THURBER ENGINEERING LTD.

PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
BRUCE STREET (COUNTY ROAD 20) INTERCHANGE
STA. 18+517, HORTON TOWNSHIP
BRUCE STREET UNDERPASS - SITE NO. 29X-0408/B1
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009

Geocres No.: 31F-234

Report to:

Ministry of Transportation Ontario

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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 in the Renfrew area. Thurber carried out the investigation under MTO Assignment No. 4018-E-0009.

This report addresses the Bruce Street Interchange, which includes the proposed Highway 17 Bruce Street Underpass (Site No. 29X-0408/B1) to carry local traffic over the new highway, and the four associated ramps: the W-N/S Ramp, the N-E Ramp, the S-W Ramp, and the E-N/S Ramp. The existing Highway 17 alignment at this site will become the future Highway 17 westbound lanes and new eastbound lanes will be constructed adjacent to the existing alignment.

Previous foundation investigation information from boreholes completed in 2004 for the proposed underpass was available under Geocres 31F-139.

This section of the report presents the factual findings obtained from historical foundation investigations available from the online Geocres Library and from the foundation investigation completed 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. A model of the subsurface conditions influencing design and construction of the proposed underpass and associated ramps was developed in the course of the investigation.

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.

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2 SITE DESCRIPTION

2.1 General

The site is located on Highway 17 at the existing County Road 20 intersection. For project purposes, although Highway 17 is oriented north south at the site it is generally an eastbound westbound highway thus it will be described as oriented east west and County Road 20 will be described as being oriented north south. Within the project limits County Road 20 is also known as Bruce Street to the south and Castleford Road to the north of Highway 17. For clarity and consistency with project documentation, County Road 20 will typically be referred to by its local road names, and the structure as the Bruce Street Underpass.

The existing intersection is an at-grade crossing controlled with traffic lights. In the vicinity of the site, Highway 17 is an undivided highway with one through lane in each direction, left and right turning lanes from westbound Highway 17 to Castleford Road and Bruce Street, as well as off- and on-ramps at Bruce Street and a left turn lane to Castleford Road from the eastbound direction. Highway 17 has gravel shoulders and a posted speed limit of 90 km/hr. It is understood that the AADT projected for 2022 for the section of Highway 17 just east of the site is 15,100.

At the intersection, the Highway 17 road surface elevation is approximately 150.9 m and decreases to the east towards the Bonnechere River. The existing road surface along Bruce Street/Castleford Road decreases nominally from south to north; however, the existing ground northeast of the intersection in the vicinity of the proposed E-N/S Ramp slopes up and away from Castleford Road to a plateau at about Elevation 154.9 m.

West of the intersection, Highway 17 is at or slightly above the natural ground surface elevation. East of the intersection, Highway 17 enters a cut section with the slope heights increasing to the east to as much as about 9 m, within the area of interest addressed herein (to approximately 300 m east of the intersection). The cut slopes generally include a bench at around mid-height and are vegetated with grass. Further to the east, bedrock outcrops are visible about 300 m and 450 m east of the intersection on the south and north sides of the highway, respectively.

Near the intersection, Bruce Street and Castleford Road comprise two-lane roadways with gravel shoulders and a rural cross-section. Elevated and paved bull-noses are present at the northwest and southwest quadrants of the intersection, directing traffic flow from the eastbound off-ramp and to the eastbound on-ramps. It is understood that the AADT values projected for 2022 are approximately 6,500 and 2,300 for Bruce Street and Castleford Road respectively. An at-grade T-intersection is present on Bruce Street approximately 140 m north of Highway 17 connecting to Dugald Road which heads eastward.

It is understood that the intersection of County Road 20 and Highway 17 was reconfigured at some point in the past with the current intersection located approximately 50 m to the west of the previous, and the old alignment of Bruce Street more linear prior to its shift to the currently curved alignment to the east.

Photographs showing the existing conditions in the area of the site are included in Appendix E for reference.

2.2 Site Geology

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.

Ontario Geological Survey Map P.3784 for Precambrian Geology for the Horton Area suggests the bedrock is dolomitic and calcitic carbonate metasedimentary bedrock including dolomite and calcite marble.

3 SITE INVESTIGATION AND FIELD TESTING

An initial foundation investigation was carried out at the site in October 2003 (Geocres 31F-139) as input to the preliminary design and environmental assessment study completed at that time. The current investigation was carried out in 2019, 2020, and 2021 to collect additional subsurface information for design of the proposed underpass structure and associated ramps at the interchange.

3.1 Previous Investigation (2003)

A total of three boreholes were put down as part of the 2003 investigation. The boreholes were advanced to depths of up to about 53.2 m below the existing ground surface at the time of the investigation using hollow stem augers, casing and wash-boring, and NQ sized coring equipment.

The northing, easting and elevation of the 2003 boreholes are shown on the Borehole Location and Soil Strata Drawings No. 1 to 3 in Appendix A, the individual Record of Borehole sheets in Appendix B, and in the table below. The site is located within MTM Zone 9.

Table 3-1: Borehole Summary – Previous Investigation (2003)

Test Hole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface* Elevation (m)	Termination Depth (m)
BRU-1	South Abutment	5039748.0 (45.497526)	291406.0 (-76.671380)	151.6	50.2
BRU-2	Pier	5039748.7 (45.497533)	291445.8 (-76.670871)	150.3	53.2
BRU-3	North Abutment	5039768.7 (45.497714)	291479.6 (-76.670439)	149.3	51.2

* Ground surface elevation measured during investigation and may have changed in intervening time.

Piezometers, 19 mm in diameter, were installed in all three boreholes. The installation details are illustrated on the respective Record of Borehole sheets provided in Appendix B.

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3.2 Current Investigation (2019/2020/2021)

The current site investigation and field-testing program was carried out in several phases in the period between September 2019 and November 2021. The current investigation consisted of advancing a total of 42 testholes which comprised: initial boreholes put down at 25 locations, supplementary boreholes put down for additional information at four of those locations, five additional boreholes for subsequent installation of monitoring wells and eight Cone Penetration Tests (CPTu). Shear wave velocity measurements were taken at regular intervals of depth during advancement of two of the CPTu soundings (BRU19-20 and BRU19-24). Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

The locations and elevations of the testholes were surveyed by Thurber with a Trimble Catalyst DA1 antenna with centimeter accuracy. The locations were surveyed prior to advancement of the testholes and, at locations where the testholes were shifted due to utility or access conflicts they were re-surveyed at the completed location. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawings No. 1 to 3 in Appendix A, the individual Record of Borehole sheets and CPTu summary plots in Appendix B and in Table 3-2, below.

Table 3-2: Testhole Summary – Current Investigation (2019/2020/2021)

Test Hole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
BRU19-01	South Abutment	5039726.4 (45.497332)	291413.0 (-76.671291)	151.2	48.2
BRU19-01A	South Abutment	5039731.4 (45.497377)	291409.7 (-76.671333)	152.2	26.5
BRU19-02	Pier	5039766.5 (45.497693)	291439.5 (-76.670952)	150.1	52.4
BRU19-03	North Abutment	5039787.2 (45.497881)	291475.1 (-76.670497)	149.8	54.1
BRU19-03A	North Abutment	5039786.4 (45.497873)	291482.2 (-76.670407)	149.9	31.1
BRU19-04	North Approach	5039792.9 (45.497932)	291496.6 (-76.670223)	149.8	1.5
BRU19-04A	North Approach	5039792.9 (45.497932)	291496.6 (-76.670223)	149.8	32.6
BRU19-05 (CPTu)	North Approach	5039813.7 (45.498119)	291524.1 (-76.669871)	149.0	31.0
BRU19-06	North Approach	5039844.3 (45.498396)	291564.0 (-76.669361)	148.5	32.0
BRU19-07	North Approach	5039876.9 (45.498689)	291602.4 (-76.668871)	148.1	29.6
BRU19-08 (CPTu)	North Approach	5039910.2 (45.49899)	291640.1 (-76.668390)	147.4	25.6
BRU19-09	North Approach	5039944.0 (45.499294)	291677.4 (-76.667913)	146.9	24.5

Test Hole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
BRU19-10	North Approach	5039979.2 (45.499612)	291713.0 (-76.667459)	146.2	11.3
BRU19-11 (CPTu)	South Approach	5039628.1 (45.496444)	291230.2 (-76.673626)	152.7	13.7
BRU19-12	South Approach	5039651.1 (45.496651)	291274.4 (-76.673061)	152.7	24.1
BRU19-13	South Approach	5039677.0 (45.496886)	291320.2 (-76.672476)	152.5	40.6
BRU19-14 (CPTu)	South Approach	5039706.8 (45.497155)	291367.5 (-76.671872)	152.6	46.5
BRU19-15	South Approach	5039724.0 (45.497310)	291393.0 (-76.671546)	152.6	40.2
BRU19-15A	South Approach	5039724.0 (45.497310)	291393.0 (-76.671546)	152.6	2.9
BRU19-16	W-N/S Ramp	5039789.1 (45.497892)	291224.4 (-76.673705)	151.5	44.5
BRU19-17 (CPTu)	W-N/S Ramp	5039729.3 (45.497354)	291240.2 (-76.673501)	149.9	32.8
BRU19-18	N-E Ramp	5039695.1 (45.497047)	291274.9 (-76.673056)	150.9	34.1
BRU19-19	N-E Ramp	5039715.7 (45.497234)	291347.4 (-76.672129)	152.2	40.9
BRU19-20 (CPTu)	South Abutment	5039735.1 (45.49741)	291411.0 (-76.671317)	152.1	39.1
BRU19-21	N-E Ramp	5039747.3 (45.497517)	291247.1 (-76.673413)	150.7	41.8
BRU19-22	S-W Ramp	5039809.4 (45.498081)	291558.9 (-76.669425)	147.3	39.5
BRU19-23	S-W Ramp	5039802.4 (45.498019)	291606.4 (-76.668817)	146.6	31.8
BRU19-24 (CPTu)	North Abutment	5039779.7 (45.497812)	291476.8 (-76.670475)	149.7	34.9
BRU19-25	S-W Ramp	5039790.3 (45.497909)	291513.8 (-76.670002)	147.9	42.4
BRU19-26	E-N/S Ramp	5039464.6 (45.494980)	291599.5 (-76.668897)	149.7	17.4
BRU19-27	E-N/S Ramp	5039515.3 (45.495436)	291601.2 (-76.668876)	154.6	21.4
BRU19-28	E-N/S Ramp	5039562.5 (45.495861)	291611.3 (-76.668749)	155.0	32.1
BRU19-29	E-N/S Ramp	5039614.8 (45.496331)	291618.2 (-76.668662)	154.7	36.5
BRU19-30	E-N/S Ramp	5039657.2 (45.496713)	291643.3 (-76.668342)	154.1	35.4
BRU19-31	E-N/S Ramp	5039746.3 (45.497516)	291650.0 (-76.668258)	149.9	37.9

Test Hole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
BRU19-32 (CPTu)	E-N/S Ramp	5039793.0 (45.497935)	291638.4 (-76.668408)	146.9	31.6
BRU19-33	E-N/S Ramp	5039840.9 (45.498365)	291598.8 (-76.668916)	146.9	33.6
BRU21-02	Pier	5039761.4 (45.497647)	291427.9 (-76.671101)	151.4	6.7
BRU21-05	North Approach	5039811.7 (45.498101)	291523.6 (-76.669878)	149.2	6.7
BRU21-15	South Approach	5039724.3 (45.497312)	291390.6 (-76.671577)	152.6	6.1
BRU21-18	N-E Ramp	5039688.1 (45.496984)	291279.4 (-76.672999)	151.4	6.1
BRU21-23	S-W Ramp	5039799.9 (45.497997)	291606.7 (-76.668814)	146.6	6.1

Boreholes BRU19-04, BRU19-04A, BRU19-06, BRU19-07, BRU19-12, BRU-13, and BRU19-15 were put down with a CME 75 truck-mounted drill rig equipped with hollow stem augers and NW casing. Boreholes BRU21-02, BRU21-05, BRU21-15, BRU21-18, and BRU21-23 were drilled with a Diedrich 50, track-mount rig equipped with hollow stem augers. The remaining boreholes were put down from a track-mounted drill rig (CME 55, CME 75, or CME 850) equipped with hollow stem augers and either NW or HW casing. Bedrock was cored in Boreholes BRU19-01, BRU19-02, and BRU19-03 with NQ-sized coring.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Thin-walled (Shelby) tube samples of the cohesive materials were retrieved at various elevations in the boreholes to obtain relatively undisturbed soil samples for further laboratory testing. In-situ vane shear testing was conducted in the cohesive deposits with an MTO 'N' sized vane.

Piezometers, 19 mm in diameter, were installed in Boreholes BRU19-01, BRU19-03, BRU19-06, and BRU19-13. Monitoring wells, 50 mm in diameter, were installed in Boreholes BRU19-21, BRU19-29, BRU21-02, BRU21-05, BRU21-15, BRU21-18, and BRU21-23. The installation details are illustrated on the respective Record of Borehole sheets provided in Appendix B. The piezometers and monitoring wells installed as part of the current investigation will be decommissioned by Thurber, as outlined in the Hydrogeological Investigation and Design Report..

The boreholes 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 members of Thurber's geotechnical staff. The drilling supervisors logged the boreholes and processed the recovered soil samples for transport to Thurber's Ottawa geotechnical laboratory for further examination and testing, as well as submission to external laboratories.

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. Supplementary specialized laboratory testing was carried out on selected soil samples in accordance with the project-specific requirements outlined in Section 7.7.1.3 RFP and included one-dimensional consolidation testing (standard incremental loading, long-term incremental loading, and controlled-strain loading), triaxial testing (unconsolidated-undrained and consolidated-drained), and unconfined compressive strength testing.

Rock cores were logged and total core recovery (TCR), solid core recovery (SCR) and rock quality designation (RQD) were determined in the field. Unconfined compressive strength (UCS) testing was carried out on selected samples to give an indication of the bedrock strength.

Chemical analysis for determination of pH, conductivity, resistivity, sulphide, sulphate, and chloride was carried out on three soil samples.

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 (current investigation) and Appendix D (2003 investigation).

5 GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and CPTu summary plots included in Appendix B, as well as the Borehole Location and Soil Strata Drawings 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, bedrock and groundwater conditions may vary between and beyond borehole locations. Soil classification is in accordance with ASTM D2487. Description of cohesive soils and secondary components of all deposits from the current boreholes are described as outlined in the MTO Guideline for Foundation Engineering Services manual (October 2020). Terminology from the 2003 borehole information may vary from current practice.

The stratigraphy at the site generally consists of topsoil and/or granular fill overlying an extensive native deposit of silty clay to clayey silt. Toward the eastern extend of the site, the silty clay to clayey silt is overlain by a deposit of native sand and silt. The extensive silty clay to clayey silt deposit is underlain by interlayered silt, sand and clayey silt which is, in turn, underlain by glacial till and marble bedrock.

5.1 Topsoil

Topsoil was encountered at surface at several boreholes put down near the proposed Bruce Street alignment (BRU-1, BRU-3, BRU19-06, BRU19-07, BRU19-13, BRU-19-22, BRU19-25 and BRU21-05), the W-N/S and N-E Ramps (BRU19-16 and BRU19-21), and the E-N/S Ramp (BRU19-23, BRU19-26, BRU19-29, and BRU19-31). The topsoil thickness ranged from about 50 to 800 mm. The topsoil ranged from clayey silt and organics to silty sand trace gravel trace roots. The N-values obtained from three SPTs completed within the topsoil ranged from 11 to 14 blows per 0.3 m of penetration, indicating a compact relative density.

The moisture content of recovered topsoil samples ranged from about 11% to 37%. The results of a grain size analysis test conducted on one sample of topsoil from Borehole BRU19-25 are summarized below and are illustrated on Figure C1.1 in Appendix C.

Soil Particle	Percentage (%)
Gravel	4
Sand	80
Silt	16
Clay	

5.2 Fill

Non-cohesive granular fill consisting of sand to gravelly silty sand was encountered at boreholes put down along the proposed Bruce Street alignment (BRU-1, BRU-2, and BRU19-01 to BRU19-15A, BRU21-02 and BRU 21-05). The thickness ranged from 0.6 m to 2.3 m (base elevation 144.7 m to 151.8 m). The SPT N-values in the fill material ranged from 4 to 73 blows but were generally between about 10 and 25 blows per 0.3 m of penetration, indicating a compact relative density.

The moisture content of samples of the granular fill ranged from 2% to 34%. The results of grain size analysis tests conducted on eight samples of fill are summarized below and are illustrated on Figures C2.1 and C2.2 in Appendix C.

Soil Particle	Percentage (%)
Gravel	5 – 46
Sand	37 – 86
Silt	8 – 30
Clay	

5.3 Upper Sand and Silt

A near-surface layer of sand and silt was encountered at boreholes BRU19-26 to BRU19-30, put down along the proposed E-N/S Ramp. The layer ranged from silt trace sand to sand trace silt. The thickness ranged from 1.5 m to 2.4 m (base elevation 147.7 m to 153.1 m). The N-values obtained from SPTs conducted in this material ranged from 4 to 23 indicating a loose to compact relative density.

The moisture content of samples of the sand and silt ranged from 7% to 33%. The results of grain size analysis tests conducted on four samples are summarized below and are illustrated on Figure C3.1 in Appendix C. Atterberg Limit testing carried out on one sample of the deposit from Borehole BRU19-30 gave non-plastic results. This soil unit could be classified as ML to SM.

Soil Particle	Percentage (%)
Gravel	0
Sand	9 – 82
Silt	18 – 91
Clay	

5.4 Silty Clay to Clayey Silt

Beneath the topsoil and fill or upper sand and silt, an extensive deposit of silty clay to clayey silt was encountered at all test hole locations. The deposit generally transitions from silty clay to clayey silt with depth. The overall thickness of the deposit ranges from about 9 m at the northern extent of the proposed Bruce Street alignment (Borehole 19-10) to 40 m within the southern portion (Borehole 19-19) with base elevations ranging from 135.6 m to 112.6 m. Along the proposed E-N/S Ramp the deposit ranges from about 14 m to 25 m thick, with base elevations ranging from 133.7 to 120.2 m.

Further description of the material properties and field test results within the layers are described in the following sections.

5.4.1 Silty Clay to Clay (Weathered Crust, CI to CH)

The upper portion of the deposit is weathered to a grey-brown crust, which generally ranges from about 1.5 to 6.9 m thick (base elevations 149.2 to 141.2m). It generally consists of silty clay to clay. SPTs conducted in the weathered crust gave N-values ranging from ranged from 3 to 28 blows per 0.3 m of penetration. In-situ shear vane tests gave the maximum recordable undrained shear strength values of 93 to 108 kPa (depending on the dimensions of the vane used), except for isolated tests carried out within the deposit at Boreholes BRU19-15 and BRU19-25 which gave undrained shear strengths of 81 and 76 kPa, respectively. These values indicate that the weathered crust is stiff to very stiff.

The corrected CPTu tip resistance (q_t) recorded during advancement of the CPTu through the weathered crust ranged between about 1,300 and 3,000 kPa, with spikes up to about 5,000 kPa.

The natural moisture content of samples of the weathered crust portion of the silty clay deposit ranged from about 16% to 52%. The results of grain size analysis tests conducted on 32 samples of the weathered crust collected during the current investigation and three samples collected during the 2003 investigation are summarized below and are illustrated on Figures C4.1 to C4.6 in Appendix C and Figures D1.1 and D1.2 in Appendix D.

Soil Particle	Percentage (%)
Gravel	0 – 1
Sand	0 – 8
Silt	37 – 51
Clay	47 – 63

The results of Atterberg Limits testing carried out on 31 samples of the weathered silty clay crust collected during the current investigation and three samples obtained during the 2003 investigation are summarized below and are illustrated on Figures C5.1 to C5.6 in Appendix C and Figure D2 in Appendix D. The laboratory results indicate that the material is generally a silty clay to clay of intermediate to high plasticity (CI to CH).

Parameter	Value
Liquid Limit	40 – 57
Plastic Limit	20 – 30
Plasticity Index	18 – 32

5.4.2 Silty Clay to Clayey Silt (CI to CL-ML)

Beneath the weathered crust, the lower portion of the deposit consists of grey silty clay to clayey silt. Along the proposed Bruce Street alignment, it extends to depths ranging up to about 40 m below the existing ground surface (base elevations ranging from 135.6 m to 112.6 m). Along the proposed E-N/S Ramp alignment, it extends to depths up to about 27 m below the existing ground surface (base elevations ranging from 133.7 to 120.2 m).

The SPT N-values recorded ranged from weight-of-hammer (WH) to 23 blows per 0.3 m of penetration but were generally between about 1 and 6 blows. In situ shear vane gave undrained shear strengths between about 50 kPa and the maximum recordable value ranging from 98 to 108 kPa (depending on the vane size).

The peak shear strength values measured at borehole locations along the proposed Bruce Street and the E-N/S Ramp alignments are shown on Figures B4.1 and B4.2 in Appendix B, respectively.

The corrected CPTu tip resistance (q_t) recorded during advancement of the CPTu through the unweathered silty clay to clayey silt ranged between about 1,000 and 3,500 kPa, with spikes up to about 7,800 kPa in the lower portions.

The moisture content of samples of the unweathered silty clay to clayey silt ranged from 23% to 54%.

Above about Elevation 133 m, the deposit generally consists of a silty clay to clayey silt.

The results of grain size analysis test conducted on 40 samples of silty clay to clayey silt from the current investigation and three samples from the 2003 investigation from above Elevation 133 m are summarized below and are illustrated on Figures C6.1 to C6.7 in Appendix C and Figures D1.1 and D1.2 in Appendix D.

Soil Particle	Percentage (%)
Gravel	0 – 5
Sand	0 – 20
Silt	39 – 61
Clay	29 – 61

The results of Atterberg Limits testing carried out on 36 samples of the deposit from the current investigation and three samples from the 2003 investigation from above Elevation 133 m are summarized below and are illustrated on Figures C7.1 to C7.6 in Appendix C and Figure D2 in Appendix D. The laboratory results indicate that the material is generally a silty clay to clayey silt of intermediate to low plasticity (CI to CL). Five additional Atterberg Limit tests carried out on samples obtained from the deposit above Elevation 133 m in Boreholes BRU19-01A, BRU19-03A, BRU19-18, BRU19-28, and BRU19-29 gave non-plastic results.

Parameter	Value
Liquid Limit	22 – 52
Plastic Limit	13 – 25
Plasticity Index	4 – 33

Below about Elevation 133 m, the deposit generally consists of a clayey silt.

The results of grain size analysis test conducted on 26 samples of clayey silt from the current investigation and four samples from the 2003 investigation from below Elevation 133 m are summarized below and are illustrated on Figures C8.1 to C8.5 in Appendix C Figures D1.1 and D1.2 in Appendix D.

Soil Particle	Percentage (%)
Gravel	0 – 2
Sand	0 – 19
Silt	49 – 66
Clay	22 – 47

The results of Atterberg Limits testing carried out on 22 samples of the deposit below Elevation 133 m are summarized below and are illustrated on Figures C9.1 to C9.4 in Appendix C. The laboratory results indicate that the material is generally a clayey silt low plasticity (CL-ML to CL). Six additional Atterberg Limit tests carried out on samples obtained from the deposit below Elevation 133 m in Boreholes BRU19-01, BRU19-03A, BRU19-15, BRU19-18, and BRU19-29 gave non-plastic results.

Parameter	Value
Liquid Limit	16 – 51
Plastic Limit	12 – 22
Plasticity Index	3 – 29

Additional laboratory testing was carried out on relatively undisturbed samples of the unweathered silty clay to clayey silt obtained with thin-walled tubes during the current investigation at Boreholes BRU19-01, BRU19-01A, BRU19-03, and BRU19-03A.

Laboratory oedometer (one-dimensional consolidation) tests using standard incremental loading per ASTM D2435, and as outlined in the RFP, were carried out on five samples of the silty clay to clayey silt. The results of testing carried out on samples from the current investigation from Boreholes BRU19-01, BRU19-01A, and BRU19-03A are presented in Appendix C. The results of testing carried out on one sample from the 2003 investigation from Borehole BRU-1 are presented in Appendix D. The results from all five tests are summarized in Table 5-1, below.

Table 5-1: Summary of One-Dimensional Consolidation Testing – Silty Clay to Clayey Silt

Parameter	Results				
Borehole	BRU19-01	BRU19-01A	BRU19-01A	BRU19-03	BRU-1
Sample	ST10	ST1	ST5	ST14	TW1
Sample Depth (m)	11	4.9	17.7	14.0	11.9
Sample Elevation (m)	140.2	147.3	134.5	135.8	139.7
Approx. Existing Effective Stress, P_0' (kPa)	104.1	57.3	167.3	120.6	160.2
Moisture Content (%)	35.6	43.7	38.4	36.3	40.7
Liquid Limit (%)	34.5	49	NP	38.9	33
Plastic Limit (%)	22	23	NP	24.8	22
Plasticity Index (%)	12.5	26	NP	14.1	11
Unit Weight, γ (kN/m^3)	17.4	17.3	18.1	17.5	18
Degree of Saturation, S_{ro} (%)	88	97	99	90	100
Specific Gravity, G_s	2.80	2.75	2.76	2.79	2.79
Initial Void Ratio e_o	1.137	1.234	1.069	1.128	1.14
Pre-consolidation Pressure, P_c' (kPa)	310	666	282	570	360
Over Consol. Ratio, OCR	3	11	2	4	2
Compression Index, C_c	0.33	0.72	0.50	0.55	0.44
Recompression Index, C_r	0.055	0.053	0.036	0.023	0.086
Coefficient of consolidation, c_v (cm^2/s)	0.007	0.001	0.001	0.009	0.003
Coefficient of re-consolidation, c_{vr} (cm^2/s)	0.022	0.003	0.003	0.060	0.013

Laboratory oedometer tests using controlled-strain loading (constant rate-of-strain, CRS) were carried out on six samples of the silty clay to clayey silt per ASTM D4186, and as outlined in the RFP. All tests imposed a strain rate of 0.8% per hour during loading, and 0.1% per hour for

unloading. The results of the testing are presented in Appendix C and summarized in Table 5-2 below.

Table 5-2: Summary of One-Dimensional Consolidation (CRS) Testing – Silty Clay to Clayey Silt

Parameter	Results					
Borehole (BRU*)	19-01	19-01	19-01A	19-01A	19-03A	19-03A
Sample	ST14	ST20	ST2	ST6	ST3	ST8
Sample Depth (m)	17.1	26.2	7.9	20.1	14.0	30.8
Sample Elevation (m)	134.1	125.0	144.3	132.1	135.9	119.4
Approx. Existing Effective Stress, P_0' (kPa)	150.4	250.9	82.9	177.2	119.0	283.5
Moisture Content (%)	40.1	29.7	41.3	37.4	38.8	29.8
Liquid Limit (%)	N/A	29.3	36.6	17.5	31.3	19.8
Plastic Limit (%)	N/A	14.2	21.2	13.7	20.8	13
Liquidity Index	N/A	15.1	15.4	3.8	10.5	6.8
Unit Weight, γ (kN/m^3)	17.4	18.6	17.7	17.6	17.4	18.6
Degree of Saturation, S_{ro}	-	-	-	-	-	-
Specific Gravity, G_s	2.77	2.78	2.75	2.78	2.78	2.76
Initial Void Ratio e_o	1.2	0.92	1.15	1.19	1.2	0.94
Pre-consolidation Pressure, P_c' (kPa)	270	600	690	320	780	710
Over Consol. Ratio, OCR	2	2	8	2	7	3
Compression Index, C_c	0.39	0.35	0.59	0.67	0.68	0.38
Recompression Index, C_r	0.100	0.033	0.043	0.050	0.020	0.049
Coefficient of consolidation, c_v (cm^2/s)	0.040	0.008	0.190	0.002	0.034	0.007
Coefficient of re-consolidation, c_{vr} (cm^2/s)	0.120	0.045	0.650	0.016	0.400	0.052

Long-term laboratory oedometer (creep) tests were carried out on samples of the silty clay to clayey silt using standard incremental loading per ASTM D2435, and as outlined in the RFP to include minimum 7-day loading hold times once the test had reached the approximate estimated sampled in-situ effective stress, and then again once the test had reached the effective stress associated with the final proposed embankment height. The test parameters and results are presented in Appendix C and summarized in Table 5-3 below.

Triaxial testing was carried out on selected samples of the silty clay to clayey silt and included testing of four samples under unconsolidated-undrained conditions and two samples under consolidated-drained conditions. The test results are presented in Appendix C and summarized in Table 5-4 and Table 5-5 below.

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Table 5-3: Summary of One-Dimensional Consolidation (Creep) Testing – Silty Clay to Clayey Silt

Parameter		Results	
Borehole		BRU19-01	BRU19-03
Sample		ST16	ST20
Sample Depth (m)		20.1	23.2
Sample Elevation (m)		131.1	126.6
Approx. Existing Effective Stress, P_0' (kPa)		173.2	230.6
Moisture Content (%)		37.9	27.7
Liquid Limit (%)		31.2	24.1
Plastic Limit (%)		18.3	14.8
Plasticity Index, %		12.9	9.3
Unit Weight, γ (kN/m^3)		17.4	19.2
Degree of Saturation, S_{ro}		90.4	95.7
Specific Gravity, G_s		2.79	2.74
Initial Void Ratio e_o		1.167	0.795
Secondary Compression Index, C_α	σ' = 193.2 kPa	0.004	0.003
	σ' = 385.7 kPa	0.014	0.010

Table 5-4: Summary of Triaxial (Unconsolidated-Undrained) Testing – Silty Clay to Clayey Silt

Parameter	Results			
Borehole	BRU19-01A	BRU19-01A	BRU19-03A	BRU19-03A
Sample	ST2	ST6	ST3	ST7
Sample Depth, (m)	7.9	20.1	14.0	27.7
Sample Elevation, (m)	144.3	132.1	135.9	122.2
Approx. Exist Eff. Stress, P_0', (kPa)	86.3	205.5	123.9	281.0
Moisture Content, (%)	37.0	36.6	38.7	29.5
Liquid Limit, %	36.6	17.5	31.3	20.5
Plastic Limit, %	21.2	13.7	20.8	17.4
Plasticity Index, %	15.4	3.8	10.5	3.1
Moist Unit Weight, γ (kN/m^3)	18.1	19.0	17.7	19.5
Specific Gravity, G_s	2.75	2.76	2.78	2.77
Initial Void Ratio e_o	1.045	0.943	1.129	0.808
Deviator Stress at Failure (kPa)	208	100	213	135
Undrained Shear Strength (kPa)	104	50	107	67

Table 5-5: Summary of Triaxial (Consolidated-Drained) Testing – Silty Clay to Clayey Silt

Parameter	Results					
Borehole	BRU19-01A			BRU19-03A		
Sample	ST4			ST5		
Sample Depth, (m)	14.6			18.6		
Sample Elevation, (m)	137.6			131.3		
Max. Major Principal Stress, σ_1 (kPa)	505.1	661.5	978.9	617.0	800.5	1112.1
Max. Minor Principal Stress, σ_3 (kPa)	188.0	280	465	214	320	531
Drained Shear Strength, c' (kPa)	68			101		
Drained Friction Angle, ϕ' (deg)	15			13		

Unconfined compressive strength testing was carried out on select soil samples as per ASTM D2166, and as outlined in the RFP. The test parameters and results are presented in Appendix C and summarized in Table 5-6 below.

Table 5-6: Summary of Unconfined Compressive Strength Testing – Silty Clay to Clayey Silt

Parameter	Results		
Borehole	BRU19-01	BRU19-03	BRU19-03
Sample	ST20	ST7	ST25
Sample Depth, (m)	26.8	4.9	30.8
Sample Elevation, (m)	124.4	144.9	119.0
Approx. Existing Effective Stress, P_0', (kPa)	259.8	61.6	296.0
Moisture Content, (%)	36.0	38.7	35.2
Liquid Limit, %	29.3	62.3	32.7
Plastic Limit, %	14.2	22.3	16.2
Plasticity Index, %	15.1	40.0	16.5
Moist Unit Weight, γ (kN/m^3)	18.7	18.2	19.0
Unconfined Compressive Strength (kPa)	101	175	100
Shear Strength (kPa)	50	87	50

5.5 Interlayered Silt, Sand and Clayey Silt

Interlayered silt, sand and clayey silt was encountered at all boreholes that penetrated the extensive silty clay to clayey silt deposit it except at Boreholes BRU19-09, BRU19-10, BRU19-12 and BRU19-28. Where fully penetrated, the interlayered deposits generally consist of a predominantly silt and sand portion overlying a sandy clayey silt portion. At some borehole locations the interlayering was more irregular, and distinct portions were not discernable.

The thickness of the interlayered silt, sand, and clayey silt, when fully penetrated ranges from 1.5 m to greater than 11.9 m (base elevations ranging from 133.3 m to 105.2 m). The N-values

obtained from SPTs conducted in this material ranged from weight-of-hammer (WH) to 67 blows per 0.3 m of penetration. At Borehole BRU19-16, a Dynamic Cone Penetration Test (DCPT) was carried out within the deposit from about Elevation 111.3 m to 107.0 m and gave DCPT N-values ranging from 11 to 65 blows per 0.3 m of advancement of the probe. The SPT and DCPT results indicate that the interlayered deposits have a very loose to very dense relative density.

The moisture content ranged from 15% to 41%. The results of grain size analysis tests conducted on 25 samples of the interlayered, sand and clayey silt obtained during the current investigation and two samples obtained during the 2003 investigation are summarized below and are illustrated on Figures C10.1 to C10.5 in Appendix C and Figure D3 in Appendix D.

Soil Particle	Percentage (%)	
Gravel	0 – 12	
Sand	1 – 86	
Silt	20 – 63	14 – 38
Clay	6 – 36	

The results of Atterberg Limits testing carried out on 16 samples recovered from cohesive interlayers of this material are summarized below and are illustrated on Figures C11.1 to C11.3 in Appendix C. The laboratory results indicate that the fines are generally a clayey silt of low plasticity (CL to CL-ML). Six additional Atterberg Limit tests carried out on samples obtained from the interlayered deposits in Boreholes BRU19-01, BRU19-02, BRU19-07, BRU19-23, BRU19-25, and BRU19-33 gave non-plastic results.

Parameter	Value
Liquid Limit	15 – 29
Plastic Limit	12 – 17
Plasticity Index	3 – 14

5.6 Till

A deposit of glacial till consisting of silty sand and gravel, containing occasional to frequent cobbles and boulders was encountered beneath the silty clay to clayey silt and interbedded layers of silt, sand, and clayey silt, where fully penetrated. The glacial till was fully penetrated at Boreholes BRU-1, BRU-2, BRU-3, BRU19-01, BRU19-02, and BRU19-03. The thickness at these locations ranged from 2.3 m to 7.4 m (base elevations ranging from 106.2 m to 98.8 m).

The N-values obtained from SPTs conducted in the till material ranged from 7 to greater than 100 blows per 0.3 m of penetration but were generally greater than 50 blows indicating a very dense relative density. Refusals within this deposit are likely due to presence of cobbles and boulders. Penetration through this layer often required the use of coring techniques.

The moisture content of samples tested ranged from 6% to 30%. The results of grain size analysis test conducted on 11 samples of till material are summarized below and are illustrated on Figures C12.1 and C12.2 in Appendix C.

Soil Particle	Percentage (%)
Gravel	3 – 52
Sand	41 – 79
Silt	7 – 34
Clay	

5.7 Bedrock

Bedrock was encountered in Boreholes BRU19-01, BRU19-02, BRU19-03, BRU-1, BRU-2, and BRU-3. The bedrock encountered consisted of moderately weathered to fresh, fine to large grained, marble that is predominantly white, grey, and black in colour. Bedrock logs are provided in Appendix B. Photographs of the bedrock cores are provided in Appendix C. The following table summarizes the rock core quality:

Summary of Rock Core Quality Parameter	Range	Average
Total Core Recovery (TCR), %	98 – 100	99
Solid Core Recovery (SCR), %	29 – 100	76
Rock Quality Designation (RQD), %	39 – 100	77
Fracture Index (fractures per 0.3m)	0 – >10	2

Based on the RQD values, the bedrock is classified as poor to excellent quality.

Unconfined compressive strength (UCS) testing was carried out on eight samples of the bedrock in the boreholes listed above. The UCS values ranged from 42 MPa to 133 MPa with an average of 86 MPa. Based on the unconfined compressive strength testing the bedrock is classified as medium strong to very strong. It should be noted that fractured zones and vertical and sub-vertical fractures were present in the bedrock encountered in most boreholes.

A summary of the bedrock surface information is provided in the table below.

Borehole No.	Depth to Bedrock Surface (mbgs)	Bedrock Surface Elevation (m)
BRU19-01	45.0	106.2
BRU19-02	48.3	101.8
BRU19-03	51.0	98.8
BRU-1	48.8	102.8
BRU-2	50.3	100.0
BRU-3	48.6	100.7

5.8 Groundwater

Groundwater levels recorded in the piezometer and monitoring wells are presented in Table 5-7.

Table 5-7: Summary of Groundwater Levels

Borehole No.	Elevation (m)		Screened Material	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
	Ground Surface*	Screen Bottom				
BRU19-01	151.2	141.3	Clayey Silt	2.1	149.1	November 26, 2019
				1.3	149.9	April 21, 2020
				1.3	149.9	December 15, 2020
				1.7	149.5	August 4, 2021
				1.4	149.8	December 22, 2021
				1.8	149.4	January 11, 2022
				1.8	149.4	January 18, 2022
BRU19-03	149.8	139.7	Silty Clay	1.3	148.4	November 26, 2019
				-0.2	149.9	April 21, 2020
				0.8	148.9	December 15, 2020
				1.2	148.5	August 4, 2021
				0.8	148.9	December 22, 2021
				1.5	148.2	January 11, 2022
				1.5	148.2	January 18, 2022
BRU19-06	148.5	141.2	Silty Clay	1.9	146.6	November 26, 2019
				1.8	146.7	April 21, 2020
				1.8	146.7	December 15, 2020
				2.0	146.5	August 4, 2021
				1.8	146.7	December 22, 2021
				2.1	146.4	January 11, 2022
				2.1	146.4	January 18, 2022
BRU19-13	152.5	142.1	Clayey Silt	2.6	149.9	November 26, 2019
				2.2	150.3	April 21, 2020
				2.5	150.0	December 15, 2020
				2.4	150.1	August 4, 2021
				2.4	150.1	December 22, 2021
				2.4	150.1	January 11, 2022
				2.4	150.1	January 18, 2022
BRU19-21	150.7	141.6	Clayey Silt	1.9	148.8	December 15, 2020
				0.7	150.0	August 4, 2021
				0.9	149.8	September 22, 2021
				7.1	143.6	October 21, 2021
				6.9	143.8	November 1, 2021
				4.1	146.6	January 11, 2022
				4.1	146.6	January 18, 2022
				3.8	146.9	January 27, 2022
BRU19-29	154.7	147.4	Silty Clay Crust	3.3	151.4	December 15, 2020
				3.5	151.2	August 4, 2021
				4.3	150.4	September 30, 2021
				4.3	150.4	October 5, 2021

BRU19-29	154.7	147.4	Silty Clay Crust	3.5	151.2	January 11, 2022
				3.6	151.1	January 18, 2022
				3.5	151.2	January 26, 2022
BRU21-02	151.4	145.3	Clay Crust	2.4	149.0	November 4, 2021
				2.3	149.1	November 30, 2021
				2.2	149.2	December 23, 2021
				2.5	148.9	January 19, 2022
BRU 21-05	149.2	143.1	Silty Clay Crust	2.0	147.2	November 16, 2021
				2.0	147.2	December 1, 2021
				2.3	146.9	January 19, 2022
BRU21-15	152.6	146.5	Silty Clay Crust	2.6	150.0	November 2, 2021
				2.6	150.0	November 3, 2021
				3	149.6	January 19, 2022
BRU21-18	151.4	145.3	Silty Clay	1.5	149.9	November 2, 2021
				1.6	149.8	November 3, 2021
				1.7	149.7	January 19, 2022
BRU21-23	146.6	140.5	Silty Clay Crust	0.3	146.3	November 16, 2021
				0.3	146.3	November 24, 2021
				0.7	145.9	January 19, 2022
BRU-1	151.6	105.9	Till	6.4	145.2	October 22, 2003
				5.4	146.2	December 18, 2003
				5.8	145.8	February 4, 2004
				5.6	146.0	March 11, 2004
BRU-2	150.3	97.1	Bedrock	1.8	148.5	October 22, 2003
BRU-3	149.3	98.1	Bedrock	3.5	145.8	December 18, 2003
				4.1	145.2	February 4, 2004
				3.6	145.7	March 11, 2004

* Ground surface elevation at the time of borehole survey

5.9 Analytical Testing

Three samples were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate, sulphide and chloride concentrations, resistivity and conductivity. The analysis results are summarized in the table below. Copies of the test results are provided in Appendix C.

Borehole	Sample (Soil Type)	Depth (m)	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (%)	pH (-)	Resistivity (Ohm-cm)
BRU19-01	SS4 (Silty Clay)	2.3 – 2.9	9	9	0.02	7.78	4850
BRU19-02	SS3 (Silty Clay)	1.5 – 2.1	1280	55	< 0.02	7.91	524
BRU19-03	SS5 (Silty Clay)	3.0 – 3.7	662	38	< 0.02	7.5	902

6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to existing site features. The as-drilled locations and ground surface elevation of the boreholes were surveyed by Thurber following completion of the field program. The elevation survey was carried out with reference to geodetic elevation benchmarks provided by the MTO.

Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario and Marathon Underground Ltd. of Greely, Ontario supplied and operated the drilling equipment and carried out the drilling, soil sampling, in-situ testing, piezometer/monitoring well installation. ConeTec Investigations Ltd. of Richmond Hill, Ontario supplied and operated the CPT equipment and carried out the in-situ testing. The field investigation was supervised on a full-time basis by Richard Howarth, Michel Johnston, Anderson de Oliveira, and Michael Wong of Thurber. Overall supervision of the investigation program was provided by Justin Gray, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. One-dimensional oedometer testing was carried out by Thurber's laboratories in Ottawa and Oakville, Ontario. UCS testing of soil and rock was completed by Thurber's laboratory in Oakville. Triaxial testing was carried out by Thurber's laboratory in Oakville and by Golder Associates Ltd. in Mississuaga. Specific gravity testing was carried out by Stantec Consulting Ltd. in Ottawa. Analytical testing was completed by Paracel Laboratories in Ottawa.

Overall project management and direction of the field program was provided by Fred Griffiths, P.Eng. Interpretation of the factual data and preparation of this report were carried out by Muhammad Imran Khan, EIT, Matt Kennedy, P.Eng., and Fred Griffiths, P.Eng. The report was reviewed by P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
BRUCE STREET (COUNTY ROAD 20) INTERCHANGE
STA. 18+517, HORTON TOWNSHIP
BRUCE STREET UNDERPASS - SITE NO. 29X-0408/B1
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009

Geocres No.: 31F-234

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 geotechnical recommendations to assist the project team in designing the foundations for the structures and ramps at the Highway 17 Bruce Street (County Road 20) interchange in Renfrew, Ontario.

The interchange includes the proposed Highway 17 Bruce Street Underpass (Site No. 29X-0408/B1) to carry local traffic over the new highway, and the ramps associated with the proposed rural Parclo A2 configuration. The existing Highway 17 alignment at this site will become the future Highway 17 westbound lanes and new eastbound lanes will be constructed adjacent to the existing alignment.

This 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 foundation elements for the proposed structures and ramps. The discussions and recommendations presented in this report are based on the information provided by the Ministry of Transportation of Ontario (MTO) and on the factual data obtained during the course of this investigation.

7.1 Proposed Structures

At the site, Highway 17 runs roughly north-south and County Road 20 runs east-west. However, the travelled lanes of Highway 17 will be described herein as eastbound and westbound to maintain continuity with convention of the overall highway. County Road 20 will be described as travelling north-south. Within the project limits County Road 20 is also known as Bruce Street to the south and Castleford Road to the north of Highway 17. For clarity and consistency with project documentation, County Road 20 will typically be referred to by its local road names, and the structure as the Bruce Street Underpass.

Based on the initial General Arrangement (GA) drawing included in the Preliminary Design Report (September 2003) and the updated GA (June 2021), the new structure will consist of an approximately 81 m long, two-span precast, prestressed girder structure with integral abutments and wingwalls. The abutments and pier are proposed to be supported on piles. It is assumed that slope paving at 2H:1V will be provided for the forward slope in front of the abutment walls. Copies of the GA drawings are provided in Appendix G.

It is understood that a rural Parclo A2 interchange design is to be used that will include two looped on-ramps (N-E Ramp and S-W Ramp) and two directional off-ramps (E-N/S Ramp and W-N/S Ramp). The ramp construction will include both cut and fill sections to achieve the required grades. The ramps south of the highway will require fill sections up to about 7 m high. The ramps north of the highway will require fill sections up to about 9 m high and a cut section for the E-N/S Ramp that is up to about 7 m deep below the existing ground surface.

7.2 Applicable Codes and Design Considerations

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

In accordance with CHBDC, the analysis and design of the structure takes into consideration the importance of the structure and the consequence associated with exceeding limit states. 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 the new structure is being designed to the “Major Route” importance category.

This project has been assigned Typical Consequence Classification, in accordance with Section 6.5.1 of the CHBDC (pending confirmation by MTO). Accordingly, a consequence factor (Ψ) of 1.0, as per Table 6.1 of the CHBDC, has been used in assessing the factored geotechnical resistances. If the consequence classification changes, the geotechnical assessment and recommendations provided within this report will need to be reviewed and revised.

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

THURBER

8 SEISMIC CONSIDERATIONS

8.1 Spectral and Peak Acceleration Hazard Values

The seismic hazard data for the CHBDC is based on the fifth-generation seismic model developed by the Geological Survey of Canada (GSC). Seismic hazard data for this site has been obtained from the GSC's seismic hazard calculator. The data includes peak ground acceleration (PGA), peak ground velocity (PGV), and the 5% damped spectral response acceleration values (Sa(T)) for the reference ground condition (Site Class C) for a range of periods (T) and for a range of return periods including the 475-year, 975-year and 2475-year events. The GSC seismic hazard calculation data sheet for this site is presented in Appendix F.

The site coefficients used to determine the design spectral acceleration and displacement values are a function of the Site Class, the peak ground acceleration (PGA), and Sa(0.2). The PGA for this location for a *reference* Site Class C with a 2% probability of exceedance in 50 years is 0.23 g (1 in 2475 year). This value is to be scaled by the F(PGA) based on the site-specific Site Class as per Section 4.4.3.3 (Table 4.8) of the CHBDC (see 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 soil conditions encountered in the upper 30 m of the stratigraphy. The shear wave velocity of the soil layers at the site were recorded during advancement of the CPTs at BRU19-20 and BRU19-24 (see shear wave velocity summary data in Appendix B). Based on the results of the shear wave velocity measurements, the harmonic mean of the shear wave velocity in the upper 30 m at the site is about 250 m/s and, therefore, the site would fall into Site Class D, in accordance with Table 4.1 of the CHBDC.

For a Site Class D, the F(PGA), as per Table 4.8 of Section 4.4.3.3 of the CHBDC, is equal to 1.13 for this site yielding a site-adjusted PGA of 0.26 g.

8.3 Seismic Performance Category

In consideration of the Site Class D spectral values for the site and the designated "Major Route" importance category, the bridge structure would fall into either seismic performance category 2, if the bridge has a fundamental period greater than or equal to 0.5 seconds, or seismic performance category 3, if the bridge has a fundamental period less than 0.5 seconds, as per Section 4.4.4 (Table 4.10) of the CHBDC.

8.4 Seismic Liquefaction Potential

The susceptibility of the cohesionless soils at the site to experience liquefaction was assessed using the SPT data following the simplified method for cohesionless soil as outlined in Boulanger and Idriss (2014)[i]. In general, the cohesionless soil deposits at the site are not considered to be liquefiable. The analyses indicated that discrete locations within the deep interlayered silt and sand deposits with SPT N values less than about 8 blows per 0.3 m of penetration may be

liquefiable under the 2,475-year event. However, based on the relatively limited presence of such soils (i.e. isolated SPTs carried out in Boreholes BRU19-15 and BRU19-33), liquefaction of these discrete layers are not considered to have a significant impact on project design.

The susceptibility of the cohesive soils at this site to experience liquefaction/cyclic softening was first assessed following the Boulanger and Idriss (2007)[ii] 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 above about Elevation 133 m is not susceptible to liquefaction or cyclic mobility.

The cohesive deposits below about Elevation 133 m had Plasticity Index (PI) values between about 4 and 12%. As outlined in Section C6.14.8.1 of the Commentary to the CHBDC, soil with PI values between 7 and 12% may be expected to behave as "clay-like" and experience some cyclic mobility but are not expected to exhibit "sand-like" liquefaction, and soil with PI values less than 7% *may* experience liquefaction if it exhibits a "sand-like" response.

The cohesive soil below Elevation 133 m were further assessed following the guidance provided by Bray et al. (2004)[iii], which considers the relationship between the PI value and the ratio of natural water content to liquid limit (w_n/LL). The assessment indicated that all samples with PI less than 7% also had a w_n/LL ratio greater than 0.85, suggesting that these layers would behave as a transitional material between "clay-like" and "sand-like" behaviour. However, the PI values of the samples of the silty clay to clayey silt obtained from below Elevation 133 m were variable throughout the deposit, indicating that the layers with PI less than 7% (and may behave as transitional soils) were interlayered between those with higher PI (that would be expected to behave as "clay-like").

Analysis of the CPT data collected in the lower silty clay to clayey silt indicated that the soil behaviour is generally "transitional-contractive" to "clay-like-contractive-sensitive", based on Robertson's modified (Normalized Soil Behavior Type) SBTn charts. This is consistent with soils that exhibit "clay-like" behaviour at high strain and tend to be less susceptible to liquefaction. Further, the modified Soil Behaviour Type Index (I_c) obtained form the CPT data in the silty clay to clayey silt below about Elevation 133 m ranged from about 2.7 to 2.9—greater than the typical limit of 2.6 used to define the transition between "sand-like" and clay-like" behaviour. The database of liquefaction case histories contains very few examples of liquefaction for soils with I_c values greater than this limit.

Based on the above, the cohesive deposits below Elevation 133 m may also be considered to act as "clay-like" and non-liquefiable for design. However, some cyclic softening (reduction in strength and stiffness) may occur.

9 STRUCTURE FOUNDATION ALTERNATIVES

9.1 Foundation Alternatives

It is understood that the Bruce Street overpass is to consist of a two-span, precast, prestressed concrete girder structure with pier and abutments supported on piles. Based on the most recent

GA drawing (June 2021, see Appendix G) the structure will be about 81 m long, comprising two 40.5 m long spans, and about 25 m wide to accommodate the planned through lanes, ramp connections, and shoulders. Retaining walls and wing walls will be present at each abutment.

The County Road 20 alignment will revert back to the former Bruce Street alignment, with the underpass constructed approximately 50 m west of the existing intersection.

It is anticipated that the underside of the pier pile cap will be at about Elevation 148 m. Based on the boreholes put down near the proposed pier location (BRU19-02, BRU21-02, and BRU-2), the soil conditions below that elevation consist of very stiff weathered silty clay crust to elevations of 144 to 145 m, over very stiff to stiff unweathered silty clay to clayey silt.

At the abutments, embankment fill with heights of up to about 7 m at the south abutment and 8.4 m at the north abutment will be constructed. It is anticipated that the underside of the pile caps at the abutments will be perched within the embankment fill at approximate elevation 151 m. The soil conditions encountered in the boreholes at the abutment locations (BRU19-01/01A, BRU19-03/03A, BRU-1, BRU-3) consist of a similar very stiff weathered silty clay crust extending to elevations ranging from about 142 to 146 m and underlain by very stiff to stiff unweathered silty clay to clayey silt.

At the structure location, the extensive deposit of silty clay to clayey silt extends to elevations of about 115 to 117 m, and is underlain by interlayered deposits of silt, sand, and clayey silt. The interlayered deposits are underlain by glacial till with a surface at elevations ranging from about 105 to 109 m. The glacial till is underlain by marble bedrock at elevations ranging from 98.8 to 106.2 m. Cobbles and boulders were observed in the glacial till, effective refusal to the split-spoon sampler, and/or HQ coring was required at various depths within the glacial till deposit at the borehole locations.

A summary of the in-situ and laboratory test results for the silty clay to clayey silt at the site are presented in Figures B4.1 and B4.2 in Appendix B. At the wells and piezometers installed near the proposed foundation elements as part of the current investigation, groundwater was measured at elevations ranging from 148.2 to 149.9 m.

Given the soil stratigraphy encountered, the following foundation options have been considered from a geotechnical perspective for the support of the bridge abutments and pier:

- Spread footings,
- Caissons (drilled shafts), and
- Steel piles (H-piles, pipe piles).

The foundation alternatives are presented below and evaluated from a geotechnical perspective in terms of their respective advantages, disadvantages, risks, and consequences. The evaluation is summarized in the table provided in Appendix G.

- Spread Footings

  Spread footings founded within the native soil present beneath the surficial fill would be within the stiff to very stiff silty clay which would offer relatively low bearing resistance for the bridge foundations. Due to the compressible nature of the soil, total and differential settlements between founding units will occur. In addition, spread footings do not allow for construction of integral abutments.

  It is not recommended to support the new bridges on spread footings; however, it may be feasible to support retaining walls on spread footings.

- Caissons

  Caisson foundations, particularly when they are socketed into bedrock, offer high geotechnical resistance. However, the high groundwater level (within a few metres of the existing ground surface) will pose additional construction challenges resulting from potential unbalanced hydraulic pressure heads and caisson base boiling when drilling through the lower, interlayered silt, sand, and clayey silt deposits, as well as the granular glacial till deposits. This would require the use of temporary liners and synthetic slurry to counterbalance groundwater pressure.

  The occasional to frequent presence of cobbles and boulders observed in the till layer in all boreholes put down at the foundation locations could also present additional difficulties during caisson installation. Founding caissons on dissimilar stratigraphy (e.g. some on bedrock and some in boulders) could result in differential settlements.

  It is not recommended to support the new bridges on caissons.

- Driven Steel Pipe Piles

  Based on the foundation soils encountered as part of the current investigation, open-ended steel pipe piles are considered to be feasible for the support of the new abutments and piers. Pipe piles would reduce the volumes of excavation required when compared to that for shallow foundations. However, pipe piles are considered to have a higher risk than driven H-piles for “hanging up” or being deflected away from their intended vertical or battered orientation if cobbles or boulders are encountered during driving.

  It is considered feasible to support the new abutments and piers on driven steel pipe piles.

- Driven Steel H-piles

  Driven steel H-piles are also considered feasible for the support of the new abutments and pier. Driven H-piles will typically reduce the volumes of excavation required when compared to shallow foundations. The use of H-Piles with reinforced tips is the option with the least risk given the cobbles and boulders in the till layer above the bedrock observed at this site.

  It is recommended to support the new abutments and piers on driven steel H-piles.

9.2 Construction Methodology

As indicated in Chapter 7 of the Preliminary Design Report (2003), MTO owns sufficient lands for the intersection expansion and, therefore, it is assumed that staging areas for the bridge construction will be set up in the proposed looped on-ramp areas and/or within the lands between the current County Road 20 alignment and the proposed alignment to the west. Depending on the construction sequence, embankment construction in advance of construction of the foundation elements (including preload and surcharge) may be required.

10 FOUNDATION DESIGN RECOMMENDATIONS

The abutments and pier may be supported on steel H-piles or pipe piles driven to refusal in the till layer or bedrock. Approximate key elevations are as follows:

- Original Grade 149.8 m to 152.2 m
- Proposed top of pavement Hwy 17 EBL / WBL 151.0 m / 150.8 m
- Underside of perched abutment pile caps, assumed 151.0 m
- Underside of pier pile cap, assumed 148.0 m
- Groundwater elevation 148.2 to 149.9 m
- Clay/Till interface 105.0 to 109.0 m
- Bedrock surface 99.0 to 106.0 m

10.1 Driven Steel H-Piles or Pipe Piles

10.1.1 Axial Geotechnical Resistance and Founding Elevation

Bedrock was proven by coring in the deep boreholes put down at the proposed foundation element locations (BRU19-01, BRU19-02, BRU19-03, BRU-1, BRU-2, and BRU-3). The boreholes put down at the abutment and pier locations encountered bedrock at elevations ranging from 98.8 to 106.2 m. Cobbles and boulders were encountered or inferred in the glacial till at all foundation element borehole locations. Difficulty drilling or refusal of the sampler that suggested the presence of cobble or boulders in the glacial till and required penetration by coring, or a combination of coring and wash boring techniques was encountered throughout the deposit.

It is anticipated that piles will not consistently be able to penetrate the till layer to reach bedrock. Accordingly, the pile recommendations provided below are based on driving the piles to refusal in till on cobbles and boulders; however, it should be noted that some of the piles may get past this layer and reach bedrock.

Piles that meet refusal in the glacial till deposit may be designed with factored ULS and SLS resistance values provided below in Table 10-1.

The structural resistance of the pile under static and seismic conditions must be checked by a structural engineer. The factored geotechnical resistances provided include the following factors:

- Consequence factor (Ψ) of 1.0
- Geotechnical resistance factors (CHBDC Table 6.2) of ϕ_{gu} = 0.4 (static analysis; typical degree of understanding)

Table 10-1 Factored Geotechnical Compressive Resistance for Single Pile

Pile Size/Type	Factored ULS (kN)	Factored SLS (kN)
HP 310x110	1,400	1,200
HP 360x132	1,600	1,400
324 mm Pipe	1,250	1,050

The estimated pile tip elevations for piles end bearing at the site are summarized Table 10-2. With the pile caps at the elevations outlined in Section 10, the piles will be between about 40 and 50 m long. Piles with a heavier section (i.e. HP 360x132) should be considered to reduce the potential for buckling.

Pile driving must be controlled by the Hiley Formula and an ultimate pile resistance should be specified by the designer in accordance with Clause 3.3.2 (b) Construction Stage of MTO's Structural Manual. Dynamic load testing (PDA) should be carried out to confirm pile capacity during construction. It is recommended the capacity of at least two piles per foundation unit are verified by PDA testing.

Table 10-2 Estimated Pile Tip Elevations

Foundation	Location	Bedrock Elevation (m)	Estimated Pile Refusal Elevation (m)	Estimated Pile Length* (m)
North Abutment	BRU19-03	98.8	102.9 Cobbles and boulders at 103	46.9 – 52.2
	BRU-3	100.7	104.1 Boulders at 104.2	
Pier	BRU19-02	101.8	107.9 Coring techniques required at 108	40.1 – 48.0
	BRU-2	100.0	105.9 Coring techniques required at 106	
South Abutment	BRU19-01	106.2	107.9 Boulders at 108	43.1 – 48.2
	BRU-1	102.8	107.9 Boulders at 108	

* Based on assumed underside of pile cap elevations described in Section 10.

Steel piles (Grade 350W steel) at this site may be designed to resist uplift forces with the factored geotechnical resistances provided in Table 10-3, applicable for HP 310x110, HP 360x132, and

324 mm diameter pipe piles. The tensile resistance would be derived from the skin friction within the silty clay and interlayered sand and slit deposits that underlie the pile cap.

The factored geotechnical tensile resistance values provided in Table 10-3 include the following factors:

- Consequence factor (Ψ) of 1.0
- Geotechnical resistance factors (CHBDC Table 6.2) of ϕ_{gu} = 0.3 (static analysis; typical degree of understanding)
- Geotechnical resistance factors (CHBDC Table 6.3) of ϕ_{gu} = 1.0 (seismic analysis; typical degree of understanding, performance-based design)

Table 10-3 Axial Geotechnical Tensile Resistances

Pile Size/Type	Static (kN per pile)	Seismic (kN per pile)
HP 310x110	675	2,250
HP 360x132	700	2,300
324 mm Pipe	550	1,800

10.1.2 Downdrag

Downdrag forces (negative skin friction) acting upon the piles supporting the abutments are expected to develop as a result of settlement of the silty clay deposit under the imposed loading from the newly placed fill. For this reason, it is recommended that the preload/surcharge period outlined below in Section 10.5 be incorporated into the design. If initiation of the driving of the abutment piles is delayed to after the end of the preload/surcharge period, downdrag forces need not be applied.

However, if the abutment piles are driven and seated prior to completion of the preload period and associated settlement, the resulting downdrag loads should be considered in the structural design. Downdrag loads were estimated as outlined in Section 6.11.4.10 of the CHBDC. The unfactored downdrag load acting on a single HP 310x110, HP 360x132, or 324 mm diameter pipe pile at the abutments are estimated to be about 1,450 kN, 1,650 kN, and 1,300 kN, respectively. In addition to the downdrag loads on the piles, lateral deflection of the abutment piles resulting from the subsequent placement of embankment fill and associated settlement should be considered in the design.

Downdrag loads need not be applied at the pier where there is no considerable grade raise that could produce settlement in the underlying soils.

10.1.3 Lateral Geotechnical Resistance and Group Effects

Piles can be installed with a batter to resist lateral loads for a conventional or semi-integral abutment.

The lateral resistance for the soil adjacent to a vertical pile is developed on the face of the pile embedded in the foundation soils and estimated using P-y curves.

The P-y curves representing the response of the soil under static loading conditions are shown in Appendix H to allow for calculation of the *ultimate* lateral capacity of an individual pile. Calculation of the P-y curves considered the abutment and pier pile cap underside elevations as outlined above in Section 10, and that the upper 3 m of the piles at the abutments would be cased in a loose sand-filled, corrugated steel pipe (CSP) as part of an integral abutment foundation. The values provided in Appendix H were calculated for a single, vertical HP 310x110 pile, considering the soil parameters summarized in Table 10-4, below.

Table 10-4 L-Pile Analysis – Soil Stratigraphy

Soil Stratum	Bulk Unit Weight (kN/m^3)	Friction Angle (degrees)	Undrained Shear Strength (kPa)	ε_{50}
Granular Fill	21.0	32	-	
Silty Clay to Clayey Silt	17.5	-	60 – 100	0.007
Interlayered Sand, Silt, and Clayey Silt	18.0	30	-	-
Silty Sand and Gravel (Till)	21.0	35	-	-

The ground would provide greater resistance (i.e. increased stiffness) to a pile with a larger face width. The P-y curves for other pile sizes may be approximated by increasing the stiffness by the percentage increase of the face size.

A geotechnical resistance factor of 0.5 (ϕ_{gu}) and 0.8 (ϕ_{gs}) as per Table 6.2 of the CHBDC (static analysis – typical understanding) should be applied to the *ultimate* ULS and SLS values, respectively.

Where lateral spacing between an adjacent pile or another structural element is less than four equivalent pile diameters, the lateral resistance will also need to be further reduced based on the center-to-center spacing. The reduction factors to be used can be obtained from Figures C6.22, C6.23, and C6.24 of the Commentary to the CHBDC.

10.1.4 Pile Tips

It is expected the pile installation will encounter cobbles and boulders. Care must be exercised not to damage the piles while driving into layers with cobbles and boulders and to bedrock. The tips of all piles must be protected from damage when driving and should be fitted with a Titus Steel (standard H-Point or Open Cutting Shoe) or approved equivalent.

10.1.5 Pile Driving

Pile driving must be carried out in accordance with OPSS.PROV 903 and Special Provision 109F57 for piles driven to refusal in the bedrock or cobble and boulder layers. Pile testing need not be used until piles are within 2 m of the design tip elevation. The appropriate pile driving note

is “Piles to be driven to an ultimate resistance of “R” kN per pile”. “R” must have a minimum value of twice the design load at ULS. The designer fill-in (*) in Section 903.07.02.07.03.01 shall be *High-Strain Dynamic Testing*.

10.1.6 Abutment Type

The subsurface conditions at this site are considered suitable for conventional, semi-integral, or integral abutments. At the abutments, a loose sand-filled, 900 mm diameter corrugated steel pipe (CSP) around the upper 3.0 m of the piles is recommended to allow for the required lateral movement for an integral abutment configuration.

10.2 Wingwalls / Retaining Walls

Based on preliminary design documents, it is understood that the abutments will consist of foundations supported on piles, with pile caps perched in the embankment fill. It has been assumed that slope paving inclined at 2H:1V will be provided in front of the abutments.

Based on the initial GA drawing (September 2003, Appendix G) the abutment wingwalls are to be supported on stepped RSS walls extending up to about 13.5 m longitudinally behind the abutments, with sloped backfill perpendicular to the roadway increasing in height with distance from the abutments. The south and north abutments are to be about 6.6 and 8.4 m high, respectively.

Retained soil system (RSS) walls are 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, the following recommendations should be confirmed:

Performance	H
Appearance	H
Acceptance	A

RSS walls should have a minimum embedment of 0.8 m. The underside elevation of the RSS walls adjacent to the abutments are anticipated to be at approximate Elevation 149 m. A minimum 1 m thick engineered fill pad constructed on the underlying undisturbed native soils should be provided below the RSS wall as well as under the reinforced retained soil. The engineered fill pads should consist of OPSS Granular A placed and compacted in accordance with OPSS.PROV 501. Engineered fill pads should be constructed with 1H:1V sides slopes with the crest of slope a minimum of 1 m from the edge of footing and reinforced retained soil on all sides. The subgrade soils may become disturbed when saturated and should be protected by prompt placement of a geotextile separator (Class II non-woven geotextile with a maximum FOS of 150 μm: OPSS.PROV 1860) and the engineered fill pad placed immediately after excavation and inspection.

Shallow foundations for the RSS walls founded directly on the native silty clay to clayey silt at or below Elevation 149 m with a minimum 1 m thick Granular A bedding layer are feasible at the site.

Shallow footings up to 6 m in width and constructed as outlined above may be designed based on a factored geotechnical resistance at ULS 250 kPa. The ULS bearing resistance value is for vertical, concentric loading. In the case of eccentric or inclined loading, the bearing resistance must be reduced in accordance with CHBDC Clause 6.10.2 and Clause 6.10.5.

The factored geotechnical resistance includes the following factors:

- Consequence factor (Ψ) of 1.0 (as per CHBDC Table 6.1)
- Geotechnical resistance factor (ϕ_{gu}) of 0.5 (static analysis; typical degree of understanding as per CHBDC Table 6.2)

The factored geotechnical resistance at SLS will be significantly influenced by the construction sequencing and the consolidation settlement of the compressible silty clay to clayey silt under the embankment loading. Further, RSS walls on the order of 8.4 m high may not be feasible if founded on the native silty clay without a gravel pad of sufficient thickness. RSS walls are considered feasible provided:

- Preloading/pre-construction of the embankments is carried out prior to the RSS walls
- A granular pad of sufficient thickness is provided below the RSS walls
- Consideration is given to founding the RSS walls at a higher elevation, within the embankments

Further discussion on anticipated settlement magnitudes beneath the embankment fill and potential mitigation measures are described below in Section 10.5.2.

The lateral pressure comments provided Section 10.3 may be used in RSS design. Please refer to Section 10.5.1 for comments on global stability.

Before selecting the RSS wall, discussions should be held with RSS wall suppliers whether RSS walls are feasible based on the relatively low bearing capacities available in the silty clay.

10.3 Backfill and Lateral Earth Pressures

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 numerous 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 42 and 40 degrees can be used respectively for Granular B Type II and quarry- sourced Granular A in this area provided the vertical effective 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”.

The backfill must be in accordance with OPSS.PROV 902 and placed to the extents shown on OPSD 3101.150 for the abutment and wingwall/retaining walls. Structural backfill should consist of Granular A or Granular B Type II placed and compacted in accordance with OPSS.PROV 501. Heavy compaction equipment used adjacent to the walls must be restricted in accordance with OPSS.PROV 501.07.02. The design of the abutment and wingwall/retaining walls, where required, must incorporate a subdrain as shown in OPSD 3101.150. A geosynthetic drainage blanket is recommended to be placed vertically on the back wall of the abutment leading to the subdrain to enhance drainage.

Lateral earth pressure parameters provided in Table 10-5 and Table 10-6. in the sections below are based on the assumptions that the wall is vertical and the backfill is fully drained so that there are no unbalanced hydrostatic pressures above the permanent groundwater level. If adequate drainage cannot be confirmed, the potential for buildup of hydrostatic pressures should be considered in design.

Where back slopes are horizontal, the corresponding coefficients provided in Table 10-5 and Table 10-6 should be used. For other backfill and wall geometries, the appropriate earth pressure coefficients will need to be calculated once the final geometry is confirmed.

10.3.1 Static Lateral Earth Pressure

Lateral earth pressures acting on structures 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 yielding walls, K_o for non-yielding 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 10-6.

Table 10-5 Static Earth Pressure Coefficients

Condition	OPSS Granular B Type II ϕ = 42°, γ = 22.8 kN/m^3	Quarry Sourced OPSS Granular A ϕ = 40°, γ = 22.8 kN/m^3	Pit Sourced OPSS Granular A ϕ = 35°, γ = 22.8 kN/m^3
Coefficient of at Rest Earth Pressure, K_o (Restrained Wall)	0.33	0.36	0.43
Coefficient of Active Earth Pressure, K_A (Unrestrained Wall)	0.20	0.22	0.27
Coefficient of Passive Earth Pressure, K_P (Movement towards Soil Mass)	5.0	4.6	3.7

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

10.3.2 Combined Static and Seismic Lateral Earth Pressure

In accordance with Clause 6.14.7.2 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 C6.14.7.2 of the Commentary of the CHBDC which states that seismically induced lateral soil pressures may be calculated using the Mononobe-Okabe Method with:

- k_h = ½ * F(PGA) * PGA, for structures that allow 25 to 50 mm of movement, and
- k_h = F(PGA) * PGA, for non-yielding walls

The coefficients of horizontal earth pressure for combined static and seismic loading presented in Table 10-6 may be used. The provided earth pressure coefficients are based on a 1 in 2,475-year, site-adjusted (Site Class D) PGA of 0.26 g, as described previously in Section 8.

Table 10-6 Combined Static and Seismic Earth Pressure Coefficients

Condition	OPSS Granular B Type II $\phi = 42^o$, $\gamma = 22.8$ kN/m^3	Quarry Sourced OPSS Granular A $\phi = 40^o$, $\gamma = 22.8$ kN/m^3	Pit Sourced OPSS Granular A $\phi = 35^o$, $\gamma = 22.8$ kN/m^3
Coefficient of Active Earth Pressure, K_{AE} (Restrained Wall)	0.34	0.37	0.44
Coefficient of Active Earth Pressure, K_{AE} (Unrestrained Wall)	0.26	0.28	0.35

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

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

where:

σ_h = lateral earth pressure at depth d (kPa)
d = depth below the top of the wall (m)
K = static earth pressure coefficient (K_A for yielding walls, K_o for non-yielding walls)
γ = unit weight of retained soil, use submerged unit weight below groundwater level
K_{AE} = combined static and seismic earth pressure coefficient
H = total height of the wall (m)

10.4 Frost Depth

The depth of frost penetration at this site is estimated to be 1.9 m (as per OPSD 3090.101). Footings and pile caps for the abutments and retaining walls should be founded at or below this depth or provided with equivalent insulation.

10.5 Embankment Fill

10.5.1 Embankment Stability

Slope stability assessment of the bridge approaches and associated ramp embankments were carried out using GeoStudio 2020 Slope/W software for limit equilibrium analysis. Input parameters for the embankment fill and foundation soils for the analysis are based on the SPT N values, measured undrained shear strength, the results of laboratory testing, typical material parameter correlations, and engineering judgement. The long-term (drained) parameters for the silty clay were informed by the results of work carried out on samples of Champlain Sea Clay that was published in the Canadian Geotechnical Journal by Lefebvre (1981). A summary table of soil parameters are shown on each stability analyses output figure provided in Appendix I.

Table 6.2 of Section 6.9.1 of the CHBDC requires minimum Factors of Safety of 1.5 and 1.3 for embankments in permanent and temporary static conditions, respectively, for a typical degree of understanding and a Ψ of 1.0**.**

For seismic analysis, Table 6.3 in Section 6.14.4.1 of the CHBDC indicates a minimum resistance factor of 0.95 ($\varphi_{gu,\ static(temporary)}$ = 0.75 + 0.2) 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. However, as is stated in Section 6.14.9.1, some embankment displacement can occur where the pseudo-static Factor of Safety is less than 1.3; in this case, the bridge foundations must be designed to withstand the permanent deformations and/or slope stabilizing measures shall be incorporated into the design. Where the pseudo-static Factor of Safety is greater than 1.3, the slope is considered to be seismically stable with deformations of less than 50 mm.

In addition, Sections 6.14.2.1 and 6.14.2.3 of the CHBDC present performance criteria requirements for Major Route geotechnical systems (embankments) inside and outside the bridge interface zone, respectively. Based on Clause 6.14.2.2, the bridge interface zone at this site extends to 20 m behind the abutment (based on a fill height of up to about 8.5 m). The performance criteria for the Major Route embankments are as follows:

- Within the bridge interface zone (bridge approaches): 100% of the travelled lanes shall be available for use following a ground motion event with a return period of at least 475 years.
- Outside the bridge interface zone (beyond bridge approaches): sites that fall within Seismic Performance Category 2 or 3 (See Section 8.3) shall have at least 50% of travelled lanes, but not less than one, available for use following ground motions with a return period of at least 475 years.

The stability analyses considered site-adjusted (Site Class D) design PGA values of 0.26 g and 0.10 g for ground motions with return periods of 2,475 and 475 years, respectively, as per Section 4.4.3.2 of the CHBDC.

Based on the preliminary design profiles and general arrangement drawings available at the time of preparation of this report, the proposed grade of the County Road 20 travelled lanes at the underpass are to be about 158.3 m and 158.8 m at the north and south abutments, respectively. Embankment fill up to about 8.4 m high above the existing ground surface near the north abutment (approximate Station 9+950) will be required.

Based on the initial GA drawing (September 2003, Appendix G) the abutment wingwalls are to be supported on stepped RSS walls extending up to about 13.5 m longitudinally behind the abutments, with sloped backfill in front increasing in height with distance from the abutments.

The existing ground surface along the proposed E-N/S Ramp alignment varies from about Elevation 147.8 m at the proposed Castleford Road alignment, to 146.3 m between the proposed and existing Castleford Road alignments, and then increases to a plateau at about Elevation 155 m to the east. Based on the available preliminary design profiles, embankment fill up to about

8.9 m high above the existing ground surface will be required at the highest portions of the ramp fill (approximate Station 18+430).

Slope stability assessments of the proposed critical abutment and ramp embankment slopes have been carried out considering two different embankment materials: Select Subgrade Material (SSM) and compacted rockfill. It is noted that fill geometry typically includes a 2 m wide bench for earth or granular fills equal to or greater than 8 m in height. For the forward slope at the bridge abutments, the placement of slope paving can replace the inclusion of a bench.

Embankment slope stability was evaluated using GeoStudio 2020 Slope/W software for limit equilibrium analysis. Input parameters for the analysis are based on the SPT N values and the results of laboratory testing. The following additional parameters were used in the analysis:

- Soil stratigraphy was based on the nearest boreholes.
- Maximum embankment fill heights of 8.4 m at the north abutment (Station 9+950) and 8.9 m at the E-N/S Ramp (Station 18+430) were considered.
- Side slopes of 2H:1V for OPSS Select Subgrade Material (SSM) fill and 1.25H:1V for rockfill were modelled.
- Mid-height 2m wide benches were used for conventional SSM slopes greater than 8 m in height.
- Retained soil at RSS walls are to consist of OPSS Granular B Type II, 5.6 m in width and supported on a 1 m thick Granular A bedding layer.
- Structural backfill behind the RSS is to consist of OPSS Granular A.
- Horizontal backslopes are present behind the RSS walls.
- Site-adjusted horizontal PGA values of 0.13 g and 0.05 g, equal to ½ of the site-adjusted horizontal PGA values were used for the 2,475-year and 475-year seismic analyses, respectively, as per Section 4.4.3.3 of the CHBDC and outlined in Sections 8.1 and 8.2 above.
- Rockfill strength has been modelled using a non-linear envelope based on vertical confining stresses. Guidance was obtained from AASHTO LRFD Bridge Design Specifications, 8th Edition (September 2017)[iv] Figure 10.4.6.2.4 1 using a Rockfill Grade of “D” which varies the secant friction angle based on effective normal stress. An interpretation of the shear normal plot is provided in Appendix I.
- A traffic surcharge of 17 kPa has been applied as a temporary load.

Copies of the output from the stability analyses are provided on the figures presented in Appendix I. Each output figure shows the slope geometry, groundwater conditions, soil stratigraphy and soil strength parameters utilized in the analysis. The stability analyses generated the following factor of safety values:

Table 10-7 Slope Stability Anaysis Results – Bruce Street Underpass North Approach (Sta. 9+950)

Condition	Case	Factor of Safety			
		2H:1V [SSM]	**1.25H:1V** [Rockfill]	**Abutment Wall**	**RSS Wall**
Permanent	Long Term (Drained)	1.6 (Fig I1.1)	1.7 (Fig I2.1)	1.5 (Fig I3.1)	1.6 (Fig I4.1)
Temporary (traffic loading)	Short Term (Undrained)	1.6 (Fig I1.2)	1.7 (Fig I2.2)	1.8 (Fig I3.2)	2.0 (Fig I4.2)
Temporary (seismic loading)	Pseudo-Static (Undrained) 2,475-year	1.2 (Fig I1.3)	1.3 (Fig I2.3)	1.5 (Fig I3.3)	1.7 (Fig I4.3)
	Pseudo-Static (Undrained) 475-year	1.4 (Fig I1.4)	n/a	n/a	n/a

Table 10-8 Slope Stability Anaysis Results – E-N/S Ramp (Sta. 14+430)

Condition	Case	Factor of Safety	
		2H:1V [SSM]	**1.25H:1V** [Rockfill]
Permanent	Long Term (Drained)	1.6 (Fig I5.1)	1.6 (Fig I6.1)
Temporary (traffic loading)	Short Term (Undrained)	1.6 (Fig I5.2)	1.6 (Fig I6.2)
Temporary (seismic loading)	Pseudo-Static (Undrained) 2,475-year	1.1 (Fig I5.3)	1.2 (Fig I6.3)
	Pseudo-Static (Undrained) 475-year	1.4 (Fig I5.4)	1.4 (Fig I6.4)

It is noted that larger trial slip surfaces (larger in both in width, with entry and exit points beyond those shown in the critical circles, and depth, with radii larger than those shown in the critical circles) were included in the analyses and gave Factor of Safety values greater than those reported in Tables 10.7 and 10.8 for the critical slip circles.

The results of all static design analyses (temporary/traffic and permanent conditions) presented above meet or exceed the target Factors of Safety.

The results of all seismic analyses meet or exceed the target Factor of Safety for seismic design for the 2475-year seismic event. However, only the rockfill embankments at the Bruce Street Underpass approaches meet or exceed a Factor of Safety of 1.3; all other pseudo-static analyses yielded factor of safety values below 1.3.

Additional analyses were carried out to determine if performance criteria were met for the major Route geotechnical systems inside and outside the bridge interface zone. Pseudo-static analyses considering the 475-year earthquake event were completed. In all instances, the projected failure surfaces indicated that the performance requirements would be met.

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the embankments. Normally slope vegetation should be established as soon as possible after

completion of embankment construction to control surficial erosion in general accordance with OPSS.PROV 804.

Although, not specifically assessed, the stability of the slope without a mid-height berm in front of the abutments is anticipated to be superior to the typical SSM embankment case provided structural fill (Granular A or B Type II) is placed beneath the slope paving and pile caps, and behind the abutment.

10.5.2 Embankment Settlement

Construction of the new embankments for underpass bridge and associated ramps will require placement of significant thicknesses of embankment fill. Based on the preliminary design profiles and general arrangement drawings available at the time of preparation of this report, the underpass approach embankments will range up to about 6.6 m and 8.4 m at the south and north abutments, respectively. The embankment for the E-N/S Ramp will range up to about 8.9 m above the existing ground surface.

The loading imposed from the new fill will increase the effective stress in underlying soil deposits and induce settlement in the compressible silty clay to clayey silt layers. Settlement analyses were carried out using the software Settle3 (Version 5) by Rocscience.

In accordance with MTO's document "Embankment Settlement Criteria for Design" (March 2, 2010), the criteria adopted for embankment design at this site is as follows:

Table 10-9. Summary of MTO Settlement Criteria

Distance from Abutment	0-20 m	20-50 m	50-75 m	>75 m	Post Construction Settlement Period
Settlement Limits Non-Freeway	25 mm	50 mm	100 mm	200 mm	15 years

A representative site stratigraphy was developed based on the Record of Borehole logs with material properties based on the results of in-situ field testing and laboratory testing. The design stratigraphy considered material parameters of the weathered crust and underlying unweathered portions on the silty clay to clayey silt deposit based on laboratory and in-situ test results.

Preconsolidation pressure and its variation with depth for each stratum was estimated based on the consolidation test results (see Section 5.4 and Appendix C) and interpretation of the data collected during advancement of the CPTs. Undrained shear strength values were calculated from the CPT data using empirical correlations and calibrated with nearby in-situ shear vane data considering an N_{kt} value of 16. A plot showing the interpreted preconsolidation pressure used in the analyses is presented on Figure I8.1 in Appendix I. Primary consolidation settlement parameters were estimated based on the results of the consolidation tests (standard and CRS). Secondary consolidation parameters were estimated based on the results of the long-term (creep) consolidation tests. The coefficients of consolidation to determine settlement rate were estimated based on the results of the consolidation tests (standard and CRS) and the results of the pore

water pressure dissipation (PPD) tests carried out during advancement of the CPTs considering a c_h/c_v ratio of 1.3 for the marine deposit (Lerouil and Jamilkowski, 1991)[v].

Table 10-10 Summary of Material Parameters

Soil Type	Thickness (m)	Unit Weight (kN/m^3)	Settlement Parameters						
			P_c' (kPa)	Primary				Secondary	
				C_c	C_r	C_v (cm^2/s)	C_{vr} (cm^2/s)	$C\alpha$	$C\alpha_r$
Silty Clay (Crust)	3.8 – 5.5	17.5	600	0.72	0.05	0.001	0.080	-	-
Upper Silty Clay to Clayey Silt	10.2 – 11.9	17.5	600 to 350	0.50	0.05	0.041	0.063	0.012	0.004
Lower Silty Clay to Clayey Silt	11.9 – 17.1	18.0	350 to 650	0.47	0.04	0.006	0.027	0.012	0.004
Interlayered Silt, Sand	4.6 – 10.2	18.0	E_s = 10 MPa						
Silty Sand (Till)	2.3 – 6.8	21.0	E_s = 80 MPa						

The soil parameters used in the model are summarized in Table 10-10, above.

Analyses were carried out to calculate the predicted settlement with time, considering SSM embankments inclined at 2H:1V, and a unit weight of 21 kN/m^3 constructed with thicknesses of 6.6 m and 8.4 m at the south and north abutments of the underpass, respectively, and 8.9 m at the point of greatest thickness along the E-N/S Ramp (approximate Station 18+430).

As noted above, it is not anticipated that the pre-consolidation pressure of the silty clay deposit will not be exceeded. A summary of the calculated settlement with time at the location of greatest settlement beneath each of the north embankment, south embankment, and E-N/S Ramp are shown on Figure I8.2 in Appendix I. The results of the settlement analyses indicated that the new embankments would settle as much as 260 mm at the north abutment and beneath the E-N-S Ramp, and as much as 200 mm at the south abutment at the end of recompression. These values include up to about 25 to 50 mm of elastic settlement in the lower interlayered deposits and glacial till, with the remaining settlement occurring in the extensive silty clay to clayey silt deposit. The elastic settlement in the lower interlayered deposits and glacial till would occur almost immediately, and the consolidation settlement in the silty clay would occur over time, with 90% of the recompression settlement occurring after about 7 months.

The compressible silty clay to clayey silt deposits will continue to settle following completion of the recompression settlement at the site. The results of the settlement analyses indicated that an

additional 50 mm of secondary consolidation settlement is expected to occur at the abutments over a post-construction settlement period of 15 years, which exceeds the limits set out above in Table 10-9.

As discussed in Sections 10.1 and 10.2, the approach and structural elements founded within the structure approach embankments will experience this settlement, which will be differential to foundation elements founded within the underlying glacial till or bedrock. Depending on the project schedule and sequencing of embankment and foundation construction, preloading (pre-constructing) the embankments prior to constructing the structure or RSS walls is recommended. If more rapid settlement is required, consideration may be given to surcharging the area and/or installing wick drains in the compressible clayey silt, or a combination thereof to increase the rate of settlement. Wick drains would provide shortened drainage paths within the compressible soil to allow more rapid dissipation of porewater pressure and, therefore, time required for consolidation settlement. The increase in rate of settlement resulting from wick drain installation would be influenced by the wick drain diameter, length, and spacing.

Construction of the embankments with lightweight fill would reduce the imposed load on the compressible soil at the site and, therefore, reduce the anticipated settlement of the embankments, including the predicted secondary consolidation settlement.

Regardless of construction methodology, monitoring of the embankments during construction would be required to determine the actual rate and magnitude of settlement of the embankment. A suitable settlement monitoring program should be required by the Contract. The detailed requirements of the requisite settlement monitoring plan should be determined at the detailed design stage by the design-build team following completion of the structural design, foundation design requirements, and final embankment geometries.

In addition to the settlement described above, there will be self-settlement of the embankment material itself. For embankments constructed with compacted rockfill the short term settlement will be approximately 100 mm (up to 1 year after completion of construction with 90% of this value occurring in the first six months). In addition, rockfill embankments continue to settle after the first year with an estimate of an additional 15 mm. Similarly, an embankment constructed of SSM material will undergo approximately 45 to 90 mm of self settlement with the majority of that complete within the one year of completion of construction. Embankments must be overbuilt to compensate for the estimated settlement.

10.6 Earth Cuts

Earth cuts in the northeast quadrant of the site will be required to achieve the proposed design grades along portions of the E-N/S and S-W Ramps. Cuts of up to about 2.0 m deep will be required along the S-W Ramp between about Station 18+650 and 18+770. Cuts ranging up to about 7.3 m will be required along the E-N/S Ramp between about Station 18+600 and 18+925.

Slope stability assessments of the earth cut slopes at their deepest (along the E-N/S Ramp at about Station 18+815) have been carried out using GeoStudio 2020 Slope/W software for limit equilibrium analysis. Input parameters for the analysis are based on the SPT N values, shear

vane test results, and the results of laboratory testing. The following additional parameters were used in the analysis:

- Soil stratigraphy was based on the nearest boreholes.
- Maximum cut depth of 7.3 m along the E-N/S Ramp (Station 18+815) was considered.
- Cut slopes of 2H:1V were modelled.
- Mid-height 2m wide benches were used to provide adequate slope stability.
- A site-adjusted horizontal PGA value of 0.13 g, equal to ½ of the site-adjusted horizontal PGA value was used for the 2,475-year seismic analyses, as per Section 4.4.3.3 of the CHBDC and outlined in Sections 8.1 and 8.2 above.
- A traffic surcharge was not included in the analyses as there will be no traffic at the top of the cut slopes.

Copies of the output from the stability analyses are provided on the figures presented in Appendix I. Each output figure shows the slope geometry, groundwater conditions, soil stratigraphy and soil strength parameters utilized in the analysis. The stability analyses generated the following factor of safety values:

Table 10-11 Slope Stability Anaysis Results – E-N/S Ramp Cut (Sta. 18+815)

Condition	Case	Factor of Safety
		2H:1V
Permanent	Long Term (Drained)	1.5 (Fig I7.1)
Temporary	Short Term (Undrained)	2.6 (Fig I7.2)
Temporary (seismic loading)	Pseudo-Static (Undrained) 2,475-year	1.7 (Fig I7.3)

The results of all static design analyses (temporary and permanent conditions) presented above meet or exceed the target Factors of Safety. The result of the seismic analysis exceeds the target Factor of Safety for seismic design for the 2475-year seismic event.

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the embankments. Normally slope vegetation should be established as soon as possible after completion of embankment construction to control surficial erosion in general accordance with OPSS.PROV 804.

10.7 Cement Type and Corrosion Potential

Chemical analysis for determination of pH, water soluble sulphate, sulphides, chloride concentrations, resistivity and electrical conductivity was carried out on samples of the native silty clay soil. The analysis results are summarized in Section 5.9 and a copy of the test results is provided in Appendix C.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The test results provided in Section 5.9 were compared with Table 3.2 of the MTO Gravity Pipe Design Guideline and generally indicated a low to severe corrosive environment. The test results provided in Section 5.9 may be used to aid in the selection of coatings and corrosion protection systems for buried steel objects.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with the soil and groundwater at the site. The sulphate results in were compared with Table 3 of Canadian Standards Association Standards A23.1-19 (CSA A23.1) and indicate a low degree of sulphate attack potential on concrete structures at this site.

The corrosive effects of road de-icing salts should also be considered.

11 CONSTRUCTION CONSIDERATIONS

11.1 Temporary Excavations

All temporary excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of OHSA, existing fill or upper sand and silt present above the groundwater table and the native stiff silty clay to clayey silt may be classified as Type 3 soil. Existing fill or upper sand and silt 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.

Excavations for the pile caps for the pier and in the ramp cut sections required for the ramps must be carried out in accordance with OPSS.PROV 902 and will extend through the existing fill and/or upper sand and silt and into the underlying native silty clay deposit. Selection of the equipment and methodology to excavate and prepare the founding surface is the responsibility of the Contractor. Stockpiling or surface surcharge should not be allowed on the embankment or side slopes.

At locations where there are space restrictions or where a slope must be retained, the excavations will need to be carried out within a protection system. Further discussion on temporary protection systems (TPS) is presented in Section 11.2 below.

11.2 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 and designed for Performance Level 2. The actual 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. The protection system should be installed at a suitable distance away from the new structures to limit the disturbance to subgrade associated

with removal of the protection system following completing of construction. Alternatively, the protection system near the structures could be left in place and cut off in accordance with OPSS.PROV 903 to limit the disturbance of subgrade during removal of the TPS.

Lateral earth pressure coefficients, under fully mobilized conditions, that can be used in design for the structural backfill are provided in Table 10-5. The lateral earth pressure coefficients for the underlying native soils are given below for a vertical wall and a horizontal backslope:

Upper Sand and Silt:

γ = 20 (kN/m^3 bulk unit weight of soil, to be adjusted below water)
K_A = 0.33
K_P = 3.0

Native silty clay to clayey silt:

γ = 17 (kN/m^3 bulk unit weight of soil, to be adjusted below water)
K_A = 0.36
K_P = 2.8
S_u = 60 kPa

If the backslope behind, or if the ground surface in front of the temporary protection systems is not horizontal, the lateral earth pressure parameters provided above do not apply and recalculation of the earth pressure parameters will be required.

Based on the anticipated depth of excavation and subsurface conditions at the site, it is anticipated that a TPS consisting of steel sheet piles or soldier piles and lagging driven to depth within the native silty clay deposit are feasible.

The design of roadway protection is 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.

11.3 Surface and Groundwater Control

Foundation construction, subgrade preparation and placement and compaction of granular bedding must be carried out in the dry. At the proposed Bruce Street underpass, the natural groundwater level is within about three metres of the existing ground surface, at elevations ranging from about 148 m to 150 m. Depending on the groundwater level at the time of construction, the excavations required to construct the pier pile cap may be up to 2 to 3 m below this elevation.

Along the proposed E-N/S Ramp alignment, the groundwater level was measured to be at elevations ranging from about 150 m to 151.5 m at Borehole BRU19-29 (approximate Sta. 18+700). Based on the inference that the existing groundwater table currently slopes down

toward the north ditch of the existing Highway 17, excavations for the E-N/S Ramp will extend below the existing groundwater table but are not expected to require significant drawdown or alteration of the groundwater table.

It is noted that a Hydrogeological Investigation and Design Report is under preparation for the Highway 17 Twinning Project. Please refer to that document for additional discussion on groundwater impacts and dewatering with respect to this assignment.

For temporary excavations for pier foundation construction, groundwater may be controlled with sump pumps in the bottom of the excavation or may also require sheet piling or similar to further control groundwater infiltration into larger excavations. Surface runoff will also tend to seep into and accumulate into the excavations. The Contractor must control groundwater, perched groundwater, and surface water flow at the site to permit the construction of the pile cap 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 No. FOUN0003 which amends OPSS 902 and SP517F01 which amends OPSS.PROV 517. Given the site conditions and anticipated works, the Designer Fill-In ***** in SP517F01 Table A should be “No”; the design Engineer and design-checking Engineer do not need a minimum of 5 years of experience in designing similar dewatering systems. A preconstruction survey is not required, thus Designer Fill-In ** in this SP should be “NA”.

Further assessment of dewatering requirements and the need for a Permit to take Water (PTTW) should be carried out by specialists experienced in this field.

11.4 Erosion Control

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the earth and granular embankment slopes. A vegetation cover should be established on exposed earth surfaces to protect against surficial erosion in general accordance with OPSS.PROV 804. Slope vegetation should be established as soon as possible after completion of the embankment fills in order to limit surficial erosion.

Particle size analysis on samples of the existing soils indicate the following erodibility (based on Wischmeier Nomograph factor, K):

- Upper Sand and Silt 0.40 to 0.65 (Moderate to High Erodibility)
- Silty Clay to Clayey Silt 0.25 to 0.35 (Moderate Erodibility)

Effective erosion protection should be provided on all exposed slopes including underpass embankments and the slopes cut into native soil along the E-N/S and S-W Ramps.

12 DESIGN AND CONSTRUCTION CONCERNS

The recommendations presented herein must be reassessed once the type, location and orientation of the foundation elements are established to ensure suitability of the foundation given the variations in stratigraphy and bedrock elevation at the site.

The planned construction methodology includes open cut excavations for the construction of foundation elements at the pier, high fills for the construction of the approach embankments, and deep cuts for the proposed ramps. Potential construction concerns include, but are not necessarily limited to:

- 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.
- Control of groundwater during excavation for construction of the pier pile cap.
- Settlement of the approach embankments and ramps under the increased load from the high fills.
- Lightweight fill should be considered within the higher portions of the embankments to reduce the magnitude of settlement resulting from embankment construction.
- Pile driving at the abutments should be carried out following embankment construction.
- Refusal of the piles at various depths within the glacial till, resulting in variable pile lengths.
- Sloping bedrock at the site, which may result in variable pile lengths across the site where designed for end bearing on bedrock (wording for a suggested contract provision has been included in Appendix J).

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

13 CLOSURE

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

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Appendix A.

Borehole Location Plan and Stratigraphic Drawings

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
WP No 4068-09-00

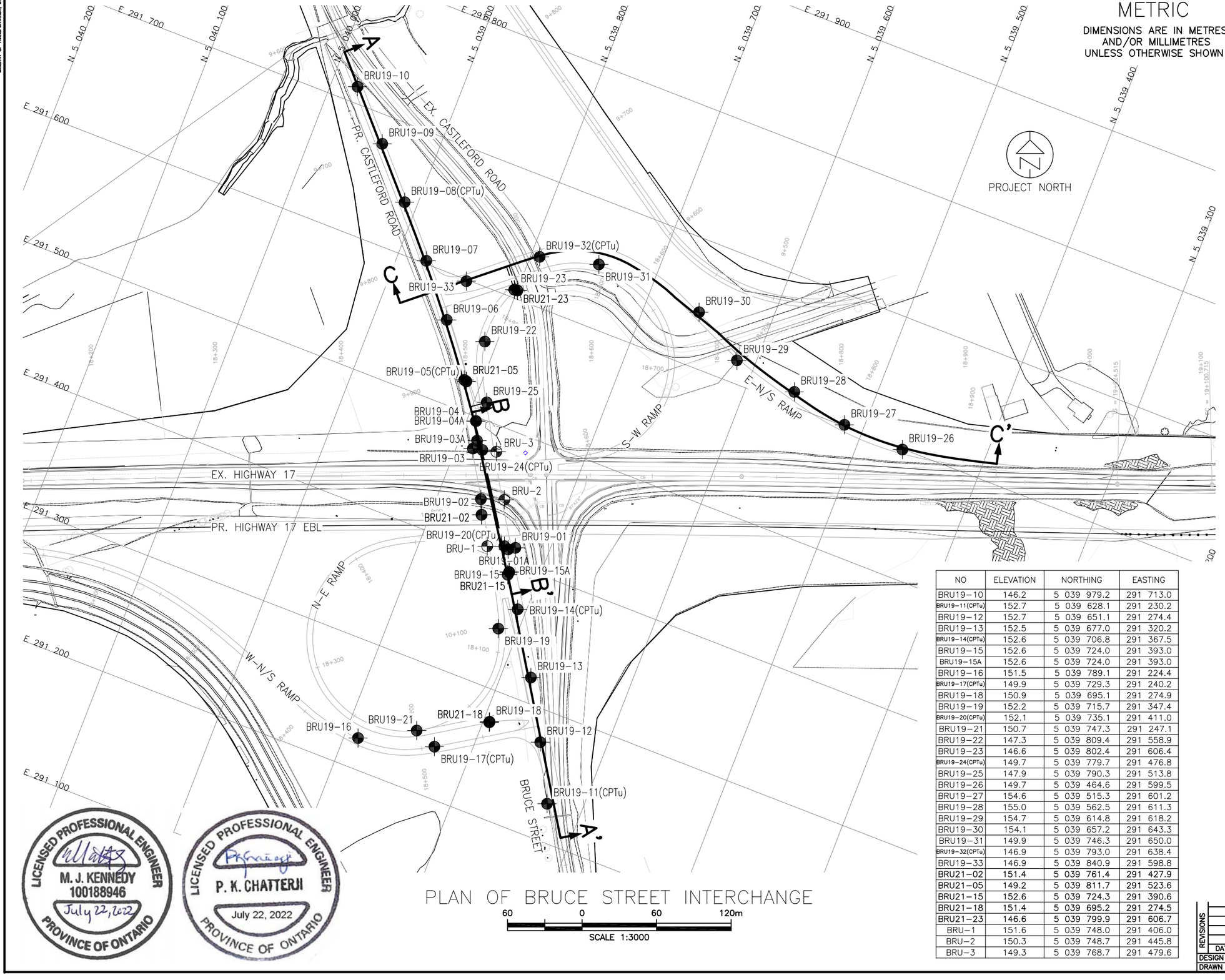
HIGHWAY 17 TWINNING
BRUCE STREET INTERCHANGE
BOREHOLE LOCATION PLAN

SHEET

Ontario

THURBER ENGINEERING LTD.

KEYPLAN



PLAN OF BRUCE STREET INTERCHANGE

60 0 60 120m

SCALE 1:3000

LEGEND

⊕	Borehole
⊕	Borehole (2003 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BRU19-10	146.2	5 039 979.2	291 713.0
BRU19-11(CPTu)	152.7	5 039 628.1	291 230.2
BRU19-12	152.7	5 039 651.1	291 274.4
BRU19-13	152.5	5 039 677.0	291 320.2
BRU19-14(CPTu)	152.6	5 039 706.8	291 367.5
BRU19-15	152.6	5 039 724.0	291 393.0
BRU19-15A	152.6	5 039 724.0	291 393.0
BRU19-16	151.5	5 039 789.1	291 224.4
BRU19-17(CPTu)	149.9	5 039 729.3	291 240.2
BRU19-18	150.9	5 039 695.1	291 274.9
BRU19-19	152.2	5 039 715.7	291 347.4
BRU19-20(CPTu)	152.1	5 039 735.1	291 411.0
BRU19-21	150.7	5 039 747.3	291 247.1
BRU19-22	147.3	5 039 809.4	291 558.9
BRU19-23	146.6	5 039 802.4	291 606.4
BRU19-24(CPTu)	149.7	5 039 779.7	291 476.8
BRU19-25	147.9	5 039 790.3	291 513.8
BRU19-26	149.7	5 039 464.6	291 599.5
BRU19-27	154.6	5 039 515.3	291 601.2
BRU19-28	155.0	5 039 562.5	291 611.3
BRU19-29	154.7	5 039 614.8	291 618.2
BRU19-30	154.1	5 039 657.2	291 643.3
BRU19-31	149.9	5 039 746.3	291 650.0
BRU19-32(CPTu)	146.9	5 039 793.0	291 638.4
BRU19-33	146.9	5 039 840.9	291 598.8
BRU21-02	151.4	5 039 761.4	291 427.9
BRU21-05	149.2	5 039 811.7	291 523.6
BRU21-15	152.6	5 039 724.3	291 390.6
BRU21-18	151.4	5 039 695.2	291 274.5
BRU21-23	146.6	5 039 799.9	291 606.7
BRU-1	151.6	5 039 748.0	291 406.0
BRU-2	150.3	5 039 748.7	291 445.8
BRU-3	149.3	5 039 768.7	291 479.6

NO	ELEVATION	NORTHING	EASTING
BRU19-01	151.2	5 039 726.4	291 413.0
BRU19-01A	152.2	5 039 731.4	291 409.7
BRU19-02	150.1	5 039 766.5	291 439.5
BRU19-03	149.8	5 039 787.2	291 475.1
BRU19-03A	149.9	5 039 786.4	291 482.2
BRU19-04	149.8	5 039 792.9	291 496.6
BRU19-04A	149.8	5 039 792.9	291 496.6
BRU19-05(CPTu)	149.0	5 039 813.7	291 524.1
BRU19-06	148.5	5 039 844.3	291 564.0
BRU19-07	148.1	5 039 876.9	291 602.4
BRU19-08(CPTu)	147.4	5 039 910.2	291 640.1
BRU19-09	146.9	5 039 944.0	291 677.4

-NOTES-

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

GEOCRES No. 31F-234

LICENSED PROFESSIONAL ENGINEER
M. J. KENNEDY
100188946
July 22, 2022
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
July 22, 2022
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MJK	CHK –	CODE	LOAD	DATE JUL 2022
DRAWN	MFA	CHK MJK	SITE	STRUCT	DWG 1

FILENAME: H:\Drafting\24000\24726\TED-24726-BHPP-BRU.dwg
PLOTDATE: 7/21/2022 11:17 AM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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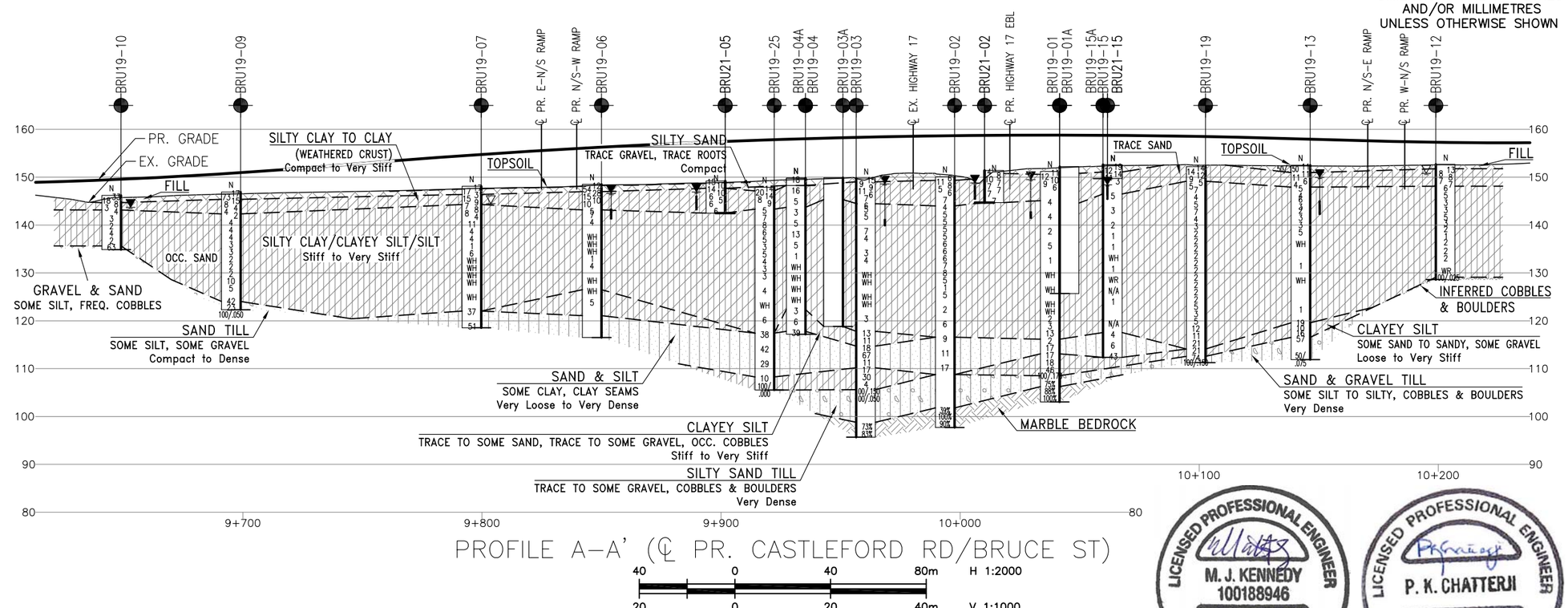

PROFILE A–A' (℄ PR. CASTLEFORD RD/BRUCE ST)

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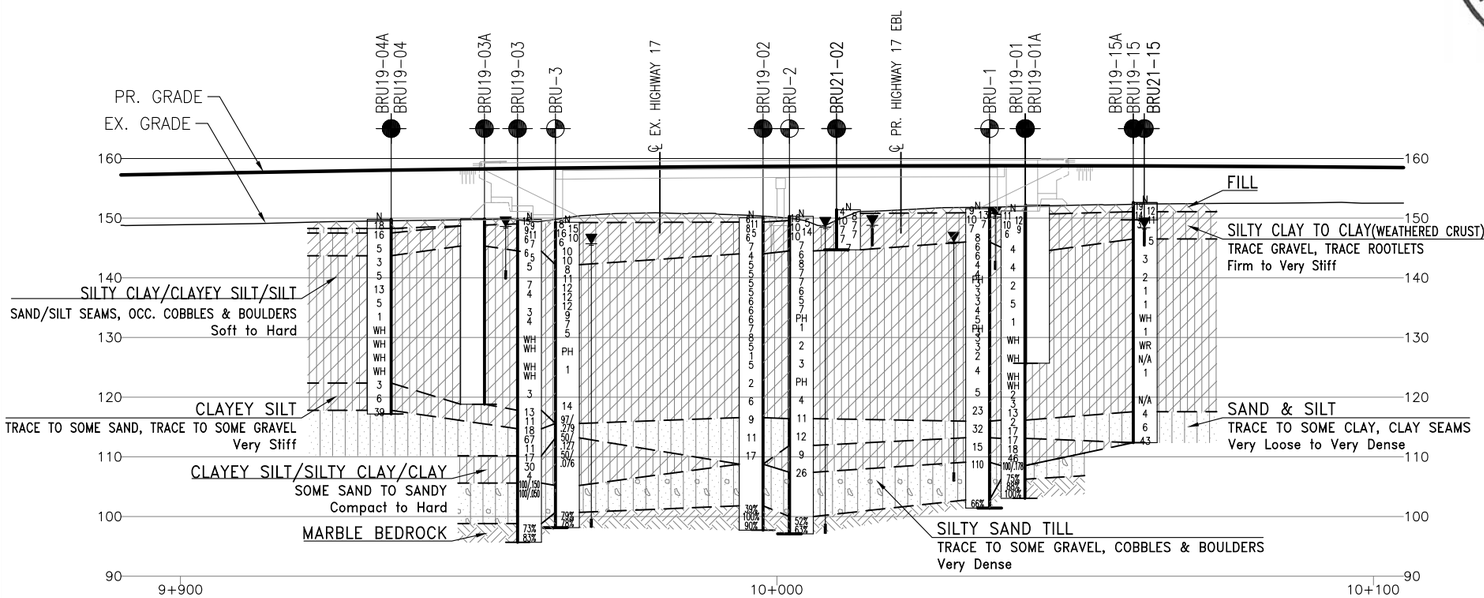
20 0 20 40m V 1:1000



PROFILE B–B' (℄ PR. CASTLEFORD RD/BRUCE ST)

20 0 20 40m H 1:1000

20 0 20 40m V 1:1000

NO	ELEVATION	NORTHING	EASTING
BRU19–10	146.2	5 039 979.2	291 713.0
BRU19–11(CPTu)	152.7	5 039 628.1	291 230.2
BRU19–12	152.7	5 039 651.1	291 274.4
BRU19–13	152.5	5 039 677.0	291 320.2
BRU19–14(CPTu)	152.6	5 039 706.8	291 367.5
BRU19–15	152.6	5 039 724.0	291 393.0
BRU19–15A	152.6	5 039 724.0	291 393.0
BRU19–16	151.5	5 039 789.1	291 224.4
BRU19–17(CPTu)	149.9	5 039 729.3	291 240.2
BRU19–18	150.9	5 039 695.1	291 274.9
BRU19–19	152.2	5 039 715.7	291 347.4
BRU19–20(CPTu)	152.1	5 039 735.1	291 411.0
BRU19–21	150.7	5 039 747.3	291 247.1
BRU19–22	147.3	5 039 809.4	291 558.9
BRU19–23	146.6	5 039 802.4	291 606.4
BRU19–24(CPTu)	149.7	5 039 779.7	291 476.8
BRU19–25	147.9	5 039 790.3	291 513.8
BRU19–26	149.7	5 039 464.6	291 599.5
BRU19–27	154.6	5 039 515.3	291 601.2
BRU19–28	155.0	5 039 562.5	291 611.3
BRU19–29	154.7	5 039 614.8	291 618.2
BRU19–30	154.1	5 039 657.2	291 643.3
BRU19–31	149.9	5 039 746.3	291 650.0
BRU19–32(CPTu)	146.9	5 039 793.0	291 638.4
BRU19–33	146.9	5 039 840.9	291 598.8
BRU21–02	151.4	5 039 761.4	291 427.9
BRU21–05	149.2	5 039 811.7	291 523.6
BRU21–15	152.6	5 039 724.3	291 390.6
BRU21–18	151.4	5 039 695.2	291 274.5
BRU21–23	146.6	5 039 799.9	291 606.7
BRU–1	151.6	5 039 748.0	291 406.0
BRU–2	150.3	5 039 748.7	291 445.8
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WP No 4068–09–00

HIGHWAY 17 TWINNING
BRUCE STREET
INTERCHANGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Ontario

THURBER ENGINEERING LTD.

KEYPLAN

LEGEND

●	Borehole
⊕	Borehole (2003 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
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BRU19–01A	152.2	5 039 731.4	291 409.7
BRU19–02	150.1	5 039 766.5	291 439.5
BRU19–03	149.8	5 039 787.2	291 475.1
BRU19–03A	149.9	5 039 786.4	291 482.2
BRU19–04	149.8	5 039 792.9	291 496.6
BRU19–04A	149.8	5 039 792.9	291 496.6
BRU19–05(CPTu)	149.0	5 039 813.7	291 524.1
BRU19–06	148.5	5 039 844.3	291 564.0
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BRU19–08(CPTu)	147.4	5 039 910.2	291 640.1
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GEOCRES No. 31F-234

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MJK	CHK –	CODE		LOAD	DATE	JUL 2022
DRAWN	MFA	CHK MJK	SITE		STRUCT	DWG	2

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PLOTDATE: 7/21/2022 11:19 AM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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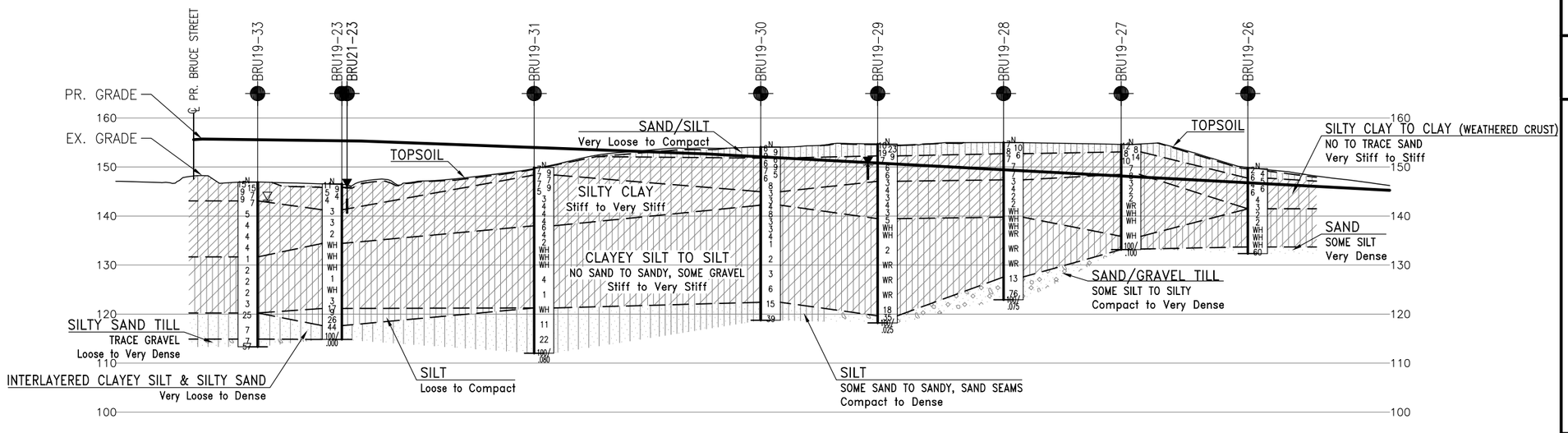

PROFILE C–C' (℄ PROPOSED E–N/S RAMP)

40 0 40 80m H 1:2000

20 0 20 40m V 1:1000

NO	ELEVATION	NORTHING	EASTING
BRU19–10	146.2	5 039 979.2	291 713.0
BRU19–11(CPTu)	152.7	5 039 628.1	291 230.2
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CONT No
WP No 4068–09–00

HIGHWAY 17 TWINNING
BRUCE STREET
INTERCHANGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Ontario

THURBER ENGINEERING LTD.

KEYPLAN

LEGEND

●	Borehole
⊕	Borehole (2003 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
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▼	Head Artesian Water
	Piezometer
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GEOCRES No. 31F-234

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MJK	CHK –	CODE	LOAD	DATE JUL 2022
DRAWN	MFA	CHK MJK	SITE	STRUCT	DWG 3

FILENAME: H:\Drafting\24000\24726\TED-24726-BHPP-BRU.dwg
PLOTDATE: 7/21/2022 11:19 AM

THURBER

Appendix B.

Record of Test Hole Sheets

THURBER

Appendix B.1

Current (2019/2020/2021) Investigation

THURBER

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:

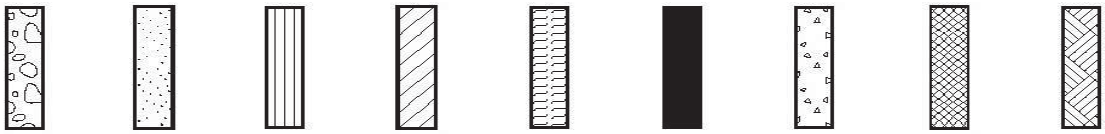
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented,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

THURBER

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

THURBER

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

THURBER

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-01 1 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497332°, Long: -76.671291° Bruce Street MTM Zone 9: N 5 039 726.4 E 291 413.0 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA, NW Casing, NQ Coring COMPILED BY MW

DATUM Geodetic DATE 2019.10.07 - 2019.10.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
151.2	**Ground Surface**											
0.0	Sandy SILT (ML), trace roots Compact Brown		1	SS	11		151					
150.6	**(FILL)**											
0.6	**CLAY (CH) to SILTY CLAY (CI)** Very Stiff Brown **(WEATHERED CRUST)**		2	SS	12		150					0 2 38 60
			3	SS	10	▽	149					
			4	SS	9		148					
			5	SS	6		147		+			0 0 41 59
			6	ST	-		146		+			
145.1							145		+			
6.1	**CLAYEY SILT (CL)** Stiff to Very Stiff Grey		7	SS	4		144		+			
			8	ST	-		143		+			
			9	SS	4		142		+			0 0 53 47

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-01 2 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497332°, Long: -76.671291° Bruce Street MTM Zone 9: N 5 039 726.4 E 291 413.0 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA, NW Casing, NQ Coring COMPILED BY MW

DATUM Geodetic DATE 2019.10.07 - 2019.10.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL) Stiff to Very Stiff Grey						141				
			10	ST	-		140				
			11	SS	2		139				
			12	ST	-		138				
			13	SS	5		137				
			14	ST	-		136				
133.2							135				
18.0	**CLAYEY SILT (CL)** to **SILT (ML)** Stiff to Very Stiff Grey						134				
			15	SS	1		133			NP	0 0 56 44
							132				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-01 3 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497332°, Long: -76.671291° Bruce Street MTM Zone 9: N 5 039 726.4 E 291 413.0 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA, NW Casing, NQ Coring COMPILED BY MW

DATUM Geodetic DATE 2019.10.07 - 2019.10.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL) to **SILT (ML)** Stiff to Very Stiff Grey		16	ST	-		131				
								3.2			
			17	SS	WH		130				
							129	4.3			
			18	ST	-		128				
			19	SS	WH		127				
			20	ST	-		126				
			21	SS	WH		125				
			22	SS	WH		124				
							123				
							122				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-01 4 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497332°, Long: -76.671291° Bruce Street MTM Zone 9: N 5 039 726.4 E 291 413.0 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA, NW Casing, NQ Coring COMPILED BY MW

DATUM Geodetic DATE 2019.10.07 - 2019.10.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	CLAYEY SILT (CL) to **SILT (ML)** Stiff to Very Stiff Grey						121				
			23	SS	2					NP	0 4 53 43
							120				
			24	SS	3		119				
							118				
			25	SS	13						
116.1							117				
35.1	Sandy **SILT (ML)** Very loose to Compact Grey		26	SS	2		116				
							115				
			27	SS	17					NP	0 36 50 14
113.1							114				
38.1	Sandy **CLAYEY SILT (CL-ML)** Compact to Dense Grey		28	SS	17		113				
							112				
			29	SS	18						1 33 46 20

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-01 5 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497332°, Long: -76.671291° Bruce Street MTM Zone 9: N 5 039 726.4 E 291 413.0 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA, NW Casing, NQ Coring COMPILED BY MW

DATUM Geodetic DATE 2019.10.07 - 2019.10.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy **CLAYEY SILT (CL-ML)** Compact to Dense Grey						111				
							110		○		
			30	SS	46						
108.5							109				
42.7	**SILTY SAND**, trace gravel Occasional cobbles Very Dense Black and Grey **(TILL)**		31	SS	100/ 178mm		108		○		
			32	NQ							
	- 300mm diameter boulder encountered at 43.8 m depth.		33	NQ			107		○		3 70 27 (SI+CL)
106.2										FI	RUN #1 TCR=100% SCR=63% RQD=75%
45.0	**MARBLE BEDROCK** Strong, slightly weathered to fresh jointed, grey and white		1	RUN			106			2 0	
			2	RUN						0 0	RUN #2 TCR=100% SCR=93% RQD=88% UCS=47MPa
							105			3 6	
			3	RUN			104			0 0 0	RUN #3 TCR=100% SCR=100% RQD=100%
103.0										0 1	
48.2	**End of Borehole** Piezometer consists of 19 mm diameter Schedule 40 PVC pipe with a 1.5 m slotted screen **WATER LEVEL READINGS:** DATE DEPTH (m) ELEV. (m) 2019.11.26 2.1 149.1 2020.04.21 1.3 149.9 2020.12.15 1.3 149.9 2021.08.04 1.7 149.5 2021.12.22 1.4 149.8 2022.01.11 1.8 149.4										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-01A 1 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497377°, Long: -76.671333° Bruce Street MTM Zone 9: N 5 039 731.4 E 291 409.7 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.12.02 - 2020.12.03 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
152.2								20 40 60 80 100	20 40 60		
0.0	See borehole BRU19-01 for Stratigraphy.						152				
							151				
							150				
							149				
147.6							148				
4.6	**SILTY CLAY (CI)** Stiff to Very Stiff Grey **(WEATHERED CRUST)**		1	ST	-						0 0 41 59
							147				
							146				
144.6							145				
7.6	**CLAYEY SILT (CL)** Stiff to Very Stiff		2	ST	-						
							144				
							143				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-01A 2 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497377°, Long: -76.671333° Bruce Street MTM Zone 9: N 5 039 731.4 E 291 409.7 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.12.02 - 2020.12.03 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL) Stiff to Very Stiff						142				
							141				
			3	ST	-				○		
							140				
							139				
							138				
			4	ST	-						
							137				
							136				
134.8							135				
17.4	**CLAYEY SILT (CL)** to **SILT (ML)** Stiff to Very Stiff		5	ST	-				○	NP	0 1 58 41
							134				
							133				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-01A 3 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497377°, Long: -76.671333° Bruce Street MTM Zone 9: N 5 039 731.4 E 291 409.7 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.12.02 - 2020.12.03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL) to **SILT (ML)** Stiff to Very Stiff		6	ST	-		132				
							131				
							130				
			7	ST	-		129				0 1 56 43
							128				
							127				
125.7			8	ST	-		126				
26.5	**End of Borehole**										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-02 1 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497693°, Long: -76.670952° Bruce Street MTM Zone 9: N 5 039 766.5 E 291 439.5 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0' to 5'), NW (5' to 135'7"), NQ COMPILED BY MW

DATUM Geodetic DATE 2019.10.15 - 2019.10.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
150.1	**Ground Surface**										
0.0	Silty SAND , some gravel, trace roots Loose Brown **(FILL)**		1	SS	6						
149.3											
0.8	**CLAY (CH)** Very Stiff Brown **(WEATHERED CRUST)**		2	SS	11						
			3	SS	8						
			4	SS	5						0 0 44 56
			5	SS	6						
			6	SS	7						
144.0											
6.1	**SILTY CLAY (CI)** Very Stiff Grey		7	SS	4						
			8	SS	5						
			9	SS	5						

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-02 2 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497693°, Long: -76.670952° Bruce Street MTM Zone 9: N 5 039 766.5 E 291 439.5 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0' to 5'), NW (5' to 135'7"), NQ COMPILED BY MW

DATUM Geodetic DATE 2019.10.15 - 2019.10.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAY (CI) Very Stiff Grey						140				
			10	SS	5		139				
			11	SS	5		138				0 0 50 50
			12	SS	6		137				
			13	SS	6		136				
133.3							135				0 0 55 45
16.8	**CLAYEY SILT (CL-ML)** Very Stiff Grey		14	SS	6		134				
			15	SS	7		133				
							132				
							131				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-02 3 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497693°, Long: -76.670952° Bruce Street MTM Zone 9: N 5 039 766.5 E 291 439.5 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0' to 5'), NW (5' to 135'7"), NQ COMPILED BY MW

DATUM Geodetic DATE 2019.10.15 - 2019.10.18 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	γ kN/m^3	GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL-ML) Very Stiff Grey		16	SS	8		130				
							129				
			17	SS	5						
							128				
			18	SS	1		127				
							126				
			19	SS	5						
							125				
							124				
							123				
			20	SS	2						
							122				
							121				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-02 4 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497693°, Long: -76.670952° Bruce Street MTM Zone 9: N 5 039 766.5 E 291 439.5 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0' to 5'), NW (5' to 135'7"), NQ COMPILED BY MW

DATUM Geodetic DATE 2019.10.15 - 2019.10.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	CLAYEY SILT (CL-ML) Very Stiff Grey						120				
			21	SS	6						0 4 60 36
							119				
							118				
116.6							117				
33.5	**SAND** and **SILT (SM)** , some clay Loose Grey		22	SS	9					NP	0 37 45 18
							116				
							115				
113.5							114				
36.6	Silty **SAND (SM)** Compact Grey		23	SS	11						
							113				
							112				
			24	SS	17		111				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-02 5 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497693°, Long: -76.670952° Bruce Street MTM Zone 9: N 5 039 766.5 E 291 439.5 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0' to 5'), NW (5' to 135'7"), NQ COMPILED BY MW

DATUM Geodetic DATE 2019.10.15 - 2019.10.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND (SM)** Compact Grey						110				
108.8							109				
41.3	Silty **SAND (SM)** ,trace to some gravel Occasional cobbles and boulders Very Dense Grey and Black **(TILL)**		25	NQ	-		108		○		
			26	NQ	-		107				7 70 23 (SI+CL)
			27	NQ	-		106		○		
	- increasing amounts of gravel		28	NQ	-		105				
			29	NQ	-		104		○		
101.8							103				20 57 23 (SI+CL)
48.3	**MARBLE BEDROCK** Strong, moderately to slightly weathered, grey and white - highly fractured with some vertical fractures from 48.3 m to 49.4 m		1	RUN			102		○	FI 1 6 >10	RUN #1 TCR=100% SCR=29% RQD=39%
	- silt seams at 49.5 m and 49.6 m						101			>10 2 1	

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-02 6 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497693°, Long: -76.670952° Bruce Street MTM Zone 9: N 5 039 766.5 E 291 439.5 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0' to 5'), NW (5' to 135'7"), NQ COMPILED BY MW

DATUM Geodetic DATE 2019.10.15 - 2019.10.18 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	MARBLE BEDROCK Strong, moderately to slightly weathered, grey and white		2	RUN			100			2	RUN #2 TCR=100% SCR=85% RQD=100% UCS=42MPa
										1	
										1	
							99			1	
			3	RUN						1	RUN #3 TCR=100% SCR=80% RQD=90%
										1	
97.7							98			1	
52.4	**End of Borehole**										

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03 1 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497881°, Long: -76.670497° Bruce Street MTM Zone 9: N 5 039 787.2 E 291 475.1 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-167'4"), NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.27 - 2019.10.04 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.8	**Ground Surface**										
0.0	Silty SAND, trace roots Compact Brown **(FILL)**		1	SS	15						
149.0							149				
0.8	**SILTY CLAY (CI)** Very Stiff Brown **(WEATHERED CRUST)**		2	SS	9	▽					
			3	SS	9		148				
			4	SS	11		147				
			5	SS	6		146				
			6	SS	7		145				0 0 44 56
			7	ST	-						
144.5							144				
5.3	**SILTY CLAY (CI)** to **SILT (ML)** Stiff to Very Stiff Grey		8	SS	6						
			9	SS	5		143	+ +			0 0 51 49
			10	SS	5		142	+			
			11	ST	-		141	+			
							140				

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03 2 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497881°, Long: -76.670497° Bruce Street MTM Zone 9: N 5 039 787.2 E 291 475.1 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-167'4"), NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.27 - 2019.10.04 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **SILT (ML)** Stiff to Very Stiff Grey						139				
			12	SS	7		138				
			13	SS	4		137				
			14	ST	-		136				
			15	SS	3		135				
			16	SS	4		134				
			17	ST	-		133				
							132				
							131				
							130				

6 6
9 2
>10
8.0
10.0

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03 3 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497881°, Long: -76.670497° Bruce Street MTM Zone 9: N 5 039 787.2 E 291 475.1 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-167'4"), NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.27 - 2019.10.04 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	SILTY CLAY (CI) to **SILT (ML)** Stiff to Very Stiff Grey		18	SS	WH		129	3.1			
								3.1			
			19	SS	WH		128		H ○		0 7 62 31
								+			
							127	+			
			20	ST	-						
							126	8.0			
								4.9			
			21	SS	WH		125		○		
								+			
							124	+			
			22	SS	WH						
							123	+			
								7.7			
			23	ST	-		122				
								+			
							121	+			
			24	SS	3				○		
119.9 29.9							120				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20
15 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03 4 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497881°, Long: -76.670497° Bruce Street MTM Zone 9: N 5 039 787.2 E 291 475.1 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-167'4"), NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.27 - 2019.10.04 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **SILT (ML)** Stiff to Very Stiff Grey										
			25	ST	-		119				
			26	ST	-		118				
117.8											
32.0	**CLAYEY SILT (CL-ML)** , some sand Trace to some gravel Very Stiff Grey		27	SS	13		117		H ○		2 18 55 25
			28	SS	11		116		○		
114.7							115		○		
35.1	Silty **SAND**, contains clay seams Compact to Very Dense Grey		29	SS	18		114				
			30	SS	67		113		○		
			31	SS	11		112		○		0 63 37 (SI+CL)
110.2							111				
39.6	**CLAYEY SILT (CL)** , some sand		32	SS	17		110		○		

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03 5 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497881°, Long: -76.670497° Bruce Street MTM Zone 9: N 5 039 787.2 E 291 475.1 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-167'4"), NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.27 - 2019.10.04 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Clayey **SILT (CL)** , with sand Very Stiff Grey						109				
			33	SS	30		108		○		
							107				
			34	SS	4				⊢●		0 20 45 35
105.6							106				
44.2	Silty **SAND (SM)** , trace to some gravel Frequent Cobbles and Boulders Very Dense Grey **(TILL)**		35	SS	100/ 150 mm		105				
			36	SS	100/ 50 mm		104				
	- 180mm cobble at depth. 47.7 m		37	NQ	-		103				
			38	NQ	-		102		○		3 63 34 (SI+CL)
							101				
							100				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03 6 OF 6 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497881°, Long: -76.670497° Bruce Street MTM Zone 9: N 5 039 787.2 E 291 475.1 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-167'4"), NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.27 - 2019.10.04 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	WATER CONTENT (%) (PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND (SM)** , trace to some gravel Frequent Cobbles and Boulders Very Dense Grey **(TILL)**		39	NQ	-				o		
98.8							99			FI	
51.0	**MARBLE BEDROCK** Moderately Weathered Coarse Grain Grey, Black, White, and Red		1	RUN			98			2 6 >10 3 2 2	RUN #1 TCR=100% SCR=37% RQD=73%
	- Silt Seam at 53.4 m		2	RUN			97			4 2 >10 >10	RUN #2 TCR=100% SCR=65% RQD=83% UCS=70MPa
95.7	- Silt Seam at 54.0 m						96			3	
54.1	**End of Borehole** Piezometer consists of 19 mm diameter Schedule 40 PVC pipe with a 1.5 m slotted screen **WATER LEVEL READINGS:** DATE DEPTH (m) ELEV. (m) 2019.11.26 1.3 148.4 2020.04.21 -0.2 149.9 2020.12.15 0.8 148.9 2021.08.04 1.2 148.5 2021.12.22 0.8 148.9 2022.01.11 1.5 148.2 2022.01.18 1.5 148.2										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03A 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497873°, Long: -76.670407° Bruce Street MTM Zone 9: N 5 039 786.4 E 291 482.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.12.03 - 2020.12.03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT w_P w w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			GR SA SI CL
149.9											
0.0							149				
							148				
							147				
							146				
145.3											
4.6	**SILTY CLAY (CI)** to **SILT (ML)** Stiff to Very stiff Grey		1	ST	-		145				
							144				
							143				
							142				
							141				
			2	ST	-		140				

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03A 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497873°, Long: -76.670407° Bruce Street MTM Zone 9: N 5 039 786.4 E 291 482.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.12.03 - 2020.12.03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT w_P w w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100			GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **SILT (ML)** Stiff to Very stiff Grey						139 138 137 136 135 134 133 132 131 130				
			3	ST	-					NP	0 1 48 51
			4	ST	-						
			5	ST	-						

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03A 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497873°, Long: -76.670407° Bruce Street MTM Zone 9: N 5 039 786.4 E 291 482.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.12.03 - 2020.12.03 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	SILTY CLAY (CI) to **SILT (ML)** Stiff to Very stiff Grey						129				
							128				
			6	ST	-		127		○	NP	
							126				
							125				
							124				
							123				
			7	ST	-		122				
							121				
							120				

Continued Next Page

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

20
15 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-03A 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497873°, Long: -76.670407° Bruce Street MTM Zone 9: N 5 039 786.4 E 291 482.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.12.03 - 2020.12.03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SILTY CLAY (CI) to **SILT (ML)** Stiff to Very stiff Grey										
			8	ST	-		119				
118.8											
31.1	**End of Borehole**										

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-04 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497932°, Long: -76.670223° Bruce Street MTM Zone 9: N 5 039 792.9 E 291 496.6 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW Casing COMPILED BY MW

DATUM Geodetic DATE 2019.09.20 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.8	**Ground Surface**										
0.0	**SAND**, some silt, trace gravel Compact Brown **(FILL)**		1	SS	18		149		○		6 86 8 (SI+CL)
148.3											
1.5	**End of Borehole** See BRU19-04A for continuation of log										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-04A 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497932°, Long: -76.670223° Bruce Street MTM Zone 9: N 5 039 792.9 E 291 496.6 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW Casing COMPILED BY JP

DATUM Geodetic DATE 2019.09.20 - 2019.09.24 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.8	**Ground Surface**										
0.0	See Borehole BRU19-04 for stratigraphy										
147.5											
2.3	**SILTY CLAY (CI)** Very Stiff Brown **(WEATHERED CRUST)**		1	SS	16						
			2	SS	5						0 0 46 54
143.7											
6.1	**SILTY CLAY (CI)** to **CLAYEY SILT (CL-ML)** Very stiff Brown		3	SS	3						
			4	SS	5						0 0 50 50

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-04A 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497932°, Long: -76.670223° Bruce Street MTM Zone 9: N 5 039 792.9 E 291 496.6 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW Casing COMPILED BY JP

DATUM Geodetic DATE 2019.09.20 - 2019.09.24 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **CLAYEY SILT (CL-ML)** Very stiff Brown						139				
			5	SS	13		138				
							137				
			6	SS	5		136				
							135				
133.8							134				
16.0	**CLAYEY SILT (CL to CL-ML)** Stiff to very stiff Grey		7	SS	1		133	6.6			
							132	7.0			
			8	SS	WH		131	5.6 5.5			0 2 63 35
							130	4.3			

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-04A 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497932°, Long: -76.670223° Bruce Street MTM Zone 9: N 5 039 792.9 E 291 496.6 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW Casing COMPILED BY JP

DATUM Geodetic DATE 2019.09.20 - 2019.09.24 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (UNCONFINED, QUICK TRIAXIAL, FIELD VANE, LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL to CL-ML) Stiff to very stiff Grey										
			9	SS	WH		129				
							128				
							127				
			10	SS	WH		126				
							125				
			11	SS	WH		124				
							123				
122.4											
27.4	**CLAYEY SILT (CL-ML)** , trace sand Very Stiff Grey		12	SS	3		122				
							121				
							120				

Continued Next Page

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

(%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-04A 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497932°, Long: -76.670223° Bruce Street MTM Zone 9: N 5 039 792.9 E 291 496.6 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW Casing COMPILED BY JP

DATUM Geodetic DATE 2019.09.20 - 2019.09.24 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL-ML) , trace sand Very Stiff Grey		13	SS	6		119				0 7 61 32
117.8							118				
32.0	**SAND** and **SILT (SM)** Dense Grey		14	SS	39				H ○		0 43 39 18
117.2											
32.6	**End of Borehole**										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-06 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498396°, Long: -76.669361° Bruce Street MTM Zone 9: N 5 039 844.3 E 291 564.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount COMPILED BY JP

DATUM Geodetic DATE 2019.09.24 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
148.5	**Ground Surface**										
0.0 / 0.1	**50mm TOPSOIL**										
	Silty gravelly **SAND (SM)** Compact to Very Dense Light Brown **(FILL)**		1	SS	12		148		○		
			2	SS	54				○		22 48 30 (SI+CL)
147.0							147				
1.5	**SILTY CLAY (CI/CH)** Very Stiff Brown **(WEATHERED CRUST)**		3	SS	28	▽			○		
			4	SS	15		146		○		
			5	SS	10		145		⊢○⊣		0 1 44 55
			6	SS	10		144		○		
143.2											
5.3	**SILTY CLAY (CI)** to **CLAYEY SILT (CL)** Stiff to Very Stiff Grey		7	SS	5		143		○		
			8	SS	7		142		○		
								+			
			9	SS	4		141		○		
							140	+			
			1	ST	-		139				

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-06 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498396°, Long: -76.669361° Bruce Street MTM Zone 9: N 5 039 844.3 E 291 564.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount COMPILED BY JP

DATUM Geodetic DATE 2019.09.24 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **CLAYEY SILT (CL)** Stiff to Very Stiff Grey							5.3			
			10	SS	WH		138				0 0 50 50
								5.1			
							137				
			11	SS	WH		136				
								>10			
							135				
			12	SS	WH						
							134				
			13	SS	1		133				
			14	SS	4		132				
							131	5.3			
			2	ST	-		130				
								3.1			
128.7							129				
19.8											

Continued Next Page

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-06 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498396°, Long: -76.669361° Bruce Street MTM Zone 9: N 5 039 844.3 E 291 564.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount COMPILED BY JP

DATUM Geodetic DATE 2019.09.24 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **CLAYEY SILT (CL)** Stiff to Very Stiff Grey		15	SS	WH		128				0 3 61 36
126.5							127	4,2			
22.0	**CLAYEY SILT (CL-ML)** , some sand Stiff to Very Stiff Grey Occasional Cobbles		16	SS	WH		126	2,5 5,8			0 19 60 21
			17	SS	5		125				
							124				
							123				
121.1							122				
27.4	Inferred Silty Sand		3	ST	-		121				
							120				
							119				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-06 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498396°, Long: -76.669361° Bruce Street MTM Zone 9: N 5 039 844.3 E 291 564.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount COMPILED BY JP

DATUM Geodetic DATE 2019.09.24 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	Inferred Silty Sand						118				
			18	SS	-						
							117				
116.5			19	SS							
32.0	**End of Borehole** Piezometer consists of 19 mm diameter Schedule 40 PVC pipe with a 1.5 m slotted screen **WATER LEVEL READINGS:** DATE DEPTH (m) ELEV. (m) 2019.11.26 1.9 146.6 2020.04.21 1.9 146.7 2020.12.15 1.8 146.7 2021.08.04 2.0 146.5 2021.12.22 1.8 146.7 2022.01.11 2.1 146.4 2022.01.18 2.1 146.4										

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-07 1 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498689°, Long: -76.668871° Bruce Street MTM Zone 9: N 5 039 876.9 E 291 602.4 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount COMPILED BY JP

DATUM Geodetic DATE 2019.09.26 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
148.1	Ground Surface										
0.0 / 0.1	**50mm TOPSOIL**						148				
	SAND, trace silt Compact Light to Dark Brown **(FILL)**		1	SS	17						6 86 8 (SI+CL)
			2	SS	17		147				
146.4											
1.7	**SILTY CLAY (CI/CH)** Compact Dark Brown **(WEATHERED CRUST)**		3	SS	31		146				
			4	SS	15						1 8 40 51
			5	SS	9	▼	145				
144.3											
3.8	**SILTY CLAY (CI)** to **CLAYEY SILT (CL)** Stiff to Very Stiff Grey		6	SS	7		144				
			7	SS	8		143				
			8	SS	8						
			9	SS	4		142				0 0 52 48
			10	SS	11		141				
			11	SS	4		140				
							139				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-07 2 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498689°, Long: -76.668871° Bruce Street MTM Zone 9: N 5 039 876.9 E 291 602.4 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount COMPILED BY JP

DATUM Geodetic DATE 2019.09.26 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **CLAYEY SILT (CL)** Stiff to Very Stiff Grey						138				
			12	SS	4		137				
			13	SS	1		136				
			14	SS	6		135				0 4 52 44
			15	SS	WH		134	3.3			
			16	SS	WH		133	7.3, 4.4			
			17	SS	WH		132	6.0, 4.3			
							131	6.0, 4.3			
							130				
							129				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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Ontario

THURBER

RECORD OF BOREHOLE No BRU19-07 3 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498689°, Long: -76.668871° Bruce Street MTM Zone 9: N 5 039 876.9 E 291 602.4 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount COMPILED BY JP

DATUM Geodetic DATE 2019.09.26 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **CLAYEY SILT (CL)** Stiff to Very Stiff Grey		18	SS	WH		128				
							127				
							126				
			19	SS	WH		125				
							124				
122.0							123				
26.1	Silty **SAND (SM)** Dense to very dense Grey		20	SS	37		122			NP	0 69 20 11
							121				
							120				
118.5			21	SS	51		119				
29.6	**End of Borehole**										

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-09 1 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.499294°, Long: -76.667913° Bruce Street MTM Zone 9: N 5 039 944.0 E 291 677.4 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-80'8") COMPILED BY JP

DATUM Geodetic DATE 2019.09.26 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
146.9	**Ground Surface**										
0.0	Gravelly **SAND (SM)** Compact to Very Dense Brown **(FILL)**		1	SS	17						
			2	SS	73		146				27 58 15 (SI+CL)
145.4											
1.5	**SILTY CLAY (CI)** Very Stiff Brown **(WEATHERED CRUST)**		3	SS	15		145				
			4	SS	8						
			5	SS	4		144				0 1 48 51
			6	SS	4		143				
142.3											
4.6	**SILTY CLAY (CI)** to **CLAYEY SILT (CL-ML)**, occasional silt seams Very Stiff Grey		7	SS	2		142				
			8	SS	4		141				
			9	SS	4		140				
			10	SS	4		139				0 0 54 46
							138				
							137				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-09 2 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.499294°, Long: -76.667913° Bruce Street MTM Zone 9: N 5 039 944.0 E 291 677.4 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-80'8") COMPILED BY JP

DATUM Geodetic DATE 2019.09.26 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **CLAYEY SILT (CL-ML)**, occasional silt seams Very Stiff Grey		11	SS	3		136				
			12	SS	3		135				
			13	SS	2		134				
			14	SS	2		133				
			15	SS	2		132				0 4 63 33
			16	SS	10		131				
							130				
							129				
							128				
							127				

Continued Next Page

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

(%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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Ontario

THURBER

RECORD OF BOREHOLE No BRU19-09 3 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.499294°, Long: -76.667913° Bruce Street MTM Zone 9: N 5 039 944.0 E 291 677.4 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-80'8") COMPILED BY JP

DATUM Geodetic DATE 2019.09.26 - 2019.09.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	SILTY CLAY (CI) to **CLAYEY SILT (CL-ML)**, occasional silt seams Very Stiff Grey		17	SS	5		126 125		○		
124.0											
22.9	**SAND**, some silt, some gravel Compact to Dense Grey **(TILL)**		18	SS	42		124		○		
			19	SS	23		123		○		14 76 10 (SI+CL)
122.4			20	SS	100/ 50 mm				○		
24.5	**End of Borehole**										

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-10 1 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.499612°, Long: -76.667459° Bruce Street MTM Zone 9: N 5 039 979.2 E 291 713.0 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA, NW COMPILED BY JP

DATUM Geodetic DATE 2019.09.26 - 2019.09.29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
146.2	**Ground Surface**										
0.0	Silty SAND, trace gravel, trace organics Dense Brown		1	SS	33		146		○		5 73 22 (SI+CL)
145.4	**(FILL)**										
0.8	Sandy SILT, some gravel, trace organics Compact Brown		2	SS	18		145		○		
144.7	**(FILL)**										
1.5	**SILTY CLAY (CI)** Very Stiff Brown **(WEATHERED CRUST)**		3	SS	8				○		
			4	SS	3	▽	144		⊢●⊣		0 1 48 51
143.2											
3.0	**CLAYEY SILT (CL)** Very Stiff Grey		5	SS	4		143		○		
							142	+			
			6	SS	3			+	○		
							141	+			
								+			
			7	SS	2		140		⊢○		0 3 61 36
								+			
							139	6.0 +			
			8	SS	4				○		
							138	+			
								+			
			9	SS	2		137		○		

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-10 2 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.499612°, Long: -76.667459° Bruce Street MTM Zone 9: N 5 039 979.2 E 291 713.0 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA, NW COMPILED BY JP

DATUM Geodetic DATE 2019.09.26 - 2019.09.29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
135.6	**CLAYEY SILT (CL)** Very Stiff Grey						136	+			
10.6 134.9	**GRAVEL** and **SAND**, some silt Frequent Cobbles **(TILL)**		10	SS	63		135		○		47 41 12 (SI+CL)
11.3	**End of Borehole** **WATER LEVEL READINGS:** DATE DEPTH (m) ELEV. (m) 2019.09.26 2.5 143.5										

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

(%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-12 1 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496651°, Long: -76.673061° Bruce Street MTM Zone 9: N 5 039 651.1 E 291 274.4 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW, NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.09 - 2019.09.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
152.7	**Ground Surface**										
0.0	**SAND** and **GRAVEL** , some silt and organics Brown sand, White gravel **(FILL)**		1	GS							40 46 14 (SI+CL)
151.8							152				
0.9	**SILTY CLAY (CI/CH)** Very Stiff Brown **(WEATHERED CRUST)**		1	SS	13						
			2	SS	8		151				
			3	SS	8		150				
			4	SS	7						0 1 46 53
			5	SS	7		149				
148.1											
4.6	**SILTY CLAY (CI)** Stiff to Very Stiff Grey		6	SS	6		148	8.0			
			7	SS	5		147				0 0 53 47
			8	SS	3		146	>10			
			9	SS	3		145				
							144				
							143				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-12 2 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496651°, Long: -76.673061° Bruce Street MTM Zone 9: N 5 039 651.1 E 291 274.4 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW, NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.09 - 2019.09.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) Stiff to Very Stiff Grey										
			10	SS	5		142				
							141				
			11	SS	3		140				
			12	SS	2		139				
			13	SS	1		138				0 1 52 47
			14	SS	2		137				
			15	SS	2		136				
			16	SS	2		135	8.8			
							134				
							133	4.0			

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-12 3 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496651°, Long: -76.673061° Bruce Street MTM Zone 9: N 5 039 651.1 E 291 274.4 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW, NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.09 - 2019.09.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) Stiff to Very Stiff Grey							6.3			
							132				
							131				
			17	SS	WR						
							130	9.0			
129.1											
23.6	Inferred Cobbles and Boulders **(TILL)**		~~18~~	~~SS~~	~~100/~~		129				
128.6			19	NQ	25 mm						
24.1	**End of Borehole**										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

WATER CONTENT (%): 20 40 60

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-13 1 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496886°, Long: -76.672476° Bruce Street MTM Zone 9: N 5 039 677.0 E 291 320.2 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW, NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.11 - 2019.09.17 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
152.5	**Ground Surface**										
0.0 / 0.1	**TOPSOIL**										
	Gravelly SAND to SAND Compact Brown **(FILL)**		1	SS	11		152				
151.7 / 0.8	GRAVEL and SAND, some silt Very Dense Brown **(FILL)**		2	SS	50/0.15 m						46 37 17 (SI+CL)
151.0 / 1.5	**SILTY CLAY (CI/CH)** Very Stiff Brown **(WEATHERED CRUST)**		3	SS	11		151				
			4	SS	11	▽	150				
			5	SS	6		149				
			6	SS	4						0 1 44 55
147.9 / 4.6	**CLAYEY SILT (CL to CL-ML)** Very Stiff Grey		7	SS	5		148				
			8	SS	4		147				
			9	SS	6		146				
			10	SS	3		145				
			11	SS	2		144				
							143				0 0 49 51

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-13 2 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496886°, Long: -76.672476° Bruce Street MTM Zone 9: N 5 039 677.0 E 291 320.2 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW, NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.11 - 2019.09.17 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL to CL-ML) Very Stiff Grey		1	ST			142				
			12	SS	3		141				
			13	SS	3		140				
			14	SS	5		139		H		0 1 47 52
136.3							138				
16.2	**CLAYEY SILT (CL-ML)** Stiff to Very Stiff Grey		15	SS	WH		137				
							136				
			2	ST			135				
							134	7.2			
							133				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-13 3 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496886°, Long: -76.672476° Bruce Street MTM Zone 9: N 5 039 677.0 E 291 320.2 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW, NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.11 - 2019.09.17 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL-ML) Stiff to Very Stiff Grey						132				
			16	SS	1		131				
			17	SS	WH		130				0 1 62 37
							129				
			3	ST			128				
							127				
							126				
							125				
							124				
							123				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-13 4 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496886°, Long: -76.672476° Bruce Street MTM Zone 9: N 5 039 677.0 E 291 320.2 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW, NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.11 - 2019.09.17 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL-ML) Stiff to Very Stiff Grey		18	SS	1		122	+	○		
							121				
119.6							120				
32.9	**CLAYEY SILT (CL)**, some sand, some gravel Loose to Dense Grey		19	SS	19		119		○ ○		
	-difficult to advance casing from 33.8 m depth		20	SS	10				⊢○		12 13 48 27
			21	SS	16		118		○		
116.5							117				
36.0	**SAND** and **GRAVEL**, some silt to silty Very Dense Grey **(TILL)**		22	SS	57		116		○		45 47 8 (SI+CL)
							115				
							114				
	- frequent cobbles and boulders below 39.6 m depth						113				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-13 5 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496886°, Long: -76.672476° Bruce Street MTM Zone 9: N 5 039 677.0 E 291 320.2 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW, NQ COMPILED BY JP

DATUM Geodetic DATE 2019.09.11 - 2019.09.17 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
111.9			23	SS	50/ 75 mm		112		○		
40.6	**End of Borehole** Piezometer consists of 19 mm diameter Schedule 40 PVC pipe with a 1.5 m slotted screen **WATER LEVEL READINGS:** DATE DEPTH (m) ELEV. (m) 2019.11.26 2.6 149.9 2020.04.21 2.2 150.3 2020.12.15 2.5 150.0 2021.08.04 2.4 150.1 2021.12.22 2.4 150.1 2022.01.11 2.4 150.1 2022.01.18 2.4 150.1										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-15 1 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497311°, Long: -76.671546° Bruce Street MTM Zone 9: N 5 039 724.0 E 291 393.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
152.6	**Ground Surface**										
0.0	See Borehole BRU19-15A for stratigraphy										
149.7											
2.9	**SILTY CLAY (CI)** Stiff to Very Stiff Brown **(WEATHERED CRUST)**		2	SS	3						0 0 42 58
146.5											
6.1	**CLAYEY SILT (CL)** Very Stiff Grey		3	SS	5						
			4	SS	3						0 0 51 49

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-15 2 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497311°, Long: -76.671546° Bruce Street MTM Zone 9: N 5 039 724.0 E 291 393.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL) Very Stiff Grey						142				
							141				
			5	SS	2		140				
							139				
			6	SS	1		138				
							137	10.0			
136.4 / 16.2	**CLAYEY SILT (CL-ML)** to **SILT(ML)** Stiff to Very Stiff Grey							>10			
			7	SS	1		136				
							135	6.4			
							134	7.6			
			8	SS	WH		133	5.3			

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-15 3 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497311°, Long: -76.671546° Bruce Street MTM Zone 9: N 5 039 724.0 E 291 393.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL-ML) to **SILT(ML)** Stiff to Very Stiff Grey						132				
			9	SS	1		131			NP	0 3 51 46
							130	9.5			
			10	SS	WR		129				
							128				
			11	SS	N/A		127				
							126				
			12	SS	1		125				
							124				
							123				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-15 4 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497311°, Long: -76.671546° Bruce Street MTM Zone 9: N 5 039 724.0 E 291 393.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	CLAYEY SILT (CL-ML) to **SILT(ML)** Stiff to Very Stiff Grey						122	+	○		
							121	+			
							120		○ H		0 4 62 34
117.5			13	SS	N/A		119	+ +			
35.1	Sandy **SILT** Loose Grey		14	SS	4		118		○		
115.3							117				
37.3	Sandy **SILT**, low-plastic fines (CL-ML) Loose to Dense Grey		15	SS	6		116				
							115		○		
							114				
			16	SS	43		113		○ H		1 35 40 24

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-15 5 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497311°, Long: -76.671546° Bruce Street MTM Zone 9: N 5 039 724.0 E 291 393.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 75 Truckmount, HSA, NW COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.20 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
112.4											
40.2	**End of Borehole**										

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-15A 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497311°, Long: -76.671546° Bruce Street MTM Zone 9: N 5 039 724.0 E 291 393.0 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-9'5") COMPILED BY MW

DATUM Geodetic DATE 2019.10.07 - 2019.10.07 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
152.6	**Ground Surface**										
0.0	Silty SAND, trace gravel and roots Compact Brown **(FILL)**		1	SS	19				○		
151.8							152				
0.8	SILT, with sand Compact Brown **(FILL)**		2	SS	12					○	
151.1											
1.5	Clayey **SILTY CLAY (CI)** Very Stiff Brown **(WEATHERED CRUST)**		3	SS	14		151			○	
			4	SS	11		150			○	
149.7											
2.9	**End of Borehole**										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-16 1 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497892°, Long: -76.673705° Bruce Street MTM Zone 9: N 5 039 789.1 E 291 224.4 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.10 - 2020.12.21 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
151.5											
0.0 / 0.1	**TOPSOIL (50mm)** CLAYEY SILT Some organics Trace fine sand Stiff Brown		1	SS	10		151				
	SILTY CLAY (Cl) Stiff to Very Stiff **(WEATHERED CRUST)**		2	SS	12						
			3	SS	12		150				0 1 44 55
			4	SS	7		149				
			5	SS	7						
			6	SS	7		148				
			7	SS	9		147				0 0 45 55
			8	SS	3		146				
144.8 / 6.7	**SILTY CLAY (Cl)** Stiff to Very stiff Grey						145				
			9	SS	3		144				0 0 47 53
							143	2.9			
			10	SS	5		142				

Continued Next Page

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-16 2 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497892°, Long: -76.673705° Bruce Street MTM Zone 9: N 5 039 789.1 E 291 224.4 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.10 - 2020.12.21 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) Stiff to Very stiff Grey						141				
			11	SS	4						
							140				
			12	SS	4		139				
								9.8			
137.8							138				
13.7	**CLAYEY SILT (CL to CL/ML)** Stiff to Very stiff Grey		13	SS	1						0 0 43 57
							137	10.0			
			14	SS	1		136				
								4.0			
			15	SS	1		135				
							134	7.3			
			16	SS	WH		133				
								5.0			
							132				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-16 3 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497892°, Long: -76.673705° Bruce Street MTM Zone 9: N 5 039 789.1 E 291 224.4 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.10 - 2020.12.21 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL to CL/ML) Stiff to Very stiff Grey		17	SS	WR		131	5.8			
			18	SS	1		130	23.0			0 1 63 36
			19	SS	3		129	>10			
			20	SS	WH		128	8.0, 4.0			
			21	SS	1		127	7.0			
			22	SS	WH		126	1.8			
			23	SS	WR		125				
							124				
							123	8.0			
							122				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-16 4 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497892°, Long: -76.673705° Bruce Street MTM Zone 9: N 5 039 789.1 E 291 224.4 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.10 - 2020.12.21 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL to CL/ML) Stiff to Very stiff Grey										
			24	SS	WH		121				
							120	9.8 6.5			
			25	SS	1		119				
			26	SS	1		118				
			27	SS	WH		117				
			28	SS	4		116				
113.4							115				
38.1	**CLAYEY SILT(CL-ML)**, some sand Stiff to Very Stiff Grey		29	SS	1		114				
							113				
			30	SS	6		112				5 18 53 24

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-16 5 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497892°, Long: -76.673705° Bruce Street MTM Zone 9: N 5 039 789.1 E 291 224.4 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.10 - 2020.12.21 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
111.3											
40.2	Inferred CLAYEY SILT						111				
							110				
							109				
							108				
107.0							107				
44.5	**End of Borehole**										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-18 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497047°, Long: -76.673056° Bruce Street MTM Zone 9: N 5 039 695.1 E 291 274.9 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.27 - 2020.11.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
150.9								20 40 60 80 100	20 40 60		
0.0	**SILTY CLAY (CI/CH)** Very Stiff Grey brown to grey **(WEATHERED CRUST)**		1	SS	6						
			2	SS	6		150				1 3 86 10
			3	SS	5		149				
			4	SS	4		148				
147.9											
3.0	**SILTY CLAY (CI)** to **CLAYEY SILT (CL-ML)** Very stiff to stiff Grey		5	SS	4						
			6	SS	5		147				0 1 48 51
			7	SS	3		146				
			8	SS	3		145				
			9	SS	3		144	+			
			10	SS	3		143	+ +			
141.8							142				
9.1	**CLAYEY SILT (CL-ML)** to **SILT (ML)** Very stiff to stiff Grey		11	SS	2		141	+		NP	0 0 51 49

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-18 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497047°, Long: -76.673056° Bruce Street MTM Zone 9: N 5 039 695.1 E 291 274.9 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.27 - 2020.11.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL-ML) to **SILT (ML)** Very stiff to stiff Grey										
			12	SS	3		140				
			13	SS	WH		139				
			14	SS	3		138				
			15	SS	WH		137				
							136				
							135				
							134				
							133				
							132				
							131				

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT; WATER CONTENT (%): 20 40 60

+ >10 at 138 m; + >10 at 132 m

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-18 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497047°, Long: -76.673056° Bruce Street MTM Zone 9: N 5 039 695.1 E 291 274.9 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.27 - 2020.11.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL-ML) to **SILT (ML)** Very stiff to stiff Grey										
			16	SS	2		130		○	NP	0 4 58 38
							129	+>10			
								+			Vane sunk during remold
							128				
							127				
			17	SS	WH		126	+>10			
								+>10			
							125				
							124				
			18	SS	WH		123	+>10			
								+>10			
							122				
							121				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-18 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497047°, Long: -76.673056° Bruce Street MTM Zone 9: N 5 039 695.1 E 291 274.9 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.27 - 2020.11.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
120.4	**CLAYEY SILT (CL-ML)** to **SILT (ML)** Very stiff to stiff Grey										
30.5	**CLAYEY SILT (CL)**, some sand, trace gravel Very Stiff Grey		19	SS	9		120		○		
							119				
							118				
116.8			20	SS	29		117		⊢○		5 14 57 24
34.1	**End of Borehole**										

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-19 1 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497234°, Long: -76.672129° Bruce Street MTM Zone 9: N 5 039 715.7 E 291 347.4 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.25 - 2020.11.25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**SILTY CLAY (CI/CH)** Trace sand Very stiff Grey **(WEATHERED CRUST)**		1	SS	14		152				
151.4											
0.8	**SILTY CLAY (CI/CH)** Very stiff Grey **(WEATHERED CRUST)**		2	SS	14		151				
			3	SS	12		150				
			4	SS	9						
149.2							149				
3.0	**SILTY CLAY (CI/CH)** Very stiff Grey		5	SS	5						0 0 39 61
			6	SS	5		148				
			7	SS	7		147				
			8	SS	4		146				
			9	SS	5		145				
			10	SS	7		144				
							143				0 1 55 44

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-19 2 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497234°, Long: -76.672129° Bruce Street MTM Zone 9: N 5 039 715.7 E 291 347.4 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.25 - 2020.11.25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI/CH) Very stiff Grey						142				
			11	SS	4		141				
			12	SS	3		140				
			13	SS	2		139				0 0 47 53
			14	SS	2		138				
135.4							137				
16.8	**SILTY CLAY (CH)** to **SILT (CL-ML)** Stiff to very stiff Grey		15	SS	2		136				
			16	SS	2		135				
							134				
							133				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-19 3 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497234°, Long: -76.672129° Bruce Street MTM Zone 9: N 5 039 715.7 E 291 347.4 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.25 - 2020.11.25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CH) to **SILT (CL-ML)** Stiff to very stiff Grey		17	SS	2		132				0 4 49 47
							131				
			18	SS	2		130				
			19	SS	2		129				
			20	SS	2		128				0 2 57 41
			21	SS	2		127				
			22	SS	2		126				
			23	SS	5		125				
							124				
							123				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-19 4 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497234°, Long: -76.672129° Bruce Street MTM Zone 9: N 5 039 715.7 E 291 347.4 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.25 - 2020.11.25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CH) to **SILT (CL-ML)** Stiff to very stiff Grey						122				
			24	SS	3				○		
							121				
			25	SS	5		120		○		
							119				
			26	SS	12				○		
							118				
			27	SS	11		117		⊢○		0 6 61 33
							116				
			28	SS	21		115		○		
114.1											
38.1	Sandy **CLAYEY SILT** Very stiff Grey		29	SS	21		114		⊢○		0 31 43 26
							113				
112.6											
39.6	**GRAVEL** and **SAND** Very dense		30	SS	74				○		52 41 7

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-19 5 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497234°, Long: -76.672129° Bruce Street MTM Zone 9: N 5 039 715.7 E 291 347.4 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.25 - 2020.11.25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	GRAVEL and **SAND** Very dense Grey **(TILL)**						112				(SI+CL)
111.3			31	SS	100/6"						
40.9	**End of Borehole**										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-21 1 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497517°, Long: -76.673413° Bruce Street MTM Zone 9: N 5 039 747.3 E 291 247.1 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.04 - 2020.12.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
150.7											
0.0 / 0.1	**TOPSOIL (50 mm)** CLAYEY SILT and organics Very soft Brown		1	SS	8						
	SILTY CLAY (CH) Stiff to Very Stiff Grey brown **(WEATHERED CRUST)**		2	SS	6		150				0 1 37 62
			3	SS	9		149				
			4	SS	9		148				
			5	SS	8		147				
			6	SS	8		146				
146.0 / 4.7	**CLAYEY SILT (CL/CL-ML)** Firm to Stiff Grey		7	SS	3			+ 3.8			
			8	SS	4		145	+			
							144	+ >10			
			9	SS	3		143	+			
							142	+			
			10	SS	2		141				0 0 52 48

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-21 2 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497517°, Long: -76.673413° Bruce Street MTM Zone 9: N 5 039 747.3 E 291 247.1 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.04 - 2020.12.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL/CL-ML) Firm to Stiff Grey										
			11	SS	1		140				
			12	SS	2		139				
			13	SS	1		138				
			14	SS	2		137				0 0 51 49
			15	SS	1		136				
			16	SS	WH		135				
							134				
							133				
							132				
							131				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-21 3 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497517°, Long: -76.673413° Bruce Street MTM Zone 9: N 5 039 747.3 E 291 247.1 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.04 - 2020.12.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL/CL-ML) Trace to some sand Stiff Grey		17	SS	1		130				
							129				
			18	SS	WR		128				0 1 66 33
							127	3.4			
							126				
			19	SS	2		125				
							124				
							123				
			20	SS	1		122				
							121				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-21 4 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497517°, Long: -76.673413° Bruce Street MTM Zone 9: N 5 039 747.3 E 291 247.1 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.04 - 2020.12.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL/CL-ML) Trace to some sand Stiff Grey						120	2 8			
							119				
			21	SS	WR						1 12 54 33
							118				
							117				
							116				
			22	SS	6						
							115				
							114				
							113				
112.6											
38.1	Sandy **CLAYEY SILT** Very Stiff Grey		23	SS	8		112				1 25 51 23
110.8							111				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-21 5 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497517°, Long: -76.673413° Bruce Street MTM Zone 9: N 5 039 747.3 E 291 247.1 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount (HSA) COMPILED BY AO

DATUM Geodetic DATE 2020.12.04 - 2020.12.10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
39.9	**INFERRED TILL**										
			24	SS	40		110				
108.9							109				
41.8	**End of Borehole** Monitoring well consists of 51 mm diameter Schedule 40 PVC pipe with a 3 m slotted screen WATER LEVEL READINGS: DATE / DEPTH (m) / ELEV. (m) 2020.12.15 1.9 148.8 2021.08.04 0.7 150.0 2021.09.22 0.9 149.8 2021.10.21 7.1 143.6 2021.11.01 6.9 143.8 2022.01.11 4.1 146.6 2022.01.18 4.1 146.6 2022.01.27 3.8 146.9										

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-22 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498081°, Long: -76.669425° Bruce Street MTM Zone 9: N 5 039 809.4 E 291 558.9 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-129'9") COMPILED BY JP

DATUM Geodetic DATE 2019.09.19 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
147.3	**Ground Surface**										
0.0	Silty **SAND**, some gravel, trace roots Compact Brown **(TOPSOIL)**		1	SS	13		147				
146.5											
0.8	**SILTY CLAY (CI)** Very Stiff Brown **(WEATHERED CRUST)**		2	SS	18						
			3	SS	8		146				
			4	SS	8		145				
			5	SS	6		144				0 0 47 53
			6	SS	4		143				
141.2							142				
6.1	**SILTY CLAY (CI)** to Clayey **SILT (CL-ML)** Very Stiff Grey		7	SS	4		141				
			8	SS	6		140				
			9	SS	5		139				
							138				0 0 50 50

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-22 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498081°, Long: -76.669425° Bruce Street MTM Zone 9: N 5 039 809.4 E 291 558.9 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-129'9") COMPILED BY JP

DATUM Geodetic DATE 2019.09.19 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAY (CI) to Clayey **SILT (CL-ML)** Very Stiff Grey						137				
			10	SS	5		136				
			11	SS	4		135				
			12	SS	4		134				
			13	SS	3		133				
130.5							132				
16.8	**CLAYEY SILT (CL/CL-ML)** Stiff to very stiff Grey		14	SS	1		131				
			15	SS	1		130	7.7			
							129				
							128	>10 8.4			

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-22 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498081°, Long: -76.669425° Bruce Street MTM Zone 9: N 5 039 809.4 E 291 558.9 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-129'9") COMPILED BY JP

DATUM Geodetic DATE 2019.09.19 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	CLAYEY SILT (CL/CL-ML) Stiff to very stiff Grey		16	SS	1		127	+	○		
							126	+			
							125				
			17	SS	3		124		○ H		0 1 58 41
								7.5 +			
							123	10.0 +			
							122				
			18	SS	3		121	+	○		
							120				
							119				
118.3											
29.0	**SAND** and **SILT** Compact to Dense Grey		19	SS	31		118		○		

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-22 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498081°, Long: -76.669425° Bruce Street MTM Zone 9: N 5 039 809.4 E 291 558.9 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-129'9") COMPILED BY JP

DATUM Geodetic DATE 2019.09.19 - 2019.09.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT** Compact to Dense Grey						117				
							116				
			20	SS	32		115		○		0 62 38 (SI+CL)
							114				
							113				
			21	SS	17		112		○		
							111				
							110				
109.2											
38.1	Sandy **CLAYEY SILT (CL-ML)** Compact Grey		22	SS	25		109		H ○		0 29 49 22
107.8			23	SS	100/ 75 mm		108		○		
39.5	**End of Borehole**										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-23 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498019°, Long: -76.668817° Bruce Street MTM Zone 9: N 5 039 802.4 E 291 606.4 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-104'3") COMPILED BY JP

DATUM Geodetic DATE 2019.09.23 - 2019.09.24 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
146.6	**Ground Surface**										
0.0	**SILT**, trace roots Compact Brown **(TOPSOIL)**		1	SS	11						
145.8											
0.8	**SILTY CLAY (CI/CH)** Very Stiff Brown **(WEATHERED CRUST)**		2	SS	9						
			3	SS	5						
			4	SS	4						0 0 48 52
			5	SS	4						
141.3											
5.3	**SILTY CLAY (CI)** Very Stiff Grey		6	SS	3						
			7	SS	3						0 0 46 54

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-23 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498019°, Long: -76.668817° Bruce Street MTM Zone 9: N 5 039 802.4 E 291 606.4 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-104'3") COMPILED BY JP

DATUM Geodetic DATE 2019.09.23 - 2019.09.24 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) Stiff to Very Stiff Grey		8	SS	2		136				
							135				
134.4											
12.2	**CLAYEY SILT (CL-ML)** Stiff to Very Stiff Grey		9	SS	WH		134				
							133	6.0			
			10	SS	WH		132	>10			0 0 58 42
			11	SS	WH		131	5.9 4.0			
							130				
							129	>10 6.7			
							128	12.0			
			12	SS	1		127				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-23 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498019°, Long: -76.668817° Bruce Street MTM Zone 9: N 5 039 802.4 E 291 606.4 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-104'3") COMPILED BY JP

DATUM Geodetic DATE 2019.09.23 - 2019.09.24 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL-ML) Stiff to Very Stiff Grey						126	6,6			
								>10			
			13	SS	WH		125				
								>10			
							124				
							123				
			14	SS	3						0 3 63 34
							122				
121.1			15	SS	17						
25.5	**SILT** Loose to Compact Grey						121				
			16	SS	9						
							120				
			17	SS	26		119				
							118				
117.6											
29.0	Silty **SAND** Dense Grey		18	SS	44		117			NP	0 72 22 6

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-23 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498019°, Long: -76.668817° Bruce Street MTM Zone 9: N 5 039 802.4 E 291 606.4 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-104'3") COMPILED BY JP

DATUM Geodetic DATE 2019.09.23 - 2019.09.24 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	Silty **SAND** Dense Grey						116				
114.8							115				
31.8	**End of Borehole**		19	SS	100/0						

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-25 1 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497909°, Long: -76.670002° Bruce Street MTM Zone 9: N 5 039 790.3 E 291 513.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-40'), NW (40'-139') COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
147.9	**Ground Surface**										
0.0	Silty **SAND**, trace gravel, trace roots Compact Brown **(TOPSOIL)**		1	SS	14						4 80 16 (SI+CL)
147.1											
0.8	**CLAY (CH)** Stiff to Very Stiff Brown **(WEATHERED CRUST)**		2	SS	20		147				
			3	SS	14		146				
			4	SS	8		145				0 1 44 55
			5	SS	9		144	2.4			
143.3											
4.6	**SILTY CLAY (CI)** Very Stiff Grey		6	SS	5		143				0 0 51 49
			7	SS	7		142				
			8	SS	8		141				
			9	SS	6		140				
							139				
							138				

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-25 2 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497909°, Long: -76.670002° Bruce Street MTM Zone 9: N 5 039 790.3 E 291 513.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-40'), NW (40'-139') COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) Stiff to Very Stiff Grey										
			10	SS	5		137				
							136				
			11	SS	3						
							135				
			12	SS	5		134				0 0 55 45
							133				
			13	SS	4						
							132				
			14	SS	3		131				
							130				
			15	SS	3		129				
							128				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-25 3 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497909°, Long: -76.670002° Bruce Street MTM Zone 9: N 5 039 790.3 E 291 513.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-40'), NW (40'-139') COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.18 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m^3	GR SA SI CL
	Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			
	SILTY CLAY (CI) Stiff to Very Stiff Grey						127				
			16	SS	4				○		
							126	8.0 6.7			
							125				
							124				
			17	SS	WH				○		
							123	7.3			
							122				
							121				
			18	SS	6				○		
							120				
							119				
							118				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-25 4 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497909°, Long: -76.670002° Bruce Street MTM Zone 9: N 5 039 790.3 E 291 513.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-40'), NW (40'-139') COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
117.4	**SILTY CLAY (CI)** Stiff to Very Stiff Grey										
30.5	**SILT** and **SAND** Compact to Dense Grey		19	SS	38		117		○	NP	0 39 47 14
			20	SS	42		114		○		
			21	SS	29		111		○		
108.3							108				
39.6	**CLAYEY SILT (CL)**, some sand Compact, Grey		22	SS	10				⊢○		0 19 48 33

Continued Next Page

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

(%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-25 5 OF 5 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497909°, Long: -76.670002° Bruce Street MTM Zone 9: N 5 039 790.3 E 291 513.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-40'), NW (40'-139') COMPILED BY JP

DATUM Geodetic DATE 2019.09.17 - 2019.09.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL), some sand Compact Grey						107				
							106				
105.5			23	SS	100/ 0mm						
42.4	**End of Borehole**										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-26 1 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.494981°, Long: -76.668897° Bruce Street MTM Zone 9: N 5 039 464.6 E 291 599.5 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME850 Trackmount, HSA COMPILED BY AO

DATUM Geodetic DATE 2021.05.19 - 2021.05.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.7											
0.0 149.4	**TOPSOIL (300 mm)**		1	SS	2		149				
0.3	**SAND**, some silt Yellow-brown Very loose to loose		2	SS	4						
147.7			3	SS	6		148				0 82 18 (SI+CL)
2.0	**SILTY CLAY (CI)** No to trace sand Grey-brown with yellow mottles Very stiff **(WEATHERED CRUST)**		4	SS	5		147				
			5	SS	4		146				
			6	SS	6						0 1 47 52
			7	SS	6		145				
			8	SS	4		144				
							143	+ +			
141.5			9	SS	3		142				
8.2	**CLAYEY SILT (CL)** Contains sand seams and partings Grey-brown Stiff						141				
			10	SS	2		140				

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-26 2 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.494981°, Long: -76.668897° Bruce Street MTM Zone 9: N 5 039 464.6 E 291 599.5 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME850 Trackmount, HSA COMPILED BY AO

DATUM Geodetic DATE 2021.05.19 - 2021.05.20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL) Contains sand seams and partings Grey-brown Stiff							3.0, 2.8			
			11	SS	2		139				0 4 57 39
								4.3			
							138	4.3			
			12	SS	WH						
							137	3.3, 2.0			
			13	SS	WH		136				
								3.3			
							135	2.3			
			14	SS	WH						
133.7							134	4.0			
16.0	**SAND**, some silt Grey Very dense										
			15	SS	60		133				0 86 14 (SI+CL)
132.3											
17.4	**End of Borehole**										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-27 1 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.495436°, Long: -76.668876° Bruce Street MTM Zone 9: N 5 039 515.3 E 291 601.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.19 - 2020.11.19 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
154.6											
0.0	**SAND** trace to some silt Loose to compact Brown		1	SS	12		154				
			2	SS	8						
153.1							153				
1.5	**SILTY CLAY (CI)** Very stiff Grey **(WEATHERED CRUST)**		3	SS	8						
			4	SS	14		152				0 2 47 51
			5	SS	10						
							151	+			
			6	SS	7		150				
							149				
148.5											
6.1	**SILTY CLAY (CI)** Very stiff to stiff Grey		7	SS	8		148				
			8	SS	3		147				0 0 50 50
								+			
							146	+			
			9	SS	2						
							145	6.0 +			

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-27 2 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.495436°, Long: -76.668876° Bruce Street MTM Zone 9: N 5 039 515.3 E 291 601.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.19 - 2020.11.19 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) Very stiff to stiff Grey										
			10	SS	2		144	5.7			
							143	5.6			
			11	SS	WR		142	16.3, 4.3			
			12	SS	WH		141	>10			5 1 55 39
							140	>10			
			13	SS	WH		139	8.0, 9.7			
							138				
							137				
			14	SS	WH		136				
135.9 / 18.7	Sandy **CLAYEY SILT (CL)**, some gravel Stiff Grey						135				11 27 40 22

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-27 3 OF 3 METRIC

WP# 4068-09-00 LOCATION Lat: 45.495436°, Long: -76.668876° Bruce Street MTM Zone 9: N 5 039 515.3 E 291 601.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.19 - 2020.11.19 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy **CLAYEY SILT (CL)**, some gravel Stiff Grey						134				
133.3											
~~133.2~~											
21.4	GRAVEL trace sand Trace silt Very dense Grey **(TILL)**		15	SS	100/4"						
	End of Borehole										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-28 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.495861°, Long: -76.668749° Bruce Street MTM Zone 9: N 5 039 562.5 E 291 611.3 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.18 - 2020.11.19 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
155.0											
0.0	**SILT**, trace to some sand Compact to loose Grey brown		1	SS	7				○		
			2	SS	10		154		○		0 9 82 9
			3	SS	8		153		○		
152.7											
2.3	**SILTY CLAY (CI)** Very Stiff Grey **(WEATHERED CRUST)**		4	SS	6		152		○		
			5	SS	7			+	○		
			6	SS	7		151		⊢○⊣		0 0 46 54
			7	SS	7		150	+			
							149		○		
							148	+			
147.4											
7.6	**SILTY CLAY (CI)** Very Stiff Grey		8	SS	3		147		○		
								+			
								+			
			9	SS	4		146		○		
								+			

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-28 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.495861°, Long: -76.668749° Bruce Street MTM Zone 9: N 5 039 562.5 E 291 611.3 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.18 - 2020.11.19 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) Very Stiff Grey										
			10	SS	2		144				0 0 53 47
							143				
			11	SS	2						
							142				
			12	SS	WH		141				
139.8											
15.2	**CLAYEY SILT (CL)** to **SILT (ML)** Stiff to Very Stiff Grey		13	SS	WH		140				
							139				
			14	SS	WH		138				
							137				
			15	SS	WR		136				

Continued Next Page

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-28 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.495861°, Long: -76.668749° Bruce Street MTM Zone 9: N 5 039 562.5 E 291 611.3 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.18 - 2020.11.19 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL/CL-ML) Stiff to Very Stiff Grey						134				
			16	SS	WR		133	>10 >10	○	NP	0 0 61 39
			17	SS	WR		132				
							131		○		
							130	4.2			
127.6							129				
27.4	**SAND**, some silt to silty Compact to very dense Grey **(TILL)**		18	SS	13		128		○		
							127				
							126				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-28 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.495861°, Long: -76.668749° Bruce Street MTM Zone 9: N 5 039 562.5 E 291 611.3 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.18 - 2020.11.19 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some silt to silty Compact to very dense Grey **(TILL)**		19	SS	76		124		○		7 79 14 (SI+CL)
122.9			20	SS	100/3"		123				
32.1	**End of Borehole**										

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-29 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496331°, Long: -76.668662° Bruce Street MTM Zone 9: N 5 039 614.8 E 291 618.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.16 - 2020.11.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
154.7											
0.0 / 0.1	**TOPSOIL**										
	SAND and **SILT** Compact to loose Brown		1	SS	10		154				
			2	SS	23		153				
			3	SS	19						0 50 50 (SI+CL)
152.3											
2.4	**SILTY CLAY (CI)** Very stiff to Stiff Grey **(WEATHERED CRUST)**		4	SS	9		152				
			5	SS	7	▼	151	+			0 2 51 47
			6	SS	6		150	+			
			7	SS	6		149				
147.1							148	+			
7.6	**SILTY CLAY (CI)** Very stiff to Stiff Grey		8	SS	3		147	3.3			
							146	3.8			
			9	SS	4		145	+			

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-29 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496331°, Long: -76.668662° Bruce Street MTM Zone 9: N 5 039 614.8 E 291 618.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.16 - 2020.11.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	SILTY CLAY (CI) Very stiff Grey							+			
			10	SS	3		144		○		
								+			
							143	+			
			11	SS	4				○		
							142				
								+			
								+			
			12	SS	3		141		○		
								+			
139.5							140	+			
15.2	**CLAYEY SILT (CL/CL-ML)** Stiff to Very stiff Grey		13	SS	5				○		
							139	2.4			
								2.4			
			14	SS	WH		138		○	NP	0 0 55 45
								>10			
							137	>10			
			15	SS	WH				○		
							136				
								10.0			
								>10			
							135				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20
15 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-29 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496331°, Long: -76.668662° Bruce Street MTM Zone 9: N 5 039 614.8 E 291 618.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.16 - 2020.11.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL/CL-ML) Stiff to Very stiff Grey						134				
			16	SS	2		133	>10			
								>10			
							132				
							131				
			17	SS	WR		130			NP	0 0 57 43
								>10			
							129				
							128				
			18	SS	WR		127				
								>10			
								>10			
							126				
124.8 29.9							125				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-29 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496331°, Long: -76.668662° Bruce Street MTM Zone 9: N 5 039 614.8 E 291 618.2 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 75 Trackmount, HSA, H Casing COMPILED BY AO

DATUM Geodetic DATE 2020.11.16 - 2020.11.18 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL/CL-ML) Stiff to Very stiff Grey										
			19	SS	WR		124	+	○		
							123	+			
121.2							122				
33.5	**CLAYEY SILT (CL)**, some sand Very stiff Grey		20	SS	18		121		○		1 12 54 33
119.6							120				
35.1	Gravelly **SAND**, some silt Very dense Grey **(TILL)**		21	SS	35		119		○		29 59 12 (SI+CL)
118.2			22	SS	100/1"						
36.5	**End of Borehole** Monitoring well consists of 51 mm diameter Schedule 40 PVC pipe with a 3 m slotted screen **WATER LEVEL READINGS:** DATE DEPTH (m) ELEV. (m) 2020.12.15 3.3 151.4 2021.08.04 3.5 151.2 2021.09.30 4.3 150.4 2021.10.05 4.3 150.4 2022.01.11 3.5 151.2 2022.01.18 3.6 151.1 2022.01.26 3.5 151.2								○		

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-30 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496713°, Long: -76.668342° Bruce Street MTM Zone 9: N 5 039 657.2 E 291 643.3 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 55 Trackmount HSA (0'-40'), NW (40'- COMPILED BY JP

DATUM Geodetic DATE 2019.11.28 - 2019.11.29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
154.1	**Ground Surface**										
0.0	Sandy **SILT** Loose Brown		1	SS	6		154				
			2	SS	9		153			NP	0 23 66 11
			3	SS	9		152				
151.8											
2.3	**SILTY CLAY (CI)** Very Stiff Grey **(WEATHERED CRUST)**		4	SS	6						
			5	SS	6		151				0 1 47 52
			6	SS	9		150				
			7	SS	7		149				
			8	SS	5						
			9	SS	6		148				
							147	+			
			10	SS	8		146				0 0 48 52
145.0											
9.1	**SILTY CLAY (CI)** Very Stiff Grey		11	SS	3		145				
144.1											

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-30 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496713°, Long: -76.668342° Bruce Street MTM Zone 9: N 5 039 657.2 E 291 643.3 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 55 Trackmount HSA (0'-40'), NW (40'- COMPILED BY JP

DATUM Geodetic DATE 2019.11.28 - 2019.11.29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
10.0	**SILTY CLAY (CI)** Very Stiff Grey						144	8.3			
								8.3			
			12	SS	3		143				
								>10			
142.2								9.1			
11.9	**CLAYEY SILT (CL/CL-ML)** Stiff to Very Stiff Grey		13	SS	4		142				
								3.3			
							141	25.0			
			14	SS	8						0 0 52 48
							140	8.7			
								10.0			
			15	SS	3		139				
							138				
			16	SS	3						
							137				
							136				
			17	SS	4						
							135	5.4			
			18	SS	1						

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-30 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496713°, Long: -76.668342° Bruce Street MTM Zone 9: N 5 039 657.2 E 291 643.3 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 55 Trackmount HSA (0'-40'), NW (40'- COMPILED BY JP

DATUM Geodetic DATE 2019.11.28 - 2019.11.29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (UNCONFINED, FIELD VANE, QUICK TRIAXIAL, LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL/CL-ML) Stiff to Very Stiff Grey						134				
							133				
							132				
			19	SS	2						0 1 54 45
							131	2.2			
							130				
							129				
			20	SS	3		128				
							127				
							126				
			21	SS	6		125				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-30 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.496713°, Long: -76.668342° Bruce Street MTM Zone 9: N 5 039 657.2 E 291 643.3 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 55 Trackmount HSA (0'-40'), NW (40'- COMPILED BY JP

DATUM Geodetic DATE 2019.11.28 - 2019.11.29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
122.4	**CLAYEY SILT (CL/CL-ML)** Stiff to Very Stiff Grey						124 123				
31.7	**SILT**, some sand to sandy With sand seams, contains low-plastic fines Compact to Dense Grey		22	SS	15		122 121 120				0 10 59 31
118.7			23	SS	39		119				
35.4	**End of Borehole**										

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-31 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497516°, Long: -76.668258° Bruce Street MTM Zone 9: N 5 039 746.3 E 291 650.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 55 Trackmount, HSA (0'-35'), NW (35'-124'3") COMPILED BY JP

DATUM Geodetic DATE 2019.11.26 - 2019.11.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.9	**Ground Surface**									
0.0	**100mm TOPSOIL**									
0.1	**CLAY (CH)** Very Stiff Brown **(WEATHERED CRUST)**		1	SS	7					
			2	SS	9		149			0 1 42 57
148.4										
1.5	**SILTY CLAY (CI)** Very Stiff Grey		3	SS	7		148			
			4	SS	7					
			5	SS	7		147			
			6	SS	9		146			0 0 45 55
			7	SS	5		145			
								+		
			8	SS	3		144			
							143	+		
			9	SS	4		142			
								+		
							141			
			10	SS	4					0 0 49 51
							140			

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-31 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497516°, Long: -76.668258° Bruce Street MTM Zone 9: N 5 039 746.3 E 291 650.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 55 Trackmount, HSA (0'-35'), NW (35'-124'3") COMPILED BY JP

DATUM Geodetic DATE 2019.11.26 - 2019.11.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) Very Stiff Grey										
			11	SS	4		139				
								3.7			
138.0											
11.9	**CLAYEY SILT (CL/CL-ML)** Stiff to Very Stiff Grey		12	SS	6		138				
								4.8			
							137	7.5			
			13	SS	4						
							136				
			14	SS	2		135				
							134				
								>10			
			15	SS	WH		133				2 20 49 29
							132				
			16	SS	WH						
							131				
			17	SS	WH		130				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-31 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497516°, Long: -76.668258° Bruce Street MTM Zone 9: N 5 039 746.3 E 291 650.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 55 Trackmount, HSA (0'-35'), NW (35'-124'3") COMPILED BY JP

DATUM Geodetic DATE 2019.11.26 - 2019.11.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL/CL-ML) Stiff to Very Stiff Grey						129				
							128				
			18	SS	4		127				
							126				
							125				
			19	SS	1		124				
							123				
							122				
121.2											
28.7	Interlayered **CLAYEY SILT (CL/CL-ML)** and Silty **SAND (SM)** Very Loose to Compact Grey		20	SS	WH		121				0 23 50 27
							120				

Continued Next Page

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-31 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497516°, Long: -76.668258° Bruce Street MTM Zone 9: N 5 039 746.3 E 291 650.0 ORIGINATED BY MJJ

HWY 17 BOREHOLE TYPE CME 55 Trackmount, HSA (0'-35'), NW (35'-124'3") COMPILED BY JP

DATUM Geodetic DATE 2019.11.26 - 2019.11.27 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Interlayered **CLAYEY SILT (CL/CL-ML)** and Silty **SAND (SM)** Very Loose to Compact Grey						119				
			21	SS	11		118		○		
							117				
							116				
			22	SS	22		115		⊢○		0 1 63 36
							114				
112.0			23	SS	100/ 0.08m		113				
37.9	**End of Borehole**										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-33 1 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498365°, Long: -76.668916° Bruce Street MTM Zone 9: N 5 039 840.9 E 291 598.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-110'2") COMPILED BY JP

DATUM Geodetic DATE 2019.09.24 - 2019.09.25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
146.9	**Ground Surface**										
0.0	**CLAY (CH)** Very Stiff Brown **(WEATHERED CRUST)**		1	SS	15						
			2	SS	15		146				
			3	SS	9		145				0 0 42 58
			4	SS	7		144				
			5	SS	9	▽					
143.1							143				
3.8	**SILTY CLAY (CI)** Very Stiff Grey-Brown to Grey		6	SS	7		142	+			
			7	SS	5		141				0 0 50 50
			8	SS	4		140	+			
							139	+			
							138	+			
							137	+			

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-33 2 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498365°, Long: -76.668916° Bruce Street MTM Zone 9: N 5 039 840.9 E 291 598.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-110'2") COMPILED BY JP

DATUM Geodetic DATE 2019.09.24 - 2019.09.25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	SILTY CLAY (CI) Very Stiff Grey-Brown to Grey										
			9	SS	4		136				
							135				
			10	SS	4		134				
							133				
							132				
131.7											
15.2	**CLAYEY SILT (CL)** Stiff to Very Stiff Grey		11	SS	1		131				0 1 65 34
							130	8.0 8.0			
			12	SS	2		129				
							128	4.6 >10			
							127				

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-33 3 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498365°, Long: -76.668916° Bruce Street MTM Zone 9: N 5 039 840.9 E 291 598.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-110'2") COMPILED BY JP

DATUM Geodetic DATE 2019.09.24 - 2019.09.25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL) Stiff to Very Stiff Grey		13	SS	2						
			14	SS	2						
			15	SS	3						
120.2											
26.7	Interlayered Silty **SAND (SM)** and **CLAYEY SILT (CL/CL-ML)** Compact Grey		16	SS	25					NP	0 68 25 7
	Continued Next Page										

+ 3, × 3: Numbers refer to Sensitivity

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU19-33 4 OF 4 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498365°, Long: -76.668916° Bruce Street MTM Zone 9: N 5 039 840.9 E 291 598.8 ORIGINATED BY MW

HWY 17 BOREHOLE TYPE CME 850 Trackmount, HSA (0'-20'), NW (20'-110'2") COMPILED BY JP

DATUM Geodetic DATE 2019.09.24 - 2019.09.25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Interlayered Silty **SAND (SM)** and **CLAYEY SILT (CL/CL-ML)** Compact Grey		17	SS	7				○		
114.9							116				
							115				
32.0	Silty **SAND**, trace gravel Loose to Very Dense Grey **(TILL)**		18	SS	7				○		
							114				
113.3			19	SS	57				○		6 73 21 (SI+CL)
33.6	**End of Borehole**										

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU21-02 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497647°, Long: -76.671101° Bruce Street MTM Zone 9: N 5 039 761.4 E 291 427.9 ORIGINATED BY NW

HWY 17 BOREHOLE TYPE Diedrich 50 (D-50) Trackmount, HSA COMPILED BY AO

DATUM Geodetic DATE 2021.11.01 - 2021.11.01 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
151.4	**Ground Surface**										
0.0	SILTY SAND some gravel Loose Brown		1	SS	4		151				
150.8	**[FILL]**										
0.6	**CLAY (CH)** Very stiff Brown to Grey **(WEATHERED CRUST)**		2	SS	8		150				
			3	SS	10						
			4	SS	7	▼	149				0 1 38 61
			5	SS	7		148				
			6	SS	7		147				
			7	SS	7						0 0 41 59
							146				
144.7			8	SS	7		145				
6.7	**End of Borehole** Monitoring well consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen Water level readings: **Date / Depth (m) / Elev. (m)** 2021.11.04 / 2.4 / 149.0 2022.11.30 / 2.3 / 149.1 2021.12.23 / 2.2 / 149.2 2022.01.19 / 2.5 / 148.9										

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

20
15 5 (%) STRAIN AT FAILURE
10

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU21-05 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.498101°, Long: -76.669878° Bruce Street MTM Zone 9: N 5 039 811.7 E 291 523.6 ORIGINATED BY NW

HWY 17 BOREHOLE TYPE Diedrich 50 (D-50) Trackmount, HSA COMPILED BY AO

DATUM Geodetic DATE 2021.11.02 - 2021.11.02 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.2	**Ground Surface**										
0.0 / 0.1	**TOPSOIL (75 mm)**										
	SILTY SAND some gravel Contains asphalt Compact Brown to Grey **[FILL]**		1	SS	15		149				11 81 8 (SI+CL)
			2	SS	10		148				
147.7 / 1.5	**CLAY (CH)** to **SILTY CLAY (CI)** Very stiff Brown **(WEATHERED CRUST)**		3	SS	14						
			4	SS	10		147				0 1 38 61
			5	SS	6		146				
			6	SS	5		145				
			7	SS	6		144				
			8	SS	6		143				0 0 51 49
142.5 / 6.7	**End of Borehole** Monitoring well consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen Water level readings: **Date** **Depth (m)** **Elev. (m)** 2021.11.16 2.0 147.2 2021.12.01 2.0 147.2 2022.01.19 2.3 146.9										

+ ³, × ³: Numbers refer to Sensitivity

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU21-15 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497312°, Long: -76.671577° Bruce Street MTM Zone 9: N 5 039 724.3 E 291 390.6 ORIGINATED BY NW

HWY 17 BOREHOLE TYPE Diedrich 50 (D-50) Trackmount, HSA COMPILED BY AO

DATUM Geodetic DATE 2021.10.29 - 2021.10.29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
152.6	**Ground Surface**									
0.0	See borehole BRU19-15 for stratigraphy.						152			
							151			
							150			
							149			
							148			
							147			
146.5										
6.1	**End of Borehole** Monitoring well consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen Water level readings: **Date** **Depth (m)** **Elev. (m)** 2021.11.03 2.6 150.0 2022.01.19 3.0 149.6									

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU21-18 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497048°, Long: -76.673058° Bruce Street MTM Zone 9: N 5 039 695.2 E 291 274.5 ORIGINATED BY NW

HWY 17 BOREHOLE TYPE Diedrich 50 (D-50) Trackmount, HSA COMPILED BY AO

DATUM Geodetic DATE 2021.10.29 - 2021.10.29 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
151.4	**Ground Surface**										
0.0	See borehole BRU19-18 for stratigraphy.						151				
							150				
							149				
							148				
							147				
							146				
145.3											
6.1	**End of Borehole** Monitoring well consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen Water level readings: **Date** **Depth (m)** **Elev. (m)** 2021.11.03 1.6 149.8 2022.01.19 1.7 149.7										

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU21-23 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.497997°, Long: -76.668814° Bruce Street MTM Zone 9: N 5 039 799.9 E 291 606.7 ORIGINATED BY NW

HWY 17 BOREHOLE TYPE Diedrich 50 (D-50) Trackmount, HSA COMPILED BY AO

DATUM Geodetic DATE 2021.11.02 - 2021.11.02 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
146.6	**Ground Surface**									
0.0	See BRU19-23 for stratigraphy.						146			
							145			
							144			
							143			
							142			
							141			
140.5										
6.1	**End of Borehole**									

Monitoring well consists of 50 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen

Water level readings:

Date	Depth (m)	Elev. (m)
2021.11.16	0.3	146.3
2021.11.24	0.3	146.3
2022.01.19	0.7	145.9

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

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

DOUBLE LINE 24726 BRUCE STREET GINT.GPJ 2012TEMPLATE(MTO).GDT 22-6-29

THURBER

Appendix B.2

Previous (2003) Investigation

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-1 1 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.0 E 291 406.0 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 07.10.03 - 10.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
151.6											
150.6	**TOPSOIL** (125mm)										
0.1	Sandy **SILT**, some gravel, occasional rootlets		1	SS	9						
150.9	Loose										
0.7	Brown										
	Moist										
	(FILL) (ML)		2	SS	13						
	Silty **CLAY** to **CLAY**, occasional oxide staining, sand seams and trace rootlets to 2.2m										
	Stiff to Firm		3	SS	10						
	Brown/ Grey										
	Moist										
	(CI-CH)		4	SS	7						0 1 37 63
	(dessicated crust)										
			5	SS	7						
			6	SS	8						
146.0											
5.6	Grey		7	SS	6						
			8	SS	6						
			9	SS	4						
141.6											

Continued Next Page

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-1 2 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 746.0 E 291 406.0 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 07.10.03 - 10.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
10.0	Silty **CLAY**, to **CLAY**, sand seams Firm Grey (CI-CH)						141		10.5			
			10	SS	4							0 1 63 37
			1	TW	PH		140				18.0	Consolidation Test
			11	SS	3		139					
	inferred sand and silt layers and seams		12	SS	3		138					Blow back in augers
							137		>10			
			13	SS	3		136					
			14	SS	4		135					Commence casing and washboring
							134					
			15	SS	5		133					
									>10			
131.6							132					

Continued Next Page

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-1 3 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.0 E 291 406.0 (Bruce Street) ORIGINATED BY JL
HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS
DATUM Geodetic DATE 07.10.03 - 10.10.03 CHECKED BY SKP

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
20.0	Silty **CLAY**, to **CLAY** Firm to Soft Grey (CI-CH)		2	TW	PH		131				
			16	SS	3				○		0 5 64 31
							130				
	sand and silt layers and seams		17	SS	3				○		
							129				
			18	SS	3				○		
							128	>10 +			
			19	SS	2		127		○		
											Blow back in augers
							126				
							125				
			20	SS	4				○		0 1 68 31
							124				
							123				
											Commence use of drilling mud
121.6							122				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-1 4 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.0 E 291 406.0 (Bruce Street) ORIGINATED BY JL
HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS
DATUM Geodetic DATE 07.10.03 - 10.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
30.0	Silty **CLAY** to **CLAY**, with sand and silt layers and seams Firm Grey (CI-CH)		21	SS	5		121		○		
							120				
							119				
	move frequent sand layers		22	SS	23		118		○		
							117				
116.0							116				
35.6	Silty **SAND** to Sandy **SILT**, trace clay Dense Grey Wet		23	SS	32		115		○ ○		
							114				
113.2							113				
38.4	Silty **CLAY** to **CLAY**, with sand and silt layers and seams Stiff Grey Moist to Wet		24	SS	15		112		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-1 5 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.0 E 291 406.0 (Bruce Street) ORIGINATED BY JL
HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS
DATUM Geodetic DATE 07.10.03 - 10.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
109.1	Silty **CLAY** to **CLAY**, with sand and silt layers and seams Stiff Grey						111 110				
42.5	Silty **SAND**, some gravel, frequent cobbles and boulders Very Dense Grey (TILL)		25	SS	110		109				
			1	RUN			108				
	no recovery from 44.42m to 45.62m		2	RUN			107				
	boulder from 46.13m to 46.76m		3	RUN			106				
	no recovery from 46.69m to 47.14m						105				
	no recovery from 47.68m to 48.67m		4	RUN			104				
102.8					FI		103				
48.8	**MARBLE (BEDROCK)** Slightly to moderately weathered, grey, brown and white with subhorizontal black banding, strong. Subvertical joint at 49.8m. Multiple vertical and subvertical joints at 49.9m		5	RUN	1 0 1 >5		102				RUN 5# TCR=98%, SCR=67%, RQD=66%, UCS=79MPa

Continued Next Page

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-1 6 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.0 E 291 406.0 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 07.10.03 - 10.10.03 CHECKED BY SKP

SOIL PROFILE			SAMPLES									
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
101.4								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100			
50.2	END OF BOREHOLE AT 50.19m. BOREHOLE OPEN TO 45.72m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.						101				

WATER LEVEL READINGS:

DATE	ELEVATION(m)
22/10/03	145.2
18/12/03	146.2
04/02/04	145.8
11/03/04	146.0

ONTMT4 7450BRU.GPJ 04/06/04

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-2 1 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.7 E 291 445.8 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 17.10.03 - 21.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
150.3												
0.0	**SAND and GRAVEL** Compact Brown Moist (FILL)		1	SS	16		150					
149.6												
0.7	Silty **CLAY** to **CLAY**, sand seams Firm to Stiff Grey/ Brown (CI-CH) (dessicated crust)		2	SS	5		149					
			3	SS	10							
			4	SS	14		148					0 1 46 53
			5	SS	10		147					
			6	SS	7		146					
144.5							145					
5.8	grey		7	SS	6		144					
			8	SS	8		143					
							142					
			9	SS	7		141					

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-2 2 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.7 E 291 445.8 (Bruce Street) ORIGINATED BY JL
HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS
DATUM Geodetic DATE 17.10.03 - 21.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Silty **CLAY** to **CLAY**, sand seams Firm Grey (CI-CH)						140				
			10	SS	7						0 2 61 37
							139				
			11	SS	6		138				
			12	SS	5		137				
							136				
			13	SS	7		135				
							134				
			1	TW	PH						
	Very Soft to Soft						133				Commence casing and washboring
							132				
			14	SS	1						
							131				

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+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-2 3 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.7 E 291 445.8 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 17.10.03 - 21.10.03 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
	Silty **CLAY** to **CLAY** with sand and silt layers and seams Very Soft to Soft Grey (CI-CH)						130 129 128 127 126 125 124 123 122 121				
			15	SS	2				○		
			16	SS	3			≥10	○		0 0 62 37
			2	TW	PH						

Continued Next Page

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-2 4 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.7 E 291 445.8 (Bruce Street) ORIGINATED BY JL
HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS
DATUM Geodetic DATE 17.10.03 - 21.10.03 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Silty **CLAY** to **CLAY** with sand and silt layers and seams Soft to Firm Grey (CI-CH)		17	SS	4		120 119 118 117	○	○		
116.4			18	SS	11		116	○	○		
33.9	Silty **SAND** to Sandy **SILT**, trace to some clay Compact Grey Wet		19	SS	12		115 114		○		0 28 50 22
111.9							113 112				
38.4	Silty **CLAY** to **CLAY**, with sand and silt layers and seams Stiff Grey Wet		20	SS	9		111		○		

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-2 5 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.7 E 291 445.8 (Bruce Street) ORIGINATED BY JL
HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS
DATUM Geodetic DATE 17.10.03 - 21.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Silty **CLAY** to **CLAY**						110				
							109				
							108				
107.4											
42.9	Silty **SAND**, some gravel, frequent cobbles and boulders, occasional clayey silt seams/ partings Grey Very Dense Wet (TILL)		21	SS	26		107				Advancing NW casing and cleaning with NQ core barrel
			1	WS			106				
			2	WS			105				
			3	WS			104				
			4	WS			103				
							102				
			5	WS			101				

Continued Next Page

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-2 6 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 748.7 E 291 445.8 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 17.10.03 - 21.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
100.0			6	WS	FI		100				
50.3	**MARBLE (BEDROCK)** Slightly to moderately weathered, grey, brown and white with subhorizontal black banding, very strong Subvertical joint from 50.8m to 50.9m. Vertical joint at 52.7m.		1	RUN	0 2 4 3 3		99				RUN 1# TCR=100%, SCR=73%, RQD=52%, UCS=128MPa
			2	RUN	1 4 3 5 4		98				RUN 2# TCR=98%, SCR=88%, RQD=63%, UCS=133MPa
97.1											
53.2	END OF BOREHOLE AT 53.2m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE ELEVATION(m) 22/10/2003 148.5 18/12/2003 destroyed										

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-3 1 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 768.7 E 291 479.6 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 27.10.03 - 29.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.3												
149.2	**TOPSOIL** (150mm)											
0.2	Black Silty **CLAY** to **CLAY**, trace rootlets, trace gravel to 1.4m Stiff to Very Stiff Brown Moist to Wet (CI-CH) (dessicated crust)		1	SS	8		149					
			2	SS	15		148					
			3	SS	16		147					
			4	SS	10							0 0 40 60
			5	SS	6		146					
			6	SS	10		145					
			7	SS	10		144					
142.2							143					
7.1	becoming grey						142					
	frequent sand and silt layers and seams		8	SS	8		141					Vane could not be turned
			9	SS	11		140					
139.3												

Continued Next Page

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-3 2 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 768.7 E 291 479.6 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 27.10.03 - 29.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
10.0	Silty **CLAY** to **CLAY** Stiff Grey (CI-CH) (dessicated crust)						139				
			10	SS	12		138		○		
			11	SS	12		137		○		
			12	SS	12		136		○		
	with sand and silt layers and seams below this level						135				
			13	SS	9		134		○		0 2 73 25
			14	SS	7		133		○		
	Firm						132				Commence casing and washboring Vane could not be turned
			15	SS	5		131		○		
129.3							130				

Continued Next Page

+ ³, × ³ : Numbers refer to Sensitivity

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-3 3 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 768.7 E 291 479.6 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 27.10.03 - 29.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
20.0	Silty **CLAY** to **CLAY**, with sand and silt layers and seams Soft to Firm Grey (CI-CH)						129				
							128				
			1	TW	PH						
							127				Vane could not be turned Casing sank under self weight from 22.5m to 24.4m depth
							126				
							125				
			16	SS	1				○		
							124				
							123				Casing sank under self weight from 25.9m to 27.4m depth
	move frequent sand and silt layers and seams						122				
							121				
			17	SS					○		0 3 78 19
							120				Sampler dropped down hole, no "N" value obtained
119.3											

Continued Next Page

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-3 4 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 768.7 E 291 479.6 (Bruce Street) ORIGINATED BY JL
HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS
DATUM Geodetic DATE 27.10.03 - 29.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
30.0	Silty **CLAY** to **CLAY**, with sand and silt layers and seams Stiff Grey (CI-CH)		18	SS	14		119 118 117 116	○ at 40	○ at 40		Vane could not be turned
115.6											
33.7	Silty **SAND** to Sandy **SILT** Very Dense Grey Wet		19	SS	97/.279		115 114	○ at 40	○ at 20, ○ at 40		0 73 27 (SI+CL)
113.2											
36.1	Silty **CLAY** to **CLAY**, with sand and silt layers and seams Hard Grey Wet		20	SS	50/.127		113 112		○ at 20		
	frequent inferred cobbles		21	SS	50/.076		111 110		○ at 20		
109.3											

Continued Next Page

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

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

ONTMT4 7450BRU.GPJ 04/06/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-3 5 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 768.7 E 291 479.6 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 27.10.03 - 29.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
40.0	Silty **CLAY** to **CLAY**, with sand and silt layers and seams Grey						109				
							108				
							107				
	some gravel, occasional cobbles and boulders		1	WS			106				
105.2											
44.1	Silty **SAND**, some gravel, occasional cobbles and boulders Grey Wet (TILL)						105				
	boulder from 45.11m to 45.49m		2	WS			104				
			3	WS			103		○		
							102				
100.7					FI		101				
48.6	**MARBLE (BEDROCK)** Slightly to moderately weathered, grey, brown and white with subhorizontal black banding, strong Multiple subvertical joints at 50.2m Subvertical joints at 49.2m and 50.0m Vertical joint at 50.9m		1	RUN	0 3 3 3		100				RUN 1# TCR=100%, SCR=100%, RQD=79%, UCS=90MPa

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BRU-3 6 OF 6 METRIC

G.W.P. 647-92-00 LOCATION N 5 039 768.7 E 291 479.6 (Bruce Street) ORIGINATED BY JL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers, Casing and Washboring, NQ Coring COMPILED BY SS

DATUM Geodetic DATE 27.10.03 - 29.10.03 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	MARBLE		2	RUN	2 3 0 5		99				RUN 2# TCR=100%, SCR=98%, RQD=78%, UCS=99MPa
98.1											
51.2	END OF BOREHOLE AT 51.18m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	ELEVATION(m)
18/12/2003	145.8
04/02/2004	145.2
11/03/2004	145.7

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

20
15 ◇ 5
10
(%) STRAIN AT FAILURE

ONTMT4 7450BRU.GPJ 04/06/04

THURBER

Appendix B.3

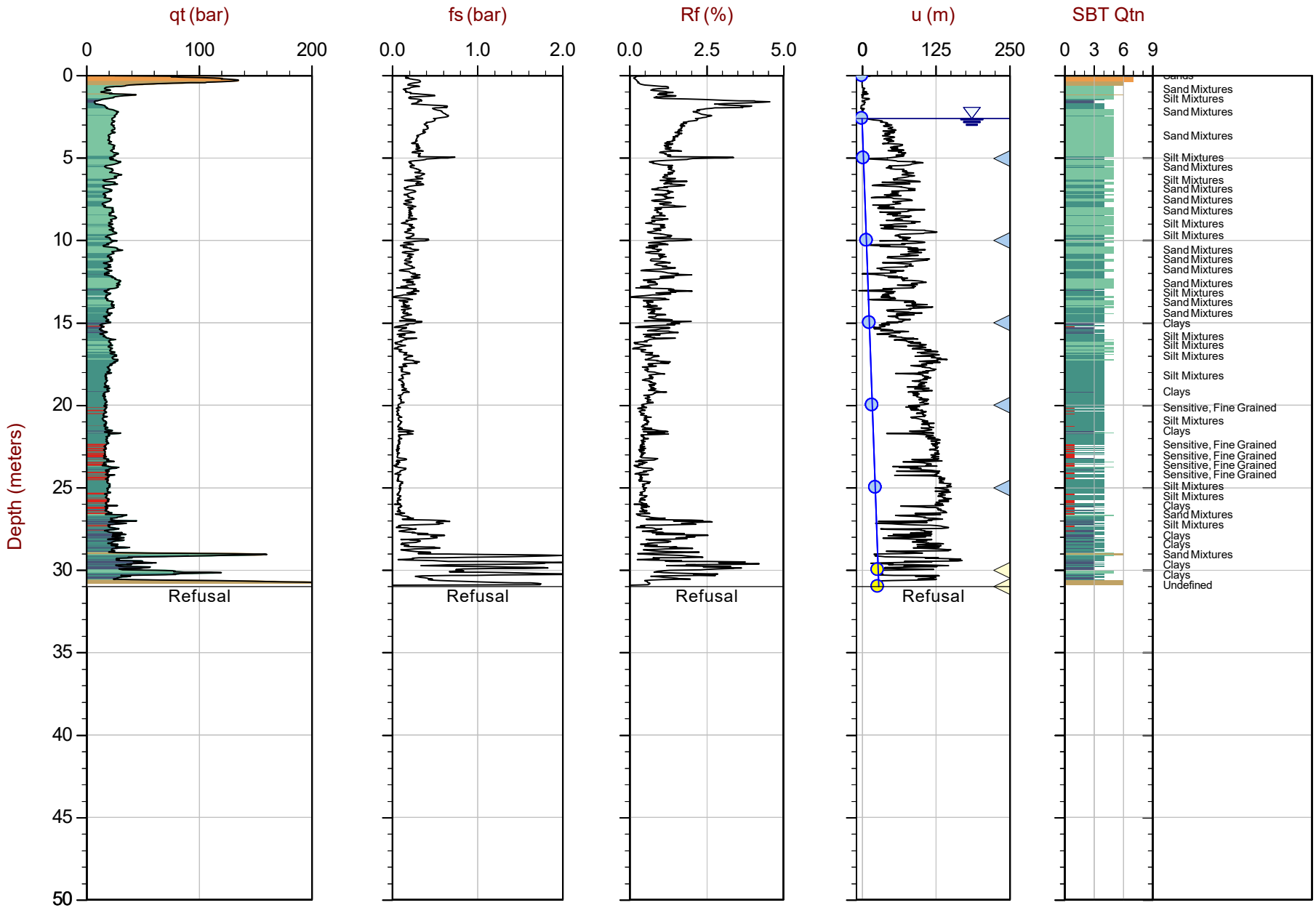
Cone Penetration Test Summary Sheets (ConeTec Investigations Ltd.)

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-28 07:10
Site: Bruce Street

Sounding: BRU19-05
Cone: 377:T1000F10U500



Max Depth: 31.000 m / 101.70 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

File: 19-05076_CP05.COR
Unit Wt: SBTQtn (PKR2009)

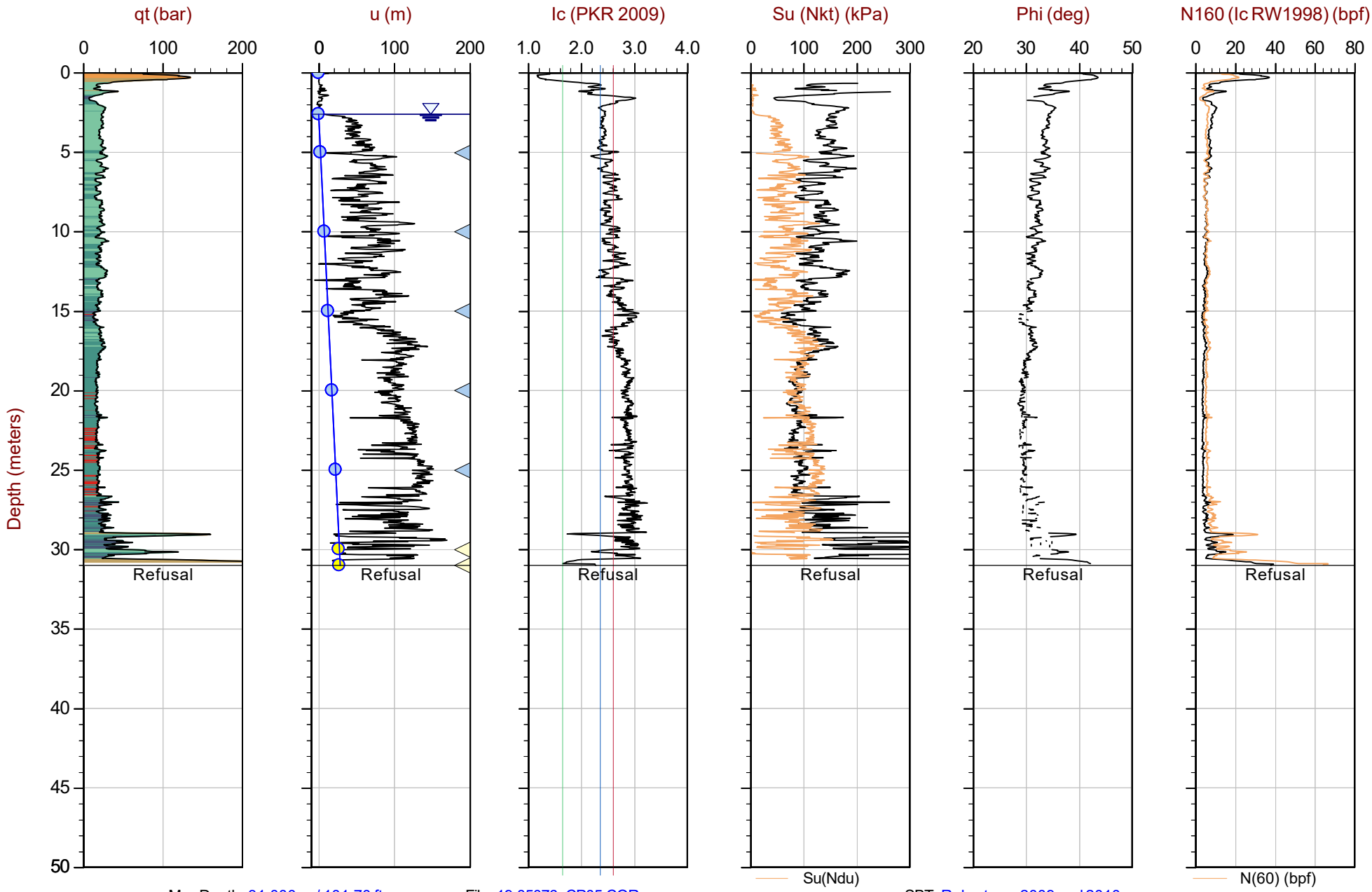
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039813.70m E: 291524.10m Elev: 149.00m
Sheet No: 1 of 1

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-28 07:10
Site: Bruce Street

Sounding: BRU19-05
Cone: 377:T1000F10U500



Max Depth: 31.000 m / 101.70 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

File: 19-05076_CP05.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

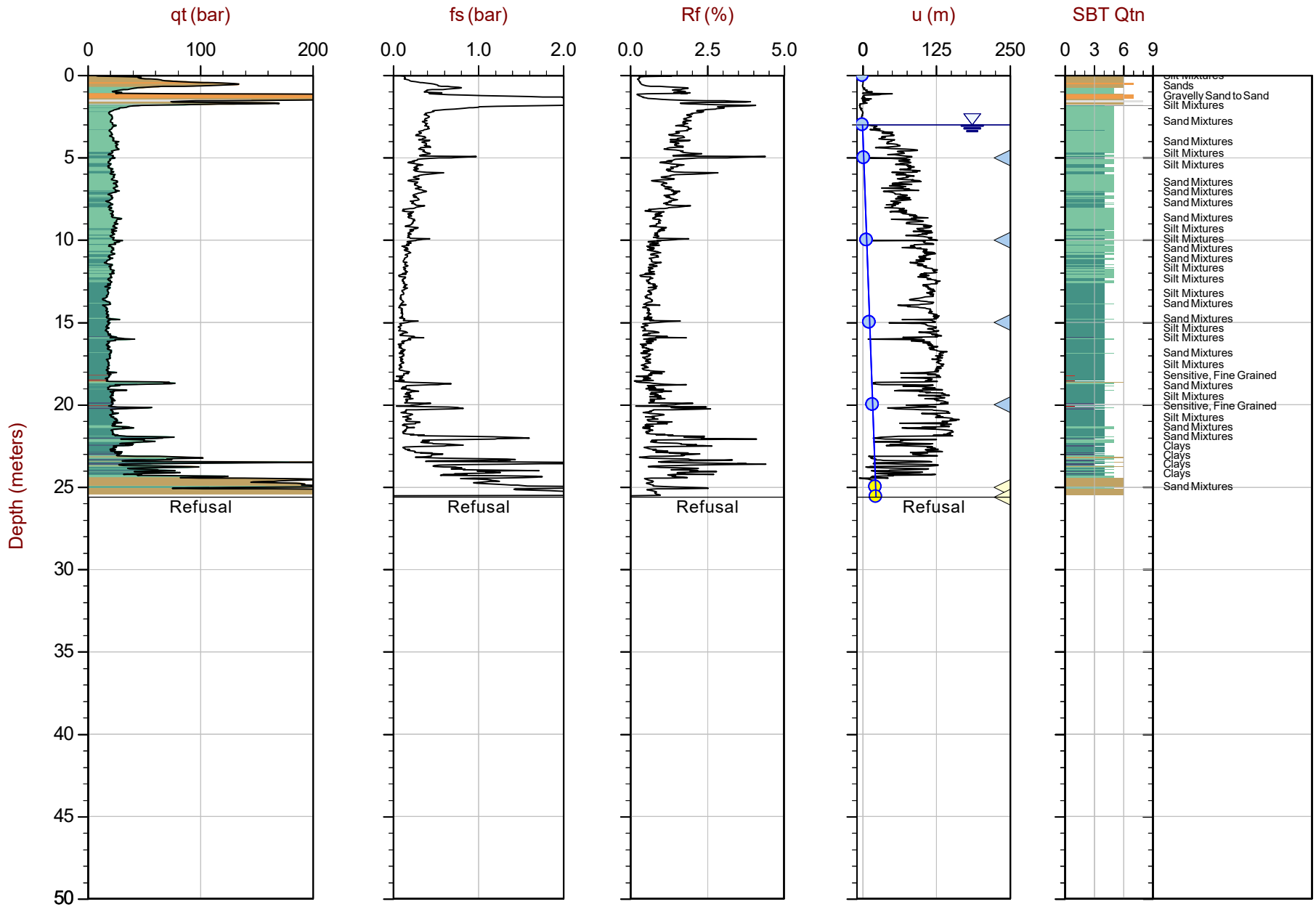
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039813.70m E: 291524.10m Elev: 149.00m
Sheet No: 1 of 1

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-27 13:44
Site: Bruce Street

Sounding: BRU19-08
Cone: 377:T1000F10U500



Max Depth: 25.600 m / 83.99 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 19-05076_CP08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039910.20m E: 291640.10m Elev: 147.40m
Sheet No: 1 of 1

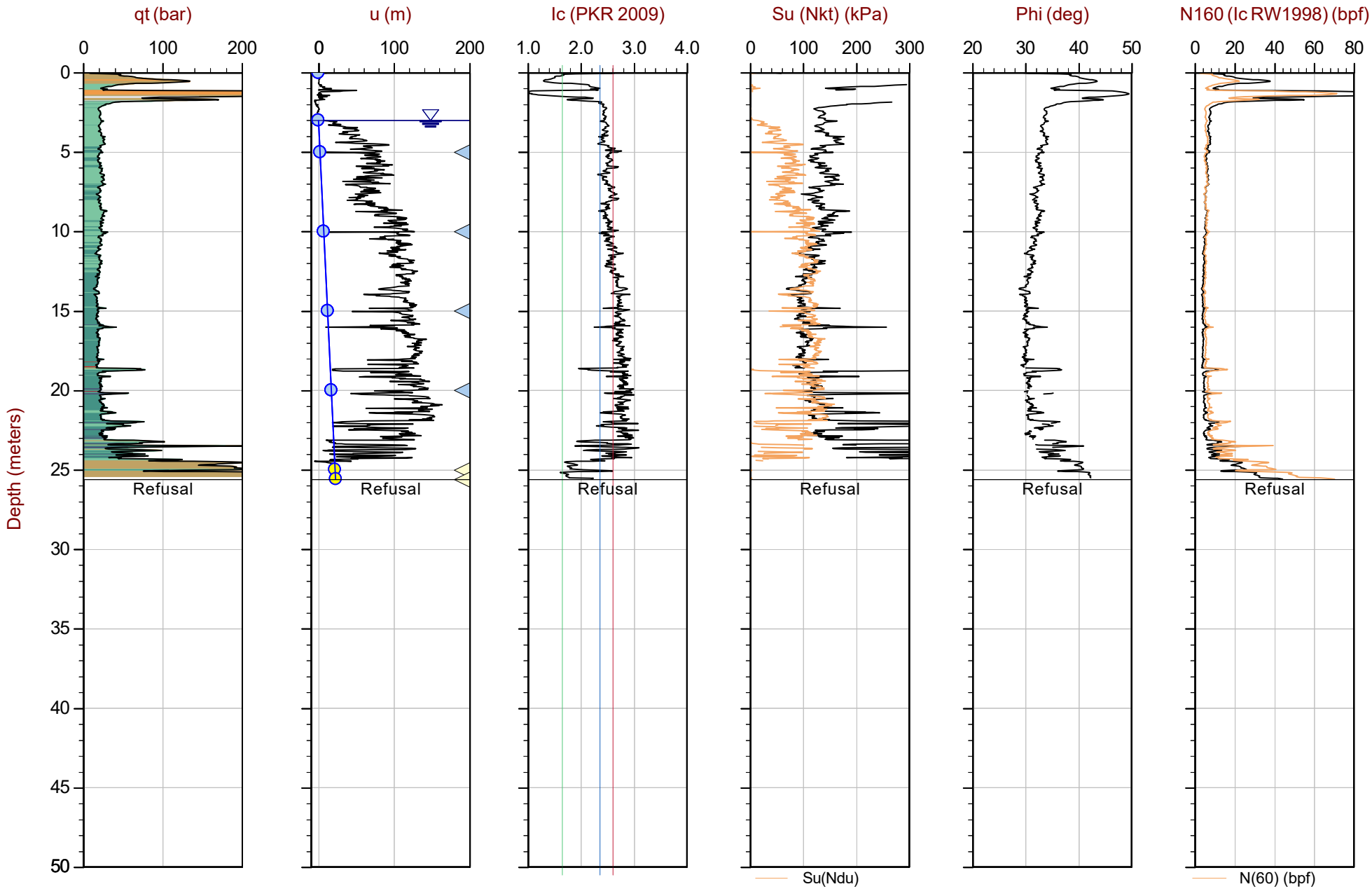
Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-27 13:44
Site: Bruce Street

Sounding: BRU19-08
Cone: 377:T1000F10U500



Max Depth: 25.600 m / 83.99 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

File: 19-05076_CP08.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

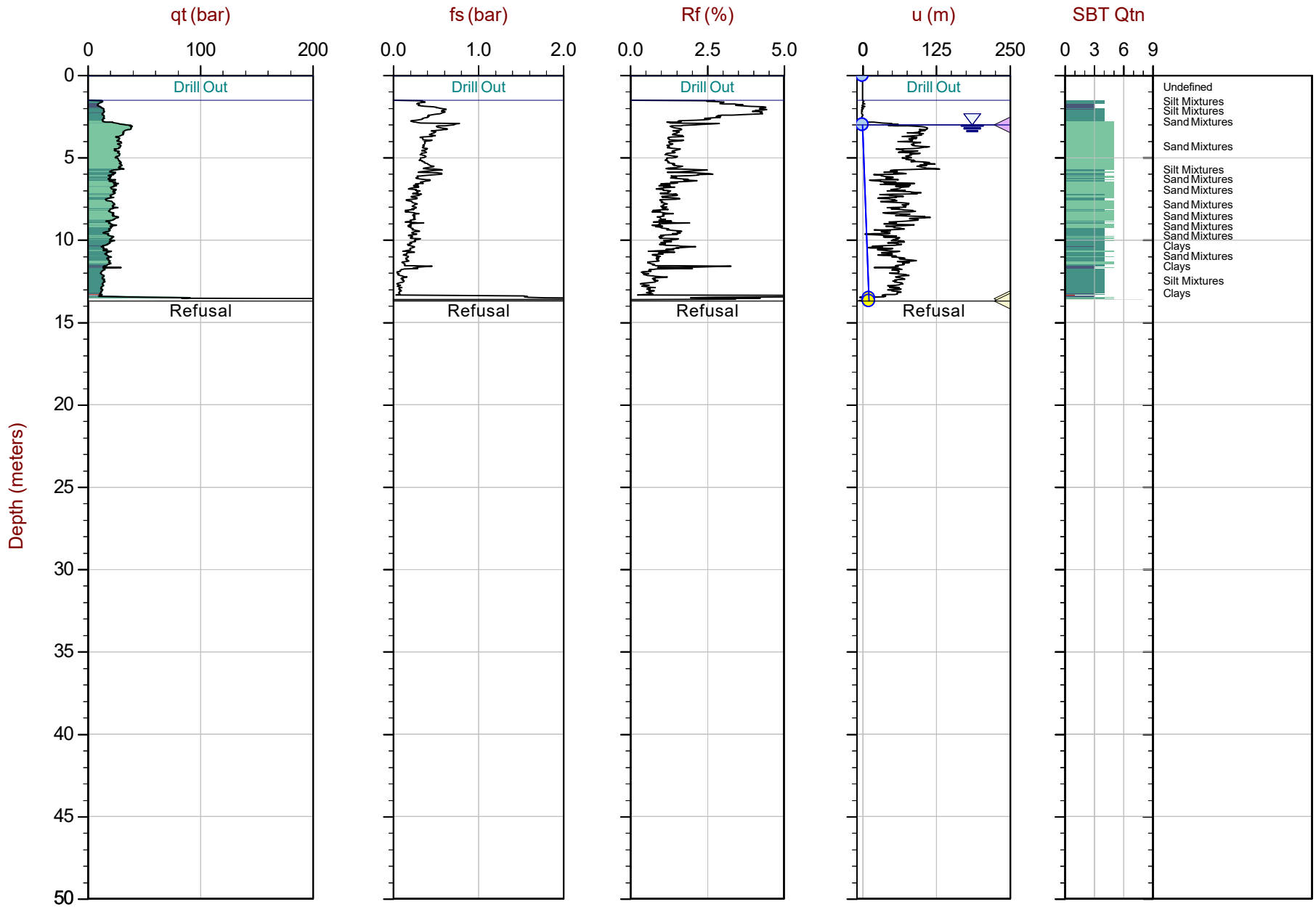
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039910.20m E: 291640.10m Elev: 147.40m
Sheet No: 1 of 1

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-27 07:45
Site: Bruce Street

Sounding: BRU19-11
Cone: 377:T1000F10U500



Max Depth: 13.700 m / 44.95 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 19-05076_CP11.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039628.10m E: 291230.20m Elev: 152.70m
Sheet No: 1 of 1

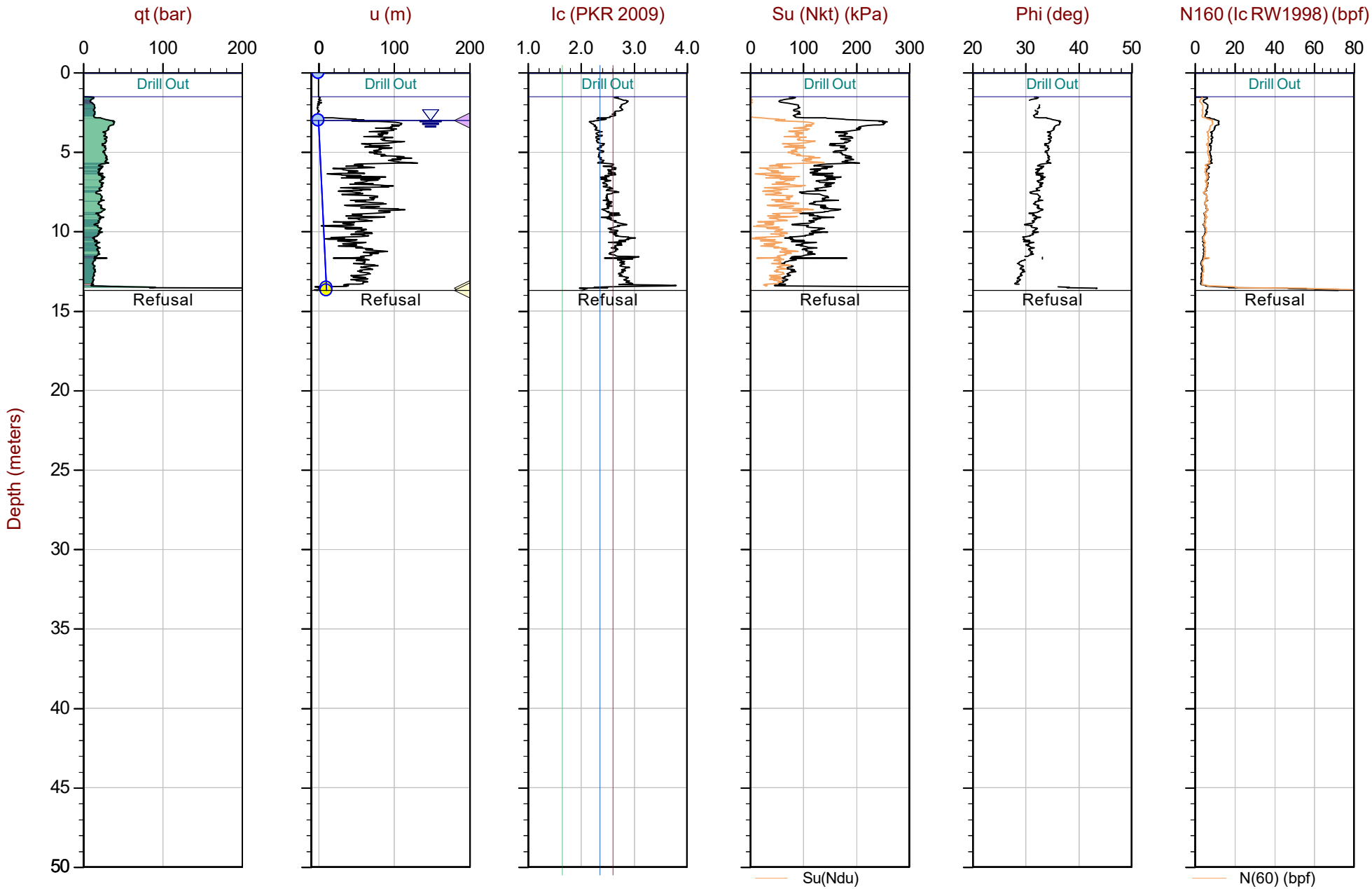
Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-27 07:45
Site: Bruce Street

Sounding: BRU19-11
Cone: 377:T1000F10U500



Max Depth: 13.700 m / 44.95 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

File: 19-05076_CP11.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

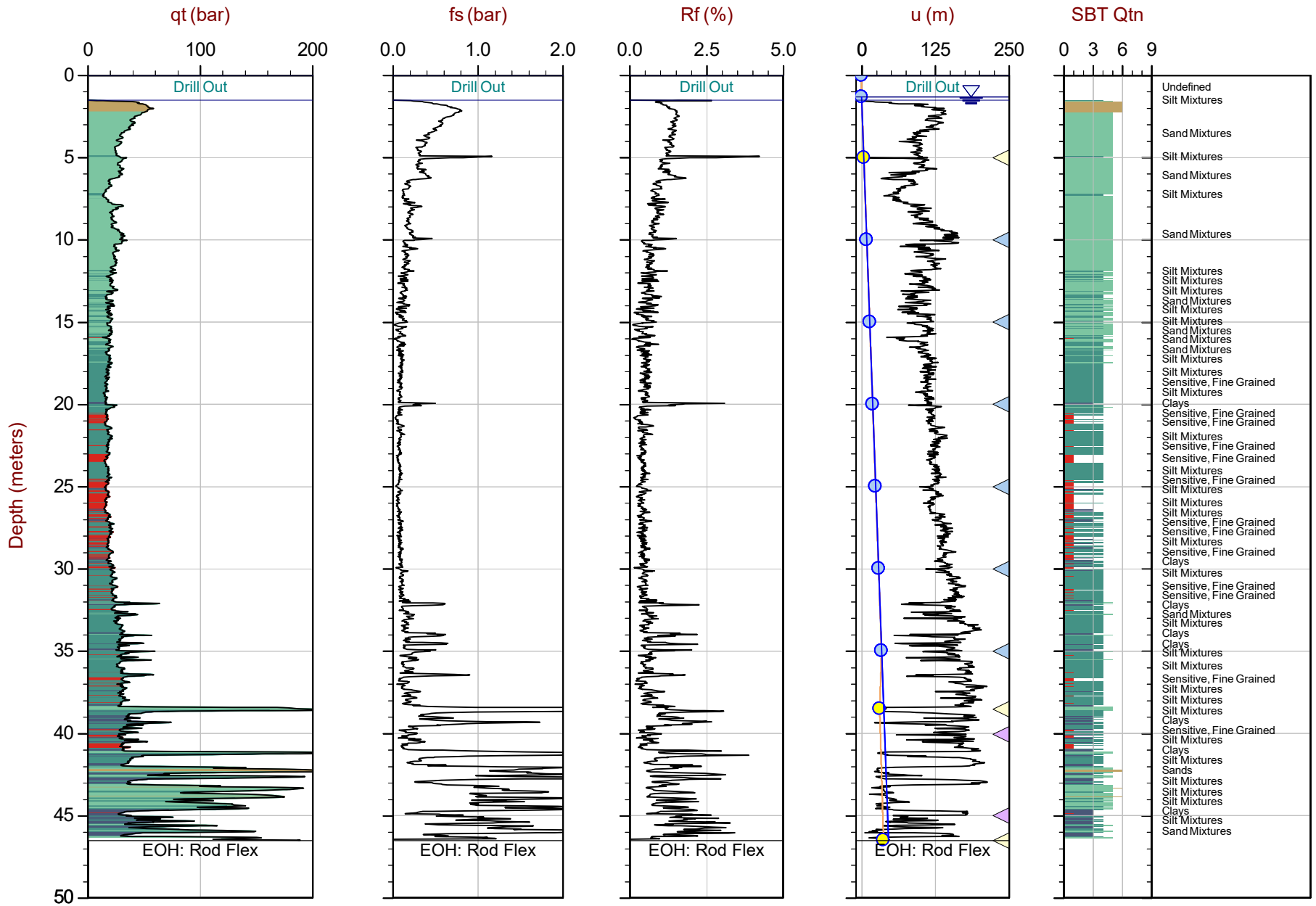
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039628.10m E: 291230.20m Elev: 152.70m
Sheet No: 1 of 1

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-26 11:31
Site: Bruce Street

Sounding: BRU19-14
Cone: 377:T1000F10U500



Max Depth: 46.525 m / 152.64 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line, Ueq Line

File: 19-05076_CP14.COR
Unit Wt: SBTQtn (PKR2009)

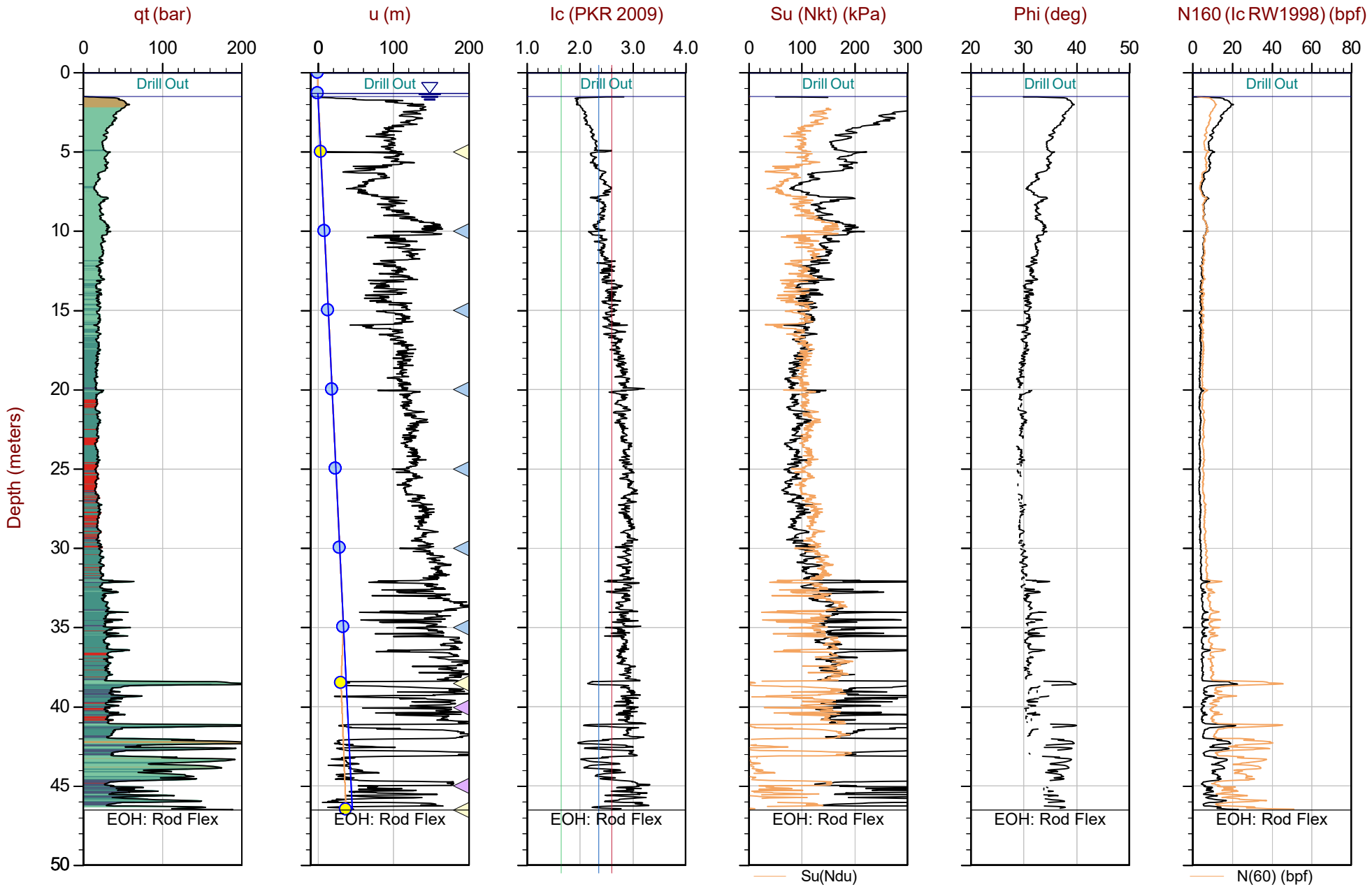
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039706.80m E: 291367.50m Elev: 152.60m
Sheet No: 1 of 1

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-26 11:31
Site: Bruce Street

Sounding: BRU19-14
Cone: 377:T1000F10U500



Max Depth: 46.525 m / 152.64 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 19-05076_CP14.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

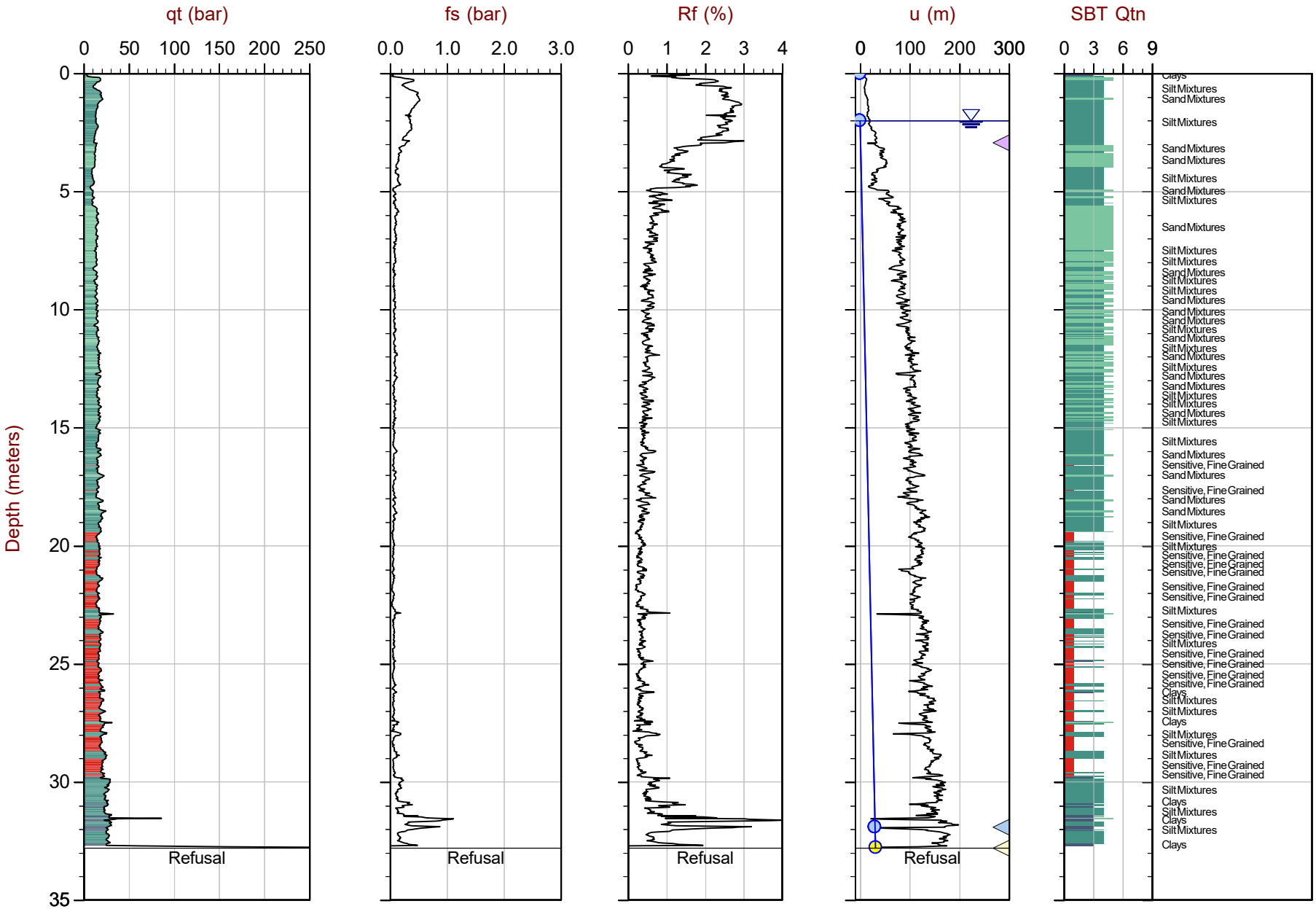
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039706.80m E: 291367.50m Elev: 152.60m
Sheet No: 1 of 1

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line, Ueq Line

Thurber Engineering

Job No: 21-05-22576
Date: 2021-08-04 08:13
Site: Renfrew Ontario

Sounding: BRU-19-17
Cone: 609:T1500F15U35



Max Depth: 32.800 m / 107.61 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Assumed Ueq, Ueq

File: 21-05-22576_CP-19-17.COR
Unit Wt: SBTQtn (PKR2009)

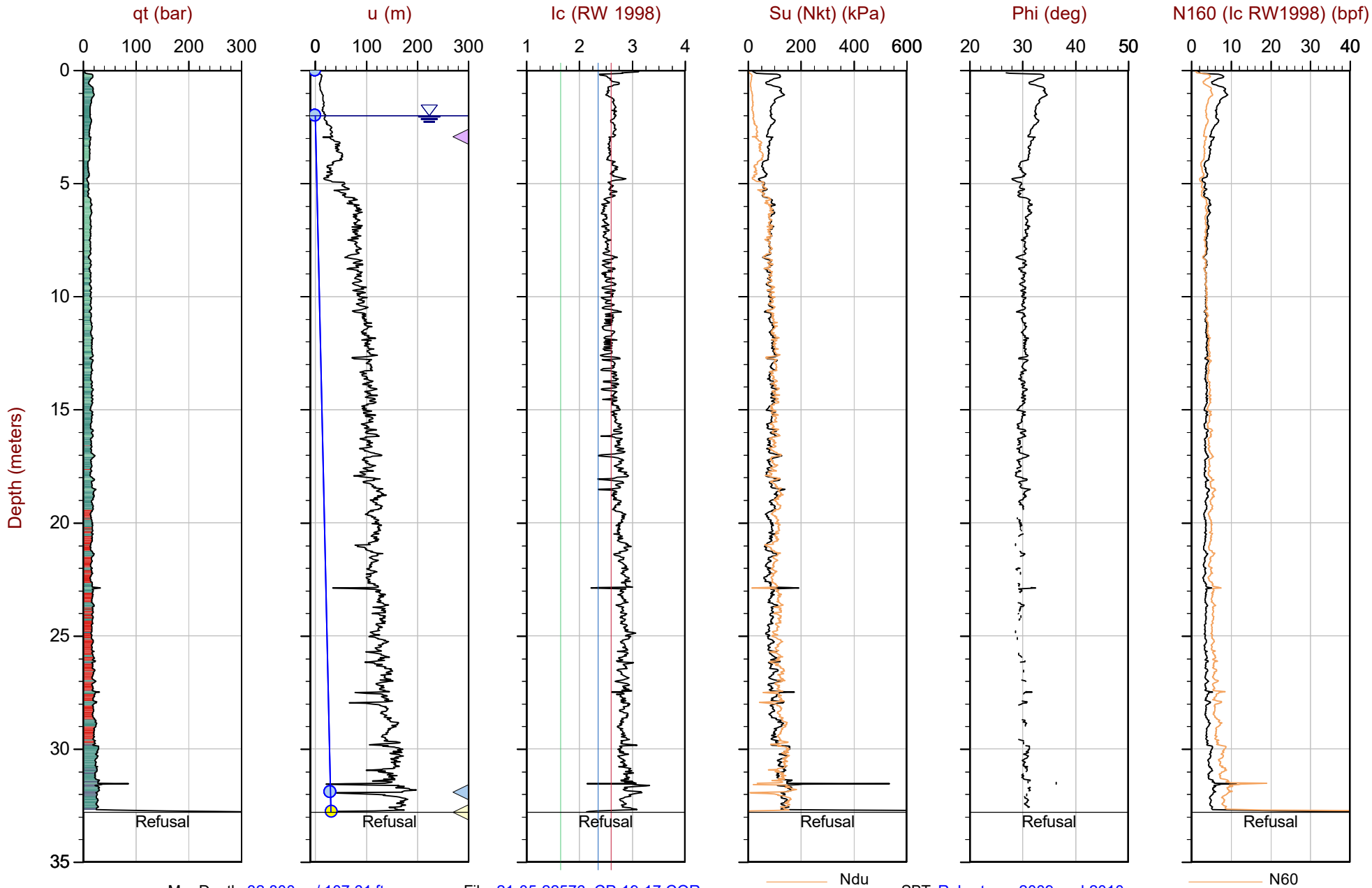
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039729.30m E: 291240.20m Elev: 149.9m
Page No: 1 of 1

Dissipation, equilibrium achieved
Dissipation, equilibrium assumed
Hydrostatic Line
Dissipation, equilibrium not achieved
Equilibrium Profile

Thurber Engineering

Job No: 21-05-22576
Date: 2021-08-04 08:13
Site: Renfrew Ontario

Sounding: BRU-19-17
Cone: 609:T1500F15U35



Max Depth: 32.800 m / 107.61 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item:

File: 21-05-22576_CP-19-17.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039729.30m E: 291240.20m Elev: 149.9m
Page No: 1 of 1

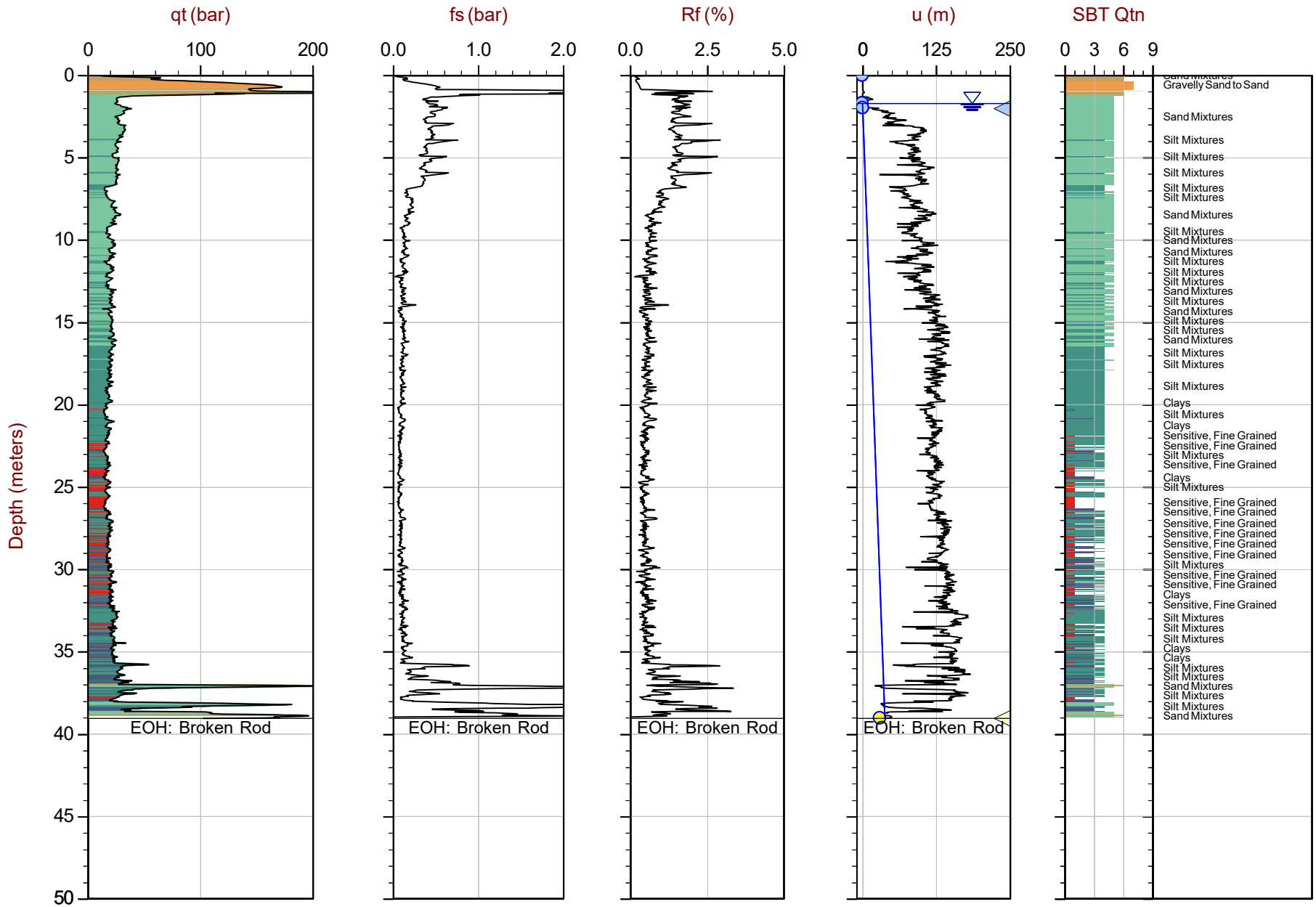
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium assumed
Hydrostatic Line
Equilibrium Profile
Dissipation, equilibrium not achieved

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-26 07:42
Site: Bruce Street

Sounding: BRU19-20
Cone: 377:T1000F10U500



Max Depth: 39.050 m / 128.12 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

File: 19-05076_SP20.COR
Unit Wt: SBTQtn (PKR2009)

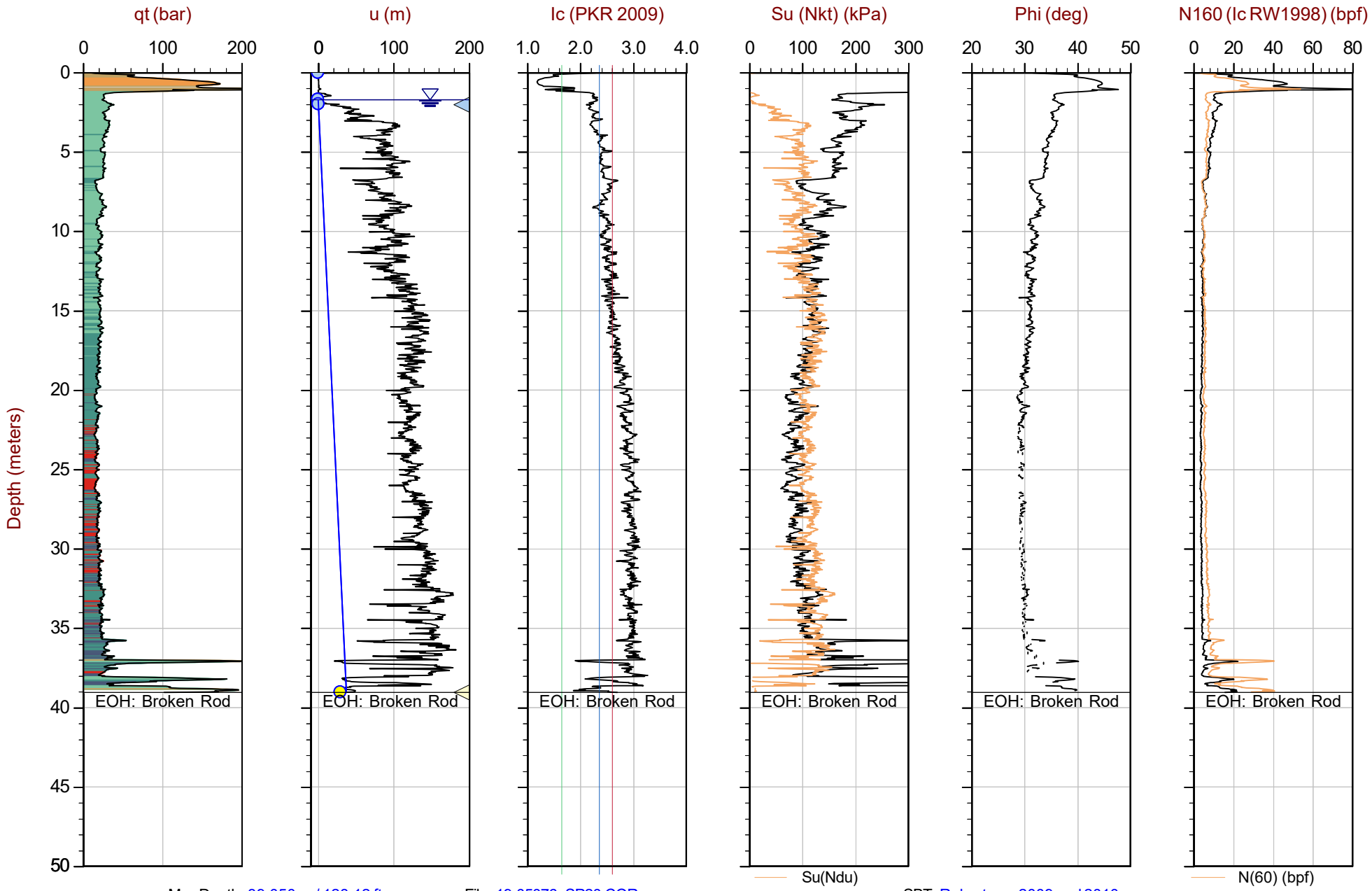
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039735.10m E: 291411.00m Elev: 152.10m
Sheet No: 1 of 1

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-26 07:42
Site: Bruce Street

Sounding: BRU19-20
Cone: 377:T1000F10U500



Max Depth: 39.050 m / 128.12 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 19-05076_SP20.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039735.10m E: 291411.00m Elev: 152.10m
Sheet No: 1 of 1

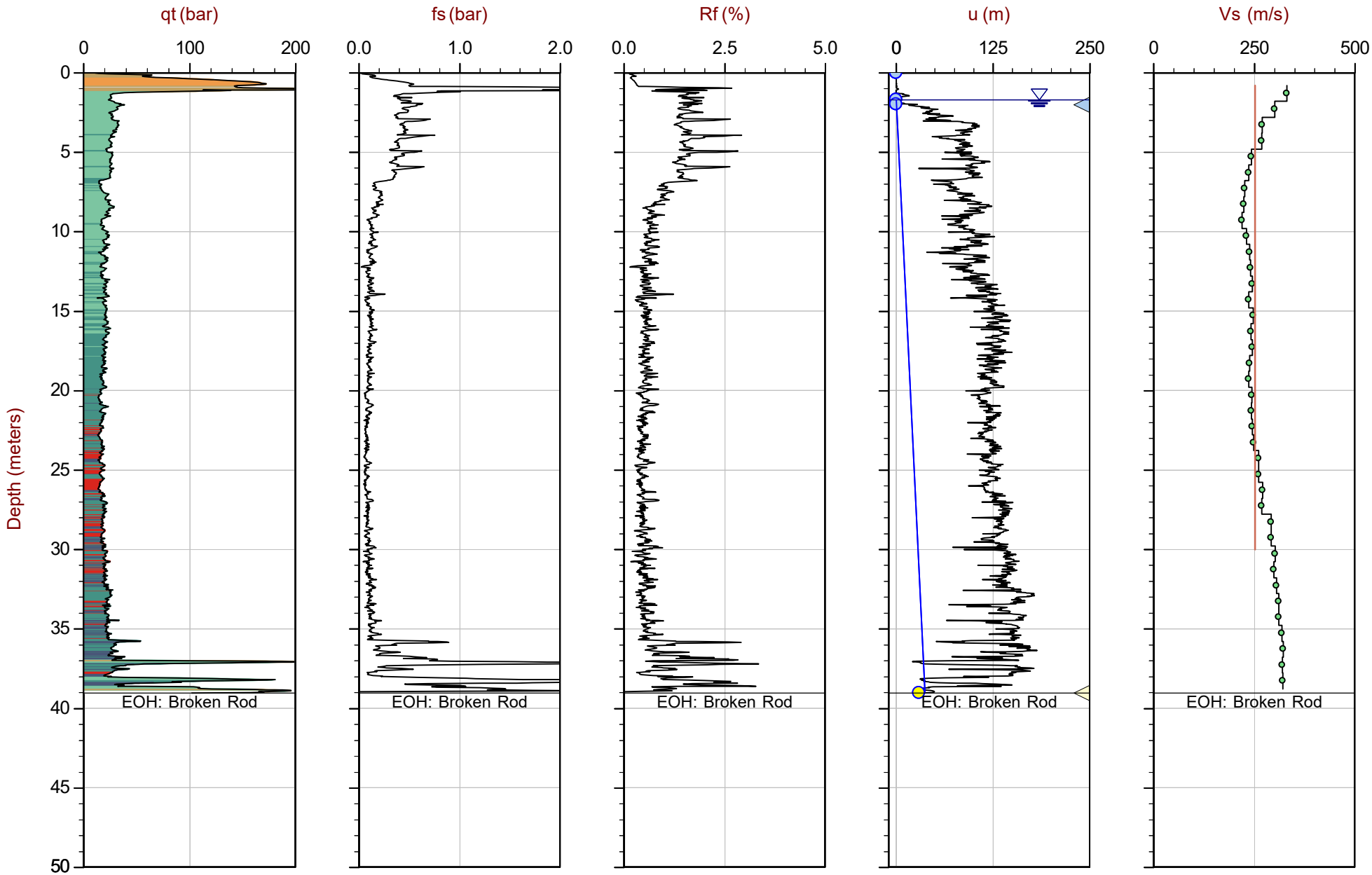
Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-26 07:42
Site: Bruce Street

Sounding: BRU19-20
Cone: 377:T1000F10U500



Max Depth: 39.050 m / 128.12 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 19-05076_SP20.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039735.10m E: 291411.00m Elev: 152.10m
Sheet No: 1 of 1

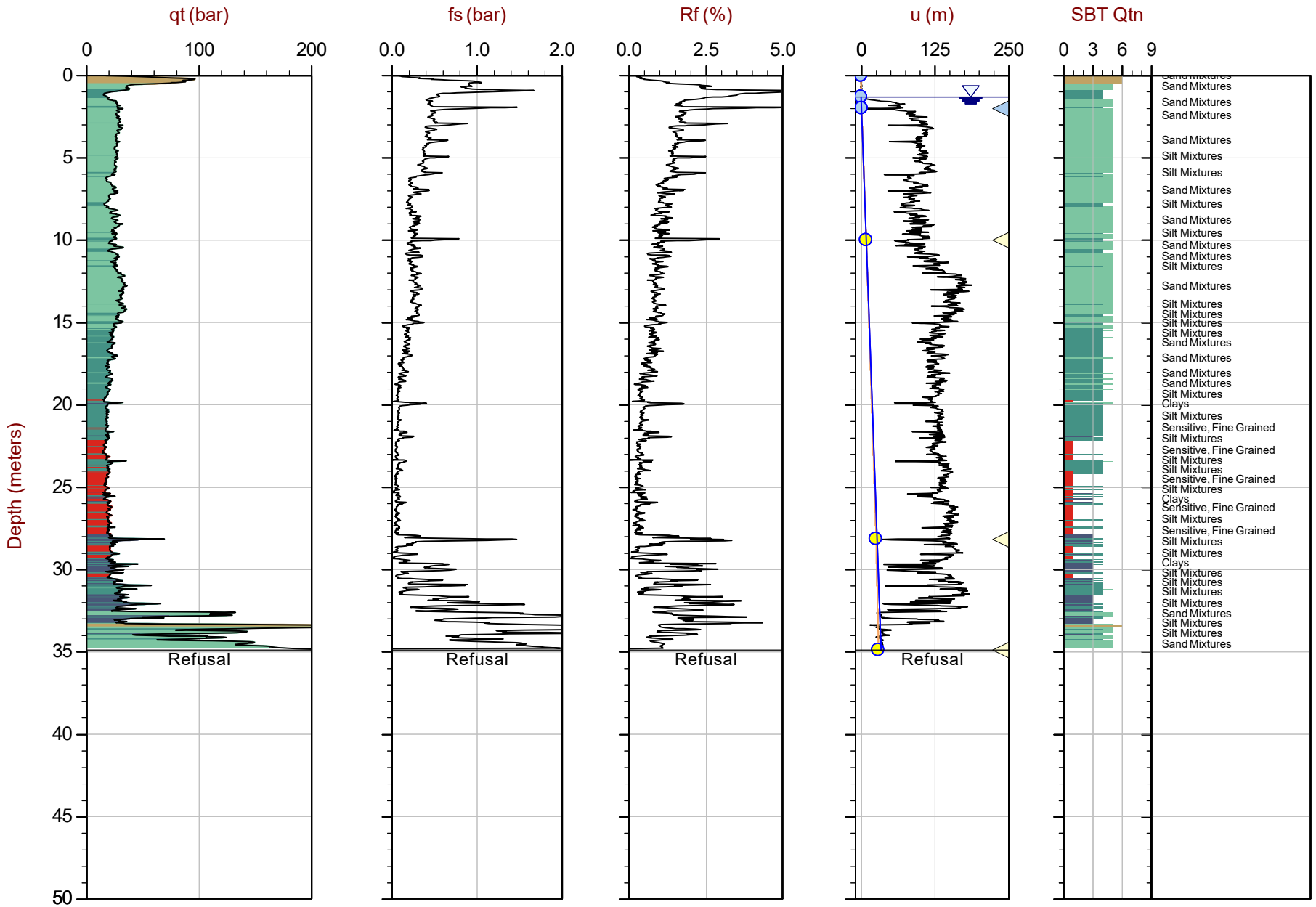
Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-28 10:39
Site: Bruce Street

Sounding: BRU19-24
Cone: 377:T1000F10U500



Max Depth: 34.900 m / 114.50 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line, Ueq Line

File: 19-05076_SP24.COR
Unit Wt: SBTQtn (PKR2009)

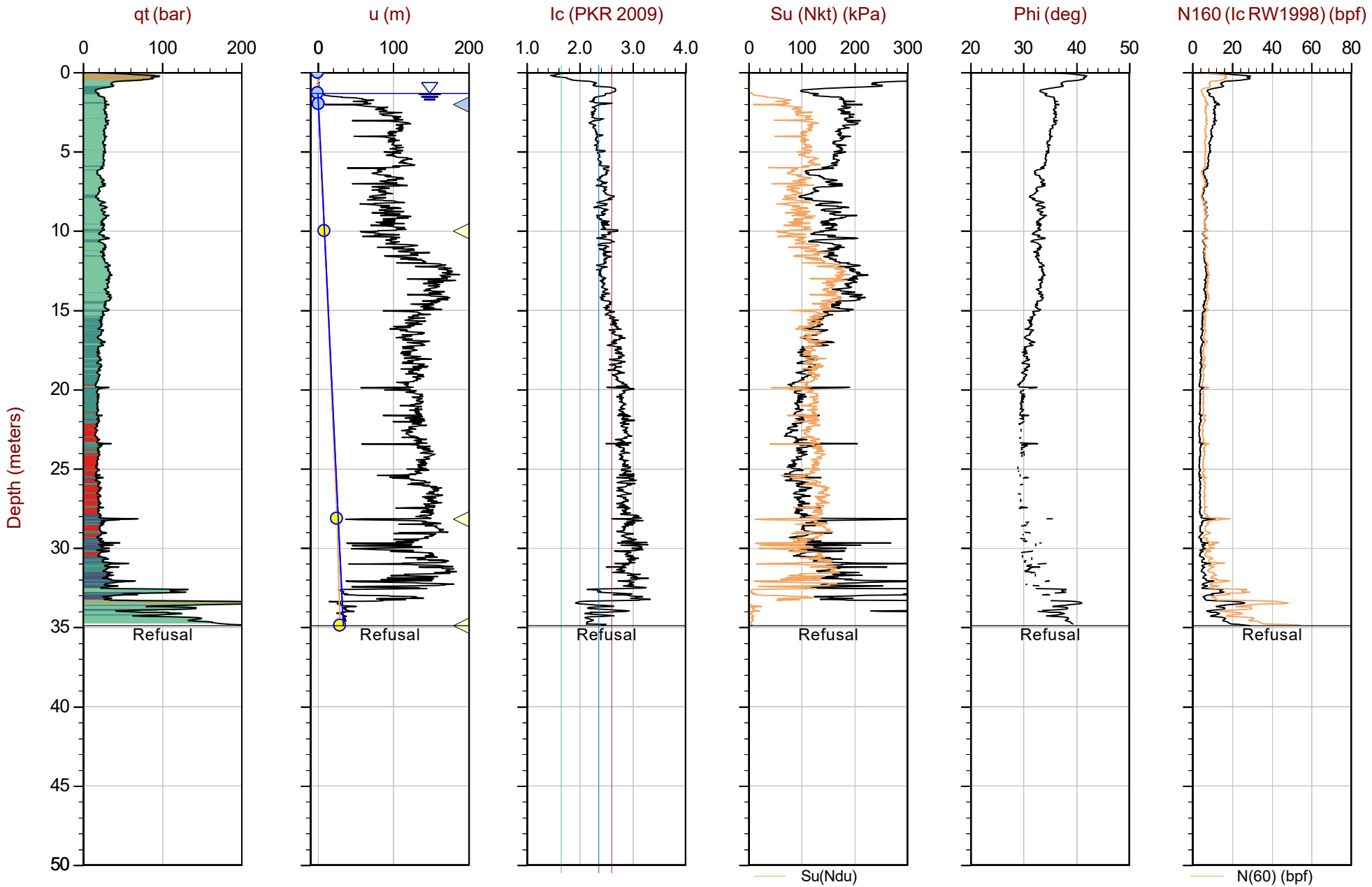
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039779.70m E: 291476.80m Elev: 149.70m
Sheet No: 1 of 1

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-28 10:39
Site: Bruce Street

Sounding: BRU19-24
Cone: 377:T1000F10U500



Max Depth: 34.900 m / 114.50 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 19-05076_SP24.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039779.70m E: 291476.80m Elev: 149.70m
Sheet No: 1 of 1

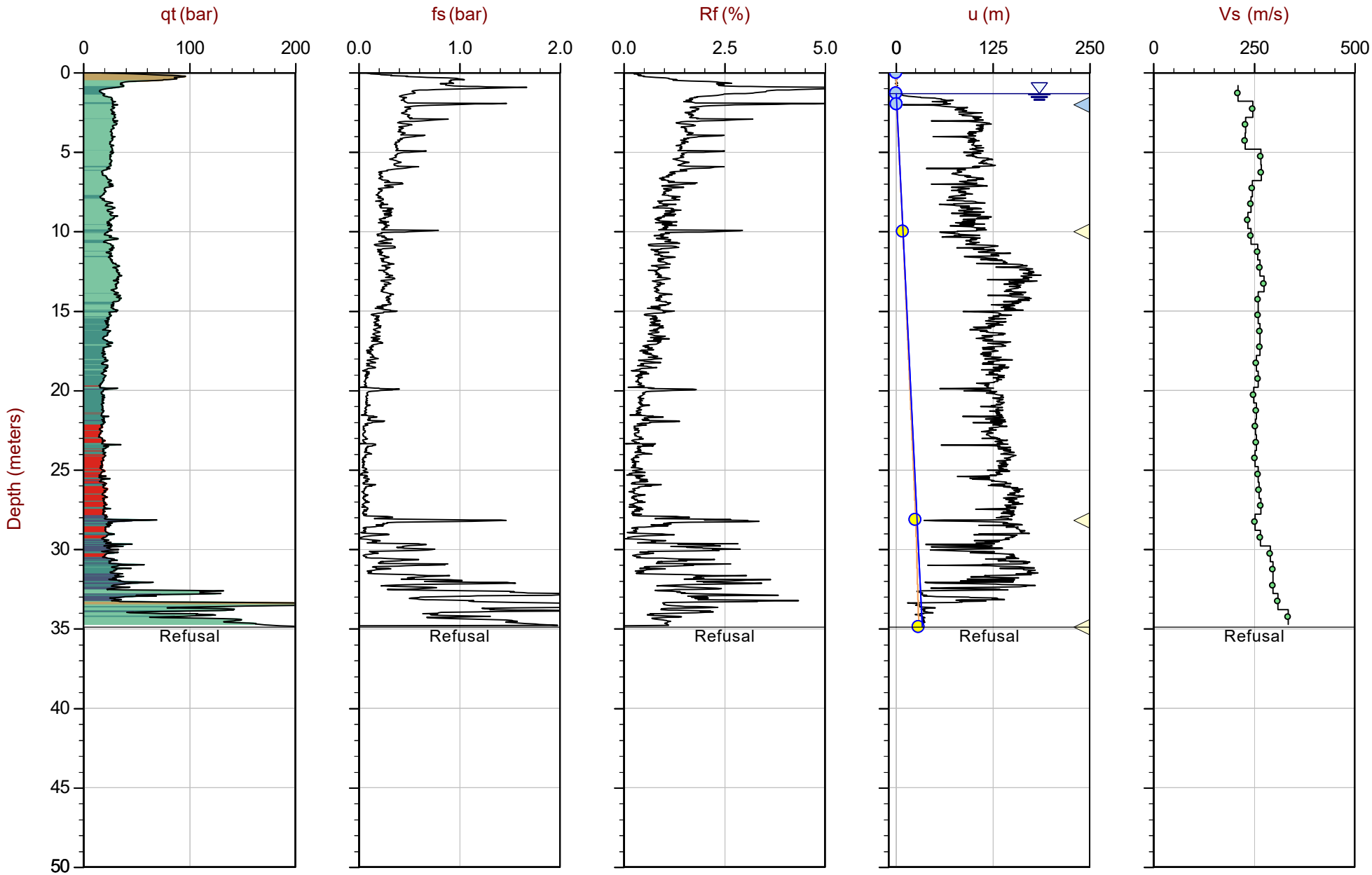
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line, Ueq Line

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-28 10:39
Site: Bruce Street

Sounding: BRU19-24
Cone: 377:T1000F10U500



Max Depth: 34.900 m / 114.50 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 19-05076_SP24.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039779.70m E: 291476.80m Elev: 149.70m
Sheet No: 1 of 1

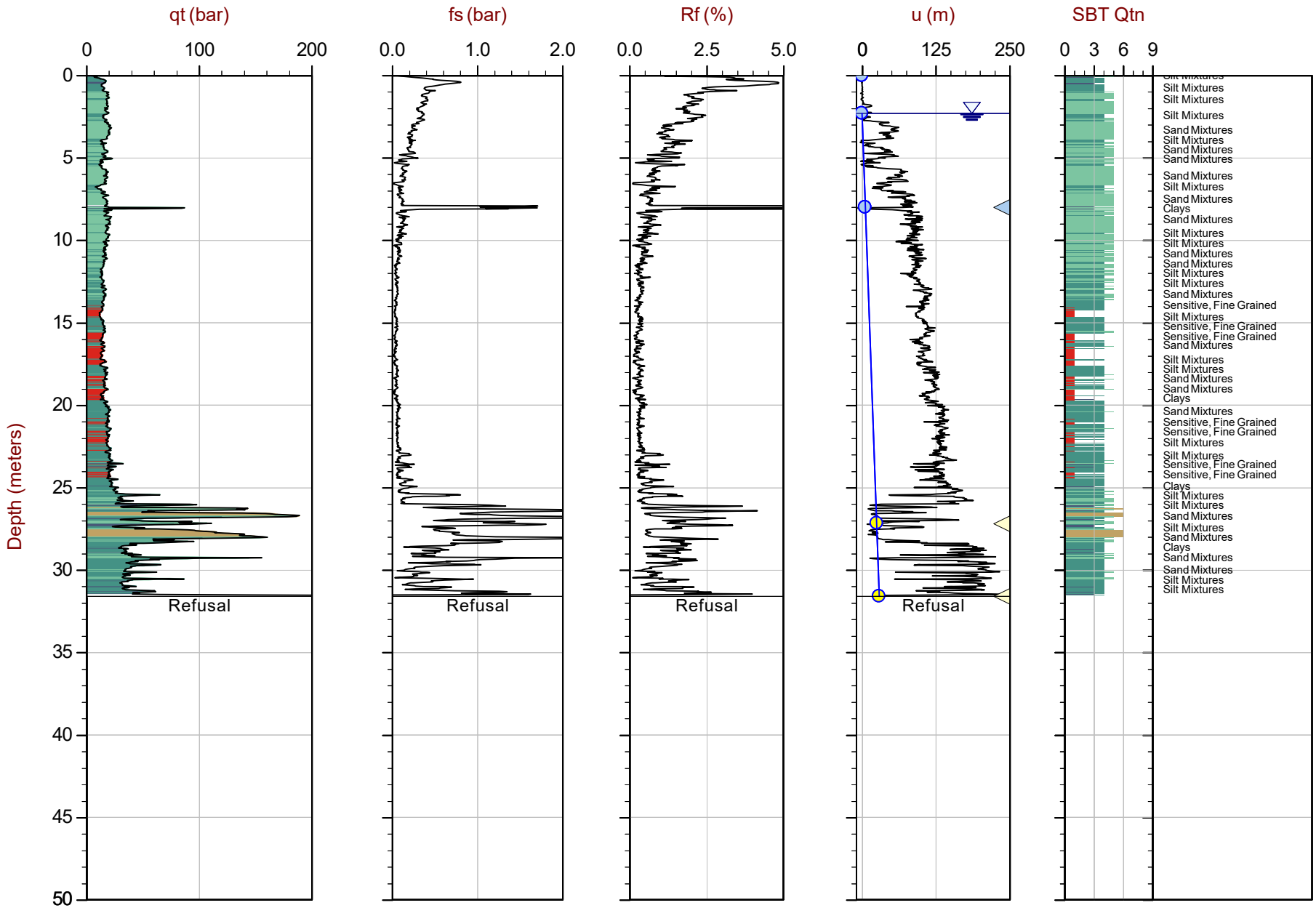
Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line | Ueq Line

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-27 10:25
Site: Bruce Street

Sounding: BRU19-32
Cone: 377:T1000F10U500



Max Depth: 31.600 m / 103.67 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point
Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, Hydrostatic Line

File: 19-05076_CP32.COR
Unit Wt: SBTQtn (PKR2009)

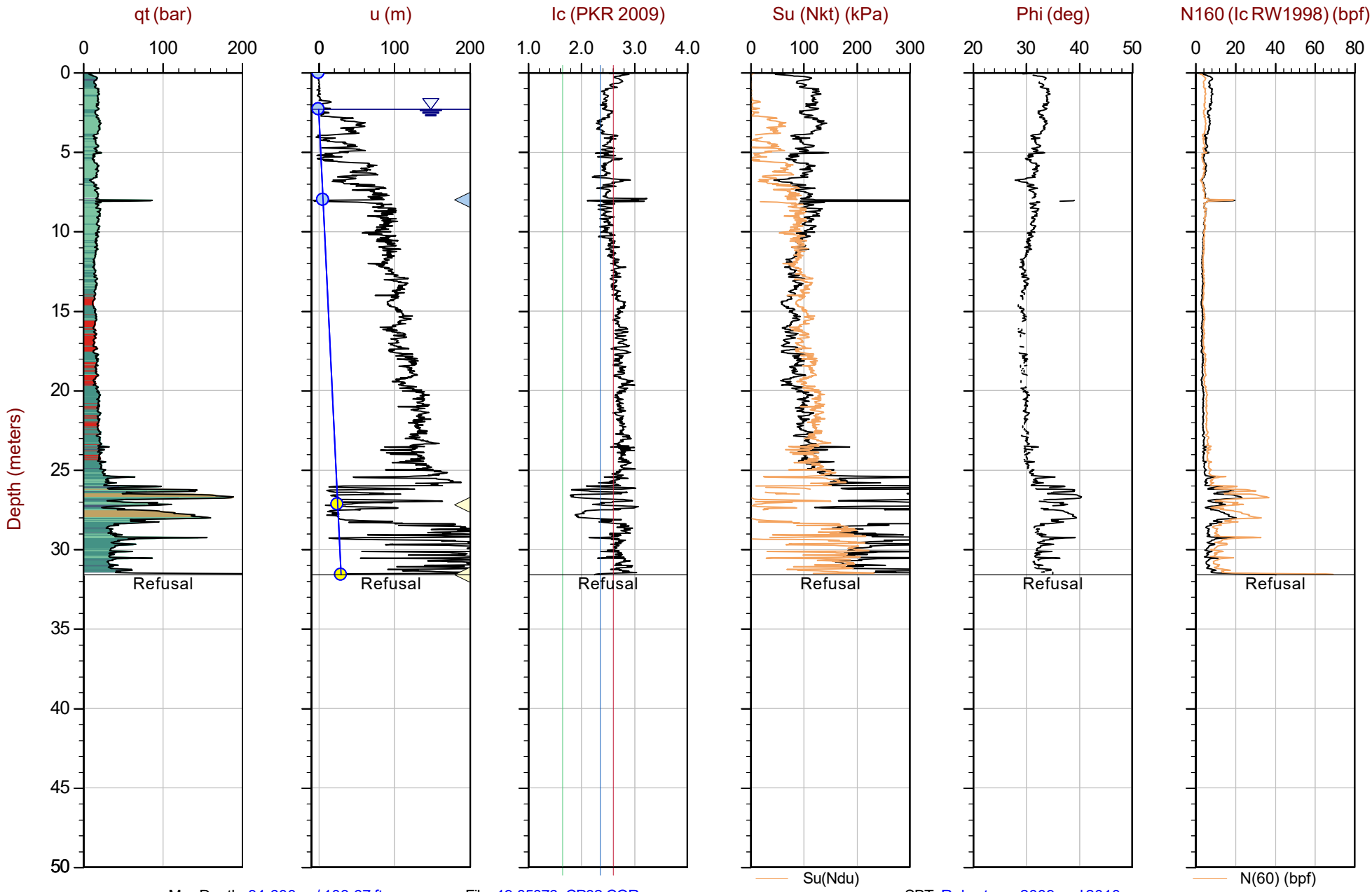
SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039793.00m E: 291638.40m Elev: 146.90m
Sheet No: 1 of 1

CONETEC

Thurber

Job No: 19-05076
Date: 2019-11-27 10:25
Site: Bruce Street

Sounding: BRU19-32
Cone: 377:T1000F10U500



Max Depth: 31.600 m / 103.67 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 19-05076_CP32.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt/Ndu: 15.0 / 9.0

SBT: Robertson, 2009 and 2010
Coords: MTM 9N N: 5039793.00m E: 291638.40m Elev: 146.90m
Sheet No: 1 of 1

Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

THURBER

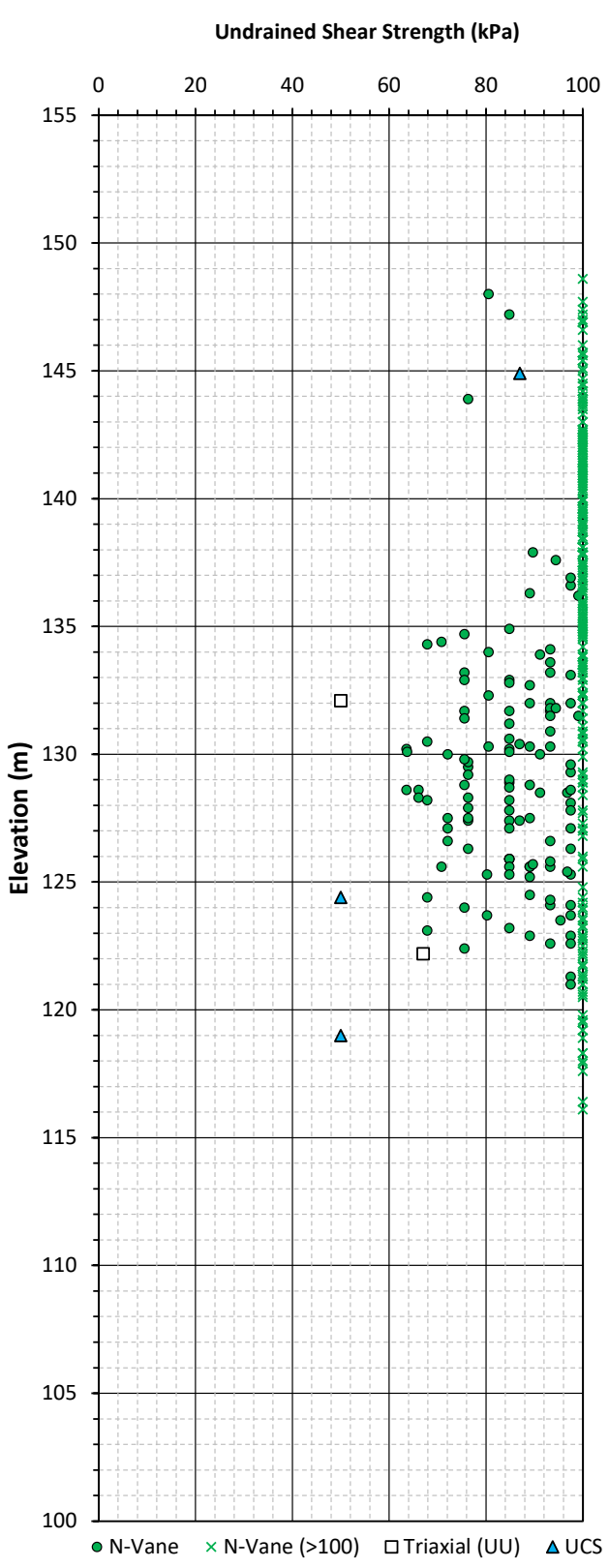
Appendix B.4

Soil Summary Figures

FIGURE B4.1

SOIL SUMMARY - BRUCE STREET ALIGNMENT

(BRU19-01 to BRU19-15A, BRU19-18, BRU19-19, BRU19-22 to BRU19-25)



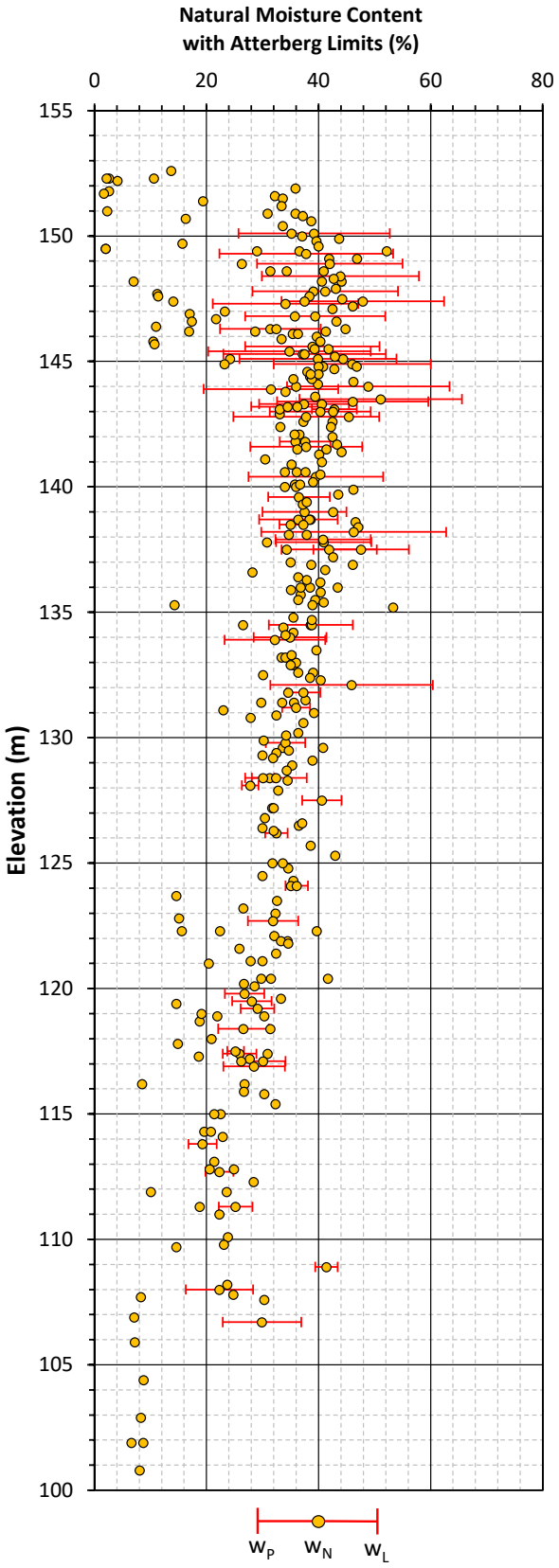
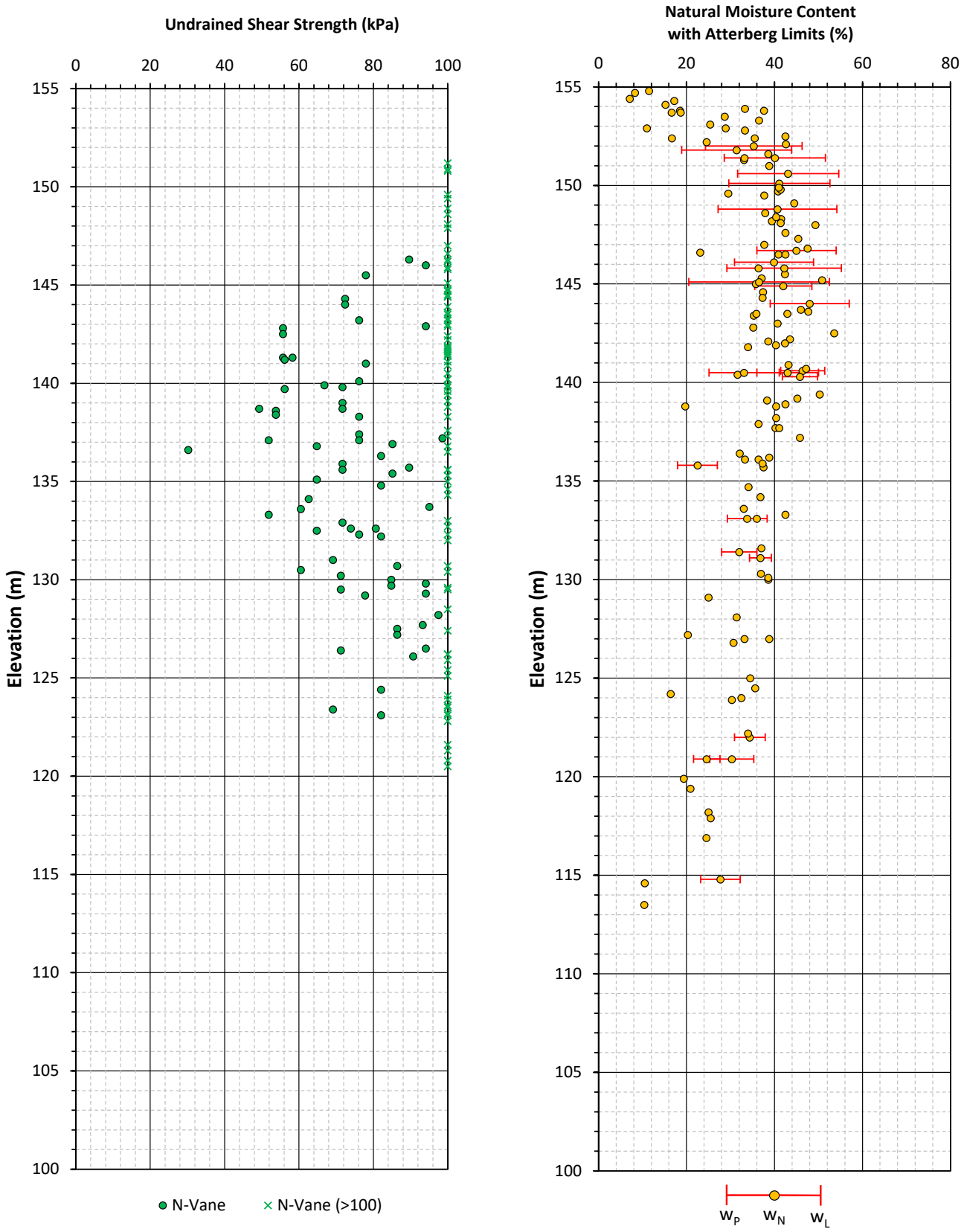


FIGURE B4.2

SOIL SUMMARY - E-N/S RAMP ALIGNMENT

(BRU19-26 to BRU19-33)



THURBER

Appendix C.

Laboratory Testing

Current (2019/2020/2021) Investigation

THURBER

Appendix C.1

Particle Size Analysis Figures

Atterberg Limit Test Results

THURBER

List of Figures – Appendix C.1

Figure C1.1	Grain Size Distribution - Topsoil
Figures C2.1 to C2.2	Grain Size Distribution - Fill
Figure C3.1	Grain Size Distribution - Upper Sand and Silt
Figures C4.1 to C4.6	Grain Size Distribution - Silty Clay (Weathered Crust)
Figures C5.1 to C5.6	Atterberg Limit Test Results - Silty Clay (Weathered Crust)
Figures C6.1 to C6.7	Grain Size Distribution - Silty Clay to Clayey Silt (Above Elevation 133 m)
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Figures C8.1 to C8.5	Grain Size Distribution - Clayey Silt (Below Elevation 133 m)
Figures C9.1 to C9.4	Atterberg Limit Test Results - Clayey Silt (Below Elevation 133 m)
Figures C10.1 to C10.5	Grain Size Distribution - Interlayered Silt, Sand, and Clayey Silt
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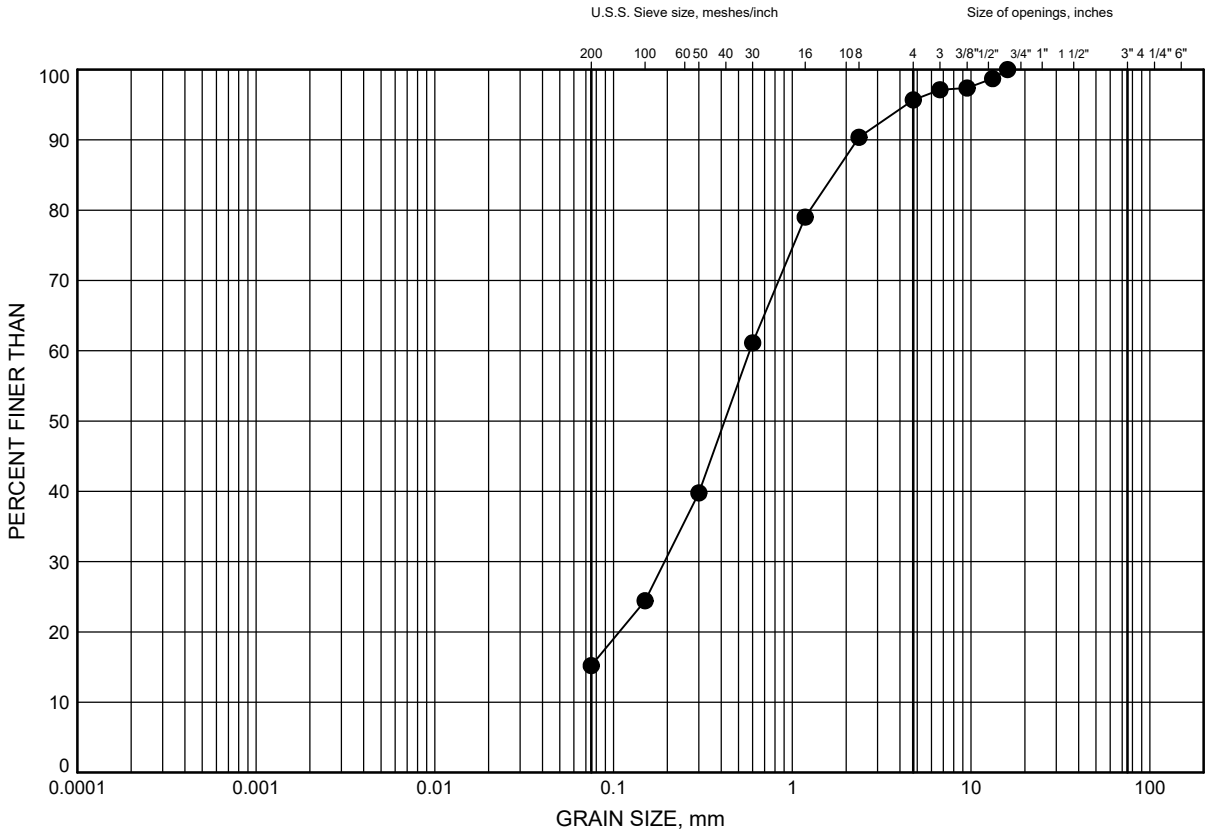
Figures C12.1 to C12.2	Grain Size Distribution - Till: Silty Sand and Gravel

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C1.1

Topsoil



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-25	0.3	147.6

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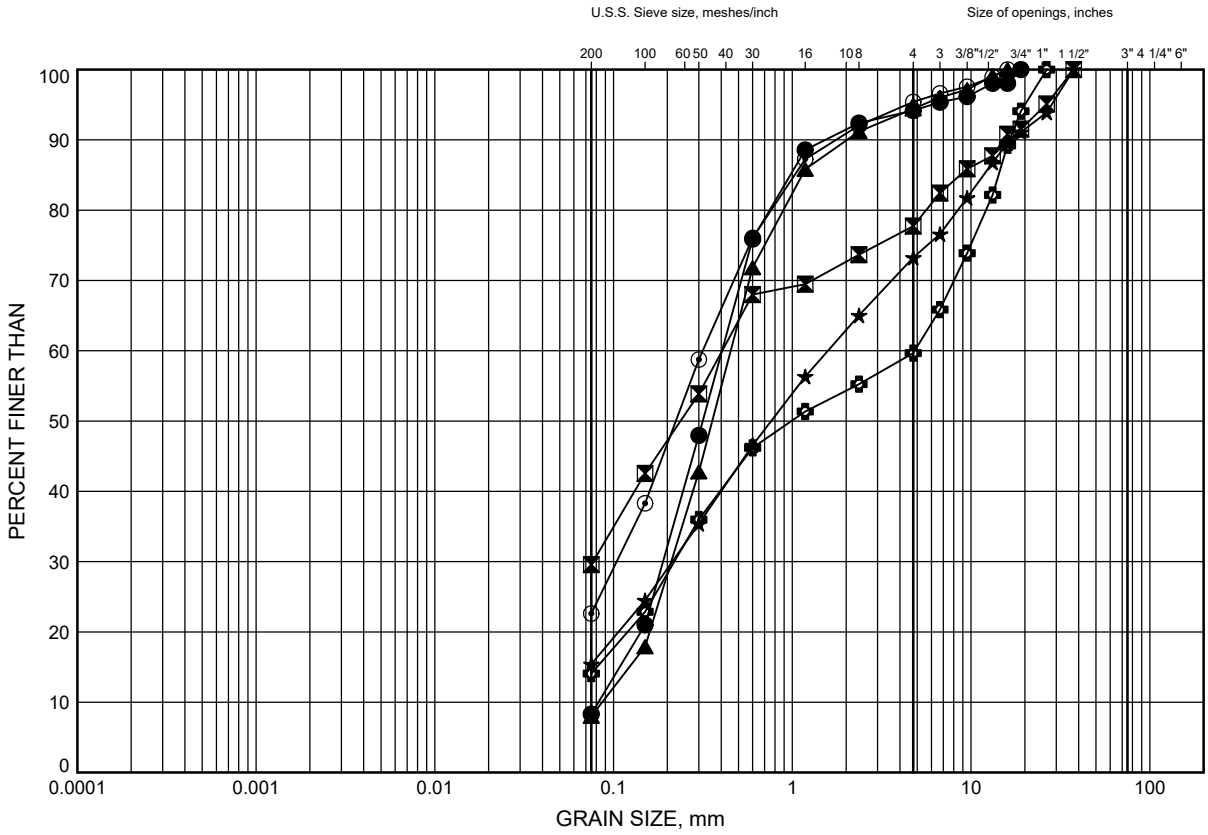
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C2.1

Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-04	0.3	149.5
⊠	BRU19-06	1.1	147.4
▲	BRU19-07	0.3	147.8
★	BRU19-09	1.1	145.8
⊙	BRU19-10	0.3	145.9
✿	BRU19-12	0.4	152.3

Date February 2022

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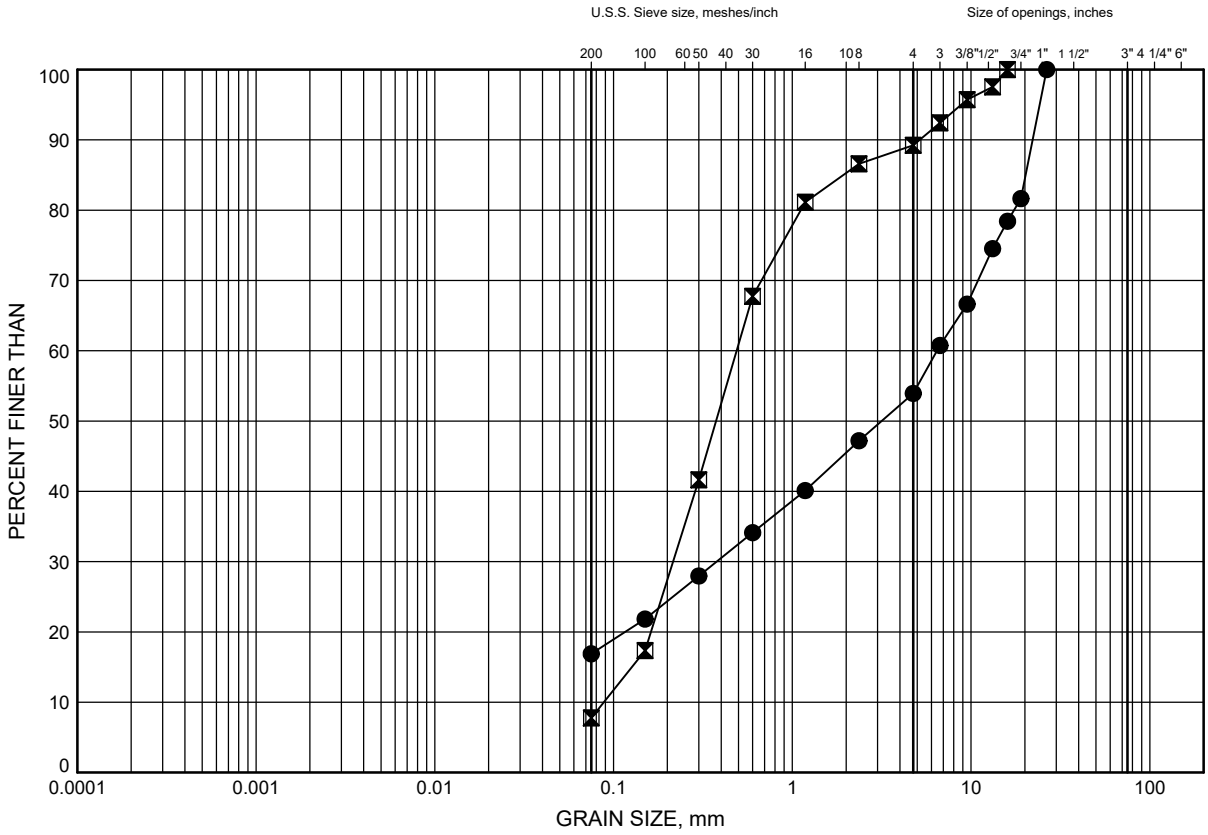
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C2.2

Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-13	0.9	151.6
⊠	BRU21-05	0.3	148.9

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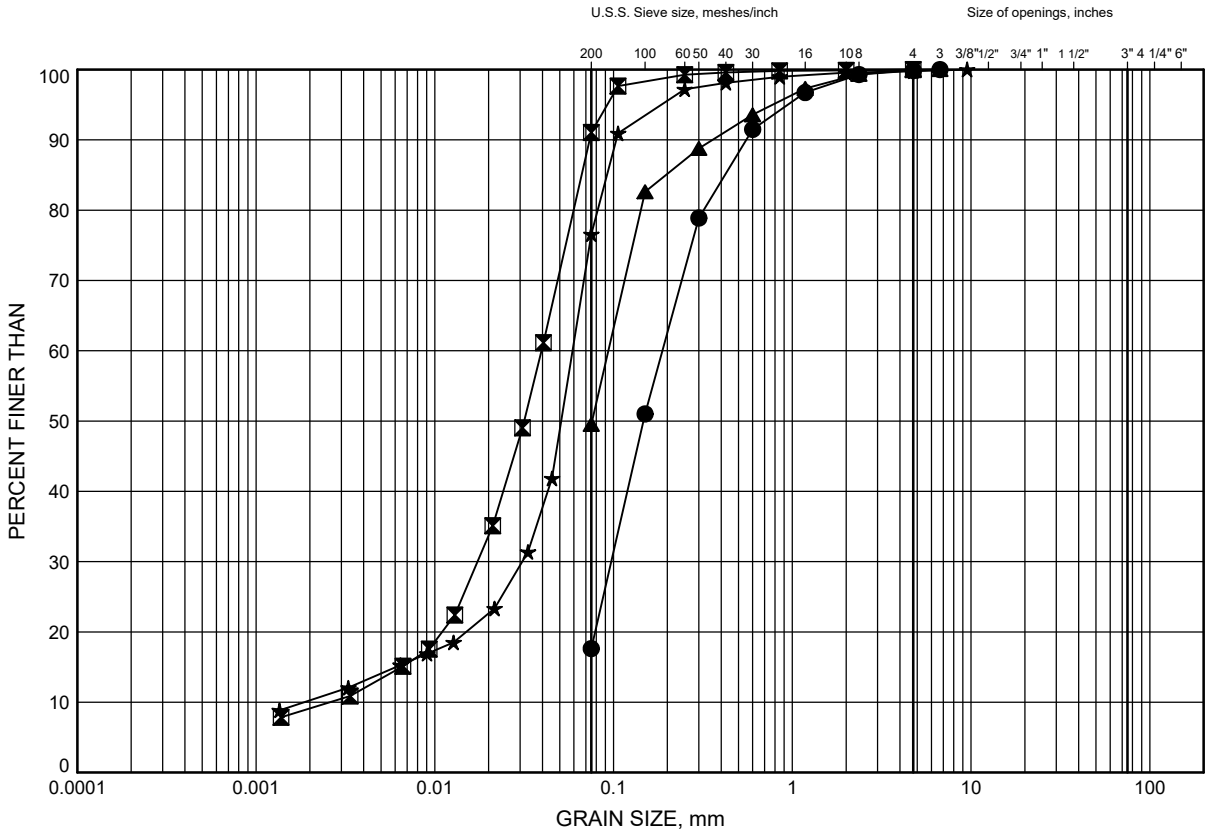
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C3.1

Upper Sand and Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-26	1.8	147.9
⊠	BRU19-28	1.1	153.9
▲	BRU19-29	1.8	152.9
★	BRU19-30	1.1	153.0

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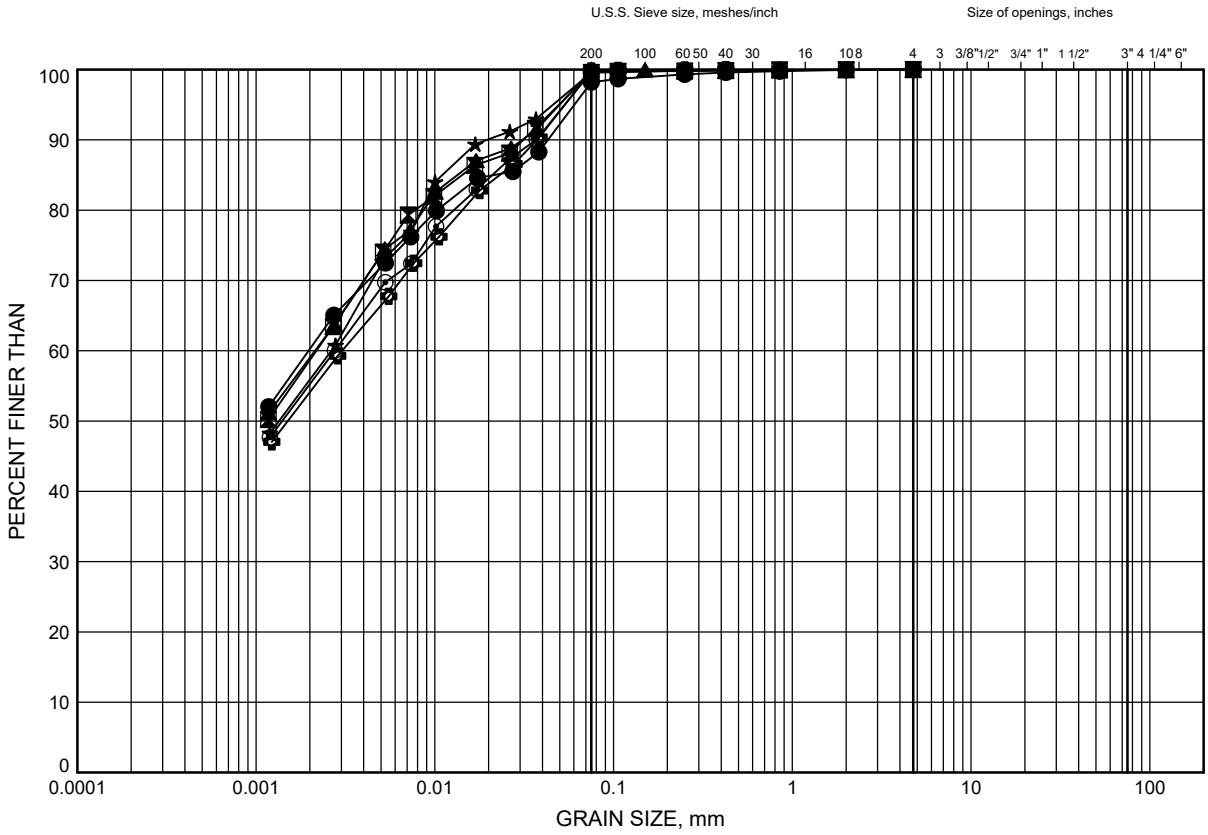
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C4.1

Silty Clay (Weathered Crust)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-01	1.1	150.1
⊠	BRU19-01	3.4	147.8
▲	BRU19-01A	4.9	147.3
★	BRU19-02	2.6	147.5
⊙	BRU19-03	4.1	145.7
✿	BRU19-04A	4.9	144.9

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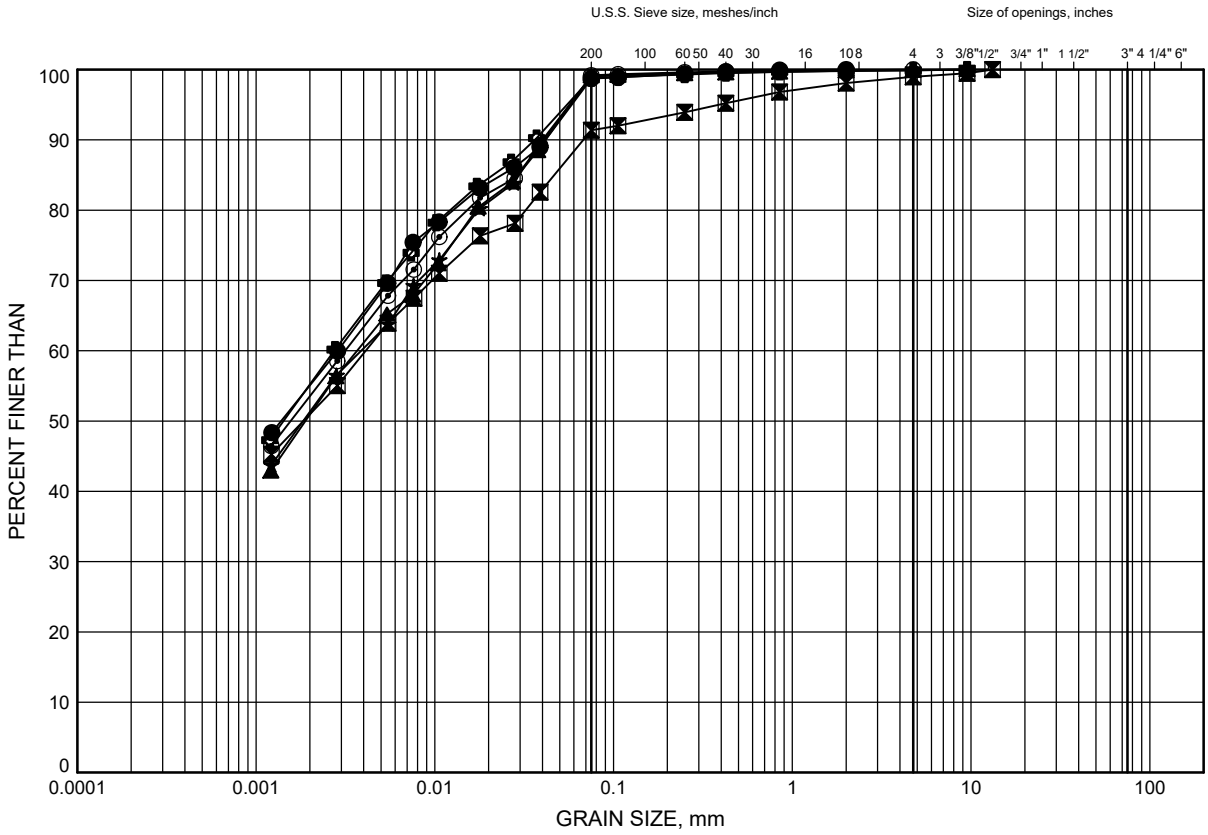
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C4.2

Silty Clay (Weathered Crust)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-06	3.4	145.1
⊠	BRU19-07	2.6	145.5
▲	BRU19-09	3.4	143.5
★	BRU19-10	2.6	143.6
⊙	BRU19-12	3.4	149.3
✿	BRU19-13	4.1	148.4

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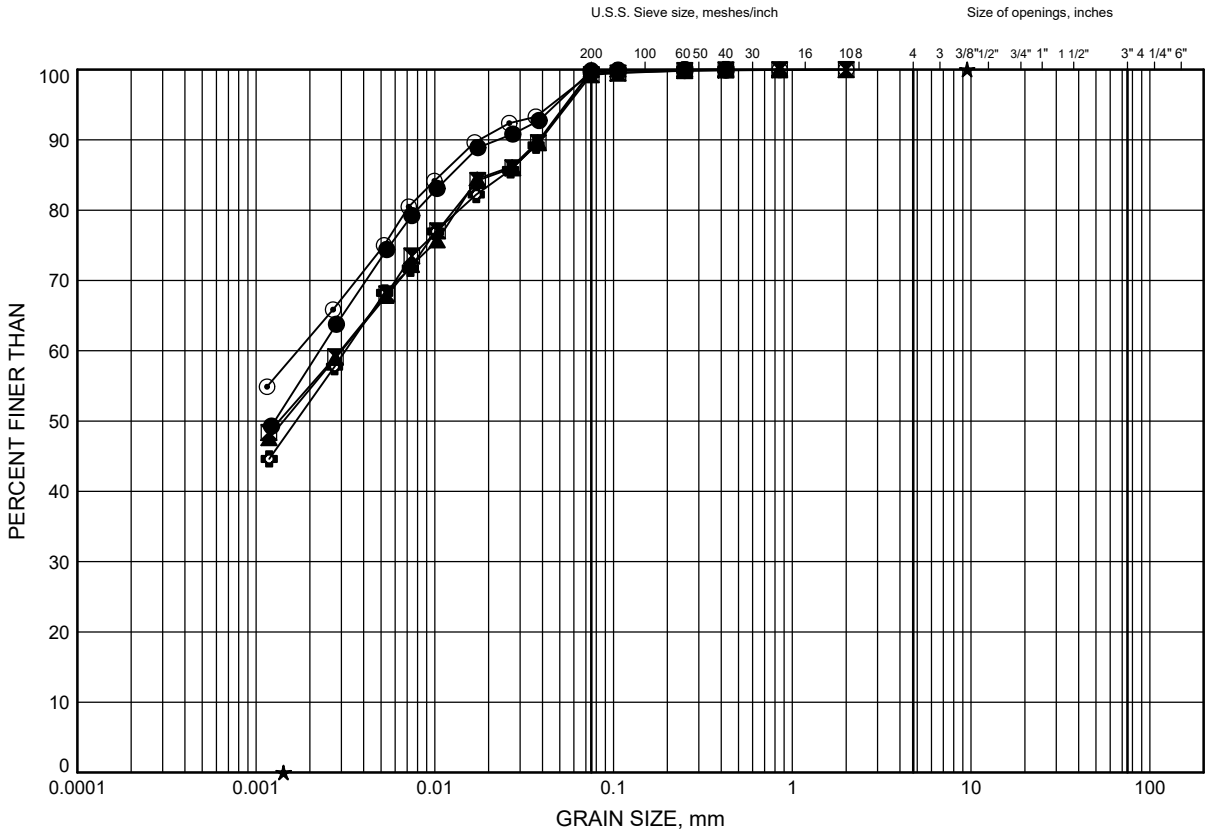
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C4.3

Silty Clay (Weathered Crust)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-15	3.5	149.1
⊠	BRU19-16	1.8	149.7
▲	BRU19-16	4.9	146.6
⊙	BRU19-21	1.1	149.6
✿	BRU19-22	3.4	143.9

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Prep'd MIK

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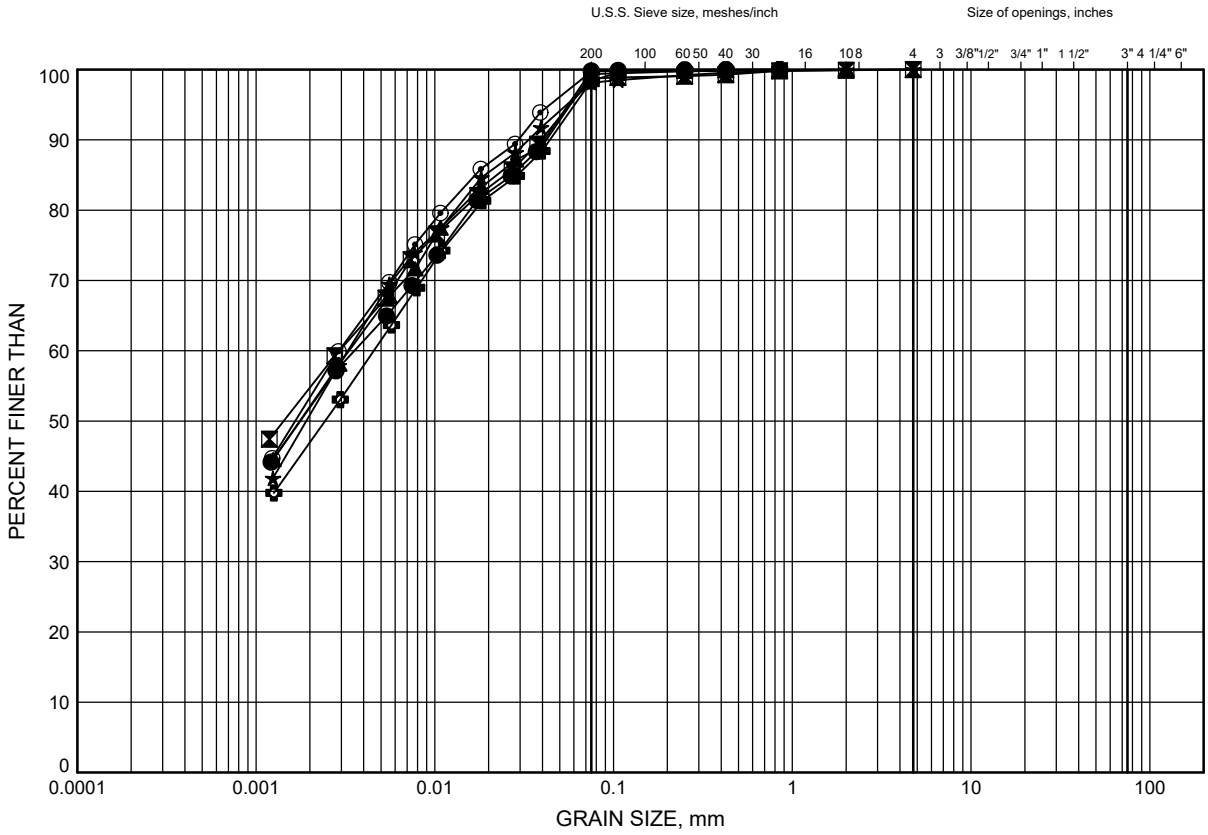
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C4.4

Silty Clay (Weathered Crust)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-23	2.6	144.0
⊠	BRU19-25	2.6	145.3
▲	BRU19-26	4.1	145.6
★	BRU19-27	2.6	152.0
⊙	BRU19-28	4.9	150.1
✿	BRU19-29	3.4	151.3

Date February 2022

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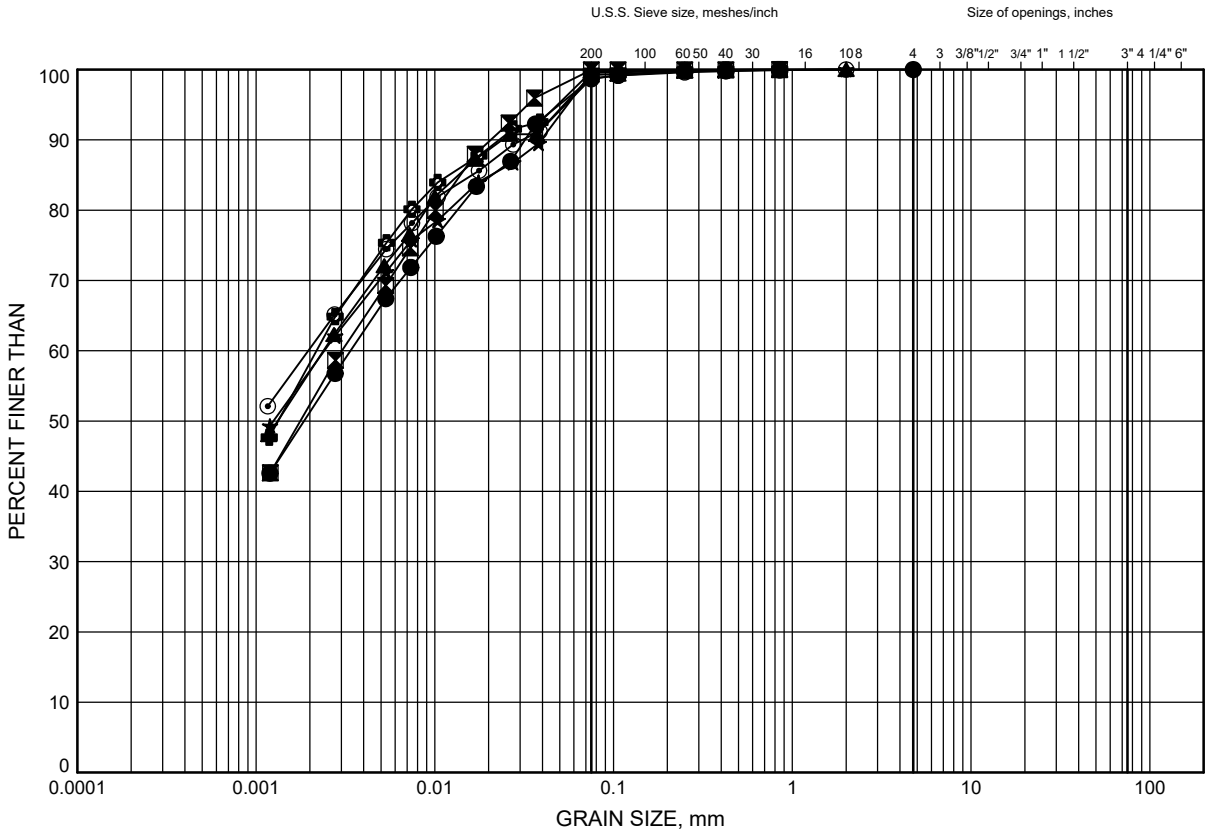
Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C4.5

Silty Clay (Weathered Crust)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-30	3.4	150.7
⊠	BRU19-30	7.9	146.2
▲	BRU19-31	1.1	148.8
★	BRU19-33	1.8	145.1
⊙	BRU21-02	2.6	148.8
✿	BRU21-02	4.9	146.5

Date February 2022

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Prep'd MIK

Chkd. MJK

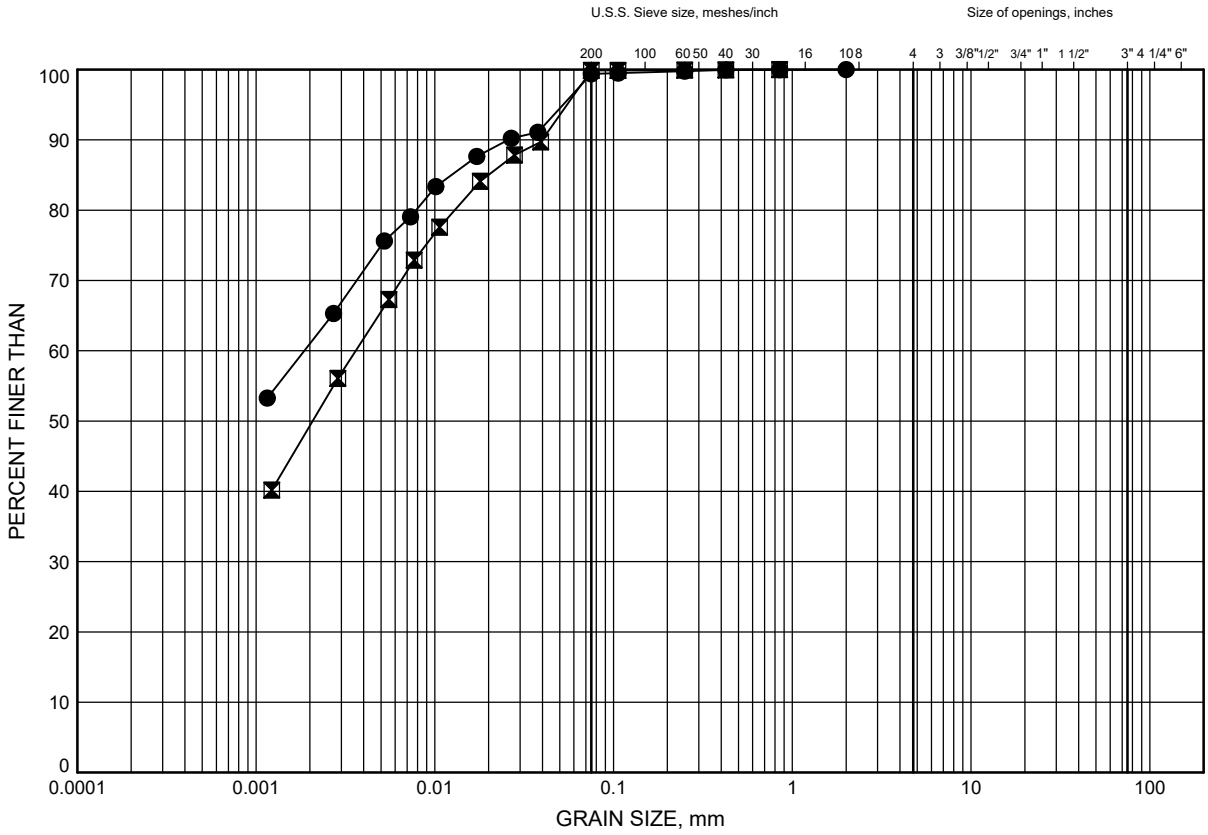
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C4.6

Silty Clay (Weathered Crust)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU21-05	2.4	146.8
⊠	BRU21-05	6.4	142.8

Date February 2022

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Chkd. MJK

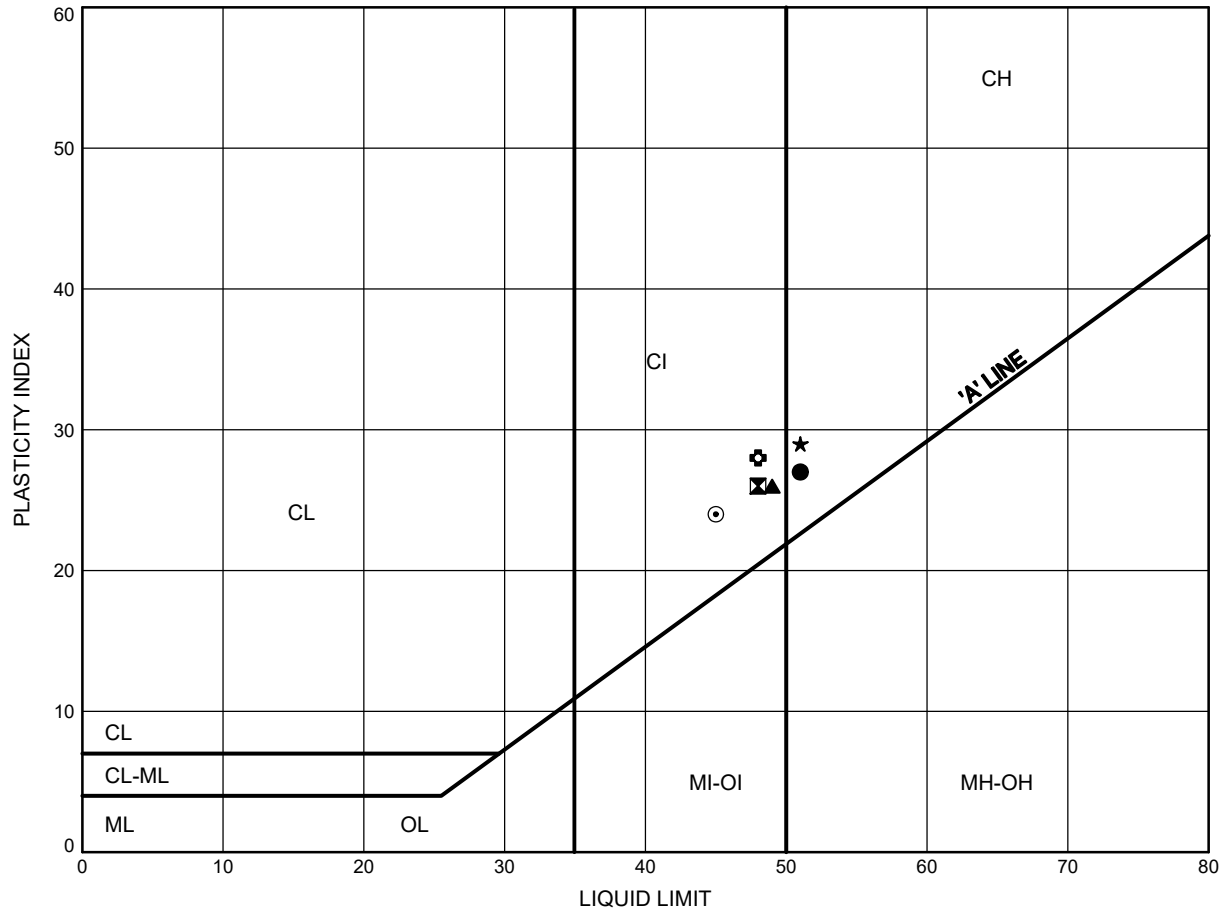
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C5.1

Silty Clay (Weathered Crust)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-01	1.1	150.1
⊠	BRU19-01	3.4	147.8
▲	BRU19-01A	4.9	147.3
★	BRU19-02	2.6	147.5
⊙	BRU19-03	4.1	145.7
✿	BRU19-04A	4.9	144.9

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

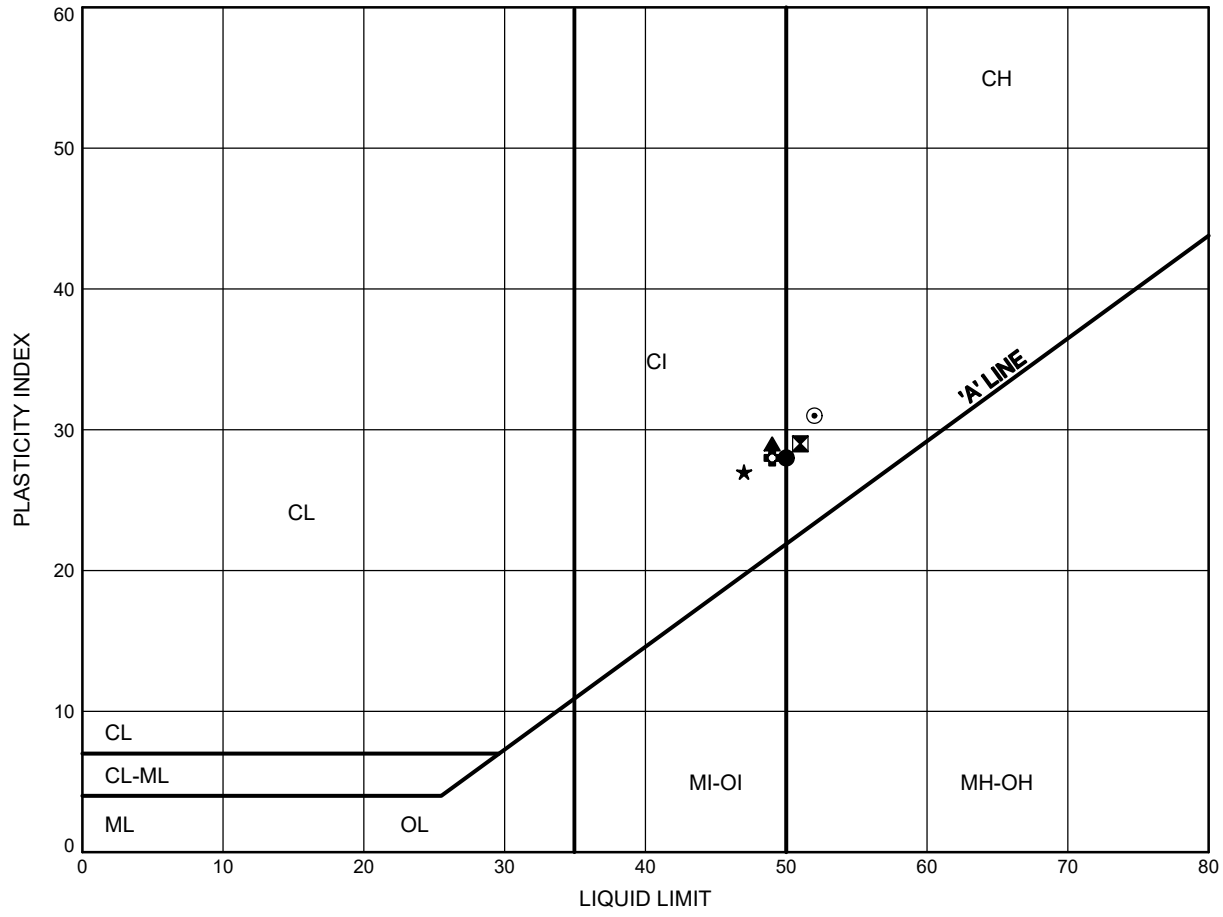
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C5.2

Silty Clay (Weathered Crust)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-06	3.4	145.1
⊠	BRU19-07	2.6	145.5
▲	BRU19-09	3.4	143.5
★	BRU19-10	2.6	143.6
⊙	BRU19-12	3.4	149.3
✿	BRU19-13	4.1	148.4

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

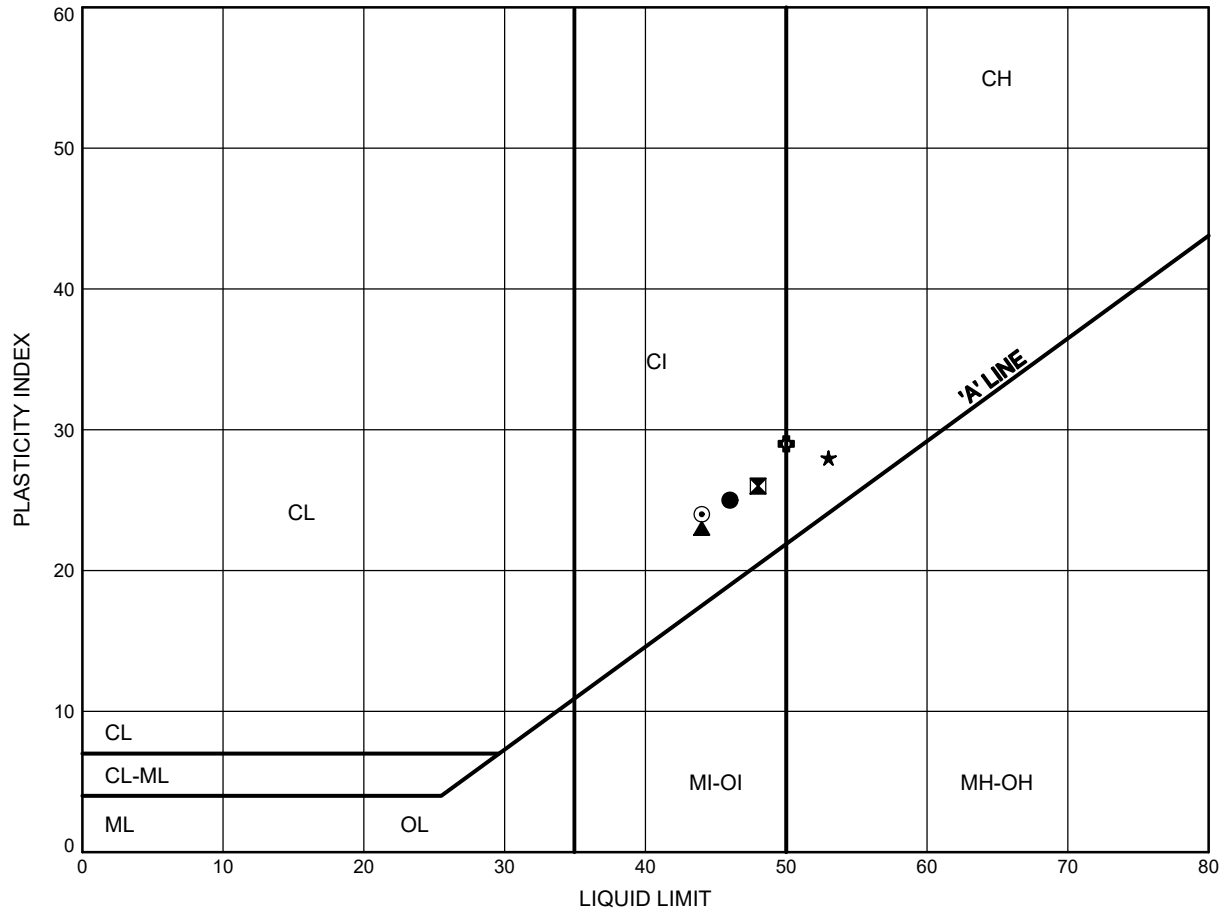
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C5.3

Silty Clay (Weathered Crust)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-15	3.5	149.1
⊠	BRU19-16	1.8	149.7
▲	BRU19-16	4.9	146.6
★	BRU19-21	1.1	149.6
⊙	BRU19-22	3.4	143.9
✿	BRU19-23	2.6	144.0

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

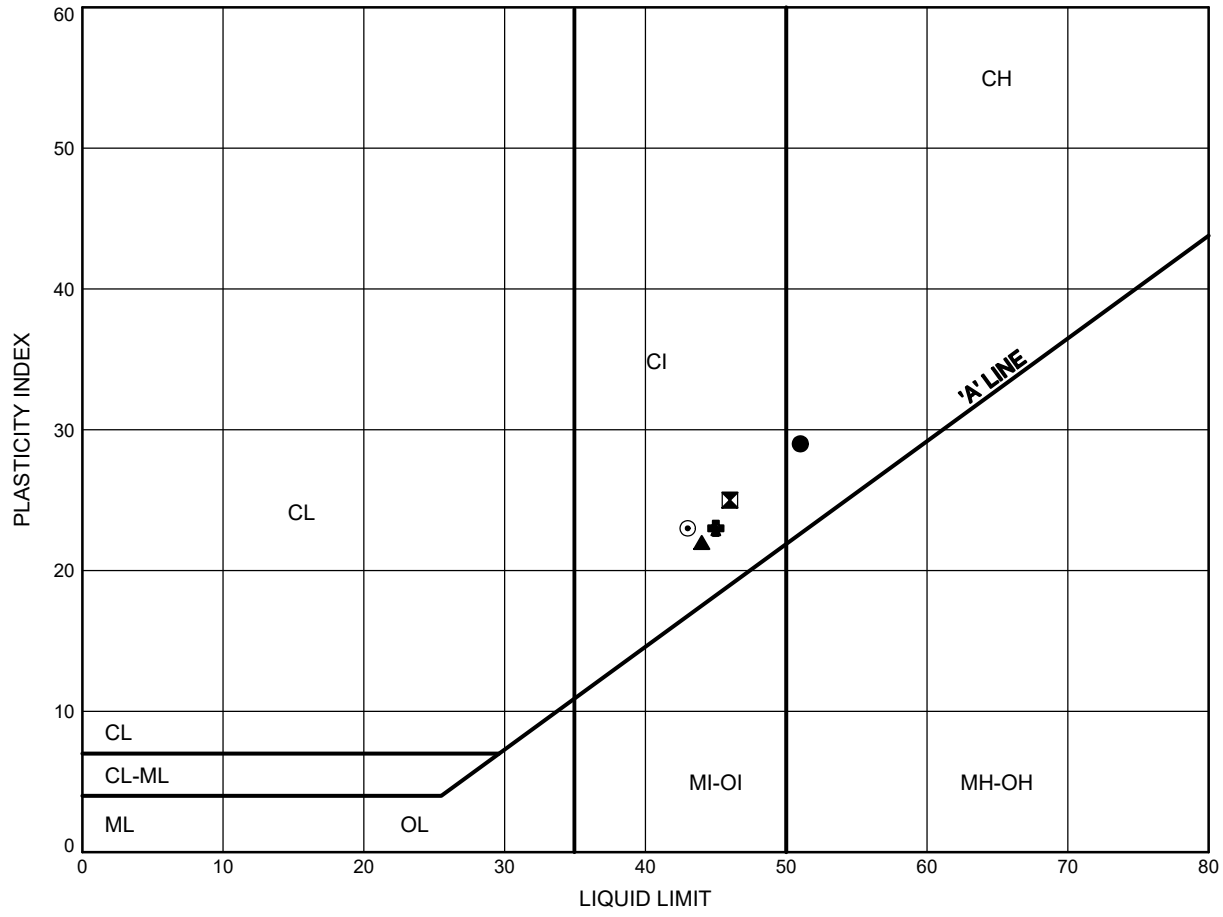
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C5.4

Silty Clay (Weathered Crust)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-25	2.6	145.3
⊠	BRU19-26	4.1	145.6
▲	BRU19-27	2.6	152.0
★	BRU19-28	4.9	150.1
⊙	BRU19-29	3.4	151.3
✿	BRU19-30	3.4	150.7

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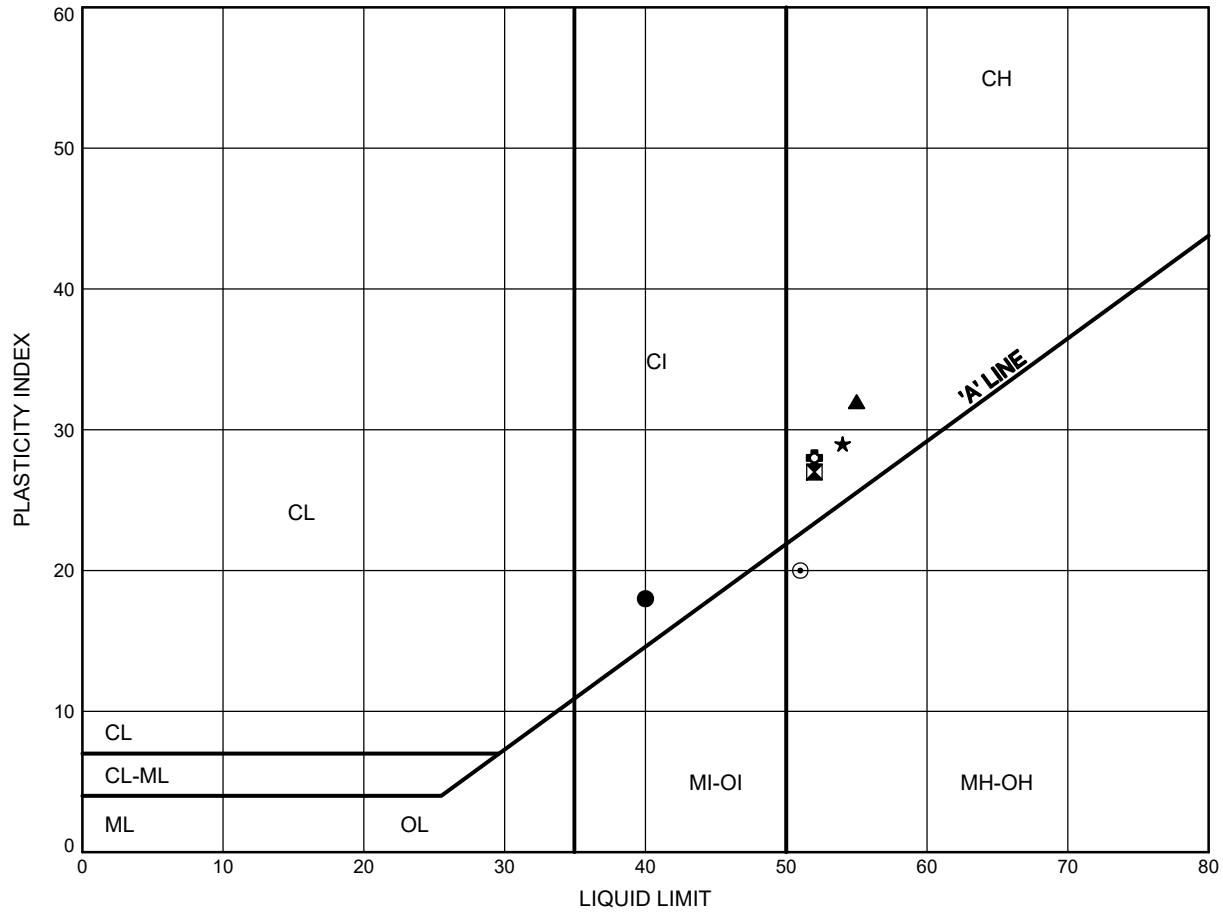
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C5.5

Silty Clay (Weathered Crust)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-30	7.9	146.2
⊠	BRU19-31	1.1	148.8
▲	BRU19-33	1.8	145.1
★	BRU21-02	2.6	148.8
⊙	BRU21-02	4.9	146.5
✿	BRU21-05	2.4	146.8

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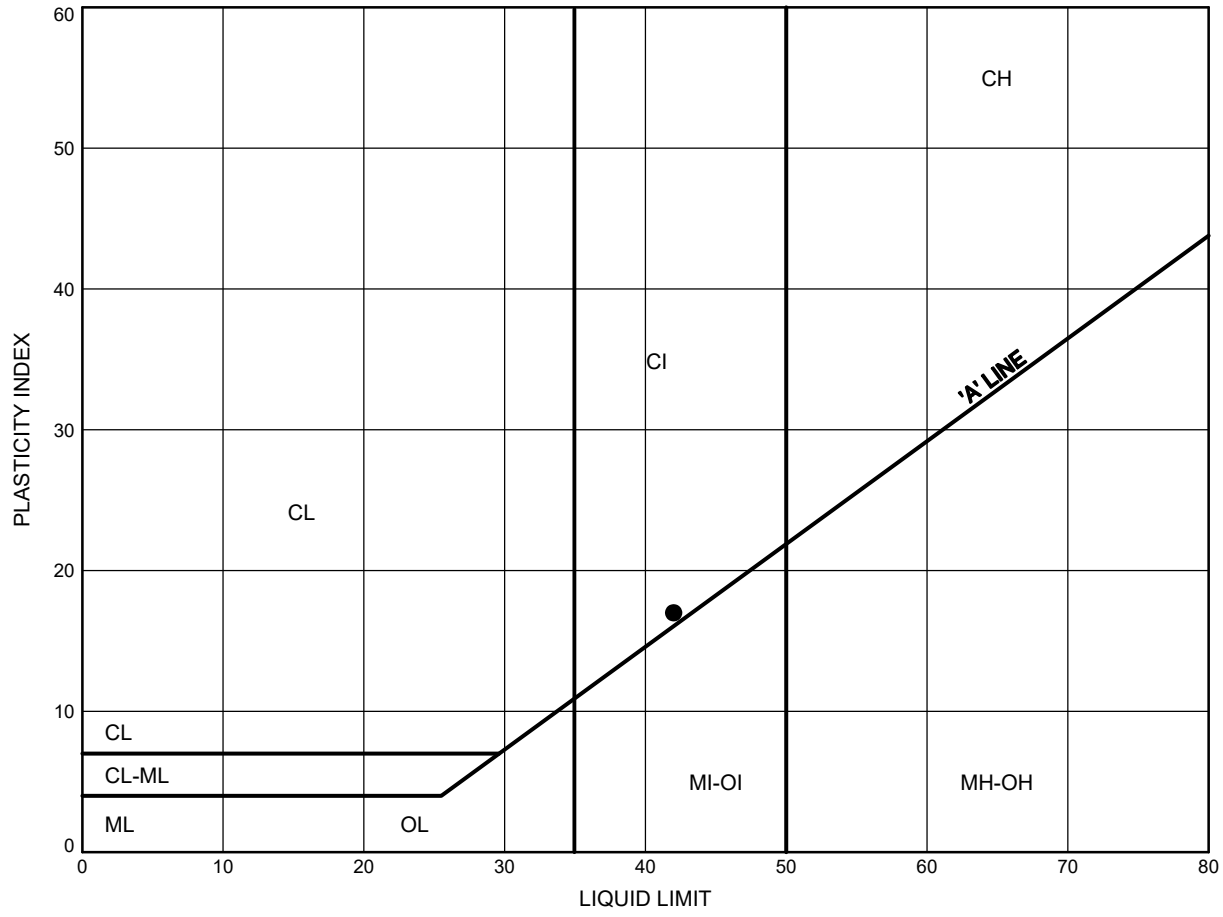
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C5.6

Silty Clay (Weathered Crust)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU21-05	6.4	142.8

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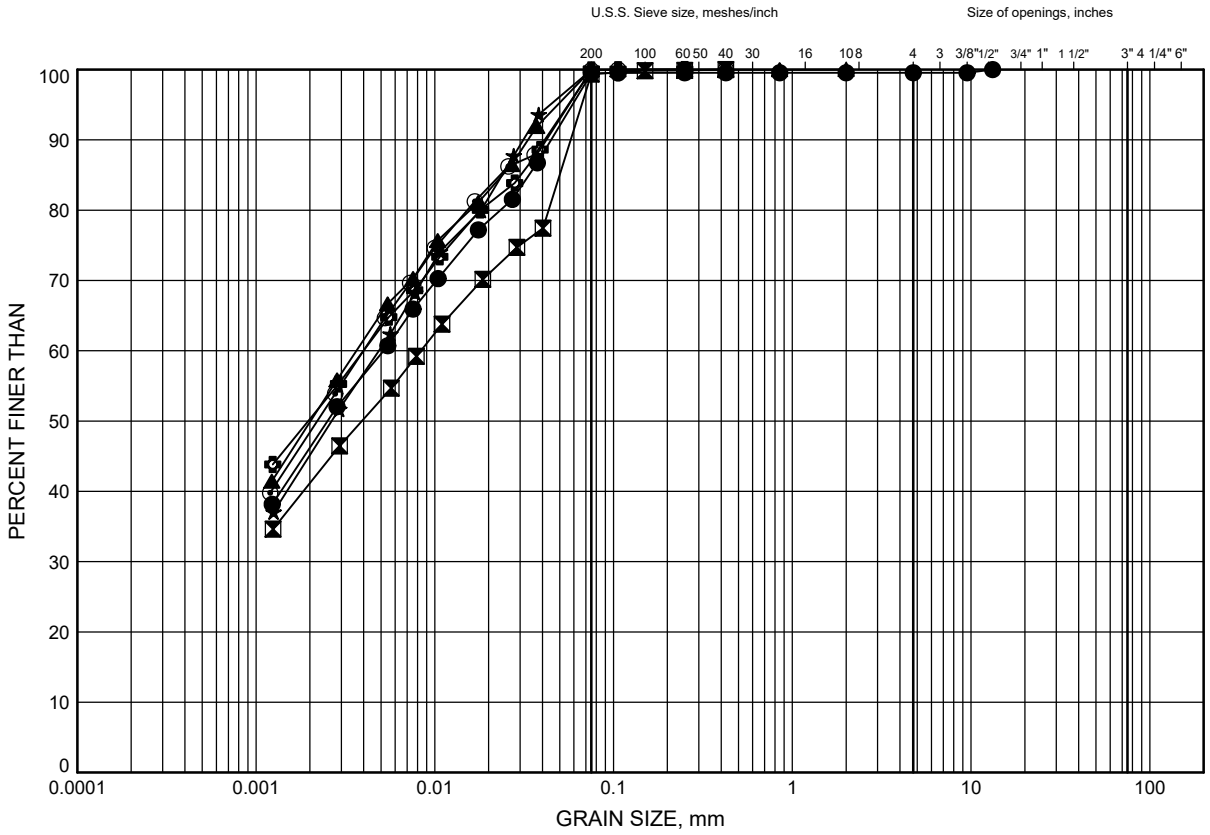
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C6.1

Silty Clay to Clayey Silt (Above Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-01	9.4	141.8
⊠	BRU19-01A	17.7	134.5
▲	BRU19-02	12.5	137.6
★	BRU19-02	15.5	134.6
⊙	BRU19-03	6.4	143.4
✿	BRU19-04A	9.4	140.4

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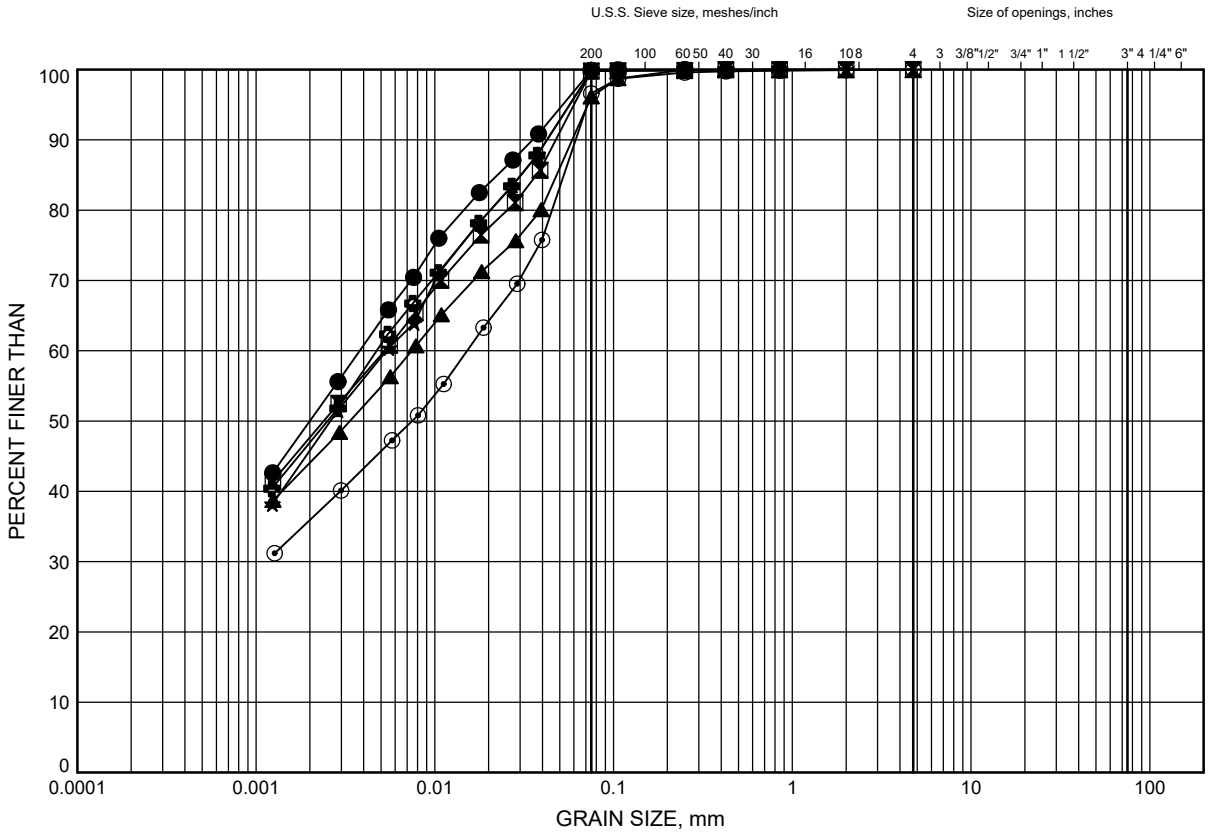
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C6.2

Silty Clay to Clayey Silt (Above Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-06	11.0	137.5
⊠	BRU19-07	6.4	141.7
▲	BRU19-07	14.0	134.1
★	BRU19-09	7.9	139.0
⊙	BRU19-10	6.4	139.8
✿	BRU19-12	6.4	146.3

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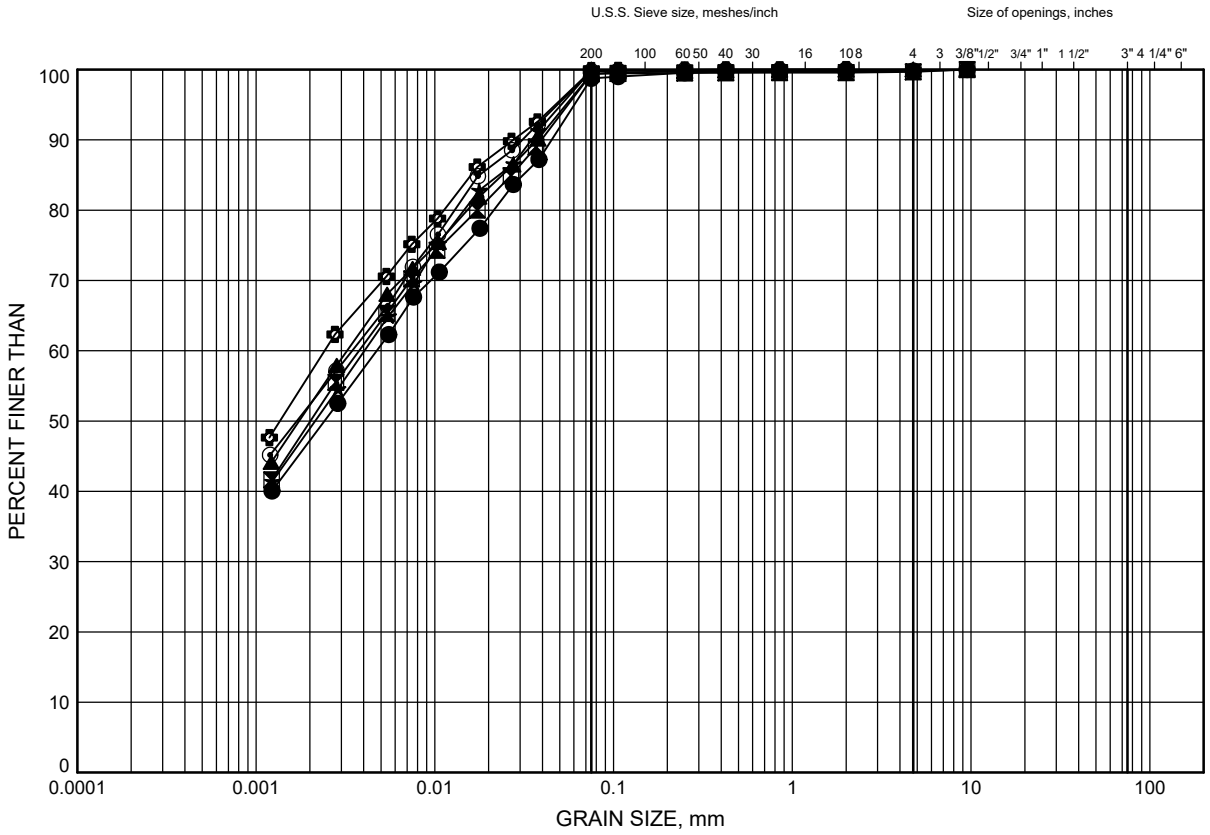
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C6.3

Silty Clay to Clayey Silt (Above Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-12	14.9	137.8
⊠	BRU19-13	9.4	143.1
▲	BRU19-13	14.0	138.5
★	BRU19-15	9.4	143.2
⊙	BRU19-16	7.9	143.6
✿	BRU19-16	14.0	137.5

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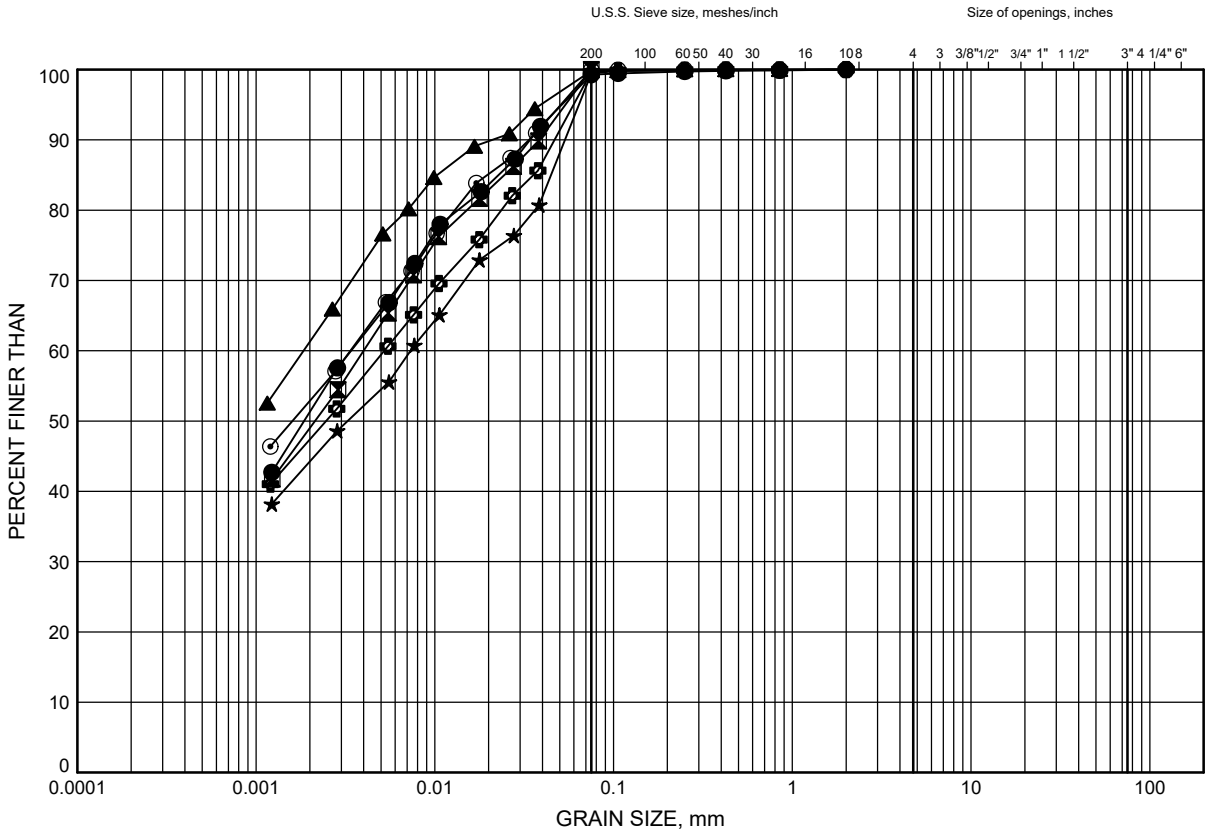
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C6.4

Silty Clay to Clayey Silt (Above Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-18	4.1	146.8
⊠	BRU19-18	9.4	141.5
▲	BRU19-19	3.4	148.8
★	BRU19-19	9.4	142.8
⊙	BRU19-19	14.0	138.2
✿	BRU19-21	9.4	141.3

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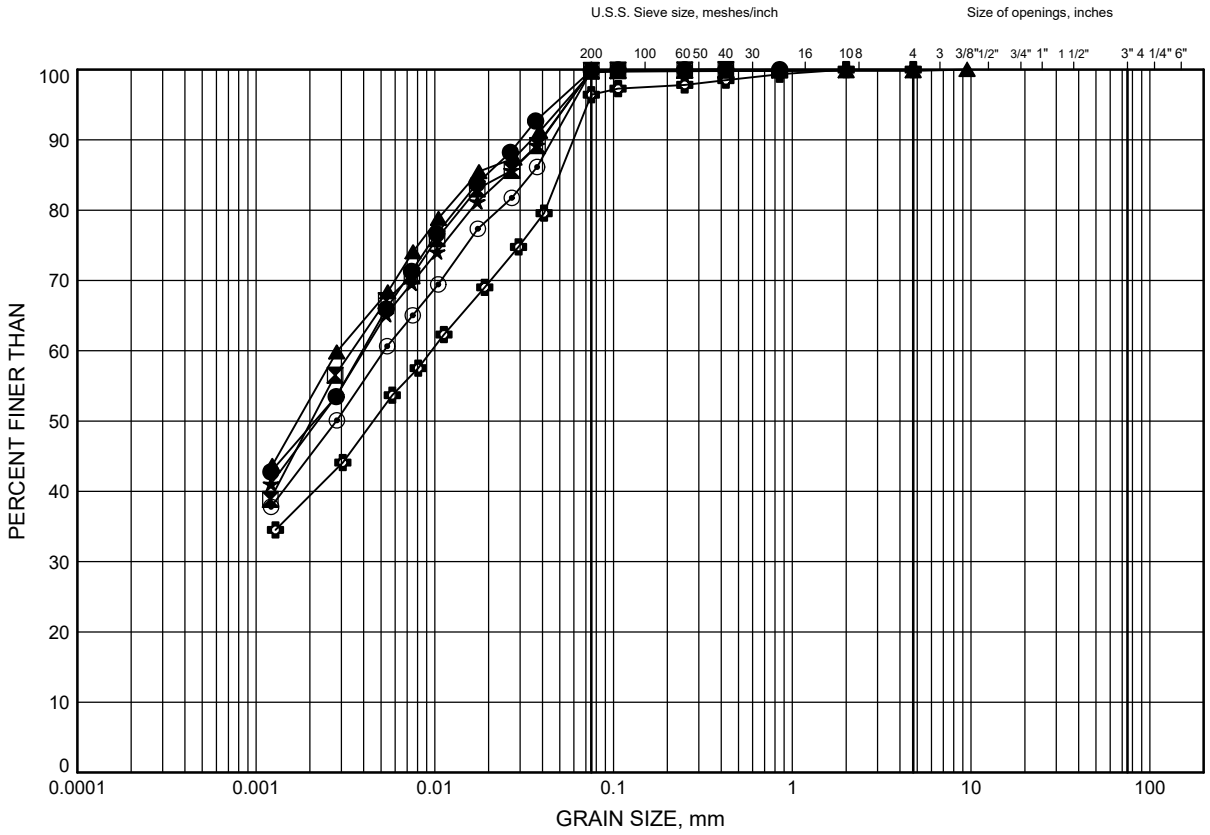
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C6.5

Silty Clay to Clayey Silt (Above Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-21	15.5	135.2
⊠	BRU19-22	9.4	137.9
▲	BRU19-23	7.9	138.7
★	BRU19-25	4.9	143.0
⊙	BRU19-25	14.0	133.9
✿	BRU19-26	11.0	138.7

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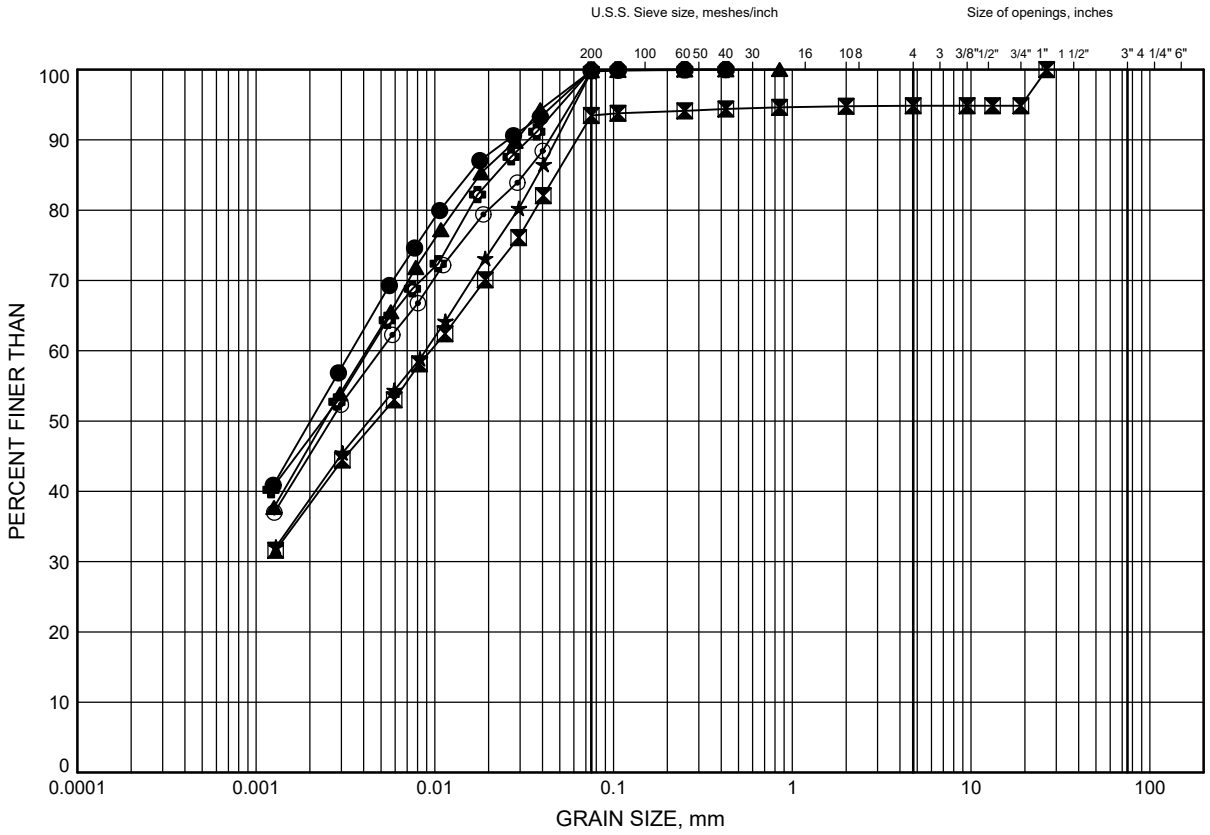
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C6.6

Silty Clay to Clayey Silt (Above Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-27	7.9	146.7
⊠	BRU19-27	14.0	140.6
▲	BRU19-28	11.0	144.0
★	BRU19-28	21.6	133.4
⊙	BRU19-29	17.1	137.6
✿	BRU19-30	13.7	140.4

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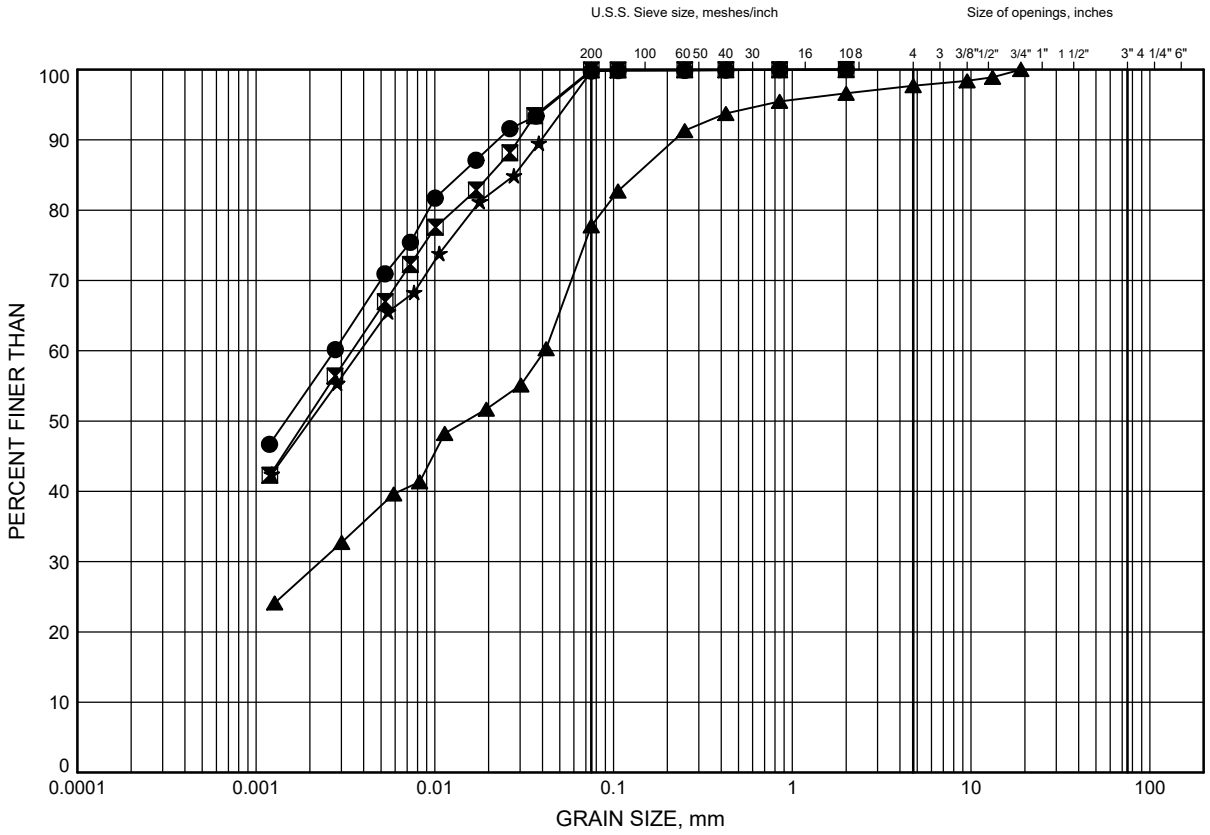
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C6.7

Silty Clay to Clayey Silt (Above Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-31	4.1	145.8
⊠	BRU19-31	9.4	140.5
▲	BRU19-31	16.8	133.1
★	BRU19-33	6.4	140.5

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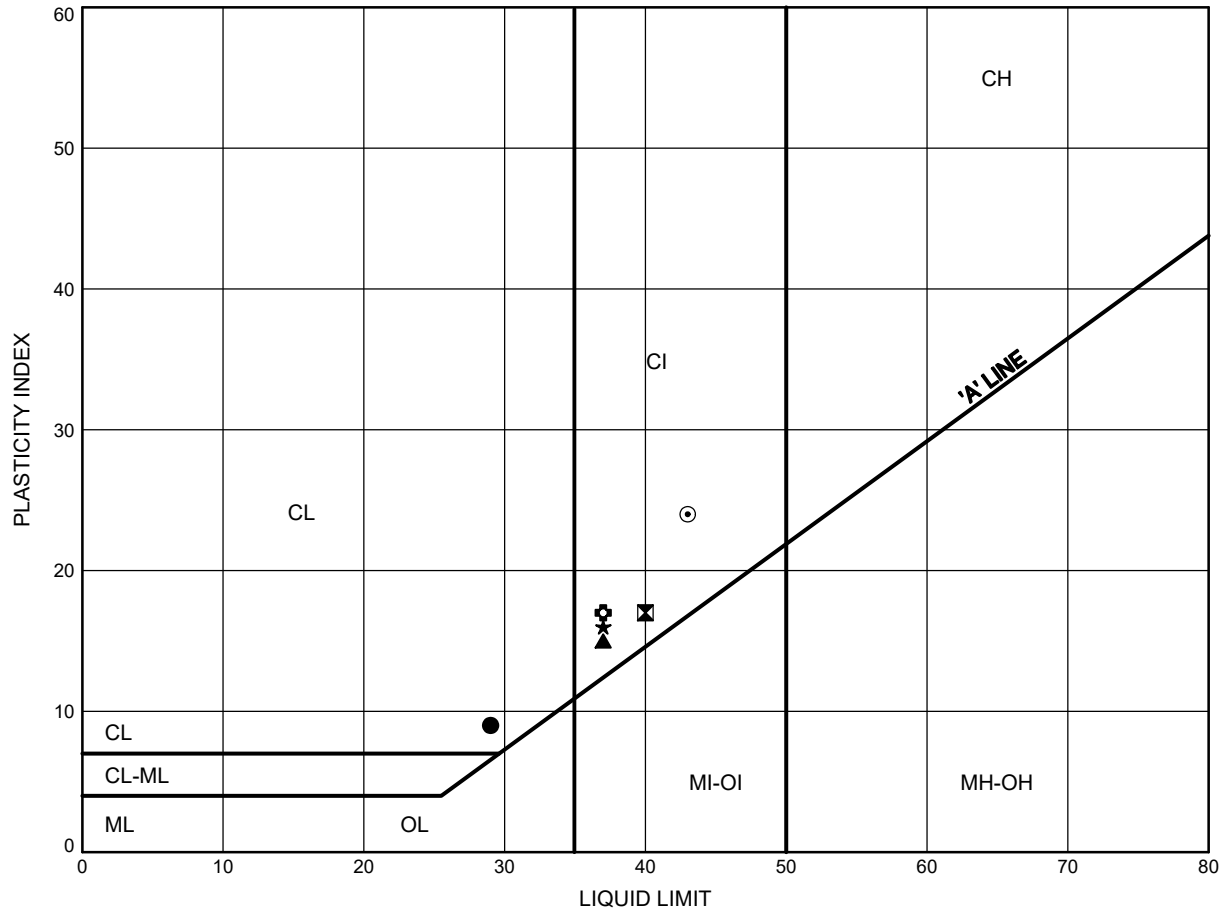
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C7.1

Silty Clay to Clayey Silt (Above Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-01	9.4	141.8
⊠	BRU19-02	12.5	137.6
▲	BRU19-02	15.5	134.6
★	BRU19-03	6.4	143.4
⊙	BRU19-04A	9.4	140.4
✿	BRU19-06	11.0	137.5

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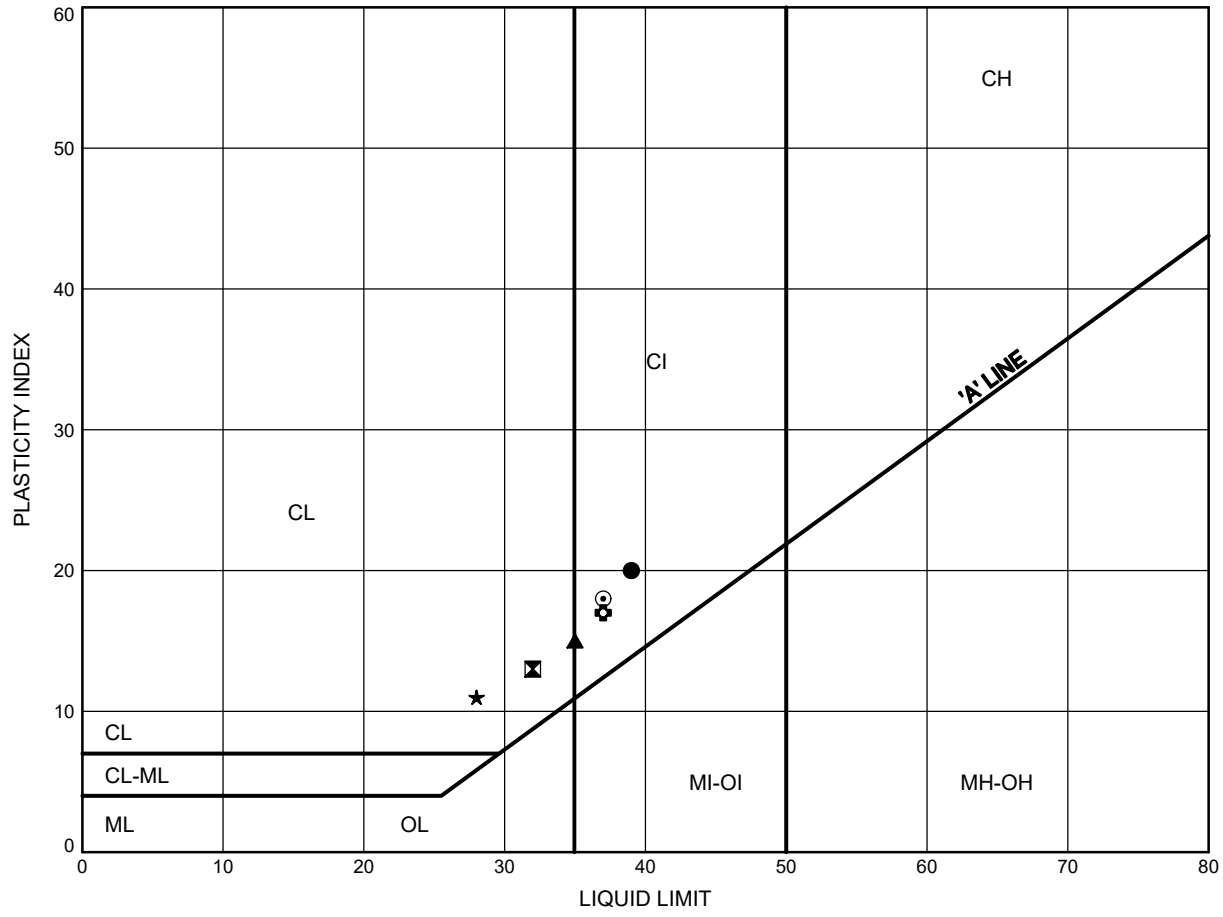
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C7.2

Silty Clay to Clayey Silt (Above Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-07	6.4	141.7
⊠	BRU19-07	14.0	134.1
▲	BRU19-09	7.9	139.0
★	BRU19-10	6.4	139.8
⊙	BRU19-12	6.4	146.3
✿	BRU19-12	14.9	137.8

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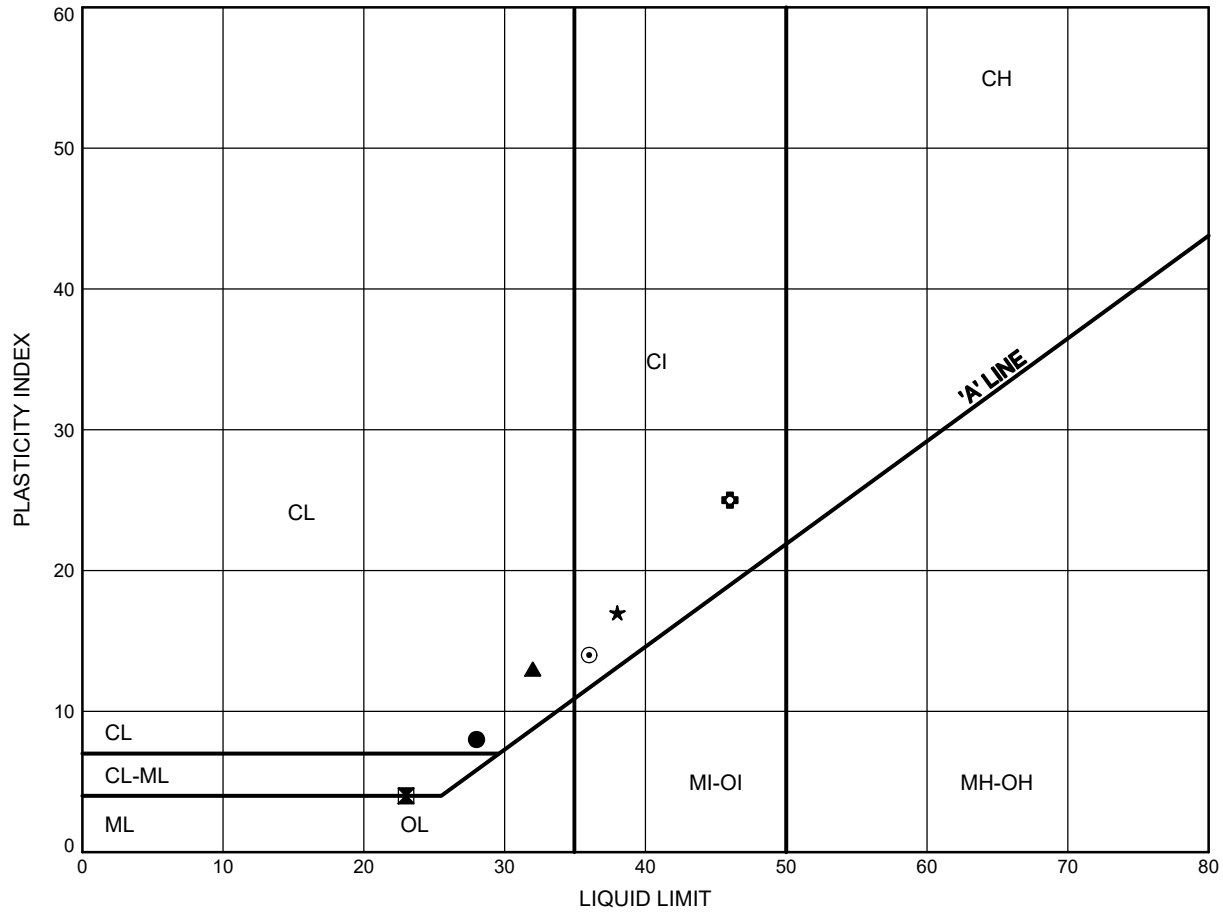
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C7.3

Silty Clay to Clayey Silt (Above Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-13	9.4	143.1
⊠	BRU19-13	14.0	138.5
▲	BRU19-15	9.4	143.2
★	BRU19-16	7.9	143.6
⊙	BRU19-16	14.0	137.5
✿	BRU19-18	4.1	146.8

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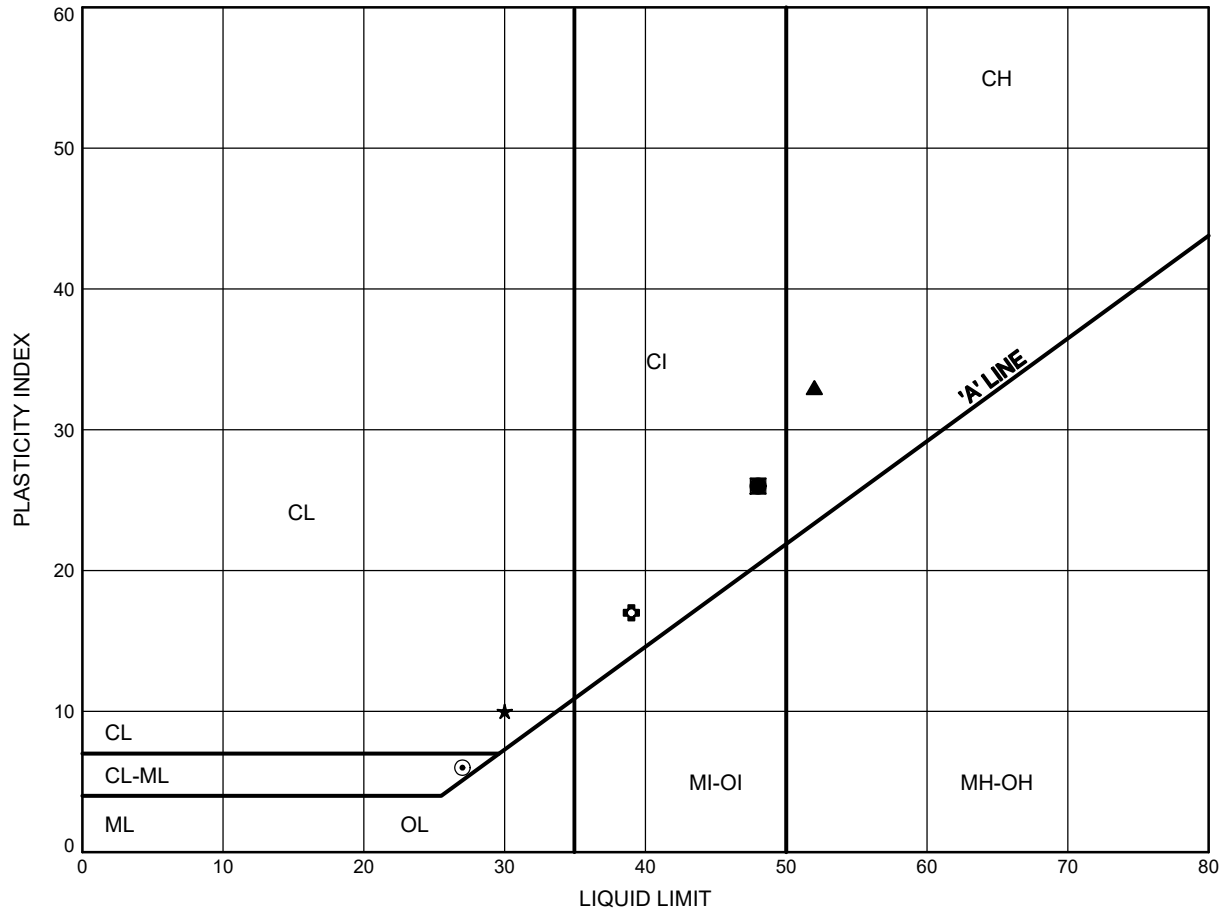
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C7.4

Silty Clay to Clayey Silt (Above Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-19	3.4	148.8
⊠	BRU19-19	9.4	142.8
▲	BRU19-19	14.0	138.2
★	BRU19-21	9.4	141.3
⊙	BRU19-21	15.5	135.2
✿	BRU19-22	9.4	137.9

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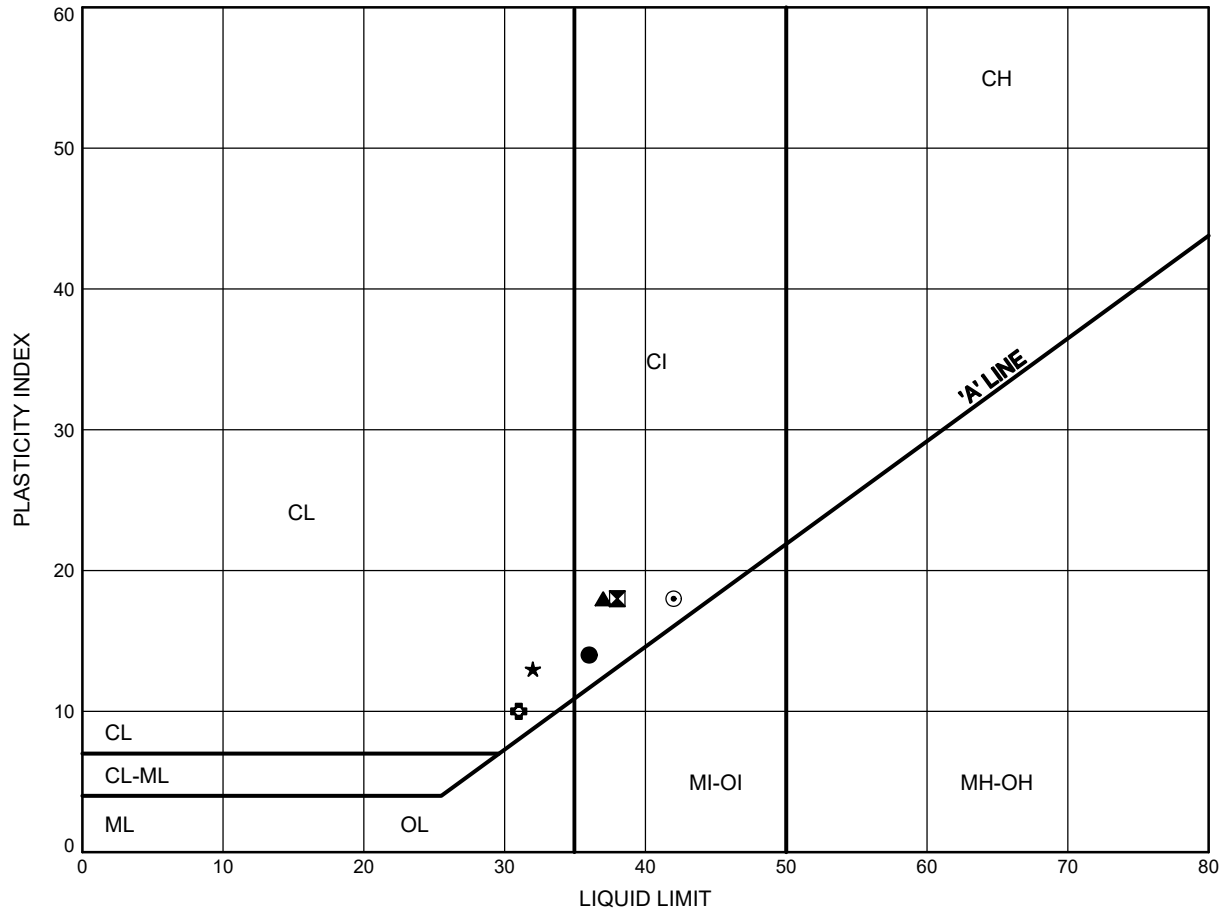
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C7.5

Silty Clay to Clayey Silt (Above Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-23	7.9	138.7
⊠	BRU19-25	4.9	143.0
▲	BRU19-25	14.0	133.9
★	BRU19-26	11.0	138.7
⊙	BRU19-27	7.9	146.7
✿	BRU19-27	14.0	140.6

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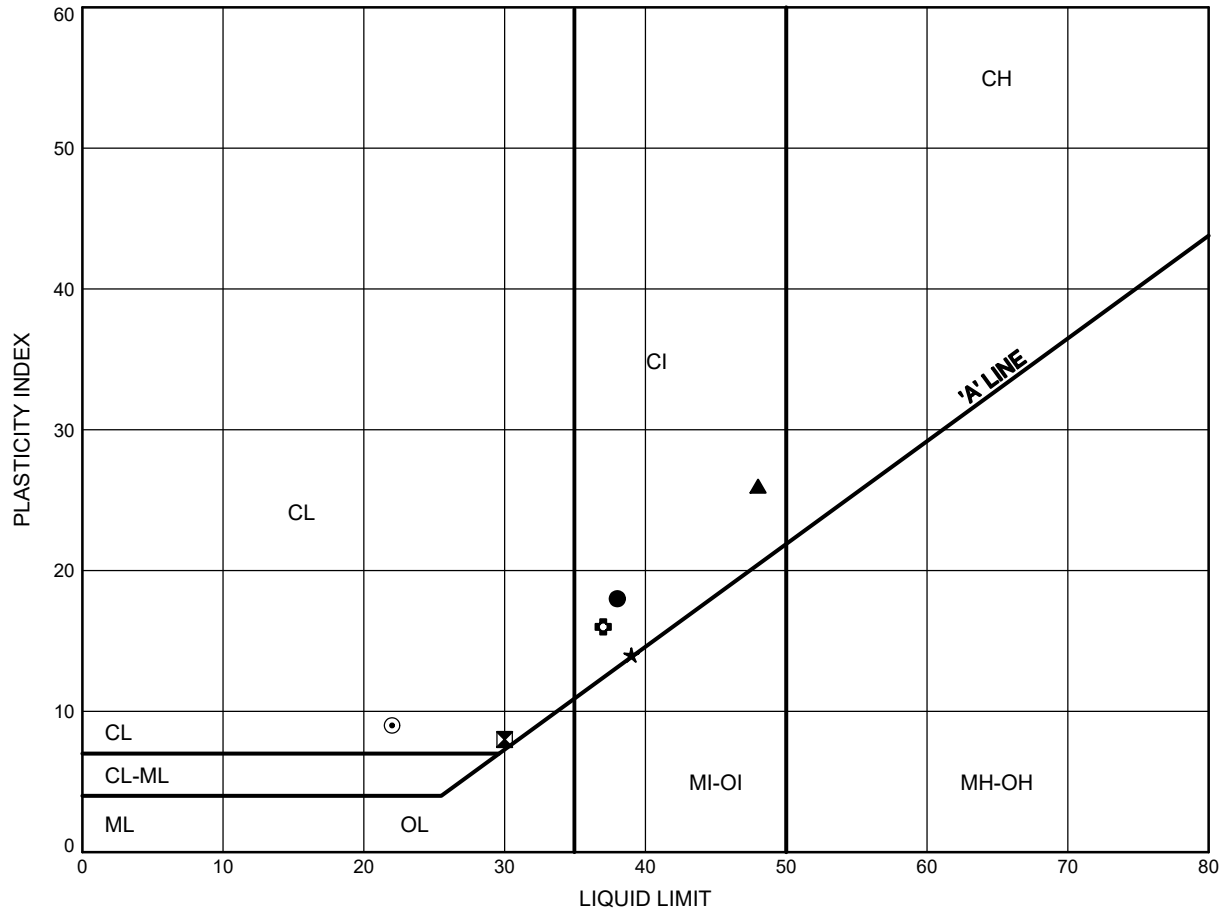
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C7.6

Silty Clay to Clayey Silt (Above Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-28	11.0	144.0
⊠	BRU19-30	13.7	140.4
▲	BRU19-31	4.1	145.8
★	BRU19-31	9.4	140.5
⊙	BRU19-31	16.8	133.1
✿	BRU19-33	6.4	140.5

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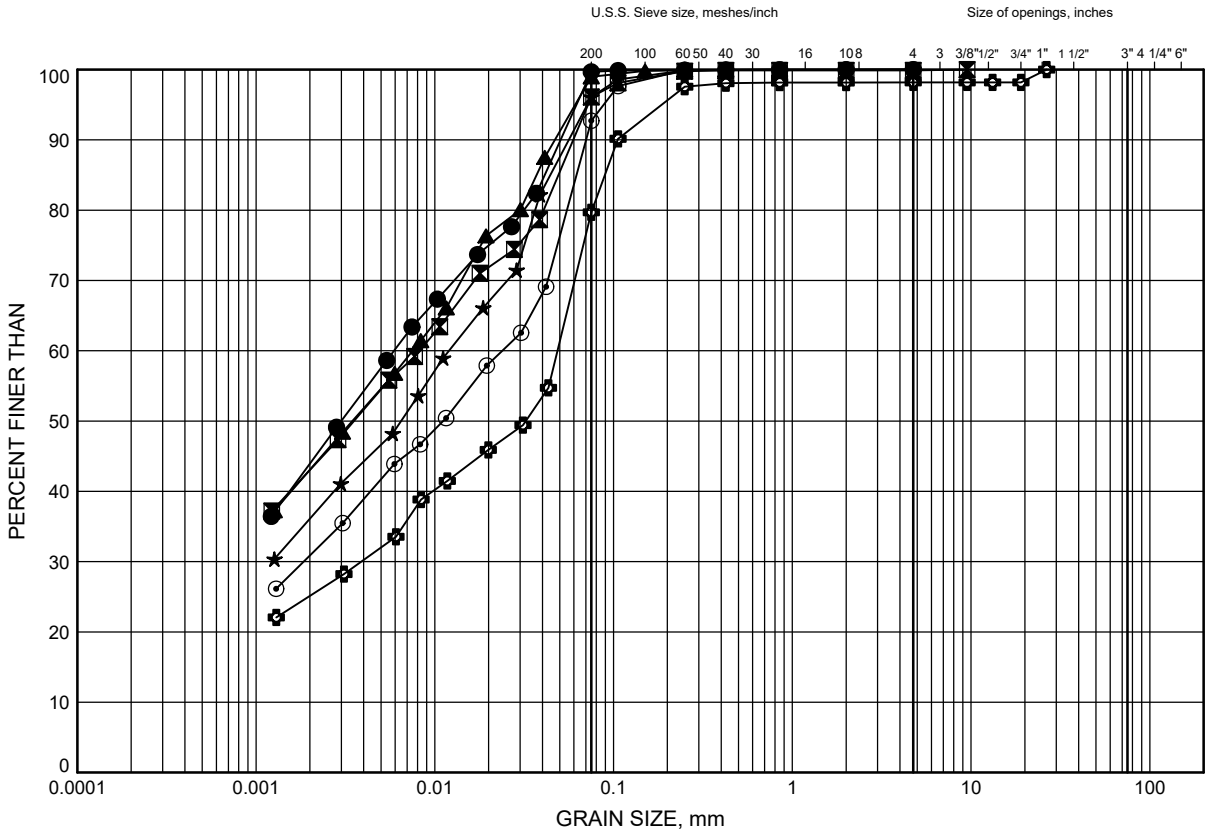
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C8.1

Clayey Silt (Below Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-01	18.6	132.6
⊠	BRU19-01	30.8	120.4
▲	BRU19-01A	23.2	129.0
★	BRU19-02	30.8	119.3
⊙	BRU19-03	21.6	128.2
✿	BRU19-03	32.3	117.5

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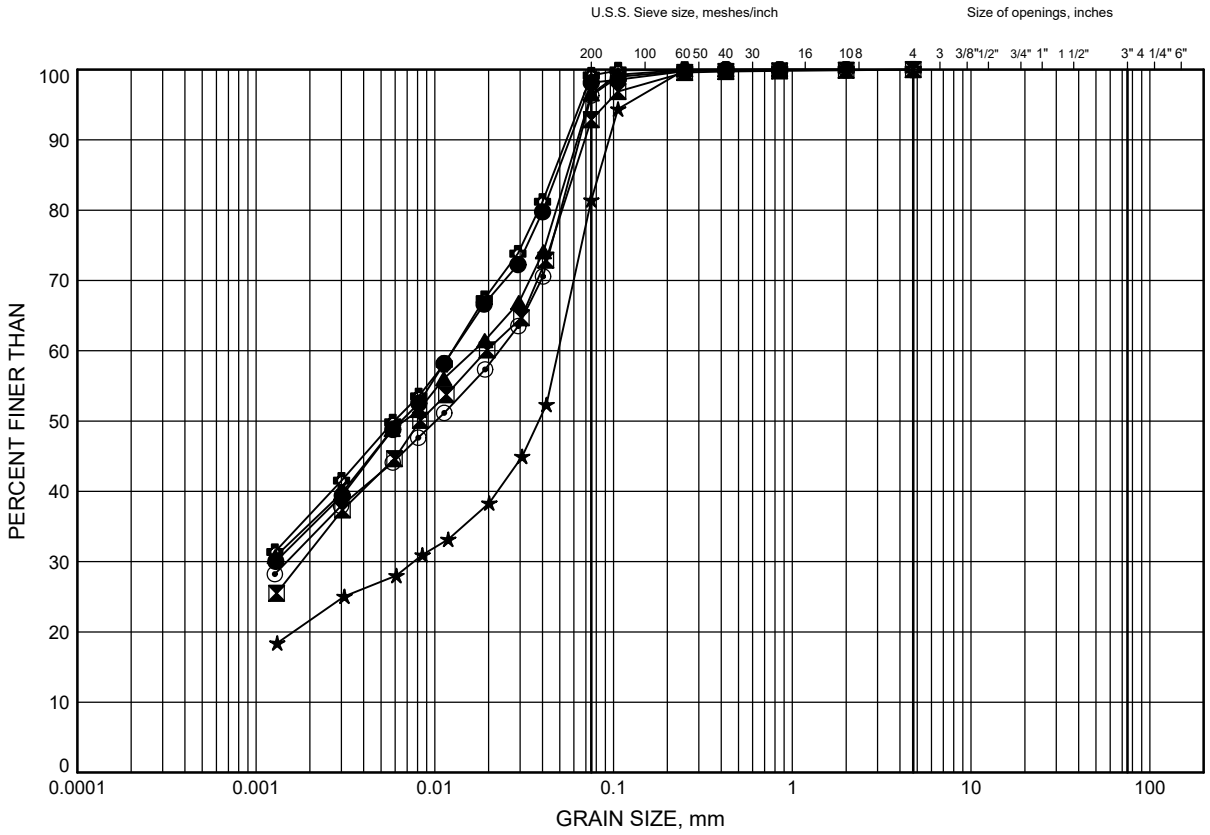
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C8.2

Clayey Silt (Below Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-04A	18.6	131.2
⊠	BRU19-04A	30.0	119.8
▲	BRU19-06	20.1	128.4
★	BRU19-06	22.3	126.2
⊙	BRU19-09	17.1	129.8
✿	BRU19-13	24.1	128.4

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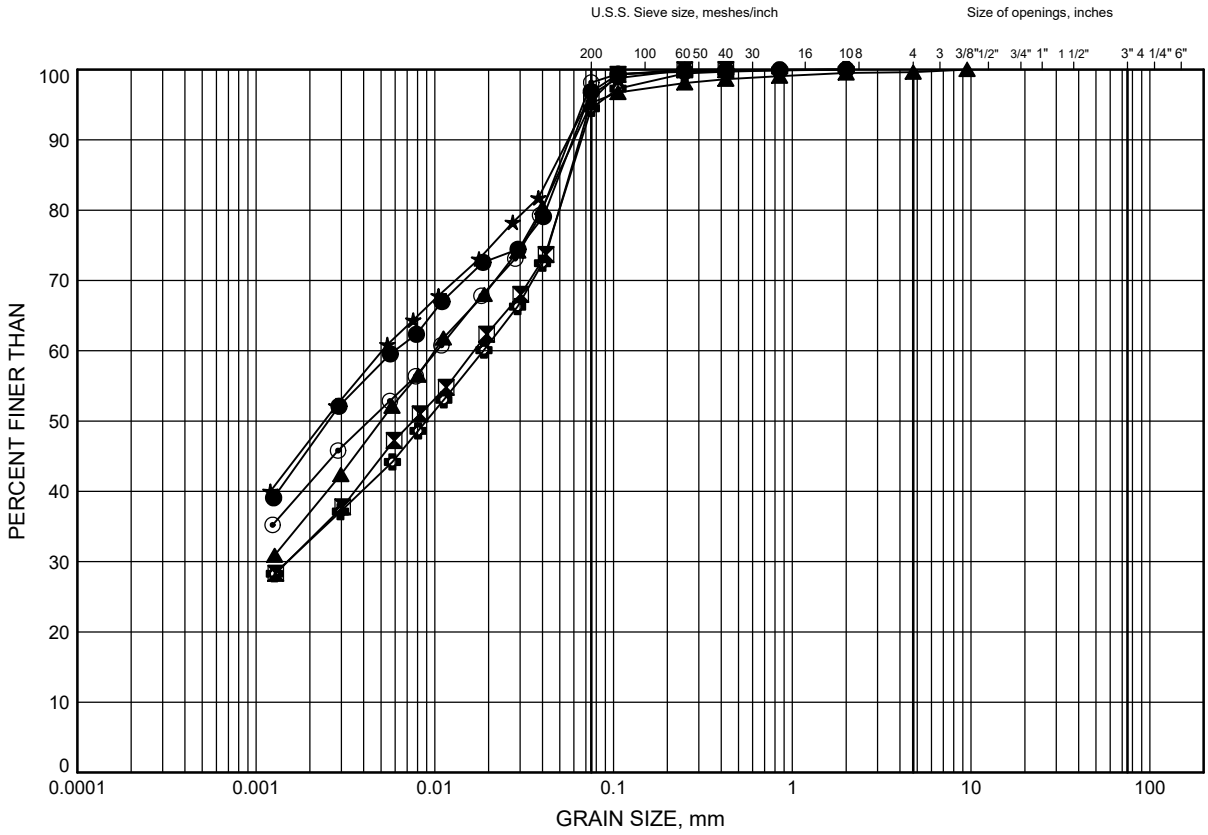
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C8.3

Clayey Silt (Below Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-15	21.6	131.0
⊠	BRU19-15	33.1	119.5
▲	BRU19-18	21.6	129.3
★	BRU19-19	20.1	132.1
⊙	BRU19-19	24.7	127.5
✿	BRU19-19	35.4	116.8

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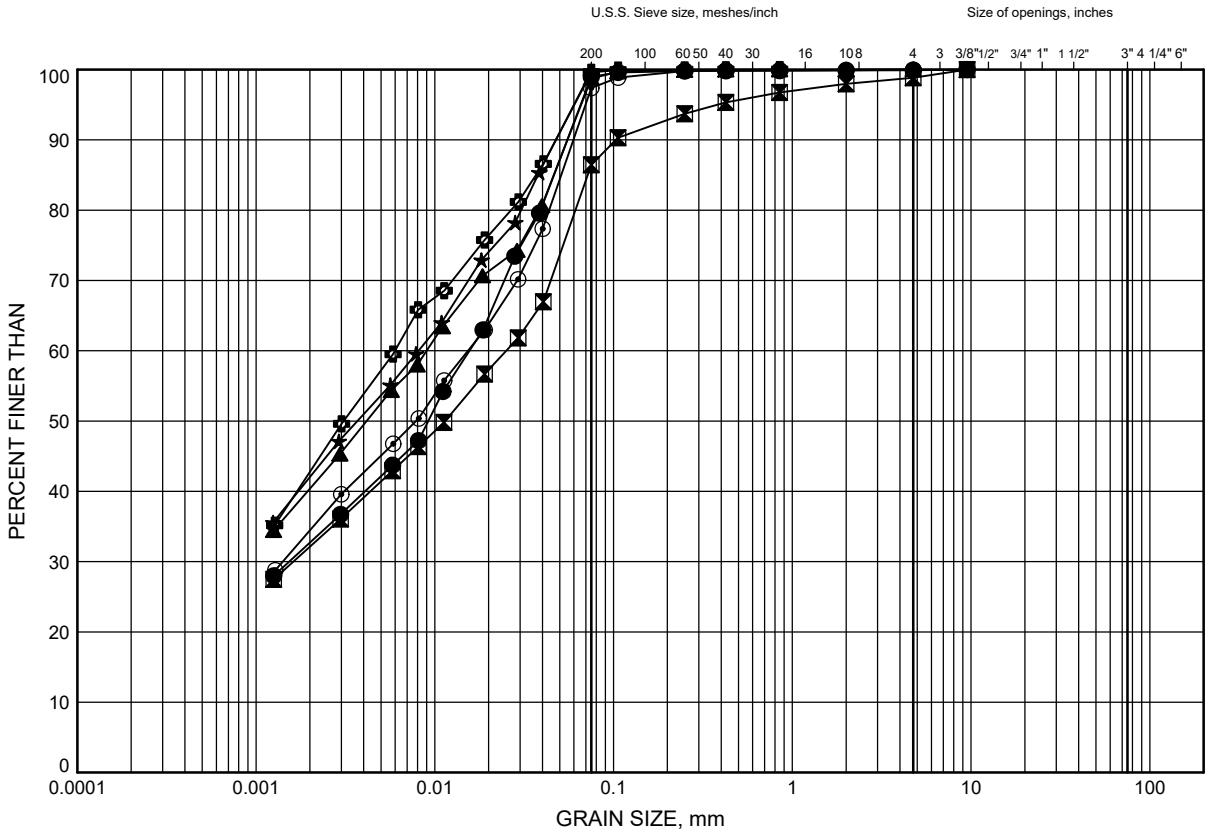
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C8.4

Clayey Silt (Below Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-21	23.2	127.5
⊠	BRU19-21	32.3	118.4
▲	BRU19-22	23.2	124.1
★	BRU19-23	14.8	131.8
⊙	BRU19-23	23.9	122.7
✿	BRU19-29	24.7	130.0

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Chkd. MJK

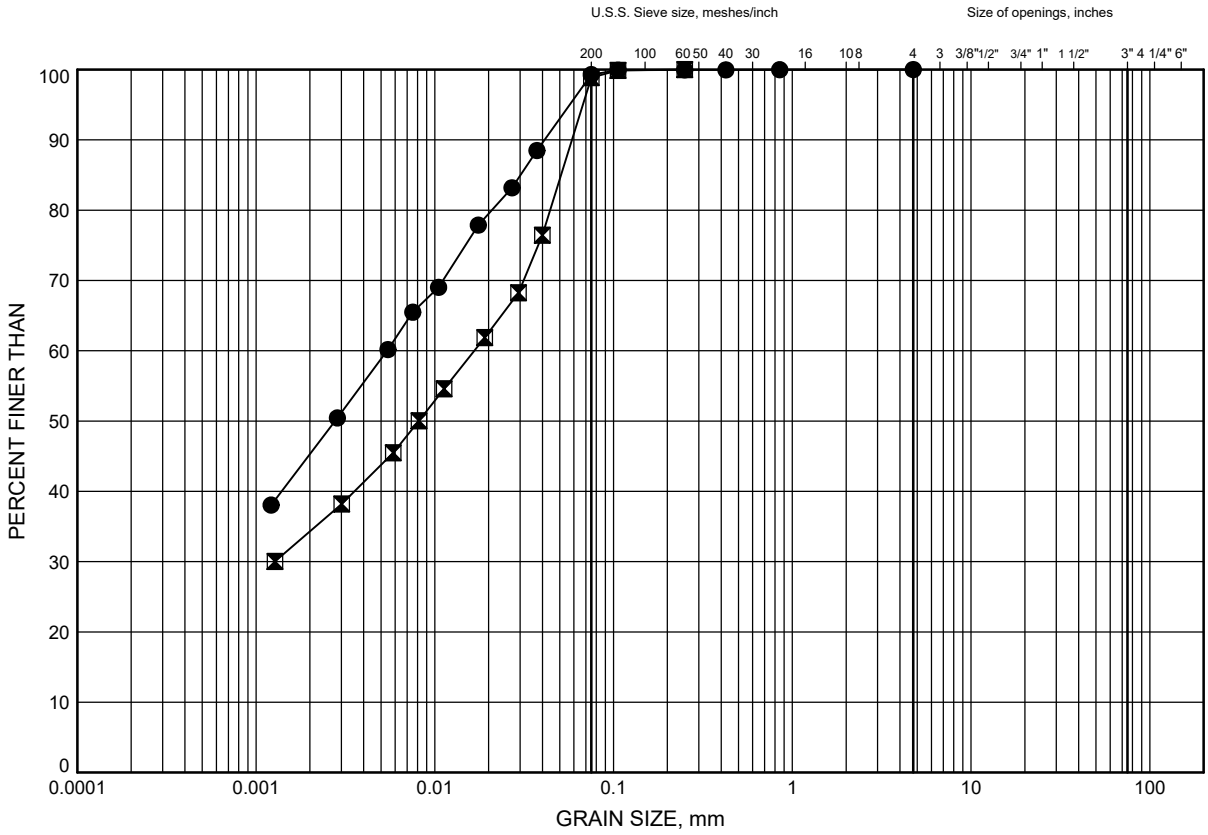
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C8.5

Clayey Silt (Below Elevation 133 m)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-30	22.9	131.2
⊠	BRU19-33	15.5	131.4

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

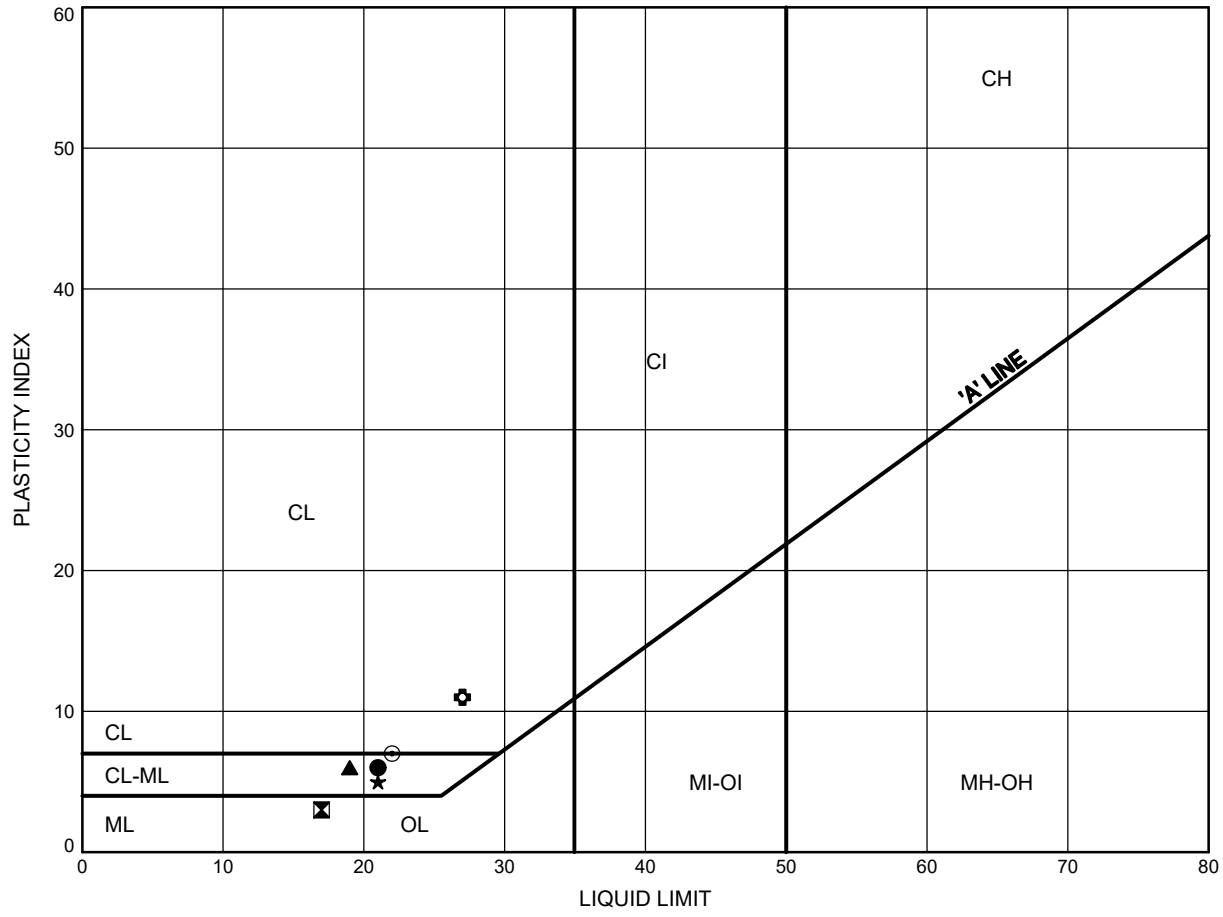
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C9.1

Clayey Silt (Below Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-02	30.8	119.3
⊠	BRU19-03	21.6	128.2
▲	BRU19-03	32.3	117.5
★	BRU19-04A	18.6	131.2
⊙	BRU19-04A	30.0	119.8
✿	BRU19-06	20.1	128.4

Date February 2022

WP# 4068-09-00

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Prep'd MIK

Chkd. MJK

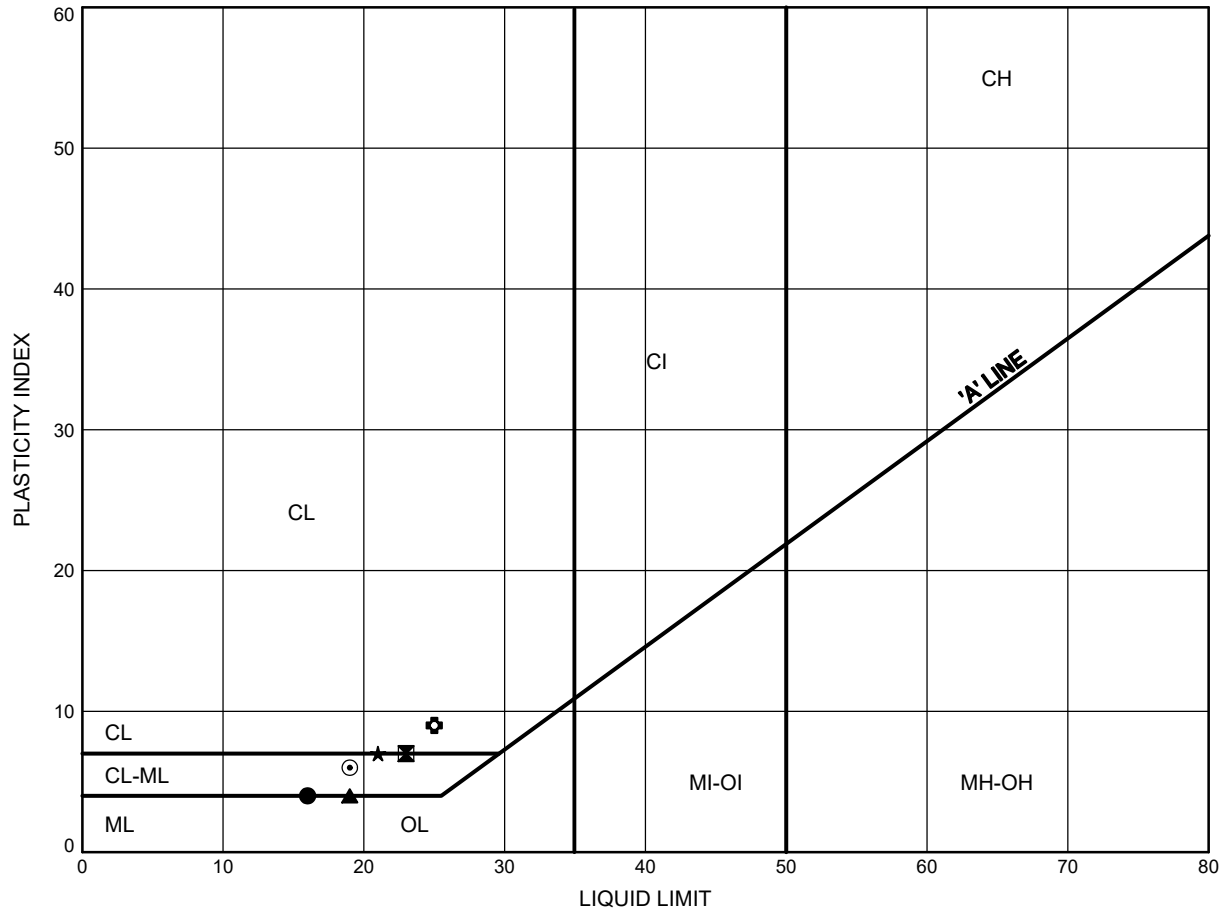
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C9.2

Clayey Silt (Below Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-06	22.3	126.2
⊠	BRU19-09	17.1	129.8
▲	BRU19-13	24.1	128.4
★	BRU19-15	33.1	119.5
⊙	BRU19-16	27.7	123.8
✿	BRU19-16	33.8	117.7

Date February 2022

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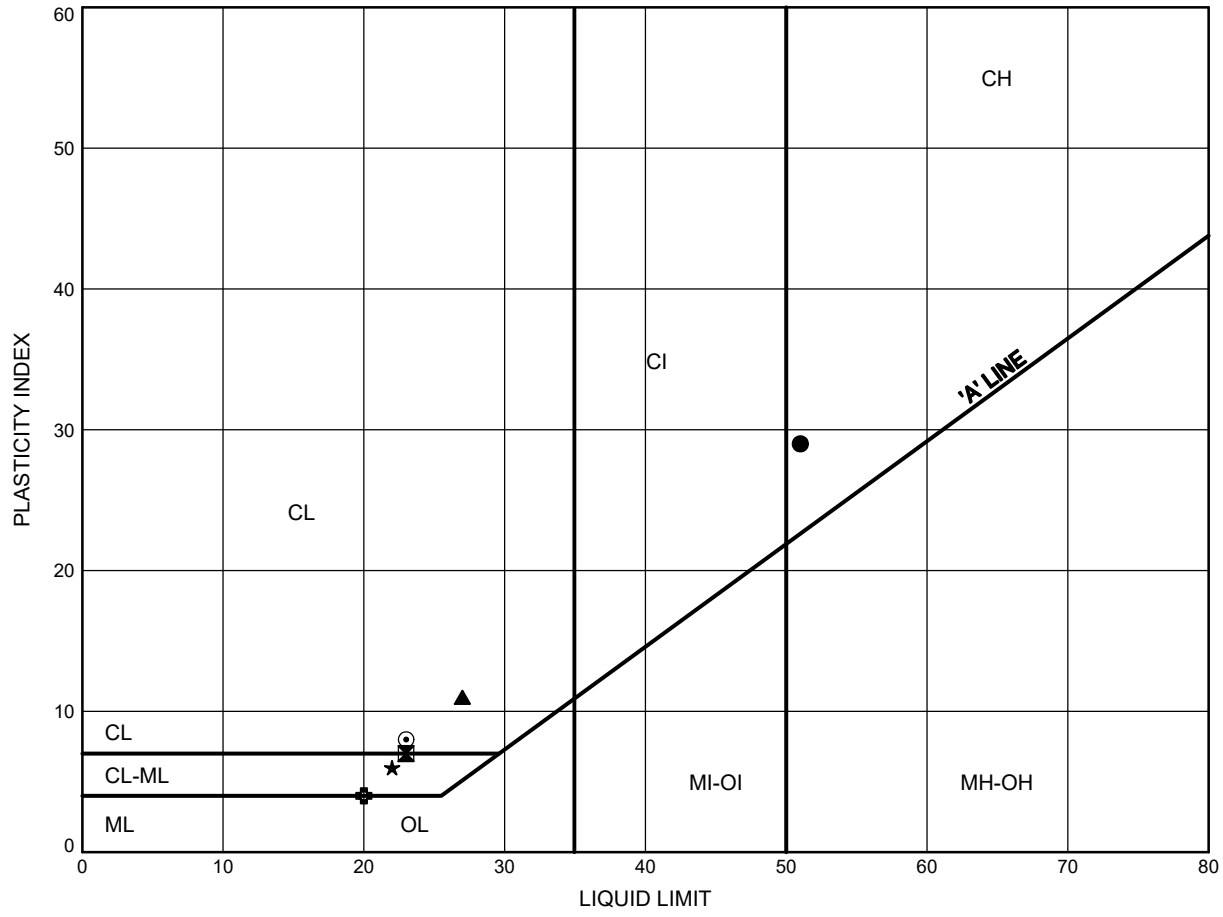
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C9.3

Clayey Silt (Below Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-19	20.1	132.1
⊠	BRU19-19	24.7	127.5
▲	BRU19-19	35.4	116.8
★	BRU19-21	23.2	127.5
⊙	BRU19-21	32.3	118.4
✿	BRU19-22	23.2	124.1

Date February 2022

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THURBER

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Chkd. MJK

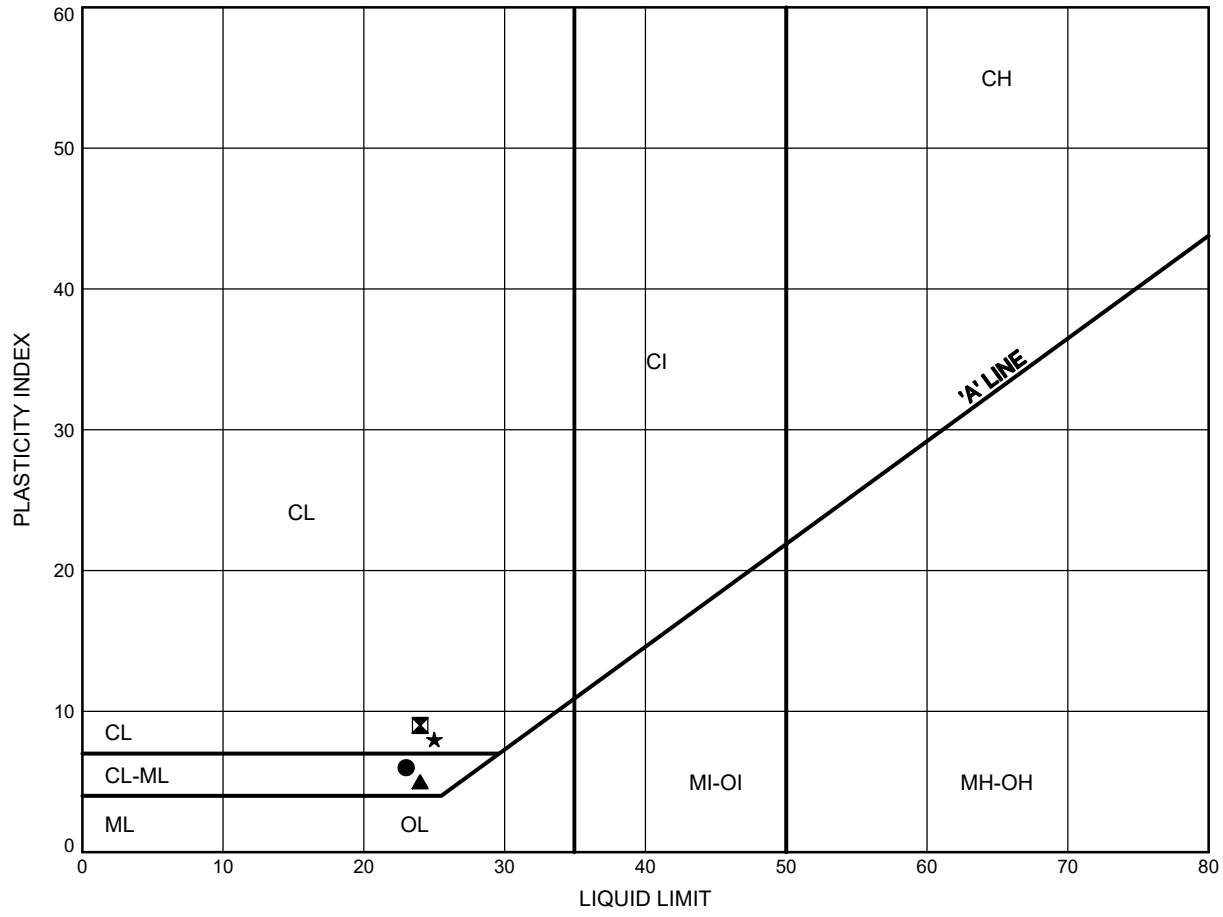
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C9.4

Clayey Silt (Below Elevation 133 m)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-23	14.8	131.8
⊠	BRU19-23	23.9	122.7
▲	BRU19-30	22.9	131.2
★	BRU19-33	15.5	131.4

Date February 2022

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THURBER

Prep'd MIK

Chkd. MJK

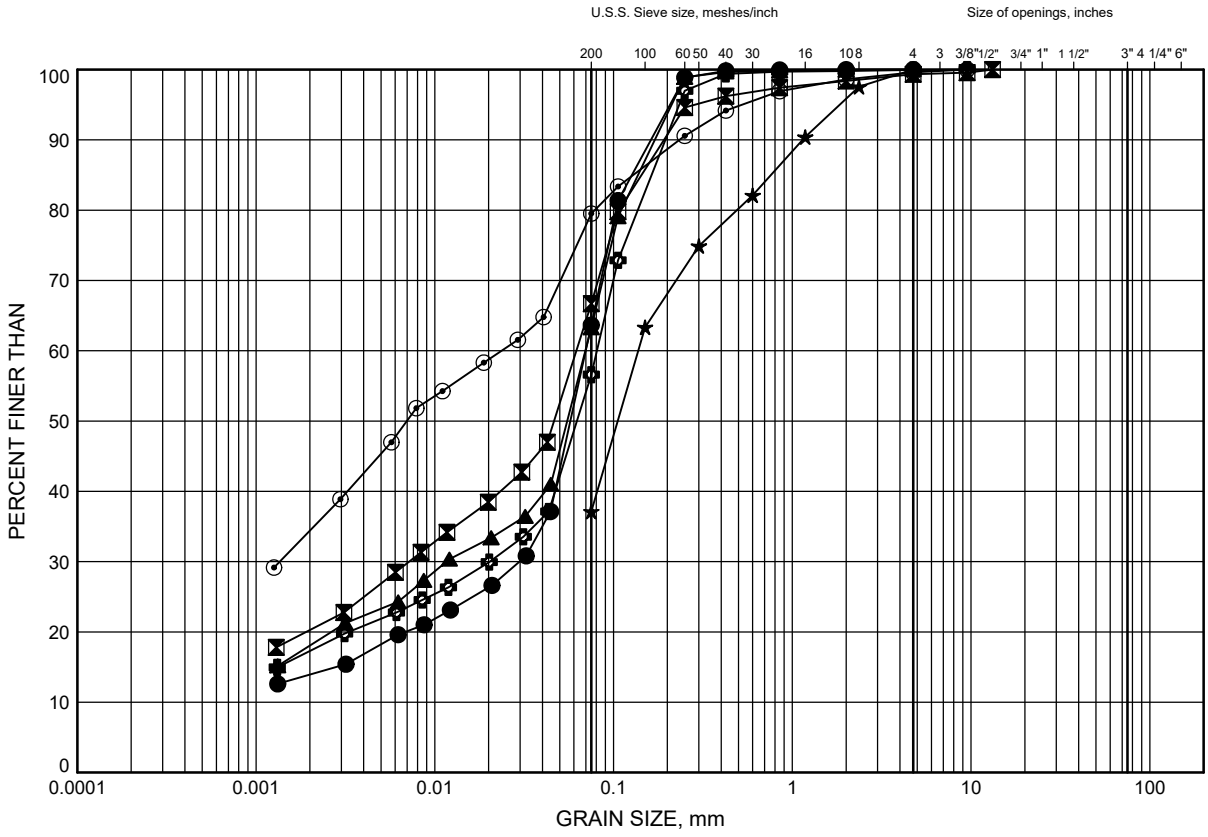
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C10.1

Interlayered Silt, Sand, and Clayey Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-01	36.9	114.3
⊠	BRU19-01	39.9	111.3
▲	BRU19-02	33.8	116.3
★	BRU19-03	38.4	111.4
⊙	BRU19-03	43.0	106.8
✿	BRU19-04A	32.3	117.5

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

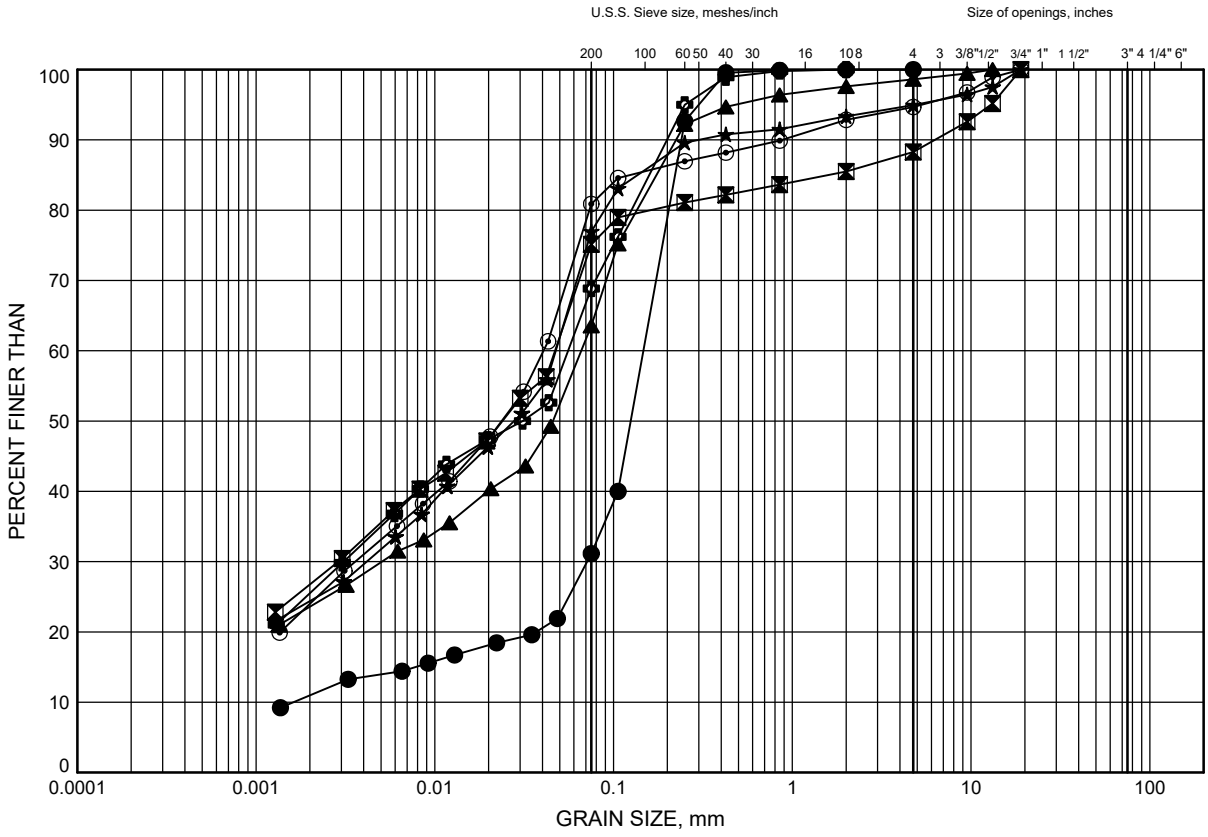
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C10.2

Interlayered Silt, Sand, and Clayey Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-07	26.4	121.7
⊠	BRU19-13	34.1	118.4
▲	BRU19-15	39.9	112.7
★	BRU19-16	39.9	111.6
⊙	BRU19-18	33.8	117.1
✿	BRU19-19	38.4	113.8

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

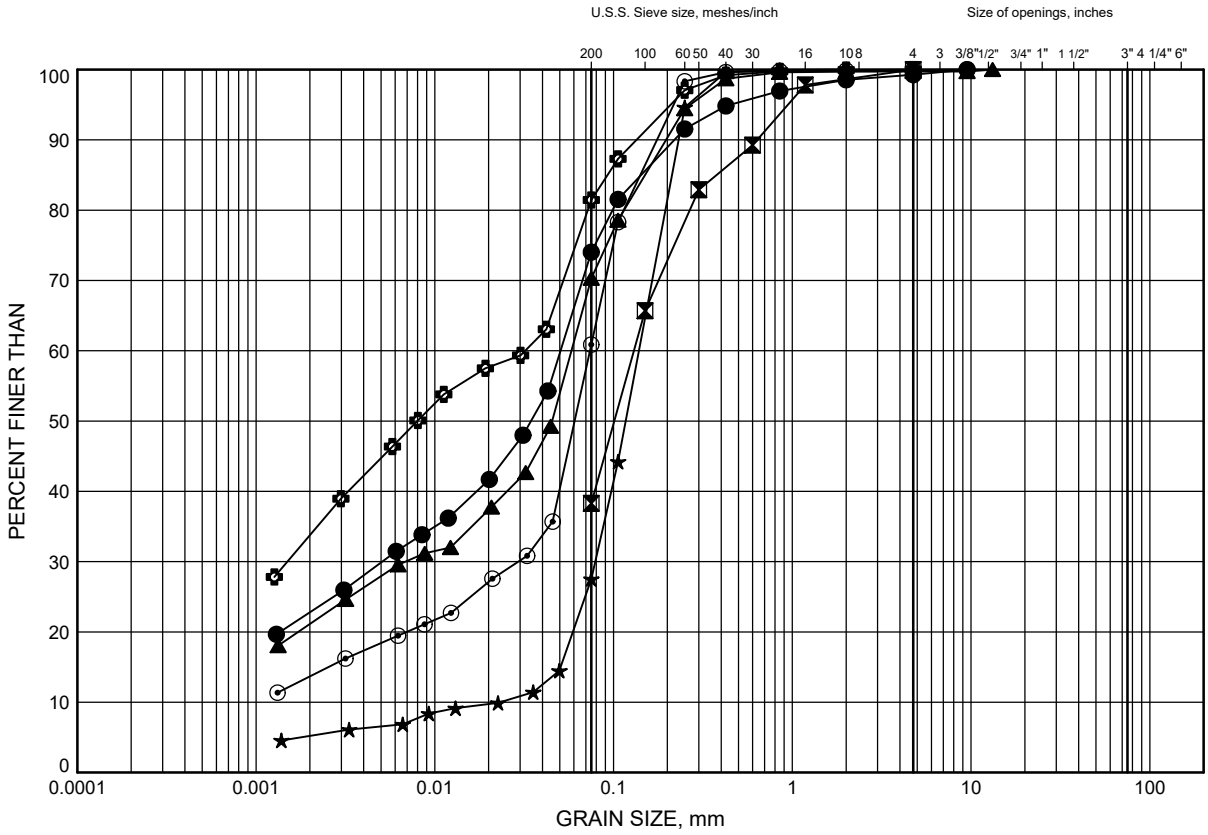
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C10.3

Interlayered Silt, Sand, and Clayey Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-21	38.4	112.3
⊠	BRU19-22	32.3	115.0
▲	BRU19-22	38.4	108.9
★	BRU19-23	29.3	117.3
⊙	BRU19-25	30.8	117.1
✿	BRU19-25	39.9	108.0

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

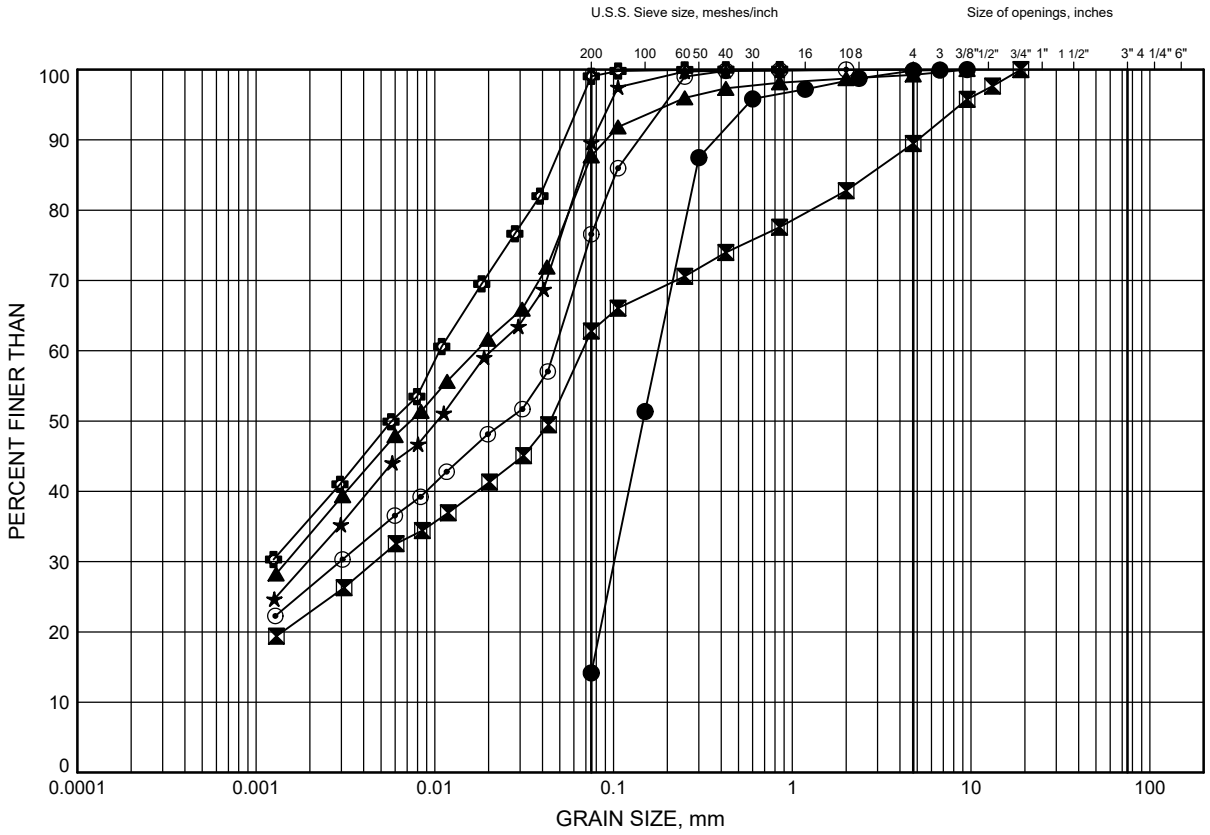
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C10.4

Interlayered Silt, Sand, and Clayey Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-26	17.1	132.6
⊠	BRU19-27	18.8	135.8
▲	BRU19-29	33.8	120.9
★	BRU19-30	32.0	122.1
⊙	BRU19-31	29.0	120.9
✿	BRU19-31	35.1	114.8

Date February 2022

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THURBER

Prep'd MIK

Chkd. MJK

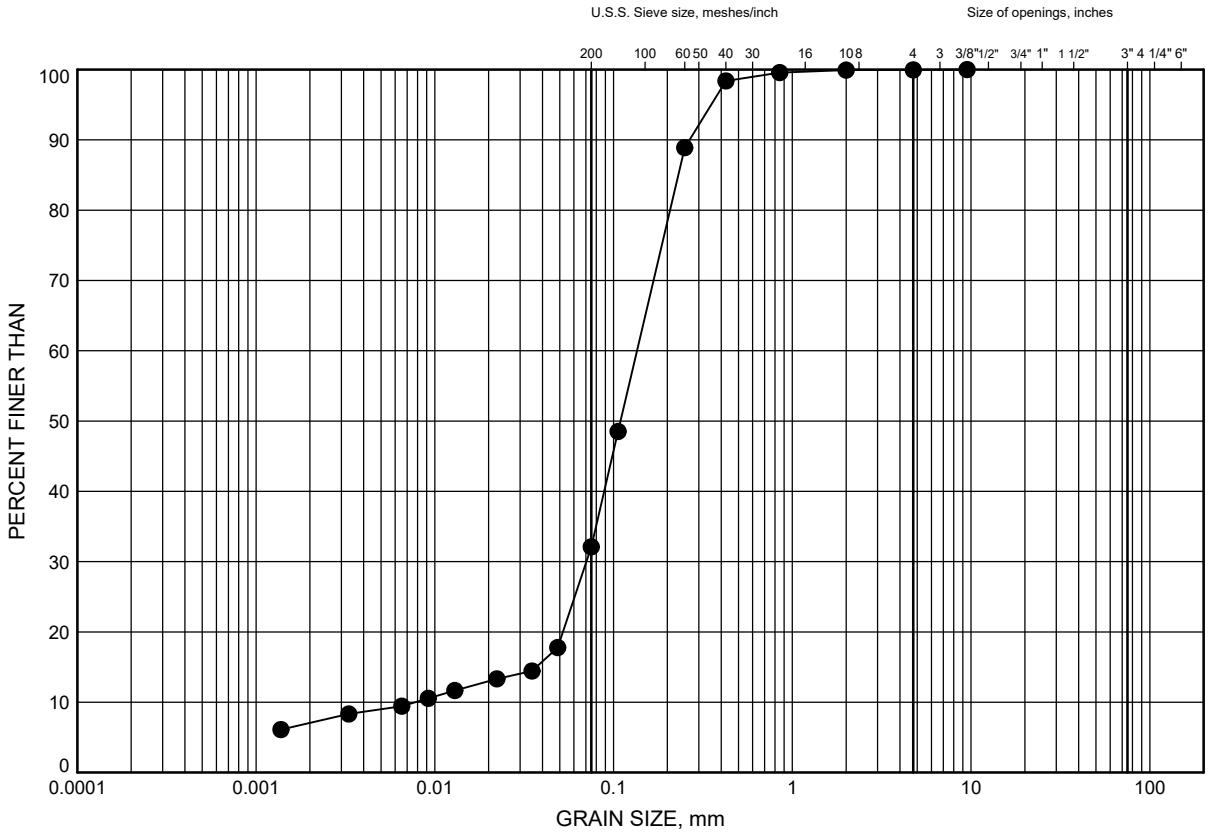
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C10.5

Interlayered Silt, Sand, and Clayey Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-33	27.0	119.9

Date February 2022

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THURBER

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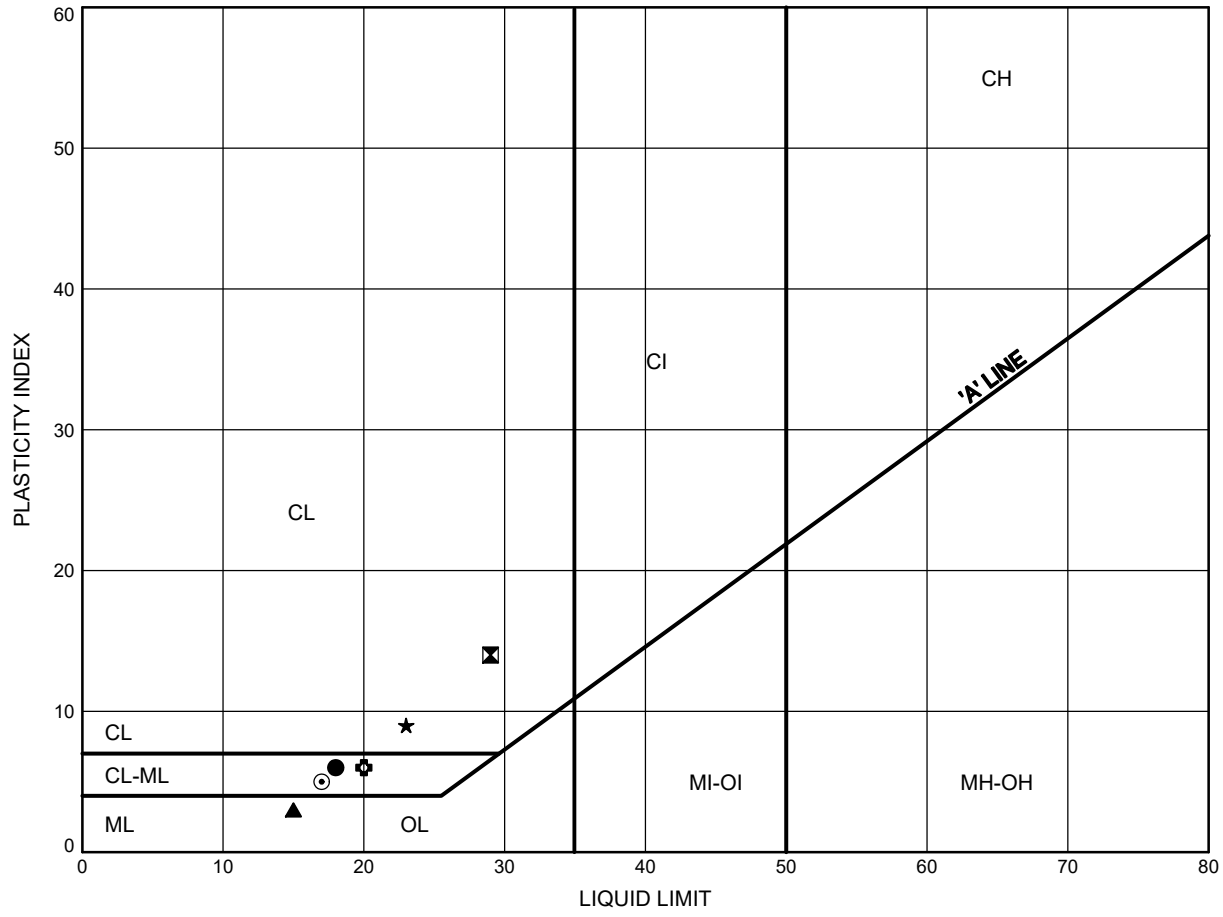
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C11.1

Interlayered Silt, Sand, and Clayey Silt



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-01	39.9	111.3
⊠	BRU19-03	43.0	106.8
▲	BRU19-04A	32.3	117.5
★	BRU19-13	34.1	118.4
⊙	BRU19-15	39.9	112.7
✿	BRU19-16	39.9	111.6

Date February 2022

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THURBER

Prep'd MIK

Chkd. MJK

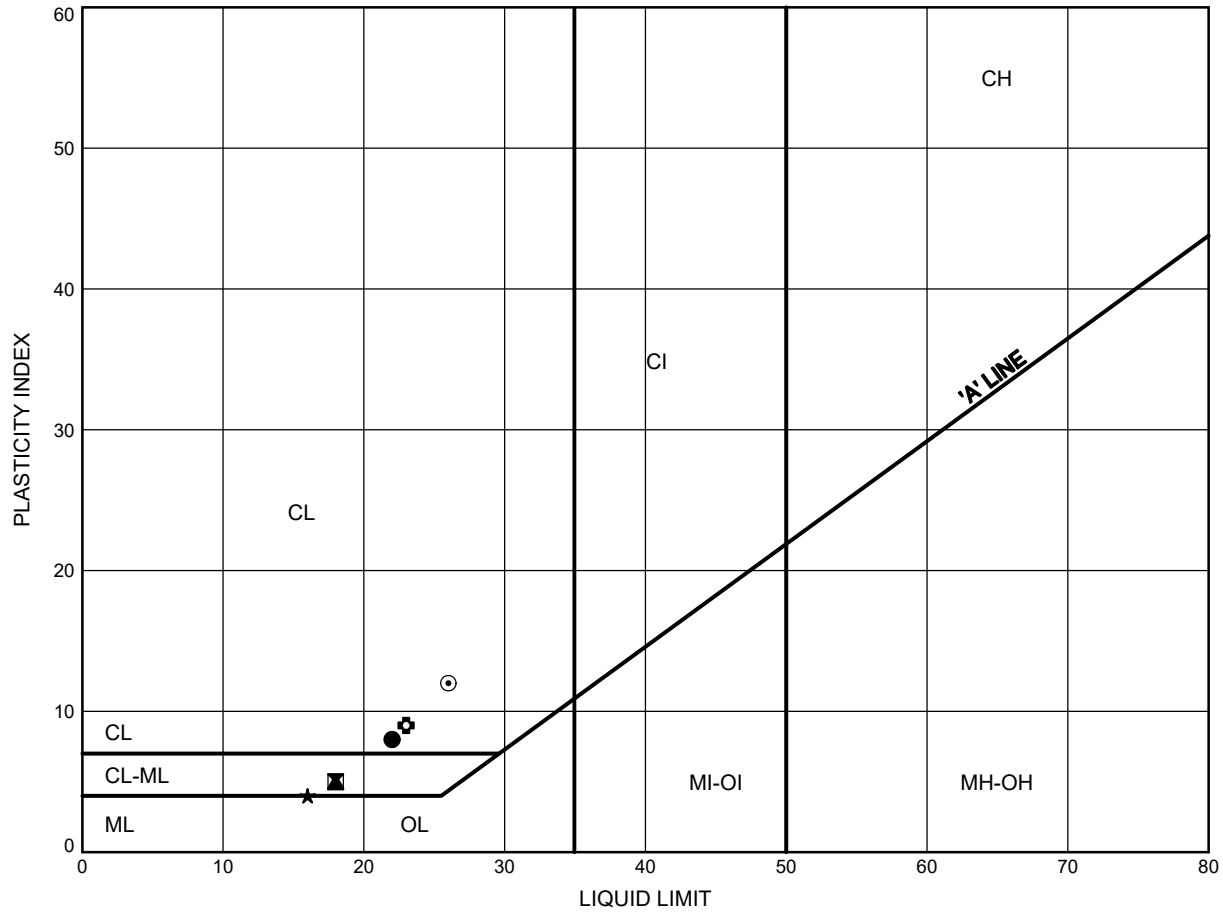
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C11.2

Interlayered Silt, Sand, and Clayey Silt



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-18	33.8	117.1
⊠	BRU19-19	38.4	113.8
▲	BRU19-21	38.4	112.3
★	BRU19-22	38.4	108.9
⊙	BRU19-25	39.9	108.0
✿	BRU19-27	18.8	135.8

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

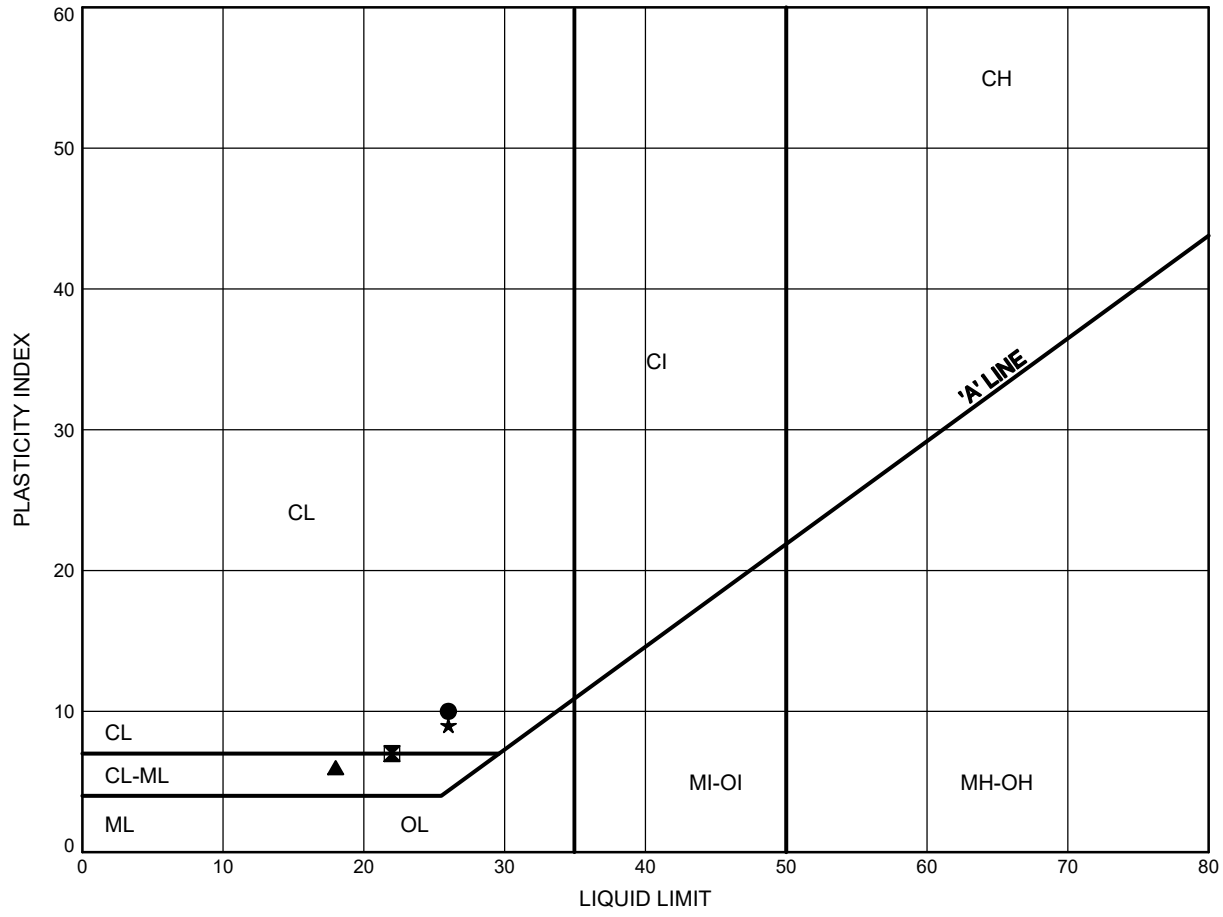
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

ATTERBERG LIMITS TEST RESULTS

FIGURE C11.3

Interlayered Silt, Sand, and Clayey Silt



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-29	33.8	120.9
⊠	BRU19-30	32.0	122.1
▲	BRU19-31	29.0	120.9
★	BRU19-31	35.1	114.8

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIK

Chkd. MJK

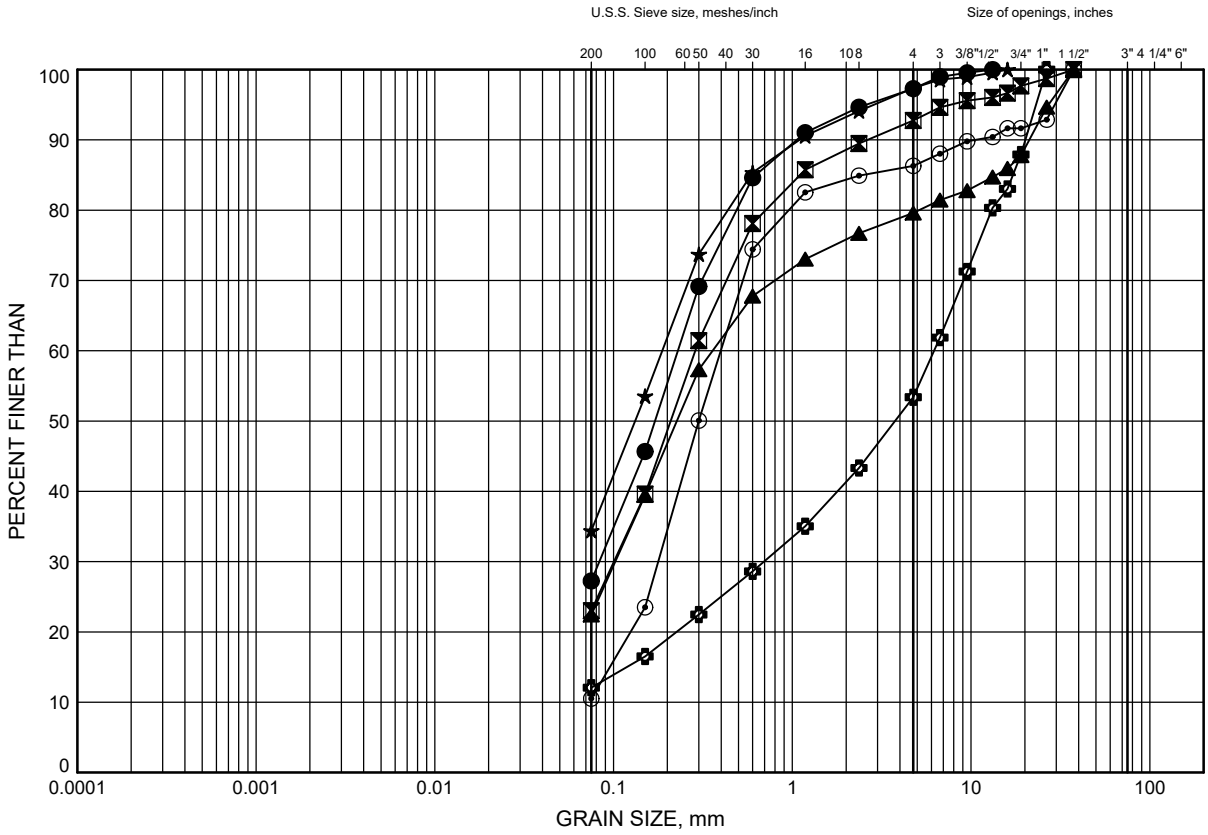
THURBALT 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C12.1

Till Silty Sand and Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-01	44.3	106.9
⊠	BRU19-02	44.1	106.0
▲	BRU19-02	48.1	102.0
★	BRU19-03	48.9	100.9
⊙	BRU19-09	24.1	122.8
✿	BRU19-10	10.7	135.5

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIk

Chkd. MJK

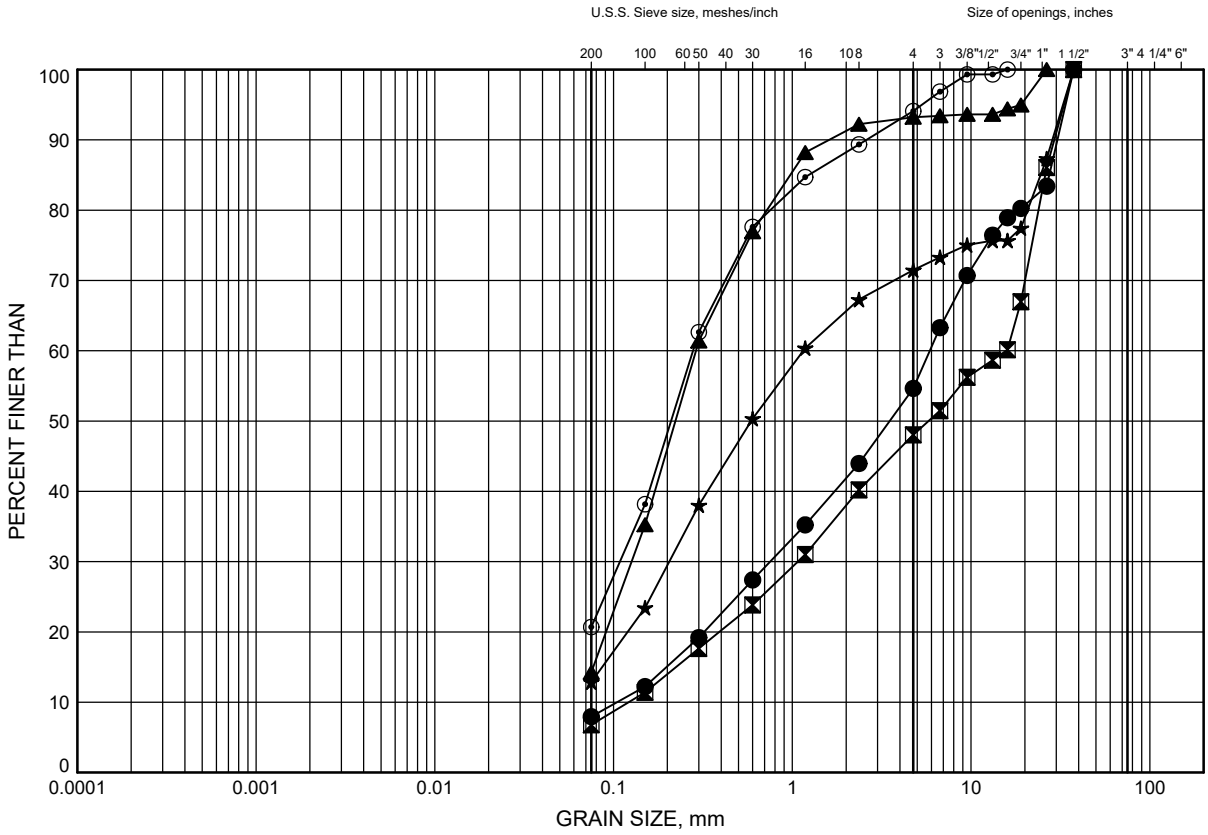
GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

Hwy 17 Twinning, Bruce Street (County Road 20) Interchange

GRAIN SIZE DISTRIBUTION

FIGURE C12.2

Till Silty Sand and Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BRU19-13	36.3	116.2
⊠	BRU19-19	39.9	112.3
▲	BRU19-28	30.8	124.2
★	BRU19-29	35.4	119.3
⊙	BRU19-33	33.4	113.5

Date February 2022

WP# 4068-09-00

THURBER

Prep'd MIk

Chkd. MJK

GRAIN SIZE DISTRIBUTION - THURBER 24726 BRUCE STREET GINT.GPJ 22-2-25

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Appendix C.2

One-Dimensional Consolidation Test Results (Standard)

THURBER ENGINEERING LTD.

Consolidation Test Report

CLIENT: Thurber Engineering (Ottawa) FILE NUMBER: 24726

PROJECT: Highway 17 Twinning - Renfrew REPORT DATE: August 10, 2020

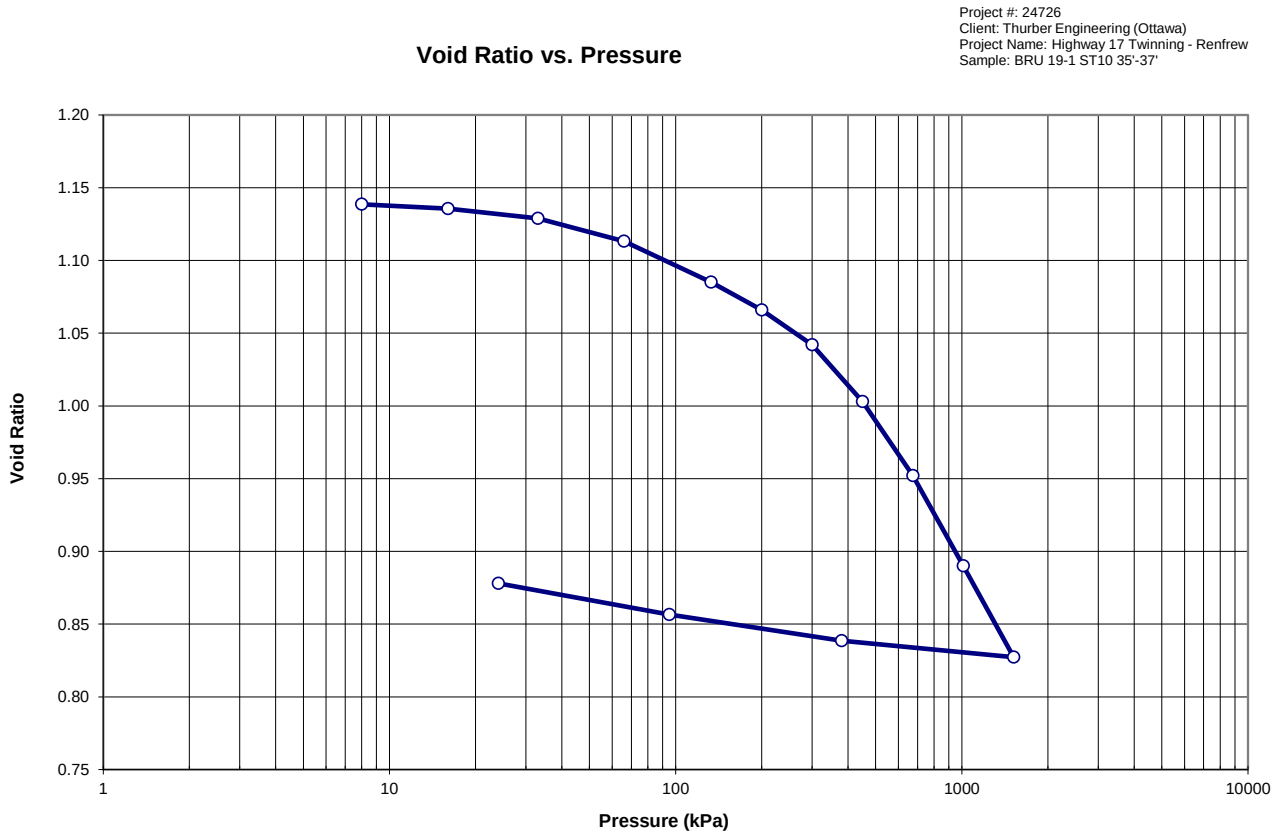
TEST DATES: April 01, 2020 - April 13, 2020

SAMPLE: BRU 19-1 ST10 35'-37'
Clay, silty, trace sand, grey, moist.
LL = 34.5, PL = 22.0, I_p = 12.5

PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	Start of Test	End of Test
Sample Height (mm)	25.40	22.32
Wet Dens. (kg/m^3)	1778.5	1954.1
Dry Dens. (kg/m^3)	1311.9	1493.0
Moisture Cont. (%)	35.6	30.9
Void Ratio	1.137	0.878
Saturation (%)	87.7	98.7

Note: A Specific Gravity (Gs) of 2.803 was obtained for the void ratio and saturation calculations.



TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

Consolidation Test Report

Highway 17 Twinning - Renfrew
24726 BRU 19-1 ST10 35'-37'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer. The average moisture content of the trimmings was 34.5%.

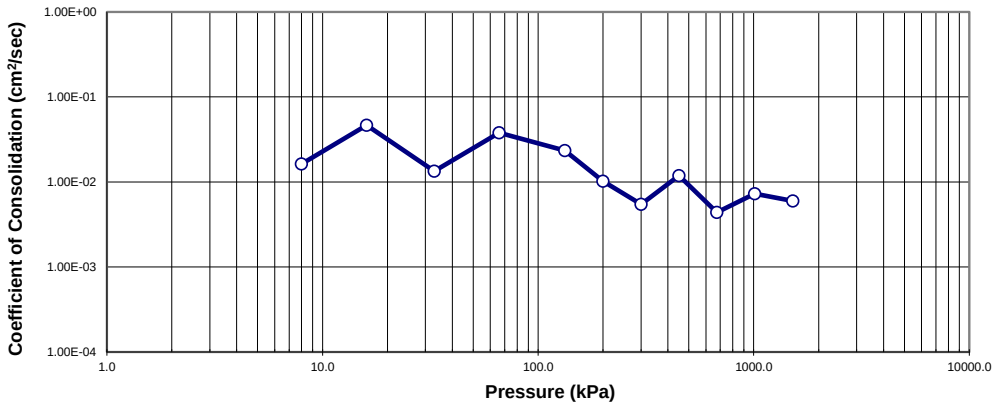
LOADING: A seating load of 8 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after 100% primary consolidation was reached at each load increment.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D_{90} (mm)	t_{90} (min)	c_v (cm^2/s)	Void Ratio	m_v (m^2/kN)	k (cm/s)
0.0	25.400					1.137		
8.0	25.419	25.409	-0.007	1.40	1.62E-02	1.139	-9.21E-05	-1.47E-07
16.0	25.383	25.401	-0.024	0.49	4.65E-02	1.136	1.78E-04	8.11E-07
33.0	25.305	25.344	-0.058	1.69	1.34E-02	1.129	1.80E-04	2.37E-07
66.0	25.118	25.212	-0.115	0.59	3.79E-02	1.113	2.23E-04	8.30E-07
133.0	24.783	24.951	-0.237	0.94	2.34E-02	1.085	1.99E-04	4.57E-07
200.0	24.556	24.669	-0.132	2.10	1.02E-02	1.066	1.37E-04	1.37E-07
300.0	24.271	24.413	-0.160	3.84	5.48E-03	1.042	1.16E-04	6.23E-08
450.0	23.806	24.038	-0.210	1.72	1.19E-02	1.003	1.28E-04	1.49E-07
675.0	23.202	23.504	-0.306	4.45	4.38E-03	0.952	1.13E-04	4.84E-08
1012.0	22.463	22.833	-0.310	2.53	7.29E-03	0.890	9.45E-05	6.75E-08
1518.0	21.718	22.090	-0.350	2.89	5.97E-03	0.827	6.56E-05	3.84E-08
380.0	21.852	21.785				0.839		
95.0	22.066	21.959				0.857		
24.0	22.320	22.193				0.878		

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-1 ST10 35'-37'

Coefficient of Consoildation vs. Pressure



Note: C_v and k calculated using t_{90} values (square root of time method)

TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

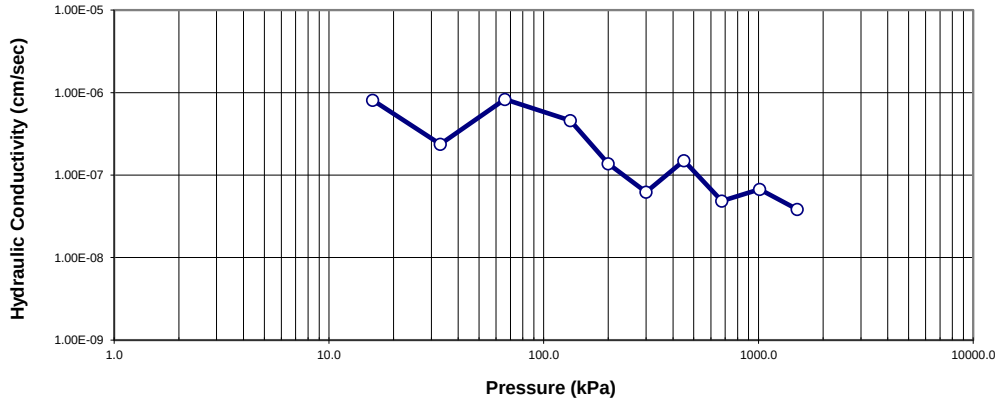
Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

BRU 19-1 ST10 35'-37'

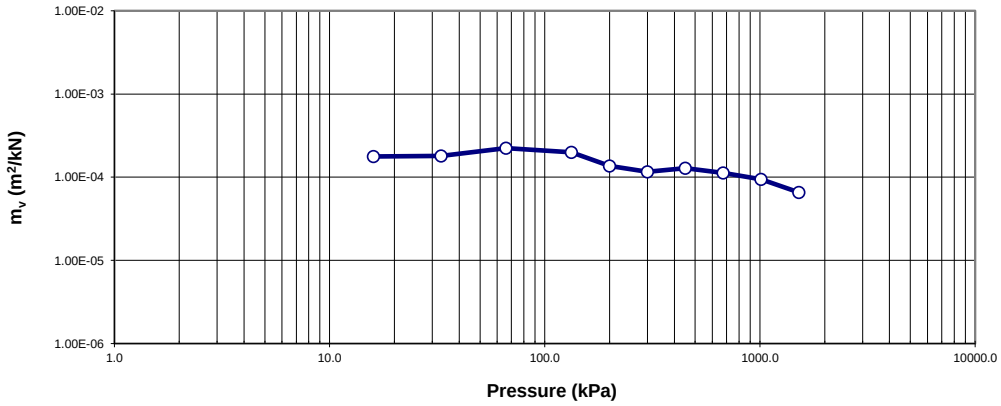
Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-1 ST10 35'-37'

Hydraulic Conductivity vs. Pressure



Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-1 ST10 35'-37'

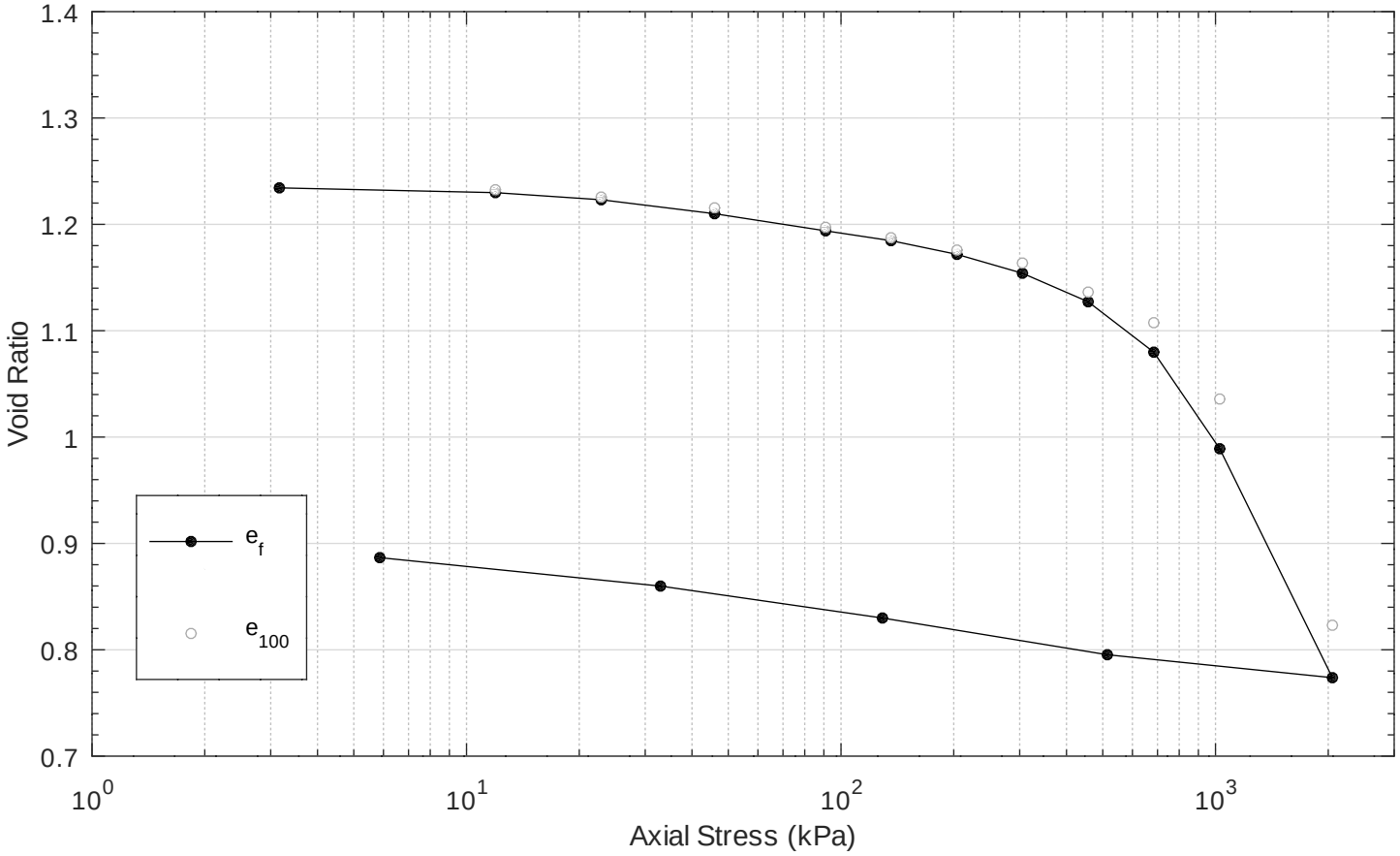
m_v vs. Pressure



TEST DONE BY: BT
REVIEWED BY: WM

THURBER

Project: 24726
Highway 17, Bruce Street
Borehole: BRU19-1-2
Sample: ST1
Depth: 4.9m
Client: Ontario Ministry of Transportation



Start of Test			2020-12-29
Diameter of Sample	cm	D	6.349
Height of Sample	cm	H_o	2.537
Height of Solids	cm	H_s	1.136
Water Content	%	w_o	43.73
Dry Density	g/cm^3	ρ_d	1.23
Moist Unit Weight	kN/m^3	γ	17.3
Void Ratio	-	e_o	1.234
Degree of Saturation	-	S_{ro}	0.97
Specific Gravity	-	G_s	2.750

End of Test			2021-01-14
Height of Sample	cm	H_f	2.143
Water Content	%	w_f	34.13
Void Ratio	-	e_f	0.887

TRIMMING: the specimen was manually trimmed to the size of the consolidation ring, then mounted in a fixed ring consolidometer

LOADING: the consolidometer was flooded with water with the seating load adjusted to limit swelling

CALCULATIONS: coefficients of consolidation were calculated by the square root time method

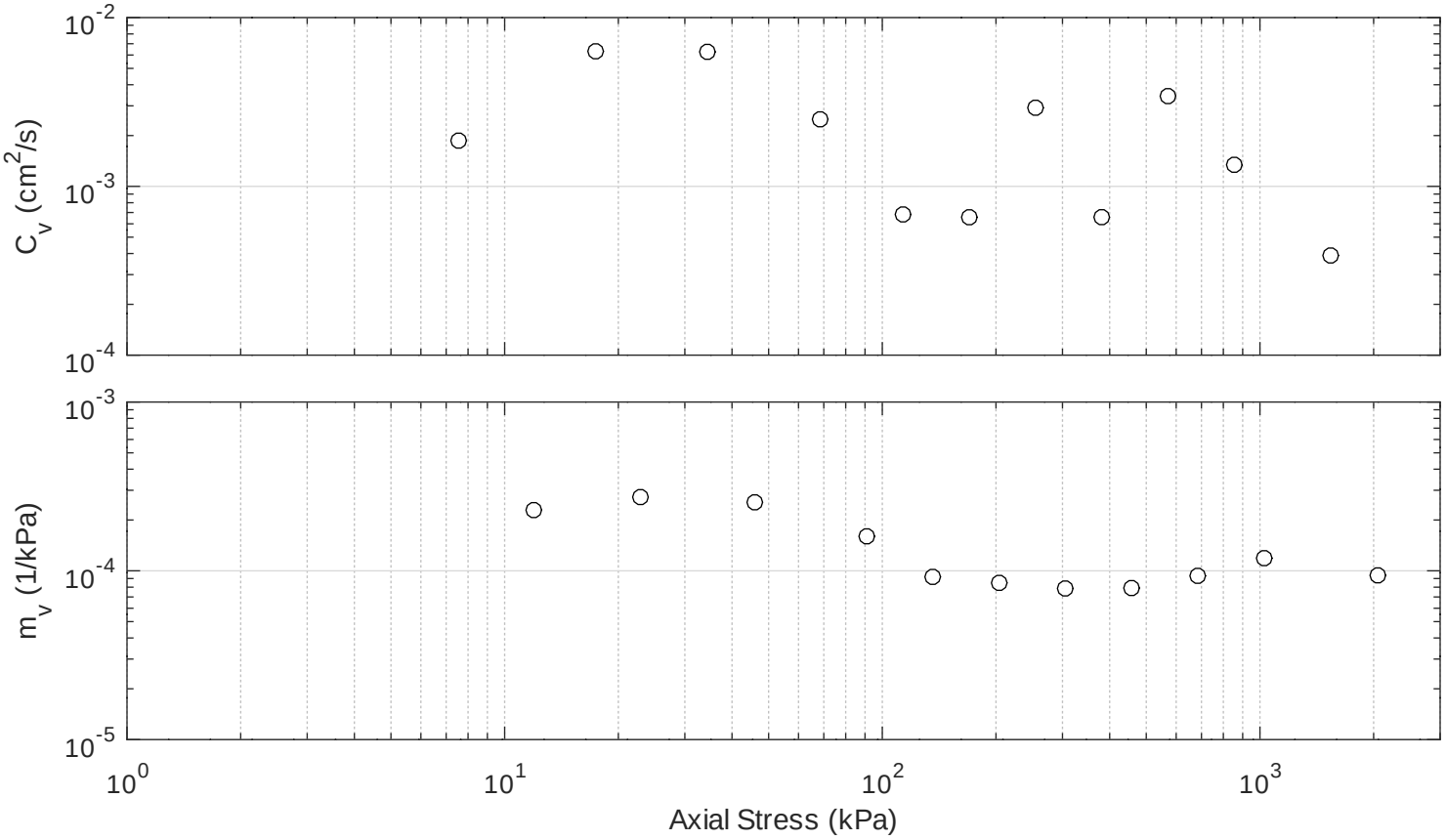
Interpreted Results

Recompression Index (reloading)	-	C_r	0.053
Compression Index	-	C_c	0.715
Recompression Index (unloading)	-	C_r	0.054
Preconsolidation Pressure	kPa	p'_c	666

Check: SP Review: PKC

THURBER

Project: 24726
Highway 17, Bruce Street
Borehole: BRU19-1-2
Sample: ST1
Depth: 4.9m
Client: Ontario Ministry of Transportation



Load No.	Axial Stress	Load Duration	System Deflec.	Dial	Sample Height	Axial Strain	Void Ratio	Time U(0.99)	C_v	k_v	$C_{a\varepsilon}$
	kPa	min	mm	mm	cm	%	-	min	cm^2/s	cm/s	-
0				10.000	2.537	0.00	1.234				
1	3.2	1440.2	0.011	9.997	2.538	-0.03	1.234				
2	11.9	1440.2	0.065	9.892	2.533	0.17	1.230	25.4	1.87e-03	4.19e-08	0.0007
3	22.9	1440.2	0.096	9.785	2.525	0.47	1.223	7.5	6.31e-03	1.69e-07	0.0005
4	46.0	1440.1	0.153	9.580	2.510	1.06	1.210	7.4	6.27e-03	1.57e-07	0.0012
5	91.0	1440.2	0.197	9.354	2.492	1.78	1.194	18.2	2.50e-03	3.92e-08	0.0008
6	136.0	1440.3	0.249	9.198	2.481	2.19	1.185	65.6	6.82e-04	6.16e-09	0.0011
7	204.0	1440.5	0.285	9.016	2.467	2.77	1.172	67.4	6.56e-04	5.46e-09	0.0017
8	305.0	1440.0	0.342	8.757	2.447	3.56	1.154	14.9	2.92e-03	2.25e-08	0.0022
9	457.1	1440.2	0.388	8.407	2.416	4.76	1.127	63.6	6.57e-04	5.09e-09	0.0034
10	684.2	1440.4	0.455	7.801	2.362	6.89	1.080	11.5	3.43e-03	3.14e-08	0.0064
11	1026.3	1440.1	0.521	6.704	2.259	10.95	0.989	24.8	1.34e-03	1.56e-08	0.0134
12	2051.7	1440.4	0.630	4.150	2.015	20.59	0.774	34.8	3.89e-04	3.59e-09	0.0146
13	514.2	1440.5	0.511	4.515	2.039	19.62	0.795				
14	129.0	1440.1	0.389	5.029	2.078	18.08	0.830				
15	33.0	1440.0	0.304	5.455	2.113	16.73	0.860				
16	5.9	1440.0	0.230	5.833	2.143	15.53	0.887				

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Ottawa, ON K1B 1A7
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Fax: (613) 722-2799

Stantec

January 22, 2021
File: 122410864

Attention: **Thurber Engineering, File #24726**

Reference: **Thurber File #24726.200a.202, LS-705 Specific Gravity**

The following table summarizes two Specific Gravity results for Bruce Street.

Source	Depth (m)	Specific Gravity
BRU19-1.2 ST1	4.9	2.750
BRU19-1.2 ST5	17.7	2.755

Sincerely,

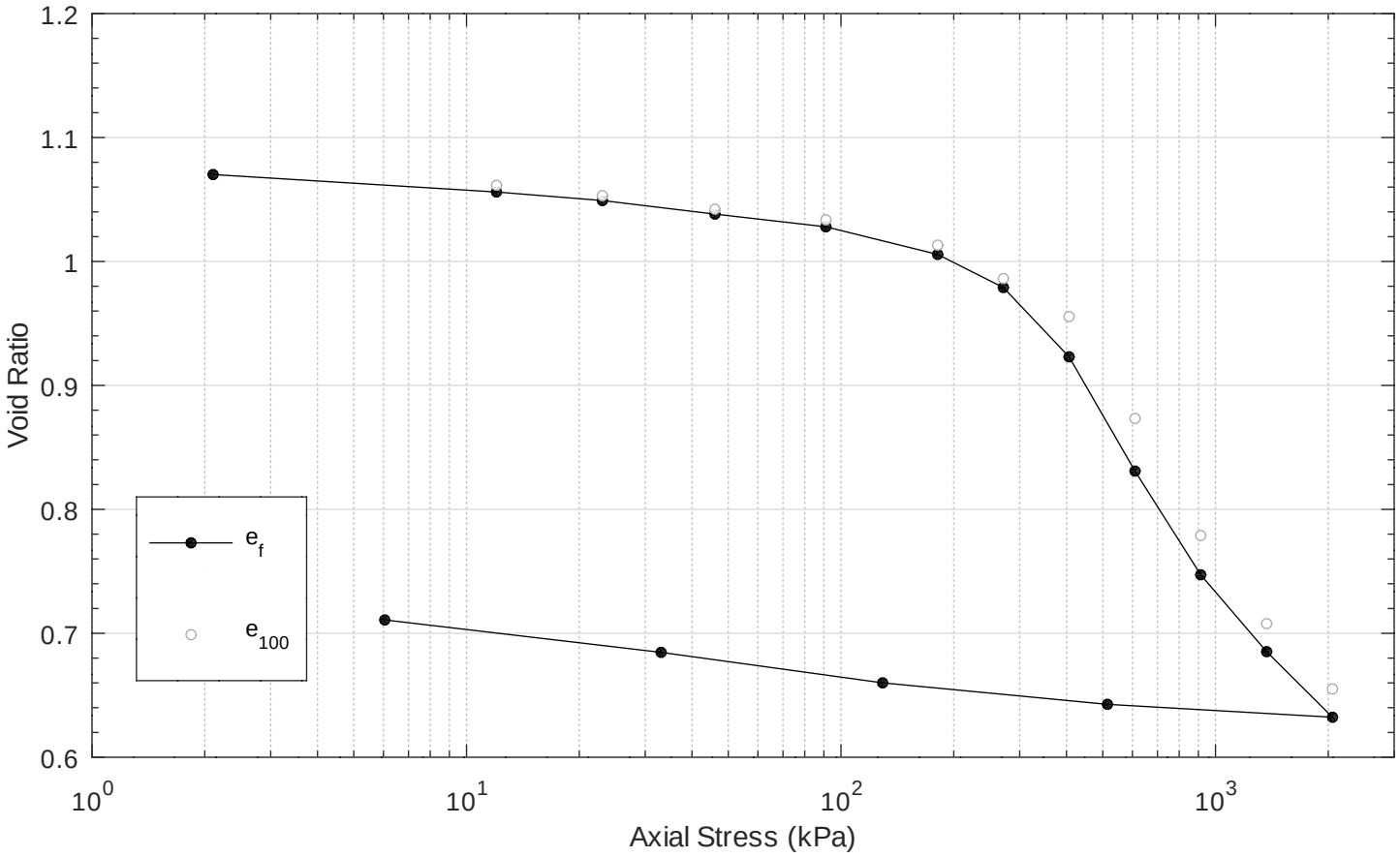
Stantec Consulting Ltd

Brian Prevost

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
Fax: 613-722-2799
brian.prevost@stantec.com

THURBER

Project: 24726
Highway 17, Bruce Street
Borehole: BRU19-1-2
Sample: ST5
Depth: 17.7m
Client: Ontario Ministry of Transportation



Start of Test			2020-12-29
Diameter of Sample	cm	D	6.347
Height of Sample	cm	H_o	2.535
Height of Solids	cm	H_s	1.225
Water Content	%	w_o	38.37
Dry Density	g/cm^3	ρ_d	1.33
Moist Unit Weight	kN/m^3	γ	18.1
Void Ratio	-	e_o	1.069
Degree of Saturation	-	S_{ro}	0.99
Specific Gravity	-	G_s	2.755

End of Test			2021-01-14
Height of Sample	cm	H_f	2.096
Water Content	%	w_f	26.54
Void Ratio	-	e_f	0.711

TRIMMING: the specimen was manually trimmed to the size of the consolidation ring, then mounted in a fixed ring consolidometer

LOADING: the consolidometer was flooded with water with the seating load adjusted to limit swelling

CALCULATIONS: coefficients of consolidation were calculated by the square root time method

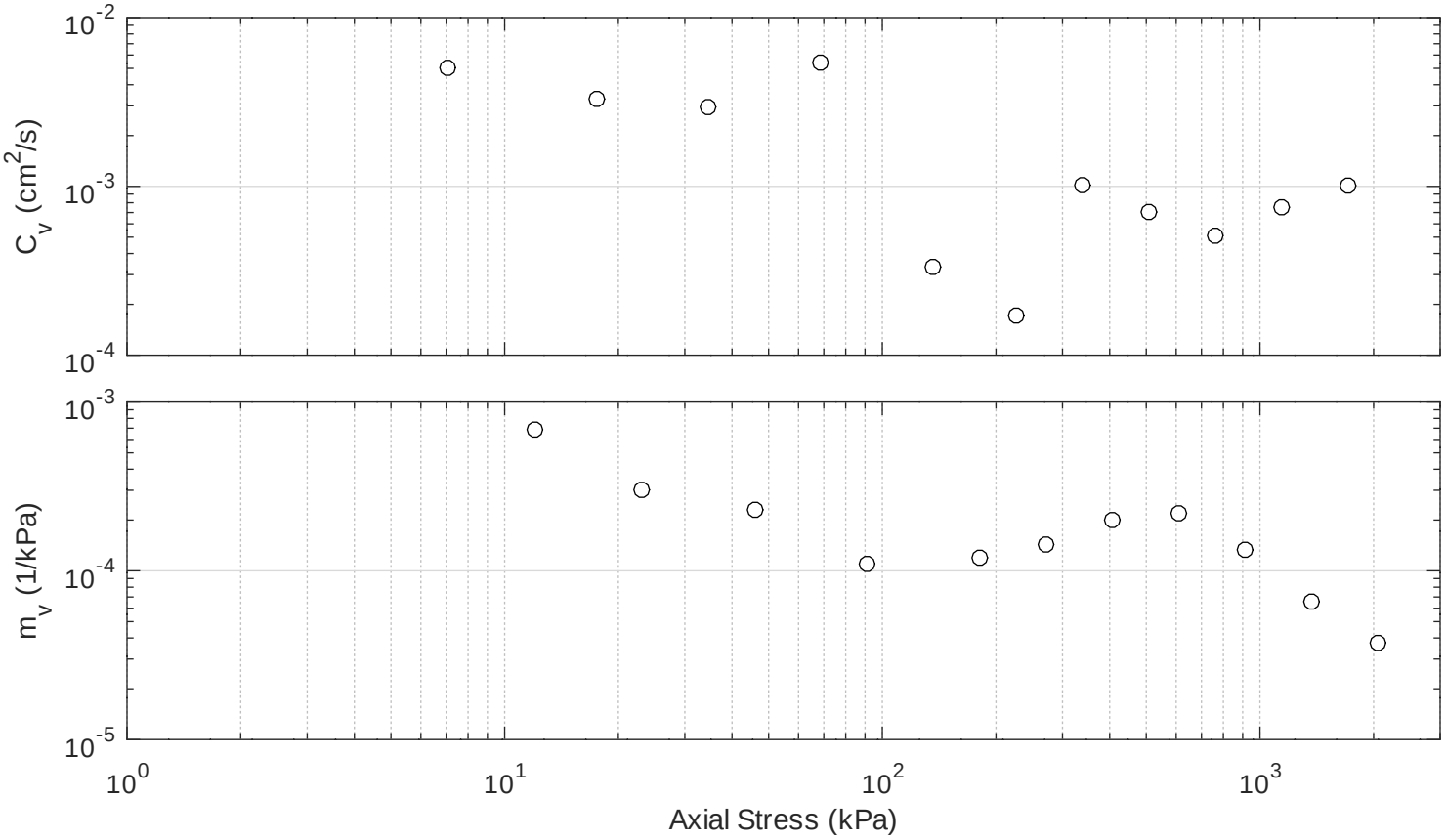
Interpreted Results

Recompression Index (reloading)	-	C_r	0.036
Compression Index	-	C_c	0.500
Recompression Index (unloading)	-	C_r	0.035
Preconsolidation Pressure	kPa	p'_c	282

Check: SP Review: PKC

THURBER

Project: 24726
Highway 17, Bruce Street
Borehole: BRU19-1-2
Sample: ST5
Depth: 17.7m
Client: Ontario Ministry of Transportation



Load No.	Axial Stress	Load Duration	System Deflec.	Dial	Sample Height	Axial Strain	Void Ratio	Time U(0.99)	C_v	k_v	$C_{a\varepsilon}$
	kPa	min	mm	mm	cm	%	-	min	cm^2/s	cm/s	-
0				10.000	2.535	0.00	1.069				
1	2.1	1440.5	0.005	10.003	2.536	-0.03	1.070				
2	12.0	1440.0	0.031	9.805	2.519	0.65	1.056	9.3	5.04e-03	3.40e-07	0.0013
3	23.1	1440.0	0.093	9.658	2.510	0.98	1.049	14.1	3.30e-03	9.75e-08	0.0010
4	46.1	1440.4	0.152	9.467	2.497	1.51	1.038	15.5	2.95e-03	6.65e-08	0.0009
5	91.1	1440.3	0.218	9.275	2.484	2.00	1.028	8.3	5.41e-03	5.83e-08	0.0013
6	181.2	1440.2	0.318	8.902	2.457	3.08	1.006	130.4	3.33e-04	3.91e-09	0.0044
7	271.3	1440.4	0.368	8.525	2.424	4.37	0.979	237.7	1.72e-04	2.41e-09	0.0051
8	406.4	1440.2	0.440	7.768	2.356	7.07	0.923	37.9	1.02e-03	2.00e-08	0.0111
9	609.6	1440.1	0.503	6.576	2.243	11.53	0.831	44.7	7.05e-04	1.52e-08	0.0149
10	913.0	1440.2	0.594	5.461	2.140	15.57	0.747	53.8	5.10e-04	6.67e-09	0.0118
11	1369.3	1440.0	0.671	4.623	2.064	18.57	0.685	35.8	7.52e-04	4.85e-09	0.0081
12	2052.9	1440.0	0.801	3.845	2.000	21.12	0.632	26.1	1.01e-03	3.71e-09	0.0075
13	514.5	1440.2	0.595	4.178	2.012	20.62	0.643				
14	129.2	1440.0	0.473	4.512	2.034	19.78	0.660				
15	33.1	1440.1	0.353	4.932	2.064	18.60	0.685				
16	6.0	1440.1	0.251	5.357	2.096	17.33	0.711				

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Stantec

January 22, 2021
File: 122410864

Attention: **Thurber Engineering, File #24726**

Reference: **Thurber File #24726.200a.202, LS-705 Specific Gravity**

The following table summarizes two Specific Gravity results for Bruce Street.

Source	Depth (m)	Specific Gravity
BRU19-1.2 ST1	4.9	2.750
BRU19-1.2 ST5	17.7	2.755

Sincerely,

Stantec Consulting Ltd

Brian Prevost

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
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brian.prevost@stantec.com

THURBER ENGINEERING LTD.

Consolidation Test Report

CLIENT: Thurber Engineering (Ottawa) FILE NUMBER: 24726

PROJECT: Highway 17 Twinning - Renfrew REPORT DATE: August 10, 2020

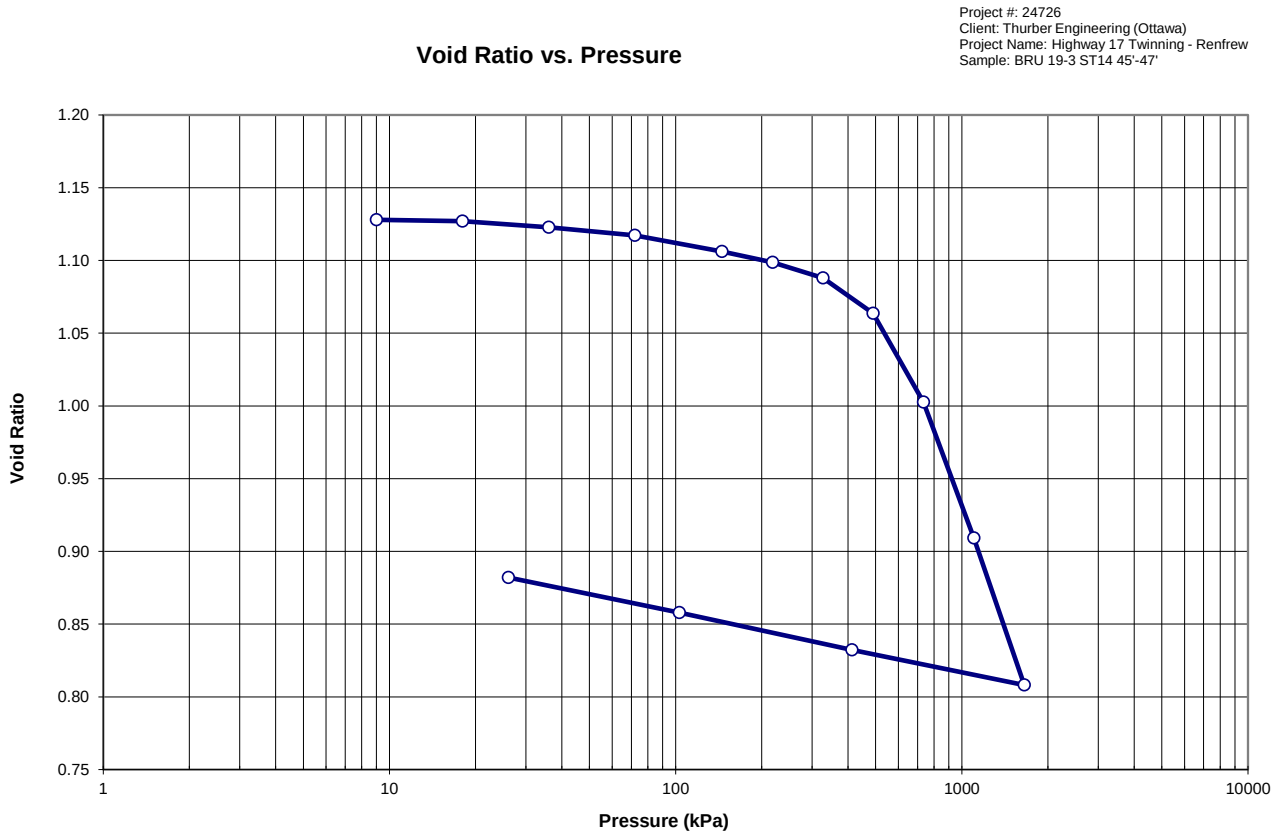
TEST DATES: April 02, 2020 - April 14, 2020

SAMPLE: BRU 19-3 ST14 45'-47'
Clay, silty, trace sand, grey, moist.
LL = 38.9, PL = 24.8, I_p = 14.1

PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	Start of Test	End of Test
Sample Height (mm)	25.40	22.46
Wet Dens. (kg/m^3)	1784.1	1933.5
Dry Dens. (kg/m^3)	1309.0	1480.2
Moisture Cont. (%)	36.3	30.6
Void Ratio	1.128	0.882
Saturation (%)	89.6	96.8

Note: A Specific Gravity (Gs) of 2.785 was obtained for the void ratio and saturation calculations.



TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

Consolidation Test Report

Highway 17 Twinning - Renfrew
24726 BRU 19-3 ST14 45'-47'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer. The average moisture content of the trimmings was 36.1%.

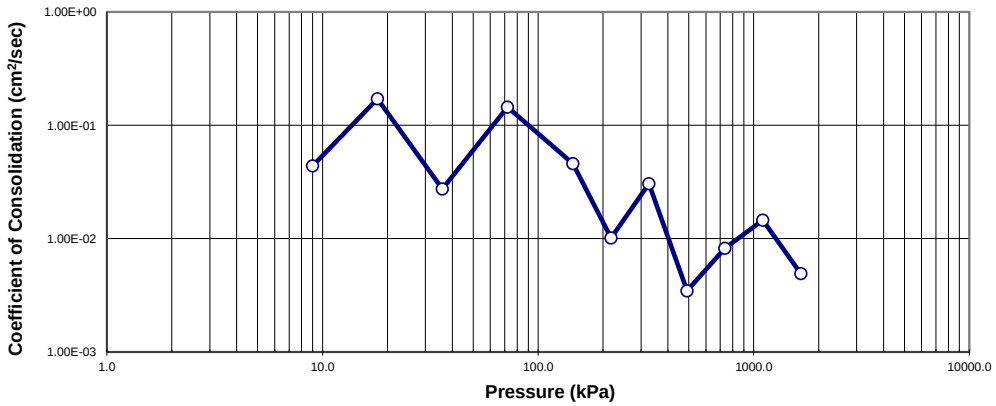
LOADING: A seating load of 9 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after 100% primary consolidation was reached at each load increment.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D_{90} (mm)	t_{90} (min)	c_v (cm^2/s)	Void Ratio	m_v (m^2/kN)	k (cm/s)
0.0	25.400					1.128		
9.0	25.399	25.400	-0.002	0.52	4.40E-02	1.128	3.02E-06	1.30E-08
18.0	25.389	25.394	-0.011	0.13	1.71E-01	1.127	4.50E-05	7.55E-07
36.0	25.338	25.363	-0.035	0.83	2.74E-02	1.123	1.12E-04	3.02E-07
72.0	25.273	25.305	-0.056	0.16	1.45E-01	1.117	7.15E-05	1.02E-06
145.0	25.139	25.206	-0.074	0.49	4.58E-02	1.106	7.24E-05	3.25E-07
218.0	25.049	25.094	-0.053	2.19	1.02E-02	1.099	4.92E-05	4.90E-08
327.0	24.923	24.986	-0.071	0.72	3.05E-02	1.088	4.60E-05	1.38E-07
490.0	24.632	24.777	-0.144	6.25	3.47E-03	1.064	7.16E-05	2.44E-08
735.0	23.902	24.267	-0.270	2.53	8.23E-03	1.003	1.21E-04	9.76E-08
1102.0	22.789	23.346	-0.412	1.32	1.46E-02	0.909	1.27E-04	1.81E-07
1653.0	21.581	22.185	-0.580	3.53	4.92E-03	0.808	9.62E-05	4.64E-08
413.0	21.870	21.725				0.832		
103.0	22.176	22.023				0.858		
26.0	22.463	22.320				0.882		

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-3 ST14 45'-47'

Coefficient of Consoildation vs. Pressure



Note: C_v and k calculated using t_{90} values (square root of time method)

TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

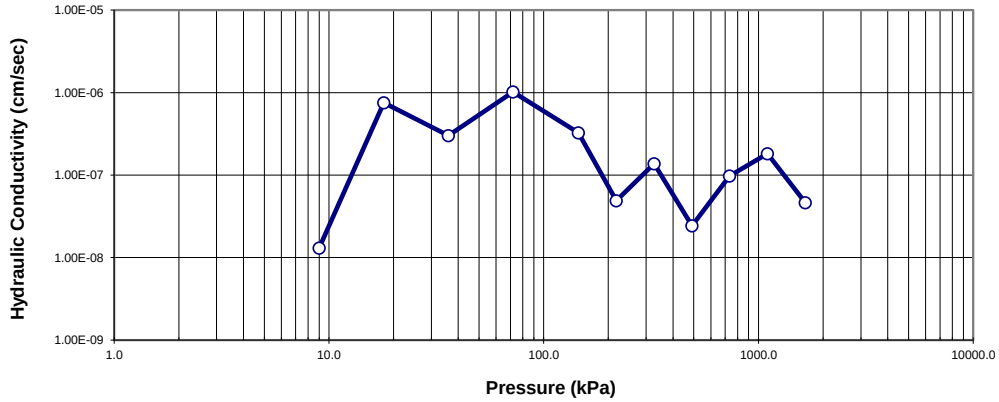
Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

BRU 19-3 ST14 45'-47'

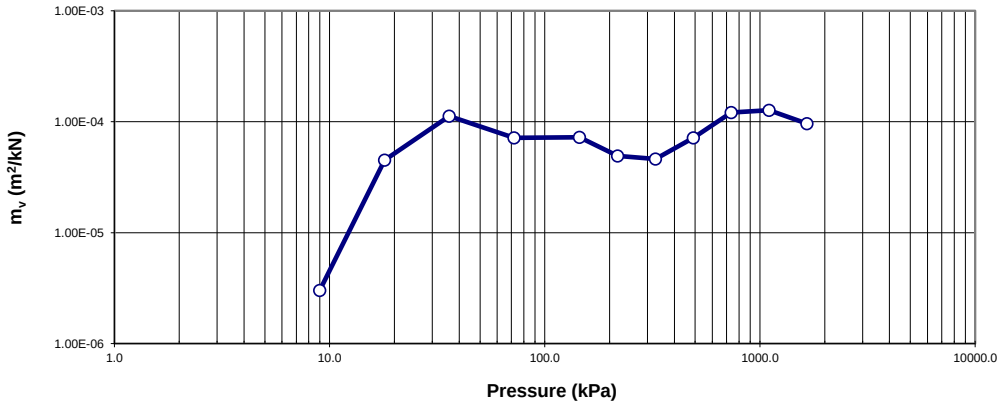
Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-3 ST14 45'-47'

Hydraulic Conductivity vs. Pressure



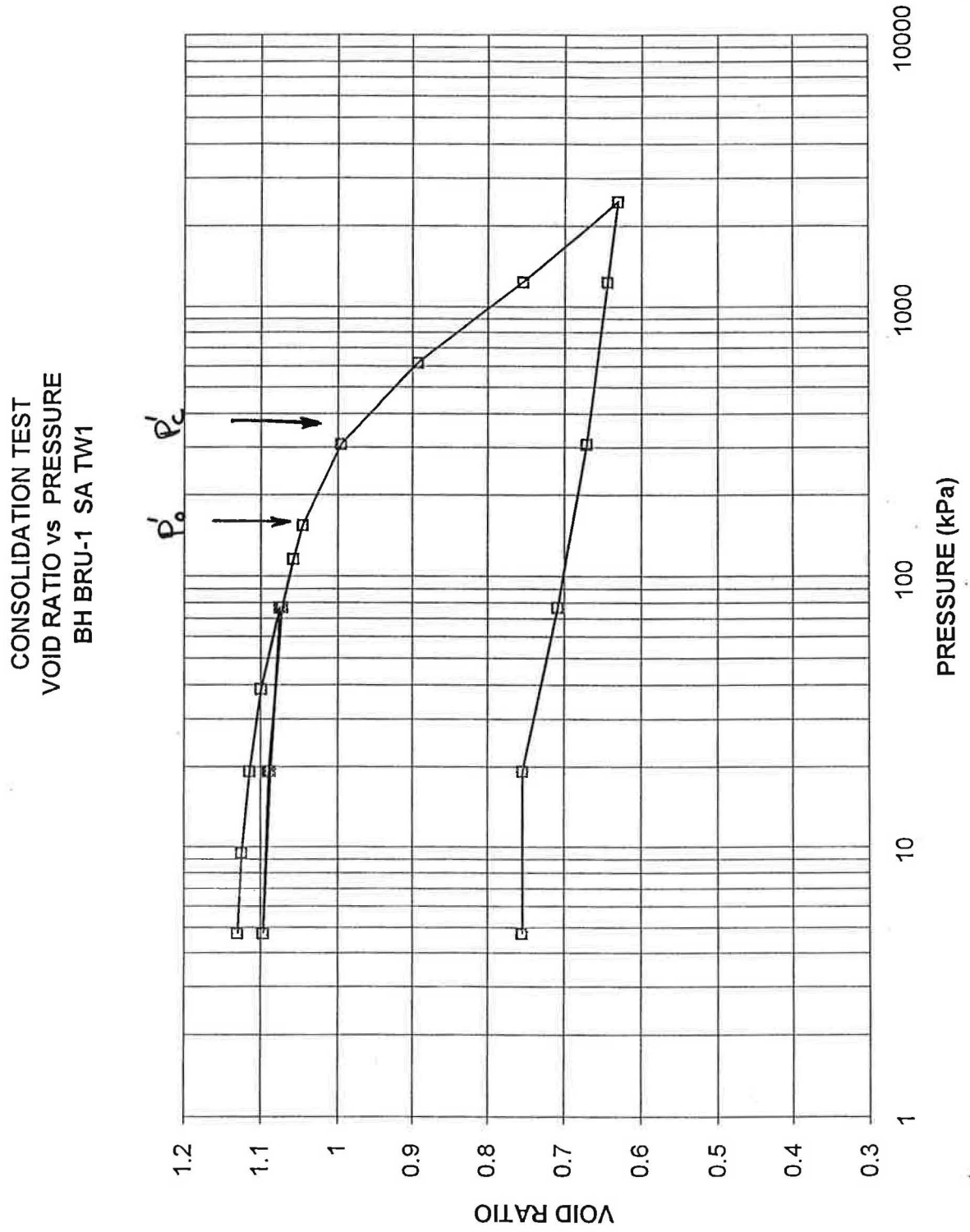
Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-3 ST14 45'-47'

m_v vs. Pressure



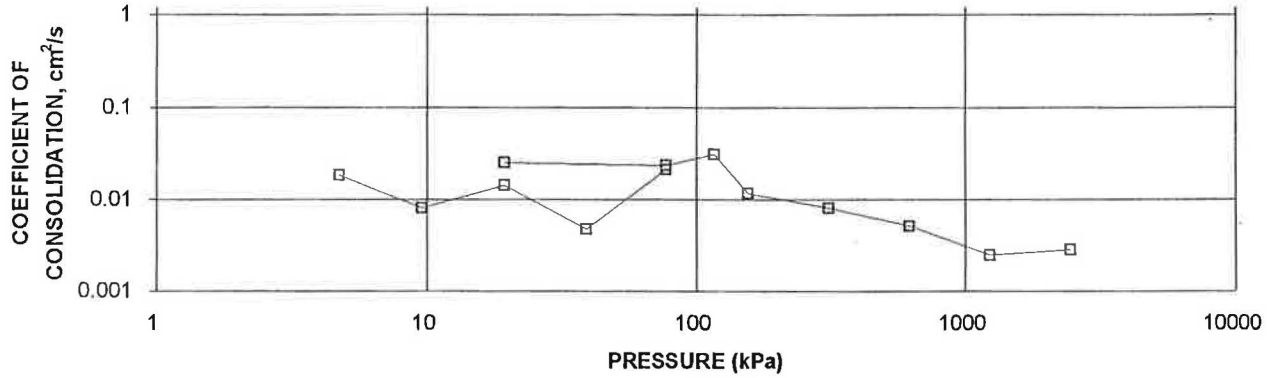
TEST DONE BY: BT
REVIEWED BY: WM

CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE

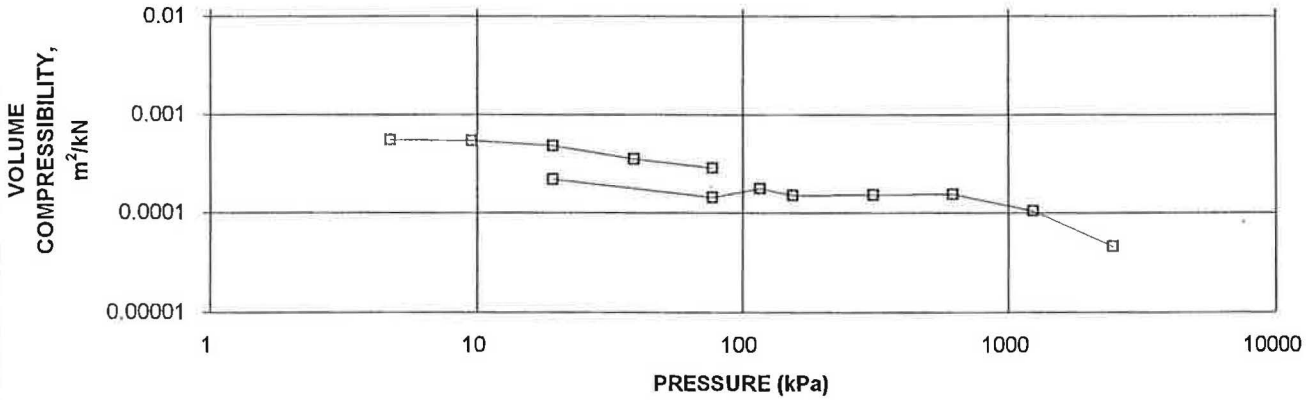


OEDOMETER CONSOLIDATION SUMMARY

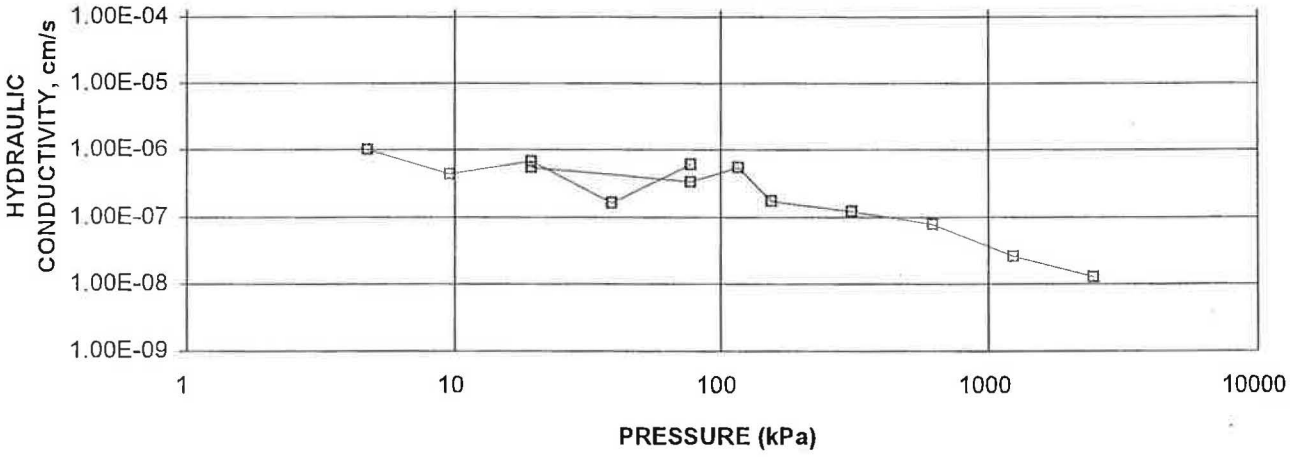
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH BRU-1 SA TW1



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH BRU-1 SA TW1



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH BRU-1 SA TW1



OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	04-1116-011	Sample Number	TW1
Borehole Number	BRU-1	Sample Depth, m	11.6-12.2

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	(0.7-24)
Oedometer Number	6		
Date Started	1/30/2004		
Date Completed	2/12/2004		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m^3	18.03
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	12.81
Area, cm^2	31.67	Specific Gravity, measured	2.79
Volume, cm^3	60.17	Solids Height, cm	0.890
Water Content, %	40.70	Volume of Solids, cm^3	28.18
Wet Mass, g	110.62	Volume of Voids, cm^3	31.99
Dry Mass, g	78.62	Degree of Saturation, %	100.0

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.900	1.135	1.900				
4.75	1.895	1.130	1.898	41	1.86E-02	5.54E-04	1.01E-06
9.54	1.890	1.124	1.893	94	8.08E-03	5.49E-04	4.35E-07
19.25	1.881	1.114	1.886	53	1.42E-02	4.88E-04	6.80E-07
38.68	1.868	1.099	1.875	158	4.71E-03	3.52E-04	1.63E-07
77.38	1.847	1.076	1.858	34	2.15E-02	2.86E-04	6.02E-07
19.25	1.857	1.087	1.852				
4.75	1.866	1.097	1.862				
19.25	1.860	1.090	1.863	29	2.54E-02	2.18E-04	5.42E-07
77.38	1.844	1.072	1.852	31	2.35E-02	1.45E-04	3.33E-07
116.07	1.831	1.058	1.838	23	3.11E-02	1.77E-04	5.39E-07
154.68	1.820	1.045	1.826	60	1.18E-02	1.50E-04	1.73E-07
309.16	1.775	0.995	1.798	85	8.06E-03	1.53E-04	1.21E-07
618.45	1.684	0.893	1.730	124	5.11E-03	1.55E-04	7.76E-08
1237.35	1.560	0.753	1.622	225	2.48E-03	1.05E-04	2.56E-08
2472.95	1.451	0.631	1.506	171	2.81E-03	4.64E-05	1.28E-08
1237.35	1.463	0.644	1.457				
309.16	1.487	0.671	1.475				
77.38	1.520	0.708	1.504				
19.25	1.560	0.753	1.540				
4.75	1.561	0.754	1.561				

Notes:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.56	Unit Weight, kN/m^3	20.41
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	15.60
Area, cm^2	31.67	Specific Gravity, measured	2.79
Volume, cm^3	49.44	Solids Height, cm	0.890
Water Content, %	30.87	Volume of Solids, cm^3	28.18
Wet Mass, g	102.89	Volume of Voids, cm^3	21.26
Dry Mass, g	78.62		

THURBER

Appendix C.3

One-Dimensional Consolidation Test Results (Constant Rate of Strain)

THURBER ENGINEERING LTD.

Constant Rate of Strain (CRS) Test Report

CLIENT: Ministry of Transportation (MTO) FILE NUMBER: 24726

PROJECT: Twinning of Hwy 17 from Arnprior to Haley Station REPORT DATE: May 10, 2021

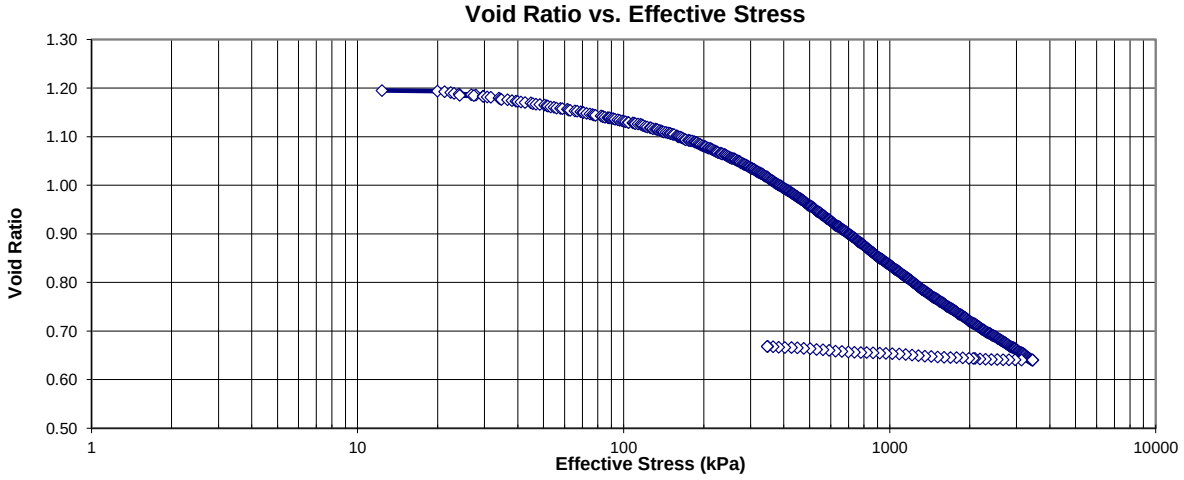
TEST DATES: November 27, 2020 - November 30, 2020

SAMPLE: BRU19-1 ST14 55'-57'
Clayey silt, grey, moist

PROCEDURE: Test carried out in general accordance with Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading, ASTM D4186.

Sample Characteristics		
	Initial	Final
Sample Height (mm):	25.40	19.27
Sample Diameter (mm):	50.70	50.70
Wet Dens. (kg/m^3):	1773	2108
Dry Dens. (kg/m^3):	1262	1664
Moisture Content (%):	40.1	26.7
Void Ratio:	1.20	0.67

Test Conditions	
Back Pressure (kPa):	400
Seating Pressure (kPa):	12.35
Strain After Seating (%):	0.12
Strain Rate - Loading (%/hr):	0.8
Strain Rate - Unloading (%/hr):	0.1
R_u at end of loading:	0.003



Note: A Specific Gravity (Gs) of 2.769 was measured for the void ratio calculations.

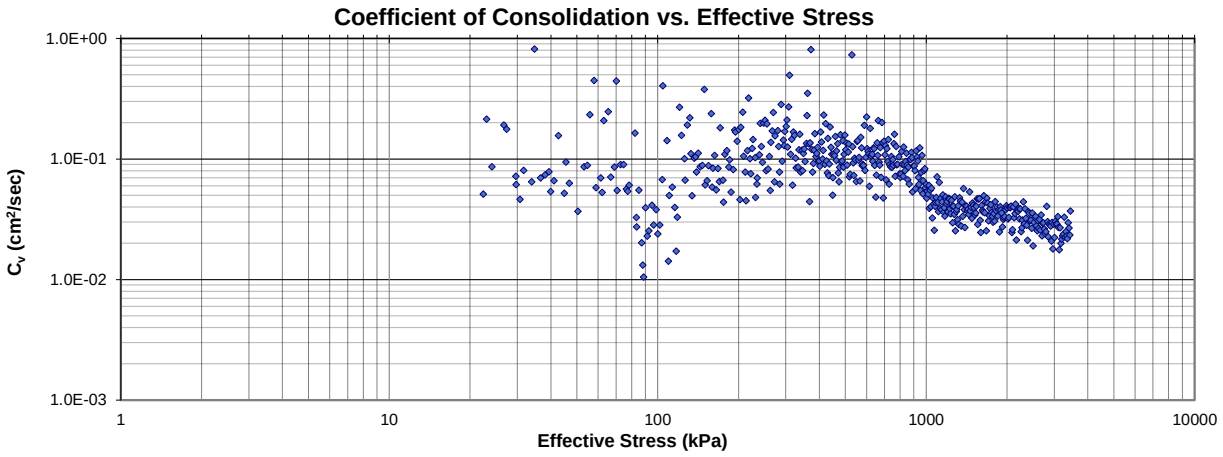
TESTED BY: BT, AA
REVIEWED BY: JL

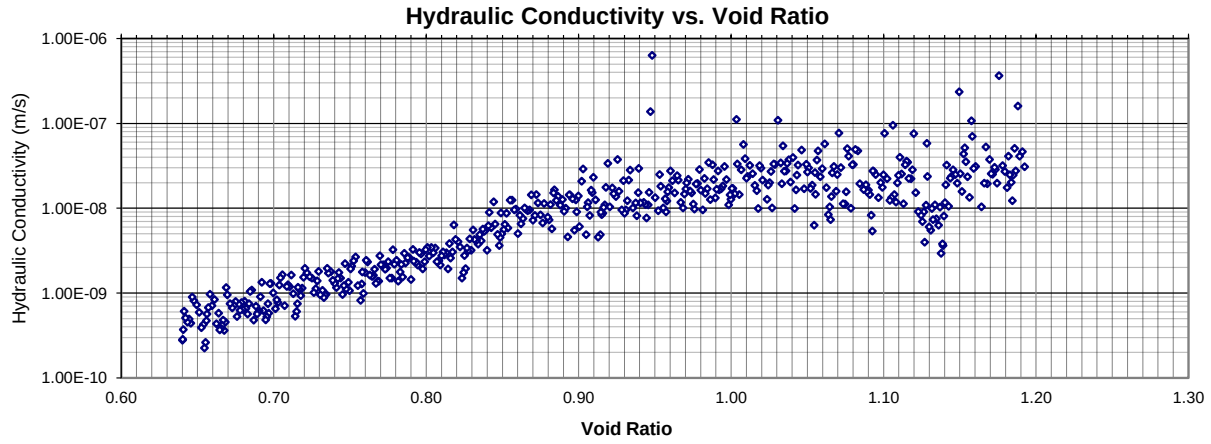
THURBER ENGINEERING LTD.

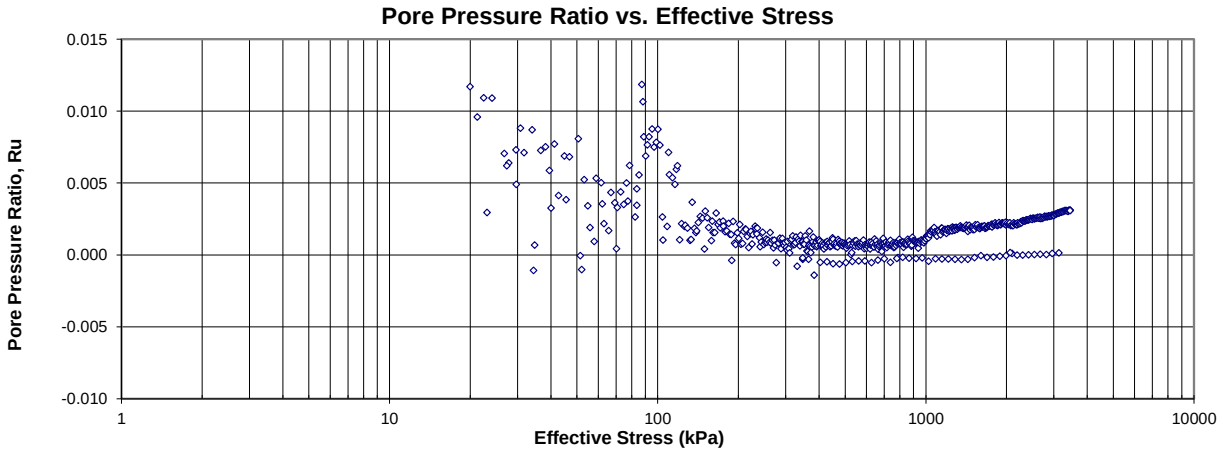
Constant Rate of Strain (CRS) Test Report

24726 BRU19-1 ST14 55'-57'

Twinning of Hwy 17 from Arnprior to Haley Station







Note: Only data from loading stage are shown in coefficient of consolidation vs. effective stress, and hydraulic conductivity vs. void ratio plots.

TESTED BY: BT, AA

REVIEWED BY: JL

THURBER ENGINEERING LTD.

Constant Rate of Strain (CRS) Test Report

CLIENT: Ministry of Transportation (MTO) FILE NUMBER: 24726

PROJECT: Twinning of Hwy 17 from Arnprior to Haley Station REPORT DATE: May 19, 2021

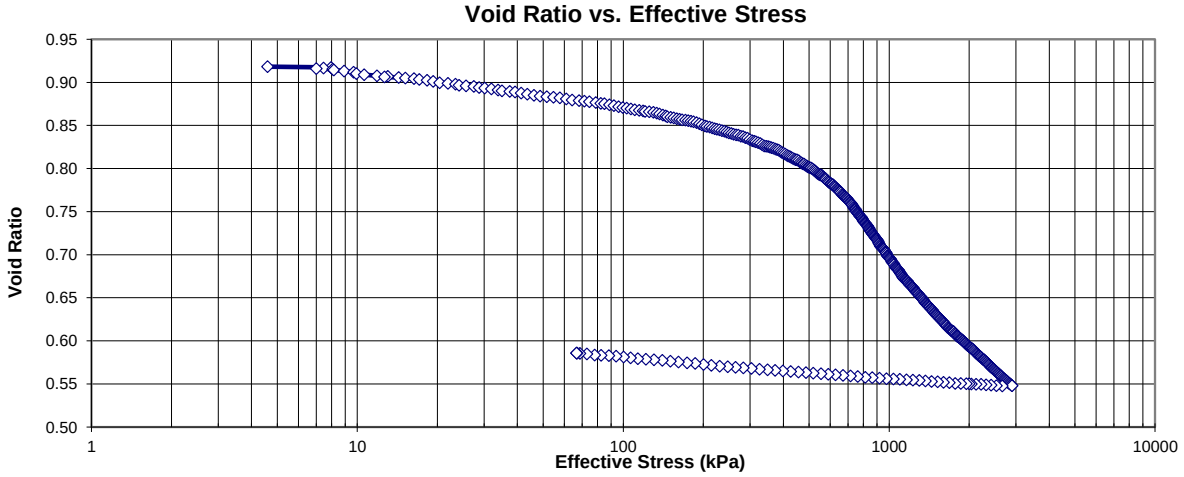
TEST DATES: November 24, 2020 - November 26, 2020

SAMPLE: BRU19-1 ST20 85'-87'
Silty clay, grey, moist
LL = 29.3, PL = 14.2

PROCEDURE: Test carried out in general accordance with Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading, ASTM D4186.

Sample Characteristics		
	Initial	Final
Sample Height (mm):	25.40	20.96
Sample Diameter (mm):	63.50	63.50
Wet Dens. (kg/m^3):	1895	2151
Dry Dens. (kg/m^3):	1451	1758
Moisture Content (%):	29.7	22.3
Void Ratio:	0.92	0.59

Test Conditions	
Back Pressure (kPa):	400
Seating Pressure (kPa):	4.60
Strain After Seating (%):	0.17
Strain Rate - Loading (%/hr):	0.8
Strain Rate - Unloading (%/hr):	0.1
R_u at end of loading:	0.01



Note: A Specific Gravity (Gs) of 2.783 was measured for the void ratio calculations.

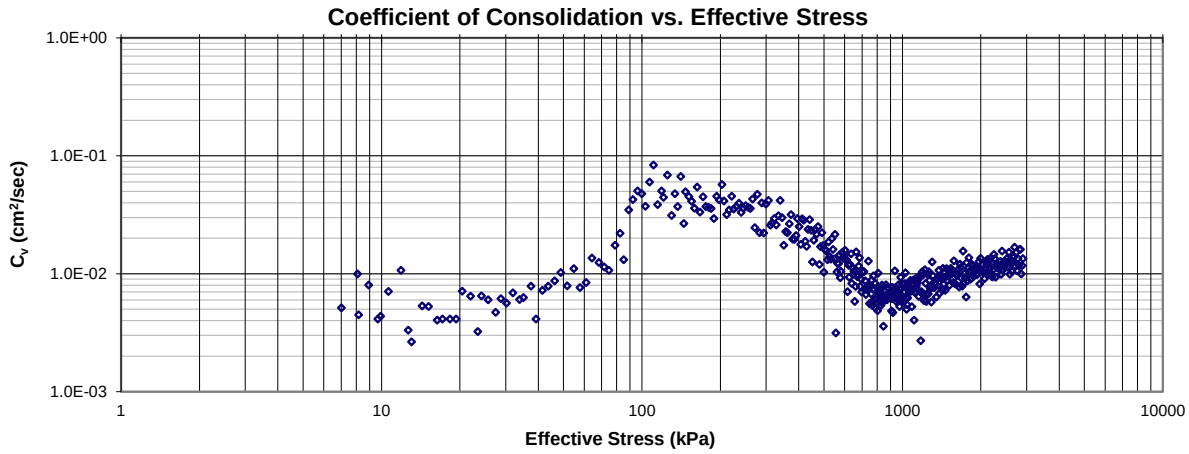
TESTED BY: BT, AA
REVIEWED BY: JL

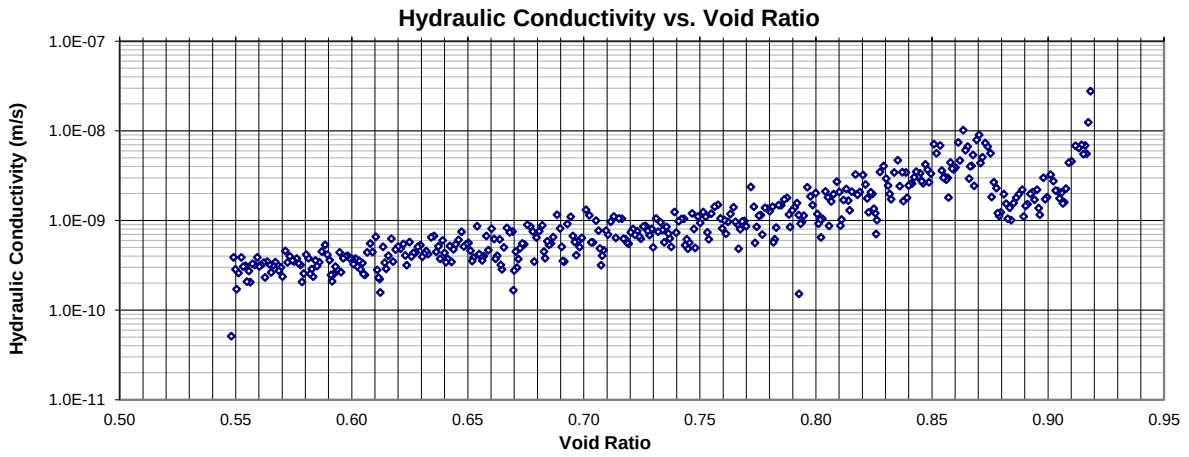
THURBER ENGINEERING LTD.

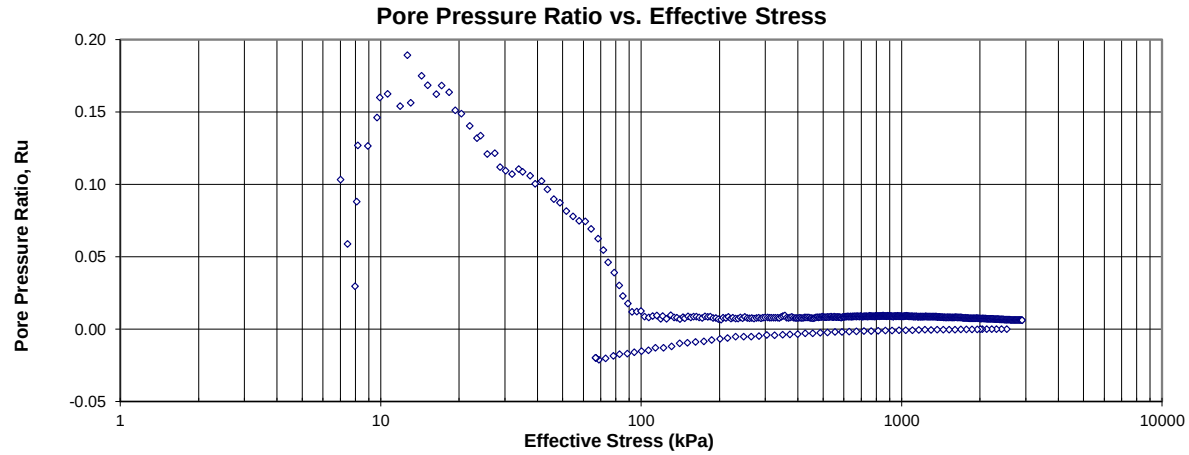
Constant Rate of Strain (CRS) Test Report

24726 BRU19-1 ST20 85'-87'

Twinning of Hwy 17 from Arnprior to Haley Station







Note: Only data from loading stage are shown in coefficient of consolidation vs. effective stress, and hydraulic conductivity vs. void ratio plots.

TESTED BY: BT, AA

REVIEWED BY: JL

THURBER ENGINEERING LTD.

Constant Rate of Strain (CRS) Test Report

CLIENT: Ministry of Transportation (MTO) FILE NUMBER: 24726

PROJECT: Twinning of Hwy 17 from Arnprior to Haley Station REPORT DATE: May 19, 2021

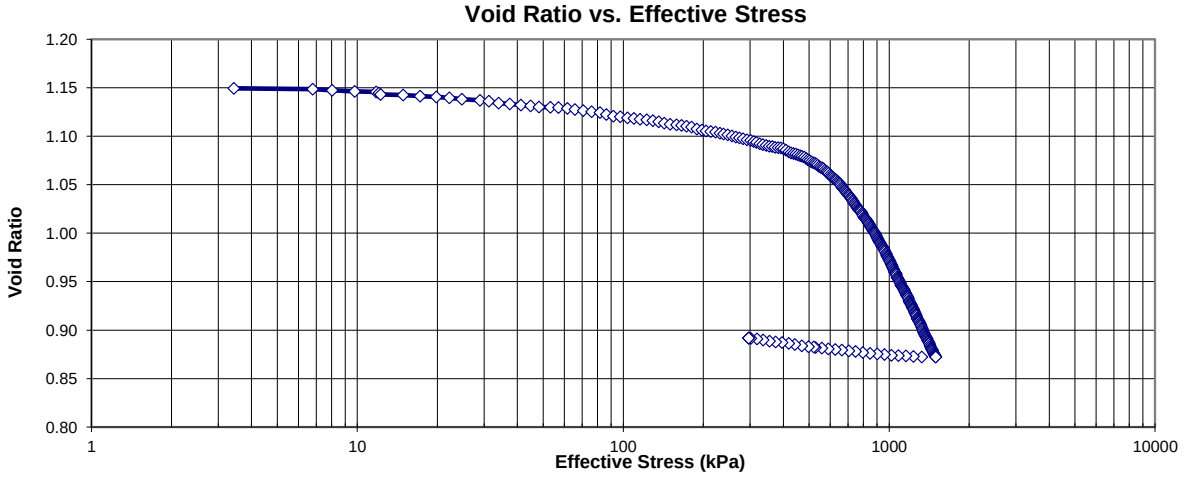
TEST DATES: January 20, 2021 - January 22, 2021

SAMPLE: BRU19-1.2 ST2 25'-27'
Silty clay, grey, moist
LL = 36.6, PL = 21.2

PROCEDURE: Test carried out in general accordance with Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading, ASTM D4186.

Sample Characteristics		
	Initial	Final
Sample Height (mm):	25.40	22.32
Sample Diameter (mm):	63.50	63.50
Wet Dens. (kg/m^3):	1806	1967
Dry Dens. (kg/m^3):	1282	1458
Moisture Content (%):	41.3	34.9
Void Ratio:	1.15	0.89

Test Conditions	
Back Pressure (kPa):	400
Seating Pressure (kPa):	3.45
Strain After Seating (%):	0.15
Strain Rate - Loading (%/hr):	0.8
Strain Rate - Unloading (%/hr):	0.1
R_u at end of loading:	0.0002



Note: A Specific Gravity (Gs) of 2.754 was measured for the void ratio calculations.

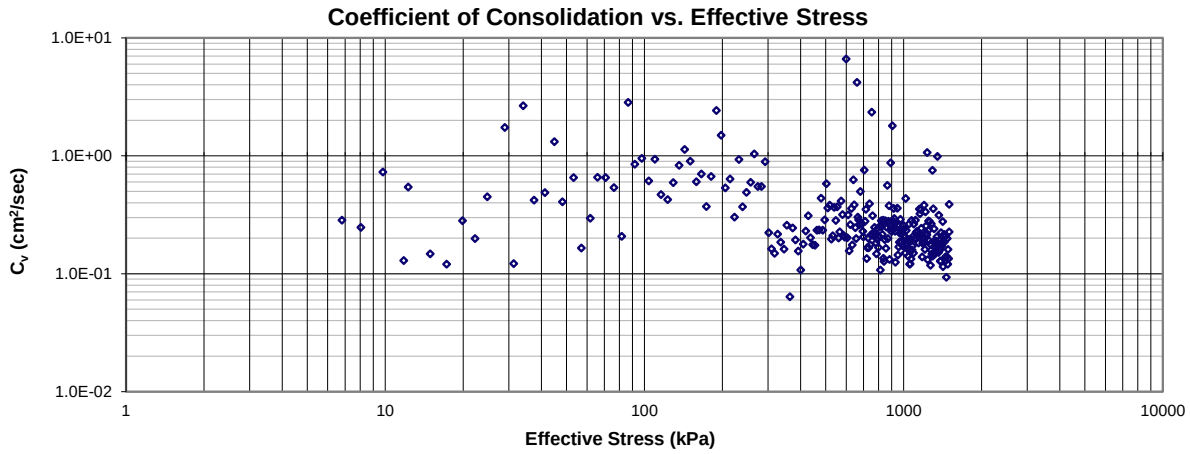
TESTED BY: BT, AA
REVIEWED BY: JL

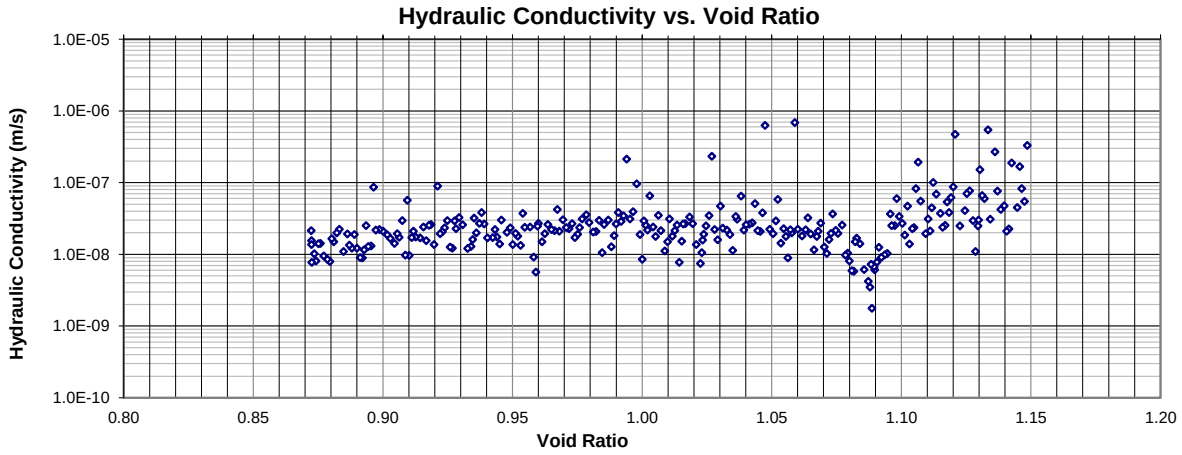
THURBER ENGINEERING LTD.

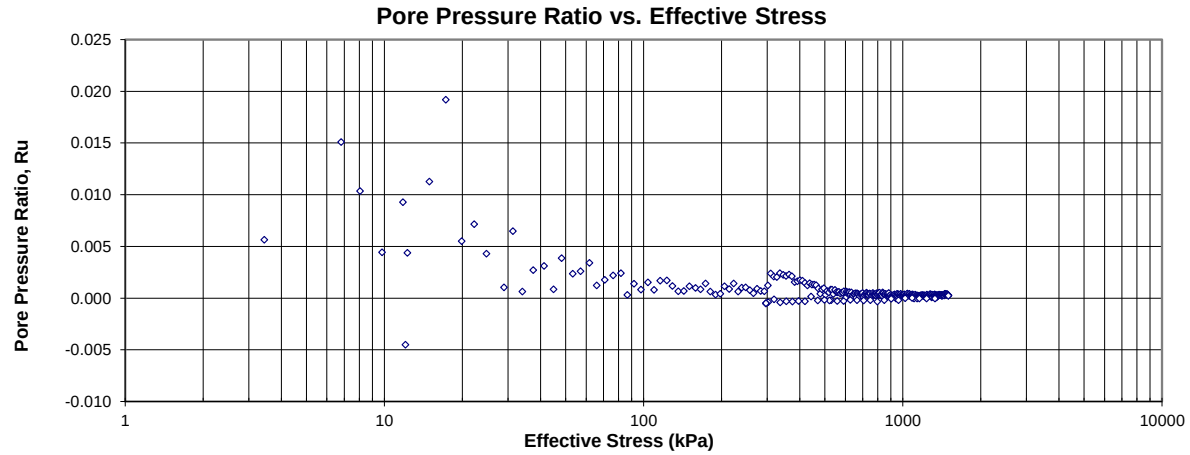
Constant Rate of Strain (CRS) Test Report

24726 BRU19-1.2 ST2 25'-27'

Twinning of Hwy 17 from Arnprior to Haley Station







Note: Only data from loading stage are shown in coefficient of consolidation vs. effective stress, and hydraulic conductivity vs. void ratio plots.

TESTED BY: BT, AA

REVIEWED BY: JL

THURBER ENGINEERING LTD.

Constant Rate of Strain (CRS) Test Report

CLIENT: Ministry of Transportation (MTO) FILE NUMBER: 24726

PROJECT: Twinning of Hwy 17 from Arnprior to Haley Station REPORT DATE: May 10, 2021

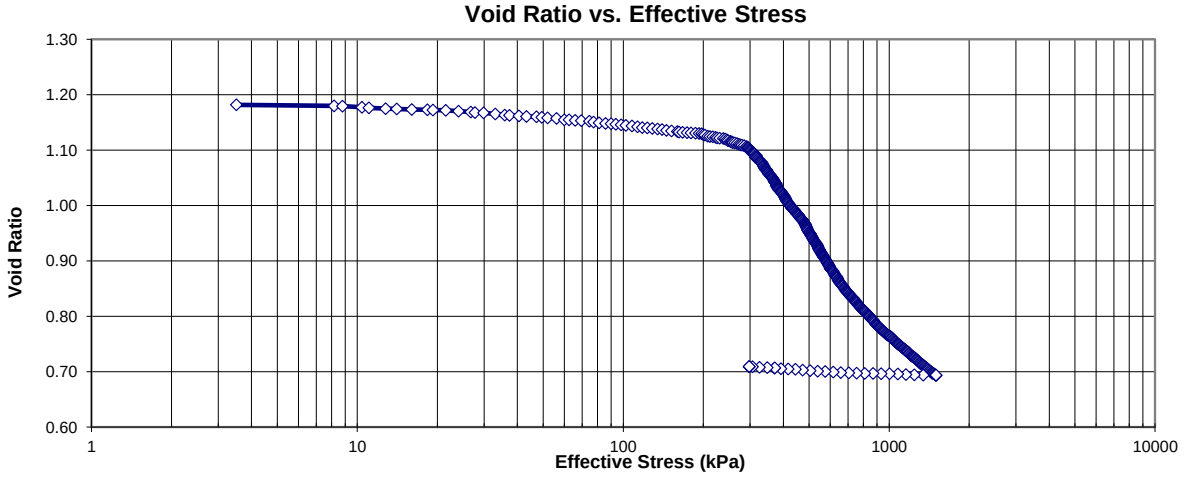
TEST DATES: January 22, 2021 - January 25, 2021

SAMPLE: BRU19-1.2 ST6 65'-67'
Clayey silt, grey, moist
LL = 17.5, PL = 13.7

PROCEDURE: Test carried out in general accordance with Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading, ASTM D4186.

Sample Characteristics		
	Initial	Final
Sample Height (mm):	25.40	19.87
Sample Diameter (mm):	63.50	63.50
Wet Dens. (kg/m^3):	1789	2064
Dry Dens. (kg/m^3):	1263	1615
Moisture Content (%):	37.4	27.8
Void Ratio:	1.19	0.71

Test Conditions	
Back Pressure (kPa):	400
Seating Pressure (kPa):	3.51
Strain After Seating (%):	0.17
Strain Rate - Loading (%/hr):	0.8
Strain Rate - Unloading (%/hr):	0.1
R_u at end of loading:	0.0163



Note: A Specific Gravity (Gs) of 2.755 was measured for the void ratio calculations.

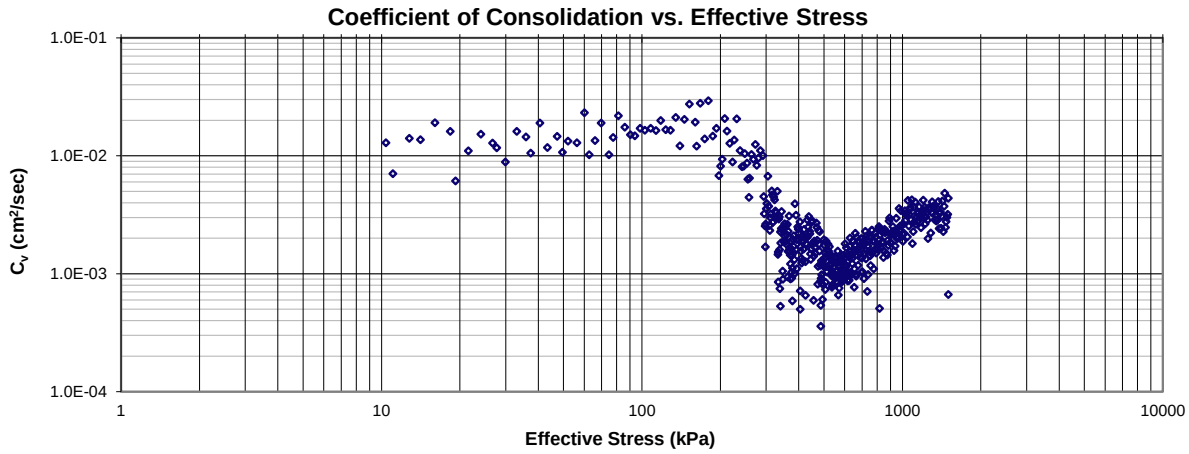
TESTED BY: BT, AA
REVIEWED BY: JL

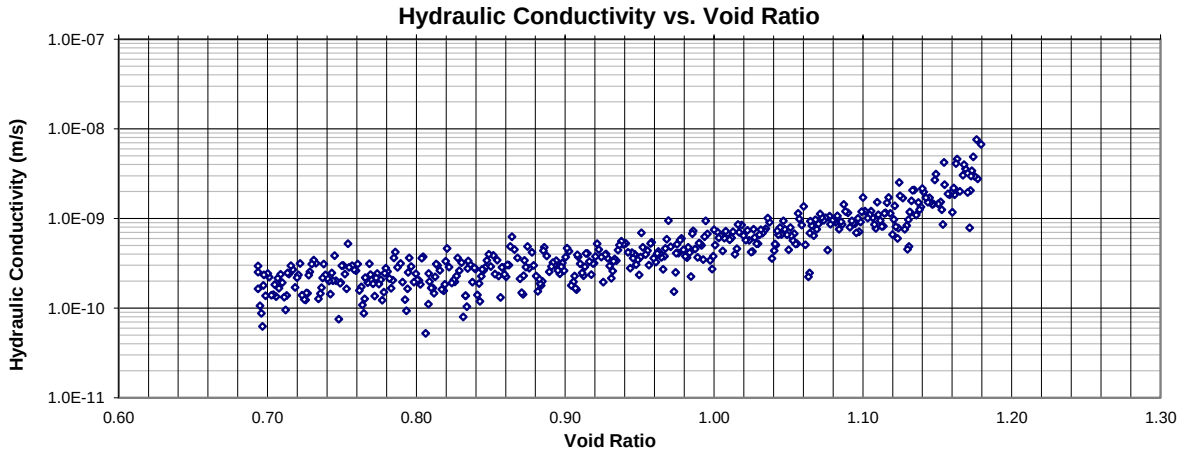
THURBER ENGINEERING LTD.

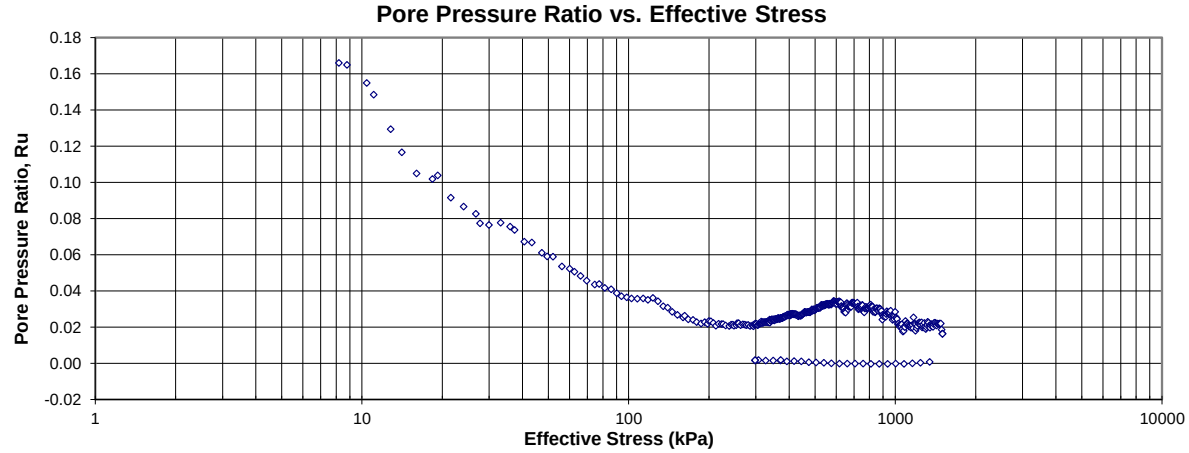
Constant Rate of Strain (CRS) Test Report

24726 BRU19-1.2 ST6 65'-67'

Twinning of Hwy 17 from Arnprior to Haley Station







Note: Only data from loading stage are shown in coefficient of consolidation vs. effective stress, and hydraulic conductivity vs. void ratio plots.

TESTED BY: BT, AA

REVIEWED BY: JL

THURBER ENGINEERING LTD.

Constant Rate of Strain (CRS) Test Report

CLIENT: Ministry of Transportation (MTO) FILE NUMBER: 24726

PROJECT: Twinning of Hwy 17 from Arnprior to Haley Station REPORT DATE: May 10, 2021

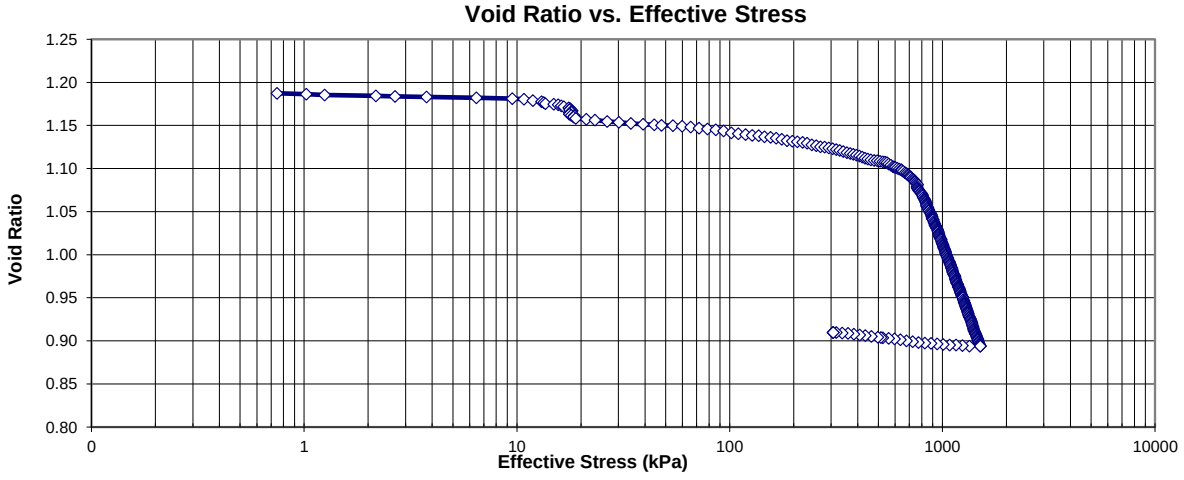
TEST DATES: January 18, 2021 - January 19, 2021

SAMPLE: BRU19-3.2 ST3 45'-47'
Silty clay, grey, moist
LL = 31.3, PL = 20.8

PROCEDURE: Test carried out in general accordance with Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading, ASTM D4186.

Sample Characteristics		
	Initial	Final
Sample Height (mm):	25.40	22.08
Sample Diameter (mm):	63.50	63.50
Wet Dens. (kg/m^3):	1778	1976
Dry Dens. (kg/m^3):	1266	1456
Moisture Content (%):	38.8	35.7
Void Ratio:	1.20	0.91

Test Conditions	
Back Pressure (kPa):	400
Seating Pressure (kPa):	0.78
Strain After Seating (%):	0.42
Strain Rate - Loading (%/hr):	0.8
Strain Rate - Unloading (%/hr):	0.1
R_u at end of loading:	0.0002



Note: A Specific Gravity (Gs) of 2.775 was measured for the void ratio calculations.

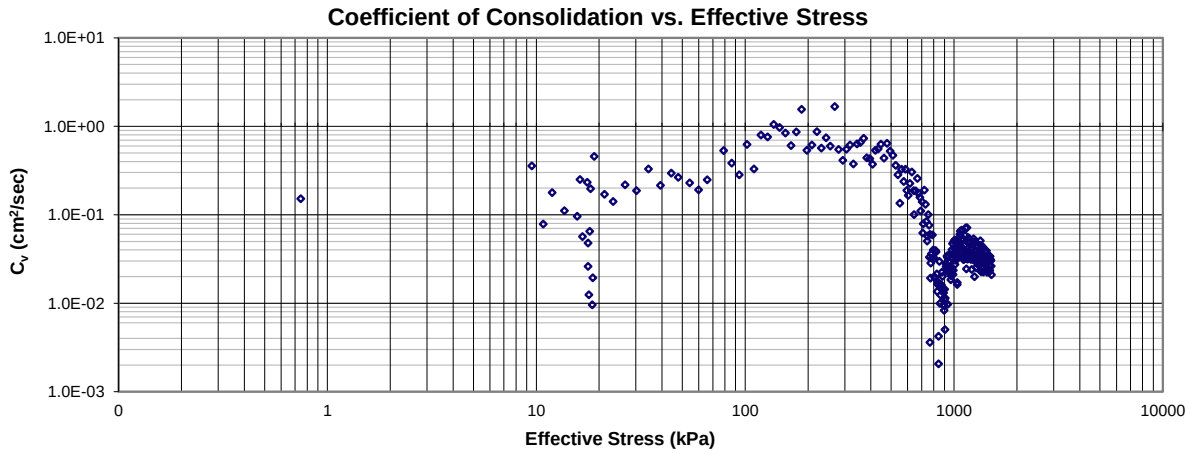
TESTED BY: BT, AA
REVIEWED BY: JL

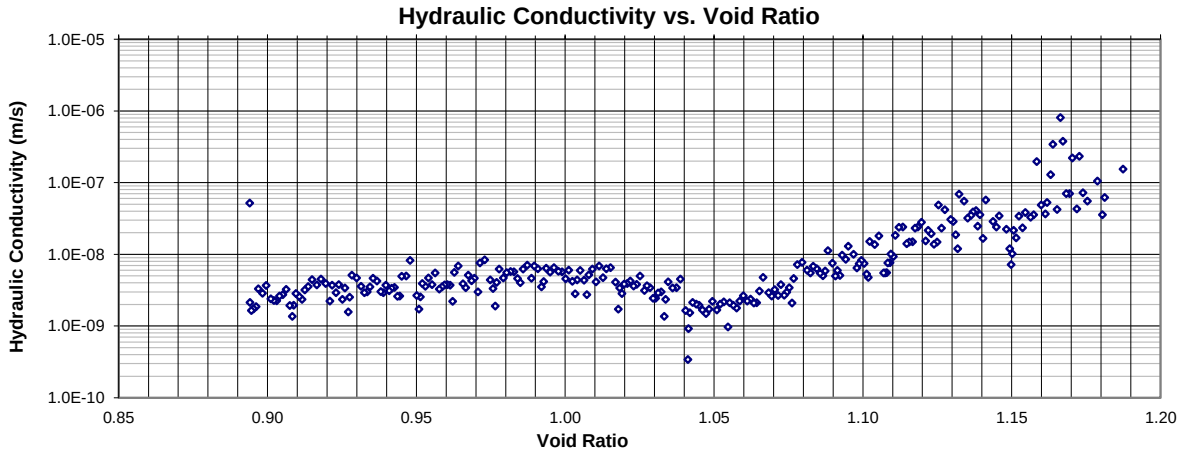
THURBER ENGINEERING LTD.

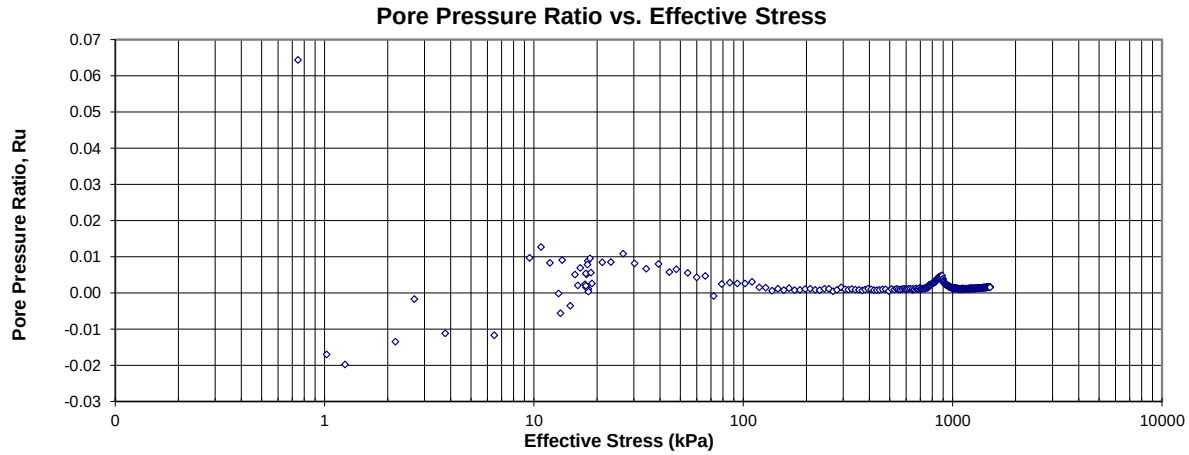
Constant Rate of Strain (CRS) Test Report

24726 BRU19-3.2 ST3 45'-47'

Twinning of Hwy 17 from Arnprior to Haley Station







Note: Only data from loading stage are shown in coefficient of consolidation vs. effective stress, and hydraulic conductivity vs. void ratio plots.

TESTED BY: BT, AA

REVIEWED BY: JL

THURBER ENGINEERING LTD.

Constant Rate of Strain (CRS) Test Report

CLIENT: Ministry of Transportation (MTO) FILE NUMBER: 24726

PROJECT: Twinning of Hwy 17 from Arnprior to Haley Station REPORT DATE: May 10, 2021

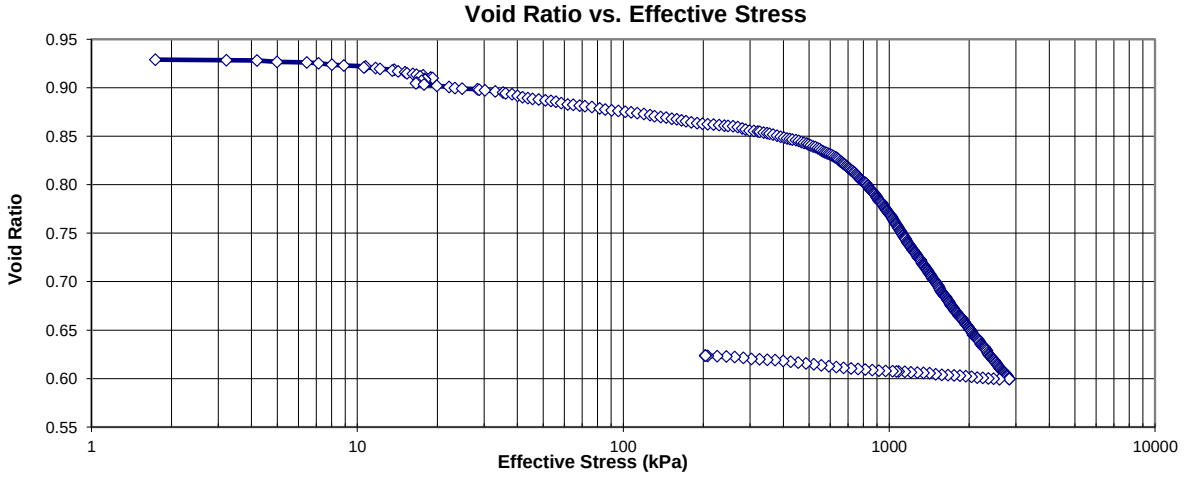
TEST DATES: January 8, 2021 - January 9, 2021

SAMPLE: BRU19-3.2 ST8 100'-102'
Silty clay, grey, moist
LL = 19.8, PL = 13.0

PROCEDURE: Test carried out in general accordance with Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading, ASTM D4186.

Sample Characteristics		
	Initial	Final
Sample Height (mm):	25.40	21.31
Sample Diameter (mm):	63.50	63.50
Wet Dens. (kg/m^3):	1893	2126
Dry Dens. (kg/m^3):	1428	1703
Moisture Content (%):	29.8	24.8
Void Ratio:	0.94	0.62

Test Conditions	
Back Pressure (kPa):	400
Seating Pressure (kPa):	2.77
Strain After Seating (%):	0.35
Strain Rate - Loading (%/hr):	0.8
Strain Rate - Unloading (%/hr):	0.1
R_u at end of loading:	-0.0040



Note: A Specific Gravity (Gs) of 2.76 was measured for the void ratio calculations.

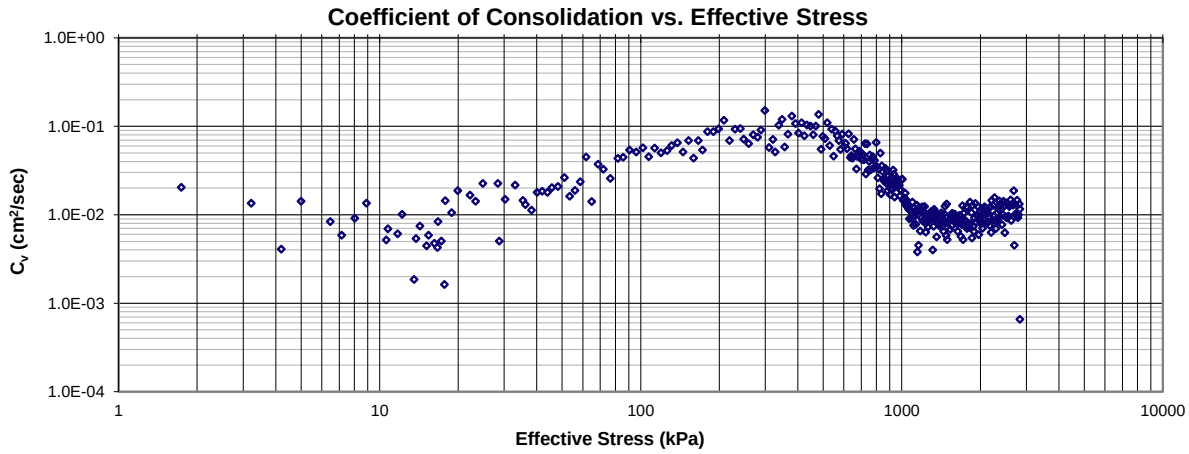
TESTED BY: BT, AA
REVIEWED BY: JL

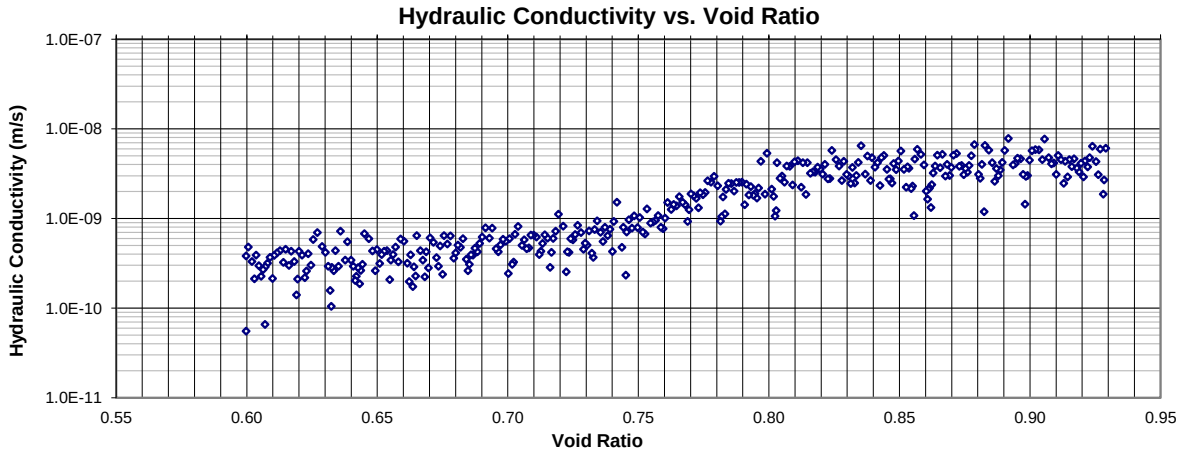
THURBER ENGINEERING LTD.

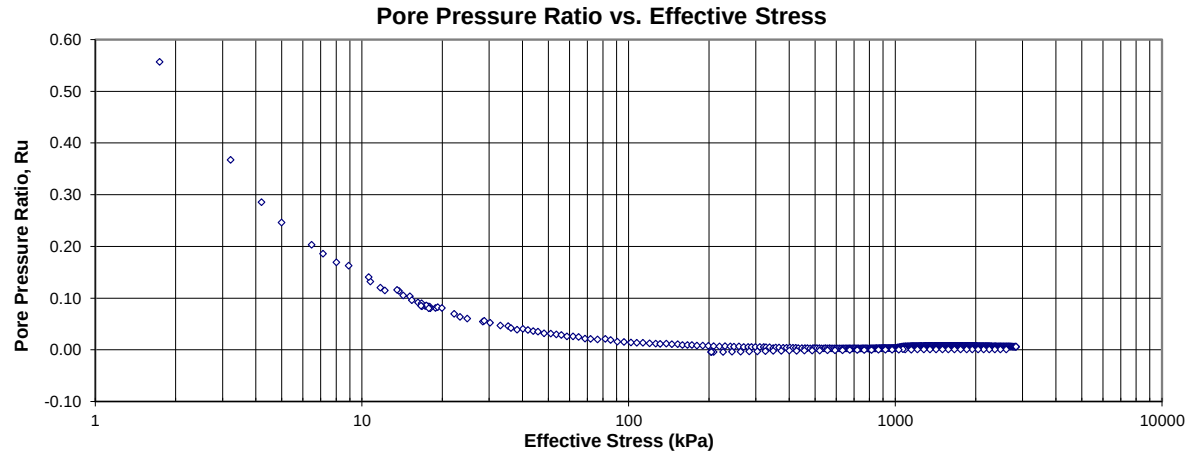
Constant Rate of Strain (CRS) Test Report

24726 BRU19-3.2 ST8 100'-102'

Twinning of Hwy 17 from Arnprior to Haley Station







Note: Only data from loading stage are shown in coefficient of consolidation vs. effective stress, and hydraulic conductivity vs. void ratio plots.

TESTED BY: BT, AA

REVIEWED BY: JL

THURBER

Appendix C.4

One-Dimensional Consolidation Test Results (Creep)

THURBER ENGINEERING LTD.

Consolidation Test Report

CLIENT: Thurber Engineering (Ottawa) FILE NUMBER: 24726

PROJECT: Highway 17 Twinning - Renfrew REPORT DATE: September 15, 2020

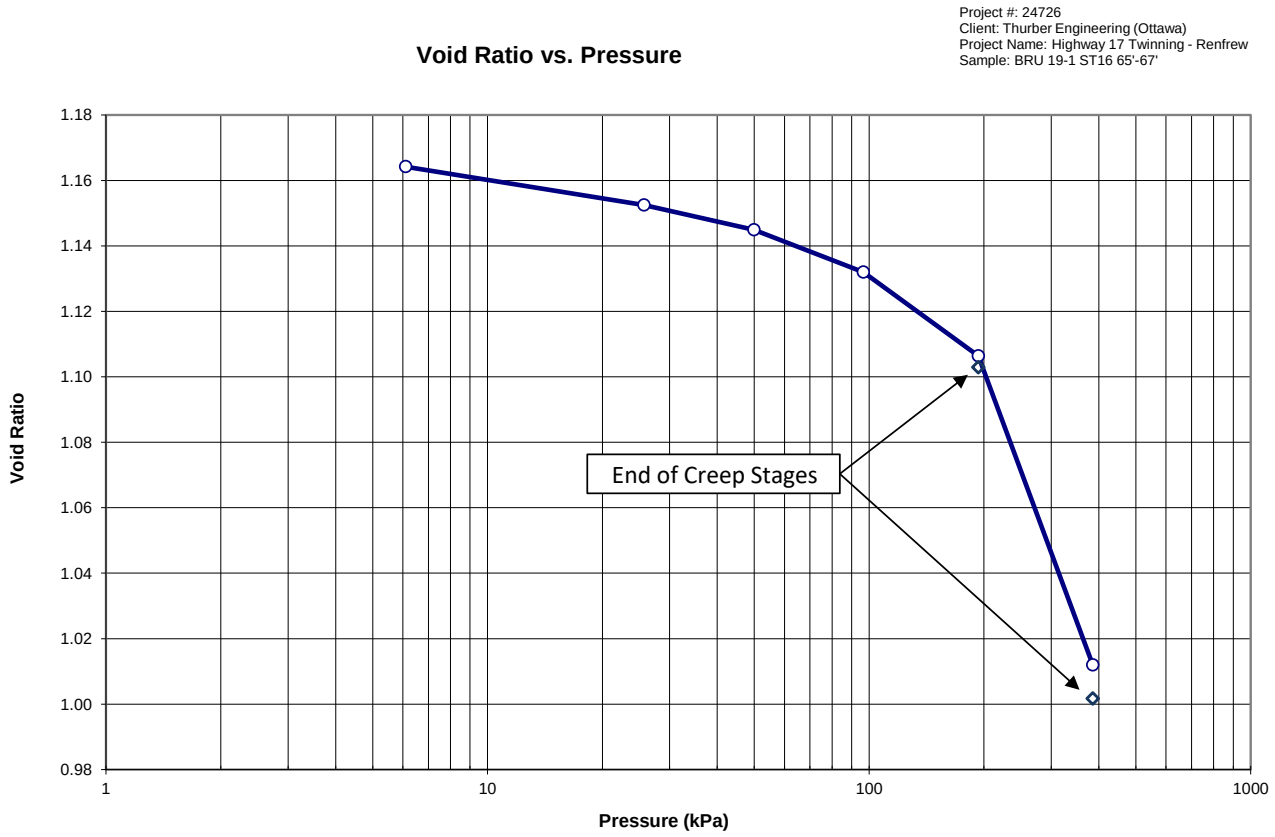
TEST DATES: May 20, 2020 - June 07, 2020

SAMPLE: BRU 19-1 ST16 65'-67'
Clay, silty, trace sand, brown, moist.
LL = 31.2, PL = 18.3, I_p = 12.9

PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	Start of Test	End of Test
Sample Height (mm)	25.40	23.46
Wet Dens. (kg/m^3)	1772.5	1892.0
Dry Dens. (kg/m^3)	1285.6	1391.7
Moisture Cont. (%)	37.9	35.9
Void Ratio	1.167	1.002
Saturation (%)	90.4	100.0

Note: A Specific Gravity (Gs) of 2.786 was obtained for the void ratio and saturation calculations.



TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

Consolidation Test Report

Highway 17 Twinning - Renfrew
24726 BRU 19-1 ST16 65'-67'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer. The average moisture content of the trimmings was 34.9%.

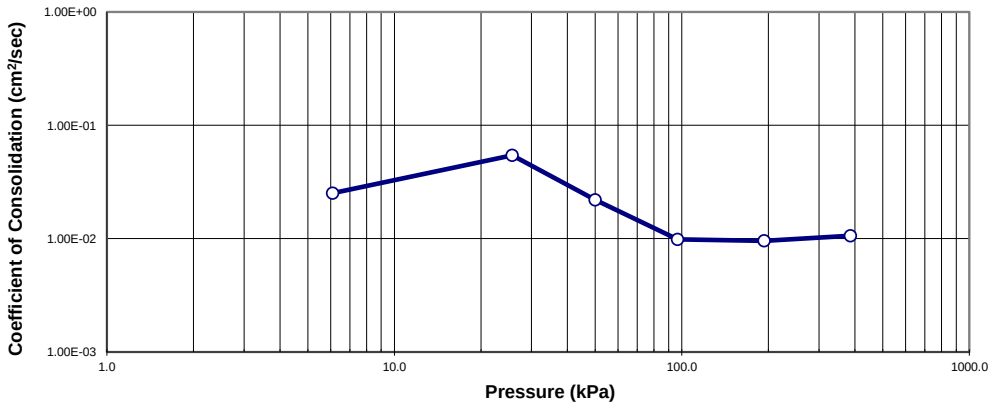
LOADING: A seating load of 6.1 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after a constant load increment duration of 24 hours. Creep stages were conducted at 193.2 kPa and 385.7 kPa; and were maintained for 7 and 8 days, respectively.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D_{90} (mm)	t_{90} (min)	c_v (cm^2/s)	Void Ratio	m_v (m^2/kN)	k (cm/s)
0.0	25.400					1.167		
6.1	25.367	25.384	-0.026	0.90	2.52E-02	1.164	2.13E-04	5.27E-07
25.7	25.230	25.299	-0.097	0.42	5.44E-02	1.152	2.76E-04	1.47E-06
49.9	25.141	25.186	-0.046	1.02	2.20E-02	1.145	1.46E-04	3.14E-07
96.6	24.990	25.066	-0.086	2.25	9.87E-03	1.132	1.29E-04	1.24E-07
193.2	24.690	24.840	-0.161	2.28	9.56E-03	1.106	1.24E-04	1.17E-07
193.2 (Creep)	24.649	24.670				1.103		
385.7	23.583	24.116	-0.483	1.93	1.06E-02	1.012	2.25E-04	2.34E-07
385.7 (Creep)	23.462	23.523				1.002		

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-1 ST16 65'-67'

Coefficient of Consoildation vs. Pressure



Note: C_v and k calculated using t_{90} values (square root of time method)

TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

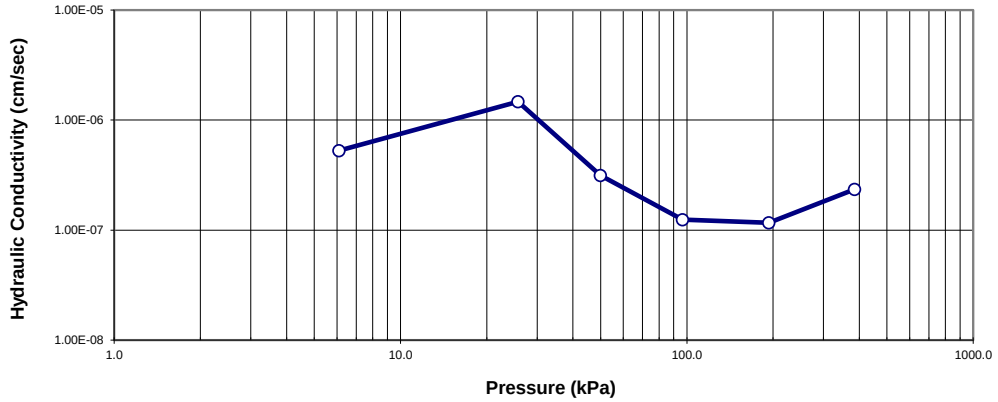
Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

BRU 19-1 ST16 65'-67'

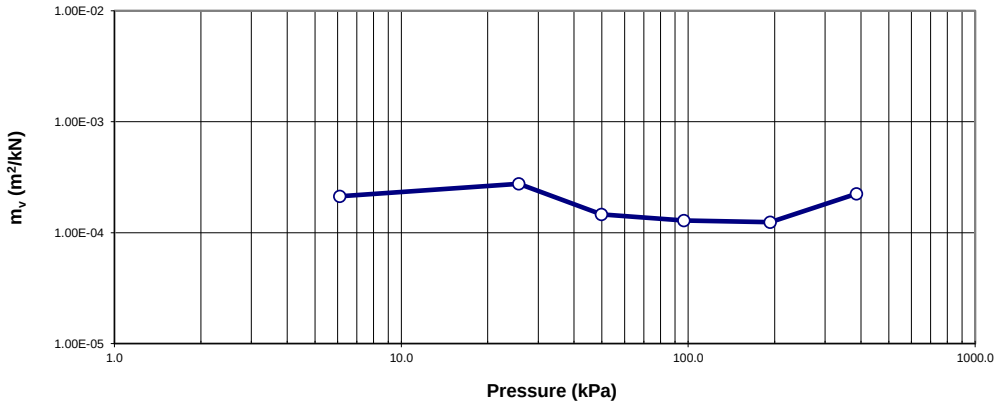
Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-1 ST16 65'-67'

Hydraulic Conductivity vs. Pressure



Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-1 ST16 65'-67'

m_v vs. Pressure



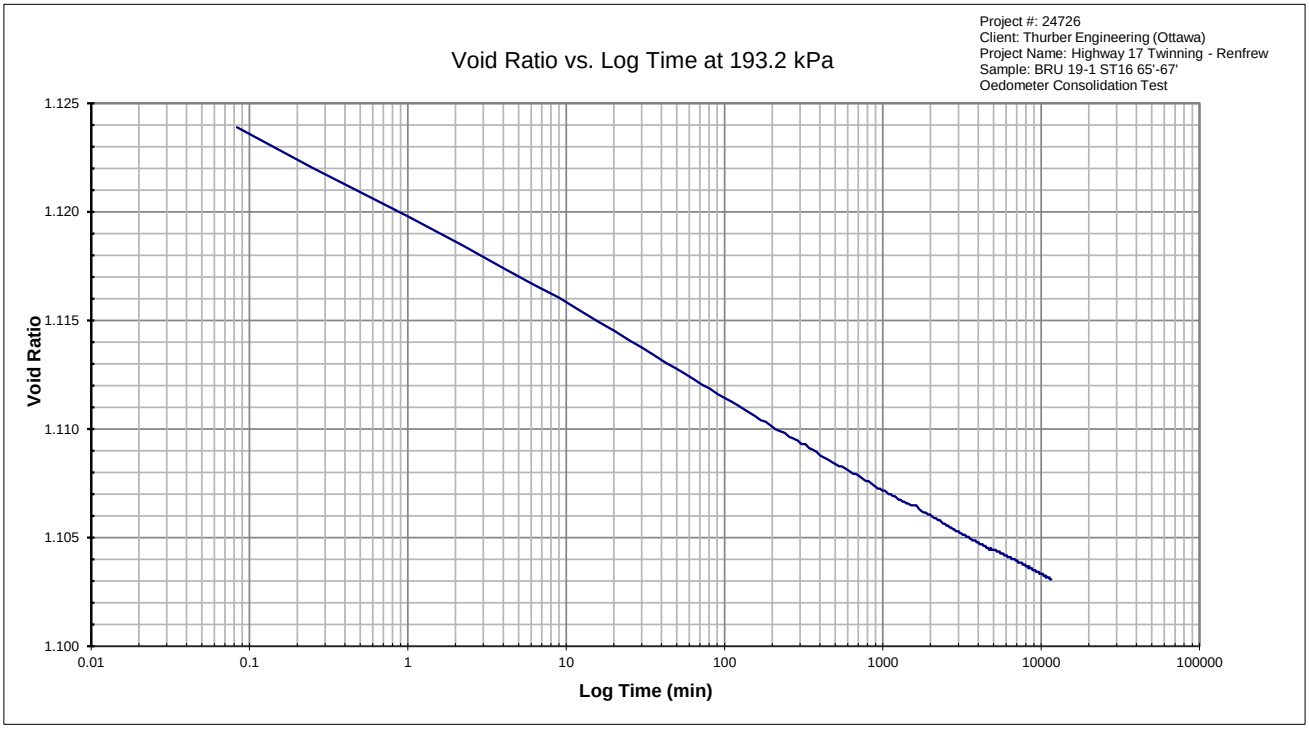
TEST DONE BY: BT
REVIEWED BY: WM

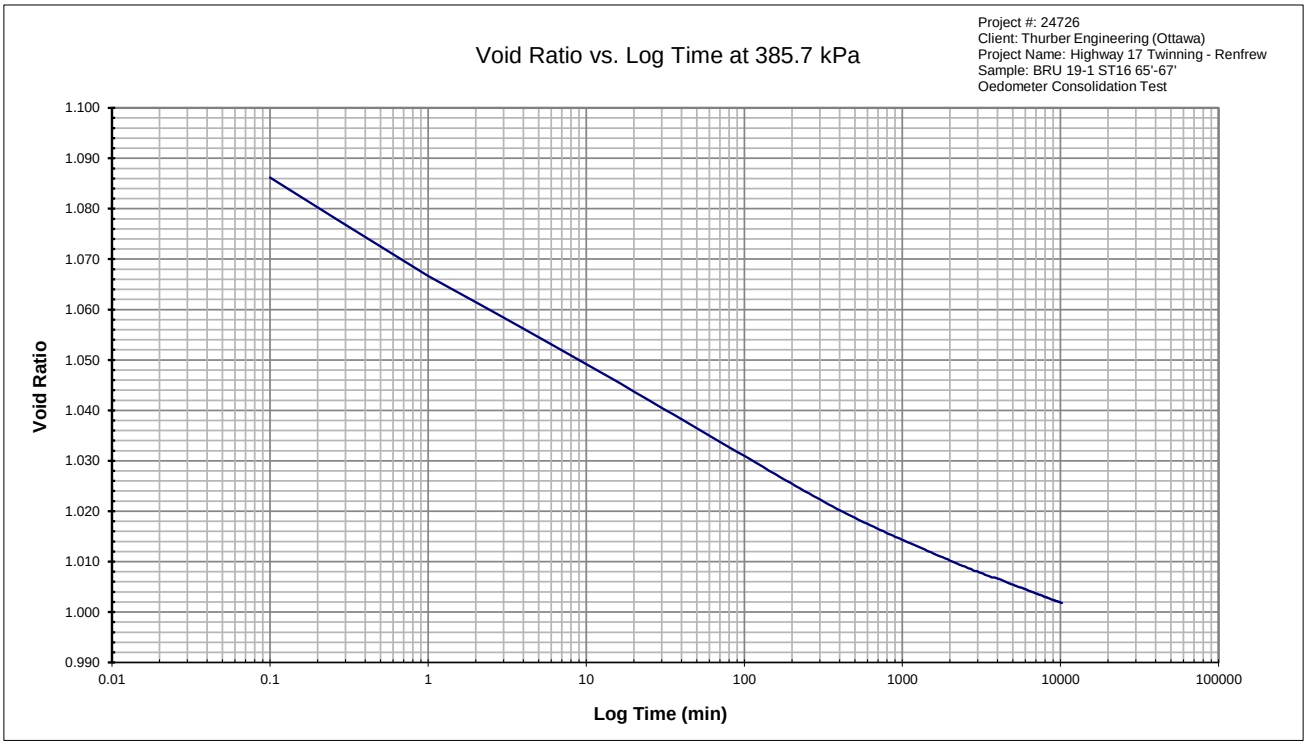
THURBER ENGINEERING LTD.

Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

BRU 19-1 ST16 65'-67'





TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

Consolidation Test Report

CLIENT: Thurber Engineering (Ottawa) FILE NUMBER: 24726

PROJECT: Highway 17 Twinning - Renfrew REPORT DATE: September 15, 2020

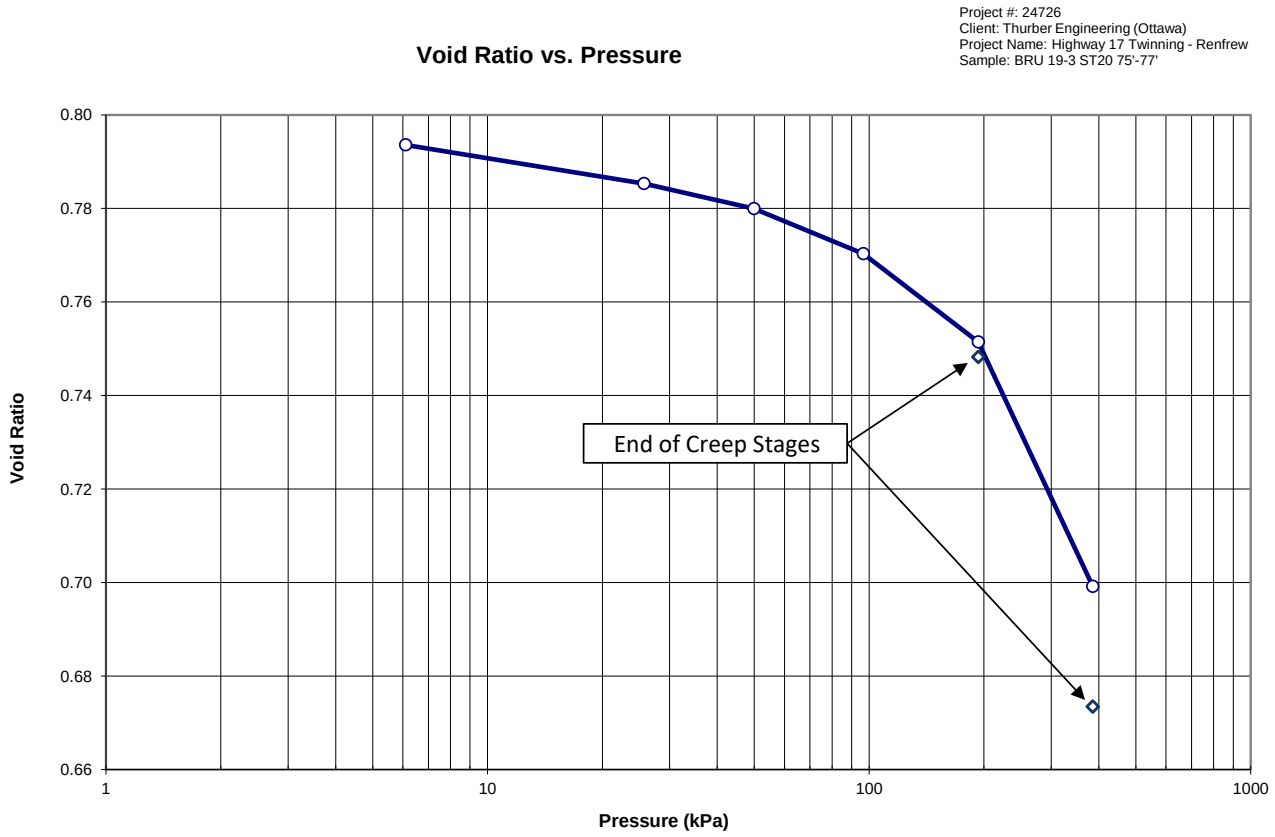
TEST DATES: July 22, 2020 - August 13, 2020

SAMPLE: BRU 19-3 ST20 75'-77'
Clay, silty, trace sand, grey, moist.
LL = 24.1, PL = 14.8, I_p = 9.3

PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	Start of Test	End of Test
Sample Height (mm)	25.40	23.68
Wet Dens. (kg/m^3)	1952.6	2042.2
Dry Dens. (kg/m^3)	1528.7	1639.8
Moisture Cont. (%)	27.7	24.5
Void Ratio	0.795	0.673
Saturation (%)	95.7	100.0

Note: A Specific Gravity (Gs) of 2.744 was obtained for the void ratio and saturation calculations.



TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

Consolidation Test Report

Highway 17 Twinning - Renfrew
24726 BRU 19-3 ST20 75'-77'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer. The average moisture content of the trimmings was 28.5%.

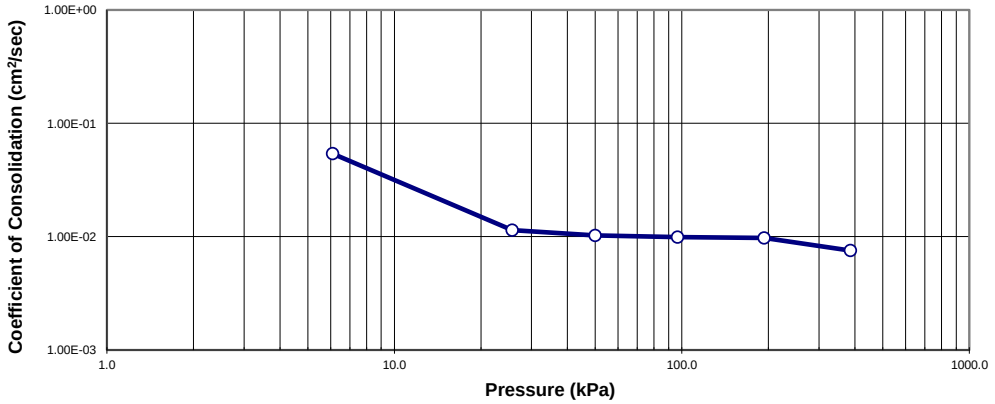
LOADING: A seating load of 6.1 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after a constant load increment duration of 24 hours. Creep stages were conducted at 193.2 kPa and 385.7 kPa; and were maintained for 9 and 10 days, respectively.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D_{90} (mm)	t_{90} (min)	c_v (cm^2/s)	Void Ratio	m_v (m^2/kN)	k (cm/s)
0.0	25.400					0.795		
6.1	25.380	25.390	-0.019	0.42	5.39E-02	0.794	1.29E-04	6.82E-07
25.7	25.263	25.322	-0.085	1.99	1.14E-02	0.785	2.35E-04	2.63E-07
49.9	25.187	25.225	-0.043	2.19	1.03E-02	0.780	1.24E-04	1.25E-07
96.6	25.051	25.119	-0.078	2.25	9.91E-03	0.770	1.16E-04	1.12E-07
193.2	24.784	24.918	-0.150	2.25	9.75E-03	0.751	1.10E-04	1.05E-07
193.2 (Creep)	24.738	24.761				0.748		
385.7	24.044	24.391	-0.303	2.79	7.54E-03	0.699	1.46E-04	1.08E-07
385.7 (Creep)	23.680	23.862				0.673		

Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-3 ST20 75'-77'
Oedometer Consolidation Test

Coefficient of Consoildation vs. Pressure



Note: C_v and k calculated using t_{90} values (square root of time method)

TEST DONE BY: BT
REVIEWED BY: WM

THURBER ENGINEERING LTD.

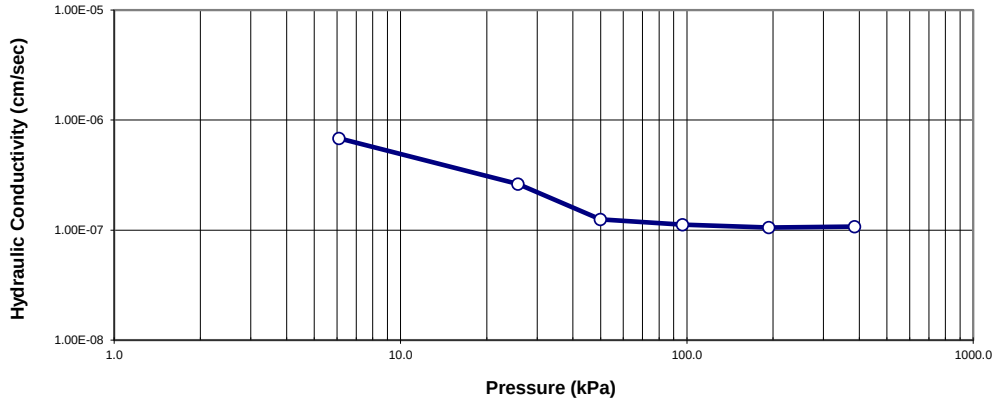
Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

BRU 19-3 ST20 75'-77'

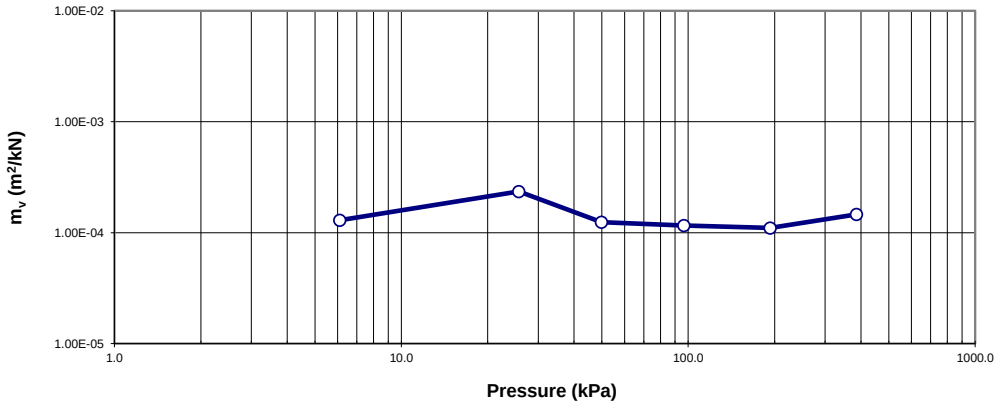
Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-3 ST20 75'-77'

Hydraulic Conductivity vs. Pressure



Project #: 24726
Client: Thurber Engineering (Ottawa)
Project Name: Highway 17 Twinning - Renfrew
Sample: BRU 19-3 ST20 75'-77'

m_v vs. Pressure



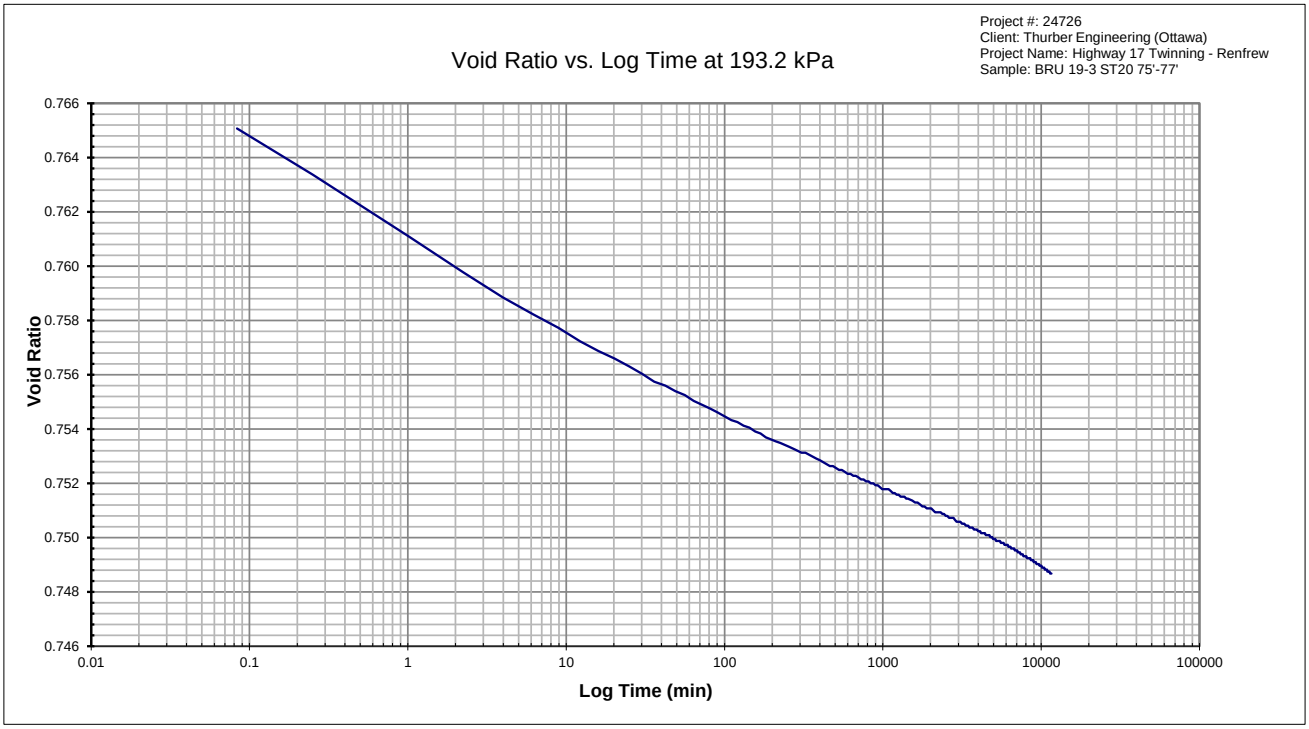
TEST DONE BY: BT
REVIEWED BY: WM

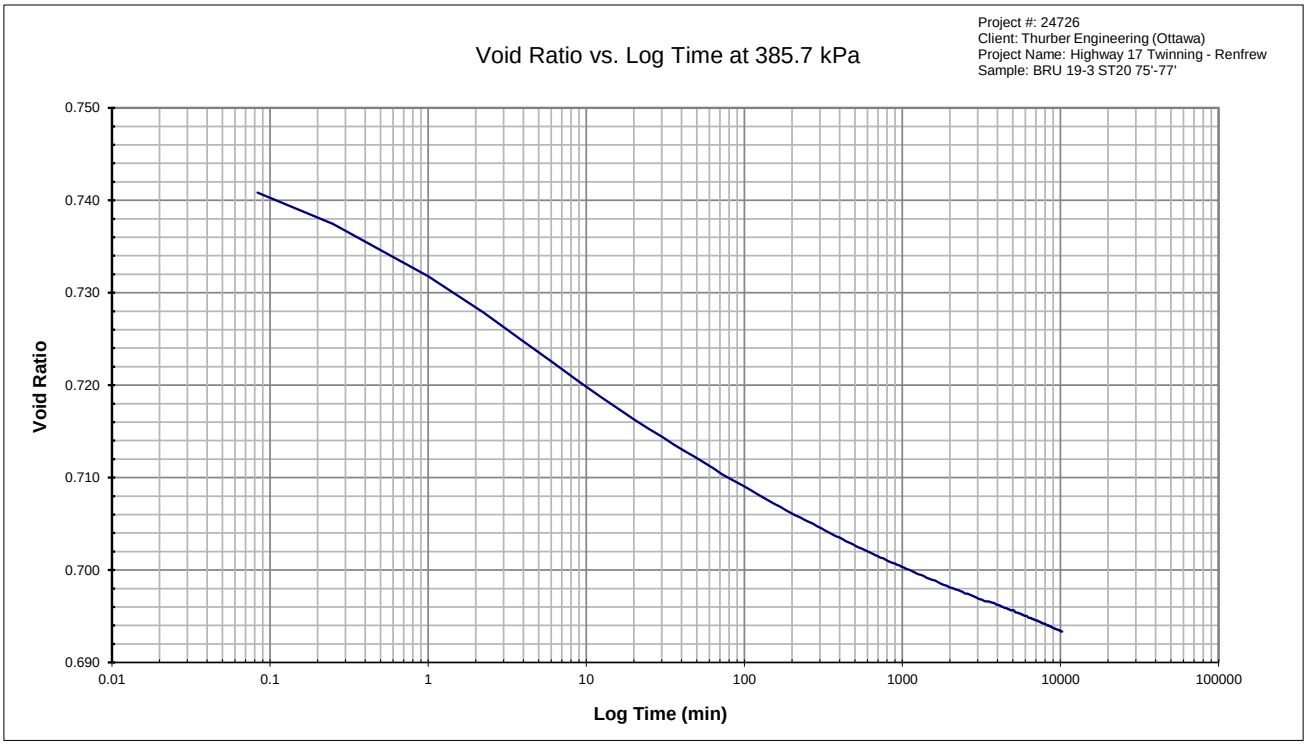
THURBER ENGINEERING LTD.

Consolidation Test Report

Highway 17 Twinning - Renfrew
24726

BRU 19-3 ST20 75'-77'





TEST DONE BY: BT
REVIEWED BY: WM

THURBER

Appendix C.5

Triaxial Test Results

Unconfined Compressive Strength Test Results

THURBER ENGINEERING LTD.

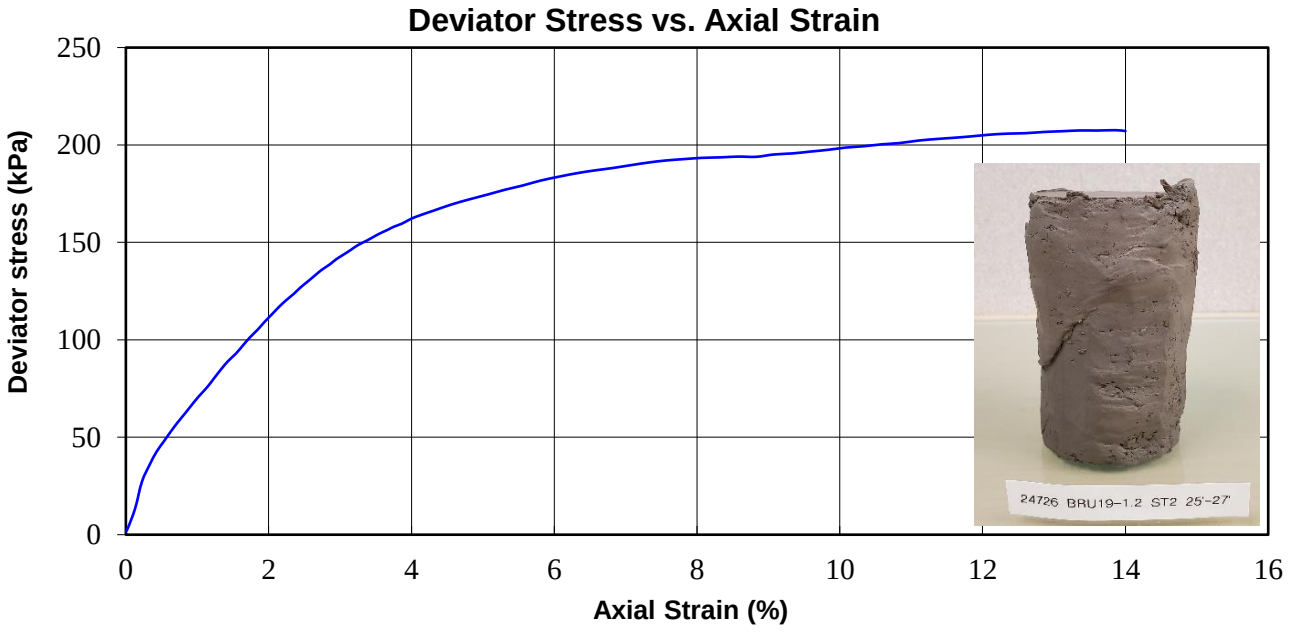
UNCONSOLIDATED-UNDRAINED TRIAXAL TEST REPORT

ASTM D2850

CLIENT:	Ministry of Transportation (MTO)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 - Twinning	REPORT DATE:	17-May-21
BOREHOLE No.:	BRU19-1.2	TEST DATE:	14-May-21
SAMPLE No.:	ST2	ATTERBERG LIMITS:	LL = 36.6, PL = 21.2
SAMPLE DEPTH:	25'-27'	PARTICLE SIZES:	CL = 49%, SI = 51%
DESCRIPTION:	Silty clay, grey, moist		SA = 0%, GR = 0%

Avg. Height (mm):	108.7	Weight (g):	400.2
Avg. Diameter (mm):	50.4	Wet Density (kg/m^3):	1,845
H. to Dia. Ratio:	2.2:1	Dry Density (kg/m^3):	1,347
Cross Sectional Area (mm^2):	1995.0	Moisture Content* (%):	37.0
G_s (Measured):	2.754	Void Ratio:	1.045

Rate of Strain to Failure (% / min):	1
Minor principal stress, $\sigma_{3\ (kPa)}$	110
Major principal stress, $\sigma_{1\ (kPa)}$	318
Deviator Stress at failure (kPa)	208
Vertical Strain at failure (%)	13.9



Note: * Moisture content was obtained from the entire specimen after the test

** Type of Failure: Diagonal Shear

TEST DONE BY: BT
REVIEWED BY: JPL

THURBER ENGINEERING LTD.

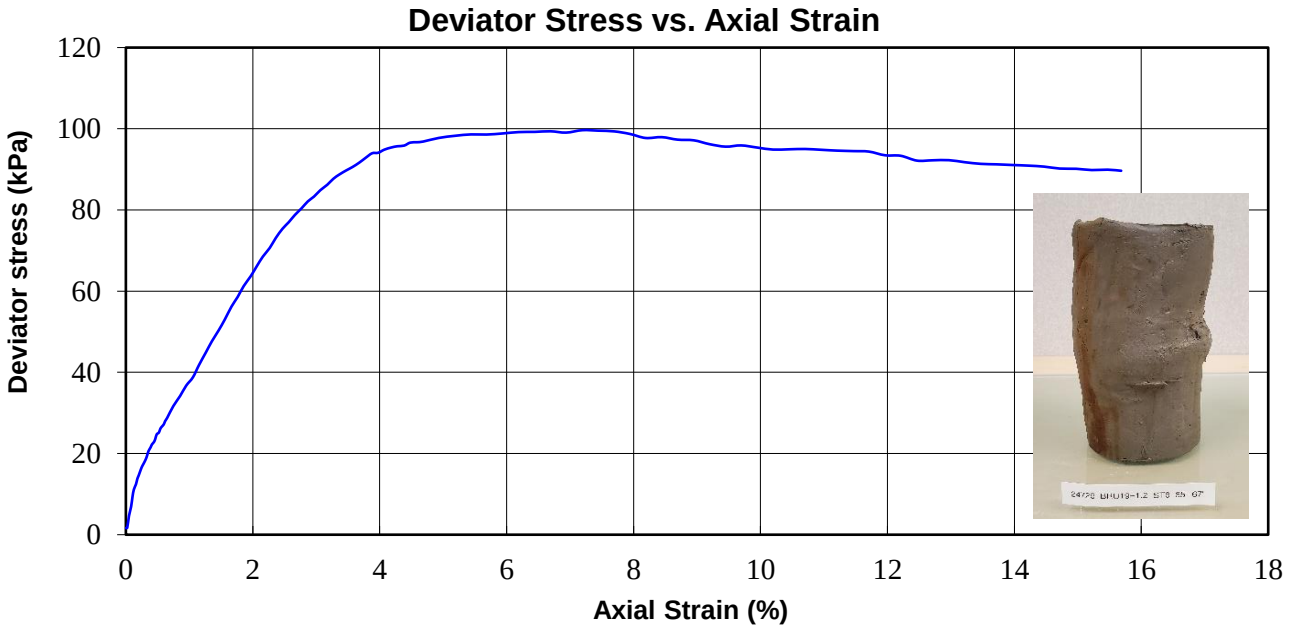
UNCONSOLIDATED-UNDRAINED TRIAXAL TEST REPORT

ASTM D2850

CLIENT:	Ministry of Transportation (MTO)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 - Twinning	REPORT DATE:	9-Jun-21
BOREHOLE No.:	BRU19-1.2	TEST DATE:	12-May-21
SAMPLE No.:	ST6	ATTERBERG LIMITS:	LL = 17.5, PL = 13.7
SAMPLE DEPTH:	65'-67'	PARTICLE SIZES:	CL = 33%, SI = 66%
DESCRIPTION:	Silty clay, grey, moist		SA = 1%, GR = 0%

Avg. Height (mm):	154.5	Weight (g):	1052.0
Avg. Diameter (mm):	66.9	Wet Density (kg/m^3):	1,937
H. to Dia. Ratio:	2.3:1	Dry Density (kg/m^3):	1,418
Cross Sectional Area (mm^2):	3515.1	Moisture Content* (%):	36.6
G_s (Measured):	2.755	Void Ratio:	0.943

Rate of Strain to Failure (% / min):	1
Minor principal stress, $\sigma_{3\ (kPa)}$	201
Major principal stress, $\sigma_{1\ (kPa)}$	301
Deviator Stress at failure (kPa)	100
Vertical Strain at failure (%)	7.2



Note: * Moisture content was obtained from the entire specimen after the test

** Type of Failure: Bulge

TEST DONE BY: BT
REVIEWED BY: JPL

THURBER ENGINEERING LTD.

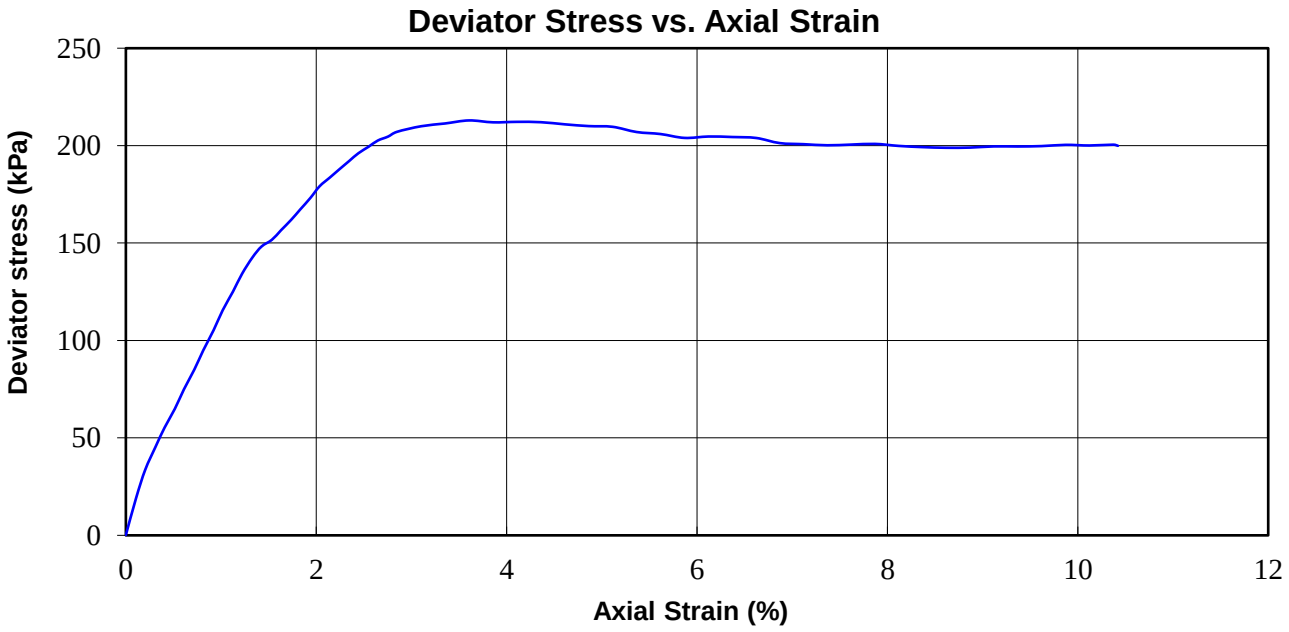
UNCONSOLIDATED-UNDRAINED TRIAXAL TEST REPORT

ASTM D2850

CLIENT:	Ministry of Transportation (MTO)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 - Twinning	REPORT DATE:	11-Feb-21
BOREHOLE No.:	BRU19-3.2	TEST DATE:	27-Jan-21
SAMPLE No.:	ST3	ATTERBERG LIMITS:	LL = 31.3, PL = 20.8
SAMPLE DEPTH:	45'-47'	PARTICLE SIZES:	CL = 43%, SI = 57%
DESCRIPTION:	Silty clay, grey, moist		SA = 0%, GR = 0%

Avg. Height (mm):	151.8	Weight (g):	1041.0
Avg. Diameter (mm):	69.5	Wet Density (kg/m^3):	1,808
H. to Dia. Ratio:	2.2:1	Dry Density (kg/m^3):	1,303
Cross Sectional Area (mm^2):	3793.7	Moisture Content* (%):	38.7
G_s (Measured):	2.775	Void Ratio:	1.129

Rate of Strain to Failure (% / min):	1
Minor principal stress, $\sigma_{3\ (kPa)}$	305
Major principal stress, $\sigma_{1\ (kPa)}$	518
Deviator Stress at failure (kPa)	213
Vertical Strain at failure (%)	3.6



Note: * Moisture content was obtained from the entire specimen after the test

** Type of Failure: Diagonal shear

TEST DONE BY: BT
REVIEWED BY: JPL

THURBER ENGINEERING LTD.

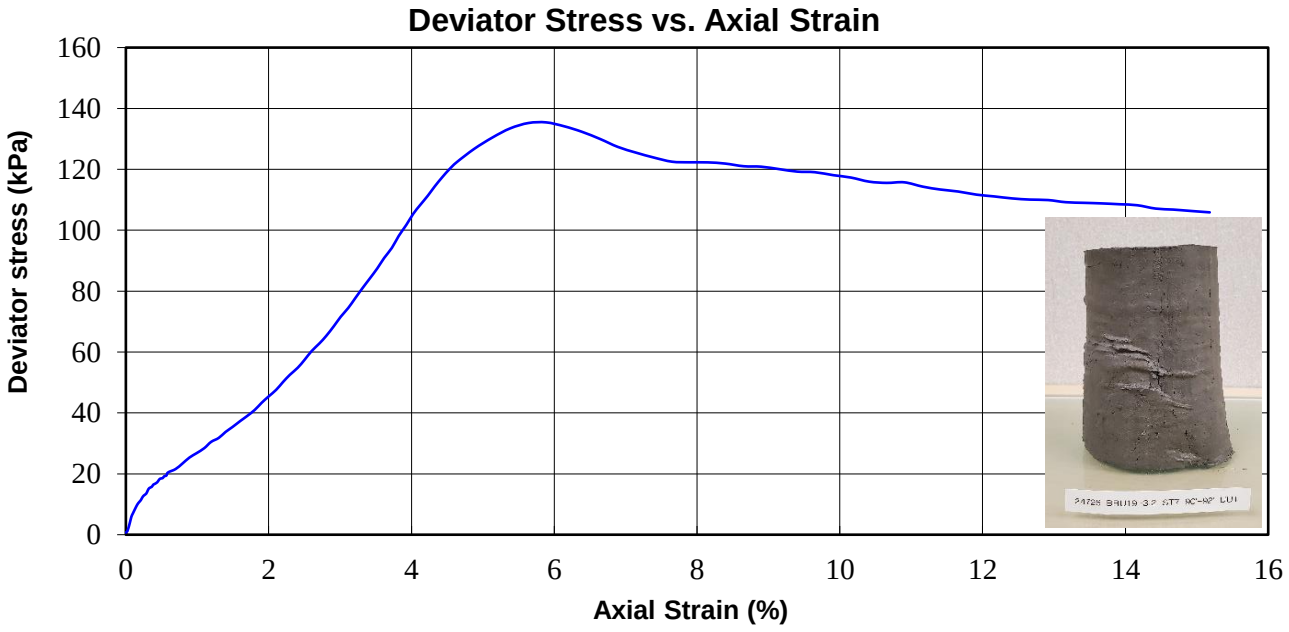
UNCONSOLIDATED-UNDRAINED TRIAXAL TEST REPORT

ASTM D2850

CLIENT:	Ministry of Transportation (MTO)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 - Twinning	REPORT DATE:	9-Jun-21
BOREHOLE No.:	BRU19-3.2	TEST DATE:	18-May-21
SAMPLE No.:	ST7	ATTERBERG LIMITS:	LL = 20.5, PL = 17.4
SAMPLE DEPTH:	90'-92'	PARTICLE SIZES:	CL = 23%, SI = 77%
DESCRIPTION:	Silt, clayey, grey, moist		SA = 0%, GR = 0%

Avg. Height (mm):	144.9	Weight (g):	1041.9
Avg. Diameter (mm):	67.9	Wet Density (kg/m^3):	1,986
H. to Dia. Ratio:	2.1:1	Dry Density (kg/m^3):	1,533
Cross Sectional Area (mm^2):	3621.0	Moisture Content* (%):	29.5
G_s (Measured):	2.773	Void Ratio:	0.808

Rate of Strain to Failure (% / min):	1
Minor principal stress, $\sigma_{3\ (kPa)}$	240
Major principal stress, $\sigma_{1\ (kPa)}$	375
Deviator Stress at failure (kPa)	135
Vertical Strain at failure (%)	5.9



Note: * Moisture content was obtained from the entire specimen after the test

** Type of Failure: Diagonal Shear

TEST DONE BY: BT
REVIEWED BY: JPL

24726 BRU19-3.2 ST7 90'-92' UU

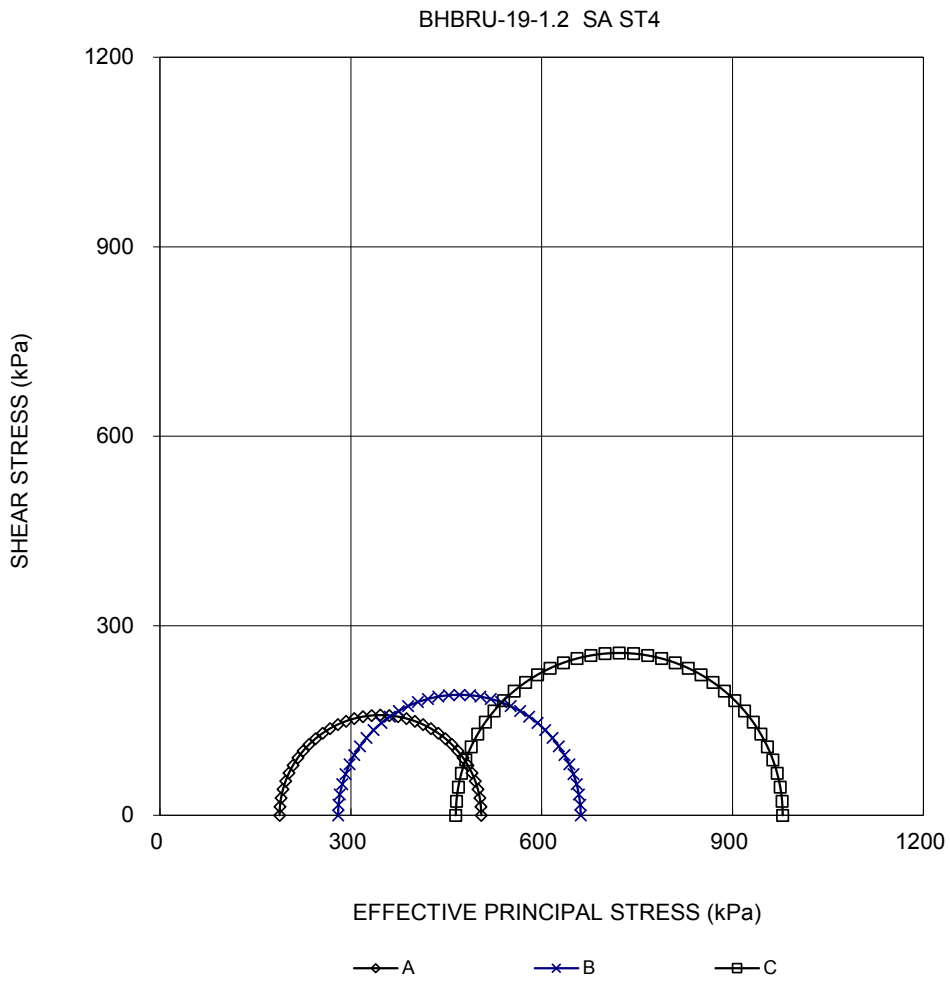
CONSOLIDATED DRAINED TRIAXIAL ASTM D7181 SHEET 1 OF 4				FIGURE
TEST STAGE	A	B	C	
BOREHOLE NUMBER		BRU19-1.2		
SAMPLE NUMBER		ST4		
DEPTH, m		14.63-14.94		
SPECIMEN DIAMETER, cm	6.96	7.00	7.02	
SPECIMEN HEIGHT, cm	14.03	13.91	14.01	
NATURAL WATER CONTENT, %	45.2	46.9	43.6	
DRY DENSITY, Mg/m^3	1.19	1.19	1.24	
WATER CONTENT BEFORE CONSOLIDATION, %	43.7	43.7	40.3	
CELL PRESSURE, σ_3, kPa	458.0	550.0	735.0	
BACK PRESSURE, kPa	270.0	270.0	270.0	
PORE PRESSURE PARAMETER "B"	0.96	0.96	0.96	
CONSOLIDATION PRESSURE, σc, kPa	188.0	280.0	465.0	
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	3.1	4.9	6.2	
WATER CONTENT AFTER CONSOLIDATION, %	41.1	39.6	35.3	
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5	
TIME TO FAILURE, HOURS	12	16	30	
WATER CONTENT AFTER TEST, %	39.5	36.9	34.4	
MAX. DEVIATOR STRESS, $(\sigma_1-\sigma_3)$, kPa	317.1	381.5	513.9	
AXIAL STRAIN AT $(\sigma_1-\sigma_3)$ MAXIMUM, %	6.0	7.8	15.0	
MAX PRINCIPAL STRESS RATIO, (σ'_1/σ'_3) maximum	2.7	2.4	2.2	
FILTER DRAINS USED, y/n	y	y	y	
TEST NOTES:				
FAILURE PLANE NUMBER	-	1.0	-	
ANGLE OF FAILURE, DEGREES	Bulged	55.0	Bulged	

Specimen A taken 0-15 cm from top of tube.
Specimen B taken 15-35.5cm from top of tube.
Specimen C taken 35.5-52cm from top of tube.

Date: 4/01/2021 Prepared By: LH

Project No. 21453742(3000) **Golder Associates** Checked By: MM

CONSOLIDATED DRAINED TRIAXIAL ASTM D7181 SHEET 2 OF 4	FIGURE



Date: 4/01/2021

Project No. 21453742(3000)

Golder Associates

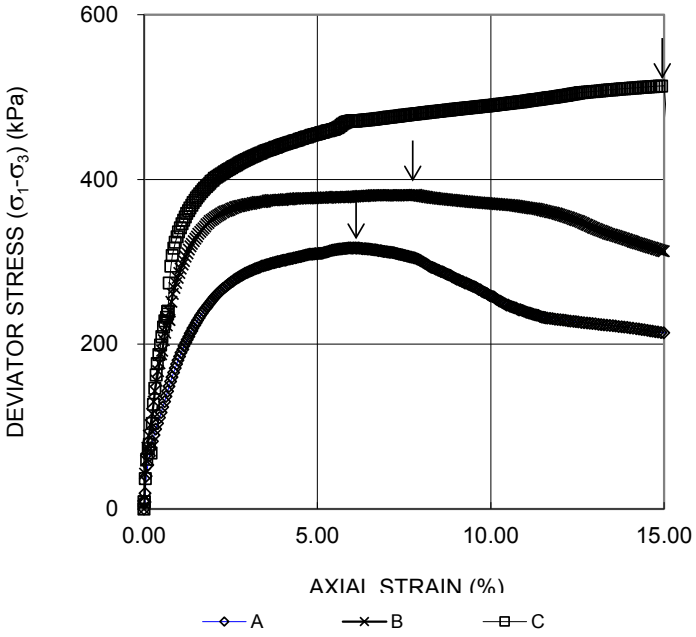
Prepared By: LH

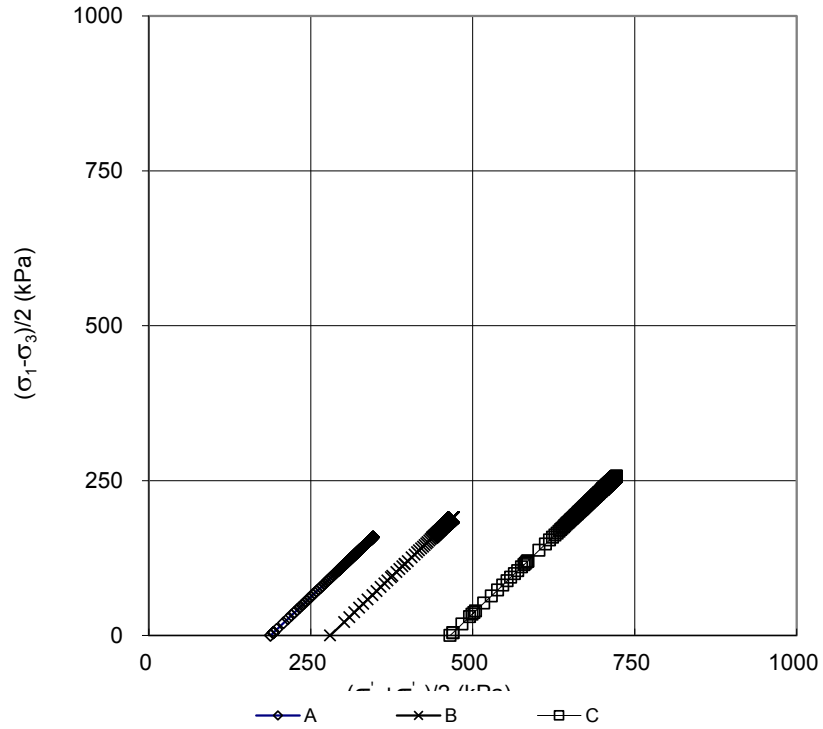
Checked By: MM

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 3 OF 4

FIGURE

BHBRU-19-1.2 SA ST4





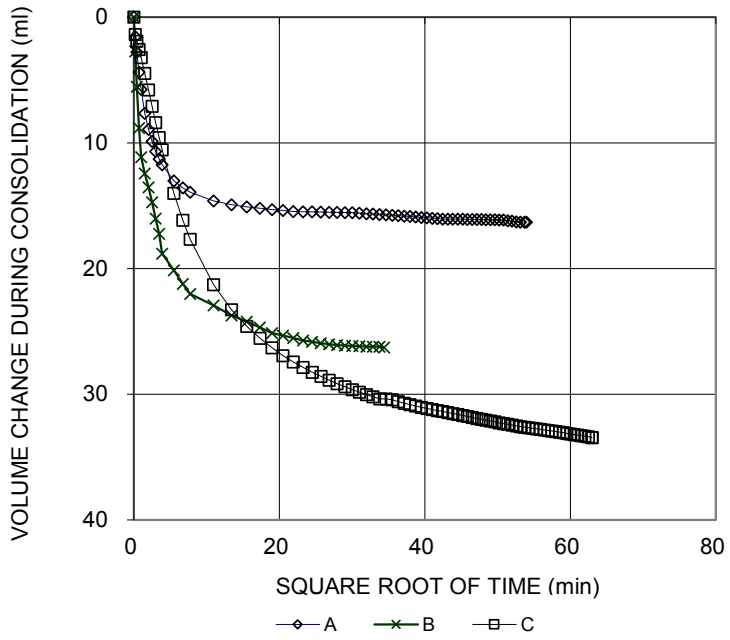
Date: 4/01/2021
Project No. 21453742(3000)

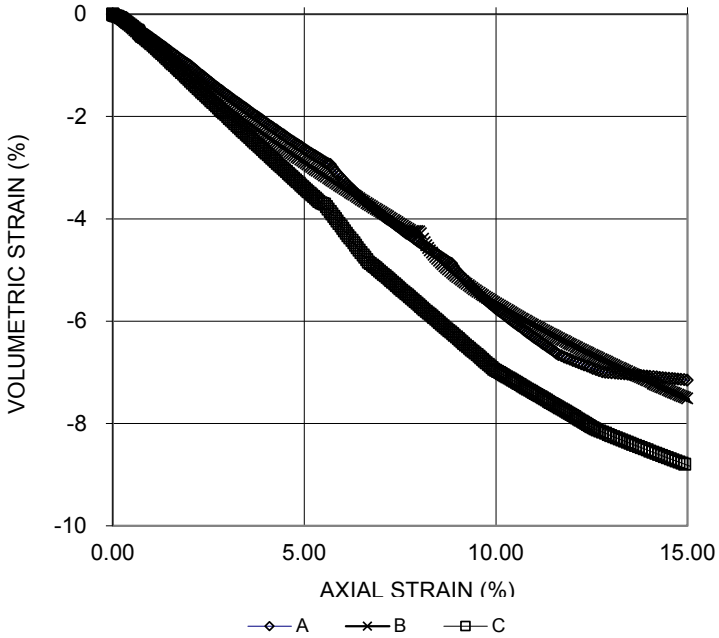
Golder Associates

Prepared By: LH
Checked By: MM

CONSOLIDATED DRAINED TRIAXIAL ASTM D7181 SHEET 4 OF 4	FIGURE

BHBRU-19-1.2 SA ST4





NOTES: POSITIVE (+) VOLUMETRIC STRAIN = SAMPLE VOLUME DECREASING

NEGATIVE(-) VOLUMETRIC STRAIN = SAMPLE VOLUME INCREASING

Date:	4/01/2021	Prepared By:	LH
Project No.	21453742(3000)	**Golder Associates**	Checked By: MM

CONSOLIDATED DRAINED TRIAXIAL ASTM D7181 SHEET 1 OF 4				FIGURE
TEST STAGE	A	B	C	
BOREHOLE NUMBER		BRU19-3.2		
SAMPLE NUMBER		ST5		
DEPTH, m		18.29-18.90		
SPECIMEN DIAMETER, cm	6.97	6.97	6.97	
SPECIMEN HEIGHT, cm	14.01	14.00	14.01	
NATURAL WATER CONTENT, %	34.3	35.5	38.2	
DRY DENSITY, Mg/m^3	1.41	1.38	1.32	
WATER CONTENT BEFORE CONSOLIDATION, %	33.2	33.6	36.4	
CELL PRESSURE, σ_3, kPa	414.0	590.0	731.0	
BACK PRESSURE, kPa	200.0	270.0	200.0	
PORE PRESSURE PARAMETER "B"	0.96	0.96	0.96	
CONSOLIDATION PRESSURE, σc, kPa	214.0	320.0	531.0	
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	2.7	3.4	7.2	
WATER CONTENT AFTER CONSOLIDATION, %	31.3	31.2	31.0	
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5	
TIME TO FAILURE, HOURS	10	30	27	
WATER CONTENT AFTER TEST, %	31.1	27.9	30.1	
MAX. DEVIATOR STRESS, $(\sigma_1-\sigma_3)$, kPa	403.0	480.5	581.1	
AXIAL STRAIN AT $(\sigma_1-\sigma_3)$ MAXIMUM, %	5.0	15.0	13.3	
MAX PRINCIPAL STRESS RATIO, (σ'_1/σ'_3) maximum	2.9	2.5	0.0	
FILTER DRAINS USED, y/n	y	y	y	

TEST NOTES:

Specimen A taken 0-15 cm from top of tube.
Specimen B taken 15-33cm from top of tube.
Specimen C taken 33-51cm from top of tube.

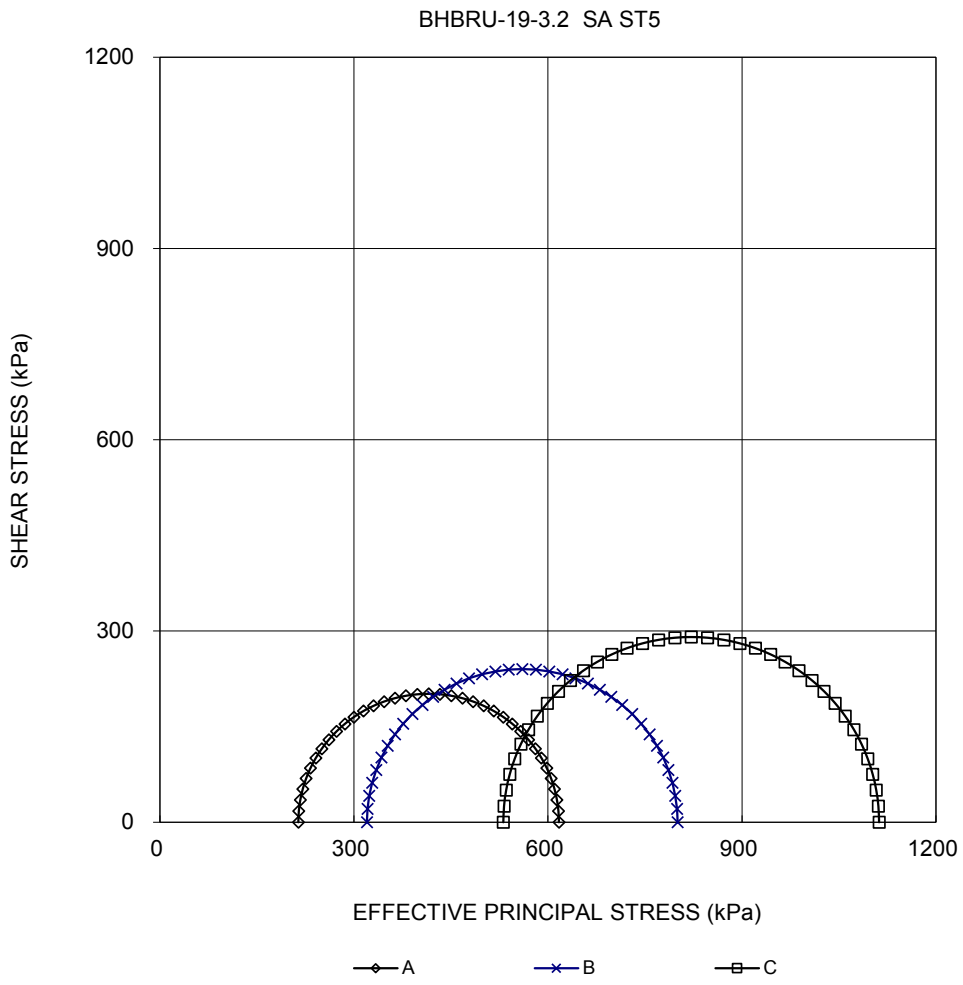
FAILURE PLANE NUMBER	1.0	-	-
ANGLE OF FAILURE, DEGREES	65.0	Bulged	Bulged

Date: 3/31/2021 Prepared By: LH

Project No. 21453742(3000) **Golder Associates** Checked By: MM

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 2 OF 4

FIGURE



Date: 3/31/2021
Project No. 21453742(3000)

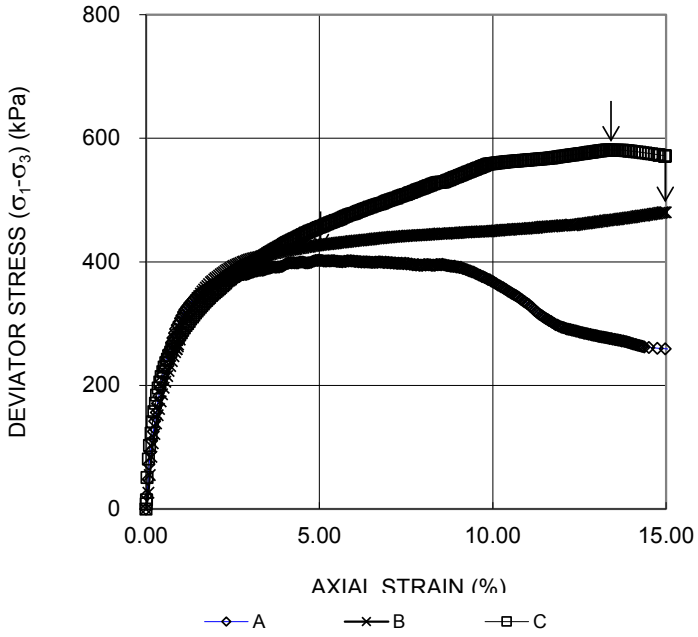
Golder Associates

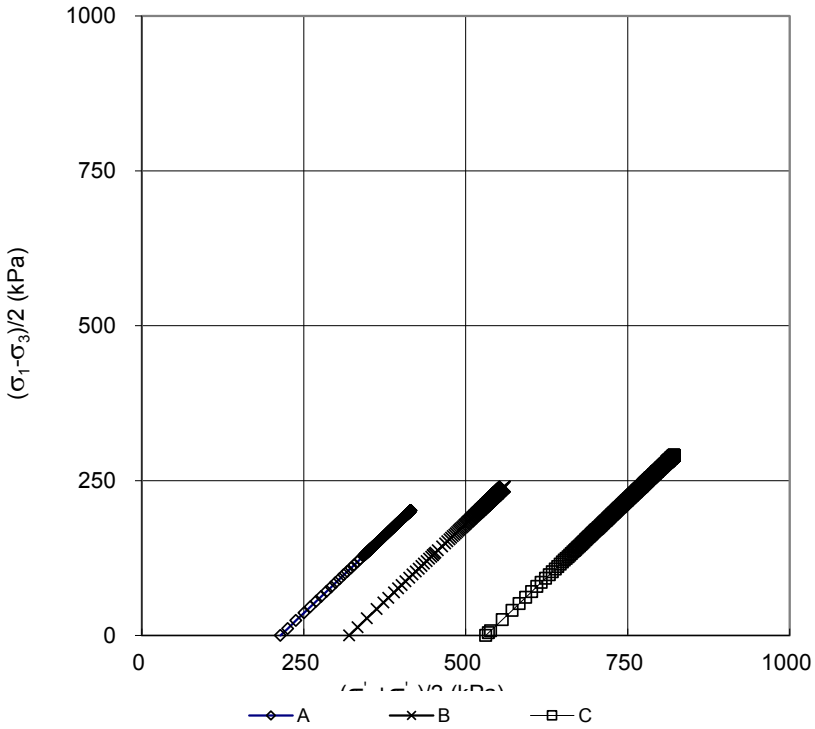
Prepared By: LH
Checked By: MM

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 3 OF 4

FIGURE

BHBRU-19-3.2 SA ST5





Date: 3/31/2021
Project No. 21453742(3000)

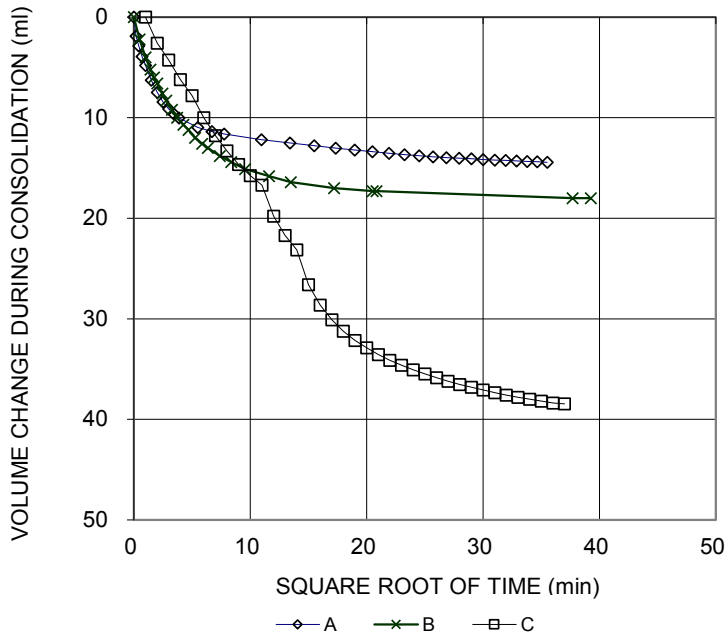
Golder Associates

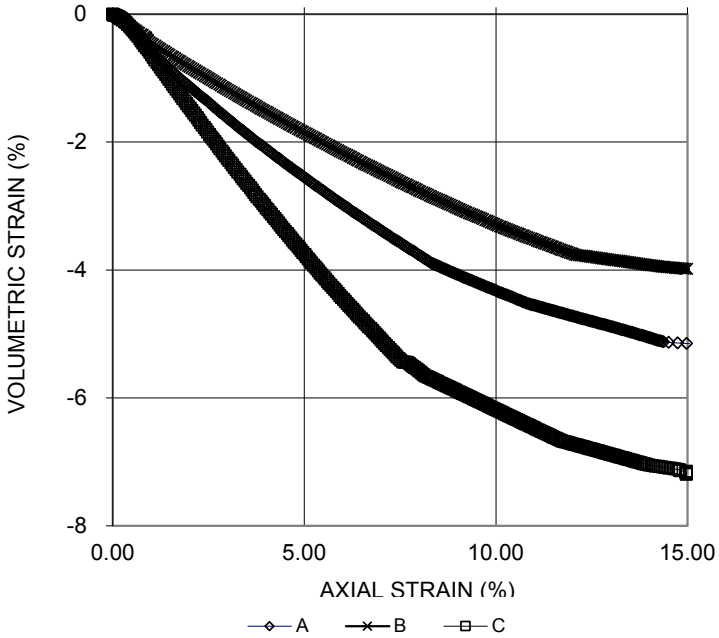
Prepared By: LH
Checked By: MM

CONSOLIDATED DRAINED TRIAXIAL
ASTM D7181
SHEET 4 OF 4

FIGURE

BHBRU-19-3.2 SA ST5





NOTES: POSITIVE (+) VOLUMETRIC STRAIN = SAMPLE VOLUME DECREASING
NEGATIVE(-) VOLUMETRIC STRAIN = SAMPLE VOLUME INCREASING

Date: 3/31/2021 Prepared By: LH

Project No. 21453742(3000) **Golder Associates** Checked By: MM

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT

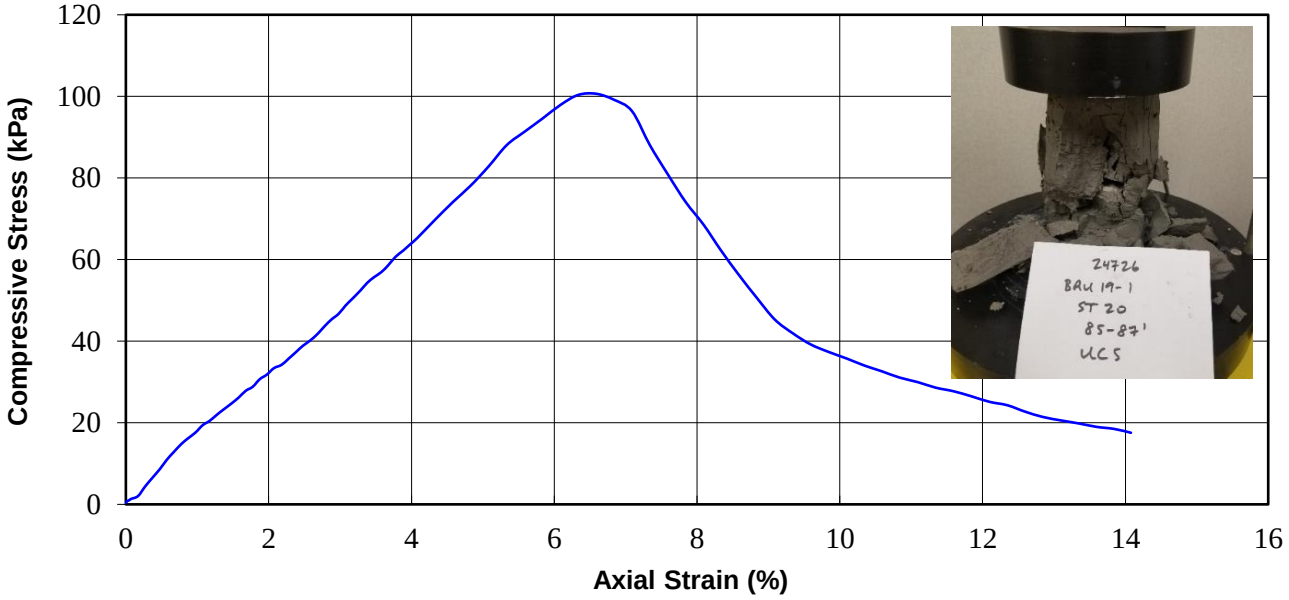
ASTM D2166 - 16

CLIENT:	Ministry of Transportation (MTO)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 - Twinning	REPORT DATE:	11-Feb-21
BOREHOLE No.:	BRU19-1	TEST DATE:	18-Nov-20
SAMPLE No.:	ST20	ATTERBERG LIMITS:	LL = 29.3, PL = 14.2
SAMPLE DEPTH:	85'-87'	PARTICLE SIZES:	CL = 36%, SI = 58%
DESCRIPTION:	Silty clay, trace sand, grey, moist		SA = 6%, GR = 0%

Avg. Height (mm):	140	Weight (g):	999.3
Avg. Diameter (mm):	69	Wet Density (kg/m^3):	1,909
H. to Dia. Ratio:	2:1	Dry Density (kg/m^3):	1,404
Cross Sectional Area (mm^2):	3739.3	Moisture Content* (%):	36.0

Avg. Rate of Strain to Failure:	1 % / min
Unconfined Compressive Strength:	100.6 kPa @ 6.6 % strain
Shear Strength:	50.3 kPa

Compressive Stress vs. Axial Strain



Note: * Moisture content was obtained from the entire specimen after the test

** Type of Failure: Multiple sub-vertical splits

TEST DONE BY: BT
REVIEWED BY: JPL

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT

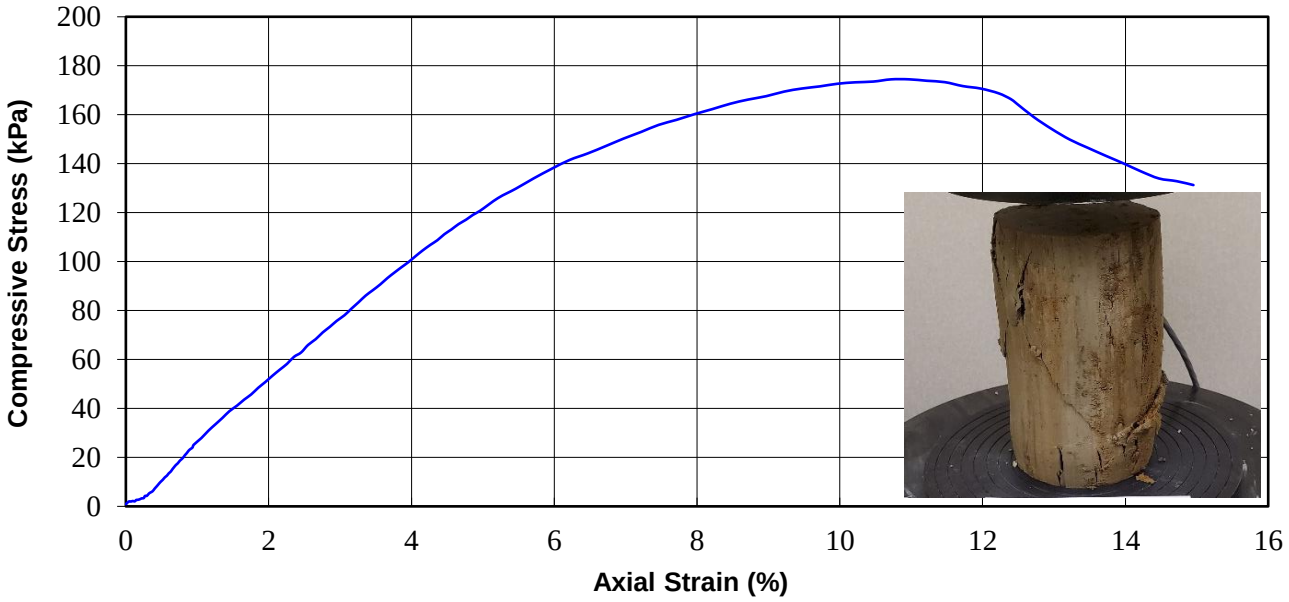
ASTM D2166 - 16

CLIENT:	Ministry of Transportation (MTO)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 - Twinning	REPORT DATE:	11-Feb-21
BOREHOLE No.:	BRU19-3	TEST DATE:	24-Nov-20
SAMPLE No.:	ST7	ATTERBERG LIMITS:	LL = 62.3, PL = 22.3
SAMPLE DEPTH:	15'-17'	PARTICLE SIZES:	CL = 54%, SI = 45%
DESCRIPTION:	Silty clay, trace sand, grey, moist		SA = 1%, GR = 0%

Avg. Height (mm):	150	Weight (g):	1041.6
Avg. Diameter (mm):	69	Wet Density (kg/m^3):	1,857
H. to Dia. Ratio:	2.2:1	Dry Density (kg/m^3):	1,339
Cross Sectional Area (mm^2):	3739.3	Moisture Content* (%):	38.7

Avg. Rate of Strain to Failure:	1 % / min
Unconfined Compressive Strength:	174.5 kPa @ 11 % strain
Shear Strength:	87.2 kPa

Compressive Stress vs. Axial Strain



Note: * Moisture content was obtained from the entire specimen after the test

** Type of Failure: Diagonal shear

TEST DONE BY: BT
REVIEWED BY: JPL

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT

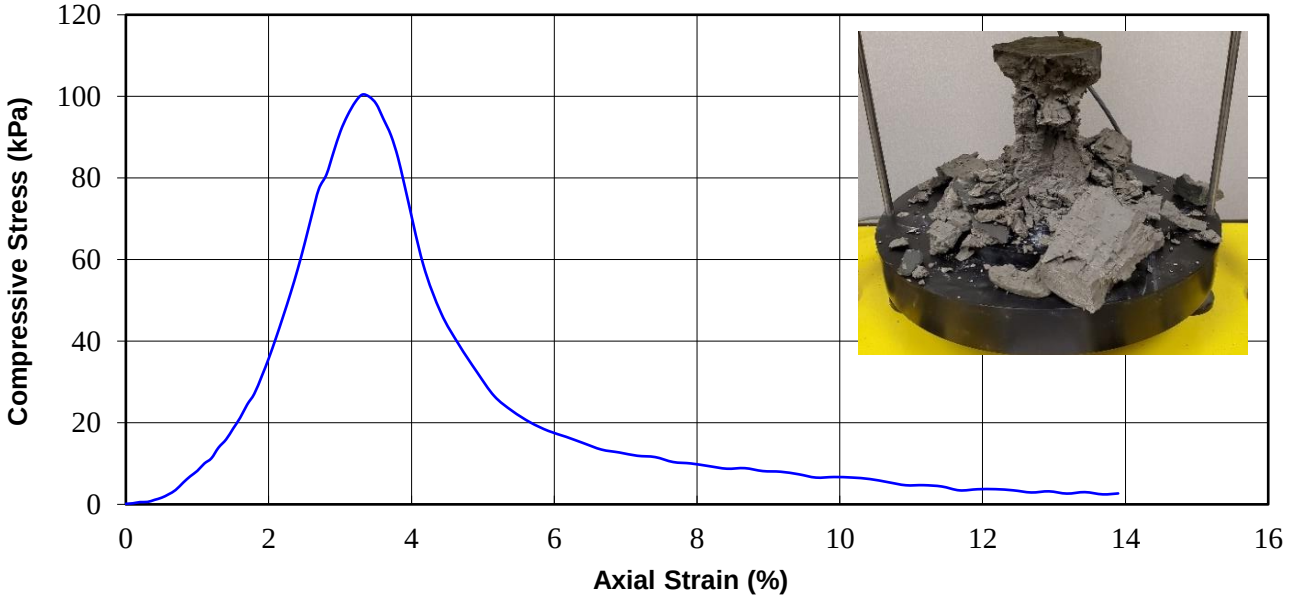
ASTM D2166 - 16

CLIENT:	Ministry of Transportation (MTO)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 - Twinning	REPORT DATE:	11-Feb-21
BOREHOLE No.:	BRU19-3	TEST DATE:	23-Nov-20
SAMPLE No.:	ST25	ATTERBERG LIMITS:	LL = 32.7, PL = 16.2
SAMPLE DEPTH:	100'-102'	PARTICLE SIZES:	CL = 37%, SI = 61%
DESCRIPTION:	Silty clay, trace sand, grey, moist		SA = 2%, GR = 0%

Avg. Height (mm):	135	Weight (g):	978.2
Avg. Diameter (mm):	69	Wet Density (kg/m^3):	1,938
H. to Dia. Ratio:	2:1	Dry Density (kg/m^3):	1,433
Cross Sectional Area (mm^2):	3739.3	Moisture Content* (%):	35.2

Avg. Rate of Strain to Failure:	1 % / min
Unconfined Compressive Strength:	100.4 kPa @ 3.3 % strain
Shear Strength:	50.2 kPa

Compressive Stress vs. Axial Strain



Note: * Moisture content was obtained from the entire specimen after the test

** Type of Failure: Multiple sub-vertical splits

TEST DONE BY: BT
REVIEWED BY: JPL

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Appendix C.6

Analytical Test Results

PARACEL LABORATORIES LTD.

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www.paracellabs.com

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5
Attn: Justin Gray

Client PO: 24726
Project: Hwy 17, Bruce Street Interchange
Custody: 49179

Report Date: 20-Oct-2019
Order Date: 16-Oct-2019

Order #: 1942188

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1942188-01	BRU19-1, SS4 (7'6" - 9'6")
1942188-02	BRU19-2, SS3 (5' - 7')
1942188-03	BRU19-3, SS5 (10' - 12')

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Any use of these results implies your agreement that our total liabilty in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 24726

Report Date: 20-Oct-2019
Order Date: 16-Oct-2019
Project Description: Hwy 17, Bruce Street Interchange

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	17-Oct-19	17-Oct-19
Conductivity	MOE E3138 - probe @25 °C, water ext	17-Oct-19	18-Oct-19
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	18-Oct-19	19-Oct-19
Resistivity	EPA 120.1 - probe, water extraction	17-Oct-19	18-Oct-19
Solids, %	Gravimetric, calculation	17-Oct-19	17-Oct-19

Certificate of Analysis

Client: Thurber Engineering Ltd.

Client PO: 24726

Report Date: 20-Oct-2019

Order Date: 16-Oct-2019

Project Description: Hwy 17, Bruce Street Interchange

	Client ID:	BRU19-1, SS4 (7'6" - 9'6")	BRU19-2, SS3 (5' - 7')	BRU19-3, SS5 (10' - 12')	-
	Sample Date:	07-Oct-19 09:00	15-Oct-19 09:00	27-Sep-19 09:00	-
	Sample ID:	1942188-01	1942188-02	1942188-03	-
	MDL/Units	Soil	Soil	Soil	-
Physical Characteristics					
% Solids	0.1 % by Wt.	71.4	71.2	75.6	-
General Inorganics					
Conductivity	5 uS/cm	206	1910	1110	-
pH	0.05 pH Units	7.78	7.91	7.50	-
Resistivity	0.10 Ohm.m	48.5	5.24	9.02	-
Anions					
Chloride	5 ug/g dry	9	1280	662	-
Sulphate	5 ug/g dry	9	55	38	-

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 24726

Report Date: 20-Oct-2019
Order Date: 16-Oct-2019
Project Description: Hwy 17, Bruce Street Interchange

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
General Inorganics									
Conductivity	ND	5	uS/cm						
Resistivity	ND	0.10	Ohm.m						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	120	5	ug/g dry	123			3.1	20	
Sulphate	323	5	ug/g dry	332			2.8	20	
General Inorganics									
Conductivity	114	5	uS/cm	117			2.6	5	
pH	7.30	0.05	pH Units	7.33			0.4	2.3	
Resistivity	87.7	0.10	Ohm.m	85.5			2.6	20	
Physical Characteristics									
% Solids	87.2	0.1	% by Wt.	87.5			0.4	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	215	5	ug/g	123	91.2	82-118			
Sulphate	421	5	ug/g	332	88.8	80-120			

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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Subcontracted Analysis

Thurber Engineering Ltd.
2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5
Attn: Justin Gray

Tel: (613) 408-6795
Fax: (613) 247-2185

Paracel Report No	**1942188**
Client Project(s):	**Hwy 17, Bruce Street Interchange**
Client PO:	**24726**
Reference:	**Standing Offer**
CoC Number:	**49179**

Order Date:	16-Oct-19
Report Date:	20-Oct-19

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
1942188-01	BRU19-1, SS4 (7'6" - 9'6")	Sulphide, solid
1942188-02	BRU19-2, SS3 (5' - 7')	Sulphide, solid
1942188-03	BRU19-3, SS5 (10' - 12')	Sulphide, solid

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

23-October-2019

Paracel Laboratories
Attn : Dale Robertson

300-2319 St.Laurent Blvd.
Ottawa, ON
K1G 4K6, Canada

Phone: 613-731-9577
Fax:613-731-9064

Date Rec. : 17 October 2019
LR Report: **CA15380-OCT19**
Reference: Project#: 1942188

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		23-Oct-19
2: Analysis Start Time		14:17
3: Analysis Completed Date		23-Oct-19
4: Analysis Completed Time		14:33
5: QC - Blank		< 0.02
6: QC - STD % Recovery		113%
7: QC - DUP % RPD		4%
8: RL		0.02
9: BRU19-1, SS4 (7'6"-9'6")	07-Oct-19	0.02
10: BRU19-2, SS3 (5'-7')	15-Oct-19	< 0.02
11: BRU19-3, SS5 (10'-12')	27-Sep-19	< 0.02

RL - SGS Reporting Limit

Note: Sample BRU19-3, SS5 (10'-12') was received past the 14 day holding time; result may be unreliable.

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0001934780

Data reported represents the sample submitted to SGS. Reproduction of this analytical report in full or in part is prohibited without prior written approval. Please refer to SGS General Conditions of Services located at http://www.sgs.com/terms_and_conditions_service.htm. (Printed copies are available upon request.)
Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

THURBER

Appendix C.7

Uniaxial Compressive Strength Test Results

THURBER ENGINEERING LTD.

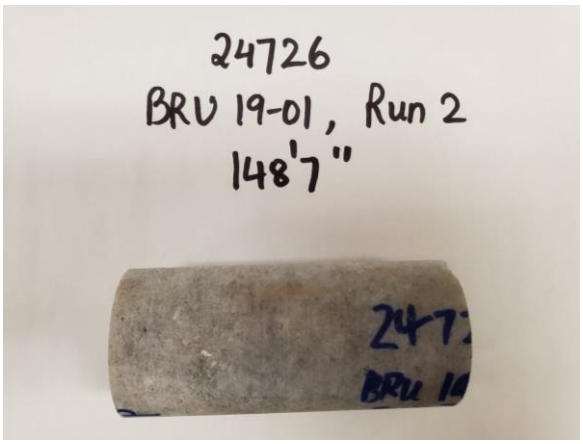
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

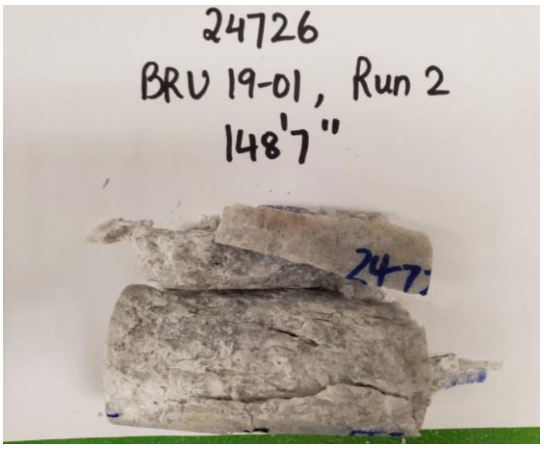
CLIENT:	Thurber Engineering (Ottawa)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 Twinning - Renfrew	REPORT DATE:	24-Mar-20
BOREHOLE No.:	BRU 19-1	TEST DATE:	12-Dec-19
SAMPLE No.:	NQ RUN 2		
SAMPLE DEPTH:	45.3m		
DESCRIPTION:	Marble		

Avg. Height (cm):	9.8	Weight (g):	471.2
Avg. Diameter (cm):	4.7	Wet Density (kg/m^3):	2,772
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m^3):	2,772
Cross Sectional Area (cm^2):	17.35	Moisture Content* (%):	N/A
Sample Volume (cm^3):	170.02		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	1.5%	/ min
MAXIMUM COMPRESSIVE LOAD:	80.8	kN
UNCONFINED COMPRESSIVE STRENGTH:	46.6	MPa

Note: * Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: BS
REVIEWED BY: WM

24726 - BRU 19-1 UCS Run 2, 148'7

THURBER ENGINEERING LTD.

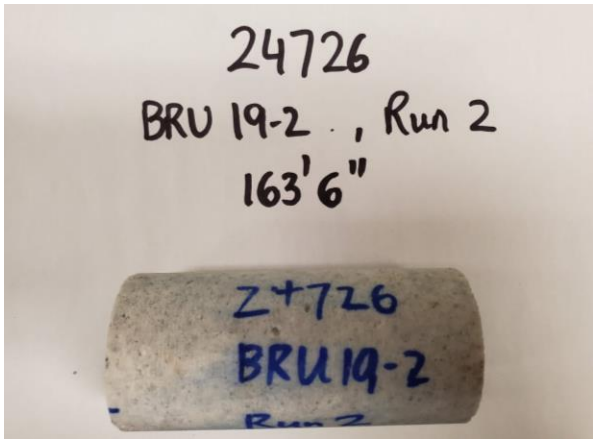
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

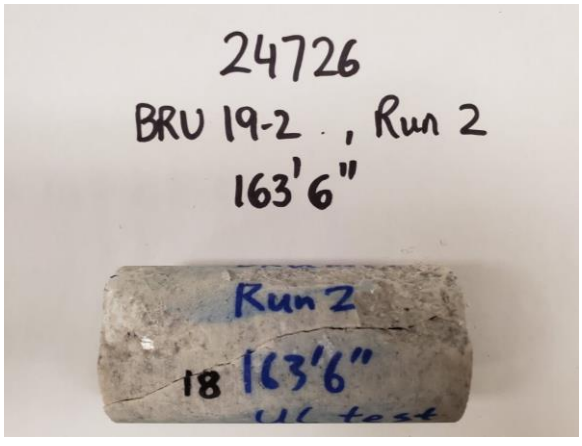
CLIENT:	Thurber Engineering (Ottawa)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 Twinning - Renfrew	REPORT DATE:	24-Mar-20
BOREHOLE No.:	BRU 19-2	TEST DATE:	12-Dec-19
SAMPLE No.:	NQ RUN 2		
SAMPLE DEPTH:	49.8m		
DESCRIPTION:	Marble		

Avg. Height (cm):	9.6	Weight (g):	473.9
Avg. Diameter (cm):	4.7	Wet Density (kg/m^3):	2,845
H. to Dia. Ratio**:	2:1	Dry Density (kg/m^3):	2,845
Cross Sectional Area (cm^2):	17.35	Moisture Content* (%):	N/A
Sample Volume (cm^3):	166.55		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	1.6%	/ min
MAXIMUM COMPRESSIVE LOAD:	72.4	kN
UNCONFINED COMPRESSIVE STRENGTH:	41.7	MPa

Note: * Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: BS
REVIEWED BY: WM

24726 - BRU 19-2 UCS Run 2, 163'6

THURBER ENGINEERING LTD.

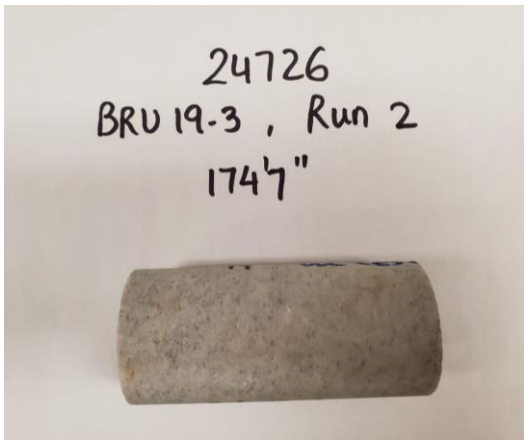
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

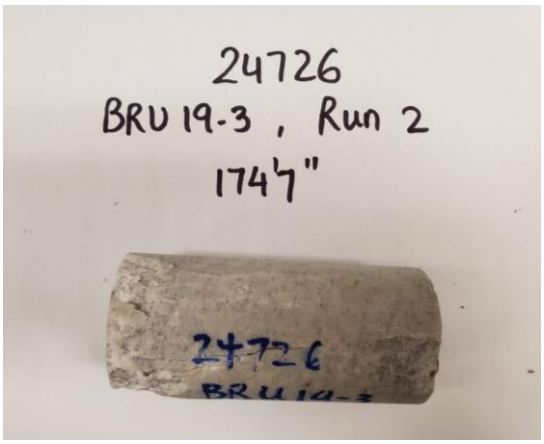
CLIENT:	Thurber Engineering (Ottawa)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 Twinning - Renfrew	REPORT DATE:	24-Mar-20
BOREHOLE No.:	BRU 19-3	TEST DATE:	12-Dec-19
SAMPLE No.:	NQ RUN 2		
SAMPLE DEPTH:	53.2m		
DESCRIPTION:	Marble		

Avg. Height (cm):	9.8	Weight (g):	480.9
Avg. Diameter (cm):	4.7	Wet Density (kg/m^3):	2,828
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m^3):	2,828
Cross Sectional Area (cm^2):	17.35	Moisture Content* (%):	N/A
Sample Volume (cm^3):	170.02		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	1.5%	/ min
MAXIMUM COMPRESSIVE LOAD:	121.8	kN
UNCONFINED COMPRESSIVE STRENGTH:	70.2	MPa

Note: * Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: BS
REVIEWED BY: WM

THURBER

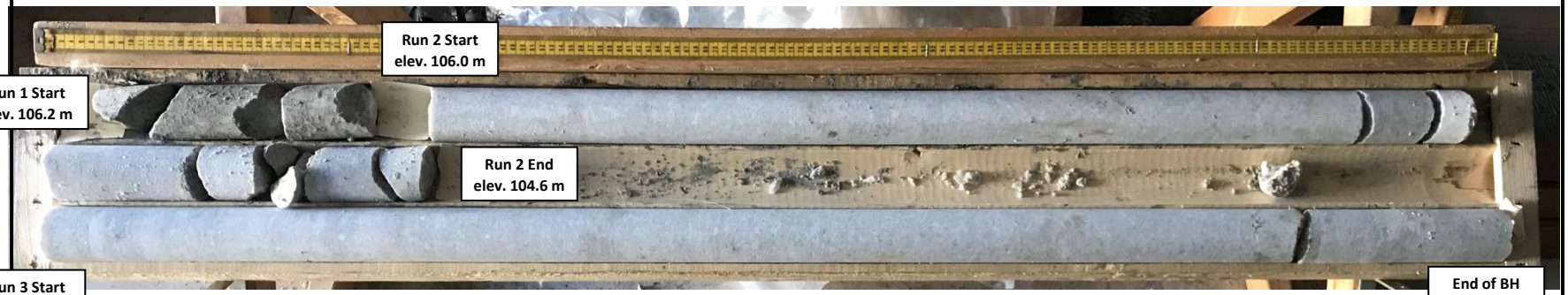
Appendix C.8

Bedrock Core Photographs

Borehole BRU19-01

Run 1 to 3 (of 3)

Elevation 106.2 m to 103.0 m



THURBER ENGINEERING LTD.

Foundation Investigation
Bruce Street (County Road 20) Interchange
Renfrew County, Ontario

W.P. 4068-09-00
Project No.: 24726

Borehole BRU19-02

Run 1 to 2 (of 2)

Elevation 101.8 m to 97.7 m

THURBER ENGINEERING LTD.

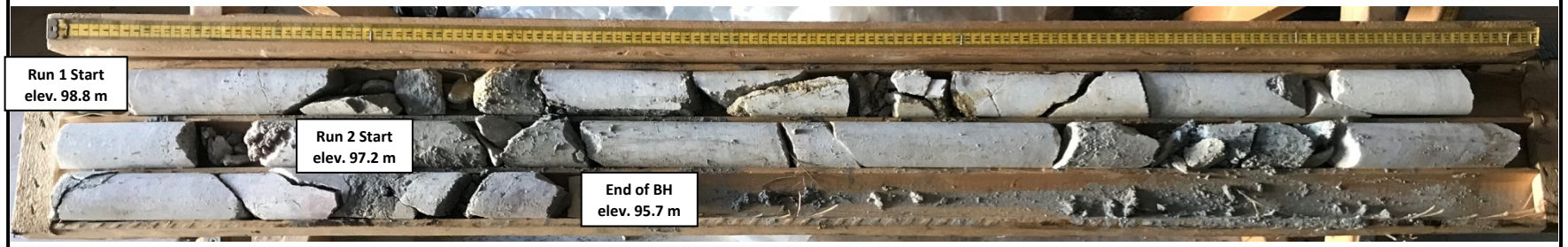
Foundation Investigation
Bruce Street (County Road 20) Interchange
Renfrew County, Ontario

W.P. 4068-09-00
Project No.: 24726

Borehole BRU19-03

Run 1 to 2 (of 2)

Elevation 98.8 m to 95.7 m



THURBER ENGINEERING LTD.

Foundation Investigation
Bruce Street (County Road 20) Interchange
Renfrew County, Ontario

W.P. 4068-09-00
Project No.: 24726

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Appendix D.

Laboratory Testing

Previous (2003) Investigation

THURBER

Appendix D.1

Particle Size Analysis Figures

Atterberg Limit Test Results

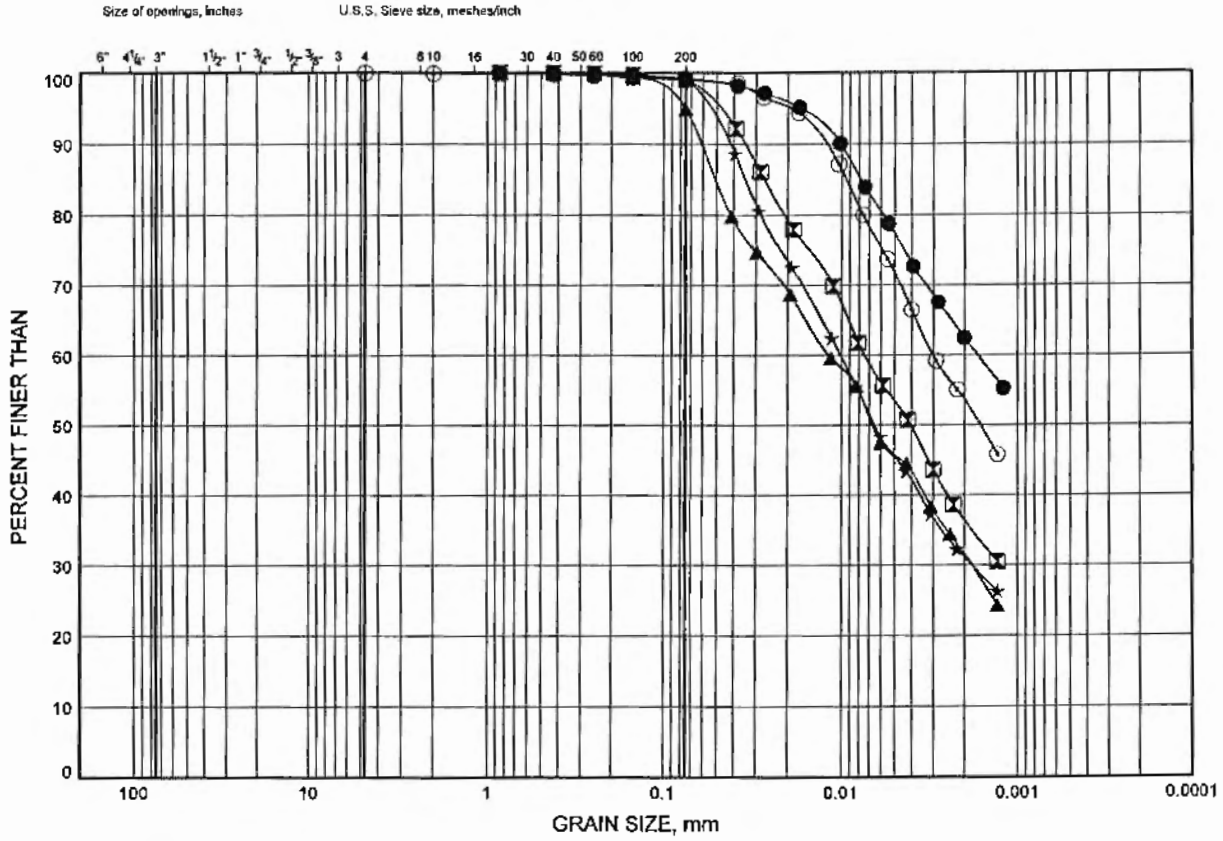
One-Dimensional Consolidation Test Results

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE D1.1

SILTY CLAY TO CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BRU-1	2.59	149.01
⊠	BRU-1	10.97	140.63
▲	BRU-1	20.73	130.87
★	BRU-1	27.13	124.47
⊙	BRU-2	2.59	147.71

Date May 2004

Project 647-92-00

THURBER

Prep'd SS

Chkd. SP

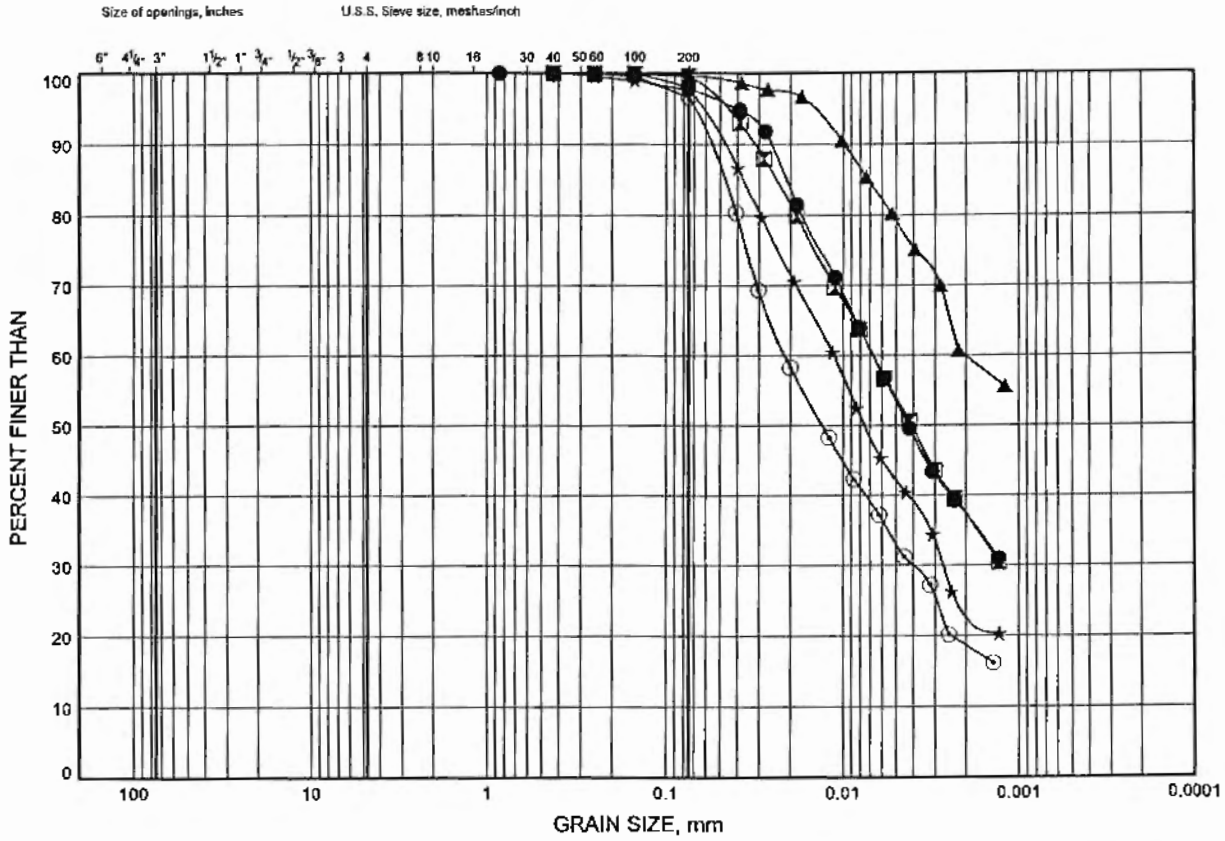
THURBGSD 7450BRU.GPJ 14/05/04

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE D1.2

SILTY CLAY TO CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BRU-2	10.97	139.33
⊠	BRU-2	24.69	125.61
▲	BRU-3	2.59	146.71
★	BRU-3	15.54	133.76
⊙	BRU-3	28.65	120.65

Date May 2004

Project 647-92-00

THURBER

Prep'd SS

Chkd. SP

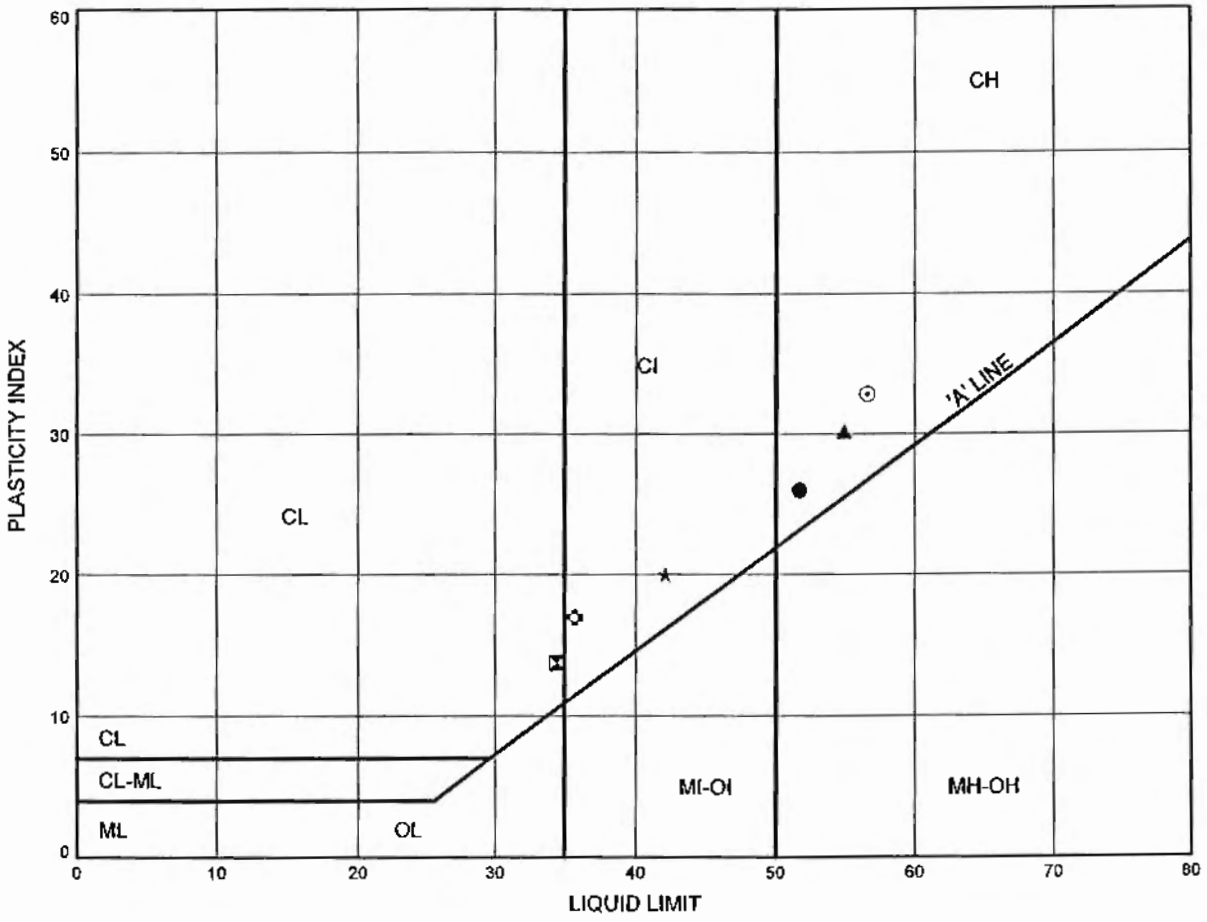
THURBGSD 7450BRU.GPJ 14/05/04

HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE D2

SILTY CLAY TO CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BRU-1	2.59	149.01
⊠	BRU-1	10.97	140.63
▲	BRU-2	2.59	147.71
★	BRU-2	10.97	139.33
⊙	BRU-3	2.59	146.71
✪	BRU-3	15.54	133.76

Date May 2004

Project 647-92-00

THURBER

Prep'd SS

Chkd. SP

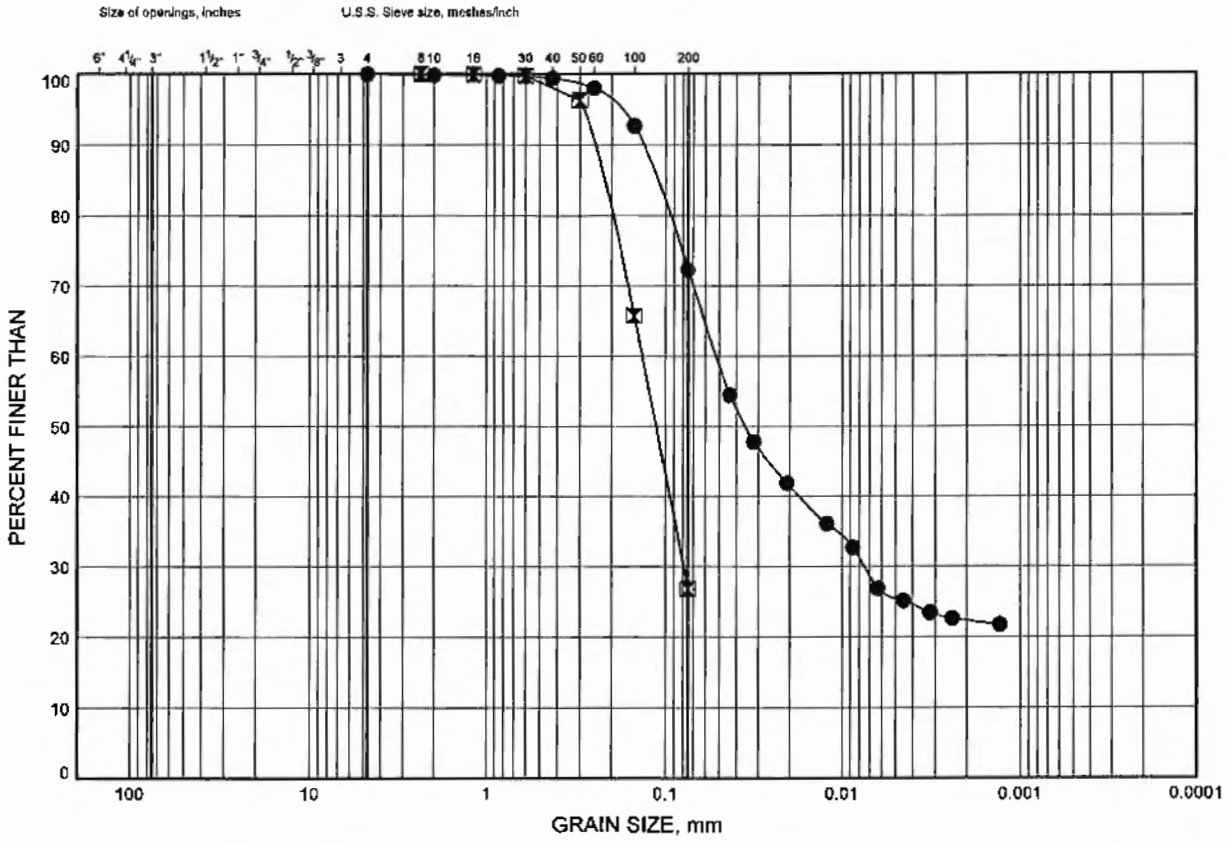
THURBALT 7450BRU.GPJ 14/05/04

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE D3

SILTY SAND TO SANDY SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BRU-2	36.88	113.42
⊠	BRU-3	33.83	115.47

Date June 2004

Project 647-92-00

THURBER

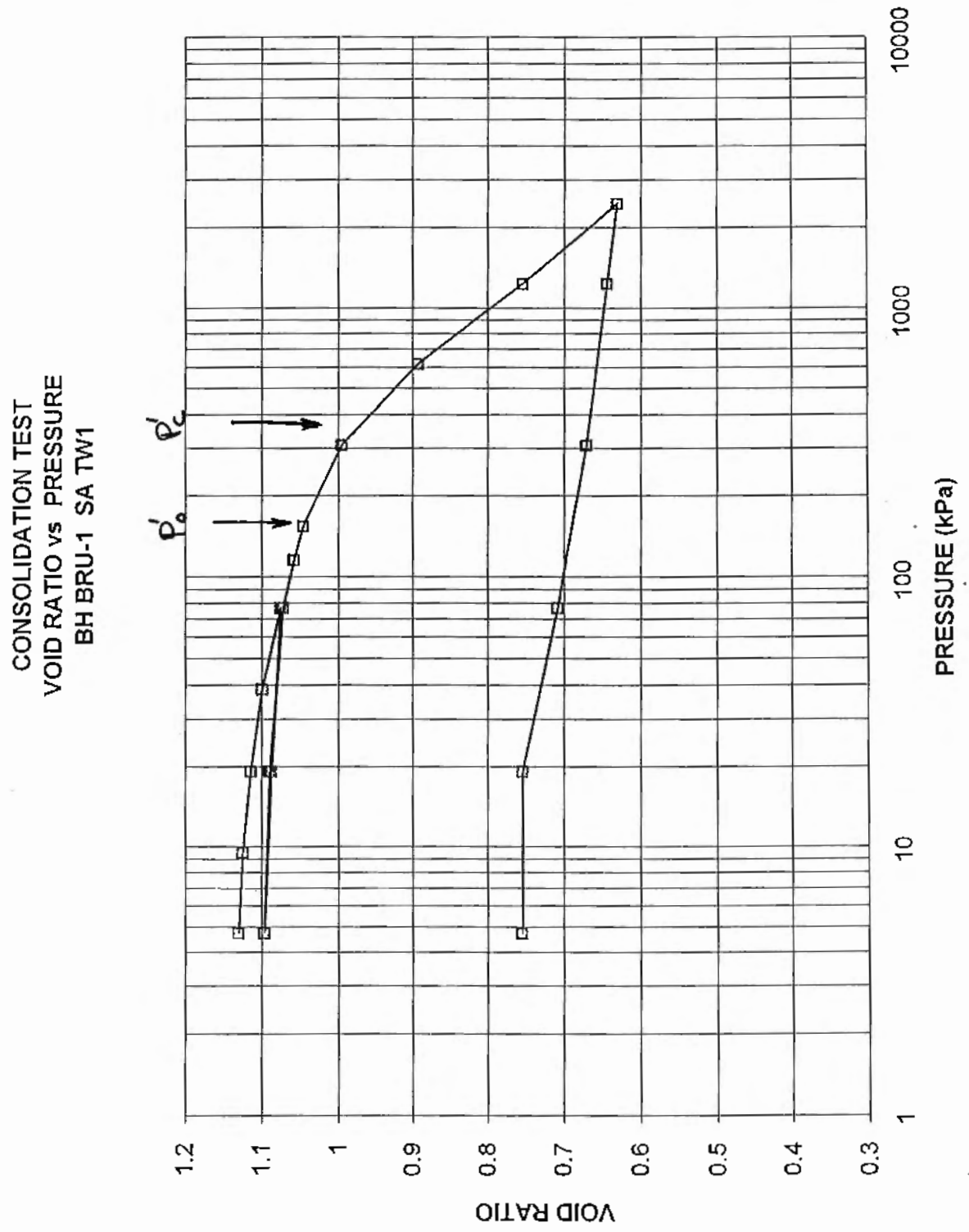
Prep'd SS

Chkd. SP

THURBGSD 7450BRU.GPJ 03/06/04

CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE

FIGURE D4

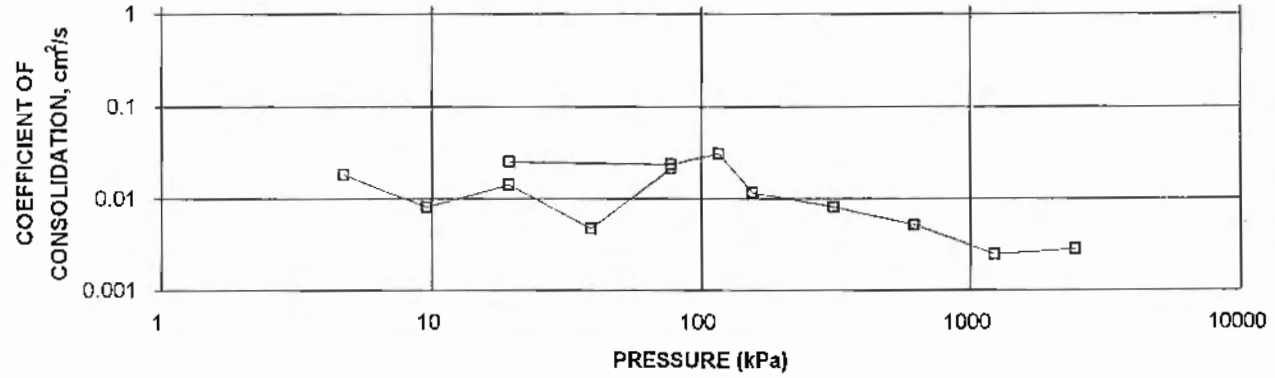


Project No. 04-1116-011

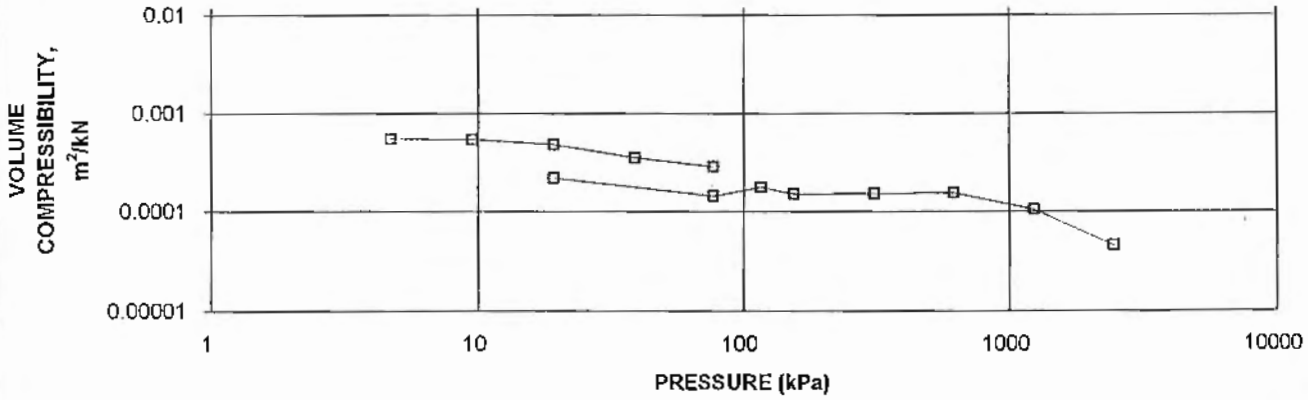
Golder Associates

OEDOMETER CONSOLIDATION SUMMARY

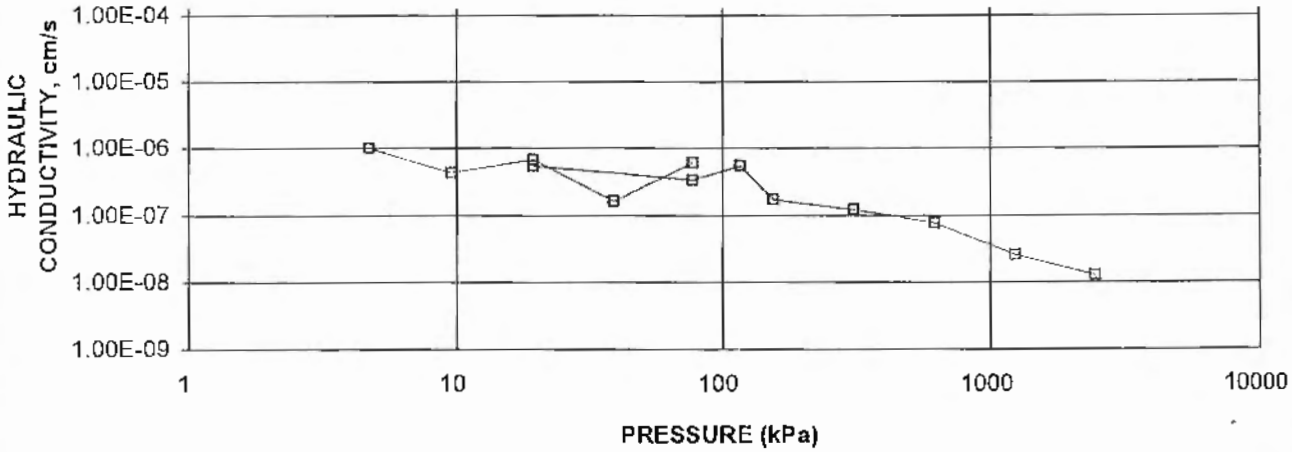
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH BRU-1 SA TW1



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH BRU-1 SA TW1



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH BRU-1 SA TW1



OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	04-1116-011	Sample Number	TW1
Borehole Number	BRU-1	Sample Depth, m	11.6-12.2

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	(0.7-24)
Oedometer Number	6		
Date Started	1/30/2004		
Date Completed	2/12/2004		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m^3	18.03
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	12.81
Area, cm^2	31.67	Specific Gravity, measured	2.79
Volume, cm^3	60.17	Solids Height, cm	0.890
Water Content, %	40.70	Volume of Solids, cm^3	28.18
Wet Mass, g	110.62	Volume of Voids, cm^3	31.99
Dry Mass, g	78.62	Degree of Saturation, %	100.0

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.900	1.135	1.900				
4.75	1.895	1.130	1.898	41	1.86E-02	5.54E-04	1.01E-06
9.54	1.890	1.124	1.893	94	8.08E-03	5.49E-04	4.35E-07
19.25	1.881	1.114	1.886	53	1.42E-02	4.88E-04	6.80E-07
38.68	1.868	1.099	1.875	158	4.71E-03	3.52E-04	1.63E-07
77.38	1.847	1.076	1.858	34	2.15E-02	2.86E-04	6.02E-07
19.25	1.857	1.087	1.852				
4.75	1.866	1.097	1.862				
19.25	1.860	1.090	1.863	29	2.54E-02	2.18E-04	5.42E-07
77.38	1.844	1.072	1.852	31	2.35E-02	1.45E-04	3.33E-07
116.07	1.831	1.058	1.838	23	3.11E-02	1.77E-04	5.39E-07
154.68	1.820	1.045	1.826	60	1.18E-02	1.50E-04	1.73E-07
309.16	1.775	0.995	1.798	85	8.06E-03	1.53E-04	1.21E-07
618.45	1.684	0.893	1.730	124	5.11E-03	1.55E-04	7.76E-08
1237.35	1.560	0.753	1.622	225	2.48E-03	1.05E-04	2.56E-08
2472.95	1.451	0.631	1.506	171	2.81E-03	4.64E-05	1.28E-08
1237.35	1.463	0.644	1.457				
309.16	1.487	0.671	1.475				
77.38	1.520	0.708	1.504				
19.25	1.560	0.753	1.540				
4.75	1.561	0.754	1.561				

Notes:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.56	Unit Weight, kN/m^3	20.41
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	15.60
Area, cm^2	31.67	Specific Gravity, measured	2.79
Volume, cm^3	49.44	Solids Height, cm	0.890
Water Content, %	30.87	Volume of Solids, cm^3	28.18
Wet Mass, g	102.89	Volume of Voids, cm^3	21.26
Dry Mass, g	78.62		

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Appendix E.

Site Photographs

Photo 1. Looking southwest from Castleford Road across Highway 17 towards Bruce Street. (2019/11/05)

Photo 2. Looking southeast towards Highway 17 and Bonnechere River valley. (2019/11/05)

Photo 3. Looking southwest along proposed Castleford Road alignment and towards Highway 17 intersection. Existing Castleford Road pictured to the left. (2019/11/26)

Photo 4. Looking southeast across Castleford Road towards existing Dugald Road and proposed E-N/S Ramp. (2019/11/26)

Photo 5. Looking northeast along proposed Bruce Street alignment and towards Highway 17 intersection. Existing Bruce Street pictured to the right. (2019/09/04)

Photo 6. Looking northeast along proposed Bruce Street alignment and towards Highway 17. (2019/09/04)

Photo 7. Looking northeast towards Garden of Eden Road and Highway 17 across proposed N-E Ramp site. (2020/11/19)

Photo 8. Looking northeast across Highway 17 toward proposed E-NS Ramp alignment. (2020/11/19)

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Appendix F.

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: 45.498N 76.671W **User File Reference:** Bruce Street Underpass 2021-11-09 20:49 UT

Requested by: Thurber Engineering Ltd.

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)	0.360	0.184	0.105	0.031
Sa (0.1)	0.427	0.229	0.138	0.045
Sa (0.2)	0.356	0.199	0.123	0.043
Sa (0.3)	0.271	0.155	0.098	0.035
Sa (0.5)	0.193	0.113	0.072	0.026
Sa (1.0)	0.098	0.059	0.038	0.013
Sa (2.0)	0.048	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)	0.229	0.126	0.076	0.024
PGV (m/s)	0.161	0.090	0.055	0.017

Notes: Spectral (Sa(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

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Appendix G.

Comparison of Foundation Alternatives

Preliminary General Arrangement (Structural Planning Report, 2003)

Preliminary General Arrangement (Parsons, 2021)

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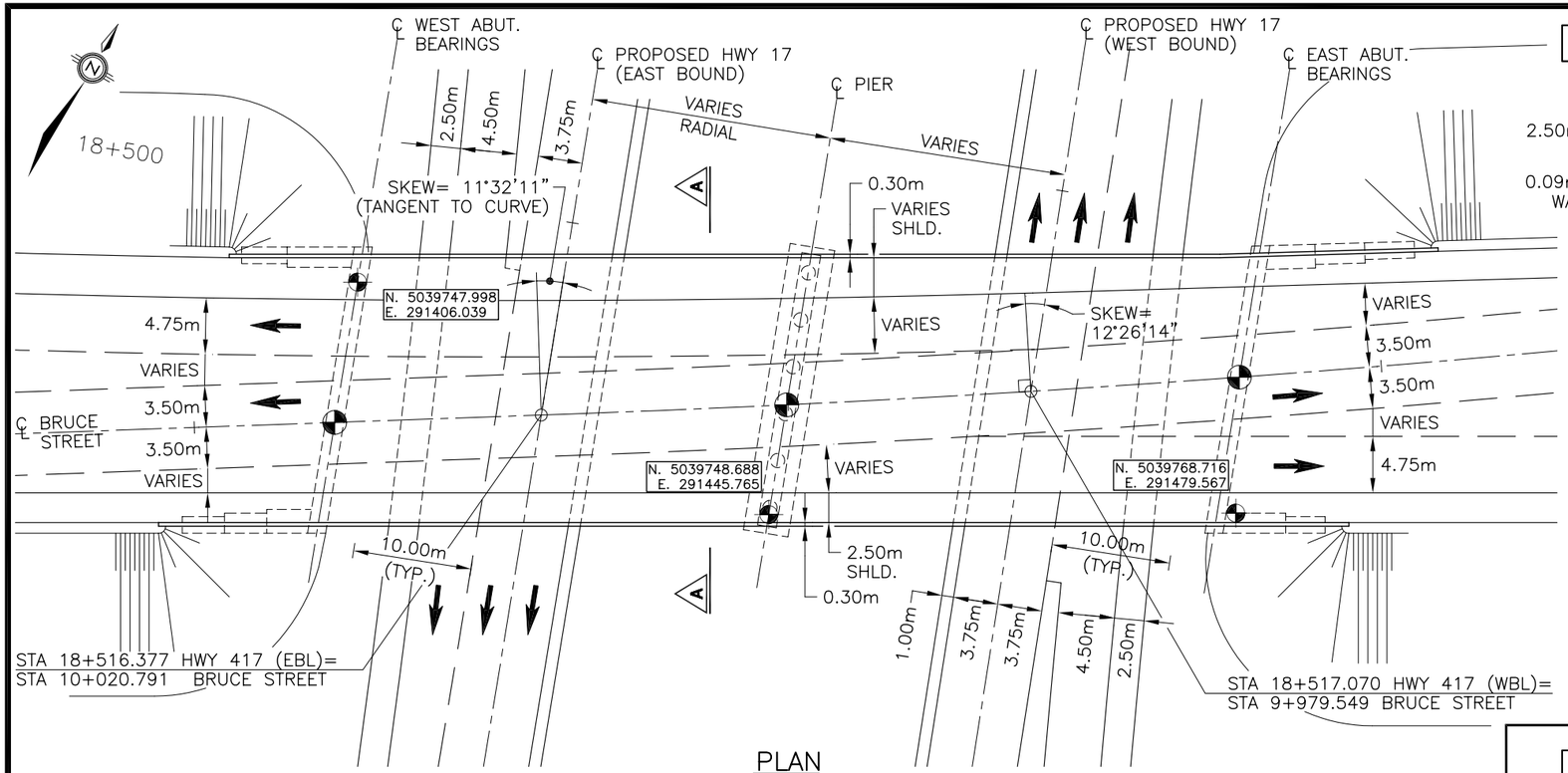
COMPARISON OF BRIDGE FOUNDATION ALTERNATIVES

Shallow Foundation	Caisson (Drilled Shafts)	Driven Steel Piles
Advantages		
Requires less specialized construction equipment	Higher geotechnical resistance than spread footings and steel piles Construction can continue in winter weather conditions Requires minimal excavation (installed from ground surface)	Higher geotechnical capacity than spread footings Construction can continue in winter weather conditions Requires less concrete than spread footings or caissons Likely requires less dewatering effort Allows for integral abutments Requires minimal excavation (installed from ground surface)
Disadvantages		
Requires large excavations, extending below groundwater table Lower geotechnical resistance than deep foundations Less efficient for resistance to uplift or overturning Does not allow for integral abutments	Specialized installation measures such as equipment, liners and drilling mud will be required Difficulty in cleaning and inspecting base Does not allow for integral abutments	Lower geotechnical resistance than caissons Has potential to encounter obstructions in the till
Risk/Consequences		
Large Excavation Differential settlement Temporary Protection required to excavate into silty clay layer	Unbalanced pressure heads and base boiling in the submerged glacial till requires liners and/or mud Difficulties advancing through obstructions	Difficulties advancing through obstructions, design based on refusal in till
Relative Cost		
Moderate	High	Moderate to High
Recommendation		
Not Recommended for support of Abutments	**Not Recommended for support of Abutments or Wingwalls**	**Recommended for support of Abutments and Wingwalls**



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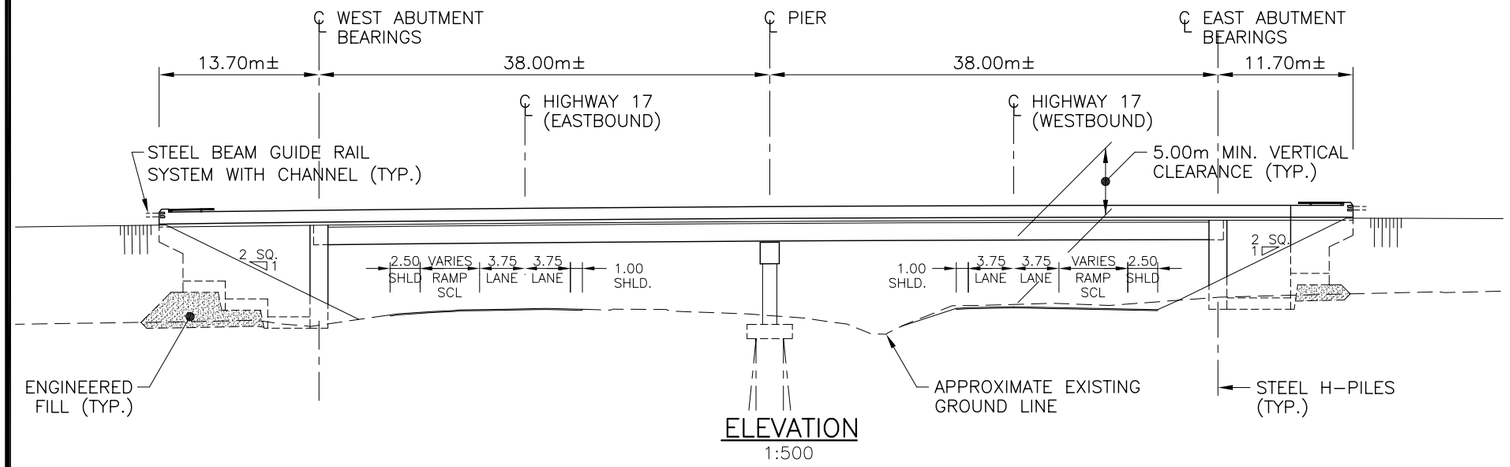

ELEVATION
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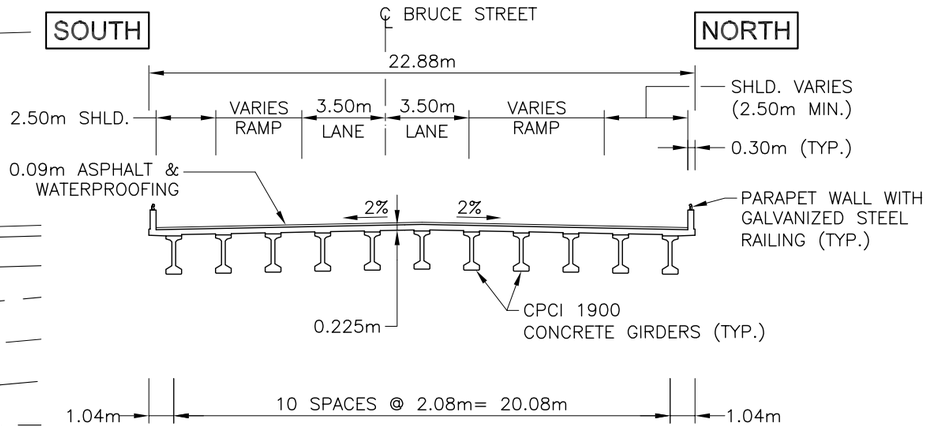


SECTION A–A
1:250

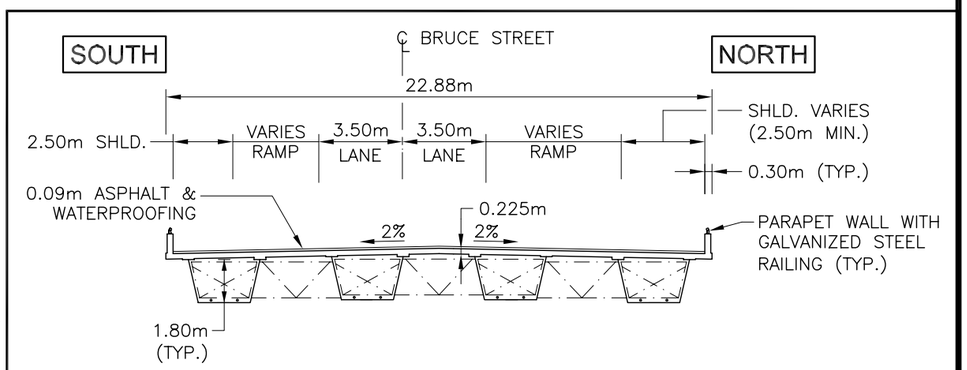
FOR SUGGESTED BOREHOLE LOCATIONS ONLY

LEGEND

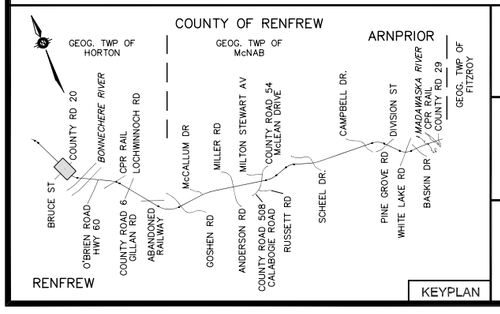
BOREHOLE LOCATION

N. 5031184.731
E. 316491.816
COORDINATES

PRELIMINARY



DECK CROSS SECTION
STEEL/CONCRETE COMPOSITE
FOUR–BOX GIRDER ALTERNATIVE
1:250



PRECAST PRESTRESSED GIRDER ALTERNATIVE (RECOMMENDED)

SCALE:

BRUCE STREET UNDERPASS

Ministry of Transportation

HIGHWAY 17 TWINNING, COUNTY ROAD 29 to 3.0 km WEST OF BRUCE STREET
PRELIMINARY DESIGN/ ENVIRONMENTAL ASSESSMENT STUDY
WP 647-92-00

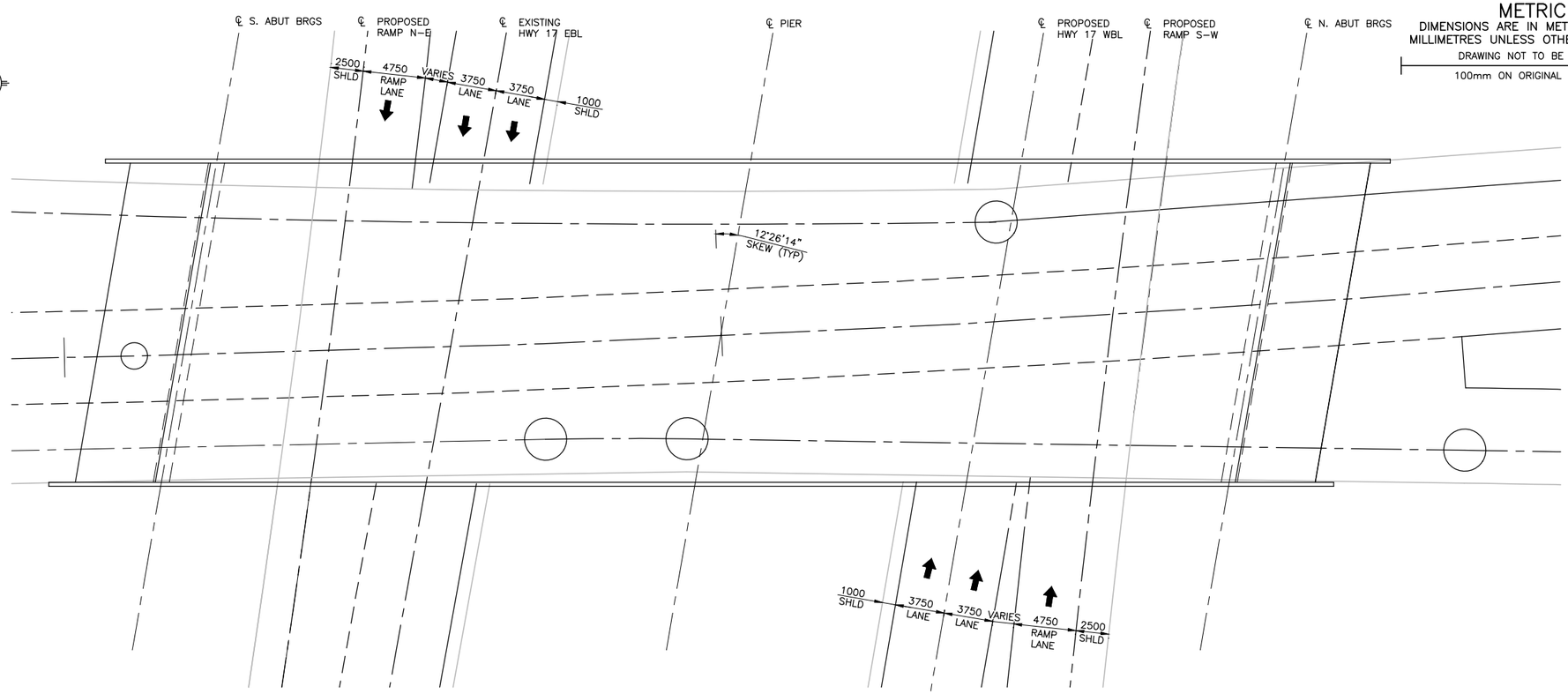
TSH engineers architects planners

Bruce_02.dwg – 11 Sep 2003 – 12:56:06

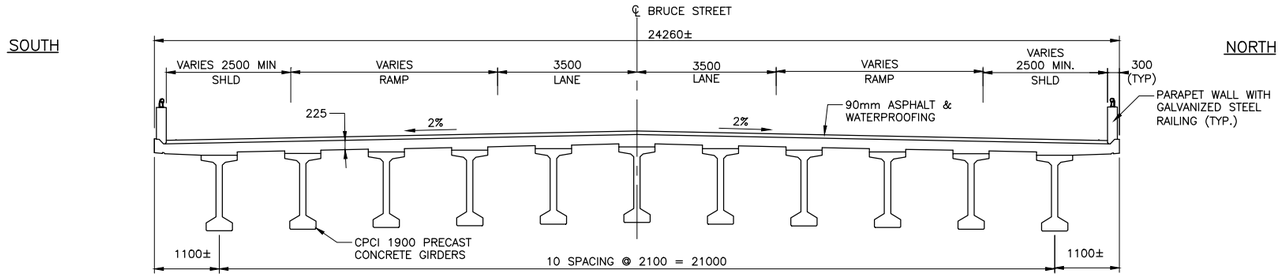
FOR CONSTRUCTION

MINISTRY OF TRANSPORTATION, ONTARIO ANSI-D 2017-08

FILE NAME: J:\TOR\477796 WO#24-P-3 Hwy 17 Twinning\5 General\8 Structural\1-CAD\Bruce Street Interchange _ GA.dwg
MODIFIED: 2021-06-14 15:42



PLAN
1:200



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1:50

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

PARSONS

CONT No –
WP –

HWY 17 TWINNING
BRUCE STREET UNDERPASS

GENERAL ARRANGEMENT

SHEET –

REVISIONS	NO	DATE	BY	DESCRIPTION

DESIGN	AL	CHK		CODE CAN/CSA S6-14	LOAD CL-625-ONT	DATE	
DRAWN	FP	CHK	AL	SITE 29x-0408/B1		DWG	

DOCUMENT CODE:

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Appendix H.

P-y Curves

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L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Abutments
Static Conditions

GENERAL NOTES

- **The values P(kN/m) represent soil reaction per metre of pile length**
- **The values y(m) represent soil/pile deflection**
- **The underside of integral abutment CSP is at Elev. 148 m**
- **The p-y data provided is unfactored. Lateral resistance or deflection calculated based on these parameters should be factored using the geotechnical resistance factors (ϕ_{gu} and ϕ_{gs}) provided in Table 6.2 of the CHBDC (S6-19)**
- **If lateral spacing between adjacent piles is less than four equivalent pile diameters, suitable reduction factors based on center to center spacing should be applied based on Figures C6.22, C6.33, and C6.24 of the CHBDC (S6-19)**

Soil Type	Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)	
Depth (m)	1		2		3		4		5		6		7		8		9	
Elev. (m)	147		146		145		144		143		142		141		140		139	
	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6
	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2
	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8
	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4
S	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0
T	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6
A	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2
T	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8
I	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4
C	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0
	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6
	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2
	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8
	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4
	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0
	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0

Soil Type	Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)	
Depth (m)	10		11		12		13		14		15		16		17		18	
Elev. (m)	138		137		136		135		134		133		132		131		130	
	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	16.7	0.0000	14.9	0.0000	13.0	0.0000	11.2	0.0000	11.2
	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	33.5	0.0000	29.8	0.0000	26.0	0.0000	22.3	0.0000	22.3
	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	50.2	0.0001	44.6	0.0001	39.1	0.0001	33.5	0.0001	33.5
	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0004	67.0	0.0004	59.5	0.0004	52.1	0.0004	44.6	0.0004	44.6
S	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0011	83.7	0.0011	74.4	0.0011	65.1	0.0011	55.8	0.0011	55.8
T	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0022	100.4	0.0022	89.3	0.0022	78.1	0.0022	67.0	0.0022	67.0
A	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0041	117.2	0.0041	104.2	0.0041	91.1	0.0041	78.1	0.0041	78.1
T	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0070	133.9	0.0070	119.0	0.0070	104.2	0.0070	89.3	0.0070	89.3
I	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0112	150.7	0.0112	133.9	0.0112	117.2	0.0112	100.4	0.0112	100.4
C	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0171	167.4	0.0171	148.8	0.0171	130.2	0.0171	111.6	0.0171	111.6
	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0251	184.1	0.0251	163.7	0.0251	143.2	0.0251	122.8	0.0251	122.8
C	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0356	200.9	0.0356	178.6	0.0356	156.2	0.0356	133.9	0.0356	133.9
t	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0490	217.6	0.0490	193.4	0.0490	169.3	0.0490	145.1	0.0490	145.1
d	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0659	234.4	0.0659	208.3	0.0659	182.3	0.0659	156.2	0.0659	156.2
.	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0868	251.1	0.0868	223.2	0.0868	195.3	0.0868	167.4	0.0868	167.4
	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.1085	251.1	0.1085	223.2	0.1085	195.3	0.1085	167.4	0.1085	167.4

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L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Abutments
Static Conditions

Soil Type	Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)	
Depth (m)	19		20		21		22		23		24		25		26		27	
Elev. (m)	129		128		127		126		125		124		123		122		121	
STATIC Ctd.	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0000	11.2	0.0000	11.2	0.0000	11.2	0.0000	11.2	0.0000	11.2	0.0000	12.6	0.0000	14.1	0.0000	15.6	0.0000	17.1
	0.0000	22.3	0.0000	22.3	0.0000	22.3	0.0000	22.3	0.0000	22.3	0.0000	25.3	0.0000	28.3	0.0000	31.2	0.0000	34.2
	0.0001	33.5	0.0001	33.5	0.0001	33.5	0.0001	33.5	0.0001	33.5	0.0001	37.9	0.0001	42.4	0.0001	46.9	0.0001	51.3
	0.0004	44.6	0.0004	44.6	0.0004	44.6	0.0004	44.6	0.0004	44.6	0.0004	50.6	0.0004	56.5	0.0004	62.5	0.0004	68.4
	0.0011	55.8	0.0011	55.8	0.0011	55.8	0.0011	55.8	0.0011	55.8	0.0011	63.2	0.0011	70.7	0.0011	78.1	0.0011	85.6
	0.0022	67.0	0.0022	67.0	0.0022	67.0	0.0022	67.0	0.0022	67.0	0.0022	75.9	0.0022	84.8	0.0022	93.7	0.0022	102.7
	0.0041	78.1	0.0041	78.1	0.0041	78.1	0.0041	78.1	0.0041	78.1	0.0041	88.5	0.0041	99.0	0.0041	109.4	0.0041	119.8
	0.0070	89.3	0.0070	89.3	0.0070	89.3	0.0070	89.3	0.0070	89.3	0.0070	101.2	0.0070	113.1	0.0070	125.0	0.0070	136.9
	0.0112	100.4	0.0112	100.4	0.0112	100.4	0.0112	100.4	0.0112	100.4	0.0112	113.8	0.0112	127.2	0.0112	140.6	0.0112	154.0
	0.0171	111.6	0.0171	111.6	0.0171	111.6	0.0171	111.6	0.0171	111.6	0.0171	126.5	0.0171	141.4	0.0171	156.2	0.0171	171.1
	0.0251	122.8	0.0251	122.8	0.0251	122.8	0.0251	122.8	0.0251	122.8	0.0251	139.1	0.0251	155.5	0.0251	171.9	0.0251	188.2
	0.0356	133.9	0.0356	133.9	0.0356	133.9	0.0356	133.9	0.0356	133.9	0.0356	151.8	0.0356	169.6	0.0356	187.5	0.0356	205.3
	0.0490	145.1	0.0490	145.1	0.0490	145.1	0.0490	145.1	0.0490	145.1	0.0490	164.4	0.0490	183.8	0.0490	203.1	0.0490	222.5
	0.0659	156.2	0.0659	156.2	0.0659	156.2	0.0659	156.2	0.0659	156.2	0.0659	177.1	0.0659	197.9	0.0659	218.7	0.0659	239.6
	0.0868	167.4	0.0868	167.4	0.0868	167.4	0.0868	167.4	0.0868	167.4	0.0868	189.7	0.0868	212.0	0.0868	234.4	0.0868	256.7
	0.1085	167.4	0.1085	167.4	0.1085	167.4	0.1085	167.4	0.1085	167.4	0.1085	189.7	0.1085	212.0	0.1085	234.4	0.1085	256.7

Soil Type	Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)	
Depth (m)	28		29		30		31		32		33		34		35		36	
Elev. (m)	120		119		118		117		116		115		114		113		112	
STATIC Ctd.	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0030	946.0	0.0030	983.3	0.0030	1007.9	0.0030	1032.4	0.0030	1057.0
	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0060	1660.1	0.0060	1725.6	0.0060	1768.7	0.0060	1811.9	0.0060	1855.0
	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0090	2093.1	0.0091	2175.7	0.0090	2230.1	0.0090	2284.5	0.0090	2338.8
	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0119	2321.7	0.0121	2413.3	0.0120	2473.6	0.0120	2534.0	0.0120	2594.3
	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0149	2433.6	0.0151	2529.6	0.0151	2592.9	0.0150	2656.1	0.0150	2719.3
	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0179	2486.4	0.0181	2584.5	0.0181	2649.1	0.0180	2713.7	0.0180	2778.2
	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0209	2510.8	0.0211	2609.9	0.0211	2675.1	0.0210	2740.3	0.0210	2805.5
	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0239	2522.0	0.0242	2621.5	0.0241	2687.0	0.0240	2752.6	0.0240	2818.1
	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0269	2527.2	0.0272	2626.8	0.0271	2692.5	0.0270	2758.2	0.0270	2823.8
	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0299	2529.5	0.0302	2629.3	0.0301	2695.0	0.0301	2760.7	0.0300	2826.4
	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0328	2530.6	0.0332	2630.4	0.0331	2696.1	0.0331	2761.9	0.0330	2827.6
	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0358	2531.1	0.0362	2630.9	0.0361	2696.7	0.0361	2762.4	0.0360	2828.2
	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0388	2531.3	0.0392	2631.1	0.0392	2696.9	0.0391	2762.6	0.0390	2828.4
	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0418	2531.4	0.0423	2631.2	0.0422	2697.0	0.0421	2762.8	0.0420	2828.5
	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0448	2531.4	0.0453	2631.3	0.0452	2697.0	0.0451	2762.8	0.0450	2828.6
	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0478	2531.5	0.0483	2631.3	0.0482	2697.1	0.0481	2762.8	0.0480	2828.6

THURBER

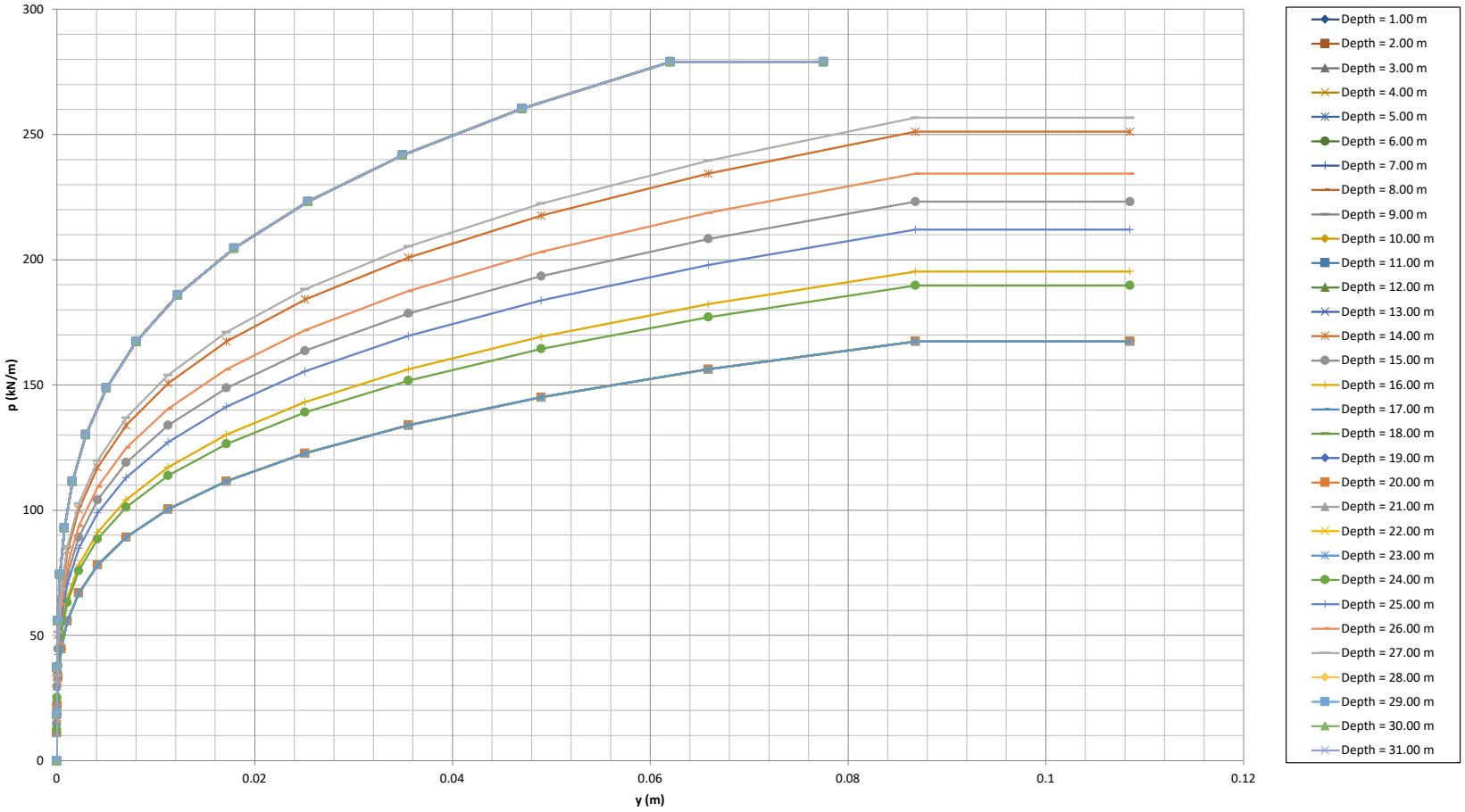
L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Abutments
Static Conditions

Soil Type	Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Silty Sand and Gravel (Below WT)		Silty Sand and Gravel (Below WT)		Silty Sand and Gravel (Below WT)	
Depth (m)	**37**		**38**		**39**		**40**		**41**		**42**		**43**		**44**		**45**	
Elev. (m)	**111**		**110**		**109**		**108**		**107**		**106**		**105**		**104**		**103**	
STATIC Ctd.	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0030	1081.6	0.0030	1106.2	0.0030	1130.7	0.0030	1155.3	0.0030	1179.9	0.0023	1642.0	0.0023	2316.8	0.0023	2379.6	0.0023	2442.5
	0.0060	1898.1	0.0060	1941.2	0.0060	1984.4	0.0060	2027.5	0.0059	2070.6	0.0047	2881.6	0.0045	4065.9	0.0045	4176.1	0.0046	4286.4
	0.0090	2393.2	0.0090	2447.6	0.0089	2502.0	0.0089	2556.3	0.0089	2610.7	0.0070	3633.3	0.0068	5126.4	0.0068	5265.4	0.0068	5404.4
	0.0120	2654.6	0.0119	2714.9	0.0119	2775.2	0.0119	2835.5	0.0119	2895.8	0.0094	4030.1	0.0090	5686.3	0.0091	5840.5	0.0091	5994.6
	0.0150	2782.5	0.0149	2845.7	0.0149	2909.0	0.0149	2972.2	0.0149	3035.4	0.0117	4224.3	0.0113	5960.4	0.0113	6122.0	0.0114	6283.6
	0.0180	2842.8	0.0179	2907.4	0.0179	2972.0	0.0179	3036.6	0.0178	3101.2	0.0140	4315.9	0.0135	6089.6	0.0136	6254.7	0.0137	6419.8
	0.0210	2870.8	0.0209	2936.0	0.0209	3001.2	0.0208	3066.4	0.0208	3131.7	0.0164	4358.2	0.0158	6149.4	0.0159	6316.1	0.0159	6482.8
	0.0239	2883.6	0.0239	2949.1	0.0239	3014.6	0.0238	3080.1	0.0238	3145.7	0.0187	4377.7	0.0180	6176.8	0.0181	6344.3	0.0182	6511.8
	0.0269	2889.5	0.0269	2955.1	0.0268	3020.8	0.0268	3086.4	0.0267	3152.1	0.0211	4386.6	0.0203	6189.4	0.0204	6357.2	0.0205	6525.0
	0.0299	2892.1	0.0299	2957.8	0.0298	3023.6	0.0298	3089.3	0.0297	3155.0	0.0234	4390.7	0.0225	6195.1	0.0227	6363.1	0.0228	6531.1
	0.0329	2893.4	0.0329	2959.1	0.0328	3024.8	0.0327	3090.6	0.0327	3156.3	0.0258	4392.5	0.0248	6197.8	0.0249	6365.8	0.0250	6533.8
	0.0359	2893.9	0.0358	2959.7	0.0358	3025.4	0.0357	3091.2	0.0357	3156.9	0.0281	4393.4	0.0270	6199.0	0.0272	6367.0	0.0273	6535.1
	0.0389	2894.2	0.0388	2959.9	0.0388	3025.7	0.0387	3091.4	0.0386	3157.2	0.0304	4393.8	0.0293	6199.5	0.0294	6367.6	0.0296	6535.7
	0.0419	2894.3	0.0418	2960.0	0.0417	3025.8	0.0417	3091.6	0.0416	3157.3	0.0328	4393.9	0.0315	6199.8	0.0317	6367.8	0.0319	6535.9
	0.0449	2894.3	0.0448	2960.1	0.0447	3025.9	0.0446	3091.6	0.0446	3157.4	0.0351	4394.0	0.0338	6199.9	0.0340	6368.0	0.0342	6536.0
	0.0479	2894.4	0.0478	2960.1	0.0477	3025.9	0.0476	3091.6	0.0475	3157.4	0.0375	4394.1	0.0360	6199.9	0.0362	6368.0	0.0364	6536.1

Soil Type	Silty Sand and Gravel (Below WT)		Silty Sand and Gravel (Below WT)	
Depth (m)	**46**		**47**	
Elev. (m)	**102**		**101**	
STATIC Ctd.	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0
	0.0023	2505.3	0.0023	2568.1
	0.0046	4396.6	0.0046	4506.8
	0.0069	5543.4	0.0069	5682.4
	0.0092	6148.8	0.0092	6303.0
	0.0114	6445.2	0.0115	6606.8
	0.0137	6584.9	0.0138	6750.0
	0.0160	6649.5	0.0161	6816.3
	0.0183	6679.2	0.0184	6846.7
	0.0206	6692.8	0.0207	6860.6
	0.0229	6699.0	0.0230	6867.0
	0.0252	6701.9	0.0253	6869.9
	0.0275	6703.2	0.0276	6871.2
	0.0298	6703.7	0.0299	6871.8
	0.0320	6704.0	0.0322	6872.1
	0.0343	6704.1	0.0345	6872.2
	0.0366	6704.2	0.0368	6872.3

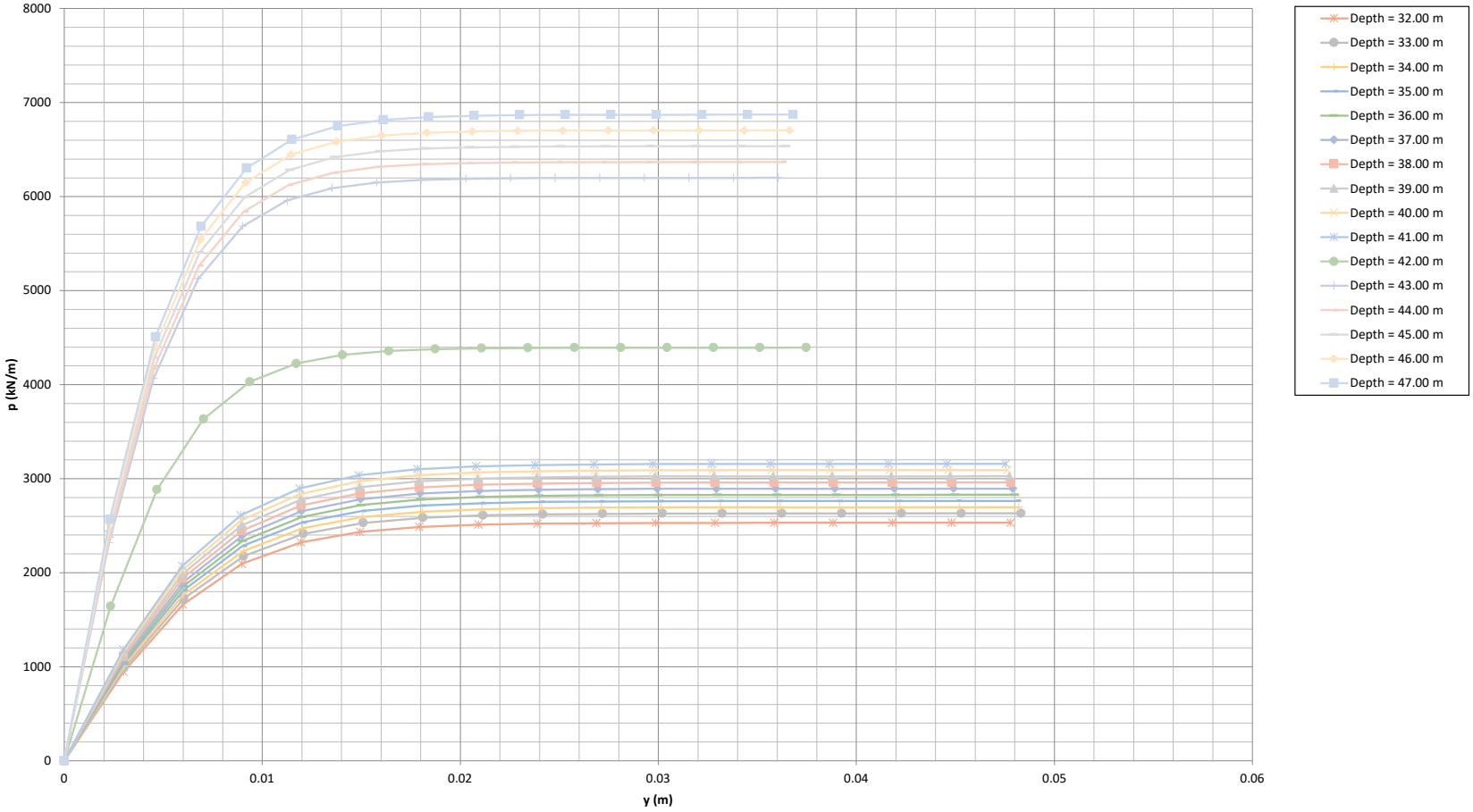
THURBER

L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Abutments
Static Conditions



THURBER

L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Abutments
Static Conditions



THURBER

L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Pier
Static Conditions

GENERAL NOTES

- **The values P(kN/m) represent soil reaction per metre of pile length**
- **The values y(m) represent soil/pile deflection**
- **The underside of the pier pile cap is at Elev. 148 m**
- **The p-y data provided is unfactored. Lateral resistance or deflection calculated based on these parameters should be factored using the geotechnical resistance factors (ϕ_{gu} and ϕ_{gs}) provided in Table 6.2 of the CHBDC (S6-19)**
- **If lateral spacing between adjacent piles is less than four equivalent pile diameters, suitable reduction factors based on center to center spacing should be applied based on Figures C6.22, C6.33, and C6.24 of the CHBDC (S6-19)**

Soil Type	Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)	
Depth (m)	1		2		3		4		5		6		7		8		9	
Elev. (m)	147		146		145		144		143		142		141		140		139	
	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
STATIC	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
	0.0000	12.4	0.0000	15.9	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6
	0.0000	24.7	0.0000	31.8	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2
	0.0001	37.1	0.0001	47.7	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8
	0.0003	49.4	0.0003	63.6	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4
	0.0008	61.8	0.0008	79.5	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0
	0.0016	74.2	0.0016	95.4	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6
	0.0029	86.5	0.0029	111.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2
	0.0050	98.9	0.0050	127.1	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8
	0.0080	111.2	0.0080	143.0	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4
	0.0122	123.6	0.0122	158.9	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0
	0.0179	136.0	0.0179	174.8	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6
	0.0254	148.3	0.0254	190.7	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2
	0.0350	160.7	0.0350	206.6	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8
	0.0470	173.1	0.0470	222.5	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4
	0.0620	185.4	0.0620	238.4	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0
	0.0775	185.4	0.0775	238.4	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0

Soil Type	Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)	
Depth (m)	10		11		12		13		14		15		16		17		18	
Elev. (m)	138		137		136		135		134		133		132		131		130	
	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
STATIC Ctd.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	16.7	0.0000	14.9	0.0000	13.0	0.0000	11.2	0.0000	11.2
	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	33.5	0.0000	29.8	0.0000	26.0	0.0000	22.3	0.0000	22.3
	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	50.2	0.0001	44.6	0.0001	39.1	0.0001	33.5	0.0001	33.5
	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0004	67.0	0.0004	59.5	0.0004	52.1	0.0004	44.6	0.0004	44.6
	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0011	83.7	0.0011	74.4	0.0011	65.1	0.0011	55.8	0.0011	55.8
	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0022	100.4	0.0022	89.3	0.0022	78.1	0.0022	67.0	0.0022	67.0
	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0041	117.2	0.0041	104.2	0.0041	91.1	0.0041	78.1	0.0041	78.1
	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0070	133.9	0.0070	119.0	0.0070	104.2	0.0070	89.3	0.0070	89.3
	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0112	150.7	0.0112	133.9	0.0112	117.2	0.0112	100.4	0.0112	100.4
	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0171	167.4	0.0171	148.8	0.0171	130.2	0.0171	111.6	0.0171	111.6
	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0251	184.1	0.0251	163.7	0.0251	143.2	0.0251	122.8	0.0251	122.8
	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0356	200.9	0.0356	178.6	0.0356	156.2	0.0356	133.9	0.0356	133.9
	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0490	217.6	0.0490	193.4	0.0490	169.3	0.0490	145.1	0.0490	145.1
	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0659	234.4	0.0659	208.3	0.0659	182.3	0.0659	156.2	0.0659	156.2
	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0868	251.1	0.0868	223.2	0.0868	195.3	0.0868	167.4	0.0868	167.4
	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.1085	251.1	0.1085	223.2	0.1085	195.3	0.1085	167.4	0.1085	167.4

THURBER

L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Pier
Static Conditions

Soil Type	Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)	
Depth (m)	**19**		**20**		**21**		**22**		**23**		**24**		**25**		**26**		**27**	
Elev. (m)	**129**		**128**		**127**		**126**		**125**		**124**		**123**		**122**		**121**	
STATIC Ctd.	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0000	11.2	0.0000	11.2	0.0000	11.2	0.0000	11.2	0.0000	9.6	0.0000	10.2	0.0000	10.9	0.0000	11.5	0.0000	12.2
	0.0000	22.3	0.0000	22.3	0.0000	22.3	0.0000	22.3	0.0001	19.2	0.0001	20.5	0.0001	21.8	0.0001	23.1	0.0001	24.4
	0.0001	33.5	0.0001	33.5	0.0001	33.5	0.0001	33.5	0.0002	28.8	0.0002	30.7	0.0002	32.7	0.0002	34.6	0.0002	36.6
	0.0004	44.6	0.0004	44.6	0.0004	44.6	0.0004	44.6	0.0006	38.4	0.0006	41.0	0.0006	43.6	0.0006	46.2	0.0006	48.8
	0.0011	55.8	0.0011	55.8	0.0011	55.8	0.0011	55.8	0.0011	48.0	0.0011	51.2	0.0011	54.5	0.0011	57.7	0.0011	61.0
	0.0022	67.0	0.0022	67.0	0.0022	67.0	0.0022	67.0	0.0020	57.6	0.0020	61.5	0.0020	65.4	0.0020	69.3	0.0020	73.2
	0.0041	78.1	0.0041	78.1	0.0041	78.1	0.0041	78.1	0.0032	67.2	0.0032	71.7	0.0032	76.3	0.0032	80.8	0.0032	85.4
	0.0070	89.3	0.0070	89.3	0.0070	89.3	0.0070	89.3	0.0047	76.8	0.0047	82.0	0.0047	87.1	0.0047	92.4	0.0047	97.6
	0.0112	100.4	0.0112	100.4	0.0112	100.4	0.0112	100.4	0.0067	86.4	0.0067	92.2	0.0067	98.0	0.0067	103.9	0.0067	109.7
	0.0171	111.6	0.0171	111.6	0.0171	111.6	0.0171	111.6	0.0092	95.9	0.0092	102.4	0.0092	108.9	0.0092	115.4	0.0092	121.9
	0.0251	122.8	0.0251	122.8	0.0251	122.8	0.0251	122.8	0.0122	105.5	0.0122	112.7	0.0122	119.8	0.0122	127.0	0.0122	134.1
	0.0356	133.9	0.0356	133.9	0.0356	133.9	0.0356	133.9	0.0159	115.1	0.0159	122.9	0.0159	130.7	0.0159	138.5	0.0159	146.3
	0.0490	145.1	0.0490	145.1	0.0490	145.1	0.0490	145.1	0.0202	124.7	0.0202	133.2	0.0202	141.6	0.0202	150.1	0.0202	158.5
	0.0659	156.2	0.0659	156.2	0.0659	156.2	0.0659	156.2	0.0252	134.3	0.0252	143.4	0.0252	152.5	0.0252	161.6	0.0252	170.7
	0.0868	167.4	0.0868	167.4	0.0868	167.4	0.0868	167.4	0.0310	143.9	0.0310	153.7	0.0310	163.4	0.0310	173.2	0.0310	182.9
	0.1085	167.4	0.1085	167.4	0.1085	167.4	0.1085	167.4	0.0329	143.9	0.0329	153.7	0.0329	163.4	0.0329	173.2	0.0329	182.9

Soil Type	Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Silty Clay to Clayey Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)	
Depth (m)	**28**		**29**		**30**		**31**		**32**		**33**		**34**		**35**		**36**	
Elev. (m)	**120**		**119**		**118**		**117**		**116**		**115**		**114**		**113**		**112**	
STATIC Ctd.	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0000	18.6	0.0028	832.8	0.0028	857.4	0.0028	882.0	0.0028	906.6	0.0028	931.1
	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0000	37.2	0.0056	1461.6	0.0056	1504.7	0.0056	1547.8	0.0056	1591.0	0.0056	1634.1
	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0001	55.8	0.0084	1842.8	0.0084	1897.2	0.0084	1951.6	0.0084	2006.0	0.0083	2060.3
	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0003	74.4	0.0111	2044.1	0.0111	2104.4	0.0111	2164.7	0.0111	2225.0	0.0111	2285.3
	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0008	93.0	0.0139	2142.6	0.0139	2205.8	0.0139	2269.0	0.0139	2332.3	0.0139	2395.5
	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0016	111.6	0.0167	2189.0	0.0167	2253.6	0.0167	2318.2	0.0167	2382.8	0.0167	2447.4
	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0029	130.2	0.0195	2210.5	0.0195	2275.8	0.0195	2341.0	0.0195	2406.2	0.0195	2471.5
	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0050	148.8	0.0223	2220.4	0.0223	2285.9	0.0223	2351.5	0.0223	2417.0	0.0223	2482.5
	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0080	167.4	0.0251	2224.9	0.0251	2290.6	0.0251	2356.2	0.0251	2421.9	0.0250	2487.5
	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0122	186.0	0.0279	2227.0	0.0279	2292.7	0.0278	2358.4	0.0278	2424.1	0.0278	2489.8
	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0179	204.6	0.0306	2227.9	0.0306	2293.7	0.0306	2359.4	0.0306	2425.2	0.0306	2490.9
	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0254	223.2	0.0334	2228.4	0.0334	2294.1	0.0334	2359.9	0.0334	2425.6	0.0334	2491.4
	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0350	241.8	0.0362	2228.6	0.0362	2294.3	0.0362	2360.1	0.0362	2425.8	0.0362	2491.6
	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0470	260.4	0.0390	2228.7	0.0390	2294.4	0.0390	2360.2	0.0390	2425.9	0.0390	2491.7
	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0620	279.0	0.0418	2228.7	0.0418	2294.5	0.0418	2360.2	0.0418	2426.0	0.0417	2491.7
	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0775	279.0	0.0446	2228.7	0.0446	2294.5	0.0445	2360.2	0.0445	2426.0	0.0445	2491.8

THURBER

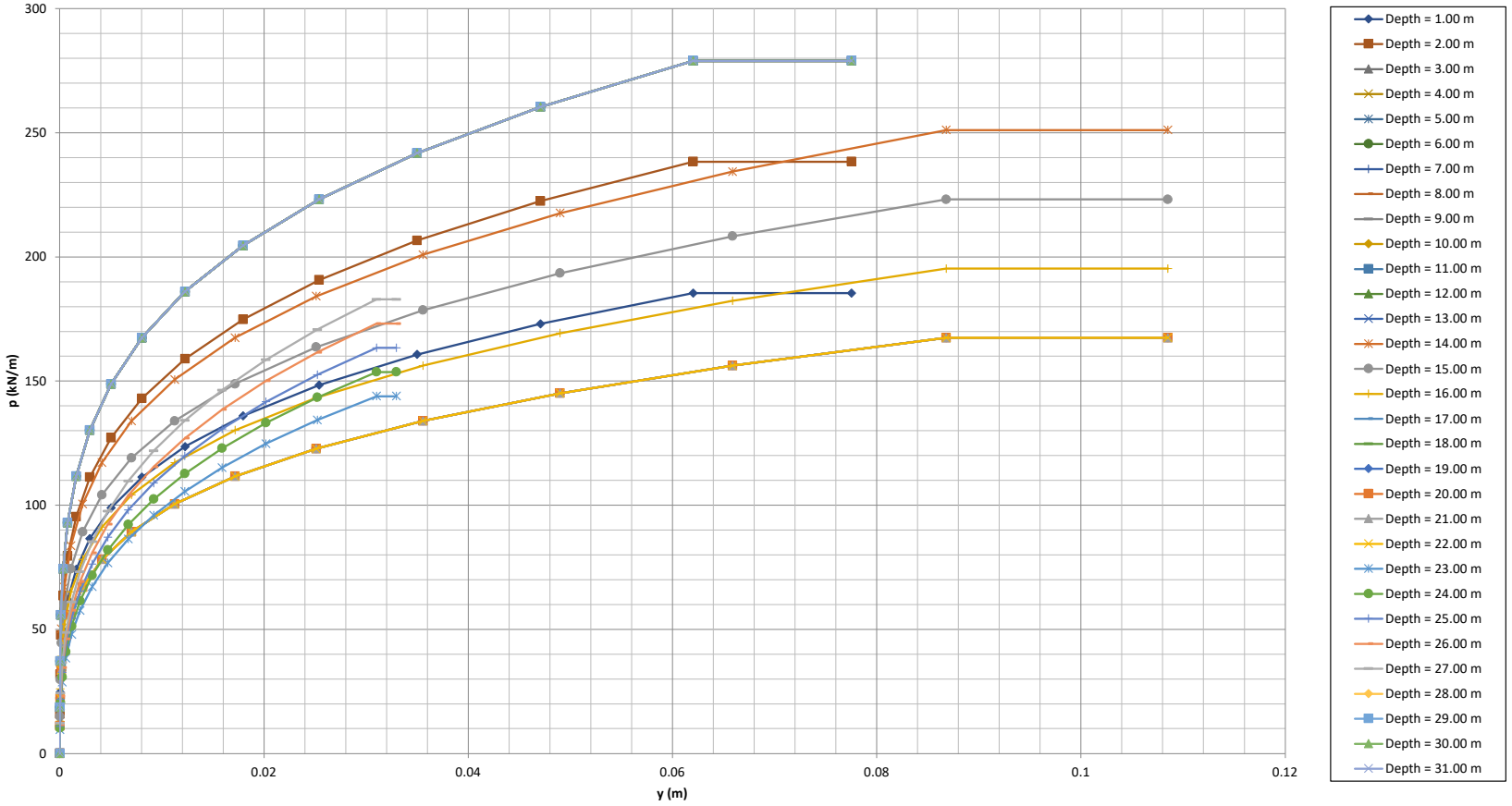
L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Pier
Static Conditions

Soil Type	Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Interlayered Sand, Silt (Below WT)		Silty Sand and Gravel (Below WT)		Silty Sand and Gravel (Below WT)		Silty Sand and Gravel (Below WT)	
Depth (m)	**37**		**38**		**39**		**40**		**41**		**42**		**43**		**44**		**45**	
Elev. (m)	**111**		**110**		**109**		**108**		**107**		**106**		**105**		**104**		**103**	
STATIC Ctd.	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.0028	955.7	0.0028	980.3	0.0028	1004.9	0.0028	1029.4	0.0028	1054.0	0.0022	1470.4	0.0021	2081.3	0.0021	2144.1	0.0021	2206.9
	0.0056	1677.2	0.0056	1720.3	0.0056	1763.5	0.0056	1806.6	0.0056	1849.7	0.0044	2580.5	0.0042	3652.5	0.0043	3762.8	0.0043	3873.0
	0.0083	2114.7	0.0083	2169.1	0.0083	2223.5	0.0083	2277.8	0.0083	2332.2	0.0066	3253.6	0.0063	4605.2	0.0064	4744.2	0.0064	4883.2
	0.0111	2345.7	0.0111	2406.0	0.0111	2466.3	0.0111	2526.6	0.0111	2586.9	0.0088	3608.9	0.0085	5108.2	0.0085	5262.3	0.0086	5416.5
	0.0139	2458.7	0.0139	2521.9	0.0139	2585.2	0.0139	2648.4	0.0139	2711.6	0.0110	3782.8	0.0106	5354.4	0.0107	5516.0	0.0107	5677.6
	0.0167	2512.0	0.0167	2576.6	0.0167	2641.2	0.0167	2705.8	0.0167	2770.4	0.0132	3864.8	0.0127	5470.4	0.0128	5635.5	0.0129	5800.6
	0.0195	2536.7	0.0195	2601.9	0.0195	2667.1	0.0195	2732.4	0.0195	2797.6	0.0154	3902.8	0.0148	5524.2	0.0149	5690.9	0.0150	5857.6
	0.0223	2548.0	0.0223	2613.5	0.0222	2679.0	0.0222	2744.6	0.0222	2810.1	0.0175	3920.2	0.0169	5548.8	0.0170	5716.3	0.0172	5883.8
	0.0250	2553.2	0.0250	2618.8	0.0250	2684.5	0.0250	2750.1	0.0250	2815.8	0.0197	3928.2	0.0190	5560.1	0.0192	5727.9	0.0193	5895.7
	0.0278	2555.6	0.0278	2621.3	0.0278	2687.0	0.0278	2752.7	0.0278	2818.4	0.0219	3931.8	0.0211	5565.3	0.0213	5733.2	0.0215	5901.2
	0.0306	2556.6	0.0306	2622.4	0.0306	2688.1	0.0306	2753.9	0.0306	2819.6	0.0241	3933.5	0.0233	5567.6	0.0234	5735.7	0.0236	5903.7
	0.0334	2557.1	0.0334	2622.9	0.0334	2688.6	0.0334	2754.4	0.0334	2820.1	0.0263	3934.3	0.0254	5568.7	0.0256	5736.8	0.0258	5904.8
	0.0362	2557.4	0.0362	2623.1	0.0361	2688.9	0.0361	2754.6	0.0361	2820.4	0.0285	3934.6	0.0275	5569.2	0.0277	5737.3	0.0279	5905.4
	0.0389	2557.5	0.0389	2623.2	0.0389	2689.0	0.0389	2754.7	0.0389	2820.5	0.0307	3934.8	0.0296	5569.4	0.0298	5737.5	0.0300	5905.6
	0.0417	2557.5	0.0417	2623.3	0.0417	2689.0	0.0417	2754.8	0.0417	2820.6	0.0329	3934.8	0.0317	5569.5	0.0320	5737.6	0.0322	5905.7
	0.0445	2557.5	0.0445	2623.3	0.0445	2689.1	0.0445	2754.8	0.0445	2820.6	0.0351	3934.9	0.0338	5569.6	0.0341	5737.7	0.0343	5905.8

Soil Type	Silty Sand and Gravel (Below WT)		Silty Sand and Gravel (Below WT)	
Depth (m)	**46**		**47**	
Elev. (m)	**102**		**101**	
STATIC Ctd.	y (m)	P (kN/m)	y (m)	P (kN/m)
	0	0	0	0
	0.0022	2269.7	0.0022	2332.5
	0.0043	3983.2	0.0043	4093.5
	0.0065	5022.2	0.0065	5161.2
	0.0086	5570.7	0.0087	5724.8
	0.0108	5839.2	0.0109	6000.8
	0.0130	5965.7	0.0130	6130.8
	0.0151	6024.3	0.0152	6191.1
	0.0173	6051.2	0.0174	6218.7
	0.0194	6063.6	0.0196	6231.4
	0.0216	6069.2	0.0217	6237.1
	0.0238	6071.7	0.0239	6239.8
	0.0259	6072.9	0.0261	6241.0
	0.0281	6073.4	0.0283	6241.5
	0.0302	6073.7	0.0304	6241.8
	0.0324	6073.8	0.0326	6241.9
	0.0346	6073.8	0.0348	6241.9

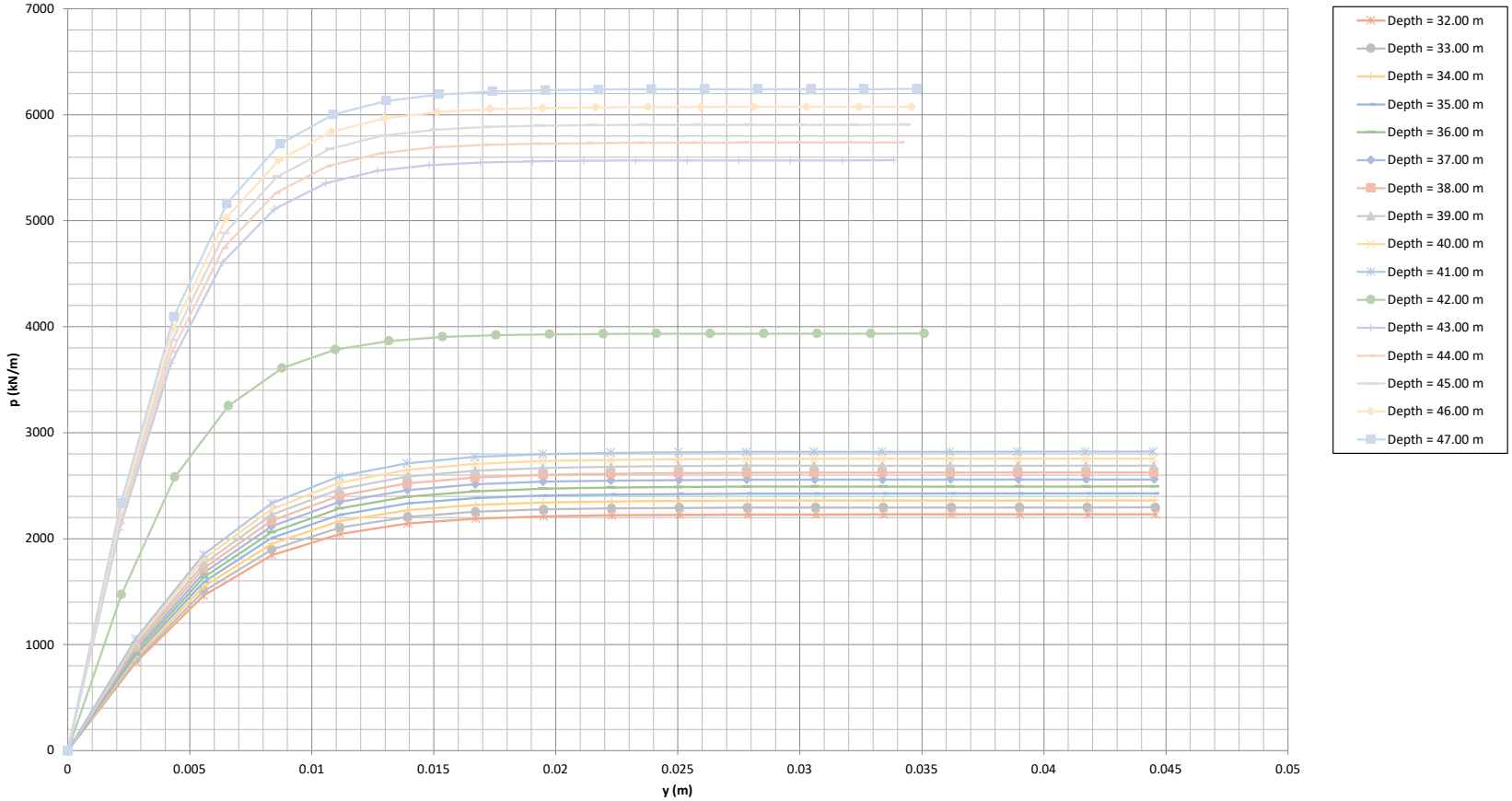
THURBER

L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Pier
Static Conditions



THURBER

L-Pile Data for P-Y Curves (310x110)
Bruce Street (County Road 20) Interchange
Bruce Street Underpass
Pier
Static Conditions



THURBER

Appendix I.

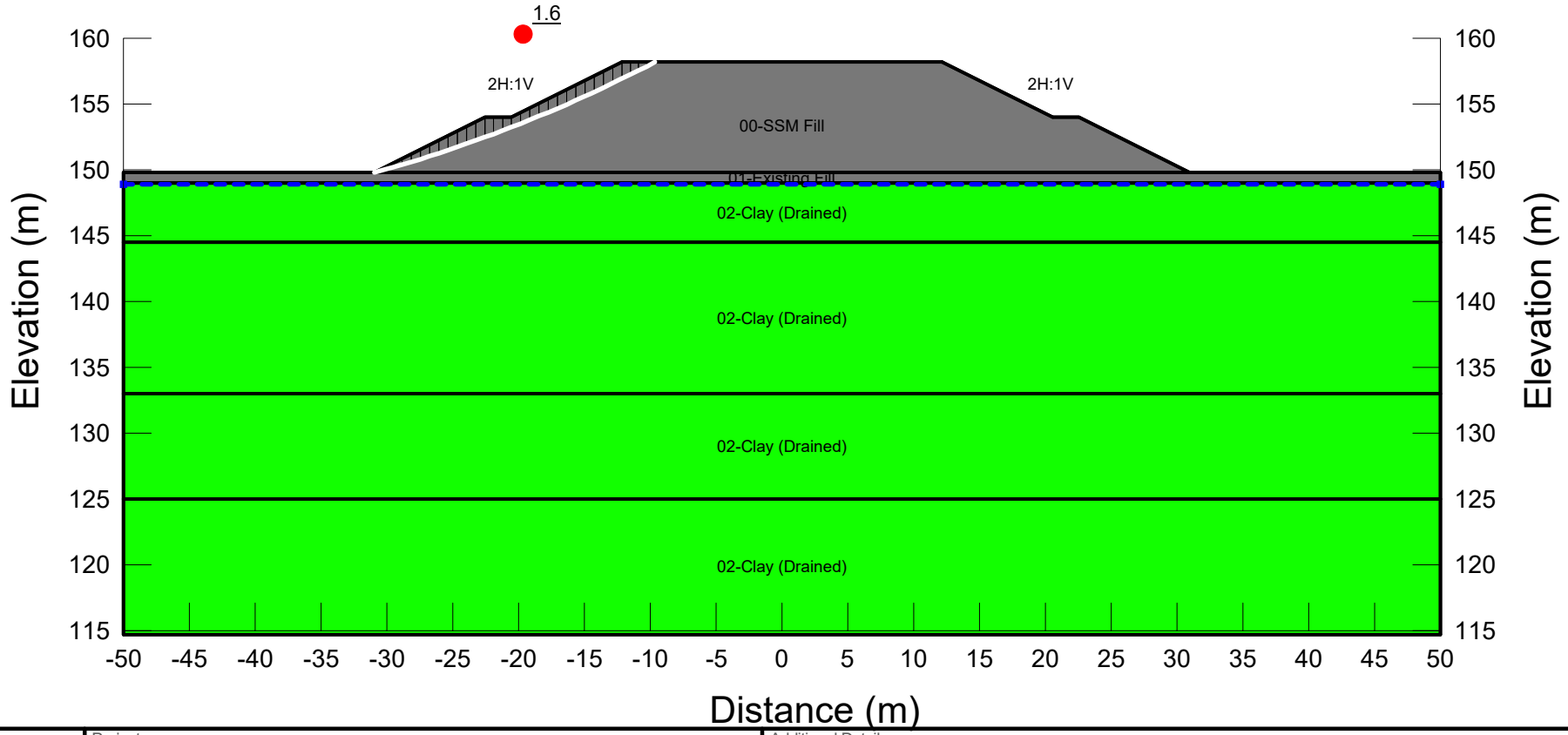
Design Profiles and Analysis Results

THURBER

Appendix I.1

Slope Stability Analysis Figures

Color	Name	Slope Stability Material Model	Unit Weight	Effective Cohesion	Effective Friction Angle
	00-SSM Fill	Mohr-Coulomb	21	0	32
	01-Existing Fill	Mohr-Coulomb	20	0	30
	02-Clay (Drained)	Mohr-Coulomb	17.5	5	28



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
01-Permanent (Long Term) (SSM)

Seismic Coefficient
H: g, V: g

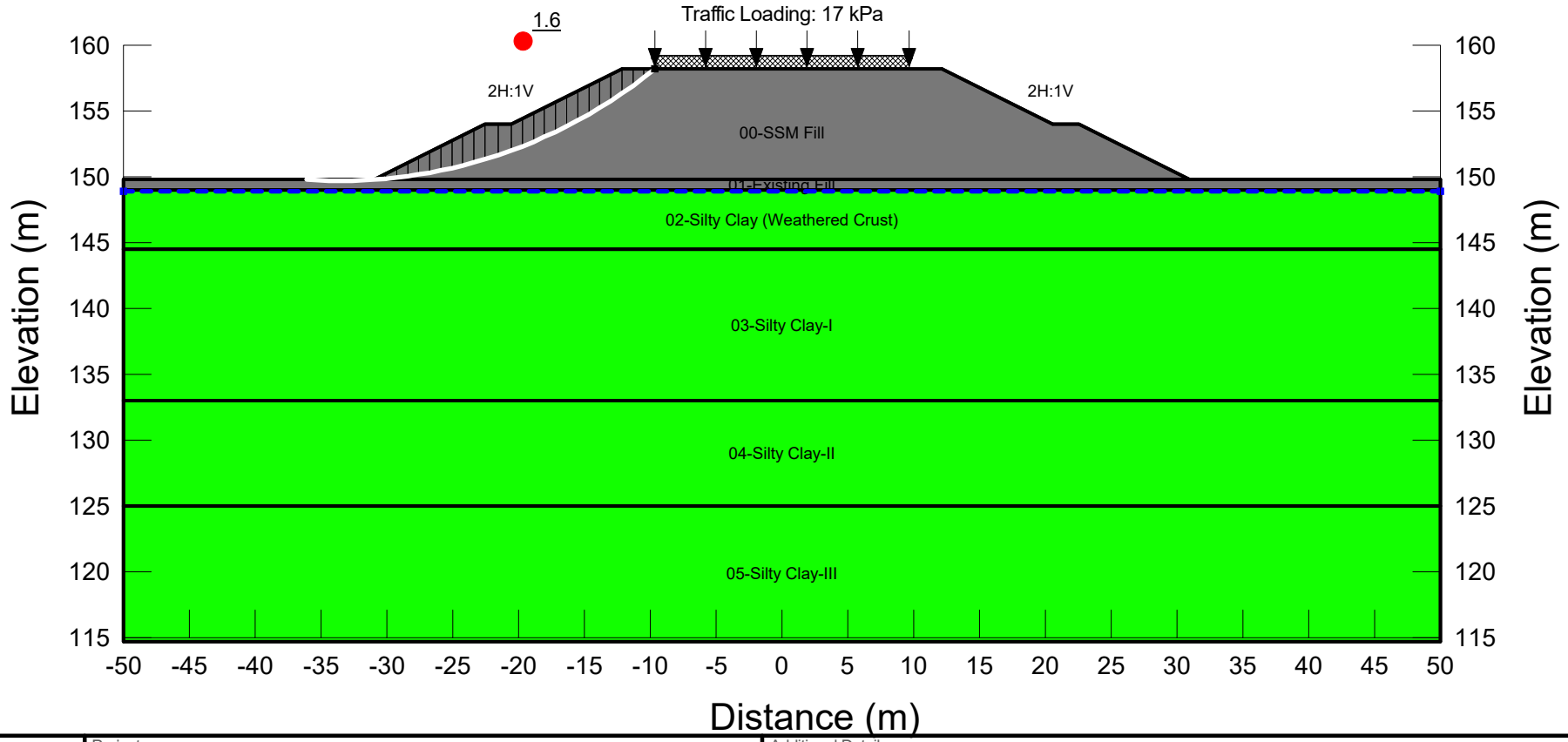
Last Run
03/24/2022, 03:21:25 PM

Scale
1:500

Additional Details
Name: Sta. 9+950, 2H:1V SSM Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-9.65, 158.2) m, Exit: (-30.95, 149.8) m
Center: (-58.755299, 251.51165) m, Radius: 105.4438 m

Figure I1.1

Color	Name	Slope Stability Material Model	Unit Weight	C-Datum	C-Rate of Change	C-Maximum	Datum (Elevation)	Total Cohesion	Effective Cohesion	Effective Friction Angle
	00-SSM Fill	Mohr-Coulomb	21						0	32
	01-Existing Fill	Mohr-Coulomb	20						0	30
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100		
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5			
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60		
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125			



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
02-Temp (Short Term)-Traffic (SSM)

Seismic Coefficient
H: g, V: g

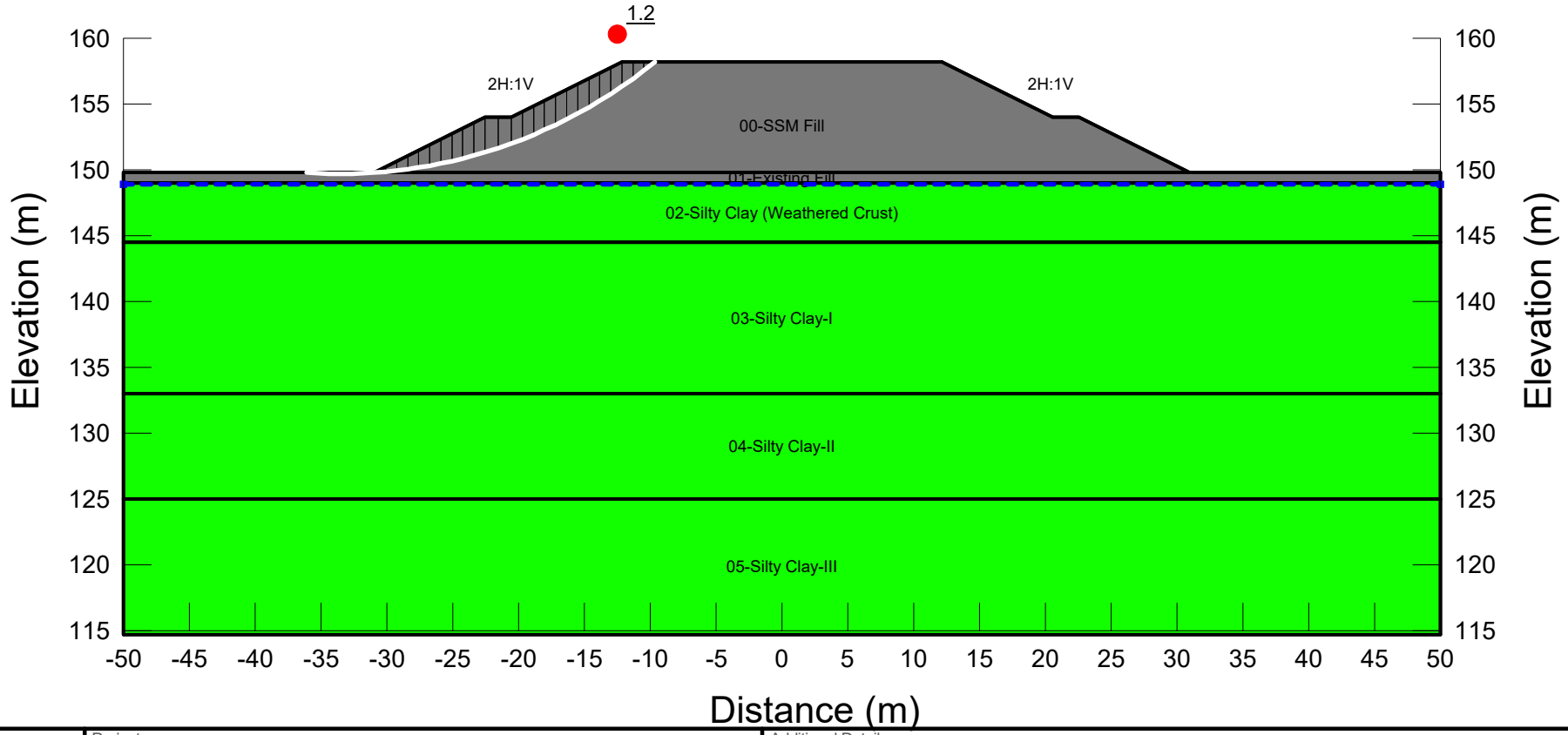
Last Run
03/24/2022, 03:21:15 PM

Scale
1:500

Additional Details
Name: Sta. 9+950, 2H:1V SSM Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-9.65, 158.2) m, Exit: (-36.103333, 149.8) m
Center: (-33.516277, 187.50633) m, Radius: 37.794975 m

Figure I1.2

Color	Name	Slope Stability Material Model	Unit Weight	C-Datum	C-Rate of Change	C-Maximum	Datum (Elevation)	Total Cohesion	Effective Cohesion	Effective Friction Angle
	00-SSM Fill	Mohr-Coulomb	21						0	32
	01-Existing Fill	Mohr-Coulomb	20						0	30
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100		
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5			
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60		
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125			



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
03-Temp (Short Term)-Pseudo-Static (2,475 yr. EQ) (SSM)

Seismic Coefficient
H: 0.13g, V: g

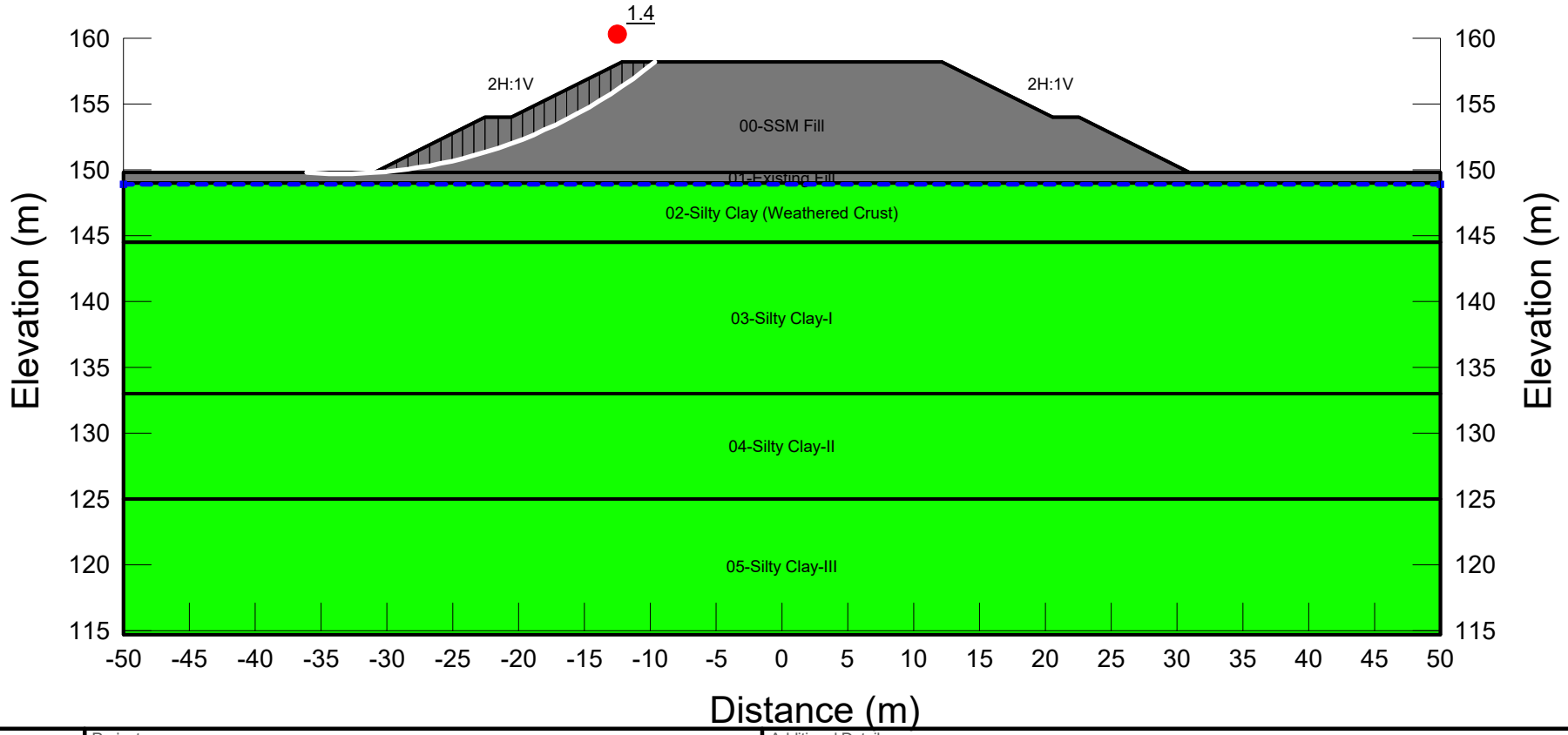
Last Run
03/24/2022, 03:22:05 PM

Scale
1:500

Additional Details
Name: Sta. 9+950, 2H:1V SSM Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-9.65, 158.2) m, Exit: (-36.103333, 149.8) m
Center: (-33.516277, 187.50633) m, Radius: 37.794975 m

Figure I1.3

Color	Name	Slope Stability Material Model	Unit Weight	C-Datum	C-Rate of Change	C-Maximum	Datum (Elevation)	Total Cohesion	Effective Cohesion	Effective Friction Angle
	00-SSM Fill	Mohr-Coulomb	21						0	32
	01-Existing Fill	Mohr-Coulomb	20						0	30
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100		
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5			
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60		
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125			



THURBER

Project
24726 Bruce Street Interchange, North Embankment

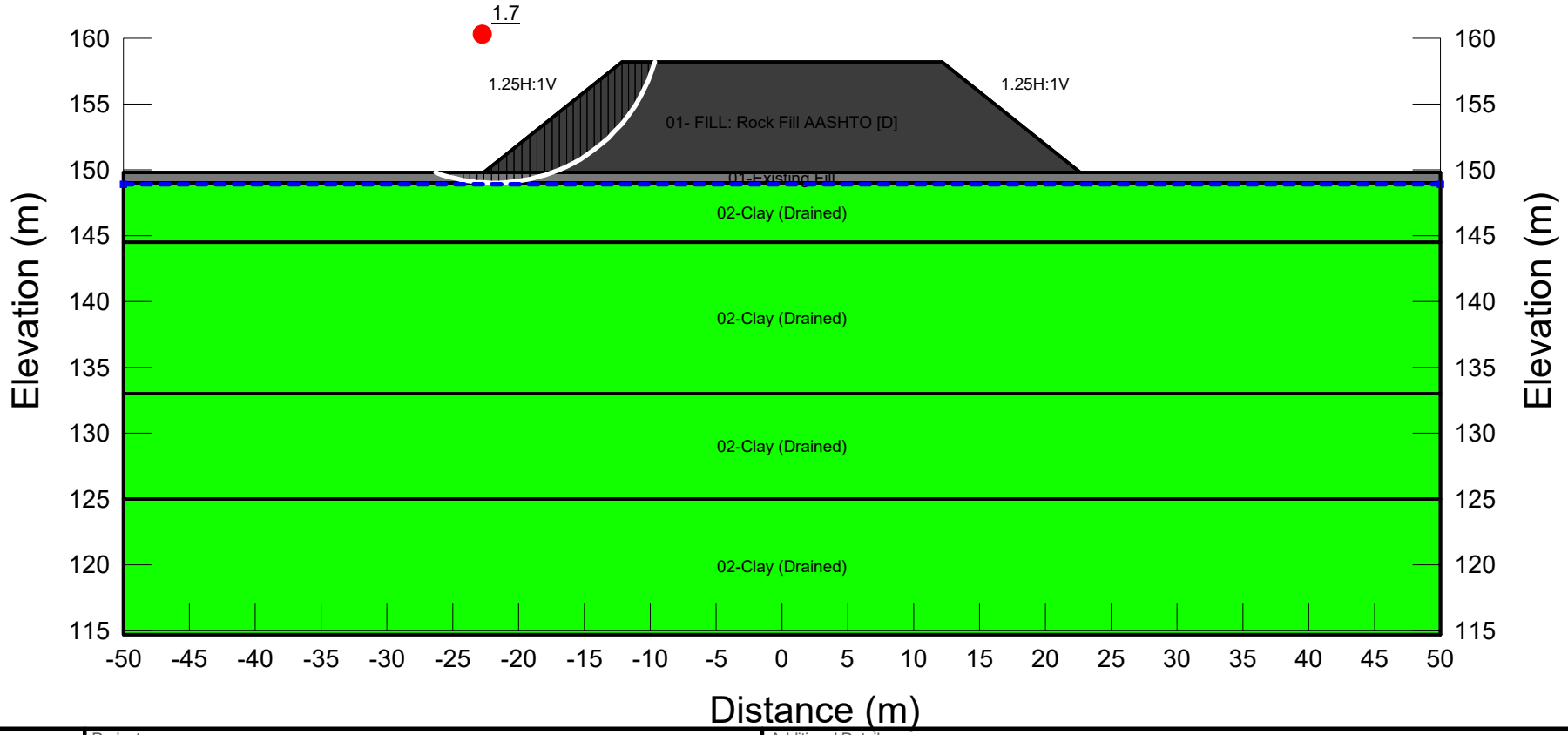
Analysis
04-Temp (Short Term)-Pseudo-Static (475 yr. EQ) (SSM)

Seismic Coefficient	Last Run	Scale
H: 0.05g, V: g	03/24/2022, 03:22:05 PM	1:500

Additional Details
Name: Sta. 9+950, 2H:1V SSM Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-9.65, 158.2) m, Exit: (-36.103333, 149.8) m
Center: (-33.516277, 187.50633) m, Radius: 37.794975 m

Figure I1.4

Color	Name	Slope Stability Material Model	Unit Weight	Effective Cohesion	Effective Friction Angle	Strength Function
	01- FILL: Rock Fill AASHTO [D]	Shear/Normal Fn.	20			AASHTO [D]
	01-Existing Fill	Mohr-Coulomb	20	0	30	
	02-Clay (Drained)	Mohr-Coulomb	17.5	5	28	



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
01-Permanent (Long Term) (RF)

Seismic Coefficient
H: g, V: g

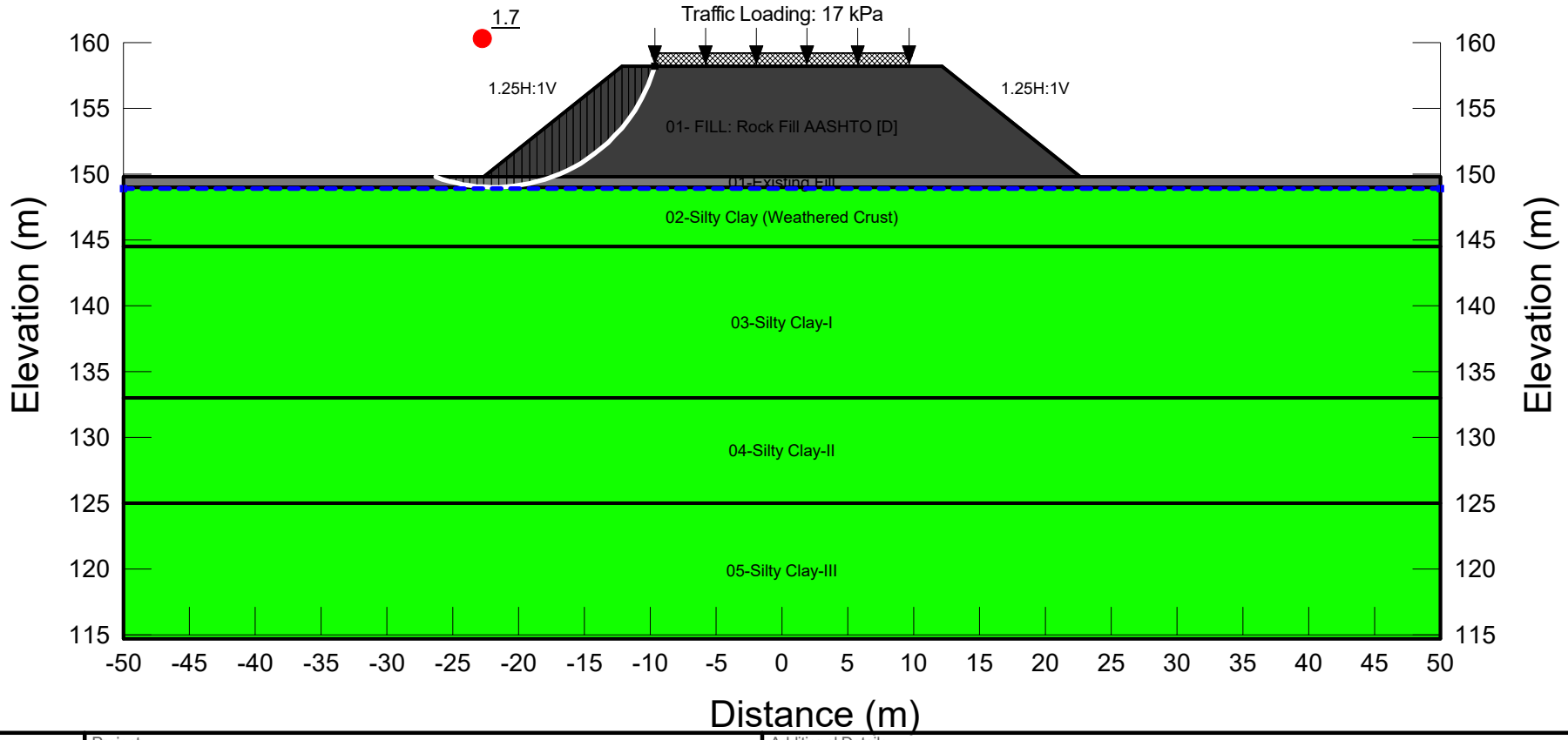
Last Run
03/24/2022, 03:21:34 PM

Scale
1:500

Additional Details
Name: Sta. 9+950, 1.25H:1V Rock Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-9.65, 158.2) m, Exit: (-26.296667, 149.8) m
Center: (-21.8611, 161.70457) m, Radius: 12.704052 m

Figure I2.1

Color	Name	Slope Stability Material Model	Unit Weight	C-Datum	C-Rate of Change	C-Maximum	Datum (Elevation)	Total Cohesion	Effective Cohesion	Effective Friction Angle	Strength Function
	01- FILL: Rock Fill AASHTO [D]	Shear/Normal Fn.	20								AASHTO [D]
	01-Existing Fill	Mohr-Coulomb	20						0	30	
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100			
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5				
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60			
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125				



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
02-Temp (Short Term)-Traffic (RF)

Seismic Coefficient
H: g, V: g

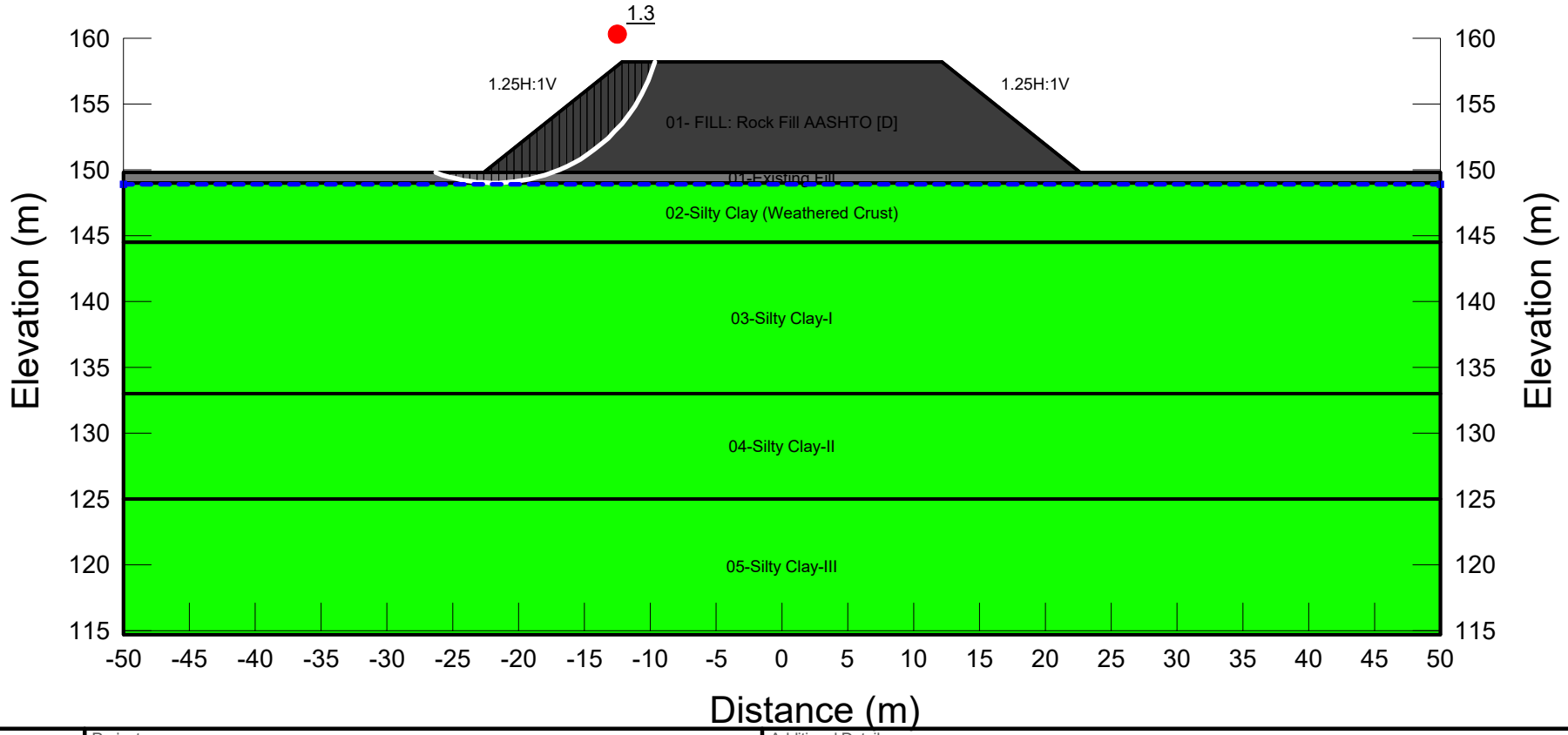
Last Run
03/24/2022, 03:21:43 PM

Scale
1:500

Additional Details
Name: Sta. 9+950, 1.25H:1V Rock Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-9.65, 158.2) m, Exit: (-26.296667, 149.8) m
Center: (-21.8611, 161.70457) m, Radius: 12.704052 m

Figure I2.2

Color	Name	Slope Stability Material Model	Unit Weight	C-Datum	C-Rate of Change	C-Maximum	Datum (Elevation)	Total Cohesion	Effective Cohesion	Effective Friction Angle	Strength Function
	01- FILL: Rock Fill AASHTO [D]	Shear/Normal Fn.	20								AASHTO [D]
	01-Existing Fill	Mohr-Coulomb	20						0	30	
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100			
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5				
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60			
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125				



THURBER

Project
24726 Bruce Street Interchange, North Embankment

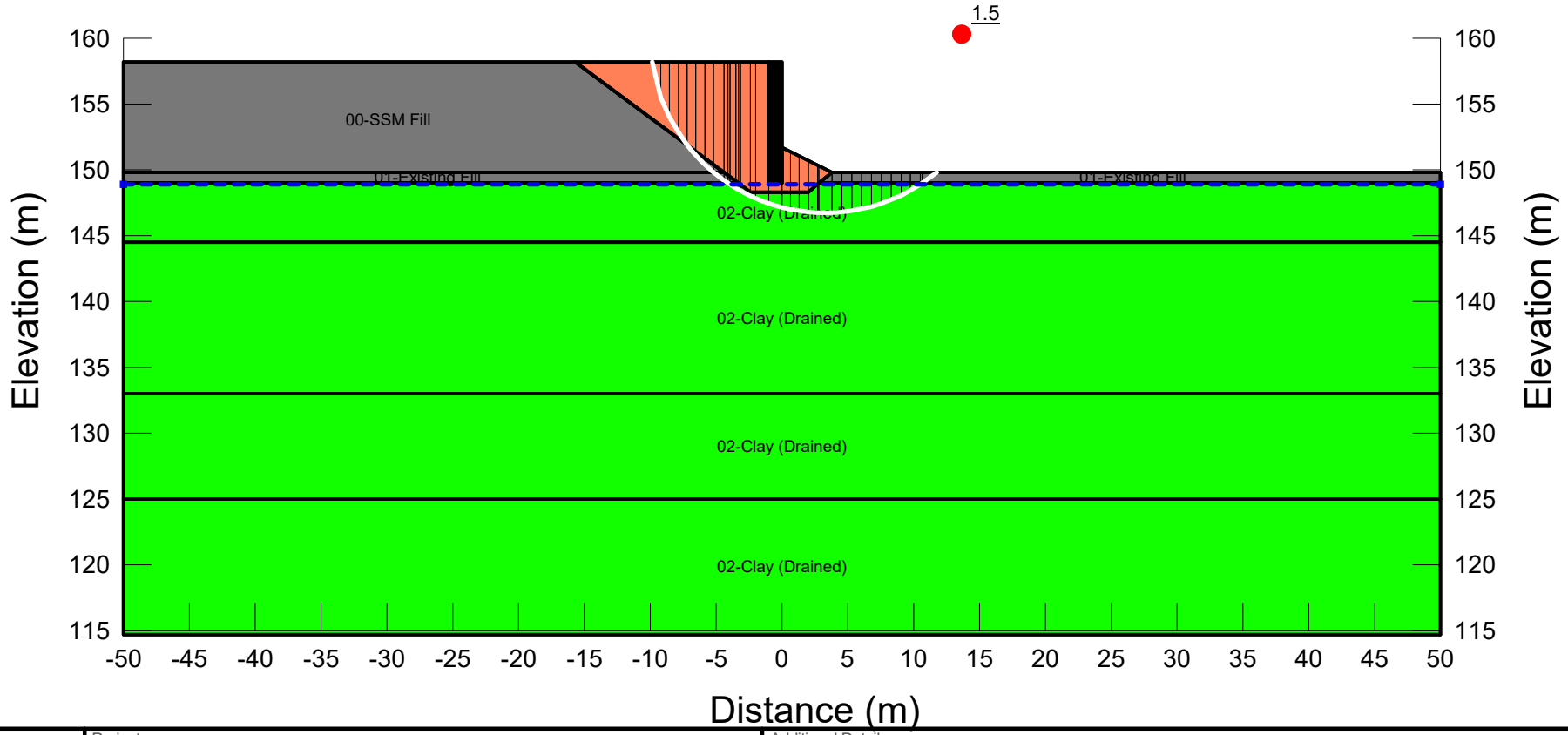
Analysis
03-Temp (Short Term)-Pseudo-Static (2,475 yr. EQ) (RF)

Seismic Coefficient	Last Run	Scale
H: 0.13g, V: g	03/24/2022, 03:22:05 PM	1:500

Additional Details
Name: Sta. 9+950, 1.25H:1V Rock Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-9.65, 158.2) m, Exit: (-26.296667, 149.8) m
Center: (-21.8611, 161.70457) m, Radius: 12.704052 m

Figure I2.3

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	00-Abutment Wall	Mohr-Coulomb	24	1,000	0
	00-Granular A	Mohr-Coulomb	22.8	0	40
	00-SSM Fill	Mohr-Coulomb	21	0	32
	01-Existing Fill	Mohr-Coulomb	20	0	30
	02-Clay (Drained)	Mohr-Coulomb	17.5	5	28



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
01-Permanent (Long Term) (Abut)

Seismic Coefficient
H: g, V: g

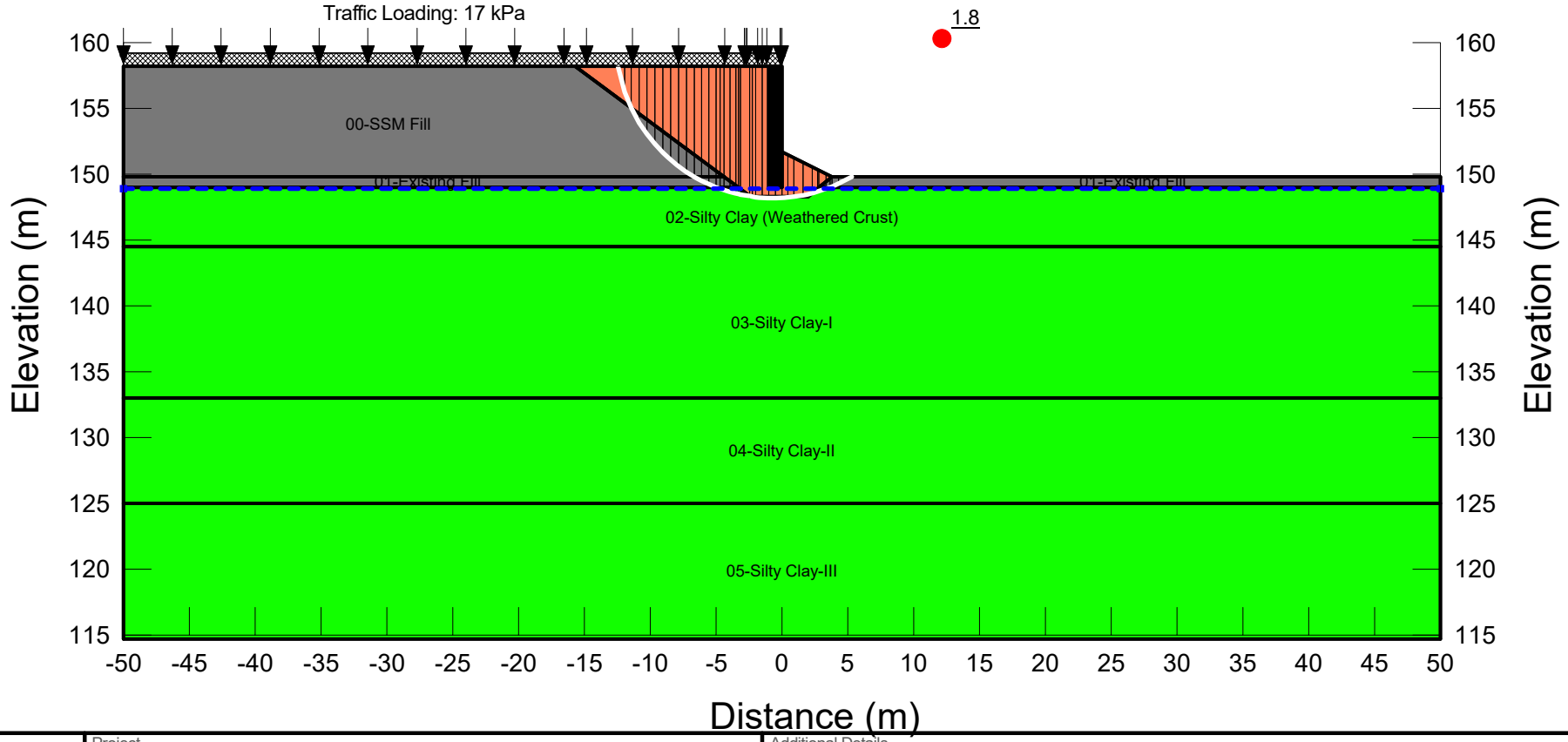
Last Run
03/24/2022, 03:21:54 PM

Scale
1:500

Additional Details
Name: North Abutment Wall
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-9.86, 158.2) m, Exit: (11.740902, 149.8) m
Center: (3.2745744, 160.00228) m, Radius: 13.257649 m

Figure I3.1

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Datum (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Datum (Elevation) (m)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	00-Abutment Wall	Mohr-Coulomb	24						1,000	0
	00-Granular A	Mohr-Coulomb	22.8						0	40
	00-SSM Fill	Mohr-Coulomb	21						0	32
	01-Existing Fill	Mohr-Coulomb	20						0	30
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100		
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5			
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60		
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125			



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
02-Temp (Short Term)-Traffic (Abut)

Seismic Coefficient
H: g, V: g

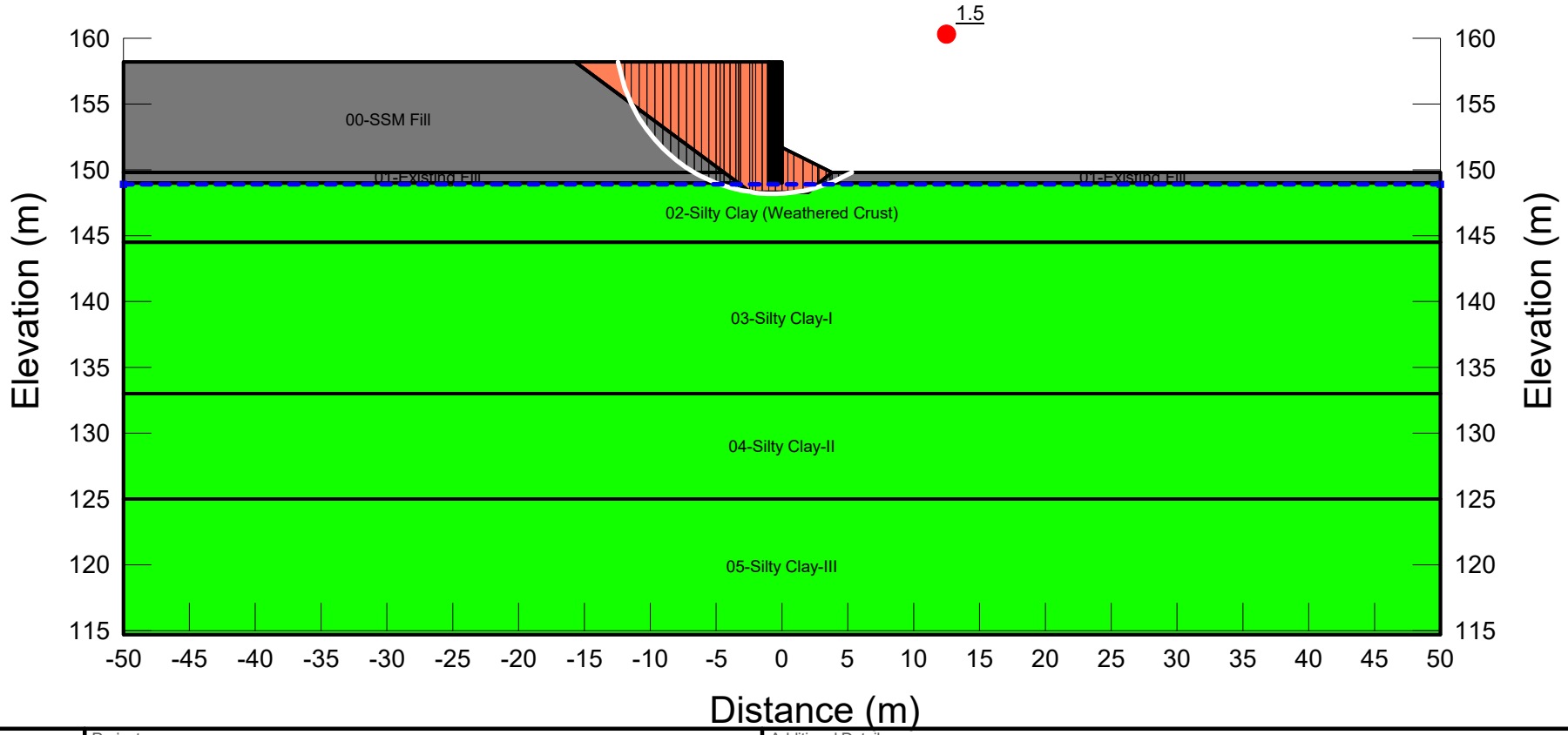
Last Run
03/24/2022, 03:22:05 PM

Scale
1:500

Additional Details
Name: North Abutment Wall
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-12.433333, 158.2) m, Exit: (5.301059, 149.8) m
Center: (-0.67119678, 160.11191) m, Radius: 11.916511 m

Figure I3.2

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Datum (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Datum (Elevation) (m)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	00-Abutment Wall	Mohr-Coulomb	24						1,000	0
	00-Granular A	Mohr-Coulomb	22.8						0	40
	00-SSM Fill	Mohr-Coulomb	21						0	32
	01-Existing Fill	Mohr-Coulomb	20						0	30
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100		
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5			
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60		
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125			



THURBER

Project
24726 Bruce Street Interchange, North Embankment

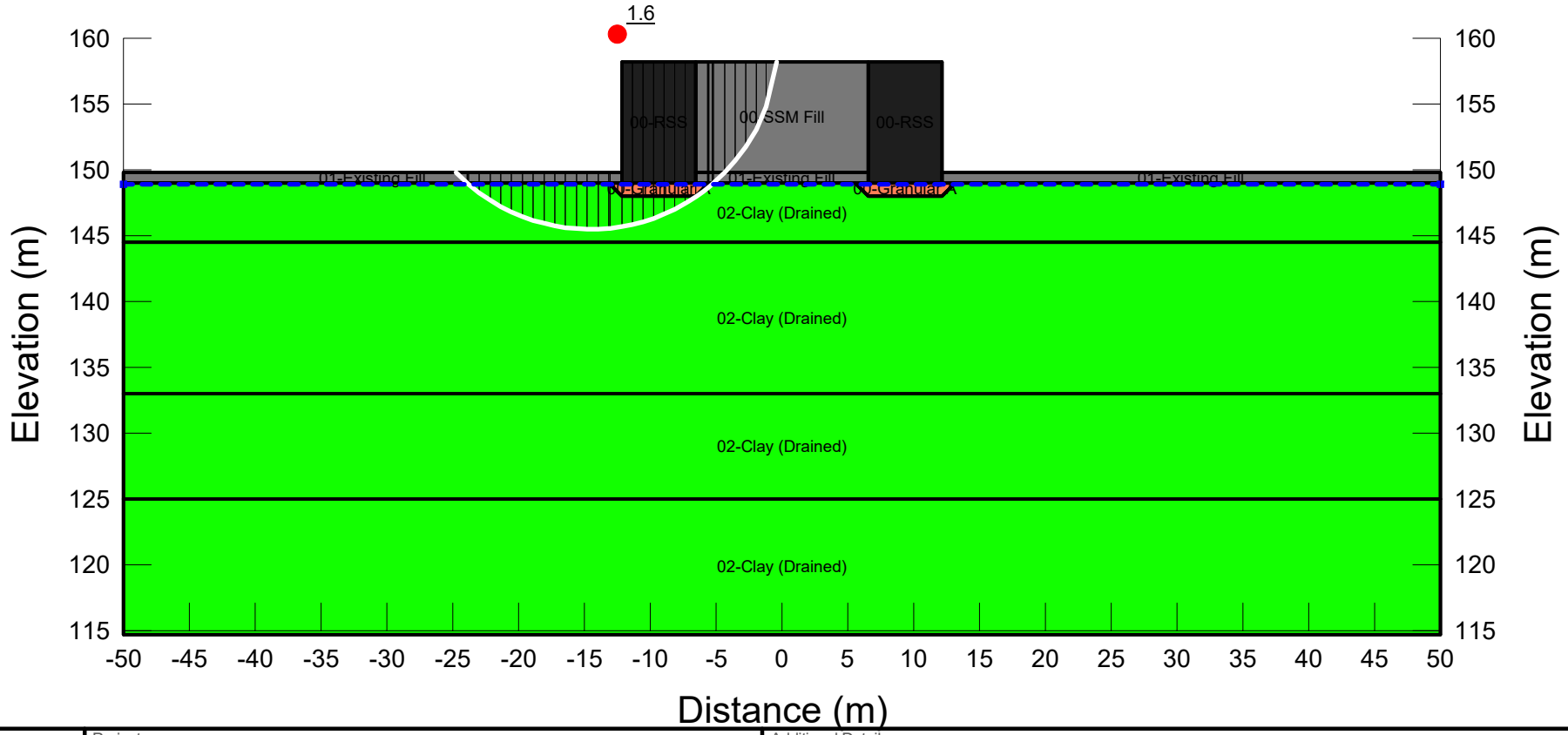
Analysis
03-Temp (Short Term)-Pseudo-Static (2,475 yr. EQ) (Abut)

Seismic Coefficient	Last Run	Scale
H: 0.13g, V: g	03/24/2022, 03:22:05 PM	1:500

Additional Details
Name: North Abutment Wall
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-12.433333, 158.2) m, Exit: (5.301059, 149.8) m
Center: (-0.67119678, 160.11191) m, Radius: 11.916511 m

Figure I3.3

Color	Name	Slope Stability Material Model	Unit Weight	Effective Cohesion	Effective Friction Angle
	00-Granular A	Mohr-Coulomb	22.8	0	40
	00-RSS	Mohr-Coulomb	22.8	250	42
	00-SSM Fill	Mohr-Coulomb	21	0	32
	01-Existing Fill	Mohr-Coulomb	20	0	30
	02-Clay (Drained)	Mohr-Coulomb	17.5	5	28



THURBER

Project
24726 Bruce Street Interchange, North Embankment

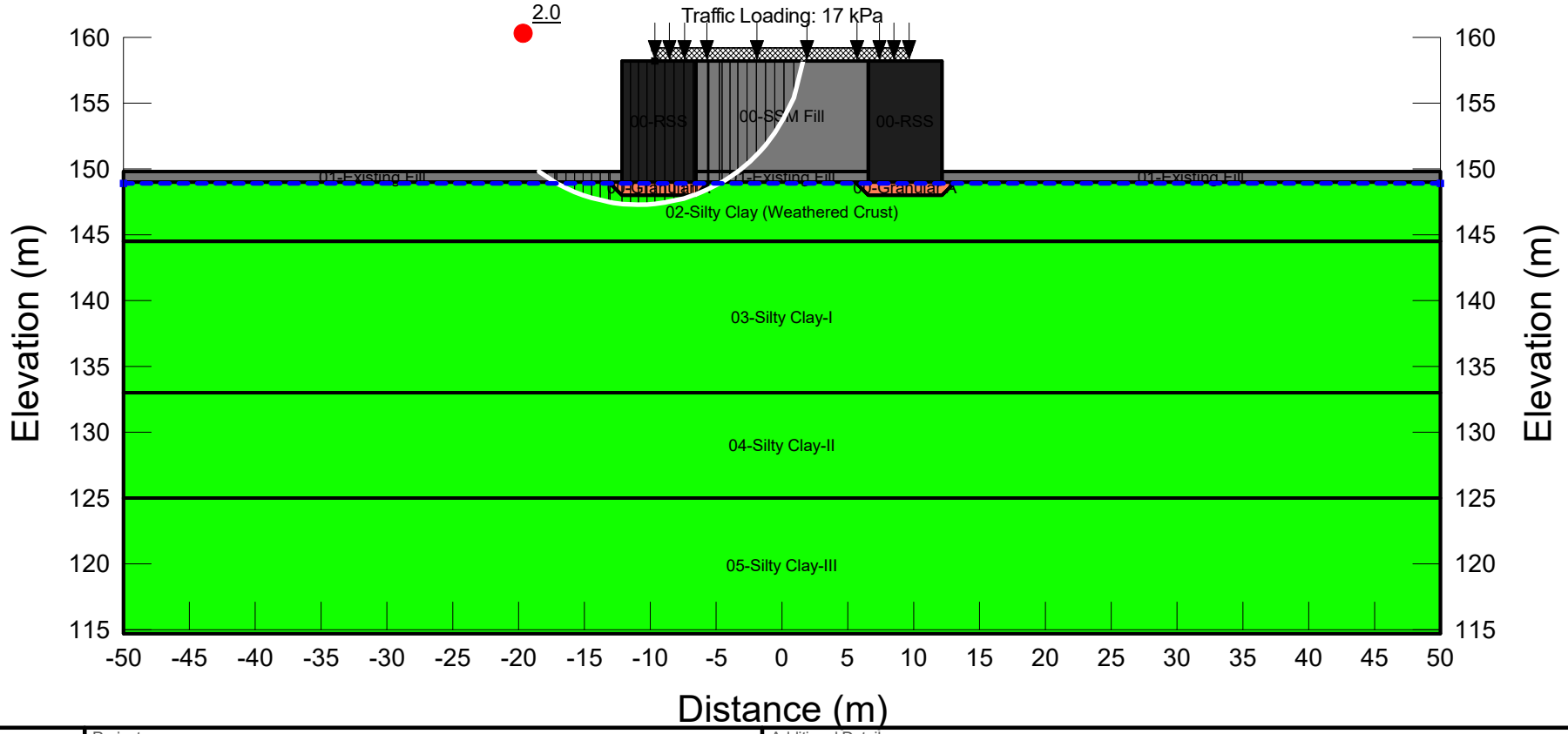
Analysis
01-Permanent (Long Term) (RSS)

Seismic Coefficient	Last Run	Scale
H: g, V: g	03/31/2022, 02:49:52 PM	1:500

Additional Details
Name: RSS Wall
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-0.39166667, 158.2) m, Exit: (-24.766667, 149.8) m
Center: (-14.555253, 159.73418) m, Radius: 14.246434 m

Figure I4.1

Color	Name	Slope Stability Material Model	Unit Weight	C-Datum	C-Rate of Change	C-Maximum	Datum (Elevation)	Total Cohesion	Effective Cohesion	Effective Friction Angle
	00-Granular A	Mohr-Coulomb	22.8						0	40
	00-RSS	Mohr-Coulomb	22.8						250	42
	00-SSM Fill	Mohr-Coulomb	21						0	32
	01-Existing Fill	Mohr-Coulomb	20						0	30
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100		
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5			
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60		
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125			



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
02-Temp (Short Term)-Traffic (RSS)

Seismic Coefficient
H: g, V: g

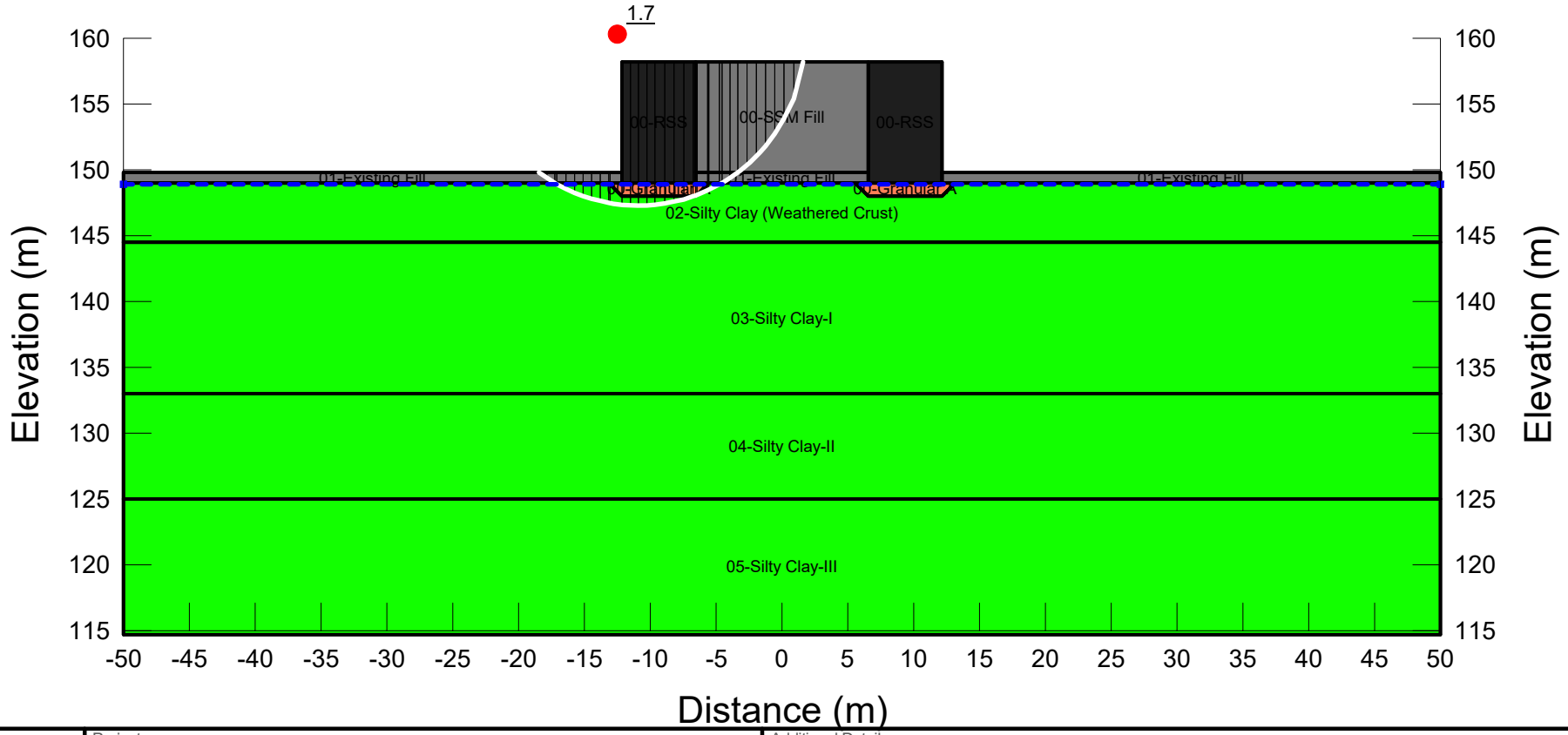
Last Run
03/31/2022, 02:51:42 PM

Scale
1:500

Additional Details
Name: RSS Wall
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (1.5833333, 158.2) m, Exit: (-18.458333, 149.8) m
Center: (-10.907344, 159.89283) m, Radius: 12.604868 m

Figure I4.2

Color	Name	Slope Stability Material Model	Unit Weight	C-Datum	C-Rate of Change	C-Maximum	Datum (Elevation)	Total Cohesion	Effective Cohesion	Effective Friction Angle
	00-Granular A	Mohr-Coulomb	22.8						0	40
	00-RSS	Mohr-Coulomb	22.8						250	42
	00-SSM Fill	Mohr-Coulomb	21						0	32
	01-Existing Fill	Mohr-Coulomb	20						0	30
	02-Silty Clay (Weathered Crust)	Undrained (Phi=0)	17.5					100		
	03-Silty Clay-I	S=f(datum)	17.5	100	-3.48	60	144.5			
	04-Silty Clay-II	Undrained (Phi=0)	17.5					60		
	05-Silty Clay-III	S=f(datum)	17.5	60	3.88	100	125			



THURBER

Project
24726 Bruce Street Interchange, North Embankment

Analysis
03-Temp (Short Term)-Pseudo-Static (2,475 yr. EQ) (RSS)

Seismic Coefficient
H: 0.13g, V: g

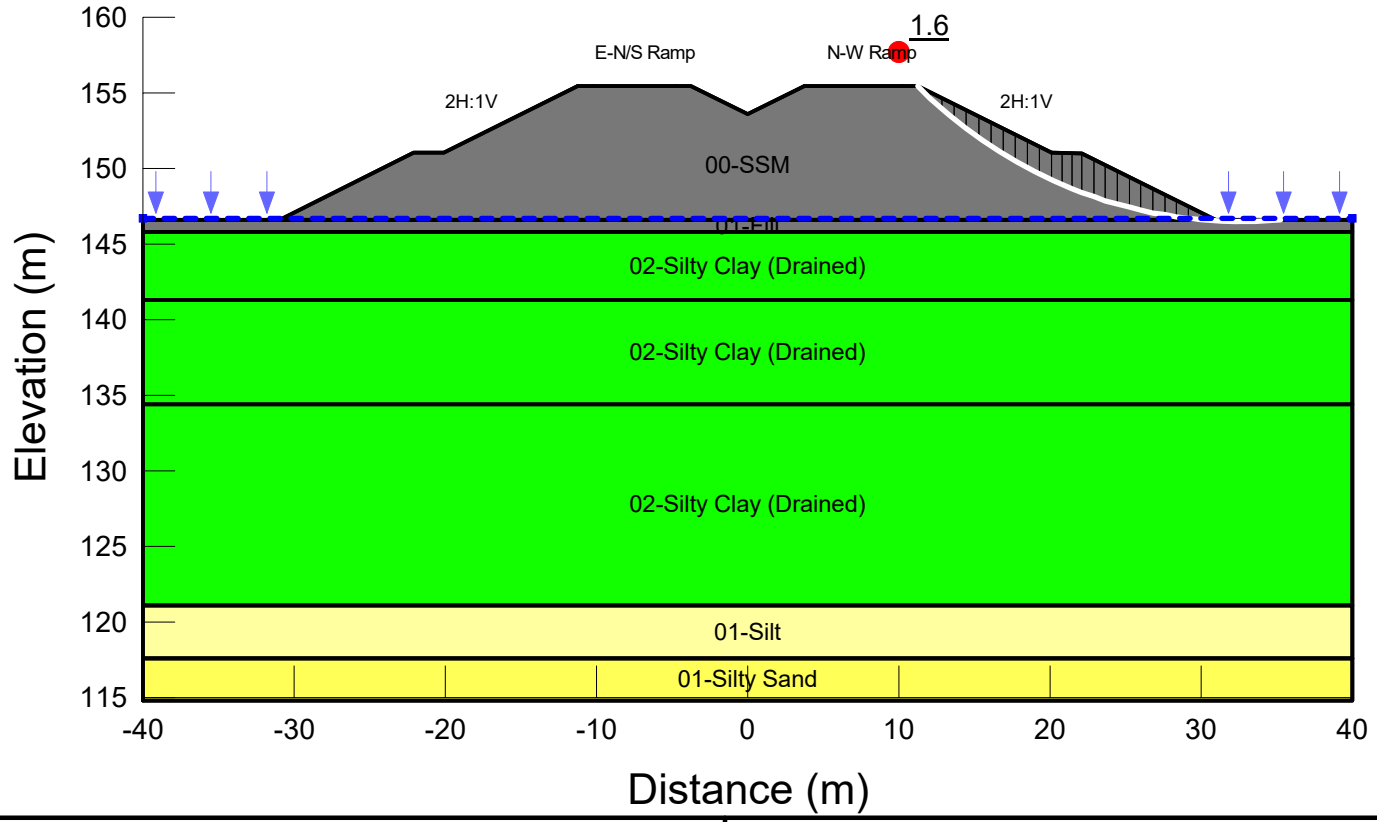
Last Run
03/31/2022, 02:59:17 PM

Scale
1:500

Additional Details
Name: RSS Wall
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (1.5833333, 158.2) m, Exit: (-18.458333, 149.8) m
Center: (-10.907344, 159.89283) m, Radius: 12.604868 m

Figure I4.3

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	00-SSM	Mohr-Coulomb	21	0	32
	01-Fill	Mohr-Coulomb	20	0	30
	01-Silt	Mohr-Coulomb	18	0	30
	01-Silty Sand	Mohr-Coulomb	19	0	30
	02-Silty Clay (Drained)	Mohr-Coulomb	17.5	5	28



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+430 (Fill)

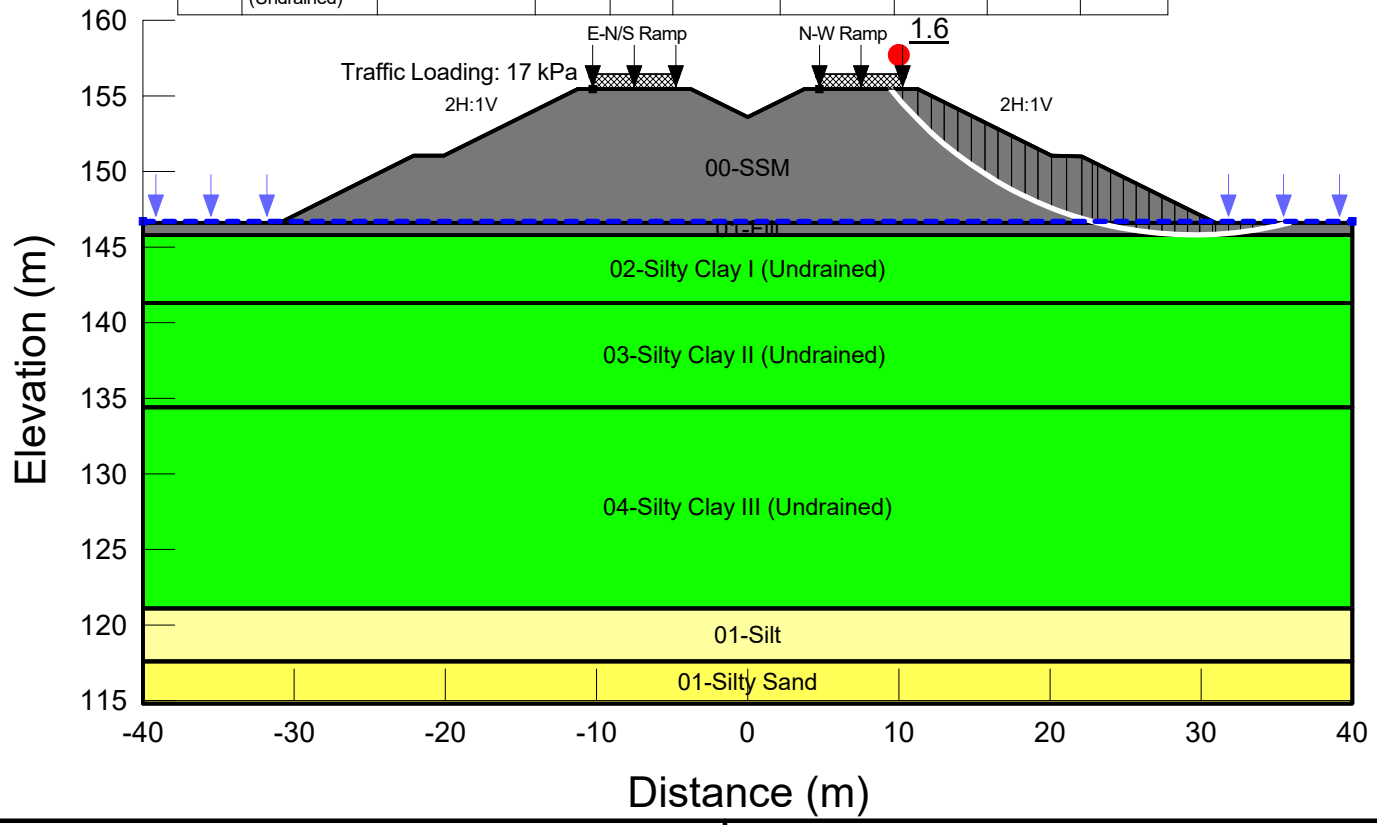
Analysis
01-Permanent (Long Term) (SSM)

Seismic Coefficient	Last Run	Scale
H: g, V: g	03/24/2022, 03:43:31 PM	1:500

Additional Details
Name: 2H:1V Earth Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (11.25, 155.46) m, Exit: (35.237333, 146.6) m
Center: (32.685493, 176.59255) m, Radius: 30.100917 m

Figure I5.1

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	00-SSM	Mohr-Coulomb	21					0	32
	01-Fill	Mohr-Coulomb	20					0	30
	01-Silt	Mohr-Coulomb	18					0	30
	01-Silty Sand	Mohr-Coulomb	19					0	30
	02-Silty Clay I (Undrained)	Undrained (Phi=0)	18				100		
	03-Silty Clay II (Undrained)	S=f(depth)	18	100	-5.9701493	60			
	04-Silty Clay III (Undrained)	Undrained (Phi=0)	18				60		



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+430 (Fill)

Analysis
02-Temp (Short Term)-Traffic (SSM)

Seismic Coefficient
H: g, V: g

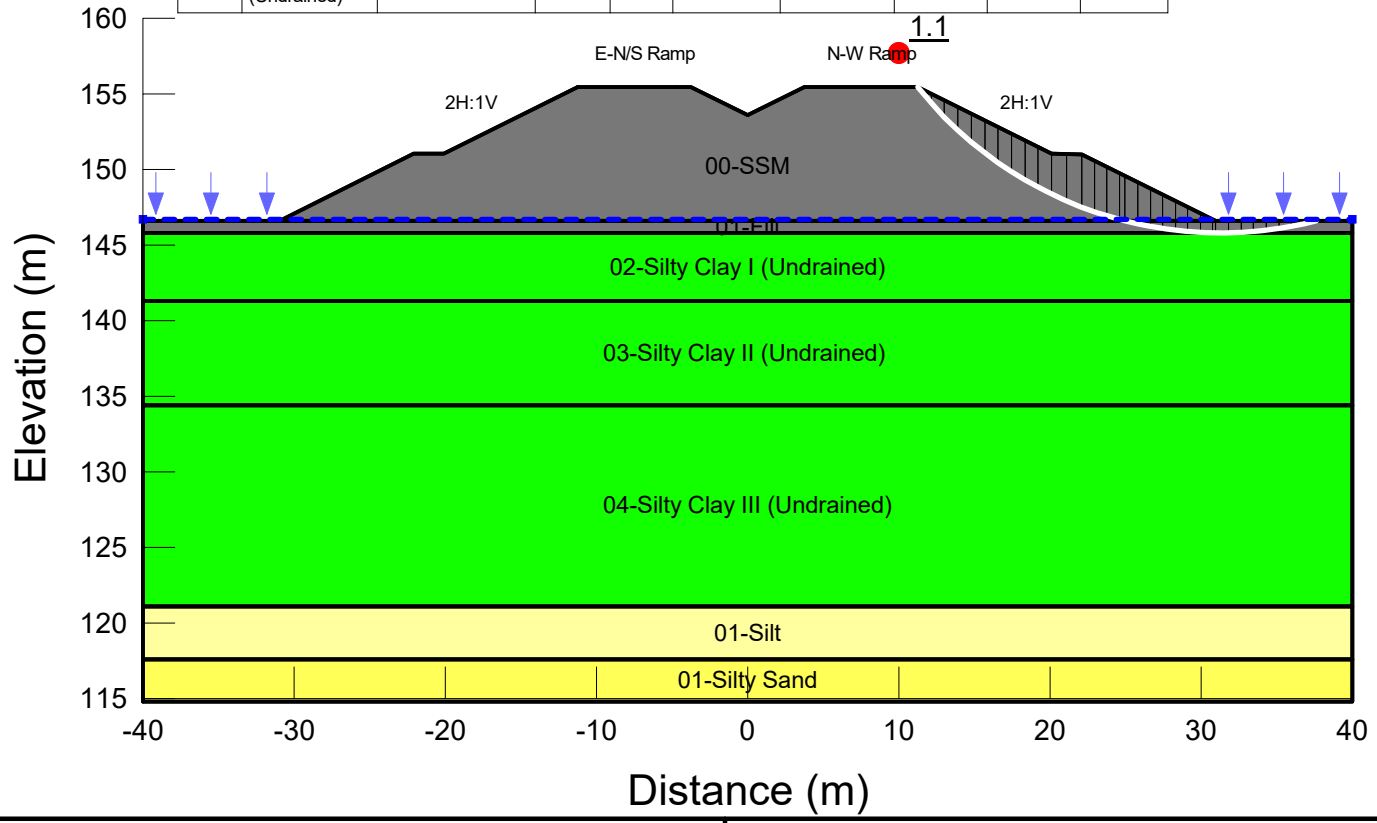
Last Run
03/24/2022, 03:43:36 PM

Scale
1:500

Additional Details
Name: 2H:1V Earth Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (9.4424275, 155.46) m, Exit: (35.832667, 146.6) m
Center: (29.497016, 171.46149) m, Radius: 25.656078 m

Figure I5.2

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	00-SSM	Mohr-Coulomb	21					0	32
	01-Fill	Mohr-Coulomb	20					0	30
	01-Silt	Mohr-Coulomb	18					0	30
	01-Silty Sand	Mohr-Coulomb	19					0	30
	02-Silty Clay I (Undrained)	Undrained (Phi=0)	18				100		
	03-Silty Clay II (Undrained)	S=f(depth)	18	100	-5.9701493	60			
	04-Silty Clay III (Undrained)	Undrained (Phi=0)	18				60		



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+430 (Fill)

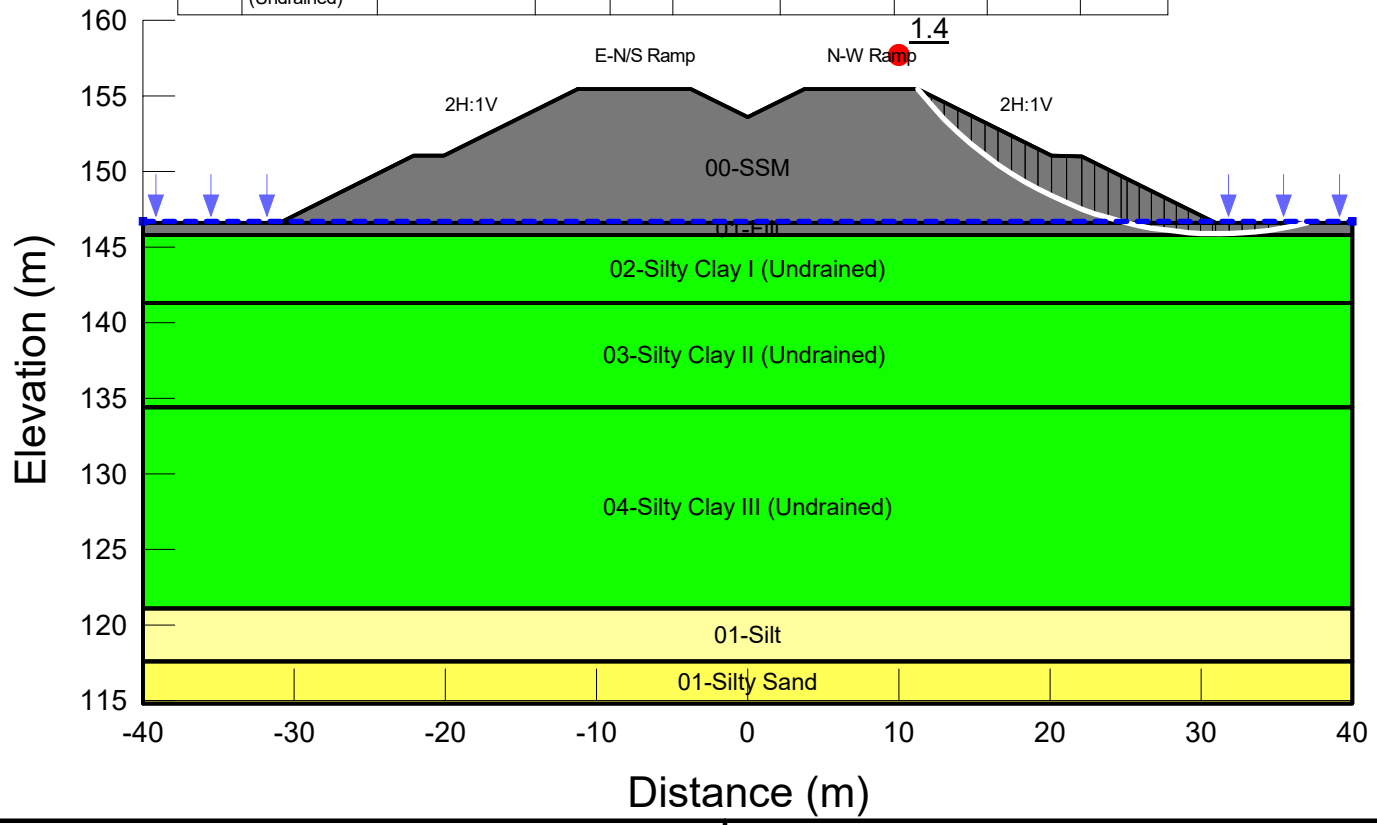
Analysis
03-Temp (Short Term)-Pseudo-Static (2,475 yr. EQ) (SSM)

Seismic Coefficient	Last Run	Scale
H: 0.13g, V: g	03/24/2022, 03:43:39 PM	1:500

Additional Details
Name: 2H:1V Earth Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (11.25, 155.46) m, Exit: (37.618667, 146.6) m
Center: (31.295929, 171.45112) m, Radius: 25.642839 m

Figure I5.3

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	00-SSM	Mohr-Coulomb	21					0	32
	01-Fill	Mohr-Coulomb	20					0	30
	01-Silt	Mohr-Coulomb	18					0	30
	01-Silty Sand	Mohr-Coulomb	19					0	30
	02-Silty Clay I (Undrained)	Undrained (Phi=0)	18				100		
	03-Silty Clay II (Undrained)	S=f(depth)	18	100	-5.9701493	60			
	04-Silty Clay III (Undrained)	Undrained (Phi=0)	18				60		



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+430 (Fill)

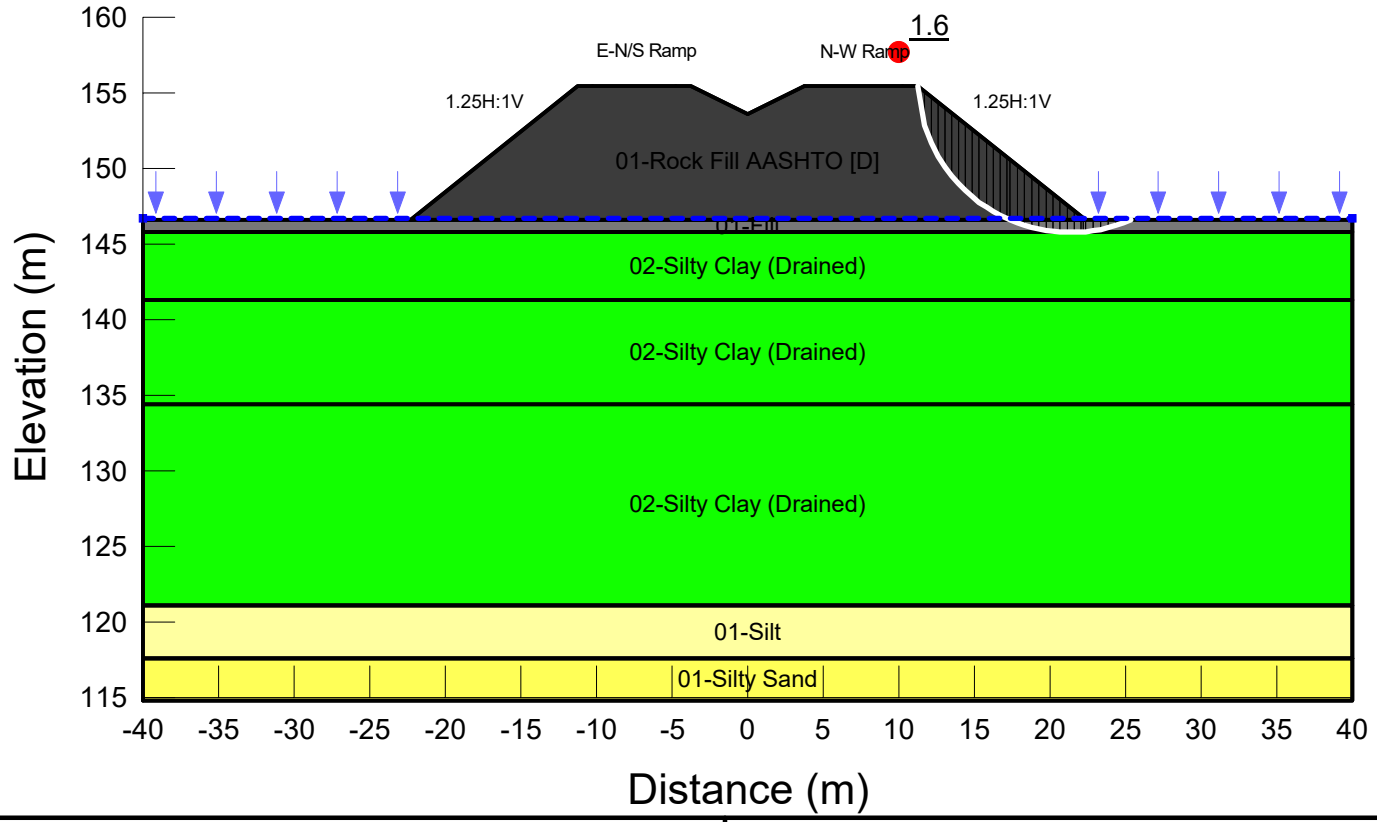
Analysis
04-Temp (Short Term)-Pseudo-Static (475 yr. EQ) (SSM)

Seismic Coefficient	Last Run	Scale
H: 0.05g, V: g	03/24/2022, 03:43:47 PM	1:500

Additional Details
Name: 2H:1V Earth Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (11.25, 155.46) m, Exit: (37.023333, 146.6) m
Center: (31.058466, 171.1652) m, Radius: 25.279013 m

Figure I5.4

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	01-Fill	Mohr-Coulomb	20		0	30
	01-Rock Fill AASHTO [D]	Shear/Normal Fn.	20	AASHTO [D]		
	01-Silt	Mohr-Coulomb	18		0	30
	01-Silty Sand	Mohr-Coulomb	19		0	30
	02-Silty Clay (Drained)	Mohr-Coulomb	17.5		5	28



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+430 (Fill)

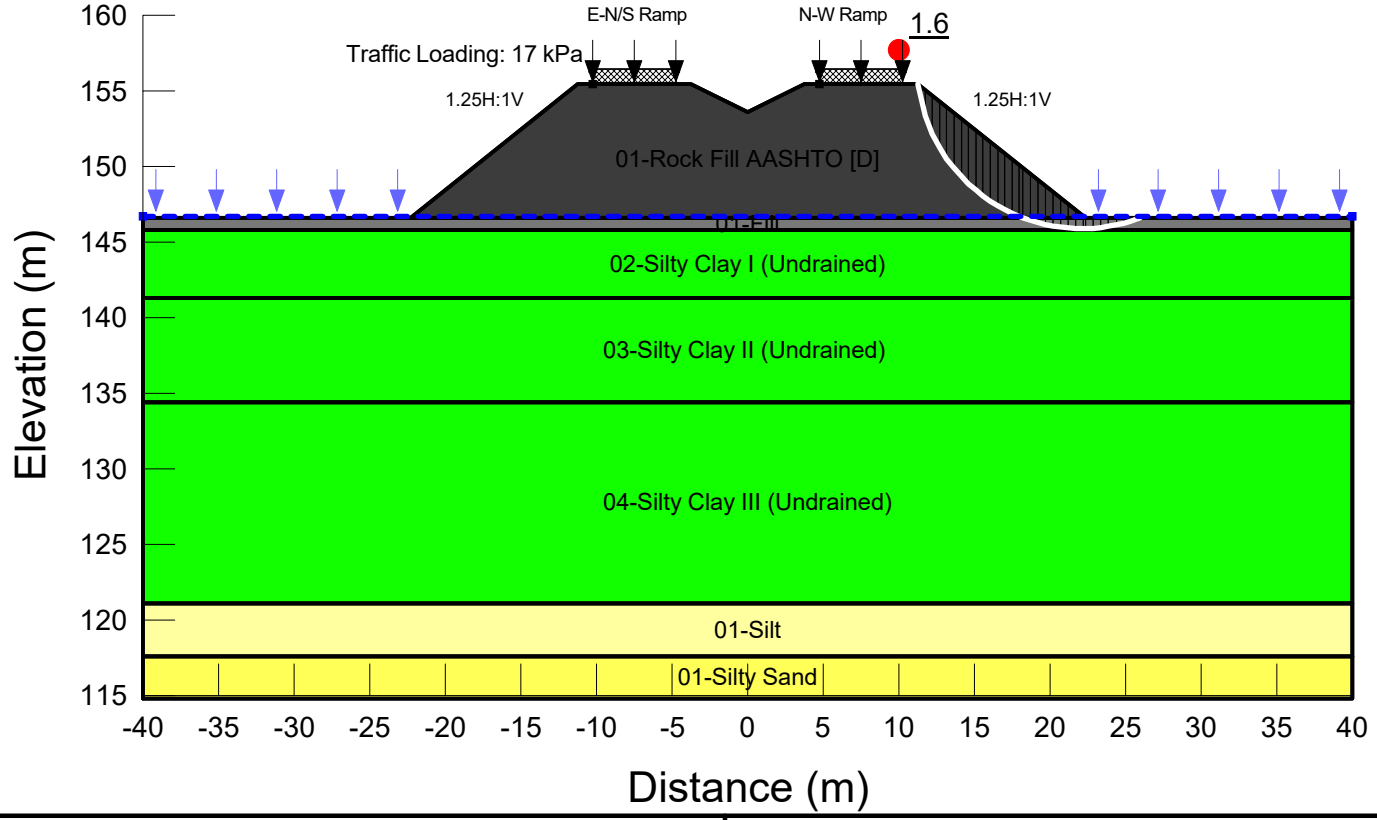
Analysis
01-Permanent (Long Term) (RF)

Seismic Coefficient	Last Run	Scale
H: g, V: g	03/24/2022, 03:43:19 PM	1:500

Additional Details
Name: 1.25H:1V Rock Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (11.25, 155.46) m, Exit: (25.354167, 146.6) m
Center: (21.357058, 155.89319) m, Radius: 10.116337 m

Figure I6.1

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	01-Fill	Mohr-Coulomb	20						0	30
	01-Rock Fill AASHTO [D]	Shear/Normal Fn.	20					AASHTO [D]		
	01-Silt	Mohr-Coulomb	18						0	30
	01-Silty Sand	Mohr-Coulomb	19						0	30
	02-Silty Clay I (Undrained)	Undrained (Phi=0)	18				100			
	03-Silty Clay II (Undrained)	S=f(depth)	18	100	-5.9701493	60				
	04-Silty Clay III (Undrained)	Undrained (Phi=0)	18				60			



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+430 (Fill)

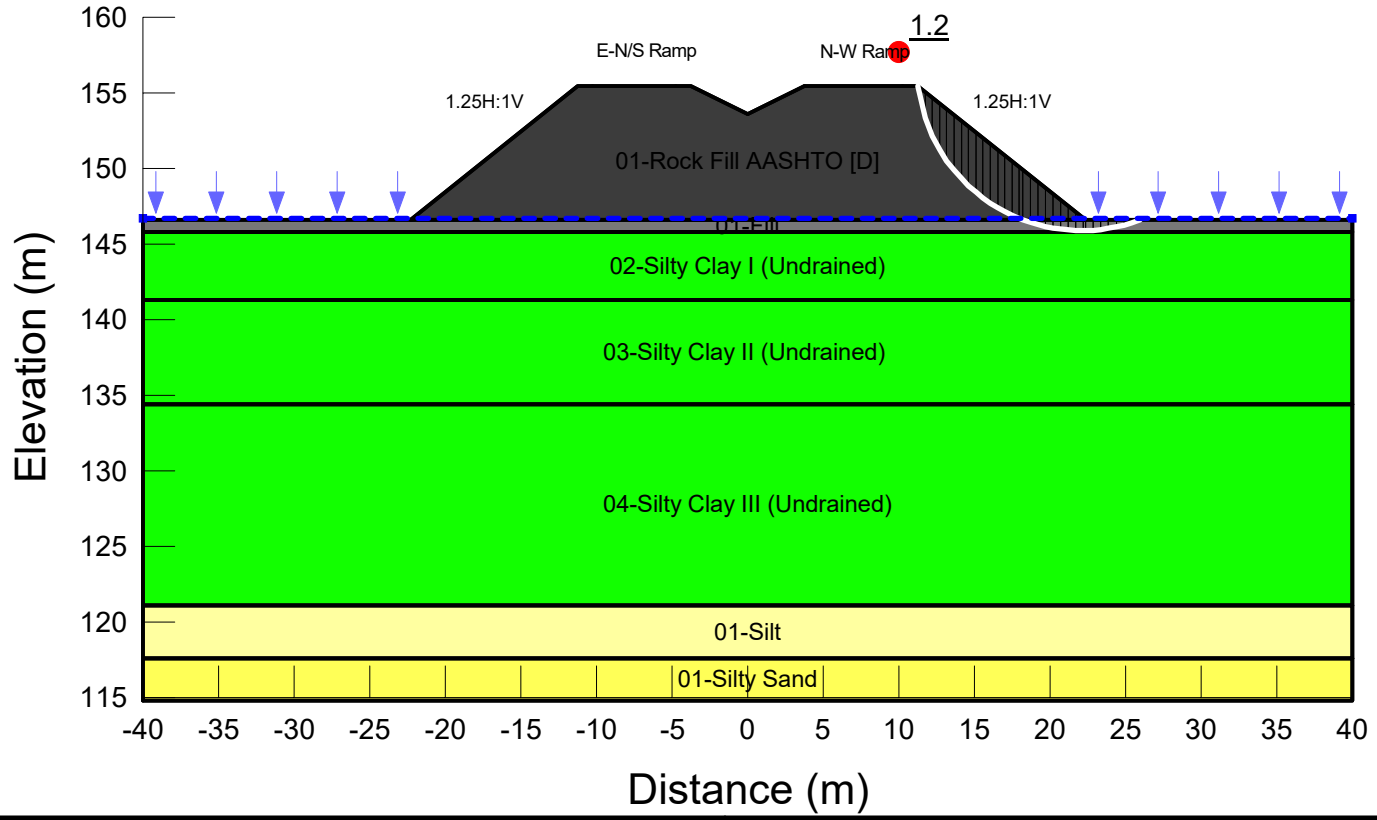
Analysis
02-Temp (Short Term)-Traffic (RF)

Seismic Coefficient	Last Run	Scale
H: g, V: g	03/24/2022, 03:43:26 PM	1:500

Additional Details
Name: 1.25H:1V Rock Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (11.25, 155.46) m, Exit: (25.94, 146.6) m
Center: (22.080544, 156.80908) m, Radius: 10.914243 m

Figure I6.2

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	01-Fill	Mohr-Coulomb	20						0	30
	01-Rock Fill AASHTO [D]	Shear/Normal Fn.	20					AASHTO [D]		
	01-Silt	Mohr-Coulomb	18						0	30
	01-Silty Sand	Mohr-Coulomb	19						0	30
	02-Silty Clay I (Undrained)	Undrained (Phi=0)	18				100			
	03-Silty Clay II (Undrained)	S=f(depth)	18	100	-5.9701493	60				
	04-Silty Clay III (Undrained)	Undrained (Phi=0)	18				60			



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+430 (Fill)

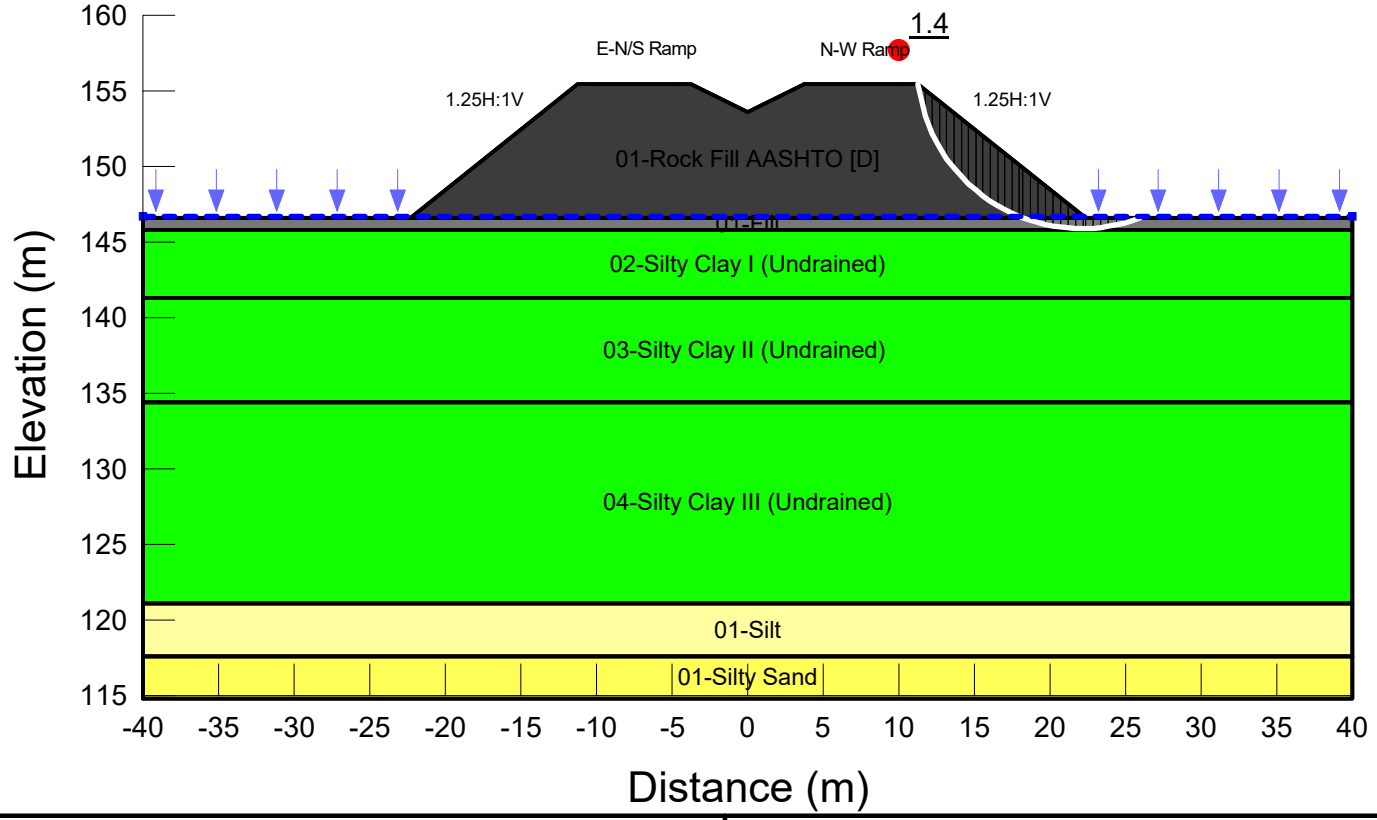
Analysis
03-Temp (Short Term)-Pseudo-Static (2,475 yr. EQ) (RF)

Seismic Coefficient	Last Run	Scale
H: 0.13g, V: g	03/24/2022, 03:43:22 PM	1:500

Additional Details
Name: 1.25H:1V Rock Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (11.25, 155.46) m, Exit: (25.94, 146.6) m
Center: (22.080544, 156.80908) m, Radius: 10.914243 m

Figure I6.3

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)
	01-Fill	Mohr-Coulomb	20						0	30
	01-Rock Fill AASHTO [D]	Shear/Normal Fn.	20					AASHTO [D]		
	01-Silt	Mohr-Coulomb	18						0	30
	01-Silty Sand	Mohr-Coulomb	19						0	30
	02-Silty Clay I (Undrained)	Undrained (Phi=0)	18				100			
	03-Silty Clay II (Undrained)	S=f(depth)	18	100	-5.9701493	60				
	04-Silty Clay III (Undrained)	Undrained (Phi=0)	18				60			



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+430 (Fill)

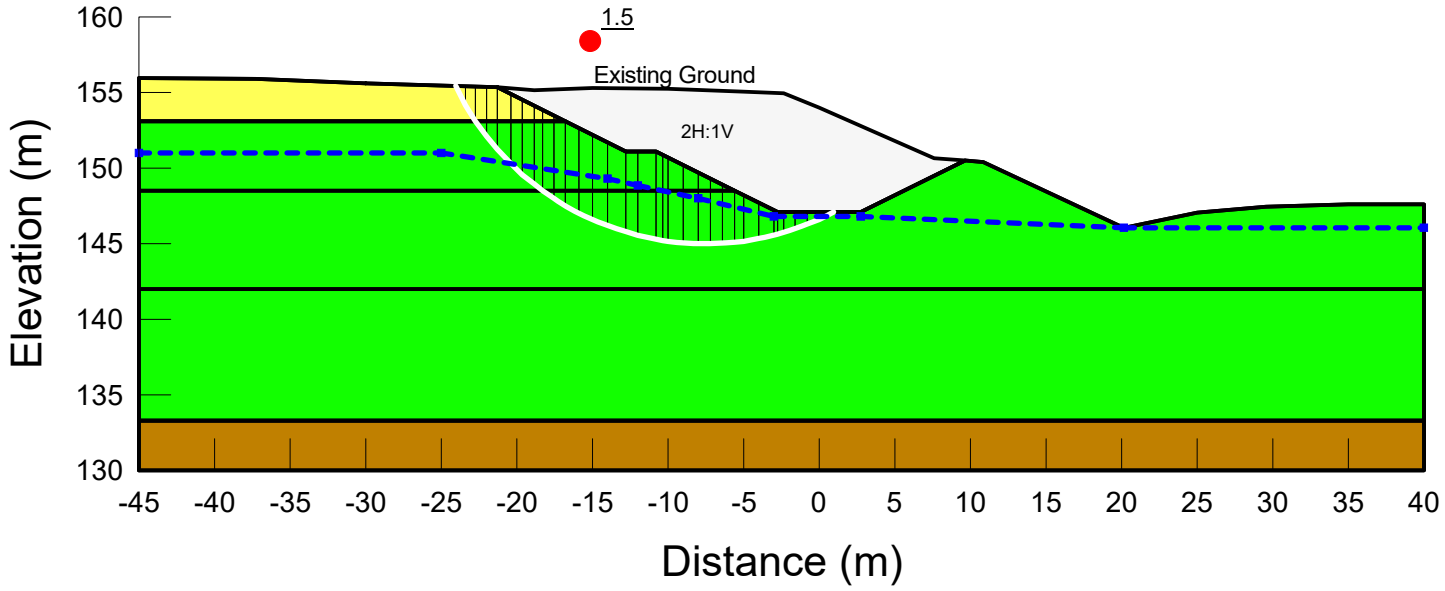
Analysis
04-Temp (Short Term)-Pseudo-Static (475 yr. EQ) (RF)

Seismic Coefficient	Last Run	Scale
H: 0.05g, V: g	03/24/2022, 03:43:43 PM	1:500

Additional Details
Name: 1.25H:1V Rock Fill Embankment
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (11.25, 155.46) m, Exit: (25.94, 146.6) m
Center: (22.080544, 156.80908) m, Radius: 10.914243 m

Figure I6.4

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	01-Sand	Mohr-Coulomb	20	0	30	1
	02-Silty Clay (Drained)	Mohr-Coulomb	17.5	5	28	1
	05-Till	Mohr-Coulomb	21	0	35	1



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+815 (Cut)

Analysis
01-Permanent (Long Term)

Seismic Coefficient
H: g, V: g

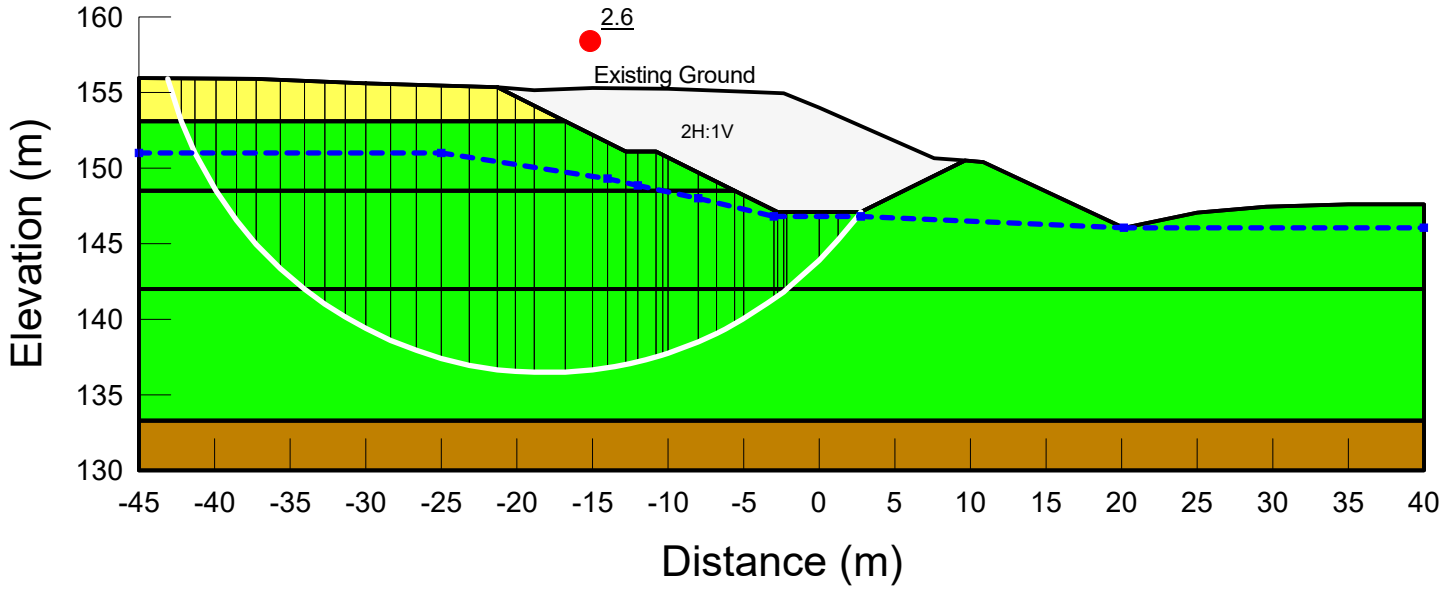
Last Run
03/24/2022, 03:54:29 PM

Scale
1:500

Additional Details
Name: Cut section
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-24.05748, 155.42861) m, Exit: (0.94466667, 147.078) m
Center: (-7.5312747, 163.30475) m, Radius: 18.307078 m

Figure I7.1

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	01-Sand	Mohr-Coulomb	20					0	30	1
	02-Silty Clay I (Undrained)	Undrained (Phi=0)	17.5				100			1
	03-Silty Clay II (Undrained)	S=f(depth)	17.5	100	-6.15	60				1
	04-Silty Clay III (Undrained)	Undrained (Phi=0)	17.5				60			1
	05-Till	Mohr-Coulomb	21					0	35	1



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Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+815 (Cut)

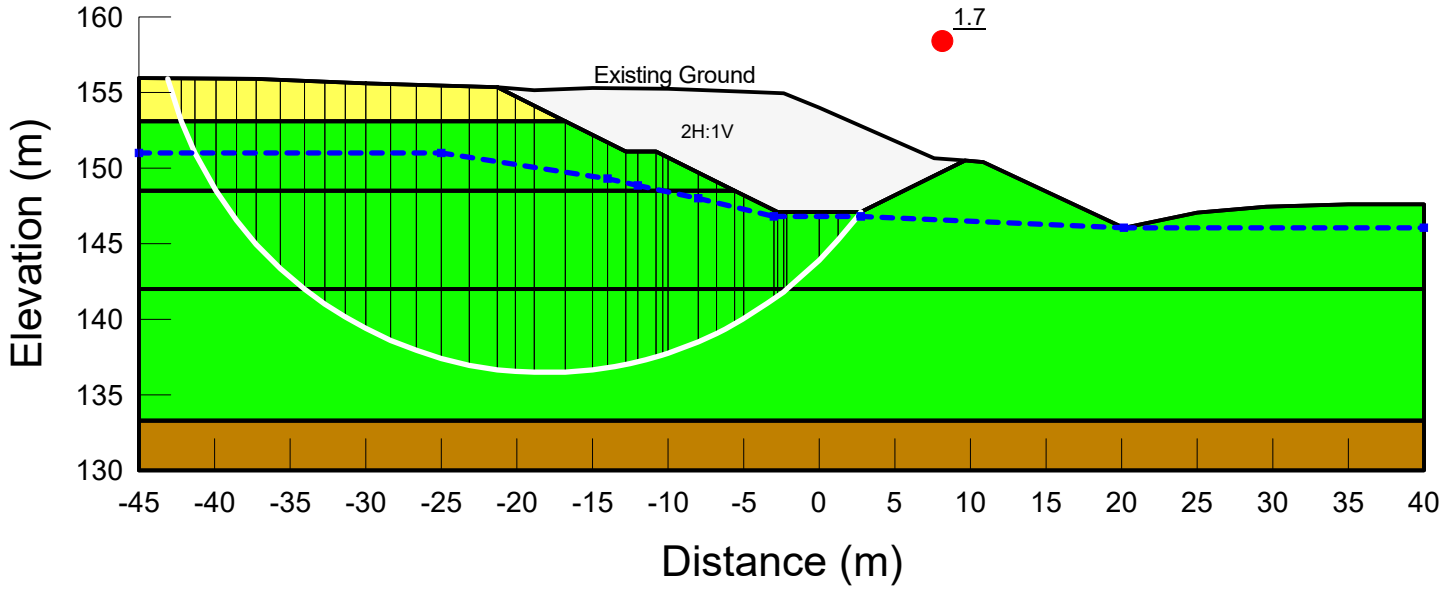
Analysis
02-Temporary (Short Term)-Traffic

Seismic Coefficient	Last Run	Scale
H: g, V: g	03/24/2022, 03:54:34 PM	1:500

Additional Details
Name: Cut section
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-43.092586, 155.92309) m, Exit: (2.75, 147.078) m
Center: (-18.098009, 162.24602) m, Radius: 25.781938 m

Figure I7.2

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	C-Top of Layer (kPa)	C-Rate of Change ((kN/m²)/m)	C-Maximum (kPa)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	01-Sand	Mohr-Coulomb	20					0	30	1
	02-Silty Clay I (Undrained)	Undrained (Phi=0)	17.5				100			1
	03-Silty Clay II (Undrained)	S=f(depth)	17.5	100	-6.15	60				1
	04-Silty Clay III (Undrained)	Undrained (Phi=0)	17.5				60			1
	05-Till	Mohr-Coulomb	21					0	35	1



THURBER

Project
Bruce Street Interchange, E-N/S Ramp, Sta. 18+815 (Cut)

Analysis
03-Temporary (Short Term)-Pseudo-Static (2,475 yr. EQ)

Seismic Coefficient	Last Run	Scale
H: 0.13g, V: g	03/24/2022, 03:54:35 PM	1:500

Additional Details
Name: Cut section
Comments:
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 0.1 m
Entry: (-43.092586, 155.92309) m, Exit: (2.75, 147.078) m
Center: (-18.098009, 162.24602) m, Radius: 25.781938 m

Figure I7.3

Rock Fill Grade	Particle Unconfined Compressive Strength (ksf)
A	>4610
B	3460– 4610
C	2590– 3460
D	1730– 2590
E	≤1730

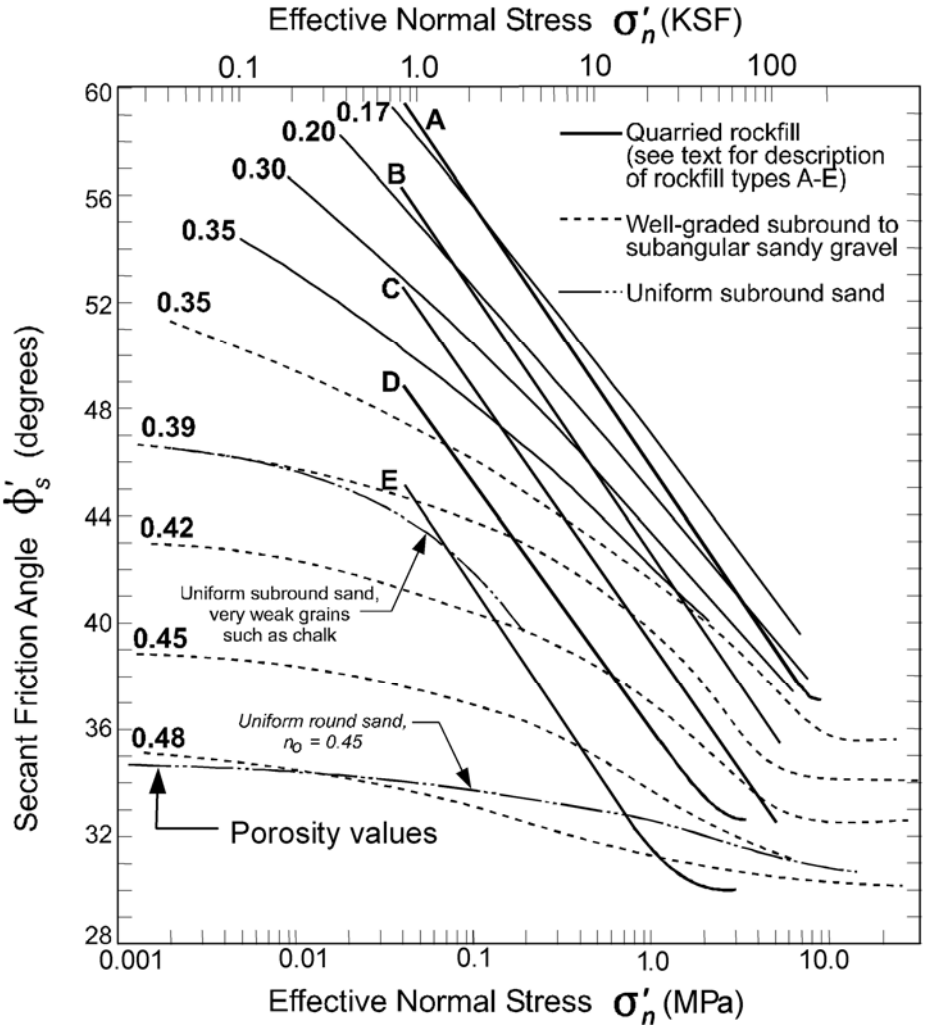
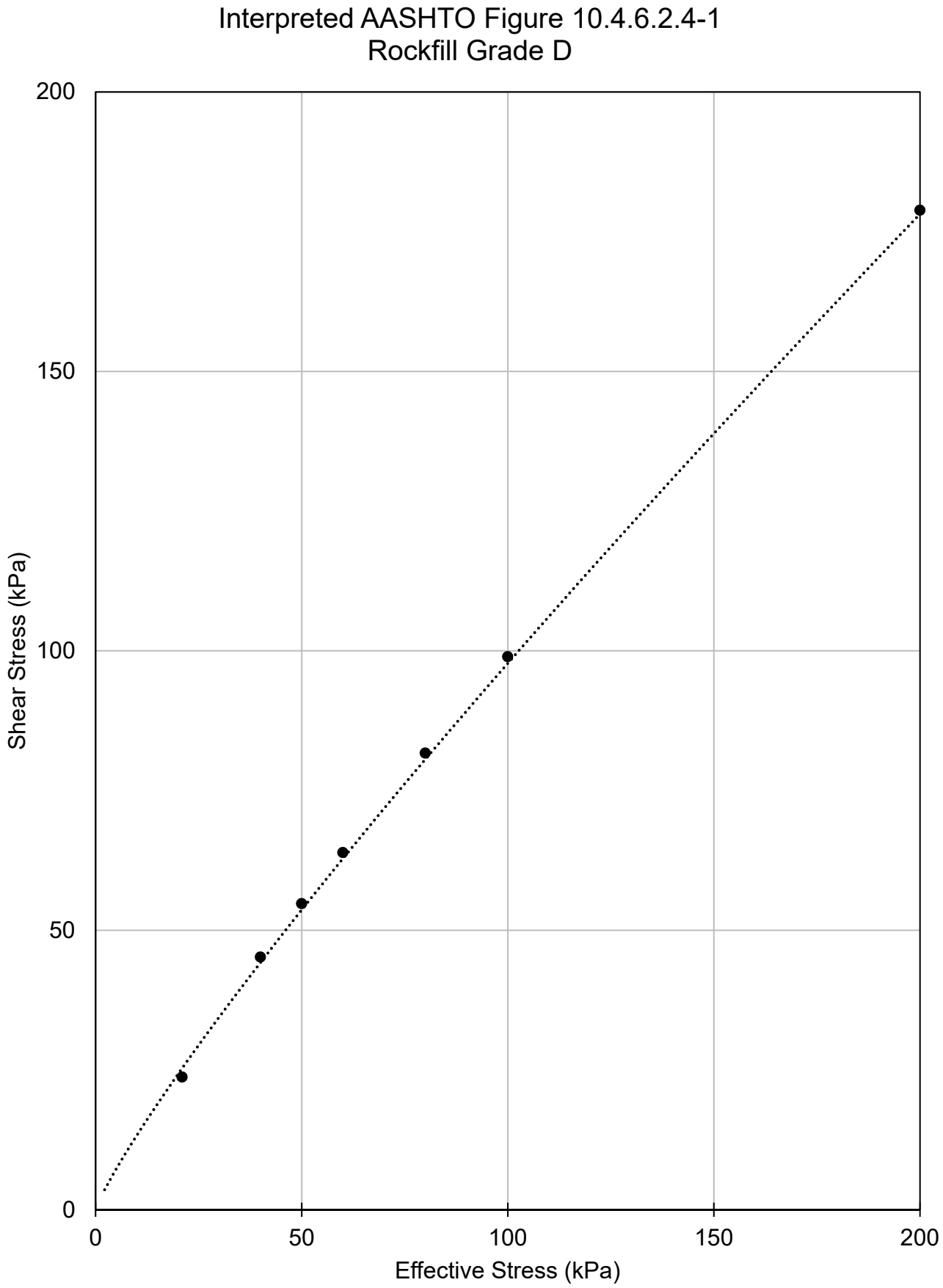


Figure 10.4.6.2.4-1—Estimation of Drained Friction Angle of Gravels and Rock Fills (modified after Terzaghi, Peck, and Mesri, 1996)

[copied from Page 10-18 of the AASHTO LRFD Bridge Design Specification[1]]

[1] American Association of State Highways and Transportation Officials (2017). AASHTO LRFD Bridge Design Specification, Washington, D.C.,


Interpreted AASHTO Figure 10.4.6.2.4-1
Rockfill Grade D
Shear Stress (kPa)
Effective Stress (kPa)
0
50
100
150
200
0
50
100
150
200

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Appendix I.2

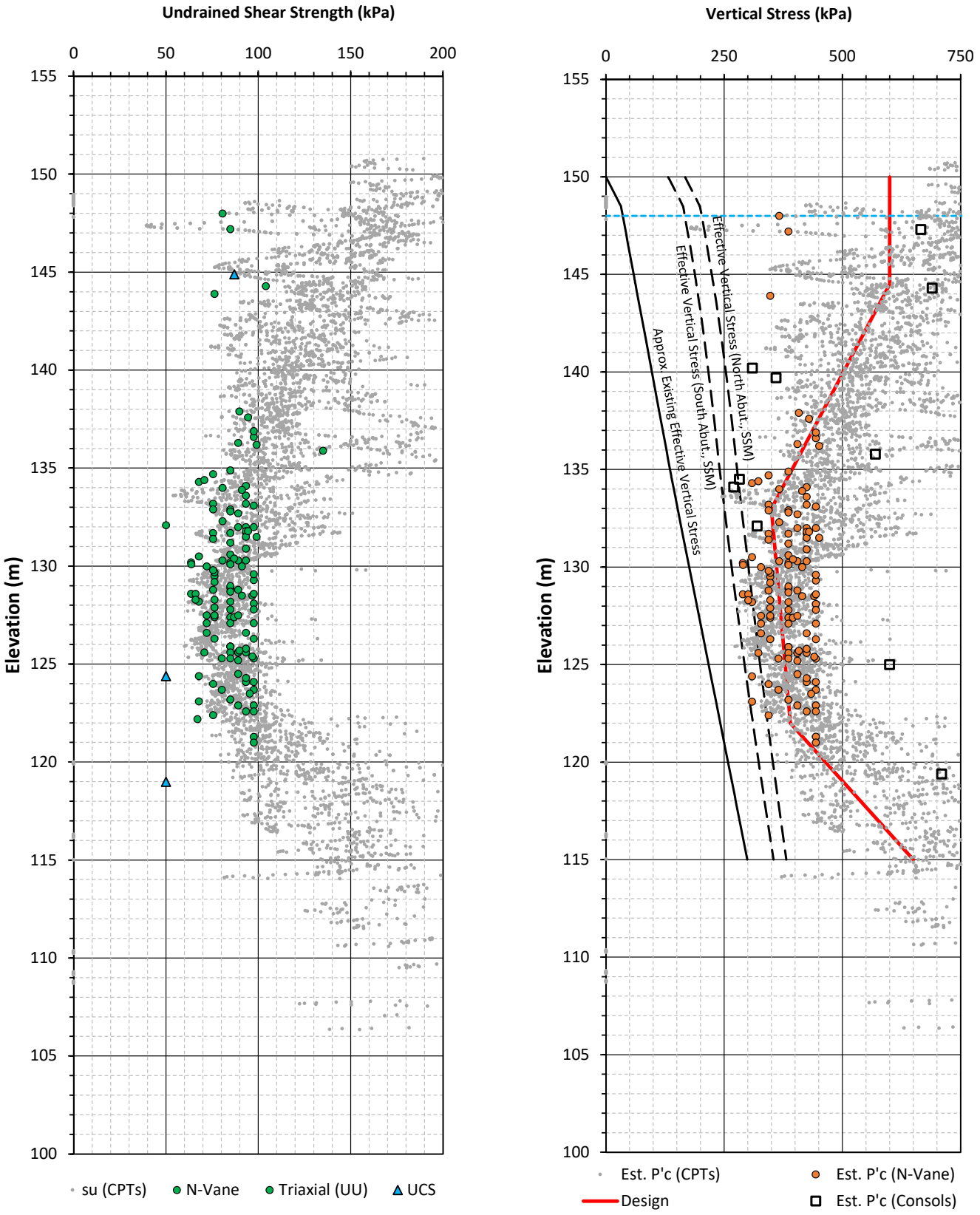
Settlement Analysis Design Parameters and Results

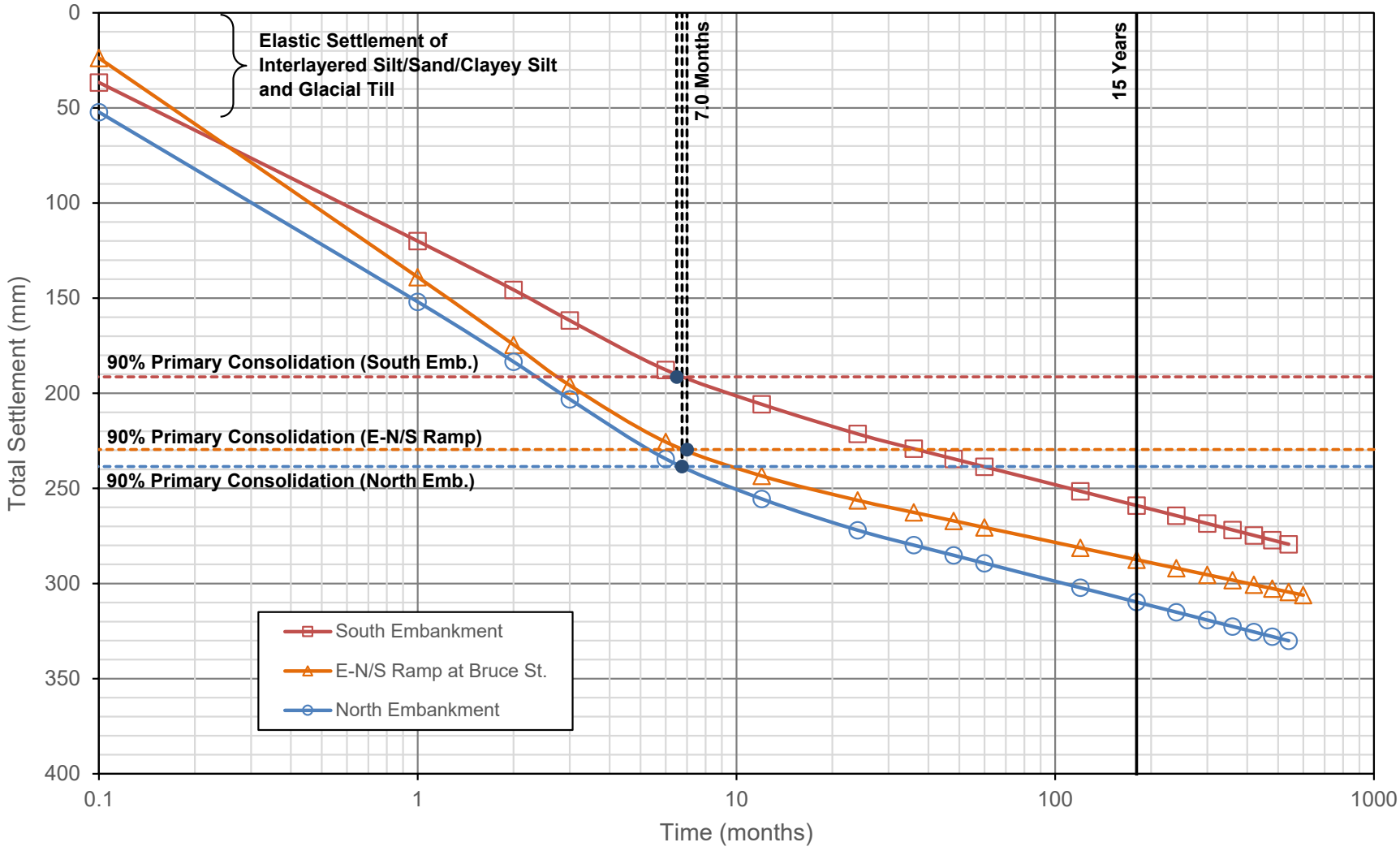
FIGURE I8.1

DESIGN SOIL SUMMARY PROFILE - BRUCE STREET ALIGNMENT

(Boreholes: BRU19-01 to BRU19-15A, BRU19-18, BRU19-19, BRU19-22 to BRU19-25)

(CPTs: BRU19-05, BRU19-14, BRU19-20, BRU19-24)





THURBER ENGINEERING LTD.

Settlement Analysis
Bruce Street (County Road 20) Interchange
Renfrew County, Ontario

W.P. 4068-09-00
Project No.: 24726

FIGURE I8.2

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Appendix J.

List of Referenced Specifications

Non-Standard Special Provisions

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

OPSD 3090.101	Foundation Frost Depths for Southern Ontario
OPSD 3101.150	Walls Abutment, Backfill Minimum Granular Requirement
OPSS.PROV 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
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 804	Construction Specification for Seed and Cover
OPSS.PROV 902	Construction Specification for Excavating and Backfilling Structures
OPSS.PROV 903	Construction Specification for Deep Foundations
SP 517F01	Amendment to OPSS 517 - Construction Specification for Dewatering
SP110S06	Amendment to OPSS 1010 - Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material

2. Suggested wording for Contract Provisions

“Structural Backfill”

Structural backfill for retaining walls and wing walls shall consist of OPSS Granular B Type II or Quarry Sourced OPSS Granular A material in accordance with SP110S06.

“Obstructions”

The Contractor is hereby notified that the native tills at the site should be expected to contain cobbles and boulders. Considerations of these obstructions must be made in the selection of appropriate equipment and procedures for excavations, installations of deep foundations and temporary protection systems.

“Protection of Sensitive Foundation Soils”

The Contractor is advised that the native silty clay to clayey silt that will be exposed at the subgrade is 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 implementing adequate groundwater control measures and to minimize construction and personnel traffic on the founding subgrade.

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“Sloping Bedrock”

The contractor is hereby notified that marble bedrock with variable elevation was encountered at the site. Where deep foundations are designed for end bearing on bedrock, installation lengths should be expected to vary across the site.