PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 7-NEW EBL AND WBL OVER THE GRAND RIVER
HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00

Geocres Number: 40P8-159

Report to

Ministry of Transportation Ontario
West Region

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a preliminary foundation investigation conducted at the site of the proposed structures to carry the eastbound lanes (EBL) and westbound lanes (WBL) of proposed Highway 7-New over the Grand River in the Regional Municipality of Waterloo, Ontario.

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

The information collected in the course of the investigation and presented in this report is intended for preliminary design purposes only. Additional site investigation, field testing and engineering analysis will be required at the detail design stage. The extent of the additional investigation will depend, in part, on the final location and General Arrangement of the structure.

Thurber carried out the investigation for the Ministry of Transportation Ontario, West Region (MTO) under Purchase Order Number 3006-E-0123.

In the preparation of this report, general reference has been made to information on subsurface conditions contained in a previous foundation report. The title of the report is listed as follows:

- Foundation investigation report for Grand River Bridges, EBL & WBL, Highway 7 (Wellington Street Extension), City of Kitchener, Regional Municipality of Waterloo, District #3, Stratford, W.P. 646-64-02, Site No. 33-266, Geocres Number 40P8-62, dated October 7, 1974.

2 SITE DESCRIPTION

The site for the proposed new WBL and EBL crossing lies across the valley of the Grand River on the east side of the City of Kitchener. At the site, the Highway 7-New alignment runs approximately parallel to the existing Highway 7 alignment, 750 m to the north and 1.4 km to the east of the existing Kitchener-Waterloo Expressway.

At the site location, the river channel is approximately 60.0 to 70.0 m wide and 1.5 m deep, flowing in an easterly direction. The south shoreline of the river consists of a generally level floodplain with a gentle slope towards the river channel. The floodplain is mainly vegetated with grass, shrubs and some trees. The north shoreline of the river consists of an approximately 12.0 m high cliff with an average slope of 2H : 1V, though some local steepening is evident. The slope is vegetated with grass and trees. Lands within the site are generally agricultural and undeveloped. A campground and a park currently occupy the east lands and lands to the south are generally industrial.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Waterloo Hills, characterized by ridges of sandy till and kames or kame moraines, with outwash sands occupying the intervening hollows. The surficial soils of this region overly Silurian bedrock of the Guelph Formation.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing at this site was carried out from June 24 to 27, 2008. Seven boreholes, numbered 08-060 to 08-066, were drilled for the proposed WBL and EBL bridges. All the boreholes of the current investigation were drilled on the south side of the Grand River. The termination depths of the seven boreholes ranged from 6.5 m to 14.2 m (Elevations 288.8 to 297.3).

Previous investigations conducted in 1971 and 1974 at this site (Reference 1) consisted of drilling and sampling a total of sixteen boreholes (numbered 1 to 15 and 10a) on the north and south banks/sides of the river and through the riverbed.

The Record of Borehole sheets for the current and previous investigation boreholes are included in Appendices A and C, respectively. The approximate locations of the current and previous boreholes are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix G.

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area.

The seven boreholes for the current investigation were drilled using hollow stem auger equipment mounted on a CME75 track-mounted drill rig. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Standpipe piezometers were installed in three boreholes. The standpipe piezometers consisted of 25 mm diameter PVC pipe with a slotted screen enclosed in filter sand to permit longer term groundwater level monitoring. The locations and completion details of the piezometers are shown in Table 3.1. Boreholes without piezometer installations were grouted with bentonite upon completion.

The completion of the boreholes and the standpipe piezometer installations were carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07).

Table 3.1 – Borehole Completion Details

Foundation Unit		Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
Piers	WBL	08-060	13.4/289.5	Piezometer with 1.5 m slotted screen installed with sand filter to 11.5 m, holeplug from 11.5 m to 10.9 m, grout from 10.9 m to 0.6 m, holeplug and auger cuttings to ground surface.
	EBL	08-061	5.8/298.0	Piezometer with 1.5 m slotted screen installed with sand filter to 4.0 m, then holeplug and auger cuttings to ground surface.
	WBL	08-062	No Installation	Borehole backfilled with grout to 0.6 m, then auger cuttings to surface.
	EBL	08-063	No Installation	Borehole backfilled with grout to 0.6 m, auger cuttings and holeplug to 0.3 m and auger cuttings to surface.
	EBL	08-064	No Installation	Borehole backfilled with grout to 0.6 m, then auger cuttings, sand and holeplug to surface.
South abutment	WBL	08-065	10.7/289.9	Piezometer with 1.5 m slotted screen installed with sand filter to 8.8 m, holeplug to 7.6 m, grout from 7.6 m to 0.6 m, holeplug and auger cuttings to ground surface.
	EBL	08-066	No Installation	Borehole backfilled with grout to 0.6 m, then auger cuttings, sand and holeplug to surface.

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

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A. Selected samples were also subjected to gradation analysis (sieve and hydrometer)

and Atterberg Limits testing where appropriate. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

Records of boreholes and laboratory test results from the previous investigation are included in Appendix C for reference.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendices A and C. Details of the encountered soil stratigraphy along the proposed alignment are presented in this appendix and on the "Borehole Locations and Soil Strata" drawings in Appendix G. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by topsoil/alluvium overlying native layers of sand and gravel, silty clay, clayey silt, sandy silt and silt underlain by an extensive deposit of sandy silt till.

5.1 Recent Alluvium

A layer of dark brown recent alluvium mixed with disseminated organics, some silt and trace of clay was contacted surficially in Borehole 08-060. The thickness of the alluvium was 2.4 m.

The depth to the base of the alluvium was 2.4 m (Elevation 300.5).

SPT 'N' values measured in the alluvium were 9 and 10 blows per 0.3 m of penetration, indicating a loose to compact relative density. Moisture content ranged from 30% to 39%.

5.2 Topsoil

Topsoil was identified at ground surface in Boreholes 08-061 to 08-066. The topsoil thickness ranged from 0.3 m to 1.0 m.

The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.3 Clayey Silt

A 900-mm thick layer of native clayey silt was contacted surficially in Borehole 1.

In Borehole 3, two layers of clayey silt with some sand and trace of gravel were contacted at 4.3 m and 7.0 m depth (Elevations 305.2 and 302.6). Thickness of these layers ranged from 1.0 m to 3.0 m.

Clayey silt was contacted at 2.3 m depth (Elevation 306.5) in Borehole 14. Thickness of the layer was 1.7 m. The depth to the base of the clayey silt is 4.0 m (Elevation 304.8).

SPT ' N' values measured in the clayey silt ranged from 18 blows per 0.3 m of penetration to 195 blows per 0.2 m of penetration, indicating a very stiff to hard consistency. Moisture content ranged from 10% to 30%.

Grain size distribution curves for clayey silt samples tested during the previous investigation are presented on Appendix C. The results of laboratory tests were as follows:

Soil Particles	(%)
Gravel	0
Sand	1
Silt	65
Clay	34

Liquid Limit	21 to 28
Plastic Limit	16 to 19

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

5.4 Sandy Silt/Silty Sand

Native layers of sandy silt and silty sand containing trace clay and trace to some gravel were contacted surficially in Boreholes 6 and 7. Thickness of the sandy silt/silty sand layers were 2.4 m and 1.5 m in Boreholes 6 and 7, respectively.

A layer of silty sand containing trace gravel and trace clay was contacted at 3.7 m depth (Elevation 305.5) in Borehole 15. Thickness of the silty sand layer was 2.7 m. The depth to the base of the silty sand was 6.4 m (Elevation 302.7.)

A 600-mm thick layer of brown silty sand was contacted in Borehole 08-061 below the topsoil, at 0.9 m depth (Elevation 302.9).

SPT 'N' values of the sandy silt/silty sand layers ranged from 3 to 18 blows per 0.3 m of penetration, indicating a loose to compact relative density. Higher SPT 'N" values ranging from 56 blows per 0.3 m of penetration to 87 blows per 0.15 m of penetration were measured in Boreholes 6 and 15, indicating a very dense relative density.

Moisture content ranged from 17% to 20%.

Grain size distribution curves for sandy silt/silty sand samples tested during the previous investigation are presented on Appendix C. The results of laboratory tests were as follows:

Soil Particles	(%)
Gravel	0 to 23
Sand	43 to 51
Silt	25 to 45
Clay	4 to 6

5.5 Sand and gravel

Layers of native brown to grey sand and gravel containing trace to some silt, trace clay and occasional cobbles were encountered below the alluvium and topsoil in all the boreholes drilled for the current investigation. In boreholes previously drilled, the sand and gravel layer was contacted surficially or below the clayey silt and sandy silt layers.

Depths and elevations where native sand and gravel were encountered are indicated in Table 5.1.

Table 5.1 – Depths and Elevations of Sand and Gravel

Foundation Unit		Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
South abutment	EBL	08-066	0.6 to 5.5	302.5 to 297.6	4.9
	WBL	08-065	0.6 to 6.4	300.0 to 294.2	5.8
South piers	EBL	08-064	1.0 to 5.8	299.9 to 295.1	4.8
	WBL	08-062	0.3 to 3.7	299.3 to 295.9	3.4
	EBL	08-063	0.8 to 4.9	298.1 to 294.0	4.1
	WBL	4	0.0 to 4.1	299.0 to 294.9	4.1
	EBL	08-061	1.5 to 5.5	302.3 to 298.3	4.0
	WBL	08-060	2.4 to 4.9	300.5 to 298.1	2.5
	EBL	5	0.0 to 5.5	298.6 to 293.1	5.5
	WBL	6	2.4 to 4.1	295.0 to 293.3	1.7
	EBL	7	1.5 to 4.0	296.5 to 294.0	2.5
	EBL/ WBL	1	0.9 to 2.4	295.3 to 293.8	1.5
	WBL	8	0.0 to 2.0	296.2 to 294.3	2.0
	EBL	9	0.0 to 2.9	297.2 to 294.3	2.9
	EBL	11(riverbed)	0.9 to 1.8	294.5 to 293.6	0.9
River Piers (at the Grand River)	EBL/ WBL	2 (riverbed)	0.8 to 1.2	294.6 to 294.1	0.4
North piers (at the Grand River)	EBL	13 (riverbed)	0.3 to 1.5	295.1 to 293.9	1.2
North abutment	WBL	14	0.0 to 2.3	308.8 to 306.5	2.3
	EBL	15	0.0 to 3.7	309.1 to 305.5	3.7
	EBL/ WBL	3	0.0 to 4.3 5.3 to 7.0	309.6 to 305.2 304.3 to 302.6	4.3 1.7

The layer of sand and gravel have a loose to very dense relative density with SPT 'N' values ranging from 6 to 100 blows per 0.3 m of penetration. SPT 'N' values higher than 100 blows per 0.2 m of penetration, were also measured within the sand and gravel layer at various depths. Moisture content ranged from 10% to 28%.

Grain size distribution curves for samples of the sand and gravel layers of the current investigation are presented on the Record of Borehole sheets and on Figures B1 and B2 of Appendix B. Laboratory test results for the previous investigation are presented on Appendix C.

The results of grain size distribution tests carried out on sand and gravel samples were as follows:

Soil Particles	(%)
Gravel	30 to 71
Sand	22 to 50
Silt	5 to 26
Clay	5

This sand and gravel layer may contain cobbles and boulders which may account for some high SPT 'N' values.

5.6 Silty Clay

Native brown to grey silty clay containing trace sand was observed below the sand and gravel layer in Borehole 08-060 at 4.9 m depth (Elevation 298.1). Thickness of the silty clay layer was 2.4 m.

The depth to the base of the silty clay was 7.3 m (Elevation 295.6).

SPT 'N' values measured within the silty clay were 24 and 33, indicating a very stiff to hard consistency. Moisture content was 15% to 22%.

Grain size distribution curve for one silty clay sample is presented on the Record of Borehole sheets and on Figure B3 of Appendix B. Atterberg Limits test results are presented on Figure B7 of Appendix B. The results of grain size distribution test are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	2
Silt	48
Clay	50

Liquid Limit	42
Plastic Limit	19

The above results show that the silty clay is of medium plasticity with a group symbol of Cl.

5.7 Silt

Native grey silt containing trace to some clay and trace of gravel was encountered below the silty clay in Borehole 08-060 at 7.3 m depth (Elevation 295.6). Thickness of the silt layer was 1.2 m. The depth to the base of the silt was 8.5 m (Elevation 294.4).

Native silt was also contacted below the sand and gravel layer in Borehole 6 at 4.1 m depth (Elevation 293.3). Thickness of the layer was 4.4 m. The depth to the base of the silt layer was 8.5 m (Elevation 288.9)

SPT 'N' values in the silt ranged from 58 blows per 0.3 m of penetration to higher than 75 blows per 0.1 m of penetration, indicating a very dense relative density.

Moisture content was 19 to 22 %.

Grain size distribution curve for one silt sample of the current investigation is presented on the Record of Borehole sheets and on Figure B4 Appendix B. The results of grain size distribution test were as follows:

Soil Particles	(%)
Gravel	0
Sand	5
Silt	86
Clay	9

5.8 Sandy Silt Till

Native deposits of brown to grey sandy silt till containing trace to some gravel, trace to some clay and occasional cobbles were observed in all the boreholes, generally below the sand and gravel layer. All the boreholes were terminated within the sandy silt till at depths ranging from 3.3 m to 18.3 m (Elevations 282.7 to 297.3).

Layers of gravel were encountered within the sandy silt till in Boreholes 10 and 10a at 5.8 m and 1.1 m depth (Elevations 288.9 and 294.3).

The sandy silt till deposit was contacted at depths ranging from 0.2 m to 10.1 m. Thickness of the sandy silt till was not determined, but based on the boreholes data, the thickness ranges from 1.0 m to greater than 12.3 m.

Depths and elevations where native sandy silt till were encountered are indicated in Table 5.2.

It should be noted that the boreholes in Table 5.2 were terminated in this very dense deposit without necessarily fully penetrating it. The very dense silt till may continue to greater depth, but his has not been proven.

Table 5.2 – Depths and Elevations of Sandy Silt Till

Foundation Unit		Borehole	Depth below existing ground surface (m)	Elevation (m)	Proven Thickness (m)
South abutment	EBL	08-066	5.5 to 10.7	297.6 to 292.3	5.2
	WBL	08-065	6.4 to 11.1	294.2 to 289.5	4.7
South piers	EBL	08-064	5.8 to 11.0	295.1 to 289.9	5.2
	WBL	08-062	3.7 to 7.8	295.9 to 291.7	4.1
	EBL	08-063	4.9 to 8.0	294.0 to 290.9	3.1
	WBL	4	4.1 to 12.3	294.9 to 286.7	8.2
	EBL	08-061	5.5 to 6.5	298.3 to 297.3	1.0
	WBL	08-060	8.5 to 14.2	294.4 to 288.8	5.7
	EBL	5	5.5 to 12.5	293.1 to 286.1	7.0
	WBL	6	8.5 to 12.5	288.9 to 284.9	4.0
	EBL	7	4.0 to 12.6	294.0 to 285.4	8.6
	EBL/ WBL	1	2.4 to 9.4	293.8 to 286.8	7.0
	WBL	8	2.0 to 12.5	294.3 to 283.7	10.5
	EBL	9	2.9 to 12.0	294.3 to 285.2	9.1
	EBL	11(riverbed)	1.8 to 12.6	293.6 to 282.7	10.8
River Piers (at the Grand River)	EBL/ WBL	2 (riverbed)	1.2 to 6.2	294.1 to 289.1	5.0
	WBL	10	1.4 to 12.5	294.0 to 282.9	11.1
	WBL	10a	1.1 to 3.3	294.3 to 292.1	2.2
North piers (at the Grand River)	WBL	12 (riverbed)	0.2 to 12.5	295.2 to 282.9	12.3
	EBL	13 (riverbed)	1.5 to 12.5	293.9 to 282.9	11.0
North abutment	WBL	14	4.0 to 12.3	304.8 to 296.5	8.3
	EBL	15	6.4 to 13.8	302.7 to 295.4	7.4
	EBL/ WBL	3	10.1 to 18.3	299.5 to 291.2	8.2

SPT 'N' values measured in the sandy silt till generally ranged from 66 to 142 blows per 0.3 m of penetration, indicating a very dense relative density. SPT 'N' values higher than 100 blows per 0.2 m of penetration were measured in most of the boreholes at various depths.

The natural moisture contents generally lay in the range of 8% to 19%.

Grain size distribution curves for sandy silt till samples of current and previous investigations are presented on the Record of Borehole sheets and on Figures B5 and B6 of Appendix B. Laboratory test results for the previous investigation are presented on Appendix C.

The results of grain size distribution tests were as follows:

Soil Particles	(%)
Gravel	0 to 27
Sand	18 to 53
Silt	28 to 63
Clay	3 to 17

Liquid Limit	11 to 25
Plastic Limit	10 to 18

Glacial till deposits typically contain cobbles and boulders which may account for some high SPT 'N' values and resistance to augering.

5.9 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in three boreholes of the current investigation (Boreholes 08-060, 08-061 and 08-065) to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.3, along with the measurements in the open boreholes (present and previous investigations) upon completion of drilling.

Table 5.3 – Water Level Measurements

Foundation Unit		Borehole	Date	Water Level (m)		Comment
				Depth	Elevation	
South abutment	EBL	08-066	June 27, 2008	1.8	301.3	During drilling
	WBL	08-065	July 4, 2008 August 20, 200	0.5 0.7	300.1 299.9	In piezometer
South piers	EBL	08-064	June 26, 2008	2.1	298.8	During drilling
	WBL	08-062	June 24, 2008	2.1	297.5	
	EBL	08-063	June 24, 2008	2.1	296.8	During drilling
	WBL	4	August 7, 1974	2.0	297.0	
	EBL	08-061	July 4, 2008 August 20, 2008	1.1 0.7	302.7 303.1	In piezometer
	WBL	08-060	July 4, 2008 August 20, 2008	1.5 1.2	301.4 301.7	
	EBL	5	August 7, 1974	1.5	297.0	During drilling
	WBL	6	August 12, 1974	1.5	295.9	
	EBL	7	August 15, 1974	2.1	295.9	
	EBL/ WBL	1	Nov. 29, 1971	1.1	295.1	During drilling
	WBL	8	August 13, 1974	0.6	295.6	
	EBL	9	August 4, 1974	1.1	296.1	
	EBL	11 (riverbed)	August 14, 1974	0.0	295.4	Water level at the Grand River Level
River Piers (at the Grand River)	EBL/ WBL	2 (riverbed)	Dec. 3, 1971	0.0	295.4	Water level at the Grand River Level
	WBL	10 (riverbed)	August 13, 1974	0.0	295.4	
	WBL	10a (riverbed)	August 19, 1974	0.0	295.4	
North pier	WBL	12 (riverbed)	August 19, 1974	0.0	295.4	Water level at the Grand River Level
North abutment	EBL	13 (riverbed)	August 15, 1974	0.0	295.4	Water level at the Grand River Level
	EBL/ WBL	3	Dec. 1, 1971	3.1	306.5	During drilling

Piezometric readings indicate water level near Elevations 299.9 to 303.1, indicating a possible upward gradient in the groundwater.

Water level in the Grand River was measured at Elevation 295.4 in 1974.

Water level observed in open boreholes during current investigation (Boreholes 08-062 to 08-063 and 08-066) ranged from Elevations 296.8 to 301.3.

Water level observed in open boreholes during previous investigation (Boreholes 1 and 4 to 9) ranged from Elevations 295.1 and 297.0.

Water level was measured at Elevation 306.5 in Borehole 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.

6 MISCELLANEOUS

All-Terrain Drilling of Waterloo, Ontario supplied a CME75 track-mounted drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. William Ball of Thurber, under the direction of Mr. Alastair E. Gorman, P.Eng.

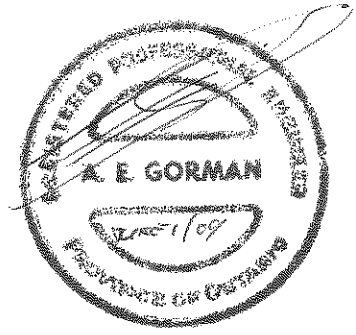
The coordinates for the boreholes and the ground surface elevations were obtained by Thurber Engineering Ltd. using GPS equipment.

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

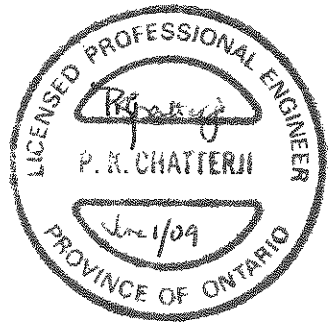
Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

Thurber Engineering Ltd.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer



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



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Review Principal, Designated MTO Contact

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents preliminary geotechnical design recommendations to assist the design team to select and design a suitable foundation system for the new structure.

Based on Plate 3 of the E.A:

- The proposed Highway 7-New EBL and WBL brigdes will cross over the Grand River. Bridge design (number of spans and piers) has not been finalized. However, a multi-span structure is anticipated with the north abutment close to the north valley slope and the south abutment approximately 450.0 m to the south. There will be several intermediate piers.
- At the south abutment, the finished grade of Highway 7-New will be at Elevation 312.0; existing ground surface lies at Elevations ranging from 300.6 to 303.1. The resulting embankment height above original ground level will be in the order of 9.0 m to 12.0 m at the south abutment.
- At the north abutment, the finished grade of Highway 7-New will be at Elevation 308.3. Based on Boreholes 3, 14 and 15, drilled during the previous investigation at the north side of the river, the ground surface elevation ranged from 308.8 to 309.6; 0.5 m to 1.3 m above the proposed finished grade of Highway 7-New.

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

8 STRUCTURE FOUNDATIONS

The stratigraphy identified in the previous as well as the current preliminary investigation consisted primarily of topsoil/alluvium overlying native layers of very stiff to hard clayey silt, loose to very dense silty sand/sandy silt, compact to very dense sand and gravel, very stiff to hard silty clay, very dense silt and very dense sandy silt till.

The groundwater levels measured in the piezometers ranged from Elevations 299.9 to 303.1. Water level observed during current investigation in open boreholes varied from Elevations 296.8 to 301.3 in the current investigation and from Elevations 295.1 and 297.0 during previous investigation. Water level of the Grand River was at elevation 295.4 in 1974.

In the preparation of the preliminary geotechnical design recommendations, consideration was given to the following foundation types:

- Spread footings bearing on native soil
- Spread footings on engineered fill
- Augered Caissons in very dense glacial till (drilled shafts)
- Steel H-piles driven into the very dense soil

A comparison of the foundation alternatives based on advantages and disadvantages of each is included in Appendix C.

8.1 Spread Footings on Native Soil

Spread footings bearing on native soil generally are the least expensive form of construction. However, at river crossings, the potential for scour to undermine the foundations must be taken into account.

The design of spread footings bearing on native undisturbed compact to very dense sand and gravel layer or very dense sandy silt till must be in accordance with the elevations and bearing resistances given in Table 8.1.

Table 8.1 – Bearing Resistances for Spread Footings on Highest Permissible Founding Elevation

Foundation Unit		Borehole	Depth (m)	Highest Permissible Founding Elevation [1]	ULS_f (kPa)	SLS (kPa)	Soil
South abutment	EBL	08-066	1.6	301.5	750	500	Very dense sand and gravel
	WBL	08-065	0.8	299.8			
South piers	EBL	08-064	2.4	298.5	750	500	Very dense sand and gravel
	WBL	08-062	0.8 2.1	298.8 297.5	450 750	300 500	Dense sand and gravel Very dense sand and gravel
	EBL	08-063	1.0 3.1	297.9 295.8	300 750	200 500	Dense sand and gravel Very dense sand and gravel
	WBL	4	1.0 3.1	298.0 296.0	450 750	300 500	Dense to very dense sand and gravel
	EBL	08-061	2.3 2.8	301.5 301.0	600 750	400 500	Very dense sand and gravel
	WBL	08-060	2.9 7.4	300.0 295.5	300 600	200 400	Compact sand and gravel Very dense sand and gravel
	EBL	5	2.9	295.7	750	500	Very dense sand and gravel
	WBL	6	2.5 6.5	295.0 291.0	600 750	400 500	Very dense sand and gravel
	EBL	7	3.0 6.0	295.0 292.0	450 750	300 500	Dense sand and gravel Very dense sandy silt till
	EBL/ WBL	1	2.4	293.8	750	500	Very dense sand and gravel
	WBL	8	2.0	294.2			Very dense sandy silt till
	EBL	9	3.0	294.2			
	EBL	11 (riverbed)	1.8 (0.9m below riverbed)	293.6			

Table 8.1 – Bearing Resistances for Spread Footings on Highest Permissible Founding Elevation (Cont'd)

Foundation Unit		Borehole	Depth (m)	Highest Permissible Founding Elevation [1]	ULS_f (kPa)	SLS (kPa)	Soil
River Piers (at the Grand River)	EBL/ WBL	2 (riverbed)	0.56 (0.56 below riverbed)	294.0	750	500	Very dense sand and gravel
	WBL	10 (riverbed)	0.61	293.4	750	500	Very dense sandy silt till
	WBL	10a (riverbed)	2.3	292.1	750	500	Very dense sandy silt till
North piers (at the Grand River)	WBL	12 (riverbed)	1.1	294.1	750	500	Very dense sandy silt till
	EBL	13 (riverbed)	1.3	293.8			
North abutment	WBL	14	4.0	304.8	550[2]	350[2]	Very dense sandy silt till
	EBL	15	2.1	307.1	550[2]	350[2]	Very dense sand and gravel
	EBL/ WBL	3	1.6 6.6	308.0 303.0	300[2] 550[2]	200[2] 350[2]	Dense to very dense sand and gravel

[1] Highest permissible founding elevations have been provided, ignoring scour, erosion or other geomorphological processes that could have impacts on the configuration of the riverbed or valley slopes.

[2] Correction for proximity to the slope

If footings are selected, they must be founded at an elevation that a river hydrologist determines will protect them against undermining by scour. During the detail design stage, it is essential that there be discussions between structural engineer, the foundation consultant, a river hydrologist and a geomorphologist to determine appropriate founding elevations.

Similarly, the recommendations have been predicated on the north valley slope remaining in its present location. This is recognized to be an unrealistic assumption and during the detail design stage, it is essential that the rate of regression of the slope be assessed and either:

- The north abutment be set back.
- The valley slope be armoured to prevent regression.
- The location/design of the abutment take account of regression.

The bearing resistances in Table 8.1 are for vertical, concentric loading. In the case of eccentric or inclined loading, the bearing resistance must be adjusted as shown in the CHBDC (2006) Clause 6.7.3 and Clause 6.7.4.

The geotechnical SLS resistance values given above are based on an estimated total settlement not exceeding 25 mm. This settlement is expected to be substantially complete by the end of construction. Differential settlement is not expected to exceed 20 mm across the width of the structure or between foundation elements.

Groundwater was measured at elevations ranging from 299.9 to 303.1, during the present investigation, generally above the proposed footings base elevation, except for north abutment footings. Groundwater control measures will be required prior to excavation to construct the footings in the dry, to prevent sloughing of the sides and to prevent disturbance of the footing bases due to the inflow of groundwater.

The design of the groundwater control requirements must be addressed during detail design. However, issues that must be taken into account are:

- Problems associated with installing well points or gravity wells.
- The permeability of the very dense soils.
- Problems associated with driving steel sheet pile cofferdams into very dense soils.

8.2 Spread Footings on Engineered Fill

The dense to very dense soils at this site would provide good founding conditions for engineered fill pads.

However, raising footings on engineered fill pads appears to be contrary to the requirements for scour protection. Accordingly, this option has not been developed for preliminary design at this site.

If necessary, the option can be evaluated further during detail design.

8.3 Augered Caissons on Very Dense Sandy Silt Till (Drilled Shafts)

Drilled shaft foundations were considered for the support of structural loads at this site. Since the caisson is a deep foundation unit, higher geotechnical resistance is available from a caisson in earth than from a similar sized spread footing.

The caissons must be founded in the very dense sandy silt till or sand and gravel at depths and elevations indicated in Table 8.2. Caisson lengths should be at least 6.0 m and each

caisson should extend 4.5 m into the "100-blow" soils. The caisson depths provided in Table 8.2 do not consider scour, erosion or other geomorphological processes that may influence the depth of caisson.

Table 8.2 – Founding Elevations for Augered Caissons

Foundation Unit		Borehole	Founding Depth (m)	Founding Elevation
South abutment	EBL	08-066	6.1	297.0
	WBL	08-065	6.6	294.0
South piers	EBL	08-064	6.9	294.0
	WBL	08-062	6.6	293.0
	EBL	08-063	6.9	292.0
	WBL	4	8.0	291.0
	EBL	08-061	6.8	297.0
	WBL	08-060	11.9	291.0
	EBL	5	7.1	291.5
	WBL	6	10.5	287.0
	EBL	7	10.0	288.0
	EBL/WBL	1	7.2	289.0
	WBL	8	6.2	290.0
	EBL	9	7.2	290.0
	EBL	11 (riverbed)	6.5	289.0
River Piers (at the Grand River)	EBL/WBL	2 (riverbed)	6.6	288.0
	WBL	10 (riverbed)	6.0	288.0
	WBL	10a (riverbed)	6.3	288.0
North piers (at the Grand River)	WBL	12 (riverbed)	6.2	289.0
	EBL	13 (riverbed)	6.1	289.0
North abutment	WBL	14	7.8	301.0
	EBL	15	10.1	299.0
	EBL/WBL	3	10.6	299.0

Typical preliminary geotechnical resistance has been calculated for a range of caisson diameters and founding depths given in Table 8.2. The values are shown in Table 8.3.

Table 8.3 – Vertical Geotechnical Resistance for Caisson Foundations

Caisson Diameter (m)	Typical Preliminary Axial Geotechnical Resistance	
	Factored ULS_r (kN)	SLS (kN)
1.5	10,000	8,000
2.0	16,000	12,000

The geotechnical resistances for caissons have been assessed on the basis of static analysis. It is anticipated that the bridge design may incorporate relatively long spans and correspondingly high foundation loads. If this is the case, caissons may present a cost effective foundation option provided the geotechnical resistance used in design can be optimized.

After the General Arrangements of the bridges have been finalized, the geotechnical information should be carefully reviewed to determine if further investigation and testing is warranted. Consideration should be given to optimizing the design geotechnical resistance through carrying out a full-scale load test on a prototype caisson during the detail design stage. Testing typically would involve installing a full-scale caisson to the design founding elevation, instrumenting the caisson and applying a test load. Statnamic testing is one loading scheme that could be considered.

In addition to full-scale testing, the constructability review must be carried out early in the detail design phase. It is considered essential that the constructability review team includes a contractor with extensive local experience with caisson construction in similar conditions.

If caissons are pursued for foundation support, additional boreholes should be drilled during detailed phase design to reassess caisson design and installation techniques.

Caisson installation should be in accordance with Special Provision No. 903S01.

8.4 Steel H-Piles

Steel H-piles can be considered for the foundations of the Grand River Bridge. However, the feasibility of driven piles at the piers and north abutments is limited by the fact that very dense soil conditions exist close to the existing surface. At the south abutment, piles driven through the approach fill may offer a more practical foundation alternative.

Table 8.4 shows the elevations at which piles driven from the existing ground surface are expected to achieve refusal and the corresponding pile length, measured from existing ground surface or river bed. In a number of cases, these pile lengths are too short to be practical. In fact, it is anticipated that pile caps will generally be constructed below the existing ground surface or the river bed and to depths that will provide protection against scour, resulting in the underside of the pile cap being at or very close to the elevation where pile driving will be impractical.

If the option of driven piles is carried forward in design, the minimum recommended pile length is 6.0 m form the underside of the pile cap. To achieve these lengths, it will be necessary to pre-auger most of the piles before driving.

Table 8.4 – Estimated Pile Tip Elevation

Foundation Unit		Borehole	Anticipated Pile Length (m)	Refusal Elevation
South abutment	EBL	08-066	2.6	300.5
	WBL	08-065	2.1	298.5
South piers	EBL	08-064	3.9	297.0
	WBL	08-062	3.4	296.2
	EBL	08-063	4.9	294.0
	WBL	4	4.0	295.0
	EBL	08-061	4.8	299.0
	WBL	08-060	11.9	291.0
	EBL	5	5.1	293.9
	WBL	6	7.9	289.6
	EBL	7	8.4	289.6
	EBL/WBL	1	4.6	291.6
	WBL	8	4.6	291.6
	EBL	9	5.6	291.6
	EBL	11 (riverbed)	5.0	290.4
River Piers (at the Grand River)	EBL/WBL	2 (riverbed)	4.9	290.5
	WBL	10 (riverbed)	4.9	290.5
	WBL	10a (riverbed)	-	-
North piers (at the Grand River)	WBL	12 (riverbed)	4.3	291.1
	EBL	13 (riverbed)	4.3	291.1
North abutment	WBL	3	7.8	301.8
	EBL	14	6.1	302.7
	EBL/WBL	15	7.6	301.5

8.4.1 Axial Resistance

For preliminary design, the vertical, axial, factored geotechnical resistance at Ultimate Limit States (ULS) and geotechnical resistance at Serviceability Limit States (SLS) for two pile sections when driven into the very dense sandy silt till are presented in Table 8.5.

Table 8.5– Axial Resistance of Two Pile Sections Founded on Very Dense Soils

Pile Section	Geotechnical Resistance (kPa)	
	Factored ULS	SLS
HP 310 X 110	1,600	1,400
HP 360 X 132	1,800	1,600

The structural resistance of the pile must be checked by the structural designer.

Installation of the piles must be in accordance with SP 903S01 and must be controlled using the Hiley Formula and an ultimate resistance of 3,200 kN for an HP 310 X 110 pile and 3,600 kN for the HP 360 X 132 pile.

These are preliminary recommendations and may change during detail design based on the final alignment, final bridge arrangement and the results of the site investigation and field testing to be completed at that time.

Due to the very dense nature of the founding stratum and the possible presence of cobbles and boulders, the tips of all driven piles should be fitted with cast steel, H-section rock points from approved manufacturer such as Titus Steel (Standard H-point) or APF hard Bite or approved equivalent.

8.4.2 Downdrag

Downdrag on the piles is not an issue at this site.

8.5 Abutment Design Considerations

Based on the length and curvature of the deck, integral and semi-integral abutments have not been considered at this stage.

It has been assumed that a conventional abutment will be designed.

8.6 Frost Cover

The design depth of frost penetration for this site is 1.4 m. All footing bases and undersides of pile caps/abutment stems must be provided with at least 1.4 m of soil cover.

8.7 Recommended Foundation

Selection of the recommended foundation type for this site should be carried out during detail design and after consultation with the structural designers regarding the structure arrangement and when the loads on the abutments and piers are known. However the following points should be borne in mind:

1. At the south abutment, the preferred foundation will most probably be steel H-piles driven through the approach fill and into the very dense native soil as described elsewhere in this report.

2. At piers that are away from the river, spread footings founded on the very dense native soils will probably be the most cost-effective. However, issues of erosion due to a changing river channel and issues of groundwater control must be addressed during detail design.

3. Depending on the structural loads to be resisted, spread footings may not provide sufficient geotechnical resistance at an economical size and deep foundations must then be considered.

4. In or close to the river channel, spread footings are not recommended unless they can be founded at depths below the predicted scour depth. Spread footing construction must be carried out in unwatered cofferdams.

5. At the river channel, caisson foundations using permanent steel casing sealed into the very dense, low-permeability till may prove to be the preferred, cost-effective option.

6. At the north abutment, a spread footing is expected to be the preferred option, unless deep foundation units have to be used on account of concerns over the long-term stability of the valley slope.

9 BRIDGE APPROACHES AND EMBANKMENTS

Based on the boreholes drilled at the site, the approach embankments will be constructed over compact to very dense sand and gravel.

Preliminary analysis indicates that at the south abutment, settlement in the order of 35 to 45 mm is estimated in the foundation soils under the loading imposed by approximately 12.0 m of the approach fill. Due to the compact to very dense nature of the general cohesionless foundation soils, these settlements will be immediate and essentially completed when construction of the fill is completed. A more detailed settlement analysis should be conducted during the detail phase design.

The 9.0 m to 12.0 m high embankments likely to be constructed will be stable with side slopes of 2H:1V if constructed using SSM or granular fill. In earth fill embankments a berm should be incorporated in the design for every 8.0 m of height, e.g. a 12.0 m high embankment requires one berm. The berms should:

- extend for the full length of each 8.0 m increment of embankment height
- be at least 2 m wide
- have 2% positive grade to shed run-off water.

For the purpose of preliminary embankment stability analyses, the commercially available slope stability program GSLOPE developed by Mitre Software Inc. was used. The Bishop's simplified method for stability analysis was employed.

Global stability analyses were conducted for a 12.0 m high, 2H:1V SSM or earth fill embankment. The stability of the embankment was also checked under seismic loading assuming an acceleration of 0.08g. The computed factors of safety are as shown in Table 9.1. Slope stability computation outputs are included in Appendix E.

Table 9.1 Computed Factors of Safety

Location / Material	Condition	Factor of Safety	Figure (Appendix E)
12 m High –South Abutment			
Earth Fill	Normal	1.6	1
Earth Fill	Seismic = 0.08g	1.3	2

These factors of safety are considered to be acceptable for the proposed embankment bearing on the foundation soils present at this site.

The global, internal and surficial stability of the approach embankment fills should be further evaluated during the detail design phase.

During detail design, when the grade has been finalized, permanent drainage and slope protection requirements must be addressed.

10 CONSTRUCTION CONCERNS

The construction concerns affecting this site will become apparent as the design of the structures and their foundations is developed. There are, however, a number of potential issues that can be identified at this stage that it should be possible to mitigate through design and operational constraints developed at the detail design stage. These include:

1. **Constructability**

   The soils encountered at this site will provide relatively high values of geotechnical resistance. However, since there are very dense soils occurring relatively close to the ground surface, it will be difficult to advance driven H-piles or sheet piles. The requirement to pre-auger for both structural piles and sheet piles must be addressed.

2. **Control of groundwater**

   Depending on the depth of excavation required, groundwater control may be necessary and must be implemented in a way that does not jeopardize the integrity of the foundation excavation.

   In this regard, attention should be paid to the possible upward hydraulic gradient noted in Section 5.9.

3. **Caisson installation**

   The native sand and gravel layer and glacial till are very dense at this site and augering for caisson installation may be laboured. The caisson installation equipment should be able to dislodge and remove any obstructions or cobbles and boulders in the till.

   The cohesionless soils would be susceptible to disturbance under conditions of unbalanced hydrostatic head. Temporary liners should be installed to support the caisson sidewalls and provide seepage cut-off where required.

   The permeable nature of the overburden soil and the presence of boulders would make it difficult to seal the bottom of the caisson liner into the founding stratum to exclude groundwater. Unwatering of the caisson would be impractical and attempts to do so might result in continued flow of fines into the caisson excavation.

11 INVESTIGATION FOR DETAIL DESIGN

The requirements for detail design must be determined after the locations and GAs of the bridges have been established. At that time, the existing pattern of borehole should be superimposed on the GAs in order to determine the extent of additional investigation that may be required.

Typically, it is recommended that there be a minimum of one sampled borehole at each foundation element for deep foundation design and a minimum of two for shallow foundation design. Boreholes will also be required at the approaches to the two structures.

The investigation, analysis and recommendations produced during detail design must also address:

1. Stability, creep and erosion of the north valley slope. This is a design exercise that must include input from a river hydrologist and a geomorphologist.
2. The constructability of the foundation option eventually chosen for the bridges. Issues that may have to be addressed include groundwater control and the feasibility of advancing deep foundation elements and installing sheet pile cofferdams.
3. If excavation below the groundwater level will be required, the possibility of a requirement to obtain a permit to take water (PTTW) should be investigated.

4. If the final geotechnical design recommendations include dewatering, this should be referred to a hydrogeologist for assessment of possible impacts on aquifers supplying drinking water in the area, including the municipal well field.

12 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.

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

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

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

$\overline{\blacktriangledown}$ 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			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

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

STRENGTH CLASSIFICATION

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

THURBER

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-060 1 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 513.62 E 227 303.57 ORIGINATED BY WB
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY EA
DATUM Geodetic DATE 2008.06.25 - 2008.06.25 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 + 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
302.9							303				
0.0	**RECENT ALLUVIUM**, some silt, trace clay, mixed with disseminated organics Stiff Dark Brown Damp		1	AS							
			1	SS	9		302				
			2	SS	10		301				
300.5											
2.4	**SAND** and **GRAVEL**, trace to some silt, trace clay, occasional cobbles Compact to Dense Brown Wet		3	SS	16						
			4	SS	30		300				42 43 15 (SI+CL)
	Auger grinding at 3.7m.						299				
298.1			5	SS	24		298				
4.9	Silty **CLAY**, trace sand Very Stiff to Hard Brown to Grey										
			6	SS	33		297				0 2 48 50
295.6							296				
7.3	**SILT**, trace sand, trace clay Very Dense Grey Moist		7	SS	78		295				0 5 87 9
294.4											
8.5	Sandy **SILT**, trace to some clay, trace gravel Very Dense Grey Moist (TILL)		8	SS	77		294				

Continued Next Page

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

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-060 2 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 513.62 E 227 303.57 ORIGINATED BY WB

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY EA

DATUM Geodetic DATE 2008.06.25 - 2008.06.25 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 / SHEAR STRENGTH kPa (20 40 60 80 100; 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						293				
	Sandy **SILT**, trace to some clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/ .275		292		o		3 37 50 10
	occasional cobbles		10	SS	100/ .275		291		o		
							290				
288.8			11	SS	100		289		o		
14.2	END OF BOREHOLE AT 14.2m. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. Water table at 2.1m WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.07.04 1.5 301.4 2008.08.20 1.2 301.7										

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

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

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-061 1 OF 1 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 500.79 E 227 356.47 ORIGINATED BY WB
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.25 - 2008.06.26 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 + 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
303.8											
0.0	**TOPSOIL**, trace clay, occasional organics Brown Damp		1	AS					○		
302.9							303				
0.9	Silty **SAND**, trace clay, trace gravel Loose Brown Damp		1	SS	7				○		
302.3							302		○		
1.5	**SAND** and **GRAVEL** Compact to Very Dense Brown to Grey Moist		2	SS	18						
	Wet		3	SS	71				○		46 39 15 (SI+CL)
	Auger grinding at 3.0m.		4	SS	100/ 275		301		○		
							300				
			5	SS	100/ .200				○		
298.3							299				
5.5	Sandy **SILT**, some clay, occasional cobbles Very dense Grey Damp (TILL)						298				
297.3			6	SS	100/ .250				○		1 42 46 11
6.5	END OF BOREHOLE AT 6.5m. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2008.07.04	1.1	302.7
2008.08.20	0.7	303.1

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-062 1 OF 1 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 419.58 E 227 281.40 ORIGINATED BY WB
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.24 - 2008.06.24 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 / 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
299.6											
0.0 / 299.3	**TOPSOIL:** (300mm), occasional organics Brown Damp		1	AS	15						
0.3	**SAND** and **GRAVEL**, trace to some silt, trace clay Compact to Dense Brown Damp		1	SS	38		299				
	occasional cobbles		2	SS	42	▽	298				
	Very Dense		3	SS	100/ .225		297				44 39 17 (SI+CL)
295.9			4	SS	100/ .275						
3.7	Sandy **SILT**, some gravel, trace clay Very Dense Brown to Grey Moist (TILL)						296				
			5	SS	100		295				27 45 28 (SI+CL)
	Slow augering.						294				
			6	SS	100/ .225		293				7 40 43 10
291.7			7	SS	100/ .225		292				
7.8	END OF BOREHOLE AT 7.8m. WATER OBSERVED AT 2.1m DURING DRILLING. BOREHOLE BACKFILLED WITH GROUT TO 0.6m, THEN AUGER CUTTINGS TO SURFACE.										

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

(%) STRAIN AT FAILURE

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-063 1 OF 1 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 457.16 E 227 352.22 ORIGINATED BY WB

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA

DATUM Geodetic DATE 2008.06.24 - 2008.06.24 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 (40 80 120 160 200) ○ 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
298.9											
0.0	**TOPSOIL**, some organics, trace clay Brown Moist		1	AS					○		
298.1											
0.8	**SAND** and **GRAVEL**, trace clay, occasional cobbles Compact to Dense Brown Moist		1	SS	35		298		○		
			2	SS	40	▽	297		○		
			3	SS	14				○		50 39 11 (SI+CL)
	Auger grinding at 3.0m. Very Dense		4	SS	100/ .050		296		○		
294.0							295				
4.9	Sandy **SILT**, some clay Very Dense Brown to Grey Damp (TILL)		5	SS	100/ .300		294		○		
	slow augering at 5.8m.		6	SS	100/ .225		293		○		2 45 41 12
							292				
290.9			7	SS	100/ .200		291		○		
8.0	END OF BOREHOLE AT 8.0m. WATER OBSERVED AT 2.1m DURING DRILLING. BOREHOLE BACKFILLED WITH GROUT TO 0.6m, HOLEPLUG AND AUGER CUTTINGS TO 0.3m, THEN AUGER CUTTINGS TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-064 1 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 360.98 E 227 325.43 ORIGINATED BY WB
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.26 - 2008.06.26 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 + 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
300.9											
0.0	**TOPSOIL**, trace clay, occasional organics Brown Moist		1	AS					○		
299.9											
1.0	**SAND** and **GRAVEL**, trace clay, trace silt, occasional cobbles Loose Brown Damp		1	SS	17		300		○		
			2	SS	10	▽	299		○		
	Very Dense		3	SS	100/ .225				○		
			4	SS	91		298		○		51 39 10 (SI+CL)
	Auger grinding at 4.6m.		5	SS	100/ .200		297		○		
295.1							296				
5.8	Sandy **SILT**, trace to some clay, trace gravel Very Dense Grey Damp (TILL) Slow augering at 5.8m.		6	SS	100/ .275		295		○		
			7	SS	100/ .150		294		○		7 53 32 8
	occasional cobbles		8	SS	100/ .125		293		○		
							292		○		
							291				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-064 2 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 360.98 E 227 325.43 ORIGINATED BY WB

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA

DATUM Geodetic DATE 2008.06.26 - 2008.06.26 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
289.9	Sandy **SILT**, trace to some clay, trace gravel Very Dense Grey Damp (TILL)		9	SS	100/ .175		290		○		
11.0	END OF BOREHOLE AT 11.0m. WATER OBSERVED AT 2.1m DURING DRILLING. BOREHOLE BACKFILLED WITH GROUT TO 0.6m, THEN AUGER CUTTINGS, SAND AND HOLEPLUG TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 08-065 1 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 318.04 E 227 257.28 ORIGINATED BY WB
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.27 - 2008.06.27 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) / WATER CONTENT (%) (PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
300.6										
0.0	**TOPSOIL**, some clay Brown Damp		1	AS						
300.0										
0.6	**SAND** and **GRAVEL**, trace to some silt, trace clay Very Dense Brown Damp		1	SS	100/.150		300			
	occasional cobbles		2	SS	100/.175		299			
			3	SS	100/.200		298			
	Auger grinding at 3.0m. occasional cobbles		4	SS	100/.200		297			38 50 13 (SI+CL)
			5	SS	100		296			
294.2							295			
6.4	Sandy **SILT**, trace to some clay, trace gravel Very Dense Grey Moist (TILL)		6	SS	89		294			3 41 45 12
			7	SS	100/.175		293			
							292			
			8	SS	100/.150		291			1 39 46 14

Continued Next Page

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-065 2 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 318.04 E 227 257.28 ORIGINATED BY WB

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA

DATUM Geodetic DATE 2008.06.27 - 2008.06.27 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 / 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							20 40 60 80 100 / 40 80 120 160 200	20 40 60		
	Sandy **SILT**, trace to some clay, trace gravel Very Dense Grey Moist (TILL)										
289.5			9	SS	100/ 275		290		o		
11.1	END OF BOREHOLE AT 11.1m. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2008.07.04	0.5	300.1
2008.08.20	0.7	299.9

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

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

ONTMT4S 6417R.GPJ 3/4/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-066 1 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 308.83 E 227 314.29 ORIGINATED BY WB

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA

DATUM Geodetic DATE 2008.06.26 - 2008.06.27 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: 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
303.1											
0.0	**TOPSOIL**, trace clay, occasional organics Brown Damp		1	AS			303				
302.5											
0.6	**SAND** and **GRAVEL**, trace silt, trace clay, occasional cobbles Dense to Very Dense Brown Damp to Wet		1	SS	32		302				
			2	SS	100	▽					
			3	SS	100/.175		301				
			4	SS	100/.150		300				
			5	SS	100/.125		299				44 50 6 (SI+CL)
297.6							298				
5.5	Sandy **SILT**, trace to some clay, some gravel, occasional cobbles Very Dense Grey Moist (TILL)		6	SS	100/.075		297				
			7	SS	100/.150		296				
			8	SS	100/.125		295				
							294				11 37 39 13

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-066 2 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 815 308.83 E 227 314.29 ORIGINATED BY WB

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA

DATUM Geodetic DATE 2008.06.26 - 2008.06.27 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 (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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy **SILT**, trace to some clay, some gravel, occasional cobbles Very Dense Grey						293				
292.3	Moist										
10.7	(TILL)		9	SS	100/ .075						
	END OF BOREHOLE AT 10.7m. WATER LEVEL AT 1.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH GROUT TO 0.6m, THEN AUGER CUTTINGS, SAND AND HOLEPLUG TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 6417R.GPJ 3/4/09

Appendix B

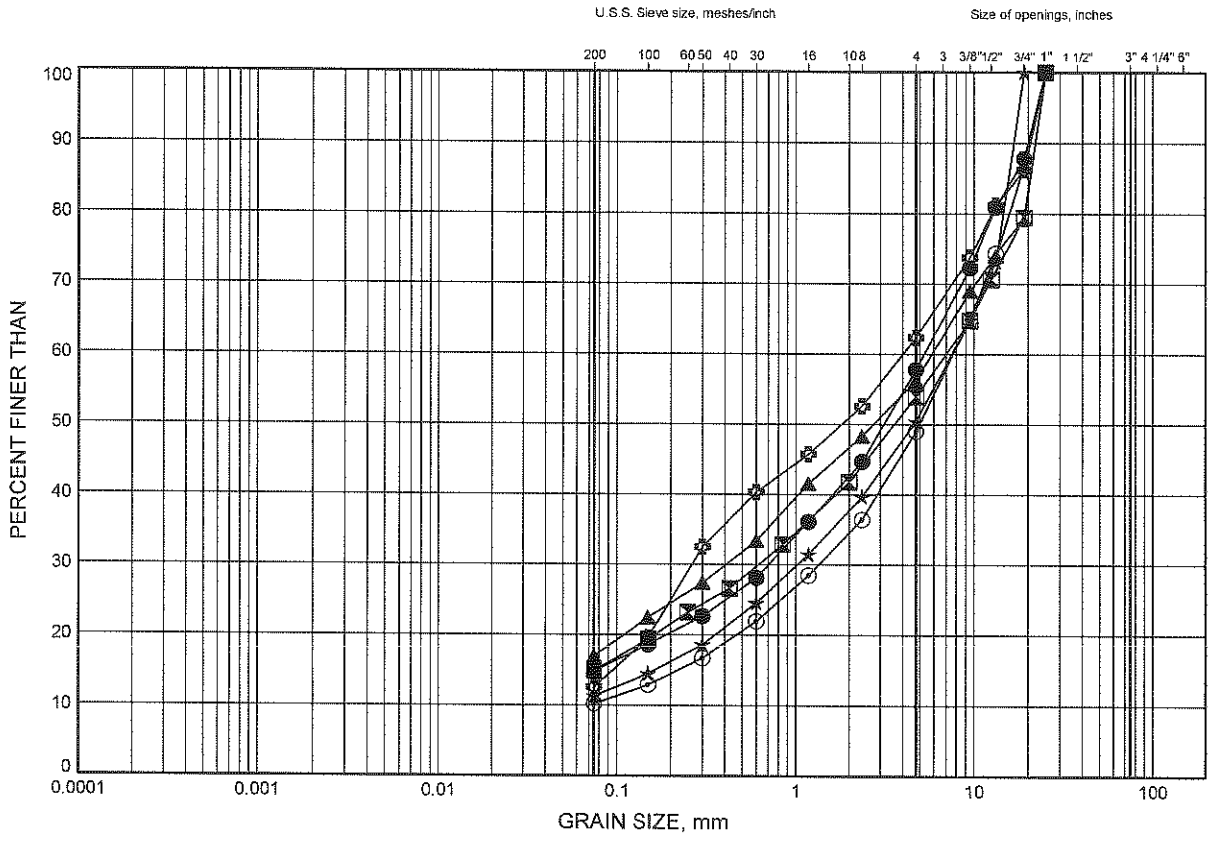
Laboratory Test Results

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B1

Sand and Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-060	3.35	299.58
⊠	08-061	2.59	301.20
▲	08-062	2.59	297.01
☆	08-063	2.59	296.29
⊙	08-064	3.35	297.55
✿	08-065	3.15	297.50

W.P.# 408-88-00
Prepared By MFA
Checked By RPR

THURBER

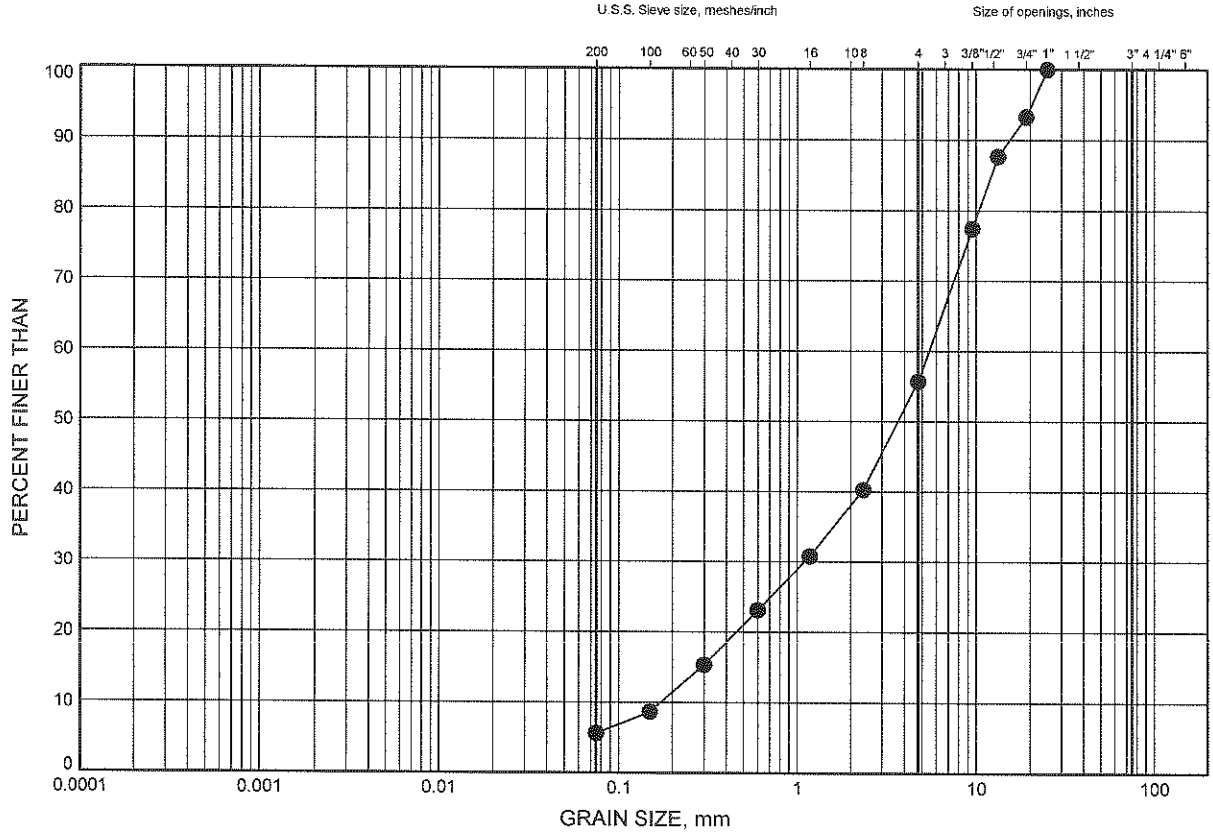
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 9/11/08

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B2

Sand and Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-066	4.72	298.34

W.P.# 408-88-00
Prepared By MFA
Checked By RPR

THURBER

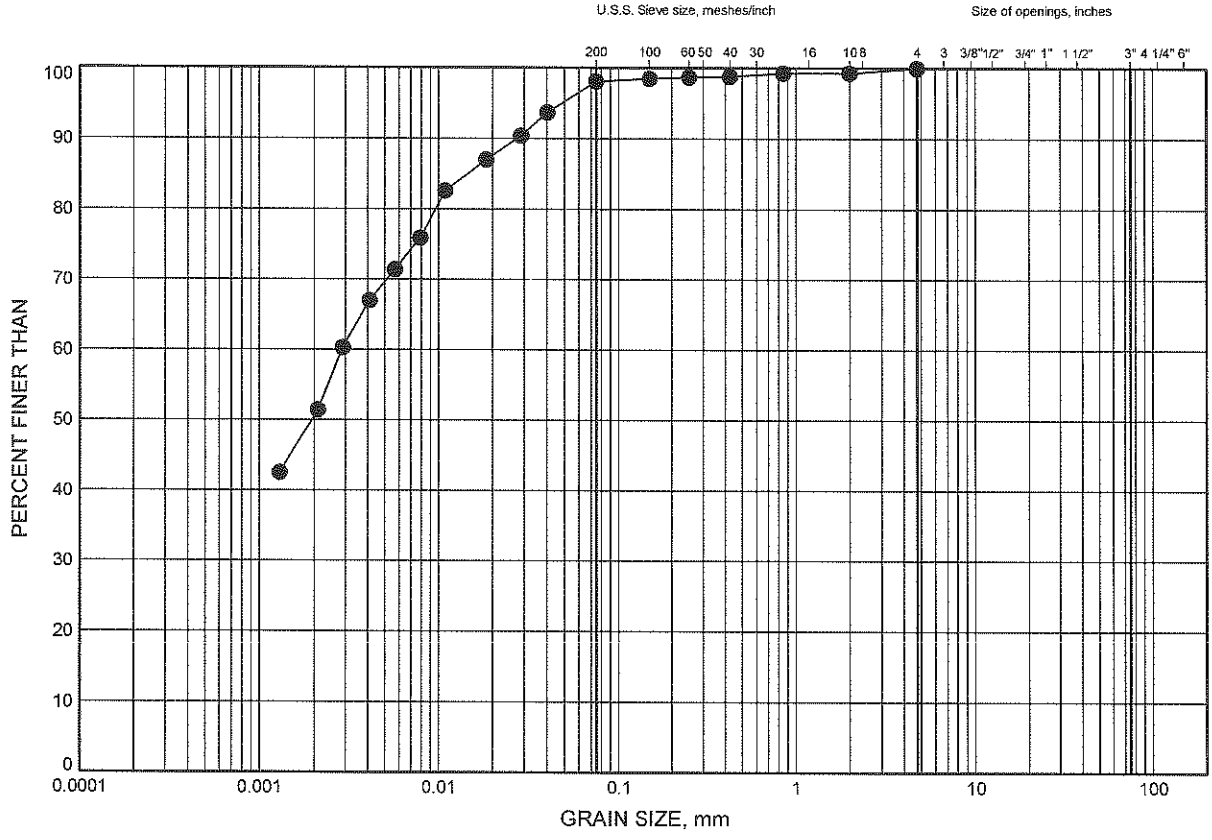
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 9/11/08

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-060	6.40	296.53

W.P.# 408-88-00
Prepared By MFA
Checked By RPR

THURBER

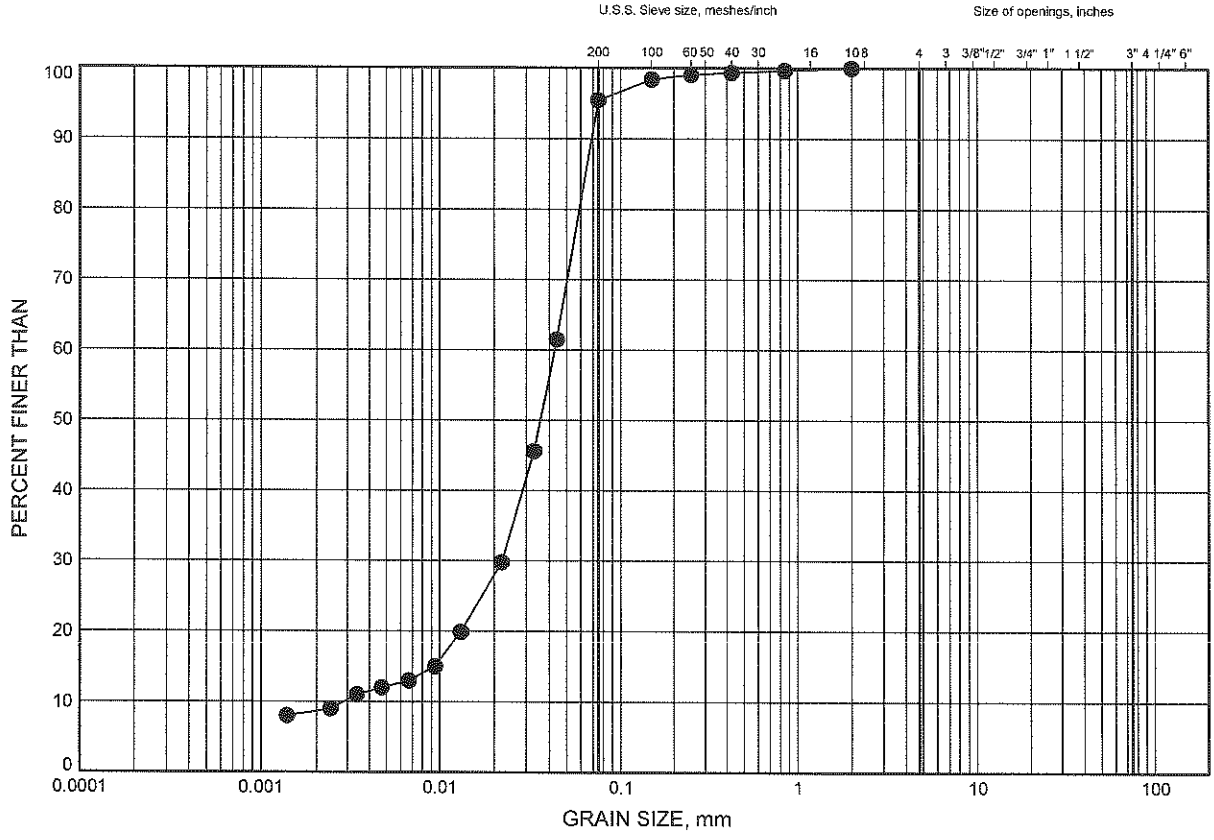
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 9/11/08

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B4

Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-060	7.92	295.01

W.P.# 408-88-00
Prepared By MFA
Checked By RPR

THURBER

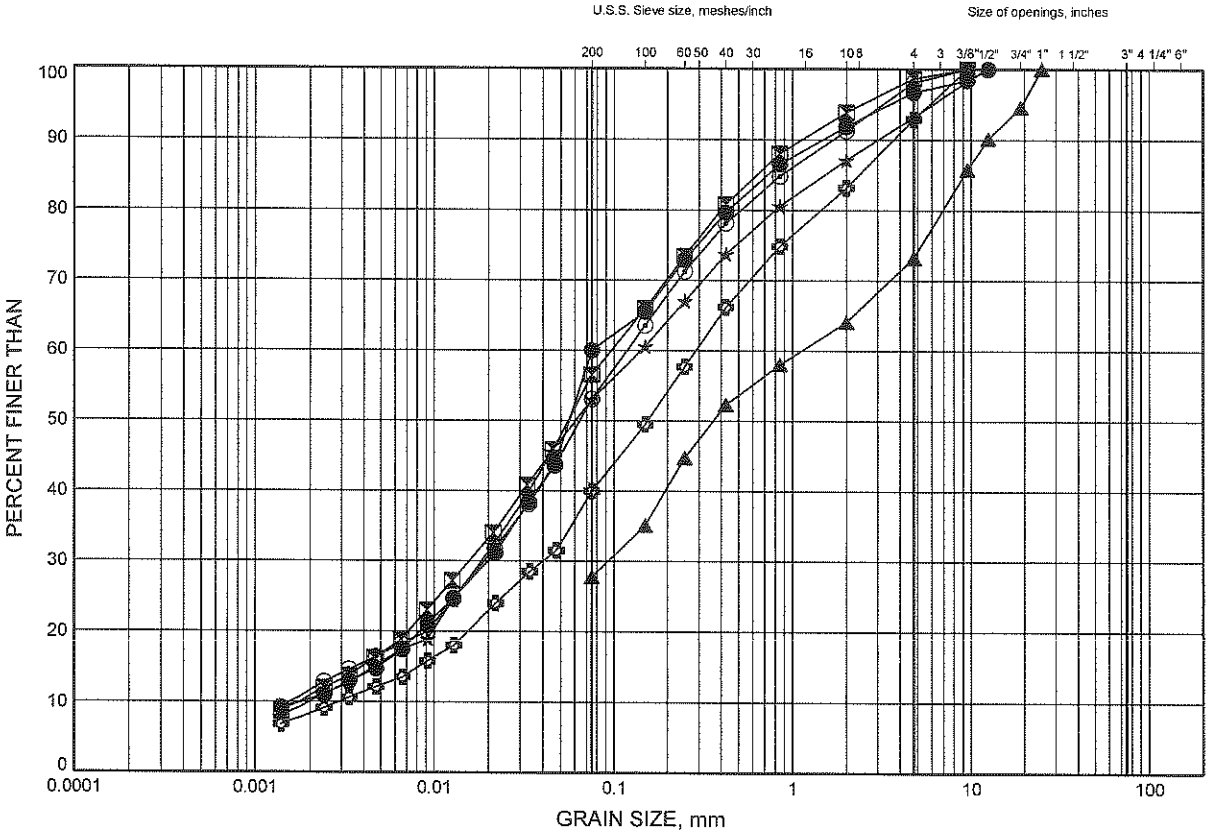
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 9/11/08

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B5

Sandy Silt Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-060	10.91	292.02
⊠	08-061	6.30	297.49
▲	08-062	4.79	294.81
☆	08-062	6.32	293.27
⊙	08-063	6.28	292.60
✿	08-064	7.92	292.97

W.P.# 408-88-00
Prepared By MFA
Checked By RPR

THURBER

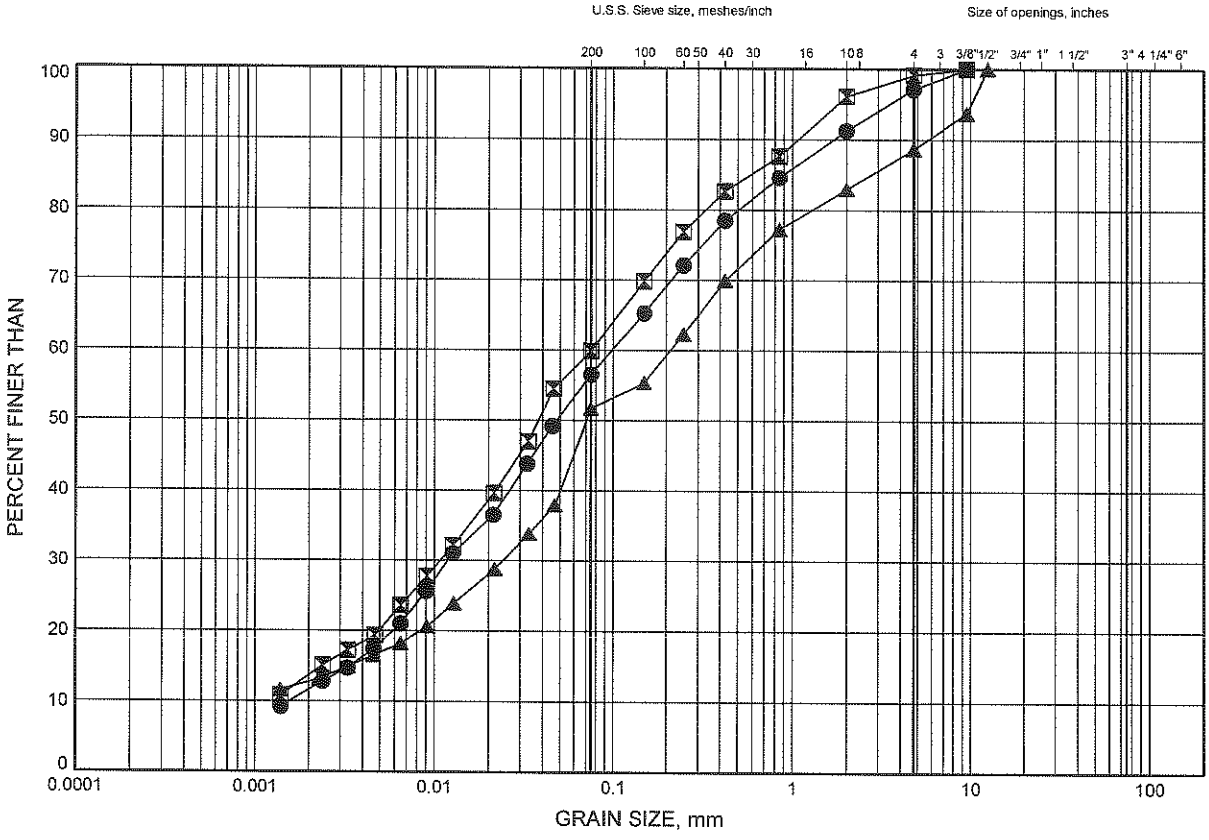
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 9/11/08

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B6

Sandy Silt Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-065	6.55	294.10
⊠	08-065	9.30	291.35
▲	08-066	9.28	293.78

W.P.# 408-88-00
Prepared By MFA
Checked By RPR

THURBER

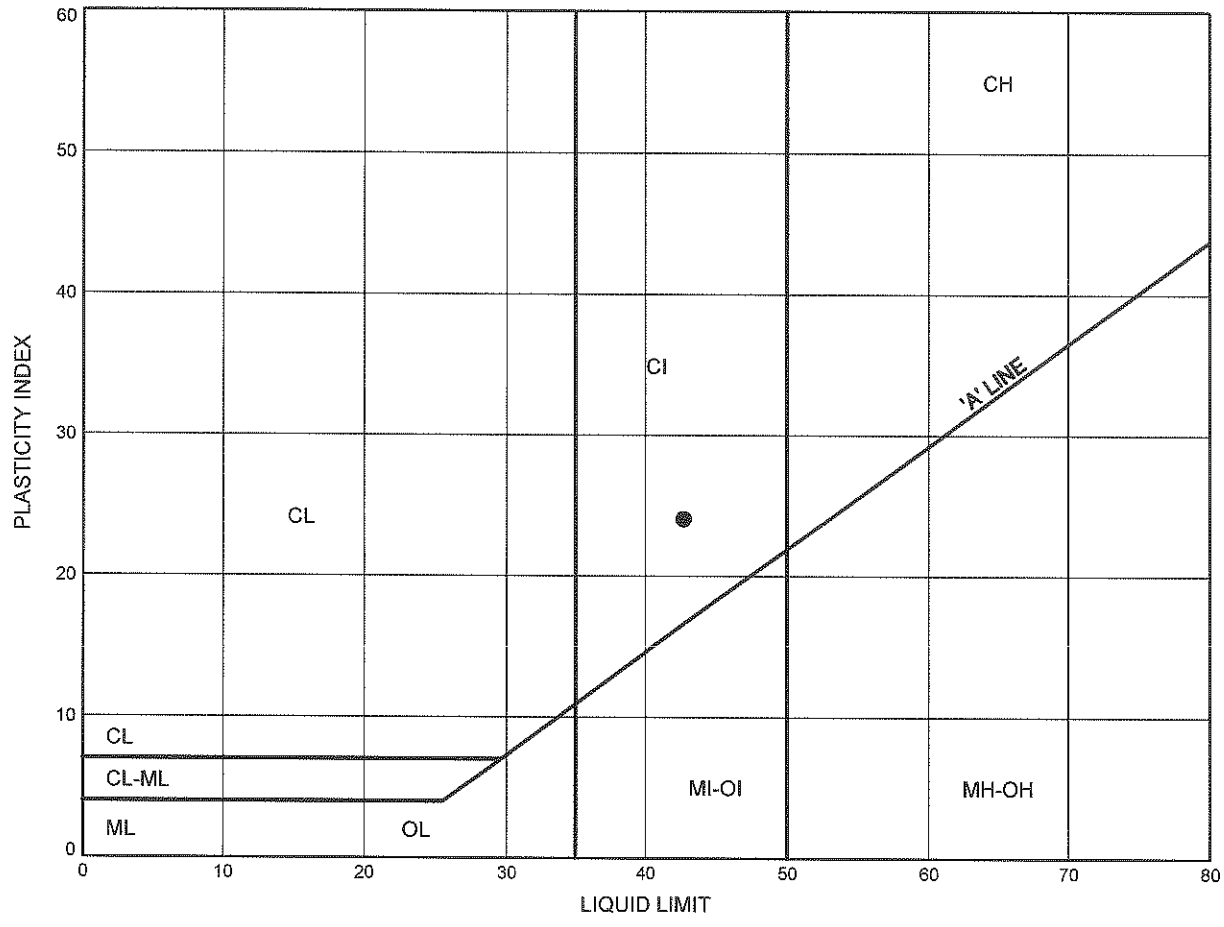
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 9/11/08

Highway 7 - New

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-060	6.40	296.53

Date September 2008

Project 408-88-00

THURBER

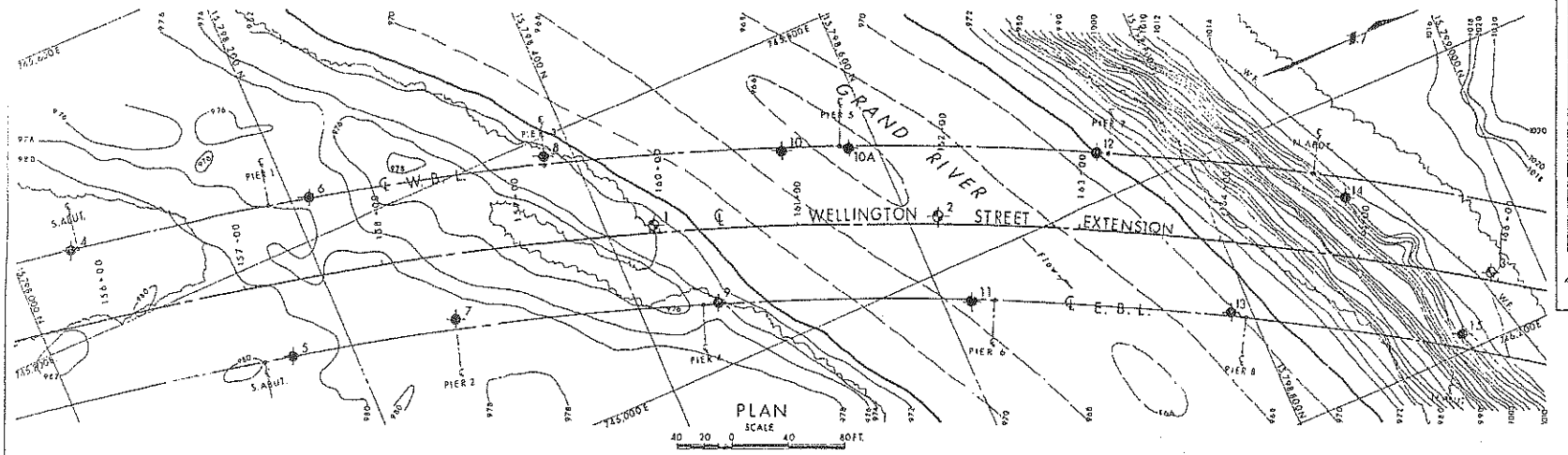
Prep'd MFA

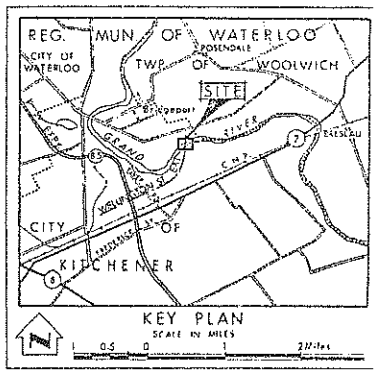
Chkd. RPR

THURBALT 6417R.GPJ 9/11/08

Appendix C

Record of Borehole Sheets (Previous Investigation

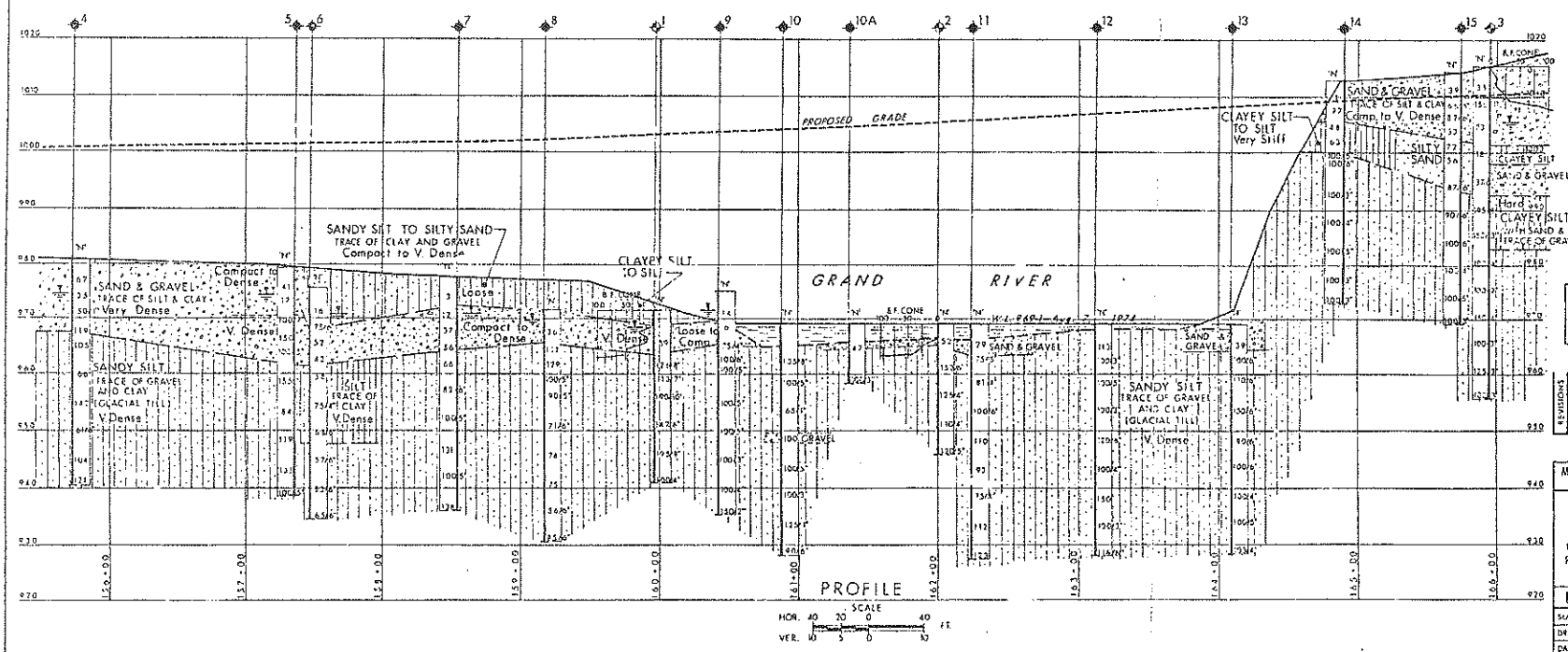




LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation, 12 AUG. 1974
  No Water Levels established in B.H. Nos. 14 & 15
  W.L. in B.H.#1, 2 & 3, Nov & Dec. 1971

NO.	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	971-8	15,798,633	745,848
2	969-0	15,798,620	745,964
3	1015-7	15,798,966	746,156
4	981-1	15,798,642	745,738
5	979-5	15,798,158	745,870
6	975-8	15,798,212	745,773
7	977-7	15,798,275	745,893
8	971-9	15,798,380	745,614
9	975-0	15,798,455	745,957
10	969-1	15,798,535	745,878
10A	— " —	15,798,582	745,895
11	— " —	15,798,618	746,028
12	— " —	15,798,742	745,968
13	— " —	15,798,785	746,108
14	1013-0	15,798,893	746,068
15	1014-2	15,798,930	746,188



REF. MID E-5350-1 (Feb 1974)

— NOTE —

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

NOTE FOR CONTRACT DOCUMENT

The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the STRATFORD District Office.

REVISIONS		
DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

GRAND RIVER BRIDGES

HIGHWAY NO. 7N (WELLINGTON ST EXT'N) DIST NO 3
Reg. Mun. of WATERLOO City of KITCHENER
TWP. LOT 112 & 122 CON G.C.T.

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD By S	CHECKED	W.P. NO 64-62-02	DRAWING NO 6466402-A
DRAWN OL J	CHECKED	W.O. NO	
DATE Sept 24, 1974		SITE NO.	BRIDGE DRAWING NO
APPROVED		CONT. NO	

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE Nº 1

FOUNDATIONS OFFICE (Ref. W.O.71-11130 BH#1)

JOB ____ LOCATION Co-ords. 15,798,433 N; 745,888 E. ORIGINATED BY CK

W.P. 646-64-02 BORING DATE November 29, 1971 COMPILED BY PP

DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger; Cone CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100; SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 1000 2000	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
971.8	Ground Level									
0.0 / 968.8	Clayey silt to silt		1A	TW	PH	970			121.5	▼ 968.3
3.0 / 963.8	Sand and gravel Very Dense		1	SS	59					
8.0	Sandy silt with some clay and gravel. (Glacial Till) Very Dense		2	SS	126/8"	960				
			3	SS	111/7"					12 37 41 10
			4	SS	190/10"					
			5	SS	147/6"	950				
			6	SS	195/8"					7 38 44 11
941.0			7	SS	100/4"	940				
30.8	End of Borehole									

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE No 2

FOUNDATIONS OFFICE

(Ref. W.O.71-11130 BH.#2)

JOB _____ LOCATION Co-ords. 15,798,620 N; 745,964 E. ORIGINATED BY PP

W.P. 646-64-02 BORING DATE December 3, 1971 COMPILED BY PP

DATUM Geodetic BOREHOLE TYPE Washbore - NX Casing; Cone CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P W W_L WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
969.0 Water Level										
966.4	Ground Level									
965.0	Sand and Gravel		1	SS	52					
4.0	Sandy silt with some clay & gravel. (Glacial Till) Very Dense		2	SS	132/6"	960		○		
			3	SS	125/4"			○		9 40 41 10
			4	SS	110/4"	950		○		
946.0			5	SS	120/6"			○		
20.4	End of Borehole					940				

20
15 ◇ S % STRAIN AT FAILURE
10

OFFICE REPORT ON EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE Nº 3

FOUNDATIONS OFFICE (Ref. W.O.71-11130 BH.#3)

JOB

W.P. 646-64-02

DATUM Geodetic

LOCATION Co-ords. 15,798,966 N; 746,156 E.

BORING DATE November 30 & December 1, 1971

BOREHOLE TYPE Cont. Flight Auger; Cone

ORIGINATED BY CK

COMPILED BY PP

CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT (20 40 60 80 100) / SHEAR STRENGTH P.S.F. (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT w_L / PLASTIC LIMIT w_p / WATER CONTENT w (w_p — w — w_L) / WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
1015.7	Ground Level									
0.0	Sand and gravel with silt & trace of clay.		1	SS	38	1010		○		33 36 26 5
			2	SS	151/11"			○		
	Dense to Very Dense		3	SS	73			○		▼1005.5
1001.3										
14.0	Clayey silt with some sand & trace of gravel		4	SS	18	1000				
998.2	Very Stiff									
17.5	Sand & gravel with traces of silt & clay		5	SS	377/6"			○		52 38 (10)
992.7	Very Dense									
23.0	Clayey silt to silt with sand & trace of gravel.		6	SS	195/3"	990		○		
			7	SS	150/3"			○		
982.7	Hard									
33.0	Sandy silt with some clay and gravel. (Glacial Till)		8	SS	100/4"	980		○		
			9	SS	100/2"			○		
	Very Dense		10	SS	150/3"	970		○		
			11	SS	100/3"			○		
			12	SS	125/3"	960		○		
955.5			13	SS	100/3"			○		9 39 41 11
60.2	End of Borehole					950				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 4

JOB _____ LOCATION Co-ords. 15,798,042 N; 745,738 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 7, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	W_P — W — W_L WATER CONTENT % 20 40 60		GR. SA. SI. CL
981.1	Ground Level									
0.0	Sand and gravel, trace of silt & clay Dense to Very Dense					980				
			1	SS	67			○		30 46 (24)
			2	SS	33			○		▼ 974.4
			3	SS	50/1"	970				
967.6			4	SS	119			○		
13.5	Sandy silt, trace of gravel & clay. (Glacial Till) Very Dense		5	SS	105			○		20 18 55 7
			6	SS	66	960		○		0 27 63 10
			7	SS	142			○		
			8	SS	61/6"	950		○⊢		12 36 43 9
			9	SS	104					
940.6			10	SS	121			⊢○		0 43 49 8
40.5	End of Borehole									

20
15 ◇ S % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 5

JOB _____ LOCATION Co-ords. 15,798,158 N; 745,870 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 7, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT _____ SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT					GR.SA.SI.CL.
979.5	Ground Level									
0.0	Sand and gravel trace of silt & clay. Compact to Dense		1	SS	41			○		▼ 974.5 50 35 (15)
			2	SS	17					
	Very Dense		3	SS	100/7"	970				
			4	SS	150			○		53 26 (11)
961.5			5	SS	100/5"					
18.0	Sandy silt, trace of gravel & clay (Glacial Till)		6	SS	155	960		⊖		15 41 35 9
			7	SS	84			⊖		7 34 48 11
	Very Dense		8	SS	119	950				
			9	SS	135					
938.6			10	SS	100/6"	940		○		10 40 43 7
40.9	End of Borehole									

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 6

JOB — LOCATION Co-ords. 15,798,212 N; 745,773 E. — ORIGINATED BY PJS

W.P. 646-64-02 — BORING DATE August 12, 1974 — COMPILED BY PJS

DATUM Geodetic — BOREHOLE TYPE Hollow Stem Auger — CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT / SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
975.8	Ground Level									
0.0	Sandy silt to silty sand, trace of clay & gravel.		1	SS	18	970		○		11 43 40 6
										970.9
967.8	Compact to Very Dense		2	SS	75/6"			○		12 49 35 4
8.0	Sand & gravel, trace of silt & clay		3	SS	52			○		52 39 (9)
962.3	Dense to Very Dense		4	SS	42					
13.5	Silt, traces of clay		5	SS	58	960		○		0 0 93 7
	Very Dense		6	SS	75/4"					
			7	SS	68/6"	950		○		0 0 92 8
947.8										
28.0	Sandy silt, trace of gravel and clay (Glacial Till)		8	SS	57/6"			○		10 37 43 10
			9	SS	83/6"	940				
	Very Dense									
934.8			10	SS	65/6"			○		6 34 50 10
41.0	End of Borehole									

OFFICE REPORT ON EXPLORATION

20 / 15 5 / 10 % STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 7

JOB ____ LOCATION Co-ords. 15,798,275 N; 745,893 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 15, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W	BULK DENSITY	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT % 20 40 60	γ P.C.F.	GR. SA. SI. CL.
977.7	Ground Level									
0.0	Sandy silt to silty sand									
972.7	Loose		1	SS	3			○		0 51 45 4
5.0	Sand & gravel, traces of silt & clay.		2	SS	12	970				▼ 970.9
	Compact to Dense		3	SS	37			○		71 22 (7)
964.7			4	SS	56			○–⊣		41 47 (12)
13.0			5	SS	66	960				
	Sandy silt, some gravel, trace of clay		6	SS	82/6"					
	(Glacial Till)		7	SS	100/5"	950		○		18 39 37 6
			8	SS	131					
	Very Dense		9	SS	100/5"	940				
936.2			10	SS	138			○–⊣		12 46 34 8
41.5	End of Borehole									

OFFICE REPORT ON EXPLORATION

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 8

JOB ____ LOCATION Co-ords. 15,798,380 N; 745,814 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 13, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P W W_L WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR SA SI CL
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT					
971.9	Ground Level									
0.0	Sand and Gravel, trace of silt and clay.					970				▽ 969.8
965.4	Dense		1	SS	36			○		47 41 (12)
			2	SS	102			○		25 36 31 8
6.5	Sandy silt, trace of clay and gravel (Glacial Till) Very Dense		3	SS	129	960		○		
			4	SS	100/5"					
			5	SS	90/5"			○		6 38 47 9
			6	SS	71/6"	950				
			7	SS	74					
			8	SS	75	940		○		12 32 50 6
			9	SS	86/6"					
930.9			10	SS	85/6"			○		13 25 50 12
41.0	End of Borehole									

20
15 ⊹ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 9

JOB ____ LOCATION Co-ords. 15,798,455 N; 745,957 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 14, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w	BULK DENSITY	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. ○ UNCONFINED ⊕ FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT % 20 40 60	γ P.C.F.	GR. SA. SI. CL.
975.0	Ground Level									
0.0	Sand & gravel, trace of silt & clay. Loose to Compact		1	SS	14	970		○		▼ 971.3
965.5			2	SS	6			○		45 48 (7)
9.5	Sandy silt, trace of gravel and clay.		3	SS	75/4"			○⊢		19 38 34 9
			4	SS	100/5"			○⊢		13 40 38 9
	(Glacial Till)		5	SS	100/5"	960				
			6	SS	100/5"					
	Very Dense		7	SS	100/5"	950		○		7 46 40 7
			8	SS	100/3"					
			9	SS	100/4"	940		○⊢		8 31 52 9
935.6			10	SS	150/2"					
39.4	End of Borehole									

20
15 ⊕ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS–ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 10

JOB _____ LOCATION Co-ords. 15,798,538 N; 745,878 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 13, 1974 COMPILED BY PJS.

DATUM Geodetic BOREHOLE TYPE Washboring - NX & BX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	SHEAR STRENGTH P.S.F. (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W — WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
969.1	Water Level										
0.0 / 964.6	Ground Level										
4.5	Sandy silt, trace of clay and gravel. (Glacial Till) gravel Very Dense		1	SS	135/3"	960			o		6 43 42 9
			2	SS	100/5"						
			3	SS	65/1"	950					
			4	SS	100				o		47 21 28 4
			5	SS	100/5"						
			6	SS	100/3"	940					
			7	SS	125/1"						
928.1			8	SS	90/6"	930					
41.0	End of Borehole										

OFFICE REPORT ON EXPLORATION

20
15 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 10A

JOB _____ LOCATION Co-ords. 15,798,582 N; 745,895 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 19, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Washboring-NX Casing CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT / SHEAR STRENGTH P.S.F. (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w (w_P — w — w_L) WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
0.0										
965.6	Ground Level									
3.5	Sandy silt, gravel, trace of clay & gravel. (Glacial Till) Very Dense		1	SS	47			○		41 36 19 4
958.4			2	SS	100/0"	960		○		6 43 40 11
10.7	End of Borehole									

20
15 ◇ S % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 11

JOB _____ LOCATION Co-ords. 15,798,618 N: 746,028 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 14, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Washboring – NX & BX Casing CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT % 20 40 60	γ P.C.F.	GR. SA. SI. CL.
969.1	Water Level									
0.0										
966.1	Ground Level									
3.0	Sand and gravel.		1	SS	29			○		64 31 (5)
963.1	Compact		2	SS	75/5"			○		20 39 35 6
6.0	Sandy silt, traces of clay & gravel (Glacial Till) Very Dense		3	SS	81/4"	960				
			4	SS	100/6"	950		○		
			5	SS	110					7 38 47 8
			6	SS	93	940				
			7	SS	75/3"			○		8 39 44 9
			8	SS	112	930		○		
927.6			9	SS	123			○		9 29 51 11
41.5	End of Borehole									

OFFICE REPORT ON SOIL EXPLORATION

15 20 10 5 % STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 12

JOB _____ LOCATION Co-ords. 15,798,742 N; 745,968 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 19, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Washboring-NX & BX Casing CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT / SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR.SA:SI.CL.
969.1	Water Level									
0.5	Sandy silt, trace of clay and gravel (Glacial Till) Very Dense		1	SS	113					15 19 56 10
			2	SS	100/3"	960				
			3	SS	100/5"					
			4	SS	100/3"	950				
			5	SS	120/5"					6 41 45 8
			6	SS	100/4"	940				
			7	SS	150					
			8	SS	100/3"	930				
928.1			9	SS	118/5"					19 25 46 10
41.0	End of Borehole									

20
15 ⊹ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 13

JOB _____ LOCATION Co-ords. 15,798,785 N; 746,108 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 15, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Washboring - NX & BX Casing CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT / SHEAR STRENGTH P.S.F. (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
969.1	Water Level									
968.1	Ground Level									
1.0 / 964.1	Sand & gravel, trace of silt & clay Very Dense		1	SS	39			○		58 35 (7)
5.0	Sandy silt, trace of clay and gravel (Glacial Till) Very Dense		2	SS	100/6"	960		⊖		5 41 46 8
			3	SS	110/5"					
			4	SS	100/5"	950		⊖		12 42 36 10
			5	SS	90/6"					
			6	SS	100/5"	940		⊖		12 43 39 6
			7	SS	100/6"					
			8	SS	100/5"	930				
928.2			9	SS	100/4"			⊖		5 39 47 9
40.9	End of Borehole									

OFFICE REPORT ON SOIL EXPLORATION

20 / 15 ◇ 5 / 10 % STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE No. 14

JOB _____ LOCATION Co-ords. 15,798,892 N; 746,068 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 20, 1974 COMPILED BY PJS

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W	BULK DENSITY	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT % 20 40 60	γ P.C.F.	GR. SA. SI. CL.
1013.0	Ground Level									
0.0	Sand & gravel, trace of silt and clay.		1	SS	14	1010		○		W.L. not established
1005.5	Compact to Very Dense		2	SS	97			○		50 37 (13)
7.5	Clayey silt sand to silt.		3	SS	48			○		0 40 52 8
1000.0	Very Stiff		4	SS	63	1000		○⊢		0 1 65 34
13.0	Sandy silt, some gravel, trace of clay. (Glacial Till) Very Dense		5	SS	100/5"			○		18 49 30 3
			6	SS	100/6"			⊢○		
			7	SS	100/3"	990				
			8	SS	100/4"			⊢		8 45 38 9
			9	SS	100/5"	980				
			10	SS	100/3"					
972.7			11	SS	100/3"			⊢		8 41 38 13
40.3	End of Borehole									

OFFICE REPORT ON SOIL EXPLORATION

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 15

JOB _____ LOCATION Co-ords. 15,798,930 N; 746,188 E. ORIGINATED BY PJS

W.P. 646-64-02 BORING DATE August 19, 1974 COMPILED BY PJS.

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY _____

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W	BULK DENSITY	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT % 20 40 60	γ P.C.F.	GR. SA. SI. CL.
1014.2	Ground Level									
0.0	Sand & gravel, trace of silt and clay.		1	SS	39	1010				W.L. not established
	Dense to Very Dense		2	SS	66/6"			○		50 41 (9)
			3	SS	89/6"					
1002.2			4	SS	50			○		61 33 (6)
12.0	Silty sand with gravel, trace of clay		5	SS	72	1000		○		23 48 25 4
			6	SS	56					
993.2	Very Dense		7	SS	87/5"					
21.0	Sandy silt, trace of gravel and clay		8	SS	90/8"	990		○		15 25 43 17
	(Glacial Till)		9	SS	100/6"					
	Very Dense		10	SS	100/4"	980				
			11	SS	100/5"			○		9 42 39 10
969.0			12	SS	100/3"	970				
45.2	End of Borehole									

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

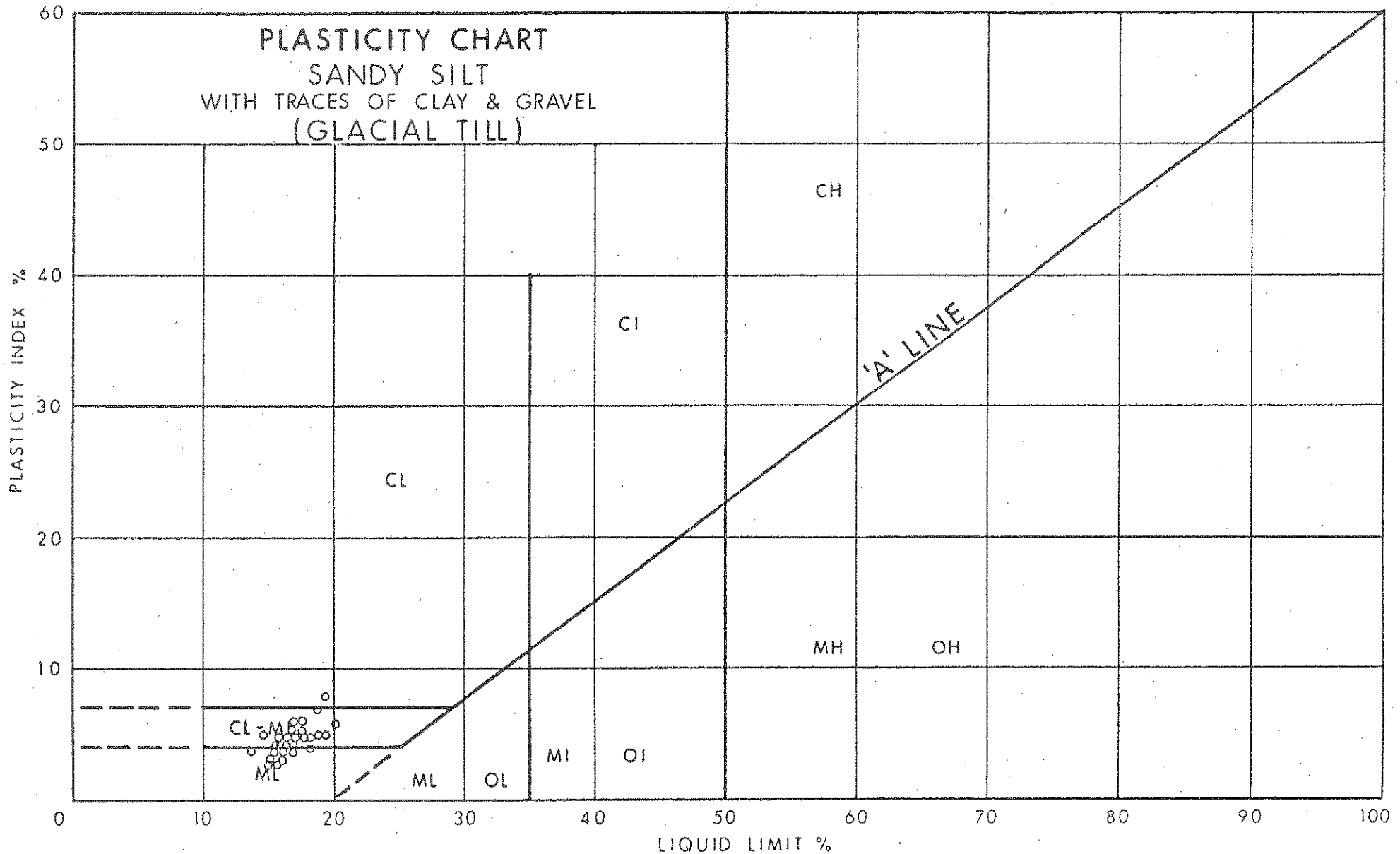


FIG. 1

W.P. 646-64-02

GRAIN SIZE DISTRIBUTION

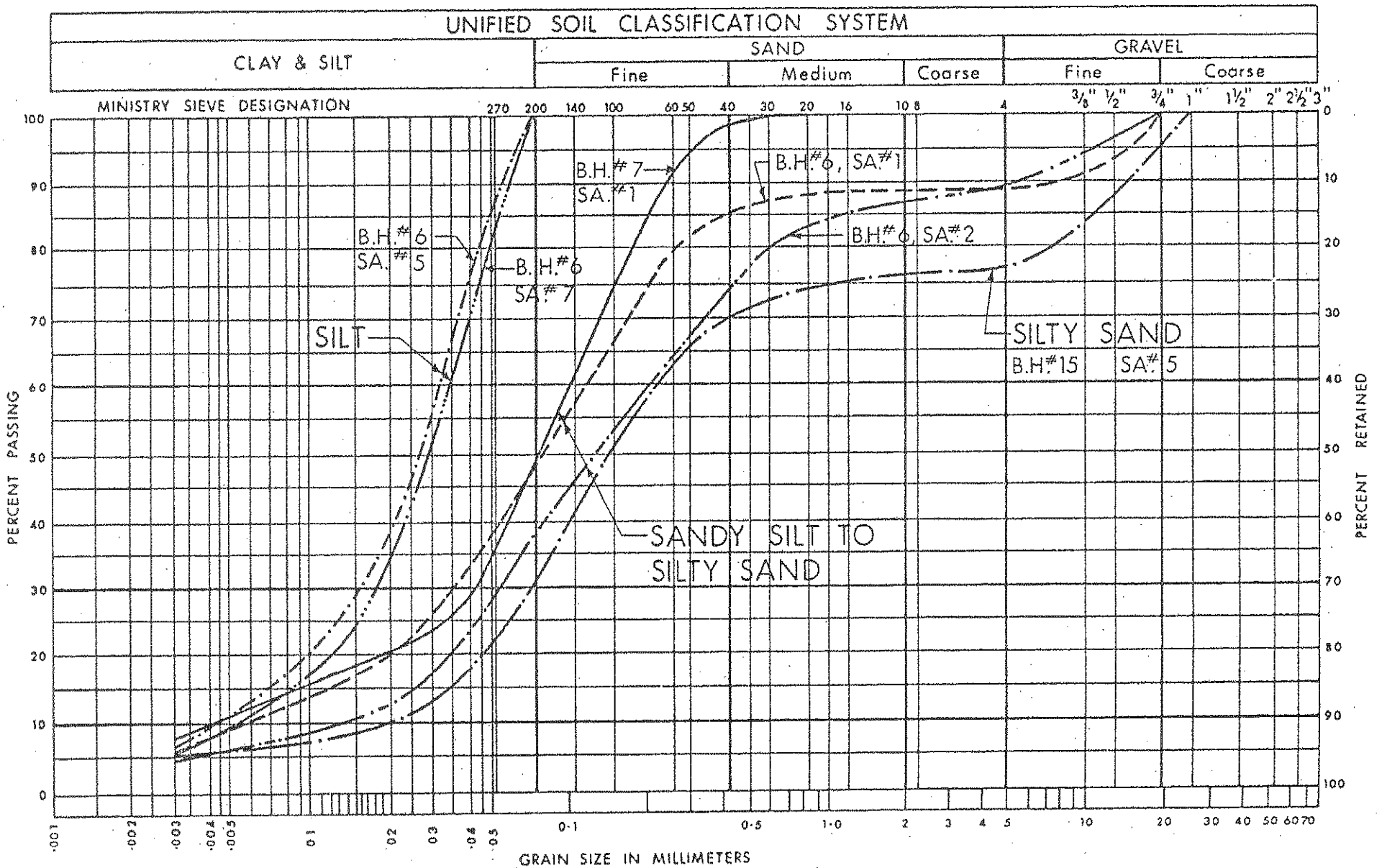


FIG. 2

W.P. 646-64-02

GRAIN SIZE DISTRIBUTION

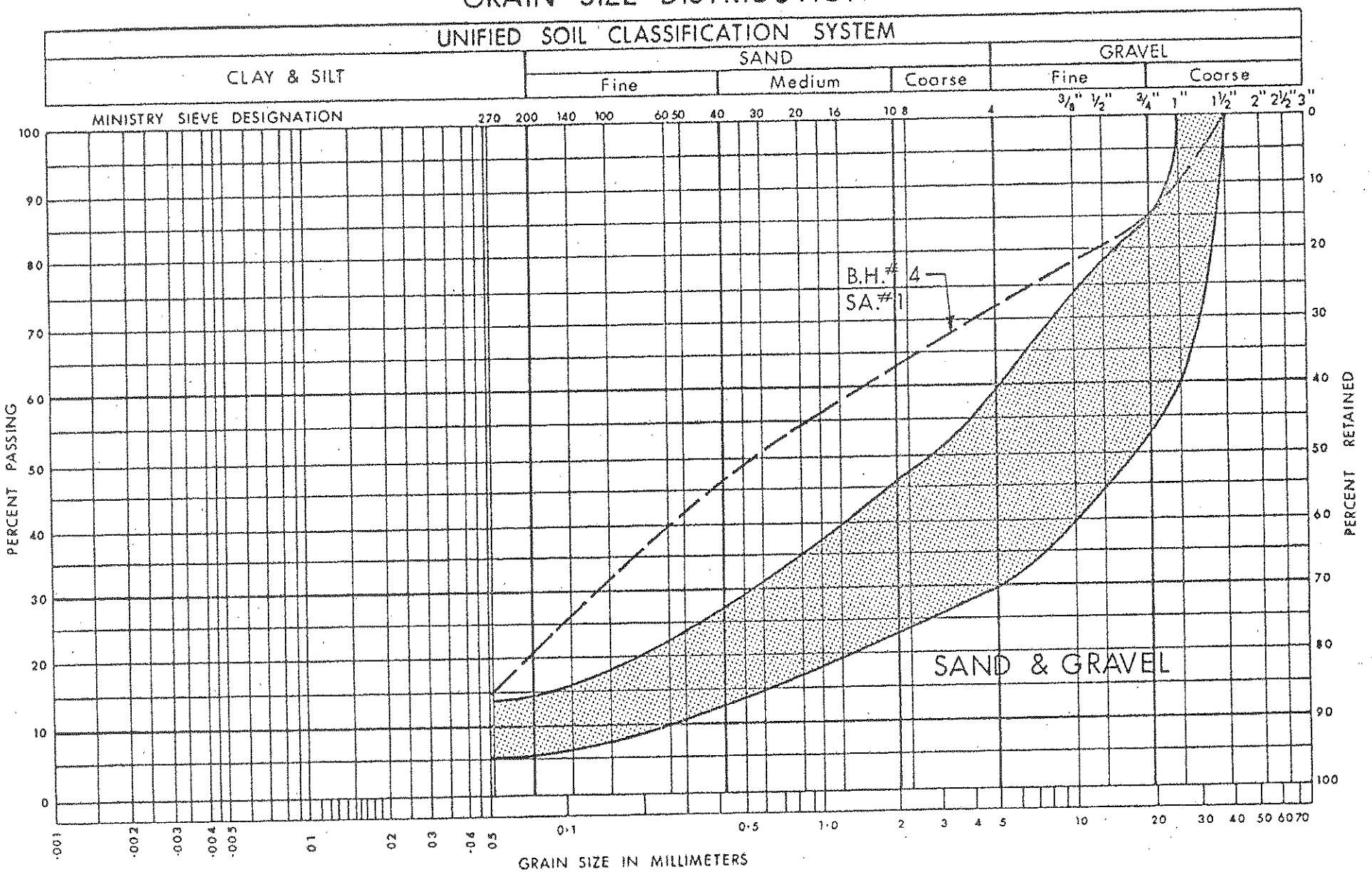


FIG. 3

W.P. 646-64-02

GRAIN SIZE DISTRIBUTION

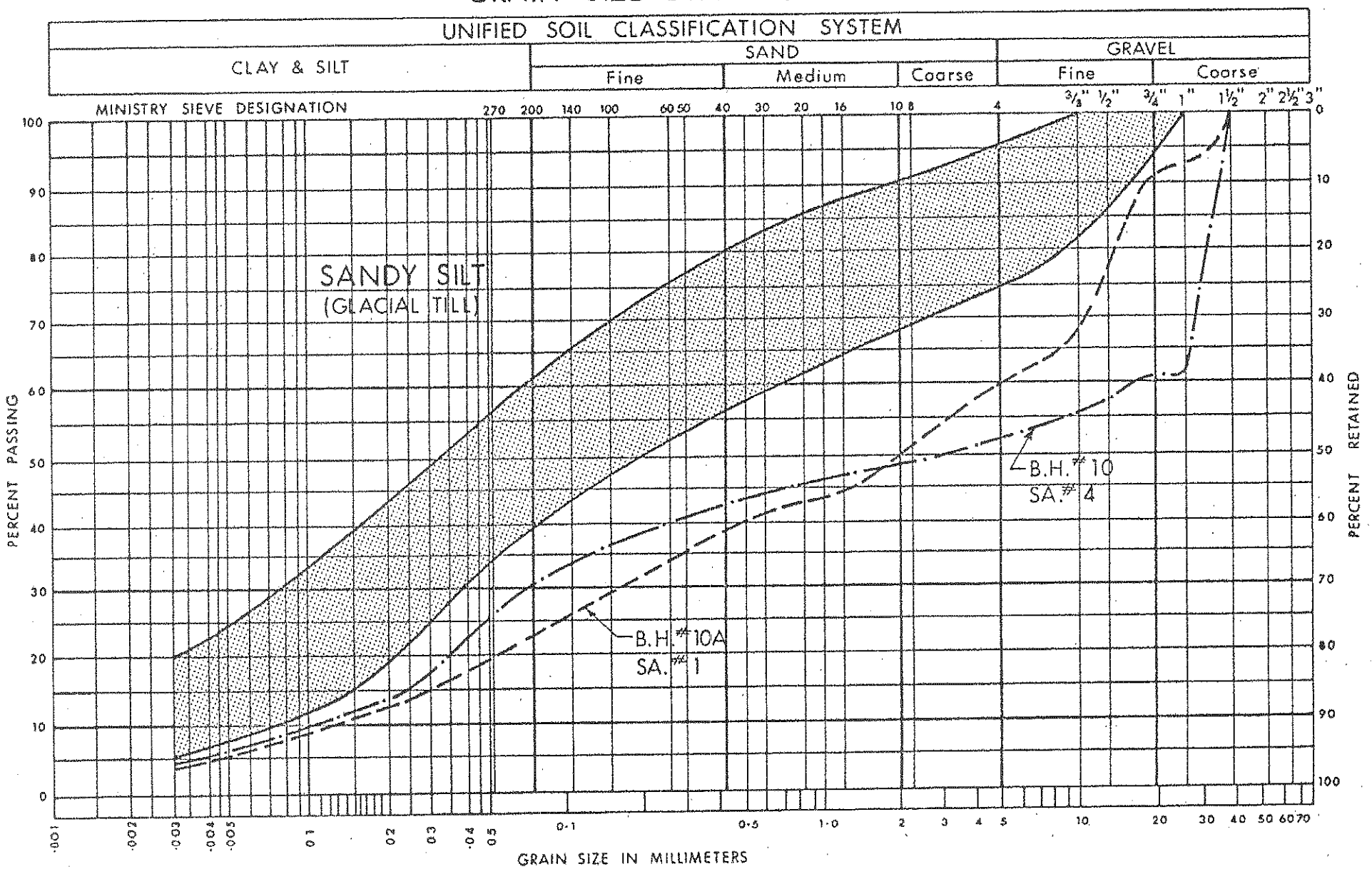


FIG. 4

W.P. 646-64-02

Appendix D

Foundation Comparison

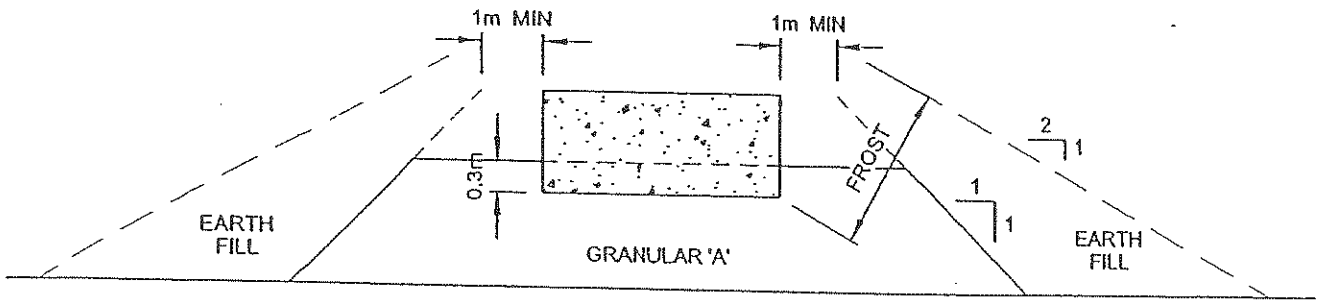
COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Foundation Element	Spread Footings	Spread Footings on Engineered Fill	Caissons	Driven Piles
	Advantages: i. Generally less costly construction than deep foundation elements. *Disadvantages:* i. Dewatering may be required, depending on depth of excavation. ii. Possible scour and undermining problems for piers adjacent to the river.	*Advantages:* i. Generally less costly construction than deep foundation elements. *Disadvantages:* i. Better geotechnical resistance than spread footings on native, but still influenced by the compact soils at the surface. ii. Dewatering may be required, depending on depth of excavation. iii. Possible scour and undermining problems for piers adjacent to the river.	*Advantages:* i. High resistance is available for caissons socketed in very dense silt till ii. Construction of caissons could continue in freezing weather. *Disadvantages:* i. Higher cost than other systems ii. Difficulties advancing the caisson shaft to the required depth iii. Difficulties in obtaining seal below the liner to pour concrete in dry conditions iv. Possibility of boulders being encountered during augering. v. Dewatering may be required vi. Potential difficulty in cleaning and inspecting bases.	*Advantages:* i. High geotechnical resistance may be developed by driving the piles into very dense soils. ii. Relatively short pile lengths required since very dense soils lie at shallow depth. iii. Independent of groundwater conditions. *Disadvantages:* i. Higher unit cost compared to footings. ii. Very dense soils at shallow depth will limit length of pile and geotechnical resistance that can be developed. iii. Pre-augering may be required in order to install the piles to adequate length.
South abutment	**NOT RECOMMENDED**	**NOT RECOMMENDED**	**NOT RECOMMENDED**	**RECOMMENDED**
South piers	**RECOMMENDED**	**NOT RECOMMENDED**	**FEASIBLE**	**NOT RECOMMENDED**
River piers	**NOT RECOMMENDED**	**NOT RECOMMENDED**	**RECOMMENDED**	**NOT RECOMMENDED**
North piers	**FEASIBLE**	**NOT RECOMMENDED**	**RECOMMENDED**	**NOT RECOMMENDED**
North abutment	**RECOMMENDED**	**NOT RECOMMENDED**	**FEASIBLE**	**FEASIBLE**

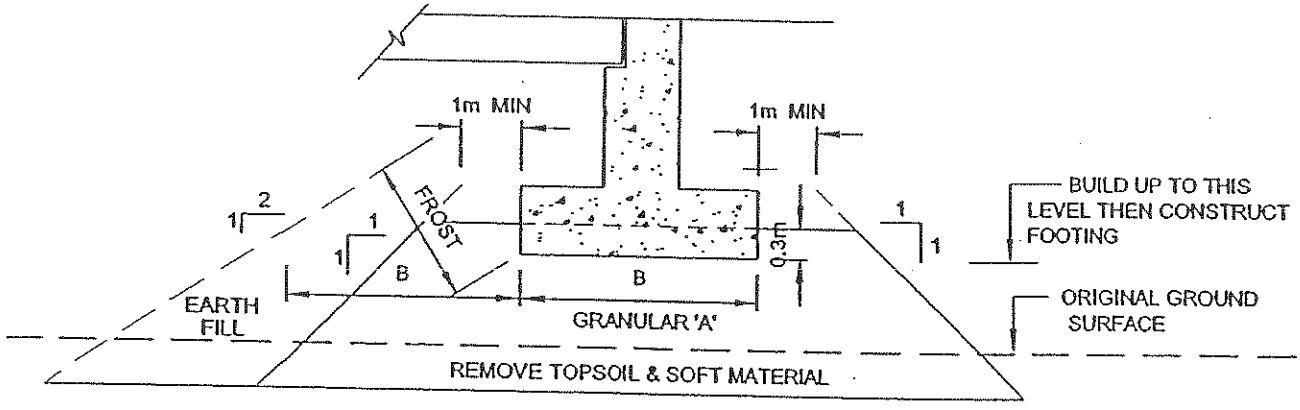
Appendix E

Figure

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 F

Slope Stability Output

	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.
Earth Fill	21	0	30	1
Sand and Gravel	20	0	32	1

Thurber Engineering Ltd. - Toronto
15-64-17 Highway 7 - New
EBL and WBL bridges over the Grand River
November 6, 2008
South abutment
12 m high

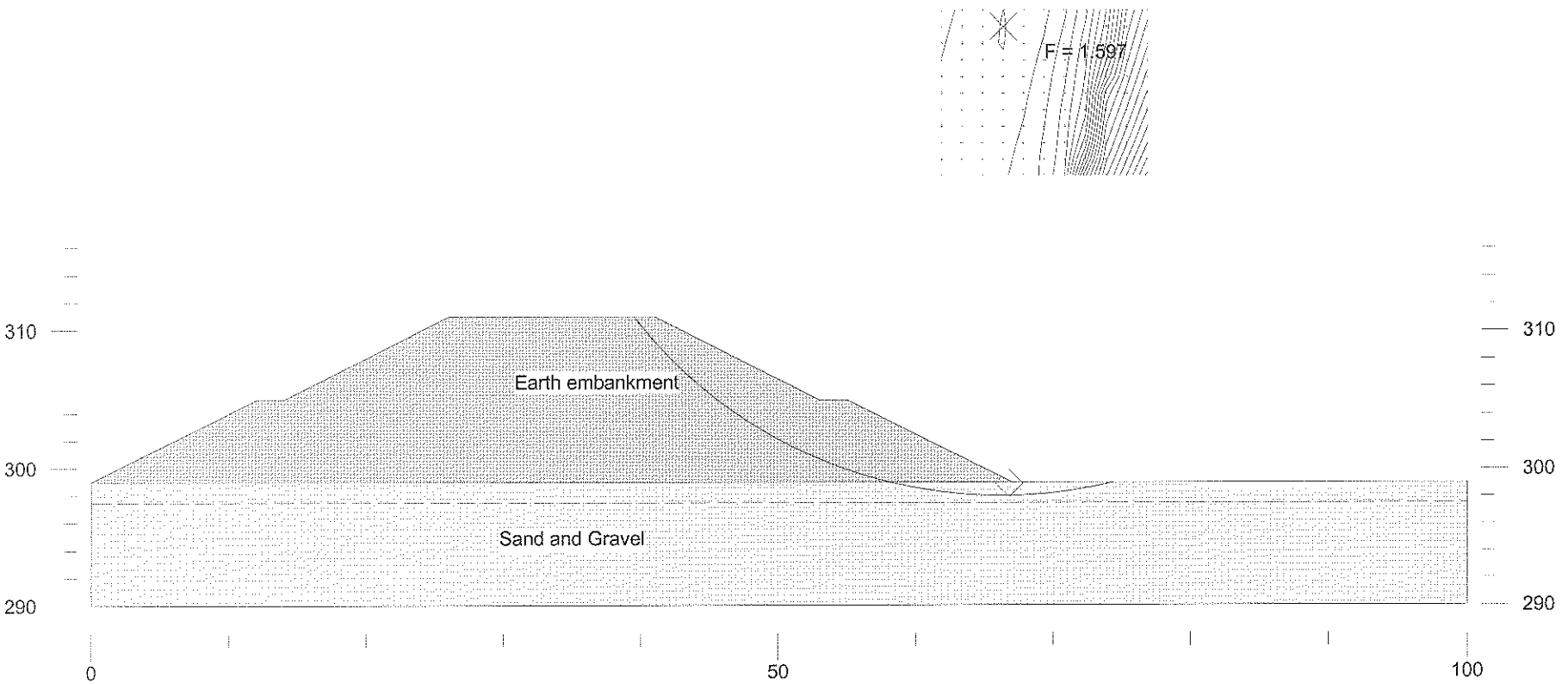


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FIGURE 1

	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.
Earth Fill	21	0	30	1
Sand and Gravel	20	0	32	1

Seismic coefficient = 0.08

Thurber Engineering Ltd. - Toronto
15-64-17 Highway 7 - New
EBL and WBL bridges over the Grand River
November 6, 2008
South abutment
12 m high

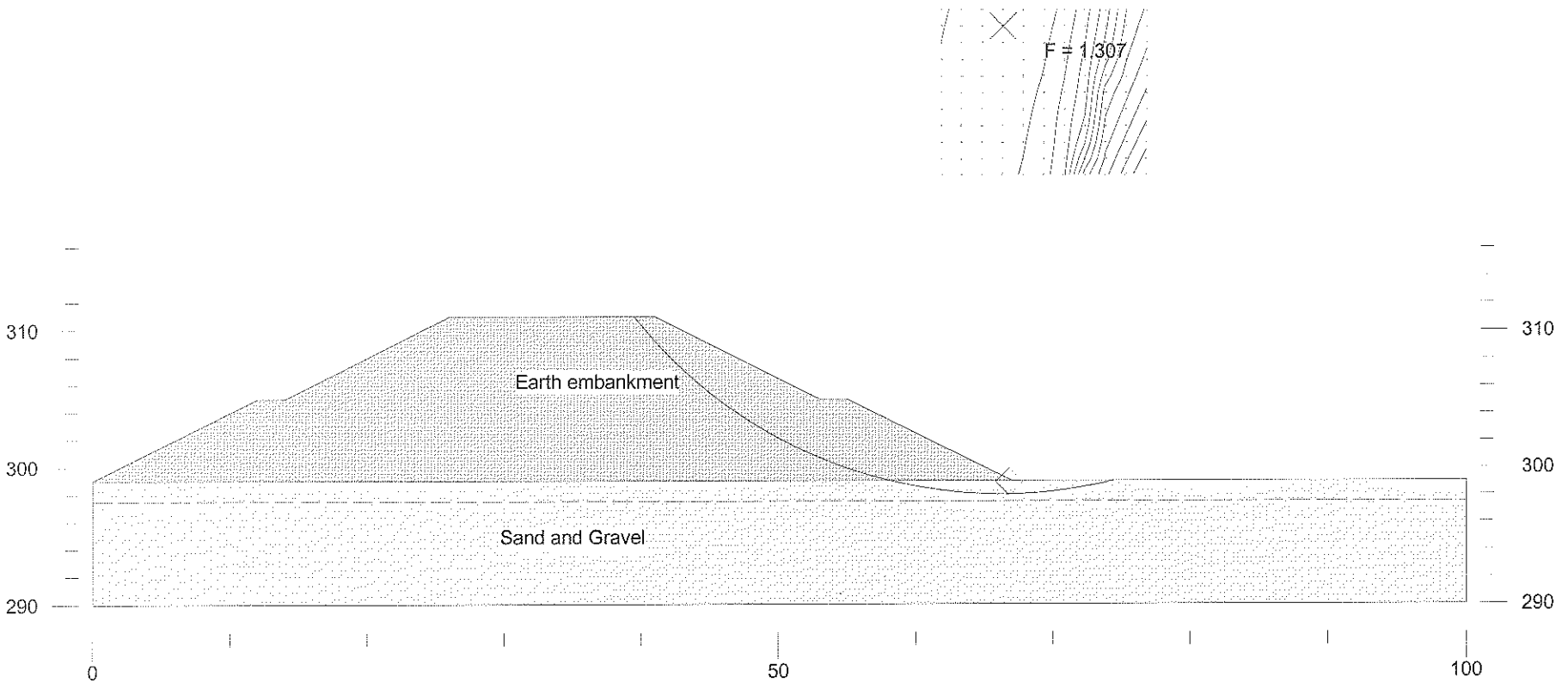

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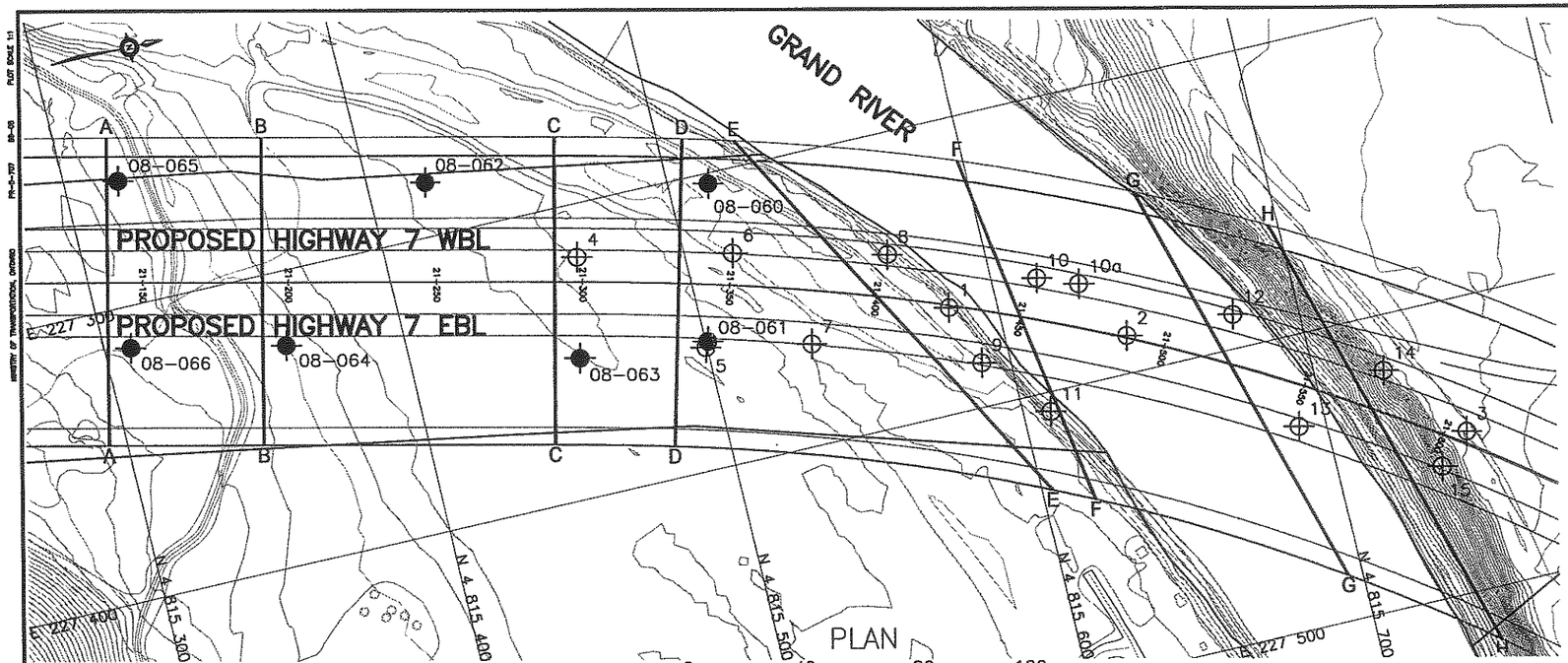
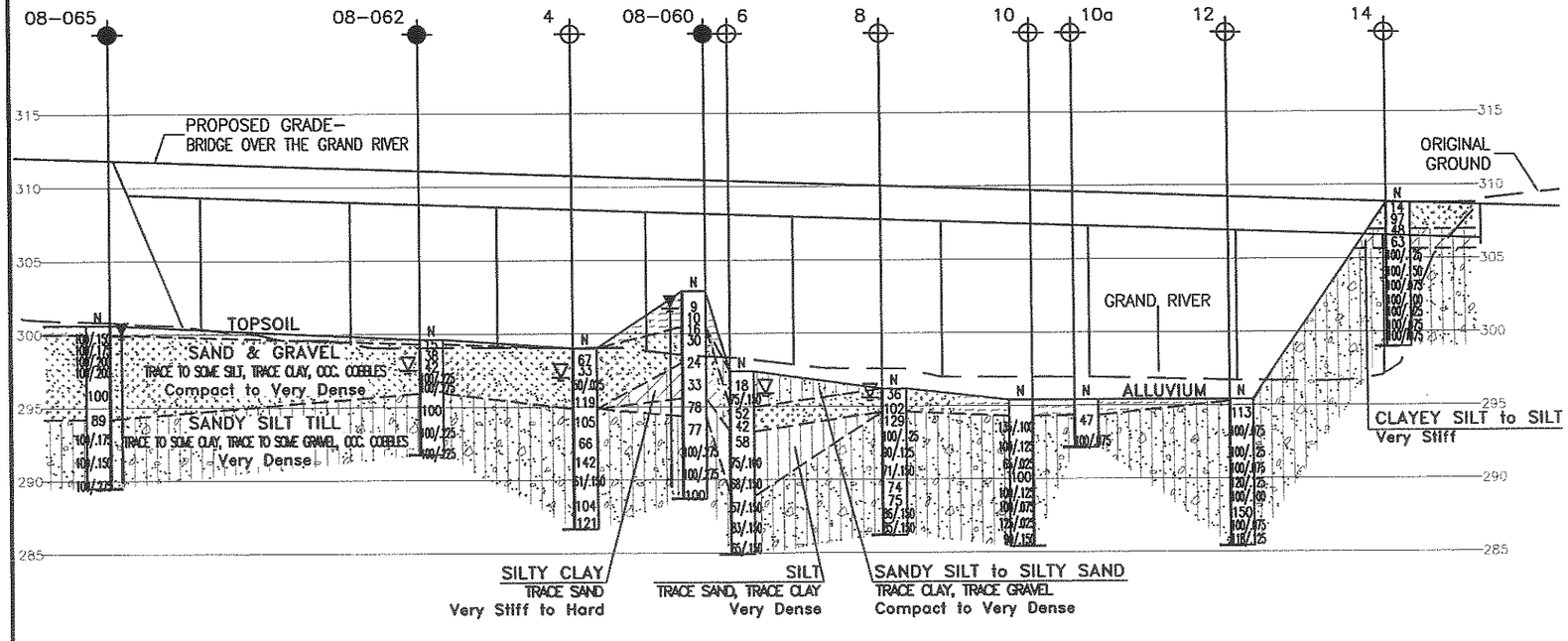
FIGURE 2

Appendix G

Drawing titled "Borehole Locations and Soil Strata"





PROFILE ALONG ℄ PROP. HIGHWAY 7 WBL

0 40 80 120m HOR 1:2000

0 8 16 24m VER 1:400

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 408-88-00

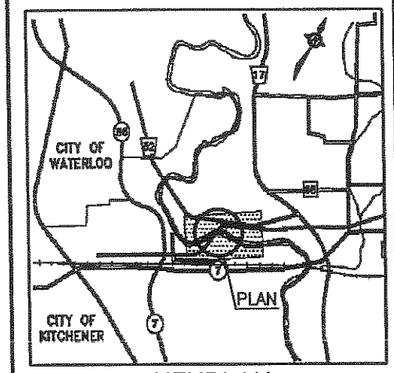
HIGHWAY 7
RECOMMENDED ROUTE
EBL & WBL BRIDGES OVER THE GRAND RIVER
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
June 1/09
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
June 1/09
PROVINCE OF ONTARIO



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Previous Borehole by others
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
05	298.6	4 815 499.6	227 358.4
06	297.4	4 815 516.1	227 328.8
07	298.0	4 815 535.3	227 365.4
08	296.2	4 815 567.3	227 341.3
09	297.2	4 815 590.1	227 384.9
10	295.4	4 815 615.4	227 360.8
10A	295.4	4 815 628.9	227 366.0
11	295.4	4 815 609.3	227 406.6
12	295.4	4 815 677.6	227 388.3
13	295.4	4 815 690.7	227 430.9
14	308.8	4 815 723.3	227 418.7
15	309.1	4 815 734.9	227 455.3

NO	ELEVATION	NORTHING	EASTING
08-060	302.9	4 815 513.6	227 303.6
08-061	303.8	4 815 500.8	227 356.5
08-062	299.6	4 815 419.6	227 281.4
08-063	298.9	4 815 457.2	227 352.2
08-064	300.9	4 815 361.0	227 325.4
08-065	300.6	4 815 318.0	227 257.3
08-066	303.1	4 815 308.8	227 314.3
01	296.2	4 815 583.4	227 363.9
02	295.4	4 815 640.4	227 387.0
03	309.6	4 815 745.9	227 445.6
04	299.0	4 815 464.3	227 318.2

-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.
3) Proposed grades are from Plate 3 of the E.A. Study.

GEOCRES No. 40P8-159

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

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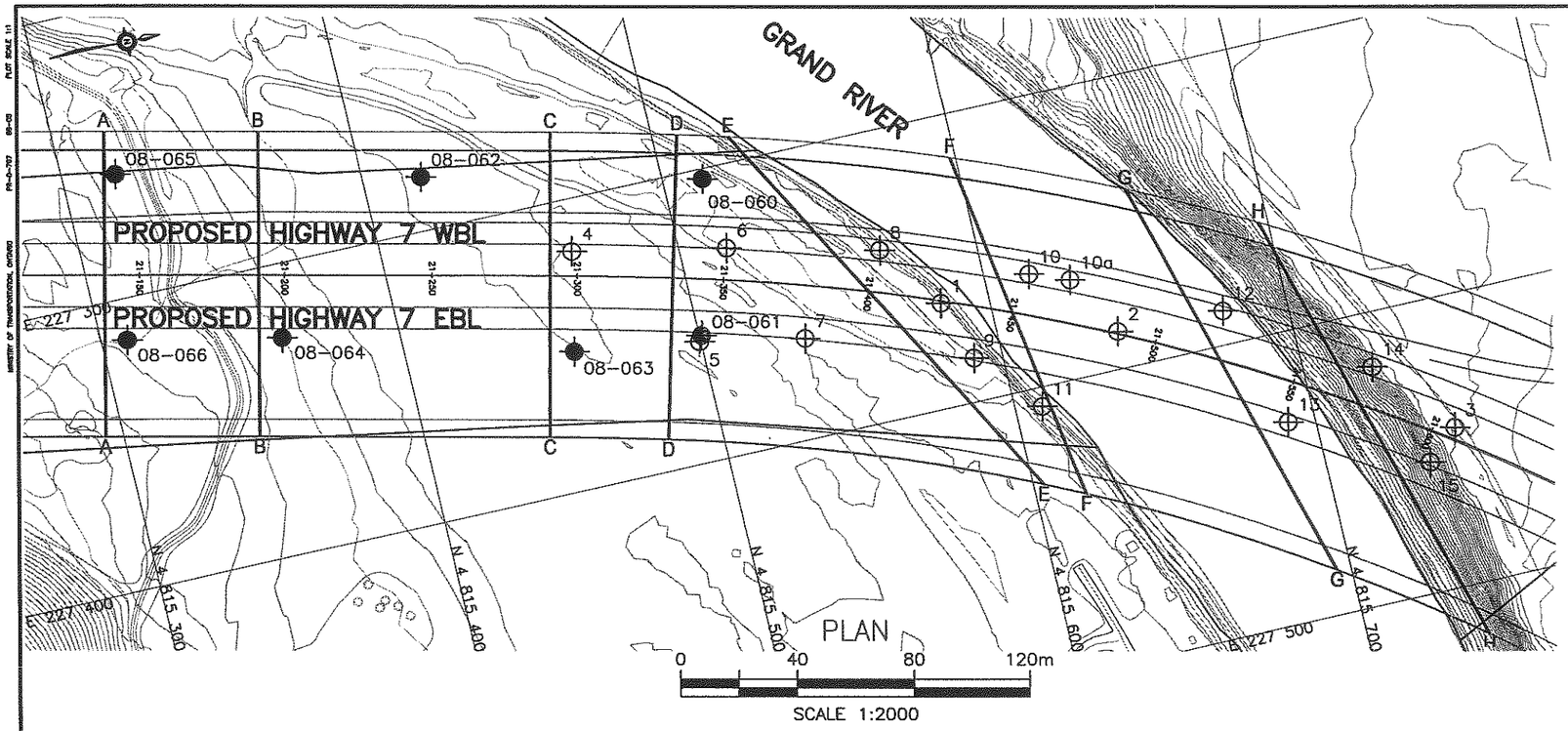
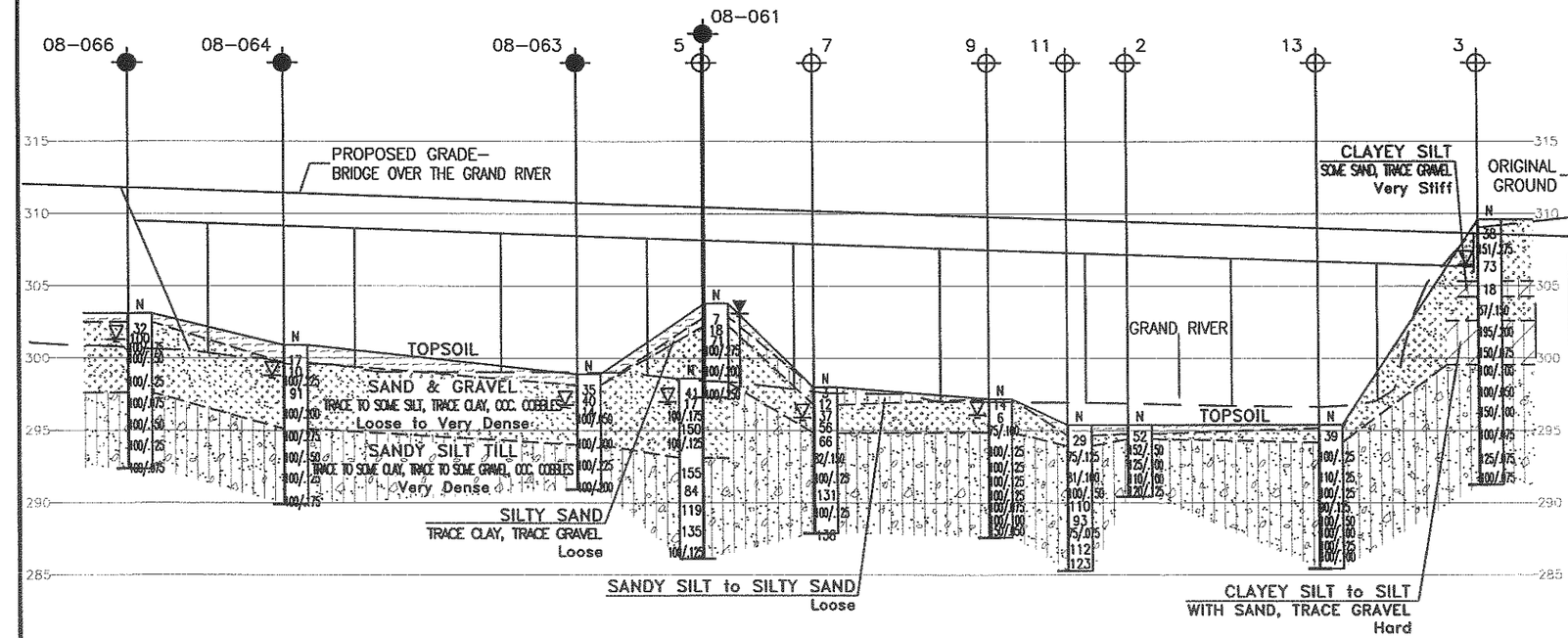
PLOT DATE 05-05-27
UNIVERSITY OF TRANSPORTATION, OXFORD





PROFILE ALONG ℄ PROP. HIGHWAY 7 EBL

0 40 80 120m HOR 1:2000

0 8 16 24m VER 1:400

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 408-88-00

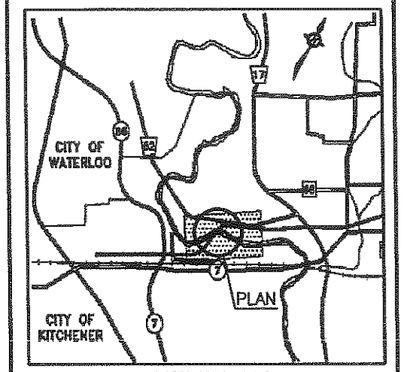
SHEET

HIGHWAY 7
RECOMMENDED ROUTE
EBL & WBL BRIDGES OVER THE GRAND RIVER
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
June 1/09
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
June 1/09
PROVINCE OF ONTARIO



KEYPLAN

	LEGEND
	Borehole
	Previous Borehole by others
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	NO	ELEVATION	NORTHING	EASTING
05	298.6	4 815 499.6	227 358.4	08-060	302.9	4 815 513.6	227 303.6
06	297.4	4 815 516.1	227 328.8	08-061	303.8	4 815 500.8	227 356.5
07	298.0	4 815 535.3	227 365.4	08-062	299.6	4 815 419.6	227 281.4
08	296.2	4 815 567.3	227 341.3	08-063	298.9	4 815 457.2	227 352.2
09	297.2	4 815 590.1	227 384.9	08-064	300.9	4 815 361.0	227 325.4
10	295.4	4 815 615.4	227 360.8	08-065	300.6	4 815 318.0	227 257.3
10A	295.4	4 815 628.9	227 366.0	08-066	303.1	4 815 308.8	227 314.3
11	295.4	4 815 609.3	227 406.6	01	296.2	4 815 583.4	227 363.9
12	295.4	4 815 677.6	227 388.3	02	295.4	4 815 640.4	227 387.0
13	295.4	4 815 690.7	227 430.9	03	309.6	4 815 745.9	227 445.6
14	308.8	4 815 723.3	227 418.7	04	299.0	4 815 464.3	227 318.2
15	309.1	4 815 734.9	227 455.3				

-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.
3) Proposed grades are from Plate 3 of the E.A. Study.

GEOCRES No. 40P8-159

REVISIONS			
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		DATE MAY 2009	DWG

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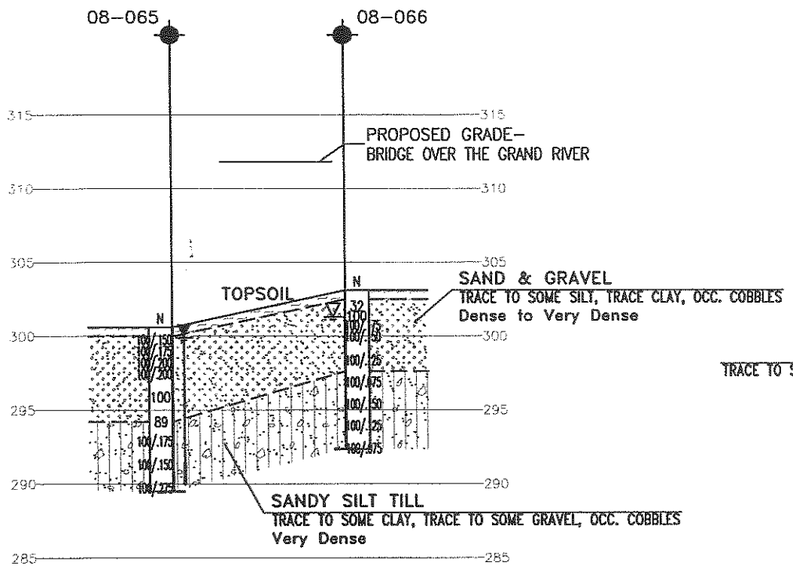

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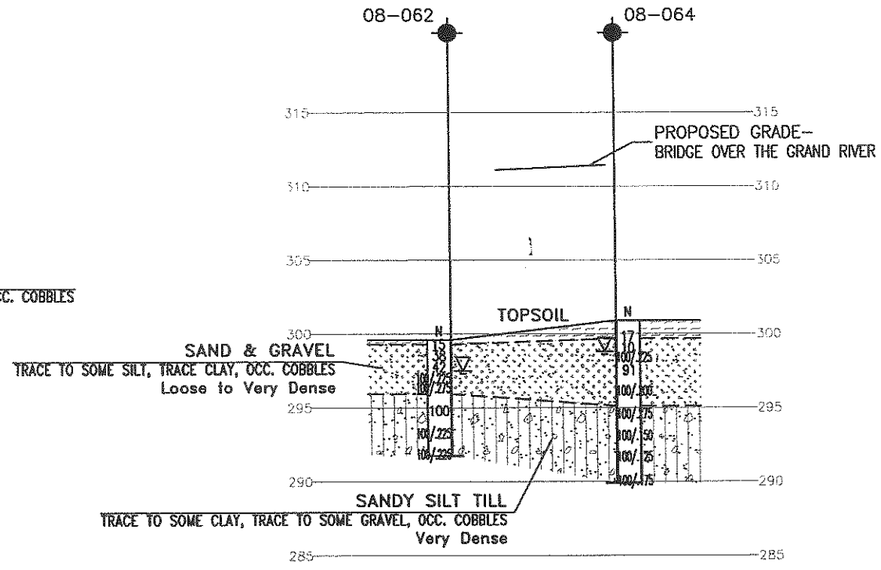

SECTION B–B

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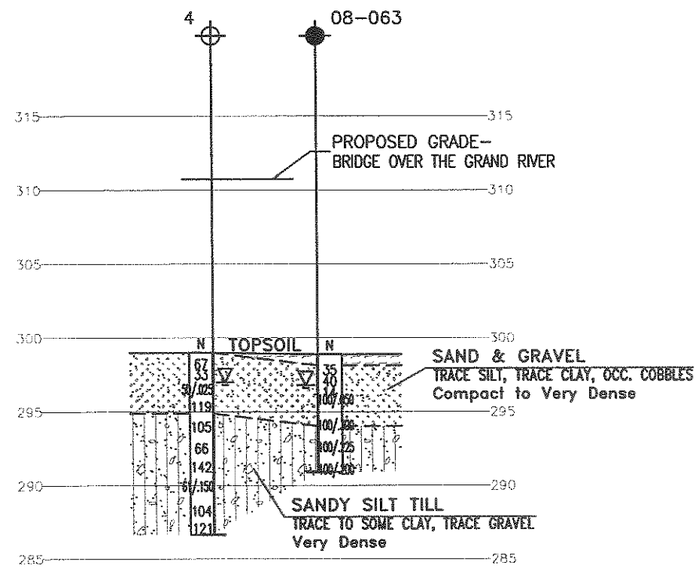
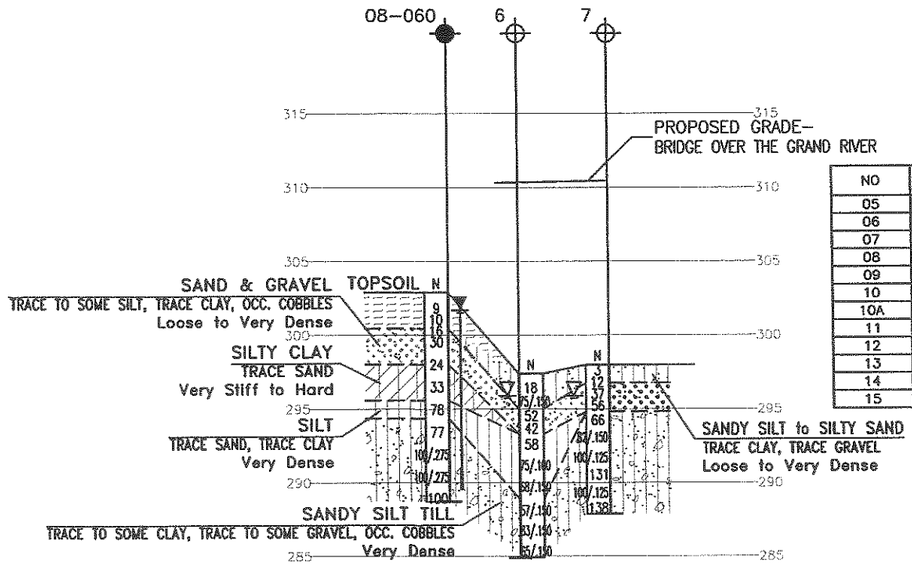


SECTION C–C

0 40 80 120m HOR 1:2000

0 8 16 24m VER 1:400



SECTION D–D

0 40 80 120m HOR 1:2000

0 8 16 24m VER 1:400

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Jun 1/09
PROVINCE OF ONTARIO

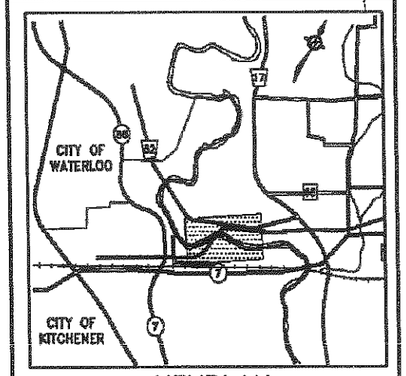
LICENSED PROFESSIONAL ENGINEER
P.K. CHATTERJI
Jun 1/09
PROVINCE OF ONTARIO

CONT No
GWP No 408-88-00

SHEET

HIGHWAY 7
RECOMMENDED ROUTE
EBL & WBL BRIDGES OVER THE GRAND RIVER
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS



KEYPLAN

LEGEND

⊕	Borehole
⊕	Previous Borehole by others
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

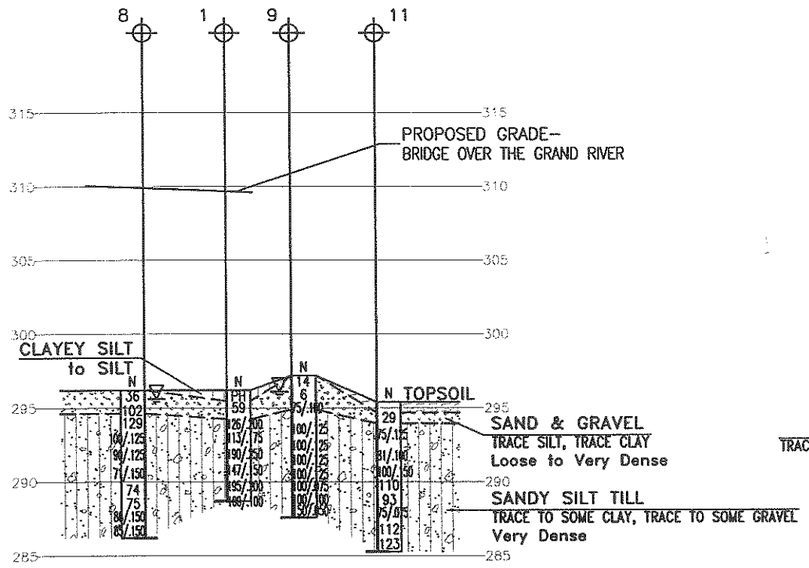
NO	ELEVATION	NORTHING	EASTING	NO	ELEVATION	NORTHING	EASTING
05	298.6	4 815 499.6	227 358.4	08–060	302.9	4 815 513.6	227 303.6
06	297.4	4 815 516.1	227 328.8	08–061	303.8	4 815 500.8	227 356.5
07	298.0	4 815 535.3	227 365.4	08–062	299.6	4 815 419.6	227 281.4
08	296.2	4 815 567.3	227 341.3	08–063	298.9	4 815 457.2	227 352.2
09	297.2	4 815 590.1	227 384.9	08–064	300.9	4 815 361.0	227 325.4
10	295.4	4 815 615.4	227 360.8	08–065	300.6	4 815 318.0	227 257.3
10A	295.4	4 815 628.9	227 366.0	08–066	303.1	4 815 308.8	227 314.3
11	295.4	4 815 609.3	227 406.6	01	296.2	4 815 583.4	227 363.9
12	295.4	4 815 677.6	227 388.3	02	295.4	4 815 640.4	227 387.0
13	295.4	4 815 690.7	227 430.9	03	309.6	4 815 745.9	227 445.6
14	308.8	4 815 723.3	227 418.7	04	299.0	4 815 464.3	227 318.2
15	309.1	4 815 734.9	227 455.3				

-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.
3) Proposed grades are from Plate 3 of the E.A. Study.

GEOCRES No. 40P8-159

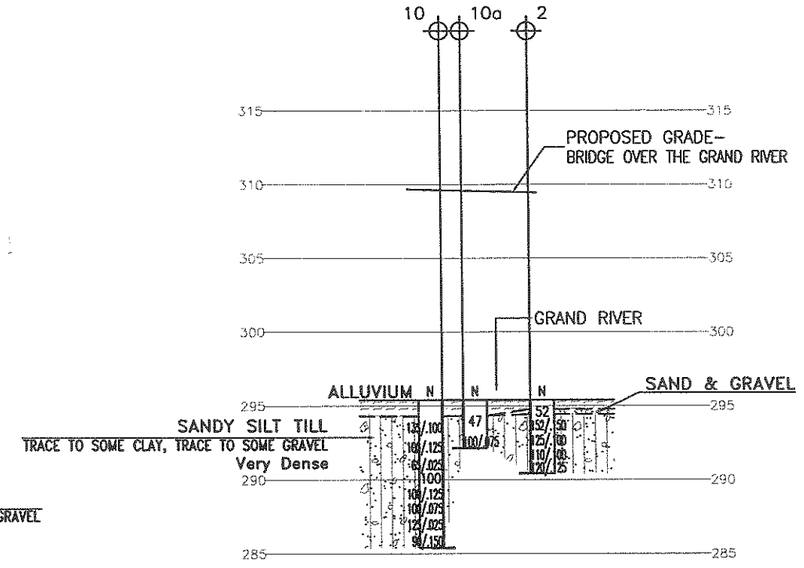
REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN AEG	CHK PKC	CODE	LOAD DATE MAY 2009
DRAWN MFA	CHK AEG	SITE	STRUCT DWG



SECTION E–E

0 40 80 120m HOR 1:2000

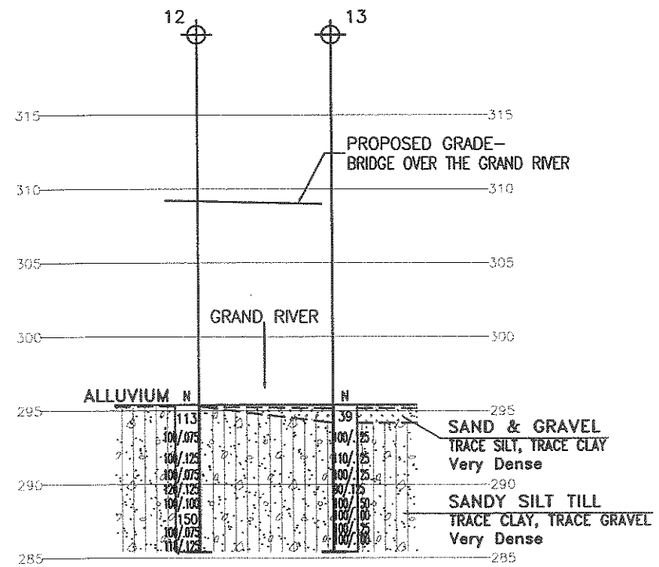
0 8 16 24m VER 1:400



SECTION F–F

0 40 80 120m HOR 1:2000

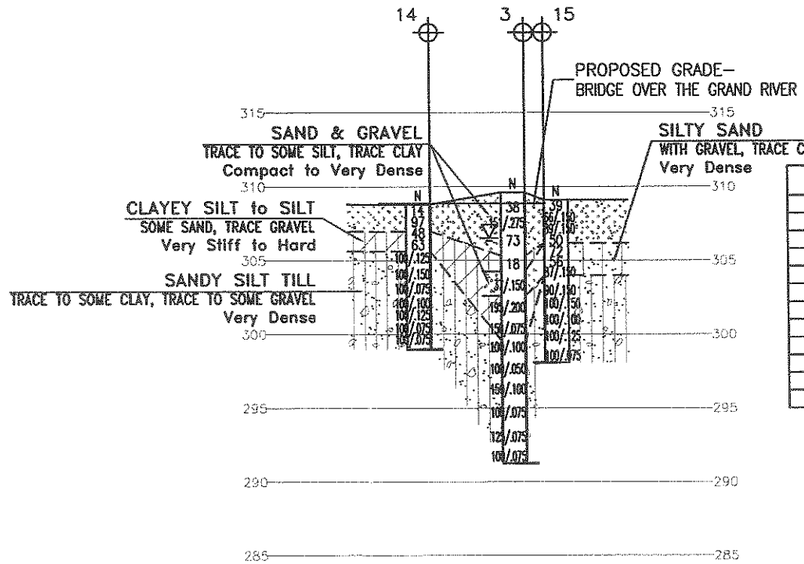
0 8 16 24m VER 1:400



SECTION G–G

0 40 80 120m HOR 1:2000

0 8 16 24m VER 1:400



SECTION H–H

0 40 80 120m HOR 1:2000

0 8 16 24m VER 1:400

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100 mm ON ORIGINAL DRAWING

METRIC

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LICENSED PROFESSIONAL ENGINEER
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June 1/09
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SHEET

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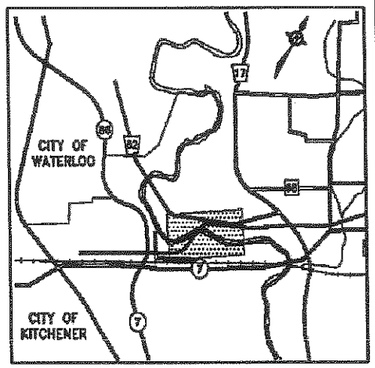

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GEOCRES No. 40P8-159

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	AEG	CHK	PKC	CODE		LOAD	DATE MAY 2009
DRAWN	MFA	CHK	AEG	SITE		STRUCT	DWG

PLOT SCALE 1:1 — PLOT DATE 09-06 — FN-D-707 — MINISTRY OF TRANSPORTATION, ONTARIO

FILENAME: H:\Drafting\LDT\64\17\tb08417-GrandRiver.dwg