	**FEASIBLE**

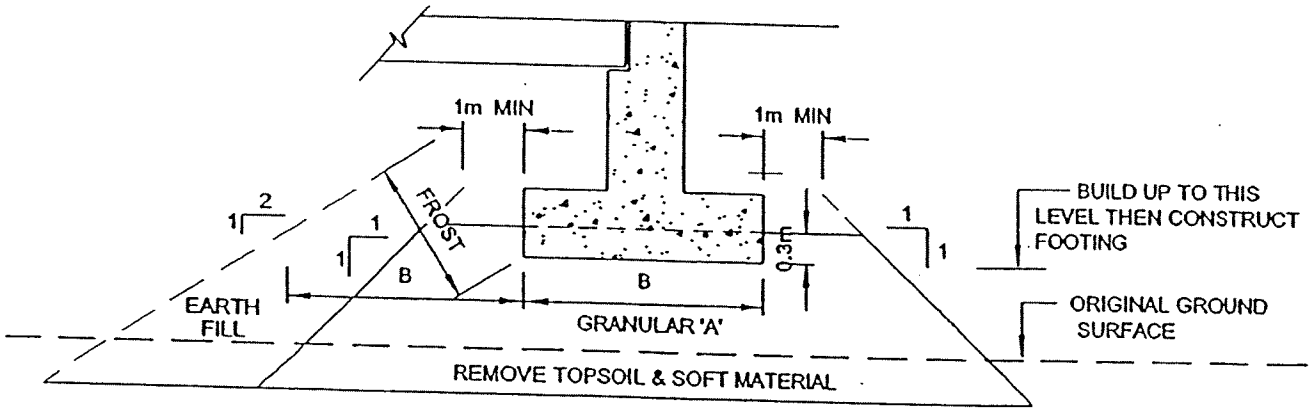
Appendix J

Figure 1

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: AEG	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR A CORE	THURBER
DRAWN: SS		
DATE: April , 2004		DWG. NO. FIGURE 1
APPROVED: PKC		
SCALE: NTS		

TED35146.DWG

Appendix K

List of SPs and OPSS, and Suggested Text for Selected NSSP

1. List of Special Provisions and OPSS Documents Referenced in this Report

- SP 902 S01
- SP 105S10
- SP 572S01
- SP 206S03
- OPSD 803.010
- OPSD 810.010
- OPSS 1205

OPSS 206, as amended by Special Provision "Amendment to OPSS 206, December 1993", dated November 2006.

2. Suggested text for a NSSP on Dewatering

The culverts for this project will carry Maskinonge River and Mount Albert Creek. Temporary stream diversion measures such as impervious dykes or cofferdams must be provided at Maskinonge River and Mount Albert Creek to divert surface water runoff and stream flow away from the culvert excavations to maintain dry excavations at all times during construction. The site of Culvert 6 was noted to be flooded. A cofferdam may be required to control this water.

The soils underlying a number of the sites are predominantly cohesionless and will be readily disturbed by unbalanced water heads or by flow of water. The Contractor shall design, install and operate systems that shall:

1. Unwater the excavations.
2. Control the flow of groundwater, surface water and river/creek water into the excavations.
3. Prevent the disturbance of the base of the excavations.
4. Prevent the sloughing of soil into the excavations.

Particular attention must be paid to the design of unwatering systems and shoring systems for foundation construction due to the proximity of the river/creek and the cohesionless nature of the overburden.

The selection and design of suitable unwatering and shoring systems shall remain the responsibility of the Contractor. Suitable systems that might be employed include:

- Pumping from properly filtered sumps may be suitable to handle the groundwater when excavations extend no more than 0.5 m below the groundwater level.
- The use of vacuum well points for deeper penetration below the groundwater level.
- Sheetpiled cofferdams assisted by vacuum well points at locations near the creek and river.

Factors that might influence the selection and design of unwatering and shoring systems include, but are by no means limited to:

- The probable water level of the river/creek during construction. The selected systems must prevent flooding of the work area due to rising river levels.

3. Suggested text for a NSSP on Culvert Construction in Flooded Area (Culvert 6)

- The Contractor is advised that standing water is expected to occur at and in the vicinity of culvert 6 site.
- All fill placed in standing water shall be rock fill and shall be placed to 150 mm above the standing water level.
- Rock fill shall not contain shale or shale fragments.
- Following placement of rock fill in accordance with SP206S03, a 300 mm layer of Granular B Type II shall be placed over the entire extent of the rock fill.

4. Suggested text for a NSSP on Rock Fill

Rock fill shall be as specified in SP 206S03, except for the following items:

Rock fill shall not contain shale or shale fragments.

Rock fragments exceeding 0.4 metre in size shall be well distributed throughout the embankment. Rock fragments up to a maximum size of 0.6 metres may be incorporated into the embankment provided that the Rock fragments are less than two-thirds the rock fill lift height and are sufficiently spaced to allow free access of the specified equipment to compact the intervening fill.

Placement in layers and compaction is not required for Rock to be placed under water. Rock placed underwater may be placed by end dumping. End dumping shall only be used to an elevation of 0.2 m above the water level after which the Embankment shall be constructed using the equipment and method specified in this special provision.

5. Suggested text for a NSSP on Subgrade Inspection and Approval

The footing subgrade for each culvert shall be inspected by the Contractor's QVE to confirm that the footings are being placed on native undisturbed compact to dense soils. Any remaining organics or soft subgrade soils shall be subexcavated and backfilled with well compacted granular backfill or 3 to 5 MPa lean mix concrete.

6. Suggested text for a NSSP Regarding Artesian Water Flow

The Contractor is advised that artesian groundwater pressures were measured at some sites.

If artesian water flow is observed, the Contractor shall immediately notify the Contract Administrator.