



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
ELLIS CREEK BRIDGES – EBL & WBL
HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00**

GEOCRES No. 40P9-59

Report

to

WSP

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TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

1.	INTRODUCTION	1
2.	SITE DESCRIPTION	1
3.	INVESTIGATION PROCEDURES.....	2
4.	LABORATORY TESTING.....	5
5.	DESCRIPTION OF SUBSURFACE CONDITIONS	5
5.1	Topsoil.....	6
5.2	Organics	6
5.3	Upper Sand and Gravel and Gravelly Sand	6
5.4	Upper Silt to Silty Sand	7
5.5	Lower Silt to Silty Sand	8
5.6	Silty Clay	9
5.7	Sand and Silt to Silty Sand Till	10
5.8	Lower Sand and Gravel.....	11
5.9	Bedrock	12
5.10	Groundwater Conditions	13
6.	CORROSIVITY AND SULPHATE TEST RESULTS.....	14
7.	MISCELLANEOUS	15

APPENDICES

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results and Analytical Laboratory Test Results
Appendix C	Borehole Locations and Soil Strata Drawings



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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a detailed foundation investigation conducted for the proposed Ellis Creek bridges along the proposed Highway 7-New mainline alignment in the Regional Municipality of Waterloo, Ontario. Two bridges are proposed to carry the westbound and eastbound lanes (WBL and EBL) of Highway 7-New over Ellis Creek.

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 profiles, cross sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions under the potential foundation footprint was developed from the data obtained in the course of the investigation.

Thurber was retained by WSP to carry out the site investigation under the Ministry of Transportation Ontario (MTO) Agreement Order Number 3014-E-0013.

2. SITE DESCRIPTION

At the site of the proposed Ellis Creek bridges, the Highway 7-New alignment runs parallel to the existing Hwy 7 and is approximately 750 m to the north. The site lies at the eastern edge of the City of Waterloo, and it is approximately 200 m east of Township Road 3 (Guelph Road 3).

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within an area referred to as the Guelph Drumlin Field, an area of drumlinized till plain, also mapped as containing eskers. The till is described as stony with boulders at the surface. Chapman and Putnam give a typical gradation of the till as being 50% sand, 35% silt and 15% clay. Swampy valleys are reported to occur between the drumlins and associated gravel terraces.



Ellis creek is part of the spillway landform and the drift thickness is shallow with the overburden soil underlain by bedrock of the Guelph Formation consisting of shale and dolostone. The locations of the proposed bridges around Ellis Creek is a flood plain that is prone to flooding.

3. INVESTIGATION PROCEDURES

The geotechnical investigation was conducted at the site from December 4, 2017 to January 19, 2018 and July 9, 2018 to July 10, 2019. Borehole drilling for EC16-07 and EC16-08 was delayed until July of 2018 due to flooding of Ellis Creek. Thirteen boreholes, numbered EC16-01 to EC16-13, were drilled at the proposed bridge foundation units. The boreholes drilled near the east and west approaches of the WBL and EBL ranged from 9.5 m to 9.8 m depth (Elevations 314.5 to 313.4). Boreholes drilled at the foundation units (abutments and piers) were terminated at depths ranging from 12.2 m to 15.0 m (Elevations 311.1 to 308.4). Five boreholes (EC16-04 to EC16-08) were further advanced into dolostone bedrock by coring to depths of 15.5 m to 17.8 m (Elevations 307.8 to 305.5), with a minimum 3.0 m of rock core recovered in each borehole. The Record of Borehole sheets are included in Appendix A.

Details of the location of the boreholes are presented in Table 3.1.

Table 3.1 – Borehole locations

Foundation Element		Borehole
Hwy 7-New EBL	West approach	EC16-02
	West abutment	EC16-04
		EC16-05
	Pier	EC16-07
		EC16-08
	East abutment	EC16-10
		EC16-11
	East approach	EC16-13
Hwy 7-New WBL	West approach	EC16-01
	West abutment	EC16-03
		EC16-04
	Pier	EC16-06



Foundation Element		Borehole
		EC16-07
	East abutment	EC16-09
		EC16-10
	East approach	EC16-12

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

The ground surface elevations and coordinates of the as-drilled boreholes were provided by WSP.

Prior to commencing the site investigation, utility clearances were obtained for all borehole locations.

During the current investigation, track mounted D52 and truck mounted CME75 drill rigs were used in conjunction with hollow-stem augers and tricone equipment to advance the boreholes through the overburden. NQ and HQ rock coring equipment were used to recover core samples of the underlying bedrock in selected boreholes. In general, soil samples were obtained at selected intervals using a 50mm diameter split spoon sampler in conjunction with the Standard Penetration Testing (SPT). All rock cores were logged and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and Fracture Indices (FI) were determined.

The drilling, sampling and in-situ testing operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples and rock cores for transport to Thurber's laboratory for further examination and testing. Results of field drilling and sampling are presented on the Record of Borehole sheets in Appendix A.

Groundwater conditions in the open boreholes were observed throughout the drilling operations.

Seven standpipe piezometers were installed in selected boreholes (EC16-01, EC16-03, EC16-04, EC16-07, EC16-10, EC16-11 and EC16-13). Each piezometer consisted of a 19 mm or 25 mm Schedule 40 PVC pipe with a 1.5 m or 3.0 m long slotted screen enclosed in a column of filter sand to permit groundwater level monitoring. Piezometer installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheets. Upon



completion of the drilling operations, the boreholes without piezometers were abandoned in general accordance with Ontario Regulation 903. The details of standpipe piezometer installation and borehole completion are summarized in Table 3.2. Upon completion of the investigation in the summer of 2020, the piezometer installations will be decommissioned as per O.Reg. 903.

Table 3.2 – Borehole Completion Details

Foundation Element		Borehole	Borehole Ground Surface Elevation (m)	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
Hwy 7- New EBL	West approach	EC16-02	323.9	9.8/314.2	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.
	West abutment	EC16-04	323.3	17.8/305.5	13.8/309.6	Piezometer with 3.0 m slotted screen installed. Sand filter from 17.8 m to 9.7 m, bentonite holeplug from 9.7 m to surface.
		EC16-05	323.1	16.5/306.6	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.
	Pier	EC16-07	323.3	15.5/307.8	12.2/311.1	Piezometer with 3.0 m slotted screen installed. Bentonite from 15.5 m to 12.5 m, sand filter from 12.5 m to 8.5 m, bentonite holeplug from 8.5 m to 6.1 m, grout from 6.1 m to 0.3 m, then holeplug to surface.
		EC16-08	323.1	15.7/307.4	None Installed	Borehole backfilled with grout to 0.2 m, then holeplug to surface.
	East abutment	EC16-10	323.0	12.3/310.8	12.3/310.8	Piezometer with 1.5 m slotted screen installed. Sand filter from 12.3 m to 9.2 m, bentonite holeplug from 9.2 m to surface.
		EC16-11	323.3	12.2/311.1	12.2/311.1	Piezometer with 1.5 m slotted screen installed. Sand filter from 12.2 m to 10.1 m, bentonite holeplug from 10.1 m to surface.
	East approach	EC16-13	323.2	9.5/313.7	9.1/314.1	Piezometer with 1.5 m slotted screen installed. Sand filter from 9.5 m to 7.0 m, bentonite holeplug from 7.0 m to surface.
Hwy 7- NewW BL	West approach	EC16-01	324.2	9.8/314.5	9.1/315.1	Piezometer with 3.0 m slotted screen installed. Sand filter from 9.8 m to 5.5 m, bentonite holeplug from 5.5 m to surface.



Foundation Element		Borehole	Borehole Ground Surface Elevation (m)	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
	West abutment	EC16-03	323.4	15.0/308.4	12.2/311.2	Piezometer with 3.0 m slotted screen installed. Sand filter from 15.0 m to 8.5 m, bentonite holeplug from 8.5 m to surface.
	Pier	EC16-06	323.3	17.8/305.6	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.
	East abutment	EC16-09	323.2	12.2/310.9	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.
	East approach	EC16-12	323.2	9.8/313.4	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.

4. LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size analysis and Atterberg Limits testing. All the laboratory tests were carried out in accordance with MTO and/or ASTM Standards, as appropriate. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

Core samples of the bedrock were carefully protected to prevent drying during transport to the laboratory. Point load tests were carried out on selected samples of intact dolostone upon arrival at the laboratory to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the selected rock core samples are included in Appendix B and on the Record of Borehole sheets in Appendix A.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the existing native soil was collected. The sample was submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil and bedrock stratigraphy along the proposed alignment are presented in this Appendix and on the "Borehole Locations and Soil Strata" drawings in Appendix C. 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, topsoil and organics were encountered surficially at this site. Below the topsoil/organics, layers of native silty sand, sand and gravel, silty clay, silty clay till and silty sand to sand and silt till were encountered. Grey dolostone bedrock was encountered below the native soils. Descriptions of the individual strata are presented below.

5.1 Topsoil

A layer of topsoil was encountered surficially in Borehole EC16-01 and EC16-13. The thickness of topsoil was 400 mm in EC 16-01 and 200 mm in EC 16-13.

Moisture content measured in the topsoil in Borehole EC16-01 was 23 percent.

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

5.2 Topsoil and Organics

A layer of dark brown to black topsoil and organics containing occasional rootlets and wood pieces was encountered surficially in all the boreholes, except in Boreholes EC16-01 and EC 16-13. The organic layer within the floodplain ranged in thickness from 0.5 m to 1.8 m.

The depth to the base of the organic layer ranged from 0.5 m to 1.8 m (Elevations 323.4 to 321.5).

The organic layer is classified as very loose to loose, based on SPT 'N' values ranging from 0 to 5 blows for 0.3 m of penetration. The natural moisture content ranged from 21 percent to 745 percent.

5.3 Upper Sand and Gravel and Gravelly Sand

Upper layers of native brown to grey sand and gravel and gravelly sand containing trace to some silt, trace clay and occasional cobbles were contacted below the topsoil, silty clay or sand and silt at depths ranging from 0.4 m to 4.9 m (Elevations 323.8 to 318.4) in Boreholes EC16-01, EC16-03, EC16-07 and EC16-09 to EC16-13. The thickness of the layer ranged from 1.1 m to 3.8 m. The depth to the base of the sand and gravel and gravelly sand layers ranged from 3.0 m to 7.2 m (Elevations 321.2 to 316.1).



The SPT 'N' values of the upper sand and gravel and gravelly sand ranged from 16 to 96 blows per 0.3 m of penetration indicating a compact to very dense relative density. SPT 'N' values of 4 and 8 blows per 0.3 m of penetration, indicating a loose state, were measured in Borehole EC16-07. The natural moisture contents generally lay in the range of 6 percent to 25 percent.

Grain size distribution curves for the upper sand and gravel and gravelly sand samples tested are presented on the Record of Borehole sheets in Appendix A and on Figure B1 of Appendix B. The results of a gradation test carried out on selected sample is summarized follows:

Soil Particles	Percentage (%)
Gravel	18 to 58
Sand	35 to 79
Silt and Clay	3 to 22

5.4 Upper Silt to Silty Sand

Layers of native brown to grey silt, sandy silt, silty sand and sand and silt containing trace to some gravel and trace to some clay were contacted below the topsoil and organics in all the boreholes, except Boreholes EC16-01 and EC16-07, at depths ranging from 0.2 m to 1.6 m (Elevations 321.5 to 323.4). The thickness of the upper silt to silty sand layers ranged from 1.0 m to 5.6 m.

The depth to the base of these layers ranged from 2.1 m to 7.2 m (Elevations 321.7 to 315.9).

The SPT 'N' values of the sand ranged from 0 to 34 blows per 0.3 m of penetration indicating a very loose to compact state. The natural moisture contents generally lay in the range of 10 percent to 22 percent.

Results of grain size distribution testing carried out on upper silt to silty sand samples are presented on the Record of Borehole sheets in Appendix A and on Figure B3 of Appendix B. The results of the gradation tests are summarized below:

Soil Particles	Sandy Silt to Silty Sand Percentage (%)	Silt Percentage (%)
Gravel	0 to 16	0
Sand	31 to 71	11
Silt	20 to 59	71
Clay	5 to 14	18



The results of Atterberg Limits testing conducted in the clayey zones within this layer are presented on the Record of Borehole sheets in Appendix A and on Figure B9 of Appendix B. The results of Atterberg Limits testing are summarized below:

Liquid Limit	19
Plastic Limit	13
Plasticity Index	6 to 7

The above results show that the clayey zones within this layer are of slight plasticity with a group symbol of CL-ML.

5.5 Lower Silt to Silty Sand

A lower layer of native brown to grey silt, sandy silt, sand and silt and silty sand containing trace to some gravel, trace to some clay and occasional cobbles was encountered either below the silty clay till, upper sand and sand and gravel to gravelly sand or upper silt to silty sand deposits in Boreholes EC 16-01 to EC 16-07 and EC 16-13 at depths ranging from 2.2 m to 8.7 m (Elevations 321.1 to 314.6). The thickness of this layer, where fully penetrated, ranged from 6.7 m to 12.1 m. Boreholes EC 16-01 to EC 16-03 and EC 16-13 were terminated within this layer at depths ranging from 9.5 m to 15.0 m (Elevations 314.5 to 308.4).

The depth of the base of this layer, where fully penetrated, ranged from 12.3 m to 14.7 m (Elev. 311.0 to 308.6).

The SPT 'N' values of this layer typically ranged from 12 to greater than 100 blows for 0.3 m of penetration indicating a compact to very dense relative density. One value of 8 blows per 0.3 m of penetration was recorded in Borehole EC 16-04 at the top of this layer, indicating a loose relative density. The natural moisture content ranged from 8 percent to 22 percent.

Results of grain size distribution testing carried out on samples collected from this layer are presented on the Record of Borehole sheets in Appendix A and on Figures B4 and B5 in Appendix B. The results are summarized in the table below:

Soil Particles	Silty Sand to Sand and Silt Percentage (%)	Sandy Silt to Silt Percentage (%)
Gravel	0 to 15	0 to 3
Sand	42 to 64	6 to 26
Silt	20 to 48	54 to 88
Clay	2 to 6	6 to 17



5.6 Silty Clay

Layers of silty clay containing trace sand and trace to gravel were encountered in Boreholes EC 16-03, EC 16-04, EC 16-08 to EC 16-10, EC 16-12 and EC 16-13 below the upper sand and gravel to gravelly sand, upper silt to silty sand layer, within the lower silt to silty sand layer and within the lower sand and gravel layer. The upper boundary of the silty clay was contacted at depths ranging from 2.1 m to 12.2 m (Elevations 321.3 to 311.1). The thickness of the silty clay layer ranged from 0.8 m to 3.1 m. The depth to the base of the silty clay layers varied from 2.9 m to 13.4 m (Elevations 320.5 to 309.9 m).

SPT 'N' values measured in the silty clay varied from 4 per 0.3 m of penetration to 100 blows for 275 mm of penetration, indicating a firm to hard consistency. The natural moisture content ranged from 15 percent to 22 percent.

Results of grain size distribution testing carried out on the silty clay are presented on the Record of Borehole sheets in Appendix A, and on Figure B2 of Appendix B. The results are summarized in the table below:

Soil Particle	Silty clay Percentage (%)
Gravel	0
Sand	0 to 6
Silt	61 to 79
Clay	21 to 37

The results of Atterberg Limits testing are presented on the Record of Borehole sheets in Appendix A and on Figure B10 of Appendix B. The results of Atterberg Limits testing are summarized below:

Liquid Limit	20 to 22
Plastic Limit	13
Plasticity Index	7 to 9

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

5.7 Silty Clay Till

Layers of silty clay till containing some sand to with sand and trace to some gravel were encountered in Boreholes EC 16-01 to EC 16-03, EC 16-06, EC 16-11, and EC 16-13 below the



the upper sand and gravel to gravelly sand, upper silt to silty sand layer. The upper boundary of the silty clay till was contacted at depths ranging from 2.2 m to 7.2 m (Elevations 321.7 to 316.1). The thickness of the silty clay layer ranged from 1.5 m to 3.7 m. The depth to the base of the silty clay layers varied from 5.8 m to 8.7 m (Elevations 318.5 to 314.6 m).

SPT 'N' values measured in the silty clay till varied from 13 to 89 per 0.3 m of penetration to 100 blows for 250 mm of penetration, indicating a stiff to hard consistency. The natural moisture content ranged from 9 percent to 21 percent.

Results of grain size distribution testing carried out on the silty clay are presented on the Record of Borehole sheets in Appendix A, and on Figures B6 and B11 of Appendix B. The results are summarized in the table below:

Soil Particle	Silty clay Percentage (%)
Gravel	2 to 14
Sand	27 to 40
Silt	29 to 50
Clay	17 to 31

The results of Atterberg Limits testing are presented on the Record of Borehole sheets in Appendix A and on Figure B10 of Appendix B. The results of Atterberg Limits testing are summarized below:

Liquid Limit	20 to 25
Plastic Limit	10 to 13
Plasticity Index	10 to 12

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

5.8 Sand and Silt to Silty Sand Till

Native grey sand and silt to silty sand till containing some gravel, some clay and occasional cobbles, was contacted below the silty clay in Borehole EC 16-10 and below the upper sand and gravel and gravelly sand in Borehole EC 16-12. This cohesionless till was contacted at a depth of 5.6 m (Elevations 317.6 and 317.4). The thickness of the cohesionless till ranged from 1.6 m to 3.1 m.



The depth to the base of the cohesionless till ranged from 7.2 m to 8.7 m (Elevations 316.0 and 314.3).

SPT 'N' values measured in the till varied from 39 to 63 blows per 0.3 m of penetration, indicating a dense to very dense state. The natural moisture content ranged from 8 percent to 20 percent.

Results of grain size distribution testing carried out on cohesionless till samples are presented on the Record of Borehole sheets in Appendix A, and on Figure B7 of Appendix B. The results of laboratory tests carried out on selected samples are as follows:

Soil Particle	Percentage (%)
Gravel	14 to 16
Sand	38 to 49
Silt	23 to 37
Clay	11 to 12

5.9 Lower Sand and Gravel

A lower layer of sand and gravel containing trace silt and trace to some clay was encountered in Boreholes EC16-08 to EC16-12 at depths ranging from 7.2 m to 8.7 m (Elevation 315.9 to 314.3).

Boreholes EC16-09 to EC16-12 were terminated in the lower sand and gravel layer at depths ranging from 9.8 m to 12.3 m (Elevation 313.4 to 310.8). Borehole EC 16-08 fully penetrated the lower sand and gravel layer and the layer was 5.3 m thick.

The SPT 'N' values of the lower sand and gravel ranged from 64 to over 100 blows per 0.3 m of penetration indicating a very dense relative density. The natural moisture contents generally lay in the range of 7 percent to 10 percent.

Results of grain size distribution testing carried out on lower sand and gravel samples are presented on the Record of Borehole sheets in Appendix A and on Figure B8 of Appendix B. The results of the gradation tests are summarized below:

Soil Particles	Percentage (%)
Gravel	34 to 59
Sand	33 to 46
Silt and Clay	8 to 23



5.10 Bedrock

The overburden soils described above are underlain by grey slightly weathered to fresh dolostone bedrock. Occasional mechanical breaks were noted throughout the bedrock cores. A rubble zone was encountered within the bedrock at 15.1 m depth (Elevation 308.2) in Borehole EC16-07.

Depths and elevations of the top of bedrock are shown in Table 5.1.

Table 5.1 – Elevation of Top of Bedrock

Foundation Element		Borehole	Top of Bedrock Depth (m)	Top of Bedrock Elevation (m)
Hwy 7- New EBL	West abutment	EC16-04	14.3	309.0
		EC16-05	13.1	310.0
	Pier	EC16-07	12.3	311.0
		EC16-08	12.5	310.6
Hwy 7- New WBL	West abutment	EC16-04	14.3	309.0
	Pier	EC16-06	14.7	308.6
		EC16-07	12.3	311.0

Total Core Recovery (TCR) in the bedrock ranged from 77% and 100% with Solid Core Recovery (SCR) of 58% and 100%. The Rock Quality Designation (RQD) determined from the recovered cores was 0% to 95%, indicating very poor to excellent rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 6.

Average unconfined compressive strengths (UCS) of the rock ranged from 110 MPa to 250 MPa, indicating that the rock is strong to very 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 are presented in Appendix B.



5.11 Groundwater Conditions

Groundwater conditions were observed during drilling operations, and groundwater levels were measured in the open boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes EC16-01, EC16-03, EC16-04, EC16-07, EC16-10, EC16-11, EC16-13 to monitor the groundwater level at the site. The groundwater levels measured in the open boreholes and in the standpipe piezometers are summarized below. Decommissioning of piezometers is planned to take place in the summer of 2020.

Table 5.1 – Water Level Measurements for EBL

Foundation Unit	Borehole	Date	Water Level (m)		Remark
			Depth	Elevation	
West Approach	EC16-02	January 9, 2018	3.7	320.2	Open borehole
West Abutment	EC16-04	August 31, 2018	-0.5	323.8 ⁽¹⁾	Piezometer
	EC16-05	January 18, 2018	Water level not taken due to the use of mud while drilling		-
Pier	EC16-07	August 31, 2018	-0.1	323.4 ⁽¹⁾	Piezometer
	EC16-08	July 10, 2018	Water level not taken due to the use of mud while drilling		-
East Abutment	EC16-10	December 7, 2017	1.5	321.5	Open borehole
		March 23, 2018	-0.2	323.2 ⁽¹⁾	Piezometer
		May 1, 2018	0.3	322.7	Piezometer
		August 31, 2018	0.2	322.8	Piezometer
	EC16-11	December 5, 2017	1.5	321.8	Open borehole
		March 23, 2018	0.1	323.2	Piezometer
		May 1, 2018	0.0	323.3	Piezometer
		August 31, 2018	0.0	323.3	Piezometer
East Approach	EC16-13	December 4, 2017	1.5	321.7	Open borehole
		March 23, 2018	0.0	323.2	Piezometer
		May 1, 2018	-0.2	323.4 ⁽¹⁾	Piezometer
		August 31, 2018	0.3	322.9	Piezometer

⁽¹⁾ Artesian conditions observed, as groundwater level was measured above ground surface.

Table 5.2 – Water Level Measurements for WBL

Foundation Unit	Borehole	Date	Water Level (m)		Remark
			Depth	Elevation	
West Approach	EC16-01	January 10, 2018	4.3	319.9	Open borehole
		March 23, 2018	0.4	323.9	Piezometer
		August 31, 2018	0.6	323.6	Piezometer
West Abutment	EC16-03	January 10, 2018	3.7	319.7	Open borehole
		March 23, 2018	-0.3	323.7 ⁽¹⁾	Piezometer
		August 31, 2018	-0.1	323.5 ⁽¹⁾	Piezometer
	EC16-04	August 31, 2018	-0.5	323.8 ⁽¹⁾	Piezometer
Pier	EC16-06	January 11, 2018	Water level not taken due to the use of mud while drilling		-
	EC16-07	August 31, 2018	-0.1	323.4 ⁽¹⁾	Piezometer
East Abutment	EC16-09	December 9, 2017	1.5	321.7	Open borehole
	EC16-10	December 7, 2017	1.5	321.5	Open borehole
		March 23, 2018	-0.2	323.2 ⁽¹⁾	Piezometer
		May 1, 2018	0.3	322.7	Piezometer
		August 31, 2108	0.2	322.8	Piezometer
East Approach	EC16-12	December 5, 2017	1.8	321.4	Open borehole

⁽²⁾ Artesian conditions observed, as groundwater level was measured above ground surface.

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

The General Arrangement (GA) drawings provided by WSP indicate that the water levels at Ellis Creek are estimated to be at following elevations:

- 100-year water level – Elevation 324.12
- 2-year water level – Elevation 323.85

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the native silty sand was submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.



Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	EC16-08 SS3 Depth 1.8 m
		Silty sand
Sulphide	%	0.86
Chloride	µg/g	4.4
Sulphate	µg/g	710
pH	No unit	8.15
Electrical Conductivity	µS/cm	227
Resistivity	Ohms.cm	4410
Redox Potential	mV	169

7. MISCELLANEOUS

Altech Drilling & Investigative Services of Elmira, Ontario supplied a D-120 track-mounted drill rig and conducted the drilling, sampling and in-situ testing operations for the present investigation, except for Boreholes EC16-07 and EC16-08 which were completed by Landshark Drilling of Brantford, Ontario, who supplied a rubber-track mounted B-57 drill rig and conducted the drilling, sampling and in-situ testing operations.

The coordinates for the boreholes were obtained with GPS equipment by Thurber, and the elevations were provided by WSP.

The drilling and sampling operations in the field for the current investigation, were supervised on a full-time basis by Thurber field technicians.

Overall supervision of the field program for the present investigation was conducted by Dr. Nancy Berg, P.Eng. Interpretation of the data and preparation of the current report was carried out by Ms. R. Palomeque Reyna, P.Eng. and Dr. Nancy Berg, P.Eng.

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



Thurber Engineering Ltd.



Nancy Berg, P.Eng.
Geotechnical Engineer



Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact



Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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


4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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


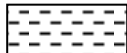



 Water Level
 Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
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)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
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.
<u>TERMS</u>		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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 EC16-01

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 606.7 E 237 101.1 ORIGINATED BY SB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.01.09 - 2018.01.10 LATITUDE 43.531316 LONGITUDE -80.337579 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 (%)				
								20	40	60	80	100	W _P	W	W _L		
324.2	GROUND SURFACE																
0.0	TOPSOIL		1	SS	4												
323.8																	
0.4	Gravelly SAND , some silt, trace clay Dense Brown Moist to Wet		2	SS	31												
			3	SS	38												
			4	SS	36												
321.2																	
3.0	Silty CLAY , sandy, trace gravel, occasional cobbles Very Stiff to Hard Grey Moist (TILL)		5	SS	29												
	Auger grinding from 4.4m to 4.6m		6	SS	60												
318.5																	
5.8	SILT , trace to some sand, trace clay Dense Grey Wet		7	SS	38												
			8	SS	47												
			9	SS	48												
314.5																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

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

RECORD OF BOREHOLE No EC16-01

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 606.7 E 237 101.1 ORIGINATED BY SB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2018.01.09 - 2018.01.10 LATITUDE 43.531316 LONGITUDE -80.337579 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															
	Continued From Previous Page																						
	<p>WATER LEVEL AT 4.3m UPON COMPLETION.</p> <p>Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.1m slotted screen.</p> <p>WATER LEVEL READINGS</p> <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH(m)</th> <th>ELEV.(m)</th> </tr> </thead> <tbody> <tr> <td>2018.03.23</td> <td>0.4</td> <td>323.9</td> </tr> <tr> <td>2018.08.31</td> <td>0.6</td> <td>323.6</td> </tr> </tbody> </table>	DATE	DEPTH(m)	ELEV.(m)	2018.03.23	0.4	323.9	2018.08.31	0.6	323.6													
DATE	DEPTH(m)	ELEV.(m)																					
2018.03.23	0.4	323.9																					
2018.08.31	0.6	323.6																					

RECORD OF BOREHOLE No EC16-02

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 593.3 E 237 130.8 ORIGINATED BY SB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2018.01.09 - 2018.01.09 LATITUDE 43.531198 LONGITUDE -80.337210 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
323.9	GROUND SURFACE							20	40	60	80	100					
0.0	ORGANICS Loose Dark Brown Wet		1	SS	5												
323.4																	
0.5	Silty SAND , some gravel, some clay Compact Brown Moist		2	SS	15		323							o			11 58 20 11
			3	SS	13		322							o			
321.7																	
2.2	Silty CLAY , with sand, trace to some gravel, occasional cobbles Very Stiff to Hard Grey Moist to Wet (TILL)		4	SS	20		321							o			14 40 29 17
			5	SS	37									o			
							320										
			6	SS	79		319							o	h		3 35 39 23
318.1																	
5.8	Silty SAND , trace gravel, trace clay Dense to Very Dense Grey Wet		7	SS	47		318							o			
							317										
			8	SS	68		316							o			
							315										
			9	SS	84									o			
314.2																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-02

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 593.3 E 237 130.8 ORIGINATED BY SB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.01.09 - 2018.01.09 LATITUDE 43.531198 LONGITUDE -80.337210 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					WATER CONTENT (%)				
							20	40	60	80	100	W _p	W	W _L			
	Continued From Previous Page																
	BOREHOLE CAVED IN TO 4.6m. WATER LEVEL AT 3.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																

RECORD OF BOREHOLE No EC16-03

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 622.9 E 237 107.3 ORIGINATED BY SB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.01.10 - 2018.01.10 LATITUDE 43.531463 LONGITUDE -80.337503 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	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
323.4	GROUND SURFACE											
0.0	ORGANICS Loose Dark Brown Wet		1	SS	4		323				122	
322.7												
0.8	SAND and SILT , trace gravel Loose to Compact Brown Wet		2	SS	6		322					
			3	SS	19							
321.3												
2.1	Silty CLAY Stiff Brown to Grey Moist		4	SS	12		321					0 0 68 32
320.5												
2.9	SAND and GRAVEL , trace silt, occasional cobbles Dense Brown Wet		5	SS	37		320					
318.8							319					
4.6	Silty CLAY , sandy to with sand, trace to some gravel Stiff to Very Stiff Grey Wet (TILL) Moist		6	SS	13		318					11 35 34 20
			7	SS	19		317					9 29 43 19
316.2												
7.2	Silty SAND to SAND and SILT , trace gravel, trace clay Compact to Dense Grey Wet		8	SS	14		316					
							315					
			9	SS	38		314					

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-03

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 622.9 E 237 107.3 ORIGINATED BY SB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.01.10 - 2018.01.10 LATITUDE 43.531463 LONGITUDE -80.337503 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE CONTENT			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
	Continued From Previous Page							20	40	60	80	100	W _p	W	W _L				

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RECORD OF BOREHOLE No EC16-04

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 613.2 E 237 126.4 ORIGINATED BY SB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP
DATUM Geodetic DATE 2018.01.19 - 2018.01.19 LATITUDE 43.531377 LONGITUDE -80.337267 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					
323.3	GROUND SURFACE						<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>				<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div></div> <div><div>W P</div><div>W</div><div>W L</div></div> <div>WATER CONTENT (%)</div>		
0.0	ORGANICS , occasional roots Very Loose to Loose Black Wet		1	SS	1		323					745	
322.1			2	SS	4								
1.2	Sandy SILT , trace clay Loose to Compact Grey Wet		3	SS	11		322						0 33 59 8
321.1													
2.2	Silty SAND , trace to some gravel, trace clay Loose to Dense Brown Wet to Moist		4	SS	8		321						
			5	SS	13		320						
			6	SS	15		319						15 63 20 2
			7	SS	12		317						
							316						
			8	SS	36								
	Grey												
							315						
			9	SS	29		314						7 64 26 3

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-04

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 613.2 E 237 126.4 ORIGINATED BY SB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP
DATUM Geodetic DATE 2018.01.19 - 2018.01.19 LATITUDE 43.531377 LONGITUDE -80.337267 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					
	Continued From Previous Page							20 40 60 80 100					
								○ UNCONFINED + FIELD VANE					
								● QUICK TRIAXIAL × LAB VANE					
								20 40 60 80 100					
									PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
									W _P	W	W _L		
									WATER CONTENT (%)				
									20 40 60				
311.1	Silty SAND , trace clay, trace gravel Very Dense Brown to Grey Moist		10	SS	53		313						
							312						
12.2	Silty CLAY Hard Brown Wet		11	SS	50		311						
309.9							310						
13.4	Silty SAND , some gravel, occasional cobbles Very Dense Brown Wet		12	SS	63		309						
309.0	Coring started at 14.3m						308						
14.3	BEDROCK , dolostone, slightly weathered to fresh, very strong, grey, occasional vertical joints: (Guelph Formation) sub horizontal joint at 14.6m horizontal joint at 14.6m sub-vertical joint at 15.3m sub-vertical joint at 15.6m horizontal joint at 14.7m, 14.8m, 15.0m, 15.1m, 15.4m and 15.6m horizontal joint at 16.5m, 16.8m, 17.0m and 17.4m		1	RUN			307						
			2	RUN			306						
			3	RUN									
305.5													
17.8	END OF BOREHOLE AT 17.8m Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.08.31 -0.5 323.8 Artesian Condition												

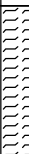


ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 11/9/18

RECORD OF BOREHOLE No EC16-05

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 605.1 E 237 149.4 ORIGINATED BY SB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.01.17 - 2018.01.18 LATITUDE 43.531307 LONGITUDE -80.336981 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 (%)				
								<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>					
								<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>					
323.1	GROUND SURFACE														
0.0	ORGANICS , occasional roots Very Loose to Loose Black Wet		1	SS	1		323						17.5		
322.1															
1.0	Sandy SILT , trace to some clay, trace gravel Loose to Compact Grey Moist		2	SS	4		322								
	clayey zone		3	SS	14		321							0 31 59 10	
320.8															
2.3	Silty SAND , trace clay, trace gravel Compact to Very Dense Brown Wet		4	SS	16		320								
			5	SS	100/ 0.250		319								
			6	SS	52		318								
			7	SS	29		317								
			8	SS	43		316								
							315							0 63 32 5	
			9	SS	65		314								

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-05

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 605.1 E 237 149.4 ORIGINATED BY SB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.01.17 - 2018.01.18 LATITUDE 43.531307 LONGITUDE -80.336981 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						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
PLASTIC LIMIT W _P				NATURAL MOISTURE CONTENT W				LIQUID LIMIT W _L						
WATER CONTENT (%)				20 40 60										
	Continued From Previous Page						313							
	Silty SAND , trace clay, trace gravel Very Dense Brown Wet		10	SS	82		312							
							311							
			11	SS	100/ 0.075									
310.0	Coring started at 13.1m						310					FI		
13.1	BEDROCK , dolostone, slightly weathered to fresh, very strong, grey, occasional vertical joints: (Guelph Formation) sub-horizontal joint at 13.3m horizontal joint at 13.6m, 13.7m, 13.9m, 14.2m, 14.3m, 14.5m, 14.9m and 15.0m sub-vertical joint at 14.2m vertical joint at 14.4m and 15.0m horizontal joint at 15.3m, 15.7m, 15.8m, 16.0m, 16.1m and 16.2m		1	RUN			309					1	RUN #1 TCR=91% SCR=64% RQD=0% UCS=169MPa	
			2	RUN			308					2	RUN #2 TCR=93% SCR=77% RQD=29% UCS=147MPa (Average)	
			3	RUN			307					3	RUN #3 TCR=84% SCR=84% RQD=47% UCS=178MPa	
306.6	END OF BOREHOLE AT 16.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.											1		
16.5														

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

RECORD OF BOREHOLE No EC16-06

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 648.0 E 237 126.2 ORIGINATED BY SB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.01.11 - 2018.01.17 LATITUDE 43.531690 LONGITUDE -80.337274 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE											
						● QUICK TRIAXIAL × LAB VANE													
323.3	GROUND SURFACE						20	40	60	80	100	20	40	60	kN/m ³	GR	SA	SI	CL
0.0	ORGANICS Very Loose Dark Brown Wet		1	SS	2														
			2	SS	2														
321.9																			
1.4	Silty SAND , some clay, some gravel Compact Grey Wet		3	SS	12														
			4	SS	14														
320.3																			
3.0	Silty CLAY , some sand to sandy, trace gravel Very Stiff to Hard Grey Wet (TILL)		5	SS	29														
			6	SS	32														
			7	SS	32														
316.6																			
6.7	Sandy SILT , trace gravel, trace clay Very Dense to Dense Grey Wet		8	SS	58														
			9	SS	43														

Continued Next Page

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

RECORD OF BOREHOLE No EC16-06

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 648.0 E 237 126.2 ORIGINATED BY SB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.01.11 - 2018.01.17 LATITUDE 43.531690 LONGITUDE -80.337274 CHECKED BY RPR

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100					W P W W L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
	Sandy SILT , trace gravel, trace clay Dense Grey Wet						313										
			10	SS	39								○		0 20 74 6		
							312										
							311						○				
							310										
	Possible hydraulic disturbance																
	Compact		12	SS	12		309						○				
308.6	Coring started at 14.7m																
14.7	BEDROCK , dolostone, slightly weathered to fresh, very strong, grey, occasional vertical joints: (Guelph Formation) vertical joint at 14.7m sub-vertical joint at 14.9m		1	RUN			308							FI	RUN #1 TCR=100% SCR=95% RQD=62% UCS=185MPa (Average)		
	sub-horizontal joint at 15.2m													3			
	horizontal joint at 15.0m, 15.1m, 15.3m, 15.4m, 15.8m and 16.1m						307							6			
	vertical joint at 17.1m		2	RUN										2	RUN #2 TCR=98% SCR=95% RQD=82% UCS=159MPa (Average)		
	horizontal joint at 16.4m, 16.6m, 16.9m, 17.3m, 17.4m and 17.5m						306							1			
305.6	END OF BOREHOLE AT 12.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.													2			
17.8														1			

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-07

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 633.1 E 237 149.8 ORIGINATED BY SJ
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.07.09 - 2018.07.09 LATITUDE 43.531558 LONGITUDE -80.336980 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						
323.3	GROUND SURFACE							20	40	60	80	100		
0.0	ORGANICS Very Loose to Loose Dark Brown Wet		1	SS	1		323							
			2	SS	1		322							
321.5			3	SS	4		321							
1.8	Gravelly SAND , trace silt, trace clay Loose Grey Wet		4	SS	4		320							
			5	SS	8		319							
			6	SS	60		318							
317.6							317							
5.6	Sandy SILT , trace to some clay, trace gravel Dense Grey Moist		7	SS	39		316							
			8	SS	35		315							
			9	SS	67		314							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-07

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 633.1 E 237 149.8 ORIGINATED BY SJ
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.07.09 - 2018.07.09 LATITUDE 43.531558 LONGITUDE -80.336980 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				WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page						20 40 60 80 100					W P W W L					
311.0	Sandy SILT , trace to some clay, trace gravel Very Dense Grey Moist		10	SS	80								○	0 11 72 17			
														</			

ONTMT452 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 11/9/18

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 11/9/18

RECORD OF BOREHOLE No EC16-08

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 625.7 E 237 172.3 ORIGINATED BY SJ
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone/NQ Coring COMPILED BY MP
DATUM Geodetic DATE 2018.07.10 - 2018.07.10 LATITUDE 43.531494 LONGITUDE -80.336700 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						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
							WATER CONTENT (%)							
							20 40 60							

313.0	Continued From Previous Page						313													
10.1	SAND and GRAVEL , trace to some silt, trace to some clay Very Dense Grey Wet Auger grinding at 11.1m		11	SS	100/ 0.200		312													
310.6	Coring started at 12.5m		12	SS	100/ 0.050															
12.5	BEDROCK , dolostone, slightly weathered to fresh, very strong, grey, occasional vertical joints: (Guelph Formation) vertical joint (75mm) at 12.5m horizontal joint at 12.6m sub vertical joint (50mm) at 13.1m horizontal joint at 13.6m, 13.7m, 14.4m and 14.8m sub vertical joint (25mm) at 14.0m vertical joint (200mm) at 14.2m, (125mm) at 14.5m vertical joint (100mm) at 14.8m horizontal joint at 15.3m		1	RUN			310													
			2	RUN			309													
			3	RUN			308													
307.4																				
15.7	END OF BOREHOLE AT 15.7m. BOREHOLE BACKFILLED WITH GROUT TO 0.2m, THEN HOLEPLUG TO SURFACE.																			








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

RECORD OF BOREHOLE No EC16-09

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 672.5 E 237 150.3 ORIGINATED BY GA
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2017.12.07 - 2017.12.09 LATITUDE 43.531913 LONGITUDE -80.336978 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	PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w			LIQUID LIMIT w _L	
323.2	GROUND SURFACE													
0.0	ORGANICS , occasional roots Very Loose Black Wet		1	SS	0		323					111		
			2	SS	2		322					113		
321.7														
1.4	SAND and SILT , some clay, trace gravel Compact to Loose Grey to Brown Wet		3	SS	11		321							
			4	SS	8									
320.2														
3.0	Silty CLAY Firm Brown Wet		5	SS	4		320							0 0 73 27
319.1														
4.1	SAND and GRAVEL , trace silt, trace clay Compact Grey Wet		6	SS	19		319							58 35 7 (SI+CL)
							318							
317.5														
5.6	Silty CLAY Hard Grey Wet		7	SS	33	317								
							316							
			8	SS	40		315					0 0 79 21		
314.5														
8.7	SAND and GRAVEL , some silt Very Dense Grey Wet		9	SS	100/ 0.200	314								

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+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

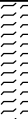



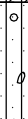
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RECORD OF BOREHOLE No EC16-10

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 662.3 E 237 171.6 ORIGINATED BY GA
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2017.12.07 - 2017.12.07 LATITUDE 43.531823 LONGITUDE -80.336713 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									
								20 40 60 80 100									
323.0	GROUND SURFACE																
0.0	ORGANICS , occasional roots, occasional wood pieces Very Loose Black Wet		1	SS	2									133			
																195	
321.6			2	SS	2												
1.4	SAND and SILT , trace gravel, trace clay Compact to Loose Grey Wet		3	SS	16											3 55 36 6	
			4	SS	7												
320.0																	
3.0	Gravelly SAND , trace silt, trace clay Compact Grey Wet		5	SS	16											29 63 8 (SI+CL)	
318.9	Silty CLAY , trace sand Firm Brown Wet		6	SS	6												
317.4	Silty SAND , some gravel, some clay Very Dense to Dense Grey Wet (TILL)																
5.6																16 49 23 12	
					7	SS	54										

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-10

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 662.3 E 237 171.6 ORIGINATED BY GA
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2017.12.07 - 2017.12.07 LATITUDE 43.531823 LONGITUDE -80.336713 CHECKED BY RPR





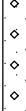
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100	W _p	W	W _L			
	Continued From Previous Page																
	SAND and GRAVEL, trace silt Very Dense Grey Wet		10	SS	100/ 0.225												
310.8																	
12.3	END OF BOREHOLE AT 12.3m. WATER LEVEL AT 1.5m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.03.23 -0.2 323.2 Artesian Condition 2018.05.01 0.3 322.7 2018.08.31 0.2 322.8				0.075												

RECORD OF BOREHOLE No EC16-11

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 653.4 E 237 193.2 ORIGINATED BY GA
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2017.12.05 - 2017.12.05 LATITUDE 43.531745 LONGITUDE -80.336445 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 (%)			
323.3	GROUND SURFACE							20 40 60 80 100	20 40 60				
0.0	ORGANICS , occasional roots Very Loose Black Wet		1	SS	2		323					110	
			2	SS	2		322						
321.8													
1.4	SAND and SILT , trace gravel, trace clay Loose to Compact Brown to Grey Wet		3	SS	8		321						0 59 36 5
			4	SS	12								
			5	SS	12		320						
319.2													
4.1	Gravelly SAND , trace silt, trace clay Compact Brown Wet		6	SS	15		319						18 79 3 (SI+CL)
							318						
			7	SS	83		317						
316.1													
7.2	Silty CLAY , sandy, trace gravel Hard Grey Wet (TILL)		8	SS	89		316						2 27 50 21
							315						
314.6													
8.7	SAND and GRAVEL , some silt to silty Very Dense Grey Wet		9	SS	100/ 0.200		314						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-11

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 653.4 E 237 193.2 ORIGINATED BY GA
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2017.12.05 - 2017.12.05 LATITUDE 43.531745 LONGITUDE -80.336445 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				WATER CONTENT (%)				
							20	40	60	80	100	W _p	W	W _L		
	Continued From Previous Page															
	SAND and GRAVEL, some silt to silty Very Dense Grey Wet						313									
			10	SS	100/	0.150										34 43 23 (SI+CL)
311.1							312									
12.2	END OF BOREHOLE AT 12.2m. WATER LEVEL AT 1.5m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.03.23 0.1 323.2 (Frozen) 2018.05.01 0.0 323.3 At surface 2018.08.31 0.0 323.2		11	SS	100/	0.050										

RECORD OF BOREHOLE No EC16-12

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 669.9 E 237 170.2 ORIGINATED BY GA
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2017.12.05 - 2017.12.05 LATITUDE 43.531892 LONGITUDE -80.336732 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								
323.2	GROUND SURFACE															
0.0	ORGANICS , occasional roots Very Loose Black Wet		1	SS	2		323							108		
			2	SS	3		322									121
321.7																
1.4	SILT , trace to some sand, some clay Compact to Loose Grey to Brown Wet		3	SS	17		321									
	clayey zone		4	SS	11											
			5	SS	9		320									
319.1								319								
4.1	SAND and GRAVEL Dense Grey Wet		6	SS	32											
								318								
317.6																
5.6	SAND and SILT , some gravel, some clay Very Dense Grey Wet (TILL)		7	SS	63		317									
316.0							316									
7.2	Silty CLAY , trace sand Hard Grey Wet		8	SS	64											
							315									
314.5																
8.7	SAND and GRAVEL , some silt Very Dense Grey Wet		9	SS	64		314									
313.4																
9.8	END OF BOREHOLE AT 9.8m.															

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

RECORD OF BOREHOLE No EC16-12

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 669.9 E 237 170.2 ORIGINATED BY GA
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2017.12.05 - 2017.12.05 LATITUDE 43.531892 LONGITUDE -80.336732 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 (%)					
	Continued From Previous Page WATER LEVEL AT 1.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.													

RECORD OF BOREHOLE No EC16-13

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 671.4 E 237 198.6 ORIGINATED BY GA
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2017.12.04 - 2017.12.04 LATITUDE 43.531908 LONGITUDE -80.336381 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									WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE								
323.2	GROUND SURFACE							20	40	60	80	100	20	40	60	GR	SA	SI	CL
0.0	TOPSOIL							20	40	60	80	100	20	40	60				
0.2	Silty SAND , trace to some gravel, occasional roots Very Loose to Compact Brown to Grey Wet		1	SS	0		323						○						
			2	SS	8		322						○						
			3	SS	20		321						○						
320.7			4	SS	5		320						○	○					
2.6	Silty CLAY Firm to Stiff Brown Wet		5	SS	8		319						○						
			6	SS	12		318						○						
318.4			7	SS	96		317						○						
4.9	SAND and GRAVEL Compact to Very Dense Brown to Grey Wet		8	SS	100/ 0.250		316						○						
316.8							315												
6.4	Silty CLAY , sandy, trace gravel Hard Grey Wet (TILL)						314						○						
314.6			9	SS	100/ 0.225		314						○						
8.7	SAND and SILT , trace gravel, trace clay Very Dense Grey Wet																		
313.7																			
9.5	END OF BOREHOLE AT 9.5m. WATER LEVEL AT 1.5m UPON COMPLETION.																		

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 11/9/18

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EC16-13

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 671.4 E 237 198.6 ORIGINATED BY GA
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2017.12.04 - 2017.12.04 LATITUDE 43.531908 LONGITUDE -80.336381 CHECKED BY RPR

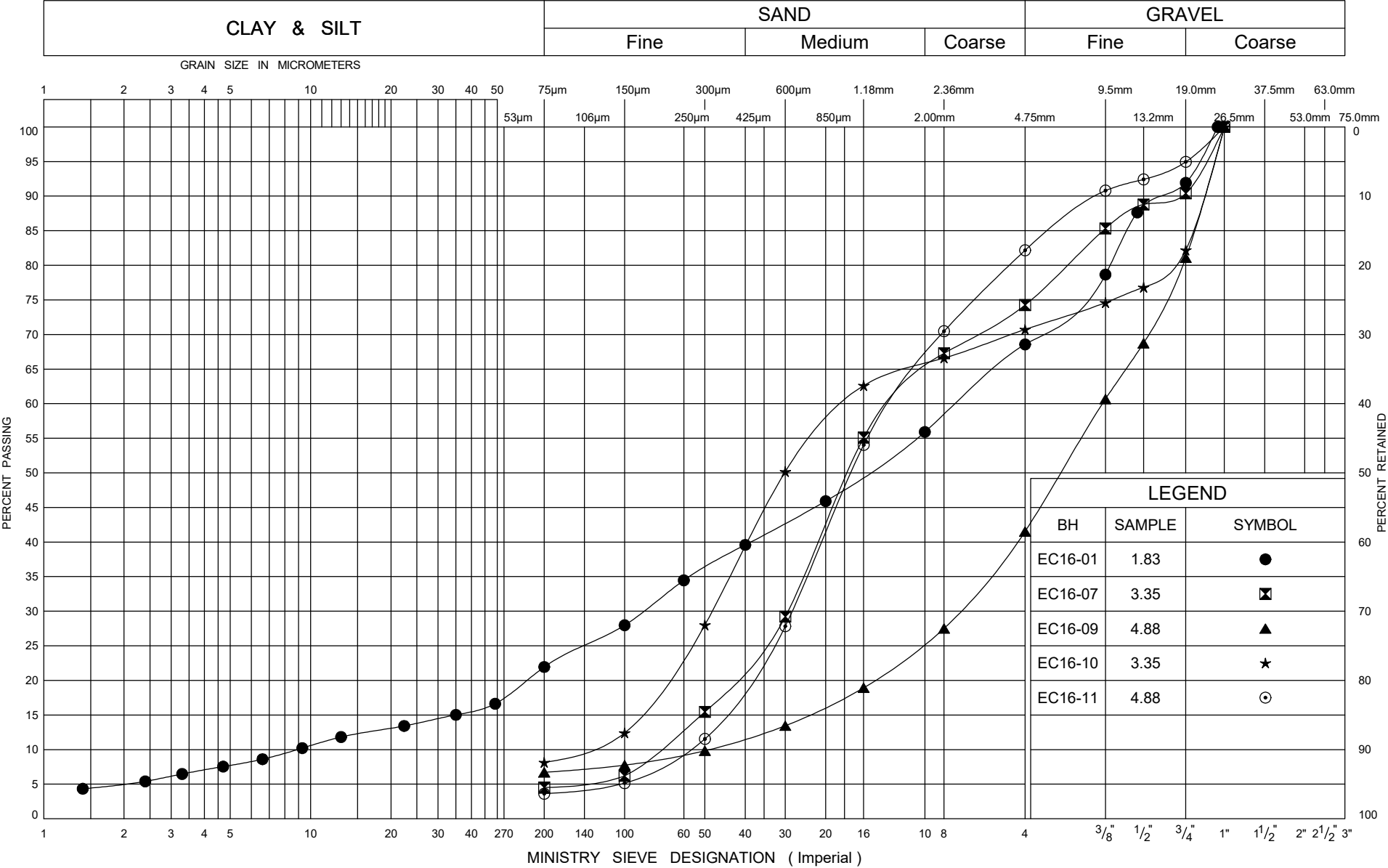
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
	Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.03.23 0.0 323.3 Artesian Condition 2018.05.01 -0.2 323.4 Artesian Condition 2018.08.31 0.3 322.9													



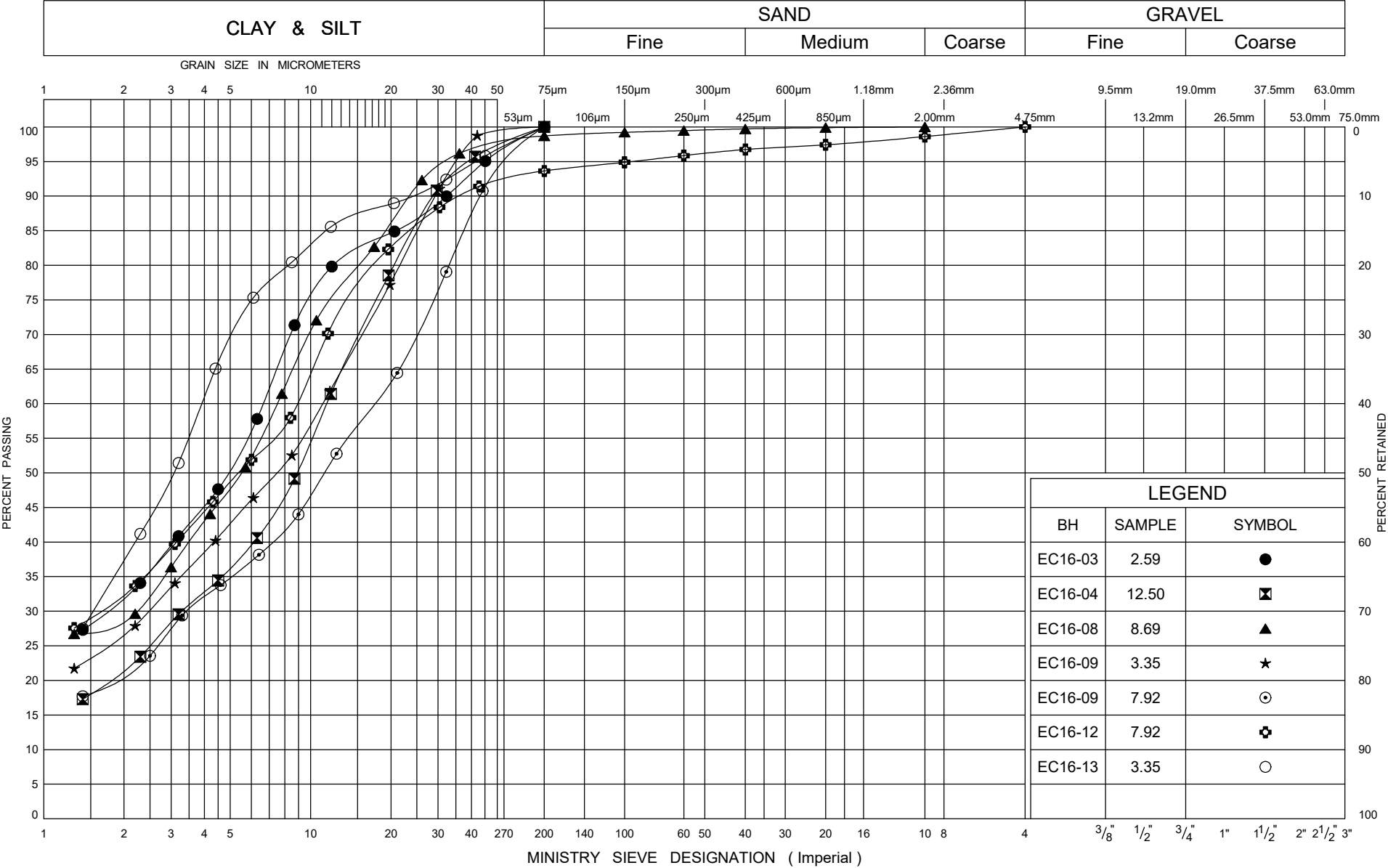
Appendix B

Laboratory Test Results and Analytical Laboratory Test Results

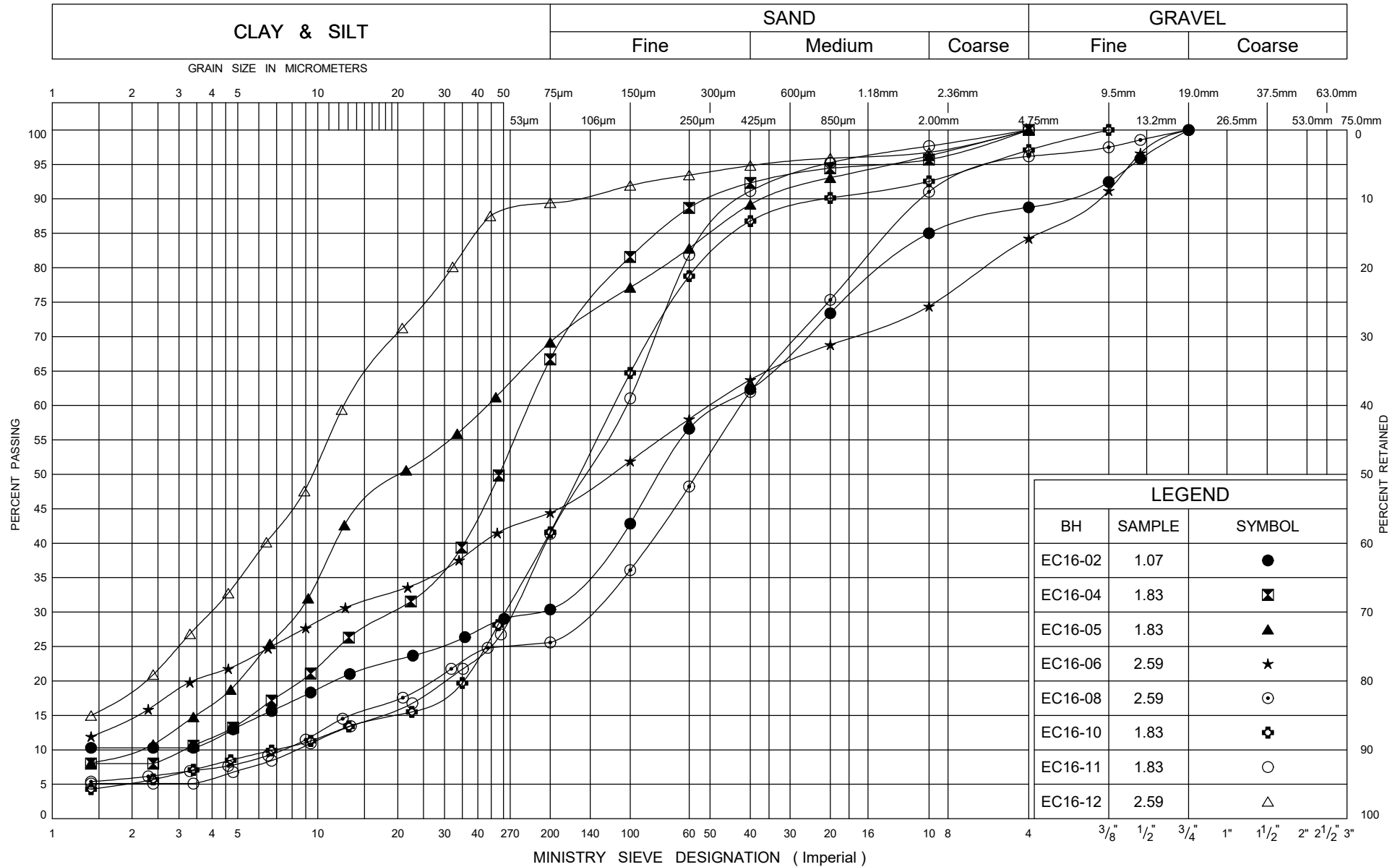
UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Upper Silt to Silty Sand

FIG No B3

W P 408-88-00

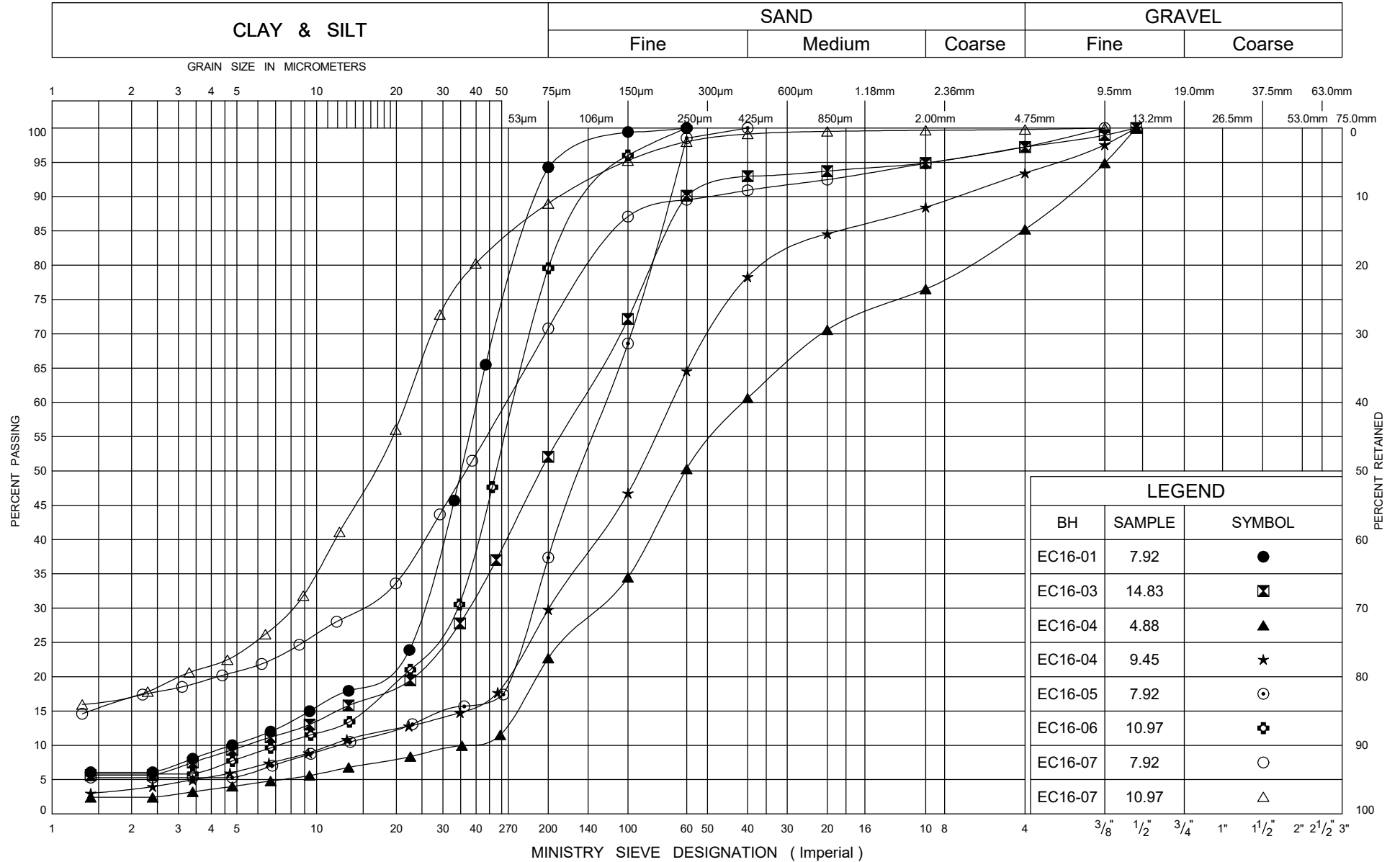
Ellis Creek



Ministry of
Transportation

Ontario

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

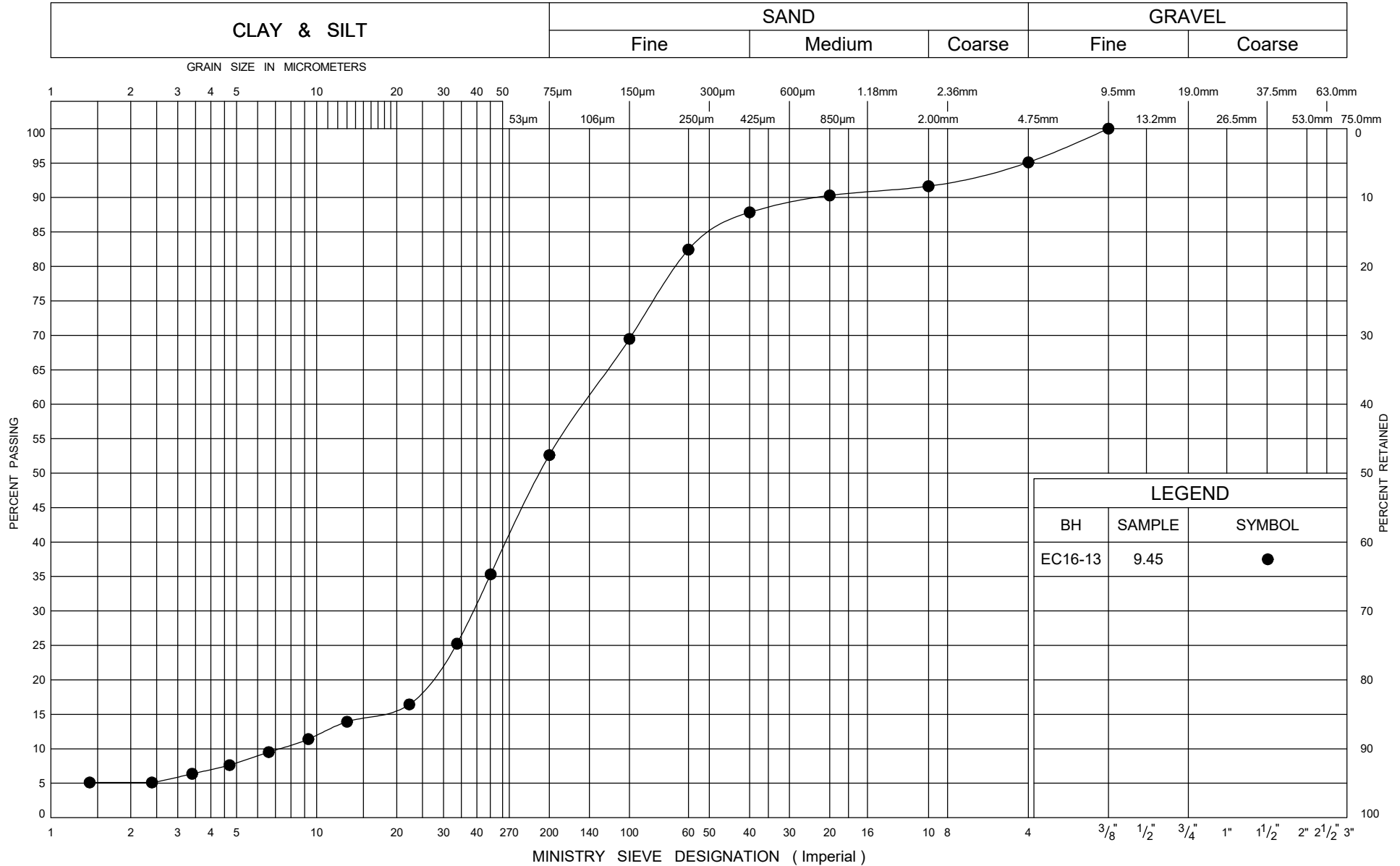
Lower Silt to Silty Sand

FIG No B4

W P 408-88-00

Ellis Creek

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

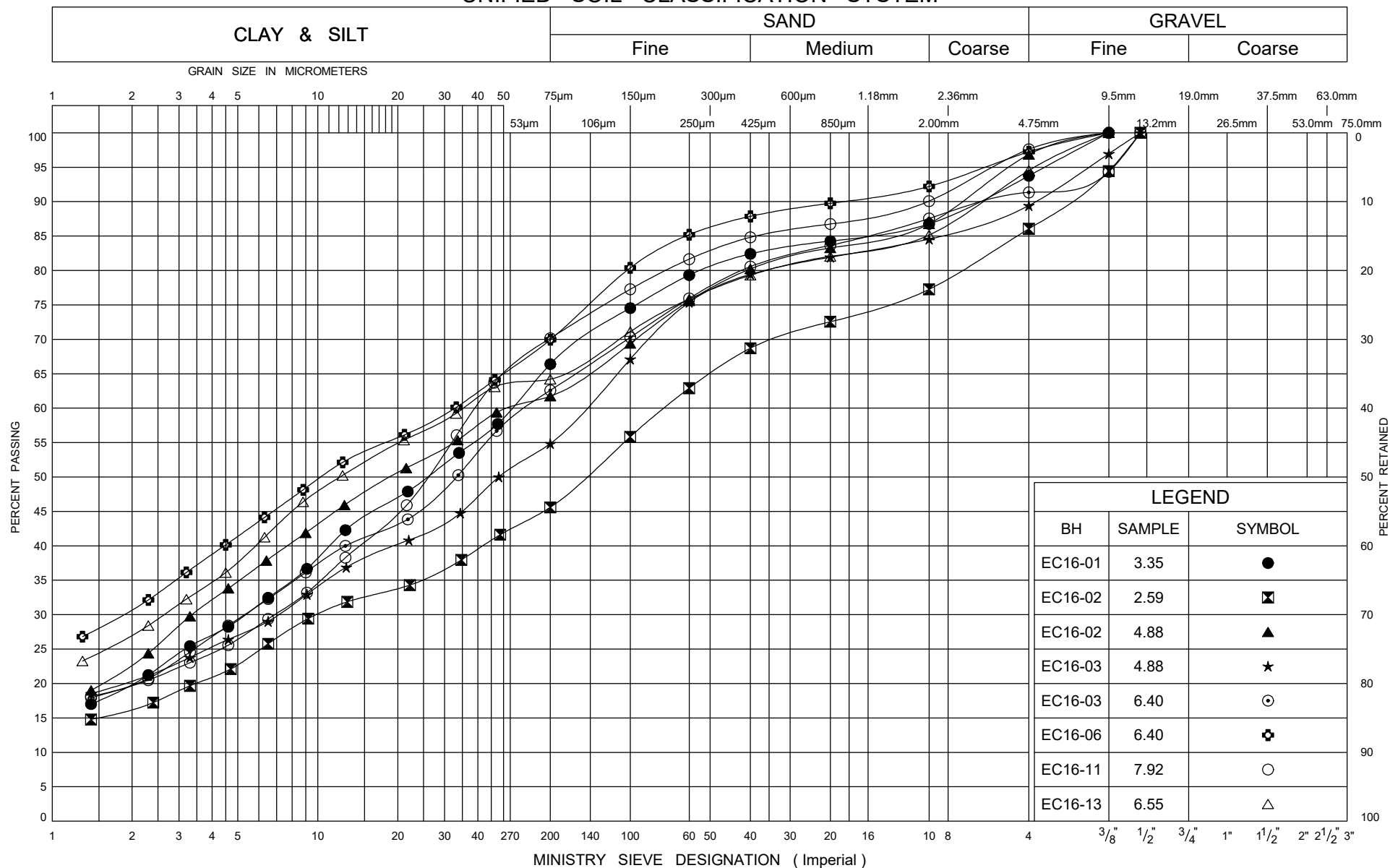
Lower Silt to Silty Sand

FIG No B5

W P 408-88-00

Ellis Creek

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

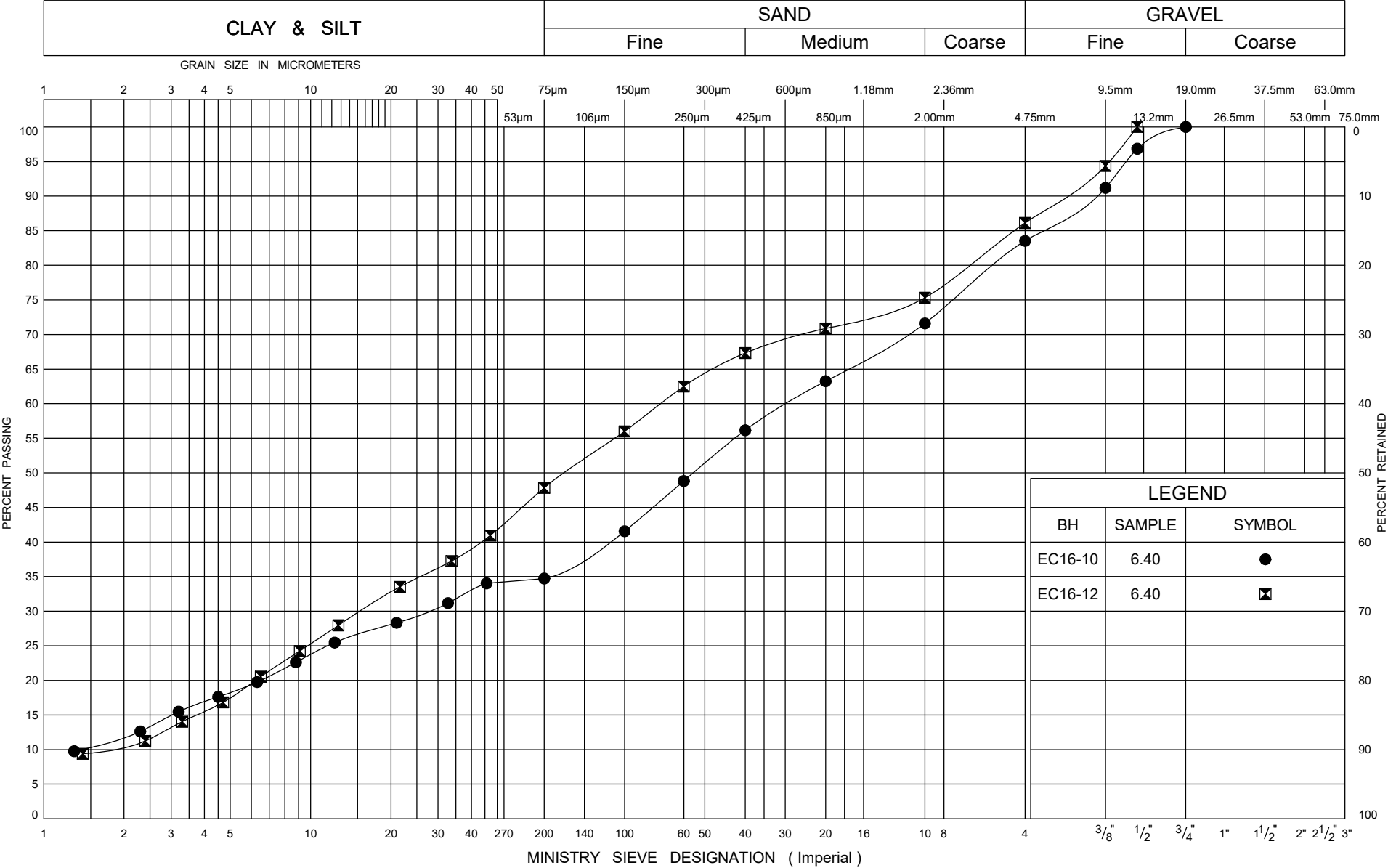
Silty Clay Till

FIG No B6

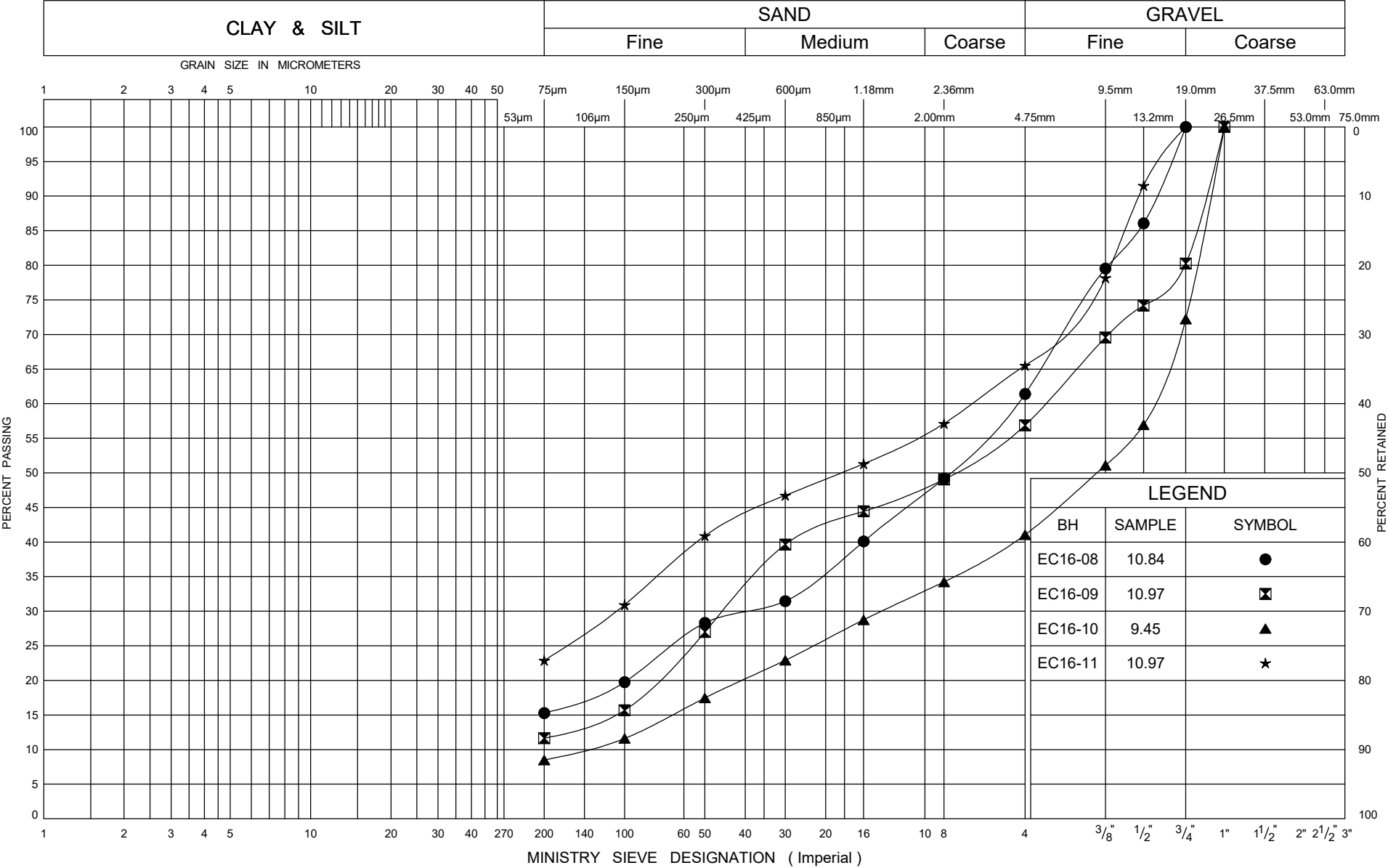
W P 408-88-00

Ellis Creek

UNIFIED SOIL CLASSIFICATION SYSTEM



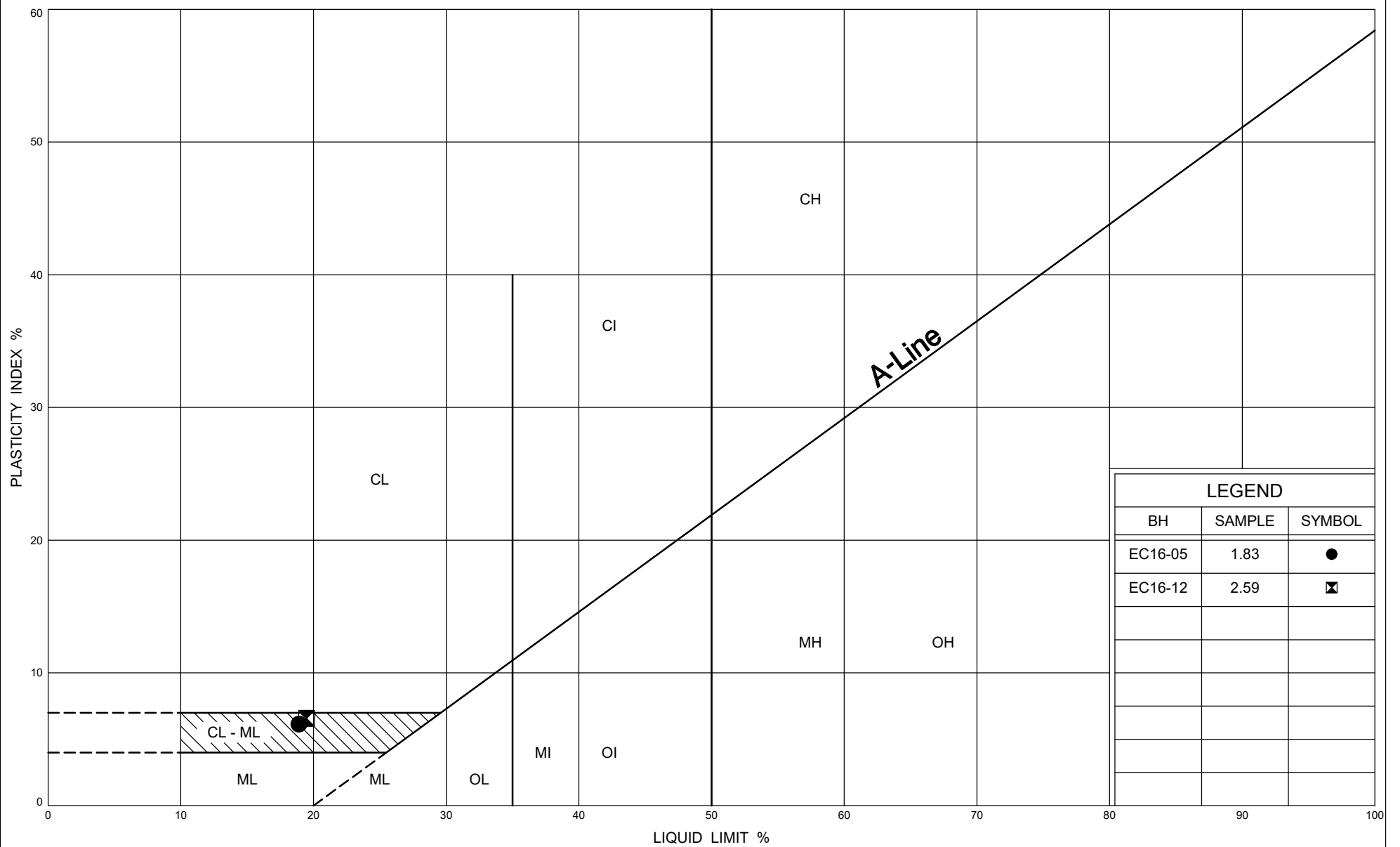
UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
Lower Sand and Gravel

FIG No B8
W P 408-88-00
Ellis Creek





LEGEND		
BH	SAMPLE	SYMBOL
EC16-05	1.83	●
EC16-12	2.59	☒



Ministry of
Transportation

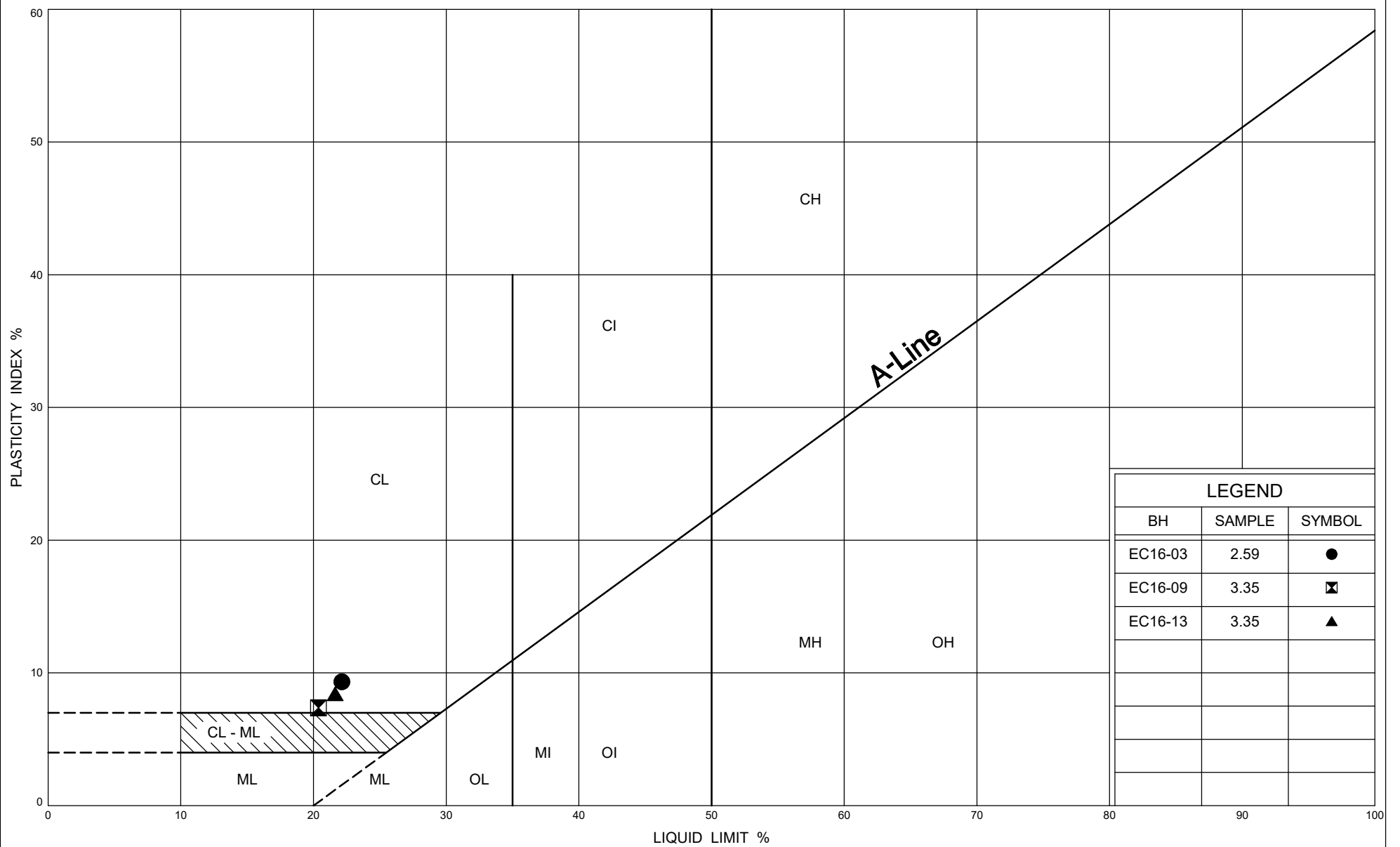
PLASTICITY CHART

Upper Silt to Silty Sand (Clayey Zones)

FIG No B9

W P 408-88-00

Ellis Creek



Ministry of
Transportation

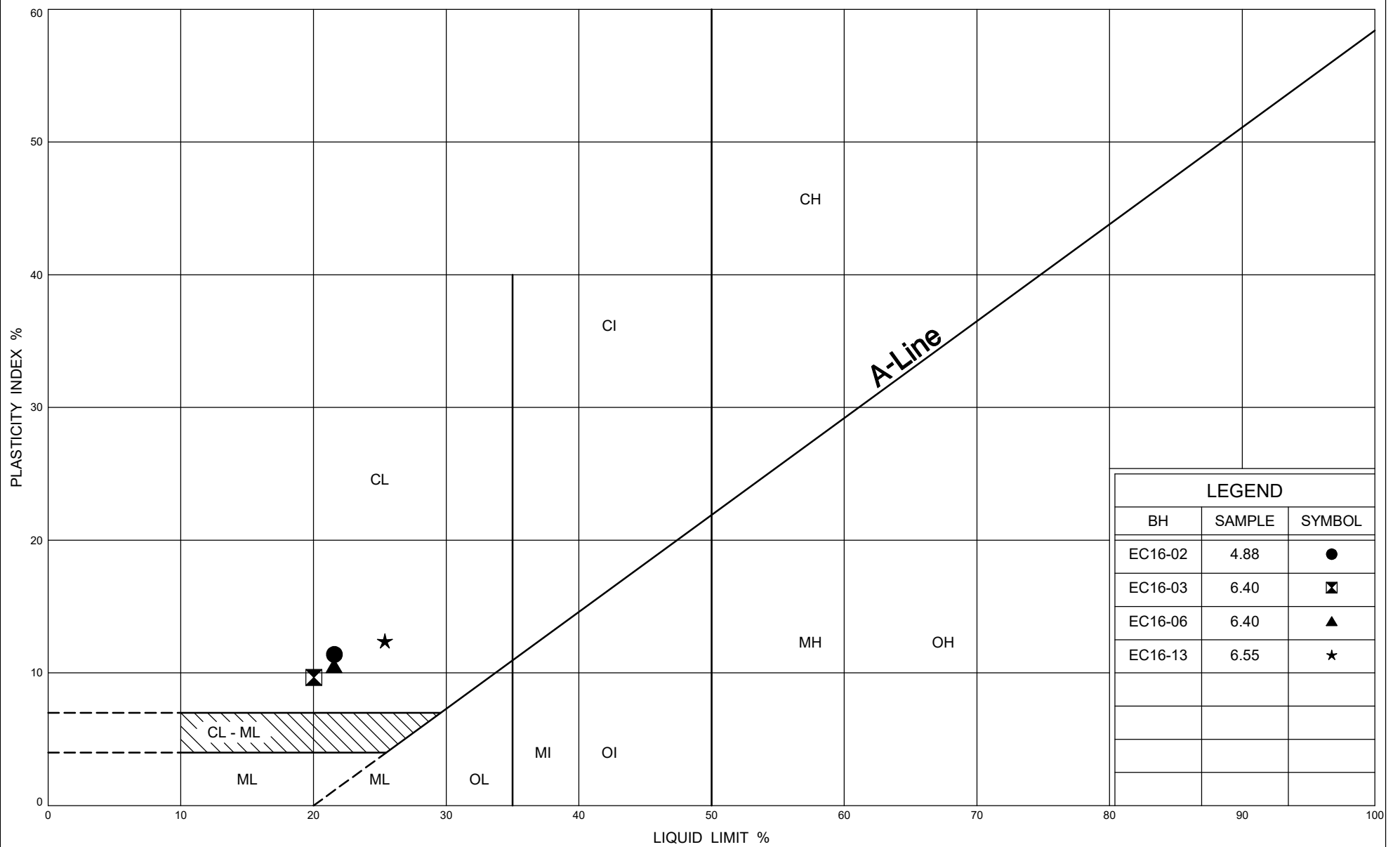
PLASTICITY CHART

Silty Clay

FIG No B10

W P 408-88-00

Ellis Creek



**THURBER ENGINEERING LTD.****POINT LOAD TEST SHEET****ASTM D5731-08**

Job No: 11375
Client: WSP
Project Name: Hwy 7-New Ellis Creek Bridges
Core Size: NQ **BH No :** EC16-04

Date Drilled: 19-Jan-18
Date Tested: 25-Jan-18
Tester: KF
Reviewed by:

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	14.5	D	19.6	46.8	78.3	8.2	197.2	Dolostone	Very Strong
2	2	15.0	D	21.1	46.9	114.4	8.8	212.3	Dolostone	Very Strong
3	2	15.5	D	20.5	47.2	97.3	8.5	203.8	Dolostone	Very Strong
4	3	16.6	D	30.2	47.3	103.0	12.5	299.5	Dolostone	Extremely Strong
5	3	17.4	D	20.2	47.1	94.1	8.4	201.3	Dolostone	Very Strong
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* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1

Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375
 Client: WSP
 Project Name: Hwy 7-New Ellis Creek Bridges
 Core Size: NQ BH No : EC16-05

Date Drilled: 18-Jan-18
 Date Tested: 22-Jan-18
 Tester: KF
 Reviewed by:

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	13.3	D	16.9	47.0	78.6	7.0	169.1	Dolostone	Very Strong
2	2	13.6	A	17.5	47.5	52.5	5.5	132.2	Dolostone	Very Strong
3	2	14.7	D	16.3	47.3	82.0	6.7	161.9	Dolostone	Very Strong
4	3	16.1	D	18.0	47.4	138.3	7.4	177.7	Dolostone	Very Strong
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 Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
- * Diametral Test should have $0.7 \times D$ on either side of test point.
- * Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375
Client: WSP
Project Name: Hwy 7-New Ellis Creek Bridges
Core Size: NQ BH No : EC16-06

Date Drilled: 17-Jan-18
Date Tested: 22-Jan-18
Tester: KF
Reviewed by:

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	14.7	D	20.7	46.9	88.8	8.7	208.7	Dolostone	Very Strong
2	1	15.5	D	16.3	47.2	107.5	6.7	161.6	Dolostone	Very Strong
3	2	16.3	D	14.6	47.3	131.5	6.1	145.3	Dolostone	Very Strong
4	2	17.0	D	17.5	47.5	179.4	7.2	172.2	Dolostone	Very Strong
5										
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* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1

Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375
 Client: WSP
 Project Name: Hwy 7-New Ellis Creek Bridges
 Core Size: HQ BH No : EC16-07

Date Drilled: 09-Jul-18
 Date Tested: 17-Jul-18
 Tester: BS
 Reviewed by:

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	12.6	D	15.1	62.4	64.5	4.1	97.4	Dolostone	Strong
2	1	13.2	D	16.4	62.3	62.3	4.4	106.1	Dolostone	Very Strong
3	1	13.8	D	22.5	62.4	67.7	6.0	145.1	Dolostone	Very Strong
4	2	14.2	D	4.1	62.4	61.5	1.1	26.2	Dolostone	Medium Strong
5	2	14.8	D	22.1	62.3	66.0	5.9	142.8	Dolostone	Very Strong
6										
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- * Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375
 Client: WSP
 Project Name: Hwy 7-New Ellis Creek Bridges
 Core Size: HQ BH No : EC16-08

Date Drilled: 10-Jul-18
 Date Tested: 17-Jul-18
 Tester: BS
 Reviewed by:

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	2	13.8	D	18.7	62.4	63.5	5.0	120.7	Dolostone	Very Strong
2	2	14.4	D	16.1	62.3	62.0	4.4	104.5	Dolostone	Very Strong
3	3	15.2	D	24.5	62.2	64.3	6.6	158.8	Dolostone	Very Strong
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- * It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
- Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
- * Diametral Test should have $0.7 \times D$ on either side of test point.
- * Correlation factor to obtain UCS values is 24.



FINAL REPORT

CA14445-AUG18 R1

11375

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

Client Thurber Engineering Ltd.

Address 103, 2010 Winston Park Drive
Oakville, ON
L6H 5R7, Canada

Contact Rocio Palomeque

Telephone 905-829-8666 x 263

Facsimile

Email rreyna@thurber.ca

Project 11375

Order Number

Samples Soil (5)

LABORATORY DETAILS

Project Specialist Deanna Edwards, B.Sc, C.Chem

Laboratory SGS Canada Inc.

Address 185 Concession St., Lakefield ON, K0L 2H0

Telephone 705-652-2000

Facsimile 705-652-6365

Email deanna.edwards@sgs.com

SGS Reference CA14445-AUG18

Received 08/16/2018

Approved 08/23/2018

Report Number CA14445-AUG18 R1

Date Reported 08/23/2018

COMMENTS

Temperature of Sample upon Receipt: 6 degrees C

Cooling Agent Present.

Custody Seal Present&intact.

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Deanna Edwards, B.Sc, C.Chem





TABLE OF CONTENTS

First Page..... 1

Index..... 2

Results..... 3-4

QC Summary..... 5-6

Legend..... 7

Annexes..... 8-9



FINAL REPORT

CA14445-AUG18 R1

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Palomeque

Samplers: N/A

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6	7	8	9
Sample Name	RS16-03-SS4	RW7-01-SS3	RW1-04-SS2	NE16-10 SS4	EC16-08 SS3
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	18/05/2018	05/06/2018	06/06/2018	27/04/2018	27/04/2018

Parameter	Units	RL		Result	Result	Result	Result	Result
Corrosivity Index								
Corrosivity Index	none	1		4.0	4.0	6.5	4.0	4.5
Soil Redox Potential	mV	-		246	362	187	205	169
Sulphide	%	0.02		< 0.02	< 0.02	0.04	< 0.02	0.86
pH	no unit	0.05		8.87	9.36	10.7	9.02	8.15
Resistivity (calculated)	ohms.cm	-9999		3320	10500	4120	4070	4410

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6	7	8	9
Sample Name	RS16-03-SS4	RW7-01-SS3	RW1-04-SS2	NE16-10 SS4	EC16-08 SS3
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	18/05/2018	05/06/2018	06/06/2018	27/04/2018	27/04/2018

Parameter	Units	RL		Result	Result	Result	Result	Result
General Chemistry								
Conductivity	uS/cm	2		301	95	243	246	227

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7	8	9
Sample Name	RS16-03-SS4	RW7-01-SS3	RW1-04-SS2	NE16-10 SS4	EC16-08 SS3
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	18/05/2018	05/06/2018	06/06/2018	27/04/2018	27/04/2018

Parameter	Units	RL		Result	Result	Result	Result	Result
Metals and Inorganics								
Moisture Content	%	0.1		19.4	3.0	7.6	11.0	13.9
Sulphate	µg/g	0.4		70	6.6	270	9.1	710



FINAL REPORT

CA14445-AUG18 R1

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Palomeque

Samplers: N/A

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6	7	8	9
Sample Name	RS16-03-SS4	RW7-01-SS3	RW1-04-SS2	NE16-10 SS4	EC16-08 SS3
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	18/05/2018	05/06/2018	06/06/2018	27/04/2018	27/04/2018

Parameter	Units	RL		Result	Result	Result	Result	Result
Other (ORP)								
Chloride	µg/g	0.4		240	13	60	130	4.4



FINAL REPORT

CA14445-AUG18 R1

QC SUMMARY

Anions by IC
Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0280-AUG18	µg/g	0.4	<0.4	2	20	96	80	120	97	75	125
Sulphate	DIO0280-AUG18	µg/g	0.4	<0.4	5	20	97	80	120	81	75	125

Carbon/Sulphur
Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0022-AUG18	%	0.02	<0.02	99	20	99	80	120			

Conductivity
Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0253-AUG18	uS/cm	2	< 0.002	0	10	99	90	110	NA		



QC SUMMARY

pH
Method: SM 4500 | Internal ref.: ME-CA-1ENVIEWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0253-AUG18	no unit	0.05	NA	0		101			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.

RL Reporting Limit.

↑ Reporting limit raised.

↓ Reporting limit lowered.

NA The sample was not analysed for this analyte

ND Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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-- End of Analytical Report --



SGS Environment,
Health and Safety

Request for Laboratory Services and CHAIN OF CUSTODY

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- London: 657 Consortium Court, London, ON N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361 Web: www.ca.sgs.com

No: 00864
Page 1 of 1

Received By: Volvo Col
Received Date: 08/15/18 (mm/dd/yy)
Received Time: 12:00 am (pm) (circle)

Received By (signature): [Signature]
Custody Seal Present: Y (circle)
Custody Seal Intact: Y (circle)

Cooling Agent Present: Y (circle)
Temperature Upon Receipt (°C): 13.14, 12

LAB LIMS #: CA 14445-603
Accession #: ACC18

REPORT INFORMATION

Company: T Huber Engineering Ltd.
Contact: Rocio Palomeque Reyna
Address: 103-2010 Winston Park Dr.
Oakville, ON L6H 5R7
Phone: 905-829-8666 x260
Fax: P. Reyna & Huber, CA
Email: [Redacted]

INVOICE INFORMATION

☐ (same as Report Information)
Company: _____
Contact: _____
Address: _____
Phone: _____
Email: _____

PROJECT INFORMATION

Quotation #: 11375 P.O. #: _____
Project #: _____ Site Location/ID: _____
TURNAROUND TIME (TAT) REQUIRED
☒ Regular TAT (5-7days) TATs are quoted in business days (exclude statutory holidays & weekends).
Samples received after 3pm or on weekends : TAT begins the next business day
RUSH TAT (Additional Charges May Apply) ☐ 1 Day ☐ 2 Days ☐ 3-4 Days
PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION
Specify Due Date: _____ Rush Confirmation ID: _____

DRINKING WATER SAMPLES (POTABLE WATER FOR HUMAN CONSUMPTION) MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

Regulation 153 (2011):
☐ Table 1 ☐ Res/Park ☐ Soil Texture: _____
☐ Table 2 ☐ Ind/Com ☐ Coarse _____
☐ Table 3 ☐ Agr/Other ☐ Medium _____
☐ Table _____ ☐ Fine _____
Other Regulations: _____
Sewer By-Law: ☐ Sanitary ☐ Storm
☐ PWQO ☐ MMER
☐ CCME ☐ Other: _____ Municipality: _____

RECORD OF SITE CONDITION (RSC)

☐ YES ☐ NO

SAMPLE IDENTIFICATION

	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1	RS16-03 - Sg4	May 18, 2018	1	Soil
2				
3	RW7-01 - S53	June 5, 2018	1	Soil
4				
5	RW1-04 - S52	June 6, 2018	1	Soil
6				
7	NE16-10 S54	Aug 24, 2018	1	Soil
8				
9	EC16-08 S53	July 16, 2018	1	Soil
10				

ANALYSIS REQUESTED

COMMENTS:
Field Filtered (F)
Preserved (P)

Observations/Comments/Special Instructions

Sampled By (NAME): _____ Signature: [Signature] Date: 08/15/2018 (mm/dd/yy) Pink Copy - Client
Relinquished by (NAME): _____ Signature: _____ Date: _____ (mm/dd/yy) Yellow & White Copy - SGS



SAMPLE INTEGRITY REPORT

Project Number: 11375

ONTARIO REGULATION 153/04

SGS Sample ID CA14445-Aug18
Date / Time Sampled see CoC

Client Sample ID

ALL

Sample Submission General Sample Integrity Violations

- Temperature >10 C upon receipt if not sampled same day ☐
- No evidence of cooling trend initiated if sampled same day ☐
- Chain of Custody not submitted ☐
- Chain of Custody incomplete ☐
- Chain of Custody not signed / dated ☒
- Chain of Custody not a current version ☐
- Bottles / Samples listed on CoC but not received ☐
- Bottles / Samples received but not listed on the CoC ☐
- Sample container received empty ☐

Sample Specific Sample Integrity Violations

- | | | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Sample received past hold time | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Incorrect preservation (including no preservation where required) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Headspace present in VOC vial (aqueous) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Sample(s) received frozen | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Bottle(s) broken or damaged in transport | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Discrepancy between sample label and chain of custody | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Analysis requirements absent / unclear | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Missing or incorrect sample label(s) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Inappropriate sample container used | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Insufficient number of bottles received | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Limited sample volume | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Insufficient sample volume | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Sample contains multiple phases | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Sediment Log

- | | | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Groundwater samples contain visible sediment / particulate | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Groundwater contains greater than 1cm of sediment / particulate matter in bottle | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Additional Comments/Remarks:

No issues upon receipt



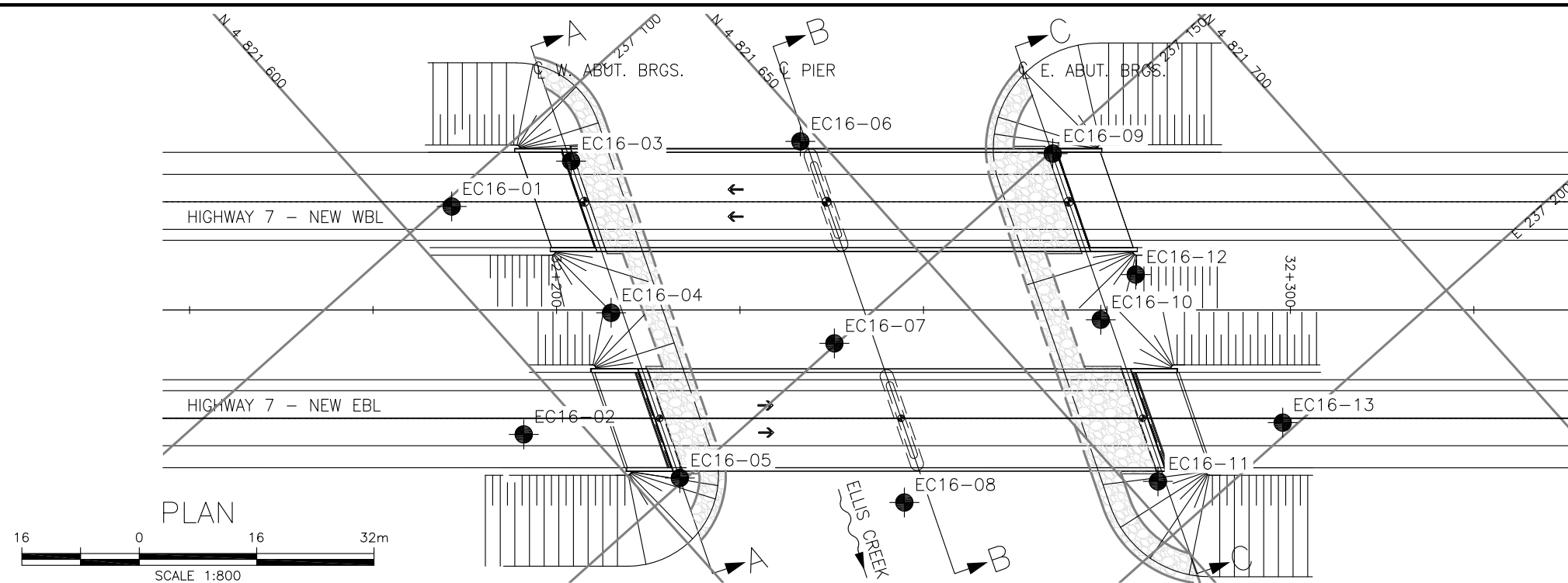
Initials:

KH



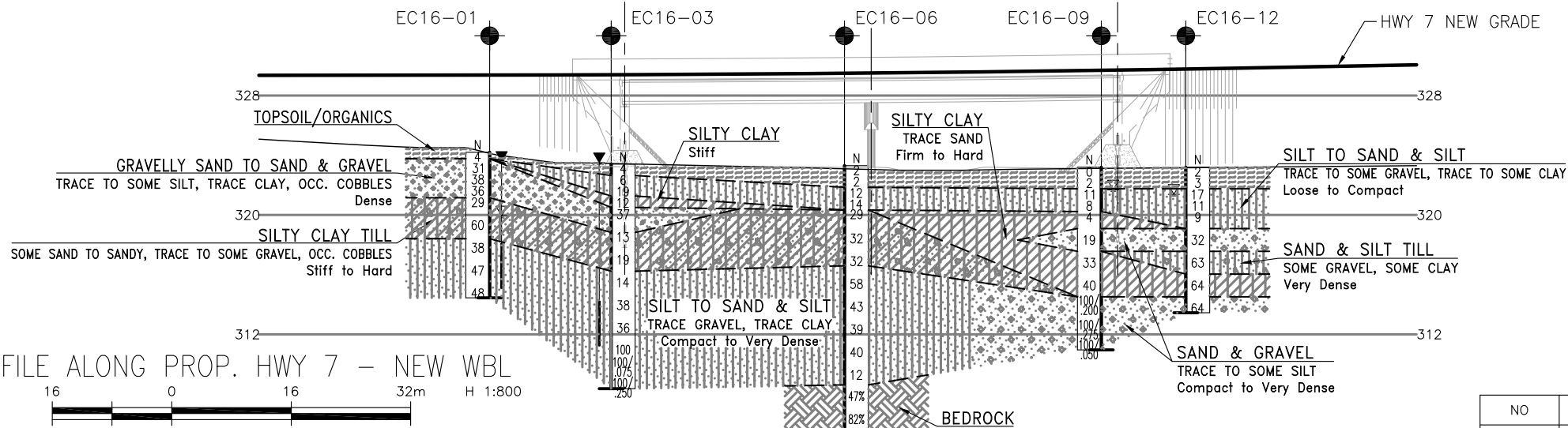
Appendix C

Borehole Locations and Soil Strata Drawings

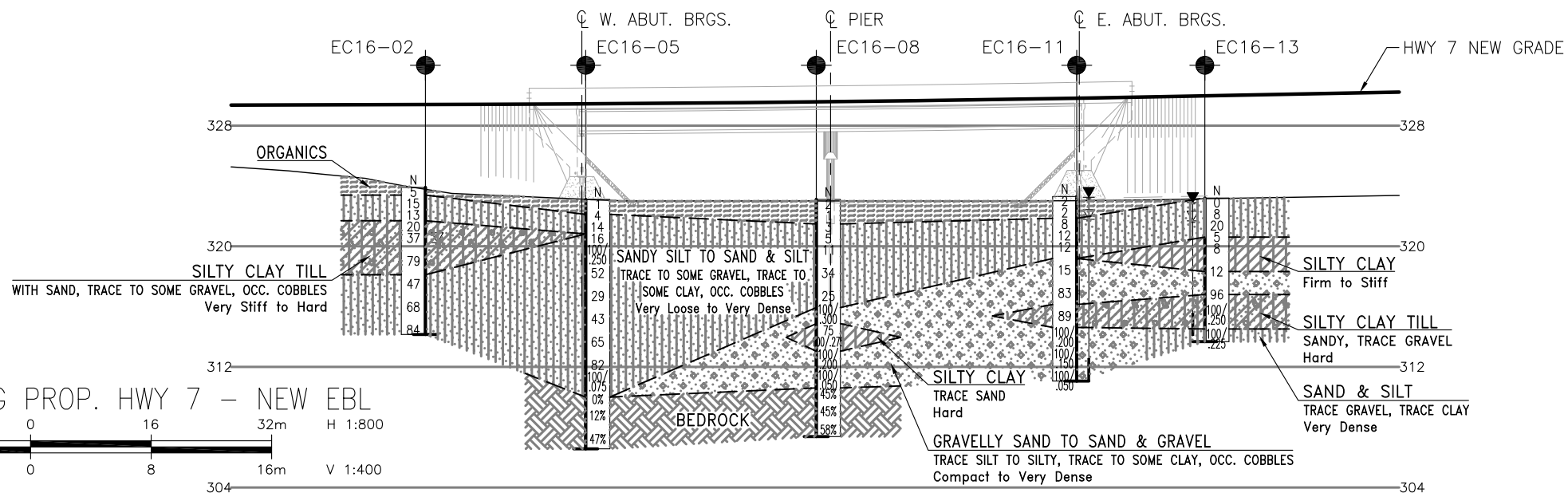


PLAN

SCALE 1:800



PROFILE ALONG PROP. HWY 7 - NEW WBL

H 1:800
V 1:400

PROFILE ALONG PROP. HWY 7 - NEW EBL

H 1:800
V 1:400

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

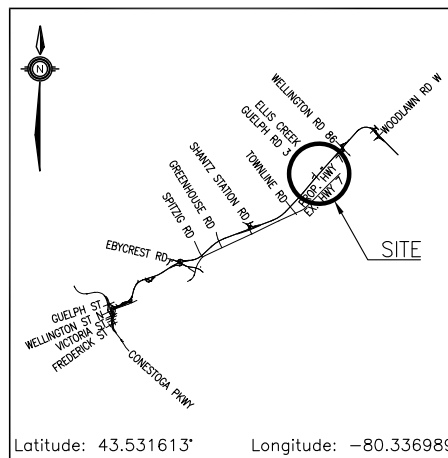


CONT No
GWP No 408-88-00

HIGHWAY 7 - NEW
ELLIS CREEK
PROPOSED BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA



THURBER ENGINEERING LTD.



Latitude: 43.531613°

Longitude: -80.336989°

KEYPLAN

LEGEND

●	Borehole (Current Investigation)
○	Borehole (2008 Investigation)
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
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

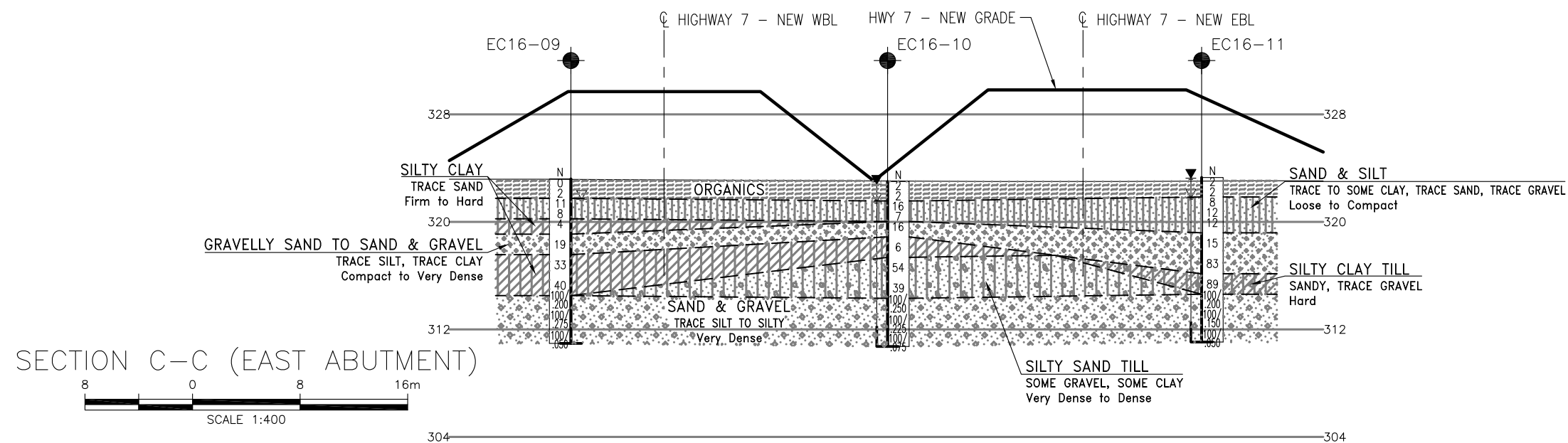
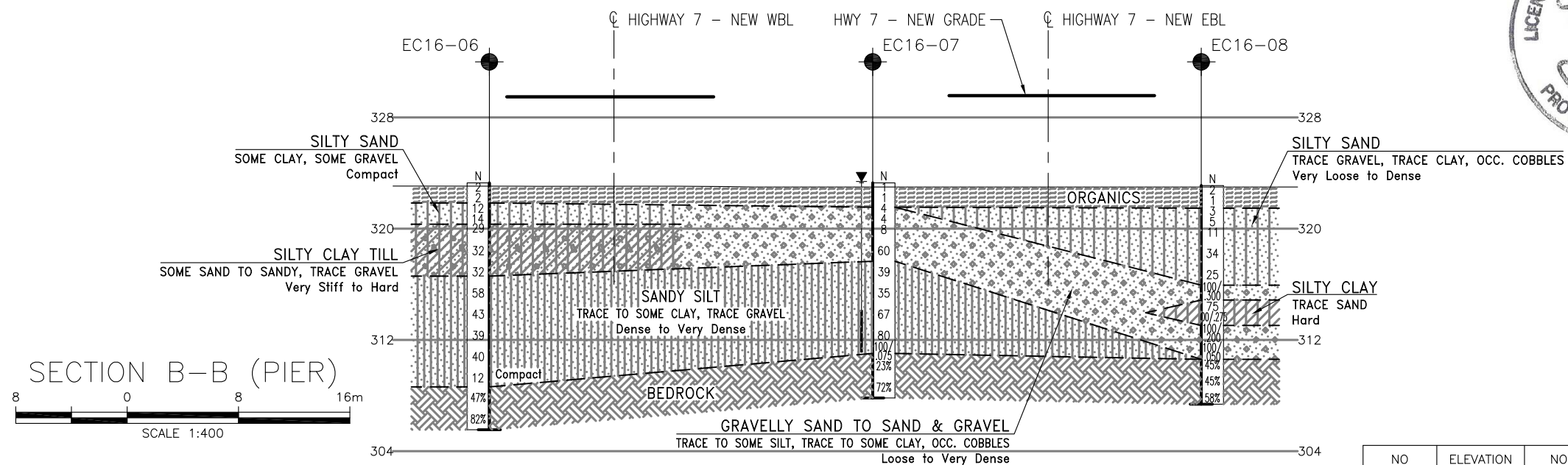
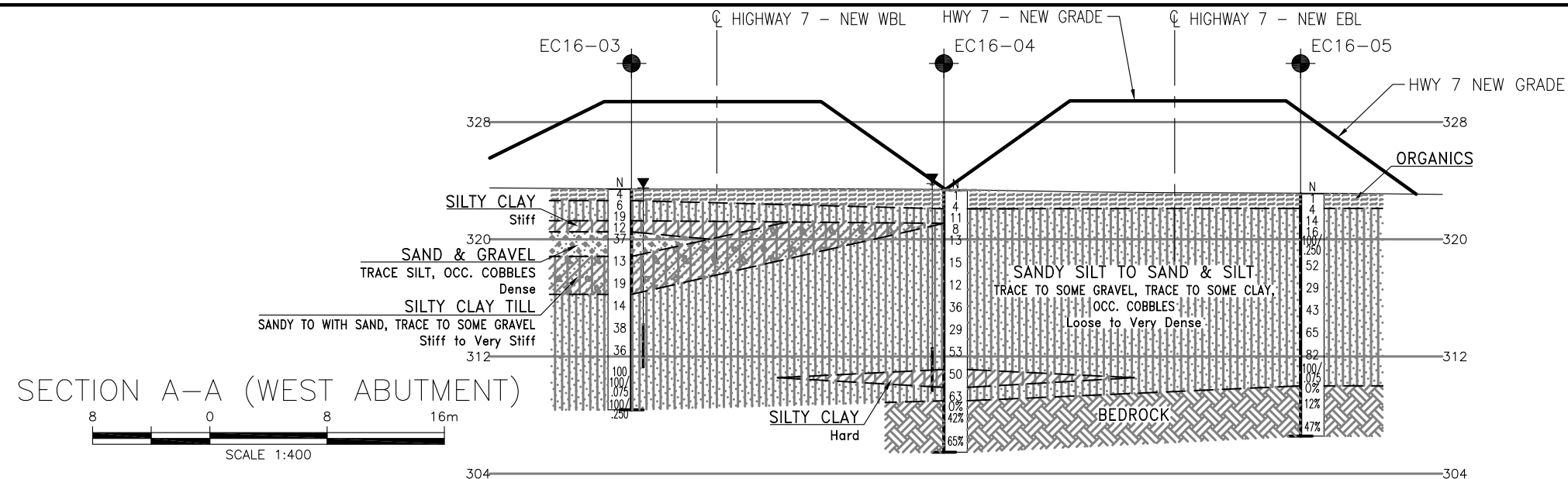
NO	ELEVATION	NORTHING	EASTING
EC16-01	324.2	4 821 606.7	237 101.1
EC16-02	323.9	4 821 593.3	237 130.8
EC16-03	323.4	4 821 622.9	237 107.3
EC16-04	323.3	4 821 613.2	237 126.4
EC16-05	323.1	4 821 605.1	237 149.4
EC16-06	323.3	4 821 648.0	237 126.2
EC16-07	323.3	4 821 633.1	237 149.8
EC16-08	323.1	4 821 625.7	237 172.3
EC16-09	323.2	4 821 672.5	237 150.3
EC16-10	323.0	4 821 662.3	237 171.6
EC16-11	323.3	4 821 653.4	237 193.2
EC16-12	323.2	4 821 669.9	237 170.2

-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.
- Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 40P9-59

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			</
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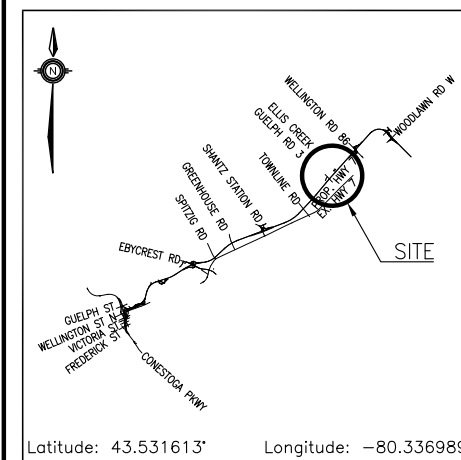


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN








CONT No
GWP No 408-88-00

HIGHWAY 7 - NEW ELLIS CREEK PROPOSED BRIDGE BOREHOLE LOCATIONS AND SOIL STRATA	SHEET
---	-------



KEYPLAN

LEGEND

	Borehole (Current Investigation)
	Borehole (2008 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
EC16-01	324.2	4 821 606.7	237 101.
EC16-02	323.9	4 821 593.3	237 130.
EC16-03	323.4	4 821 622.9	237 107.
EC16-04	323.3	4 821 613.2	237 126.
EC16-05	323.1	4 821 605.1	237 149.
EC16-06	323.3	4 821 648.0	237 126.
EC16-07	323.3	4 821 633.1	237 149.
EC16-08	323.1	4 821 625.7	237 172.
EC16-09	323.2	4 821 672.5	237 150.
EC16-10	323.0	4 821 662.3	237 171.
EC16-11	323.3	4 821 653.4	237 193.
EC16-12	323.2	4 821 669.9	237 170.

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 40P9-59

[illegible]