



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
FREDERICK STREET UNDERPASS
HIGHWAY 7- NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00**

GEOCRES NO. 40P8-285

Latitude 43.458853°, Longitude -80.471394°

Report

to

WSP

Date: February 9, 2021
File: 11375



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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a detailed foundation investigation conducted at the site of the proposed structure that will carry the eastbound lanes (EBL) and westbound lanes (WBL) of Frederick Street over the Kitchener-Waterloo Expressway (KWE) in the Regional Municipality of Waterloo, Ontario.

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

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

Reference has been made to information on subsurface conditions contained in previous foundation reports for the site. The titles of the reports are listed as follows:

- Foundation Investigation Report for Frederick Street Underpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 66-F-53, W.P. 634-64, Geocres No. 40-P8-48, prepared by DHO (Department of Highways Ontario), dated July 21, 1966, (Reference 1)
- Preliminary Foundation Investigation and Design Report for Frederick Street Underpass, Highway 7-New, Kitchener to Guelph, G.W.P. 408-88-00, Geocres No. 40P8-203, prepared by Thurber Engineering Ltd, dated November 13, 2012 (Reference 2)
- Foundation investigation and design report for Northeast Corner Retaining Wall, Frederick Street Underpass, Site No. 33-234, G.W.P. 3110-09-00, City of Kitchener,



Ontario, Geocres No. 40P8-199, prepared by Peto MacCallum Ltd, dated May 31, 2012
(Reference 3)

2 SITE DESCRIPTION

The site is located in the City of Kitchener, approximately 350 m south of the KWE and Victoria Street interchange. At this location, an underpass structure carries Frederick Street over the northbound and southbound lanes (NBL and SBL) of the KWE and existing ramps (E-S and S-E). The existing underpass at KWE and Frederick Street is a four-span structure supported on two abutments and three piers. The original 1959 GA drawing for the structure indicates that the existing abutments and piers are supported on spread footings.

The existing grade on Frederick Street is at about Elev. 327.5 m and 325.0 m adjacent to the west and east abutments, respectively. The KWE has been constructed in a cut up to about 6.5 m deep and the existing KWE grade ranges from about Elev. 321 to 320 m, decreasing towards the east. The site is primarily surrounded by industrial and commercial lands and is relatively flat.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Waterloo Hills, characterized by ridges of sandy till and kames or kame moraines, with outwash sands occupying the intervening hollows.

3 SITE INVESTIGATION AND FIELD TESTING

A previous investigation conducted in 1966 at this site (Reference 1) consisted of drilling and sampling a total of nine boreholes (numbered 2, 3, 6, 7, 10, 11, 14, 16 and 17) and sixteen dynamic cone penetration tests (DCPTs). Nine DCPTs were conducted adjacent to the boreholes and seven DCPTS were conducted at various locations within the underpass area.

The current investigation was completed in August 2020 and involved the completion of two boreholes numbered BH20-01 and BH20-02. The boreholes were advanced through Frederick Street to depths ranging from 38.3 to 38.4 m.

Details of boreholes drilled during the previous and current site investigations and field testing, including location and termination depths are presented in Table 3.1.



It should be noted that no boreholes were drilled at the Pier as part of the current site investigation at the direction of MTO.

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

The ground surface elevations and coordinates of the recent as-drilled boreholes were determined by Thurber using a Trimble R10 survey unit.

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

During the current investigation, a truck-mounted B60 drill rig was used in conjunction with hollow-stem augers and tricone to advance the boreholes. In general, soil samples were obtained at selected intervals using a 50mm diameter split spoon sampler in conjunction with the Standard Penetration Testing (SPT).

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations. One standpipe piezometers were installed in Borehole BH20-01 to permit groundwater level monitoring. The piezometer consisted of a 25 mm Schedule 40 PVC pipe with a 3.0 m long slotted screen enclosed in a column of filter sand. to permit groundwater level monitoring. The completion details of the piezometers and boreholes are summarized in Table 3.1. The piezometer in Borehole BH20-01 was decommissioned in accordance with O.Reg. 903.



Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole	Ground Surface Elevation (m)	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth /Elevation (m)	Completion Details
West Abutment	BH20-01	327.5	38.3/289.2	19.8/307.7	Piezometer with 3.0 m slotted screen installed with sand filter from 19.8 m to 15.8 m, bentonite holeplug to 13.7 m, and grout from 13.7 m to surface
	02	326.9	25.5/301.4	None Installed	N/A
	03	326.7	18.1/308.6	None Installed	N/A
Pier	07	325.9	17.0/308.9	None Installed	N/A
	10	325.5	17.5/308.0	None Installed	N/A
East Abutment	BH20-02	325.0	38.4/286.6	None Installed	Borehole backfilled with holeplug, to 0.1 m and asphalt cold patch to surface
	14	325.3	20.3/305.0	None Installed	N/A

4 LABORATORY TESTING

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

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



5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendices A and B. Details of the encountered soil stratigraphy along the proposed alignment are presented in these appendices and on the “Borehole Locations and Soil Strata” drawings in Appendix C. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the subsurface conditions at the site consist of a pavement structure and layers of sand fill and sand overlying clayey silt and silty clay above a deposit of sandy silt to silty sand. The sandy silt to silty sand is underlain by a lower silty clay layer which is in turn underlain by a deposit of silty clay till.

A detailed description of the subsurface conditions is presented in the following sections.

5.1 Pavement Structure

Pavement structure consisting of asphalt overlying sand and gravel fill (road base) was encountered in the recent boreholes advanced through the Frederick Street road platform (i.e. BH20-01 and BH20-02)

The measured thickness of the asphalt ranged between 163 mm and 200 mm at the borehole locations. The sand and gravel fill underlying the asphalt was approximately 0.5 to 0.6 m thick.

5.2 Sand Fill

Sand fill was encountered underlying the sand and gravel fill (pavement structure) in BH20-01 and BH20-02.

The thickness of the fill ranged from approximately 1.6 m to 3.3 m and the base of the fill was encountered at depths of 2.3 m and 4.1 m (Elev. 323.4 to 322.7). The fill was generally described as gravelly to some gravel and contained some silt within the upper 1.4 to 1.6 m, and contained no gravel and trace silt below the upper 1.4 to 1.6 m.

The SPT ‘N’ values measured in the sand fill ranged from 1 to 28 blows per 0.3 m of penetration, indicating a highly variable very loose to compact relative density. The natural moisture contents measured on samples of the sand fill ranged from 3 percent to 6 percent.



The results of a grain size analysis test conducted on a sample of the sand fill are provided on the Record of Borehole Sheets in Appendix A and illustrated in Figure A1 in Appendix A. The results are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	89
Silt + Clay	11

5.3 Sand

A native sand deposit was encountered in all of the historic boreholes. The sand was encountered underlying topsoil in all of the historic boreholes with the exception of Borehole 10 where it was encountered underlying gravelly sand fill. It is expected that this layer was removed from beneath the bridge during construction of the KWE.

The thickness of the sand ranged from 2.8 m to 6.4 m and the depth to the base of the sand deposit ranged from 4.3 m to 7.9 m below ground surface (Elev. 321.6 to 317.4). The fill generally contained trace amounts of silt.

The SPT 'N' values measured in the sand ranged from 6 to 62 blows per 0.3 m of penetration, indicating a loose to very dense relative density (typically compact). The natural moisture contents measured on samples of the sand ranged from 3 percent to 29 percent.

The results of grain size analysis testing conducted on samples of the sand are provided on the historic Record of Borehole Sheets in Appendix B. The results are summarized as follows:

Soil Particles	(%)
Gravel	0 to 47
Sand	46 to 97
Silt	1 to 20
Clay	0

5.4 Clayey Silt

A clayey silt layer was encountered underlying the sand fill in BH20-01, underlying the sand deposit in historic boreholes 2, 3, 6, 7, and beneath the silty sand/sandy silt interlayer in boreholes 10 and 11. The clayey silt layer ranges from 0.9 to 2.7 m thick and the base of the layer was encountered at depths ranging from 6.1 m to 8.7 m (Elev. 319.3 to 318.5). Trace to some gravel and sand was noted in the clayey silt.



SPT 'N' values measured in the clayey silt ranged from 9 to 64 blows per 0.3 m of penetration, indicating a stiff to hard consistency (typically very stiff to hard). The natural moisture contents measured on samples of the clayey silt ranged from 9 percent to 19 percent.

The results of grain size analyses testing conducted on samples of the clayey silt are provided on the Record of Borehole Sheets in Appendices A and B. The results of one test performed as part of the current investigation are shown on Figure A2 in Appendix A. The results from both investigations are summarized as follows:

Soil Particles	(%)
Gravel	0 to 14
Sand	7 to 27
Silt	44 to 78
Clay	14 to 20

The results of Atterberg Limits testing conducted on samples of the clayey silt from the previous investigation are summarized below.

Liquid Limit	19 to 34
Plastic Limit	12 to 17
Plasticity Index	6 to 17

The above results indicate that the clayey silt is of low plasticity with a group symbol of CL-ML.

5.5 Silty Sand/Sandy Silt Interlayer

A silty sand/sandy silt interlayer was encountered underlying the clayey silt layer in historic boreholes 6 and 7, underlying the sand deposit in boreholes 10 and 11, and beneath the upper silty clay layer in borehole 14. The interlayer ranged from 0.9 m to 3.7 m in thickness and the base of the interlayer was encountered at depths between 6.1 m and 12.5 m below ground surface (Elev. 319.4 and 312.8).

SPT 'N' values measured in the silty sand/sandy silt interlayer ranged from 29 blows per 0.3 m of penetration to 100 blows per 0.09 m of penetration, indicating a compact to very dense relative density (typically very dense). The natural moisture contents measured on samples of the silty sand/sandy silt interlayer ranged from 11 percent to 18 percent.



Grain size testing was performed on samples of the interlayer during the previous investigation. The results of the testing are shown on the Record of Borehole Sheets in Appendix B and summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	25 to 67
Silt	32 to 75
Clay	0

5.6 Upper Silty Clay

A deposit of silty clay was encountered in all of the boreholes advanced at the site underlying the sand fill, clayey silt, and silty sand/sandy silt layers. The silty clay deposit ranged from 3.9 m to 10.3 m thick and the base of the deposit was encountered at depths between 11.9 m and 18.0 m below ground surface (Elev. 314.8 and 307.6). Trace sand was noted in the silty clay.

SPT 'N' values measured in the silty clay ranged from 24 to 194 blows per 0.3 m of penetration, indicating a very stiff to hard consistency (typically hard). The natural moisture contents measured on samples of the silty clay ranged from 13 percent to 40 percent. The results of grain size analyses testing conducted on samples of the silty clay are provided on the Record of Borehole Sheets in Appendices A and B and the results of grain size testing performed during the current investigation are shown on Figure A3 in Appendix A. A summary of the test results from both investigations is provided below:

Soil Particles	(%)
Gravel	0
Sand	0 to 1
Silt	30 to 54
Clay	45 to 70

The results of Atterberg Limits testing conducted on samples of the silty clay are shown on the Record of Borehole Sheets in Appendices A and B. The results of the testing from the current investigation are presented on Figure A7 in Appendix A. The results from both the current and previous investigations are summarized below. Based on the results, the silty clay is of intermediate to high plasticity (CI to CH).

Liquid Limit	33 to 55
Plastic Limit	15 to 23
Plasticity Index	18 to 37



5.7 Sandy Silt to Silty Sand

A deposit of sandy silt to silty sand containing trace clay was encountered underlying the upper silty clay deposit in all boreholes advanced at this site. The thickness of the sandy silt to silty sand deposit ranged from 0.7 m to 6.1 m and the base of the deposit was encountered at depths ranging from 17.8 m and 19.4 m below ground surface (Elev. 308.9 and 306.7). A number of boreholes were terminated in this layer.

SPT 'N' values measured in the sandy silt to silty sand ranged from 45 blows per 0.3 m of penetration to 123 blows per 0.15 m of penetration, indicating a dense to very dense relative density (typically very dense). The natural moisture contents measured on samples of the sandy silt to silty sand ranged from 10 percent to 31 percent.

The results of grain size analyses testing conducted on samples of the sandy silt to silty sand are provided on the Record of Borehole Sheets in Appendices A and B and the results of a grain size test performed during the current investigation are shown on Figure A4 in Appendix A. A summary of the test results from both investigations is provided below:

Soil Particles	(%)
Gravel	0
Sand	5 to 28
Silt	66 to 95
Clay	0 to 6

5.8 Lower Silty Clay

A relatively thick deposit of grey silty clay containing trace sand was encountered in the boreholes which penetrated the sandy silt to silty sand deposit (i.e. BH20-01, BH20-02, 2, and 14). Where fully penetrated, this lower silty clay deposit ranged in thickness from 14.4 to 14.5 m and the base of the layer was located between 32.3 m and 33.8 m depth (Elev. 293.7 and 292.7). Historic boreholes 2 and 14 were terminated in this deposit.

SPT 'N' values measured within the lower silty clay ranged from 23 to 130 blows per 0.3 m of penetration, indicating a very stiff to hard consistency. The natural moisture contents measured on samples of the lower silty clay ranged from 16 percent to 29 percent.

Grain size analyses were carried out on samples of the lower silty clay as part of the current investigation. The results of grain size analyses are provided on the Record of Borehole Sheets



in Appendix A and illustrated in Figure A5 in Appendix A. The results are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	1 to 4
Silt	36 to 43
Clay	56 to 61

The results of Atterberg Limits testing conducted on samples of the lower silty clay are shown in Figure A8 in Appendix A and summarized below.

Liquid Limit	35 to 44
Plastic Limit	17 to 18
Plasticity Index	18 to 26

The results indicate that the silty clay is of medium plasticity with a group symbol of CI.

5.9 Lower Sand

A layer of sand with gravel and trace silt was encountered in BH20-02 underlying the lower silty clay deposit. The sand layer was 2.3 m thick and its base was at a depth of 34.6 m (Elev. 290.4).

An SPT 'N' value of 69 blows per 0.3 m of penetration was measured within the sand layer, indicating a very dense relative density. A natural moisture content of 10 percent was measured on a sample of the sand.

5.10 Silty Clay Till

Silty clay till, sandy to with sand, trace gravel to gravelly, was encountered underlying the lower silty clay and sand layers in BH20-01 and BH20-02, respectively. The surface of the till was encountered at depths ranging from 33.8 m to 34.6 m (Elev. 293.7 to 290.4). BH20-01 and BH20-01 were terminated in this till deposit at depths between 38.3 m and 38.4 m.

SPT 'N' values measured within the till ranged from 76 blows per 0.25 m of penetration to 105 blows per 0.17 m of penetration, indicating a hard consistency. The natural moisture contents measured on samples of the till ranged from 9 percent to 27 percent.



The results of grain size analyses conducted on samples of the till are provided on the Record of Borehole Sheets in Appendix A and illustrated in Figure A6 in Appendix A. The results are summarized as follows:

Soil Particles	(%)
Gravel	3 to 21
Sand	31 to 36
Silt	28 to 51
Clay	15

The results of an Atterberg Limits test conducted on a sample of the till are shown in Figure A9 in Appendix A and summarized below.

Liquid Limit	19
Plastic Limit	11
Plasticity Index	8

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

5.11 Groundwater Conditions

A monitoring well was installed in BH20-01 to permit monitoring of the water level. Water levels were observed in the current and historic boreholes during and upon completion of drilling. The water levels measured in the piezometers and upon completion of drilling are summarized below.

Table 5.4 – Water Level Measurements

Foundation Unit	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
West Abutment	BH20-01	August 24, 2020	5.5	322.0	Piezometer
	02	May 26, 1966	4.0	322.9	Open Borehole
	03	May 31, 1966	3.9	322.8	Open Borehole
Pier	07	May 31, 1966	3.2	322.7	Open Borehole
	10	June 3, 1966	3.5	322.0	Open Borehole



East Abutment	BH20-02	August 21, 2020	2.3	322.7	Open Borehole
	14	June 2, 1966	4.0	321.3	Open Borehole

The groundwater levels measured in the piezometers and open boreholes ranged from 2.3 m to 5.5 m below the ground surface (Elev. 322.9 to 321.3). It is noted that the water levels at the site were either measured behind the abutments or prior to cut excavation for the KWE. Therefore, no piezometers were installed through the KWE lanes to determine the groundwater level beneath the bridge. In general, the groundwater level beneath the bridge is expected to be located slightly below the highway grade (i.e. at or below Elev. 320 m).

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

6 CORROSIVITY AND SULPHATE TEST RESULTS

Soil samples from Boreholes BH 20-01 and BH 20-02 were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix A.

Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Test Results	
		BH20-01 SS 4 Depth 3.4 m	BH20-02 SS 3 Depth 2.6 m
		(Sand Fill)	(Native Sand)
Sulphide	%	<0.04	<0.04
Chloride	µg/g	210	750
Sulphate	µg/g	8.3	21
pH	No unit	9.66	9.37
Electrical Conductivity	µS/cm	547	1120
Resistivity	Ohms.cm	1830	892
Redox Potential	mV	287	285



7 MISCELLANEOUS

Landshark Drilling of Brantford, Ontario supplied a B60 truck-mounted drill rig and conducted the drilling, sampling and in-situ testing operations for the present investigation.

The coordinates and elevations for the boreholes were obtained by Thurber using a Trimble R10.

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

Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory. Analytical laboratory testing was carried out by SGS Canada Inc.

Overall supervision of the field program, interpretation of the data, and preparation of the report was conducted by Mr. Geoff Lay, P.Eng. Mr. Jason Lee, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

Thurber Engineering Ltd



Geoff Lay, P.Eng.
Geotechnical Engineer



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





Appendix A
Record of Borehole Sheets, Laboratory Test Results for Present Site Investigation and
Analytical Laboratory Test Results

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level
 Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

RECORD OF BOREHOLE No BH20-01

1 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
327.5	GROUND SURFACE							20 40 60 80 100	PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
0.0	ASPHALT: (200mm)											
0.2	SAND and GRAVEL Brown Dry (FILL)						327					
326.7												
0.8	SAND, some silt, some gravel Compact Brown Dry (FILL)		1	SS	28		326					
			2	SS	12							
325.3												
2.2	SAND, trace silt Very Loose to Loose Brown Dry (FILL)		3	SS	3		325					
			4	SS	8		324					
323.4												
4.1	SAND, trace silt Compact Brown Wet		5	SS	27		323					
							322					
			6	SS	17		321					
320.3												
7.2	Clayey SILT, trace sand, trace gravel Stiff Brown Wet		7	SS	9		320					
318.8							319					
8.7	Silty CLAY, trace sand Very Stiff to Hard Grey Wet		8	SS	31		318					

Continued Next Page

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH20-01

2 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
314.2			9	SS	24		317					0 0 30 70
			10	SS	31		316					
							315					
13.3	Silty SAND to Sandy SILT , trace clay Very Dense to Dense Grey Wet		11	SS	72		314					
							313					
			12	SS	85		312					
							311					
			13	SS	88		310					0 28 66 6
							309					
308.1			14	SS	45		308					
19.4	Silty CLAY , trace sand Hard Grey Wet											

Continued Next Page

ONTMT452 MTO-11375(GINTDATA)\GPJ 2017TEMPLATE(MTO)_GDT 2/9/21


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

RECORD OF BOREHOLE No BH20-01

3 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)						
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	w _p	w			w _L	
Continued From Previous Page								20	40	60	80	100	20	40	60		
			15	SS	39		307							○			
			16	SS	37		304						○				
							303										
							302										
							301						○				
							300										
							299										
							298						○				
			18	SS	30								○				

Continued Next Page

ONTMT4S2 MTO-11375(GINTDATA)\GPJ 2017TEMPLATE(MTO)_GDT 2/9/21

+³, ×³: Numbers refer to
Sensitivity

20
15
10
5
0
5
10
15
20
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH20-01

4 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page													
293.7	Very Stiff		19	SS	23									
33.8	Silty CLAY , sandy, trace gravel Hard Grey Wet (TILL)		20	SS	100/ 0.275									
			21	SS	76/ 0.250									
289.2			22	SS	105/ 0.175									
38.3	END OF BOREHOLE AT 38.3m. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2020.08.24 5.5 322.0													

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 2/9/21

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No BH20-02

2 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 695.8 E 226 245.9 ORIGINATED BY MC
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2020.08.20 - 2020.08.21 LATITUDE 43.459054 LONGITUDE -80.470721 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
			9	SS	25		314					
							313					
			10	SS	31							0 0 34 66
							312					
310.9			11	SS	34		311					
14.1	SAND Dense Brown Wet											
310.2							310					
14.8			12	SS	33							
							309					
308.7												
16.3	SAND Very Dense Brown Wet		13	SS	71		308					
							307					
307.2												
17.8	Silty CLAY, trace sand Hard Grey Wet		14	SS	50		306					0 1 43 56
							305					

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH20-02

3 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 695.8 E 226 245.9 ORIGINATED BY MC
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2020.08.20 - 2020.08.21 LATITUDE 43.459054 LONGITUDE -80.470721 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
	Continued From Previous Page		15	SS	103		304						
			16	SS	57		303						
							302						
							301						
			17	SS	44		300						
							299						
							298						
			18	SS	28		297						
							296						
							295						

Continued Next Page

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

RECORD OF BOREHOLE No BH20-02

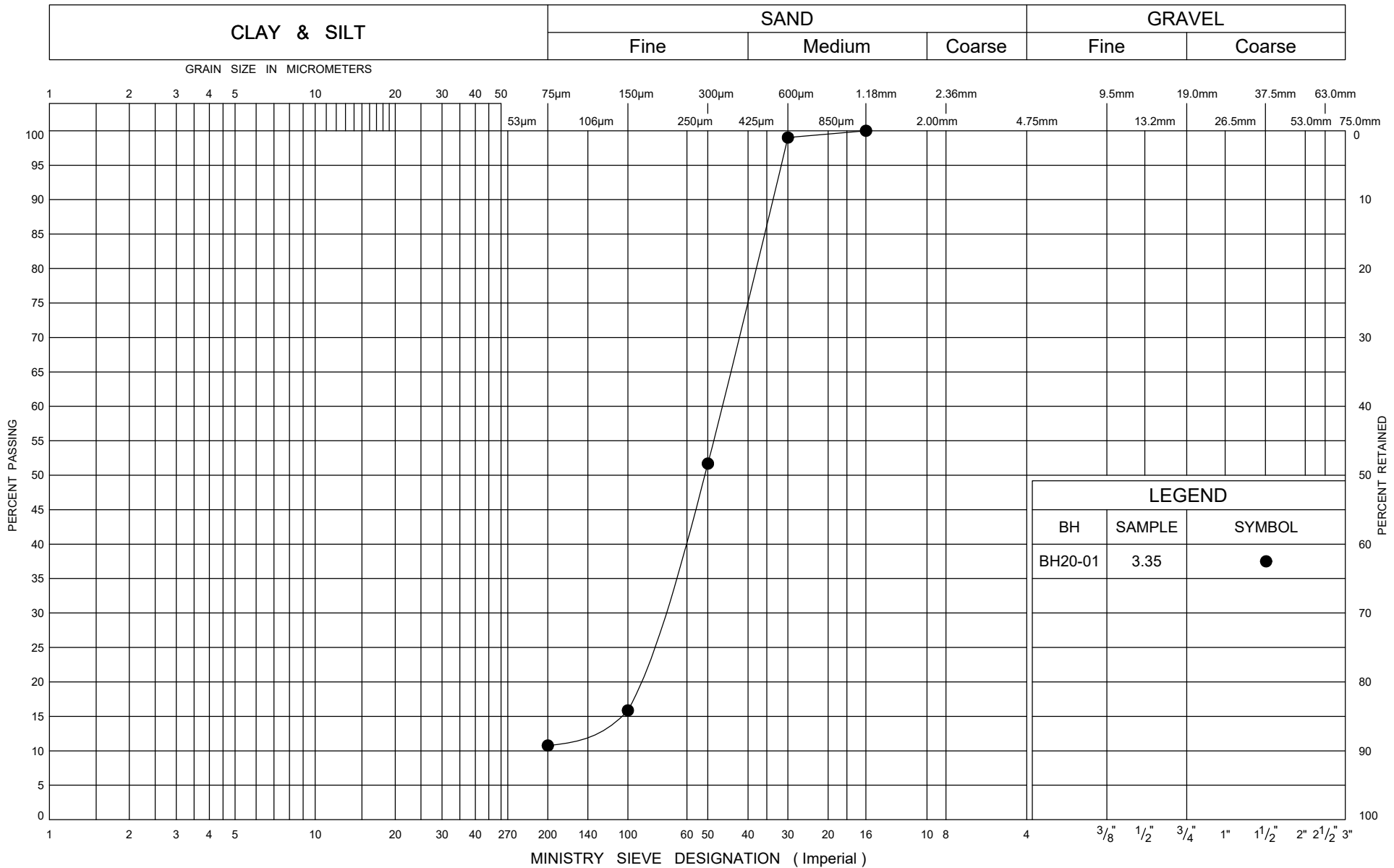
4 OF 4

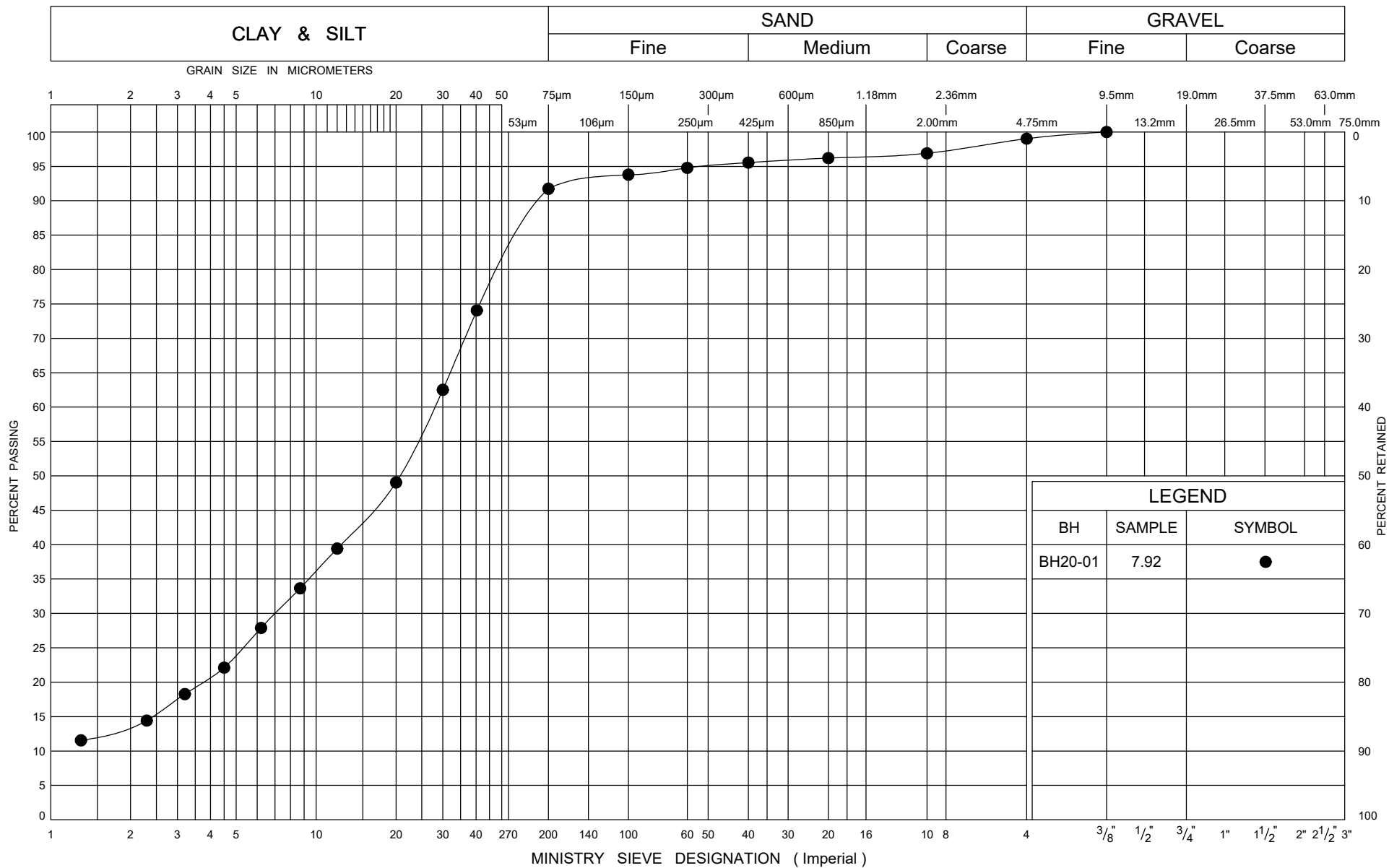
METRIC

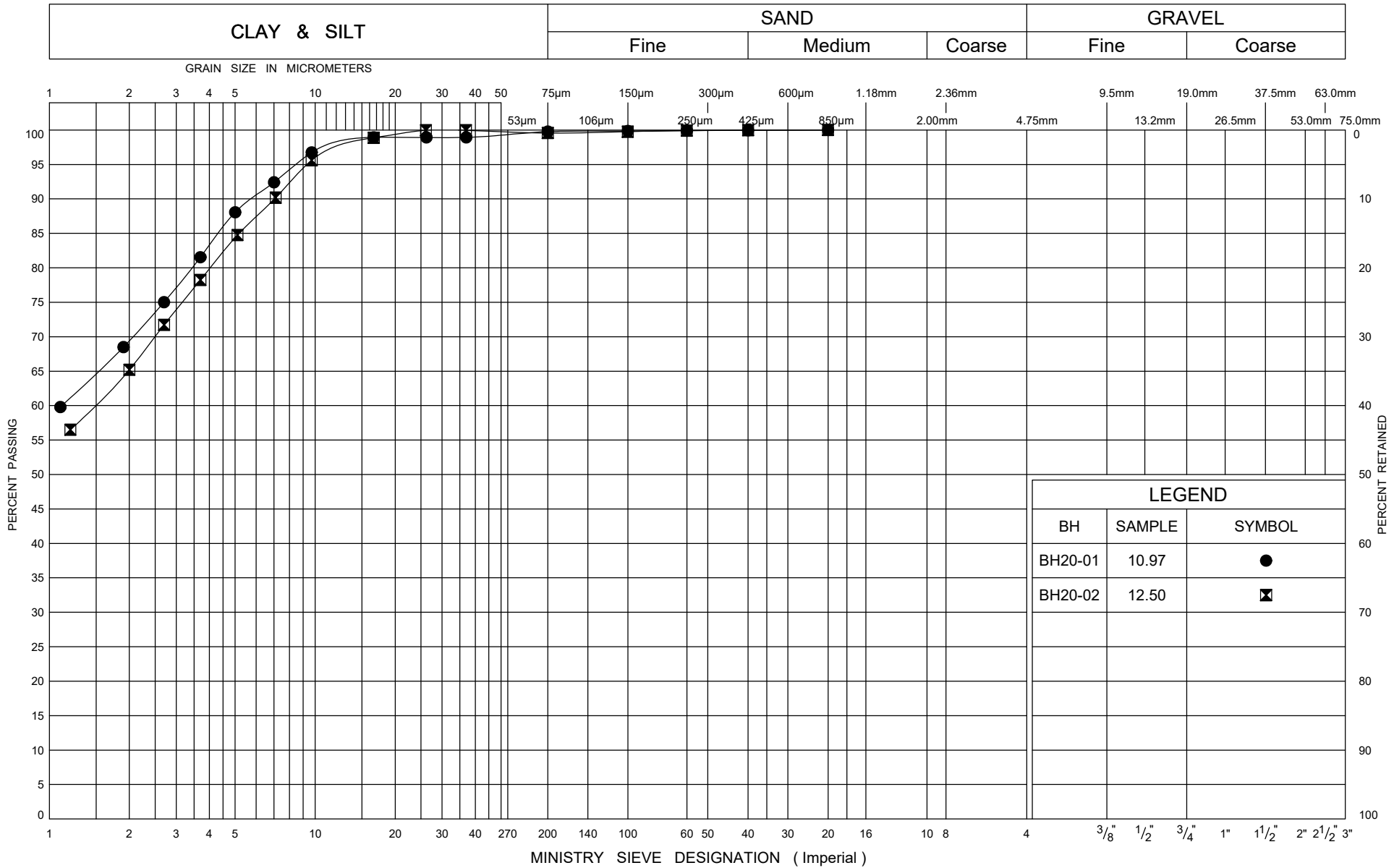
GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 695.8 E 226 245.9 ORIGINATED BY MC
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2020.08.20 - 2020.08.21 LATITUDE 43.459054 LONGITUDE -80.470721 CHECKED BY GRL

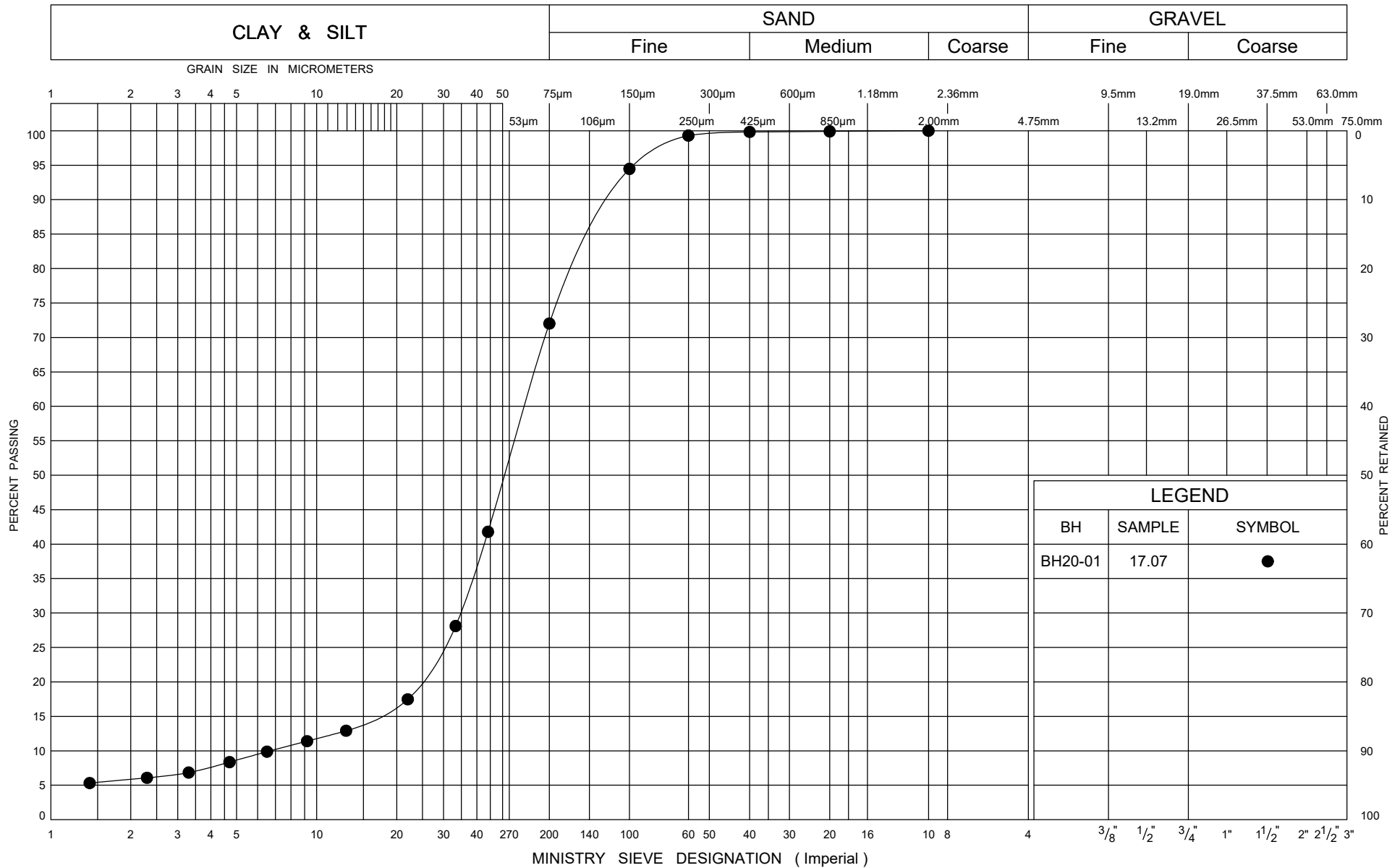
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page													
292.7			19	SS	24		294							
32.3	SAND, with gravel, trace silt Very Dense Grey Wet						293							
							292							
290.4			20	SS	69		291							
34.6	Silty CLAY, with sand, gravelly Hard Grey Wet (TILL)		21	SS	101/ 0.275		290							
							289							
			22	SS	103/0.225		288							
							287							
286.6			23	SS	104/ 0.250									
38.4	END OF BOREHOLE AT 38.35m. WATER LEVEL AT 2.3m. BOREHOLE BACKFILLED WITH BENTONITE CUTTINGS AND ASPHALT COLD PATCH TO SURFACE.													

ONTMT4S2 MTO-11375(GINTDATA)\GPJ 2017\TEMPLATE(MTO)_GDT 2/9/21









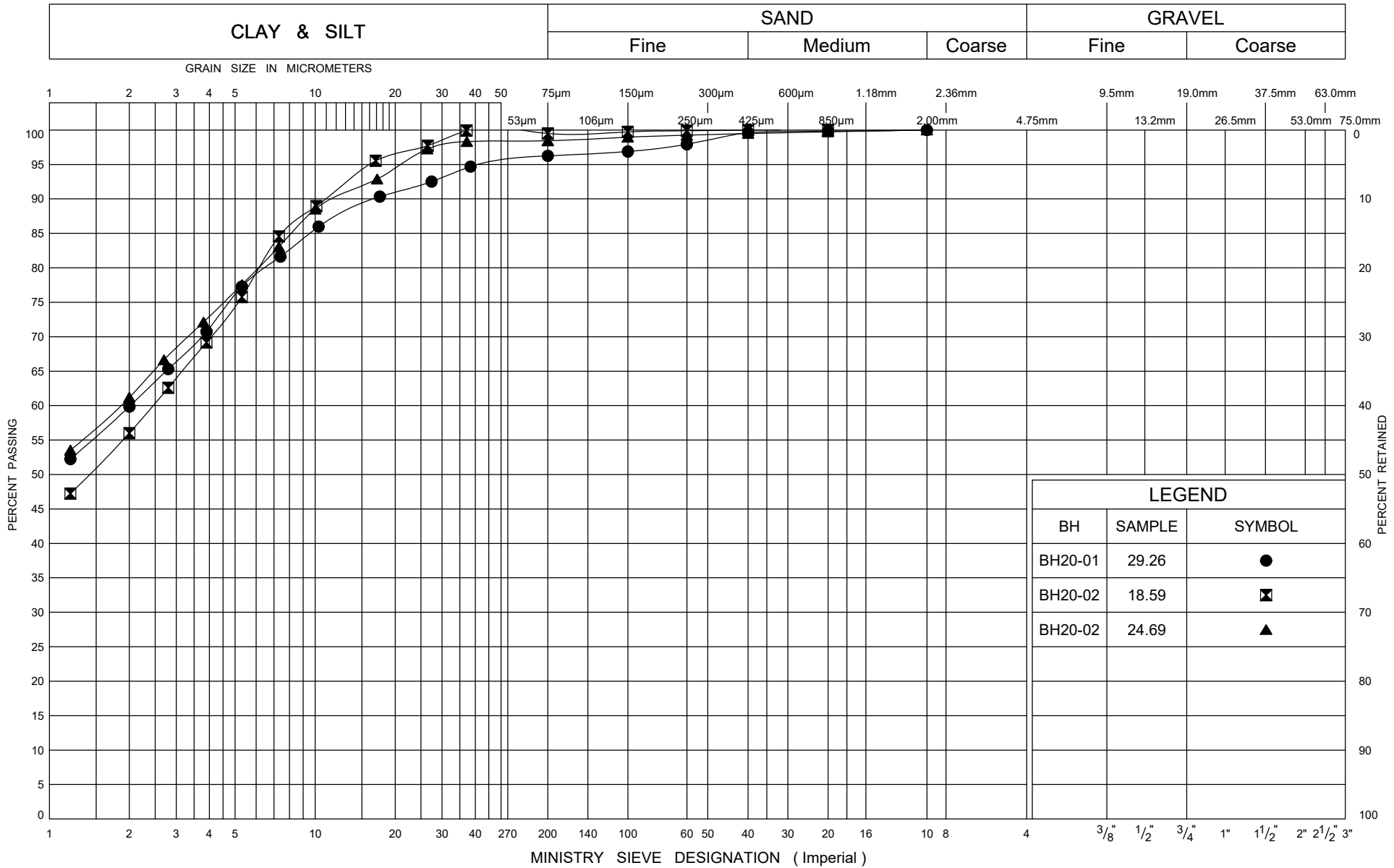
Ministry of
Transportation

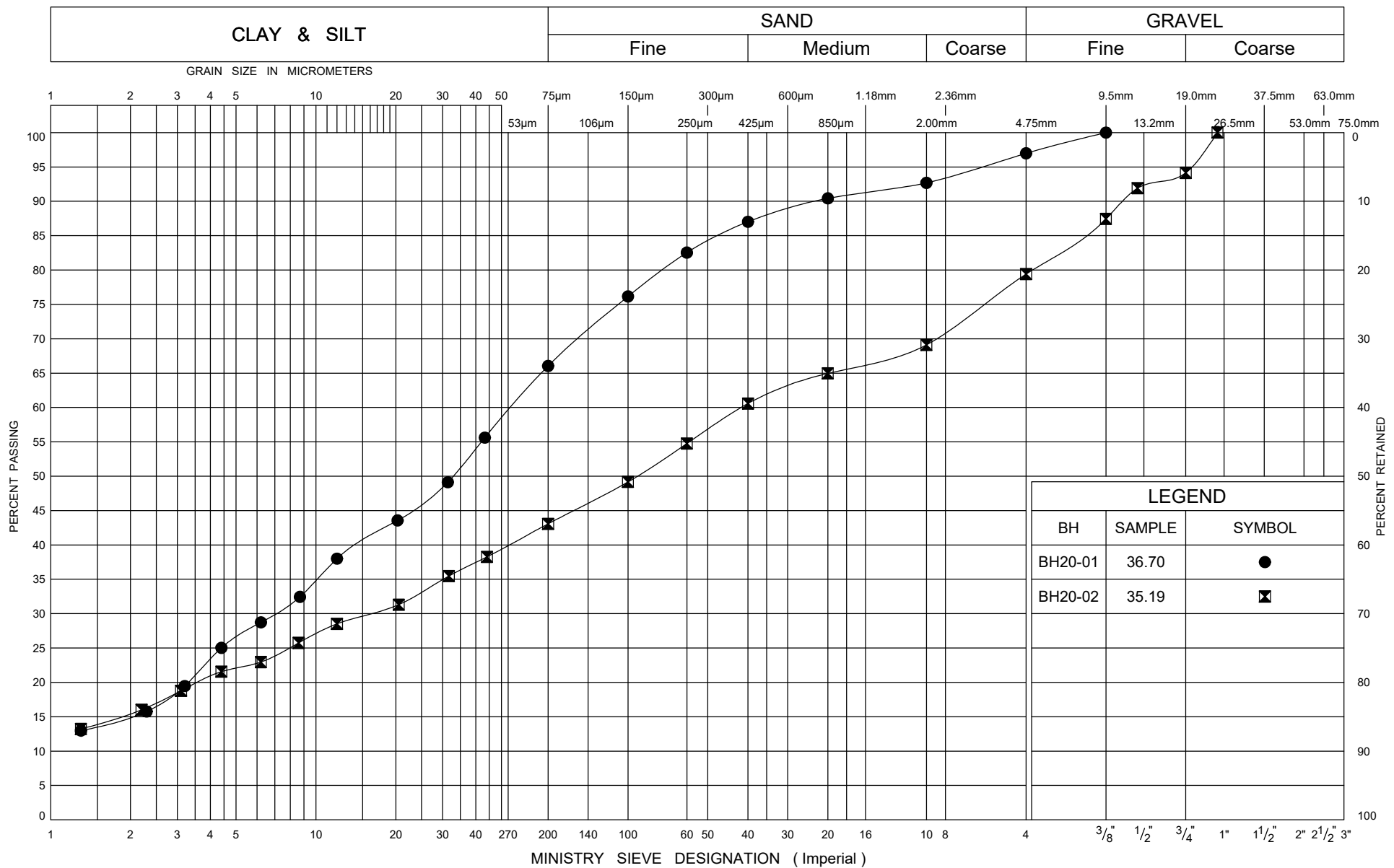
GRAIN SIZE DISTRIBUTION

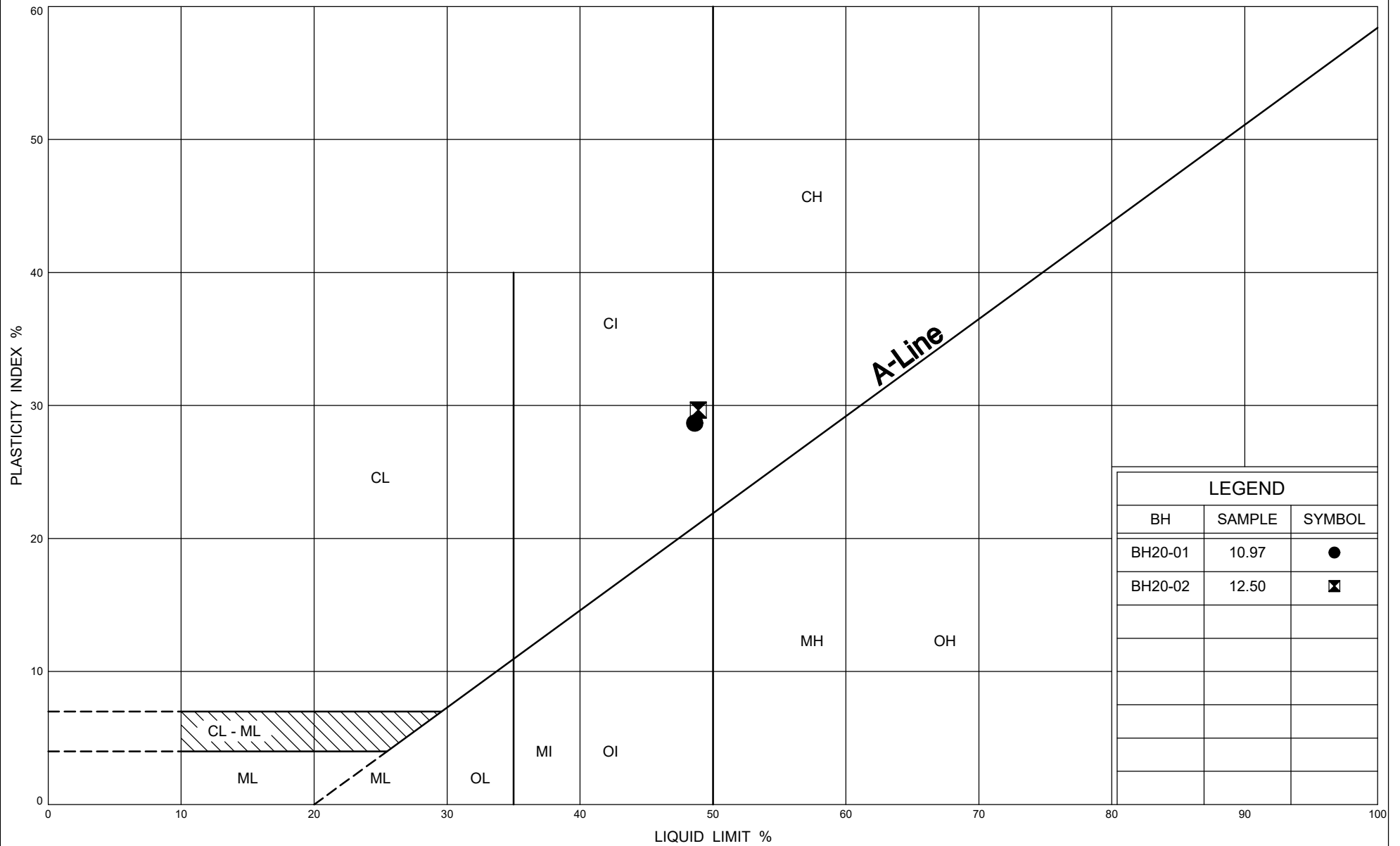
Sandy SILT to Silty SAND

FIG No A4

W P 408-88-00







LEGEND		
BH	SAMPLE	SYMBOL
BH20-01	10.97	●
BH20-02	12.50	☒



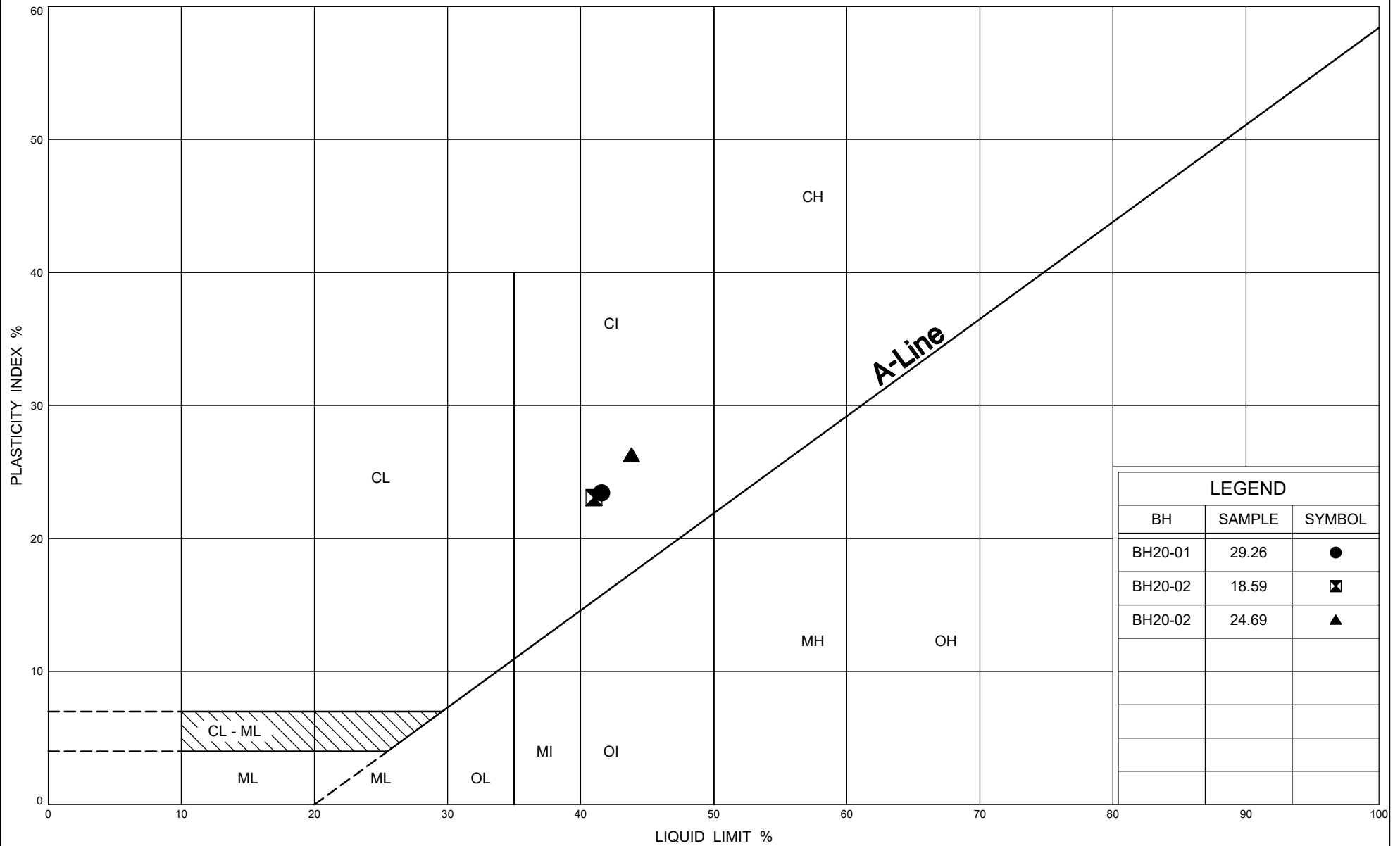
Ministry of
Transportation

PLASTICITY CHART

Upper Silty CLAY

FIG No A7

W P 408-88-00



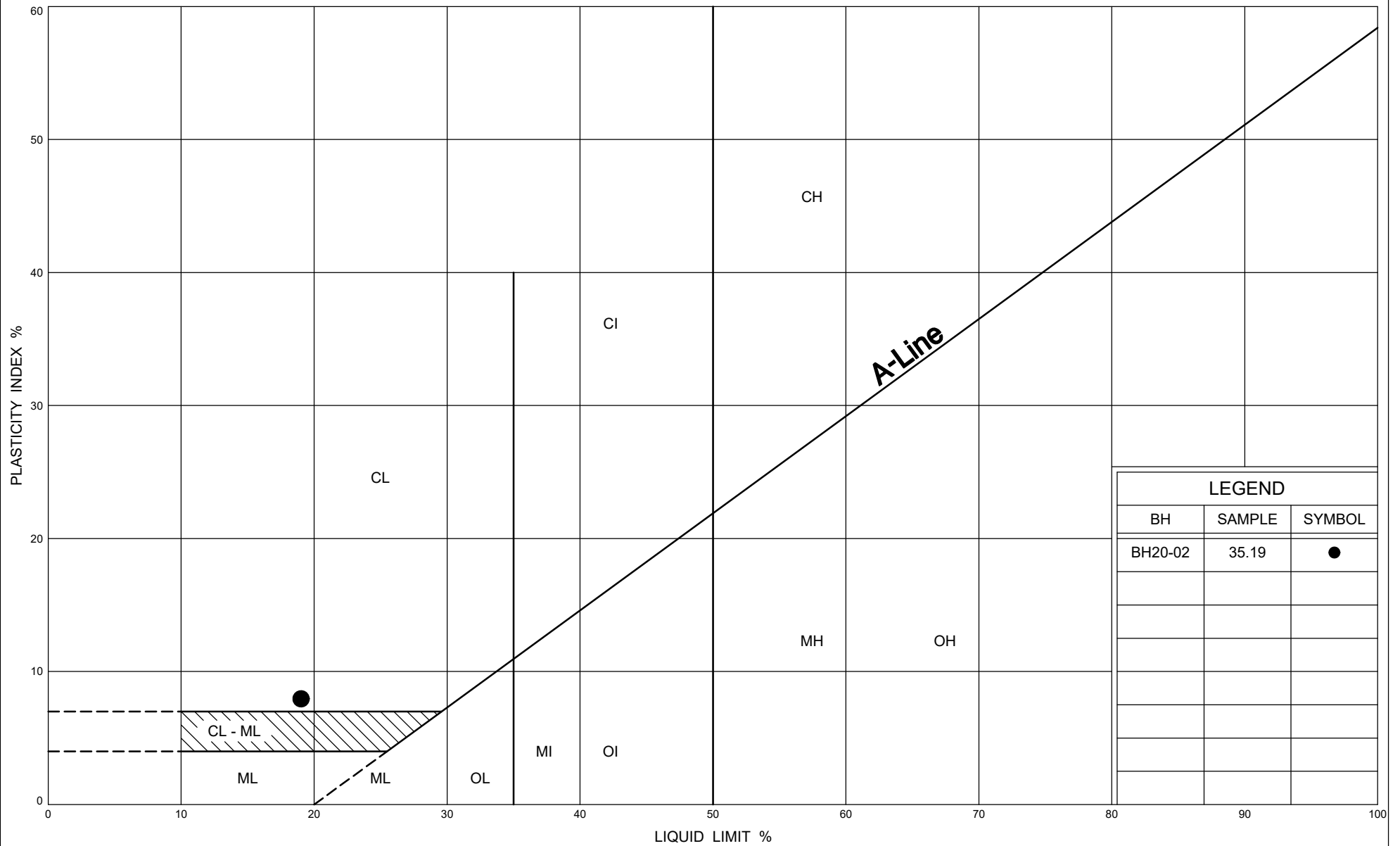
Ministry of
Transportation

PLASTICITY CHART

Lower Silty CLAY

FIG No A8

W P 408-88-00



Ministry of
Transportation

PLASTICITY CHART

Silty CLAY TILL

FIG No A9

W P 408-88-00



FINAL REPORT

CA14882-AUG20 R1

1375 Frederick St.

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

Client Thurber Engineering Ltd.

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

Contact Geoff Lay

Telephone 905-829-8666

Facsimile

Email glay@thurber.ca

Project 1375 Frederick St.

Order Number

Samples Soil (2)

LABORATORY DETAILS

Project Specialist Jill Campbell, B.Sc.,GISAS

Laboratory SGS Canada Inc.

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

Telephone 2165

Facsimile 705-652-6365

Email jill.campbell@sgs.com

SGS Reference CA14882-AUG20

Received 08/28/2020

Approved 09/03/2020

Report Number CA14882-AUG20 R1

Date Reported 09/03/2020

COMMENTS

Temperature of Sample upon Receipt:7 degrees C

Cooling Agent Present:YES

Custody Seal Present:YES

Chain of Custody Number:NA

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

Jill Campbell, B.Sc.,GISAS





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QC Summary..... 6-7

Legend..... 8

Annexes..... 9



FINAL REPORT

CA14882-AUG20 R1

Client: Thurber Engineering Ltd.

Project: 1375 Frederick St.

Project Manager: Geoff Lay

Samplers: Brett Thomas

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL		Result	Result
Corrosivity Index					
Corrosivity Index	none	1		8	13
Soil Redox Potential	mV	-		287	285
Sulphide	%	0.04		< 0.04	< 0.04
pH	pH Units	0.05		9.66	9.37
Resistivity (calculated)	ohms.cm	-9999		1830	892

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL		Result	Result
General Chemistry					
Conductivity	uS/cm	2		547	1120

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL		Result	Result
Metals and Inorganics					
Moisture Content	%	0.1		3.8	4.4
Sulphate	µg/g	0.4		8.3	21



FINAL REPORT

CA14882-AUG20 R1

Client: Thurber Engineering Ltd.

Project: 1375 Frederick St.

Project Manager: Geoff Lay

Samplers: Brett Thomas

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL		Result	Result
Other (ORP)					
Chloride	µg/g	0.4		210	750



FINAL REPORT

CA14882-AUG20 R1

QC SUMMARY

Anions by IC

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0461-AUG20	µg/g	0.4	<0.4	2	20	96	80	120	103	75	125
Sulphate	DIO0461-AUG20	µg/g	0.4	<0.4	8	20	98	80	120	95	75	125

Carbon/Sulphur

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0001-SEP20	%	0.04	< 0.04	ND	20	100	80	120			

Conductivity

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

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0414-AUG20	uS/cm	2	< 0.002	1	20	99	90	110	NA		



QC SUMMARY

pH
Method: SM 4500 | Internal ref.: ME-CA-|ENVIEWL-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	EWL0414-AUG20	pH Units	0.05	NA	1		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.

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-- End of Analytical Report --



Appendix B
Record of Borehole Sheets and Laboratory Test Results for Previous Site Investigation

FOUNDATION SECTION

CHECKED BY K.G.S.


[illegible]

FOUNDATION SECTION

CHECKED BY K.G.S.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— WL		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT ——— WP	WATER CONTENT ——— W		
							20		40	60		
1072.4	Groundlevel											
0.0	Sand (Topsoil)					1070						
1068.4	Loose		1	SS	8							Sa 80%
4.0	Sand occasional trace of silt. Compact.		2	SS	24							Si 20%
			3	SS	20							
			4	SS	25	1060						
			5	SS	10							
			6	SS	30							
1052.4				7	SS	28	1050					
20.0	Clayey silt with some sand and gravel Stiff to hard.		8	SS	15							
			9	SS	57							
1045.4			10	SS	71							
27.0	Silty clay Hard Brownish grey.		11	SS	44	1040						
			12	SS	194							
			13	SS	88	1030						
1028.4			14	SS	100/11"							
44.0	Fine sandy silt to silty fine sand. Very dense.		15	SS	85/6"	1020						
			16	SS	120	1010						
1013.4	Silty clay Hard Brownish grey.		17	SS	92	1000						
59.0			18	SS	46							
988.9			19	SS	130	990						
83.5	End of borehole.					980						

FOUNDATION SECTION

JOB 66-F-53 LOCATION N 200,803.248, E 210,761.731 ORIGINATED BY D.W.
 W.P. 634-64 BORING DATE May 31, 1966. COMPILED BY D.W.
 DATUM Geodetic BOREHOLE TYPE Penetration & Washboring. CHECKED BY K.G.S. 

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _p WATER CONTENT ——— w			BULK DENSITY Y P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT 20 40 60 80 100					w _p w w _L				
							SHEAR STRENGTH P.S.F.					WATER CONTENT % 15 30 45				
1071.9	Groundlevel															
0.0	Sand (Topsoil)					1070									Sa 92% Si 8%	
1067.9	Loose		1	SS	2											
4.0	Sand		2	SS	10											
	Compact to dense.		3	SS	36											
1060.9	Silty fine sand		4	SS	22	1060									GWL Elev. 1059.1	
1057.9	Compact		5	SS	45										Gr 47% Sa 46% Si 7%	
14.0	Gravelly sand		6	SS	62											
	Dense to very dense		7	SS	27	1050										
1051.9	Clayey silt		8	SS	31										Gr 7% Sa 19% Si 54% Cl 20%	
20.0	Hard		9	SS	49											
1045.9	Grey		10	SS	108	1040										
26.0	Silty clay		11	SS	60											
	Hard															
	Brownish grey															
1032.9			12	SS	99	1030										
39.0			13	SS	158										Sa 22% Si 78%	
	Silty fine sand to fine sandy silt.		14	SS	87 7/8"	1020										
	Very dense.															
1012.4			15	SS	50 3/4"											
59.5	End of borehole.					1010										

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20 40 60 80 100	PLASTIC LIMIT — WP	WATER CONTENT — W		
							SHEAR STRENGTH P.S.F.	WP W WL	WATER CONTENT %		
1069.3 0.0	Groundlevel										
						1060					
						1050					
1044.5 24.8	End of borehole.					1040					

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 66-F-53

LOCATION N 200.821.407. E210.811.176

ORIGINATED BY D.W.

W.P. 634-64

BORING DATE May 31, 1966.

COMPILED BY D.W.

DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration

CHECKED BY K.G.S. *[Signature]*

SOIL PROFILE

SAMPLES

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT

20 40 60 80 100

SHEAR STRENGTH P.S.F.

LIQUID LIMIT ——— WL

PLASTIC LIMIT ——— WP

WATER CONTENT ——— W

WP ——— W ——— WL

WATER CONTENT %

BULK
DENSITY
Y
P.C.F.

REMARKS

ELEV.
DEPTH

DESCRIPTION

STRAT. PLOT

NUMBER

TYPE

BLOWS / FOOT

ELEV. SCALE

Groundlevel

0.0

1060

1050

End of borehole.

20.0

1040

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 66-F-53

LOCATION N 200,919.964, E 210,802.832

ORIGINATED BY D.W.

W.P. 634-64

BORING DATE May 30, 1966.

COMPILED BY D.W.

DATUM Geodetic

BOREHOLE TYPE Penetration & Washboring.

CHECKED BY K.G.S.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 66-F-53

LOCATION N 200.844.706. E 210.861.156

ORIGINATED BY D.W.

W. P. 634-64

BORING DATE May 31, 1966.

COMPILED BY D.W.

DATUM Geodetic

BOREHOLE TYPE Penetration & Washboring.

CHECKED BY K.G.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— WL	PLASTIC LIMIT ——— WP	WATER CONTENT ——— W	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20 40 60 80 100					
1069.1	Groundlevel											
0.0	Sand (Topsoil) Loose											Sa 88% Si 12%
1062.6			1	SS	6							GWL El. 1058.6
6.5	Sand with trace of silt. Compact.		2	SS	20	1060						
1055.1			3	SS	19							
14.0	Clayey silt with trace of sand and gravel.		4	SS	16	1050						
1046.1	Very stiff to hard. Grey		5	SS	34							Sa 67% Si 32%
23.0			6	SS	100/11"		100/4"					
1036.1	Silty fine sand. Very dense.		7	SS	100/9"	1040						
33.0			8	SS	52/3"							
1036.1			9	SS	80							
33.0	Silty clay. Hard. Brownish grey.		10	SS	61	1030						
1023.1			11	SS	97							
46.0	Fine sandy silt. Very dense.					1020						Sa 28% Si 72%
1013.2			12	SS	110/5"							
55.9	End of borehole.					1010						

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 66-F-53

LOCATION N 200,939.749, E 210,847.402

ORIGINATED BY D.W.

W. P. 634-64

BORING DATE June 6, 1966.

COMPILED BY D.W.

DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration.

CHECKED BY K.G.S.

[illegible]

[illegible]

FOUNDATION SECTION

CHECKED BY K.G.S.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOA 66-F-53

LOCATION N 200,883.088, E 210,947.710

ORIGINATED BY D.W.

W. P. 634-64

BORING DATE May 31, 1966.

COMPILED BY _____ D.W.

DATUM Geodetic

BOREHOLE TYPE Penetration & Washboring

CHECKED BY K.G.S.

[illegible]

FOUNDATION SECTION

CHECKED BY K.G.S. *[Signature]*

[illegible]

FOUNDATION SECTION

CHECKED BY K.G.S.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION
JOB 66-F-53
W.P. 634-64
DATUM Geodetic

RECORD OF BOREHOLE NO. 14

FOUNDATION SECTION

LOCATION N 200,997.938, E 210,999.324
BORING DATE June 2, 1966
BOREHOLE TYPE Penetration & Washboring.
ORIGINATED BY D.W.
COMPILED BY D.W.
CHECKED BY K.G.S.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.			WATER CONTENT %				
067.2	Groundlevel													
0.0	Sand (Topsoil)													
1062.2	Compact		1	SS	11									
5.0			2	SS	14	1060								
			3	SS	18									
	Sand with trace of silt.		4	SS	15									
			5	SS	15									
	Compact.		6	SS	17	1050								
			7	SS	20									
			8	SS	28									
041.2	Silty clay with trace of sand. Hard.		9	SS	130	1040								
038.2			10	SS	100	1039"								
29.0	Sand with some silt.													
	Very dense.		11	SS	62	1030								
026.2			12	SS	93									
41.0	Silty clay.													
	Hard.		13	SS	47	1020								
015.2														
52.0	Fine sandy silt.													
	Very dense.		14	SS	109	1010								
006.2														
61.0	Silty clay													
	Hard													
000.7	Brownish grey		15	SS	120	1000								
66.5	End of borehole.													

Sa 89%
Si 11%
GWL El.
1054.2
Sa 93%
Si 7%
Gr 2%
Sa 97%
Si 1%

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 66-F-53

LOCATION N 201,116.543, E 210,741.917

ORIGINATED BY D.W.

W.P. 634-64

BORING DATE June 3, 1966

COMPILED BY D.W.

DATUM Geodetic

BOREHOLE TYPE Penetration & Washboring

CHECKED BY K.G.S.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT — WL	PLASTIC LIMIT — WP	WATER CONTENT — W	BULK DENSITY P.C.F.	REMARKS	
F. EV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WP	W			WL
							20 40 60 80 100						
1065.0	Groundlevel												
0.0	Sand					1060							
	Compact		1	SS	17								
1056.0													
9.0	Clayey silt to silty clay with some sand and gravel. Very stiff to hard Brownish grey.		2	SS	26								
			3	SS	62	1050							
			4	SS	111								
			5	SS	126								
			6	SS	87	1040							
			7	SS	85								
1036.0													
29.0	Silty clay		8	SS	83								
	Hard		9	SS	39	1030							
	Brownish grey.												
1024.0													
41.0	Silty fine sand.		10	SS	105								
	Very dense		11	SS	93 76	1020							
1008.5													
			12	SS	116	1010							
56.5	End of borehole.					1000							

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 17

FOUNDATION SECTION

JOB 66-F-53 LOCATION N 200,754.293, E 210,935.966 ORIGINATED BY D.W.
W.P. 634-64 BORING DATE June 2, 1966 COMPILED BY D.W.
DATUM Geodetic BOREHOLE TYPE Penetration & Washboring CHECKED BY K.G.S.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WP	W	WL		
1069.6	Groundlevel															
0.0	Sand															
	Loose to v. dense		1	SS	9											
			2	SS	70	1060										
			3	SS	28											
1054.6	Clayey silt		4	SS	34											
15.0	Very stiff to hard.		5	SS	22	1050										
1049.1	Fine sandy silt, v. dense		6	SS	27											
20.5			7	SS	53											
1046.6	Clayey silt to silty clay.		8	SS	150	1040										
23.0	Hard.		9	SS	60											
	Brownish grey.		10	SS	88											
			11	SS	75	1030										
1025.3	Fine sandy silt.		12	SS	68	1020										
44.2	Very dense															
1013.8	End of borehole.		13	SS	50	1010										
55.8																

Sa 91%
Si 9%
GWL
El. 1057.8

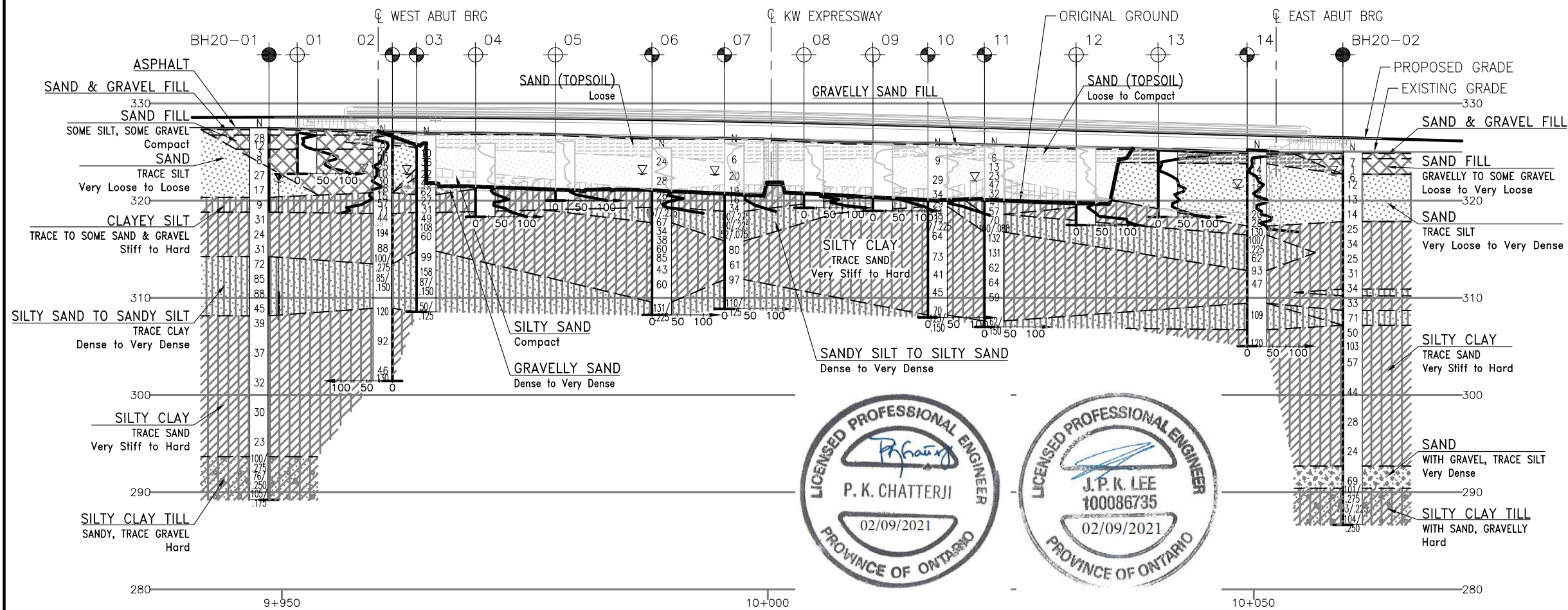
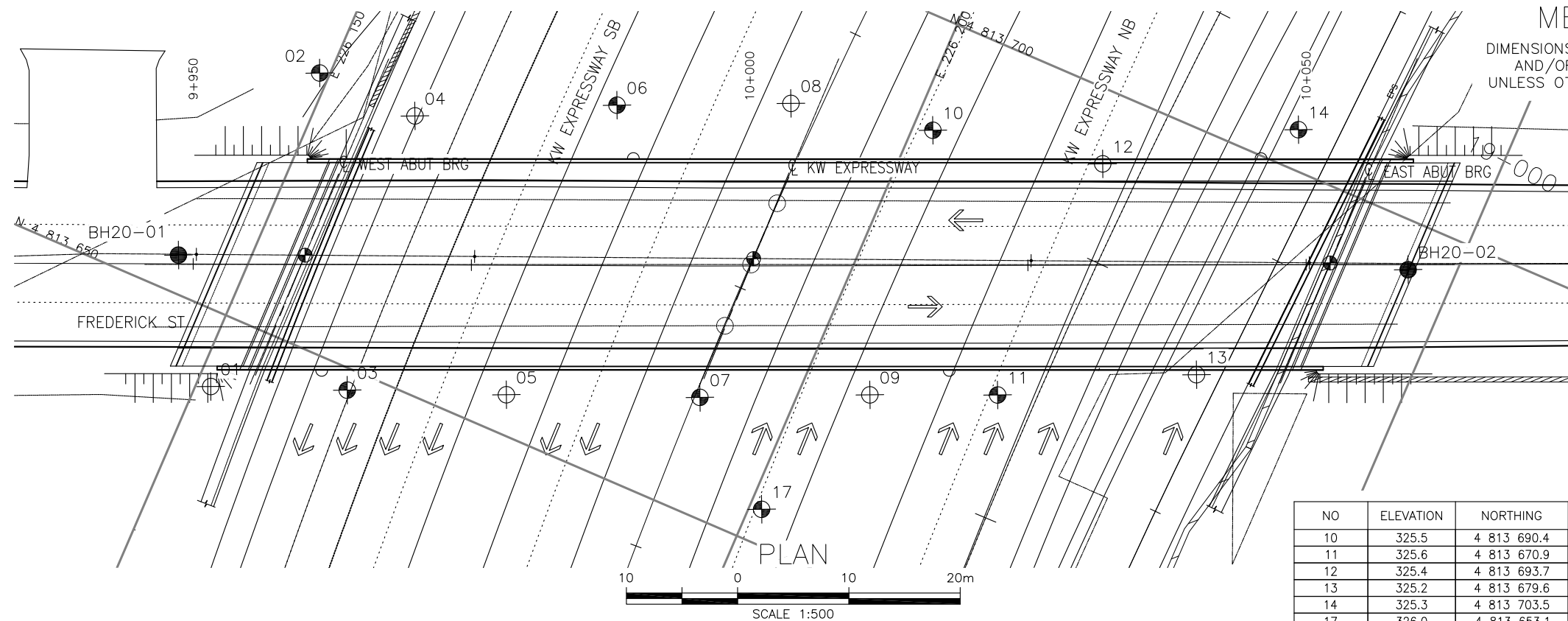
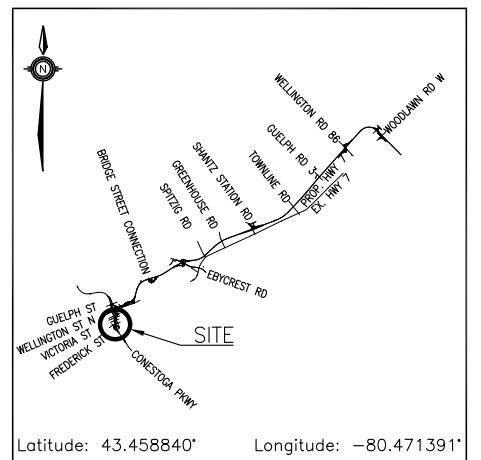
Sa 1%
Si 80%
Cl 19%

Sa 28%
Si 72%

100/7"



Appendix C
Borehole Locations and Soil Strata Drawing

CONT No
GWP No 408-88-00HIGHWAY 7
FREDERICK STREET
PROPOSED BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

KEYPLAN			
LEGEND			
	Borehole (Current Investigation)		
	Borehole and Cone (Previous Investigation)		
	Cone Penetration Hole (Previous Investigation)		
	Blows /0.3m (Std Pen Test, 475J/blow)		
	Blows /0.3m (60' Cone, 475J/blow)		
	Pressure, Hydraulic		
	Water Level		
	Head Artesian Water		
	Piezometer		
	90% Rock Quality Designation (RQD)		
	Auger Refusal		
NO	ELEVATION	NORTHING	EASTING
BH20-01	327.5	4 813 653.3	226 144.0
BH20-02	325.0	4 813 695.8	226 245.9
01	327.0	4 813 643.6	226 151.3
02	326.9	4 813 673.3	226 149.1
03	326.7	4 813 648.2	226 162.7
04	325.9	4 813 673.2	226 158.5
05	326.1	4 813 653.4	226 176.0
06	325.4	4 813 681.2	226 174.8
07	325.9	4 813 660.1	226 192.0
08	325.6	4 813 687.6	226 189.1
09	325.8	4 813 666.4	226 206.0

-NOTES-

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

GEOCRES No. 40P8-285

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	GL	CHK	PKC	CODE
DRAWN	MFA	CHK	GL	SITE
LOAD	DATE	FEB	2021	
STRUCT	DWG	1		