THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
STRAWBERRY CREEK BRIDGE #8 REPLACEMENT
WARE ROAD NORTH, DISTRICT OF THUNDER BAY, WARE TOWNSHIP, ONTARIO
LATITUDE: 48.604697°, LONGITUDE: -89.471511°
G.W.P. 6014-18-00, SITE No. 48W-054

GEOCRES Number: 52A-250

Report

to

Ministry of Transportation Ontario

Date: June 5, 2020
File: 27323

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TABLE OF CONTENTS

APPENDICES

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1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the Strawberry Creek #8 Bridge, located on Ware Road North, in Ware Township, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the existing Strawberry Creek #8 bridge site, and based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber was retained by the Ministry of Transportation (MTO), Northwest Region, to carry out this foundation investigation under the MTO Agreement Number 6017-E-0062, Assignment #2.

2. SITE DESCRIPTION

The site is located on Ware Road North, approximately 3.2 km north of Auto Road, in Ware Township, Thunder Bay District, Ontario. The existing bridge allows Strawberry Creek #8 to flow under Ware Road North in a general west to east direction. Ware Road North runs in a general north-south direction at the bridge site. Ware Road North is a two-lane gravel road that narrows to single lane across the existing bridge. The immediate approaches to the bridge deck are paved with asphalt.

The Ontario Structure Inspection Manual (OSIM) report prepared by MTO on July 18, 2018 indicates that the existing structure is a single-span, wooden rectangular beam / girder bridge with a wooden deck. The inspection report indicates that the bridge has a span of 6.3 m and the structure is approximately 5.5 m wide. Based on a November 2019 survey plan of the site provided

by MTO (Plan E-1019-0-7), the ground surface elevation of Ware Road North at the existing bridge is approximately Elevation 366.3 m. The existing bridge is supported on timber sitting on ballast walls. The OSIM report notes that the bridge has a very low clearance. Measurements collected in October 2019 indicate that the surface water level of the creek varies from approximate Elevation 365.4 to 365.2 m from upstream to downstream of the bridge.

The lands surrounding the bridge site are predominantly heavily forested, with mature trees, grass and shrubs. The area along the creek floodplain near the bridge also contains marshy conditions. Photographs of the bridge and surrounding area are presented in Appendix C.

Based on published geological information, the bridge lies within an area consisting of glaciolacustrine plains of silt and clay, surrounded by bedrock knobs, with some sand and gravel pits in the general vicinity. Based on local geological maps, the bedrock in the area consists of metasedimentary rocks and minor metavolcanic rocks.

3. INVESTIGATION PROCEDURES

The field investigation for the replacement bridge was carried out between November 4 and 9, 2019 and consisted of drilling and sampling six (6) boreholes, labeled SC8-01 to SC8-06. The boreholes were drilled to depths ranging from 7.2 to 18.3 m (Elevation 359.1 to 348.0 m). Boreholes SC8-01 and SC8-02 were drilled near the north abutment of the bridge and Boreholes SC8-03 and SC8-04 were drilled near the south abutment. Boreholes SC8-05 and SC8-06 were drilled at the north and south approaches to the bridge respectively. The boreholes were drilled through either the paved bridge approaches or the granular road surface. Flowing artesian groundwater pressure of greater than 3 m above the ground surface were encountered when penetrating the thick native silty clay deposit in Borehole SC8-01 near the north abutment. Due to the difficulty in sealing the artesian pressure in this borehole and following discussion with MTO, the remaining boreholes were terminated near the base of the silty clay deposit to avoid encountering additional flowing artesian conditions.

The borehole logs are included in Appendix A and the approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata drawings included in Appendix D.

Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were estimated from field measurements and the survey drawing provided to Thurber by MTO. The coordinate system MTM NAD 83, Zone 15 was used for the boreholes.

A rubber tracked CME 55 drill rig was used to advance the boreholes using hollow stem augers

and NW casing. Soil samples were obtained in the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) as well as thin-walled tube samples. A Dynamic Cone Penetration Test (DCPT) was conducted at the base of Borehole SC8-04. NQ coring methods were used to advance Borehole SC8-01 into bedrock.

The drilling and sampling 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 and rock samples for transport to Thurber's laboratory for further examination and testing.

The rock core was logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

The boreholes were decommissioned in general accordance with Ontario Regulation 903 as amended upon completion of drilling.

Completion details of the boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
SC8-01	18.3 / 348.0	Artesian groundwater pressure to greater than 3 m above the ground surface. Sealed pressure and backfilled borehole with mix of Portland cement, bentonite grout and concrete to surface.
SC8-02	8.7 / 357.7	Backfilled with bentonite from 8.7 to 0.3 m, then cement to surface.
SC8-03	7.2 / 359.1	Backfilled with bentonite from 7.2 to 0.3 m, then cement to surface.
SC8-04	10.4 / 356.0	Backfilled with bentonite from 10.4 to 0.3 m, then cement to surface.
SC8-05	11.3 / 354.9	Backfilled with bentonite from 11.3 to 0.3 m, then cement to surface.
SC8-06	8.2 / 358.0	Backfilled with bentonite from 8.2 to 0.3 m, then cement to surface.

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses

(sieve and/or hydrometer) and Atterberg Limits tests, where appropriate. One-dimensional consolidation tests were also conducted on two samples of the silty clay. Point load tests were conducted on the rock core. The results of this laboratory testing program are shown on the Record of Borehole sheets included in Appendix A and on the figures included in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the fill soil from Borehole SC8-04 near the south abutment and a sample of the native silty clay soil from Borehole SC8-02 near the north abutment were selected for testing. A surface water sample from the creek on the upstream side of the bridge was also collected. The soil and water samples were submitted to Bureau Veritas Laboratories, a CALA accredited analytical laboratory in Mississauga, Ontario, for analytical testing of corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix B.

5. SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the Borehole Locations and Soil Strata Drawing included in Appendix D. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It must be recognized and expected that soil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions encountered at the boreholes consisted of gravelly sand to silty sand fill overlying a thick native deposit of firm to stiff silty clay, overlying compact silt and sand, and very dense gravelly sand, which are underlain by granodiorite bedrock. A buried organic layer was also encountered below the fill in the boreholes on the south side of the bridge, and the upper part of the silty clay was noted to contain organic pockets. Descriptions of the individual strata are presented below.

5.1 Asphalt

A 50 mm thick layer of asphalt was encountered at the ground surface in Boreholes SC8-01 and SC8-03, which were drilled on the edge of the paved bridge approaches.

5.2 Gravelly Sand to Silty Sand Fill

A layer of fill ranging from gravelly sand, silty with trace clay to silty sand, trace to some gravel, trace clay was encountered at the ground surface or below the asphalt in all of the boreholes. The fill extended to depths ranging from 0.7 to 1.4 m (Elev. 365.6 to 364.9 m). The fill was loose to very dense, with SPT 'N' values ranging from 5 to greater than 100 blows for 0.3 m of penetration. The measured moisture content in the fill ranged from 4 to 17%.

The results of grain size analyses conducted on samples of the gravely sand fill are illustrated on Figure B1 in Appendix B. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	22 to 27
Sand	49 to 52
Silt	21 to 22
Clay	2 to 3
Silt and Clay	26

5.3 Organics

A 0.4 to 0.7 m thick layer of organic soil containing some peat, some sand, trace gravel, and occasional rootlets and wood fragments was encountered below the fill in Boreholes SC8-04 and SC8-06 on the south side of the bridge. The organic layer extended to a depth from 1.4 to 1.8 m (Elev. 364.8 m). The organic soil was very soft, based on SPT 'N' values of 2 blows per 0.3 m of penetration. The measured moisture content of the organic soil ranged from 134 to 161%.

5.4 Silty Clay with Organics

A layer of silty clay containing organic pockets and wood fragments was encountered below the fill or organic soil in Boreholes SC8-01 to SC8-04 and SC8-06. The silty clay with organics also contained trace to some sand and trace gravel. The silty clay with organics layer was 0.8 to 1.6 m thick and extended to depths ranging from 2.1 to 3.0 m (Elev. 364.2 to 363.3 m).

The silty clay with organics layer was very soft to very stiff, with SPT 'N' values ranging from 0 (weight of hammer) to 30 blows for 0.3 m of penetration, but typically soft. The measured moisture content ranged from 34 to 101%, but typically greater than 40%.

The results of grain size analyses and Atterberg Limit tests conducted on samples of the silty clay with organics are illustrated on Figures B2 and B7 in Appendix B. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 1
Sand	9 to 18
Silt	28 to 43
Clay	48 to 53

Soil Property	Percentage (%)
Liquid Limit	70
Plastic Limit	39
Plasticity Index	31

The results of the Atterberg Limit test indicate that the silty clay is organic with high plasticity, with group symbol OH.

5.5 Silty Clay

A relatively thick deposit of silty clay with trace sand was encountered below the fill and silty clay with organics layers in all of the boreholes. The silty clay ranged to clay with trace to some silt with depth. Where fully penetrated, the silty clay deposit ranged in thickness from 5.0 to 9.0 m and extended to depths from 7.2 to 10.2 m (Elev. 359.1 to 355.9 m). Boreholes SC8-02 and SC8-03 were terminated in the silty clay at depths from 7.2 to 8.7 m (Elev. 359.1 to 357.7 m).

SPT ‘N’ values recorded in the silty clay ranged from 0 (weight of hammer) to 6 blows per 0.3 m of penetration. In-situ vane shear tests conducted in the silty clay measured undrained shear strengths ranging from 46 to 92 kPa, indicating that the silty clay ranges from firm to stiff. The sensitivity of the silty clay ranged from 1.7 to 3.0, indicating a low to medium sensitivity. The measured moisture content of the silty clay ranged from 36 to 69%, but typically greater than 50%.

The results of grain size analysis and Atterberg Limit tests conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A, and illustrated on Figures B3, B4, B7 and B8 in Appendix B. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	0 to 4
Silt	7 to 29
Clay	70 to 93

Soil Property	Percentage (%)
Liquid Limit	62 to 78
Plastic Limit	23 to 30
Plasticity Index	35 to 50

The results of the Atterberg Limits tests indicate that the silty clay has high plasticity with group symbol CH.

Consolidation tests were performed on two samples of the silty clay (thin walled tube samples), which were collected from Boreholes SC8-02 and SC8-04. The results of the testing are presented in Appendix B and are summarized in the following table.

Borehole	Sample Depth (m)	e_o	C_c	C_r	p_c' (kPa)	p_o' (kPa)	OCR	c_v (m^2/year)	c_{vr} (m^2/year)
SC8-02	6.1 to 6.7	1.982	0.736	0.080	125	51	2.4	1.3 - 1.8	2.6 - 3.0
SC8-04	3.4 to 4.0	1.433	0.656	0.077	220	39	5.7	4.9 - 10.4	21.9 - 28.9

5.6 Silt to Silt and Sand

A deposit of native silt to silt and sand was encountered below the silty clay where it was penetrated in Boreholes SC8-01 and SC8-04 to SC8-06. The thickness of the silt and sand was 3.0 m in Borehole SC8-01, where it extended to a depth 11.7 m (Elev. 354.6 m). A DCPT was conducted in the silt and sand at the base of Borehole SC8-04, and refusal of 100 blows per 0.3 m of penetration was encountered at a depth of 10.4 m (Elev. 356.0 m). Boreholes SC8-05 and SC8-06 were terminated within the silt to silt and sand at depths from 8.2 to 11.3 m (Elev. 358.0 to 354.9 m). Artesian groundwater pressure was encountered within the silt to silt and sand deposit as described in Section 5.9 below.

SPT ‘N’ values measured in the silt to silt and sand deposit ranged from 9 to 17 blows for 0.3 m of penetration, indicating that the deposit is compact. The measured moisture contents in the deposit ranged from 17 to 23%.

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

Soil Particle	Percentage (%)
Gravel	0
Sand	11 to 47
Silt	49 to 82
Clay	4 to 7

5.7 Gravelly Sand

A deposit of gravelly sand that was silty with occasional cobbles and boulders was encountered below the silt and sand in Borehole SC8-01. The gravelly sand layer was 5.0 m thick and extended to a depth of 16.7 m (Elev. 349.6 m), where it was underlain by bedrock. NQ coring methods were required to penetrate cobbles and boulders within this deposit. Four (4) boulders ranging in thickness from 200 to 280 mm were cored through. Photos of the cobbles and boulders that were retrieved from the coring process are shown as Runs #1 to #3 on Photo B1 in Appendix B. Artesian groundwater pressure was encountered within the gravelly sand deposit and measured at a height of greater than 3.0 m above the ground surface, as described in Section 5.9 below.

The SPT ‘N’ values recorded in the gravelly sand ranged from 29 to greater than 100 blows for 0.3 m of penetration, indicating that the deposit is compact to very dense. The measured moisture content ranged from 2 to 12%.

The results of a grain size analysis conducted on a sample of the gravelly sand deposit are provided on the Record of Borehole sheets in Appendix A, and illustrated on Figure B6 in Appendix B. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	33
Sand	47
Silt and Clay	20

5.8 Bedrock

The overburden soils described above are underlain by bedrock, which was encountered at a depth of 16.7 m (Elev. 349.6 m) in Borehole SC8-01 near the north abutment. The bedrock was described as granodiorite, grey in colour and slightly weathered. The bedrock was cored 1.6 to a depth of 18.3 m (Elev. 348.0 m) before the borehole was terminated due to high artesian pressure. A photograph of the rock core is included as Run #4 on Photo B1 in Appendix B.

Total Core Recovery (TCR) in the bedrock ranged was 100%, and Solid Core Recovery (SCR) was 95%. The Rock Quality Designation (RQD) determined from the recovered core was 40%, which indicates poor rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 1 to 5, with one broken zone with FI of greater than 10.

The average unconfined compressive strength (UCS) of the rock was 170 MPa, indicating the rock is very strong. The estimated rock strength value is interpreted from point load tests that were conducted on the rock core. A summary of the point load tests results are presented in Appendix B.

5.9 Groundwater Conditions

Groundwater conditions were observed during drilling operations.

Artesian groundwater pressure was encountered within the silt to silt and sand and the gravelly sand deposits. In Borehole SC8-01, the height of the artesian pressure was measured at greater than 3.0 m above the ground surface. The artesian pressure in Boreholes SC8-04 to SC8-06 was sealed before measurements could be taken in order to avoid difficulty backfilling these boreholes. In general, it is anticipated that the source of the artesian groundwater pressure is within the cohesionless deposits below the silty clay, at approximate depths from 7.2 to 10.2 m (Elev. 359.1 to 355.9 m).

The groundwater level near the surface should also be anticipated to reflect the local creek water level. The water level in the creek was measured in October 2019 at Elevation 365.4 to 365.2 m from upstream to downstream of the bridge.

Groundwater levels are short-term observations and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the fill soil from Borehole SC8-04 and a sample of the native silty clay soil from Borehole SC8-02, as well as a surface water sample from the creek on the upstream side of the bridge 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 B.

Table 6.1 - Analytical Test Results

Parameter	Units (soil)	Units (water)	Test Results		
			SC8-02, SS#3, 1.5 to 2.1 m	SC8-04, SS#1, 0.0 to 0.6 m	SC8 Strawberry Creek #8 Bridge
			Silty Clay	Native Silty Clay	Creek Water
Sulphide	%	mg/L	<0.5	<0.5	<0.02
Chloride	µg/g	mg/L	40	28	<10
Sulphate	µg/g	mg/L	<20	330	<10
pH	no unit	no unit	6.58	10.0	9.34
Conductivity	umho/cm	umho/cm	187	488	160
Resistivity	ohm.cm	ohm.cm	5400	2000	6400
Redox Potential	mV	mV	238.2	144.5	186.6

7. MISCELLANEOUS

Thurber obtained subsurface utility clearances prior to drilling. The northing and easting coordinates and ground surface elevations were estimated based on field measurements relative to the survey plan provided by MTO.

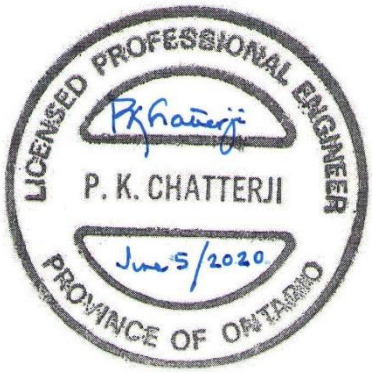
RPM Drilling of Thunder Bay, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field investigation. The field investigation was supervised on a full-time basis by Mr. Kevin Kweon of Thurber. The overall supervision of the field program was conducted by Mr. Mark Farrant, P.Eng. of Thurber. Geotechnical laboratory testing was carried out in Thurber's geotechnical laboratory.

Interpretation of the field data and preparation of this report was carried out by Mr. Mark Farrant,

P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Mark Farrant, P.Eng.
Geotechnical Engineer



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

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

▼ Water Level

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

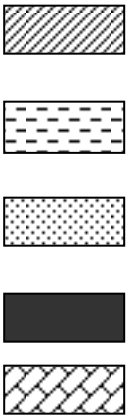
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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

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RECORD OF BOREHOLE No SC8-01 1 OF 2 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 269.3 E 343 774.2 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Solid Stem Augers/Washbore/NQ Coring COMPILED BY BH

DATUM Geodetic DATE 2019.11.04 - 2019.11.06 LATITUDE 48.604746 LONGITUDE -89.471476 CHECKED BY MF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
366.3	GROUND SURFACE										
0.0 / 0.1	**ASPHALT** (50mm)										
	Silty **SAND**, trace gravel, trace clay, contains rootlets Loose Brown Moist (FILL)		1	SS	6						Artesian Pressure >3 m Above Ground Surface
365.6 / 0.7			2	SS	13						0 9 43 48
	Silty **CLAY**, trace sand, trace gravel, some organic pockets and wood fragments Stiff to Very Stiff Dark Grey/Grey Moist		3	SS	30						
364.2 / 2.1	(OH)										
	Silty **CLAY**, trace sand Firm Brown Moist (CH)		1	ST							
			4	SS	2						0 4 23 73
			2	ST							
			5	SS	3						
	becoming stiff		3	ST							
357.6 / 8.7	**SILT** and **SAND**, trace clay Compact to Loose Grey Wet		6	SS	12						0 47 49 4

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S2 MTO-27323.GPJ 2017TEMPLATE(MTO).GDT 6/10/20

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC8-01 2 OF 2 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 269.3 E 343 774.2 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Solid Stem Augers/Washbore/NQ Coring COMPILED BY BH

DATUM Geodetic DATE 2019.11.04 - 2019.11.06 LATITUDE 48.604746 LONGITUDE -89.471476 CHECKED BY MF

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						356				
			7	SS	9		355		○		
354.6											
11.7	Gravelly **SAND**, silty, occasional cobbles and boulders Very Dense Grey Wet		8	SS	100/ 0.050		354				
	artesian pressure encountered increasing with depth cored through 4 boulders ranging in size from 200 to 280mm thick		9	SS	100/ 0.050		353		○		
							352				
	becoming compact		10	SS	29		351		○		
349.6							350				33 47 20 (SI+CL)
16.7	**BEDROCK** (Granodiorite) Slightly weathered,very strong, grey		1	RUN			349			FI 3 5 4 >10 1	RUN #1 TCR=100% SCR=95% RQD=40% UCS=170MPa Average
	rubble zone(100mm) at 17.8m										
348.0											
18.3	END OF BOREHOLE AT 18.3m. BOREHOLE BACKFILLED AND ARTESIAN PRESSURE SEALED WITH MIX OF PORTLAND CEMENT , BENTONITE GROUT, AND CONCRETE TO SURFACE.										

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

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

ONTMT4S2 MTO-27323.GPJ 2017TEMPLATE(MTO).GDT 6/10/20

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC8-02 1 OF 1 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 267.4 E 343 777.5 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH

DATUM Geodetic DATE 0209.11.09 - 2019.11.09 LATITUDE 48.604729 LONGITUDE -89.471431 CHECKED BY MF

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
366.4	GROUND SURFACE											
0.0	Gravelly **SAND**, silty, trace clay, occasional rootlets Loose Brown Moist (FILL)		1	SS	5		366					24 52 22 2
365.2			2	SS	13							
1.1	Silty **CLAY**, trace sand, trace gravel, some organic pockets and wood fragments Stiff to Very Soft Brown/Dark Brown Moist		3	SS	2		365					
364.2												
2.2	Silty **CLAY**, trace sand Stiff Brown Moist (CH)		4	SS	2		364					0 2 23 75
			5	SS	4		363		3.0			
			6	SS	6		362					
							361		2.3			
	becoming **CLAY**, trace to some silt, trace sand Firm			ST			360					0 1 11 88
							359		2.5			
			7	SS	3							0 0 7 93
357.7							358					
8.7	END OF BOREHOLE AT 8.7m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m, THEN CEMENT TO SURFACE.											

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No SC8-03 1 OF 1 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 258.2 E 343 767.8 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH

DATUM Geodetic DATE 2019.11.09 - 2019.11.09 LATITUDE 48.604646 LONGITUDE -89.471564 CHECKED BY MF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
366.3	GROUND SURFACE										
0.0 / 0.1	**ASPHALT** (50mm)										
	Gravelly **SAND**, silty, trace clay Dense to Compact Brown Moist (FILL)		1	SS	44		366				27 49 21 3
			2	SS	13						
364.9							365				
1.4	Silty **CLAY**, trace sand, trace gravel, some organic pockets and wood fragments Soft Brown Moist		3	SS	2						
			4	SS	3		364		10+		
363.3											
3.0	Silty **CLAY**, trace sand Stiff Brown Moist (CH)		1	ST			363				
			5	SS	1						
							362				
			6	SS	WH						0 0 22 78
							361	1.8			
			2	ST			360				
359.1								2.5			
7.2	END OF BOREHOLE AT 7.2m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m, THEN CEMENT TO SURFACE.										

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

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

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THURBER

RECORD OF BOREHOLE No SC8-04 1 OF 2 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 256.2 E 343 771.2 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY BH

DATUM Geodetic DATE 2019.11.08 - 2019.11.08 LATITUDE 48.604628 LONGITUDE -89.471518 CHECKED BY MF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
366.4	GROUND SURFACE						366				
0.0	Silty **SAND**, trace to some gravel, trace clay Dense to Loose Brown Moist (FILL)		1	SS	36						
364.9			2	SS	6		365				
1.4 364.6	**ORGANICS**, some peat, some sand, trace gravel, occasional rootlets and wood fragments Very Soft Black Moist		3	SS	2						
1.8	Silty **CLAY**, some sand, trace gravel, occasional organic pockets Very Soft Brown Moist (CH)		4	SS	2		364				0 14 36 50
363.7 2.7	Silty **CLAY** trace sand Firm to Stiff Brown Moist (CH)		1	ST			363	1.7			0 1 29 70
			2	ST			362	2.3			
							361	1.9			
	becoming **CLAY**, some silt		5	SS	1		360				0 0 15 85
							359	2.1			
358.2			6	SS	2						
358.2 8.2	**SILT** and **SAND**, trace clay Grey Wet artesian pressure noted						358				
	END OF SAMPLING. START OF DCPT.						357				

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 SC8-04 2 OF 2 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 256.2 E 343 771.2 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration Test COMPILED BY BH

DATUM Geodetic DATE 2019.11.08 - 2019.11.08 LATITUDE 48.604628 LONGITUDE -89.471518 CHECKED BY MF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
356.0							356				
10.4	END OF BOREHOLE AT 10.4m. SEALED ARTESIAN PRESSURE AND BACKFILLED BOREHOLE WITH BENTONITE TO 0.3m, THEN CEMENT TO SURFACE.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC8-05 1 OF 2 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 284.2 E 343 782.5 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH

DATUM Geodetic DATE 2019.11.07 - 2019.11.07 LATITUDE 48.604879 LONGITUDE -89.471362 CHECKED BY MF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
366.2	GROUND SURFACE										
0.0	Gravelly **SAND**, some silt Very Dense to Loose Brown Moist (FILL)		1	SS	100/0.175		366				
			2	SS	6						
364.9							365				
1.2	Silty **CLAY**, trace sand Stiff Brown Moist (CH)		3	SS	5						0 1 20 79
			4	SS	4		364				
			5	SS	3		363				
							362	3.0			
	becoming **CLAY**, some silt, trace sand		6	SS	3						0 1 16 83
							361	2.1			
			1	ST			360				
							359	2.0			
			7	SS	WH						0 2 9 89
							358				
								2.7			
			8	SS	3		357				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC8-05 2 OF 2 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 284.2 E 343 782.5 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH

DATUM Geodetic DATE 2019.11.07 - 2019.11.07 LATITUDE 48.604879 LONGITUDE -89.471362 CHECKED BY MF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
355.9											
10.2	**SILT**, some sand, trace clay Compact Grey Wet artesian pressure noted		9	SS	17		356 355		○		0 11 82 7
354.9											
11.3	END OF BOREHOLE AT 11.3m. ARTESIAN PRESSURE SEALED AND BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m, THEN CEMENT TO SURFACE.										

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No SC8-06 1 OF 1 METRIC

GWP# 6014-18-00 LOCATION Strawberry Creek Bridge #8 N 5 385 241.4 E 343 762.9 ORIGINATED BY KK

DIST Thunder Bay HWY Ware Road N. BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH

DATUM Geodetic DATE 2019.11.07 - 2019.11.07 LATITUDE 48.604496 LONGITUDE -89.471632 CHECKED BY MF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
366.2	GROUND SURFACE						366				
0.0	Gravelly **SAND**, silty Compact Brown/Dark Brown Moist		1	SS	24						22 52 26 (SI+CL)
365.6	(FILL)										
0.7	**ORGANICS**, some peat, occasional rootlets and wood fragments Very Soft Black		2	SS	2		365				
364.8	Moist										
1.4	Silty **CLAY**, some sand, trace gravel, some organic pockets and wood fragments Very Soft Brown/Grey		3	SS	WH						1 18 28 53
364.0	Moist						364				
2.2	Silty **CLAY**, trace sand Stiff Brown Moist (CH)		4	SS	1						0 1 28 71
			5	SS	1		363				
							362	2.7			
			1	ST							
							361	2.0			
			6	SS	WH		360				
359.1								2.4			
7.2	**SILT** and **SAND**, trace clay Grey Wet artesian pressure encountered collected disturbed sample						359				
358.0											
8.2	END OF BOREHOLE AT 8.2m. ARTESIAN PRESSURE SEALED AND BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m, THEN CEMENT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

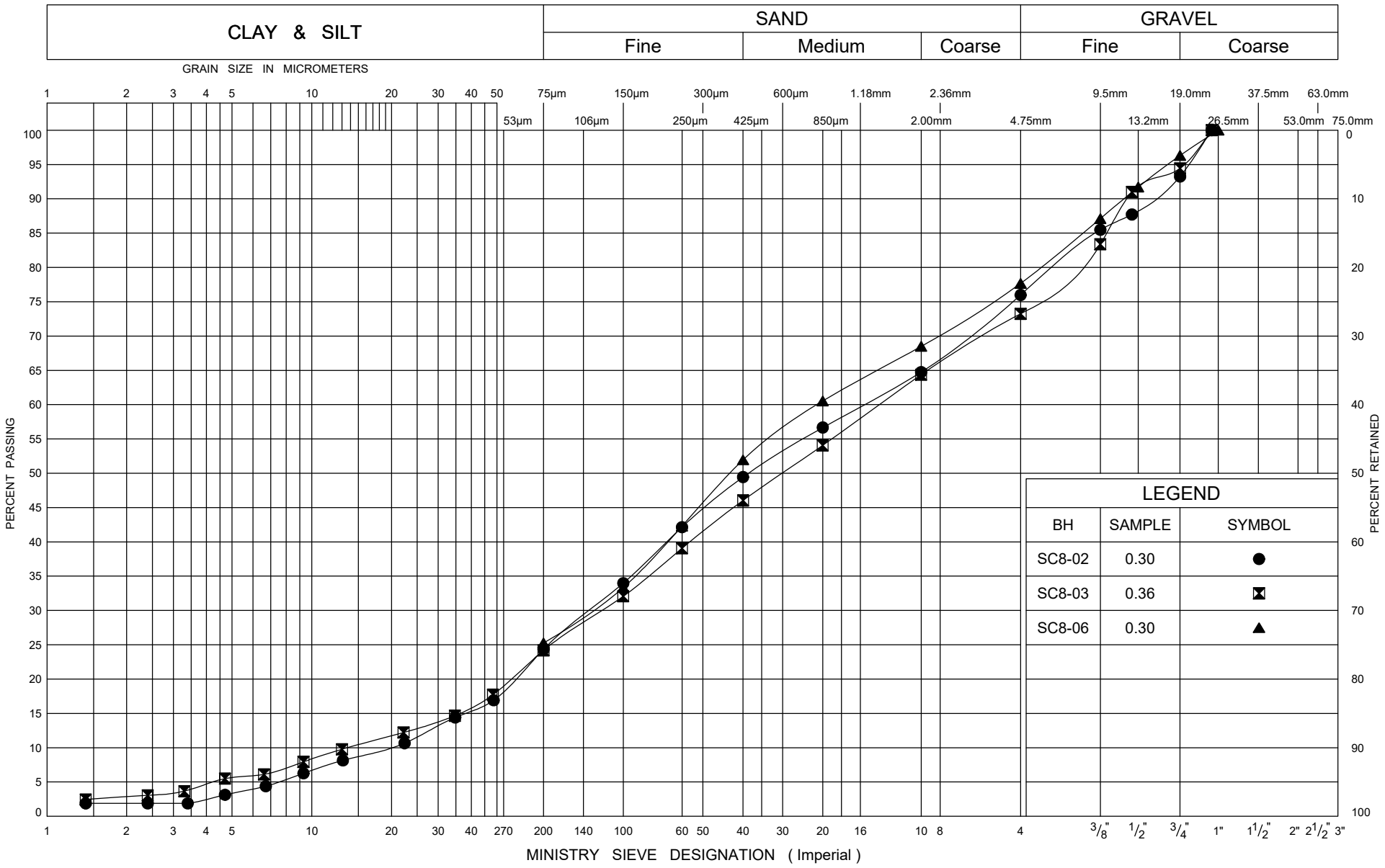
(%) STRAIN AT FAILURE

ONTMT4S2 MTO-27323.GPJ 2017TEMPLATE(MTO).GDT 6/10/20

THURBER

Appendix B

Geotechnical and Analytical Laboratory Test Results



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GRAIN SIZE DISTRIBUTION

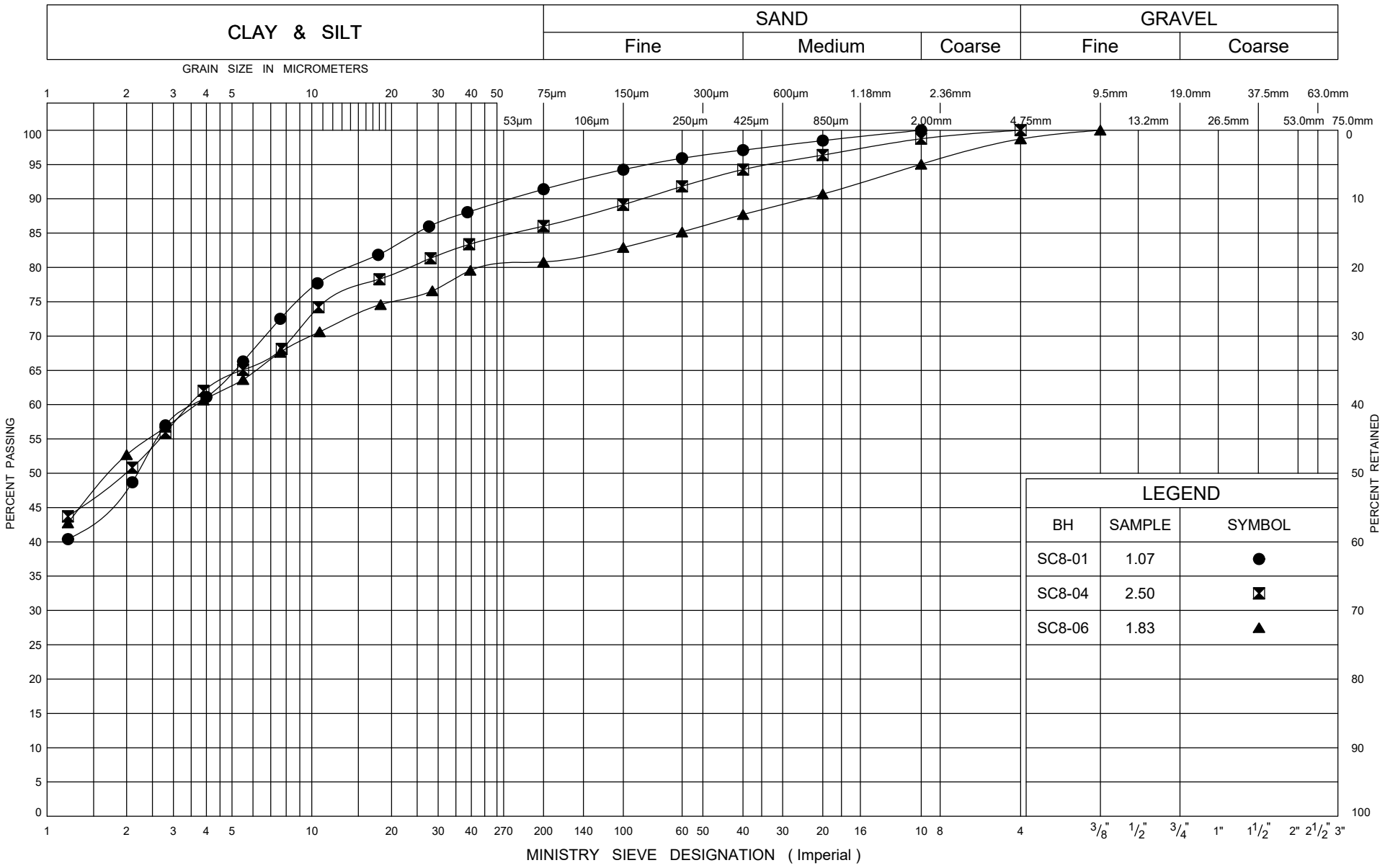
Gravelly SAND FILL

FIG No B1

W P 6014-18-00

Strawberry Creek Bridge #8

ONTARIO MOT GRAIN SIZE 2 MTO-27323.GPJ ONTARIO MOT.GDT 4/1/20



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GRAIN SIZE DISTRIBUTION

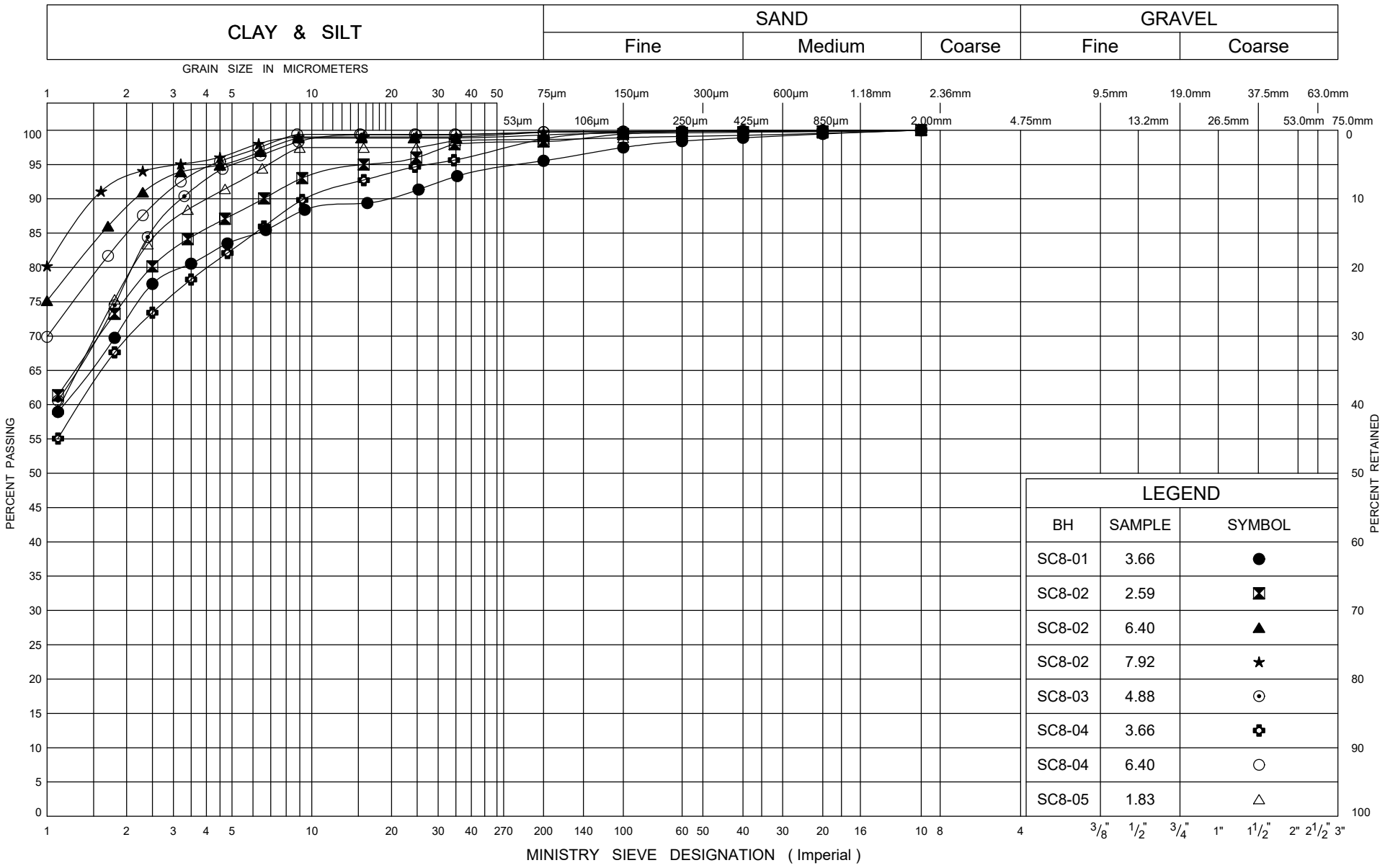
Silty CLAY with Organics

FIG No B2

W P 6014-18-00

Strawberry Creek Bridge #8

ONTARIO MOT GRAIN SIZE 2 MTO-27323.GPJ ONTARIO MOT.GDT 4/1/20



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GRAIN SIZE DISTRIBUTION

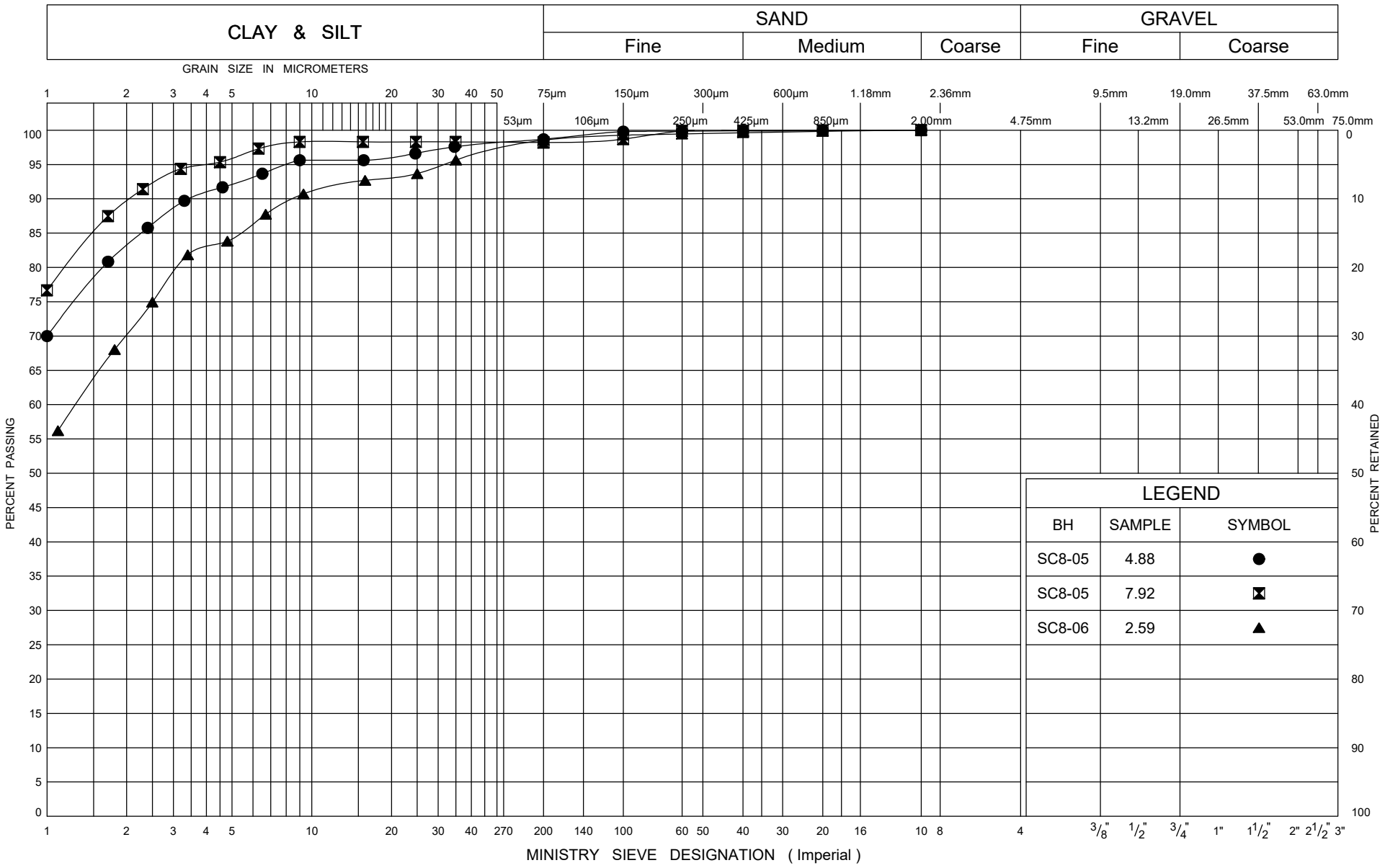
Silty CLAY

FIG No B3

W P 6014-18-00

Strawberry Creek Bridge #8

ONTARIO MOT GRAIN SIZE 2 MTO-27323.GPJ ONTARIO MOT.GDT 4/1/20



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GRAIN SIZE DISTRIBUTION

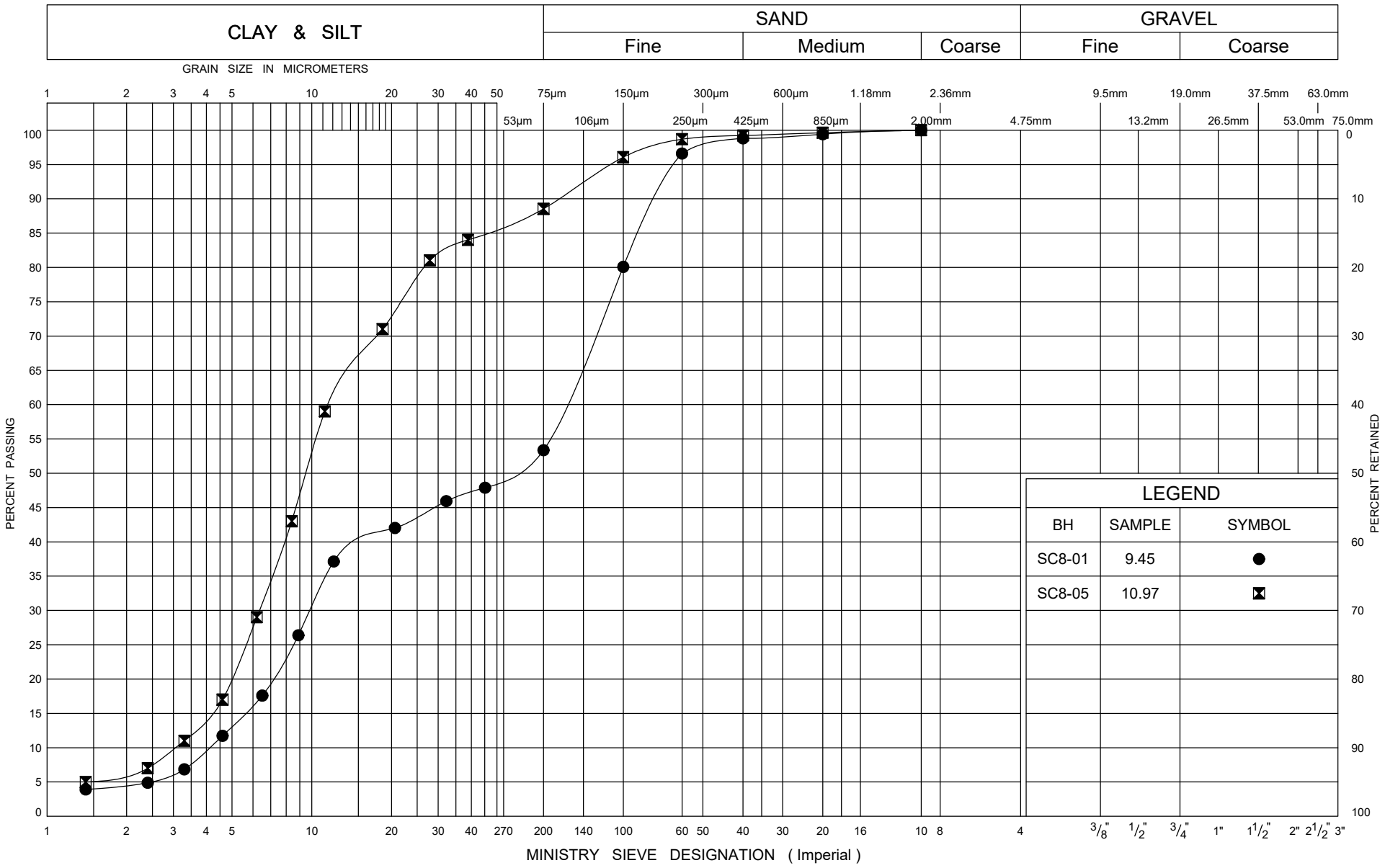
Silty CLAY

FIG No B4

W P 6014-18-00

Strawberry Creek Bridge #8

ONTARIO MOT GRAIN SIZE 2 MTO-27323.GPJ ONTARIO MOT.GDT 4/1/20



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GRAIN SIZE DISTRIBUTION

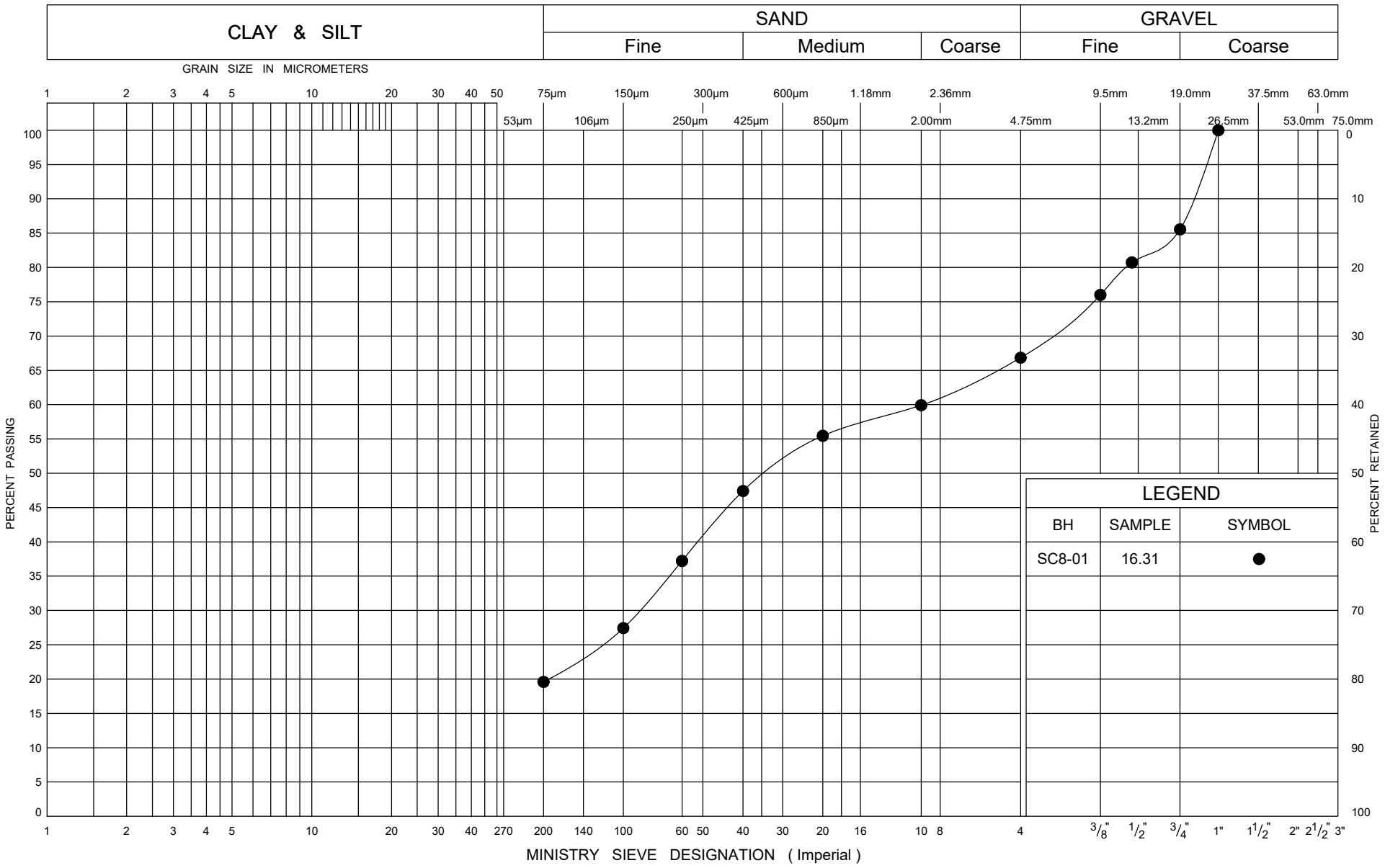
SILT to SILT and SAND

FIG No B5

W P 6014-18-00

Strawberry Creek Bridge #8

ONTARIO MOT GRAIN SIZE 2 MTO-27323.GPJ ONTARIO MOT.GDT 4/1/20



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GRAIN SIZE DISTRIBUTION

Gravelly SAND

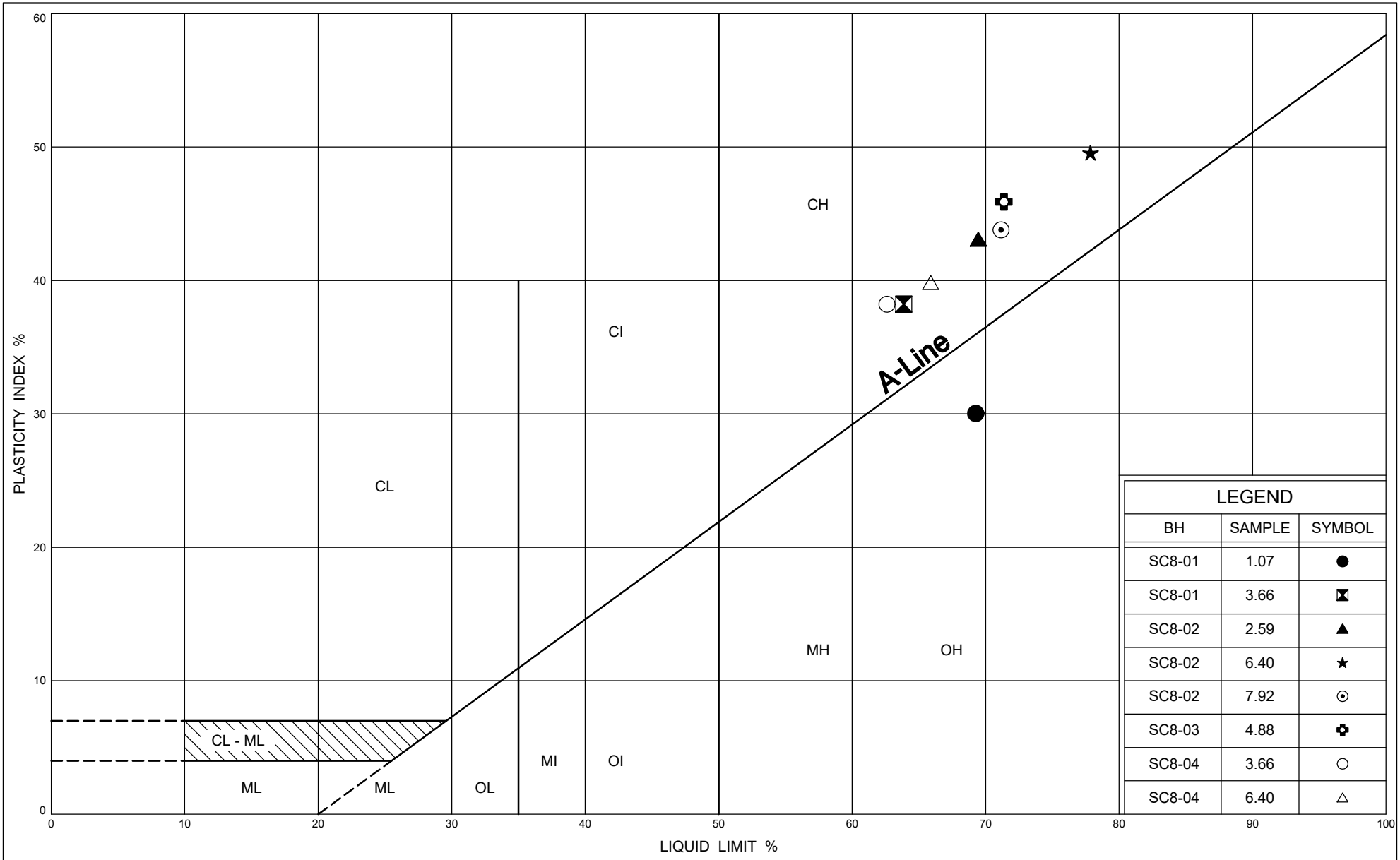
FIG No B6

W P 6014-18-00

Strawberry Creek Bridge #8

ONTARIO MOT GRAIN SIZE 2 MTO-27323.GPJ ONTARIO MOT.GDT 4/1/20

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART 2 MTO-27323.GPJ ONTARIO MOT.GDT 4/1/20

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PLASTICITY CHART

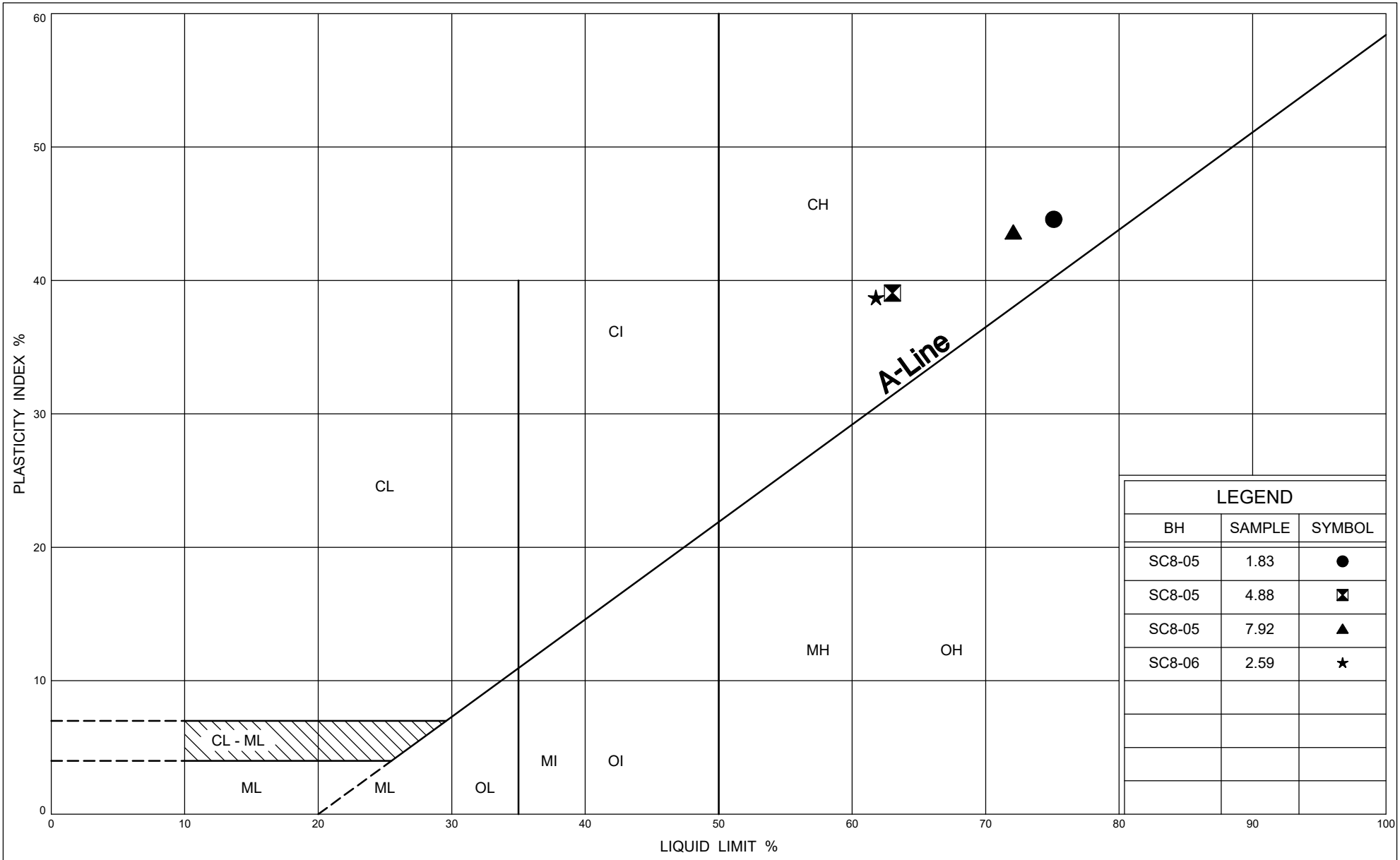
Silty CLAY

FIG No B7

W P 6014-18-00

Strawberry Creek Bridge #8

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART 2 MTO-27323.GPJ ONTARIO MOT.GDT 4/1/20

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Ontario

PLASTICITY CHART

Silty CLAY

FIG No B8

W P 6014-18-00

Strawberry Creek Bridge #8

THURBER ENGINEERING LTD.

Consolidation Test Report

CLIENT: MTO

FILE NUMBER: 27323

PROJECT: Sunshine Creek #2 and Strawberry Creek #8 Bridges

REPORT DATE: February 3, 2020

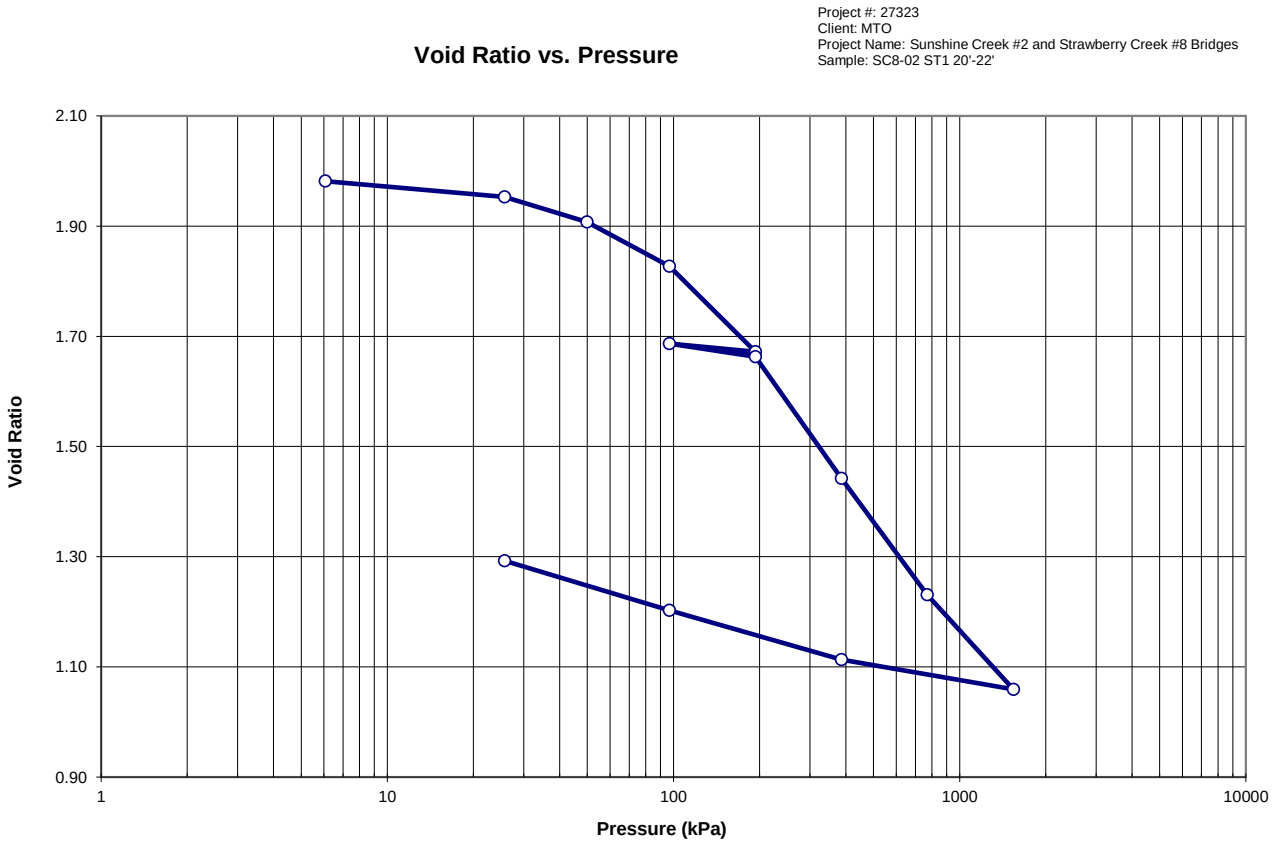
TEST DATES: November 27, 2019 - December 07, 2019

SAMPLE: SC8-02 ST1 20'-22'
Silty clay, trace gravel, reddish brown, moist.
LL=78, PL=28, I_p = 50

PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	Start of Test	End of Test
Wet Dens. (kg/m^3)	1591.6	1768.7
Dry Dens. (kg/m^3)	932.7	1213.3
Moisture Cont. (%)	70.6	45.8
Void Ratio	1.982	1.293
Saturation (%)	99.1	

Note: A Specific Gravity (Gs) of 2.78 was obtained for the void ratio and saturation calculations.



TEST DONE BY: BT
REVIEWED BY: KS

THURBER ENGINEERING LTD.

Consolidation Test Report

Sunshine Creek #2 and Strawberry Creek #8 Bridges
27323 SC8-02 ST1 20'-22'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer.

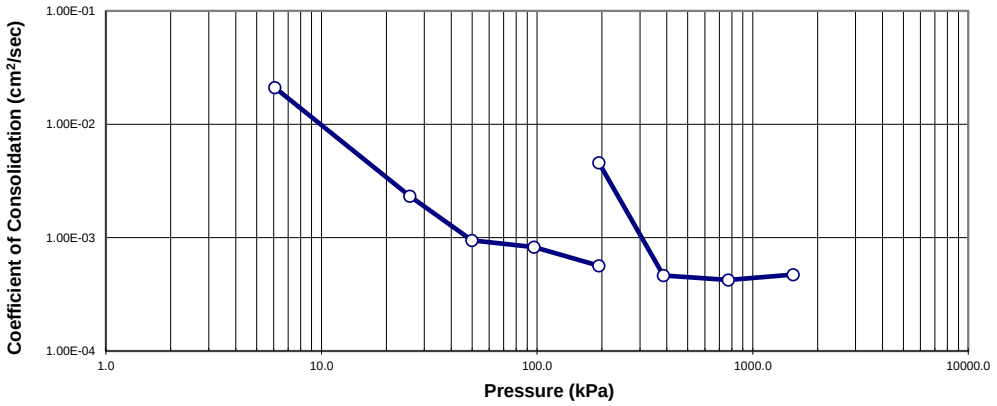
LOADING: A seating load of 6.1 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after 100% primary consolidation was reached at each load increment.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D_{90} (mm)	t_{90} (min)	c_v (cm^2/s)	Void Ratio	m_v (m^2/kN)	k (cm/s)
0.0	25.400					1.982		
6.1	25.396	25.398	-0.033	1.08	2.11E-02	1.982	2.59E-05	5.36E-08
25.7	25.153	25.275	-0.246	9.73	2.32E-03	1.953	4.88E-04	1.11E-07
49.9	24.767	24.960	-0.306	23.33	9.44E-04	1.908	6.34E-04	5.87E-08
96.6	24.080	24.424	-0.490	25.50	8.26E-04	1.827	5.93E-04	4.81E-08
193.2	22.761	23.421	-0.950	34.22	5.66E-04	1.672	5.67E-04	3.15E-08
96.6	22.886	22.824				1.687		
193.2	22.682	22.784	-0.113	4.00	4.59E-03	1.663	9.23E-05	4.15E-08
385.7	20.801	21.742	-1.368	36.00	4.64E-04	1.442	4.31E-04	1.96E-08
770.7	19.003	19.902	-1.400	33.06	4.23E-04	1.231	2.25E-04	9.32E-09
1540.7	17.539	18.271	-1.187	24.98	4.72E-04	1.059	1.00E-04	4.63E-09
385.7	17.999	17.769				1.113		
96.6	18.760	18.380				1.203		
25.7	19.527	19.144				1.293		

Project #: 27323
Client: MTO
Project Name: Sunshine Creek #2 and Strawberry Creek #8 Bridges
Sample: SC8-02 ST1 20'-22'
Oedometer Consolidation Test

Coefficient of Consoildation vs. Pressure



Notes: C_v and k calculated using t_{90} values

TEST DONE BY: BT
REVIEWED BY: KS

THURBER ENGINEERING LTD.

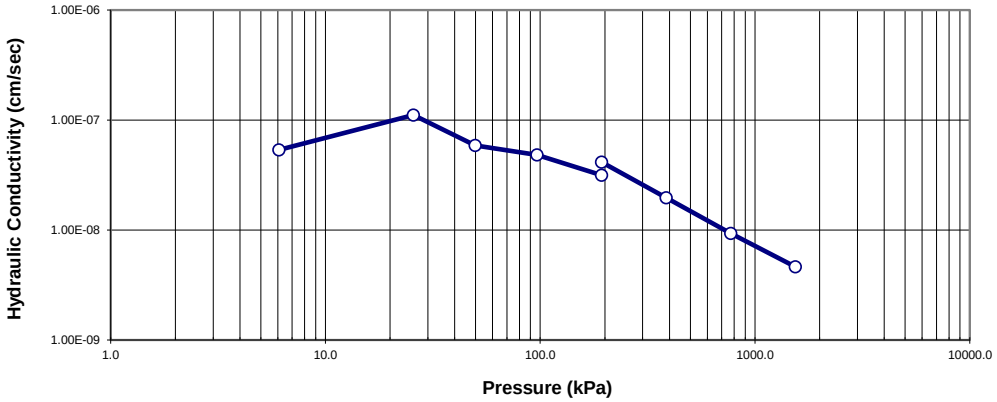
Consolidation Test Report

Sunshine Creek #2 and Strawberry Creek #8 Bridges

27323 SC8-02 ST1 20'-22'

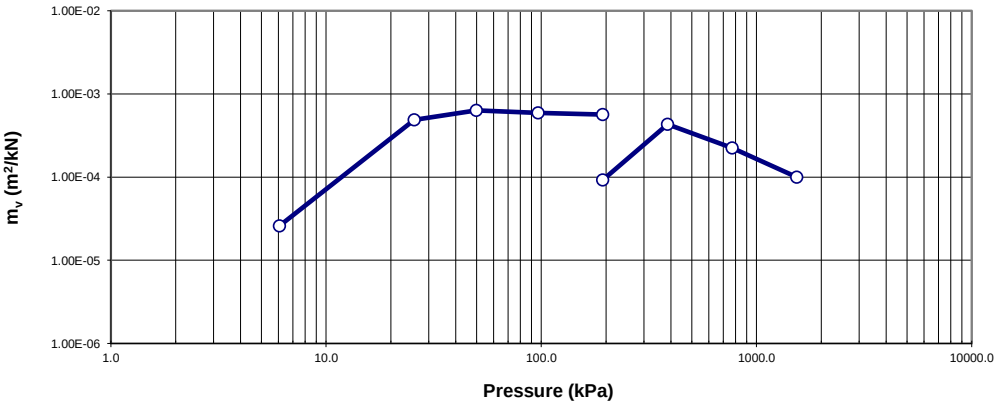
Hydraulic Conductivity vs. Pressure

Project #: 27323
Client: MTO
Project Name: Sunshine Creek #2 and Strawberry Creek #8 Bridges
Sample: SC8-02 ST1 20'-22'



m_v vs. Pressure

Project #: 27323
Client: MTO
Project Name: Sunshine Creek #2 and Strawberry Creek #8 Bridges
Sample: SC8-02 ST1 20'-22'



TEST DONE BY: BT
REVIEWED BY: KS

THURBER ENGINEERING LTD.

Consolidation Test Report

CLIENT: MTO | FILE NUMBER: 27323

PROJECT: Sunshine Creek #2 and Strawberry Creek #8 Bridges | REPORT DATE: February 4, 2020

TEST DATES: November 27, 2019 - December 07, 2019

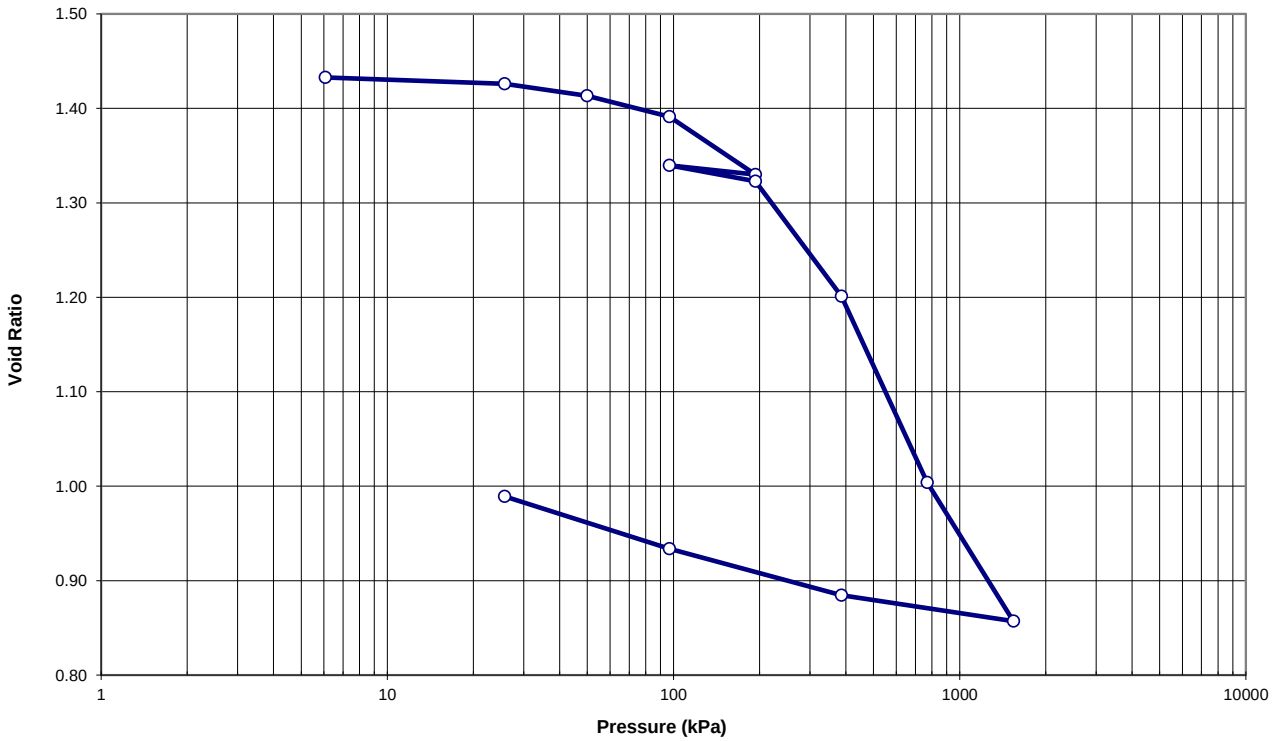
SAMPLE: SC8-04 ST1 11'-13'
Silty clay, trace sand, brown, moist.
LL=62.7, PL=24.4, I_p = 38.2

PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-11, method B

	Start of Test	End of Test
Wet Dens. (kg/m^3)	1723.9	1895.3
Dry Dens. (kg/m^3)	1155.0	1412.7
Moisture Cont. (%)	49.3	34.2
Void Ratio	1.433	0.989
Saturation (%)	96.6	

Note: A Specific Gravity (Gs) of 2.81 was obtained for the void ratio and saturation calculations.

Project #: 27323
Client: MTO
Project Name: Sunshine Creek #2 and Strawberry Creek #8 Bridges
Sample: SC8-04 ST1 11'-13'



TEST DONE BY: BT
REVIEWED BY: KS

THURBER ENGINEERING LTD.

Consolidation Test Report

Sunshine Creek #2 and Strawberry Creek #8 Bridges

27323 SC8-04 ST1 11'-13'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer.

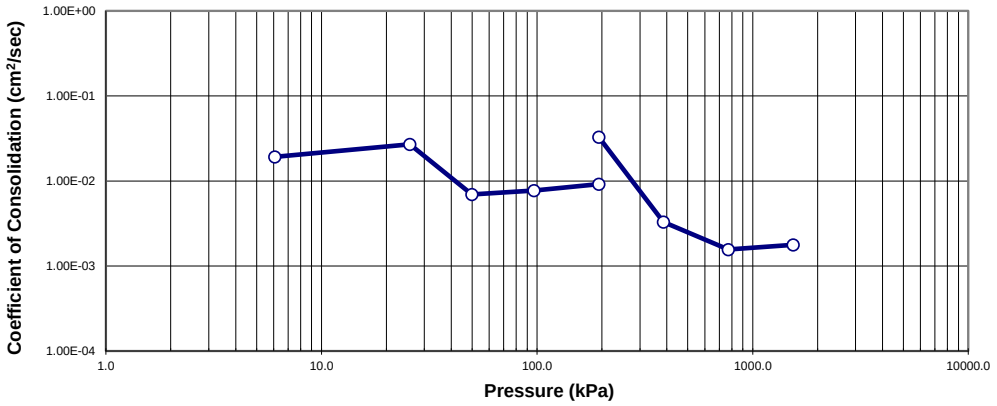
LOADING: A seating load of 6.1 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after 100% primary consolidation was reached at each load increment.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	D_{90} (mm)	t_{90} (min)	c_v (cm^2/s)	Void Ratio	m_v (m^2/kN)	k (cm/s)
0.0	25.400					1.433		
6.1	25.397	25.399	-0.029	1.19	1.92E-02	1.433	1.95E-05	3.66E-08
25.7	25.328	25.363	-0.135	0.85	2.69E-02	1.426	1.39E-04	3.65E-07
49.9	25.195	25.262	-0.125	3.24	6.96E-03	1.413	2.17E-04	1.48E-07
96.6	24.965	25.080	-0.182	2.89	7.69E-03	1.391	1.95E-04	1.47E-07
193.2	24.323	24.644	-0.370	2.34	9.17E-03	1.330	2.66E-04	2.39E-07
96.6	24.424	24.374				1.340		
193.2	24.251	24.338	-0.090	0.64	3.27E-02	1.323	7.33E-05	2.35E-07
385.7	22.980	23.616	-0.615	6.00	3.28E-03	1.201	2.72E-04	8.76E-08
770.7	20.921	21.951	-1.230	10.89	1.56E-03	1.004	2.33E-04	3.57E-08
1540.7	19.387	20.154	-1.000	8.12	1.77E-03	0.857	9.52E-05	1.65E-08
385.7	19.675	19.531				0.885		
96.6	20.189	19.932				0.934		
25.7	20.767	20.478				0.989		

Coefficient of Consoildation vs. Pressure

Project #: 27323
Client: MTO
Project Name: Sunshine Creek #2 and Strawberry Creek #8 Bridges
Sample: SC8-04 ST1 11'-13'



Notes: C_v and k calculated using t_{90} values

TEST DONE BY: BT
REVIEWED BY: KS

THURBER ENGINEERING LTD.

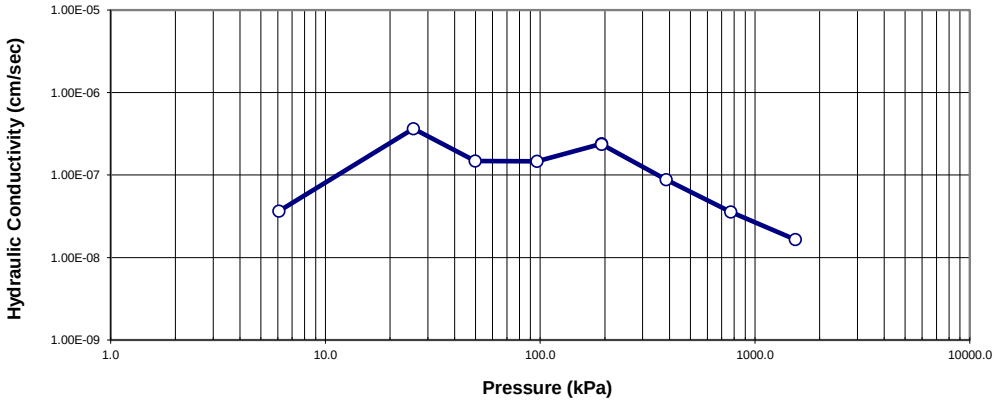
Consolidation Test Report

Sunshine Creek #2 and Strawberry Creek #8 Bridges

27323 SC8-04 ST1 11'-13'

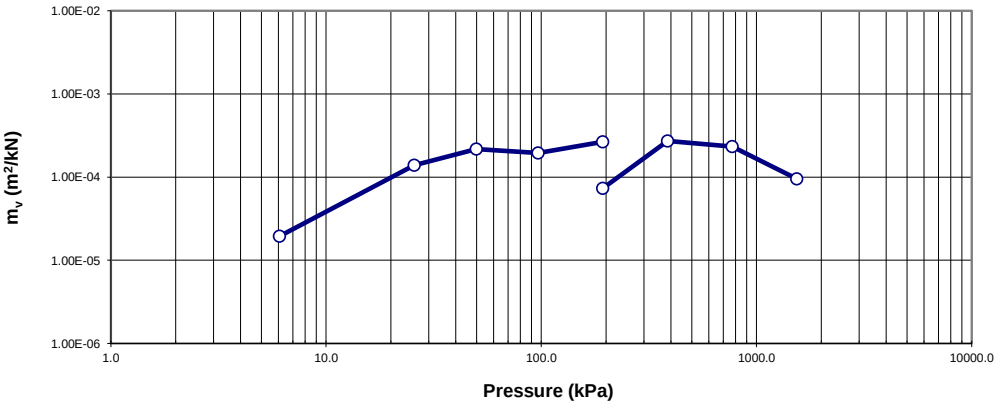
Hydraulic Conductivity vs. Pressure

Project #: 27323
Client: MTO
Project Name: Sunshine Creek #2 and Strawberry Creek #8 Bridges
Sample: SC8-04 ST1 11'-13'



m_v vs. Pressure

Project #: 27323
Client: MTO
Project Name: Sunshine Creek #2 and Strawberry Creek #8 Bridges
Sample: SC8-04 ST1 11'-13'



TEST DONE BY: BT
REVIEWED BY: KS

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	27323	**Date Drilled:**	05-Nov-19
Client:	MTO	**Date Tested:**	18-Feb-20
Project Name:	Strawberry Creek Bridge #8	**Tester:**	RG
Core Size:	NQ **BH No :** SC8-01	**Reviewed by:**	MEF

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	16.8	A	21.1	47.5	48.5	7.1	170.0	Granodiorite	Very Strong
2	1	17.6	D	17.4	47.5	66.6	7.1	171.1	Granodiorite	Very Strong
3										
4					**RUN #1 (AVERAGE) =**			170.5		Very Strong
5										
6										
7										
8										
9										
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* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.

Last Modified: September 14, 2016

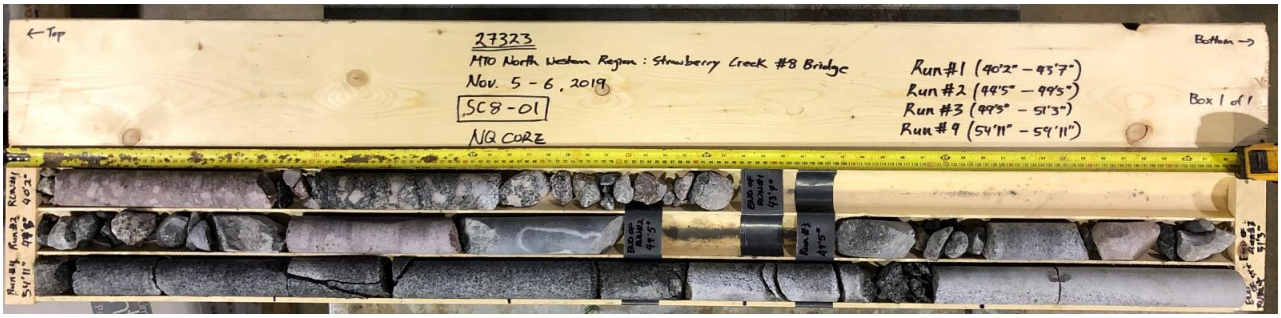

Photo B1: Borehole SC8-01 cobbles and boulders (Runs #1 to #3) and bedrock core (Run #4).

Your Project #: 27323
Your C.O.C. #: 744039-03-01

Attention: Mark Farrant

Thurber Engineering Ltd
2010 Winston Park Dr
Suite 103
Oakville, ON
CANADA L6H 5R7

Report Date: 2020/03/19
Report #: R6116722
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B9X0440
Received: 2019/11/22, 15:04

Sample Matrix: Soil
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Chloride (20:1 extract)	2	2019/11/27	2019/11/27	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	2	2019/11/27	2019/11/27	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	2	N/A	2019/11/28	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	2	N/A	2019/12/06	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	2	2019/11/25	2019/11/25	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	2	2019/11/22	2019/11/27	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	2	2019/11/27	2019/11/27	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by BVLabs Calgary via Mississauga
(2) Offsite analysis requires that subcontracted moisture be reported.

Your Project #: 27323
Your C.O.C. #: 744039-03-01

Attention: Mark Farrant

Thurber Engineering Ltd
2010 Winston Park Dr
Suite 103
Oakville, ON
CANADA L6H 5R7

Report Date: 2020/03/19
Report #: R6116722
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B9X0440
Received: 2019/11/22, 15:04

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Antonella Brasil, Senior Project Manager
Email: Antonella.Brasil@bvlabs.com
Phone# (905)817-5817
==========

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

BV Labs Job #: B9X0440
Report Date: 2020/03/19

Thurber Engineering Ltd
Client Project #: 27323

SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		LJR499	LJR499	LJR499	LJR500		
Sampling Date		2019/11/08	2019/11/08	2019/11/08	2019/11/08		
COC Number		744039-03-01	744039-03-01	744039-03-01	744039-03-01		
	UNITS	SC8-02, SS#3, 5'-7'	SC8-02, SS#3, 5'-7' Lab-Dup	SC8-02, SS#3, 5'-7' Lab-Dup 2	SC8-04, SS#1, 0'-2'	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm	5400	N/A	N/A	2000	N/A	6458073
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	40	N/A	N/A	28	20	6465367
Conductivity	umho/cm	187	N/A	N/A	488	2	6465498
Available (CaCl2) pH	pH	6.58	N/A	N/A	10.0	N/A	6460996
Soluble (20:1) Sulphate (SO4)	ug/g	<20	N/A	N/A	330	20	6465370
Sulphide	mg/kg	<0.5 (1)	<0.5	<0.5	<0.5	0.5	6484316
Physical Testing							
Moisture-Subcontracted	%	29	N/A	N/A	13	0.30	6484315

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable
(1) Matrix Spike exceeds acceptance limits due to matrix interference. Reanalysis yields similar results.

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	8.0°C

Revised Report (2020/03/19): Split reports as per client request .

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6460996	KAD	Spiked Blank	Available (CaCl2) pH	2019/11/25		100	%	97 - 103
6460996	KAD	RPD	Available (CaCl2) pH	2019/11/25	0.027		%	N/A
6465367	DRM	Matrix Spike	Soluble (20:1) Chloride (Cl-)	2019/11/27		104	%	70 - 130
6465367	DRM	Spiked Blank	Soluble (20:1) Chloride (Cl-)	2019/11/27		103	%	70 - 130
6465367	DRM	Method Blank	Soluble (20:1) Chloride (Cl-)	2019/11/27	<20		ug/g	
6465367	DRM	RPD	Soluble (20:1) Chloride (Cl-)	2019/11/27	NC		%	35
6465370	ADB	Matrix Spike	Soluble (20:1) Sulphate (SO4)	2019/11/27		NC	%	70 - 130
6465370	ADB	Spiked Blank	Soluble (20:1) Sulphate (SO4)	2019/11/27		106	%	70 - 130
6465370	ADB	Method Blank	Soluble (20:1) Sulphate (SO4)	2019/11/27	<20		ug/g	
6465370	ADB	RPD	Soluble (20:1) Sulphate (SO4)	2019/11/27	2.1		%	35
6465498	KAD	Spiked Blank	Conductivity	2019/11/27		104	%	90 - 110
6465498	KAD	Method Blank	Conductivity	2019/11/27	<2		umho/cm	
6465498	KAD	RPD	Conductivity	2019/11/27	0.36		%	10
6484315	SAY	Method Blank	Moisture-Subcontracted	2019/11/28	<0.30		%	
6484316	éBS	Matrix Spike	Sulphide	2019/12/06		52 (1)	%	75 - 125
6484316	éBS	RPD	Sulphide	2019/12/06	3.0		%	30
			Sulphide	2019/12/06	10		%	30
6484316	éBS	Spiked Blank	Sulphide	2019/12/06		94	%	75 - 125
6484316	éBS	Method Blank	Sulphide	2019/12/06	<0.5		mg/kg	
6484316	éBS	RPD [LJR499-02]	Sulphide	2019/12/06	NC		%	30

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Anastassia Hamanov, Scientific Specialist

Ghayasuddin Khan, M.Sc., P.Chem., QP, Scientific Specialist, Inorganics

Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Bureau Veritas Laboratories
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-free:800-563-6266 Fax:(905) 817-5777 www.bvlabs.com

22-Nov-19 15:04
Antonella Brasil
B9X0440
SWE ENV-1164

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Lab Use Only:
Company Name:	#5843 Thurber Engineering Ltd	Company Name:		Quotation #:	B90187	Bottle Order #: 744039
Attention:	Mark Farrant	Attention:		P.O. #:		
Address:	2010 Winston Park Dr Suite 103 Oakville ON L6H 5R7	Address:		Project:	27323	
Tel:	(905) 829-8666 Ext: 528 Fax: (905) 829-1166	Tel:	Fax:	Project Name:		COC #: C#744039-03-01
Email:	mfarrant@thurber.ca	Email:		Site #:		Project Manager: Antonella Brasil
				Sampled By:		

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ For RSC
☐ Table ___

Other Regulations
☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ___
☐ PWQO
☐ Other ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

Field Filtered (please circle): Metals / Hg / Cr VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered	Corrosivity Assessment Package	# of Bottles	Comments
1		SC8-03, SS#3, 5'-7'	Nov. 8/19		Soil		X	2	
2		SC8-04, SS#1, 0'-2'	Nov. 8/19		Soil		X	2	
3		SC2-01, SS#2A/2B, 2'6"-4'6"	Nov. 11/19		Soil		X	2	
4		SC2-02, SS#3, 5'-7'	Nov. 12/19		Soil		X	2	
5									
6									
7									
8									
9									
10									

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Mark Farrant	19/11/22			19/11/22		
			TRUSHNA PATEL	2019/11/22	15:04	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	8 8 8	Present		
		Intact		✓

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BV LABS' STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVLABS.COM/TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVLABS.COM/RESOURCES/CHAIN-OF-CUSTODY-FORMS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BV LABS

White: BV Labs Yellow: Client

Bureau Veritas Canada (2019) Inc.

Certificate of Analysis

Client: Bureau Veritas Canada (2019) Inc.
6740 Campobello Road
Mississauga, ON
L5N 2L8
Attention: Antonella Brasil
PO#:
Invoice to: Bureau Veritas Canada (2019) Inc.

Report Number: 1921583
Date Submitted: 2019-11-26
Date Reported: 2019-12-03
Project: B9X0440
COC #: 851753

Dear Antonella Brasil:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: _____
Sarah Horner, Inorganics Technician

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: http://www.cala.ca/scopes/2602.pdf.

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Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

eurofins | Environment Testing

Client: Bureau Veritas Canada (2019) Inc.
6740 Campobello Road
Mississauga, ON
L5N 2L8
Attention: Antonella Brasil
PO#:
Invoice to: Bureau Veritas Canada (2019) Inc.

Report Number: 1921583
Date Submitted: 2019-11-26
Date Reported: 2019-12-03
Project: B9X0440
COC #: 851753

Group	Analyte	MRL	Units	Guideline	Lab I.D. / Sample Matrix / Sample Type / Sampling Date / Sample I.D.		
					1468740 Soil 2019-11-08 LJR499-SC8-02 SS#3 5'-7'	1468741 Soil 2019-11-08 LJR500-SC8-04 SS#1 0'-2'	
Redox Potential	REDOX Potential		mV		238.2	144.5	

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

Client: Bureau Veritas Canada (2019) Inc.
6740 Campobello Road
Mississauga, ON
L5N 2L8
Attention: Antonella Brasil
PO#:
Invoice to: Bureau Veritas Canada (2019) Inc.

Report Number: 1921583
Date Submitted: 2019-11-26
Date Reported: 2019-12-03
Project: B9X0440
COC #: 851753

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 376921 **Analysis/Extraction Date** 2019-12-03 **Analyst** SKH **Method** C SM2580B			
REDOX Potential	197.2 mV	101	

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Your Project #: 27323
Your C.O.C. #: 745256-01-01

Attention: Mark Farrant

Thurber Engineering Ltd
2010 Winston Park Dr
Suite 103
Oakville, ON
CANADA L6H 5R7

Report Date: 2020/03/19
Report #: R6116757
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B9W0881
Received: 2019/11/13, 17:10

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Chloride by Automated Colourimetry	1	N/A	2019/11/18	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	1	N/A	2019/11/18	CAM SOP-00414	SM 23 2510 m
pH	1	2019/11/15	2019/11/18	CAM SOP-00413	SM 4500H+ B m
Resistivity of Water	1	2019/11/14	2019/11/19	CAM SOP-00414	SM 23 2510 m
Sulphate by Automated Colourimetry	1	N/A	2019/11/18	CAM SOP-00464	EPA 375.4 m
Sulphide	1	N/A	2019/11/18	CAM SOP-00455	SM 23 4500-S G m

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Antonella Brasil, Senior Project Manager
Email: Antonella.Brasil@bvlabs.com
Phone# (905)817-5817
==========

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

BV Labs Job #: B9W0881
Report Date: 2020/03/19

Thurber Engineering Ltd
Client Project #: 27323

RESULTS OF ANALYSES OF WATER

BV Labs ID		LHP067		
Sampling Date		2019/11/10 09:30		
COC Number		745256-01-01		
	UNITS	SC8 STRAWBERRY CREEK #8 BRIDGE	RDL	QC Batch
Calculated Parameters				
Resistivity	ohm-cm	6400	N/A	6442476
Inorganics				
Conductivity	umho/cm	160	1.0	6445661
pH	pH	9.34	N/A	6445667
Dissolved Sulphate (SO4)	mg/L	<10 (1)	10	6446783
Sulphide	mg/L	<0.020	0.020	6448198
Dissolved Chloride (Cl-)	mg/L	<10 (1)	10	6446782

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
(1) Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly.

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	9.0°C

Revised Report (2020/03/19) : Split Reports as per client request .

Results relate only to the items tested.

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6445661	SAU	Spiked Blank	Conductivity	2019/11/18		101	%	85 - 115
6445661	SAU	Method Blank	Conductivity	2019/11/18	<1.0		umho/cm	
6445661	SAU	RPD	Conductivity	2019/11/18	0.11		%	25
6445667	SAU	Spiked Blank	pH	2019/11/18		102	%	98 - 103
6445667	SAU	RPD	pH	2019/11/18	0.80		%	N/A
6446782	DRM	Matrix Spike	Dissolved Chloride (Cl-)	2019/11/18		NC	%	80 - 120
6446782	DRM	Spiked Blank	Dissolved Chloride (Cl-)	2019/11/18		103	%	80 - 120
6446782	DRM	Method Blank	Dissolved Chloride (Cl-)	2019/11/18	<1.0		mg/L	
6446782	DRM	RPD	Dissolved Chloride (Cl-)	2019/11/18	0.43		%	20
6446783	DRM	Matrix Spike	Dissolved Sulphate (SO4)	2019/11/18		99	%	75 - 125
6446783	DRM	Spiked Blank	Dissolved Sulphate (SO4)	2019/11/18		102	%	80 - 120
6446783	DRM	Method Blank	Dissolved Sulphate (SO4)	2019/11/18	<1.0		mg/L	
6446783	DRM	RPD	Dissolved Sulphate (SO4)	2019/11/18	0.0039		%	20
6448198	KAD	Matrix Spike	Sulphide	2019/11/18		108	%	80 - 120
6448198	KAD	Spiked Blank	Sulphide	2019/11/18		83	%	80 - 120
6448198	KAD	Method Blank	Sulphide	2019/11/18	<0.020		mg/L	
6448198	KAD	RPD	Sulphide	2019/11/18	3.7		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

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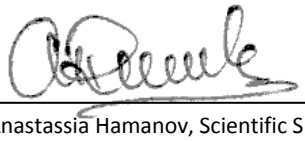
VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist

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6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-free:800-563-6266 Fax:(905) 817-5777 www.bvlabs.com

Page 1 of 1

13-Nov-19 17:10

Antonella Brasil

B9W0881

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Only:
Company Name:	#5843 Thurber Engineering Ltd	Company Name:	Thurber Engineering Ltd.	Quotation #:	B90187	Bottle Order #:
Attention:	Mark Farrant	Attention:	Mark Farrant	P.O. #:		745256
Address:	2010 Winston Park Dr Suite 103 Oakville ON L6H 5R7	Address:	2010 Winston Park Dr. #103 Oakville, ON, L6H 5R7	Project:	27323 MIB THU-001	Project Manager:
Tel:	(905) 829-8666 Ext: 528 Fax: (905) 829-1166	Tel:	(905) 829 8666, x528 Fax: (905) 829-1166	Project Name:		
Email:	mfarrant@thurber.ca	Email:	mfarrant@thurber.ca	Site #:		C#745256-01-01
				Sampled By:		Antonella Brasil

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine; ☐ Table 2 ☐ Ind/Comm ☐ Coarse; ☐ Table 3 ☐ Agri/Other ☐ For RSC; ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw; ☐ Reg 558 ☐ Storm Sewer Bylaw; ☐ MISA Municipality ___; ☐ PWQO; ☐ Other ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

Field Filtered (please circle): Metals / Hg / Cr VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Redox Potential	pH	Chloride by Automated Colourimetry	Sulphate by Automated Colourimetry	Resistivity of Water	Sulphide	Corrosive Package	# of Bottles	Comments
1	SC8	Strawberry Creek #8 Bridge	Nov. 10, 19	9:30 AM	water							✓	3	
2	SC2	Sunstone Creek #2 Bridge	Nov. 13, 19	2:00 PM	water							✓	3	
3														
4														
5														
6														
7														
8														
9														
10														

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT:
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___
Rush Confirmation Number: ___ *(call lab for #)*

RECEIVED TBay

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Kevin Kucan	19/11/13	5:10 PM	Michelle Huth	2019/11/13	17:10	
				2019/11/15	10 38	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	9/9/9 °C	Present		
		Intact		N/A

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BV LABS' STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVLABS.COM/TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVLABS.COM/RESOURCES/CHAIN-OF-CUSTODY-FORMS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BV LABS

White: BV Labs Yellow: Client

Bureau Veritas Canada (2019) Inc.

0/0/0 ice

Certificate of Analysis

Client: Bureau Veritas Canada (2019) Inc.
6740 Campobello Road
Mississauga, ON
L5N 2L8
Attention: Antonella Brasil
PO#:
Invoice to: Bureau Veritas Canada (2019) Inc.

Report Number: 1921179
Date Submitted: 2019-11-19
Date Reported: 2019-11-22
Project: B9W0881
COC #: 851547

Dear Antonella Brasil:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: _____
Sarah Horner, Inorganics Technician

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Certificate of Analysis

eurofins | Environment Testing

Client: Bureau Veritas Canada (2019) Inc.
6740 Campobello Road
Mississauga, ON
L5N 2L8
Attention: Antonella Brasil
PO#:
Invoice to: Bureau Veritas Canada (2019) Inc.

Report Number: 1921179
Date Submitted: 2019-11-19
Date Reported: 2019-11-22
Project: B9W0881
COC #: 851547

Group	Analyte	MRL	Units	Guideline	Lab I.D. 1467134 Sample Matrix Water Sample Type Sampling Date 2019-11-10 Sample I.D. LH067-SC8 STRAWBERRY CREEK #8 BRIDGE	
Redox Potential	REDOX Potential		mV		186.6	

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
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Mississauga, ON
L5N 2L8
Attention: Antonella Brasil
PO#:
Invoice to: Bureau Veritas Canada (2019) Inc.

Report Number: 1921179
Date Submitted: 2019-11-19
Date Reported: 2019-11-22
Project: B9W0881
COC #: 851547

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 376353 **Analysis/Extraction Date** 2019-11-21 **Analyst** SKH **Method** C SM2580B			
REDOX Potential	212.7 mV	100	

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

THURBER

Appendix C

Site Photographs

Photo C1: Existing Strawberry Creek #8 bridge looking south along Ware Road North.

(Date taken: November 4, 2019)

Photo C2: Existing Strawberry Creek #8 bridge looking south along Ware Road North.

(Date taken: November 10, 2019)

Photo C3: South approach to existing bridge looking north along Ellis Road.

(Date taken: November 10, 2019)

Photo C4: Looking north at east side of bridge and northeast embankment from southeast side.

(Date taken: November 10, 2019)

Photo C5: Looking south at northwest embankment and west side of bridge.

(Date taken: November 4, 2019)

Photo C6: Looking north at southeast embankment and east side of bridge.

(Date taken: November 10, 2019)

Photo C7: Looking north at southwest embankment and west side of bridge.

(Date taken: November 10, 2019)

THURBER

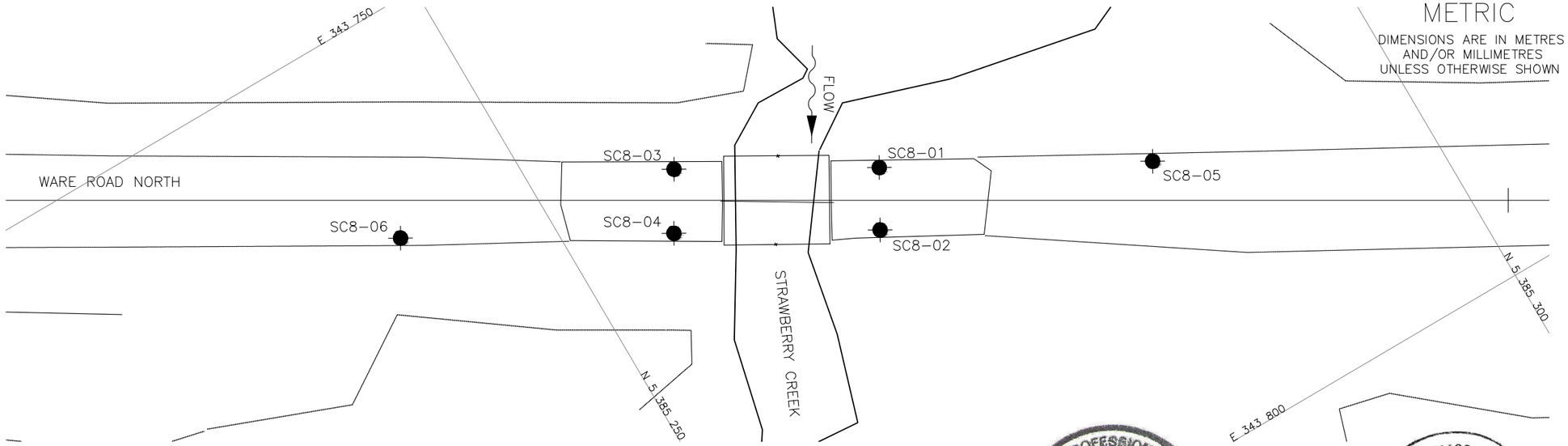
Appendix D

Borehole Locations and Soil Strata Drawing

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

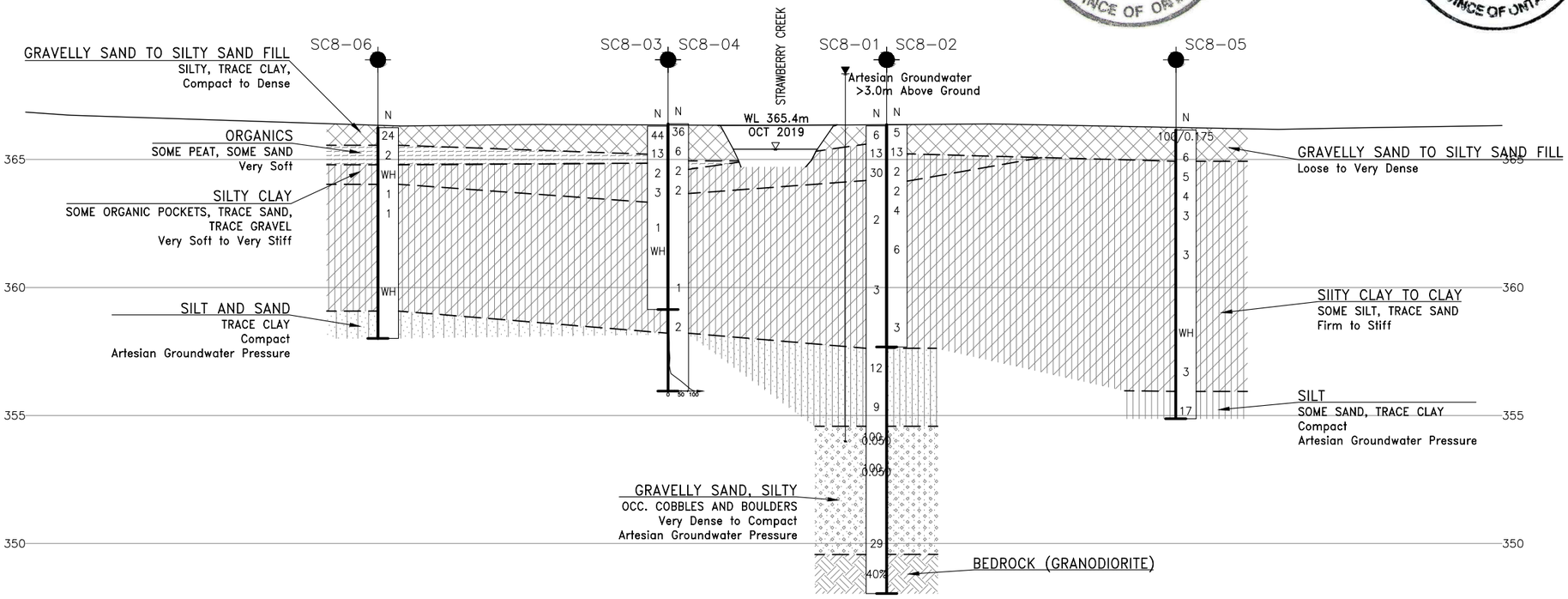
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

6 0 6 12m

SCALE 1:300



PROFILE ALONG WARE ROAD NORTH

6 0 6 12m H 1:300

4 0 4 8m V 1:200

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
June 5/2020
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
June 5/20
PROVINCE OF ONTARIO

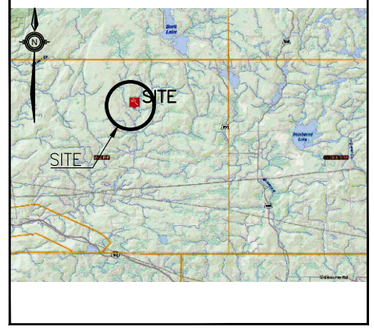
CONT No
GWP No 6014-18-00

STRAWBERRY CREEK BRIDGE #8 REPLACEMENT

BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Borehole
⊕	Borehole and Cone
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
SC8-01	366.31	5 385 269.3	343 774.2
SC8-02	366.36	5 385 267.4	343 777.5
SC8-03	366.30	5 385 258.2	343 767.8
SC8-04	366.39	5 385 256.2	343 771.2
SC8-05	366.15	5 385 284.2	343 782.5
SC8-06	366.24	5 385 241.4	343 762.9

-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 15.

GEOCRES No. 52A-250

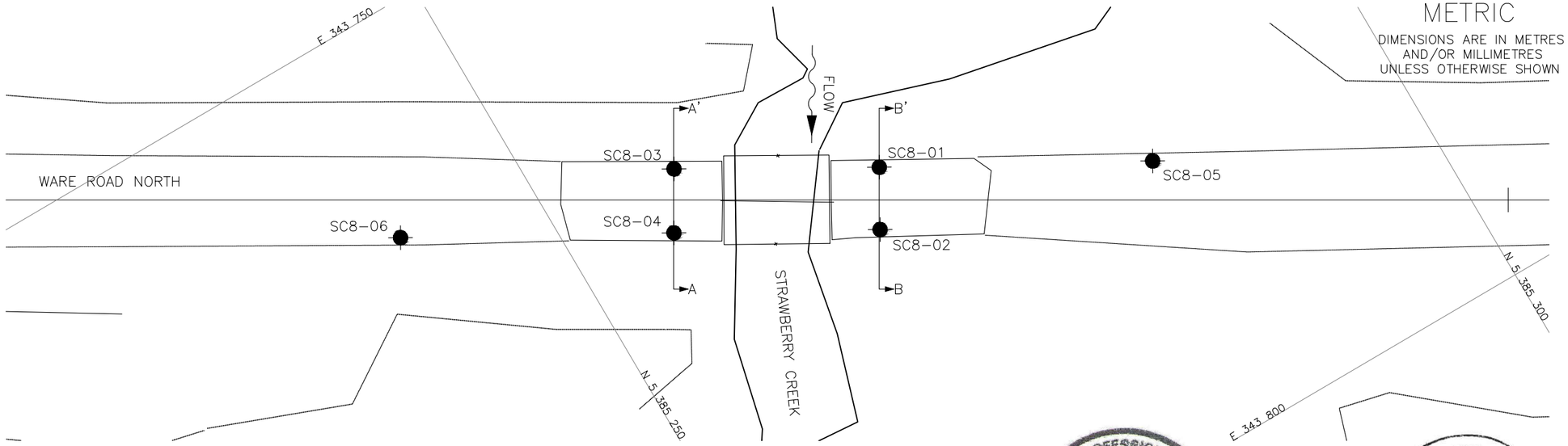
REVISIONS			
	DATE	BY	DESCRIPTION
DESIGN MEF	CHK PKC	CODE	LOAD	DATE JUN 2020
DRAWN BH	CHK MEF	SITE 48W-054	STRUCT	DWG 1

FILENAME: H:\Drafting\27000\27323\TED-27323-BHPL-SC8.dwg
PLOTDATE: 6/10/2020 1:48 PM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

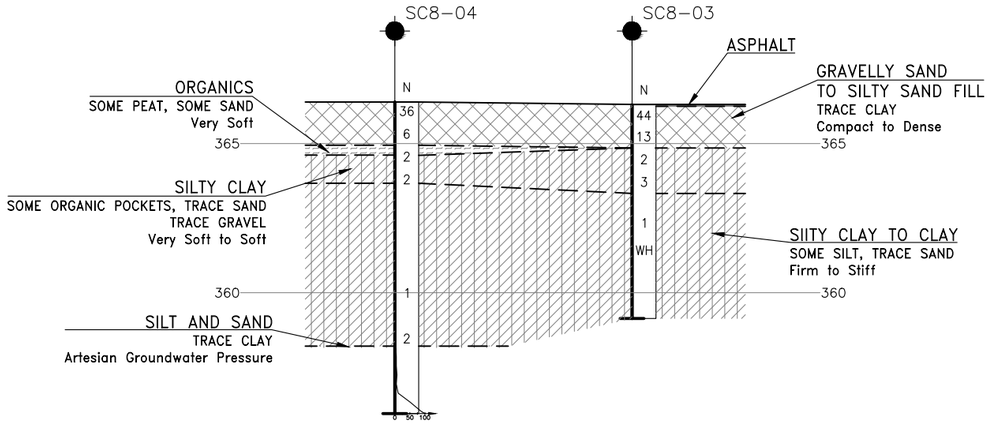
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

6 0 6 12m

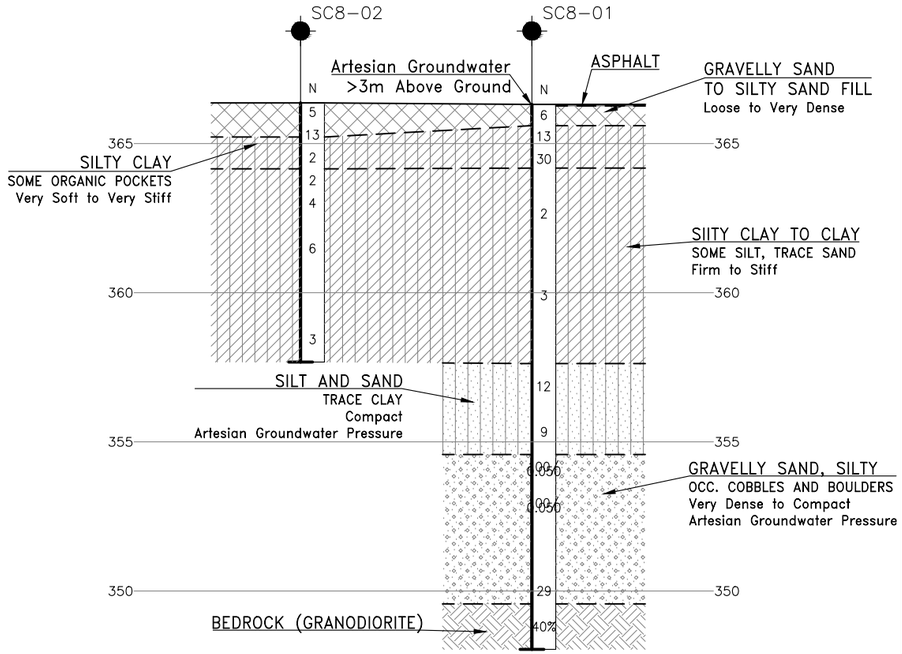
SCALE 1:300



SECTION A–A'

2 0 2 4m H 1:100

4 0 4 8m V 1:200



SECTION B–B'

2 0 2 4m H 1:100

4 0 4 8m V 1:200

CONT No

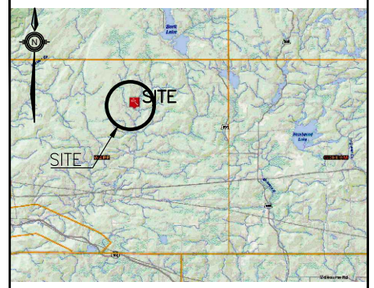
GWP No 6014-18-00

STRAWBERRY CREEK BRIDGE #8 REPLACEMENT

BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
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
SC8-01	366.31	5 385 269.3	343 774.2
SC8-02	366.36	5 385 267.4	343 777.5
SC8-03	366.30	5 385 258.2	343 767.8
SC8-04	366.39	5 385 256.2	343 771.2
SC8-05	366.15	5 385 284.2	343 782.5
SC8-06	366.24	5 385 241.4	343 762.9

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
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3) Coordinate system is MTM NAD 83 Zone 15.

GEOCRES No. 52A-250

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
June 5/2020
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
June 5/20
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MEF	CHK PKC	CODE	LOAD	DATE JUN 2020
DRAWN	BH	CHK MEF	SITE 48W-054	STRUCT	DWG 2

FILENAME: H:\Drafting\27000\27323\TED-27323-BHPL-SC8.dwg
PLOTDATE: 6/10/2020 1:48 PM