THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
SUNNIDALE ROAD UNDERPASS
HIGHWAY 400
CITY OF BARRIE, ONTARIO
SITE 30-173
G.W.P. 2445-15-00

GEOCRES NO. 31D-771

Latitude:44.392498°
Longitude:-79.703831°

Report

to

McIntosh Perry

Date: October 12, 2021
File: 22424

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the existing Highway 400 Sunnidale Road underpass structure located in the City of Barrie, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the proposed foundation locations, and based on the data obtained, to provide borehole location and soil strata drawings, records of boreholes, laboratory test results, and a written description of the subsurface conditions. A model of the subsurface conditions was developed for the site, based on data obtained from the present investigation and selected data from previous investigations by others, to describe the geotechnical conditions influencing design and construction of the foundations and approach embankments for the structure.

Thurber was retained by McIntosh Perry (MP) to carry out this foundation investigation under the Ministry of Transportation Ontario (MTO) Assignment Number 2017-E-0032. The overall assignment includes reconstruction of the Dunlop Street and Highway 400 interchange, and replacement of the Highway 400 at Dunlop Street and Anne Street underpass structures. This report addresses the proposed replacement of the Sunnidale Road underpass structure.

Reference has been made to information on subsurface conditions contained in a previous foundation report prepared by others for this site. The title of this report is:

- Preliminary Foundation Investigation Report, Sunnidale Road Underpass, Site 30-173, Highway 400 Widening, from 1 Km South of Highway 89 to Junction of Highway 11, Ministry of Transportation, Ontario, W.O. 06-20016, prepared by Golder Associates Ltd., GEOCRES No. 31D-665, dated October 20, 2016. (Reference 1).

2 SITE DESCRIPTION

The existing Sunnidale Road underpass structure is located at the intersection of Highway 400 and Sunnidale Road in Barrie, Ontario. The underpass structure runs in a east-west direction and carries two lanes of Sunnidale Road traffic over Highway 400. Based on the General Arrangement (GA) drawing, the existing underpass consists of a single-span reinforced concrete rigid frame supported on spread footings. The total length of the bridge is approximately 28.8 m between abutments, and the width is about 11.8 m. The bridge is at an approximate 5° skew to the centreline of Highway 400. There is also a 1.8 m wide sidewalk with steel railing along the north side of the structure. There are approach slabs at both ends of the structure. The length of the west and east approach slabs are 7.0 m and 6.8 m, respectively.

The overall surface topography in the vicinity of the site is relatively flat and consists of residential and commercial properties to the east and west of Highway 400. At the structure site, Highway 400 was constructed in a cut of up to approximately 8.5 m deep. The existing grade of Highway 400 is at approximate Elevation 248.5. The Sunnidale Road grade rises from approximate Elevations 254.0 to 257.6, east to west.

Photographs of the site, taken during the course of the investigation, are presented in Appendix D.

Based on published geological mapping, the study area is located within the Simcoe Lowlands physiographic region. This region borders Georgian Bay and Lake Simcoe and can generally be separated into two major divisions: the Nottawasaga basin to the west, consisting of plains draining into Nottawasaga Bay, and the Lake Simcoe basin to the east, consisting of the lowlands which surround Lake Simcoe. These two basins are connected at Barrie by a flat- floored valley which extends from the shores of Kempenfelt Bay. The Simcoe Lowlands region is generally comprised of sand, silt and clay deposits of deltaic and lacustrine origin.

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3 SITE INVESTIGATION AND FIELD TESTING

The current borehole investigation and field testing program for this site was carried out between January 28 and July 20, 2019, and consisted of drilling and sampling five (5) boreholes, designated as Boreholes SUN-01 to SUN-05. Three boreholes (SUN-01, SUN-02 and SUN-05) were drilled near the locations of the proposed foundation elements (abutments and pier) and terminated at depths ranging from 24.7 m to 24.8 (Elevations 223.7 to 232.7). The other two boreholes (SUN-03 and SUN-04) were drilled for the immediate approaches and terminated at 9.5 m to 9.8 m depths (Elevations 244.6 and 247.9). The records of borehole sheets of the present investigation are provided in Appendix A.

A geotechnical investigation was carried out at this site on February 6 and 7, 2001 (Reference 1), and consisted of advancing two boreholes (labelled B13-1 and B13-2). Boreholes B13-1 and B13-2 were drilled near the existing west and east abutments, respectively. The depths of the boreholes were 12.4 m and 13.4 m (Elevations 244.4 and 241.7). The Record of Borehole sheets for the boreholes from this previous investigation are included in Appendix C.

The approximate locations of all the boreholes (previous and present investigations) are shown on the Borehole Location Plan and Stratigraphic Drawings in Appendix E.

McIntosh Perry surveyed the boreholes in the field using a combination of GPS and total station equipment, and provided Thurber with the borehole coordinates and ground surface elevations. It is understood that the horizontal and vertical accuracy of the survey results meet the MTO terms of reference requirements of 0.5 m and 0.1 m, respectively. The coordinates and elevations of the boreholes are given on the individual Record of Borehole Sheets and the drawings in Appendices A and E, respectively.

Lane closures and traffic control were implemented for drilling each borehole for the current investigation. Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

The current boreholes were advanced using track-mounted and truck-mounted drill rigs using hollow stem augers, as well as wash boring with tri-cone and casing. Soil samples were obtained at selected depth intervals using a 50 mm outside diameter split-spoon sampler driven in conjunction with the Standard Penetration Test (SPT) which was performed in accordance with ASTM D1586.

The current field investigation was supervised on a full-time basis by a member of Thurber's technical staff who marked/staked the boreholes in the field, directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the current drilling operations. Two standpipe piezometers (25 mm diameter) were installed and enclosed in filter sand in selected boreholes to permit groundwater level monitoring. One standpipe piezometer was installed in Borehole B13-2 during the 2001 investigation. The details of the piezometers are shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth/ Elevation (m)	Completion Details
West Abutment	SUN-01	24.7 / 232.7	24.4 / 233.0	Piezometer with 3.0 m slotted screen installed with sand filter from 24.7 m to 18.3 m. Borehole caved to 17.7 m, then backfilled with bentonite holeplug from 17.7 m to ground surface.
East Abutment	SUN-05	24.7 / 227.9	12.2 / 240.4	Borehole caved to 12.2 m. Piezometer with 3.0 m slotted screen installed with sand filter from 12.2 m to 8.8 m, bentonite holeplug from 8.8 m to 7.9 m, then auger cuttings from 7.9 m to ground surface.
	B13-2(1)	13.4 / 241.7	13.1 / 242.0	Piezometer installed with sand filter from 13.4 m to 10.6 m, bentonite holeplug from 10.6 m to 0.4 m, then concrete from 0.4 m to ground surface.

(1) Borehole drilled during the previous investigation (Reference 1). Borehole backfilled description was interpreted from Record of Borehole Sheet (B13-2).

All boreholes without standpipe piezometer were backfilled upon completion of drilling in general accordance with O.Reg. 903. Once the final readings are taken, the two piezometers from the current investigation will be decommissioned in general accordance with O.Reg. 903. Asphalt was reinstated in boreholes drilled on the highway or road platform (Boreholes SUN-02 to SUN-04).

4 LABORATORY TESTING

The recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and/or hydrometer), and Atterberg Limits testing. Geotechnical laboratory testing results of the current investigation, are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B. Laboratory tests results from the previous investigation (Reference 1) are included in Appendix C.

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

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendices A and C, and on the Borehole Locations and Soil Strata drawings in Appendix E. A general description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized and anticipated that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface stratigraphy encountered at the site consists of pavement structure or topsoil overlying embankment fill which is underlain by an upper layer of silty sand to sand and silt till, and layers of sand, silty sand and sandy silt. Interbedded layers of hard silty clay/clayey silt and clayey silt till were encountered within the cohesionless soils. A lower deposit of very dense silty sand till with occasional lenses of gravelly sand were encountered in Borehole SUN-01. The groundwater level was observed to be at approximately 9 m to 11 m depths below the Sunnidale Road grade and in the order of 2 m to 5 m below the Highway 400 grade.

More detailed descriptions of the individual stratum are presented below.

5.1 Topsoil

A layer of topsoil was encountered surficially in Boreholes SUN-01 and SUN-05 with measured thicknesses of 700 mm and 200 mm, respectively.

The natural moisture contents measured on samples of the topsoil were 9 percent and 24 percent.

An SPT 'N' value of 11 blows per 0.3 m penetration was measured in Borehole SUN-01 indicating a compact condition.

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

5.2 Pavement Structure

Pavement structure consisting of approximately 100 mm to 200 mm of asphalt overlying granular (sand and gravel fill, sand fill) road base was encountered in the boreholes advanced through the Sunnidale Road platform (Boreholes SUN-03 and SUN-04), and the Highway 400 platform (Borehole SUN-02). The granular fill ranged in thickness from 1.0 m to 1.2 m. In Boreholes B13-1 and B13-2, the asphalt was approximately 200 mm thick, but a road base thickness was not identified.

SPT 'N' values recorded in the sand and gravel fill and sand fill ranged from 8 to 45 blows per 0.3 m of penetration indicating a loose to dense condition. The moisture contents measured on samples of the road base fill ranged from 2 percent to 7 percent.

The results of grain size analyses conducted on samples of the granular road base fill are provided on the Record of Borehole sheets in Appendix A, and illustrated on Figure B1 Appendix B. The results are summarized as follows:

Soil Particle	Granular Road Base Fill (Percent)
Gravel	9
Sand	79
Silt and Clay	12

5.3 Embankment Fill

Embankment fill was encountered underlying the pavement structure in the boreholes advanced through the Sunnidale Road platform (Boreholes SUN-03, SUN-04, B13-1 and B13-2), and below the topsoil in Borehole SUN-01.

The embankment fill typically consisted of layers of brown sand and silt, sand and gravel, and sand, containing some gravel and trace to some clay. The fill also contained occasional cobbles. A 1.1 m thick layer of silty clay fill was contacted in Borehole SUN-03 at 1.1 m depth.

The overall thickness of the embankment fill varied from 1.1 m to 3.4 m in Boreholes SUN-01, SUN-03 and SUN-04. In Boreholes B13-1 and B13-2, the embankment fill was 7.1 m and 6.7 m thick, respectively.

The SPT 'N' values recorded in the cohesionless embankment fill ranged from 9 to 62 blows per 0.3 m of penetration indicating a loose to very dense condition. SPT 'N' values of 8 and 11 blows per 0.3 m of penetration were measured in the silty clay fill indicating a firm to stiff consistency.

The natural moisture contents measured on samples of the cohesionless fill generally ranged from 9 percent to 21 percent. Moisture contents of 8 to 12 percent were measured in the silty clay fill.

The results of a grain size analyses conducted on samples of the sand and silt fill are provided on the Record of Borehole sheets in Appendix A, and illustrated on Figure B2 Appendix B. The results are summarized as follows:

Soil Particle	Embankment Fill (Percent)
Gravel	1 to 12
Sand	45 to 57
Silt	40
Clay	14
Silt and Clay	13

5.4 Upper Silty Sand to Sand and Silt Till

An upper layer of native brown silty sand to sand and silt till containing trace gravel, trace clay and occasional cobbles was contacted below the fill at depths ranging from 1.4 m to 5.6 m, and at 0.2 m below the topsoil in Borehole SUN-5. The thickness of this till varied from 2.7 m to

11.4m. The depth to the base of this upper till ranged from 4.0 m to 16.3 m (Elevations 248.6 to 241.1).

Borehole SUN-04 was terminated within the upper silty sand till at 9.8 m depth (Elevation 247.9).

The SPT 'N' values recorded in the upper silty sand till and sand and silt till layer ranged from 17 to over 100 blows per 0.3 m of penetration indicating a compact to very dense condition. An SPT 'N' value of 6 blows per 0.3 m of penetration, indicating a loose state, was measured in Borehole SUN-05 just below the topsoil. The natural moisture contents measured on samples of cohesionless till ranged from 6 percent to 19 percent.

The results of grain size distribution analyses carried out on selected samples of the upper silty sand till and sand and silt till are shown on Figure B3 in Appendix B, and Figure 1 in Appendix C. The results are summarized as follows:

Soil Particle	Silty Sand Till to Sand and Silt Till (Percent)
Gravel	4 to 7
Sand	50 to 59
Silt	26 to 39
Clay	3 to 9

Glacial tills inherently contain cobbles and boulders. Auger grinding was noted in the till in Borehole SUN-01.

5.5 Gravelly Sand

An 800-mm thick layer of brown gravelly sand was contacted at 12.2 m depth in Borehole SUN-01.

An SPT 'N' value measured in the gravelly sand was 100 blows per 0.225 m of penetration, indicating a very dense state. The moisture content measured in the gravelly sand was 9 percent.

5.6 Sand to Silty Sand

Layers of brown sand to silty sand containing trace to some gravel, trace to some silt and trace clay were contacted at depths ranging from 3.0 m to 7.3 m in Boreholes SUN-02 to SUN-05, B13-1 and B13-2, and at 16.3 m in Borehole SUN-01. The thickness of the sand to silty sand

ranged from 0.7 m to 7.6 m.

The depth to the base of the sand to silty sand varied from 5.6 m to and 24.0 m (Elevations 252.0 to 233.4) in Boreholes SUN-01, SUN-02, SUN-04 and B13-1.

Boreholes SUN-03, SUN-05 and B13-2 were terminated within the sand to silty sand layer at depth varying from 9.5 m to 24.7 m (Elevations 244.6 to 227.9).

The SPT 'N' values recorded in the sand varied from 13 to 134 blows per 0.3 m of penetration to greater than 100 blows for 0.175 m of penetration indicating compact to very dense condition. The natural moisture contents measured on the sand/silty sand samples ranged from 2 percent to 33 percent.

The results of grain size analyses conducted on sand samples are provided on the Record of Borehole sheets in Appendix A, and illustrated on Figures B4 and B5 of Appendix B, and Figure 2 of Appendix C. The results are summarized as follows:

Soil Particle	Sand (Percent)	Silty Sand (Percent)
Gravel	0	0
Sand	84 to 97	65 to 76
Silt	7 to 13	22 to 32
Clay	0 to 3	2 to 3
Silt and Clay	3	-

5.7 Silty Clay and Clayey Silt

Interbedded layers of brown to grey silty clay and clayey silt containing trace sand were contacted in the cohesionless soils at 14.8 m and 8.7 m depths in Boreholes SUN-02 and SUN-05, respectively. The thickness of the silty clay/clayey silt was 3.6 m and 7.6 m.

In Borehole B13-1, drilled during the previous investigation, a layer of brown clayey silt till was contacted at 10.5 m depth.

The depth to the base of the silty clay/clayey silt was at 22.4 m and 12.3 m (Elevations 226.2 and 240.3) in Boreholes SUN-02 and SUN-05, respectively. Borehole B13-1 was terminated within the clayey silt till at 12.4 m (Elevation 244.4) depth.

SPT 'N' values in the silty clay/clayey silt ranged from 37 to 100 blows per 0.3 m of penetration, indicating a hard consistency. The SPT 'N' values measured in Borehole B13-1, in the clayey silt

till were 102 blows per 0.3 m of penetration and 100 blows per 0.18 m of penetration, indicating a hard consistency. Moisture contents measured in the silty clay/clayey silt/clayey silt till ranged from 18 percent to 35 percent in the boreholes drilled during the present investigation. Moisture content measured in the clayey silt till in Borehole B13-2 drilled during the previous investigation had a moisture content of 9 percent.

The results of grain size distribution analyses carried out on selected samples of the silty clay/clayey silt are presented on the Record of Borehole sheets included in Appendix A. Grain size distribution curves of samples tested during the present investigation are presented on Figure B6 Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Silty Clay /Clayey Silt (Percent)
Gravel	0
Sand	1
Silt	50 to 77
Clay	22 to 49

The results of Atterberg Limits tests conducted on samples of the silty clay/clayey silt are presented on the Record of Borehole sheets in Appendix A, and illustrated in Figure B8 of Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	29 to 41
Plasticity Index	14 to 22

The results of the Atterberg Limits testing indicate that the silty clay/clayey silt is of low to medium plasticity with group symbols of CL and CI.

5.8 Lower Silty Sand Till/Sandy Silt Till

Lower layers of brown silty sand till and sandy silt till containing trace to some gravel and trace clay were contacted in Boreholes SUN-01 and SUN-02 at 20.9 m and 11.7 m depth, respectively, and also at 24.0 m depth in Borehole SUN-01. The thickness of the lower sandy silt till was 3.1 m in Borehole SUN-02.

The depth to the base of the lower silty sand till/sandy silt till was at 14.8 m (Elevation 233.8) in Borehole SUN-02. Borehole SUN-01 was terminated within the lower silty sand till at 24.7 m depth (Elevation 232.7).

SPT ‘N’ values recorded in the lower silty sand till were greater than 100 blows per 0.175 m, indicating a very dense state. The natural moisture contents measured on the lower silty sand till samples ranged from 19 percent to 22 percent.

Glacial tills inherently contain cobbles and boulders.

5.9 Sandy Silt

Grey sandy silt containing trace clay was contacted at 22.4 m depth in Borehole SUN-02.

Borehole SUN-02 was terminated within the sandy silt at 24.8 m depth (Elevation 223.7).

The SPT ‘N’ values recorded in the sandy silt deposit ranged from 100 blows per 0.3 m of penetration and 100 blows for 0.25 m of penetration indicating a very dense condition. The natural moisture content measured on samples of the sandy silt was 19 percent.

The results of grain size distribution analyses carried out on the sandy silt are shown on Figure B7 in Appendix B. The results are summarized as follows:

Soil Particle	Silty Sand to Sandy Silt (Percent)
Gravel	0
Sand	22
Silt	73
Clay	5

5.10 Groundwater Conditions

Groundwater levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. Standpipe piezometers were installed in Boreholes SUN-01, SUN-05 and B13-2 to permit monitoring of groundwater levels. Water levels measured in the three installed standpipes and open boreholes from the current investigation are presented in Table 5.1 below.

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Table 5.1 - Groundwater Level Measurements

Foundation Unit	Borehole	Date	Groundwater Level		Comments
			Depth (m)	Elev. (m)	
West Abutment	SUN-01	June 18, 2019	-	-	Open borehole (caved to 18.3 m)
		July 4, 2019	10.6	246.8	
		August 27, 2019	10.9	246.5	
		March 4, 2021	11.2	246.2	Piezometer
		April 19, 2021	10.9	246.5	
		April 30, 2021	10.9	246.5	
		June 22, 2021	11.0	246.4	
	SUN-04	July 4, 2019	Dry	-	Open borehole
	B13-1[(1)]	February 6, 2001	Dry	-	Open borehole
Pier	SUN-02	January 20, 2019	-	-	Unable to determine water level due to use of drilling mud
East Abutment	SUN-03	July 4, 2019	Dry	-	Open borehole
	SUN-05	July 20, 2019	-	-	Open borehole (caved to 12.2 m)
		August 27, 2019	9.5	243.1	
		March 4, 2021	10.2	242.4	
		April 19, 2021	9.9	242.7	Piezometer
		April 30, 2021	9.9	242.7	
		June 22, 2021	9.9	242.7	
	B13-2[(1)]	February 7, 2001	11.0	244.1	Open borehole
		March 15,2001	9.0	246.1	

The values shown in Table 5.1 are short-term readings, and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant or prolonged precipitation.

5.11 Corrosivity and Sulphate Test Results

Selected soil samples were submitted for analytical testing of corrosivity parameters including sulphate content. The results of the analytical tests are shown in Table 5.2. The laboratory certificates of analysis are presented in Appendix B.

Table 5.2 – Analytical Corrosivity Test Results

Sample ID	Depth (m)	Soil Sample Descripti	Sulphide (percent)	Chloride (µg/g)	Sulphate (µg/g)	pH	Resistivity (ohm.cm)	Redox Potential (mV)	Electrical Conductivity (µS/cm)
SUN-01 SS5	3.0 - 3.6	Sand and silt fill	<0.2	34	2.3	9.17	4720	365	212
SUN-02 SS4	3.0 - 3.6	Silty sand till	<0.2	52	4.4	9.09	4550	348	220
SUN-03 SS2	1.5 - 2.1	Silty clay fill	<0.2	1900	57	8.64	331	278	3020
SUN-05 SS7	6.1 - 6.7	Silty sand	<0.2	66	6.3	9.69	3160	303	316

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. McIntosh Perry surveyed the boreholes in the field, and provided the borehole coordinates and ground surface elevations.

Walker Drilling of Utopia, Ontario supplied and operated the drilling and sampling equipment for the field program.

Full time supervision of the field activities was carried out by Mr. Bryan Lui and Mr. Kevin Kweon of Thurber. Overall supervision of the field program was performed by Mr. Karel Furbacher, P.Eng. of Thurber.

Interpretation of the field data and preparation of the report were carried out by Ms. Rocio Palomeque Reyna, P.Eng. and Dr. Sydney Pang, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Appendix A

Record of Borehole Sheets
Present Investigation

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

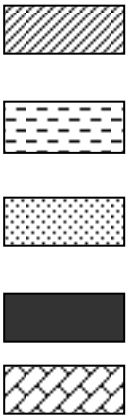
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

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

TERMS

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

STRENGTH CLASSIFICATION

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

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-01 1 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 997.6 E 288 541.5 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers and Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.06.17 - 2019.06.18 LATITUDE 44.392803 LONGITUDE -79.704080 CHECKED BY GRL

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)	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
257.4	GROUND SURFACE										
0.0 / 256.8	**TOPSOIL**, some silt and sand, trace gravel, occasional organics Compact Dark Brown Moist		1	SS	11		257		○		
0.7	**SAND** and **SILT**, trace gravel, some clay Compact to Dense Brown Moist (FILL) Clayey silt layer at 1.2m (200mm)		2	SS	15		256		○ ○		
			3	SS	28				○		
			4	SS	30		255		○		1 45 40 14
253.3			5	SS	49		254		○		
4.1	Silty **SAND**, trace gravel, trace clay, occasional cobbles Very Dense Brown Moist (TILL)		6	SS	100		253		○		Augers grinding at 4.6m
			7	SS	100/ 0.050		252				Augers grinding at 6.0m Switch to Tricone Spoon bouncing No recovery
	Occasional cobbles from 6.9m to 7.2m		8	SS	100/ 0.225		251		○		7 58 26 9
			9	SS	100/ 0.225		250		○		
			10	SS	100/ 0.075		249		○		
247.5							248				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-01 2 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 997.6 E 288 541.5 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers and Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.06.17 - 2019.06.18 LATITUDE 44.392803 LONGITUDE -79.704080 CHECKED BY GRL

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
	Continued From Previous Page										
9.9	**SAND** and **SILT**, trace gravel, trace clay Very Dense Brown Moist to Wet (TILL)		11	SS	58		247	○	○		4 59 34 3
245.3							246				
12.2	Gravelly **SAND** Very Dense Brown Wet		12	SS	100/ 0.225		245	○	○		
244.4											
13.0	**SAND** and **SILT**, trace gravel, trace clay Very Dense Brown Moist (TILL)		13	SS	100/ 0.100		244		○		
241.1							243				
16.3	**SAND**, trace to some gravel, trace to some silt Very Dense Brown Wet		14	SS	100/ 0.275		242		○		
							241				
			15	SS	100/ 0.250		240				
							239		○		
							238				

Continued Next Page

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 7/26/21

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Ontario

THURBER

RECORD OF BOREHOLE No SUN-01 3 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 997.6 E 288 541.5 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers and Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.06.17 - 2019.06.18 LATITUDE 44.392803 LONGITUDE -79.704080 CHECKED BY GRL

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, trace to some gravel, trace to some silt Very Dense Brown to Grey Wet		16	SS	100/ 0.250		237				
236.6											
20.9	Silty **SAND**, trace to some gravel, trace clay Very Dense Brown Moist (TILL)		17	SS	100/ 0.275		236				
235.0							235				
22.4	**SAND**, trace to some silt, trace clay Very Dense Brown Wet		18	SS	100/ 0.275		234				0 84 13 3
233.4											
24.0	Silty **SAND**, trace clay Very Dense Brown Moist (TILL)		19	SS	100/ 0.175		233				
232.7											
24.7	END OF BOREHOLE AT 24.7m. BOREHOLE CAVED TO 18.3m AND WATER LEVEL NOT OBSERVED. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2019.07.04	10.6	246.8
2019.08.27	10.9	246.5
2021.03.04	11.2	246.2
2021.04.19	10.9	246.5
2021.04.30	10.9	246.5
2021.06.22	11.0	246.4

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 7/26/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-02 1 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 963.7 E 288 561.3 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.01.28 - 2019.01.30 LATITUDE 44.392498 LONGITUDE -79.703831 CHECKED BY GRL

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
248.6	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND**, trace gravel, some silt and clay Dense Brown Moist (FILL)		1	GS			248		○		
247.1			1	SS	45				○		9 79 12 (SI+CL)
1.4	Silty **SAND**, trace to some gravel, trace clay, occasional cobbles Dense Brown Moist to Wet (TILL)		2	SS	32		247		○		
			3	SS	42		246		○		
			4	SS	35		245		○		
244.5											
4.1	**SAND**, trace silt, trace clay Very Dense Brown Moist		5	SS	134		244		○		0 97 3 (SI+CL)
							243				Switch to Tricone
	Moist to Wet		6	SS	100/ 0.250		242		○		
			7	SS	100/ 0.275		241		○		
							240				
			8	SS	100/ 0.250		239		○		

Continued Next Page

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

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

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No SUN-02 2 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 963.7 E 288 561.3 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.01.28 - 2019.01.30 LATITUDE 44.392498 LONGITUDE -79.703831 CHECKED BY GRL

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)	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, trace silt, trace clay Very Dense Grey Moist										
			9	SS	100		238				
236.9							237				
11.7	Sandy **SILT**, trace clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/ 0.250		236				
			11	SS	100/ 0.225		235				
233.8							234				
14.8	Clayey **SILT**, trace sand Hard Grey Moist		12	SS	38		233				
			13	SS	49		232				
							231				
			14	SS	74		230				0 1 77 22
							229				

Continued Next Page

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 7/26/21

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Ontario

THURBER

RECORD OF BOREHOLE No SUN-02 3 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 963.7 E 288 561.3 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.01.28 - 2019.01.30 LATITUDE 44.392498 LONGITUDE -79.703831 CHECKED BY GRL

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**, trace sand Hard Grey Moist		15	SS	84		228				
			16	SS	100		227				
226.2											
22.4	Sandy **SILT**, trace clay Very Dense Grey Moist		17	SS	100/0.250		226				0 22 73 5
							225				
223.7			18	SS	100		224				
24.8	END OF BOREHOLE AT 24.8m. BOREHOLE OPEN BUT NOT ABLE TO DETERMINE THE WATER LEVEL AS MUD WAS USED DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.3m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 7/26/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-03 1 OF 2 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 957.8 E 288 605.2 ORIGINATED BY KK

DIST Central HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.04 - 2019.07.04 LATITUDE 44.392447 LONGITUDE -79.703280 CHECKED BY GRL

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
254.0	GROUND SURFACE						254				
0.0	**ASPHALT:** (100mm)										
0.1	**SAND** and **GRAVEL** Loose Brown Moist (FILL)		1	GS							
252.9			1	SS	8		253				
1.1	Silty **CLAY**, some sand, trace gravel, occasional cobbles Stiff Brown Moist (FILL)		2	SS	11						
251.8							252				
2.2	**SAND** and **SILT**, trace gravel, trace clay, occasional cobbles Dense to Very Dense Brown Moist (TILL)		3	SS	39						4 50 39 7
			4	SS	32		251				
			5	SS	70		250				
			6	SS	87		249				
246.9							248				
7.2	Silty **SAND**, trace clay Very Dense Brown Moist		7	SS	72		247				
							246				
244.6			8	SS	100/0.175		245				0 76 22 2
9.5	END OF BOREHOLE AT 9.5m. BOREHOLE OPEN AND DRY UPON COMPLETION.										

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 SUN-03 2 OF 2 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 957.8 E 288 605.2 ORIGINATED BY KK

DIST Central HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.04 - 2019.07.04 LATITUDE 44.392447 LONGITUDE -79.703280 CHECKED BY GRL

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										
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 7/26/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-04 1 OF 2 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 985.9 E 288 533.3 ORIGINATED BY KK

DIST Central HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.04 - 2019.07.04 LATITUDE 44.392697 LONGITUDE -79.704182 CHECKED BY GRL

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
257.6	GROUND SURFACE										
0.0	**ASPHALT:** (125mm)										
0.1	**SAND** and **GRAVEL** Dense Brown Moist (FILL)		1	GS			257				
256.5			1	SS	34						
1.1	**SAND**, some gravel, trace to some silt and clay Compact Brown Moist (FILL)		2	SS	21		256				12 75 13 (SI+CL)
254.7			3	SS	23		255				
3.0	**SAND**, trace silt, trace clay Compact to Dense Brown Moist		4	SS	29		254				
252.0			5	SS	36		253				
5.6	Silty **SAND**, trace gravel, trace clay, occasional stains Very Dense Brown Moist (TILL)		6	SS	94		252				
			7	SS	96		251				
247.9			8	SS	73		250				
9.8	END OF BOREHOLE AT 9.8m.						249				
							248				

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 SUN-04 2 OF 2 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 985.9 E 288 533.3 ORIGINATED BY KK

DIST Central HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.04 - 2019.07.04 LATITUDE 44.392697 LONGITUDE -79.704182 CHECKED BY GRL

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										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.125m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 7/26/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-05 1 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 945.5 E 288 599.7 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.19 - 2019.07.20 LATITUDE 44.392336 LONGITUDE -79.703348 CHECKED BY GRL

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
252.6	GROUND SURFACE										
0.0	**TOPSOIL** (200mm)										
0.2	Silty **SAND**, trace gravel, trace to some clay Loose to Compact Brown Moist (TILL)		1	SS	6		252				
			2	SS	17						
			3	SS	19		251				
			4	SS	24		250				7 56 28 9
	Occasional cobbles from 3.0m to 3.7m Very Dense		5	SS	75		249				
248.6											
4.0	Silty **SAND**, trace gravel, trace clay Dense to Very Dense Brown Moist		6	SS	30		248				
			7	SS	41		247				
			8	SS	60		246				
							245				0 76 22 2
244.0							244				
8.7	Silty **CLAY**, trace sand Hard Grey to Brown Moist		9	SS	37		243				0 1 50 49 Tricone

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 SUN-05 2 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 945.5 E 288 599.7 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.19 - 2019.07.20 LATITUDE 44.392336 LONGITUDE -79.703348 CHECKED BY GRL

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										
	Silty **CLAY**, trace sand Hard Grey to Brown Moist						242				
			10	SS	49						
							241				
240.3											
12.3	Silty **SAND**, trace clay Compact to Very Dense Brown Moist to Wet		11	SS	13		240				
							239				
			12	SS	67						0 65 32 3
	Wet						238				
			13	SS	100/ 0.275		237				
236.4											
16.2	**SAND**, trace silt, trace clay Very Dense Brown Moist to Wet						236				
			14	SS	100/ 0.250						
							235				
			15	SS	100/ 0.275		234				
							233				

Continued Next Page

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 7/26/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-05 3 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 945.5 E 288 599.7 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.19 - 2019.07.20 LATITUDE 44.392336 LONGITUDE -79.703348 CHECKED BY GRL

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, trace silt, trace clay Very Dense Brown Moist to Wet		16	SS	100/ 0.225		232				
			17	SS	100/ 0.225		231				
							230				
			18	SS	100/ 0.250						0 90 7 3
							229				
227.9			19	SS	100/ 0.200		228				
24.7	END OF BOREHOLE AT 24.7m. BOREHOLE CAVED TO 12.2m AND WATER LEVEL NOT OBSERVED UPON COMPLETION. Piezometer installation consists of 30mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2019.08.27 9.5 243.1 2021.03.04 10.2 242.4 2021.04.19 9.9 242.7 2021.04.30 9.9 242.7 2021.06.22 9.9 242.7										

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

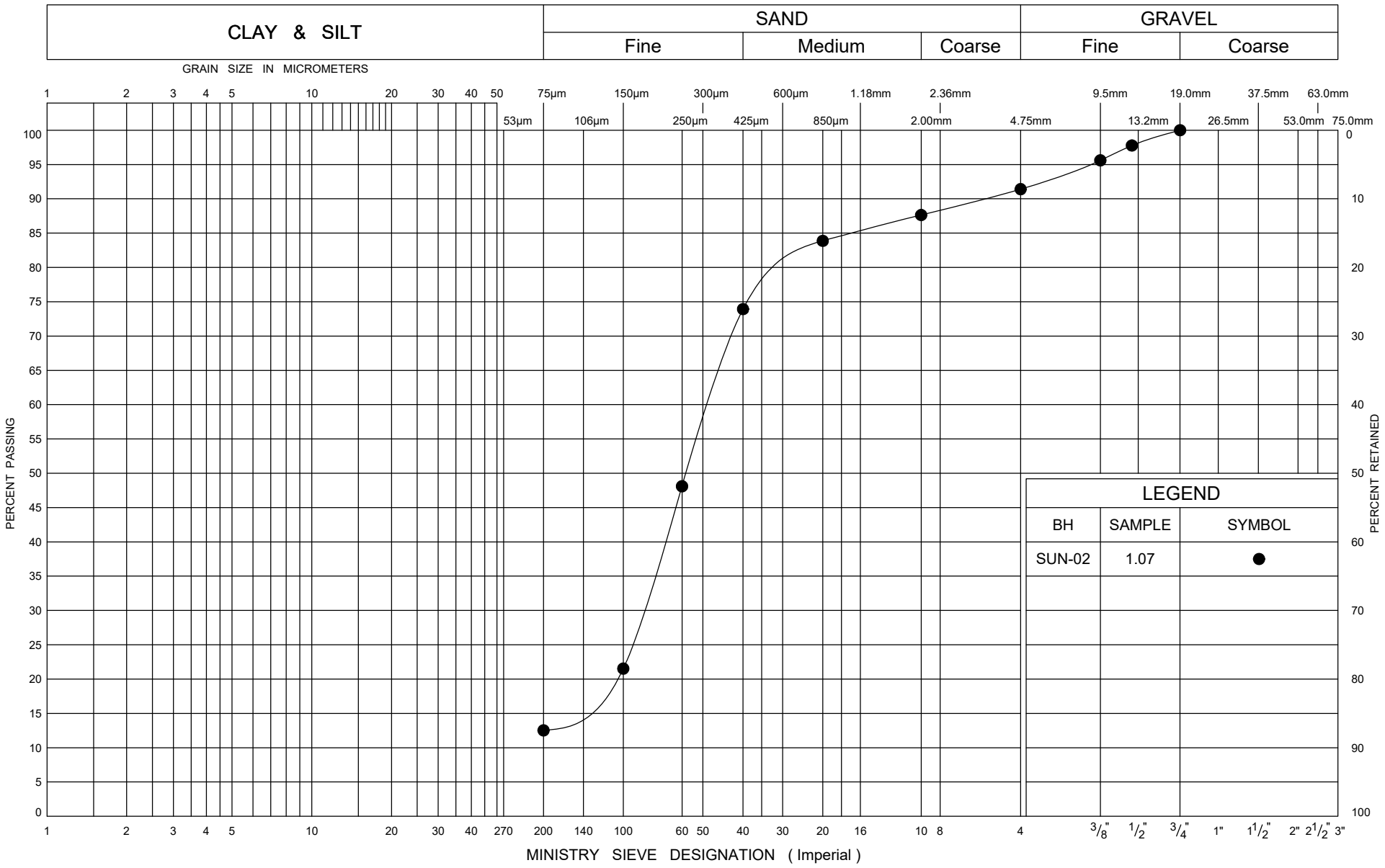
$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 7/26/21

THURBER

Appendix B

Geotechnical and Analytical Laboratory Test Results
Present Investigation



Ministry of Transportation
Ontario

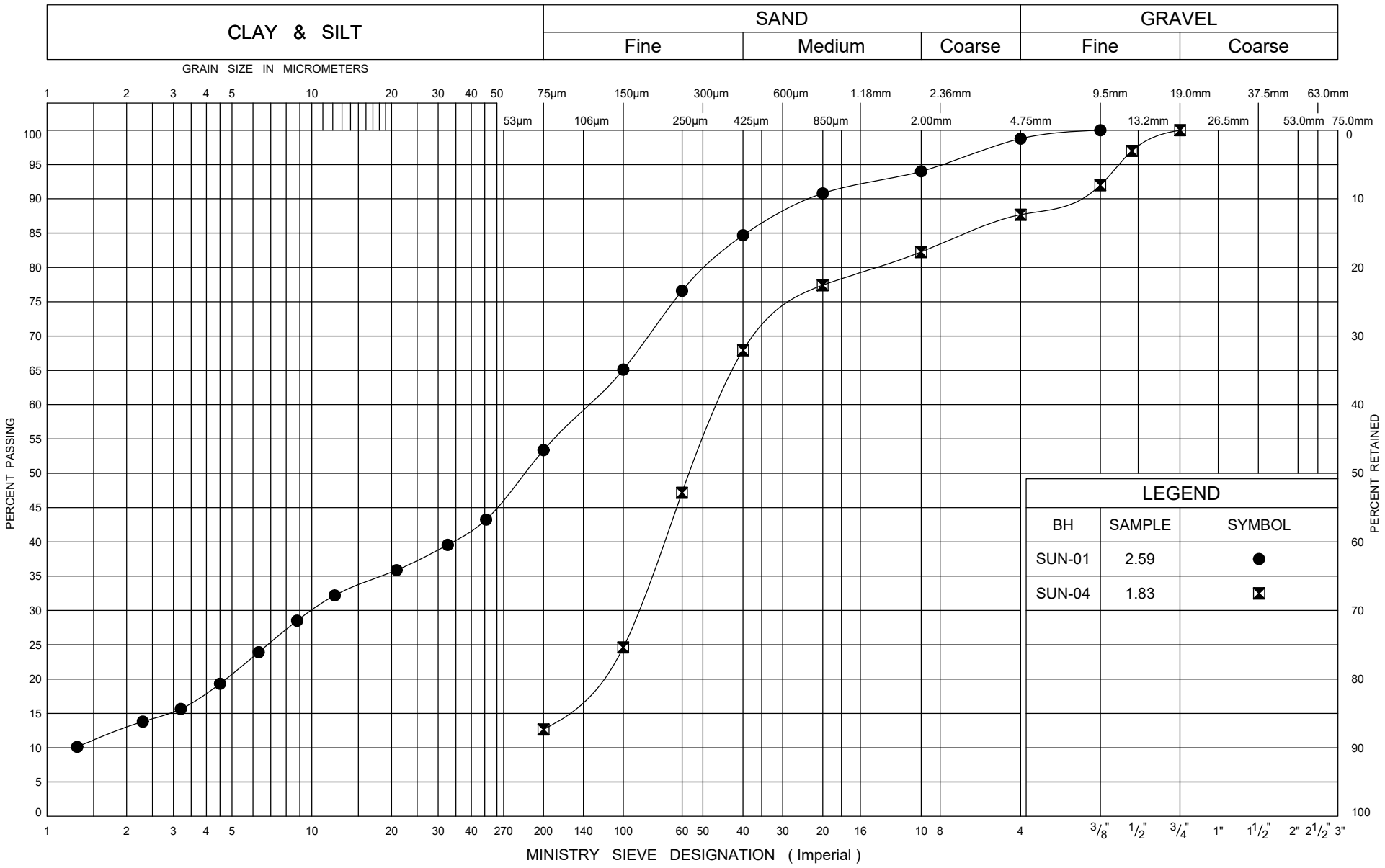
GRAIN SIZE DISTRIBUTION

SAND FILL (Granular Road Base)

FIG No B1

W P 2445-15-00

ONTARIO MOT GRAIN SIZE 2 MTO-22424.GPJ ONTARIO MOT.GDT 8/17/20



ONTARIO MOT GRAIN SIZE 2 MTO-22424.GPJ ONTARIO MOT.GDT 8/17/20

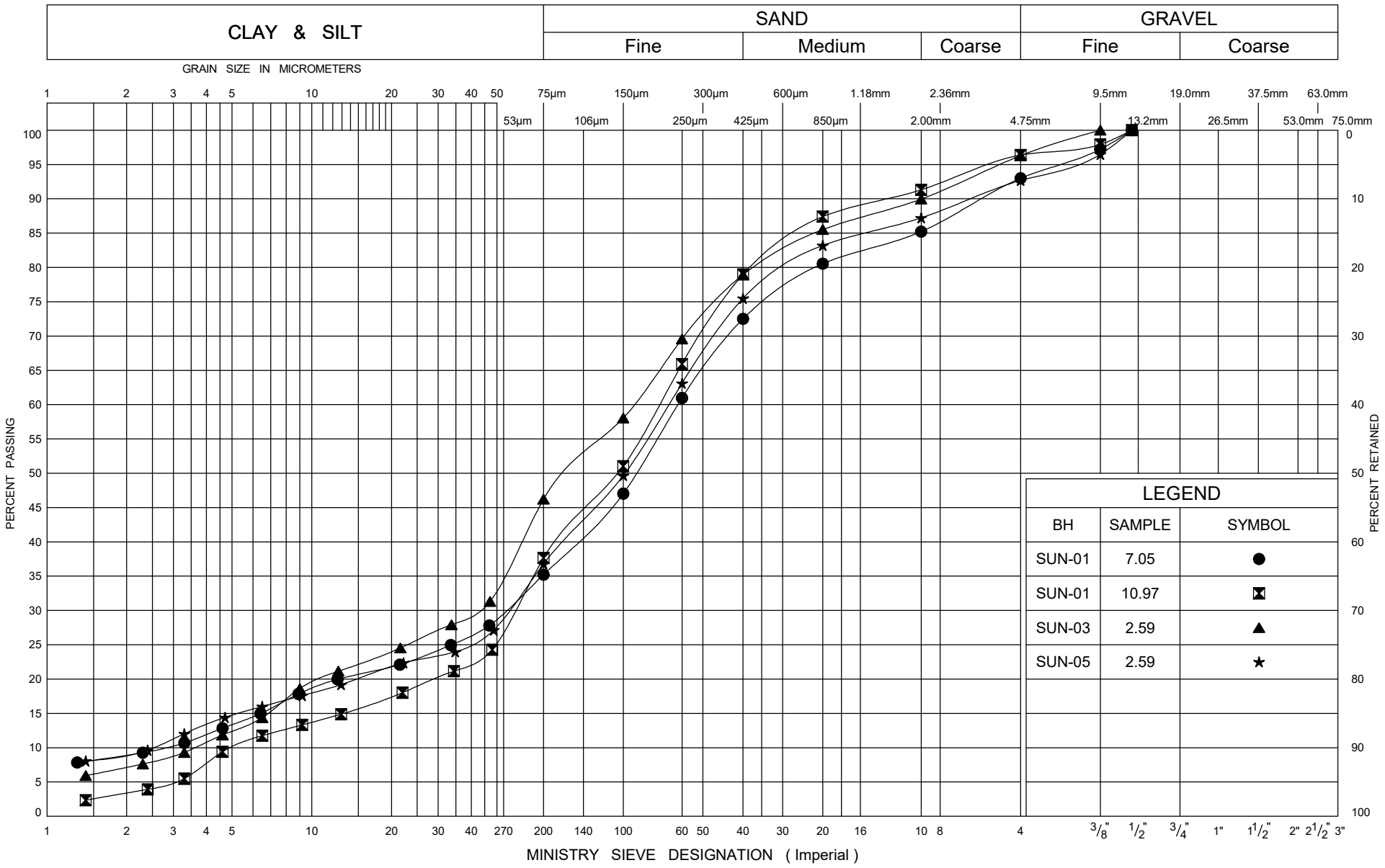
Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SAND and SILT FILL

FIG No B2

W P 2445-15-00



Ministry of Transportation
Ontario

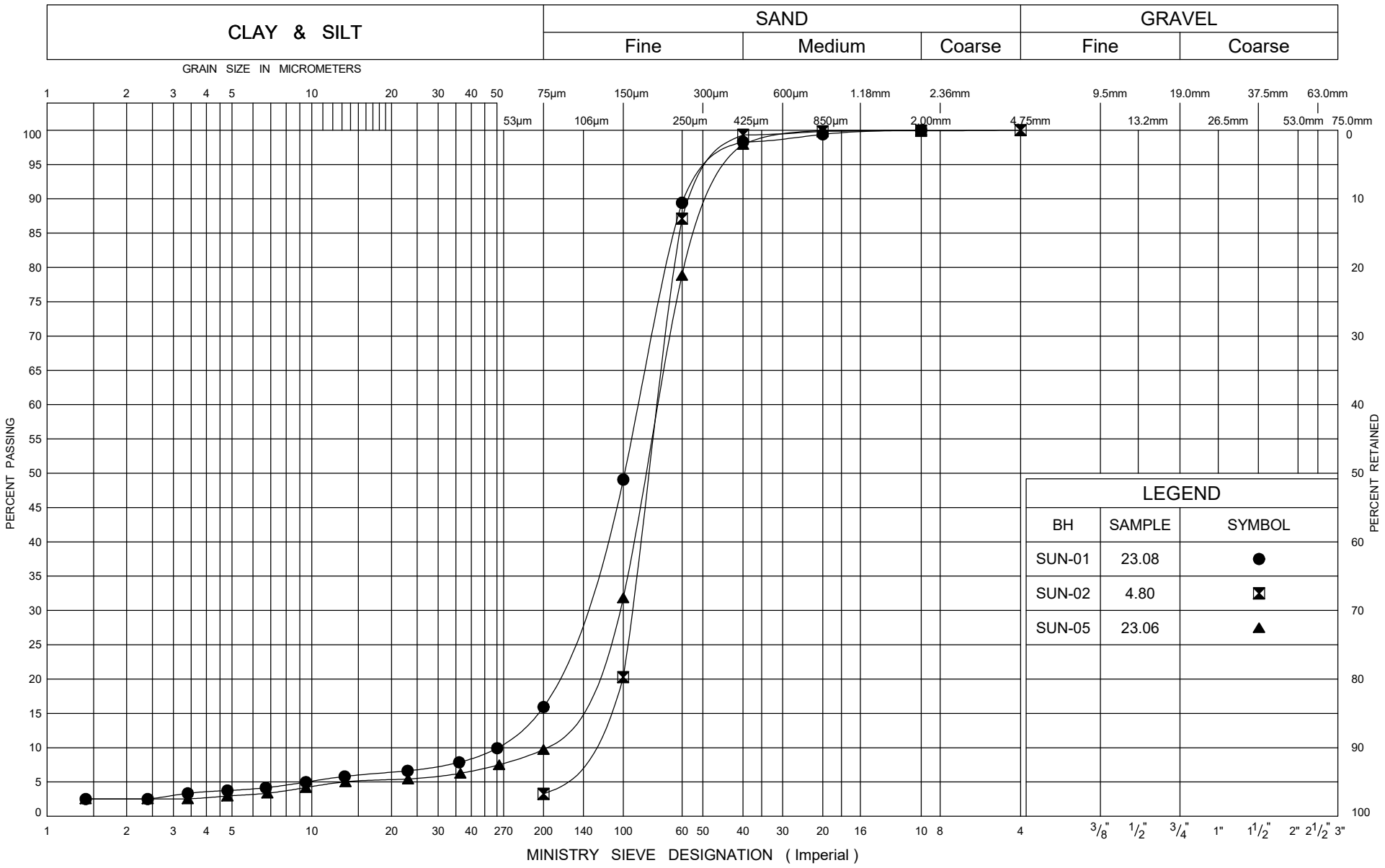
GRAIN SIZE DISTRIBUTIONS

SAND and SILT TILL to Silty SAND TILL

FIG No B3

W P 2445-15-00

ONTARIO MOT GRAIN SIZE 2 MTO-22424.GPJ ONTARIO MOT.GDT 8/7/19



Ministry of Transportation
Ontario

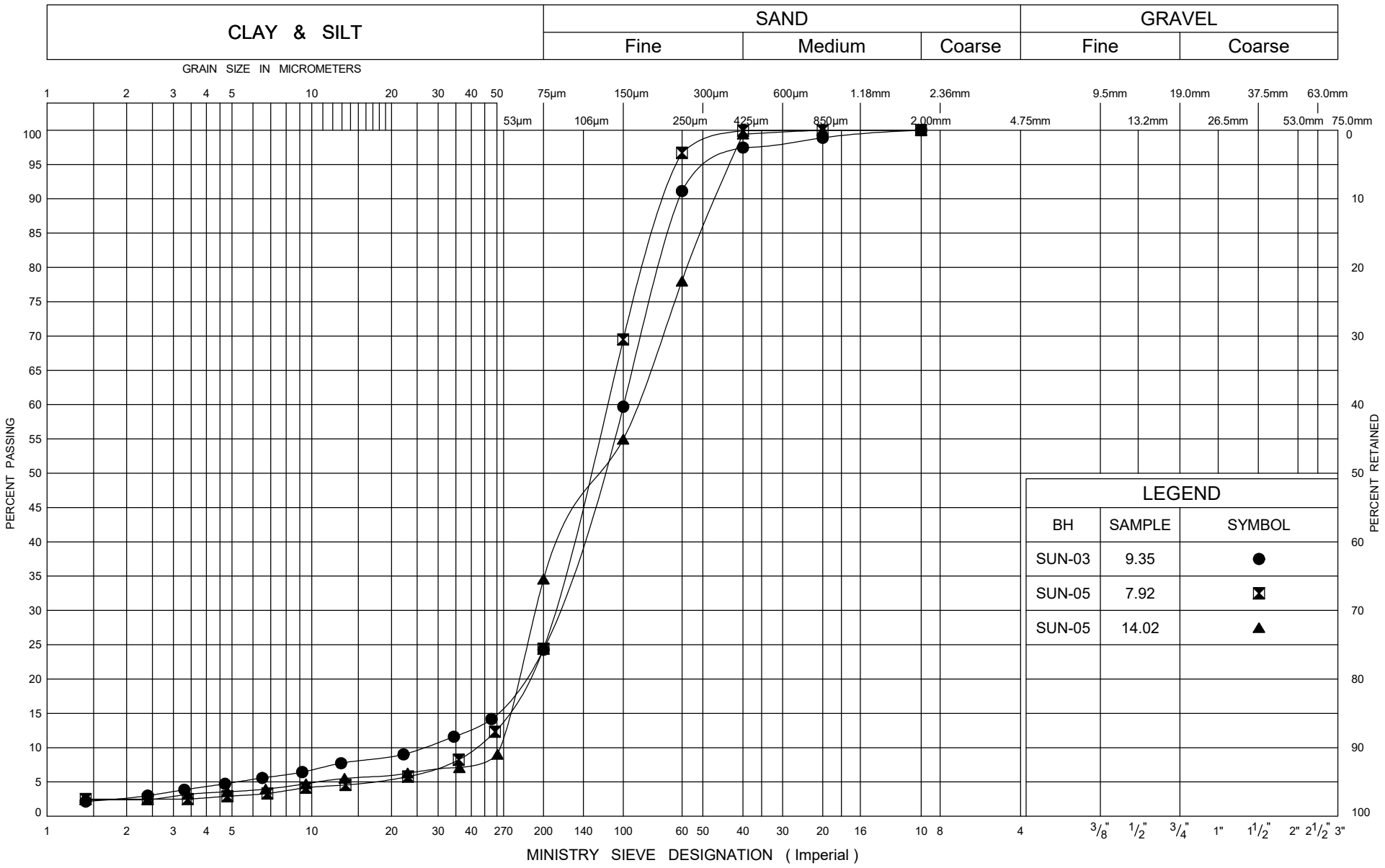
GRAIN SIZE DISTRIBUTION

SAND

FIG No B4

W P 2445-15-00

ONTARIO MOT GRAIN SIZE 2 MTO-22424.GPJ ONTARIO MOT.GDT 8/7/19



Ministry of Transportation
Ontario

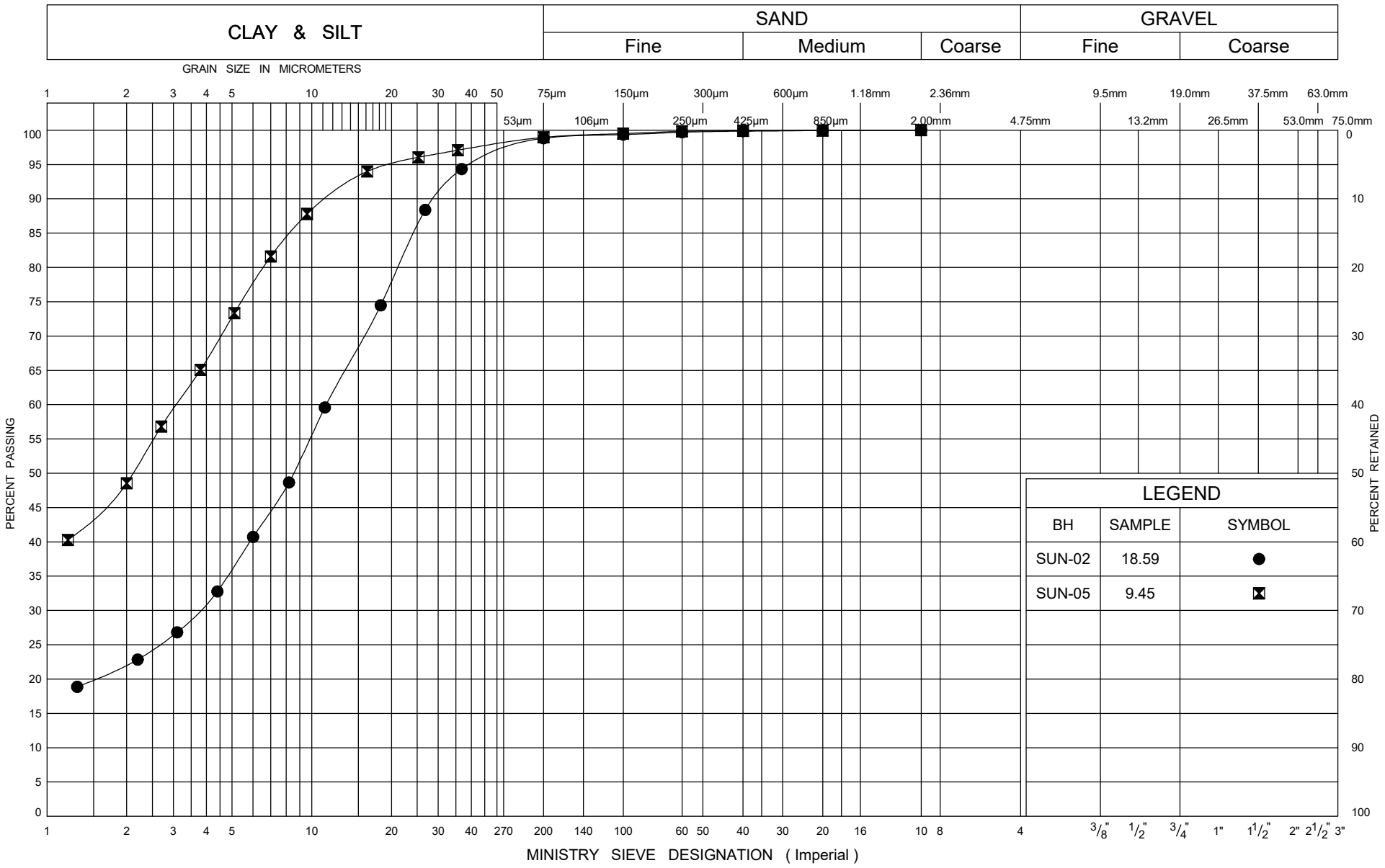
GRAIN SIZE DISTRIBUTION

Silty SAND

FIG No B5

W P 2445-15-00

ONTARIO MOT GRAIN SIZE 2 MTO-22424.GPJ ONTARIO MOT.GDT 8/29/19



ONTARIO MOT GRAIN SIZE 2 MTO-22424.GPJ ONTARIO MOT.GDT 8/7/19

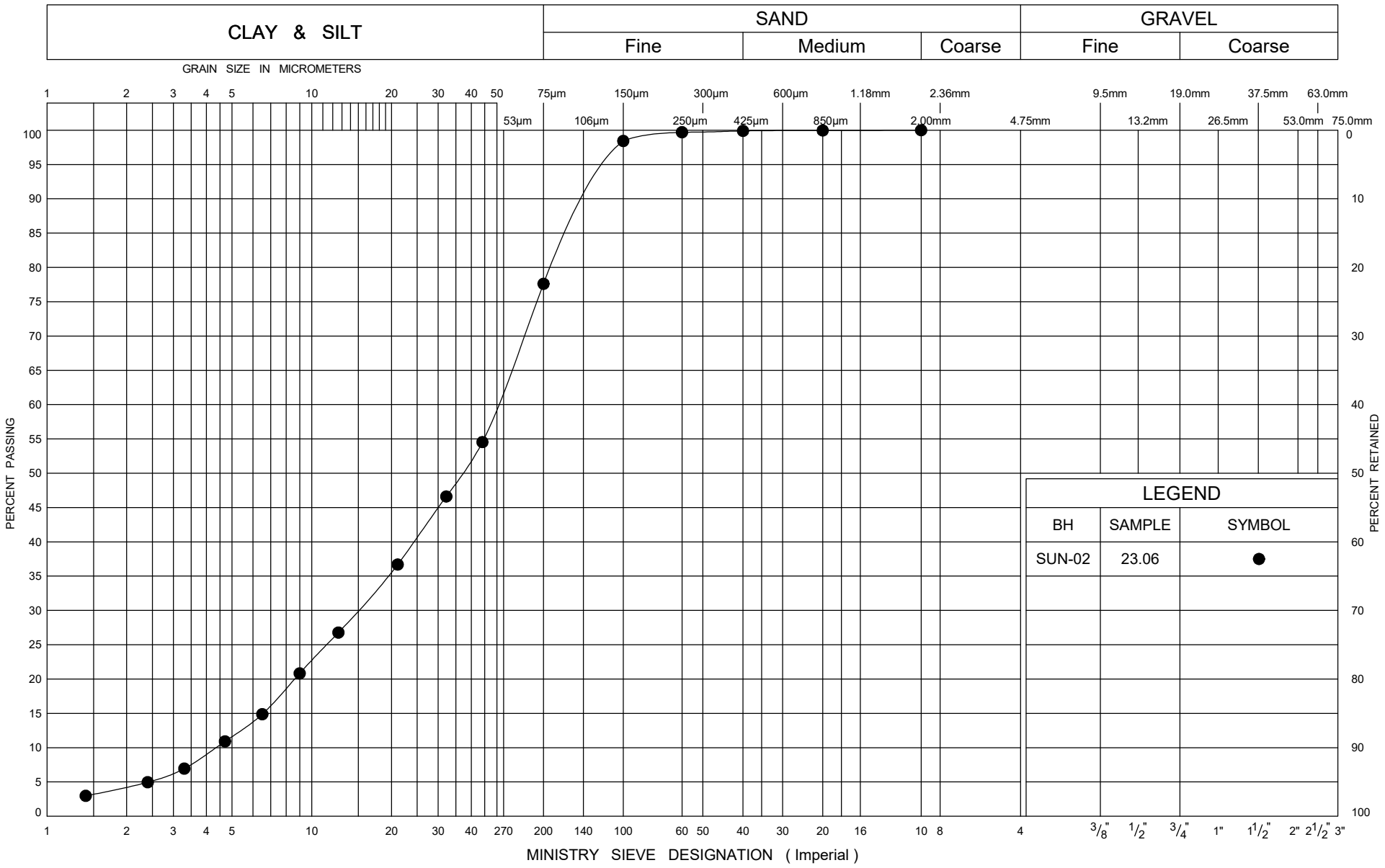
Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Silty CLAY to Clayey SILT

FIG No B6

W P 2445-15-00



ONTARIO MOT GRAIN SIZE 2 MTO-22424.GPJ ONTARIO MOT.GDT 8/29/19

Ministry of Transportation
Ontario

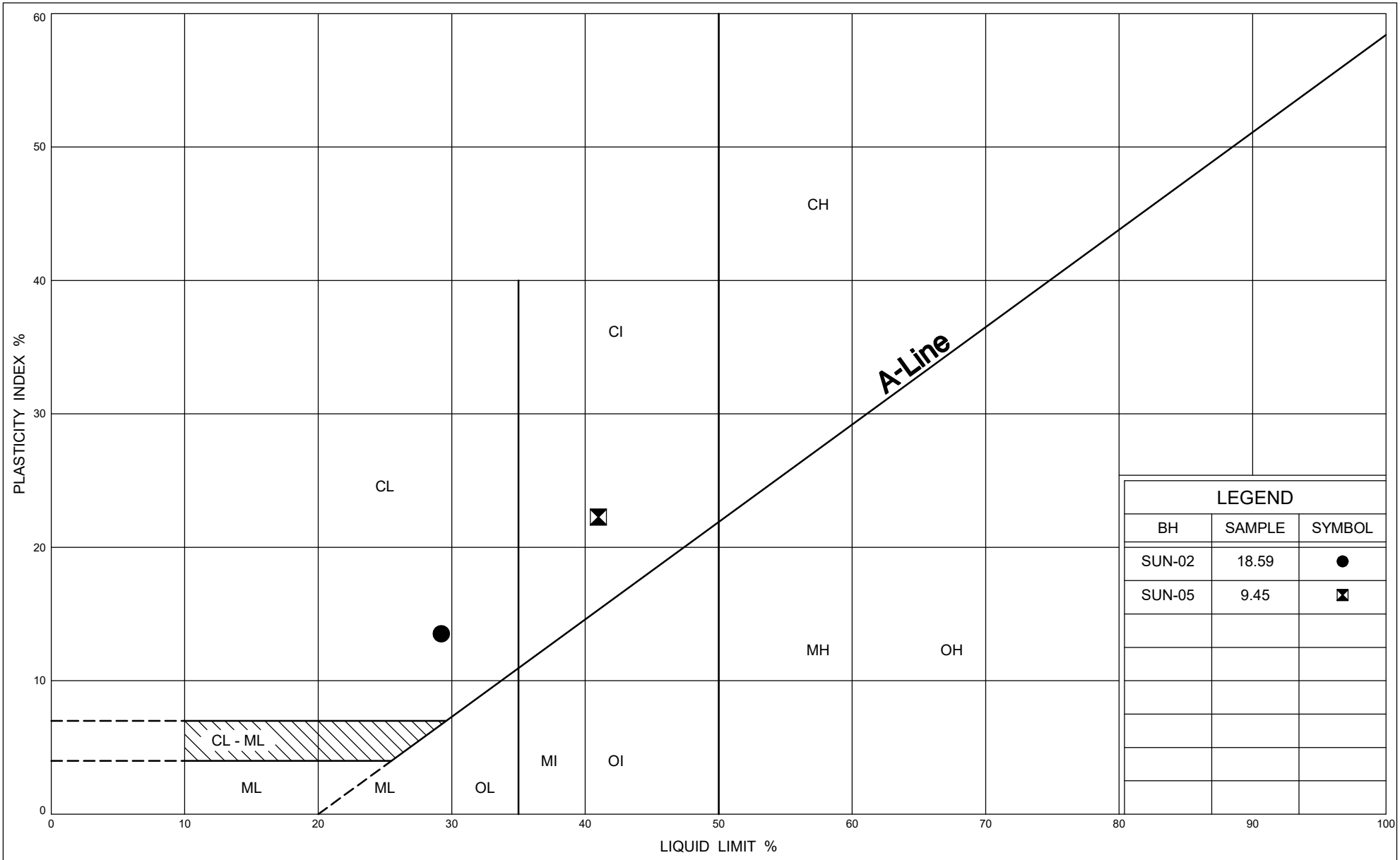
GRAIN SIZE DISTRIBUTION

Sandy SILT

FIG No B7

W P 2445-15-00

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-22424.GPJ ONTARIO MOT.GDT 8/7/19

Ministry of Transportation
Ontario

PLASTICITY CHART

Silty CLAY to Clayey SILT

FIG No B8

W P 2445-15-00

FINAL REPORT

CA14976-AUG19 R1

22424

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada
Contact	Rocío Reyna
Telephone	905-829-8666 x 263
Facsimile	
Email	rreyna@thurber.ca
Project	22424
Order Number	
Samples	Soil (4)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
Facsimile	705-652-6365
Email	brad.moore@sgs.com
SGS Reference	CA14976-AUG19
Received	08/27/2019
Approved	09/04/2019
Report Number	CA14976-AUG19 R1
Date Reported	09/04/2019

COMMENTS

Temperature of Sample upon Receipt: 9 degrees C
Cooling Agent Present:YES
Custody Seal Present:NO

Chain of Custody Number:002537

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

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 22424
Project Manager: Rocío Reyna
Samplers: N/A

PACKAGE: **- Corrosivity Index** (SOIL)

Sample Number			5	6	7	8
Sample Name			SUN-01, SS5	SUN-02-SS4	SUN-05-SS7	SUN-03-SS2
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			17/07/2019	28/07/2019	19/07/2019	04/07/2019
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index						
Corrosivity Index	none	1	4	3	3	17.5
Soil Redox Potential	mV	-	365	348	303	278
Sulphide	%	0.02	< 0.02	< 0.02	< 0.02	0.02
pH	pH Units	0.05	9.17	9.09	9.69	8.64
Resistivity (calculated)	ohms.cm	-9999	4720	4550	3160	331

PACKAGE: **- General Chemistry** (SOIL)

Sample Number			5	6	7	8
Sample Name			SUN-01, SS5	SUN-02-SS4	SUN-05-SS7	SUN-03-SS2
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			17/07/2019	28/07/2019	19/07/2019	04/07/2019
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**
General Chemistry						
Conductivity	uS/cm	2	212	220	316	3020

PACKAGE: **- Metals and Inorganics** (SOIL)

Sample Number			5	6	7	8
Sample Name			SUN-01, SS5	SUN-02-SS4	SUN-05-SS7	SUN-03-SS2
Sample Matrix			Soil	Soil	Soil	Soil
Sample Date			17/07/2019	28/07/2019	19/07/2019	04/07/2019
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics						
Moisture Content	%	0.1	7.4	0.3	4.6	9.0
Sulphate	µg/g	0.4	2.3	4.4	6.3	57

FINAL REPORT

CA14976-AUG19 R1

Client: Thurber Engineering Ltd.
Project: 22424
Project Manager: Rocío Reyna
Samplers: N/A

PACKAGE: **- Other (ORP)** (SOIL)

Sample Number	5	6	7	8
Sample Name	SUN-01, SS5	SUN-02-SS4	SUN-05-SS7	SUN-03-SS2
Sample Matrix	Soil	Soil	Soil	Soil
Sample Date	17/07/2019	28/07/2019	19/07/2019	04/07/2019

Parameter	Units	RL		Result	Result	Result	Result
Other (ORP)							
Chloride	µg/g	0.4		34	52	66	1900

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0563-AUG19	µg/g	0.4	<0.4	9	20	94	80	120	108	75	125
Sulphate	DIO0563-AUG19	µg/g	0.4	<0.4	5	20	96	80	120	95	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0052-AUG19	%	0.02	<0.02	ND	20	116	80	120			

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0466-AUG19	uS/cm	2	0.014	0	10	100	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0466-AUG19	pH Units	0.05	NA	0		100			NA		

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

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

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

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

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

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

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

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

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

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

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

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

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

-- End of Analytical Report --

SGS Request for Laboratory Services and CHAIN OF CUSTODY

No: 002537

Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Page ____ of ____

Laboratory Information Section - Lab use only

Received By: Ahmed Al-Mawlawi
Received Date (mm/dd/yyyy): 08/27/2019 (mm\dd\yy)
Received Time: 16:00
Received By (signature):
Custody Seal Present: ☒ No
Custody Seal Intact: ☒ No
Cooling Agent Present: ☒ ICE
Temperature Upon Receipt (°C) 9°, 9°, 9°
LAB LIMS #: CA14976-Aug19

REPORT INFORMATION

Company: Thurber Engineering
Contact: Rocio Reyna
Address: 103-2010 Winston Park Dr. Oakville, ON
Phone: 905-829-8666
Fax:
Email: rreyna@thurber.ca

INVOICE INFORMATION

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

PROJECT INFORMATION

Quotation #: P.O. #:
Project #: 22424 Site Location/ID:

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends).
Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: Rush Confirmation ID:

REGULATIONS

Regulation 153/04:
☐ Table 1 ☐ Res/Park Soil Texture: ☐ Coarse
☐ Table 2 ☐ Ind/Com ☐ Medium
☐ Table 3 ☐ Agri/Other ☐ Fine
☐ Table ____

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☐ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

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

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PHC F1-F4 ☐ VOC ☐ BTEX ☐ BTEX/F1 ☐ F2-F4 ☐	PAH ☐ ABN ☐ SVOC(all) ☐	PCB Total ☐ Aroclor ☐	Pesticides OC ☐ OP ☐	TCLP M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit. ☐	Water Pkg Gen. ☐ Ext. ☐	Sewer Use:	Corrosivity Package					COMMENTS:
1	SUN-01, SS5	17/Jul/19		1	Soil										✓					
2	SUN-02 ~~SS3~~ SS4	28/Jun/19		1	"										✓					
3	SUN-05- SS7	19/Jun/19		1	"										✓					
4	SUN-03 - SS2	04/Jul/19		1	"										✓					
5					"															
6																				
7																				
8																				
9																				
10																				
11																				
12																				

Observations/Comments/Special Instructions

Sampled By (NAME): Signature: Date: __/__/__ (mm/dd/yy) Pink Copy - Client

Relinquished by (NAME): Rocio Reyna Signature: Date: 26/08/19 (mm/dd/yy) Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 04 April, 2018

THURBER

Appendix C

Record of Borehole Sheets and Laboratory Test Results
Previous Investigation

RECORD OF BOREHOLE No B13-1 1 OF 1 METRIC

PROJECT 001-1143F
W.P. 30-95-00
DIST SW HWY 400
DATUM Geodetic

LOCATION N 4916980.9; E 288547.3
BOREHOLE TYPE 108mm ID HOLLOW STEM AUGERS
DATE Feb.6/2001

ORIGINATED BY PKS
COMPILED BY LCC
CHECKED BY ASP

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 × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.8	GROUND SURFACE										
0.0	Asphalt										
0.2	Sand and Gravel, some cobbles (Fill) Compact to dense Brown Moist		1	SS	32		256				
			2	SS	21		255				
			3	SS	9		254				
249.5							253				
7.3	Silty Sand, trace gravel Compact Brown Moist		4	SS	19		252		○		
248.4							251				
8.4	Silty Sand, trace clay, trace gravel (Till) Very dense Brown Moist		5	SS	104		250				
			6	SS	100/.15		249		○		4 57 30 9
			7	SS	101		248				
246.3							247				
10.5	Clayey Silt, trace to some sand and gravel (Till) Hard Brown Moist		8	SS	102		246		○H		
244.4			9	SS	100/.18		245				
12.4	END OF BOREHOLE Notes: 1. Borehole dry on completion of drilling. 2. Borehole backfilled with bentonite and surface cold patch on sand bedding.										

+³,×³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

RECORD OF BOREHOLE No B13-2 1 OF 1 METRIC

PROJECT 001-1143F
W.P. 30-95-00
DIST SW HWY 400
DATUM Geodetic

LOCATION N 4916967.4; E 288585.1
BOREHOLE TYPE 108mm ID HOLLOW STEM AUGERS
DATE Feb.6-7/2001

ORIGINATED BY PKS
COMPILED BY LCC
CHECKED BY ASP

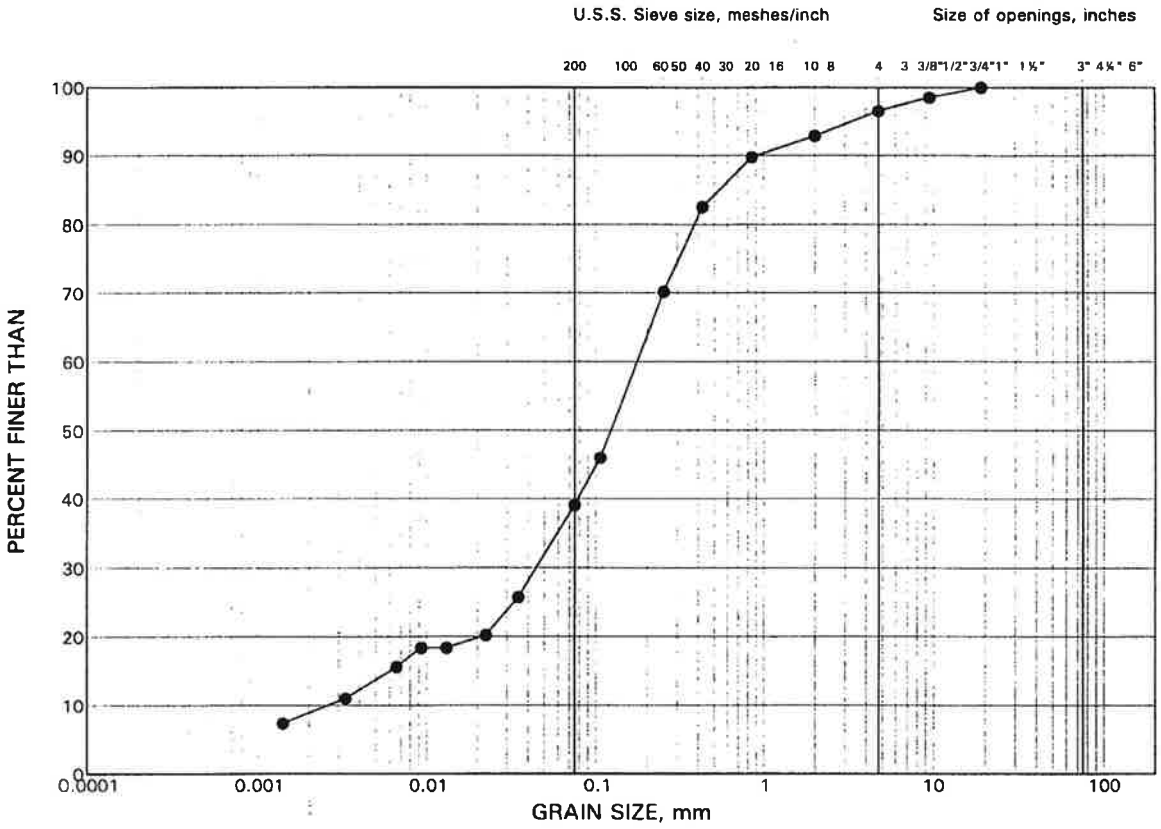
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.1	GROUND SURFACE						255				
0.0	Asphalt										
0.2	Sand and Gravel (Fill) Compact to very dense Brown Moist		1	SS	62		254				
			2	SS	11		253				
			3	SS	15		252				
			4	SS	25		251				
248.2							250				
6.9	Silty Sand, trace clay, some gravel, trace wood and organics Dense Brown Moist		5	SS	31		249				
247.5							248				
7.6	Silty Sand, trace clay, trace to some gravel (Till) Compact to very dense Brown Moist		6	SS	21		247				
			7	SS	84	▽	246				
246.0											
9.1	Silty Sand to Sand, some silt, trace gravel Very dense Wet Brown		8	SS	69		245				0 85 15 0
			9	SS	129		244				
			10	SS	100/.15		243				
			11	SS	108		242				
			12	SS	96						
241.7	Thin silty clay layers present in Sample 13.		13	SS	110						
13.4	END OF BOREHOLE Notes: 1. Water level on completion of drilling at 11m depth (Elev.244.1m). 2. Water level in piezometer measured at 9m depth (Elev.246.1m) on March 15, 2001.										

+³, ×³: Numbers refer to Sensitivity O^3% STRAIN AT FAILURE

ON_MOT 0011143F.GPJ ON_MOT.GDT 14/1/02

GRAIN SIZE DISTRIBUTION TEST RESULT
Silty Sand Till

FIGURE 1



LEGEND

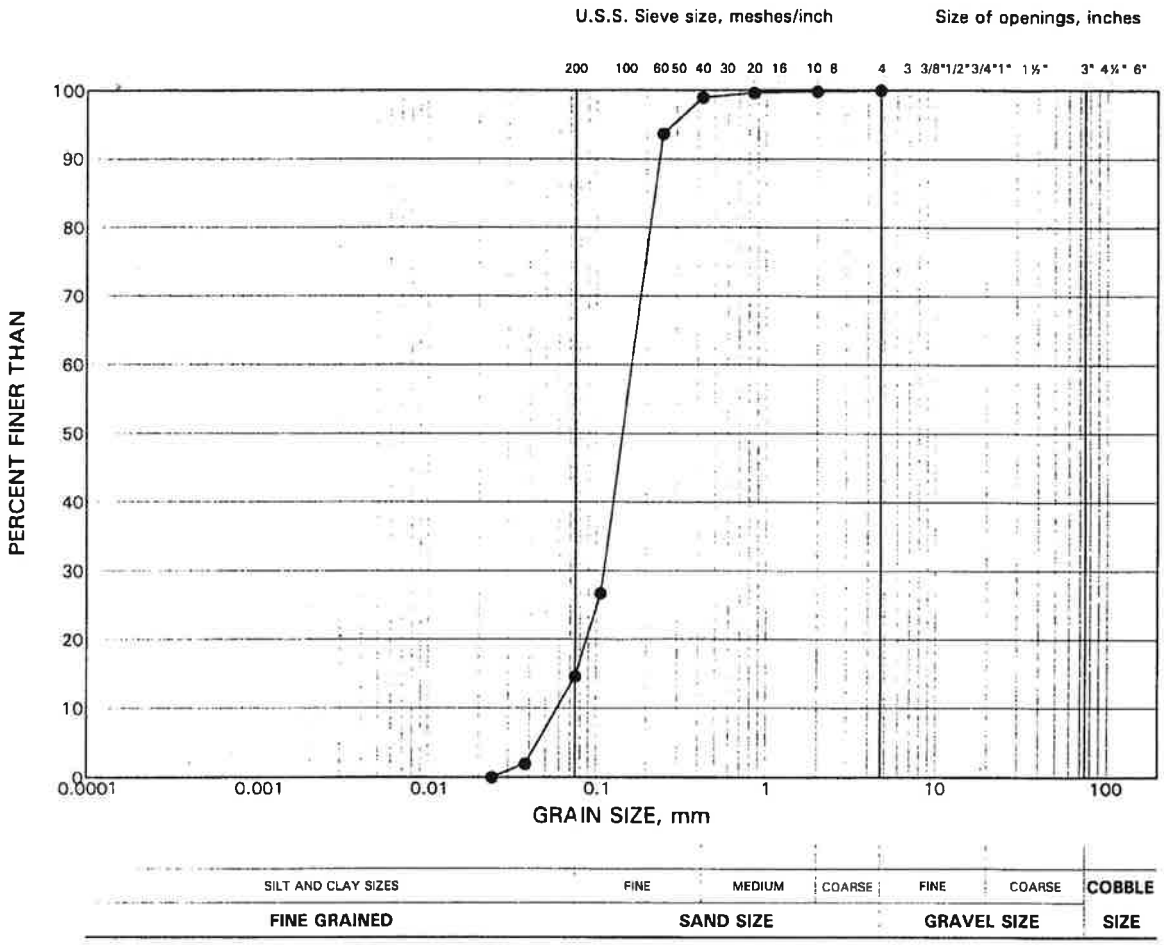
SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	B13-1	6	247.5

Project 001-1143F

Golder Associates

GRAIN SIZE DISTRIBUTION TEST RESULT
Sand, some silt

FIGURE 2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	B13-2	8	245.6

Project 001-1143F

Golder Associates

THURBER

Appendix D

Selected Site Photographs

Photo 1- South side of existing Sunnidale Road Underpass

Photo 2- North side of existing Sunnidale Road Underpass

THURBER

Photo 3- Northwest side of existing Sunnidale Road Underpass (Borehole SUN-01)
June 18, 2019

THURBER

Photo 4- Southwest side of existing Sunnidale Road Underpass (Borehole SUN-03)
May 8, 2019

THURBER

Photo 5- Southwest side of existing Sunnidale Road Underpass (Borehole SUN-04)
May 8, 2019

THURBER

Photo 6- Southeast side of existing Sunnidale Road Underpass (Borehole SUN-05)
June 20, 2019

THURBER

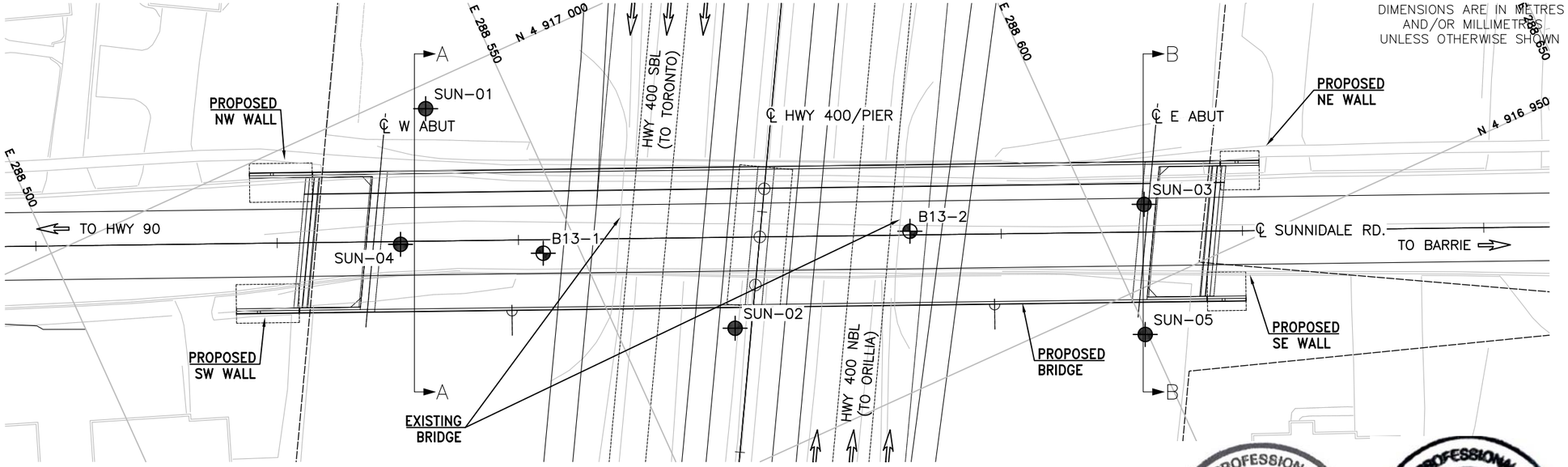
Appendix E

Borehole Locations and Soil Strata Drawing

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

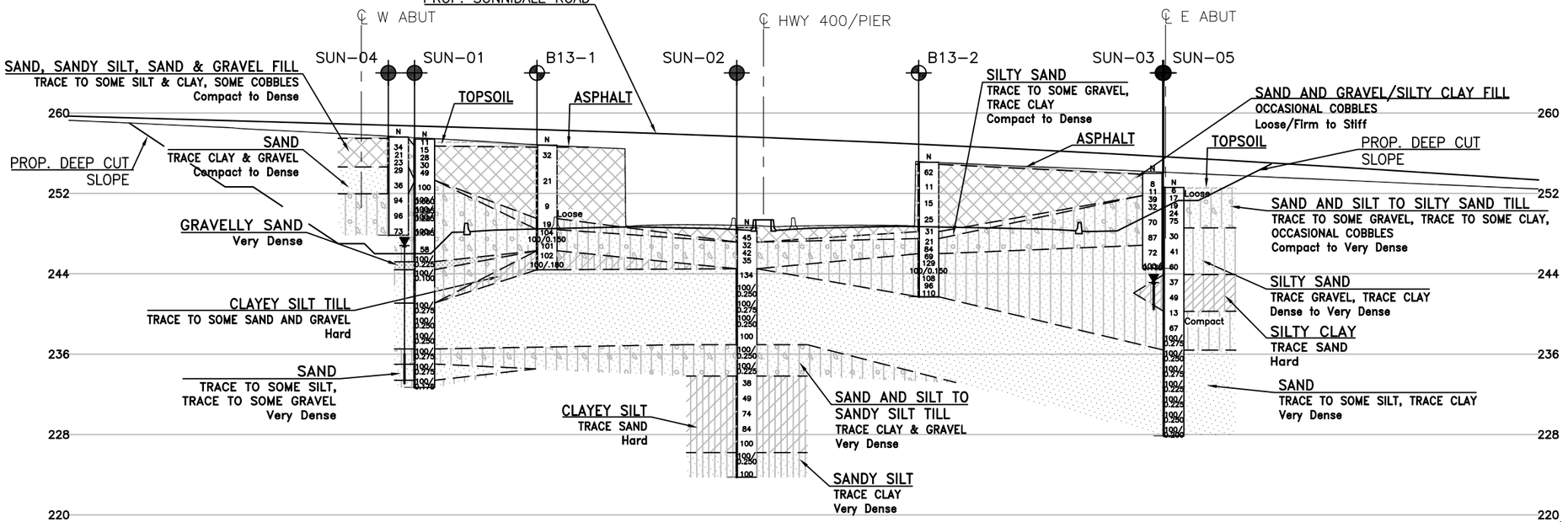
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

10 0 10 20m

SCALE 1:500



SUNNIDALE ROAD ℄ PROFILE

10 0 10 20m

SCALE 1:500

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
10/12/2021
PROVINCE OF ONTARIO

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10/12/2021
PROVINCE OF ONTARIO

CONT No
WP No 2445-15-00

HWY 400
SUNNIDALE ROAD
UNDERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

McINTOSH PERRY

THURBER ENGINEERING LTD.

KEYPLAN

	LEGEND
⊕	Borehole (Current Investigation)
⊕	Borehole (Previous 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
SUN-01	257.4	4 916 997.6	288 541.5
SUN-02	248.6	4 916 963.7	288 561.3
SUN-03	254.0	4 916 957.8	288 605.2
SUN-04	257.6	4 916 985.9	288 533.3
SUN-05	252.6	4 916 945.5	603 241.9
B13-1	256.8	4 916 978.9	288 582.7
B13-2	255.1	4 916 965.3	288 581.9

-NOTES-

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

GEOCRES No. 31D-771

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK SKP	CODE	LOAD	DATE OCT 2021
DRAWN	BH	CHK RPR	SITE 30-173	STRUCT	DWG 1

FILENAME: H:\Drafting\22000\22424\TES-22424-PLPP-SUN.dwg
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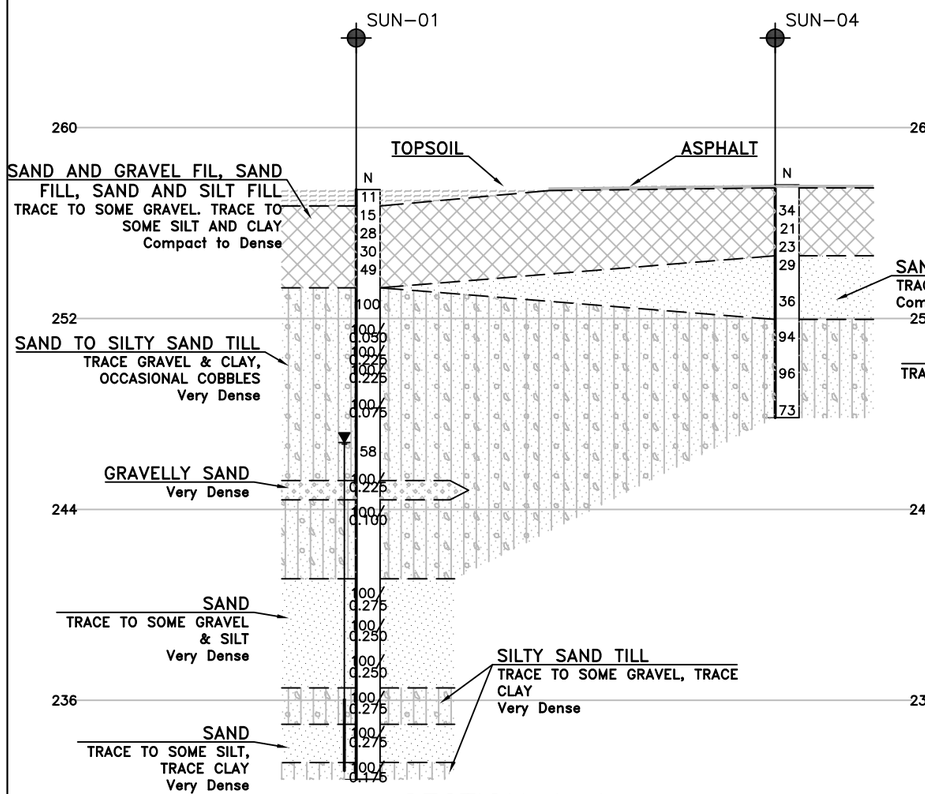
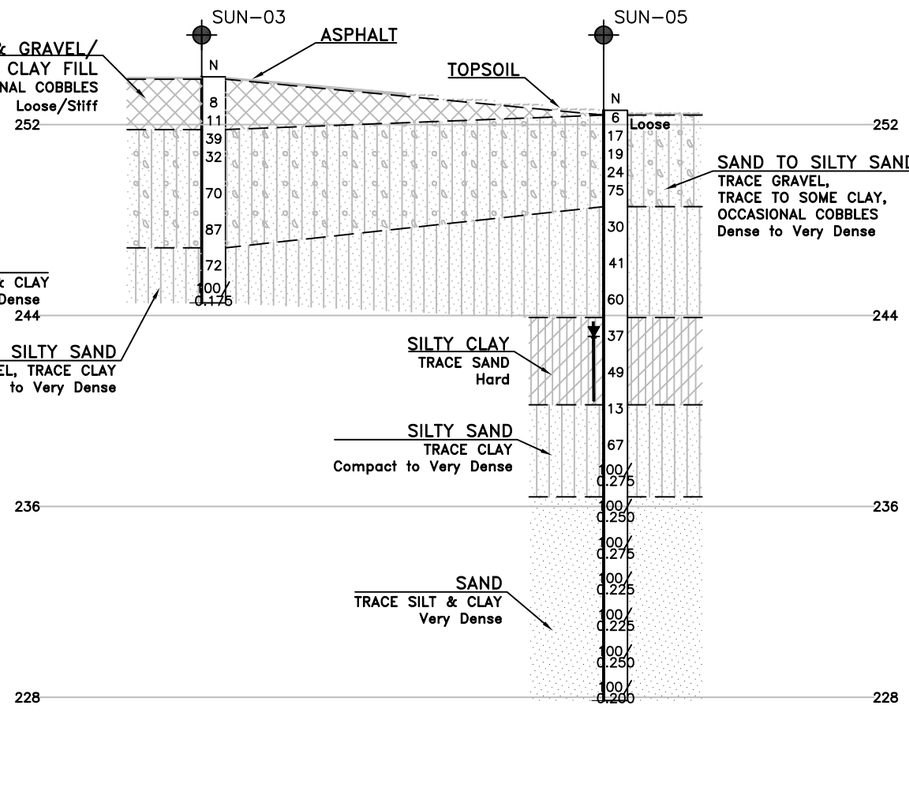
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



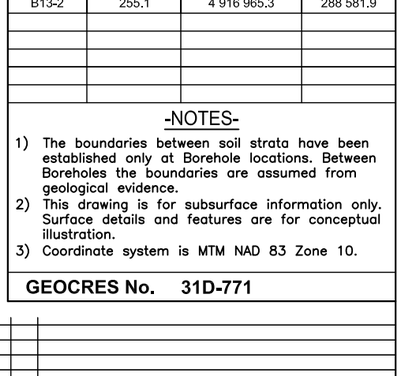
SECTION A–A
(WEST ABUTMENT)

4 0 4 8m H 1:200
2 0 2 4m V 1:100



SECTION B–B
(EAST ABUTMENT)

4 0 4 8m H 1:200
2 0 2 4m V 1:100



KEYPLAN

CONT No
WP No 2445-15-00

HWY 400
SUNNIDALE ROAD
UNDERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK SKP	CODE	LOAD	DATE OCT 2021
DRAWN	BH	CHK RPR	SITE 30-173	STRUCT	DWG 2

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