

**FOUNDATION INVESTIGATION AND DESIGN REPORT
HARRIS RIVER BRIDGE, NBL
HIGHWAY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 529,
NORTHERLY 15 KM**

W.P. 5200-06-01, G.W.P. 5294-08-00, SITE No. 44-162/1

Geocres Number: 41H-86

Report to

MMM Group Limited

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

May 10, 2012

File: 19-5161-21

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TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

1	INTRODUCTION	1
2	SITE DESCRIPTION	2
3	SITE INVESTIGATION AND FIELD TESTING	2
4	LABORATORY TESTING	6
5	DESCRIPTION OF SUBSURFACE CONDITIONS	7
5.1	Topsoil	7
5.2	Fill	7
5.3	Sand	8
5.4	Sandy Silt	9
5.5	Silt	10
5.6	Sand and Silt	10
5.7	Silty Clay	12
5.8	Gravelly Sand.....	13
5.9	Sand and Gravel.....	13
5.10	Bedrock	14
5.11	Water Levels	16
6	MISCELLANEOUS	17

PART 2 ENGINEERING DISCUSSION AND RECOMMENDATIONS

7	GENERAL.....	19
8	STRUCTURE FOUNDATIONS.....	20
8.1	Spread Footings on Native Soils	20
8.2	Spread Footings on Bedrock	20
8.2.1	South Abutment.....	21
8.2.2	North Abutment.....	21
8.2.3	Lateral Resistance on Bedrock	23
8.3	Drilled Piles	23
8.4	Driven Piles.....	24
8.4.1	Axial Resistance	24
8.4.2	Pile Tips.....	25
8.4.3	Pile Installation	25
8.4.4	Abutments.....	25

8.4.5	Pile Driving	26
8.4.6	Downdrag	26
8.5	Abutment Design Considerations	26
8.6	Lateral Resistance	27
8.7	Recommended Foundation	28
8.8	Frost Cover.....	28
9	EXCAVATION	29
9.1	Earth Excavation.....	29
9.2	Rock Excavation	29
10	UNWATERING	29
10.1	Abutments.....	29
11	SCOUR AND EROSION PROTECTION	30
12	APPROACH EMBANKMENTS	30
13	BACKFILL TO ABUTMENTS	32
14	EARTH PRESSURE	32
15	SEISMIC CONSIDERATIONS	34
15.1	Seismic Design Parameters.....	34
15.2	Liquefaction Potential	34
15.3	Retaining Wall Dynamic Earth Pressures	34
16	CONSTRUCTION CONCERNS	35
17	CLOSURE	36

Appendices

Appendix A	Record of Borehole Sheets from current investigation
Appendix B	Laboratory Test Results
Appendix C	Record of Borehole Sheet from previous investigation
Appendix D	Foundation Comparison
Appendix E	List of SPs and OPSS, and Suggested Text for Selected NSSP
Appendix F	Figure
Appendix G	Site Photographs
Appendix H	Drawing titled “Borehole Locations and Soil Strata”

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of a proposed bridge carrying Highway 69 Northbound lanes (NBL) over Harris River in the Township of Wallbridge, Ontario. The proposed bridge is part of the four-laning of Highway 69 from the south junction of Highway 69 and Highway 529 northerly for 15 km.

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

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (MMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 5006-E-0030.

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

1. Preliminary Foundation Investigation and Design Report for Selected Structures, Highway 69 Route Selection Study, 3.5 km North of Highway 559 to 3.8 km North of Highway 522, GWP 5377-02-00, Highway 69, prepared by Trow Associates Inc., dated September 12, 2005, GEOCRE No: 41H-50.

A record of borehole sheet from the previous report is attached in Appendix C for reference.

2 SITE DESCRIPTION

The site of the proposed structure lies immediately east of the existing concrete arch structure that carries Highway 69 over Harris River in the Township of Wallbridge, Ontario.

At the location of the proposed Harris River Bridge NBL, the river channel width varies between 12.0 m to 20.0 m and water flows westerly. The water level in the river was measured at Elevation 179.25 in September 2008.

The south valley slope is approximately 10.5 m high and the inclination varies from approximately 3H:1V above mid-height to 1.6H:1V below mid-height. The north valley slope is approximately 7.5 m high and the inclination is approximately 3H:1V. The slopes are well treed, with grass and shrubs along the river banks and in the open areas. The river bed and banks are lined with boulders.

The lands surrounding the site are generally undeveloped, forested and contain open swamps. Bedrock outcroppings, ridges and small creeks/water bodies are visible along the existing Highway 69 corridor.

Photographs in Appendix G show the general nature of the site and the existing structure.

The site lies within the physiographic region known as the Georgian Bay Fringe, which covers Parry Sound and Muskoka. The region is characterized by very shallow overburden and bare rock knobs and ridges. Bedrock is exposed in many areas and intermittent swamps were filled in when glacial lake Algonquin inundated the area. The overburden materials consist of sand, silt and clay. Recent organic deposits of peat and muck occur in abundance in the bedrock hollows and valleys.

The area is underlain by strongly foliated and highly to moderately deformed rocks of Precambrian age of the following types:

- Gneisses of metasedimentary origin.
- Migmatitic rocks and gneisses.
- Felsic igneous rocks (tonalite, granodiorite, monzonite, granite, syenite, derived gneisses).
- Tectonite unit (tectonites, various gneisses).

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried out in two phases. The first phase was carried out from October 20 to 26 and November 16 to 19, 2009 and the second phase was carried out in May, 2010.

Phase 1 consisted of drilling, conducting manual excavation and sampling a total of 34 boreholes (numbered HRB09-01 to HRB09-34) at the proposed foundation elements (abutments and piers) and approaches of the proposed Harris River NBL structure. Phase 2 consisted of drilling and sampling 20 additional boreholes (identified as HRB10-1 to 8, 11, and 12, and BH10-A to J) at the proposed foundation elements. The locations of Boreholes BH10-A to J were selected based on the proposed Option 3 Single Span General Arrangement.

Borehole advancement within the overburden generally ranged from 0.2 m to 7.5 m where the drill rig encountered refusal. The overburden in Boreholes HRB10-07, 08, 11, and 12 was not logged or sampled. Bedrock outcrops and very shallow bedrock (less than 0.1 m depth) were noted at the locations of Boreholes HRB09-25, HRB09-26, and HRB09-28. At these three boreholes, visual assessment and manual excavation were conducted to assess the thickness of the overburden. Thirteen boreholes from Phase 1 and all 20 boreholes from Phase 2 were advanced 3.0 m to 3.9 m into bedrock by NQ size diamond coring. The boreholes drilled during Phase 1 were also supplemented by six dynamic cone penetration tests (DCPT), numbered HRB-D1 to HRB-D6, conducted in close proximity to the boreholes.

The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix H.

The Record of Borehole sheet for Borehole HRN-1 drilled during the previous investigation (Reference 1) and the associated laboratory test results are included in Appendix C.

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

Phase 1 drilling was carried out using a track mounted CME 55 drill rig where the locations were accessible. Where a track mounted rig could not be used, portable drilling and coring equipment consisting of a Hilti DD-250 was used. All of the Phase 2 boreholes were drilled using portable drilling and coring equipment. A combination of hollow-stem auger drilling techniques and rotary coring methods were used to advance the boreholes. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Four standpipe piezometers consisting of 19 mm PVC pipe with slotted screens were installed and 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.

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
NBL STRUCTURE			
South Approach	HRB09-33	None installed	Borehole backfilled with bentonite holeplug to 2.9 m then auger cuttings to surface.
South Abutment Area	HRB09-01	None installed	Borehole backfilled with holeplug to 2.4 m then auger cuttings to surface.
	HRB09-02	None installed	Borehole backfilled with holeplug to 4.3 m then auger cuttings to surface.
	HRB09-03	None installed	Borehole backfilled with holeplug to 4.1 m then auger cuttings to surface.
	HRB09-04	10.7/179.4	Sand from 10.7 m to 7.3 m, holeplug from 7.3 m to 3.7 m, then auger cuttings to surface.
	HRB09-05	None installed	Borehole backfilled with holeplug to 3.5 m then auger cuttings to surface.
	HRB09-06	None installed	Borehole backfilled with holeplug to 3.9 m then auger cuttings to surface.
	HRB09-07	None installed	Borehole backfilled with holeplug to 4.3 m then auger cuttings to surface.
	HRB09-08	None installed	Borehole backfilled with holeplug to 2.4 m then auger cuttings to surface.
	BH10-A	None installed	Borehole backfilled with holeplug to 3.1 m then drill cuttings to surface.
	BH10-B	None installed	Borehole backfilled with holeplug to surface.
	BH10-C	None installed	Borehole backfilled with holeplug to surface.
	BH10-D	None installed	Borehole backfilled with holeplug to surface.
South River Bank	HRB09-09	None installed	Borehole backfilled with holeplug to surface.
	HRB09-10	None installed	Borehole backfilled with holeplug to 1.5 m then sand to surface.
	HRB09-11	None installed	Borehole backfilled with holeplug to surface.
	HRB09-12	None installed	Borehole backfilled with holeplug to 1.8 m then sand to surface.
	HRB09-13	None installed	Borehole backfilled with holeplug to surface.
	HRB09-14	None installed	Borehole backfilled with holeplug to surface.
	HRB09-15	3.7/180.3	Sand from 3.7 m to 2.0 m, holeplug from 2.0 m to surface.
	HRB09-16	None installed	Borehole backfilled with sand to surface.

Table 3.1 – Borehole Completion Details (Cont'd)

Foundation Unit	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
NBL STRUCTURE			
South River Bank	HRB10-1	None installed	Borehole backfilled with holeplug to surface.
	HRB10-2	None installed	Borehole backfilled with holeplug to surface.
	HRB10-3	None installed	Borehole backfilled with holeplug to surface.
	HRB10-4	None installed	Borehole backfilled with holeplug to surface.
	HRB10-5	None installed	Borehole backfilled with holeplug to surface.
	HRB10-6	None installed	Borehole backfilled with holeplug to surface.
North River Bank	HRB09-17	None installed	Borehole backfilled with holeplug to 1.8 m then auger cuttings to surface.
	HRB09-18	None installed	Borehole backfilled with holeplug to 3.8 m then auger cuttings to surface.
	HRB09-19	None installed	Borehole backfilled with holeplug to 5.5 m then auger cuttings to surface.
	HRB09-20	None installed	Borehole backfilled with holeplug to 2.1 m then auger cuttings to surface.
	HRB09-21	8.1/173.4	Sand from 8.1 m to 4.0 m, holeplug from 4.0 m to 2.4 m, then auger cuttings to surface.
	HRB09-22	None installed	Borehole backfilled with holeplug to 3.0 m then auger cuttings to surface.
	HRB09-23	None installed	Borehole backfilled with holeplug to 1.2 m then auger cuttings to surface.
	HRB09-24	None installed	Borehole backfilled with holeplug to 3.4 m then auger cuttings to surface.
	HRB10-7	None installed	Borehole backfilled with holeplug to surface.
	HRB10-8	None installed	Borehole backfilled with holeplug to surface.
	HRB10-11	None installed	Borehole backfilled with holeplug to surface.
	HRB10-12	None installed	Borehole backfilled with holeplug to 1.8 m then sand to surface.

Table 3.1 – Borehole Completion Details (Cont'd)

Foundation Unit	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
NBL STRUCTURE			
North Abutment Area	HRB09-25	None installed	Manual excavation. Very shallow bedrock.
	HRB09-26	None installed	Manual excavation. Very shallow bedrock.
	HRB09-27	4.0/183.3	Sand from 4.0 m to 0.8 m, then auger cuttings to surface.
	HRB09-28	None installed	Manual excavation. Very shallow bedrock.
	HRB09-29	None installed	Borehole backfilled with holeplug to 2.7 m then auger cuttings to surface.
	HRB09-30	None installed	Borehole backfilled with holeplug to surface.
	HRB09-31	None installed	Borehole backfilled with holeplug to surface.
	HRB09-32	None installed	Borehole backfilled with holeplug to surface.
	BH10-E	None installed	Borehole backfilled with holeplug to surface.
	BH10-F	None installed	Borehole backfilled with holeplug to surface.
	BH10-G	None installed	Borehole backfilled with holeplug to surface.
	BH10-H	None installed	Borehole backfilled with holeplug to 0.6 m then sand to surface.
	BH10-I	None installed	Borehole backfilled with holeplug to surface.
	BH10-J	None installed	Borehole backfilled with holeplug to 0.6 m then sand to surface.
North Approach	HRB09-34	None installed	Borehole backfilled with holeplug to surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and rock samples to geological logging. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. Moisture content determinations were carried out on all soil samples. The results of this testing program are summarized on the Record of Borehole sheets in Appendix A and on the figures presented in Appendix B.

Point load tests were carried out in the laboratory on selected samples of intact bedrock to assist in evaluation of the compressive strength of the bedrock. The results of the point load tests performed on the rock core samples are tabulated in Table 1 immediately following the text of this report and on the Record of Borehole sheets in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendices A and C. Details of the encountered soil and rock stratigraphy are presented in these sheets and on the “Borehole Locations and Soil Strata” drawing in Appendix H. 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 terms, the overburden encountered at this site consists of topsoil overlying native layers of sand, silty clay, sandy silt and sand and silt. Isolated layers of gravelly sand and sand and gravel were encountered at some borehole locations within the sand layer. Granitic gneiss bedrock was encountered below the overburden and topsoil, generally at depths ranging from 0.05 m to 7.5 m. More detailed descriptions of the individual strata are presented below.

5.1 Topsoil

Dark brown topsoil containing occasional roots, rootlets and wood fibres was contacted in Boreholes HRB09-03 to HRB09-11, HRB09-13 to HRB09-15, HRB09-21 to HRB09-23, HRB09-25, HRB09-26, HRB09-28, HRB09-29, HRB09-33, HRB09-34, HRN-1, BH10-E to BH10-H, HRB10-02, HRB10-04 and HRB10-05. All topsoil was encountered at the surface, with the exception of the topsoil encountered in Borehole BH10-G which was encountered below fill that was placed for drill rig access.

The thickness of the topsoil varied from 25 mm to 500 mm. The topsoil thickness may vary between and beyond the borehole locations and this data is not intended for the purpose of estimating quantities.

The moisture content of samples from the topsoil layer generally varies between 25% and 38%. A moisture content of 130% was measured in Borehole HRB09-21.

5.2 Fill

A layer of brown sand fill containing some gravel, trace silt, occasional bedrock fragments and occasional roots and rootlets was placed surficially at the locations of Boreholes HRB09-18 and HRB09-20 for drill rig access to these borehole locations. A similar sand fill was also placed surficially for drilling access to Borehole BH10-G. The fill was approximately 0.8 m thick at the location of Boreholes HRB09-18 and HRB09-20 and 0.6 m thick at the location of BH10-G.

SPT N-values in the sand fill ranged from 4 to 22 blows per 0.3 m of penetration, indicating a loose to compact relative density. The moisture content of the fill samples ranged from 18 to 35%.

5.3 Sand

Layers of native brown to grey sand containing trace silt to silty, trace gravel, trace clay, occasional roots, rootlets and organics and occasional cobbles, boulders and bedrock fragments were encountered at depths and elevations indicated in Table 5.1. Micaceous sand was encountered at some borehole locations.

Table 5.1 – Depths and Elevations of Sand Layer

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
South Abutment Area	HRB09-01	0.0 to 1.7* 2.5 to 3.0	189.4 to 187.7 186.9 to 186.3	1.7 0.5
	HRB09-02	0.0 to 1.8 2.4 to 3.0	189.7 to 187.9 187.3 to 186.7	1.8 0.6
	HRB09-03	0.1 to 1.2 4.1 to 7.4 (Borehole termination depth)	190.0 to 188.9 186.0 to 182.7	1.1 3.3
	HRB09-06	4.1 to 5.6 (Borehole termination depth)	186.0 to 184.4	1.5
	BH10-B	0.0 to 0.6	190.0 to 189.4	0.6
	BH10-C	4.3 to 5.3	185.8 to 184.8	1.0
South River Bank	HRB09-09	0.1 to 5.3 (Borehole termination depth)*	185.6 to 180.4	5.2
	HRB09-10	0.1 to 5.4 (Borehole termination depth)*	184.5 to 179.1	5.3
	HRB09-11	0.1 to 5.1 (Borehole termination depth)*	185.2 to 180.2	5.0
	HRB09-12	0.0 to 4.1 (Borehole termination depth)	183.8 to 179.7	4.1
	HRB09-15	0.2 to 0.6 (Borehole termination depth)*	183.9 to 183.5	0.4
	BH10-01	0.0 to 1.8 2.0 to 7.0	186.7 to 184.9 184.7 to 179.7	1.8 5.0
	BH10-02	0.0 to 4.5*	183.5 to 179.0	4.5
	BH10-03	0.0 to 5.2	186.3 to 181.1	5.2
	BH10-06	0.0 to 0.2	182.4 to 182.2	0.2
North River Bank	HRB09-17	0.0 to 4.0 (Borehole termination depth)	181.7 to 177.7	4.0
	HRB09-19	0.0 to 4.7 (Borehole termination depth)	181.2 to 176.5	4.7
	HRB09-21	0.4 to 4.2 (Borehole termination depth)	181.1 to 177.3	3.8
	HRB09-22	0.5 to 4.5 (Borehole termination depth)	181.2 to 177.2	4.0
	HRB09-23	0.5 to 4.9 (Borehole termination depth)	180.2 to 175.8	4.4
	HRB09-24	0.0 to 4.7 (Borehole termination depth)	181.6 to 176.9	4.7
North Abutment Area	HRB09-27	0.0 to 0.8	187.3 to 186.5	0.8
	HRB09-30	0.0 to 0.5	186.8 to 186.3	0.5
	HRB09-31	0.0 to 0.5	185.7 to 185.2	0.5
	HRB09-32	0.0 to 0.4	186.1 to 185.7	0.4

	BH10-E	0.1 to 0.4	185.8 to 185.5	0.3
	BH10-F	0.1 to 0.6	186.8 to 186.3	0.5
	BH10-G	0.7 to 1.0	185.8 to 185.5	0.3
	BH10-H	0.1 to 0.8	185.9 to 185.2	0.7
	BH10-I	0.0 to 0.4	186.9 to 186.5	0.4
	BH10-J	0.0 to 0.2	186.2 to 186.0	0.2
North Approach	HRB09-34	0.1 to 1.3	191.4 to 190.2	1.2

* Micaceous Sand

Standard Penetration tests in the sand layer gave SPT N-values generally in the range of 1 to 47 blows per 0.3 m of penetration, indicating a very loose to dense relative density.

Isolated higher SPT N-values of 83 blows per 0.25 m of penetration and 73 blows per 0.275 m of penetration, indicating a very dense relative density, were measured in Boreholes HRB09-10 and HRB09-12 near elevation 180.0. An SPT N-value of 69 blows per 0.3 m of penetration was measured in Borehole HRB09-22 near elevation 178.5. Higher SPT N-values were also recorded in Boreholes BH10-E, G, H, I, and J and in Boreholes HRB10-04 and HRB10-06 in the thin layer of sand overlying bedrock.

The moisture contents of samples from the sand layer generally vary between 5% and 55%.

Grain size distribution curves for the sand samples tested are presented in Appendix B, Figures B1 to B5. The results are also summarized on the Record of Borehole sheets in Appendix A. The results of grain size distribution test are summarized as follows:

Soil Particles	Sand (%)
Gravel	0 to 32
Sand	63 to 96
Silt	14 to 34
Clay	2 to 5
Silt & Clay	2 to 26

5.4 Sandy Silt

Native brown to grey sandy silt containing trace clay was encountered at the surface in Boreholes BH10-A and BH10-C and below the silty clay in Boreholes BH10-B and BH10-D. The thickness of the surficial sandy silt layer ranges from 1.8 to 2.7 m (underside elevation 187.2 to 188.3) and the thickness of the lower sandy silt layer ranges from 1.2 to 1.8 m (underside elevation 184.4 to 185.3). Sandy silt containing some clay was also encountered below the topsoil in Borehole HRN-1, drilled at the south abutment

during the previous investigation. The thickness of this layer is 5.5 m (underside elevation 185.1).

SPT 'N' values in the sandy silt ranged from 4 to 29 blows per 0.3 m of penetration, indicating a loose to compact relative density. Moisture contents of the sandy silt range from 8% to 24%.

Grain size distribution curves for four sandy silt samples are presented in Appendix B, Figure B6 and the results are summarized on the Record of Borehole sheets. The results of grain size distribution test are summarized as follows:

Soil Particles	Sandy Silt (%)
Gravel	0
Sand	17 to 34
Silt	55 to 75
Clay	4 to 15

5.5 Silt

An 800-mm thick layer of grey silt containing some sand and some clay was contacted below the sand layer at 1.7 m depth (Elevation 187.7) in Borehole HRB09-01.

The depth to the base of the silt was 2.5 m (Elevation 186.9).

SPT 'N' values in the silt were 2 and 3 blows per 0.3 m of penetration, indicating a very loose relative density. Moisture content was 46 %.

The grain size distribution curve for one silt sample is presented in Figure B7, Appendix B and the results are also included on the Record of Borehole sheets. The results of the grain size distribution test are summarized as follows:

Soil Particles	Silt (%)
Gravel	0
Sand	10
Silt	77
Clay	13

5.6 Sand and Silt

Layers of native brown to grey sand and silt containing, trace gravel, trace to some clay, occasional roots, rootlets, organics and occasional bedrock fragments were encountered at depths and elevations indicated in Table 5.2.

Table 5.2 – Depths and Elevations of Sand and Silt Layer

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
South Approach	HRB09-33	0.8 to 4.3 (Borehole termination depth)	189.7 to 186.2	3.5
South Abutment Area	HRB09-01	4.0 to 6.5	185.3 to 182.9	2.5
	HRB09-02	4.1 to 7.0 (Borehole termination depth)	185.6 to 182.7	2.9
	HRB09-03	1.2 to 3.0	188.9 to 187.1	1.8
	HRB09-04	0.1 to 3.1	190.0 to 187.0	3.0
		4.1 to 7.5	186.0 to 182.6	3.4
	HRB09-05	0.1 to 3.3	190.0 to 186.8	3.2
		4.1 to 5.4 (Borehole termination depth)	185.9 to 184.6	1.3
	HRB09-06	0.1 to 3.3	190.0 to 186.8	3.2
	HRB09-07	0.05 to 4.2	190.3 to 186.2	4.1
	HRB09-08	0.05 to 3.9 (Borehole termination depth)	190.3 to 186.5	3.8
	BH10-A	4.0 to 6.2	185.9 to 183.7	2.2
	BH10-B	0.6 to 3.0	189.4 to 187.0	2.4
South River Bank	BH10-C	1.8 to 3.2	188.3 to 186.9	1.4
	BH10-D	0.0 to 2.4	189.1 to 186.7	2.4
	HRB09-13	0.2 to 1.8 (Borehole termination depth)	183.5 to 181.9	1.6
	HRB09-14	0.3 to 1.3	182.1 to 181.1	1.0
	HRB09-16	0.0 to 0.2	183.0 to 182.8	0.2
North Abutment Area	HRB10-04	0.0 to 2.4	182.7 to 180.3	2.4
	HRB10-05	0.0 to 0.6	184.0 to 183.4	0.6
	HRB09-29	0.5 to 1.4	185.9 to 184.9	1.0

Standard Penetration tests in the sand and silt layer gave SPT N-values generally in the range of 1 to 31 blows per 0.3 m of penetration, indicating a very loose to dense relative density. The layer in general is in a loose to compact condition.

The moisture content of samples from the sand and silt layer generally varies from 5% to 25%.

Grain size distribution curves for the sand and silt samples tested are presented in Figures B8 to B12, Appendix B and the results are summarized on the Record of Borehole sheets in Appendix A. The results of grain size distribution test are summarized as follows:

Soil Particles	Sand (%)
Gravel	0 to 2
Sand	22 to 64
Silt	31 to 70
Clay	2 to 15

5.7 Silty Clay

Native brown to grey silty clay containing trace to some sand and occasional sand seams was contacted below the sandy silt and sand and silt layers at depths ranging from 1.8 m to 3.3 m (Elevations 186.3 to 187.9) in Boreholes HRB09-01 to HRB09-06 and BH10-A to BH10-D drilled at the south abutment. In Borehole HRB09-33, drilled at the south approach, the silty clay was contacted below the topsoil at 0.04 m depth (Elevation 190.3). The thickness of the silty clay layer varies from 0.2 m to 1.3 m.

Layers of silty clay were encountered within the sand and silt near Elevation 188.5 in Borehole HRB09-33 and near Elevation 184.9 and 182.3 in Boreholes HRB10-01 and HRB10-02, respectively. The thickness of these silty clay layers range from 50 to 500 mm.

The depths to the base of the silty clay ranged from 2.6 m to 4.3 m (Elevations 185.3 to 186.5) in Boreholes HRB09-01 to HRB09-06 and BH10-A to BH10-D.

SPT 'N' values in the silty clay ranged from 2 to 9 blows per 0.3 m of penetration, indicating a soft to stiff consistency. Moisture contents ranged from 21% to 55%.

Grain size distribution curves for selected silty clay samples are presented in Appendix B, Figures B13 and B14. The results are also summarized on the Record of Borehole sheets included in Appendix A. Atterberg Limits test results are presented in Figure B17 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particle / Index Property	Percentage (%)
Gravel	0
Sand	1 to 20
Silt	42 to 78
Clay	16 to 57
Liquid Limit	23 to 44
Plastic Limit	16 to 22

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

5.8 Gravelly Sand

In Borehole HRB09-20, a layer of brown gravelly sand containing trace to some silt, trace clay and occasional organics, roots and rootlets was contacted below the fill at 0.8 m depth (Elevation 180.7). Thickness of this gravelly sand layer was 2.7 m. The depth to the base of the gravelly sand in Borehole HRB09-20 was 3.5 m (Elevation 178.0).

Isolated layers of brown gravelly sand were contacted within the sand layer in Boreholes HRB09-17, HRB09-22 and HRB09-24 at elevations ranging from 178.5 to 181.0.

Standard Penetration tests in the gravelly sand layers gave SPT N-values ranging from 5 to 31 blows per 0.3 m of penetration, indicating a loose to dense relative density. An SPT N-value of 62 blows per 0.3 m of penetration, indicating very dense relative density, was measured in Borehole HRB09-20 near borehole termination depth.

The moisture contents of samples from the sand layer generally vary between 8% and 19%.

Grain size distribution curves for the gravelly sand samples tested are presented in Figure B15, Appendix B. The results of grain size distribution tests included on the Record of Borehole Sheets in Appendix A and are summarized as follows:

Soil Particles	Gravelly Sand (%)
Gravel	27 to 28
Sand	58 to 64
Silt & Clay	9 to 14

5.9 Sand and Gravel

A 2.5-m thick layer of sand and gravel containing trace silt, trace clay, occasional organics, roots, rootlets and bedrock fragments was contacted below the fill at 0.8 m depth (Elevation 181.3) in Borehole HRB09-18.

A layer of sand and gravel was also contacted within the sand layer near elevation 179.5 in Borehole HRB09-19.

The base of the sand and gravel layer is at 3.3 m (elev. 178.8) in Borehole HRB09-18.

Standard Penetration tests in the sand and gravel layer gave SPT N-values ranging from 14 to 35 blows per 0.3 m of penetration, indicating a compact to dense relative density. The moisture contents of samples from the sand and gravel layer generally range from 5% to 18%.

Grain size distribution curves for the sand and gravel samples tested are presented in Appendix B, Figure B16. The results of grain size distribution tests are summarized as follows and are included on the Record of Borehole Sheets in Appendix A.

Soil Particles	Sand and Gravel (%)
Gravel	38 to 46
Sand	44 to 53
Silt & Clay	9 to 10

5.10 Bedrock

The overburden soils described above are underlain by granitic gneiss bedrock with feldspathic layers. The bedrock is moderately/slightly weathered to fresh. The bedrock was generally grey with occasional pink and white bands visible in most cores. Occasional mechanical breaks and sub-vertical fractures were observed in the rock cores.

Bedrock was encountered below the topsoil at 25 mm to 100 mm depth in Boreholes HRB09-25, HRB09-26 and HRB09-28.

Bedrock was encountered at various depths and it was proved by coring near the locations of each proposed abutment. Table 5.3 summarizes depths and elevations to the top of bedrock in the boreholes. Where coring was not carried out, bedrock was inferred from auger refusal.

Table 5.3 – Depths and Elevations of Top of Bedrock

Foundation Unit	Borehole	Top of Bedrock	
		Depth (m)	Elevation (m)
South Approach	HRB09-33	4.3**	186.2
South Abutment Area	HRB09-01	6.5*	182.9
	HRB09-02	7.0**	182.7
	HRB09-03	7.4**	182.7
	HRB09-04	7.5*	182.6
	HRB09-05	5.4**	184.6
	HRB09-06	5.6**	184.4

	HRB09-07	4.2*	186.2
	HRB09-08	3.9**	186.5
	HRN-1	5.5*	185.1
	BH10-A	6.2*	183.7
	BH10-B	5.6*	184.4
	BH10-C	5.3*	184.8
	BH10-D	3.8*	185.3
South River Bank	HRB09-09	5.3**	180.4
	HRB09-10	5.4*	179.1
	HRB09-11	5.1*	180.2
	HRB09-12	4.1**	179.7
	HRB09-13	1.8**	181.9
	HRB09-14	1.3*	181.1
	HRB09-15	0.6*	183.5
	HRB09-16	0.2**	182.8
	HRB10-01	7.0*	179.7
	HRB10-02	4.5*	179.0
	HRB10-03	5.2*	181.1
	HRB10-04	2.4*	180.3
	HRB10-05	0.6*	183.4
	HRB10-06	0.2*	182.2
	HRB09-17	4.0**	177.7
North River Bank	HRB09-18	3.3*	178.8
	HRB09-19	4.7*	176.5
	HRB09-20	3.5**	178.0
	HRB09-21	4.2*	177.3
	HRB09-23	4.9**	175.8
	HRB09-24	4.7**	176.9
	HRB10-07	4.6*	177.0
	HRB10-08	2.7*	179.3
	HRB10-11	5.8*	175.3
	HRB10-12	4.9*	176.4
	HRB09-25	0.040	188.1
North Abutment Area	HRB09-26	0.1	188.6
	HRB09-27	0.8*	186.5
	HRB09-28	0.025	187.6
	HRB09-29	1.4*	184.9

	HRB09-30	0.5**	186.3
	HRB09-31	0.5*	185.2
North Abutment Area	HRB09-32	0.4**	185.7
	BH10-E	0.4*	185.5
	BH10-F	0.6*	186.3
	BH10-G	1.0*	185.5
	BH10-H	0.8*	185.2
	BH10-I	0.6*	186.3
	BH10-J	0.2*	186.0
North Approach	HRB09-34	1.3**	190.2

* Bedrock proved by coring

** Refusal on inferred bedrock or boulder

Core recovery in the bedrock generally ranged from 83% to 100%, with the exception of 56% recovery in Borehole HRB09-29 Run 1. The RQD values generally ranged from 50% to 100% indicating fair to excellent rock quality. RQD values of 25% to 49% (indicating a poor rock quality) were noted in 7 of 115 core runs and RQD values of 0% to 24% (indicating a very poor rock quality) were noted in 8 of 115 core runs. RQD values of 0% were noted in Boreholes HRB09-10 Run 1, HRB09-14 Run 1, BH10-I Run 3, HRB10-11 Run 1, HRB10-12 Run 1 and HRB10-12 Run 2.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, generally ranged from 0 to greater than 10 in most of the cores. In some cores the FI was greater than 20.

The estimated uniaxial compressive strength of the rock cores generally ranges from 52 MPa to 282 MPa, indicating a strong to extremely strong rock. Lower uniaxial compressive strength values ranging from 5 MPa to 45 MPa were also measured in some cores, indicating the rock to be weak to medium strong. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. A summary of the Point Load Test Results is presented in Table 1 immediately following the text of this report.

5.11 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. Four standpipe piezometers were installed during the 2009 investigation to monitor water levels after completion of drilling. The water levels measured in the piezometers and open boreholes are summarized in Table 5.4.

Table 5.4 – Water Level Measurements

Location	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
South Abutment	HRB09-04	October 27, 2009	7.2	182.9	In piezometer
		November 20, 2009	7.5	182.6	
	HRN-1	March 24, 2005	6.25	184.3	In piezometer
		April 6, 2005	6.23	184.3	
South River Bank	HRB09-12	November 11, 2009	2.8	181.0	In open borehole
	HRB09-14	November 17, 2009	0.6	181.8	In open borehole
	HRB09-15	November 20, 2009	0.5	183.5	In piezometer
North River Bank	HRB09-17	October 23, 2009	2.3	179.4	In open borehole
	HRB09-20	October 24, 2009	2.6	178.9	In open borehole
	HRB09-21	October 27, 2009	2.5	179.0	In piezometer
		November 20, 2009	2.9	178.6	
	HRB09-22	October 24, 2009	2.9	178.8	In open borehole
	HRB09-23	October 24, 2009	1.5	179.2	In open borehole
North Abutment	HRB09-24	October 24, 2009	2.9	178.7	In open borehole
		October 27, 2009	0.8	186.5	
	HRB09-27	November 20, 2009	1.2	186.1	In piezometer

The piezometric readings taken at the South Abutment, North Abutment and South River Bank indicate that the groundwater levels range from Elevations 182.6 m to 186.5 m. At the North River Bank, the piezometric readings indicate that the groundwater levels range from Elevations 178.6 m to 179.0 m.

The GA drawing shows a water level measured at Harris River at Elevation 179.25 in September 2008.

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

6 MISCELLANEOUS

Borehole locations were selected by Thurber Engineering Ltd. Surveyors from MMM Group Limited staked these locations in the field, confirmed the co-ordinates and obtained the ground surface elevations.

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

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied a track mounted CME 55 drill rig and conducted the drilling, sampling and in-situ testing operations.

OGS Drilling Inc. of Almonte, Ontario supplied portable coring equipment to drill and core boreholes that were not accessible using a track mounted rig.

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

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

Thurber Engineering Ltd
Lindsey Blaine, E.I.T.

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

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



**FOUNDATION INVESTIGATION AND DESIGN REPORT
HARRIS RIVER BRIDGE, NBL
HIGHWAY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 529,
NORTHERLY 15 KM**

W.P. 5200-06-01, G.W.P. 5294-08-00, SITE No. 44-162/1

Geocres Number: 41H-86

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team to select and design a suitable foundation system and approach embankment for the proposed Highway 69 NBL bridge structure over Harris River in the Township of Wallbridge, Ontario.

Based on the preliminary General Arrangement (GA) drawing for Option 3 provided by MMM Group Limited, a 62 m long single span structure supported on two abutments is proposed. The proposed finished grade at the structure will vary from Elevations 195.1 to 194.4.

At the south abutment, the finished grade will be at Elevation 195.2 and the existing ground is at Elevation 190, approximately. The approach embankment will be approximately 5 m high relative to the existing ground. Below the approach embankment, the forward slope down to the river level will be formed by cutting into the existing river valley slope. The total height of the forward slope from the abutment to the river level will be about 15.5 m.

At the north abutment, the finished grade will be at Elevation 194.4 and the existing ground is at Elevation 187, on average. The approach embankment will be approximately 7.5 m high relative to the existing ground though the forward slope will spill down to the bottom of the valley and will be approximately 15 m high.

The discussion and recommendations presented in this report are based on the information provided by MMM Group Ltd. and on the factual data obtained in the course of the investigations.

8 STRUCTURE FOUNDATIONS

In general terms, the overburden encountered at this site consists of topsoil overlying layers of native very loose to dense sand, sandy silt and sand and silt. Layers of soft to stiff silty clay were encountered below the sand and sand and silt layers at the South Abutment and South Approach. Granitic gneiss bedrock was contacted below the overburden and topsoil, generally at depths ranging from 0.025 m to 7.5 m.

The piezometric readings measured at the south and north abutments indicate that the groundwater levels range from Elevations 182.6 m to 186.5 m.

Water level measured at Harris River was at Elevation 179.25 in September 2008.

Initial consideration was given to the following foundation types:

- Spread footings on native soils
- Spread footings on bedrock
- Drilled piles
- Driven steel H-piles

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

8.1 Spread Footings on Native Soils

Spread footings founded on native soils are not recommended at the abutments due to low geotechnical capacities of the native foundation soils and the effect of the close proximity to the river valley slope.

Furthermore, the bedrock in the north abutment area is very shallow, generally at depths ranging from 0.05 m to 1.4 m, which precludes consideration of spread footings on native soils.

Higher bearing capacities will be available if spread footings extend to top of bedrock.

8.2 Spread Footings on Bedrock

Based on the subsurface stratigraphy encountered at this site, spread footings founded on bedrock are feasible for the support of the proposed structure.

Spread footings bearing on undisturbed bedrock at or below elevations presented in Table 8.1 may be designed for the following geotechnical resistance:

- Factored geotechnical resistance of 2,000 kPa at Ultimate Limit States (ULS)

The SLS condition will not govern design of footings founded on bedrock.

The ULS resistance was selected taking account of the proximity of the slope. The edge of the footing nearest to the valley slope should be set back at least 3 m from the final forward slope.

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

Prior to constructing the footing or the mass concrete, if the slope of the bedrock surface exceeds 5%, the rock must be excavated to the minimum extent necessary to prepare a bearing surface with a slope no greater than 5%. It is recommended that this be determined during design and be shown on the Contract Drawings in order to be biddable.

In practical terms, spread footings on bedrock are most applicable at the north abutment, where the bedrock occurs at shallow depths. Comments related to the applicability of spread footings at specific foundations elements are presented below.

8.2.1 South Abutment

At the south abutment and depending on the final design, the finished grade will be 8.7 to 12.5 m above the bedrock surface, which ranges in elevation from 182.6 to 186.5 m. Allowing for a typical abutment stem height of 6 m, the depth from underside of abutment to bedrock is in the range of 2.7 to 6.5 m thus requiring:

- Deeper excavation
- A much taller abutment stem, or alternatively
- A mass concrete plinth to extend from the underside of the footing to the top of bedrock

8.2.2 North Abutment

At the north abutment, the bedrock elevation varies from 184.9 to 188.6 and finished grade will be at Elevation 194.4. Allowing for a typical 6 m abutment stem, the underside of the abutment will vary from marginally below the bedrock surface to 3.5 m above it.

Founding a spread footing on bedrock is feasible, provided a mass concrete plinth is designed to accommodate the variations in bedrock elevation across the footing.

From a geotechnical and cost perspective, this is the preferred solution for the north abutment. However, this design precludes an integral abutment design. If an integral abutment design is pursued, the necessary minimum pile length can be accommodated as described elsewhere in this report.

Table 8.1 – Highest Permitted Founding Elevations

Foundation Unit	Borehole	Top of Bedrock	
		Depth below existing ground surface (m)	Founding Elevation
South Abutment	HRB09-01	6.5	182.9
	HRB09-02	7.0	182.7
	HRB09-03	7.4	182.7
	HRB09-04	7.5	182.6
	HRB09-05	5.4	184.6
	HRB09-06	5.6	184.4
	HRB09-07	4.2	186.2
	HRB09-08	3.9	186.5
	HRN-1	5.5	185.1
	BH10-A	6.2	183.7
	BH10-B	5.6	184.4
	BH10-C	5.3	184.8
	BH10-D	3.8	185.3
North Abutment North Abutment	HRB09-25	0.04	188.1
	HRB09-26	0.1	188.6
	HRB09-27	0.8	186.5
	HRB09-28	0.025	187.6
	HRB09-29	1.4	184.9
	HRB09-30	0.5	186.3
	HRB09-31	0.5	185.2
	HRB09-32	0.4	185.7
	BH10-E	0.4	185.5
	BH10-F	0.6	186.3
	BH10-G	1.0	185.5
	BH10-H	0.8	185.2
	BH10-I	0.6	186.3
	BH10-J	0.2	186.0

8.2.3 Lateral Resistance on Bedrock

Initial calculations of the horizontal resistance may be carried out using a value of 0.7 for the ultimate friction factor of concrete poured on rock.

If the frictional component is insufficient, the horizontal resistance may be increased by dowelling the footing into the rock mass. Dowels are considered to be comparatively short steel bars that may be assumed to provide only shear resistance. If vertical resistance in tension is required, rock anchors must be included in the design.

The dowel will fail geotechnically when the ultimate lateral resistance of the rock or grout is exceeded. Using lower bound values for the strength of the rock, an ultimate horizontal resistance of 2.6 MN may be assumed for a 50 mm steel dowel embedded 1,200 mm into the rock. The depth of embedment is measured below the bedrock surface.

The shearing resistance of the selected dowel must be checked structurally.

8.3 Drilled Piles

Drilled piles are considered to be a feasible solution at the abutments of the Harris River bridge. It must be noted that the following discussion concerns drilled piles, as distinct from auger caissons. The latter are not considered feasible due to anticipated difficulties in advancing into bedrock and obtaining a seal. The system typically referred to as micropiles satisfies the requirements envisaged in this section but larger diameter drilled solutions are also acceptable.

The recommended solution employs a duplex drilling system that advances a steel casing as the hole is being drilled. The method of advance can be left to the Contractor, provided the resulting cased holes meets the requirements. However, systems that could be considered include rotary drilling with roller bits or a down the hole hammer (DTH) system with simultaneous casing advance.

One possible solution is to advance a suitable sized hole into bedrock, flush the hole clean and grout a steel H-pile into the rock socket. If an HP 310 X 110 pile is used, design can be carried out on the basis of a factored ULS resistance of 2,000 kN per pile. The SLS condition will not govern for a pile grouted into bedrock. A possible construction sequence is:

- i. Drill a cased hole of suitable size, e.g.900 mm, to bedrock and advance far enough into bedrock to achieve a seal
- ii. Advance a 750 mm diameter hole, but not the casing, a further 1 m into bedrock and to a depth of at least 1.5 m below the rock surface
- iii. Flush the hole clean

- iv. Place the pile in contact with bedrock at the bottom of the hole and brace it in position
- v. Grout at least the lower 1.2 m of the pile in bedrock with 30 MPa grout
- vi. From a geotechnical perspective, the casing can be cut off at the base of the abutment stem or it can be removed provided the Contractor can demonstrate that the grout in the rock socket will not be displaced or adversely impacted

This is considered to be the recommended foundation solution for the south abutment.

It may also have application at the north abutment. An engineered granular pad may be required at the north abutment to reduce the length of the abutment stem and to facilitate pile installation. .

8.4 Driven Piles

The bedrock encountered at this site will provide resistance for steel H-piles.

The minimum recommended pile length is 5.0 m below the underside of the abutment stem. To achieve this length at some locations, rock excavation or holes advanced into rock by coring will be required to achieve sufficient pile length/embedment. This issue is addressed below.

The piles are expected to develop the required resistance on the top of bedrock at the elevations given in Table 8.1.

8.4.1 Axial Resistance

The vertical, axial, factored geotechnical resistances at Ultimate Limit States (ULS_f) for three pile sections bearing on bedrock are presented in Table 8.2.

Table 8.2 – Axial Resistance of Three Pile Sections Founded on Bedrock

Pile Section		
HP 310 x 110 ULS (Factored) (kN)	HP 310 x 132 ULS (Factored) (kN)	HP 310 x 152 ULS (Factored) (kN)
2,000	2,400	2,750

The SLS condition will not govern for piles founded on the bedrock.

8.4.2 Pile Tips

If driven piles are selected, the tips of all piles should be fitted with cast steel, H-section rock points from an approved manufacturer such as Titus Steel (Standard H-point) or approved equivalent.

If the piles are placed into sockets in the bedrock, pile tips are not required.

8.4.3 Pile Installation

Driven piles or caissons must be installed in accordance with Special Provision No. 903S01.

More specific commentary on the use of piles at the individual foundation elements is given below.

8.4.4 Abutments

If steel H-piles are used for this foundation element, a minimum pile length of 5 m is recommended. The pile tip must, therefore, be founded at elevations no higher than:

- 184.2 at the south abutment
- 183.4 at the north abutment

This condition cannot be met by the existing conditions as the bedrock on the east half of the south abutment is higher than Elevation 184.2 and the bedrock is higher than 183.4 across the entire north abutment.

Accordingly, the following construction sequence is recommended:

- i. Expose the bedrock across the footprint of each abutment foundation
- ii. Excavate the bedrock to Elevation 184.2 where necessary at the south abutment and to Elevation 183.4 at the north abutment
- iii. For each pile, drill a 1.2 m deep socket into the bedrock at a diameter sufficient to accept the pile and allow grouting
- iv. The base of the socket must be cleaned of soil, cuttings or broken rock
- v. Place the pile in the socket and hold in position by use of temporary supports
- vi. Grout the pile in place in the socket using 30 MPa concrete
- vii. Backfill to the limits shown in Figure 1 in Appendix F using granular backfill and concurrently installing CSPs, if specified
- viii. Continue with the balance of construction.

8.4.5 Pile Driving

If driven piles are selected, the piles must be driven to bedrock. The appropriate pile driving note is “Piles to be driven to bedrock”.

The NSSP should require the QVE to terminate driving before the pile is damaged by overdriving.

To facilitate pile installation, embankment fill through which piles will be driven must not contain oversize material, i.e. no particles exceeding 75 mm in size.

8.4.6 Downdrag

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

8.5 Abutment Design Considerations

The ground conditions at this site are considered suitable for conventional or semi-integral abutment design.

To develop an integral abutment design, a minimum pile length below the abutment stem of 5 m is required. An integral abutment design can be used provided the pile installation procedures described above are followed.

The integral abutment design requires that the piles possess flexibility in the upper 3 m of the pile length. However, the upper 3 m of the pile will lie within the compacted fill of the approach embankment. Accordingly, to provide the required flexibility in the piles, the upper 3 m of the piles must be surrounded by a 600 mm diameter CSP as specified by the integral abutment design procedures.

After the pile is driven, the space between the pile and the CSP must be filled with sand. An NSSP should be included in the contract drawings specifying the gradation of the sand according to Table 8.3 and SP included in Appendix E.

Table 8.3 – Integral Abutment Sand Backfill Grading

MTO Sieve Designation		Percentage Passing
2 mm	#10	100%
600 µm	#30	80%-100%
425 µm	#40	40%-80%
250 µm	#60	5%-25%
150 µm	#100	0%-6%

8.6 Lateral Resistance

The lateral resistance of a pile in the predominantly cohesionless soils encountered at this site may be calculated using a value for the coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$$k_s = n_h \cdot z / D \quad (\text{kN/m}^3)$$

$$p_{ult} = 3 \cdot \gamma \cdot z \cdot K_p \quad (\text{kPa})$$

where z = depth of embedment of pile in metres

D = pile width in metres

n_h = value from Table 8.4

γ = unit weight (Table 8.4)

K_p = passive earth pressure coefficient (Table 8.4)

The above equations and recommended parameters may be used to analyze the interaction between a pile and the surrounding soil. The lateral pressures obtained from the analysis should not exceed the ultimate lateral resistance.

The spring constant, K , for analysis may be obtained by the expression, $K = k_s \cdot L \cdot D$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kN/m^3), D is the pile width (m) and L is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance on any one segment of pile, P_{ult} , may be obtained from the expression, $P_{ult} = p_{ult} \cdot L \cdot D$. This represents the ultimate load at which the pile fails and will not support any additional load at greater displacements. It is recommended, however, that the total lateral resistance assumed in one pile be limited to no more than 150 kN at ULS and 50 kN at SLS.

Parameters for lateral pile resistance are shown in Table 8.4.

Table 8.4 – Parameters for Lateral Pile Resistance

Location	Elevation	n_h (kN/m^3)	K_p	Unit Weight (kN/m^3)	Soil Conditions
South Abutment	OGL to 184.0	2,000	3.0	21	Sand, loose
	Below 184.0	4,500	3.3	11	Sand, compact
Compacted granular fill	As specified on drawings	8,000	3.7	21	Compacted granular

The vertical resistance will not be significantly affected by the pile spacing for piles bearing on bedrock. Pile interaction for piles bearing in soil should be considered with reference to CHBDC Clause 6.8.9.2.

For lateral soil/pile group interaction analysis, the modulus of subgrade reaction (k_s) may have to be reduced based on pile spacing.

Where a pile group is oriented *perpendicular* to the direction of loading, group action may be considered by reducing values for k_s by a reduction factor R as follows:

Pile Spacing Perpendicular to Direction of Loading	Horizontal Subgrade Reaction Reduction Factor, R
4 D*	1.00
1 D*	0.50

* D is the width of the pile, and spacing is measured centre to centre

Where a pile group is oriented *parallel* to the direction of loading, group action may be considered by reducing values for k_s by a reduction factor R as follows:

Pile Spacing Parallel to Direction of Loading	Horizontal Subgrade Reaction Reduction Factor, R
8 D	1.00
6 D	0.70
4 D	0.40
3 D	0.25

Intermediate values may be obtained by interpolation.

For conventional abutments, the lateral resistance may be provided by battered piles.

8.7 Recommended Foundation

From a geotechnical perspective, based on the subsurface conditions and taking account of the relative costs, the following are the recommended foundation types for this site:

Foundation Element	Recommended Foundation Type
Both abutments	H-piles grouted in rock sockets

8.8 Frost Cover

The design depth of frost penetration at this site is 1.8 m.

However, frost penetration is not an issue for footings bearing on bedrock or mass concrete fill placed on bedrock.

9 EXCAVATION

9.1 Earth Excavation

Excavation of overburden soils (native sand) and bedrock will be required at this site.

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

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

Excavation below the groundwater level without prior dewatering is not recommended since the inflow of groundwater will cause boiling and sloughing of the soil below the water table making it difficult to maintain a dry, sound base on which to work.

9.2 Rock Excavation

Rock excavation will be required at the south and north abutments in order to achieve the necessary minimum pile length. For these purposes, the Contractor may elect to use blasting methods.

The Special Provision governing the use of explosives must be included in the contract. The text of the SP is included in Appendix E.

The design of the blast and removal procedures should be the responsibility of the Contractor. However, it is important that his procedures incorporate methods of reducing damage to the founding surfaces or to any adjacent structures. Such methods may include, though not necessarily be limited to, line drilling, pre-splitting and cushion blasting.

10 UNWATERING

The groundwater levels measured in the course of the investigation, and in a previous investigation, are shown in Table 5.4. The elevations of the top of bedrock are shown in Table 5.3. The water level in the Harris River on September 2008 is shown on the GA as Elevation 179.25.

Wording for a NSSP on unwatering and surface water control is included in Appendix E.

10.1 Abutments

Comparison of the groundwater elevations and bedrock elevations at the abutments at the time of investigation indicates that the groundwater level was essentially at or slightly below the bedrock surface at the time of investigation. However, the latest readings were

taken in November 2009, at a time when the groundwater levels may have been at a low point and higher levels may occur in the spring or after heavy rainfall events.

Since it has been recommended that the bridge be supported on foundations bearing in bedrock, groundwater disturbance of the bearing stratum will not be a factor. However, if the groundwater levels rise in the fine grained, non-cohesive soils through which excavations must be formed then sloughing of the excavation sides may occur. If these soils slough into the foundation bearing surfaces, it must be removed in accordance with SP 902S01.

Thus at the abutments, the main issue will be controlling any sloughing of soil into the foundation excavations and pumping all accumulated water out of the foundation prior to placing concrete.

The design of the dewatering system should be the responsibility of the Contractor and the Contract Documents should alert him to this responsibility and the need to engage a dewatering specialist. While the responsibility for dewatering should remain with the Contractor, some of the following dewatering systems and associated issues that must be taken into account are:

- Problems installing vacuum well-points around the proposed excavation.
- With the use of a piled foundation, it is expected that work at the south abutment will not require excavation below the groundwater level. However, if excavation for pile cap construction is required below the groundwater level, the Contractor should be prepared to pump from sumps to remove any water collecting in the excavation.
- In the case of rock sockets for piles, if unwatering cannot be achieved, concrete may be placed by tremie methods.

11 SCOUR AND EROSION PROTECTION

For abutments founded on bedrock, scour is not an issue. Erosion protection should be provided for the forward slopes at the river valley in the immediate vicinity of the bridge.

12 APPROACH EMBANKMENTS

Approach embankment construction using either earth fill or rock fill is feasible on the foundation soils encountered at this site. The fills will be constructed on native sands or bedrock. The proposed approach embankment heights at the north and south abutments are presented in Table 14.1.

Table 14.1- Proposed Approach Embankment Heights

Foundation Unit	Ground Surface Elevation		Proposed Harris River finished grade	Height of new fill (top of existing slope to finished grade) (m)	Total Height of forward slope (m)
	Top of existing slope	Toe of existing slope			
South Abutment	190.5	180.0	195.2	4.7	15.5
North Abutment	187.0	179.4	194.4	7.4	15.0

It is estimated that at the south abutment, settlements in the order of 35 mm to 45 mm will occur in the foundation soils under the loading imposed by approximately 5.0 m of the new approach fill. Due to the non-cohesive nature of the foundation soils, this settlement will be immediate and essentially complete when construction of the fill is completed. At the north abutment, the settlement in the foundation soils is estimated to be in the order of 50 to 60 mm under loading imposed by 7.5 m of new approach fill. This foundation settlement is also expected to be completed by the end of fill construction.

Earth fill embankments typically compress by as much as 0.5% of the height of the fill. However, provided non-cohesive fill is used, this compression occurs as the embankment is constructed and can be assumed to be complete at the end of earthworks construction.

In the case of rock fill, experience has shown that post construction settlement at the top of the embankment can amount to 1% of the fill height, approximately 50 mm and 75 mm at the south and north approaches, respectively.

Rock fill embankments should be overbuilt in accordance with current Northeastern Region policies and guidelines.

The global, internal and surficial stability of the approach embankment fills will depend on the slope geometry and also to a large degree on the material used to construct the embankment. If the embankment is constructed of blast rock fill, it may be assumed that the side slopes will be stable at inclinations up to 1.25H:1V. Embankments constructed using granular material, select subgrade material or non-cohesive earth fill will have stable side slopes at inclinations of up to 2H:1V.

It is recommended that all organic, deleterious materials and loose sand be stripped prior to constructing the approach fills. Embankment construction must be in accordance with SP206S03, dated July 2007.

Where earth fill embankments are higher than 8 m, mid-height berms should be incorporated in the design. The berms should:

- extend for the length through which the embankment height exceeds 8 m
- be at least 2 m wide
- have 2% positive grade to shed run-off water.

Where rock fill embankments are higher than 10 m, mid-height berms should be incorporated in the design. The berms should:

- extend for the length through which the embankment height exceeds 10 m
- be at least 2 m wide

Earth fill embankment slopes must be provided with erosion protection in accordance with OPSS 572.

13 BACKFILL TO ABUTMENTS

Backfill to the abutment should be granular material.

In the case of a conventional abutment, granular backfill is recommended but rock backfill can be permitted.

In all cases where the approach embankment consists of rock fill and granular backfill to the abutment wall is used, the granular backfill must consist of OPSS Granular “B” Type II.

The backfill to the abutment walls must be in accordance with OPSS 902 as amended by Special Provision 902S01. Granular backfill must be placed to the extents shown in OPSD 3101.150, and rock backfill must be placed to the extents shown in OPSD 3101.200. All granular material should meet the requirements of SP 110F13 Amendment to OPSS 1010, March 1993.

Compaction equipment to be used adjacent to the abutment walls must be restricted in accordance with SP 105S10.

The design of the abutment must incorporate a subdrain as shown in OPSD 3101.150 or OPSD 3101.200, as applicable.

14 EARTH PRESSURE

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

$$P_h = K*(\gamma h + q)$$

Where:

P_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see table below)

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

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

q = value of any surcharge (kPa)

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

Earth pressure coefficients for backfill to the abutment wall are dependent on the material used as backfill. Typical values are shown in Table 14.1.

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

The factors in Table 14.1 are “ultimate” values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the Canadian Highway Bridge Design Code.

Table 14.1 – Earth Pressure Coefficient (K)

Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$		Rock Fill (Limited to 300 mm size) $\phi = 42^\circ, \gamma = 19 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall(2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall(2H: 1V)
Active (Unrestrained Wall)	0.27	0.40*	0.31	0.48*	0.2	0.28*
At rest (Restrained Wall)	0.43	-	0.47	-	0.33	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	5.0	-

* For wing walls.

15 SEISMIC CONSIDERATIONS

15.1 Seismic Design Parameters

The site is treated as lying in Seismic Zone 2. The following seismic parameters should be used for design:

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

The soil profile type at this site has been classified as Type I. Therefore, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient “S” (ground motion amplification factor) of 1.0 should be used in seismic design.

15.2 Liquefaction Potential

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

15.3 Retaining Wall Dynamic Earth Pressures

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

For the design of retaining walls, the coefficients of horizontal earth pressure in Table 15.1 may be used:

Table 15.1 – Earth Pressure Coefficient for Earthquake Loading

Earth Pressure Coefficient (K) for Earthquake Loading						
Wall Condition	Granular A or Granular B Type II $\phi = 35^\circ$; $\gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I $\phi = 32^\circ$; $\gamma = 21.2 \text{ kN/m}^3$		Rock Fill $\phi = 42^\circ$; $\gamma = 19.0 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (K_{AE})*	0.3	0.47	0.34	0.58	0.22	0.31
Passive (K_{PE})	3.6	-	3.2	-	4.9	-
At Rest (K_{OE})**	0.53	-	0.57	-	0.43	-

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

** After Woods

16 CONSTRUCTION CONCERNS

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

1. Variations in the elevation of the bedrock surface.

The surface of the bedrock has been shown in the investigation to be variable. Since the elevation of the bedrock surface was only established at discrete points, it is possible that higher or lower elevations will be encountered during construction. Also, the slope of the bedrock is expected to be locally steeper than that depicted by joining the elevations established at the boreholes.

The bedrock elevation variability may lead to one or more of the following issues:

- More bedrock excavation than originally anticipated
- Deeper excavations than expected
- H-piles or sheet piles sliding on steep bedrock surfaces
- Difficulty sealing out groundwater at the toe of a sheet pile enclosure

The Construction Administrator and the Contractor should work cooperatively to solve these issues on site. However, if it appears there is an impact on the design, the matter must be referred to the design team for comment.

2. Control of groundwater and surface water.

Above the river level, the results of the investigation indicate that groundwater is limited to a thin seepage zone on top of the bedrock and it is not expected to present significant problems.

17 CLOSURE

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

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

Thurber Engineering Ltd.



Rocío Palomeque Reyna, P.Eng., M.Eng.
Geotechnical Engineer



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



Report reviewed by:
P.K. Chatterji, P.Eng., Ph.D.
Review Principal

Appendix A

Record of Borehole Sheets from Current Investigation

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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


4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level


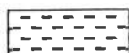



C_{pen} Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

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

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

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.

RECORD OF BOREHOLE No BH10-A

1 OF 2

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 254.6 E 231 001.2 ORIGINATED BY JM
HWY 69 BOREHOLE TYPE Tripod/Hand Auger COMPILED BY MFA
DATUM Geodetic DATE 2010.05.15 - 2010.05.15 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100	20 40 60	w _p w w _L				
189.9	GROUND SURFACE													
0.0	Sandy SILT, trace clay, trace peat Loose to Compact Brown to Grey Moist		1	SS	4									
			2	SS	4		189							0 24 61 15
			3	SS	29									
			4	SS	12		188							
187.2			5	SS	5									
2.7	Silty CLAY, trace sand Soft Grey (CL-ML)		6	SS	4		187							0 4 78 18
185.9			7	SS	14									
4.0	SAND and SILT, trace clay Compact Grey Moist to Wet		8	SS	18		186							
			9	SS	17									
			10	SS	12		185							0 39 56 5
183.7	Very Dense at 6.1m		11	SS	100/ 0.225		184							
6.2	BEDROCK, granitic gneiss, fresh, strong to very strong, thickly bedded, grey with occasional pink and white Sub-vertical breaks at: 100mm at 6.6m 50mm at 9.0m		1	RUN										
			2	RUN			183							RUN #1 TCR=100% SCR=100% RQD=100% UCS=219MPa (Average)
			3	RUN			182							RUN #2 TCR=100% SCR=100% RQD=100% UCS=192MPa (Average)
180.6	END OF BOREHOLE AT 9.3m. BOREHOLE OPEN TO 9.3m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.1m						181							RUN #3 TCR=100% SCR=91% RQD=91% UCS=230MPa (Average)
9.3														

Continued Next Page

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Sensitivity

20
15
10

(%) STRAIN AT FAILURE

ONTMT4S 6121(HRB).GPJ 5/9/12

RECORD OF BOREHOLE No BH10-A

2 OF 2

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 254.6 E 231 001.2 ORIGINATED BY JM
 HWY 69 BOREHOLE TYPE Tripod/Hand Auger COMPILED BY MFA
 DATUM Geodetic DATE 2010 05 15 - 2010 05 15 CHECKED BY TJH

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

ONTMT4S 6121(HRB) GPJ 5/9/12

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15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-B

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 255.8 E 231 004.3 ORIGINATED BY JM
HWY 69 BOREHOLE TYPE Tripod/Hand Auger COMPILED BY MFA
DATUM Geodetic DATE 2010.05.15 - 2010.05.15 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)					
								20 40 60 80 100	20 40 60	w _p w w _L						
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
190.0	GROUND SURFACE															
0.0	SAND, some silt Loose Brown Moist		1	SS	6		190									
189.4																
0.6	SAND and SILT, trace clay Compact Brown to Grey Moist		2	SS	11		189									
			3	SS	21										0 22 65 13	
			4	SS	17		188									
			5	SS	20											
187.0							187									
3.0	Silty CLAY, trace sand Soft Grey (Cl)		6	SS	3										0 1 57 42	
186.2																
3.8	Sandy SILT, trace clay Compact Grey Moist to Wet		7	SS	16		186									
			8	SS	23											
			9	SS	21		185								0 26 70 4	
184.4																
5.6	BEDROCK, granitic gneiss, fresh, strong to very strong, thickly bedded, grey Sub-vertical breaks at: 100mm at 6.5m 100mm at 7.7m 50mm at 8.0m		1	RUN			184								RUN #1 TCR=100% SCR=100% RQD=100% UCS=148MPa (Average)	
			2	RUN			183								RUN #2 TCR=100% SCR=100% RQD=100% UCS=211MPa (Average)	
			3	RUN			182								RUN #3 TCR=100% SCR=97% RQD=97% UCS=224MPa (Average)	
181.4																
8.6	END OF BOREHOLE AT 8.6m. BOREHOLE OPEN TO 8.6m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															

ONTMT4S 6121(HRB)GPJ 5/9/12

RECORD OF BOREHOLE No BH10-C

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 261.2 E 231 009.6 ORIGINATED BY JM
 HWY 69 BOREHOLE TYPE Tripod/Hand Auger COMPILED BY MFA
 DATUM Geodetic DATE 2010 05 15 - 2010 05 15 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE										
								● QUICK TRIAXIAL × LAB VANE										
190.1	GROUND SURFACE						20	40	60	80	100	20	40	60				
0.0	SILT, some sand to sandy, trace clay, trace roots Loose to Compact Brown to Grey Moist		1	SS	5													
			2	SS	18										0 17 75 8			
			3	SS	11													
188.3																		
1.8	SAND and SILT Compact Grey Moist		4	SS	18													
			5	SS	15													
186.9																		
3.2	Silty CLAY, trace sand Soft to Firm Grey		6	SS	8													
			7	SS	3										0 7 77 16			
185.8																		
4.3	SAND, some silt Compact Grey Moist		8	SS	15													
			9	SS	25													
184.8																		
5.3	BEDROCK, granitic gneiss, fresh, strong to very strong, medium bedded, grey with pink and white bands		1	RUN														
			2	RUN														
			3	RUN														
181.7																		
8.4	END OF BOREHOLE AT 8.4m. BOREHOLE OPEN TO 8.4m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																	

ONTMT4S 6121(HRB).GPJ 5/9/12

RECORD OF BOREHOLE No BH10-D

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 262.6 E 231 013.0 ORIGINATED BY JM
 HWY 69 BOREHOLE TYPE Tripod/Hand Auger/Casing COMPILED BY MFA
 DATUM Geodetic DATE 2010.05.16 - 2010.05.17 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE												
189.1	GROUND SURFACE						20	40	60	80	100									
0.0	SAND and SILT , trace to some clay, trace topsoil, trace roots Very Loose to Compact Dark Brown to Grey Moist to Wet		1	SS	2								○			0 26 60 14				
			2	SS	11								○							
			3	SS	14								○							
			4	SS	8								○							
186.7													○							
186.4	Silty CLAY , trace sand Firm Grey to Brown		5	SS	17								○							
2.6	Sandy SILT , trace clay Compact Brown to Grey Moist		6	SS	23								○			0 24 72 4				
			7	SS	50/ 150								○							
185.3															FI					
3.8	BEDROCK , granitic gneiss, fresh, strong to very strong, medium to thickly bedded, grey Sub-vertical breaks at 4.04 to 4.19m. Sub- horizontal breaks at 4.27, 4.65, and 4.80m. Highly broken zone at 4.19 to 4.27m. Sub- horizontal breaks at 4.93, 5.13, and 5.64m. Sub-vertical breaks at 5.69 to 5.77m.		1	RUN											>10	RUN #1 TCR=100% SCR=78% RQD=78% UCS=136MPa (Average)				
			2	RUN											3	RUN #2 TCR=100% SCR=91% RQD=91% UCS=65MPa (Average)				
			3	RUN											>5	RUN #3 TCR=100% SCR=100% RQD=100% UCS=158MPa (Average)				
182.1															1					
7.0	END OF BOREHOLE AT 7.0m. BOREHOLE OPEN TO 7.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.														1					

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-E

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 312.1 E 230 977.9 ORIGINATED BY SLL/JM
 HWY 69 BOREHOLE TYPE Split Spoon/Casing COMPILED BY MFA
 DATUM Geodetic DATE 2010.05.13 - 2010.05.14 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
185.9	GROUND SURFACE						20 40 60 80 100							GR SA SI CL
0.0	TOPSOIL, with roots and rootlets (100mm)		1	SS	28/ 250			○ UNCONFINED + FIELD VANE						
0.1								● QUICK TRIAXIAL × LAB VANE						
185.5	Silly SAND, trace rootlets Compact Brown Moist		1	RUN			20 40 60 80 100							
0.4	BEDROCK, granitic gneiss, strong, very thinly to medium bedded, grey to brown Joints at 0.69, 0.89, and 0.99m. Vertical breaks at 0.69, 0.74, 0.86 to 0.89, and 0.99 to 1.12m. Joints at 1.24, 1.40, and 1.98m. Vertical breaks at 1.98 to 2.08m. Joints at 2.23, 2.64, 2.80, and 3.15m.		2	RUN		185								
			3	RUN		184								
			4	RUN		183								
182.4	Joint at 3.30m.													
3.5	END OF BOREHOLE AT 3.5m. BOREHOLE OPEN TO 3.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

RECORD OF BOREHOLE No BH10-F

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 314.8 E 230 976.8 ORIGINATED BY SLJ/JM
 HWY 69 BOREHOLE TYPE Split Spoon/Casing COMPILED BY MFA
 DATUM Geodetic DATE 2010.05.13 - 2010.05.15 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
186.9	GROUND SURFACE												
0.0 0.1	TOPSOIL, with roots and rootlets (75mm)		1	SS	9								0 73 25 2
186.3 0.6	Silty SAND Loose Brown Moist												
	BEDROCK, granitic gneiss, strong to very strong, medium bedded, grey		1	RUN									RUN #1 TCR=88% SCR=29% RQD=29% UCS=117MPa (Average)
	Sub-vertical breaks at: 50mm at 1.4m 50mm at 1.6m												
	150mm vertical breaks at 2.5m		2	RUN									RUN #2 TCR=100% SCR=87% RQD=87% UCS=164MPa (Average)
			3	RUN									RUN #3 TCR=100% SCR=100% RQD=100% UCS=168MPa (Average)
183.1	END OF BOREHOLE AT 3.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.												
3.8													

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-G

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 313 3 E 230 981.1 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE Split Spoon/Casing COMPILED BY MFA
DATUM Geodetic DATE 2010.05.13 - 2010.05.14 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
186.5	GROUND SURFACE													
0.0	SAND , trace roots and rootlets Loose Brown Moist (FILL PLACED TO PREPARE SITE ACCESS)		1	SS	4		186							RUN #1 TCR=100% SCR=100% RQD=51% UCS=143MPa (Average)
185.9			2	SS	56/ 225									
185.8	TOPSOIL: (50mm)													
0.7														
185.5														
1.0	SAND , with roots and rootlets Very Dense Brown Moist BEDROCK , granitic gneiss, strong, with quartz seams and pockels Sub-horizontal joints at 1.55, 1.65, and 1.75m. Vertical joint at 1.85 to 2.26m. Vertical joint at 2.26 to 2.41m. Sub-horizontal joints at 2.97, 3.02, and 3.07m.		1	RUN			185							RUN #2 TCR=100% SCR=100% RQD=83% UCS=122MPa (Average)
			2	RUN			184							
			3	RUN			183							
182.1	END OF BOREHOLE AT 4.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													RUN #3 TCR=100% SCR=100% RQD=56% UCS=123MPa (Average)
4.4														

METRIC

[illegible]

RECORD OF BOREHOLE No BH10-I

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 317.4 E 230 983.0 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE Split Spoon/Casing COMPILED BY MFA
 DATUM Geodetic DATE 2010.05.13 - 2010.05.14 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
186.9	GROUND SURFACE						20 40 60 80 100	20 40 60	W _P W W _L				GR SA SI CL	
0.0	SAND, trace gravel Very Dense		1	SS	56/									
186.5	Brown				200									
0.4	Moist		1	RUN										
186.3														
0.6	BOULDER, with quartz seam													
	BEDROCK, granitic gneiss, strong, dark grey, with quartz seams		2	RUN			186						FI	RUN #1 TCR=100% SCR=100% RQD=100%
													2	RUN #2 TCR=100% SCR=100% RQD=84% UCS=122MPa (Average)
													1	
													2	RUN #3 TCR=100% SCR=0% RQD=0%
	Vertical joint at 1.75 to 1.91m. Vertical joint at 1.91 to 2.06m. Sub-vertical joint at 2.11 to 2.31m.		3	RUN			185						4	
													3	RUN #4 TCR=100% SCR=100% RQD=86% UCS=191MPa (Average)
													4	
	Sub-vertical joint at 3.38 to 3.43m.												1	RUN #5 TCR=100% SCR=100% RQD=100%
			5	RUN			184						2	UCS=169MPa (Average)
183.3													3	
3.6	END OF BOREHOLE AT 3.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S 6121(HRB) GPJ 5/9/12

+³ ×³ Numbers refer to
Sensitivity


20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-J

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 320.1 E 230 989.7 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE Hammer/Casing COMPILED BY MFA
 DATUM Geodetic DATE 2010.05.13 - 2010.05.13 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
186.2	GROUND SURFACE							20	40	60	80	100					
0.0	SAND, trace gravel, occasional cobbles		1	SS	50/ 100												
0.2	Very Dense Brown Moist		1	RUN													
	BEDROCK, granitic gneiss, weathered, strong, with quartz and quartzite seams Vertical joint at 0.58 to 0.84m. Vertical joint at 0.84 to 0.89m. Rubble zone at 1.07 to 1.14m.		2	RUN													
	Vertical joint at 2.03 to 2.13m.		3	RUN													
			4	RUN													
182.8																	
3.4	END OF BOREHOLE AT 3.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.61m, THEN SAND TO SURFACE.																

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

(%) STRAIN AT FAILURE

CONTMT4S 6121(HRB) GPJ 5/9/12

RECORD OF BOREHOLE No HRB09-02

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 258 9 E 230 999 8 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.10.20 - 2009.10.20 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				w _p w w _L					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)					
189.7	GROUND SURFACE						20	40	60	80	100						
0.0	SAND, fine grained, trace to some silt Very Loose Brown Damp		1	SS	3									○			
			2	SS	4										○		
187.9																	
1.8	Silly CLAY, sandy, occasional rootlets Soft Greyish Brown		3	SS	2									○			0 20 57 23
187.3																	
2.4	SAND, some silt Very Loose Brown Moist		4	SS	2									○			
186.7																	
3.0	Silly CLAY, trace sand, occasional sand pockets, occasional oxide staining Soft Brown to Grey		5	SS	3									○			0 2 54 44
185.6																	
4.1	SAND and SILT, trace clay, occasional oxide staining Compact Brown to Grey Damp		6	SS	14									○			0 42 55 3
</																	

ONTMT4S 6121(HRB)GPJ 5/9/12

RECORD OF BOREHOLE No HRB09-03

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 257 8 E 231 003 8 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.10.20 - 2009.10.20 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100	20 40 60	w _p w w _L				
190.1	GROUND SURFACE													
0.0 0.1	TOPSOIL: (60mm)													
	SAND, fine grained, trace to some silt, trace clay, occasional roots Loose Brown Damp		1	SS	4		190					○		
188.9			2	SS	6		189					○		
1.2	SAND and SILT, some clay, occasional oxide staining Loose to Compact Brown to Grey Damp		3	SS	20		188					○		0 31 58 11
			4	SS	11							○		
187.1														
3.0	Silty CLAY, trace sand Firm Brown to Grey		5	SS	6		187					┌───┐ ○		0 1 42 57
186.0							186							
4.1	SAND, fine grained, some silt, trace clay, occasional oxide staining Compact Brown Damp		6	SS	16		185					○		
							184					○		0 84 14 2
			7	SS	26									
182.7							183							
7.4	END OF BOREHOLE AT 7.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 4.1m, THEN AUGER CUTTINGS TO SURFACE.													

ONTMT4S 6121(HRB).GPJ 5/9/12

+ 3, x 3: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-04

1 OF 2

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 258.9 E 231 003.7 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2009.10.21 - 2009.10.21 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P	W	W _L		
190.1	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL: (75mm)							20 40 60 80 100						
0.1	SAND and SILT Loose to Compact Brown Damp to Moist		1	SS	4		190							
			2	SS	6		189							0 25 60 15
	Occasional oxide staining		3	SS	18		188							
	Moist to Wet		4	SS	10		187							
187.0	Silty CLAY, trace sand Firm Grey		5	SS	5		186							
186.0	SAND and SILT, fine grained, trace clay, occasional oxide staining Compact Brown to Grey Damp		6	SS	12		185							0 29 68 3
			7	SS	25		184							
			8	SS	23		183							
182.6	BEDROCK, granitic gneiss, containing feldspathic layers, fresh, grey, pink and white bands, occasional mechanical breaks Coring started at 7.5m		9	SS	60/		182							
7.5			1	RUN	0.275		181							
	Sub-vertical fractures: 100mm at 7.8m 50mm at 9.1m		2	RUN										
	Highly broken zone (125mm) at 8.6m													

Continued Next Page

+ 3, x 3, Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

ONTMT4S 6121(HRB).GPJ 5/9/12

RECORD OF BOREHOLE No HRB09-04

2 OF 2

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 258.9 E 231 003.7 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2009 10 21 - 2009 10 21 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L				
	Continued From Previous Page													
179.4	BEDROCK, granitic gneiss, containing feldspathic layers, fresh, grey, pink and white bands, occasional mechanical breaks		3	RUN			180						0	RUN #3 TCR=100% SCR=100%
10.7	END OF BOREHOLE AT 10.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct 27/09 7.2 182.9 Nov 20/09 7.5 182.6												0	RQD=100% UCS=125MPa (Average)

ONTMT4S 6121(HRB).GPJ 5/9/12

+³, ×³: Numbers refer to Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-05

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 257.9 E 231 009.6 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.10.21 - 2009.10.21 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							WATER CONTENT (%) w _P w w _L
190.1	GROUND SURFACE														
0.0	TOPSOIL: (75mm)														
0.1	SAND and SILT, some clay, occasional oxide staining Loose to Compact Brown Moist Occasional oxide staining		1	SS	4		190								
			2	SS	16		189								
	Occasional sand pockets		3	SS	15		188								0 26 63 11
	Wet		4	SS	13		187								
186.8							187								
3.3	Silty CLAY, trace sand Firm Grey		5	SS	6		186								0 1 45 54
185.9							186								
4.1	SAND and SILT, trace clay, occasional sand seams Compact Grey Damp		6	SS	14		185								0 26 70 4
184.6															
5.4	END OF BOREHOLE AT 5.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 3.5m THEN AUGER CUTTINGS TO SURFACE.														

+³ . X³ : Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-06

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 259.2 E 231 009.6 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.10.21 - 2009.10.21 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
190.1	GROUND SURFACE							20 40 60 80 100					
0.0 0.1	TOPSOIL: (75mm)							20 40 60 80 100					
	SAND and SILT, trace to some clay, occasional roots and rootlets, occasional oxide staining Loose to Compact Brown Damp		1	SS	12		190						
			2	SS	19		189						0 34 53 13
			3	SS	9		188						0 36 59 5
			4	SS	13								
186.8							187						
3.3	Silty CLAY, trace sand Stiff Grey		5	SS	9								
186.0							186						
4.1	SAND, fine grained, trace silt Compact Grey Damp		6	SS	14		185						
184.4													
5.6	END OF BOREHOLE AT 5.6m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 3.9m, THEN AUGER CUTTINGS TO SURFACE.												

ONTMT4S 6121(HRB).GPJ 5/9/12

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-07

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 258 1 E 231 014 3 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2009.10.22 - 2009.10.22 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
190.4	GROUND SURFACE						20	40	60	80	100						
0.0	TOPSOIL: (50mm)		1	SS	4												
	SAN and SILT, trace clay Loose to Compact Brown Damp		2	SS	14												
	Occasional oxide staining		3	SS	14											0 30 62 8	
	Layer of silty clay (100mm) Dense Grey		4	SS	15												
			5	SS	31											0 46 51 3	
186.2																FI	
4.2	BEDROCK, granitic gneiss, feldsphatic layers, fresh, grey, pink and white bands, occasional mechanical breaks Coring started at 4.2m		1	RUN												2 0 0 1 1 1 0 0 2 1	
	Sub-vertical fractures at 5.5m		2	RUN												RUN #1 TCR=100% SCR=100% RQD=100% UCS=207MPa (Average)	
																RUN #2 TCR=100% SCR=100% RQD=100% UCS=154MPa (Average)	
			3	RUN												RUN #3 TCR=100% SCR=100% RQD=100% UCS=123MPa (Average)	
	Sub-vertical fractures: 50mm at 6.9m																
183.0																	
7.4	END OF BOREHOLE AT 7.4m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 4.3m, THEN AUGER CUTTINGS TO SURFACE.																

ONTMT4S 6121(HRB).GPJ 5/9/12

RECORD OF BOREHOLE No HRB09-08

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 259 3 E 231 014.2 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.10.22 - 2009.10.22 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
190.4	GROUND SURFACE													
8.8	TOPSOIL: (50mm)													
	SAND and SILT, trace to some clay Loose to Compact Brown Damp Occasional oxide staining		1	SS	4		190							
			2	SS	13		189							0 29 56 15
			3	SS	12		188							
	Brown to Grey													
			4	SS	11		187							0 35 61 4
	Grey													
			5	SS	24									
186.5														
3.9	END OF BOREHOLE AT 3.9m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 2.4m, THEN AUGER CUTTINGS TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-09

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 273.2 E 230 993.5 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Portable Auger/Coring Equipment / 3rd Weight Hammer COMPILED BY AN
DATUM Geodetic DATE 2009.11.18 - 2009.11.18 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE									
185.7	GROUND SURFACE																			
0.0	TOPSOIL: (125mm)																			
0.1	SAND, micaceous, fine grained, trace silt, trace clay, occasional roots and rootlets, occasional wood fibers, occasional black staining Very Loose to Compact Brown Damp Layer of sand and silt at 0.9m Occasional cobbles Grey		1	SS	2															
			2	SS	2											0 63 34 3				
			3	SS	4															
			4	SS	11											0 90 10 (SI+CL)				
			5	SS	14															
			6	SS	18															
			7	SS	15															
			8	SS	28											0 86 14 (SI+CL)				
180.4			9	SS	79.1 0.250															
5.3	END OF BOREHOLE AT 5.3m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.																			

+³, X³: Numbers refer to Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-10

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 274 8 E 230 993 4 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Portable Auger/Coring Equipment / 3rd Weight Hammer COMPILED BY AN
 DATUM Geodetic DATE 2009.11.18 - 2009.11.18 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							WATER CONTENT (%) w _p w w _L		
184.6	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (100mm)							20	40	60	80	100					
0.1	SAND, micaceous, fine grained, trace to some silt, trace clay, occasional rootlets, occasional staining Very Loose to Loose Brown Damp Possible boulders at 0.9m (100mm)		1	SS	1		184										
			2	SS	56/ 0.200												
			3	SS	4		183									0 87 13 (SI+CL)	
			4	SS	6												
	Compact Brown to Grey		5	SS	12		182										
			6	SS	12											0 83 17 (SI+CL)	
	Grey Wet		7	SS	18		181										
			8	SS	36												
	Dense to Very Dense						180									0 89 11 (SI+CL)	
			9	SS	83/ 0.250												
179.1																	
5.4	BEDROCK, granitic gneiss, feldspathic layers, moderately weathered to fresh, pink and white bands, occasional mechanical breaks Coring started at 5.4m Sub-vertical fractures: 25mm at 5.8m 50mm at 6.1m 25mm at 6.3m 50mm at 6.5m 50mm at 7.5m 25mm at 7.6m Horizontal fractures at 6.8m, 9.8m, 7.2m and 7.5m Highly broken zone at 6.4m (100mm)		1	RUN			179									FI RUN #1 TCR=100% SCR=0% RQD=0%	
			2	RUN													RUN #2 TCR=100% SCR=46% RQD=46% UCS=143MPa (Average)
							178										3 RUN #3 TCR=100% SCR=71% RQD=60% UCS=116MPa (Average)
			3	RUN													2 RUN #4 TCR=100% SCR=100% RQD=100% UCS=206MPa (Average)
							177										3
			4	RUN													>5
																	0
175.9																	0
8.7	END OF BOREHOLE AT 8.7m BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING BOREHOLE BACKFILLED WITH HOLEPLUG TO 1.5m, THEN SAND TO SURFACE						176										0

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-11

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 273 4 E 230 997 4 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Portable Auger/Coring Equipment / 3rd Weight Hammer COMPILED BY AN
DATUM Geodetic DATE 2009.11.17 - 2009.11.18 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
185.3	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL: (125mm)							20	40	60	80	100						
0.1	SAND, micaceous, fine grained, trace to some silt, trace clay, occasional organics Very Loose to Loose Brown Damp		1	SS	1		185											
			2	SS	2												0 77 23 (SI+CL)	
			3	SS	2		184											
			4	SS	4													
			5	SS	9		183										0 80 20 (SI+CL)	
			6	SS	16		182											
			7	SS	22												0 96 4 (SI+CL)	
			8	SS	47		181											
180.2																		
5.1	BEDROCK, granitic gneiss, feldspathic layers, slightly weathered to fresh, pink and white bands, occasional mechanical breaks Coring started at 5.1m Sub-vertical fractures: 25mm at 5.3m 25mm at 5.6m 75mm at 5.9m 200mm at 6.7m 50mm at 7.9m Sub-horizontal fractures at 5.1m (25mm), 6.0m, 6.6m, 6.7m, 7.2m and 7.4m		1	RUN			180										FI 4 1 4 0 8 0 1 1 0 0 0	RUN #1 TCR=100% SCR=92% RQD=69% UCS=157MPa (Average) RUN #2 TCR=100% SCR=76% RQD=76% UCS=151MPa (Average) RUN #3 TCR=100% SCR=96% RQD=96% UCS=189MPa (Average)
			2	RUN			179											
			3	RUN			178											
177.1																		
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE																	

ONTMT4S 6121(HRB).GPJ 5/9/12

+ 3 × 3 : Numbers refer to Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-12

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 274 9 E 230 997 4 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Portable Auger/Coring Equipment / 3rd Weight Hammer COMPILED BY AN
DATUM Geodetic DATE 2009.11.19 - 2009.11.19 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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183.8	GROUND SURFACE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
0.0	SAND, trace to some silt, trace clay, occasional roots and organics Very Loose to Compact Brown to Grey Damp to Moist		1	SS	2		183																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

+ 3 x 3; Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-13

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 273.6 E 231 003.3 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Portable Auger/Coring Equipment / 3rd Weight Hammer COMPILED BY AN
 DATUM Geodetic DATE 2009.11.17 - 2009.11.17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)						
183.7	GROUND SURFACE							20	40	60	80	100	W _P	W	W _L	
0.0	TOPSOIL: (225mm)							○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	LAB VANE			
0.2	SAND and SILT, some clay, occasional organics and roots Very Loose to Loose Brown to Grey Moist		1	SS	1	183										0 51 36 13
			2	SS	4											
			3	SS	9											
181.9							182									
1.8	END OF BOREHOLE AT 1.8m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER BOREHOLE OPEN AND DRY UPON COMPLETION BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.															

+ 3 x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-14

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 275.1 E 231 003.2 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Portable Auger/Coring Equipment / 3rd Weight Hammer COMPILED BY AN
DATUM Geodetic DATE 2009.11.17 - 2009.11.17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	w _p	w	w _L		
182.4	GROUND SURFACE																
0.0	TOPSOIL, occasional roots and wood fibers		1	SS	1	182										1 58 31 10	
182.1	Dark Brown (300mm)		2	SS	3												
0.3	SAND and SILT, some sand, trace gravel, micaceous Very Loose Brown Wet		3	SS	50/												
181.1	BEDROCK, granitic gneiss, feldspathic layers, slightly weathered to fresh, pink and white bands, occasional mechanical breaks Coring started at 1.3m		1	RUN	0.125	181										RUN #1 TCR=100% SCR=86% RQD=0% UCS=184MPa (Average)	
1.3	Horizontal fractures at 1.4m	2	RUN		180												
	Sub-horizontal fractures at 1.5m	3	RUN				179										
	Sub-vertical fractures at: 50mm at 1.5m 50mm at 2.4m 75mm at 2.6m 50mm at 4.8m	4	RUN			178											
177.3	END OF BOREHOLE AT 5.1m. BOREHOLE OPEN AND WATER LEVEL AT 0.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.																
5.1																	

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

RECORD OF BOREHOLE No HRB09-15

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 273 8 E 231 009 9 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Portable Auger/Coring Equipment / 3rd Weight Hammer COMPILED BY AN
DATUM Geodetic DATE 2009 11 16 - 2009 11 16 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
184.0	GROUND SURFACE														
0.0	TOPSOIL: (200mm)														
0.2	SAND, trace silt, trace clay, micaceous Very Loose Brown Moist BEDROCK, granitic gneiss, feldspathic layers, fresh, pink and white bands, occasional mechanical breaks Coring started at 0.6m Sub-vertical fractures at: 50mm at 0.5m 25mm at 1.8m 75mm at 1.9m 50mm at 2.8m Horizontal fractures at 0.6m and 1.5m Sub-horizontal fractures at 2.8m		1	SS	2										
183.5			1	RUN											
0.6			2	RUN											
			3	RUN											
			4	RUN											
180.3	END OF BOREHOLE AT 3.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov 20/09 0.5 183.5														
3.7															

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-16

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 275.3 E 231 007.8 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Portable Auger/Coring Equipment / 3rd Weight Hammer COMPILED BY AN
 DATUM Geodetic DATE 2009.11.17 - 2009.11.17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
183.0														
0.0	SAND and SILT , mixed with organics Very Loose Dark Brown Wet		1	SS	50/		183							
0.2	END OF BOREHOLE AT 0.2m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE BACKFILLED WITH SAND TO SURFACE.				0.075									

+ ³/₃, × ³/₃ Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-17

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 301.1 E 230 982.2 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.10.23 - 2009.10.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
181.7	GROUND SURFACE							DYNAMIC CONE PENETRATION RESISTANCE PLOT						
0.0	SAND, occasional organics, topsoil, roots and rootlets Very Loose to Loose Brown Damp		1	SS	2		181	20 40 60 80 100						
			2	SS	5			20 40 60 80 100						
	Some gravel, some silt, trace clay Compact		3	SS	16		180	20 40 60 80 100						16 73 11 (SI+CL)
			4	SS	12		179	20 40 60 80 100						
	Gravelly		5	SS	28			20 40 60 80 100						28 57 15 (SI+CL)
177.7			6	SS	50/		178	20 40 60 80 100						
4.0	END OF BOREHOLE AT 4.0m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND WATER LEVEL AT 2.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 1.8m, THEN AUGER CUTTINGS TO SURFACE.				0.075			20 40 60 80 100						

+³, ×³: Numbers refer to
Sensitivity

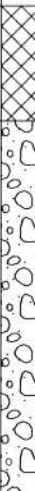

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-18

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 302.6 E 230 982.2 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2009.10.23 - 2009.10.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE				
182.9	GROUND SURFACE													GR SA SI CL	
0.0	SAND , fine grained, some gravel, trace silt, occasional roots and rootlets, occasional bedrock fragments Compact Brown Damp (FILL PLACED TO PREPARE SITE ACCESS) SAND and GRAVEL , trace silt, trace clay, occasional organics, roots and rootlets, occasional bedrock fragments, occasional oxide staining Compact Brown Damp Dense		1	SS	22										
182.1															
0.8			2	SS	14										38 53 9 (SI+CL)
			3	SS	18										
			4	SS	35										46 44 10 (SI+CL)
179.6			5	SS	50/										
3.3	BEDROCK , granitic gneiss, feldspathic layers, slightly weathered to fresh, grey, pink and white bands, occasional mechanical breaks Coring started at 3.3m Sub-vertical fractures: 50mm at 3.5m 25mm at 3.9m 50mm at 4.1m 25mm at 4.3m 50mm at 4.7m Sub-horizontal fractures: 25mm at 4.1m Horizontal fractures at 3.4m and 3.5m		1	RUN	0.050									FI 4 2 1 1 2 2 0 1 0 0	RUN #1 TCR=100% SCR=69% RQD=69% UCS=182MPa (Average) RUN #2 TCR=100% SCR=97% RQD=97% UCS=148MPa (Average) RUN #3 TCR=100% SCR=100% RQD=100% UCS=160MPa (Average)
			2	RUN											
			3	RUN											
176.6															
6.3	END OF BOREHOLE AT 6.3m UPON AUGER REFUSAL. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 3.8m, THEN AUGER CUTTINGS TO SURFACE.														

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

RECORD OF BOREHOLE No HRB09-19

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 301.2 E 230 986.2 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2009.10.23 - 2009.10.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
181.2	GROUND SURFACE													
0.0	SAND, fine grained, trace silt, trace clay, occasional roots and rootlets Very Loose to Loose Brown Damp		1	SS	1		181							
			2	SS	5		180							
	Layer of sand and gravel Occasional bedrock fragments Compact		3	SS	29		179							
			4	SS	29		178							
	Dense Grey Wet		5	SS	37		177							
176.5			6	SS	50/		176							
4.7	BEDROCK , granitic gneiss, feldspathic layers, moderately weathered to fresh, grey, pink and white bands, occasional mechanical breaks Coring started at 4.7m Sub-vertical fractures at 5.4m (50mm) Sub-horizontal fractures at 5.8m (25mm) Sub-vertical fractures at 6.9m (25mm)		1	RUN	150		175							
			2	RUN			174							
			3	RUN										
173.5														
7.7	END OF BOREHOLE AT 7.7m. BOREHOLE OPEN AND DRY UPON COMPLETION BOREHOLE BACKFILLED WITH HOLEPLUG TO 5.5m, THEN AUGER CUTTINGS TO SURFACE.													

ONTWT4S 6121(HRB).GPJ 5/9/12

+ 3, X 3: Numbers refer to Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-20

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 302 7 E 230 986 1 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.10.24 - 2009.10.24 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _P W W _L WATER CONTENT (%)			
182.3	GROUND SURFACE					▽	182	20	40	60	80	100	20	40	60	GR SA SI CL	
0.0	SAND, fine grained, occasional roots Loose Brown Moist (FILL PLACED TO PREPARE SITE ACCESS)		1	SS	5												
181.5																	
0.8	Gravelly SAND, trace to some silt, trace clay, occasional organics, roots and rootlets Loose to Compact Brown Damp		2	SS	5												
			3	SS	24												
	Dense		4	SS	31		180									27 64 9 (SI+CL)	
	Very Dense Grey Wet		5	SS	62		179									28 58 14 (SI+CL)	
178.8																	
3.5	END OF BOREHOLE AT 3.5m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND WATER LEVEL AT 2.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 2.1m, THEN AUGER CUTTINGS TO SURFACE.																

+³ ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-21

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 301.4 E 230 992.0 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2009 10 25 - 2009 10 25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								WATER CONTENT (%)					
181.5	GROUND SURFACE												
0.0	TOPSOIL, occasional roots and rootlets, wood fibres		1	SS	6								
181.1	Loose												
0.4	Dark Brown Damp (400mm)												
	SAND, fine grained, trace to some silt, trace clay, trace gravel, occasional cobbles		2	SS	7								
	Loose to Compact												
	Brown		3	SS	19								
	Damp												
	Wet		4	SS	21								
	Brown to Grey												
	Very Dense		5	SS	35								
177.3													
4.2	BEDROCK, granite gneiss, feldspathic layers, moderately weathered to fresh, grey, pink and white bands, occasional mechanical breaks												
	Coring started at 4.2m		1	RUN									
	Sub-vertical fractures: 25mm at 5.4m 150mm at 6.1m 50mm at 6.7m												
	Horizontal fractures at 4.9m, 5.2m and 5.5m		2	RUN									
	Sub-horizontal fractures: 50mm at 5.9m 150mm at 6.1m 25mm at 7.8m												
			3	RUN									
173.4													
8.1	END OF BOREHOLE AT 8.1m UPON COMPLETION.												
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.												
	WATER LEVEL READINGS:												
	DATE DEPTH (m) ELEV. (m)												
	Oct 27/09 2.5 179.0												
	Nov 20/09 2.9 178.6												

ONTMT4S 6121(HRB).GPJ 5/9/12

RECORD OF BOREHOLE No HRB09-22

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 302 9 E 230 991 9 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.10.24 - 2009.10.24 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
181.7	GROUND SURFACE						20	40	60	80	100						
0.0	TOPSOIL, some sand, occasional roots and rootlets		1	SS	1												
181.2	Very Loose																
0.5	Dark Brown																
	Damp (500mm)																
	SAND, fine grained, trace silt, trace clay		2	SS	4												
	Loose to Compact																
	Brown																
	Damp																
	Cobbles at 1.3m		3	SS	20												
	Layer of gravelly sand with occasional bedrock fragments																
	Some gravel																
	Brown to Grey		4	SS	21												
	Wet																
	Occasional cobbles, occasional bedrock fragments																
	Very dense		5	SS	69												
177.2																	
4.5	END OF BOREHOLE AT 4.5m. BOREHOLE OPEN AND WATER LEVEL AT 2.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 3.0m, THEN AUGER CUTTINGS TO SURFACE.																

+³ ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100			W _p	W
180.7	GROUND SURFACE															
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%)					
								20	40	60	80	100	20	40	60	
															kn/m ³	GR SA SI C

[illegible]

END OF BOREHOLE AT 4.9m UPON
REFUSAL ON PROBABLE BEDROCK
OR BOULDER.
BOREHOLE OPEN AND WATER
LEVEL AT 1.5m UPON
COMPLETION.
BOREHOLE BACKFILLED WITH
HOLEPLUG TO 1.2m, THEN AUGER
CUTTINGS TO SURFACE.

13	85	2
(S)+CL		

RECORD OF BOREHOLE No HRB09-24

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 303.1 E 230 996.6 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009 10 24 - 2009 10 24 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
181.6	GROUND SURFACE													
0.0	SAND , fine grained, trace silt, trace clay, occasional roots Very Loose to Compact Brown Damp Layer of gravelly sand with occasional cobbles Occasional oxide staining Medium grained, some gravel Dense Wet		1	SS	1									
			2	SS	17									32 63 5 (SI+CL)
			3	SS	16									
			4	SS	19									
			5	SS	40									16 74 10 (SI+CL)
			6	SS	50/									
176.9														
4.7	END OF BOREHOLE AT 4.7m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND WATER LEVEL AT 2.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 3.4m, THEN AUGER CUTTINGS TO SURFACE.				0.100									

+ ³ . X ³ : Numbers refer to
Sensitivity

20
15 10 5
10 (%) STRAIN AT FAILURE

METRIC

[illegible]

RECORD OF BOREHOLE No HRB09-27

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 317.1 E 230 979.8 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2009.10.25 - 2009.10.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
187.3	GROUND SURFACE							20	40	60	80	100						
0.0	SAND, some silt, trace gravel, trace clay, occasional roots and rootlets Very Loose Brown Damp		1	SS	1													
186.5			2	SS	50/													
0.8	BEDROCK, granitic gneiss, feldspathic layers, moderately weathered to fresh, grey, pink and white bands, occasional mechanical breaks Coring started at 0.7m Horizontal fractures at 1.0m, 1.1m, 1.2m, 1.3m Sub-vertical fractures at 1.7m, 1.9m 50mm at 2.0m 50mm at 2.4m 100mm at 2.8m 125mm at 2.9m Sub-horizontal fractures at 1.4m, 2.5m 100mm at 2.8m 175mm at 2.9m		1	RUN	0.025													
			2	RUN														
			3	RUN														
183.3	END OF BOREHOLE AT 4.0m UPON AUGER REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct 27/09 0.8 186.5 Nov 20/09 1.2 186.1																	
4.0																		

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

METRIC

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-29

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 317.3 E 230 985.6 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers / NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2009.10.25 - 2009.10.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
186.3	GROUND SURFACE							20 40 60 80 100							
0.0	TOPSOIL, mixed with sand and organics, trace silt, occasional roots and rootlets Very Loose Brown Damp (500mm)		1	SS	1	▽	186								
185.9			2	SS	4										
0.5			3	SS	50/										
184.9	SAND and SILT, trace gravel, trace clay, occasional bedrock fragments Loose Brown Damp to Wet Layer of cobbles at 1.3m				0.050		185								
1.4	BEDROCK, granitic gneiss, feldspathic layers, moderately weathered, grey, pink and white bands, occasional quartz interbeds Coring started at 1.4m Becoming slightly weathered to fresh Sub-vertical fractures at 5.0m, 5.1m and 5.2m 125mm at 2.4m 50mm at 4.1m 75mm at 4.2m 25mm at 4.7m Sub-horizontal fractures at 2.4m, 2.5m and 3.1m 25mm at 4.7m		1	RUN			184								
			2	RUN			183								
			3	RUN			182								
181.0	END OF BOREHOLE AT 5.3m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 2.7m, THEN AUGER CUTTINGS TO SURFACE.														
5.3															

+ 3. x 3: Numbers refer to Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-30

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 318.5 E 230 985.6 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2009.10.26 - 2009.10.26 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
186.8	GROUND SURFACE							20 40 60 80 100		20 40 60				GR SA SI CL
0.0	SAND, fine to medium grained, trace gravel Compact Brown Damp		1	SS	30									
186.3														
0.5	END OF BOREHOLE AT 0.5m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.													

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No HRB09-32

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 318.7 E 230 990.3 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.10.26 - 2009.10.26 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
186.1	GROUND SURFACE							20 40 60 80 100						
0.0	SAND, mixed with organics, trace gravel, occasional roots and rootlets		1	SS	56/		186							
185.7	Loose				0.275									
0.4	Brown Damp													
	END OF BOREHOLE AT 0.4m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.													

ONTMT4S 6121(HRB).GPJ 5/9/12

+³ X³: Numbers refer to Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB09-33

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 249.2 E 230 010.6 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.10.22 - 2009.10.22 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
190.4	GROUND SURFACE												
0.8	TOPSOIL: (35mm)		1	SS	5		190						
189.7	Silty CLAY, some sand Firm Brown												
0.8	SAND and SILT, occasional oxide staining Loose to Compact Brown Damp		2	SS	13		189						0 31 60 9
	Layers of silty clay (500mm)		3	SS	12								
	Brown to Grey Wet		4	SS	9		188						
			5	SS	11		187						0 33 61 6
186.2													
4.3	END OF BOREHOLE AT 4.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 2.9m THEN AUGER CUTTINGS TO SURFACE.												

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

RECORD OF BOREHOLE No HRB09-34

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 327.1 E 230 979.1 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009.10.23 - 2009.10.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
191.5	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL, some sand, trace roots and rootlets (125mm)		1	SS	2		191							
0.1	SAND, some silt, mixed with organics, trace gravel, trace clay, occasional roots and rootlets Very Loose to Compact Dark Brown Damp		2	SS	22									3 77 18 2
190.2														
1.3	END OF BOREHOLE AT 1.3m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.													

+³ . x³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB10-01

1 OF 2

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 272 2 E 230 993.5 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE 3rd Weight Hammer/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.05.05 - 2010.05.05 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
186.7	GROUND SURFACE						20 40 60 80 100	20 40 60	W _P W W _L					
0.0	SAND, fine grained, some silt, trace gravel, mixed with topsoil Very Loose to Loose Brown Moist		1	SS	1									
			2	SS	2									
			3	SS	4									
184.9														
184.7	CLAY, trace silt, trace sand Firm Brown		4	SS	6									
2.0	SAND, fine grained, trace gravel Compact Brown Moist		5	SS	21									

Continued Next Page

+ 3, x 3, Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

ONTMT4S 6121(HRB).GPJ 5/9/12

RECORD OF BOREHOLE No HRB10-01

2 OF 2

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 272.2 E 230 993.5 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE 3rd Weight Hammer/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2010.05.05 - 2010.05.05 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)							
								<div>20406080100</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>					<div>w_p w w_L</div>							
	Continued From Previous Page																			
176.1																	3			
10.6	END OF BOREHOLE AT 10.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																4			

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

RECORD OF BOREHOLE No HRB10-02

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 275.8 E 230 993.4 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE 3rd Weight Hammer/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2010.05.04 - 2010.05.04 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
183.5	GROUND SURFACE													
0.0	TOPSOIL: (50mm)													
	Silty SAND, fine grained, micacious, trace gravel, trace clay, trace rootlets Very Loose to Dense Brown Moist		1	SS	1		183							1 63 31 5
	50mm silty clay layer at 1.2m		2	SS	3									
			3	SS	4		182							
			4	SS	7									
			5	SS	18		181							
	Becomes coarse grained		6	SS	25		180							4 70 26 (SI+CL)
			7	SS	38									
179.0														
4.5	BEDROCK, granitic gneiss, occasional quartz interbeds, strong, reddish grey Coring started at 4.5m 50mm sub-vertical fractures at 5.2m 250mm highly broken zone at 6.1m		1	RUN			179							RUN #1 TCR=100% SCR=100% RQD=100% RUN #2 TCR=100% SCR=69% RQD=64% UCS=174MPa (Average)
	Horizontal fractures at: 500mm at 6.0m 25mm at 7.0m 625mm vertical fractures at 6.0m		2	RUN			178							
			3	RUN			177							RUN #3 TCR=100% SCR=38% RQD=38% UCS=192MPa (Average)
	25mm sub-horizontal fractures at 7.2m		4	RUN			176							RUN #4 TCR=100% SCR=100% RQD=100% UCS=175MPa (Average)
175.5														
8.0	END OF BOREHOLE AT 8.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S 6121(HRB)GPJ 5/9/12

RECORD OF BOREHOLE No HRB10-03

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 272.5 E 231 000.5 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE 3rd Weight Hammer/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2010.05.06 - 2010.05.06 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	20	40		60			
186.3	GROUND SURFACE																		
0.0	Silty SAND , fine grained, trace clay, trace roots Very Loose to Loose Brown Moist to Wet Occasional oxide staining		1	SS	1													0 73 25 2	
			2	SS	5														
			3	SS	2														
			4	SS	4														
			5	SS	4													0 71 27 2	
			6	SS	3														
	Trace roots and organics from 3.6m to 3.7m		7	SS	6														
181.1																			
5.2	BEDROCK , granitic gneiss, strong, reddish grey Coring started at 5.2m Sub-vertical fractures at: 50mm at 6.7m 75mm at 7.2m 50mm at 7.4m 100mm at 7.5m 50mm at 7.6m 50mm at 7.7m 125mm at 8.4m		1	RUN															
			2	RUN															
			3	RUN															
177.7																			
8.6	END OF BOREHOLE AT 8.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																		

ONTMT4S 6121(HRB).GPJ 5/9/12

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB10-04

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 276.0 E 231 000.4 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE 3rd Weight Hammer/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2010.05.03 - 2010.05.03 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100	20 40 60 80 100	20 40 60	20 40 60	20 40 60					
182.7	GROUND SURFACE																
182.7	TOPSOIL: (40mm)		1	SS	1												
	SAND and SILT, trace clay, trace gravel, trace rootlets Very Loose Brown Moist to Wet		2	SS	1											0 54 43 3	
			3	SS	2												
			4	SS	54/ 0.275												
180.3																	
2.4	BEDROCK, granitic gneiss, strong, reddish grey Coring started at 2.4m		1	RUN													
			2	RUN													
	75mm sub-vertical fractures at 4.5m																
	425mm highly broken zone at 5.0m		3	RUN													
177.2																	
5.5	END OF BOREHOLE AT 5.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

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

RECORD OF BOREHOLE No HRB10-05

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 272 8 E 231 008.1 ORIGINATED BY ES
HWY 69 BOREHOLE TYPE 3rd Weight Hammer/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2010.05.03 - 2010.05.03 CHECKED BY TH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
184.0	GROUND SURFACE													
183.8	TOPSOIL: (25mm)		1	SS	2									0 52 42 6
183.4	SAND and SILT, trace clay Very Loose Light Brown Moist													
0.6	BEDROCK, granitic gneiss, strong, micaceous, greyish black to reddish grey Coring started at 0.6m		1	RUN										RUN #1 TCR=100% SCR=100% RQD=100% UCS=197MPa (Average)
			2	RUN										RUN #2 TCR=100% SCR=98% RQD=98% UCS=190MPa (Average)
	50mm sub-vertical fractures at 3.2m		3	RUN										RUN #3 TCR=100% SCR=94% RQD=94% UCS=199MPa (Average)
180.2														
3.8	END OF BOREHOLE AT 3.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

+ 3, × 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB10-06

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 276.3 E 231 007.9 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE 3rd Weight Hammer/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.05.03 - 2010.05.03 CHECKED BY TH

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100	W _p	W	W _L		
182.4	GROUND SURFACE															
0.0	SAND, trace silt, trace organics		1	SS	50/											
0.2	Very Loose Light Brown Moist		1	RUN	0.150	182										
	BEDROCK, granitic gneiss, strong, reddish grey Coring started at 0.2m															
			2	RUN		181										
			3	RUN		180										
	Sub-vertical fractures at: 125mm at 2.8m 75mm at 3.0m 75mm at 3.2m															
179.1																
3.3	END OF BOREHOLE AT 3.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															

+³, ×³ Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB10-07

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 300.1 E 230 982.2 ORIGINATED BY SLL
HWY 69 BOREHOLE TYPE EW Casing COMPILED BY MFA
DATUM Geodetic DATE 2010.05.14 - 2010.05.14 CHECKED BY TJH

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa			WATER CONTENT (%)							
						20 40 60 80 100			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			w _p w w _L				
181.6 0.0	GROUND SURFACE															
177.0 4.6	BEDROCK, granitic gneiss, strong, grey, with quartz seams Coring started at 4.6m Sub-vertical joints at 6.02, 6.04, 6.10, 6.17, 6.21, and 6.22m. Sub-vertical joints at 6.25, 6.30, 6.38, 6.40, 6.45, 6.53, 6.55, 6.59, 6.61, 6.63, 6.65, and 6.68m.		1	RUN										FI	RUN #1 TCR=100% SCR=100% RQD=100% UCS=153MPa (Average)	
			2	RUN										1	RUN #2 TCR=100% SCR=100% RQD=56% UCS=126MPa (Average)	
			3	RUN										7	RUN #3 TCR=100% SCR=100% RQD=32% UCS=82MPa (Average)	
			4	RUN										7	RUN #4 TCR=100% SCR=100% RQD=32% UCS=82MPa (Average)	
174.0 7.6	END OF BOREHOLE AT 7.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													4	RUN #4 TCR=100% SCR=100% RQD=32% UCS=82MPa (Average)	
														5	RUN #4 TCR=100% SCR=100% RQD=32% UCS=82MPa (Average)	
														2	RQD=71% UCS=74MPa (Average)	

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

RECORD OF BOREHOLE No HRB10-08

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 303 5 E 230 982 2 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE EW Casing COMPILED BY MFA
 DATUM Geodetic DATE 2010.05.10 - 2010.05.11 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						W _P	W	W _L
182.0	GROUND SURFACE							20	40	60	80	100	20	40	60		
0.0																	
	No sampling																
179.3																	
2.7	BEDROCK , granitic gneiss, fresh, strong, dark grey Coring started at 2.7m Vertical joints at 2.87, 3.10, 3.12, 3.18, 3.24, and 3.28m. Horizontal joints at 3.00, and 3.38m. Sub-vertical joints at 3.66, 3.81, 3.83, and 3.89m. With quartz seams Sub-vertical joints at 4.42, 4.44, 4.57, 4.80, and 4.82m. Sub-horizontal joint at 4.88 to 5.03m. Vertical joint at 5.28m.		1	RUN													
			2	RUN													
			3	RUN													
176.3																	
5.7	END OF BOREHOLE AT 5.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

+ 3, × 3 : Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB10-11

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 300.6 E 230 996.8 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE EW Casing COMPILED BY MFA
 DATUM Geodetic DATE 2010.05.11 - 2010.05.12 CHECKED BY TJH

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa			WATER CONTENT (%)							
181.1	GROUND SURFACE															
0.0	No sampling						181									
							180									
							179									
							178									
							177									
							176									
							175									
175.3	BEDROCK , granitic gneiss, fresh, grey, with quartz and micaceous lenses Horizontal joint at 5.84 to 6.00m. Horizontal joint at 6.00 to 6.20m. Horizontal joint at 6.20 to 6.35m. Horizontal joint at 7.75 to 8.10m.		1	RUN										FI	RUN #1 TCR=100% SCR=0% RQD=0% RUN #2 TCR=100% SCR=88% RQD=50% RUN #3 TCR=100% SCR=100% RQD=89% UCS=156MPa (Average) RUN #4 TCR=100% SCR=100% RQD=96% UCS=195MPa (Average) RUN #5 TCR=100% SCR=100% RQD=80% UCS=150MPa (Average)	
5.8			2	RUN												6
			3	RUN												3
			4	RUN												2
			5	RUN												1
							174							2		
							173							0		
														0		
172.0	Horizontal joint at 8.99 to 9.07m.													3		
9.1	END OF BOREHOLE AT 9.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													2		
														3		

ONTMT4S 6121(HRB).GPJ 5/9/12

+³, ×³ Numbers refer to
Sensitivity

20
15
10




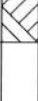
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HRB10-12

1 OF 1

METRIC

W.P. 5076-06-00 LOCATION Harris River Bridge, N 5 061 304.1 E 230 996.7 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE EW Casing COMPILED BY MFA
 DATUM Geodetic DATE 2010.05.12 - 2010.05.13 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
181.3 0.0	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	20 40 60			
176.4 4.9	No sampling											
173.3 8.0	BEDROCK, granitic gneiss, fresh, strong, with quartz lenses		1	RUN								FI
			2	RUN								
			3	RUN								
			4	RUN								
			5	RUN								
176.4 4.9	Horizontal joint at 6.07 to 6.63m.											4
175.0 6.4	With pink quartzite Hidden joint at 6.63 to 6.91m.											3
174.0 8.0	END OF BOREHOLE AT 8.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, THEN SAND TO SURFACE.											1
173.3 8.0												2

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

Appendix B

Laboratory Test Results

TABLE 1 - Point Load Test Results
HARRIS RIVER BRIDGE
HWY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

19-5161-21

HRB09-01	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	22	1	6.73	21.5	D	47.60	135.10	ok	222.75				
	23	6	7.16	20.5	D	47.60	89.00	ok	212.39				
	23	7	7.19	29.5	A	47.60	45.80	ok	261.14				
RUN #2	23	9	7.24	14.5	D	47.60	88.40	ok	150.23				
	23	8	7.21	21.0	A	47.60	45.30	ok	187.49				
	25	1	7.65	22.0	D	47.60	144.30	ok	227.93				
	25	0	7.62	28.0	A	47.60	43.50	ok	257.96				
	26	2	7.98	25.0	D	47.60	89.10	ok	259.01				
	26	3	8.00	28.0	A	47.60	44.70	ok	252.58				
	27	5	8.36	23.0	D	47.60	107.10	ok	238.29				
RUN #3	29	7	9.02	25.5	D	47.60	85.20	ok	264.19		AVERAGE	MAX	MIN
	28	11	8.81	31.0	A	47.60	48.60	ok	262.09	RUN #1:	232	261	212
	30	0	9.14	24.0	D	47.60	103.50	ok	248.65	RUN #2:	225	259	150
	32	0	9.75	18.0	D	47.60	90.50	ok	186.49	RUN #3:	240	264	186

HRB09-04	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	24	10	7.57	20.5	D	47.40	121.40	ok	213.78				
	25	1.5	7.66	29.0	A	47.40	50.60	ok	238.41				
	26	1	7.95	15.0	D	47.40	130.70	ok	156.43				
	27	5.5	8.37	14.5	D	47.40	115.40	ok	151.21				
	27	7	8.41	24.0	A	47.40	45.30	ok	214.97				
RUN #2	29	0	8.84	7.0	D	47.40	106.10	ok	73.00				
	29	1	8.86	15.0	A	47.40	42.50	ok	141.17				
	30	6	9.30	12.5	D	47.40	87.00	ok	130.36				
	30	7	9.32	24.0	A	47.50	49.70	ok	189.74				
	31	6	9.60	15.5	D	47.50	98.90	ok	161.11				
	31	3	9.53	28.0	A	47.50	55.80	ok	197.82				
	32	5	9.88	16.5	D	47.50	137.80	ok	171.51				
	33	8	10.26	12.5	A	47.50	53.10	ok	98.63				
										RUN #1:	195	238	151
										RUN #2:	147	200	73
RUN #3	34	0	10.38	12.0	D	47.50	130.00	ok	124.73	RUN #3:	125	125	125

HRB09-07	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	13	10	4.22	18.0	D	47.60	75.70	ok	186.49				
	14	2	4.32	15.5	D	47.60	108.00	ok	160.59				
	14	0.5	4.28	32.5	A	47.60	49.00	ok	273.03				
RUN #2	14	6	4.42	21.0	D	47.60	78.00	ok	217.57				
	14	5	4.39	31.0	A	47.60	44.30	ok	281.59				
	15	8	4.78	11.5	D	47.60	76.70	ok	119.15				
	15	7.5	4.76	18.5	A	47.60	60.00	ok	132.84				
	16	9	5.11	16.0	D	47.50	98.30	ok	166.31				
	16	11	5.16	16.0	A	47.50	53.20	ok	126.32				
	18	0	5.49	9.0	D	47.50	96.00	ok	93.55				
	17	9	5.41	15.5	A	47.50	42.70	ok	145.10				
	19	1	5.82	10.0	D	47.50	77.00	ok	103.94				
	19	1.5	5.83	17.5	A	47.50	47.60	ok	150.60				
RUN #3	19	6	5.94	14.5	D	47.50	105.00	ok	150.72				
	19	7	5.97	22.0	A	47.50	51.60	ok	177.85				
	20	8	6.30	12.0	D	47.50	139.50	ok	124.73				
	20	9	6.32	13.0	A	47.50	38.20	ok	132.67				
	21	5	6.53	13.0	D	47.50	152.80	ok	135.13				
	21	9	6.63	16.0	A	47.50	48.10	ok	136.58				
	23	2	7.06	10.0	D	47.50	91.60	ok	103.94				
	23	2.5	7.07	2.5	A	47.50	40.50	ok	24.38				
										RUN #1:	207	273	161
										RUN #2:	154	282	94
										RUN #3:	123	178	24

HRB09-10	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	18	3	5.56	1.0	D	47.70	75.10	ok	10.33				
RUN #2	19	2	5.84	21.0	D	50.60	151.50	ok	197.91				
	20	0	6.10	15.0	D	50.40	108.00	ok	142.23				
	19	11.5	6.08	8.0	A	50.40	57.60	ok	56.72				
	20	10	6.35	13.0	D	40.30	94.50	ok	174.34				
RUN #3	22	2	6.76	20.0	D	50.40	49.70	ok	189.64				
	22	5	6.83	5.0	A	50.40	49.70	ok	39.74				
	23	7	7.19	16.0	D	50.40	105.20	ok	151.71				
	23	11	7.29	15.0	A	50.40	66.10	ok	95.59				
	24	11	7.59	11.0	D	50.40	84.40	ok	104.30				
RUN #4	25	11	7.90	23.5	D	50.60	102.20	ok	221.47		AVERAGE	MAX	MIN
	26	0	7.92	26.0	A	50.60	49.30	ok	207.33	RUN #1:	10	10	10
	27	2	8.28	19.5	D	50.50	77.70	ok	184.33	RUN #2:	143	198	57
	27	2.5	8.29	32.5	A	50.50	44.20	ok	282.49	RUN #3:	116	190	40
	28	4	8.64	14.0	D	50.40	66.70	ok	132.75	RUN #4:	206	282	133

TABLE 1 - Point Load Test Results
HARRIS RIVER BRIDGE
HWY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

19-5161-21

HRB09-11	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	17	5	5.31	15.0	D	50.50	95.70	ok	141.80				
	17	4	5.28	25.0	A	50.50	40.10	ok	234.33				
	18	4	5.59	15.0	D	50.30	109.80	ok	142.67				
	19	3	5.87	11.5	D	50.20	50.20	ok	109.72				
RUN #2	20	3	6.17	17.0	D	50.40	107.20	ok	161.20				
	20	4	6.20	29.5	A	50.40	55.50	ok	215.27				
	21	7.5	6.59	8.0	D	50.20	69.80	ok	76.33				
RUN #3	23	1	7.04	22.0	D	50.50	91.70	ok	207.97				
	23	2	7.06	33.0	A	50.50	48.90	ok	265.23				
	24	5	7.44	14.0	D	50.50	114.50	ok	132.34				
	24	6	7.47	11.0	A	50.50	51.30	ok	85.19				
	25	9	7.85	24.5	D	50.50	89.70	ok	231.60				
	25	8	7.82	27.5	A	50.50	49.50	ok	218.94				
	26	9	8.15	24.0	D	50.50	120.60	ok	226.67				
	26	8	8.13	19.0	A	50.50	53.80	ok	142.22				
										AVERAGE	MAX	MIN	
										RUN #1:	157	234	110
										RUN #2:	151	215	76
										RUN #3:	189	265	85

HRB09-14	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	4	10	1.47	19.5	D	47.70	83.00	ok	201.38				
	4	11	1.50	17.5	A	47.70	41.90	ok	165.71				
RUN #2	5	8	1.73	24.0	D	47.70	102.70	ok	247.85				
	5	9	1.75	23.0	A	47.70	48.30	ok	195.07				
	7	2	2.18	15.0	D	47.70	71.31	ok	154.90				
	8	9	2.67	14.0	D	50.50	79.50	ok	132.34				
RUN #3	9	5	2.87	18.5	D	50.60	133.30	ok	174.35				
	9	5.5	2.88	22.0	A	50.60	47.90	ok	179.40				
	10	6	3.20	20.5	D	50.60	149.70	ok	193.19				
	11	2	3.40	19.5	D	50.60	180.00	ok	183.77				
	12	6	3.81	23.0	D	50.60	133.50	ok	216.76				
RUN #4	13	6	4.11	15.5	D	50.50	105.70	ok	146.52				
	14	6	4.42	20.5	D	50.50	117.10	ok	193.79				
	14	7	4.45	10.0	A	50.50	45.90	ok	84.41				
	15	2	4.62	25.0	D	50.50	111.60	ok	236.33				
	15	3	4.65	20.0	A	50.50	57.10	ok	142.55				
	16	4	4.98	26.0	D	50.50	137.40	ok	245.78				
										AVERAGE	MAX	MIN	
										RUN #1:	184	201	166
										RUN #2:	183	248	132
										RUN #3:	189	217	174
										RUN #4:	175	246	84

HRB09-16	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	2	0	0.61	16.0	D	47.80	117.10	ok	164.70				
	2	1	0.64	23.0	A	47.80	53.10	ok	180.96				
RUN #2	3	0	0.91	21.0	D	50.20	76.50	ok	200.36				
	4	0	1.22	14.0	D	49.60	110.00	ok	136.08				
	4	1	1.24	17.0	A	49.60	47.80	ok	141.01				
	5	3	1.60	23.0	D	50.50	93.40	ok	217.42				
	7	0	2.13	18.5	D	50.50	96.00	ok	174.88				
	6	11	2.11	22.5	A	50.50	44.10	ok	195.91				
RUN #3	8	1	2.46	23.0	D	50.50	152.50	ok	217.42				
	9	7	2.92	21.5	D	50.50	93.00	ok	203.24				
	9	7	2.92	23.0	D	50.50	69.80	ok	217.42				
RUN #4	11	2	3.40	19.0	D	50.50	105.00	ok	179.61				
	11	3	3.43	15.5	A	50.50	47.80	ok	126.79				
										AVERAGE	MAX	MIN	
										RUN #1:	173	181	165
										RUN #2:	178	217	136
										RUN #3:	213	217	203
										RUN #4:	153	180	127

HRB09-18	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	11	0	3.35	22.0	D	47.50	152.00	ok	228.68				
	11	3	3.43	18.5	A	47.50	36.40	ok	196.00				
	12	2	3.71	12.0	D	47.50	92.20	ok	124.73				
	12	3.5	3.75	17.5	A	47.50	36.00	ok	187.00				
	13	2	4.01	16.5	D	47.50	150.40	ok	171.51				
RUN #2	13	10	4.22	15.0	D	47.50	147.00	ok	155.92				
	14	11	4.55	13.0	D	47.50	153.00	ok	135.13				
	15	2.5	4.64	19.0	A	47.50	43.70	ok	174.71				
	16	2	4.93	15.0	D	47.50	91.60	ok	155.92				
	16	1.5	4.91	18.5	A	47.50	51.80	ok	149.11				
	17	5	5.31	11.5	D	47.50	153.00	ok	119.54				
RUN #3	18	9	5.72	12.0	D	47.50	123.40	ok	124.73				
	18	8	5.69	21.5	A	47.50	47.90	ok	184.12				
	20	6	6.25	14.0	D	47.50	91.80	ok	145.52				
	20	5.5	6.24	21.0	A	47.50	45.60	ok	186.83				
										AVERAGE	MAX	MIN	
										RUN #1:	182	229	125
										RUN #2:	148	175	120
										RUN #3:	160	187	125

TABLE 1 - Point Load Test Results
HARRIS RIVER BRIDGE
HWY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

19-5161-21

HRB09-19	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	16	0	4.88	14.0	D	47.50	131.00	ok	145.52				
	15	11.5	4.86	11.5	A	47.50	48.10	ok	98.17				
	17	0	5.18	8.5	D	47.50	120.00	ok	88.35				
	16	11	5.16	18.0	A	47.50	51.70	ok	145.29				
	18	6	5.64	9.5	D	47.50	95.60	ok	98.75				
	18	5.5	5.63	19.5	A	47.50	46.90	ok	169.75				
RUN #2	19	3	5.87	14.0	D	47.50	89.20	ok	145.52				
	19	2	5.84	25.5	A	47.50	52.00	ok	204.91				
	20	5	6.22	7.5	D	47.50	133.50	ok	77.96				
	20	7	6.27	19.0	A	47.50	57.10	ok	142.00				
	21	8	6.60	13.0	D	47.50	71.60	ok	135.13				
	21	8.5	6.62	21.5	A	47.50	47.10	ok	186.54				
	22	8	6.91	14.0	D	47.50	90.10	ok	145.52				
	22	7	6.88	23.0	A	47.50	55.00	ok	176.96				
	24	0	7.32	5.0	D	47.50	67.70	ok	51.97				
RUN #3	24	3	7.39	7.5	D	47.50	108.00	ok	77.96	RUN #1:	124	170	88
	24	7	7.49	19.5	A	47.50	47.90	ok	167.00	RUN #2:	141	205	52
										RUN #3:	122	167	78
											AVERAGE	MAX	MIN

HRB09-21	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	16	3	4.95	12.0	D	47.50	105.50	ok	124.73				
	16	4	4.98	19.0	A	47.50	46.80	ok	165.67				
	17	2	5.23	14.0	D	47.50	108.60	ok	145.52				
	17	3.5	5.27	21.0	A	47.50	47.80	ok	180.13				
	18	3	5.58	13.0	D	47.50	73.40	ok	135.13				
RUN #2	18	7	5.66	8.5	D	47.50	104.20	ok	88.35				
	19	4.5	5.91	4.0	A	47.50	45.50	ok	35.65				
	20	10	6.35	0.5	D	47.50	85.50	ok	5.20				
	21	1	6.43	0.0	D	47.50	70.60	ok	0.00				
	21	6	6.55	5.0	A	47.50	44.70	ok	45.18				
	21	9	6.63	11.0	D	47.50	74.90	ok	114.34				
	23	1	7.04	15.5	A	47.50	58.80	ok	113.24				
RUN #3	23	4	7.11	7.5	D	47.50	102.20	ok	77.96				
	23	5	7.14	18.5	A	47.50	49.00	ok	155.67				
	24	11.5	7.61	13.5	D	47.50	90.90	ok	140.32				
	24	10	7.57	27.0	A	47.50	55.40	ok	206.57				
	25	3	7.70	12.5	D	47.50	93.70	ok	129.93	RUN #1:	150	180	125
	25	3.5	7.71	19.0	A	47.50	49.50	ok	158.62	RUN #2:	57	114	0
	26	7	8.10	12.5	D	47.50	49.50	ok	129.93	RUN #3:	143	207	78
											AVERAGE	MAX	MIN

HRB09-27	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	2	11	0.89	12.0	D	47.50	67.50	ok	124.73				
	3	5	1.04	6.0	A	47.50	58.50	ok	45.21				
	3	11	1.19	7.5	D	47.50	114.90	ok	77.96				
	4	2	1.27	24.0	A	47.50	54.30	ok	186.50				
RUN #2	5	0	1.52	14.0	D	47.50	97.00	ok	145.52				
	5	10	1.78	15.0	D	47.50	140.00	ok	155.92				
	7	0	2.13	15.5	D	47.50	79.90	ok	161.11				
	6	11	2.11	26.0	A	47.50	46.80	ok	226.71				
	7	11	2.41	3.5	D	47.50	83.30	ok	36.38				
RUN #3	10	6	3.20	9.0	D	47.50	124.80	ok	93.55				
	11	3	3.43	14.0	D	47.50	109.00	ok	145.52				
	11	2	3.40	20.0	A	47.50	91.60	ok	103.63				
	11	11	3.63	20.0	D	47.50	83.50	ok	207.89	RUN #1:	109	186	45
	12	11	3.94	8.5	D	47.50	80.80	ok	88.35	RUN #2:	145	227	36
	12	11.5	3.95	27.5	A	47.50	47.10	ok	238.60	RUN #3:	146	239	88
											AVERAGE	MAX	MIN

HRB09-29	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	6	10.5	2.10	16.0	D	47.00	67.50	ok	169.06				
	7	1	2.16	29.0	A	47.10	64.70	ok	198.03				
	8	9	2.67	4.0	D	47.10	85.30	ok	42.13				
	8	8.5	2.65	21.0	A	47.10	43.80	ok	194.02				
RUN #2	10	0	3.05	14.5	D	47.20	106.20	ok	152.21				
	10	1	3.07	9.0	A	47.20	45.70	ok	80.33				
	11	4	3.45	12.0	D	47.20	117.80	ok	125.96				
	11	9.5	3.59	29.0	A	47.20	44.70	ok	263.31				
	12	8	3.66	11.0	D	47.20	73.90	ok	115.47				
	12	5	3.78	16.5	A	47.20	50.00	ok	137.36				
RUN #3	15	2	4.62	15.0	D	47.20	150.00	ok	157.45				
	15	4.5	4.69	25.5	A	47.20	57.10	ok	191.52				
	15	11	4.85	19.0	D	47.20	91.50	ok	189.44				
	15	10	4.83	19.0	A	47.20	49.00	ok	160.66	RUN #1:	151	196	42
	17	1	5.21	10.5	D	47.20	94.50	ok	110.22	RUN #2:	145	263	80
	17	1.5	5.22	27.0	A	47.20	42.80	ok	253.55	RUN #3:	179	254	110
											AVERAGE	MAX	MIN

TABLE 1 - Point Load Test Results
HARRIS RIVER BRIDGE
HWY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

19-5161-21

HRB09-31	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	2	2	0.66	18.0	D	47.20	104.00	ok	188.95				
RUN #2	4	4	1.32	0.5	D	47.20	98.20	ok	5.25				
	4	4.5	1.33	19.5	A	47.20	48.20	ok	172.58				
	4	7	1.40	15.5	D	47.20	77.90	ok	162.70				
	5	8	1.73	20.0	D	47.20	107.60	ok	209.94				
	6	8	2.03	16.5	D	47.20	101.00	ok	173.20				
	6	7	2.01	19.0	A	47.20	51.90	ok	153.68				
	8	2	2.49	18.5	D	47.20	97.40	ok	173.20				
	8	1.5	2.48	18.5	A	47.20	51.10	ok	151.43				
RUN #3	9	0	2.74	11.0	D	47.60	98.40	ok	113.97				
	9	0.5	2.76	15.0	A	47.60	48.80	ok	128.41	RUN #1:	AVERAGE	MAX	MIN
	10	8	3.25	3.5	D	47.60	108.70	ok	36.26	RUN #2:	189	189	189
	11	9	3.58	18.5	A	47.60	45.20	ok	165.45	RUN #3:	150	210	5
										RUN #3:	111	165	36

BH10-A	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	23	0	7.01	28.5	D	50.84	183.21	ok	249.43				
	23	2	7.06	25.0	A	50.52	53.20	ok	188.17				
RUN #2	25	9	7.85	20.5	D	50.87	156.69	ok	191.61				
RUN #3	28	1	8.56	24.5	D	50.68	190.18	ok	230.33				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	219	249	188
										RUN #3:	192	192	192
										RUN #3:	230	230	230

BH10-B	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	20	3	6.17	15.5	D	50.15	263.45	ok	148.11				
RUN #2	23	1	7.04	25.5	D	50.28	180.32	ok	242.89				
	23	2	7.06	22.5	A	50.17	49.66	ok	179.60				
RUN #3	27	3	8.31	23.5	D	50.21	120.13	ok	224.14				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	148	148	148
										RUN #3:	211	243	180
										RUN #3:	224	224	224

BH10-C	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	19	6	5.94	20.0	D	50.86	143.30	ok	186.99				
RUN #2	23	5	7.14	19.0	D	51.34	207.28	ok	175.07				
RUN #3	27	2	8.28	17.5	D	51.61	132.04	ok	159.95				
	27	3	8.31	19.0	A	51.46	46.77	ok	131.18				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	187	187	187
										RUN #3:	175	175	175
										RUN #3:	146	160	131

BH10-D	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	14	6	4.42	14.5	D	50.78	38.78	ok	135.90				
RUN #2	16	6	5.03	7.0	D	51.03	212.00	ok	65.11				
RUN #3	20	1	6.12	17.0	D	51.01	381.00	ok	158.22				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	136	136	136
										RUN #3:	65	65	65
										RUN #3:	158	158	158

BH10-E	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	2	6	0.76	21.0	D	50.82	183.42	ok	197.79				
RUN #2	3	9	1.14	16.5	A	50.51	50.88	ok	128.58				
RUN #3	8	10	2.69	14.0	D	50.55	132.46	ok	132.14				
RUN #4	10	11	3.33	18.5	D	50.64	170.22	ok	174.13				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	198	198	198
										RUN #3:	129	129	129
										RUN #3:	132	132	132
										RUN #4:	174	174	174

TABLE 1 - Point Load Test Results
HARRIS RIVER BRIDGE
HWY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

19-5161-21

BH10-F	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	2	11	0.89	12.5	D	50.71	245.21	ok	117.41				
RUN #2	7	6	2.29	17.5	D	50.72	139.66	ok	164.32				
RUN #3	10	9	3.28	18.5	D	50.92	154.95	ok	172.65				
	10	10	3.30	21.5	A	50.88	52.10	ok	163.56				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	117	117	117
										RUN #3:	164	164	164
											168	173	164

Tested: June 2, 1010

BH 10-G	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	4	0	1.22	15.5	D	50.08	97.56	ok	148.52	NO HCL REACTION			
	4	11	1.50	18.8	A	50.31	50.96	ok	146.77				
	5	8	1.73	14.0	D	50.12	89.71	ok	133.90				
RUN #2	8	9	2.67	11.8	D	50.18	133.48	ok	112.65				
	9	7	2.92	10.6	D	49.88	117.52	ok	102.14				
	10	6	3.20	16.8	D	50.08	114.57	ok	160.88				
	11	3	3.43	14.0	A	50.04	50.11	ok	111.19				
RUN #3	12	1	3.68	10.3	D	50.27	109.63	ok	98.06				
	13	0	3.96	18.7	D	50.10	155.00	ok	178.96				
	13	10	4.22	9.6	D	50.17	93.74	ok	91.66				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	143	149	134
										RUN #3:	122	161	102
											123	179	92

Tested: June 2, 1010

BH 10-H	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	4	0	1.22	15.3	D	50.13	320.00	ok	148.29	NO HCL REACTION			
	5	4	1.63	18.1	D	50.51	332.00	ok	171.05				
	6	5	1.96	10.8	D	50.39	93.54	ok	102.44				
RUN #2	7	5	2.26	18.2	D	50.32	73.25	ok	173.00				
	8	2	2.49	8.1	D	50.08	93.91	ok	77.57				
	9	5	2.67	13.0	D	50.49	105.43	ok	122.93				
RUN #3	10	5	3.18	15.0	D	50.06	235.00	ok	143.73				
RUN #4	12	2	3.71	16.5	D	50.13	147.37	ok	157.76				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	140	171	102
										RUN #3:	124	173	78
										RUN #4:	144	144	144
											158	158	158

Tested: June 2, 1010

BH 10-I	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #2	2	8	0.81	10.5	D	50.14	193.00	ok	100.36	NO HCL REACTION			
	4	0	1.22	9.1	D	50.17	97.58	ok	86.90				
	5	0	1.52	16.3	D	50.15	124.88	ok	155.76				
	5	7	1.70	15.2	D	50.15	123.71	ok	145.24				
RUN #4	8	0	2.44	20.3	D	50.66	113.24	ok	190.96				
RUN #5	9	7	2.92	19.0	D	50.11	116.54	ok	181.76				
	10	8	3.25	16.2	D	50.00	225.00	ok	155.52				
										RUN #2:	AVERAGE	MAX	MIN
										RUN #4:	122	156	87
										RUN #5:	191	191	191
											169	182	156

BH10-J	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	1	9	0.53	16.5	D	50.61	107.36	ok	155.45				
RUN #2	4	1	1.24	18.5	D	50.77	671.02	ok	173.44				
	4	4	1.32	20.5	A	50.65	52.44	ok	155.72				
RUN #3	8	9	2.67	12.5	D	50.53	156.93	ok	118.05				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	155	155	155
										RUN #3:	165	173	156
											118	118	118

Tested: June 3, 1010

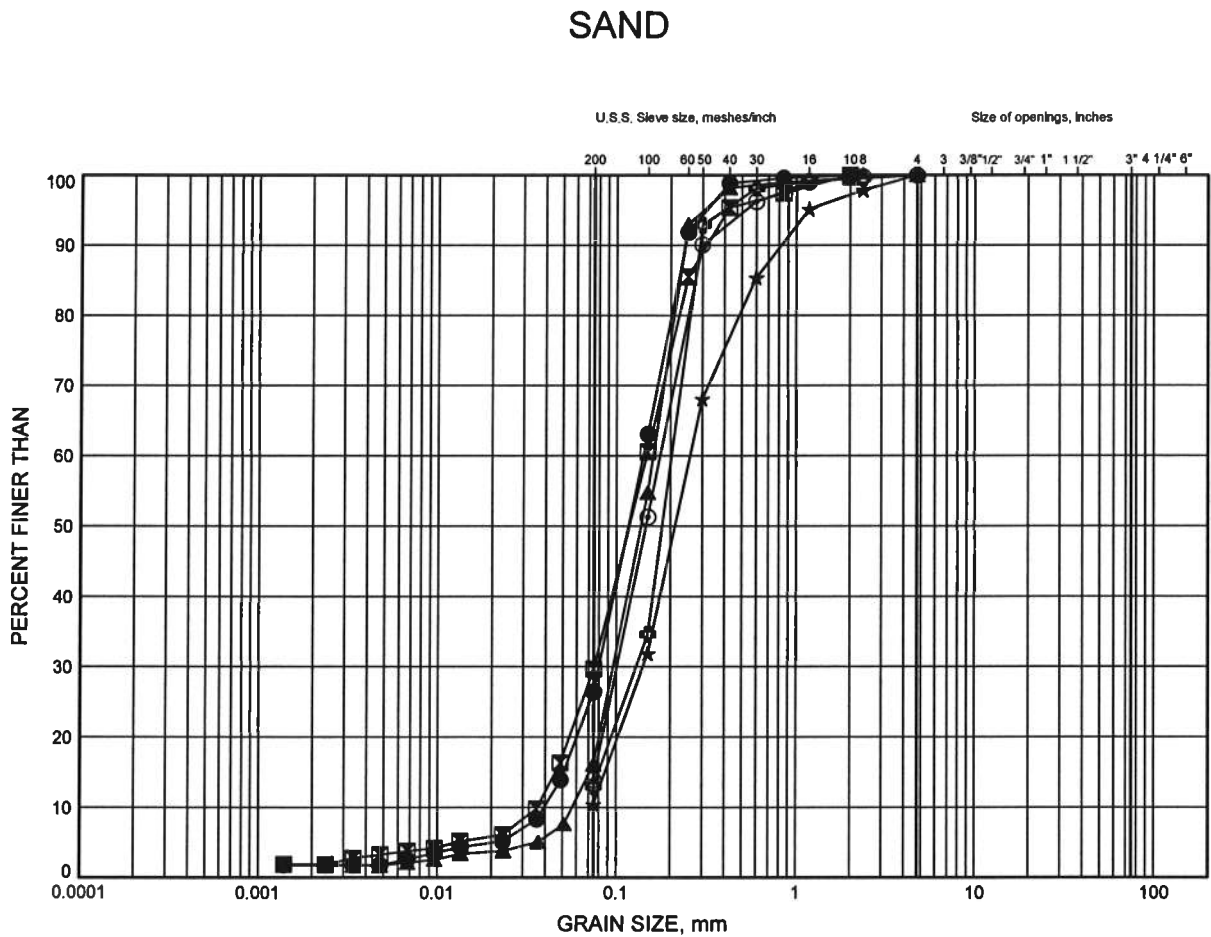
HRB10-1	DEPTH			FORCE (kN)	AXIAL / DIAMETRIC	DIAMETER (mm)	LENGTH (mm)	BREAK	UCS (Mpa)	CONCLUSIONS			
	FT.	IN.	METERS										
RUN #1	23	10	7.26	12.5	D	50.51	135.18	ok	118.13				
RUN #2	29	7	9.02	17.0	D	50.72	152.68	ok	159.62				
RUN #3	30	2	9.19	18.5	D	50.84	256.71	ok	173.07				
	30	4	9.25	21.5	A	50.65	49.82	ok	169.93				
										RUN #1:	AVERAGE	MAX	MIN
										RUN #2:	118	118	118
										RUN #3:	160	160	160
											172	173	170

TABLE 1 - Point Load Test Results

[illegible][illegible][illegible][illegible]

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B1



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

LEGEND

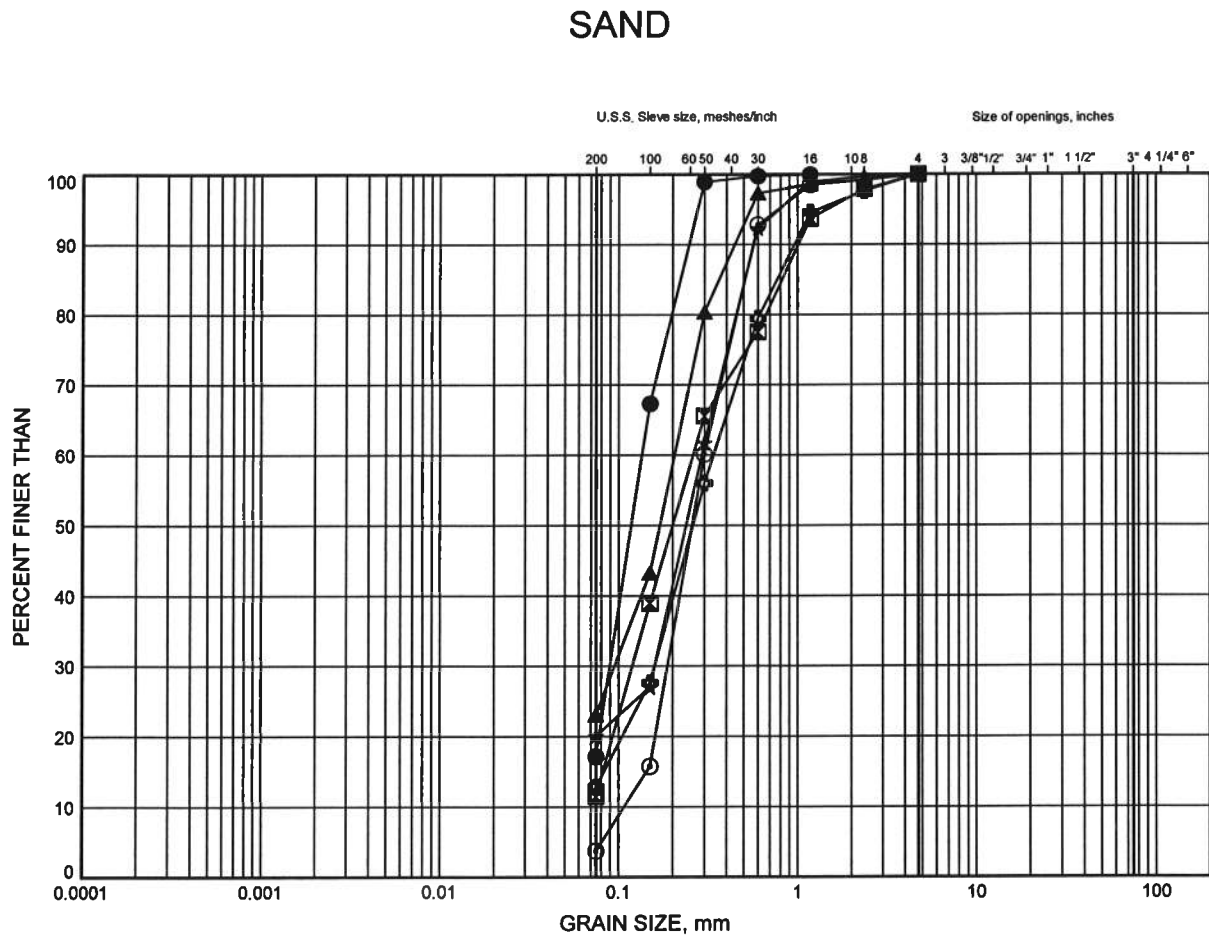
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-F	0.30	186.60
⊠	BH10-H	0.30	185.70
▲	HRB09-03	6.40	183.73
★	HRB09-09	2.13	183.55
⊙	HRB09-09	4.57	181.11
⊕	HRB09-10	1.37	183.21



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Hwy 69 Four-Laning North of Hwy 529 GRAIN SIZE DISTRIBUTION

FIGURE B2



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

LEGEND

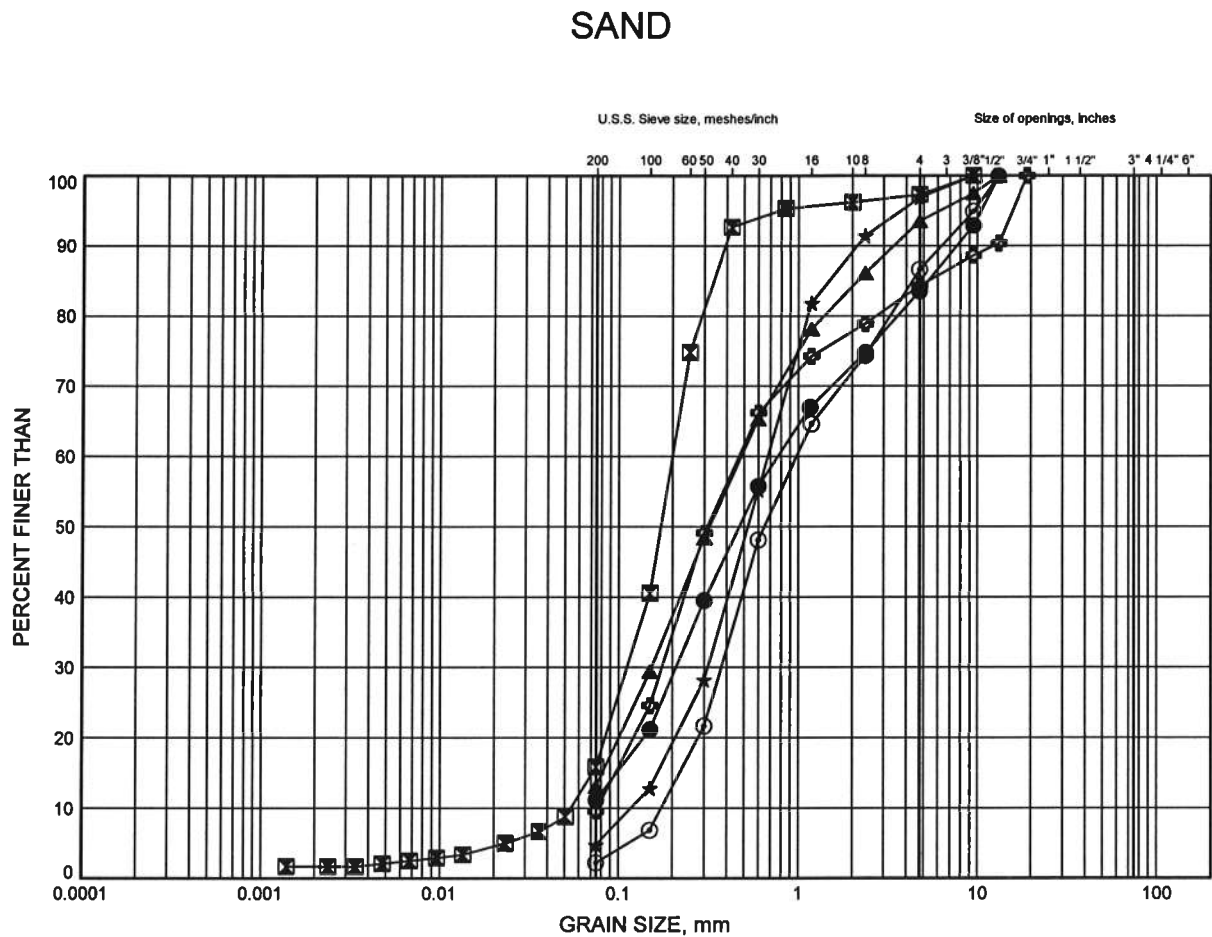
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-10	3.20	181.38
⊠	HRB09-10	4.42	180.16
▲	HRB09-11	0.91	184.41
★	HRB09-11	2.74	182.58
⊙	HRB09-11	3.96	181.36
⊕	HRB09-12	2.74	181.10



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Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B3



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

LEGEND

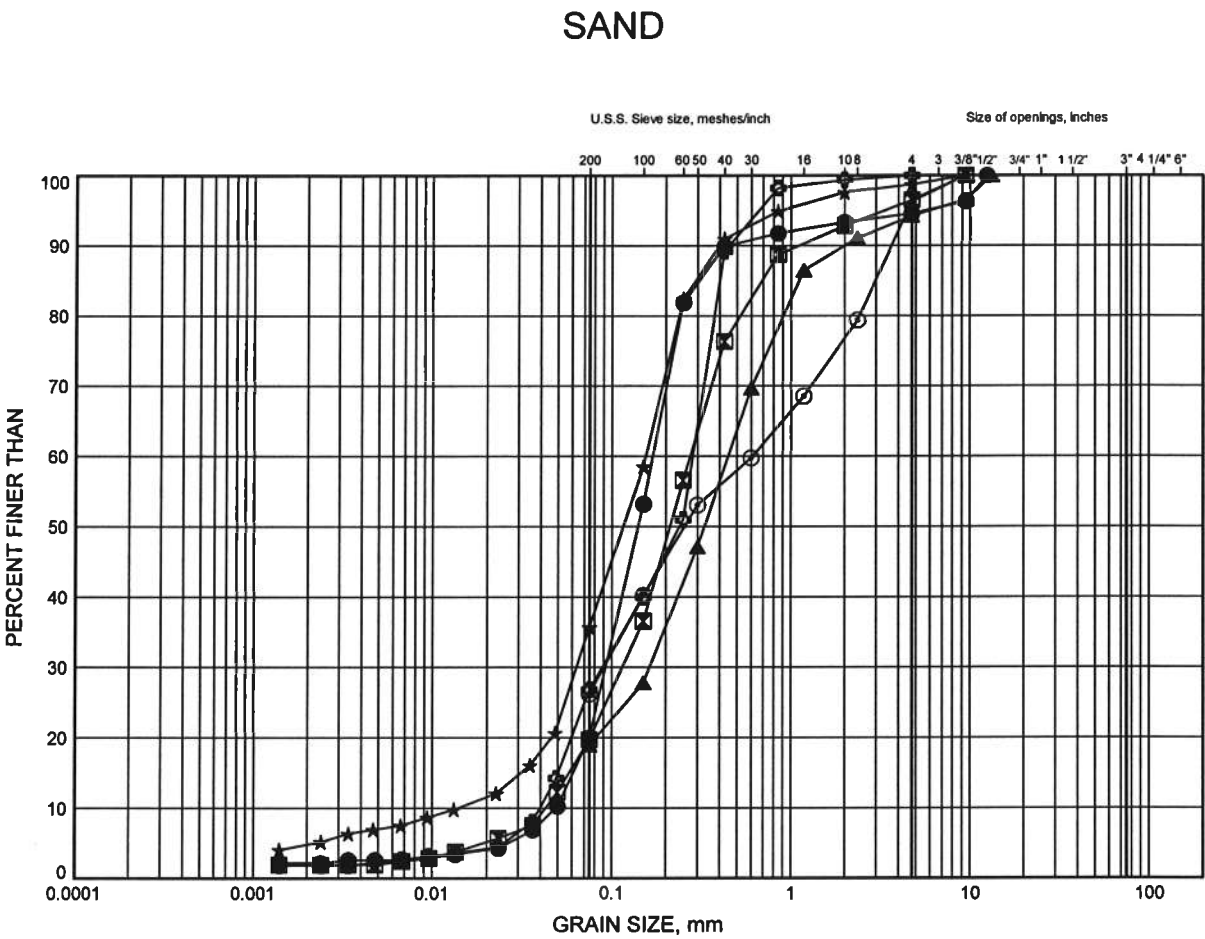
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-17	1.83	179.91
⊠	HRB09-21	1.07	180.43
▲	HRB09-21	2.59	178.90
★	HRB09-23	2.59	178.15
⊙	HRB09-23	4.75	175.99
⊕	HRB09-24	3.35	178.24



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Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B4



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-27	0.70	186.60
⊠	HRB09-34	1.04	190.44
▲	HRB10-01	1.50	185.20
★	HRB10-02	0.90	182.60
⊙	HRB10-02	3.35	180.15
⊕	HRB10-03	0.30	186.00

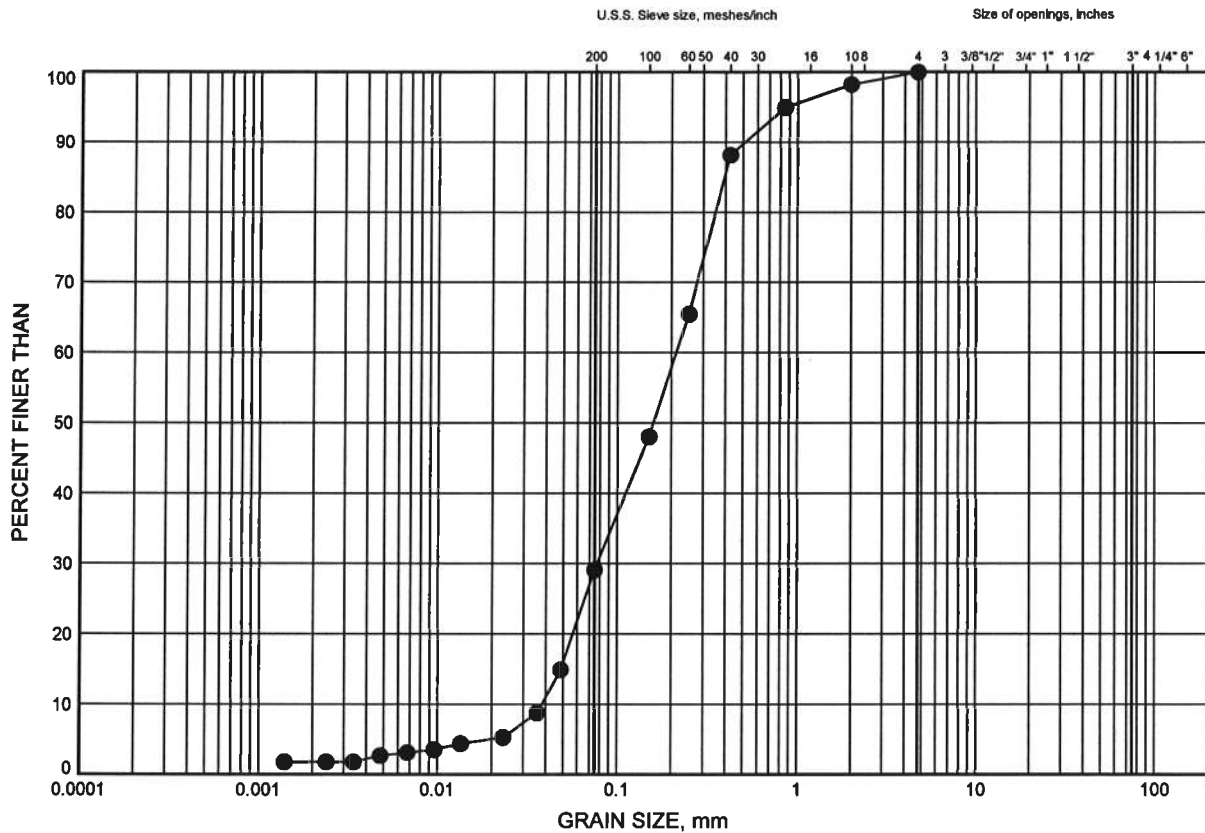


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Hwy 69 Four-Laning North of Hwy 529 GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND



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

LEGEND

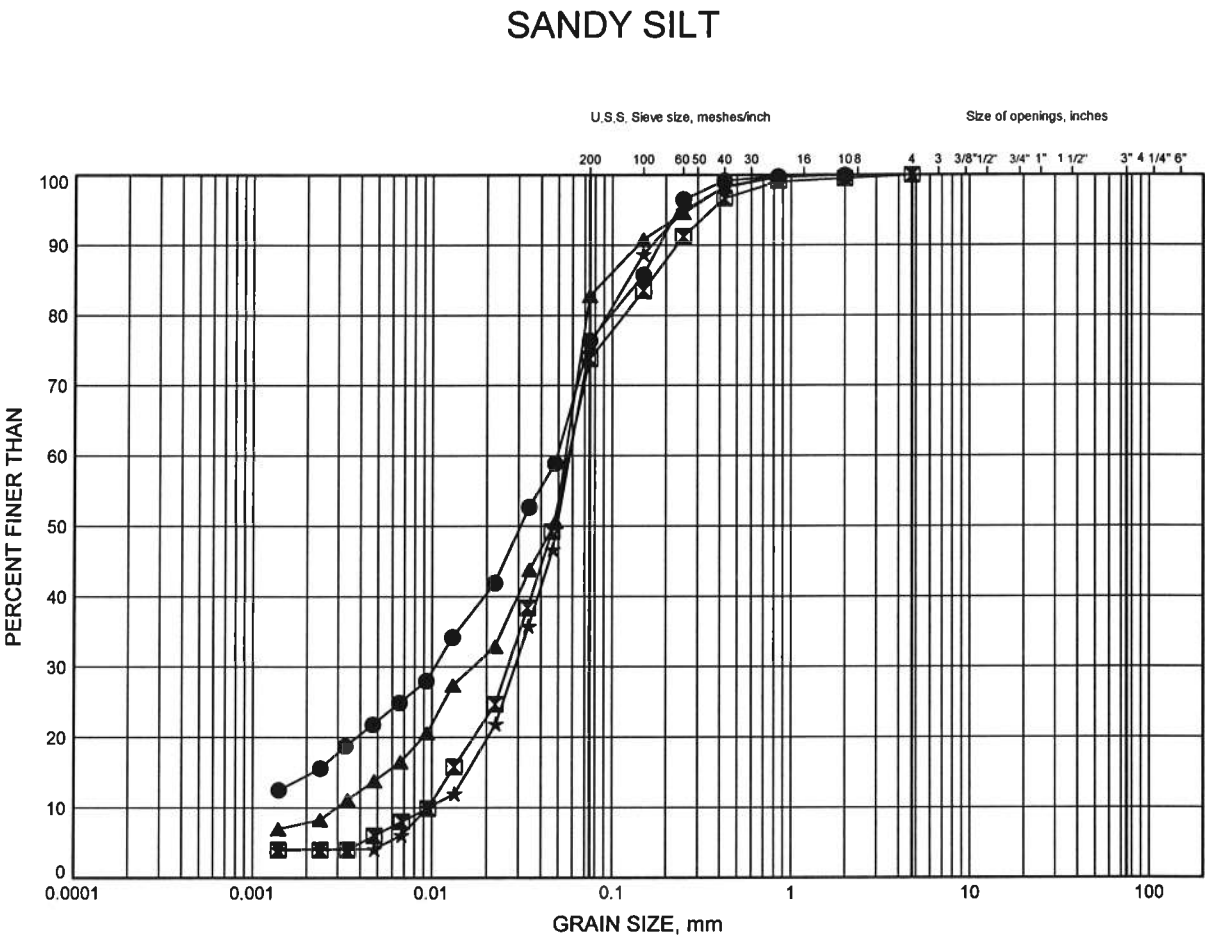
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB10-03	2.74	183.56



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Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B6



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-A	0.91	188.99
⊠	BH10-B	5.18	184.82
▲	BH10-C	0.91	189.19
★	BH10-D	3.35	185.75

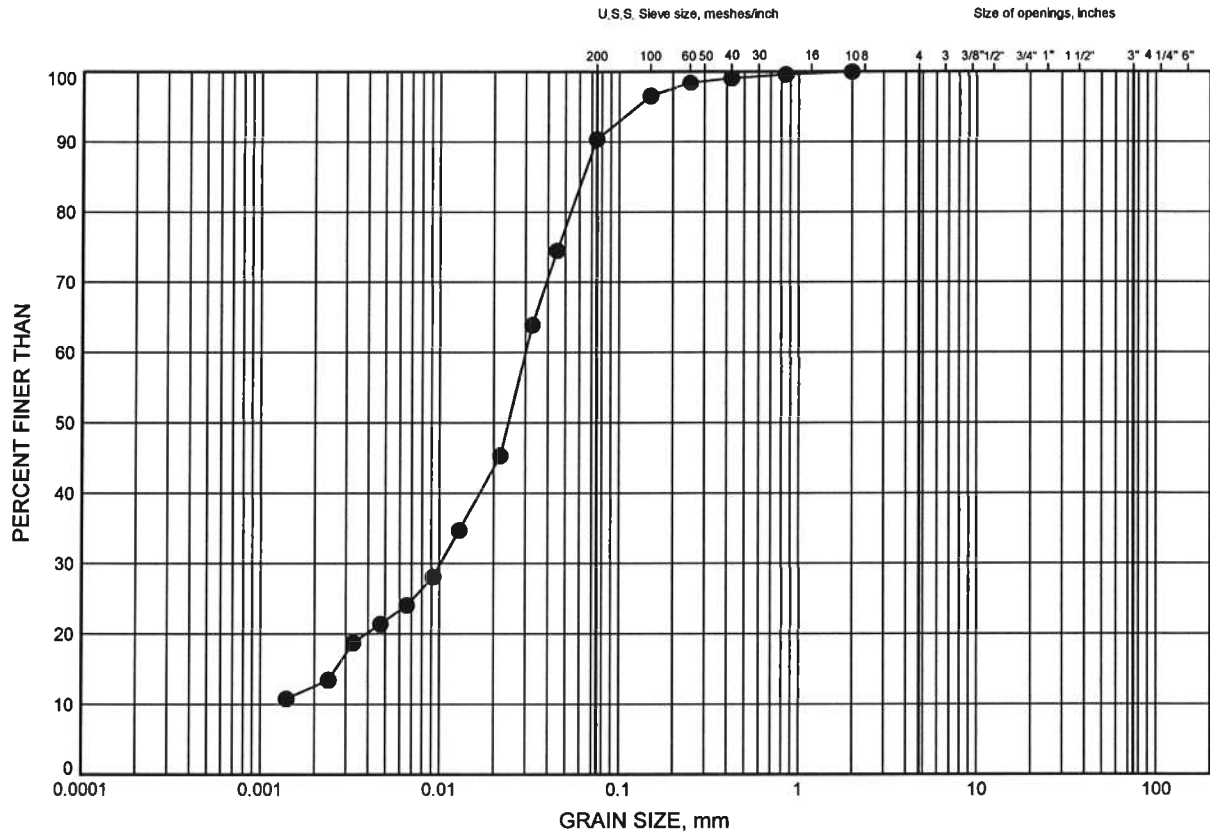


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Hwy 69 Four-Laning North of Hwy 529 GRAIN SIZE DISTRIBUTION

FIGURE B7

SILT



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

LEGEND

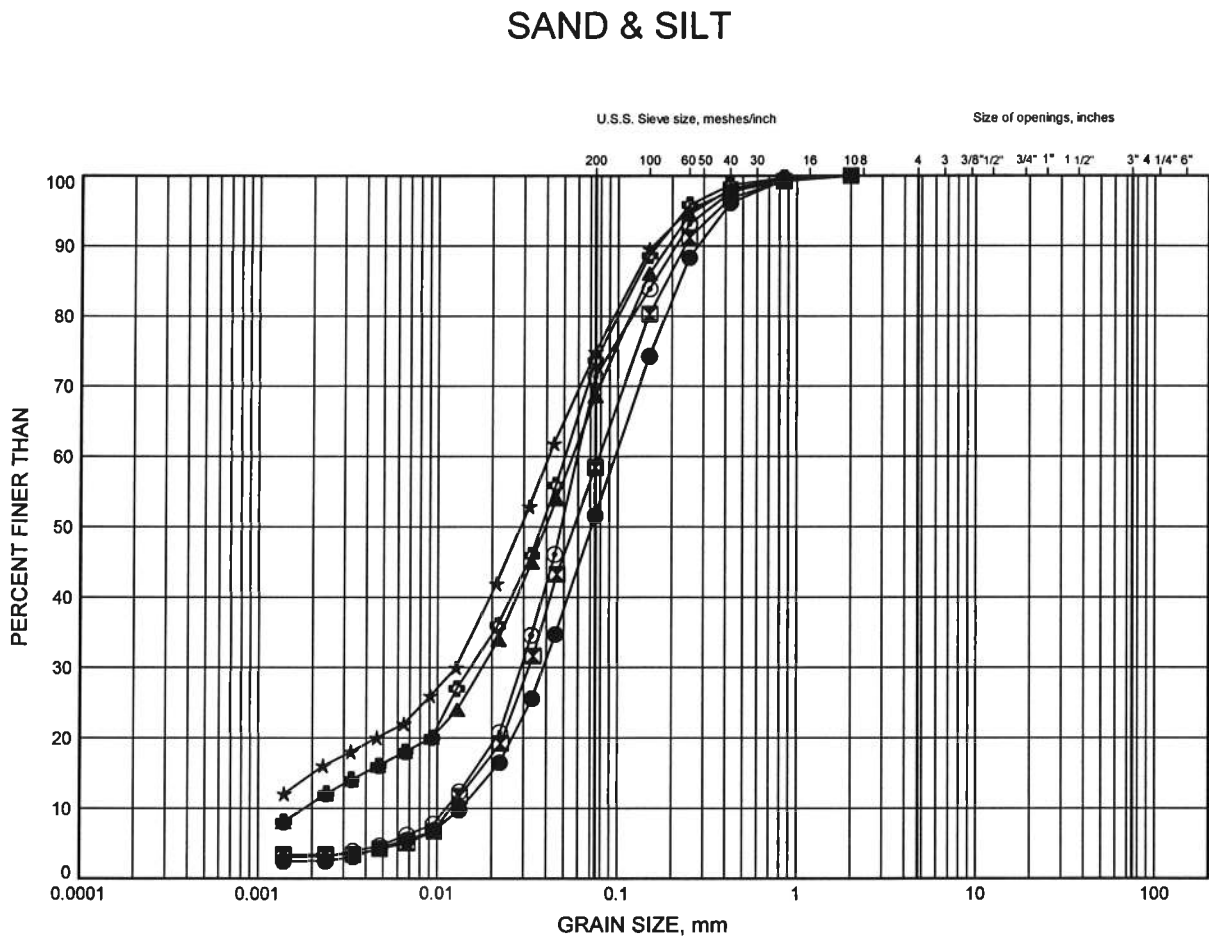
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-01	1.83	187.55



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Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B8



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

LEGEND

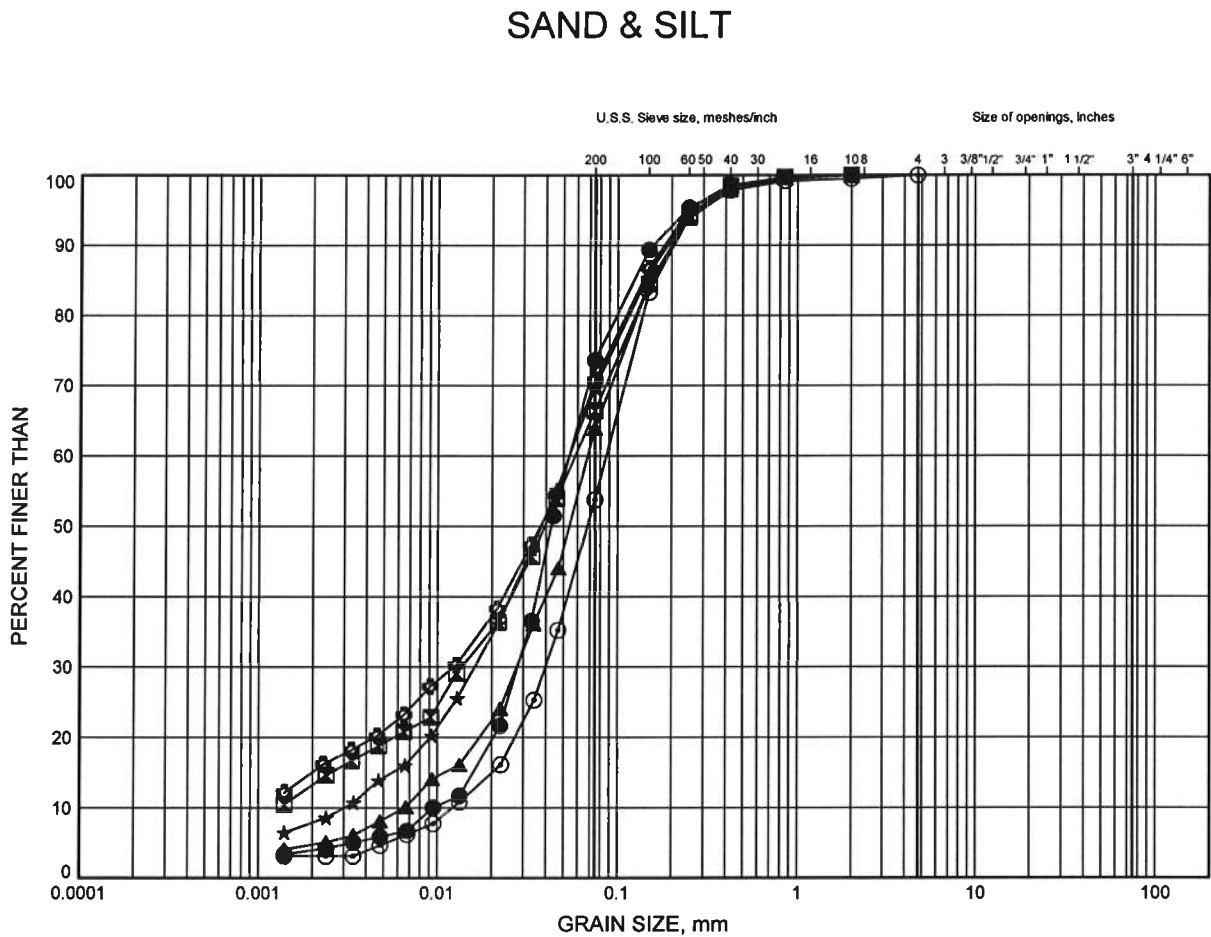
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-01	4.88	184.50
⊠	HRB09-02	4.88	184.82
▲	HRB09-03	1.83	188.30
★	HRB09-04	1.07	189.00
⊙	HRB09-04	4.88	185.19
⊕	HRB09-05	1.83	188.23



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Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B9



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-05	4.88	185.19
⊠	HRB09-06	1.07	189.00
▲	HRB09-06	2.29	187.78
★	HRB09-07	1.83	188.57
⊙	HRB09-07	3.35	187.04
⊕	HRB09-08	1.07	189.29

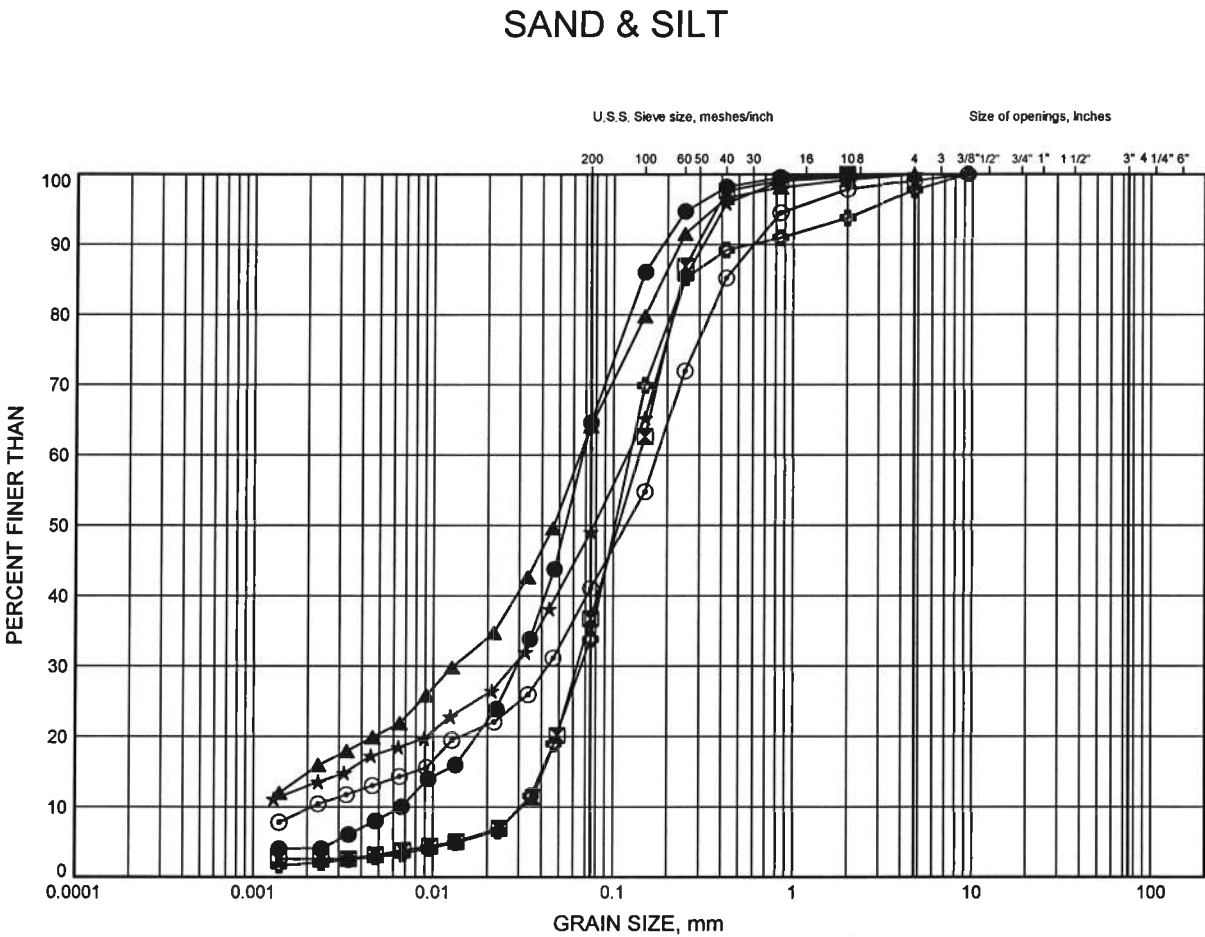


THURBER

W.P.# 5076-06-00
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Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B10



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-08	2.59	187.77
⊠	HRB09-09	0.91	184.77
▲	HRB09-12	1.52	182.32
★	HRB09-13	0.91	182.79
⊙	HRB09-14	0.91	181.52
⊕	HRB09-29	0.99	185.32



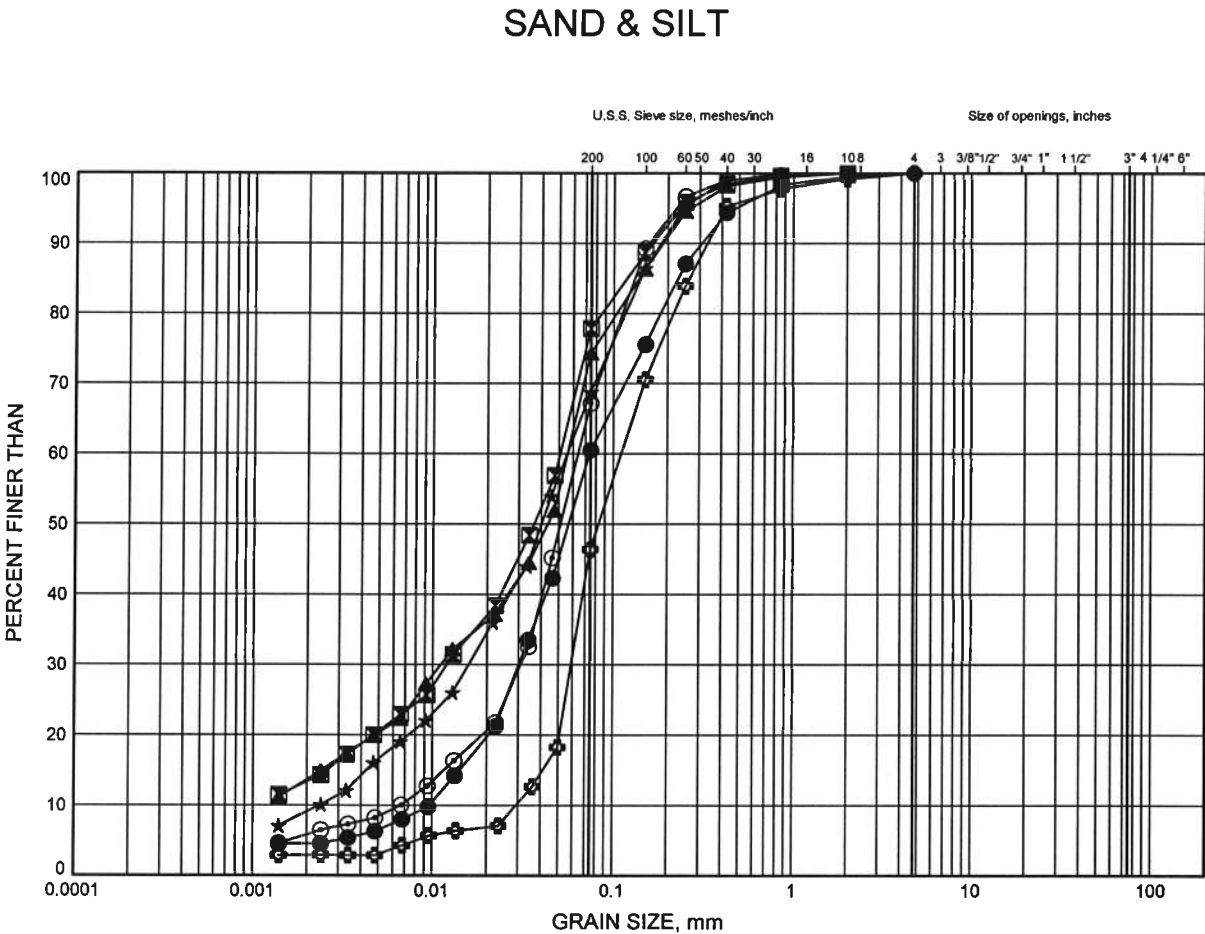
THURBER

GRAIN SIZE DISTRIBUTION - THURBER 6121(HRB).GPJ 6/11/10

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Prepared By .AN.....
Checked By .LRB.....

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B11



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

LEGEND

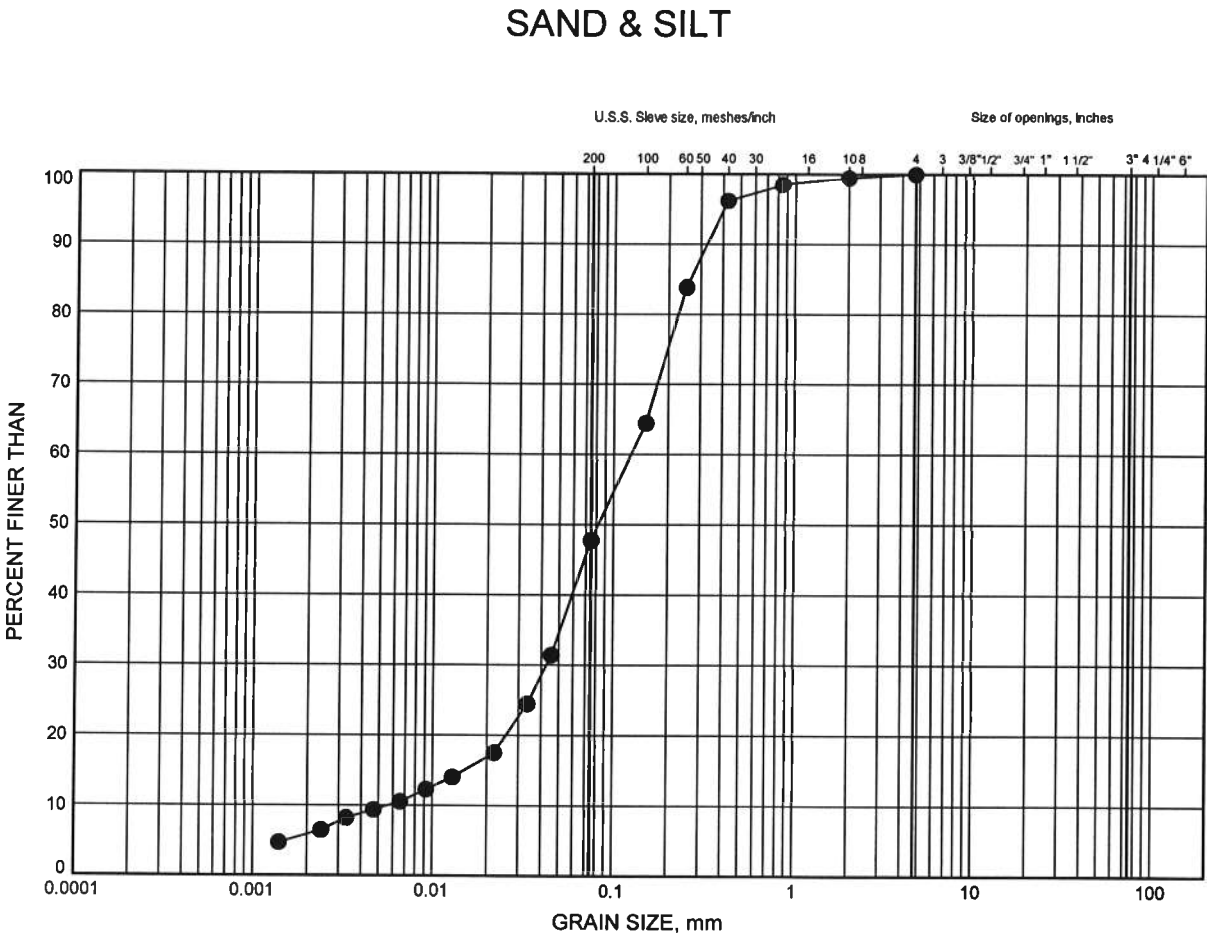
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-A	5.18	184.72
⊠	BH10-B	1.52	188.48
▲	BH10-D	0.30	188.80
★	HRB09-33	1.07	189.37
⊙	HRB09-33	3.35	187.08
⊕	HRB10-04	0.91	181.79



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Prepared By AN
Checked By LRB

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B12



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB10-05	0.28	183.72

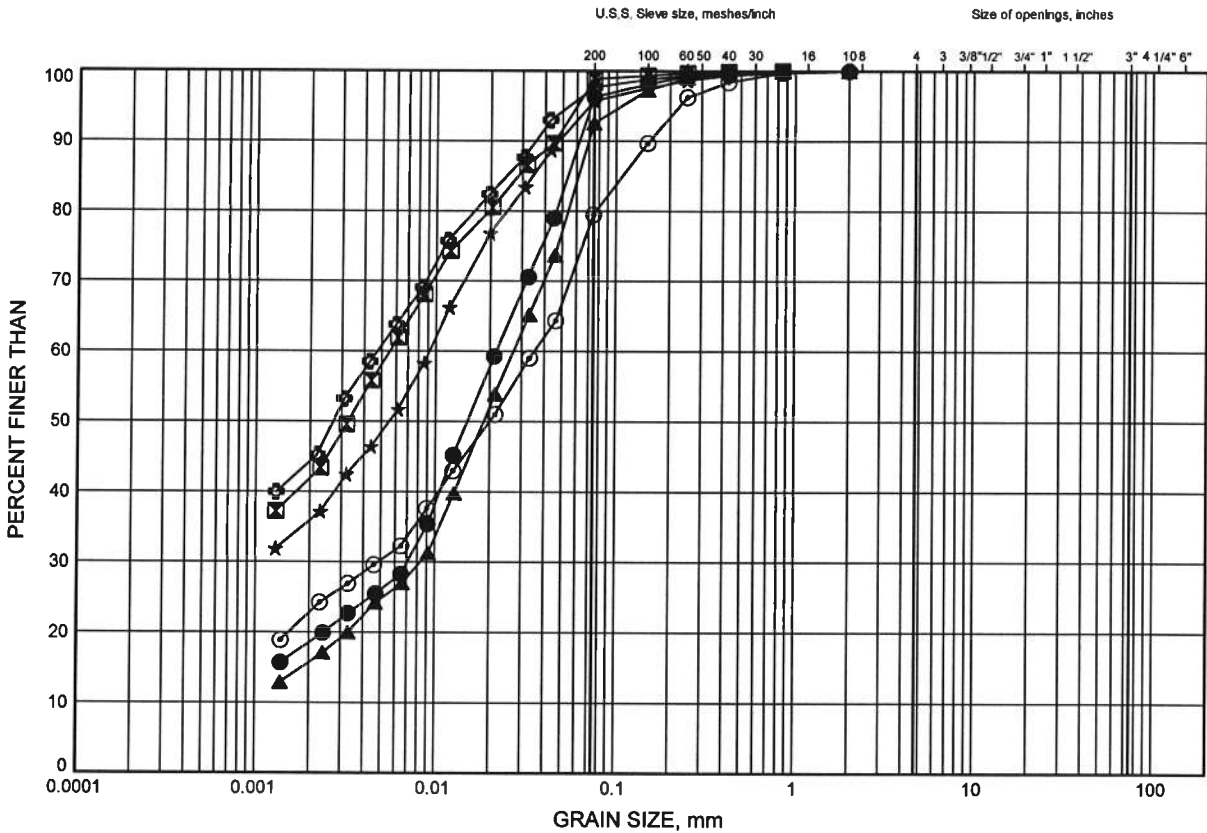


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Prepared By AN
Checked By LRB

Hwy 69 Four-Laning North of Hwy 529 GRAIN SIZE DISTRIBUTION

FIGURE B13

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-A	3.35	186.55
⊠	BH10-B	3.35	186.65
▲	BH10-C	3.96	186.14
★	HRB09-01	3.35	186.03
⊙	HRB09-02	1.83	187.87
⊕	HRB09-02	3.35	186.35

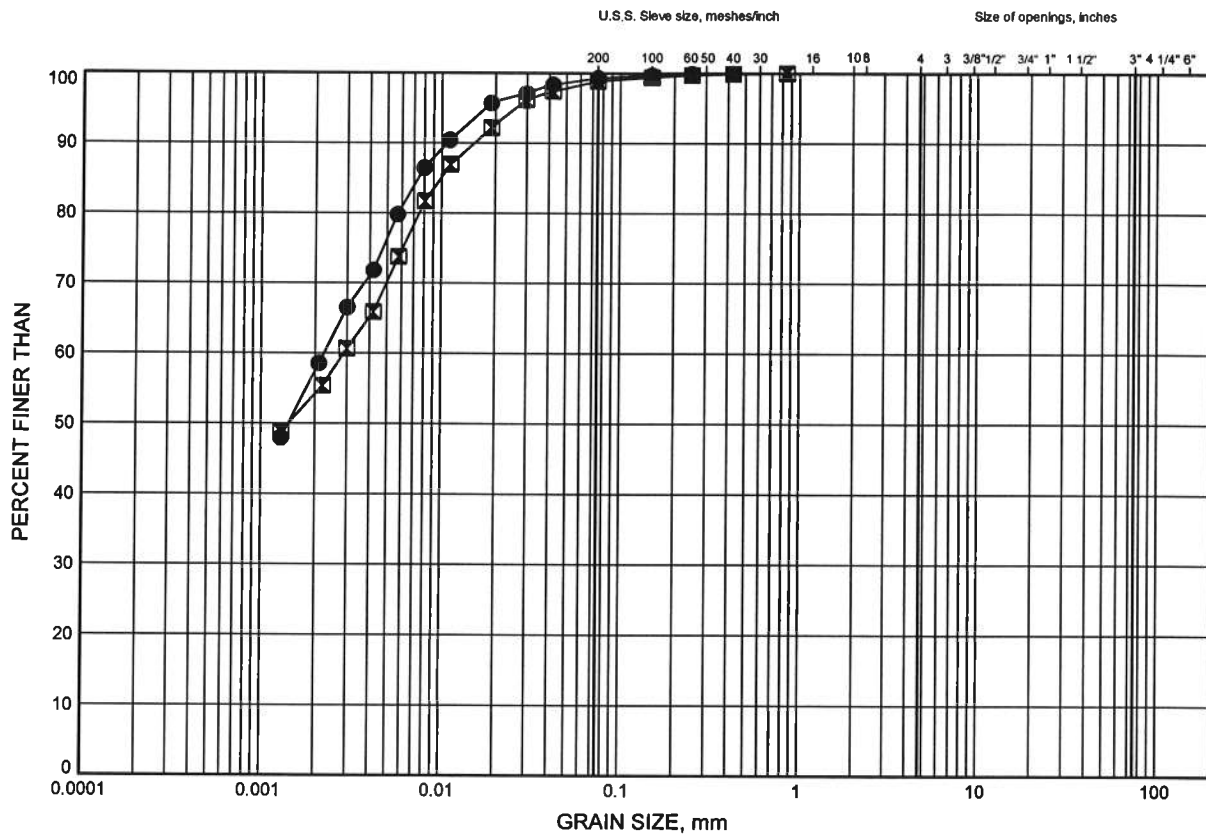


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Hwy 69 Four-Laning North of Hwy 529 GRAIN SIZE DISTRIBUTION

FIGURE B14

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-03	3.35	186.78
■	HRB09-05	3.35	186.71

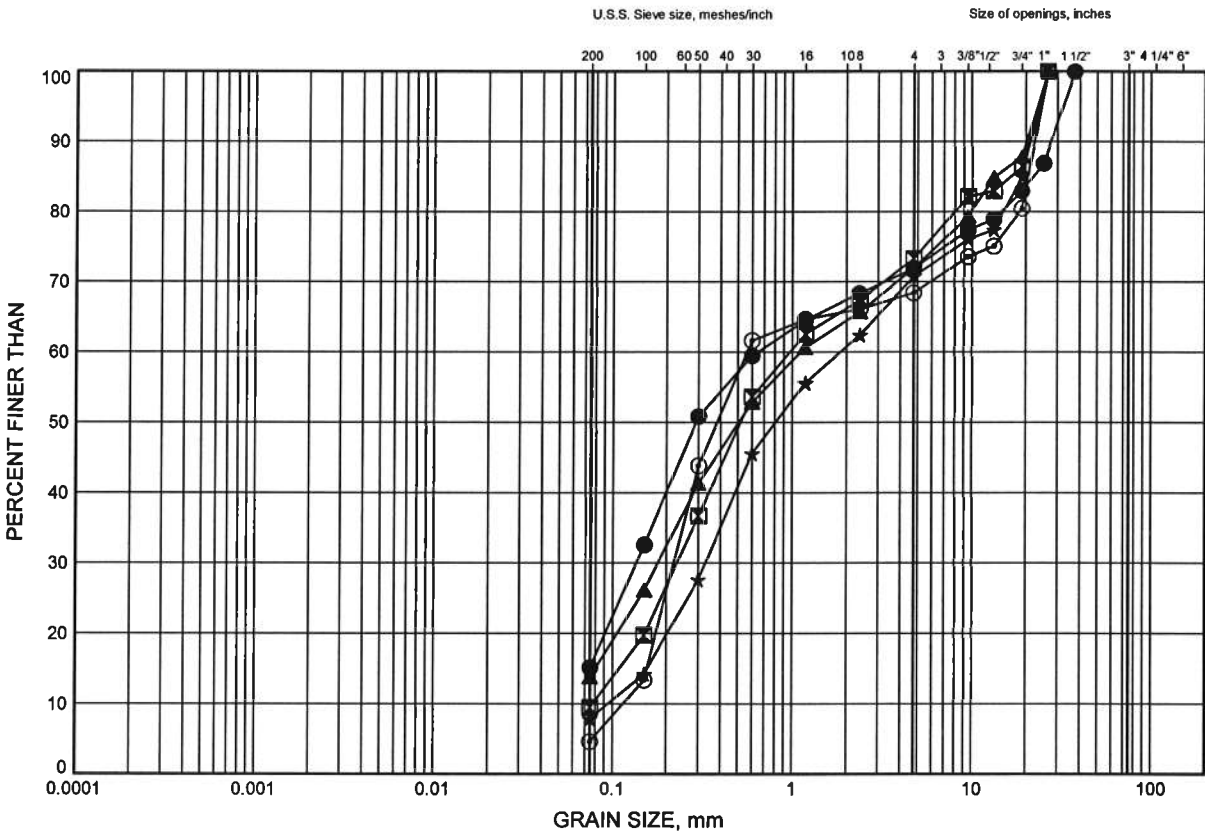


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Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B15

GRAVELLY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-17	3.35	178.39
⊠	HRB09-20	1.83	180.47
▲	HRB09-20	3.29	179.01
★	HRB09-22	1.83	179.89
⊙	HRB09-24	1.07	180.52



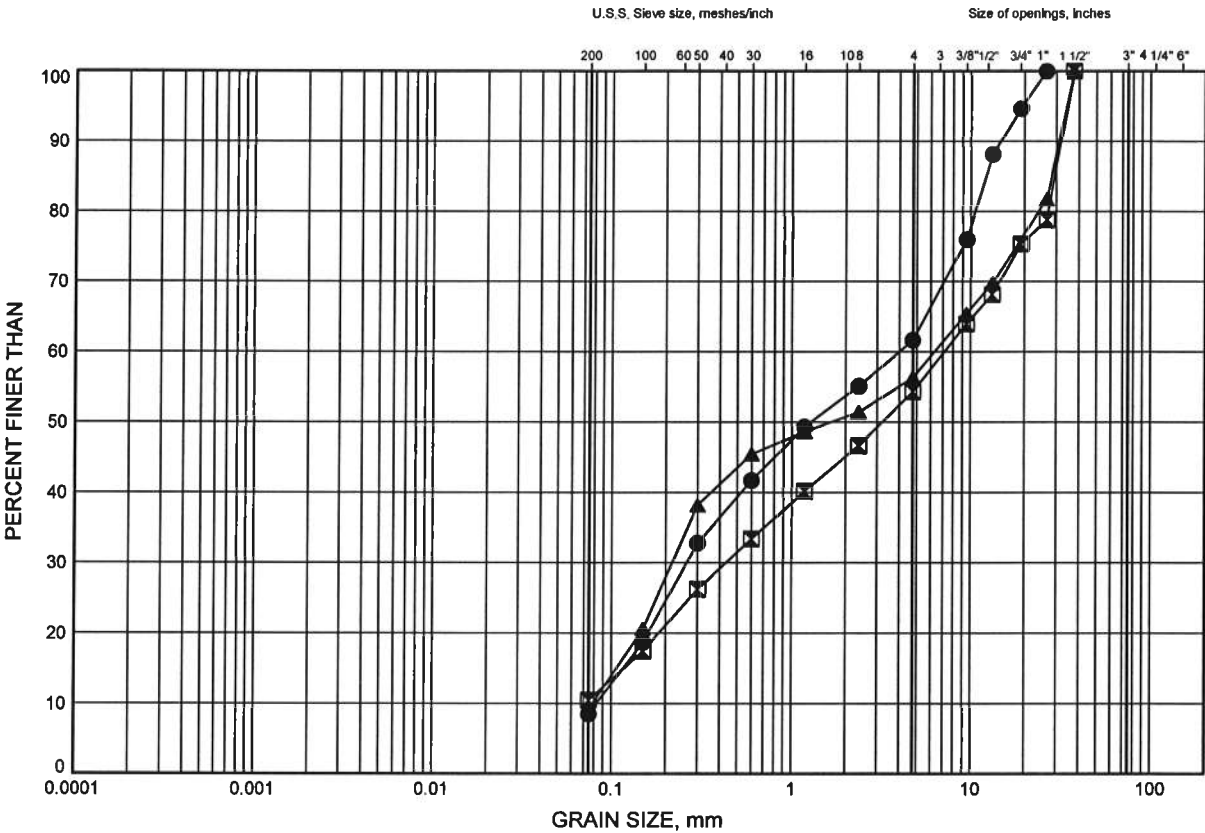
GRAIN SIZE DISTRIBUTION - THURBER 6121(HRB),GPJ 6/11/10

W.P.# 5076-06-00
Prepared By AN
Checked By LRB

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B16

SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HRB09-18	1.07	181.83
⊠	HRB09-18	2.59	180.31
▲	HRB09-19	1.83	179.38



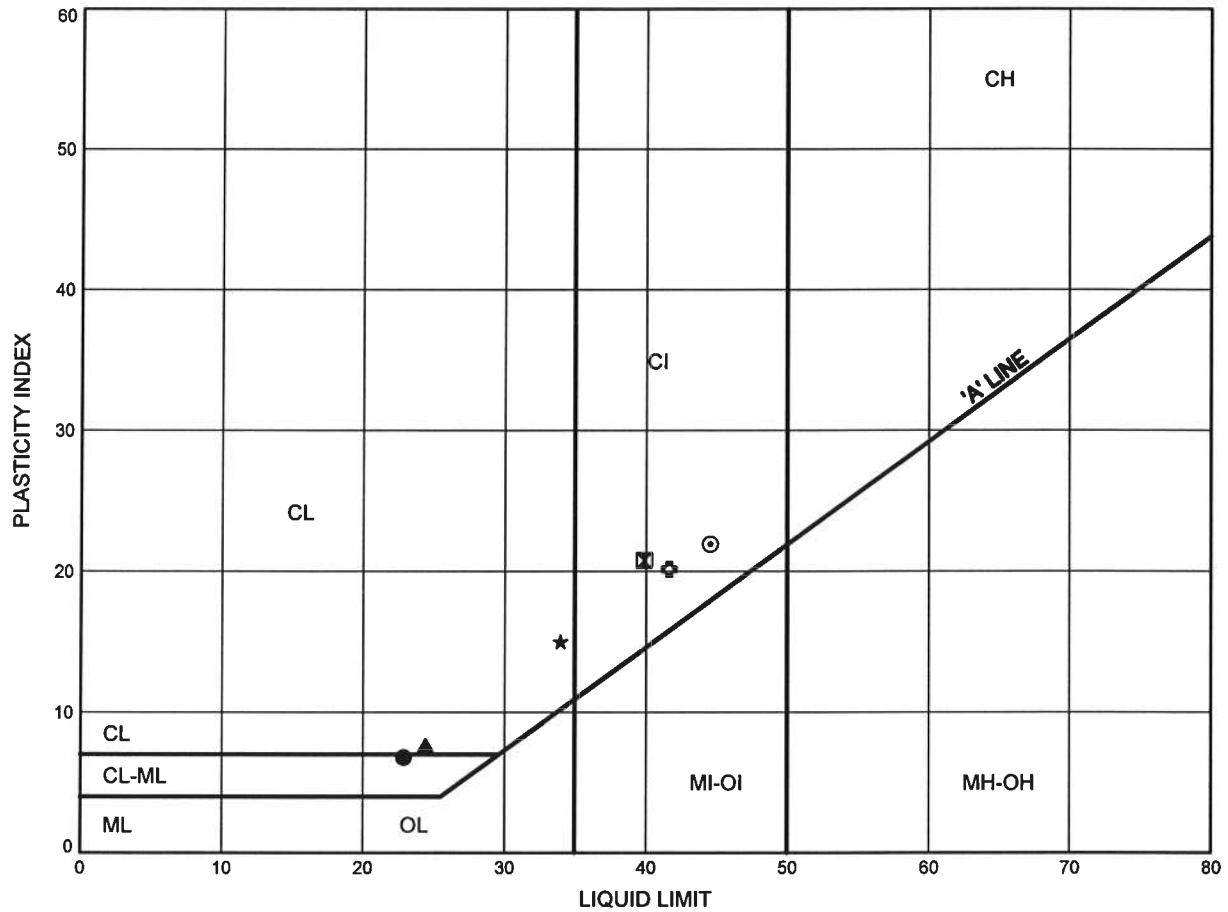
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W.P.# .5076-06-00.....
Prepared By .AN.....
Checked By .LRB.....

Hwy 69 Four-Laning North of Hwy 529
ATTERBERG LIMITS TEST RESULTS

FIGURE B17

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH10-A	3.35	186.55
⊠	BH10-B	3.35	186.65
▲	HRB09-01	3.35	186.03
★	HRB09-02	3.35	186.35
⊙	HRB09-03	3.35	186.78
⊕	HRB09-05	3.35	186.71

Date June 2010

Project 5076-06-00



Prep'd AN

Chkd. LRB

Appendix C

Record of Borehole Sheets from Previous Investigation

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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


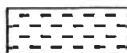



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

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

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

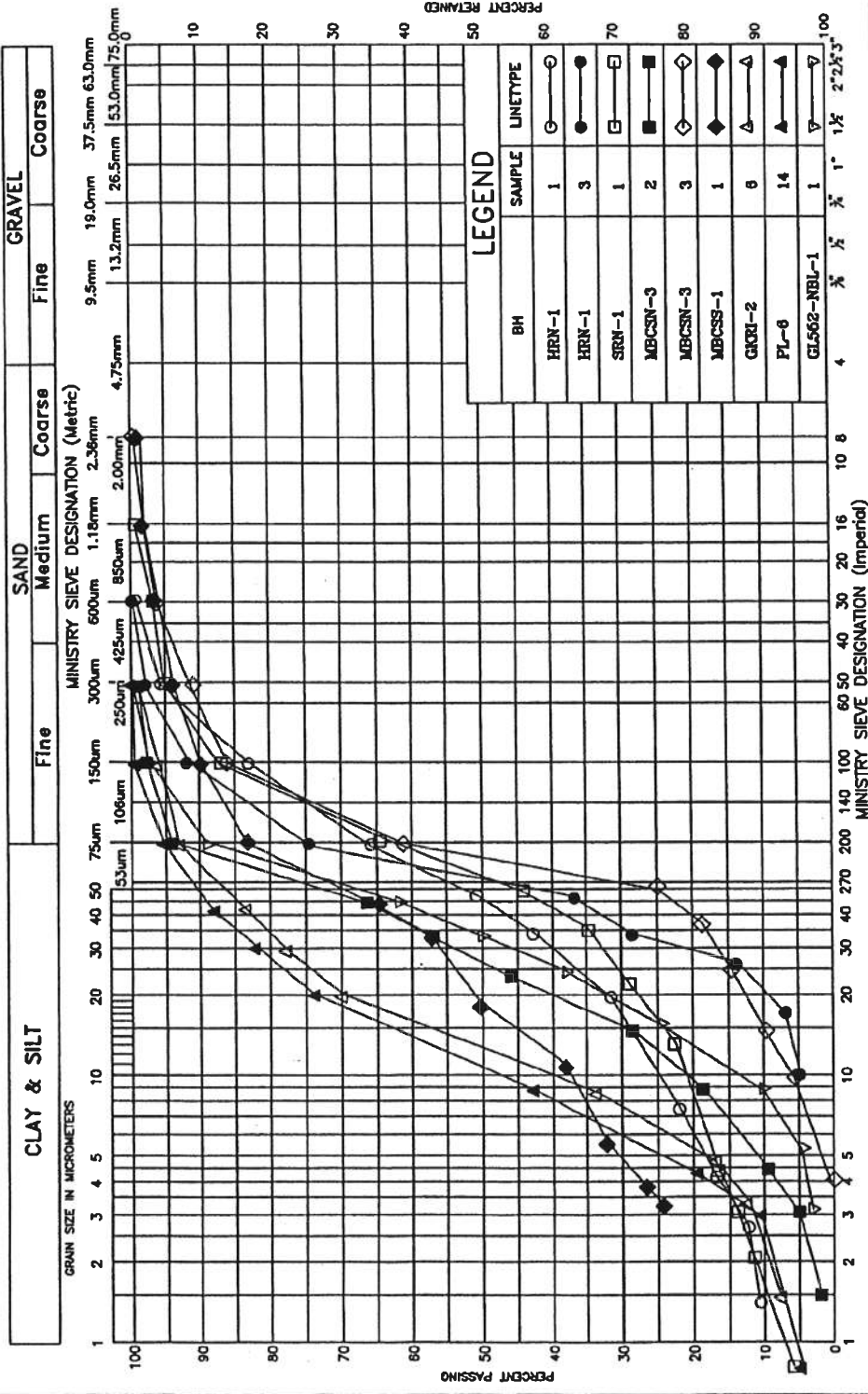
TERMS	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered 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.

RECORD OF BOREHOLE No HRN-1 1 OF 1 METRIC												
G.W.P. 5377-02-00		LOCATION Hwy 69, Harris River NBL Co-ords: 5081257 N, 231006 E		ORIGINATED BY SM								
DIST 54 HWY 69		BOREHOLE TYPE Continuous Hollow Stem Auger and HQ Rock Coring		COMPILED BY H.G.								
DATUM Geodetic		DATE 2005.02.12 - 2005.02.12		CHECKED BY H.G.								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			W VALUES	SHEAR STRENGTH kPa				
190.6	Ground Surface											
190.4 0.2	150 mm loosefill Sandy silt, brown, moist to wet, compact, some clay		1	SS	13							0 34 55 11
			2	SS	14							
			3	SS	22							0 25 (75)
185.1 5.5	Auger refusal. Coring started. Granitic GNEISS Slightly weathered, pinkish grey, coarse grained, strong Good to excellent quality Some fractures: Planar, wide spaced, at 70 degrees to vertical, smooth, no filling		4	NQRC	Rec 100%							RQD = 100%, 3 fractures in 1.5 m
			5	NQRC	Rec 100%							RQD = 83%, 3 fractures in 1.5 m
182.1 8.5	End of Borehole Groundwater not encountered at time of drilling. Groundwater encountered at 6.25 m on March 24, 2005. Groundwater measured at 6.23 m on April 6, 2005.											

ONTARIO MOT 07 HARRIS RIVER NBL GPJ ONTARIO MOT.GDT 05/08/23

+ 3, x 3: Numbers refer to Sensitivity 0 3% STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



Appendix D

Foundation Comparison

COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Footing on Native Soil	Footings on Bedrock	Driven Piles	Drilled Piles
<p>Advantages:</p> <ul style="list-style-type: none"> i. Economical to install. ii. Ease of construction <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Soil conditions encountered at this site are considered unsuitable. ii. Not suitable for integral abutment design. <p>NOT RECOMMENDED</p>	<p>Advantages:</p> <ul style="list-style-type: none"> i. High values of geotechnical resistance are available on the bedrock. ii. Lower cost than deep foundations <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Stepped footing may be required ii. High cost of excavation to bedrock. iii. Mass concrete fill required to create a level founding surface. iv. Control of groundwater will be required v. Not suitable for integral abutment design. <p>NOT RECOMMENDED</p>	<p>Advantages:</p> <ul style="list-style-type: none"> i. High geotechnical resistance available by driving piles to achieve resistance in the bedrock. ii. Permits integral abutment design. iii. Readily installed. iv. Installation less influenced by weather and groundwater than spread footings. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Rock excavation may be required in order to install the piles to minimum length and to accommodate an integral abutment. ii. Higher unit cost compared to footings <p>FEASIBLE AT ABUTMENTS</p>	<p>Advantages:</p> <ul style="list-style-type: none"> i. High geotechnical resistance available for units founded on bedrock. ii. Permits integral abutment design. iii. Installation less influenced by weather and groundwater than spread footings. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher unit cost compared to other foundation options such as footings or driven piles. ii. Difficulties in obtaining seal below the liner to pour concrete in dry conditions iii. Potential difficulty in unwatering, cleaning and inspecting bases. <p>RECOMMENDED AT ABUTMENTS</p>

Appendix E

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

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

- OPSS 902 as modified by SP 902S01 (June 2006).
- OPSS 572
- OPSD 3101.150,
- OPSD 3101.200.
- SP 110F13 Amendment to OPSS 1010, March 1993.
- SP 105S10.

2. Suggested text for a NSSP on Dewatering

Excavations at the abutments will penetrate below the groundwater level.

The soils overlying the bedrock at this site are predominantly cohesionless and will be readily disturbed by unbalanced water heads or by flow of water.

The Contractor shall design, install and operate systems that shall:

1. Unwater the excavations
 2. Control the flow of groundwater and surface water into the excavations
 3. Prevent the disturbance of the base of the excavation
 4. Prevent the sloughing of soil into the excavations.
1. The selection and design of suitable unwatering and shoring systems shall remain the responsibility of the Contractor.

3. Suggested text for pile driving

Steel H-piles driven at this site must be founded on bedrock. All driven piles shall be fitted with cast steel, H-section rock points from an approved manufacturer such as Titus Steel (Standard H-point) or approved equivalent. Piles placed in rock sockets shall not be fitted with rock points.

NSP 98 Northeastern

REQUIREMENTS FOR BLASTING

1. GENERAL

- 1.1** The Contractor shall comply with OPSS 120 unless otherwise noted in the Contract.

Highway 69 Four Laning: South junction of Hwy 529, northerly 15 Km
Harris River Bridge – NBL

- 1.2 For the purpose of work related to blasting, a Blasting Consultant is defined as: A Professional Engineer licensed to practice in the Province of Ontario with a minimum of five years (5) experience related to blasting.

The Blasting Consultant shall be retained by the Contractor and shall be independent of the Contractor and any subcontractor doing blasting work. The Blasting Consultant shall be required to complete the specified monitoring of vibration levels and provide a report detailing the vibration levels and copies of the recorded ground vibration documents to the Contractor and the Contract Administrator immediately following each blast and prior to the next blast.

- 1.3 All blasting shall be designed and carried out in a manner, such that no damage occurs to the buildings or equipment.
- 1.4 Under no circumstances will the Contractor blast within the vicinity of any TransCanada Pipelines, Union Gas Pipelines, Ontario Hydro lines and Bell Fibre optics lines without a representative from TransCanada Pipelines, Ontario Hydro or Bell Canada on site.

The Contractor shall notify the following appropriate representative 72 hours in advance of blasting.

* Fill - in as appropriate for the project

Hydro One Networks Inc.
45 Sarjeant Drive
Box 6700
Barrie, ON
L4M 5N5

Attn: Arthur Conlon
Telephone : (888) 238-2398
Fax: (705) 746-7293

Bell Canada
9 High Street
Huntsville, ON
P1H 1P2

Attn: Timothy Beachy
Telephone: (705) 789-9638
Fax: (705) 789-6223

The Contractor shall notify the following appropriate representative 10 days in advance of blasting.

* Fill - in as appropriate for the project

TransCanada Pipelines Ltd.
801 Seventh Avenue S.W.
P.O. Box 2535, Station M
Calgary, Alberta

Attn: Elio Ramos
Telephone: (403) 261-8256
and Ron Marsh
(705) 840-7454

T2P 2N6

Union Gas Limited
P.O. Box 3040
36 Charles Street East
North Bay, ON
P1B 8K7

Attn: Jeff Peroff
Telephone: (705) 475-7923
Fax: (866) 252-2012



2.0 DESIGN AND SUBMISSION REQUIREMENTS

2.1 Section 120.04.02 b) iii is deleted and replaced with:

A letter signed by the Contractor certifying that a pre-blast survey has been carried out in accordance with the Pre-Blast Survey subsection. A copy of the pre-blast survey shall be provided to the Contract Administrator.

3.0 EQUIPMENT

3.1 Section 120.06.02 is amended by the addition of the following:

The transducer used to measure ground vibration levels shall be coupled to the ground by either pinning or burying.

4.0 CONSTRUCTION

4.1 The last bullet (c) of Section 120.07.03 is deleted and replaced with the following:

- (c) Clear quality 35 mm photographs and/or DVD videos, and written report necessary for proper recording of areas of concern and condition of the property. Photographs and DVDs shall be clearly labeled as to location.

4.2 Section 120.07.03 is amended by the addition of the following:

The contractor will be supplied with a "Permission to Enter For Pre-Blast and Post-Blast Inspection" form that the contractor shall use to record the permission to carry out an inspection.

4.3 Section 120.07.05.02 is amended by the addition of the following:

TransCanada Pipelines has requirements in addition to Table 1. When providing vibration monitoring within 100m of the TransCanada pipeline, the Contractor shall ensure that the following vibration limits in the vicinity of the pipeline are measured and are met:

- ☐ Vibrations are to be controlled to a maximum peak particle velocity of 50mm/s above the pipeline.
- ☐ Should any two consecutive seismographic readings fall between 50 and 80mm/s the pipeline is to be exposed and monitored to ensure that a third reading taken on the pipe falls below 50mm/s.
- ☐ should any seismographic reading taken below the pipe fall above 80mm/s or taken on the pipe fall above 50mm/s the loading pattern should be adjusted to fall below these limits.
- ☐ Delays shall be designed to prevent double readings.

When blasting is within 100m of the TransCanada pipeline, a TransCanada representative and /or blasting consultant may be present to monitor vibrations and any other effects on the pipeline.

5.0 RESPONSIBILITY

This special provision in no way intends to remove any of the responsibility for a safe blast from the Blasting Contractor.

6.0 BASIS OF PAYMENT

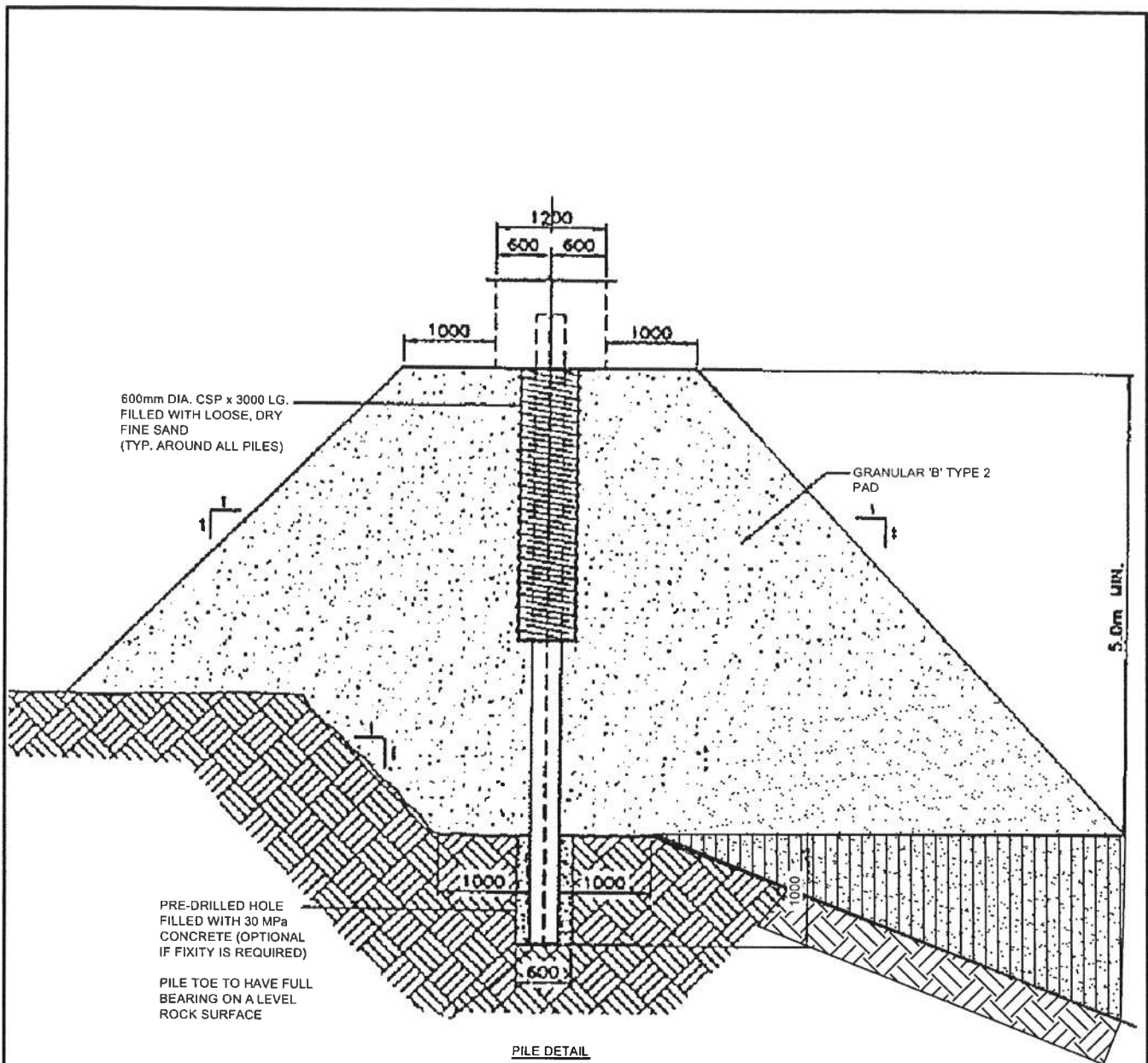
Compensation for the Contractor to provide blast monitoring and schedule his operations in accordance with these requirements, including all equipment, labour and materials, shall be deemed to be included in the contract bid price for the various tender items.

Note to designer:

Confirm with the Contracts Office whether the minimum distance for the Pre-Blast Survey should be increased.

Appendix F

Figure



ENGINEER	AEG
DRAWN	MFA
DATE	FEBRUARY 2010
APPROVED	PKC
SCALE	NTS

FOUNDATION DETAILS FOR INTEGRAL ABUTMENT CONSTRUCTION IN SHALLOW BEDROCK



DWG. NO.

FIGURE 2

Appendix G

Site Photographs



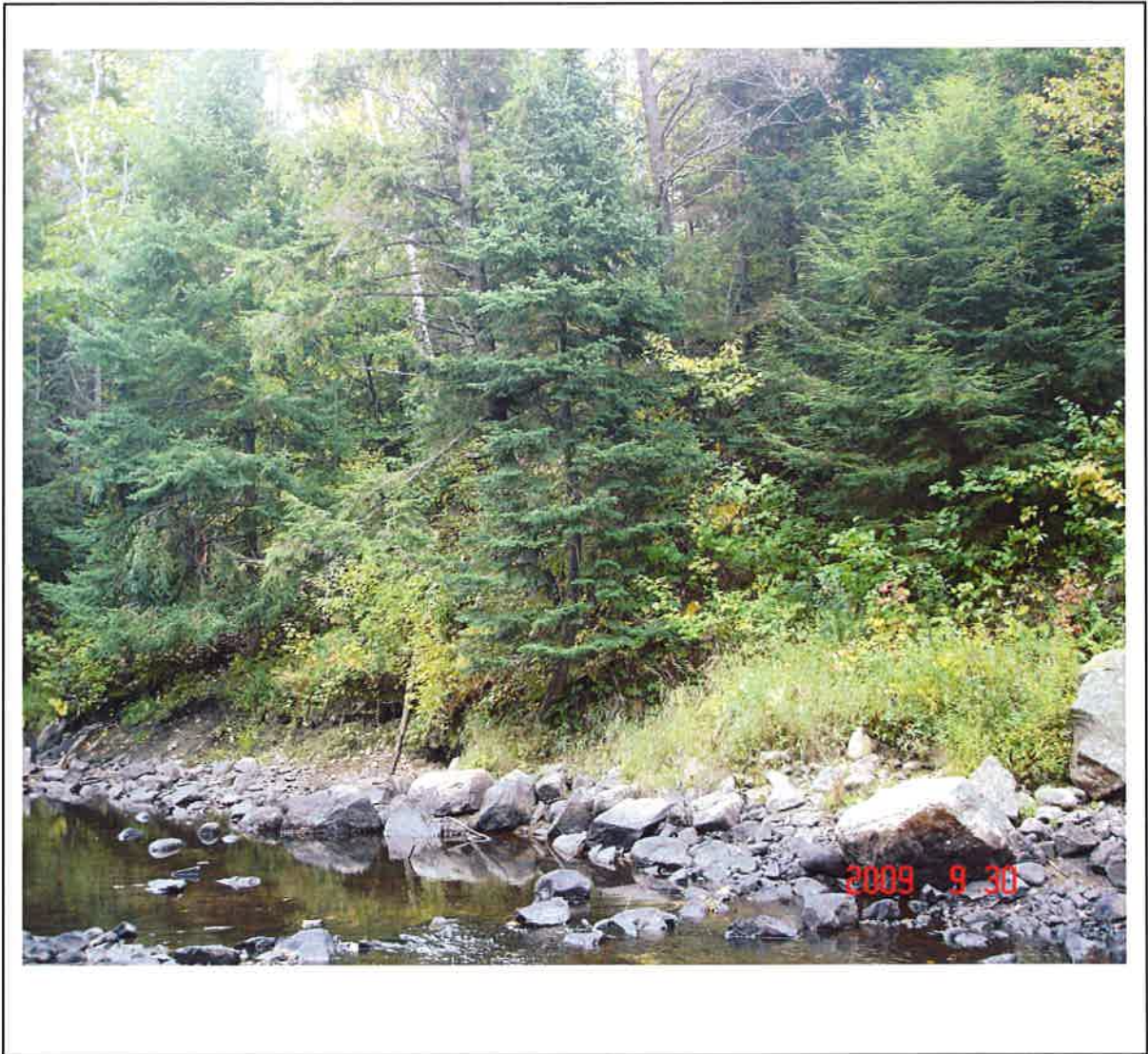
Photograph 1 – Existing conditions of Harris River looking east at site



Photograph 2 – Existing structure at Highway 69 and Harris River crossing looking west



Photograph 3 – South river bank at location of proposed structure.



Photograph 4 – Looking southeast at south river bank at location of proposed structure.



Photograph 5 – Looking northeast at north river bank at location of proposed structure.

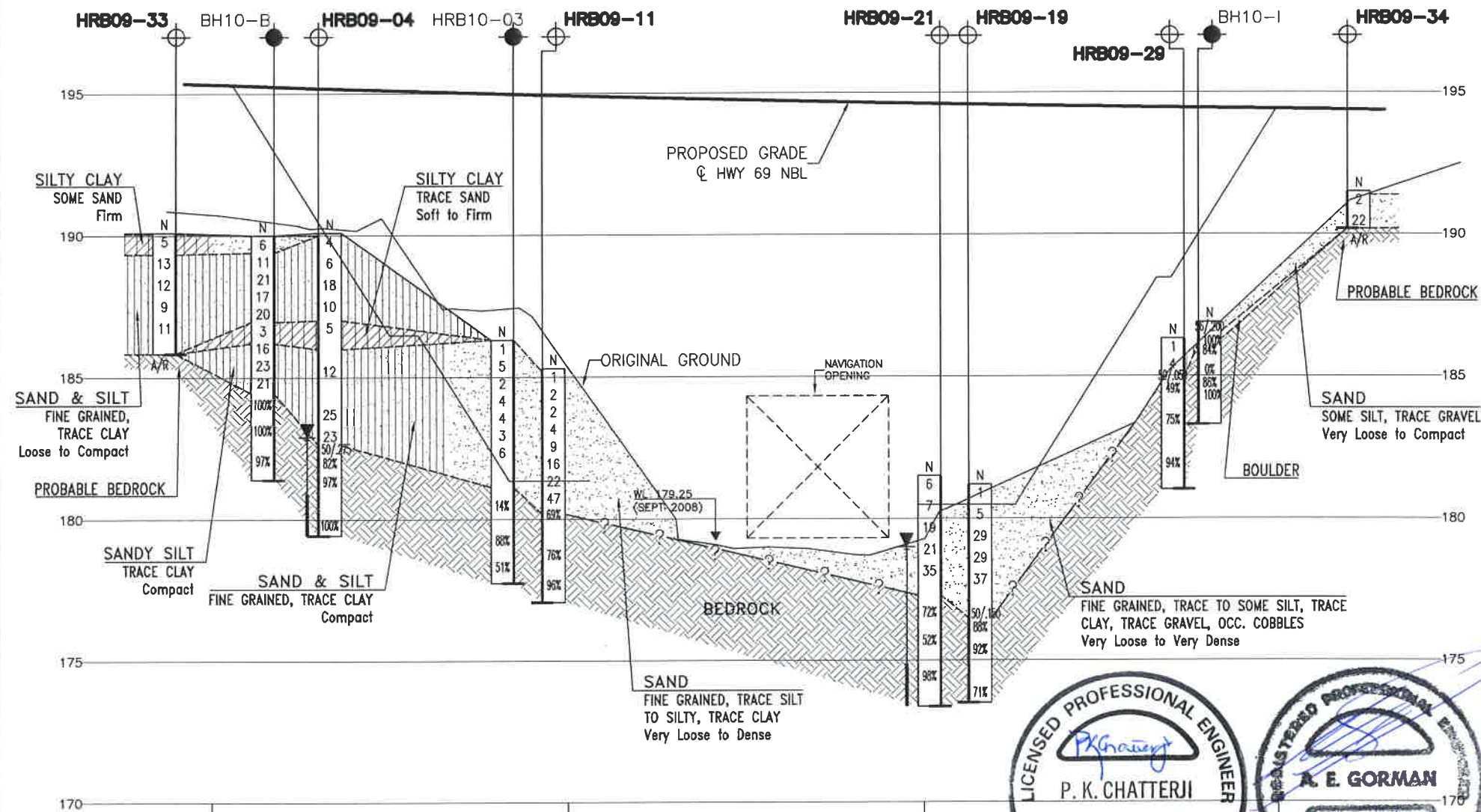
Appendix H

Drawing

Borehole Locations and Soil Strata



0 8 16 24m
SCALE 1:400



11+200 11+225 11+250
PROFILE ALONG CL HIGHWAY 69 NBL

0 8 16 24m HOR 1:400
0 4 8 12m VER 1:200



METRIC

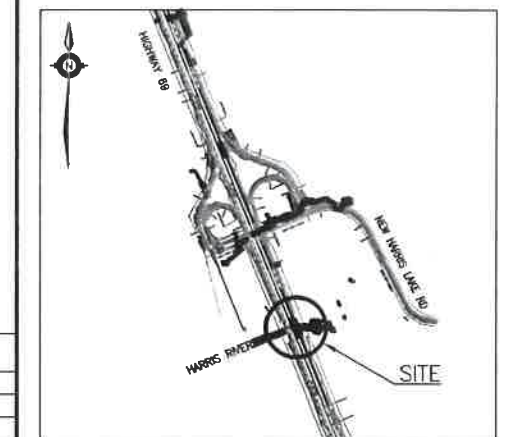
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 69
CONT No
WP No 5200-06-01

HIGHWAY 69 FOUR-LANING
HARRIS RIVER BRIDGE
NORTHBOUND LANES
BOREHOLE LOCATIONS AND SOIL STRATA

MMM GROUP

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN LEGEND

- Borehole (2010 Investigation)
- Borehole (2009 Investigation)
- Cone
- Borehole By Others
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HRB09-01	189.4	5 061 257.6	230 999.8
HRB09-02	189.7	5 061 258.9	230 999.8
HRB09-03	190.1	5 061 257.8	231 003.8
HRB09-04	190.1	5 061 259.0	231 003.7
HRB09-05	190.1	5 061 258.0	231 009.6
HRB09-06	190.1	5 061 259.2	231 009.6
HRB09-07	190.4	5 061 258.1	231 014.3
HRB09-08	190.4	5 061 259.3	231 014.2
HRB09-09	185.7	5 061 273.2	230 993.5
HRB09-10	184.6	5 061 274.8	230 993.4
HRB09-11	185.3	5 061 273.4	230 997.4
HRB09-12	183.8	5 061 274.9	230 997.4
HRB09-13	183.7	5 061 273.6	231 003.3

NOTES

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

GEOCREs No. 41H-86

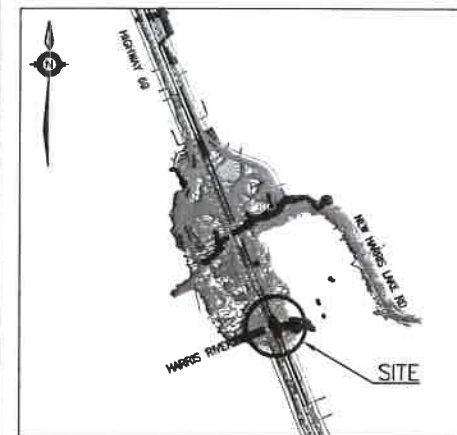
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DRAWN	MFA	CHK PKC	SITE
LOAD	DATE	MAY 2012	
STRUCT	DWG	2	

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

HWY 69
CONT No
WP No 5200-06-01

HIGHWAY 69 FOUR-LANING
HARRIS RIVER BRIDGE
NORTHBOUND LANES
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN LEGEND

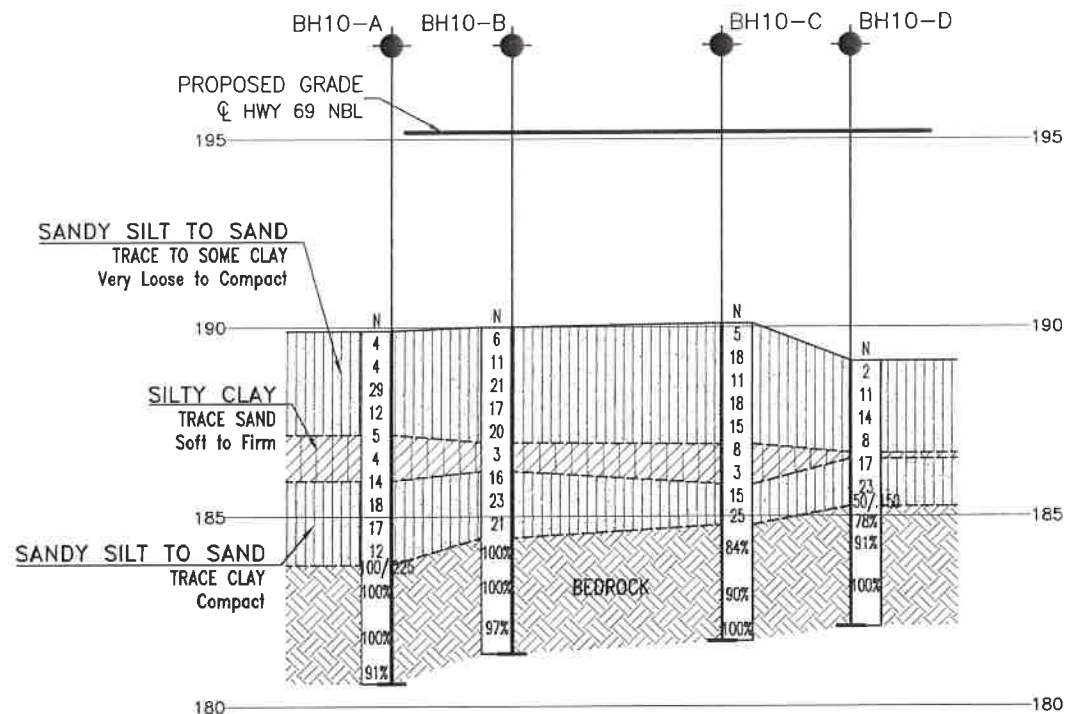
- ◆ Borehole (2010 Investigation)
- ⊕ Borehole (2009 Investigation)
- ◆ Cone
- ◆ Borehole By Others
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HRB09-14	182.4	5 061 275.1	231 003.2
HRB09-15	184.0	5 061 273.8	231 007.9
HRB09-16	183.0	5 061 275.3	231 007.9
HRB09-17	181.7	5 061 301.1	230 982.2
HRB09-18	182.9	5 061 302.6	230 982.2
HRB09-19	181.2	5 061 301.2	230 986.2
HRB09-20	182.3	5 061 302.7	230 986.1
HRB09-21	181.5	5 061 301.4	230 992.0
HRB09-22	181.7	5 061 302.9	230 992.0
HRB09-23	180.7	5 061 301.6	230 996.7
HRB09-24	181.6	5 061 303.1	230 996.6
HRB09-25	188.1	5 061 317.0	230 975.9
HRB09-26	188.7	5 061 318.2	230 975.8
HRB09-27	187.3	5 061 317.1	230 979.8
HRB09-28	187.7	5 061 318.3	230 979.8
HRB09-29	186.3	5 061 317.3	230 985.6
HRB09-30	186.8	5 061 318.5	230 985.6
HRB09-31	185.7	5 061 317.5	230 990.3
HRB09-32	186.1	5 061 318.7	230 990.3
HRB09-33	190.4	5 061 249.2	231 010.6
HRB09-34	191.5	5 061 327.1	230 979.1
HRN-1	190.6	5 061 257.0	231 006.0
HRB10-01	186.7	5 061 272.2	230 993.5
HRB10-02	183.5	5 061 275.8	230 993.4
HRB10-03	186.3	5 061 272.5	231 000.5
HRB10-04	182.7	5 061 276.0	231 000.4
HRB10-05	183.9	5 061 272.8	231 008.1
HRB10-06	182.4	5 061 276.3	231 007.9
HRB10-07	181.6	5 061 300.1	230 982.2
HRB10-08	182.0	5 061 303.5	230 982.2
HRB10-11	181.1	5 061 300.6	230 996.8
HRB10-12	181.3	5 061 304.1	230 996.7
BH10-A	189.9	5 061 254.6	231 001.2
BH10-B	190.0	5 061 255.8	231 004.3
BH10-C	190.1	5 061 261.2	231 009.6
BH10-D	189.1	5 061 262.6	231 012.9
BH10-E	185.9	5 061 312.1	230 977.9
BH10-F	186.9	5 061 314.8	230 976.8
BH10-G	186.5	5 061 313.3	230 981.0
BH10-H	186.0	5 061 314.6	230 984.1
BH10-I	186.9	5 061 317.4	230 983.0
BH10-J	186.2	5 061 320.1	230 989.7

NO	ELEVATION	NORTHING	EASTING
HRB09-01	189.4	5 061 257.6	230 999.8
HRB09-02	189.7	5 061 258.9	230 999.8
HRB09-03	190.1	5 061 257.8	231 003.8
HRB09-04	190.1	5 061 259.0	231 003.7
HRB09-05	190.1	5 061 258.0	231 009.6
HRB09-06	190.1	5 061 259.2	231 009.6
HRB09-07	190.4	5 061 258.1	231 014.3
HRB09-08	190.4	5 061 259.3	231 014.2
HRB09-09	185.7	5 061 273.2	230 993.5
HRB09-10	184.6	5 061 274.8	230 993.4
HRB09-11	185.3	5 061 273.4	230 997.4
HRB09-12	183.8	5 061 274.9	230 997.4
HRB09-13	183.7	5 061 273.6	231 003.3

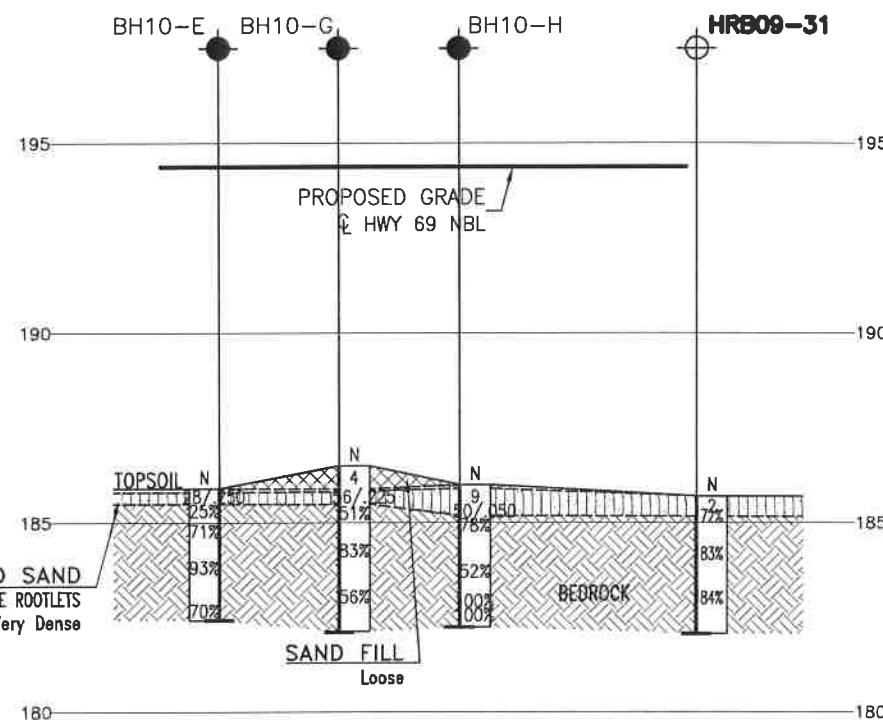
-NOTES-

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

GEOCREs No. 41H-86

SECTION A-A (SOUTH ABUTMENT)

0 4 8 12m
SCALE 1:200



SECTION B-B (NORTH ABUTMENT)

0 4 8 12m
SCALE 1:200



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK AEG	CODE
DRAWN	MFA	CHK PKC	SITE
			STRUCT
			DWG 3