



THURBER ENGINEERING LTD.

**PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
EASTBOUND DEEP CUT
STA.20+450 TO 20+900, HORTON TOWNSHIP
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009**

Geocres No.: 31F07-008

Report to:

Ministry of Transportation Ontario

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Longitude: -76.652285°

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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

Thurber Engineering Ltd. (Thurber) has been engaged by the Ministry of Transportation Ontario (MTO) to carry out Foundation Investigations to support the design of the Highway 17 Twinning Project which extends from Scheel Drive westerly to 3 km west of Bruce Street within the County of Renfrew, Ontario. Thurber carried out the investigations under Ministry of Transportation (MTO) Assignment No. 4018-E-0009.

This report addresses the proposed eastbound Highway 17 cut slope located between the Bonnechere River and O'Brien Road (approx. Sta. 20+450 to 20+900) in Horton Township within the Renfrew County, Ontario. The existing Highway 17 alignment at this site will become the future Highway 17 westbound lanes and new eastbound lanes will be constructed to the south of the existing alignment at this location.

This section of the report presents the factual findings obtained from the foundation investigation conducted by Thurber as part of the current study.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results, and a written description of the subsurface conditions.

It should be noted that the use of and reliance on Part 1 of the Report is governed by and limited to the terms and conditions set out in the Report and a reliance letter. The Preferred Proponent remains responsible to assess the need for additional investigations and to complete that work.

2 SITE DESCRIPTION

2.1 General

For project purposes, Highway 17 is described as oriented east-west. It is noted that the stations on the proposed eastbound lanes do not match those of the existing highway (future westbound lanes). For clarity, all station references in this report will be with respect to the new eastbound alignment unless noted otherwise. The proposed earth cut is located along the south side of the



proposed Highway 17 eastbound lanes between the Bonnechere River and the O'Brien Road intersection (between Sta. 20+450 and 20+900).

The side slope of the existing cut to the south of the current Highway 17 is inclined at approximately 2.5H:1V to 2.0H:1V. Between the crest of that existing cut slope and the southern right-of-way limit, the ground is relatively flat. Slope heights are variable but are typically less than 10 m between Sta. 20+450 and 20+900. Visible signs of global instabilities were not observed. Some trees, grass, shrubs characterize the face of the slopes.

At the site, the existing Highway 17 is a two-lane highway and has a posted speed limit of 90 km/h. Based on the available CAD profile drawings, the existing highway profile increases from Elevation 112.0 m at Sta. 20+450 to 124.9 m at Sta. 20+900. The eastbound shoulder has a width ranging from approximately 4.5 m to 5.0 m. Traffic volumes on this section of Highway 17 are understood to have been 12,300 AADT in 2016.

The area directly north of the highway generally consists of undeveloped private property vegetated with grasses, shrubs, deciduous, and coniferous trees. A grassed property is present at the crest of the existing slope, directly south of the highway right-of-way, and includes a Library and Archives building between approximately Sta. 20+600 and 20+700. Overhead utility lines parallel the westbound ditch and cross the highway near Sta. 20+925. Storm water drainage in the area is to roadside ditch at the toe of the slope. Water flows toward the Bonnechere, which is located approximately 170 m west of Sta. 20+450.

Photographs of the project area are included in Appendix D. These photographs show the existing condition of the highway embankment and existing earth cut slope at the time of the field investigation.

2.2 Site Geology

According to Crins et al. 2009¹ the project area is described as Ecoregion 6E (Lake Simcoe-Rideau Ecoregion) within the Mixedwood Plains Ecozone. According to Wester et al. 2018² the ecoregion is subdivided into Ecodistrict 6E-16 (Pembroke Ecodistrict). The area is characterized by glaciolacustrine dominated landscape overlying a mix of Paleozoic to Precambrian bedrock.

Based on published geological information in *The Physiography of Southern Ontario* by Chapman and Putnam (1984), the site lies within the physiographic region known as the Ottawa Valley Clay Plains. The Ottawa Valley Clay Plains are characterized primarily by clay plains deposited by the Champlain Sea (Leda Clay) interrupted by ridges of rock or sand.

¹ <https://files.ontario.ca/mnrf-ecosystemspart1-accessible-july2018-en-2020-01-16.pdf>

² <https://files.ontario.ca/ecosystems-ontario-part2-03262019.pdf>



Base mapping by the Ontario Geological Survey (MRD126)³ indicates the bedrock in the area is carbonate metasedimentary rocks, marble, calc-silicate rocks, skarn, tectonic breccias of the Grenville Supergroup and Flinton Group.

3 SITE INVESTIGATION AND FIELD TESTING

As part of the current assignment, foundation investigations were conducted by Thurber at several locations along the Highway 17 twinning project boundaries. The available information relevant to the current site was reviewed prior to this investigation and can be found in the Geocres Library under Geocres Number 31F-216 (O'Brien Road Interchange) and 31F-236 (Bonnechere River Bridge). From those investigations, Boreholes OBR19-14, OBR19-15, OBR19-16, BON19-6, BON19-7, BON19-8, and BON19-9 are relevant to the present report and have been included in the discussion below and in Appendix B.

Boreholes BON19-6 through BON19-9 were drilled off-road between approximate Sta. 20+400 and 20+530 between September 14 and 17, 2020, using a CME 45 track mounted drill equipped with hollow stem augers. Boreholes OBR19-14, OBR19-15, and OBR19-16 were drilled off-road between approximate Sta. 20+860 and 20+960 on February 5 and 6, 2020, using a CME 55 track mounted drill equipped with hollow stem augers.

The foundation investigation and field-testing program was augmented with ten additional off-road boreholes identified as EB23-01 through EB23-10 that were put down between March 13 and 26, 2024. The boreholes were advanced with a CME 75 track mounted drill rig utilizing hollow stem augers and NW casing.

Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

A summary of the borehole coordinates, elevations, and termination depths is provided in Table 3-1. The locations and elevations of the boreholes were surveyed by Thurber with a Trimble Catalyst DA1 antenna with centimeter accuracy and were measured relative to BM HCP 102 (Elevation 129.023 m). Horizontal locations were measured by Thurber relative to existing site features. The elevations and borehole coordinates were reviewed and referenced to the survey data provided by the MTO. The borehole coordinates and elevations are shown on the Borehole Location and Soil Strata drawing included in Appendix A and on the individual Record of Borehole sheets included in Appendix B. The borehole coordinates are referenced to MTM Zone 9. The reference stations correspond to those for the new eastbound lanes.

³ <http://www.geologyontario.mndm.gov.on.ca/index.html>

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
EB23-01	Near Crest Sta. 20+450	5 038 384.5 (45.485281)	292 670.5 (-76.655167)	118.6	15.8 (DCPT 21.0)
EB23-02	Near Crest Sta. 20+490	5 038 364 (45.485096)	292 706.1 (-76.65471)	119.6	15.8
EB23-03	Near Crest Sta. 20+545	5 038 340.2 (45.484883)	292 757.0 (-76.654061)	119.8	15.8
EB23-04	Near Crest Sta. 20+590	5 038 317.6 (45.484679)	292 792.8 (-76.653601)	120.7	15.8
EB23-05	Near Crest Sta. 20+645	5 038 290.9 (45.484441)	292 842.5 (-76.652965)	121.6	15.8
EB23-06	Near Crest Sta. 20+705	5 038 261.4 (45.484176)	292 895.5 (-76.652285)	122.7	16.6
EB23-07	Near Crest Sta. 20+745	5 038 243.3 (45.484013)	292 929.8 (-76.651846)	123.5	20.4 (DCPT 22.7)
EB23-08	Near Crest Sta. 20+800	5 038 218.6 (45.483792)	292 981.4 (-76.651186)	126.1	16.6
EB23-09	Near Crest Sta. 20+860	5 038 191.4 (45.483548)	293 030.0 (-76.650563)	127.7	17.5
EB23-10	Near Crest Sta. 20+900	5 038 167.1 (45.483331)	293 064.3 (-76.650124)	128.4	15.8
BON19-6	Near Crest Sta. 20+420	5 038 422.9 (45.485625)	292 651.3 (-76.655414)	116.9	14.3
BON19-7	Near Crest Sta. 20+445	5 038 407.3 (45.485485)	292 674.7 (-76.655113)	118.0	14.3
BON19-8	Near Toe Sta. 20+495	5 038 384.8 (45.485283)	292 718.9 (-76.654548)	117.7	14.3
BON19-9	Near Toe Sta. 20+530	5 038 365.0 (45.485106)	292 751.0 (-76.654137)	117.8	14.0
OBR19-14	Near Crest Sta. 20+970	5 038 130.9 (45.483006)	293 126.1 (-76.649333)	132.2	14.3
OBR19-15	Near Crest Sta. 20+920	5 038 164.8 (45.483311)	293 088.4 (-76.649816)	129.1	12.8
OBR19-16	Near Crest Sta. 20+880	5 038 190.7 (45.483542)	293 049.7 (-76.650316)	127.9	8.2 (DCPT 15.2)



Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D 1586. In-situ shear vane testing was carried out within the cohesive layers, where possible, using an MTO 'N' sized vane in general accordance with ASTM D 2573. Thin-walled (Shelby) Tube samples were obtained in Borehole EB23-01 for further laboratory testing.

Monitoring wells, 50 mm in diameter, were installed in each of Boreholes EB23-02, EB23-05, EB23-09, BON19-6, and OBR19-15 to allow for measurements of the groundwater level after drilling. The details of the well installation are illustrated on the respective Record of Borehole sheets provided in Appendix B. The monitoring wells installed as part of the current investigation will be decommissioned by Thurber, as outlined in the Hydrogeological Investigation and Design Report.

Boreholes without a well were backfilled in accordance with MOE requirements (O.Reg 903, as amended).

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

4 LABORATORY TESTING

Laboratory testing was selected in accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. At least 25% of the recovered soil samples were subjected to testing for grain size distribution analysis and, where appropriate, Atterberg Limits in accordance with MTO and ASTM standards.

The results of the geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and all laboratory results are presented on the figures included in Appendix C.

5 GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata Drawing included in Appendix A. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in the following sections. However, the factual data presented on the Borehole Records takes precedence over the Soil Strata Drawing and the general description. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations. Soil classification is in accordance with the MTO Guideline for Foundation Engineering Services (GFES) Manual (April 2022) and the 5th edition of the Canadian Foundation Engineering Manual (2024).

In general, the stratigraphy west of about Sta. 20+750 consists of a native deposit of clay to silty clay underlain by clayey silt, overlying dense silty sand. The stratigraphy east of about Sta.



20+750 consists of a native deposit of sand over silty clay to clayey silt, which is underlain by a deeper deposit of sand.

5.1 Topsoil

A 50 to 150 mm thick layer topsoil was encountered at the ground surface in Boreholes BON19-6, BON19-7, OBR19-14, OBR19-15, and OBR19-16.

5.2 Sandy Clayey Silt (CL)

A native deposit of sandy clayey silt was encountered at the ground surface in Boreholes EB23-01 through EB23-05 and EB23-08. Varying amounts of organics were noted within the layer. The thickness of the layer ranged from 0.8 to 1.8 m (base Elevation 124.3 to 117.7 m). The SPT N-values ranged from 5 to 10 blows, indicating a very stiff relative density.

The moisture content of the samples tested ranged from 23 to 42%. The results of grain size analyses conducted on two samples of this layer are summarized in the table below and are illustrated on Figure C1 in Appendix C.

Summary of Grain Size Distribution Testing – Sandy Clayey Silt

Soil Particle	Percentage (%)
Gravel	0 – 6
Sand	22 – 32
Silt	37 – 51
Clay	21 – 31

The results of Atterberg Limits testing carried out on two samples of this material are summarized below and are illustrated on Figure C2 in Appendix C. The laboratory results indicate that the sandy clayey silt is of low plasticity (CL).

Summary of Atterberg Limit Testing – Sandy Clayey Silt

Parameter	Value
Liquid Limit	32 – 34
Plastic Limit	19 – 22
Plasticity Index	10 – 15

5.3 Upper Sand and Silty Sand

A deposit of sand to silty sand was encountered at the ground surface in Boreholes EB23-09 and EB23-10, below the topsoil in Boreholes OBR19-14 through OBR19-16, and below the sandy clayey silt in Borehole EB23-08. Shells were encountered within the layer in Boreholes EB23-09 and EB23-10. Where fully penetrated, the thickness of this sand layer ranged from 4.1 m to 10.1 m

(base Elevation 120.2 m to 117.6 m). The layer was not fully penetrated in Boreholes OBR19-14 and OBR19-16 but was proven to extend to depths ranging from 8.2 m to 14.3 m (Elevation 119.7 m to 117.9 m).

The SPT N-values ranged from 2 blows per 0.3 m of penetration to 100 blows for 150 mm of penetration but were generally between about 5 and 26 blows per 0.3 m of penetration, indicating a loose to compact relative density. The practical refusal blow count may also be attributed to the presence of cobbles within the layer.

The moisture content of the samples tested ranged from 3 to 44% but were typically less than 25%. The results of gradation analyses completed on 12 samples of the layer are illustrated in Figures C3 and C4 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheets in Appendix B.

Summary of Grain Size Distribution Testing – Upper Sand to Silty Sand

Soil Particle	Percentage (%)	
Gravel	0 – 36	
Sand	55 – 98	
Silt	19 – 27	2 – 20
Clay	10 – 17	

The results of Atterberg Limit testing conducted on the fines portion of a sample of the deposit from Borehole EB23-10 indicate a non-plastic material.

A sample from the layer in Borehole OBR19-14 had a higher gravel content and a lower sand content than the rest of the tested samples. The results of gradation analyses completed on that sample are summarized below and are illustrated on Figure C5 of Appendix C.

Summary of Grain Size Distribution Testing – Gravel with Silt and Sand

Soil Particle	Percentage (%)
Gravel	62
Sand	32
Silt	6
Clay	

The results of the grainsize analyses carried out on samples of this deposit are also summarized on the Record of Borehole sheets in Appendix B.

5.4 Silty Clay

A native deposit of clay to silty clay to clayey silt was encountered at the ground surface in Boreholes EB23-06, EB23-07, BON19-8, and BON19-9; below the topsoil in Boreholes BON19-6 and BON19-7; below the sandy clayey silt in Boreholes EB23-01 through EB23-05; and below the upper sand to silty sand in Boreholes EB23-08 through EB23-10 and OBR19-15. Sand partings and seams were encountered throughout the deposit.

The upper portion of the deposit has been identified as weathered crust and was noted in all boreholes except for Boreholes EB23-08 through EB23-10 and OBR19-14 through OBR19-16. The thickness of the weathered crust ranges from 7.1 m to 10.7 m (base Elevation 115.9 m to 110.0 m). Where SPTs were conducted within the weathered crust, the N-values ranged from 3 to 17 blows per 0.3 m of penetration but were typically greater 5 blows per 0.3 m of penetration. Field vane tests were attempted within this layer and gave undrained shear strengths of 118 kPa (the maximum values recordable with the available shear vanes), indicating a very stiff consistency. The moisture content of the samples tested ranged from 20 to 46%.

Below the weathered crust, an unweathered portion of the deposit was generally encountered. The unweathered silty clay to clayey silt was also encountered beneath the upper sand to silty sand in Boreholes EB23-08 through EB23-10 and OBR19-15. The unweathered deposit was not fully penetrated in Boreholes EB23-01 and EB23-05 through EB23-09 but was proven to extend to depths ranging from 15.8 m to 20.4 m (Elevation 110.2 to 102.8 m). Where SPT was conducted within the unweathered deposit, the N-values ranged from weight-of-hammer (WH) to 17 blows per 0.3 m of penetration but were typically less than 4 blows. Field vane tests were performed within this layer where possible. Undrained shear strengths were obtained and ranged from 47 kPa to greater than 118 kPa, but were typically greater than 80 kPa, indicating a stiff to very stiff in consistency. Remolded vane tests recorded sensitives typically ranging from 4 to 12, indicating a sensitive to extra sensitive material (CFEM, 2006). The moisture content of the samples tested ranged from 19 to 61%.

The results of grain size analysis tests conducted on 38 samples of this material are summarized in the table below and are illustrated on Figures C6 to C12 in Appendix C.

Summary of Grain Size Distribution Testing – Clay to Silty Clay to Clayey Silt

Soil Particle	Percentage (%)
Gravel	0 – 6
Sand	0 – 9
Silt	36 – 64
Clay	26 – 62

The results of Atterberg Limits testing carried out on 38 samples of this material are summarized below and are illustrated on Figures C13 to C19 in Appendix C. The laboratory results indicate that the clay to silty clay to clayey silt is of high to low plasticity (CH to CI to CL).

Summary of Atterberg Limit Testing – Clay to Silty Clay to Clayey Silt

Parameter	Value
Liquid Limit	23 – 54
Plastic Limit	15 – 29
Plasticity Index	8 – 29

Three samples from the lower portion of the silty clay to clayey silt deposit in Boreholes EB23-04 and EB23-07 had a higher sand content. The results of grain size analysis tests conducted on the three samples from this portion of the deposit are summarized in the table below and are illustrated on Figure C20 in Appendix C.

Summary of Grain Size Distribution Testing – Clayey Silt, some Sand

Soil Particle	Percentage (%)
Gravel	0
Sand	13 – 16
Silt	51 – 66
Clay	21 – 34

The results of Atterberg Limits testing carried out on those 3 samples are illustrated in Figures C13 to C19 in Appendix C. The laboratory results indicate that the clayey silt, some sand is of low plasticity (CL).

Summary of Atterberg Limit Testing – Clayey Silt, some Sand

Parameter	Value
Liquid Limit	26 – 32
Plastic Limit	17 – 18
Plasticity Index	9 – 14

5.5 Lower Sand to Silty Sand

A deeper deposit of dense sand to silty sand was encountered below the clay to silty clay to clayey silt in Boreholes EB23-02, EB23-03, EB23-04, EB23-10, BON19-6 through BON19-9, and OBR19-15. This lower layer was not fully penetrated but was proven to extend to depths ranging from 12.8 m to 15.8 m (Elevation 116.3 m to 102.6 m).

The SPT N-values ranged from 18 blows per 0.3 m of penetration to 100 blow for 280 mm of penetration, but were generally greater than about 35 blows per 0.3 m of penetration, indicating a dense to very dense relative density. Refusal blow counts may also be attributed to the presence of cobbles within the layer.

The moisture content of the samples tested ranged from 2 to 24%. The results of gradation analyses completed on six samples of the layer are illustrated on Figure C21 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheets in Appendix B.

Summary of Grain Size Distribution Testing – Lower Sand to Silty Sand

Soil Particle	Percentage (%)
Gravel	0 – 28
Sand	55 – 83
Silt & Clay	11 – 23

5.6 Refusal

Bedrock was not encountered within the depth of the borehole investigation. However, a Dynamic Cone Penetration Test (DCPT) was carried out below the sampled depth in Boreholes EB23-01 and EB23-07, and a refusal blow count was encountered at tip elevations of 97.6 m and 100.8 m, respectively. A DCPT was also carried out below the sampled depth in Borehole OBR19-16 to a depth of 15.2 m (Elevation 112.7 m), but did not encounter refusal.

5.7 Groundwater

Monitoring wells with a 50 mm of diameter were installed in each of Boreholes EB23-02, EB23-05, EB23-09, BON19-6, and OBR19-15. Groundwater levels recorded in the wells are presented in Table 5-1.

Table 5-1: Summary of Groundwater Levels

Borehole No.	Bottom of Screen Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
EB23-02	108.9	6.1	113.5	March 28, 2024
		3.7	115.9	April 10, 2024
		5.7	113.9	April 24, 2024
		7.4	112.2	June 20, 2024
		8.2	111.4	June 26, 2024
		7.5	112.1	June 28, 2024
		7.6	112.0	August 29, 2024
EB23-05	112.5	0.8	120.8	March 26, 2024
		0.9	120.7	March 28, 2024
		0.6	121.0	April 10, 2024
		0.6	121.0	April 24, 2024
		1.7	119.9	June 27, 2024
		1.7	119.9	June 28, 2024
		1.5	120.1	July 15, 2024
		3.8	117.8	August 29, 2024

Borehole No.	Bottom of Screen Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
EB23-09	118.3	5.7	122.0	March 20, 2024
		5.7	122.0	March 28, 2024
		5.7	122.0	April 10, 2024
		5.5	122.2	April 24, 2024
		5.5	122.2	June 20, 2024
		5.4	122.3	June 27, 2024
		5.9	121.8	July 16, 2024
		5.4	122.3	August 29, 2024
BON19-6 Shallow	110.2	Dry	-	September 29, 2020
		Dry		November 11, 2020
		Dry		August 06, 2021
		Dry		January 11, 2022
		Dry ^(a)		August 29, 2024
BON19-6 Deep	103.3	Dry	-	September 29, 2020
		Dry		November 11, 2020
		Dry		August 06, 2021
		Dry		January 11, 2022
		Dry ^(a)		August 29, 2024
OBR19-15	119.8	8.0	121.1	February 07, 2020
		6.3	122.8	April 21, 2020
		6.9	122.2	September 29, 2020
		6.9	122.2	September 29, 2021
		6.9	122.2	October 04, 2021
		8.0	121.1	October 20, 2021
		7.1	122.0	January 20, 2022
		6.9 ^(a)	122.2	April 24, 2024
		6.8 ^(a)	122.3	August 29, 2024

Note: ^(a) water level taken after borehole log was finalized

These observations are considered short term as they were recorded at discrete times, and it should be noted that the groundwater level at the time of construction may be different and seasonal fluctuations of the groundwater level are to be expected. In particular, groundwater levels may be at a higher elevation after periods of significant and/or prolonged precipitation.

6 MISCELLANEOUS

The borehole locations reflect existing site features and access constraints. The as-drilled locations and ground surface elevation were measured by Thurber following completion of the field program. George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, supplied and operated the drill rigs used to drill, test, sample, install the monitoring wells, and decommission the boreholes. The field investigation was supervised on a full-time basis by Mr. B. Coote, EIT. Overall supervision of the field investigation program was provided by Mr. J. Gray, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa.

Interpretation of the factual data and preparation of this report was completed A. de Oliveira, P.Eng. and M. Kennedy, P.Eng. The report was reviewed by Dr. F. Griffiths, P.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

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PART 2. ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

Part 2 of the report provides an interpretation of the factual data from Part 1 and presents preliminary geotechnical recommendations to assist the project team in designing the proposed deep cut slopes as part of the proposed Highway 17 eastbound lanes between the Bonnechere River and the O'Brien Road intersection (Sta. 20+450 to 20+900) in Horton Township. Thurber carried out the investigation under Ministry of Transportation (MTO) Assignment No. 4018-E-0009.

This preliminary foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation and shall not be used or relied upon for any other purposes or by any other parties including design-build contractors. It should be noted that the use of and reliance on Part 1 of the Report is governed by and limited to the terms and conditions set out in the Report and a reliance letter. The Preferred Proponent remains responsible to assess the need for additional investigations and to complete that work. The Preferred Proponent must make their own interpretation based on the factual data in Part 1 of the report. The information included in Part 2 is not to be relied upon for design purposes and foundation design is the sole responsibility of the Preferred Proponent. No use shall be made of Part 2 or any part thereof. The Preferred Proponent must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The following sections provide preliminary geotechnical recommendations for the construction of the deep soil cuts along the new alignment. The discussion and preliminary recommendations presented in this report are based on information provided by the MTO and the factual data obtained during the current field investigation.

7.1 Background Information

The site is located on the south side of Highway 17 between the Bonnechere River and the O'Brien Road intersection (Sta. 20+450 and 20+900 EBL) in Horton Township, Renfrew County. For project purposes, Highway 17 is herein described as oriented east-west. It is noted that the stations on the proposed eastbound lanes do not match those of the existing highway (future

westbound lanes). For clarity, all station references in this report will be with respect to the new eastbound alignment unless noted otherwise.

The side slopes of the existing cut to the south of the current Highway 17 are typically less than 10 m high and are inclined at approximately 2.5H:1V to 2.0H:1V. Between the crest of the existing slope and the southern right-of-way limit, the ground is relatively flat. Based on the available CAD information, the existing Highway 17 profile (which will become the future westbound lanes) ranges from Elevation 112.0 m at Sta. 20+450 to 124.9 m at Sta. 20+900.

The subsurface stratigraphy west of about Sta. 20+750 EBL consists of a native deposit of clay to silty clay underlain by clayey silt, overlying dense sand. The stratigraphy east of Sta. 20+750 consists of a native deposit of sand over silty clay to clayey silt underlain by a deeper deposit of sand. It is noted that the groundwater elevation in the monitoring wells installed in Boreholes EB23-02, EB23-05, and EB23-09 ranged from 122.3 m to 112.0 m on August 29, 2024.

7.2 Proposed Works

It is understood that the new Highway 17 eastbound lanes will be constructed approximately 40 m south of the existing alignment at this location. The top of pavement elevation of the new eastbound lanes will be similar to the grade of the existing Highway 17 (future westbound) lanes and will require excavation and lowering of the existing grade to meet design elevations. The depth of cut will vary along the site. Table 7-1 summarizes the deep cut site properties at select cross sections. Based on the result of the borehole investigation, no rock excavation is expected at the site.

Table 7-1: Summary of Deep Cut Site Properties

Location	Approximate Stations, EBL (m)	Reference Stations	Earth Excavation Depth ⁽¹⁾ (m)
New EBL	20+450 to 20+900	20+450	10.3
		20+600	7.0
		20+750	5.5
		20+900	6.3

Notes: ⁽¹⁾ Elevation at right-of-way (ROW) minus proposed right ditch elevation

It is understood that two preliminary design options are being considered to accommodate the proximity of the right-of-way and adjacent private property located near the crest of the proposed excavated slope: a 2.0H:1.0V cut slope that would require property acquisition beyond the existing right-of-way; and, a retaining wall constructed within the existing right-of-way that would reduce the encroachment conflicts with the private property. The location of the proposed retaining wall / cut slope alternatives are shown in the drawings dated September 19, 2022 and October 4, 2022, provided by Parsons and included in Appendix A.



The preliminary recommendations presented herein must be reassessed once the preferred alternative for the proposed works is established.

7.3 Applicable Codes and Design Considerations

The preliminary geotechnical assessment presented below has been prepared based on the available data regarding the proposed work, existing ground conditions, and in accordance with the Canadian Highway Bridge Design Code (CHBDC), version CSA S6-19.

The importance category and consequence classification are defined by the Regulatory Authority which, in this case, is the Ministry of Transportation, Ontario (MTO). It is understood that Highway 17 falls under a “Major Route” importance category. This project has been assigned Typical Consequence Classification, in accordance with Section 6.5.1 of the CHBDC. Accordingly, a consequence factor (Ψ) of 1.0, as per Table 6.1 of the CHBDC, has been used in assessing factored geotechnical resistances.

The degree of site and prediction model understanding for this site has been assessed to be typical understanding (Section 6.5.3 of CHBDC).

The frost penetration depth and associated recommendations are provided in Section 9.5.

8 SEISMIC CONSIDERATIONS

8.1 Spectral and Peak Acceleration Hazard Values

The seismic hazard data considered herein for project design is based on the fifth-generation seismic model developed by the Geological Survey of Canada (GSC)⁴. The GSC seismic hazard calculation data sheet for this site for the *reference* ground condition (Site Class C) is presented in Appendix E. The site coefficients used to determine the design spectral acceleration values are a function of the Site Class, PGA, and S_a (0.2). The PGA value at this site provided by GSC for a *reference* Site Class C with a 2% probability of exceedance in 50 years (2475-year event) is 0.225 g. Similarly, the PGA value at this site provided by GSC for a reference Site Class C with a 10% probability of exceedance in 50 years (475-year event) is 0.075 g. These values are to be scaled by $F(\text{PGA})$ based on the *site-specific* Site Class, as discussed in Section 8.2.

8.2 CHBDC Seismic Site Classification

In accordance with the CHBDC, the selection of the seismic site classification is based on the nature of the soil deposits within the upper 30 m of the stratigraphy. As per Table 4.1 within Section 4.4.3.2 of the CHBDC, the site has been classified as a Seismic Site Class D based on the measured shear strength in the cohesive layers and SPT N values obtained in the cohesionless layers.

⁴ <https://earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/calc-en.php>

The $F(PGA)$, as per Table 4.8 within Section 4.4.3.3 of the CHBDC, is equal to 1.14 for this site yielding a scaled *site-specific* Site Class D PGA of 0.26 g for a seismic event with a 2% probability of exceedance in 50 years (2475-year event). Similarly, the $F(PGA)$ is 1.29 and the Site Class D PGA is 0.097 g for a seismic event with a 10% probability of exceedance in 50 years (475 year event).

8.3 Seismic Liquefaction Potential

The susceptibility of the cohesive soils at this site to experience liquefaction/cyclic softening was assessed following the Boulanger and Idriss (2007)⁵ criteria using measured undrained shear strengths. This methodology is appropriate for cohesive soil that will exhibit “clay-like” behaviour and the results of the analysis indicate that the cohesive material at the site is not susceptible to liquefaction or cyclic mobility.

Based on an assessment of the cohesionless soil using the SPT data, following the simplified method as outlined in Chapter C6.14 of the Commentary to the CHBDC, a thickness of the lower portion of the sand to silty sand deposit ranging between about 1.5 m to 2.5 m in Boreholes EB23-08, EB23-09, EB23-10, and OBR19-16 is considered susceptible to liquefaction during a 1 in 2475 year design earthquake. Associated post-seismic reconsolidation settlements of up to about 130 mm are anticipated, based on the available borehole information.

However, since the proposed cut slope treatment (slope flattening, RSS wall, etc.) is a geotechnical system outside of any bridge interface zone, Clause 6.14.2.3b of the CHBDC that states that “*major route geotechnical systems shall have at least 50% of the travelled lanes, but not less than one, available for use following ground motions with a return period of at least 475 years*” applies. As such, the site soils were further assessed and the sand to silty sand in these boreholes are not considered susceptible to liquefaction during a 1 in 475 year design earthquake.

9 PRELIMINARY DESIGN RECOMMENDATIONS

The new Highway 17 eastbound lanes will be constructed approximately 40 m south of the existing alignment at the site. As described in Section 7.2 above, the existing grade along the alignment of the proposed eastbound lanes will have to be lowered to achieve the design grade. The required height of earth cuts is variable and ranges up to about 10.3 m at the highest (see Table 7-1).

9.1 Global Stability of Slope Options

Slope stability assessments of the cut slope design concepts have been carried out perpendicular to the highway alignment at Stations 20+450 and 20+875, locations that are representative of the highest cuts and variable subsurface conditions.

⁵ Boulanger, R. W. and Idriss, I. M. (2007). *Evaluation of cyclic softening in silts and clays*, ASCE, *Journal of Geotechnical and Geoenvironmental Engineering*, 133(6), 641-652.

The recommendations provided in the CHBDC and a Ψ of 1.0 have been applied to generate a target minimum Factor of Safety of 1.5 and 1.3 for soil cut slopes and retaining walls for a permanent and temporary conditions respectively with a typical degree of understanding.

Table 6.3 in Section 6.14.4.1 of the CHBDC indicates a minimum seismic resistance factor of 0.95 for force-based design and 1.0 for performance-based design. Based on these values and Ψ of 1.0, a target Factor of Safety of 1.1 for this temporary condition with a typical degree of understanding is appropriate for the pseudo-static seismic analysis.

The slope stability analyses were carried out using GeoStudio 2024 Slope/W software for limit equilibrium analysis. The analyses considered the two general stratigraphic conditions at the site: an extensive deposit of stiff, silty clay over dense silty sand (Sta. 20+450) and loose to compact sand over silty clay (Sta 20+875). Input parameters for the analysis are based on the SPT N values, undrained shear strength, and the results of laboratory testing. Drained soil parameters for the silty clay are based on the recommendations on strength of clay of the Ottawa area provided by Lefebvre (1981) that are consistent with that assumed for the silty clay at adjacent project sites. The soil parameters used in the analyses are summarized on the stability analyses output figures provided in Appendix F.

9.1.1 Soil Slope Stability

The following additional parameters and assumptions were used in the slope stability analyses considering unreinforced, inclined soil slopes:

- The soil stratigraphy is based on the nearest boreholes.
- Slope geometry is 2H:1V with mid-height benches for earth cut slopes deeper than 6 m.
- A design groundwater level ranging from about Elevation 112.0 m near the western extent of the site (Borehole EB23-02) to about Elevation 122.3 m near the eastern extent (Borehole EB23-09).
- A site adjusted PGA value of 0.05 g, equal to $\frac{1}{2}$ of the site adjusted PGA value (0.097 g) for ground motions with a return period of 475 years, was used for seismic analysis as per Sections 4.4.3.3 and 6.14.2.3 of the CHBDC and outlined in Section 8.2.
- No traffic is anticipated on the upper slopes; therefore, traffic loading was omitted from the analysis.

Copies of the output from the stability analyses are provided in Appendix F. Each output figure shows the slope geometry, groundwater conditions, soil stratigraphy and soil strength parameters utilized in the analysis.

Table 9-1: Slope Stability Analysis Results – Soil Slopes

Condition	Case	Factor of Safety	
		West Extent (Sta. 20+450)	East Extent (Sta. 20+875)
Permanent (no traffic loading)	Long Term (Drained)	1.7 (Fig F1-1)	1.7 (Fig F2-1)
Temporary	Short Term (Undrained)	3.8 (Fig F1-2)	1.7 (Fig F2-2)
Temporary (includes seismic)	Pseudo-Static (Undrained) 475-year	3.2 (Fig F1-3)	1.5 (Fig F2-3)

For the cut slope design, the stability analyses generated the factor of safety values presented in Table 9-1, above.

All results (static and seismic) presented in Table 9-1 meet or exceed the target Factors of Safety.

However, as shown on the associated stability analysis output figures, though the 2H:1V benched slopes are stable and suitable from an engineering standpoint, they extend past the existing right-of-way limit and property acquisition would be required. To minimize the requirement for property acquisition, a Retained Soil System (RSS) wall or similar may be considered.

9.1.2 RSS Retaining Wall Stability

The results of preliminary stability analyses considering RSS walls closer to the right-of-way limit indicated that, though suitable Factors of Safety could be achieved, the RSS wall would encroach significantly beyond the edge of the right-of-way. As such, smaller RSS walls constructed near the slope toe were analysed.

The following additional parameters and assumptions were used in the stability analyses considering slopes retained by RSS walls:

- The soil stratigraphy is based on the nearest boreholes.
- RSS walls up to 4.2 m high with a reinforced soil mass extending 2.0 m to 3.4 m into the slope.
- The backfill behind the RSS wall is constructed of Granular B Type II backfill. The design parameters for Granular B Type II are as described in Section 9.4.
- The backslope retained behind/above the RSS wall is inclined at 2H:1V.
- A site adjusted PGA value of 0.05 g, equal to ½ of the site adjusted PGA value (0.097 g) for ground motions with a return period of 475 years, was used for seismic analysis, as per Sections 4.4.3.3 and 6.14.2.3 of the CHBDC and outlined in Section 8.2.
- No traffic is anticipated on the upper slopes; therefore, traffic loading was omitted from the analysis.

Copies of the output from the stability analyses are provided in Appendix F. Each output figure shows the slope geometry, groundwater conditions, soil stratigraphy and soil strength parameters utilized in the analysis.

Table 9-2: Slope Stability Analysis Results – RSS Walls

Condition	Case	Factor of Safety	
		West Extent (Sta. 20+450)	East Extent (Sta. 20+875)
Permanent (no traffic loading)	Long Term (Drained)	1.5 (Fig F1-4)	1.5 (Fig F2-4)
Temporary	Short Term (Undrained)	2.9 (Fig F1-5)	1.5 (Fig F2-5)
Temporary (includes seismic)	Pseudo-Static Seismic (Undrained)	2.6 (Fig F1-6)	1.3 (Fig F2-6)

The stability analyses considering an RSS toe wall as part of the slopes generated factor of safety values presented in Table 9-2, above.

All the results (static and seismic) presented in Table 9-2 meet or exceed the target Factors of Safety.

The results of the stability analyses considering an RSS wall (Table 9-2) achieved the target Factors of Safety and placed the walls with a minimal impact on the adjacent property. At the western section (Sta. 20+450), the slope crest is approximately 1.0 m in front of the existing right-of-way limit (see Figure F1-4). It is understood that a sliver of property ranging up to about 20 m wide between about Sta. 20+750 and 20+880 is to be acquired to facilitate ramp construction. Considering this proposed right-of-way limit, the slope crest at the eastern section (Sta. 20+875) is approximately 0.3 m in front of the right-of-way limit (see Figure F2-4).

The width of the reinforced block required to satisfy the global stability of the RSS wall has been considered in the slope models as shown. However, it should be noted that the width of the reinforced block required to satisfy the ultimate design of the RSS wall to consider sliding, overturning, and retention of the soil mass (to be carried out by others) may be larger than that shown on results of the global stability analyses since it will be supporting a 2H:1V slope of significant height and could influence the design and feasibility.

Excavations for construction of the bedding layer and RSS wall will extend below the anticipated groundwater level. Considerations of surface and groundwater control during construction are described further in Section 10.3, below.

9.2 Settlement Considerations

The proposed cut slope represents a net unloading; therefore, the underlying soils are anticipated to behave elastically. Rebound of up to about 25 mm should be anticipated as the soils are removed during construction of the eastbound lanes. Given the thickness of the native cohesive

soils after excavation, time dependent swelling is expected to occur rapidly and should be predominantly completed at the end of construction.

9.3 Earth Cut Design

Earth cuts should be constructed in accordance with OPSS.PROV 206 and OPSD 200.020 unless otherwise specified. Horizontal mid-height benches should be provided for surficial stability of earth cut slopes higher than 6 m. To maintain stability of the cut slopes and reduce erosion from flow down the slope, an interceptor ditch should be provided at the top of earth cuts as per both OPSD 200.020. Roadside ditches at the base on the cut slopes are expected to provide an adequate level of surface drainage.

9.3.1 Erosion Protection

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the earth cut slopes. The erodibility of the soil at each site was assessed using the Wischmeier Nomograph. The results are summarized in Table 9-3 below.

The contractor should provide silt fences and erosion control blankets, as required, throughout the duration of the construction and until vegetation is established on the slopes to prevent silt/sediments from running off the site as per OPSS.PROV 804. Normally slope vegetation should be established as soon as possible after completion of the earth cut slopes to control surficial erosion in general accordance with OPSS.PROV 803.

Table 9-3: Deep Cut Soil Erodibility

Soil Type	Wischmeier Nomograph	Erodibility
Sandy Clayey Silt	0.28 – 0.36	Moderate
Clay to Silty Clay	0.21 – 0.38	Moderate
Clayey Silt	0.35 – 0.47	Moderate
Sand to Silty Sand	0.05 – 0.15	Low

The finished earth cut slopes should be inspected for ongoing seepage emerging from the cut slopes. Gravel sheeting or rock protection may be required to provide drainage of the seepage to prevent erosion of the slope face.

9.3.2 Drainage

Prior dewatering of the site is not considered necessary; however, groundwater seepage is expected to enter the open excavation and may require action on the part of the contractor in order to proceed with construction. Some sloughing may occur as a result of groundwater seepage during excavation. The cut should begin at the low end of the deep cut and proceed up the profile to allow drainage as excavation progresses.



The existing groundwater levels measured at the site range from about Elevation 122 m, in the sand at the east end of the site, to about Elevation 112 m in the silty clay at the west end (see Table 5-1 in Section 5.7). These are near the proposed centreline grade of the eastbound Highway 17 lanes and, since local excavation for ditching along the eastbound lanes is expected to vary and will be deeper than the centreline grade, some permanent groundwater lowering may result.

Lowering of the groundwater level could result in settlement of the silty clay at the site. It is anticipated that the settlement of up to about 10 mm at the right-of-way limit could result from lowering of the groundwater table by up to 2 m at the eastbound lane ditches and would have limited impact on the Library and Archives building located about 30 m beyond the right-of-way.

9.3.3 Material Re-Use

It is anticipated that portions of the excavated materials will be suitable for re-use where they meet the requirements stipulated in OPSS.PROV 1010, and they can achieve optimum moisture content and compaction targets at the time of construction. Sensitive marine clay shall not be re-used as structural or earth fill anywhere on the project.

9.4 RSS Wall Design

Retained soil systems (RSS) walls up to 4.2 m high are considered feasible at this site. The design of proprietary RSS walls is the responsibility of the supplier. Typically, such systems do not require full frost protection as they are able to tolerate some movement due to frost heave. The RSS system should be designed in accordance with the MTO RSS Design Guidelines. Once the location and height of the wall is established, recommendations will be provided concerning Performance, Appearance and Acceptance.

Structural backfill material should consist of Granular A or Granular B Type II meeting the OPSS.PROV 1010 and SP110S06 specifications. Large scale direct shear box testing on samples of Granular A and Granular B Type II from several nearby aggregate sources was completed for this project. The results indicate that for design of structural backfill for this project, an internal angle of friction of 40 degrees and 42 degrees can be used for quarry-sourced Granular A and Granular B Type II, respectively, generated within this area provided the effective vertical pressure on the material is less than 150 kPa (Geocres Memorandum 31F-213). An Operational Constraint will be required in the contract restricting the source of Granular A to quarries. Throughout this report, the term “Granular A” is defined as “Quarry-Source Granular A” unless specifically described as “Pit-Source Granular A”.

9.4.1 Subgrade Preparation

All organics, soft or loose deposits, disturbed soils, and deleterious materials must be stripped from the footprint of the retaining wall to expose competent subgrade at or below the desired founding elevations. The fill or other deleterious material is considered unsuitable to support the retaining wall and should be sub-excavated within the foundation footprints and replaced with OPSS.PROV 1010 Granular A or Granular B Type II that is placed and compacted up to the

bedding level as per OPSS.PROV 501. The exposed final subgrade must be inspected to confirm that the subgrade is suitable and uniformly competent.

A minimum 1 m thick engineered fill pad constructed on the underlying undisturbed native soils should be provided below the reinforced retained soil. The engineered fill pad is required to provide a leveling pad and uniform bearing surface. The engineered fill pad should consist of OPSS Granular A or Granular B Type II placed and compacted in accordance with OPSS.PROV 501. Engineered fill pads should be constructed with 1H:1V sides slopes.

Given the sensitive silty clay soils anticipated at the founding level of the retaining wall, construction equipment should not be permitted to travel on the exposed subgrade. The compaction of granular directly above the subgrade may result in disturbance of the material with pumping of fines into the granular and difficulty achieving the specified degree of compaction. After inspection and approval of the silty clay subgrade, protection of the subgrade should include installation of a Class II, non-woven geotextile with a maximum FOS of 150 μm (OPSS.PROV 1860) installed beneath the Granular A material. The geotextile should be placed as soon as possible after preparation of the final subgrade level and the excavation should be backfilled to the top of the bedding elevation to protect the subgrade from disturbance from both construction traffic and weather. An NSSP is provided in Appendix G to include in the contract documents to alert the Contractor of the sensitive nature of the foundation soils.

Based on the encountered groundwater levels, it is noted that construction is expected to extend below the anticipated groundwater elevation during subgrade preparation. Excavation dewatering will be required to control groundwater, surface water, any perched water, and precipitation runoff. Refer to Section 10.3 for additional comments on water control.

9.4.2 RSS Retaining Wall Foundations

RSS walls with a minimum embedment of 0.8 m and bearing on an engineered fill pad place up to about 1.5 m below the proposed eastbound lanes, as described above, may be designed based on the following factored geotechnical:

- Factored geotechnical resistance at ULS 220 kPa
- Factored geotechnical resistance at SLS 175 kPa

The factored geotechnical resistances include the following factors:

- Consequence factor (Ψ) of 1.0 (as per CHBDC Table 6.1)
- Geotechnical resistance factors (as per CHBDC Table 6.2):
 - $\phi_{gu} = 0.5$ (static analysis; typical degree of understanding)
 - $\phi_{gs} = 0.8$ (static analysis; typical degree of understanding)

9.4.2.1 Backfill and Lateral Earth Pressures

Where excavation for construction of a retaining wall is carried out, structural backfill material should consist of Granular A or Granular B Type II meeting the OPSS.PROV 1010 specifications and SP 110S06. The backfill must be in accordance with OPSS.PROV 902 and placed and compacted in accordance with OPSS.PROV 501. Backfill should be compacted and compaction equipment to be used adjacent to the structure must be restricted in accordance with OPSS.PROV 501.07.02.

Lateral earth pressure provided in the equations in the sections below are based on the assumption that the backfill is fully drained so that there are no unbalanced hydrostatic pressures. Drains should be included through the retaining wall. If adequate drainage cannot be confirmed, the potential for buildup of hydrostatic pressures should be considered in wall design.

9.4.2.2 Static Lateral Earth Pressure

Lateral earth pressures should be computed in accordance with the CHBDC. Under drained conditions the lateral earth pressure is generally given by the following expression:

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

where:

σ_h	=	horizontal pressure on the wall at depth h (kPa)
K	=	earth pressure coefficient (see table below) (K_A for unrestrained walls, K_0 for restrained walls)
γ	=	unit weight of retained soil (see table below), use submerged unit weight below groundwater level
h	=	depth below top of fill where pressure is computed (m)
q	=	value of any surcharge (kPa)

A lateral earth pressure due to backfill compaction should be added to the calculated lateral earth pressure in accordance with Clause 6.12.3 of the CHBDC. Typical earth pressure coefficients for OPSS Granular A and OPSS Granular B Type II backfill are shown in Table 9-4.

The parameters in Table 9-4 correspond to full mobilization of active and passive earth pressures and require certain relative movements between the wall and adjacent soil to produce these conditions. The movement required can be assessed from Table C6.12 of the Commentary to the CHBDC. Active earth pressures should be used for unrestrained walls. For rigid structures, at-rest horizontal earth pressures would apply for design.

Table 9-4: Static Earth Pressure Coefficients

Condition	Pit Sourced OPSS Granular A $\phi = 35^\circ$, $\gamma = 22.8 \text{ kN/m}^3$		Quarry Sourced OPSS Granular A $\phi = 40^\circ$, $\gamma = 22.8 \text{ kN/m}^3$		Quarry Sourced OPSS Gran B Type II $\phi = 42^\circ$, $\gamma = 22.8 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	2H:1V Slope Behind Wall	Horizontal Surface Behind Wall	2H:1V Slope Behind Wall	Horizontal Surface Behind Wall	2H:1V Slope Behind Wall
Coefficient of at Rest Earth Pressure, K_0 (Restrained Wall)	0.43	0.62	0.36	0.52	0.33	0.48
Coefficient of Active Earth Pressure, K_A (Unrestrained Wall)	0.27	0.39	0.22	0.30	0.20	0.26

9.4.2.3 Combined Static and Seismic Lateral Earth Pressure

In accordance with Clause 6.14 of the CHBDC, retaining structures should be designed using dynamic earth pressure coefficients that incorporate the effects of earthquake loading. The following recommendations are per Section C6.14 of the Commentary of the CHBDC which states that seismically induced lateral soil pressures may be calculated using Mononobe Okabe Method with:

- $k_h = \frac{1}{2} * F(\text{PGA}) * \text{PGA}$, for structures that allow 25 to 50 mm of movement, and
- $k_h = F(\text{PGA}) * \text{PGA}$, for restrained walls

The coefficients of horizontal earth pressure for seismic loading presented in Table 9-5, below, may be used for vertical walls. The provided earth pressure coefficients are based on a Seismic Site Class D. Please see Section 8.2 for the respective PGA and $F(\text{PGA})$ values.

Table 9-5: Combined Static and Seismic Earth Pressure Coefficients – Site Class D (2,475-year)

Condition	Pit Sourced OPSS Granular A $\phi = 35^\circ$, $\gamma = 22.8 \text{ kN/m}^3$		Quarry Sourced OPSS Granular A $\phi = 40^\circ$, $\gamma = 22.8 \text{ kN/m}^3$		Quarry Sourced OPSS Granular B Type II $\phi = 42^\circ$, $\gamma = 22.8 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	2H:1V Slope Behind Wall	Horizontal Surface Behind Wall	2H:1V Slope Behind Wall	Horizontal Surface Behind Wall	2H:1V Slope Behind Wall
Coefficient of Active Earth Pressure, K_{AE} (Restrained Wall)	0.44	1.1	0.37	0.75	0.34	0.67
Coefficient of Active Earth Pressure, K_{AE} (Unrestrained Wall)	0.35	0.64	0.28	0.44	0.26	0.39



The total pressure due to combined static and seismic loads acting at a specific depth below the top of the wall/soil may be determined using the following equation that includes consideration of material properties and the soils profile.

$$\sigma_{hAE} = K * \gamma * d + (K_{AE} - K_A) * \gamma * (H - d)$$

where:

σ_{hAE}	=	combined static and seismic lateral earth pressure on wall at depth d (kPa)
d	=	depth below the top of the wall where pressure is computed (m)
K	=	static earth pressure coefficient (K_A for unrestrained, K_o for restrained walls)
γ	=	unit weight of retained soil, adjusted below water level
K_{AE}	=	combined static and seismic earth pressure coefficient
H	=	total height of the wall (m)

9.5 Frost Penetration Depth

The depth of frost penetration at this site is estimated to be 1.9 m (as per OPSD 3090.101) and should be considered in the design of conventional retaining walls, as required. Typically, RSS walls do not require full frost protection as they are able to tolerate some movement due to frost heave. The RSS system should be designed in accordance with the MTO RSS Design Guidelines.

10 CONSTRUCTION CONSIDERATIONS

10.1 Excavations

All temporary and permanent excavations must be conducted in accordance with the requirements of the Occupational Health & Safety Act & Regulations (OHSA) for Construction Projects. The native cohesive and cohesionless materials may be classified as Type 3 soil above the water table. Silty clay, clayey silt, or silty sand present below the water table should be classified as Type 4 soil. **Side slopes for excavations through more than one soil type must be entirely based on the highest soil type number.** Unsupported excavations in Type 4 soil must have side slopes no steeper than 3H:1V from the base of the excavation if no dewatering is employed. Unsupported excavations made in Type 3 soils must have side slopes no steeper than 1H:1V from the base of the excavation. However, the stability of temporary excavations may decrease with depth and must be assessed.

Excavation should be carried out in accordance OPSS.PROV 902. The management and disposal of excess material shall be in accordance with OPSS.PROV 180. Excavations will extend into the weathered crust of the silty clay in the central and eastern portions of the site, and into the upper silty sand at the western portions of the site. The native silty clay subgrade at the site tends to be sensitive and requires careful consideration during construction to minimize disturbance of the soil from the natural condition.

Selection of the equipment and methodology to excavate and prepare the founding surface is the responsibility of the Contractor. Material stockpiling is a temporary construction measure, and the associated stability implications are the responsibility of the Contractor. The selection and placement of construction equipment (such as cranes) and construction of temporary construction access roads are also the Contractor's responsibility.

Based on the available information, excavations for RSS wall construction will extend below the groundwater level and groundwater management by the Contractor will be required. If there are space restrictions at the foundation locations or where a slope must be retained, those excavations will also need to be carried out within a protection system. Further discussion on temporary protection systems (TPS) and groundwater control are presented below in Sections 10.2 and 10.3, respectively.

10.2 Temporary Protection Systems

Temporary Protection Systems (TPS) could be used for excavation support or groundwater control. They must be implemented in accordance with OPSS.PROV 539. Performance Level 2 (maximum 25 mm horizontal deflection) is considered appropriate where the protection supports an existing roadway. More stringent performance levels may be required if the protection system is intended to support existing structures or utilities. The pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall, and these factors must be considered when designing the shoring system.

Steel sheet piles are considered a suitable option for this site; however, the selection and design of protection systems are the responsibility of the Contractor. All protection systems should be designed by a licensed Professional Engineer experienced in such designs and retained by the Contractor. The design of the roadway protection system must incorporate traffic loading and surcharge loading due to construction equipment and operations. An anchoring and/or internal bracing system may need to be incorporated into the temporary protection design to resist lateral earth pressure loadings.

The lateral earth pressure coefficients and undrained strengths for the existing soils are given in Table 10-1 for a temporary vertical wall and a horizontal backslope. Unit weights provided herein are to be adjusted for applications below the groundwater level. Unbalanced hydrostatic pressures should be considered in the design of the protection systems.

Table 10-1: Static Earth Pressure Coefficients for Existing Soils

Material	Unit Weight ^(*) (kN/m ³)	K _A	K _P	K ₀	S _u (kPa)	Ground Surface Behind Wall
Cohesive Soils	17.5	-	-	-	100	Horizontal
Upper Sand to Silty Sand	19	0.33	3.00	0.50	-	Horizontal
Deep Sand to Silty Sand	21	0.27	3.69	0.43	-	Horizontal

Note: () to be adjusted when below water level*



When designing roadway protection systems, the Contractor should consider the potential for obstructions. Frequent cobbles have been noted in the sand layer in Borehole OBR19-14. Suggested wording for an NSSP for obstructions is included in Appendix G.

10.3 Surface and Groundwater Control

The groundwater elevation measured at the site ranges from about Elevation 122 m, in the sand at the east end of the site, to about Elevation 112 m in the silty clay at the west end (see Table 5-1 in Section 5.7). The measured groundwater levels are near the proposed centreline grade of the eastbound Highway 17 lanes and range from within 1 m below (at Boreholes EB23-02 and EB23-09) to about 0.8 m above (at Borehole EB23-05). Local excavation for ditching along the eastbound lanes is expected to vary and will be deeper than the centreline grade.

It has been assumed that permanent groundwater levels and surface water will be managed with design of appropriate drainage ditches, but existing groundwater conditions must be considered during construction. Further, subgrade preparation and placement and compaction of granular bedding for RSS walls must be carried out in the dry. The Contractor must control groundwater, perched groundwater and surface water flow at the site to permit construction in a dry and stable excavation.

The design of dewatering systems is the responsibility of the Contractor. The Contract Documents must alert the Contractor to this responsibility and to design the system in accordance with SP 517F01 which amends OPSS.PROV 517. The contractor's design should include an assessment of any adverse effects the dewatering method, construction layout and staging may have on adjacent structures, utilities and facilities. Given the site conditions, the Designer Fill-In (Note 2) in SP 517F01 Table 1 should be "Yes" for dewatering systems; the design Engineer and design-checking Engineer need a minimum of 5 years of experience in designing similar dewatering systems. A preconstruction survey is recommended; thus, Designer Fill-In Note 4 in this SP should be 100 m. Based on the groundwater elevation at the time of the investigation, it is anticipated that the site will require dewatering to lower the groundwater to below the final excavation or footing level; Note 5 of SP 517F01 Table 1 should be a minimum of 0.5 m below the underside of the planned excavation base prior to each stage of excavation.

The water level will fluctuate and the minimum groundwater elevation for the site at the time of the excavation should be taken as the expected base of wall/cut level defined in SP 517F01.

The dewatering plan should be coordinated with TPS design. The dewatering system will be required to remain operational and effective until the temporary excavations are backfilled and then should be decommissioned and removed.

Further assessment of dewatering requirements and the need for registration on the Environmental Activity and Sector Registry (EASR) or a Permit to take Water (PTTW) should be carried out by specialists experienced in this field.



Please refer to Hydrogeological Investigation and Design Report for additional discussion on dewatering with respect to this assignment.

11 DESIGN AND CONSTRUCTION CONCERNS

The preliminary recommendations presented herein must be reassessed once the type, location, elevation and orientation of the works are established.

The seismic hazard data considered for the preliminary design recommendations provided in this report were obtained from the fifth-generation seismic model developed by the Geological Survey of Canada (GSC). Additional seismic analyses will be required to reflect the reference seismic hazard available at the time of detailed design.

The DB Contractor must review the existing factual information and determine the extent of additional field investigations and laboratory testing required to support the foundation design of the proposed works. The preliminary recommendations provided herein will need to be reevaluated once the cut slope geometry/retaining wall founding elevations are confirmed.

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

- Control of groundwater seepage during excavation and permanent drainage in the cut section. Adequate and effective surface water management, dewatering and erosion control plans must be implemented to construct the works in the dry.
- The clayey silt/silty clay which will be exposed at the subgrade is sensitive and readily disturbed. A suggested Notice to Contractor is provided in Appendix G.
- Buried obstructions may be encountered during construction and will interfere with excavations and installation of temporary protection/dewatering systems. A Notice to Contractor has been included in Appendix G.
- The Contractor's selection of construction equipment and methodology must include assessment of the capability of the existing soils to support the proposed construction equipment and supplies.

The successful performance of the works will depend largely upon good workmanship and quality control during construction. Observation of the excavation and backfilling operations will be required as per OPSS.PROV 902 during construction to confirm that the foundation recommendations are correctly implemented, and material specifications are met.

12 CLOSURE

Engineering analysis and preparation of this report was carried out by A. de Oliveira, P.Eng. and M. Kennedy, P.Eng. The report was reviewed by Dr. F. Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

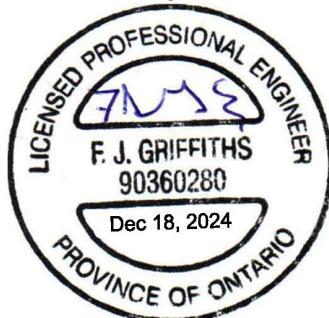
Thurber Engineering Ltd.
Report Prepared By:



Anderson de Oliveira, M.A.Sc., P.Eng.
Geotechnical Engineer



Matt Kennedy, M.Sc.(Eng.), P.Eng.
Senior Geotechnical Engineer



Dr. Fred Griffiths, P.Eng.
Senior Geotechnical Engineer,
Senior Associate

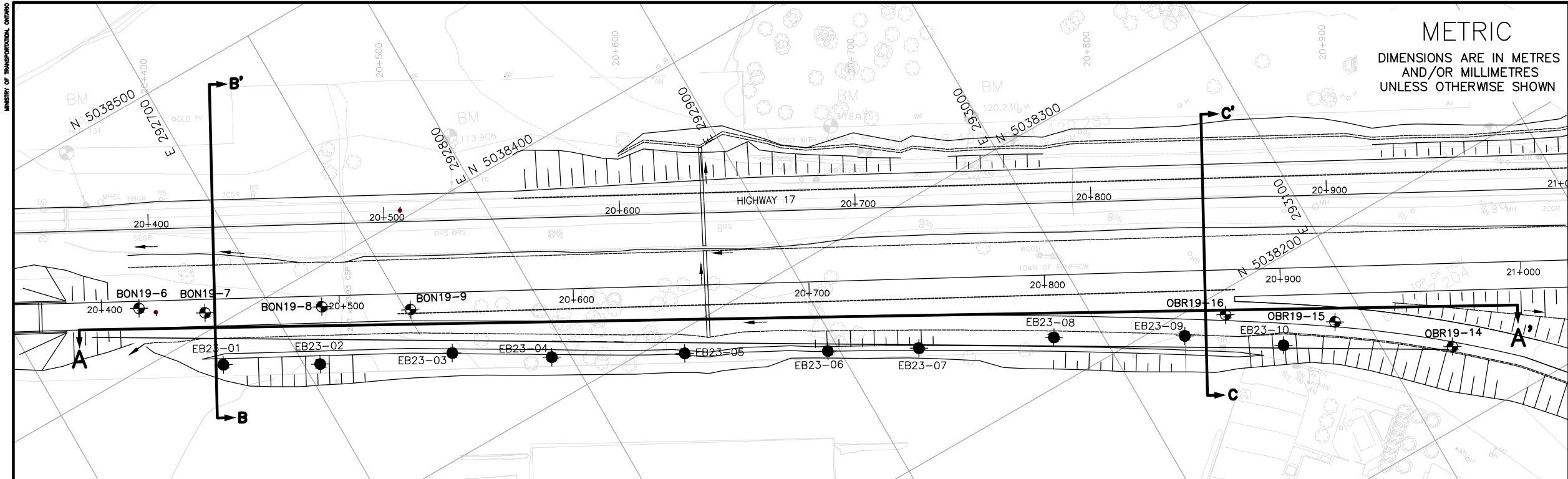


Dr. P.K. Chatterji, P.Eng.
Designated Principal Contact,
Senior Geotechnical Engineer



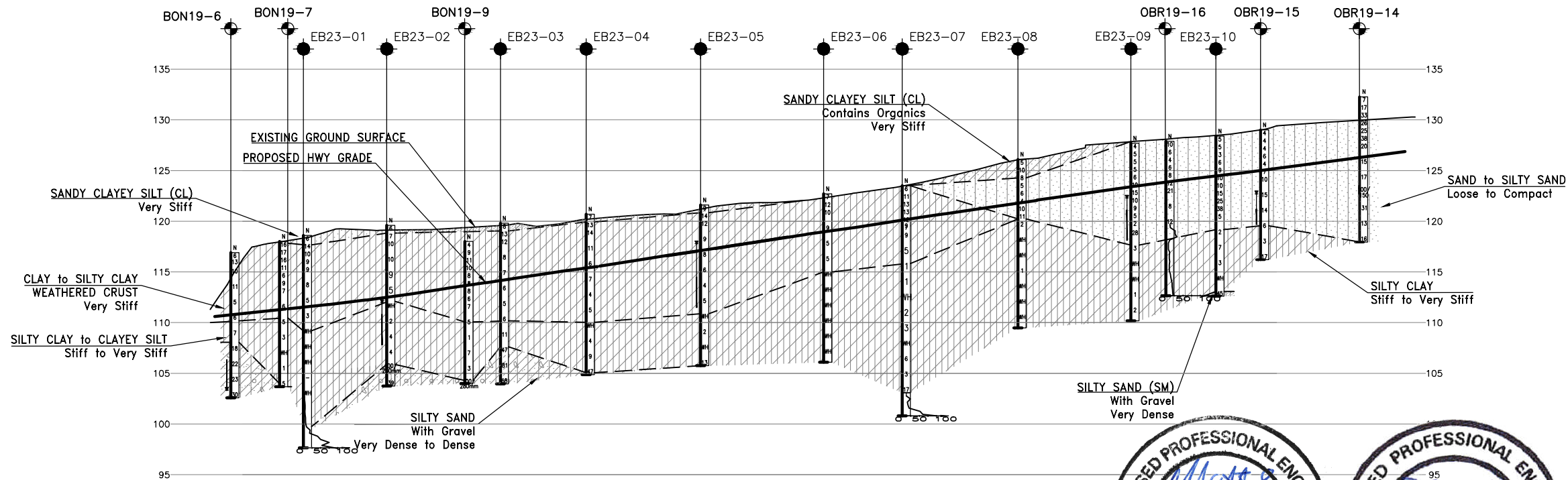
Appendix A.

Borehole Location Plan and Stratigraphic Drawings



(GEOCRES 31F-236)
(GEOCRES 31F-236)
(GEOCRES 31F-236)
(GEOCRES 31F-236)
(GEOCRES 31F-216)
(GEOCRES 31F-216)
(GEOCRES 31F-216)

NO	ELEVATION	NORTHING	EASTING
BON19-6	116.9	5 038 422.9	292 651.3
BON19-7	118.0	5 038 407.3	292 674.7
BON19-8	117.7	5 038 384.8	292 718.9
BON19-9	117.8	5 038 365.0	292 751.0
OBR19-14	132.2	5 038 130.9	293 126.1
OBR19-15	129.1	5 038 164.8	293 088.4
OBR19-16	127.9	5 038 190.7	293 049.4



METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No 4068-09-00

HIGHWAY 17 TWINNING
STATION 20+450 to 20+900
HORTON TOWNSHIP
BOREHOLE LOCATION PLAN AND SOIL STRATA

Ontario

THURBER



KEYPLAN

LEGEND

- Borehole
- Historic Borehole
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well/Piezometer
- Monitoring Well/Piezometer Screen
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

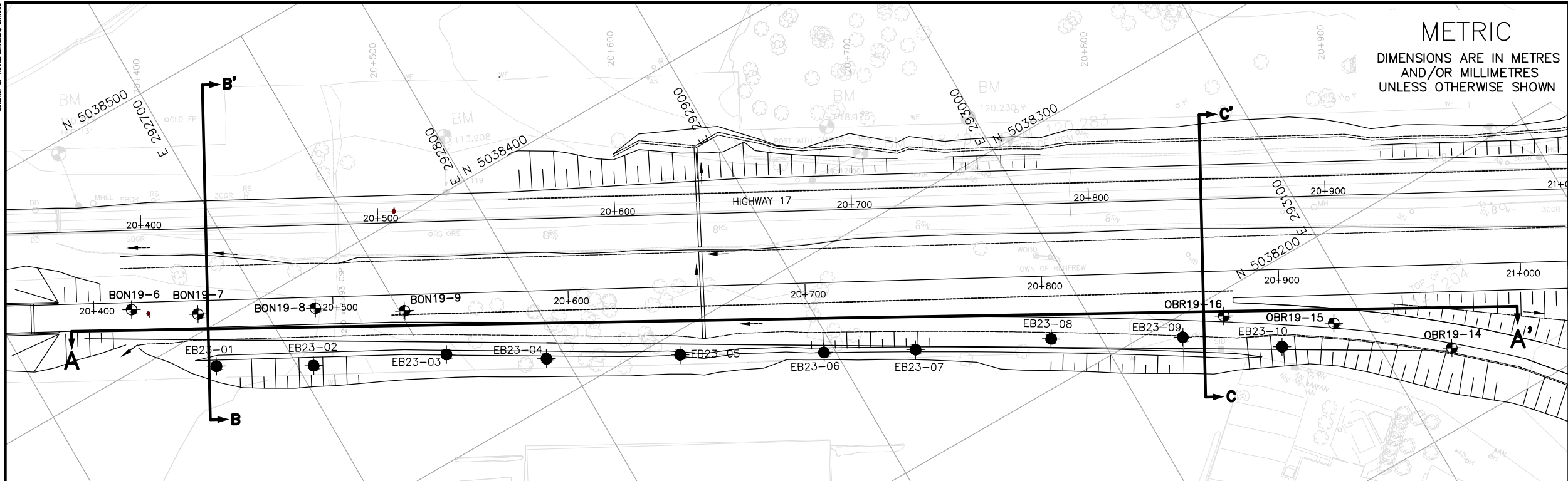
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EB23-02	119.6	5 038 364.0	292 706.1
EB23-03	119.8	5 038 340.2	292 757.0
EB23-04	120.7	5 038 317.6	292 792.8
EB23-05	121.6	5 038 290.9	292 842.5
EB23-06	122.7	5 038 261.4	292 895.5
EB23-07	123.5	5 038 243.3	292 929.8
EB23-08	126.1	5 038 218.6	292 981.4
EB23-09	127.7	5 038 191.4	293 030.0
EB23-10	128.4	5 038 167.1	293 064.3

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 9.

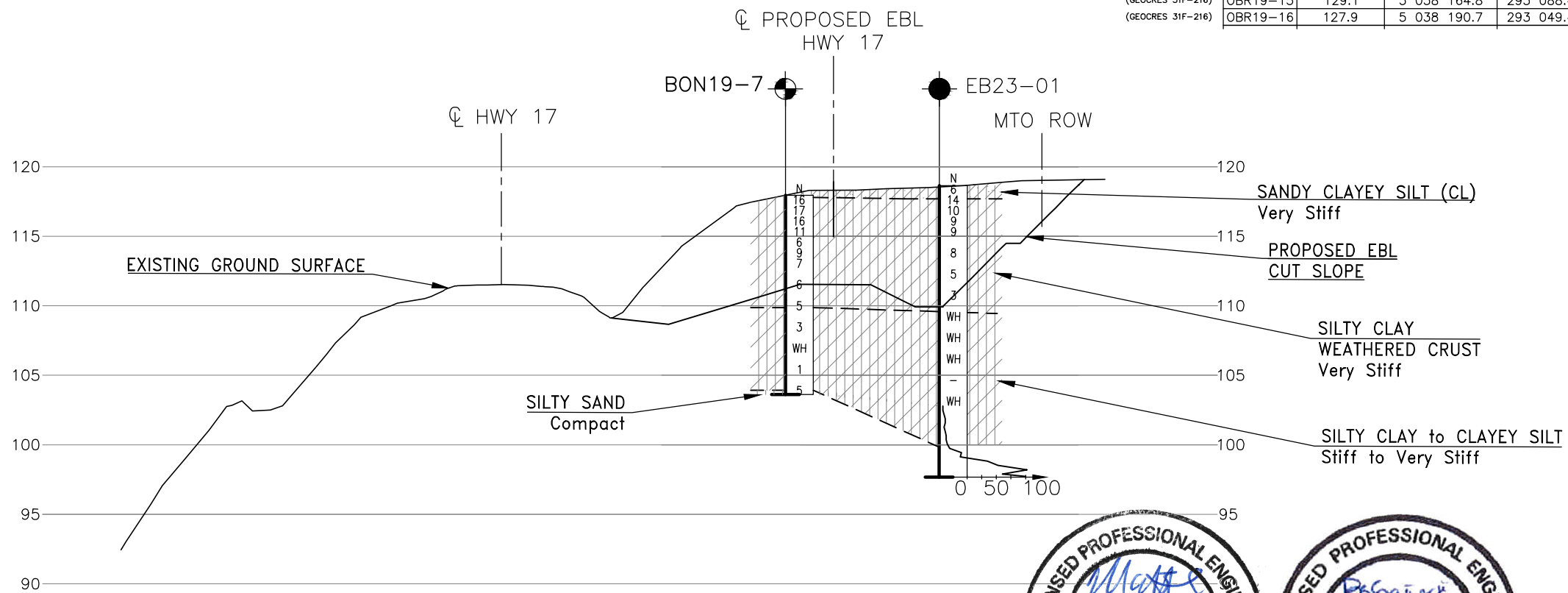
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			STRUCT
			DWG 1
			DATE NOV 2024

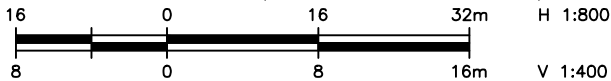


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(GEOCRES 31F-236)
(GEOCRES 31F-236)
(GEOCRES 31F-216)
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SECTION B-B' (STA. 20+450)



REVISIONS	DATE	BY	DESCRIPTION
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			LOAD
			STRUCT
			DWG 1
			DATE NOV 2024

CONT No
GWP No 4068-09-00

HIGHWAY 17 TWINNING
STATION 20+450 to 20+900
HORTON TOWNSHIP
BOREHOLE LOCATION PLAN AND SOIL STRATA

Ontario

THURBER



KEYPLAN

LEGEND

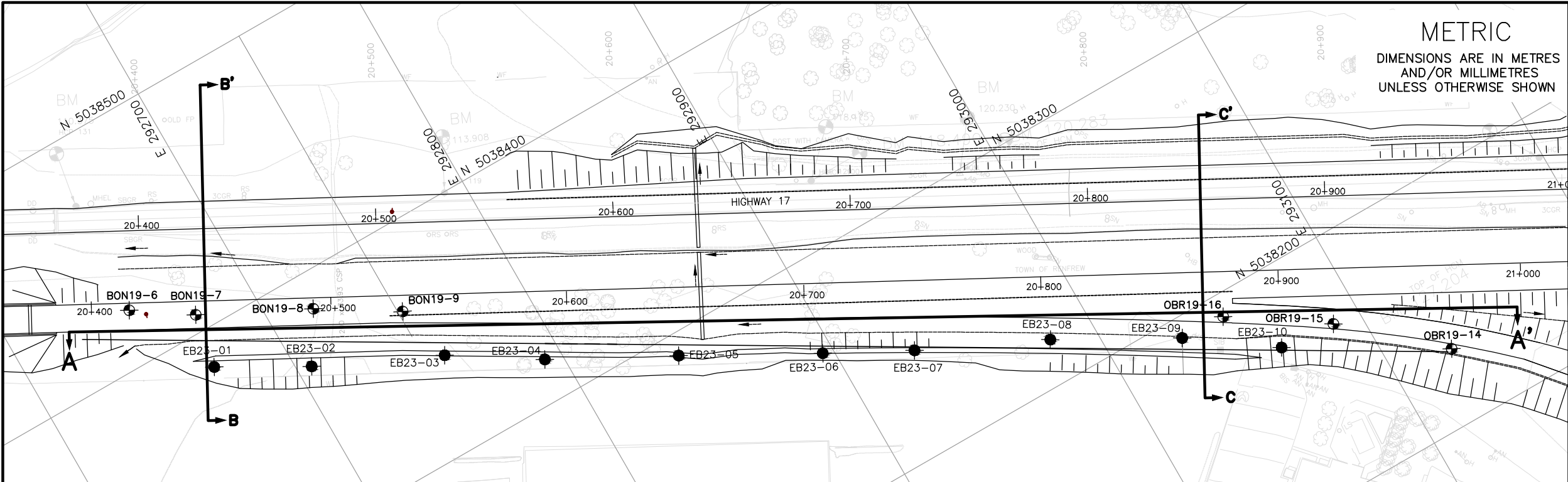
- Borehole
- Historic Borehole
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well/Piezometer
- Monitoring Well/Piezometer Screen
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
EB23-01	118.6	5 038 384.5	292 670.5
EB23-02	119.6	5 038 364.0	292 706.1
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-NOTES-

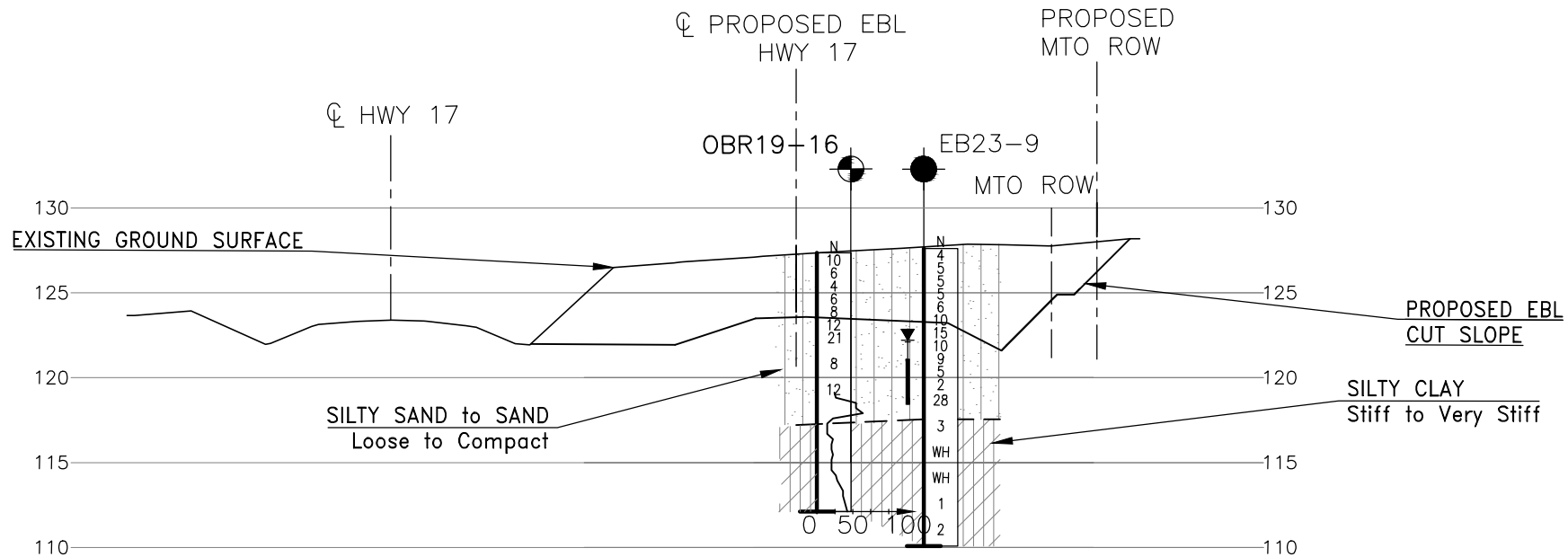
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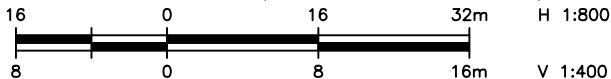


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OBR19-16	127.9	5 038 190.7	293 049.4



SECTION C-C' (STA. 20+875)



METRIC

DIMENSIONS ARE IN METRES
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UNLESS OTHERWISE SHOWN

CONT No
GWP No 4068-09-00

HIGHWAY 17 TWINNING
STATION 20+450 to 20+900
HORTON TOWNSHIP
BOREHOLE LOCATION PLAN AND SOIL STRATA

Ontario

THURBER



KEYPLAN

LEGEND

●	Borehole
●	Historic Borehole
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▽	Water Level in Monitoring Well/Piezometer
▽	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

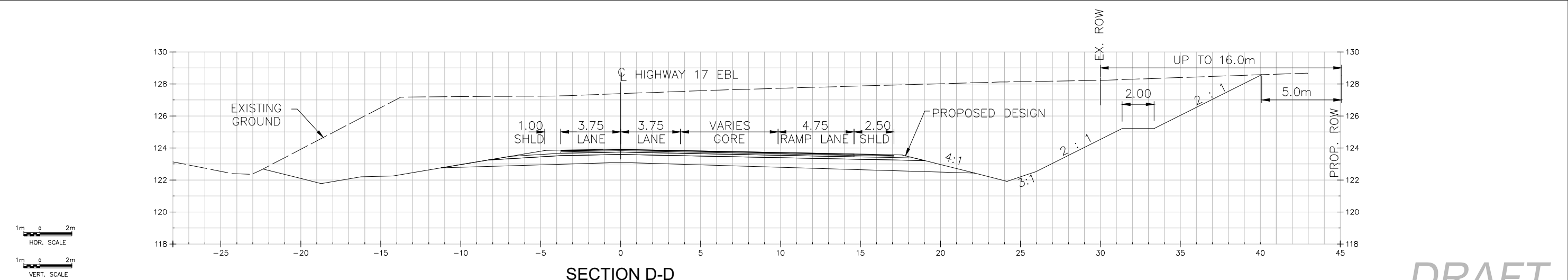
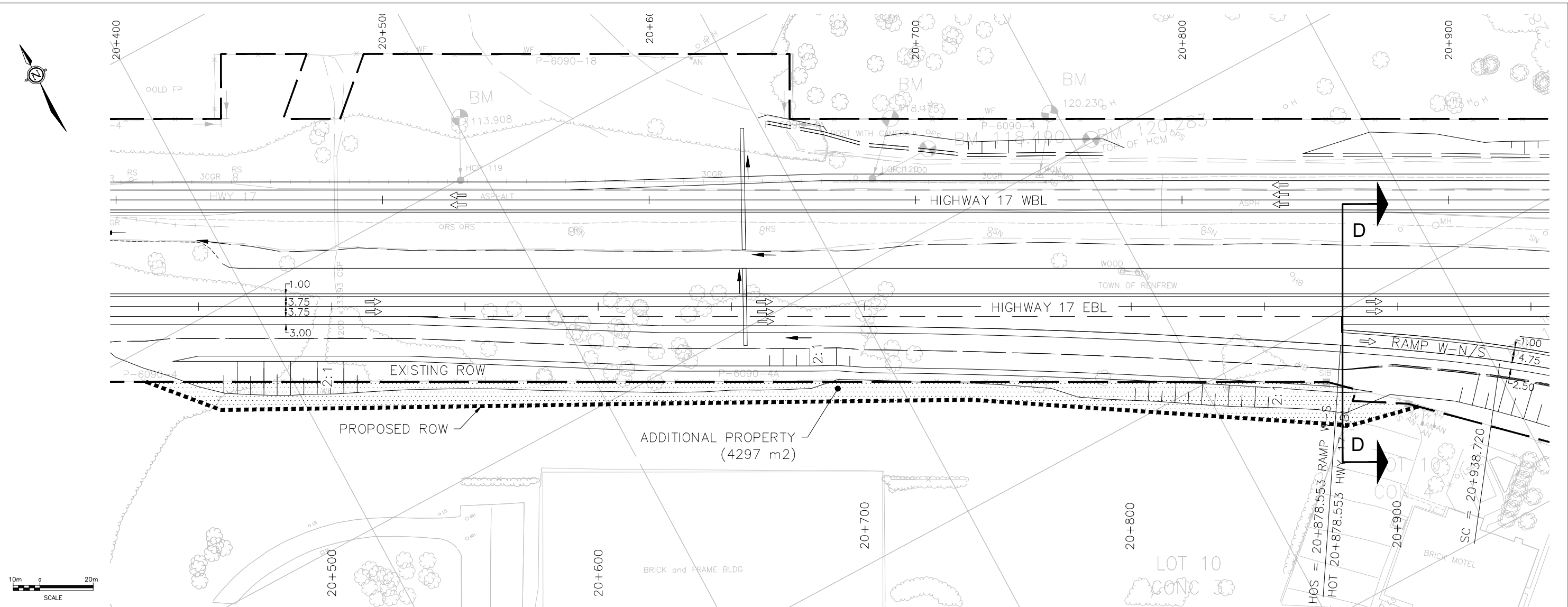
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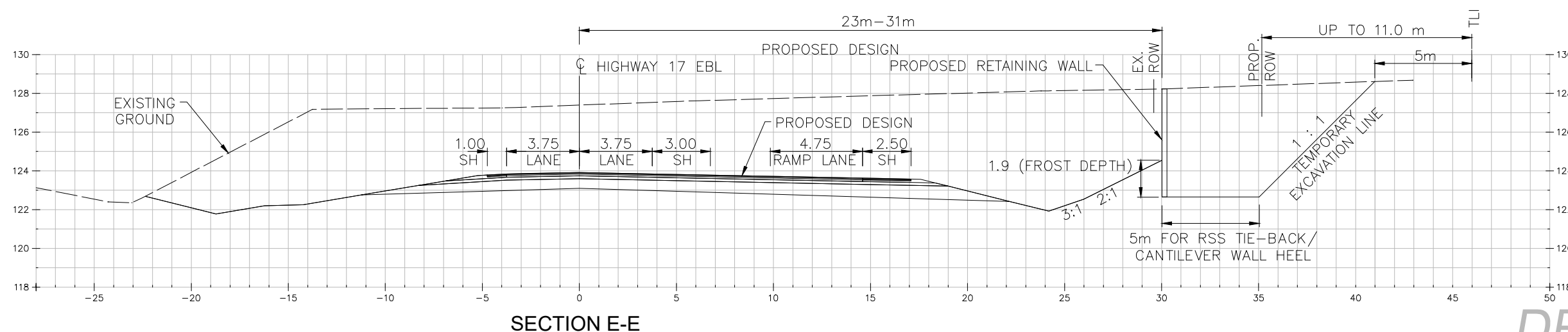
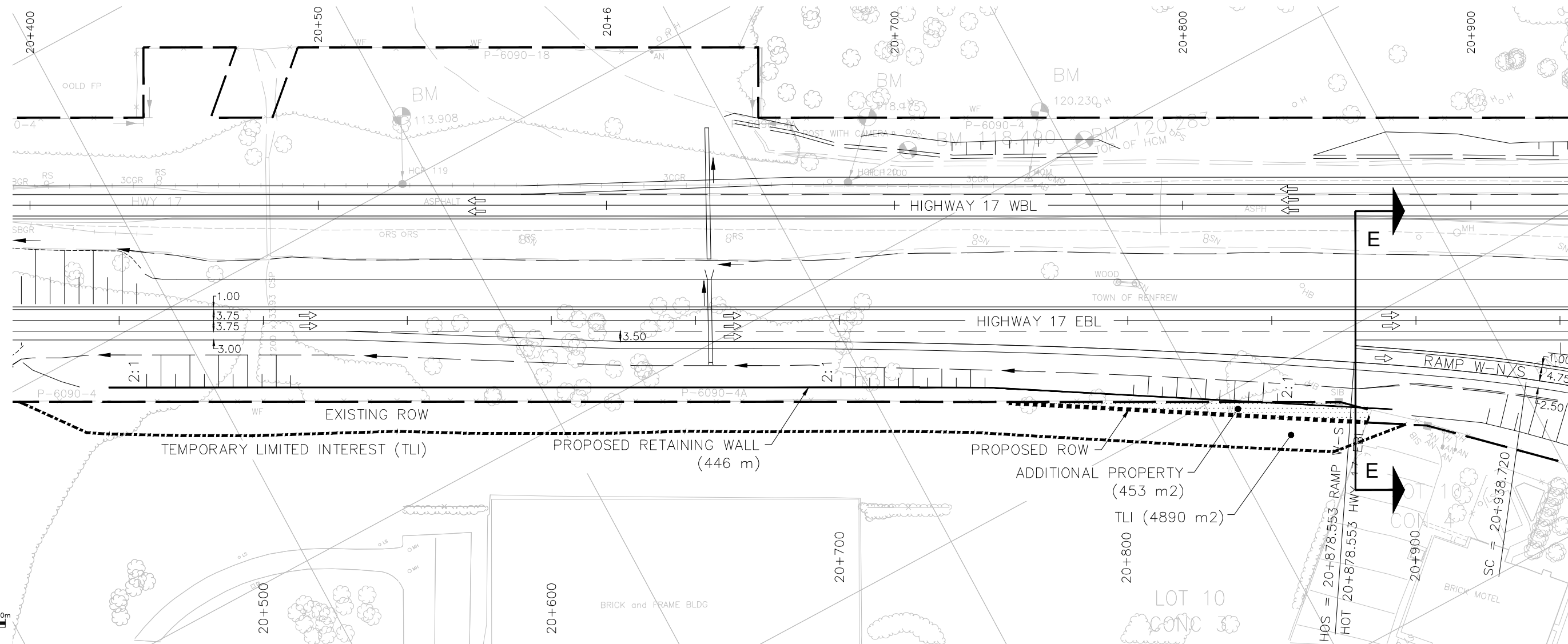
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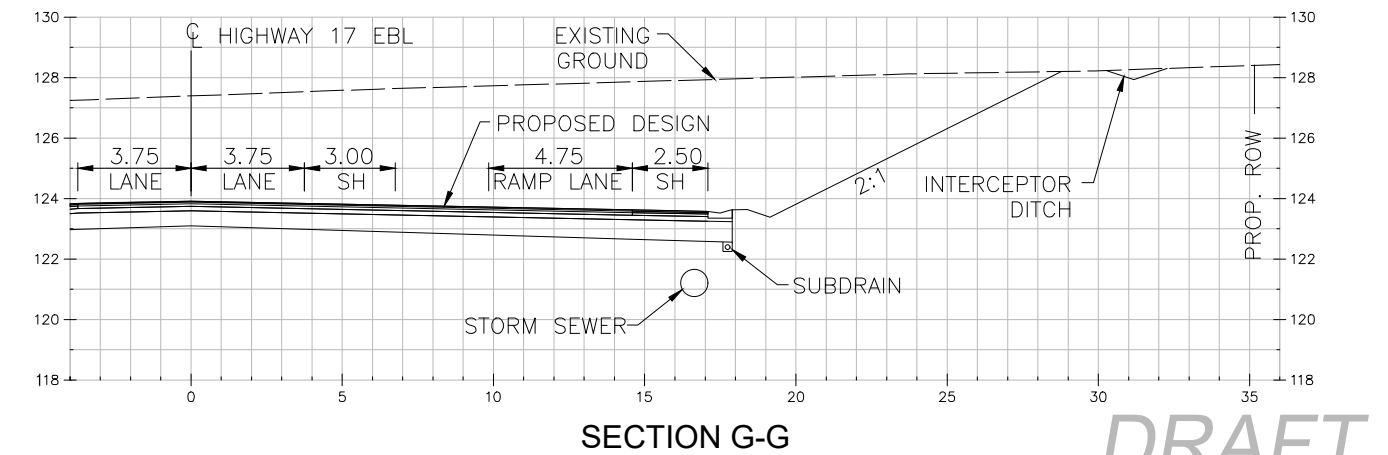
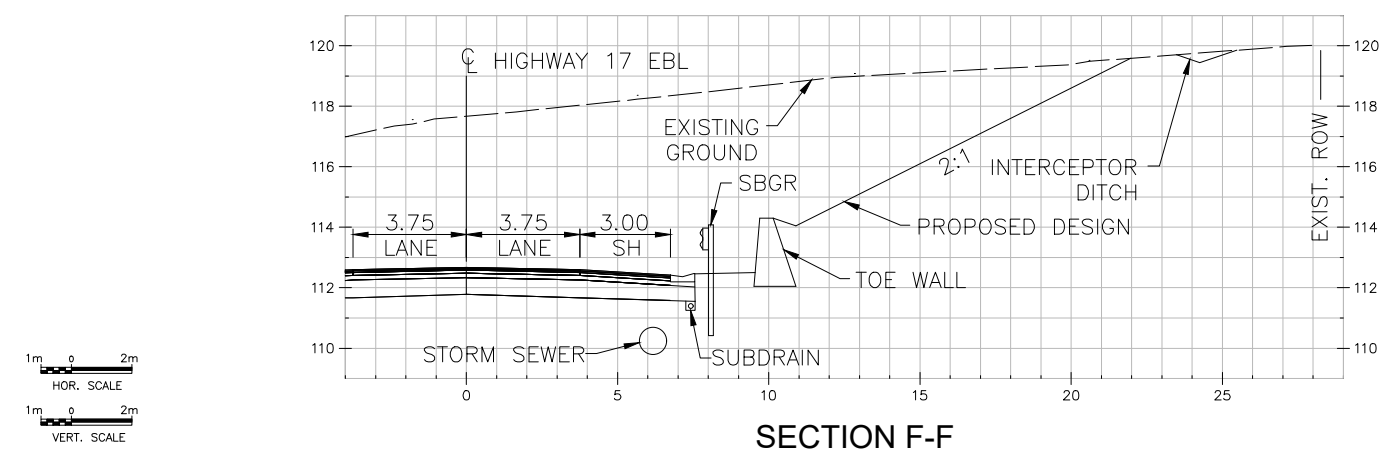
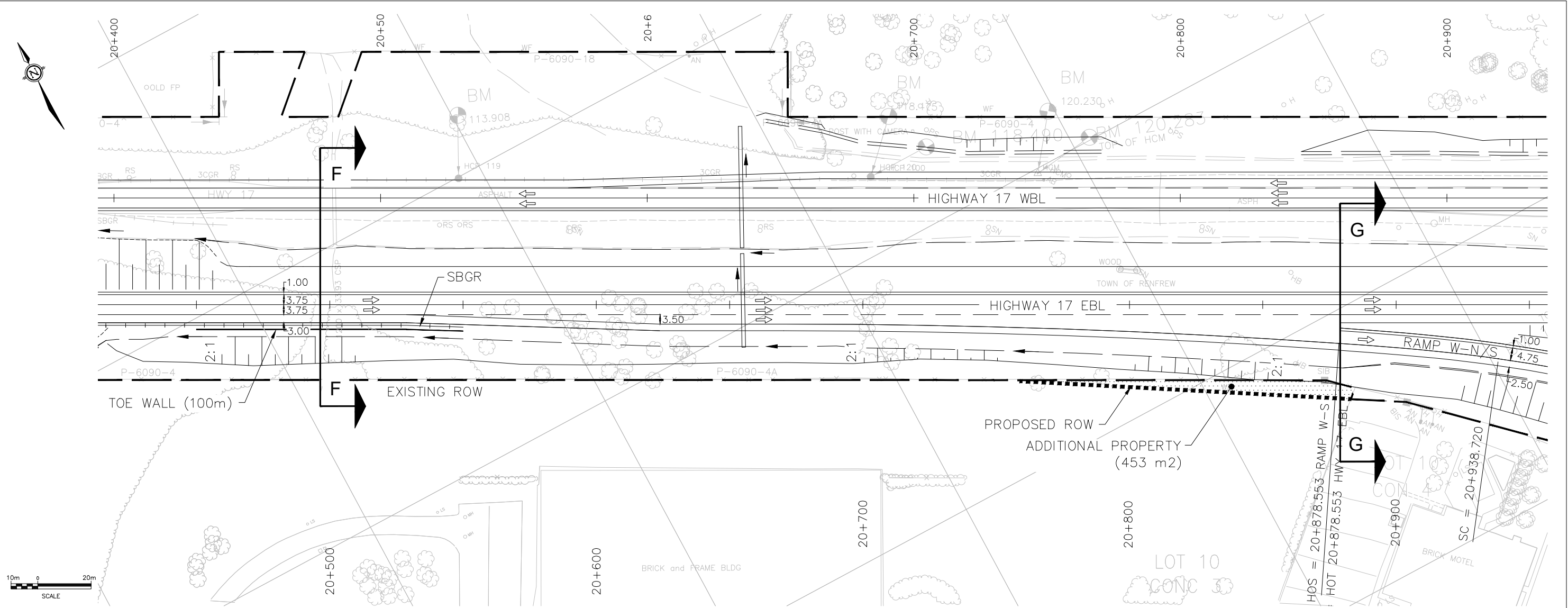
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			DATE SEPT 2024



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Appendix B.

Record of Borehole Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

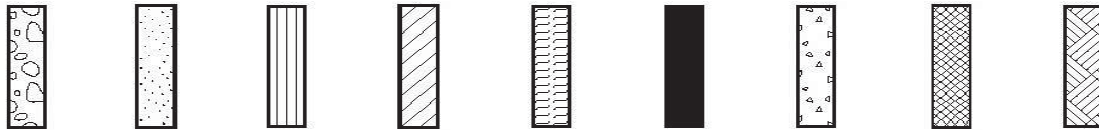
DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel Sand Silt Clay Organics Asphalt Concrete Fill Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

TERMS

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

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

METRIC

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

METRIC

Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 384.5 E 292 670.5 ORIGINATED BY BC

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No EB23-01

3 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485281°, Long: -76.655167°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 384.5 E 292 670.5 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.26 - 2024.03.26 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%) w _P w w _L					
	Continued From Previous Page							20	40	60	80	100	20	40	60	
	Borehole Advanced with DCPT															
97.6							98									
21.0	End of Borehole on DCPT refusal															
	Borehole dry upon completion.															

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

METRIC

Lat: 45.485096°, Long: -76.654711°
Eastbound 20+450 to 20+900; Hortic

+³, ×³: Numbers refer to Sensitivity



DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-03

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484883°, Long: -76.654061°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 340.2 E 292 757.0 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.25 - 2024.03.25 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE													
119.8	Ground Surface							20	40	60	80	100		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L					
0.0	Sandy CLAYEY SILT (CL) Trace gravel Contains organics Very stiff Brown		1	SS	8													6	22	51	21
119.0																					
0.8	SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown WEATHERED CRUST		2	SS	13		119														
			3	SS	12		118														
			4	SS	8																

Continued Next Page

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



DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-03

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484883°, Long: -76.654061°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 340.2 E 292 757.0 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.25 - 2024.03.25 CHECKED BY AO

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	20	40	60			
107.6	SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown WEATHERED CRUST - Unable to push vane		9	SS	11								○				
12.2	SAND with silt and gravel Dense to very dense Brown		10	SS	47								○				
			11	SS	81								○				
			12	SS	68								○				
104.0																	
15.8	End of Borehole Borehole dry upon completion.																

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-04

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484679°, Long: -76.653601°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 317.6 E 292 792.8 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.21 - 2024.03.21 CHECKED BY AO

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					
120.7	Ground Surface							20 40 60 80 100					
0.0	Sandy CLAYEY SILT (CL) Contains organics Very stiff Brown		1	SS	7								
119.9							120						
0.8	SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown WEATHERED CRUST		2	SS	13								
			3	SS	14								
			4	SS	11								
			5	SS	6								
			6	SS	7								
			7	SS	4								
			8	SS	5								

Continued Next Page

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-04

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484679°, Long: -76.653601°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 317.6 E 292 792.8 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.21 - 2024.03.21 CHECKED BY AO

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		
	Continued From Previous Page							SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								WATER CONTENT (%)						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
								W _p W W _L						
110.0	SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown						110							
10.7	WEATHERED CRUST													
	CLAYEY SILT (CL) Contains sand partings and seams Stiff to very stiff Grey to greyish brown		9	SS	WH									
							109							
			10	SS	4									0 15 51 34
							108							
			11	SS	9		107							0 16 60 24
							106							
	- Unable to push vane													
105.1			12	SS	47		105							28 55 17
104.9	SILTY SAND (SM) with gravel Dense Greyish brown													(SI+CL)
15.8	End of Borehole Borehole dry upon completion.													

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-05

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484441°, Long: -76.652965°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 290.9 E 292 842.5 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.20 - 2024.03.20 CHECKED BY AO

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		
121.6	Ground Surface											
0.0	Sandy CLAYEY SILT (CL) Contains organics Very stiff Brown		1	SS	9							
120.8	CLAY (CH) to SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown WEATHERED CRUST		2	SS	14							
0.8			3	SS	12							
				4	SS	9						
				5	SS	8						
				6	SS	6						
				7	SS	4						
				8	SS	5						

Continued Next Page

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-05

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484441°, Long: -76.652965°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 290.9 E 292 842.5 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.20 - 2024.03.20 CHECKED BY AO




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				
	Continued From Previous Page						20	40	60	80	100	> 113 kPa					GR SA SI CL					
110.9	CLAY (CH) to SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown											> 113 kPa										
10.7	WEATHERED CRUST																					
	CLAYEY SILT (CL) Contains sand partings and seams Very stiff Grey to greyish brown		9	SS	WH																	
												> 113 kPa										
												> 113 kPa										
			10	SS	2												0 1 60 39					
												> 113 kPa										
												> 113 kPa										
			11	SS	WH																	
												> 113 kPa										
												> 113 kPa										
			12	SS	13												6 9 59 26					
105.8																						
15.8	End of Borehole																					
	Monitoring Well Installed: Schedule 40 PVC standpipe with 50-mm diameter and 3.0-m slotted screen. Stick-up cover installed at ground surface. Water Level Readings: DATE DEPTH (m) ELEV. (m) 2024/03/26 0.8 120.8 2024/03/28 0.9 120.7 2024/04/10 0.6 121.0 2024/04/24 0.6 121.0 2024/06/20 3.7 117.9 2024/06/27 1.7 119.9 2024/06/28 1.7 119.9 2024/07/15 1.5 120.1 2024/08/29 3.8 117.8																					

RECORD OF BOREHOLE No EB23-06

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484176°, Long: -76.652285°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 261.4 E 292 895.5 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.19 - 2024.03.20 CHECKED BY AO

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	W _P	W	W _L				
122.7	Ground Surface						20	40	60	80	100							
0.0	CLAY (CH) to SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown WEATHERED CRUST		1	SS	7													
			2	SS	12													0 2 43 55
			3	SS	10													
			4	SS	9													
115.1	- Unable to push vane																	
			5	SS	5													0 0 48 52
			6	SS	5													
7.6	SILTY CLAY (CI) Contains sand partings and seams Very stiff Grey		7	SS	WH													
																		
			8	SS	WH													

Continued Next Page

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-06

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484176°, Long: -76.652285°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 261.4 E 292 895.5 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.19 - 2024.03.20 CHECKED BY AO

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) w _p w w _L				GR	SA	SI	CL		
	Continued From Previous Page							20	40	60	80	100										
112.0	SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown												> 118 kPa									
10.7	CLAYEY SILT (CL) Contains sand partings and seams Very stiff Grey - Unable to push vane		9	SS	WH		112								○							
							111															
			10	SS	WH		110								┌─○				0	1	61	38
							109						4.0 + > 118 kPa									
			11	SS	WH		108						> 118 kPa		○							
							107						> 118 kPa									
106.1			12	SS	WH								> 118 kPa		○							
16.6	End of Borehole												> 118 kPa									

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE


DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-07

1 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484013°, Long: -76.651846°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 243.3 E 292 929.8 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.13 - 2024.03.13 CHECKED BY AO

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		
123.5	Ground Surface																			
0.0	CLAY (CH) to SILTY CLAY (CI) Contains sand partings and seams Very stiff Greyish brown WEATHERED CRUST		1	SS	6															
			2	SS	11															
			3	SS	13															
			4	SS	13															
	5	SS	12																	
	6	SS	7																	
	7	SS	9																	

Continued Next Page

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

METRIC

Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 243.3 E 292 929.8 ORIGINATED BY BC

BOREHOLE TYPE CME 75 Trackmount / HSA

DATUM	Geodetic	DATE	2024.03.13 - 2024.03.13	CHECKED BY	AO
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SS

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No EB23-07

3 OF 3

METRIC

WP# 4068-09-00 LOCATION Lat: 45.484013°, Long: -76.651846°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 243.3 E 292 929.8 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.13 - 2024.03.13 CHECKED BY AO

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		
	Continued From Previous Page							SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								WATER CONTENT (%)						
								20	40	60				
103.1	CLAYEY SILT (CL) Contains sand partings and seams Very stiff Grey		17	SS	17		103							0 13 66 21
20.4	End of Sampled Borehole Borehole Advanced with DCPT						102							
							101							
100.8	End of Borehole on DCPT refusal													
22.7	Borehole dry upon completion.													

RECORD OF BOREHOLE No EB23-08

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483792°, Long: -76.651186°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 218.6 E 292 981.4 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.14 - 2024.03.14 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				w _P w w _L							
126.1	Ground Surface						20	40	60	80	100	20	40	60					
0.0	Sandy CLAYEY SILT (CL) Contains organics Very stiff Brown to greyish brown		1	SS	5								○						
				2	SS	10								○					
														○					
124.3			3	SS	8								○						
1.8	SAND with silt Loose to compact Brown												○						
				4	SS	5								○					
				5	SS	6								○					
				6	SS	4								○					
				7	SS	10								○					
			8	SS	11								○						
120.2																			
5.9	SILTY CLAY (CI) Contains sand partings and seams Stiff to very stiff Grey													○					
				9	SS	2								○					
				10	SS	WH													
																		</	

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No EB23-08

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483792°, Long: -76.651186°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 218.6 E 292 981.4 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA COMPILED BY RH
DATUM Geodetic DATE 2024.03.14 - 2024.03.14 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					w _p w w _L			
	Continued From Previous Page						116										
	SILTY CLAY (CI) Contains sand partings and seams Stiff to very stiff Grey - Unable to push vane <																

RECORD OF BOREHOLE No EB23-09

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483548°, Long: -76.650563°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 191.4 E 293 030.0 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA / NW Casing COMPILED BY RH
DATUM Geodetic DATE 2024.03.15 - 2024.03.18 CHECKED BY AO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE										
127.7	Ground Surface																				
0.0	SILTY SAND to SAND Very loose to compact Brown to greyish brown		1	SS	4																
			2	SS	5														0 56 27 17		
			3	SS	5																
			4	SS	5																
			5	SS	6																
			6	SS	10																
			7	SS	15																
			8	SS	10																
			9	SS	9																
			10	SS	5																
			11	SS	2														0 98 2 (SI+CL)		
			12	SS	28																

Continued Next Page

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

RECORD OF BOREHOLE No EB23-09

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483548°, Long: -76.650563°
Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 191.4 E 293 030.0 ORIGINATED BY BC
HWY 17 BOREHOLE TYPE CME 75 Trackmount / HSA / NW Casing COMPILED BY RH
DATUM Geodetic DATE 2024.03.15 - 2024.03.18 CHECKED BY AO

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%) w _P w w _L				GR	SA	SI	CL		
117.6 10.1	Continued From Previous Page																		
	SILTY CLAY (CI) Contains sand partings and seams Stiff to very stiff Greyish brown		13	SS	3		117								0	1	37	62	
							116												
							115												
							114												
							113												
							112												
							111												
110.2 17.5	End of Borehole																		
	Monitoring Well Installed: Schedule 40 PVC standpipe with 50-mm diameter and 3.0-m slotted screen. Stick-up cover installed at ground surface.																		
	Water Level Readings: DATE DEPTH (m) ELEV. (m) 2024/03/20 5.7 122.0 2024/03/28 5.7 122.0 2024/04/10 5.7 122.0 2024/04/24 5.5 122.2 2024/06/20 5.5 122.2 2024/06/27 5.4 122.3 2024/07/16 5.9 121.8 2024/08/29 5.4 122.3																		

METRIC

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS
			NUMBER	"N" VALUES	
128.4 0.0	Ground Surface				
	SILTY SAND Very loose to dense Brown		1	SS	5
	2		SS	5	
	3		SS	3	
	4		SS	6	
	5		SS	9	
	6		SS	10	
	- Frequent shells noted below a depth of 6.1 m (elev. 122.3 m)				
	7	SS	10		
	8	SS	15		
	9	SS	25		
	10	SS	38		
	11	SS	5		
119.2 9.2	SILTY CLAY (Cl) Contains sand partings and seams Stiff to very stiff Greyish brown		12	SS	2

+³, ×³: Numbers refer to Sensitivity

METRIC

Eastbound 20+450 to 20+900; Horton Twp; MTM z9: N 5 038 167.1 E 293 064.3 ORIGINATED BY BC

BOREHOLE TYPE CME 75 Trackmount / HSA

DATUM	Geodetic	DATE	2024.03.19 - 2024.03.19	CHECKED BY	AO
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+³, ×³: Numbers refer to Sensitivity

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 12-16-24

RECORD OF BOREHOLE No B0N19-6

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485625°, Long: -76.655414°
Bonnechere River Bridge N 5 038 422.9 E 292 651.3 ORIGINATED BY JG
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.09.17 - 2020.09.17 CHECKED BY MJK

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 (%)				
								○ UNCONFINED + FIELD VANE				w P w w L				
								● QUICK TRIAXIAL × LAB VANE								
116.9	Ground Surface															
0.0	TOPSOIL (100 mm)															
0.1	SILTY CLAY (CI) Occassional silty sand seam Very stiff Brown WEATHERED CRUST		1	SS	6								○			
			2	SS	13								○			
			3	SS	10								○		0 2 40 58	
			4	SS	11								○			
			5	SS	5								○			
			6	SS	6								○		0 1 58 41	
			7	SS	7								○			
			8	SS	18								○			
108.1	SAND, some silt to silty Compact Brown															
8.8																

Continued Next Page

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No B0N19-7

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485485°, Long: -76.655113°
Bonnechere River Bridge N 5 038 407.3 E 292 674.7 ORIGINATED BY SH
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.09.16 - 2020.09.17 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P W W _L			WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE									
118.0	Ground Surface							20 40 60 80 100									
0.0	TOPSOIL (150mm)							20 40 60 80 100									
0.2	SILTY CLAY (CI) Occasional sand seam Very stiff Grey-brown WEATHERED CRUST		1	SS	16												
			2	SS	17		117										0 2 36 62
			3	SS	16		116										
			4	SS	11		115										
			5	SS	6		114										
			6	SS	9		113										0 0 54 46
			7	SS	7		112										
			8	SS	6		111										
			9	SS	5		110										
			109.9														
8.1	CLAYEY SILT (CL) Very stiff Grey																
			10	SS	3		109									0 0 58 42	

Continued Next Page

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

RECORD OF BOREHOLE No B0N19-7

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485485°, Long: -76.655113°
Bonnechere River Bridge N 5 038 407.3 E 292 674.7 ORIGINATED BY SH
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.09.16 - 2020.09.17 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
								20	40	60	80	100						20	40	60
	Continued From Previous Page																			
	CLAYEY SILT (CL) Very stiff Grey		11	SS	WH		107													
							106													
				12	SS	1		105												
104.0																				
14.0	SILTY SAND Compact Brown		13	SS	5		104													
103.7																				
14.3																				
	End of Borehole																			
	Borehole dry upon completion.																			

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

RECORD OF BOREHOLE No B0N19-8

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485283°, Long: -76.654548°
Bonnechere River Bridge N 5 038 384.8 E 292 718.9 ORIGINATED BY JP
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.09.15 - 2020.09.15 CHECKED BY MJK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W P W W L				GR	SA	SI	CL	
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)										
117.7	Ground Surface							20	40	60	80	100	20	40	60					
0.0	SILTY CLAY (CI) Occasional sand seams Very stiff Grey-brown WEATHERED CRUST		1	SS	4								○							
			2	SS	7								┌───○───┐				0	7	40	53
			3	SS	7								○							
			4	SS	5								○							
			5	SS	5								○							
													+							
													+							
			6	SS	6								┌───○───┐				0	0	52	48
			7	SS	5								○							
			8	SS	6								○							
													+							
													+							
			9	SS	4								┌───○───┐				0	1	56	43
109.5																				
8.2	CLAYEY SILT (CL) Stiff to very stiff Grey-brown to brown												+							
			10	SS	7								○							

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

Continued Next Page



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

RECORD OF BOREHOLE No B0N19-8

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485283°, Long: -76.654548°
Bonnehchere River Bridge N 5 038 384.8 E 292 718.9 ORIGINATED BY JP
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.09.15 - 2020.09.15 CHECKED BY MJK

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						
Continued From Previous Page							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _P W W _L WATER CONTENT (%) 20 40 60							
106.4	CLAYEY SILT (CL) Stiff to very stiff Grey-brown to brown		11	SS	9		107							0 8 59 33
11.3			SILTY SAND, some gravel Dense Brown		12	SS	43		106					
								105						
103.4					13	SS	39		104					
14.3	End of Borehole Borehole dry upon completion.													

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

RECORD OF BOREHOLE No B0N19-9

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.485106°, Long: -76.654137°
Bonnechere River Bridge N 5 038 365.0 E 292 751.0 ORIGINATED BY JP
HWY 17 BOREHOLE TYPE CME 45 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.09.14 - 2020.09.14 CHECKED BY MJK

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 (%)					GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE														
117.8	Ground Surface																								
0.0	SILTY CLAY (CI) Occasional sand seams Very stiff Grey-brown WEATHERED CRUST		1	SS	4								○												
			2	SS	9								○												
			3	SS	11								○												
			4	SS	10								○					0	0	45	55				
			5	SS	8								○												
			6	SS	8								○												
			7	SS	8								○												
			8	SS	6								○												
			9	SS	7								○												
			10	SS	5								○												
109.9			11	SS	1								○												
7.9	CLAYEY SILT (CL) Occasional sand seams Stiff Grey																								

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

Continued Next Page

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OBR19-14

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483006°, Long: -76.649333°
O'Brien Road W-S Ramp N 5 038 130.9 E 293 126.1 ORIGINATED BY NW
HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.02.05 - 2020.02.05 CHECKED BY FG

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		
132.2	Ground Surface													
0.9	TOPSOIL (50 mm)		1	SS	7		132							
	SILTY SAND Loose to compact Brown		2	SS	17		131							
130.7			3	SS	33		130							
1.5	SAND with silt and gravel to GRAVEL with silt and sand Occasional to frequent cobbles Compact to very dense Brown		4	SS	26		129							
			5	SS	25		128							
			6	SS	38		127							
	- Grinding while augering		7	SS	20		126							
			8	SS	15		125							
	- Poor sample recovery below elevation 126 m		9	SS	17		124							
			10	SS	100/ 150mm		123							
	- Very heavy grinding while augering													

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OBR19-14

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483006°, Long: -76.649333°
O'Brien Road W-S Ramp N 5 038 130.9 E 293 126.1 ORIGINATED BY NW
HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.02.05 - 2020.02.05 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
	Continued From Previous Page						20	40	60	80	100	20	40	60		
117.9 																

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

RECORD OF BOREHOLE No OBR19-15

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483311°, Long: -76.649816°
O'Brien Road W-S Ramp N 5 038 164.8 E 293 088.4 ORIGINATED BY NW
HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.02.06 - 2020.02.06 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P	W	W _L		
129.1	Ground Surface							20 40 60 80 100						
0.0	TOPSOIL (50 mm)							20 40 60 80 100						
	SILTY SAND to SAND with silt Loose to compact Brown		1	SS	4		129							
			2	SS	4		128							
			3	SS	4		127							0 85 15 (SI+CL)
			4	SS	6		126							
			5	SS	4		125							
			6	SS	7		124							
			7	SS	10		123							
			8	SS	15		122							3 86 11 (SI+CL)
			9	SS	14		121							
119.7	CLAYEY SILT (CL)		10	SS	6		120							
9.4	Stiff Brown													

Continued Next Page

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

RECORD OF BOREHOLE No OBR19-15

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483311°, Long: -76.649816°
O'Brien Road W-S Ramp N 5 038 164.8 E 293 088.4 ORIGINATED BY NW
HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.02.06 - 2020.02.06 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			
								○ UNCONFINED	+	FIELD VANE									
								● QUICK TRIAXIAL	×	LAB VANE									
	Continued From Previous Page																		
	CLAYEY SILT (CL) Stiff Brown						119												
			11	SS	3		118												

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

RECORD OF BOREHOLE No OBR19-16

1 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483542°, Long: -76.650316°
O'Brien Road W-S Ramp N 5 038 190.7 E 293 049.4 ORIGINATED BY NW
HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.02.05 - 2020.02.05 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL × LAB VANE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
127.9	Ground Surface						20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

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

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24

RECORD OF BOREHOLE No OBR19-16

2 OF 2

METRIC

WP# 4068-09-00 LOCATION Lat: 45.483542°, Long: -76.650316°
O'Brien Road W-S Ramp N 5 038 190.7 E 293 049.4 ORIGINATED BY NW
HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA COMPILED BY JP
DATUM Geodetic DATE 2020.02.05 - 2020.02.05 CHECKED BY FG

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 DCPT continued																
							117										
							116										
							115										
							114										
							113										
112.7	DCPT ended																
15.2	End of Borehole																

DOUBLE LINE 24726 EASTBOUND 20+450 TO 20+900.GPJ 2012TEMPLATE(MTO).GDT 11-20-24



Appendix C.

Laboratory Testing



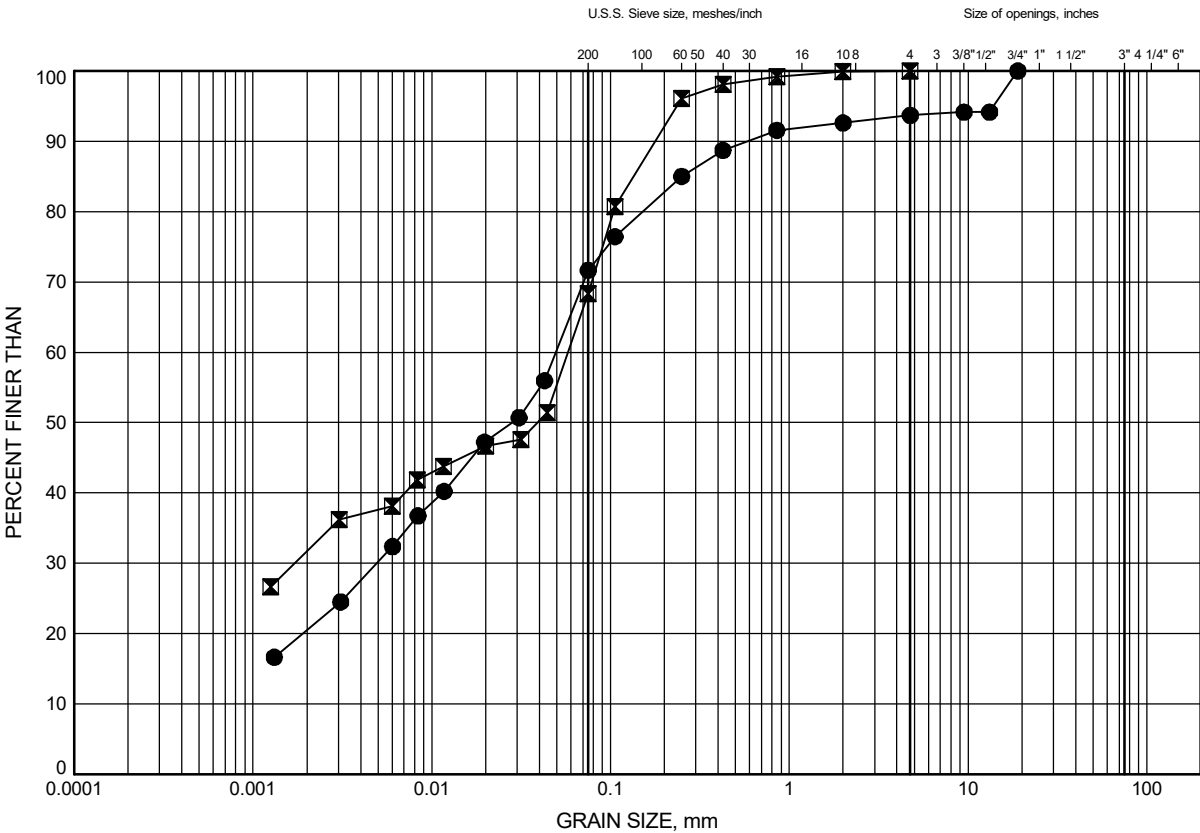
Appendix C.1
Particle Size Analysis Figures
Atterberg Limit Test Results

Highway 17 Twinning, Sta. 20+450 to 20+900

GRAIN SIZE DISTRIBUTION

FIGURE C1

Sandy Clayey Silt (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-03	0.3	119.5
⊠	EB23-08	1.0	125.1

GRAIN SIZE DISTRIBUTION - THURBER 24726 EASTBOUND 20+450 TO 20+900.GPJ 10-1-24

Date ..October 2024.....

WP# ..4068-09-00.....



Prep'dRH.....

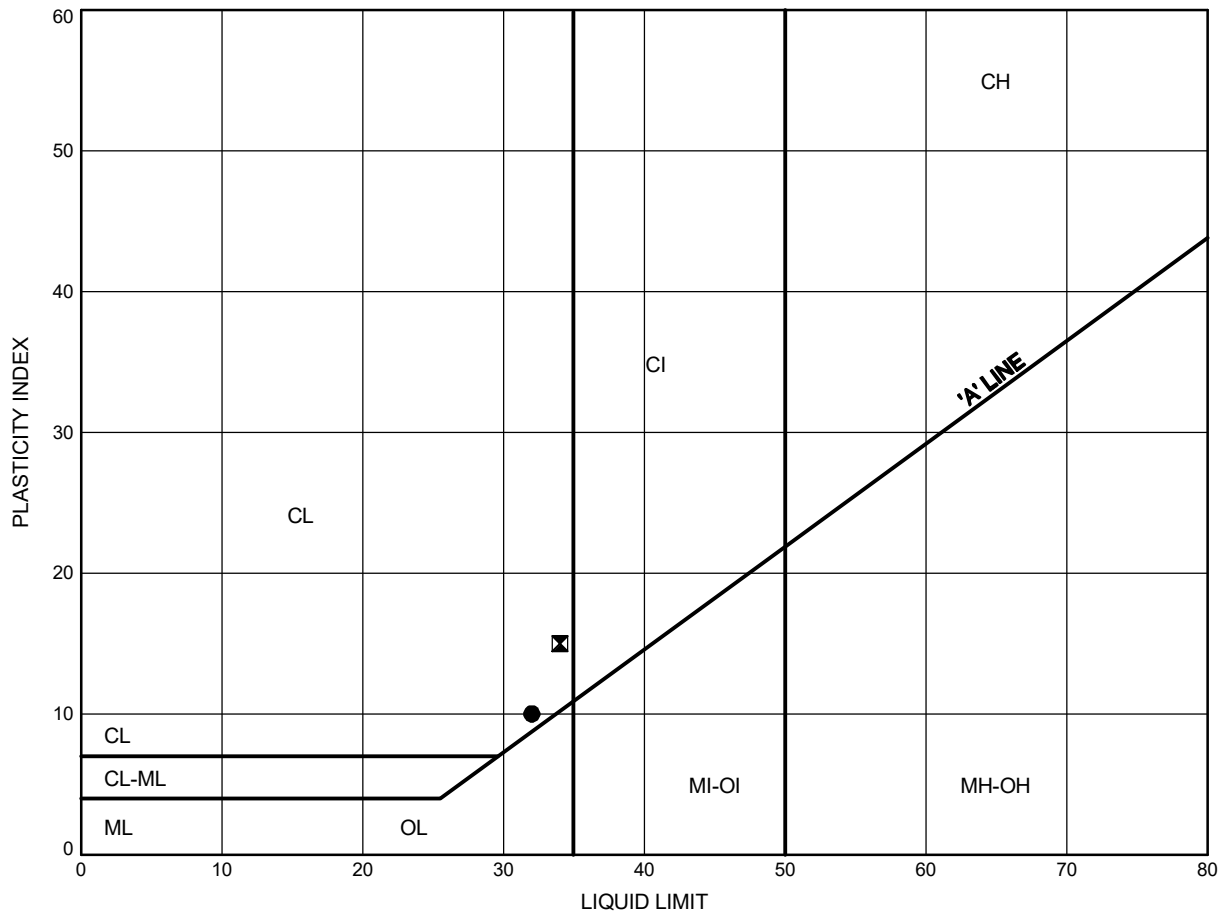
Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

ATTERBERG LIMITS TEST RESULTS

FIGURE C2

Sandy Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-03	0.3	119.5
⊠	EB23-08	1.1	125.0

Date ..October 2024.....
WP# ..4068-09-00.....

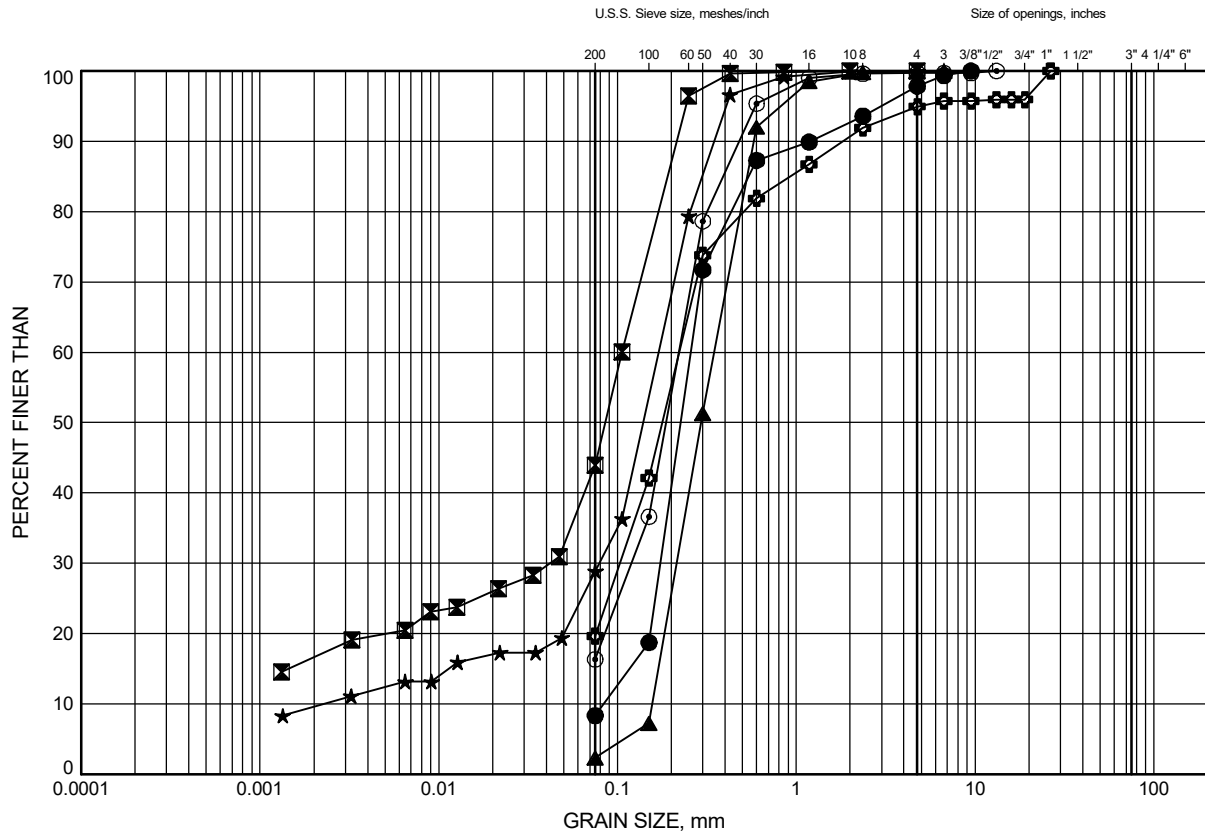


Prep'dRH.....
Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900 GRAIN SIZE DISTRIBUTION

FIGURE C3

Upper Sand to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-08	4.9	121.2
⊠	EB23-09	1.1	126.6
▲	EB23-09	7.9	119.8
★	EB23-10	1.1	127.3
⊙	EB23-10	5.6	122.8
⊕	EB23-10	7.9	120.5

Date ..October 2024.....
 WP# ..4068-09-00.....



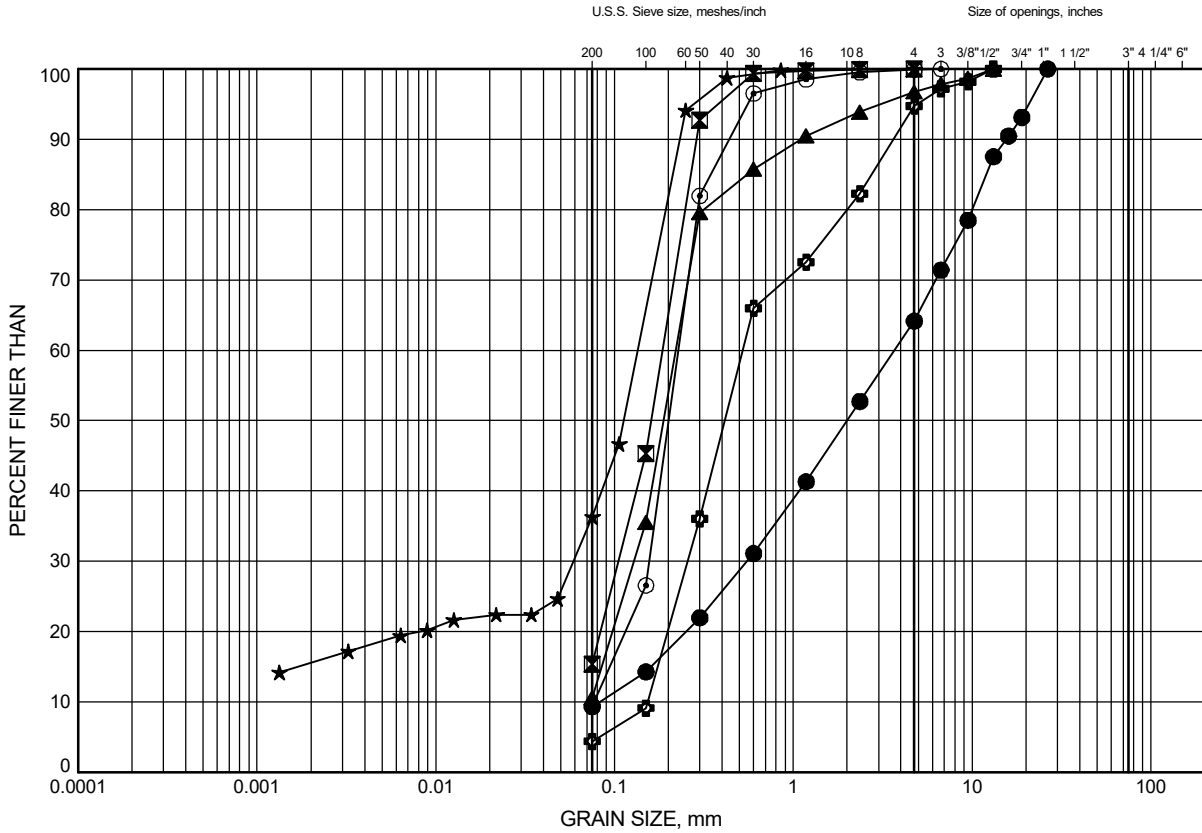
Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

GRAIN SIZE DISTRIBUTION

FIGURE C4

Upper Sand to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OBR19-14	2.6	129.6
⊠	OBR19-15	1.8	127.3
▲	OBR19-15	6.4	122.7
★	OBR19-16	2.6	125.3
⊙	OBR19-16	4.9	123.0
⊕	OBR19-16	7.9	120.0

Date ..October 2024.....
 WP# ..4068-09-00.....



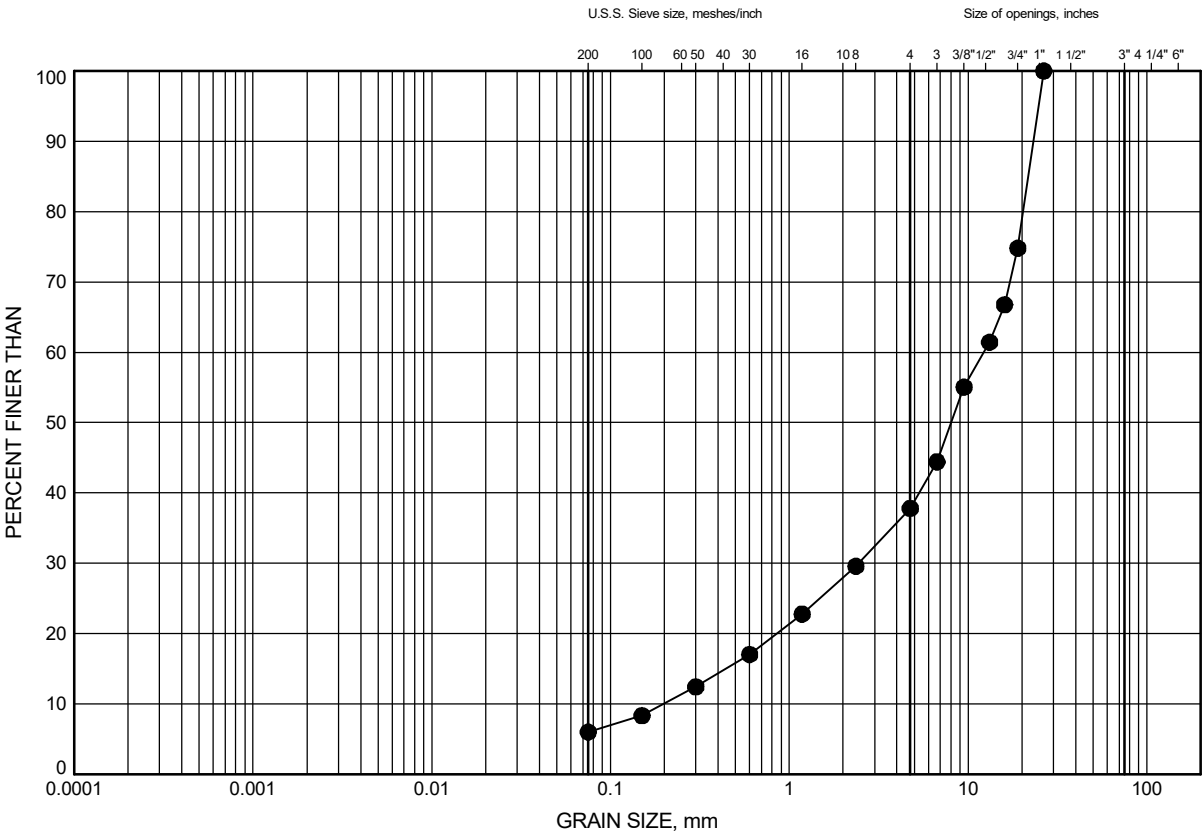
Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

GRAIN SIZE DISTRIBUTION

FIGURE C5

Gravel with Silt and Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OBR19-14	11.0	121.2

GRAIN SIZE DISTRIBUTION - THURBER 24726 EASTBOUND 20+450 TO 20+900.GPJ 10-1-24

Date ..October 2024.....

WP# ..4068-09-00.....



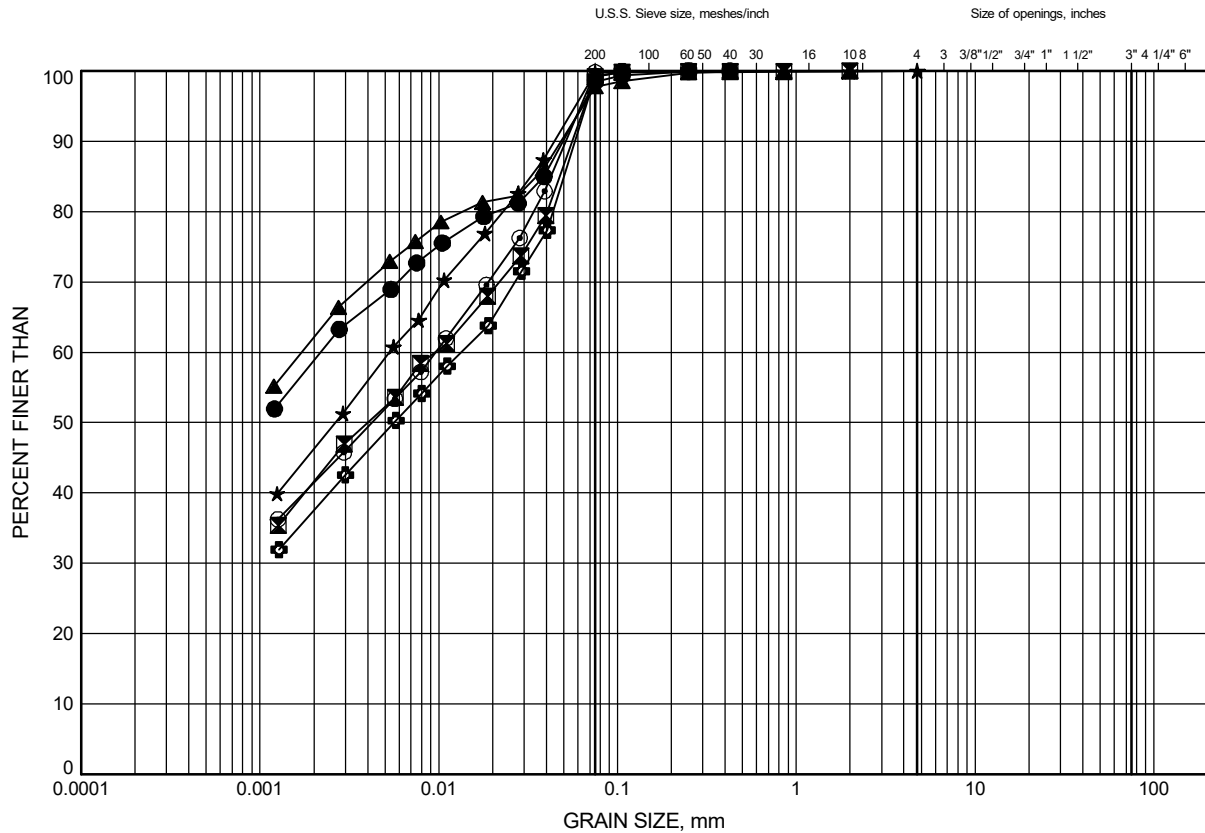
Prep'dRH.....

Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900 GRAIN SIZE DISTRIBUTION

FIGURE C6

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-6	1.8	115.1
⊠	BON19-6	6.4	110.5
▲	BON19-7	1.1	116.9
★	BON19-7	4.9	113.1
⊙	BON19-7	9.4	108.6
⊕	BON19-7	12.5	105.5

Date ..October 2024.....
 WP# ..4068-09-00.....



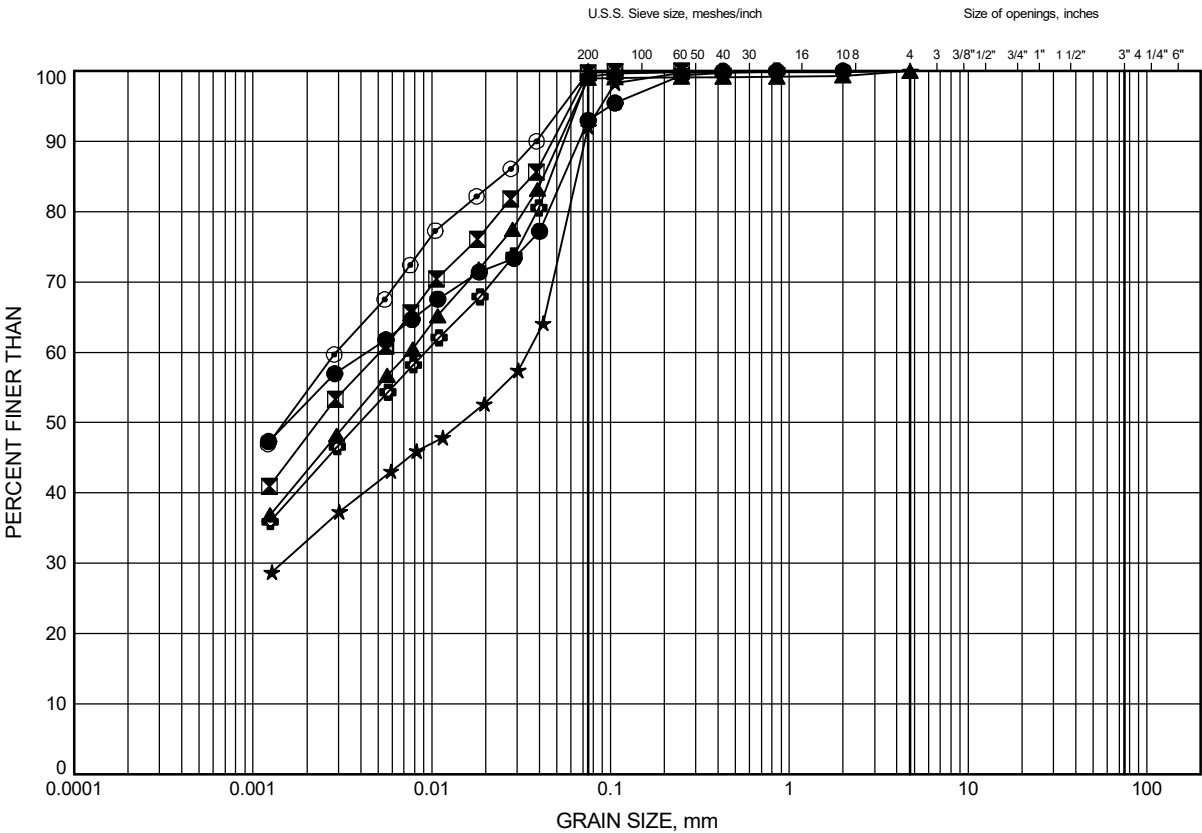
Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

GRAIN SIZE DISTRIBUTION

FIGURE C7

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-8	1.1	116.6
⊠	BON19-8	4.9	112.8
▲	BON19-8	7.9	109.8
★	BON19-8	11.0	106.7
⊙	BON19-9	2.6	115.2
⊕	BON19-9	9.4	108.4

GRAIN SIZE DISTRIBUTION - THURBER 24726 EASTBOUND 20+450 TO 20+900.GPJ 10-1-24

Date ..October 2024.....
WP# ..4068-09-00.....

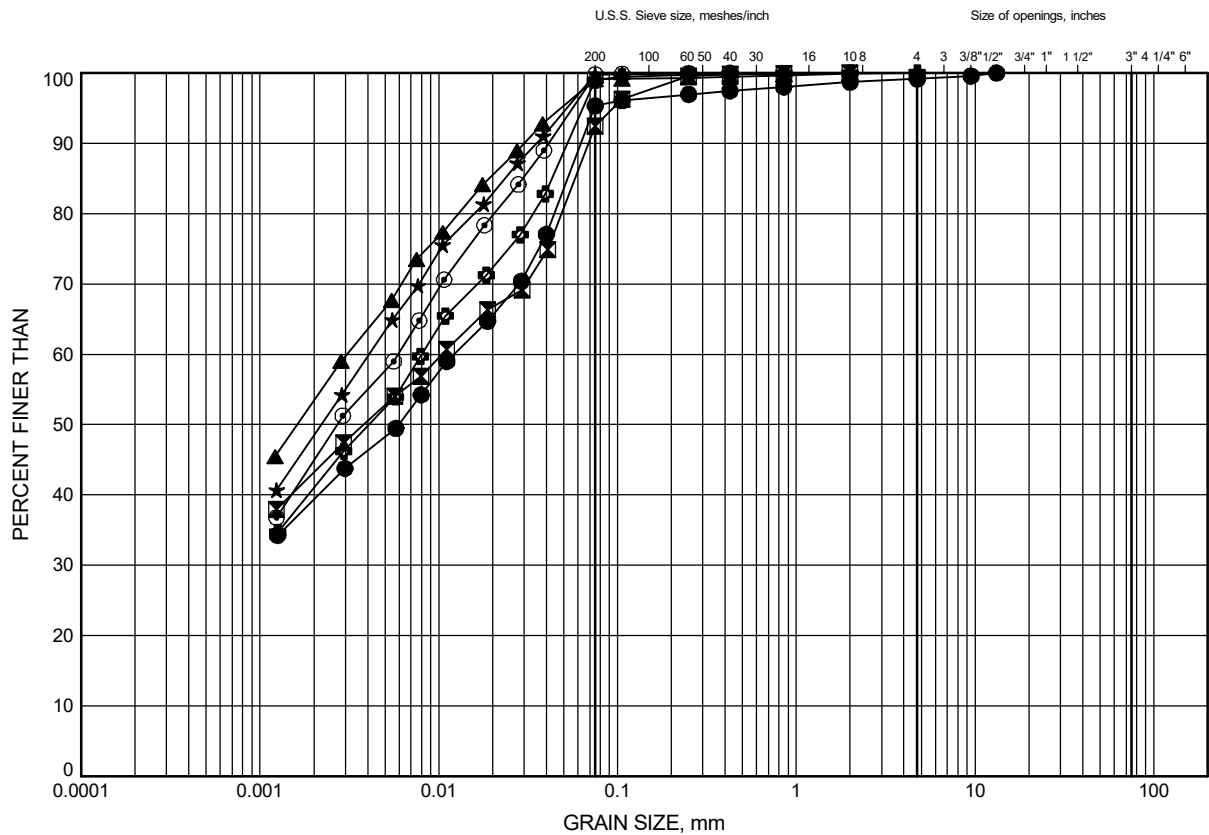


Prep'dRH.....
Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900 GRAIN SIZE DISTRIBUTION

FIGURE C8

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-9	11.0	106.8
⊠	EB23-01	1.2	117.4
▲	EB23-01	6.4	112.2
★	EB23-01	11.0	107.6
⊙	EB23-02	3.4	116.2
⊕	EB23-02	9.4	110.2

Date ..October 2024.....
 WP# ..4068-09-00.....

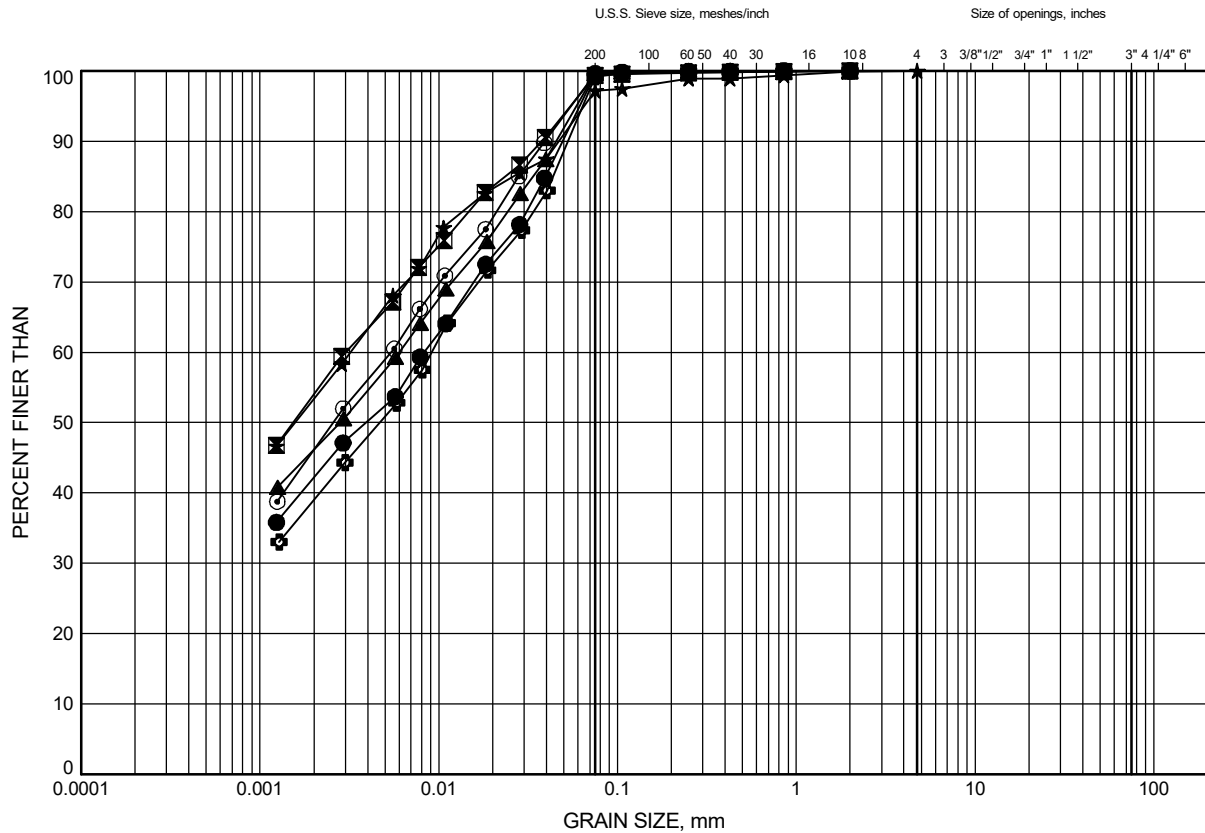


Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900 GRAIN SIZE DISTRIBUTION

FIGURE C9

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-03	6.4	113.4
⊠	EB23-04	1.8	118.9
▲	EB23-04	7.9	112.8
★	EB23-05	1.1	120.5
⊙	EB23-05	7.9	113.7
⊕	EB23-05	12.5	109.1

Date ..October 2024.....
 WP# ..4068-09-00.....



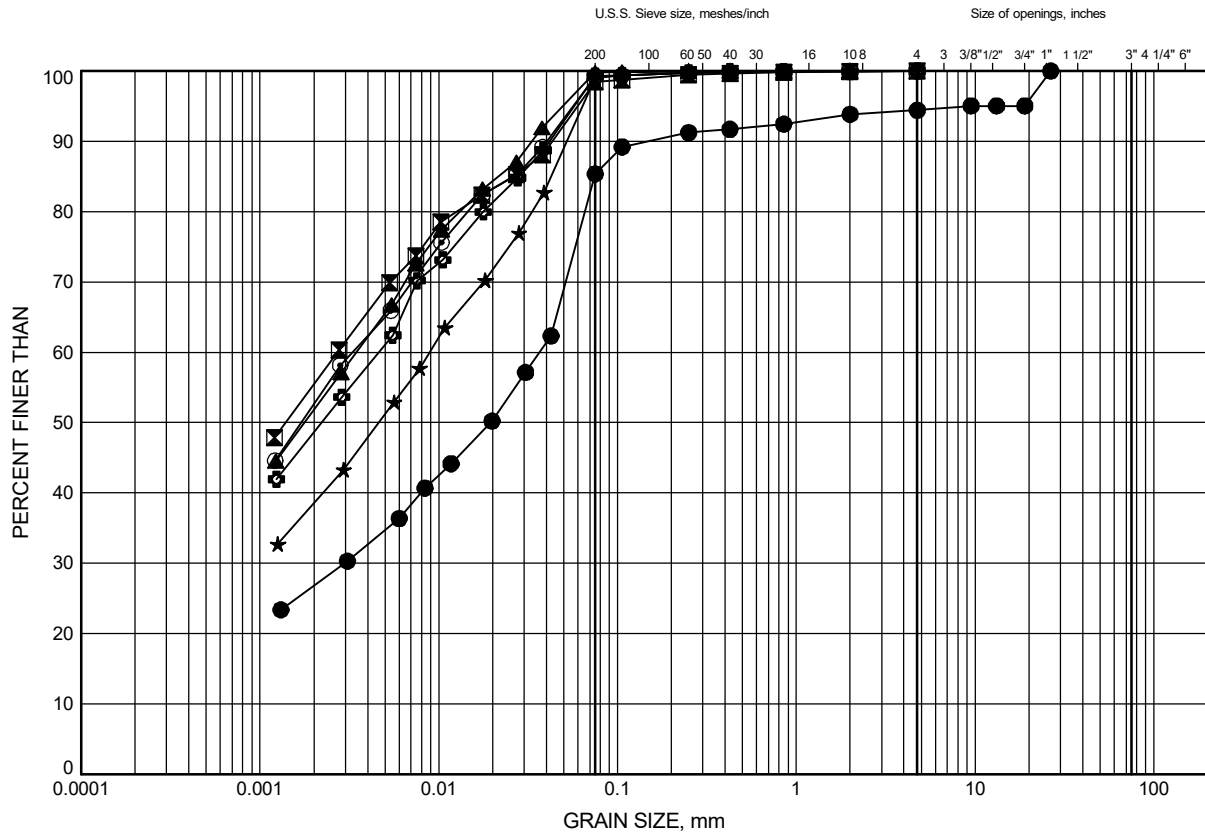
Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

GRAIN SIZE DISTRIBUTION

FIGURE C10

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-05	15.5	106.1
⊠	EB23-06	1.1	121.6
▲	EB23-06	4.9	117.8
★	EB23-06	12.5	110.2
⊙	EB23-07	1.8	121.7
⊕	EB23-07	6.4	117.1

Date ..October 2024.....
 WP# ..4068-09-00.....



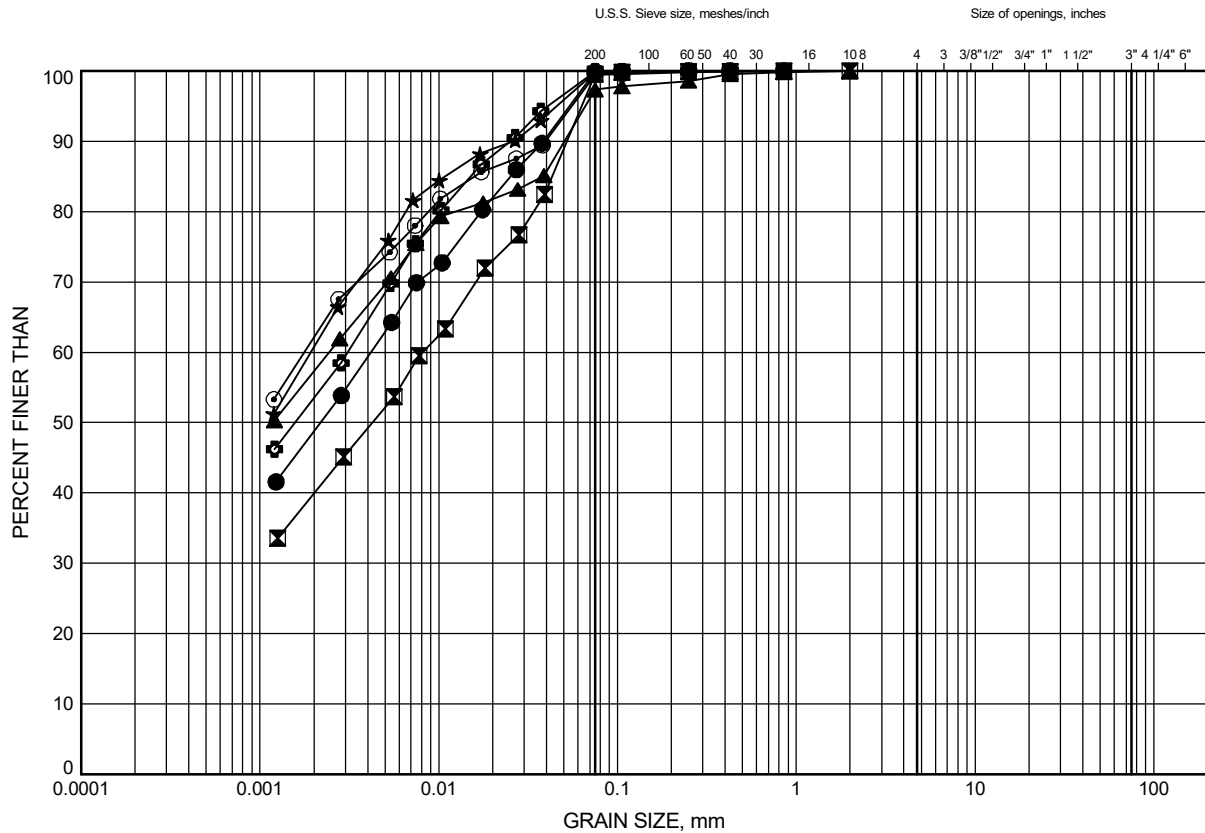
Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

GRAIN SIZE DISTRIBUTION

FIGURE C11

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-07	7.9	115.6
⊠	EB23-07	14.0	109.5
▲	EB23-08	6.4	119.7
★	EB23-08	12.5	113.6
⊙	EB23-09	10.4	117.3
⊕	EB23-09	14.9	112.8

Date ..October 2024.....
 WP# ..4068-09-00.....



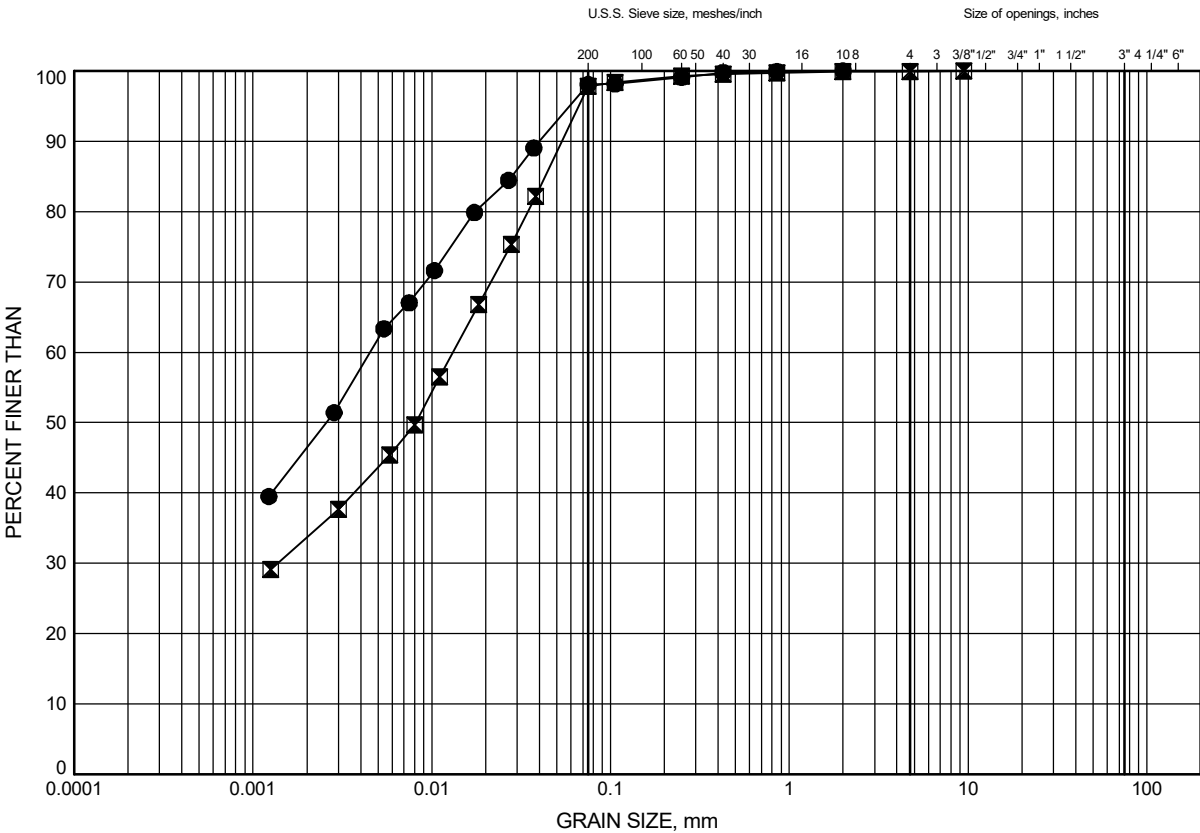
Prep'd ..RH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

GRAIN SIZE DISTRIBUTION

FIGURE C12

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-10	12.5	115.9
⊠	OBR19-15	11.0	118.1

GRAIN SIZE DISTRIBUTION - THURBER 24726 EASTBOUND 20+450 TO 20+900.GPJ 10-1-24

Date ..October 2024.....
WP# ..4068-09-00.....



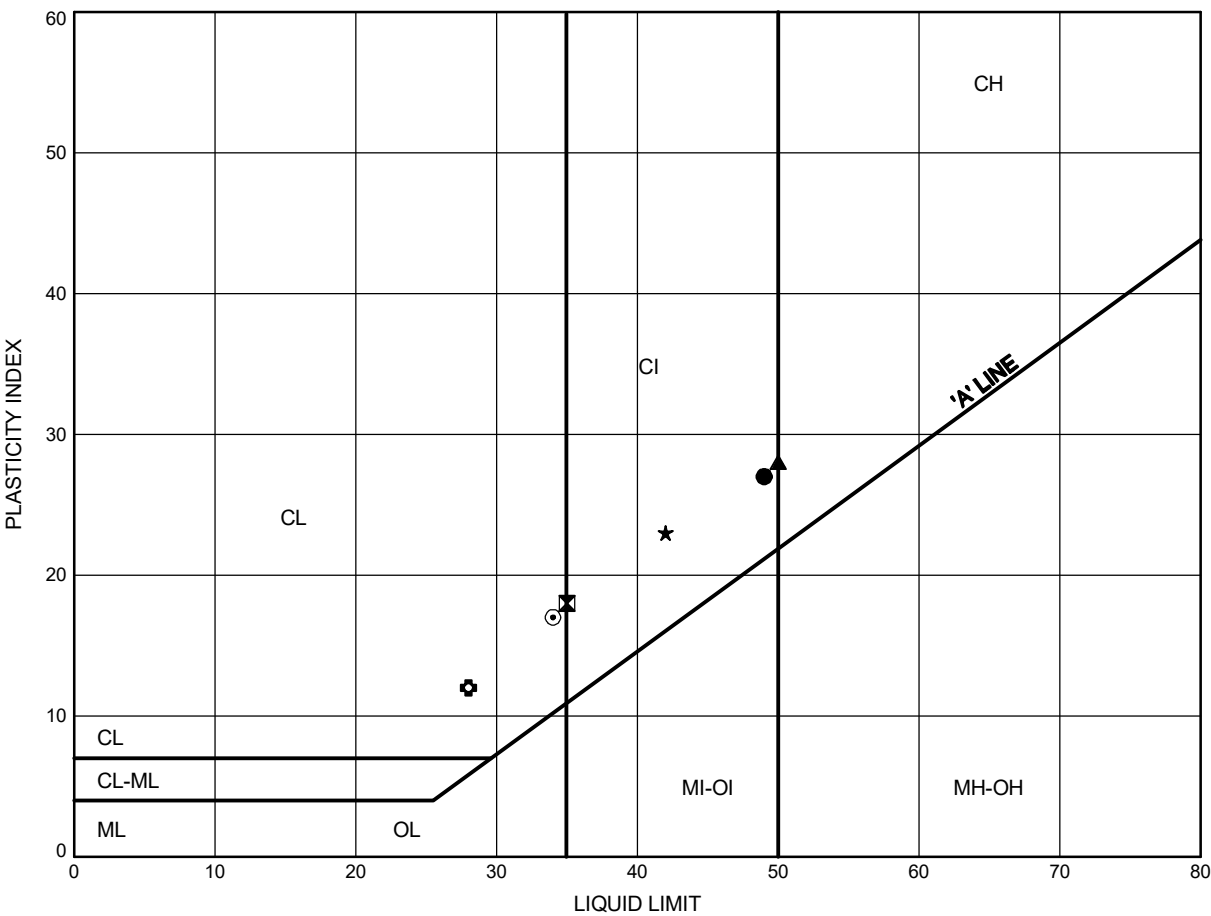
Prep'dRH.....
Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

ATTERBERG LIMITS TEST RESULTS

FIGURE C13

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-6	1.8	115.1
⊠	BON19-6	6.4	110.5
▲	BON19-7	1.1	116.9
★	BON19-7	4.9	113.1
⊙	BON19-7	9.4	108.6
⊕	BON19-7	12.5	105.5

Date ..October 2024.....
WP# ..4068-09-00.....



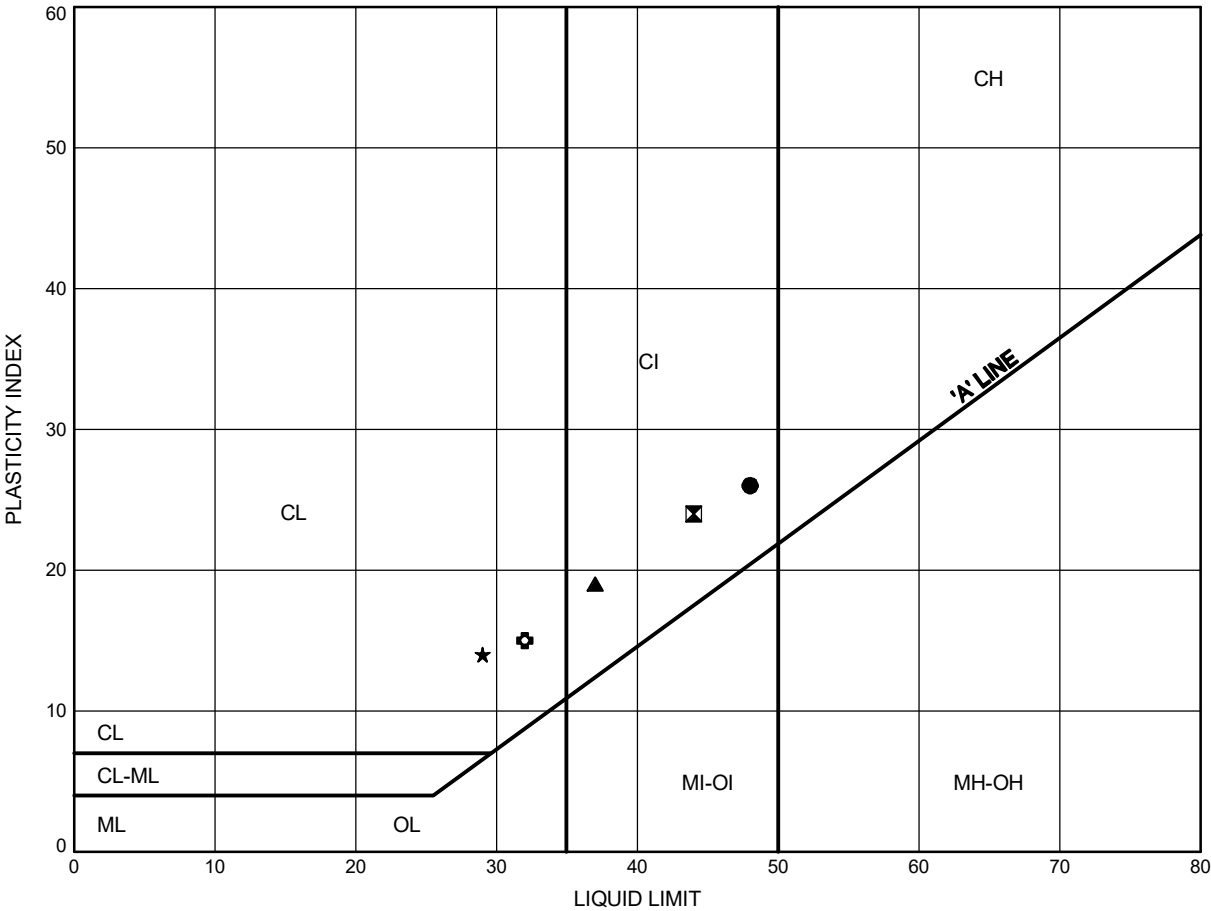
Prep'dRH.....
Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

ATTERBERG LIMITS TEST RESULTS

FIGURE C14

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-8	1.1	116.6
⊠	BON19-8	4.9	112.8
▲	BON19-8	7.9	109.8
★	BON19-8	11.0	106.7
⊙	BON19-9	2.6	115.2
⊕	BON19-9	9.4	108.4

Date ..October 2024.....
WP# ..4068-09-00.....



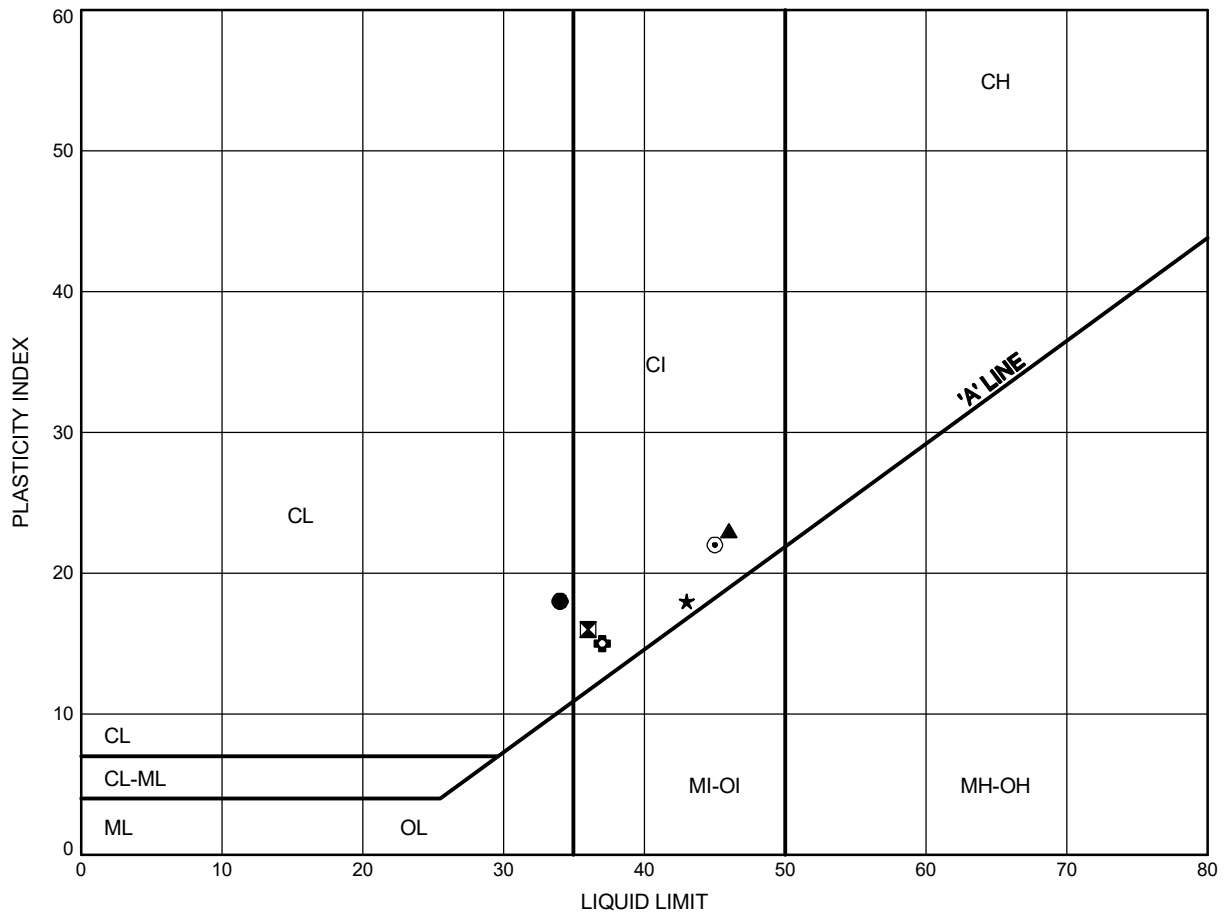
Prep'dRH.....
Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

ATTERBERG LIMITS TEST RESULTS

FIGURE C15

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-9	11.0	106.8
⊠	EB23-01	1.2	117.4
▲	EB23-01	6.4	112.2
★	EB23-01	11.0	107.6
⊙	EB23-02	3.4	116.2
⊕	EB23-02	9.4	110.2

Date ..October 2024.....
 WP# ..4068-09-00.....



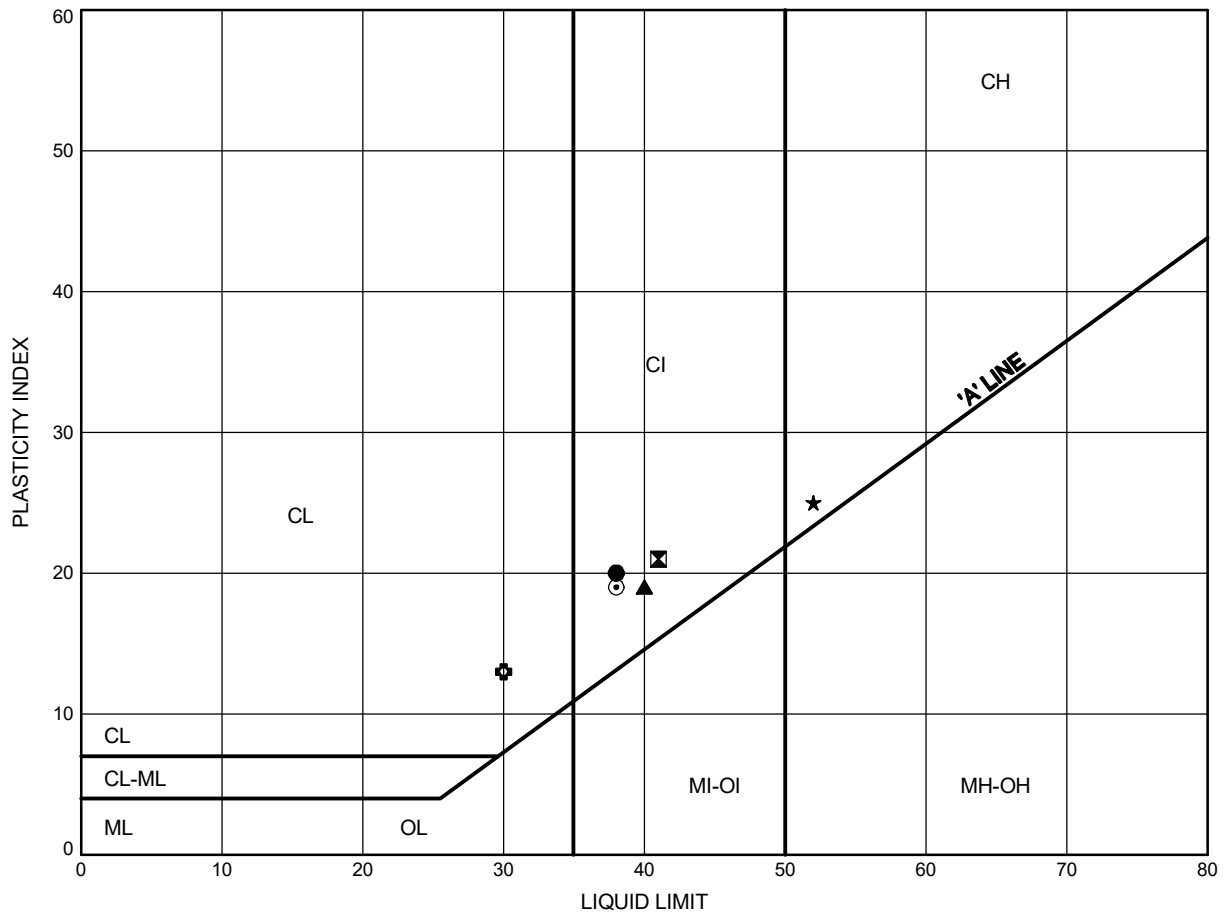
Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

ATTERBERG LIMITS TEST RESULTS

FIGURE C16

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-03	6.4	113.4
⊠	EB23-04	1.8	118.9
▲	EB23-04	7.9	112.8
★	EB23-05	1.1	120.5
⊙	EB23-05	7.9	113.7
⊕	EB23-05	12.5	109.1

Date ..October 2024.....
 WP# ..4068-09-00.....



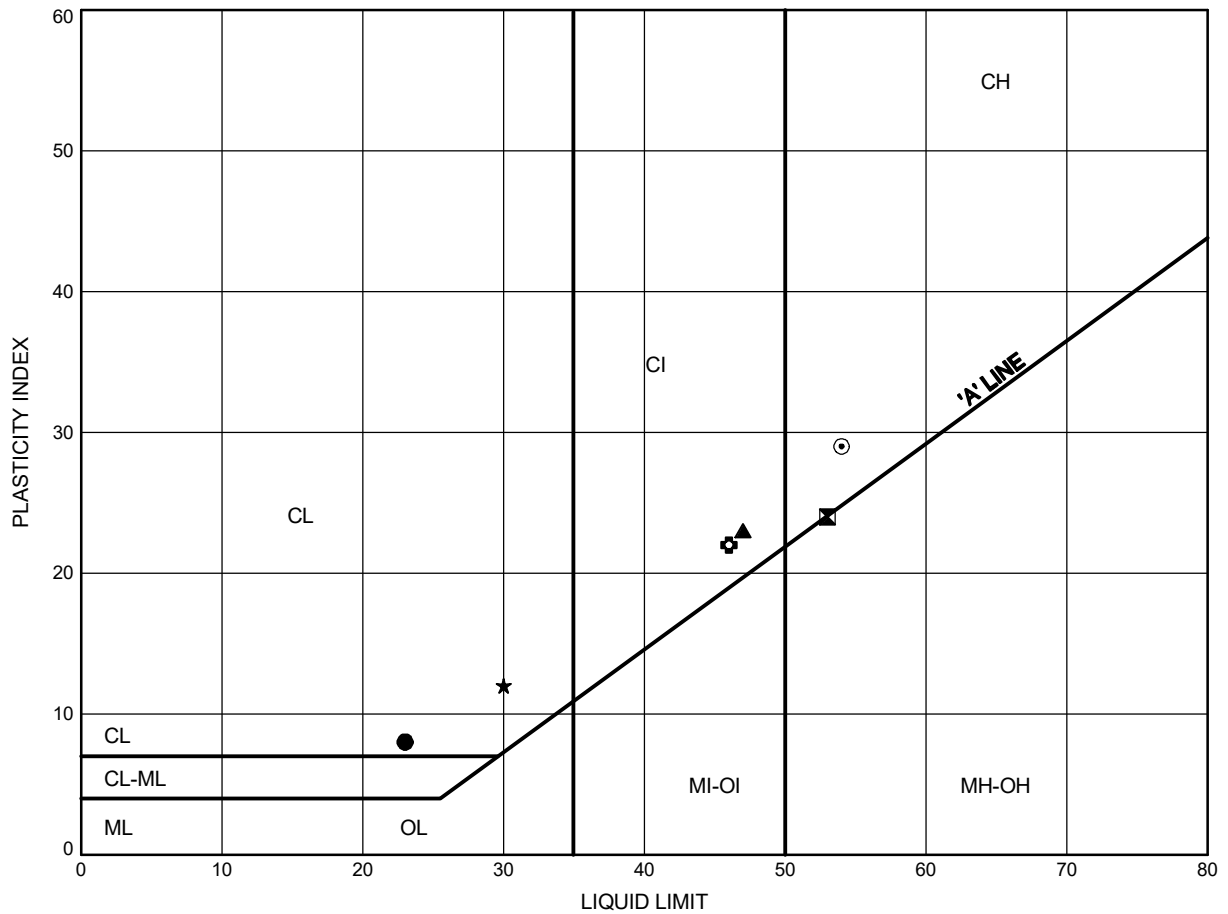
Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

ATTERBERG LIMITS TEST RESULTS

FIGURE C17

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-05	15.5	106.1
⊠	EB23-06	1.1	121.6
▲	EB23-06	4.9	117.8
★	EB23-06	12.5	110.2
⊙	EB23-07	1.8	121.7
⊕	EB23-07	6.4	117.1

Date ..October 2024.....
 WP# ..4068-09-00.....



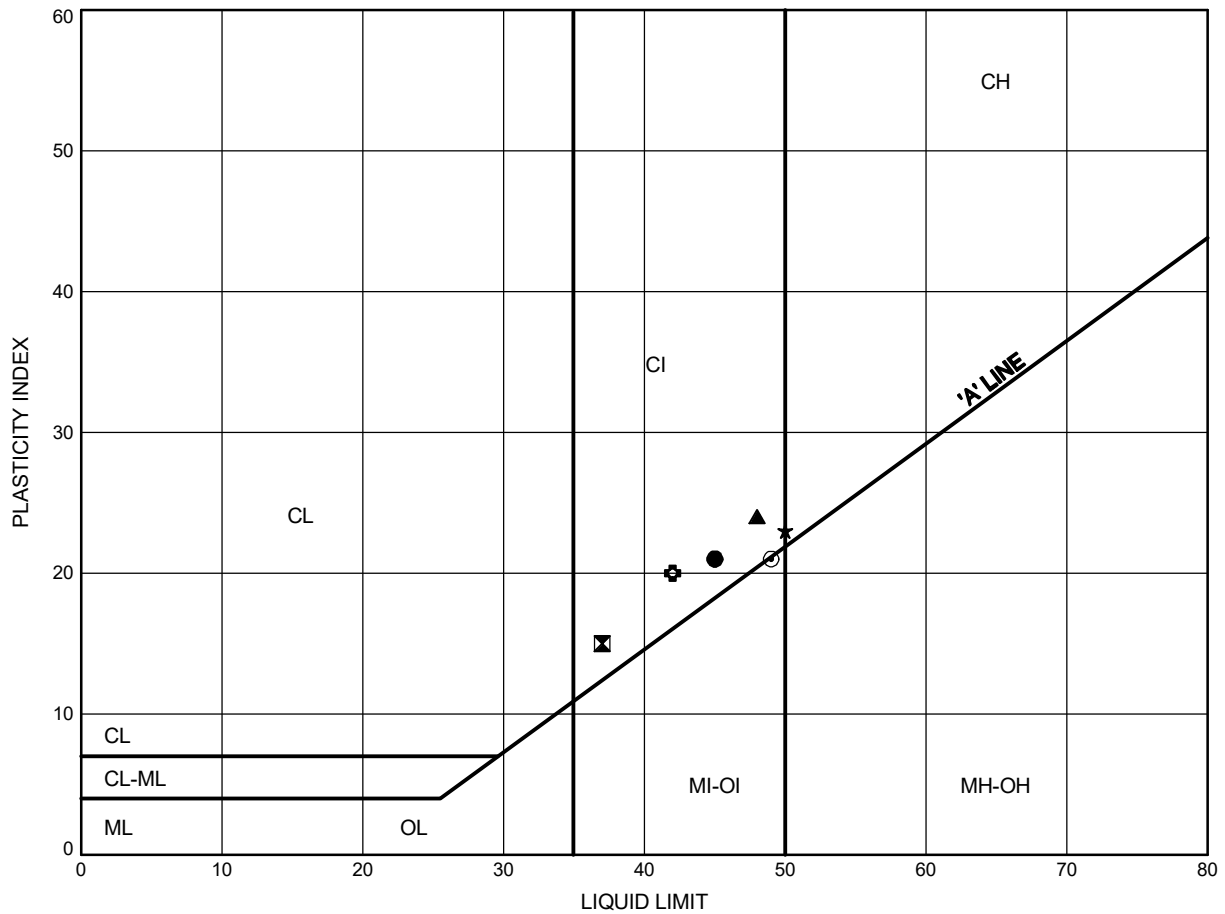
Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

ATTERBERG LIMITS TEST RESULTS

FIGURE C18

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-07	7.9	115.6
⊠	EB23-07	14.0	109.5
▲	EB23-08	6.4	119.7
★	EB23-08	12.5	113.6
⊙	EB23-09	10.4	117.3
⊕	EB23-09	14.9	112.8

Date ..October 2024.....
 WP# ..4068-09-00.....



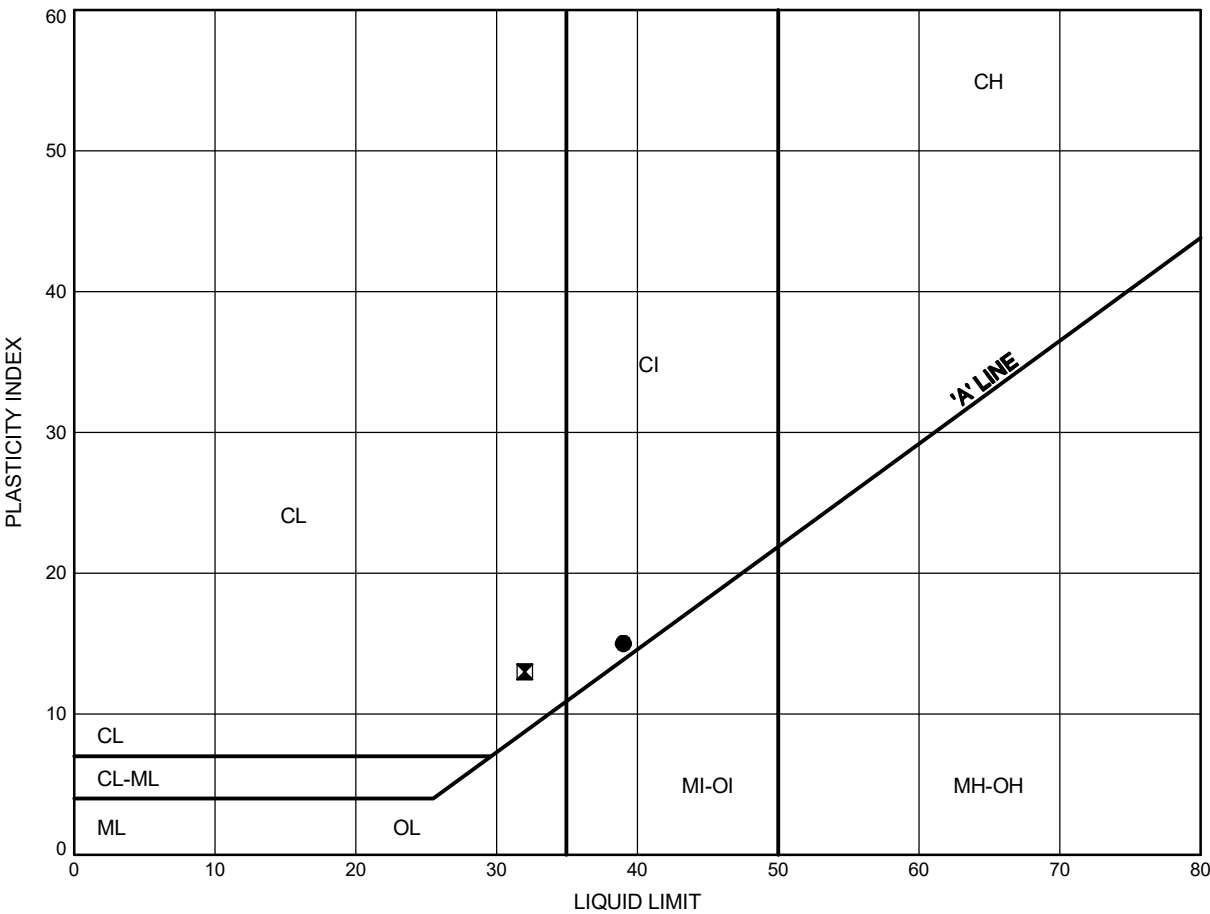
Prep'dRH.....
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Highway 17 Twinning, Sta. 20+450 to 20+900

ATTERBERG LIMITS TEST RESULTS

FIGURE C19

Clay (CH) to Silty Clay (CI) to Clayey Silt (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-10	12.5	115.9
⊠	OBR19-15	11.0	118.1

Date ..October 2024.....
WP# ..4068-09-00.....



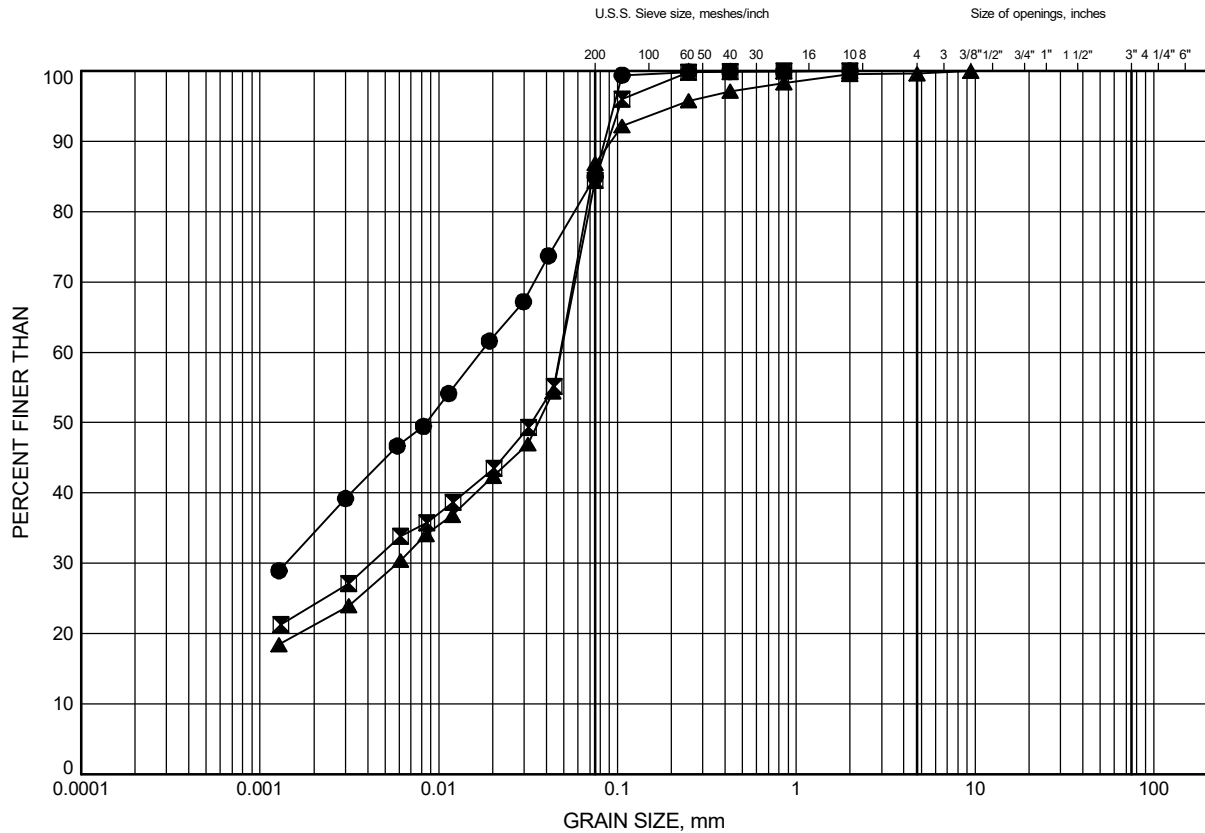
Prep'dRH.....
Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900

GRAIN SIZE DISTRIBUTION

FIGURE C20

Clayey Silt (CL), some Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	EB23-04	12.5	108.2
⊠	EB23-04	14.0	106.7
▲	EB23-07	20.2	103.3

Date ..October 2024.....
 WP# ..4068-09-00.....

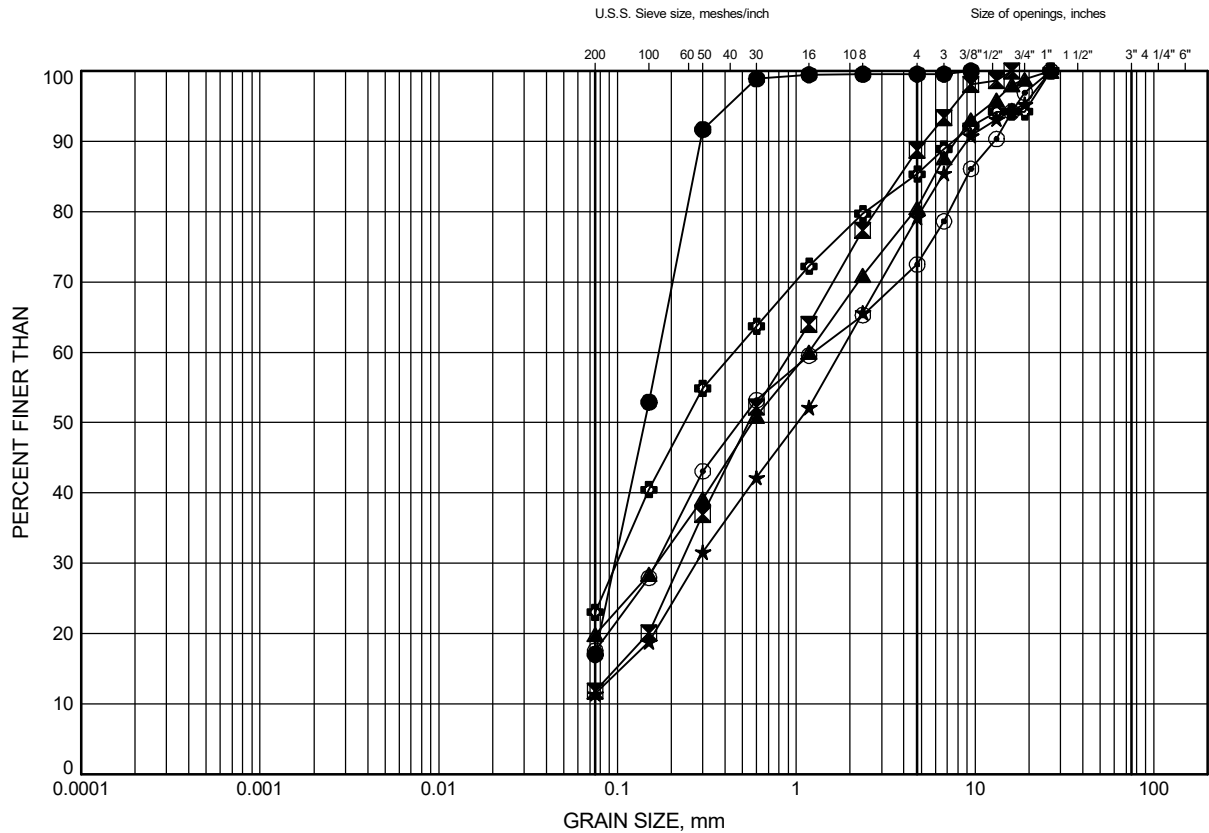


Prep'dRH.....
 Chkd.AO.....

Highway 17 Twinning, Sta. 20+450 to 20+900 GRAIN SIZE DISTRIBUTION

FIGURE C21

Lower Sand to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BON19-6	11.0	105.9
⊠	BON19-9	13.9	103.9
▲	EB23-02	13.9	105.7
★	EB23-03	14.0	105.8
⊙	EB23-04	15.7	105.0
⊛	EB23-10	15.6	112.8

Date October 2024
 WP# 4068-09-00



Prep'd RH
 Chkd. AO



Appendix D.

Site Photographs



Photo 1. Looking east from crest of slope near Sta. 20+450 (March 08, 2024)



Photo 2. Looking east from crest of slope near Sta. 20+500 (March 08, 2024)



Photo 3. Looking east from crest of slope near Sta. 20+580 (March 08, 2024)



Photo 4. Looking southwest from toe of slope near Sta. 20+700 (March 08, 2024)



Photo 5. Looking west from crest of slope near Sta. 20+800 (March 08, 2024)



Appendix E.

GSC Seismic Hazard Calculation

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.484N 76.652W

User File Reference: Highway 17, Sta. 20+450 to 20+900

2024-09-11 15:25 UT

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.353	0.181	0.104	0.031
Sa (0.1)	0.419	0.226	0.136	0.045
Sa (0.2)	0.350	0.196	0.122	0.043
Sa (0.3)	0.267	0.153	0.097	0.035
Sa (0.5)	0.190	0.112	0.072	0.026
Sa (1.0)	0.097	0.058	0.038	0.013
Sa (2.0)	0.047	0.028	0.018	0.005
Sa (5.0)	0.013	0.007	0.004	0.001
Sa (10.0)	0.005	0.003	0.002	0.001
PGA (g)	0.225	0.124	0.075	0.024
PGV (m/s)	0.159	0.090	0.055	0.017

Notes: Spectral ($S_a(T)$, where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s . Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information



Natural Resources
Canada

Ressources naturelles
Canada

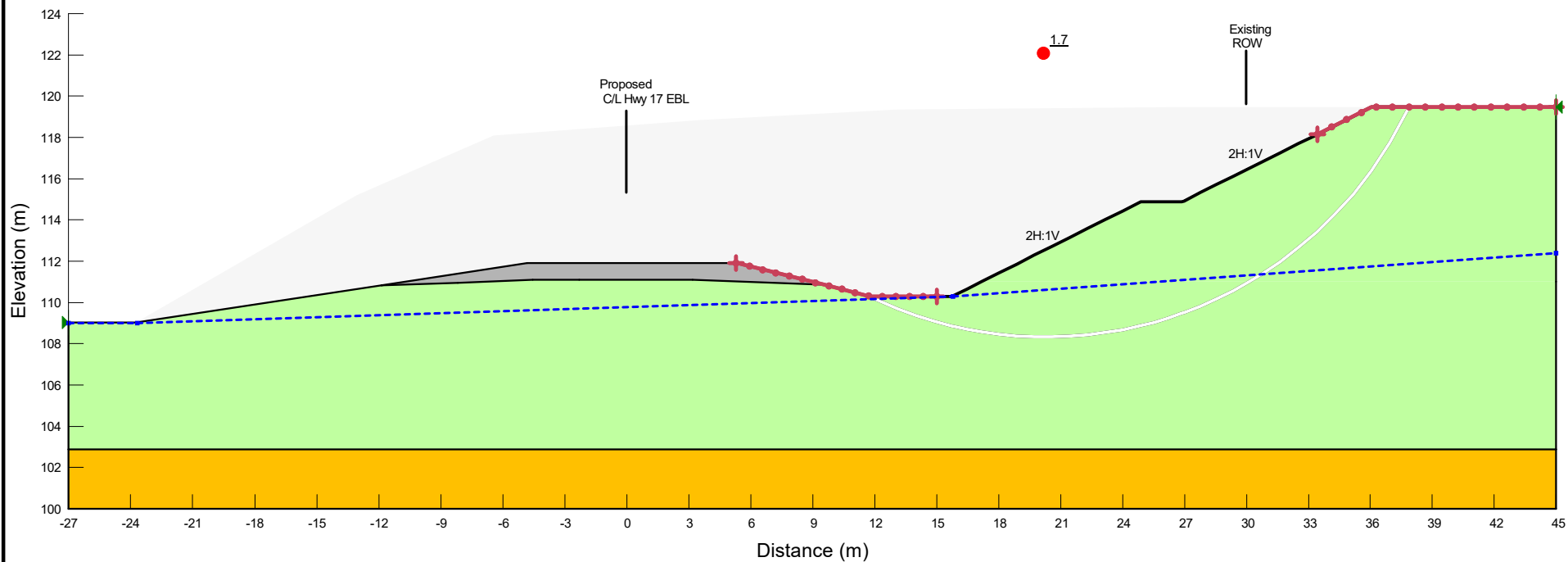
Canada



Appendix F.

Slope Stability Analysis Figures

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
■	aa) Silty Sand	Mohr-Coulomb	21	0	35	1
■	c) Silty Clay (Drained)	Mohr-Coulomb	17.5	5	28	1
■	d) SSM	Mohr-Coulomb	21	0	32	1




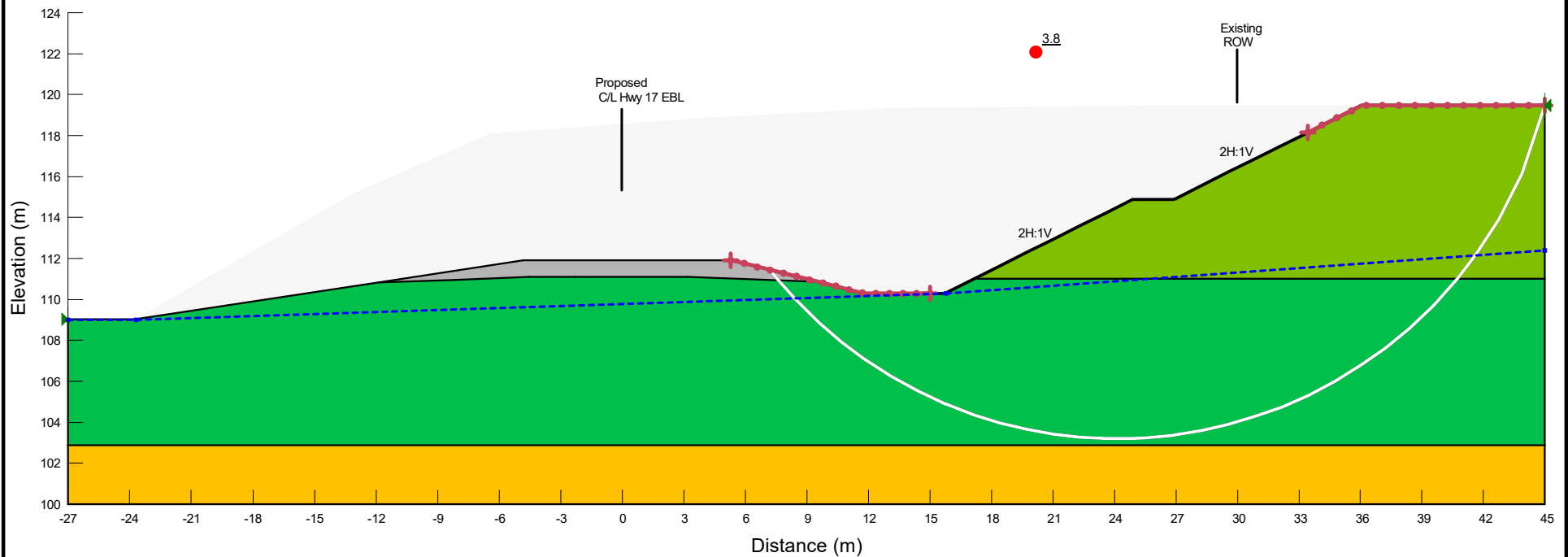
	Project		Additional Details	
	24726 - Hwy 17, Cut Slope		Name: b) Sta 20+450	
	Analysis		Comments:	
	b1) Permanent, long term, static, drained		Method: Morgenstern-Price, Half-Sine	
Seismic Coefficient	Last Run	Scale	Minimum Slip Surface Depth: 1.5 m	
H: g, V: g	2024-12-17, 10:15:54 AM	1:300	Entry: (11.70394, 110.32263) m, Exit: (37.869716, 119.46003) m	
			Center: (20.290615, 127.76665) m, Radius: 19.442859 m	

Figure F1-1

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Undrained Shear Strength (kPa)
■	aa) Silty Sand	Mohr-Coulomb	21	0	35	1	
■	b) Weathered Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	118
■	bb) Unweathered Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	85
■	d) SSM	Mohr-Coulomb	21	0	32	1	




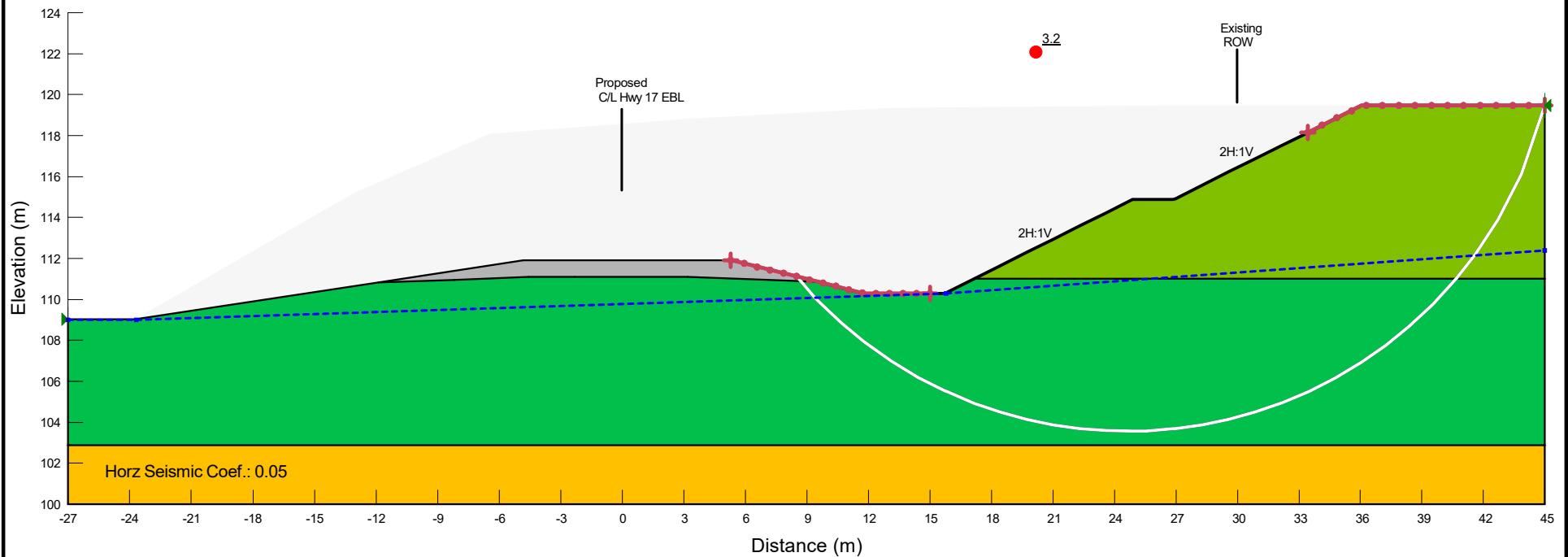
	Project			Additional Details	
	24726 - Hwy 17, Cut Slope			Name: b) Sta 20+450	
	Analysis			Comments:	
	b2) Temporary, undrained			Method: Morgenstern-Price, Half-Sine	
Seismic Coefficient		Last Run		Minimum Slip Surface Depth: 1.5 m	
H: g, V: g		2024-12-17, 10:15:57 AM		Entry: (7.2221991, 111.43529) m, Exit: (44.999877, 119.46013) m	
		Scale		Center: (24.145076, 124.70265) m, Radius: 21.503645 m	
		1:300			

Figure F1-2






Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Undrained Shear Strength (kPa)
■	aa) Silty Sand	Mohr-Coulomb	21	0	35	1	
■	b) Weathered Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	118
■	bb) Unweathered Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	85
■	d) SSM	Mohr-Coulomb	21	0	32	1	

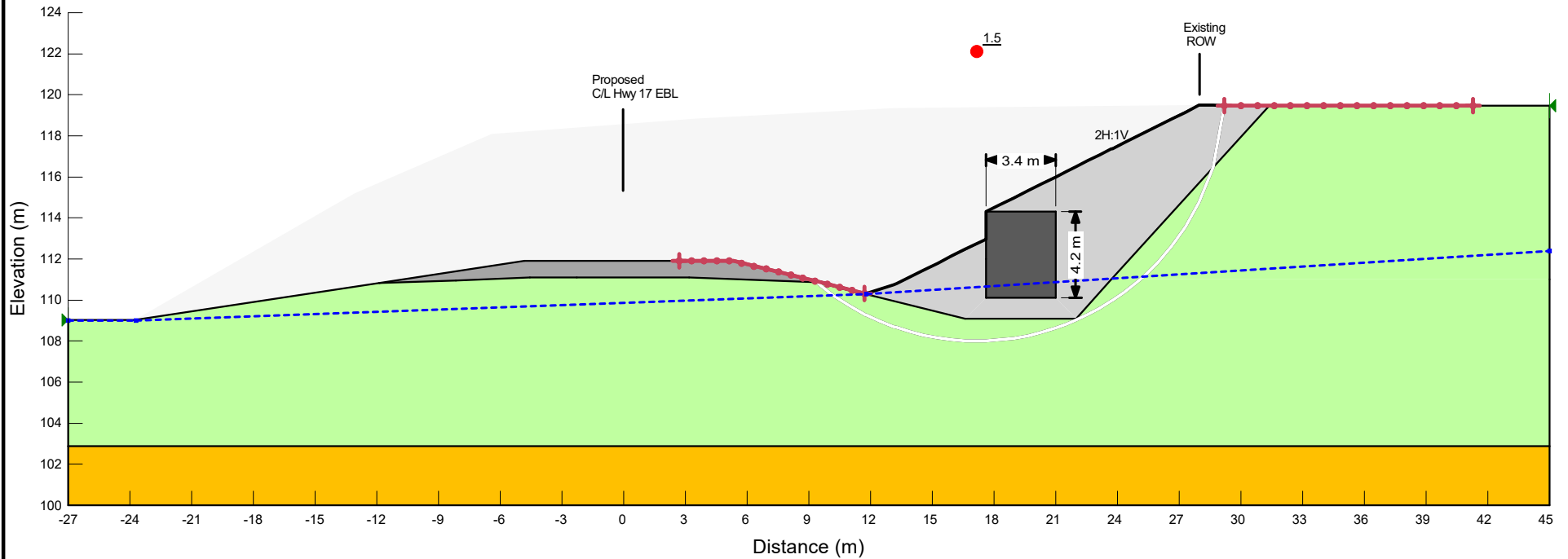


Project 24726 - Hwy 17, Cut Slope		
Analysis b3) Temporary (seismic), pseudo-static, undrained		
Seismic Coefficient H: 0.05g, V: g	Last Run 2024-12-17, 10:15:56 AM	Scale 1:300

Additional Details
 Name: b) Sta 20+450
 Comments:
 Method: Morgenstern-Price, Half-Sine
 Minimum Slip Surface Depth: 1.5 m
 Entry: (8.5026546, 111.11722) m, Exit: (44.999877, 119.46013) m
 Center: (24.633784, 124.55189) m, Radius: 20.992945 m

Figure F1-3

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	aa) Silty Sand	Mohr-Coulomb	21	0	35	1
	c) Silty Clay (Drained)	Mohr-Coulomb	17.5	5	28	1
	d) SSM	Mohr-Coulomb	21	0	32	1
	f) RSS	Mohr-Coulomb	22.8	250	42	1
	g) Granular B Type II	Mohr-Coulomb	22.8	0	42	1










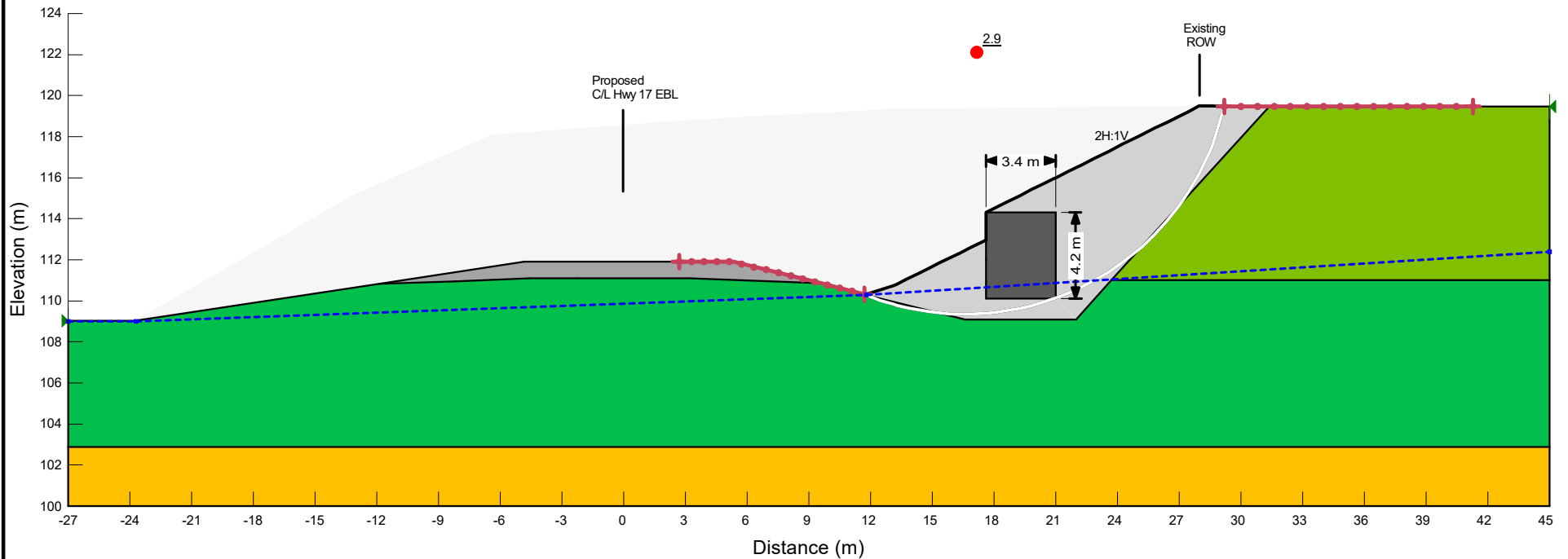
 THURBER	Project			Additional Details	
	24726 - Hwy 17, Toe RSS Wall			Name: c) Sta 20+450 - 1H:0.8H 4.2 m high	
	Analysis			Comments:	
	c1) Permanent, long term, static, drained			Method: Morgenstern-Price, Half-Sine	
Seismic Coefficient	Last Run		Scale	Minimum Slip Surface Depth: 1.5 m	
H: g, V: g	2024-12-17, 10:31:28 AM		1:300	Entry: (9.3225264, 110.91855) m, Exit: (29.2, 119.48457) m	
				Center: (17.173784, 120.04556) m, Radius: 12.039293 m	

Figure F1-4

Figure F1-4

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Undrained Shear Strength (kPa)
	aa) Silty Sand	Mohr-Coulomb	21	0	35	1	
	b) Weathered Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	118
	bb) Unweathered Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	85
	d) SSM	Mohr-Coulomb	21	0	32	1	
	f) RSS	Mohr-Coulomb	22.8	250	42	1	
	g) Granular B Type II	Mohr-Coulomb	22.8	0	42	1	










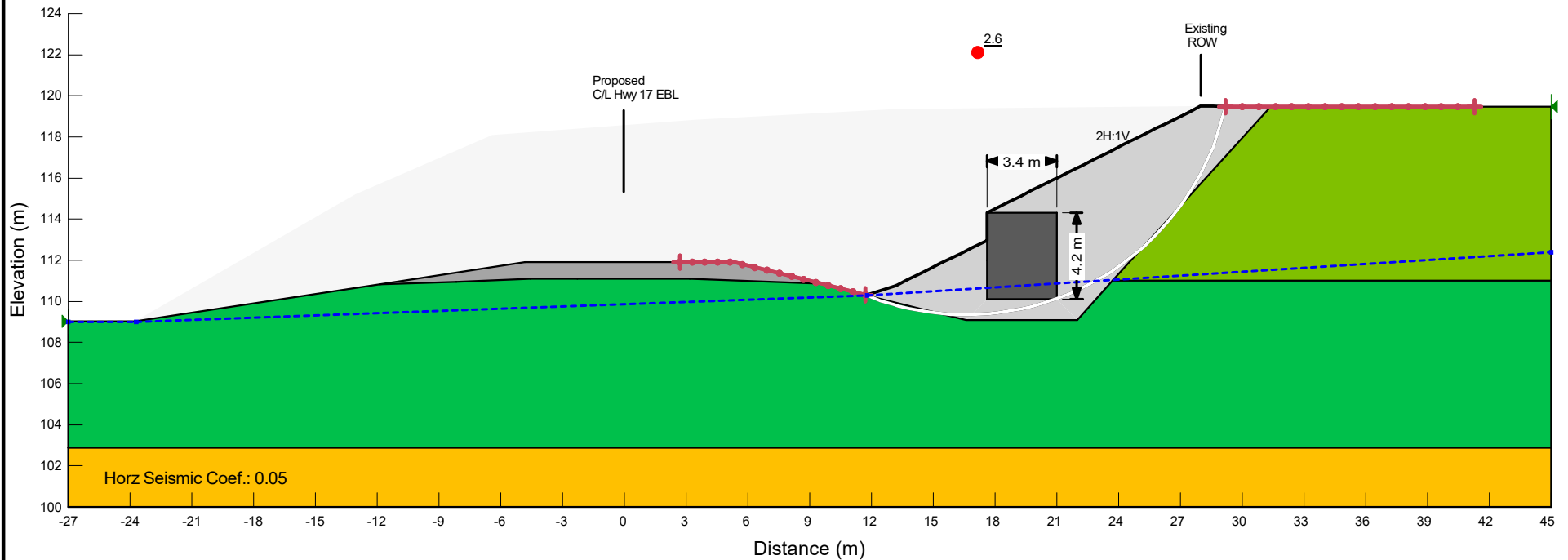
	Project			Additional Details	
	24726 - Hwy 17, Toe RSS Wall			Name: c) Sta 20+450 - 1H:0.8H 4.2 m high	
	Analysis			Comments:	
	c2) Temporary, undrained			Method: Morgenstern-Price, Half-Sine	
	Seismic Coefficient			Minimum Slip Surface Depth: 1.5 m	
	Last Run			Entry: (11.700006, 110.32018) m, Exit: (29.2, 119.48457) m	
	H: g, V: g			Center: (16.600623, 122.25302) m, Radius: 12.899945 m	
	2024-12-17, 10:31:33 AM				
	1:300				

Figure F1-5

Figure F1-5

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Undrained Shear Strength (kPa)
	aa) Silty Sand	Mohr-Coulomb	21	0	35	1	
	b) Weathered Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	118
	bb) Unweathered Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	85
	d) SSM	Mohr-Coulomb	21	0	32	1	
	f) RSS	Mohr-Coulomb	22.8	250	42	1	
	g) Granular B Type II	Mohr-Coulomb	22.8	0	42	1	




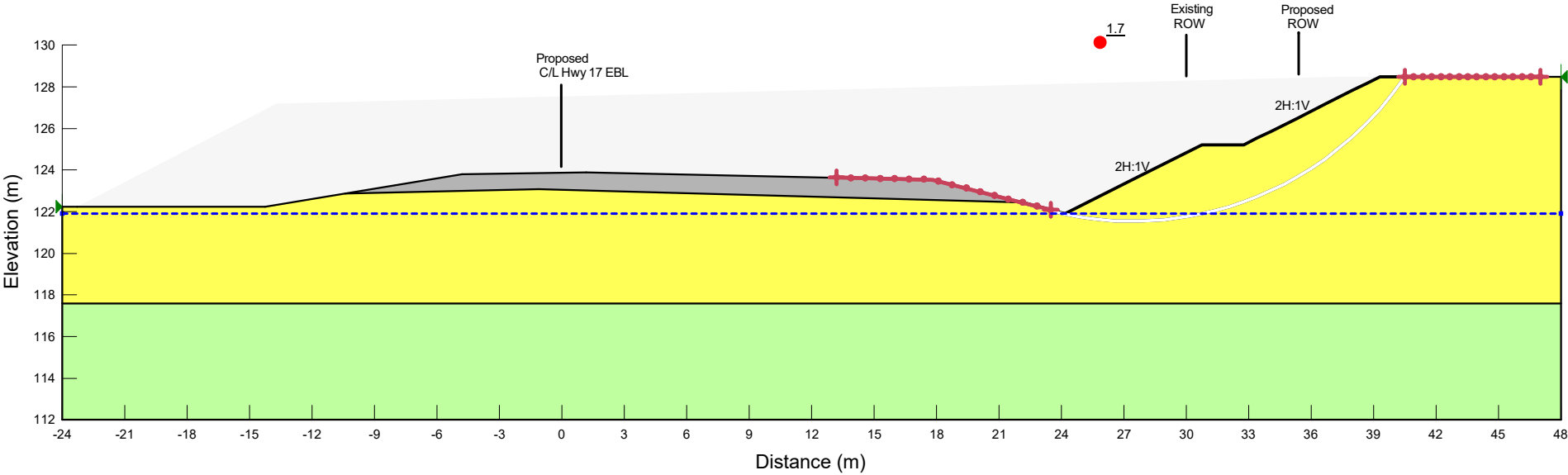
 THURBER	Project			Additional Details	
	24726 - Hwy 17, Toe RSS Wall			Name: c) Sta 20+450 - 1H:0.8H 4.2 m high	
	Analysis			Comments:	
	c3) Temporary (seismic), pseudo-static, undrained			Method: Morgenstern-Price, Half-Sine	
	Seismic Coefficient			Minimum Slip Surface Depth: 1.5 m	
	Last Run			Entry: (11.700006, 110.32018) m, Exit: (29.2, 119.48457) m	
	H: 0.05g, V: g			Center: (16.600623, 122.25302) m, Radius: 12.899945 m	
	2024-12-17, 10:31:32 AM				
	Scale				
	1:300				

Figure F1-6

Figure F1-6

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
Yellow	a) Silty Sand	Mohr-Coulomb	19	0	30	1
Light Green	c) Silty Clay (Drained)	Mohr-Coulomb	17.5	5	28	1
Grey	d) SSM	Mohr-Coulomb	21	0	32	1

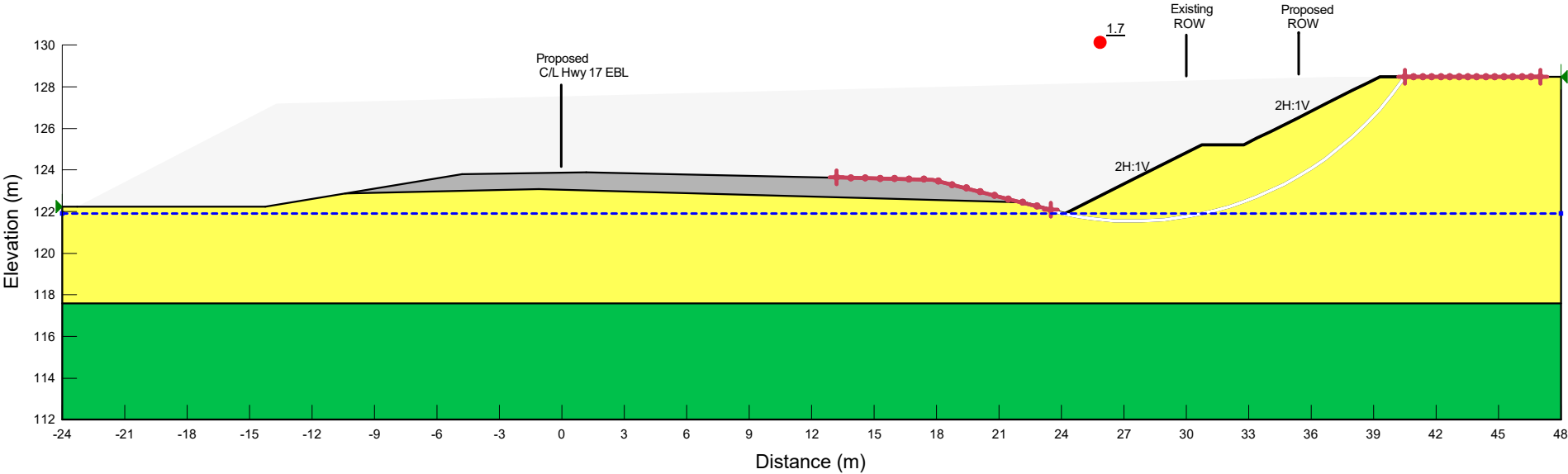


Project 24726 - Hwy 17, Cut Slope		
Analysis a1) Permanent, long term, static, drained		
Seismic Coefficient H: g, V: g	Last Run 2024-10-01, 08:12:08 AM	Scale 1:300

Additional Details
 Name: a) Sta 20+875
 Comments:
 Method: Morgenstern-Price, Half-Sine
 Minimum Slip Surface Depth: 1.5 m
 Entry: (22.146383, 122.43512) m, Exit: (40.5, 128.48) m
 Center: (27.392801, 137.39112) m, Radius: 15.849502 m

Figure F2-1

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Undrained Shear Strength (kPa)
	a) Silty Sand	Mohr-Coulomb	19	0	30	1	
	b) Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	85
	d) SSM	Mohr-Coulomb	21	0	32	1	

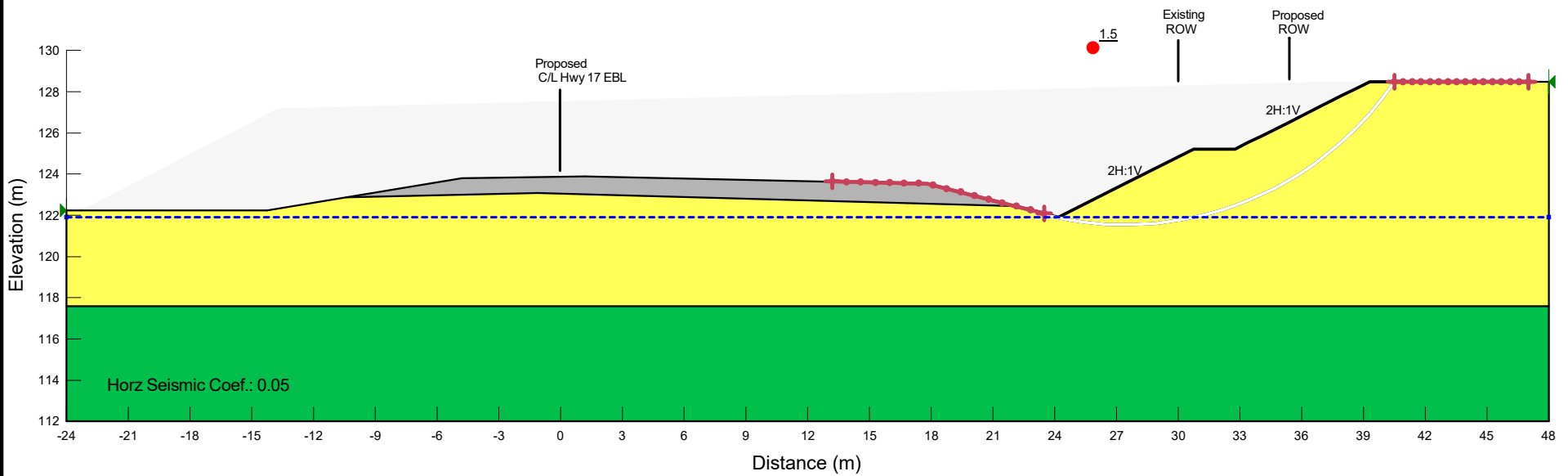


Project 24726 - Hwy 17, Cut Slope		
Analysis a2) Temporary, undrained		
Seismic Coefficient H: g, V: g	Last Run 2024-09-30, 04:42:44 PM	Scale 1:300

Additional Details
 Name: a) Sta 20+875
 Comments:
 Method: Morgenstern-Price, Half-Sine
 Minimum Slip Surface Depth: 1.5 m
 Entry: (22.146383, 122.43512) m, Exit: (40.5, 128.48) m
 Center: (27.392801, 137.39112) m, Radius: 15.849502 m

Figure F2-2

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Undrained Shear Strength (kPa)
	a) Silty Sand	Mohr-Coulomb	19	0	30	1	
	b) Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	85
	d) SSM	Mohr-Coulomb	21	0	32	1	









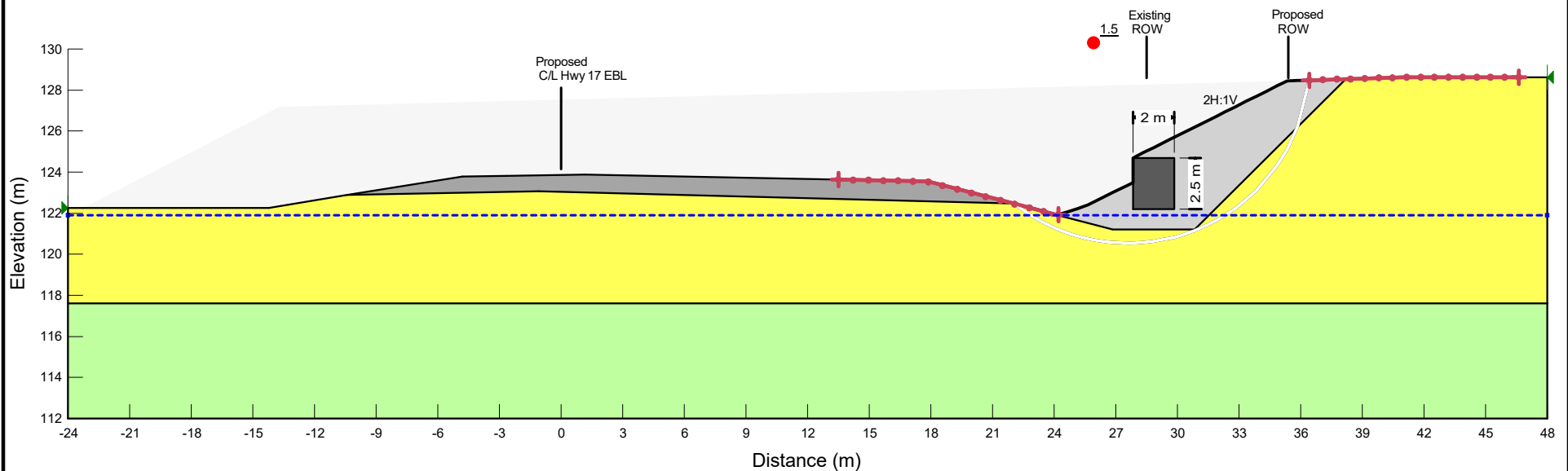
	Project			Additional Details	
	24726 - Hwy 17, Cut Slope			Name: a) Sta 20+875	
	Analysis			Comments:	
	a3) Temporary (seismic), pseudo-static, undrained			Method: Morgenstern-Price, Half-Sine	
Seismic Coefficient		Last Run		Minimum Slip Surface Depth: 1.5 m	
H: 0.05g, V: g		2024-09-30, 04:42:38 PM		Entry: (22.146383, 122.43512) m, Exit: (40.5, 128.48) m	
Scale		1:300		Center: (27.392801, 137.39112) m, Radius: 15.849502 m	

Figure F2-3

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	a) Silty Sand	Mohr-Coulomb	19	0	30	1
	c) Silty Clay (Drained)	Mohr-Coulomb	17.5	5	28	1
	d) SSM	Mohr-Coulomb	21	0	32	1
	f) RSS	Mohr-Coulomb	22.8	250	42	1
	g) Granular B Type II	Mohr-Coulomb	22.8	0	42	1









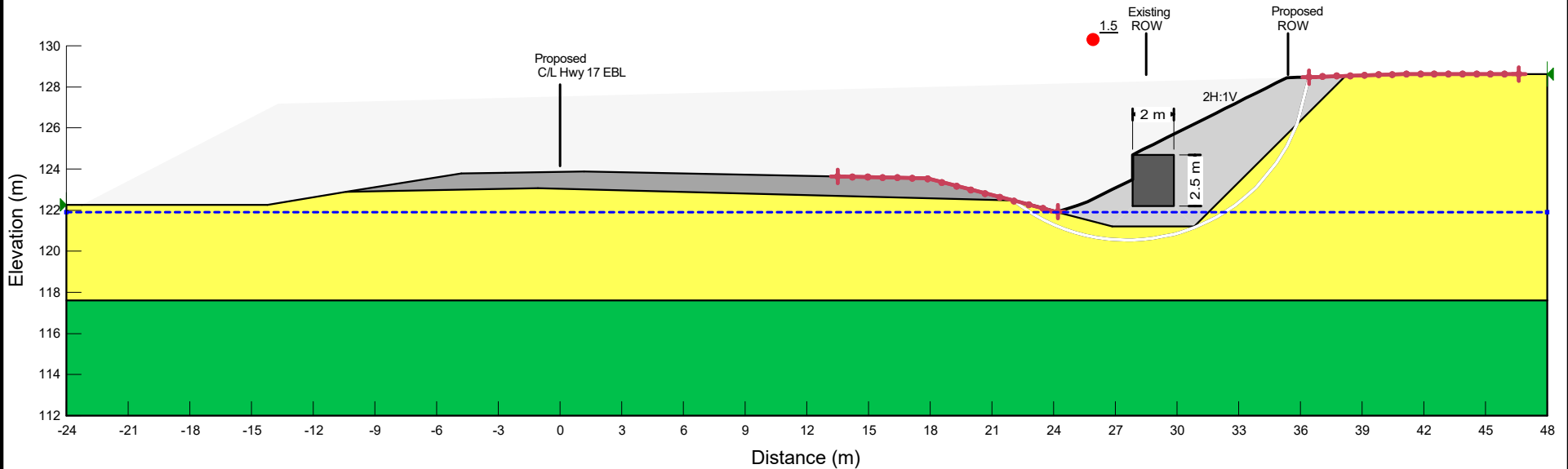
	Project			Additional Details	
	24726 - Hwy 17, Toe RSS Wall			Name: a) Sta 20+875	
	Analysis			Comments:	
	a1) Permanent, long term, static, drained			Method: Morgenstern-Price, Half-Sine	
Seismic Coefficient	Last Run		Scale	Minimum Slip Surface Depth: 1.5 m	
H: g, V: g	2024-10-03, 12:42:02 PM		1:300	Entry: (22.08831, 122.44758) m, Exit: (36.4, 128.48163) m	
				Center: (27.581059, 129.40918) m, Radius: 8.8675849 m	

Figure F2-4

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface	Undrained Shear Strength (kPa)
	a) Silty Sand	Mohr-Coulomb	19	0	30	1	
	b) Silty Clay (Undrained)	Undrained (Phi=0)	17.5			1	85
	d) SSM	Mohr-Coulomb	21	0	32	1	
	f) RSS	Mohr-Coulomb	22.8	250	42	1	
	g) Granular B Type II	Mohr-Coulomb	22.8	0	42	1	




	Project			Additional Details		
	24726 - Hwy 17, Toe RSS Wall			Name: a) Sta 20+875		
	Analysis			Comments:		
	a2) Temporary, undrained			Method: Morgenstern-Price, Half-Sine		
Seismic Coefficient		Last Run		Minimum Slip Surface Depth: 1.5 m		
H: g, V: g		2024-10-03, 12:42:07 PM		Entry: (22.08831, 122.44758) m, Exit: (36.4, 128.48163) m		
				Center: (27.581059, 129.40918) m, Radius: 8.8675849 m		
				Scale		
				1:300		

Figure F2-5



Appendix G.

List of Referenced Specifications Non-Standard Special Provisions



1. The following Special Provisions and OPSS Documents are referenced in this report:

OPSD 200.020	Earth/Shale Grading Divided Rural
OPSD 3090.101	Foundation Frost Depths for Southern Ontario
OPSS.PROV 180	General Specification for the Management of Excess Materials
OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 517	Construction Specification for Dewatering
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 803	Vegetative Cover
OPSS.PROV 804	Construction Specification for Seed and Cover
OPSS.PROV 902	Construction Specification for Excavating and Backfilling Structures
OPSS.PROV 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
OPSS.PROV 1860	Material Specification for Geotextiles
SSP 110S06	Amendment to OPSS 1010 - Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
SSP 517F01	Amendment to OPSS 517 - Construction Specification for Dewatering

2. Suggested wording for NSSPs

“Protection of Sensitive Foundation Soils”

The Contractor is advised that the native silty and clayey soils that will be exposed at the subgrade are moisture sensitive and may become disturbed or otherwise negatively impacted when subjected to construction or personnel traffic, freeze-thaw actions, ingress or ponding water. The Contractor shall be responsible for selecting appropriate granular compaction equipment, implementing adequate groundwater control measures and to minimize construction and personnel traffic on the founding subgrade.

“Structural Backfill”

Structural backfill for the retaining walls shall consist of OPSS Granular B Type II or Quarry Sourced OPSS Granular A material.

“Notice to Contractor: Obstructions”

Buried obstructions may be encountered during construction and interfere with excavations and installation of temporary protection/dewatering systems. Cobbles and boulders may be encountered within the sand to silty sand deposits. The Contractor must be prepared to



dislodge or penetrate obstructions. Where obstructions are encountered near the surface, the Contractor may choose to remove such obstructions, provided it does not destabilize the existing slope or temporary works.