THURBER ENGINEERING LTD.

FINAL
FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF BRIDGE STRUCTURE No. 46-015
SIDEBURNED LAKE BRIDGE HIGHWAY 101
CHAPLEAU TOWNSHIP
G.W.P. 5144-10-00
5015-E-0027

GEOCRES NUMBER: 41O-26

SUBMITTED TO

MCINTOSH PERRY CONSULTING ENGINEERS

Location:
Latitude: 47.7764
Longitude: -83.4896

October 2018
THURBER FILE NO.: 13624

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thurber.ca

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the Sideburned Lake Bridge located on Highway 101, within Chapleau Township. Thurber carried out the investigation as a subconsultant to McIntosh Perry Consulting Engineers (MPCE) as part of Agreement No. 5015-E-0027.

No previous foundation investigation information for the subject site was available within the online Geocres Library. However, a historical General Arrangement drawing from 1957 was available and a copy is provided in Appendix A. A Preliminary General Arrangement (GA) drawings and base plan mapping were provided by MPCE for the preparation of this report.

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

2 SITE DESCRIPTION

Structure No. 46-015 is located on Highway 101, approximately 8.5 km west of the junction of Highway 129 south of Chapleau, Ontario. It is noted that for project orientation purposes, Highway 101 within the project limits, will be described with an east-west alignment. The location of the bridge is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

Within the project limits, Highway 101 is a two-lane, rural, arterial, undivided highway. Based on the December 2016 drawing the roadway cross-section consists of two, 3.5 m wide lanes, and paved shoulders with a width of 2.0 m and 2.6 m on the WBL and EBL respectively. Steel cable guide rails are located on both sides of the highway for a short distance from the bridge. The southeast steel guide rail is extended with a 3-cabled guide rail.

The existing bridge is an 18.75 m single span, rolled “I” beam bridge with a reinforced cast-in-place concrete deck and was constructed in 1958, see Historic General Arrangement Drawing in Appendix A. The bridge deck was to be horizontal on profile with an elevation of 1460.76 ft (445.2 m).

The bridge deck is approximately 3 m above the water level. The embankment slopes located adjacent to the abutment are inclined at approximately 1.5H:1V with the surface consisting mainly of rock fill with granular infill material. The east approach embankment is built into the water approximately 50 m from the shoreline. Based on the Preliminary GA drawing, the elevation of

the center line of roadway is to be approximately 445.095 m and 445.250 m at the east and west abutments, respectively.

Directly adjacent to the south side of the bridge alignment are remnants of a staging platform used to support a bailey bridge for a temporary detour during the initial construction of the bridge. The topography adjacent to the lake at the site is rolling forested lands with frequent bedrock outcrops. The land in the vicinity of the bridge is uninhabited and undeveloped with the exception of a motel which is present east of the bridge site. Traffic volumes are understood to be 425 AADT (2012)

Site photographs showing the general conditions at the site during the time of the field investigation are presented in Appendix D.

3 SITE INVESTIGATION AND FIELD TESTING

Thurber contacted Ontario One Call in advance of the field investigation to provide utility locate clearances in the vicinity of the boreholes.

The field investigation for this site included advancing seven boreholes drilled from October 30, 2016 to November 4, 2016. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and are summarized in Table 3-1.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth below Existing Ground Surface (m)
16-14	East Approach – westbound lane	5293164.3	343042.0	444.5	5.8
16-14B	East Approach – westbound lane	5293161.4	343046.1	444.5	1.9
16-15	East Abutment – westbound lane	5293174.6	343031.7	444.4	19.1
16-16	East Abutment – eastbound lane	5293168.2	343026.6	444.5	16.2
16-17	West Abutment – westbound lane	5293191.1	343006.7	444.7	7.2
16-18	West Abutment – westbound lane	5293186.5	343003.5	444.7	8.7
16-19	West Approach – eastbound lane	5293196.0	342992.2	444.7	6.5

All boreholes were advanced through the roadway embankment with a truck mounted CME 75 drill rig equipped with hollow stem augers and HW/NW casing. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Where possible split spoon samples were collected at regular depth intervals in the boreholes via the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586. All soil samples recovered from the boreholes were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing.

A 19 mm inside diameter PVC standpipe piezometer was installed in Borehole 16-15 to allow for measurement of the groundwater level at the east abutment following completion of drilling. The piezometer construction details are illustrated on the Record of Borehole sheet for Borehole 16-15, provided in Appendix B. The piezometer was decommissioned November 4, 2016 following completion of the field investigation program.

The boreholes without a piezometer were backfilled with a low-permeability mixture of auger cuttings and bentonite pellets in accordance with Ontario MOE Regulation 903. Boreholes advanced within paved areas were capped with auger cuttings followed by 150 mm of cold patch asphalt to reinstate the travelling surface.

The as-drilled locations and ground surface elevation of the boreholes were surveyed by MPCE in November 2016.

3.1 Laboratory Testing

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples in accordance with the current MTO standards. Grain size distribution analyses testing was also carried out on selected samples to MTO and ASTM standards. Chemical analysis for determination of pH, resistivity, soluble sulphate and chloride concentrations was carried out on two soil samples.

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

4 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 Overview / General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. Stratigraphic profiles for the bridge area are presented on Drawing No. 1 in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions.

The stratigraphy in the area of the boreholes through the embankment is generally characterized by the asphalt pavement structure and rockfill embankment overlying silty sand or silt above bedrock.

4.2 Asphalt

All boreholes were advanced through the Highway 101 pavement structure. The thickness of the asphalt ranged from 130 mm to 210 mm.

4.3 Fill

Granular Fill

Granular fill consisting predominantly of sand with silt and gravel to gravel with silt and sand was encountered below the asphalt in all boreholes. This layer has a thickness ranging from 0.5 m to 2.7 m (bottom elevation of 441.8 m to 443.8 m). The SPT 'N' values ranged from 41 blows to greater than 100 blows per 175 mm of penetration; indicating a dense to very dense condition.

The moisture content of the samples tested ranged from 1% to 8%. The results of grain size analyses conducted on five samples of this material are summarized in Table 4-1 and are illustrated on Figure C1 in Appendix C.

Table 4-1: Gradation Results for Granular Fill

Soil Particle	%
Gravel	23 to 62
Sand	30 to 66
Silt and Clay	7 to 12

Rockfill

A fill layer consisting predominantly of rockfill was encountered beneath the granular fill in all abutment boreholes (16-15, 16-16, 16-17 and 16-18) as well as in approach borehole 16-14. The voids between rockfill pieces contained a granular infill material. Borehole 16-14 was terminated within this layer at a depth of 5.8 m below ground surface. This layer has a top elevation of 442.9 m to 443.8 m, and a thickness ranging from 2.3 m to 9.9 m where fully penetrated. Boreholes were advanced through the rockfill using casing and coring techniques. Sampling was attempted, however due to the nature of this material sample recovery was poor or not feasible. The SPT 'N' values varied from 5 blows to greater than 100 blows for 200 mm of penetration; indicating a loose to very dense condition. The lower N-values were obtained within the granular infill

Rockfill pieces were cored and indicated particles with diameters ranging from 200 mm to 900 mm. Boulders estimated as large as 1.5 m in diameter were observed on the side slopes of the embankment in the area of the bridge.

4.4 Silt (ML) to Sandy Silt (ML)

A native layer of silt to sandy silt was encountered in Boreholes 16-15 and 16-16. Cobbles and boulders were observed in this unit in both boreholes. The surface of this deposit ranged in elevation from 433.9 m to 434.7 m. This layer has a thickness ranging from 1.7 m to 5.3 m. The SPT 'N' values ranged from 3 to 29 blows per 0.3 m of penetration; indicating a very loose to compact condition.

The moisture content for the samples tested typically ranged from was 13% to 27% with a single moisture content value as high as of 74% recorded near the surface of the layer in Borehole 16-15. The results of grain size analyses conducted on three samples of this material are summarized in Table 4-2 and are illustrated on Figure C2 in Appendix C.

Table 4-2: Gradation Results for Silt (ML) to Sandy Silt (ML)

Soil Particle	%
Gravel	0 to 10
Sand	1 to 24
Silt	58 to 82
Clay	8 to 19

Atterberg Limit testing was completed on one sample of the silt deposit. The result is summarized on the Record of Borehole sheets in Appendix B and the Atterberg Limit graph is included in Figure C3 of Appendix C. The laboratory results indicate that the silt exhibits low plasticity (ML).

4.5 Silty Sand (SM)

A native layer of silty sand with gravel was encountered in Boreholes 16-15, 16-17 and 16-18. Frequent boulders were noted in Borehole 16-15 and wood pieces were present within Borehole 16-17. The surface of this deposit ranged in elevation from 432.2 m to 440.6 m. This layer has a thickness ranging from 0.5 m to 3.0 m. The SPT 'N' values ranged from 36 blows to greater than 100 blows per 200 mm of penetration; indicating a dense to very dense condition.

The moisture content for the samples tested ranged from was 10% to 33%.

4.6 Bedrock

The overburden materials were underlain by granite bedrock. Boreholes 16-15 through 16-19 were advanced into the bedrock by coring. The bedrock surface ranges from elevation 429.2 to 441.8 m as summarized in the table below:

Table 4-3 Summary of Bedrock Elevation

Location	Borehole No.	Depth Below Existing Ground Surface (m)	Top of Bedrock Elevation (m)
East Approach	16-14 16-14B	N/A(*)	N/A(*)
East Abutment	16-15	15.2	429.2
	16-16	15.1	429.3
West Abutment	16-17	3.7	441.0
	16-18	5.4	439.3
West Approach	16-19	2.9	441.8

Note: (*) not encountered within the depth of investigation

The Total Core Recovery (TCR) ranged from 98 to 100%, the Solid Core Recovery (SCR) ranged from 95 to 100% and the Rock Quality Designation (RQD) ranged from 72 to 100%. Based on the RQD value the bedrock is classified as fair to excellent quality. Point load strength correlations indicated a strength of very strong or better and Unconfined Compressive Strength tests indicated

a compressive strength of 65 to 206 MPa, please refer to Appendix C for UCS test results and rock core photos.

4.7 Groundwater

Groundwater was measured in the open Boreholes 16-14, 16-15, 16-16, and 16-18 during drilling and were noted to range from elevation 441.0 to 441.3m.

The groundwater level was measured in the piezometer installed in Borehole 16-15 on November 4, 2016 at a depth of 3.1 m; corresponding to an elevation of 441.3 m. The water level in Sideburned Lake was measured at the time of Thurber's field investigation at an elevation of 441.3 m.

These observations are considered 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 and/or prolonged precipitation. Due to the open nature of the rockfill approach embankments, it is expected that the groundwater level will respond rapidly to the water level changes in Sideburned Lake.

5 MISCELLANEOUS

Thurber obtained utility clearances prior to drilling and the borehole locations were positioned relative to existing site features and proposed foundations. MPCE surveyed the borehole locations and ground surface elevations. George Downing Estate Drilling Ltd. of Hawkesbury, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, in-situ testing, standpipe piezometer installation and borehole decommissioning. The drilling, and sampling operations in the field were supervised on a full- time basis by Mr. Christopher Murray, P.Eng. of Thurber. Laboratory testing was carried out in Thurber's MTO-approved laboratory in Ottawa.

Overall project management and direction of the field program was provided by Mr. Stephen Peters, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Justin Gray P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.

Justin Gray, P.Eng.
Geotechnical Engineer

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F. J. GRIFFITHS
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Dr. Fred Griffiths, P.Eng.
Senior Associate
Senior Geotechnical Engineer

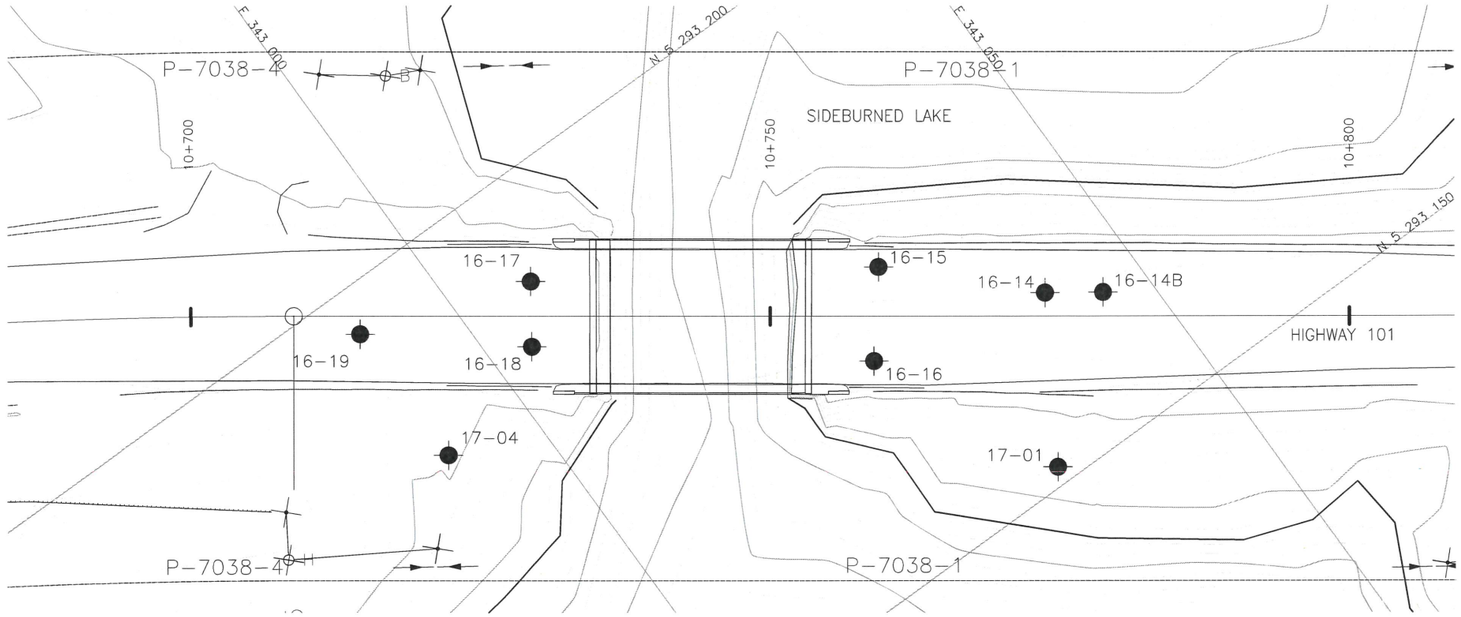
LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 19/18
PROVINCE OF ONTARIO

Dr. P.K. Chatterji, P.Eng.
MTO Review Principal
Senior Geotechnical Engineer

APPENDIX A

BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

10 0 10 20m

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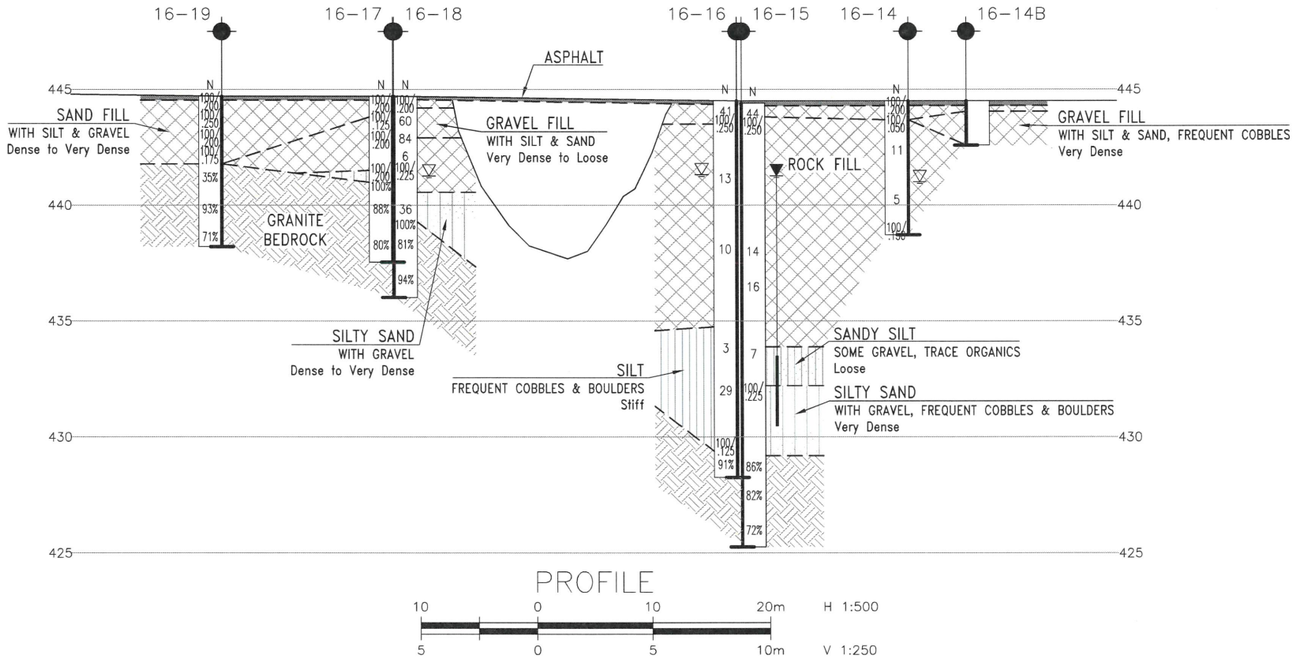

PROFILE

10 0 10 20m H 1:500

5 0 5 10m V 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

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P.K. CHATTERJI
Oct 19/18
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
Oct 25/18
PROVINCE OF ONTARIO

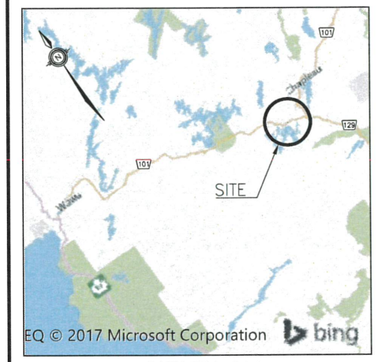
CONT No
GWP No 5144-10-00

SHEET

HIGHWAY 101
SIDEBURNED LAKE
BRIDGE REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

McINTOSH PERRY

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
16-14	444.5	5 293 164.3	343 042.0
16-14B	444.5	5 293 161.4	343 046.1
16-15	444.4	5 293 174.6	343 031.7
16-16	444.5	5 293 168.2	343 026.6
16-17	444.7	5 293 191.1	343 006.7
16-18	444.7	5 293 186.5	343 003.5
16-19	444.7	5 293 196.0	342 992.2
17-01	443.6	5 293 151.5	343 034.1
17-04	443.8	5 293 183.1	342 992.2

-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) Borehole locations are shown in MTM Zone 13 coordinates.

GEOCRES No. 41O-26

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN JG	CHK –	CODE	LOAD	DATE OCT 2018	
DRAWN MFA	CHK JG	SITE 46-015	STRUCT	DWG 1	

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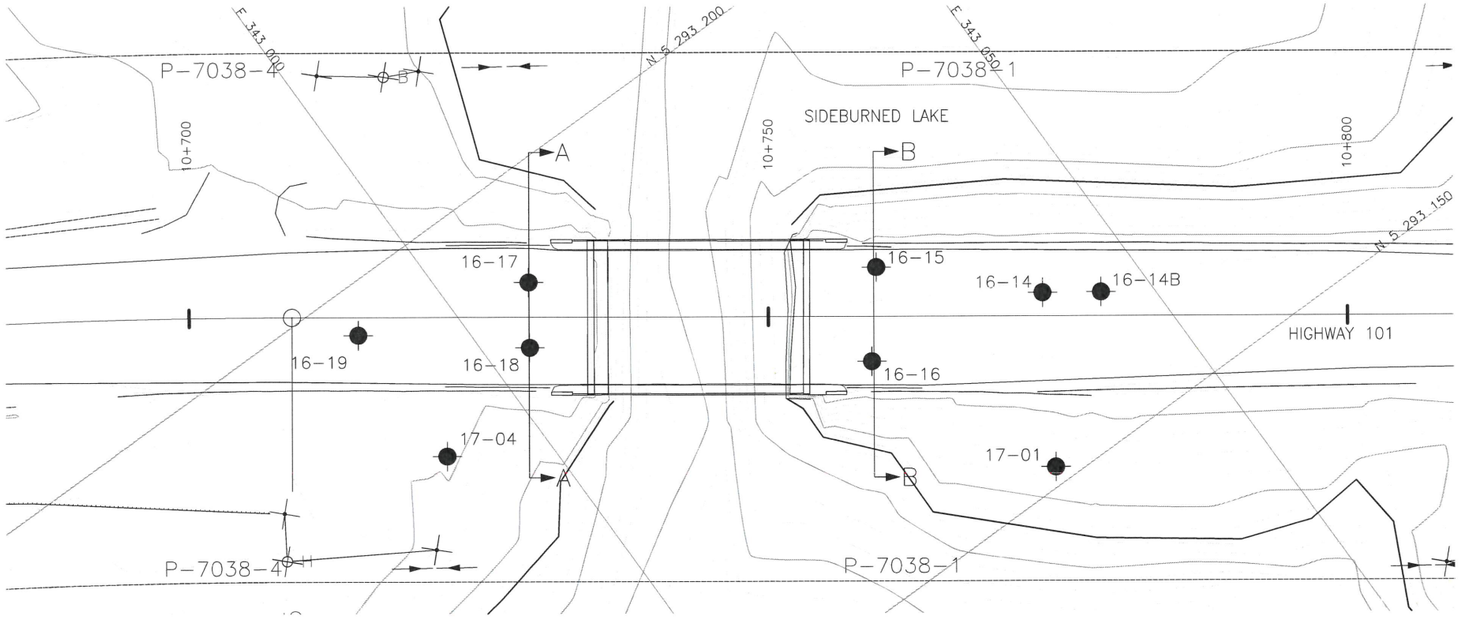

PLAN

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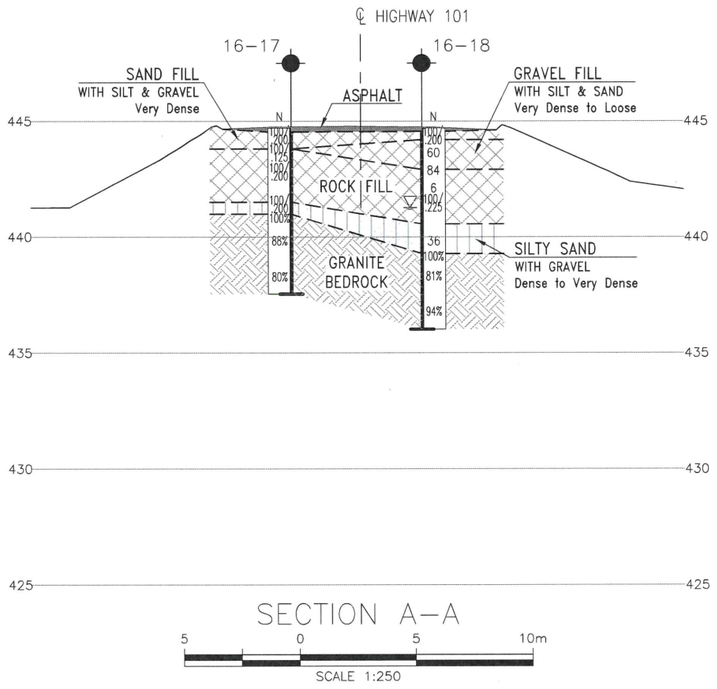
SCALE 1:500



SECTION A–A

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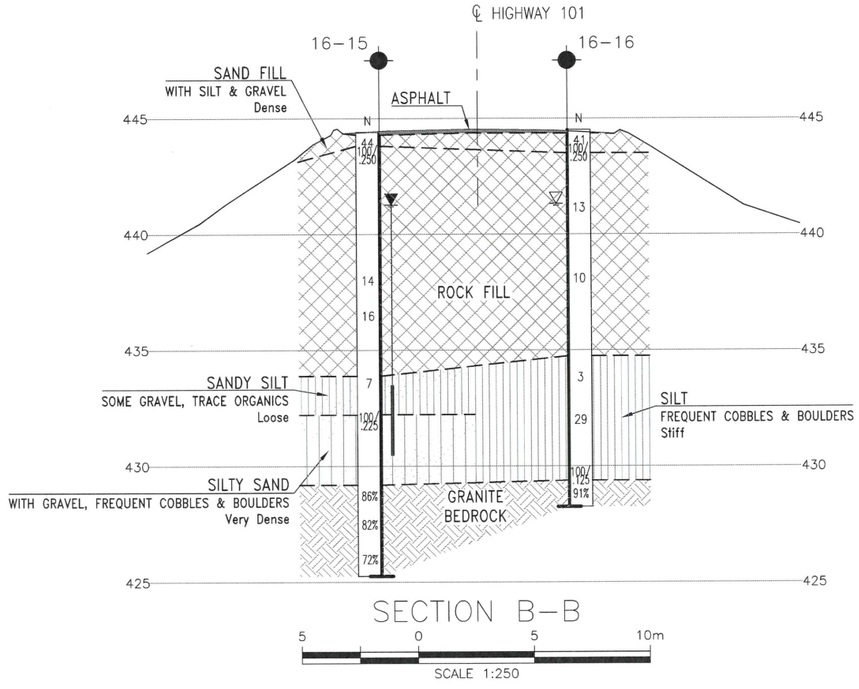

SECTION B–B

5 0 5 10m

SCALE 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

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LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
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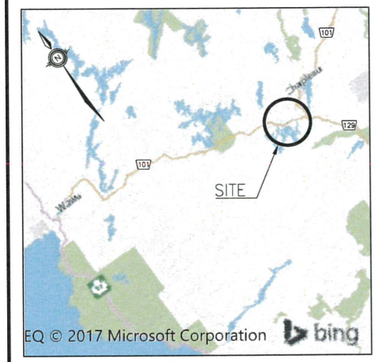
CONT No
GWP No 5144-10-00

SHEET

HIGHWAY 101
SIDEBURNED LAKE
BRIDGE REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

McINTOSH PERRY

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
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16-18	444.7	5 293 186.5	343 003.5
16-19	444.7	5 293 196.0	342 992.2
17-01	443.6	5 293 151.5	343 034.1
17-04	443.8	5 293 183.1	342 992.2

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GEOCRES No. 41O-26

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN JG	CHK –	CODE	LOAD	DATE OCT 2018	
DRAWN MFA	CHK JG	SITE 46-015	STRUCT	DWG 2	

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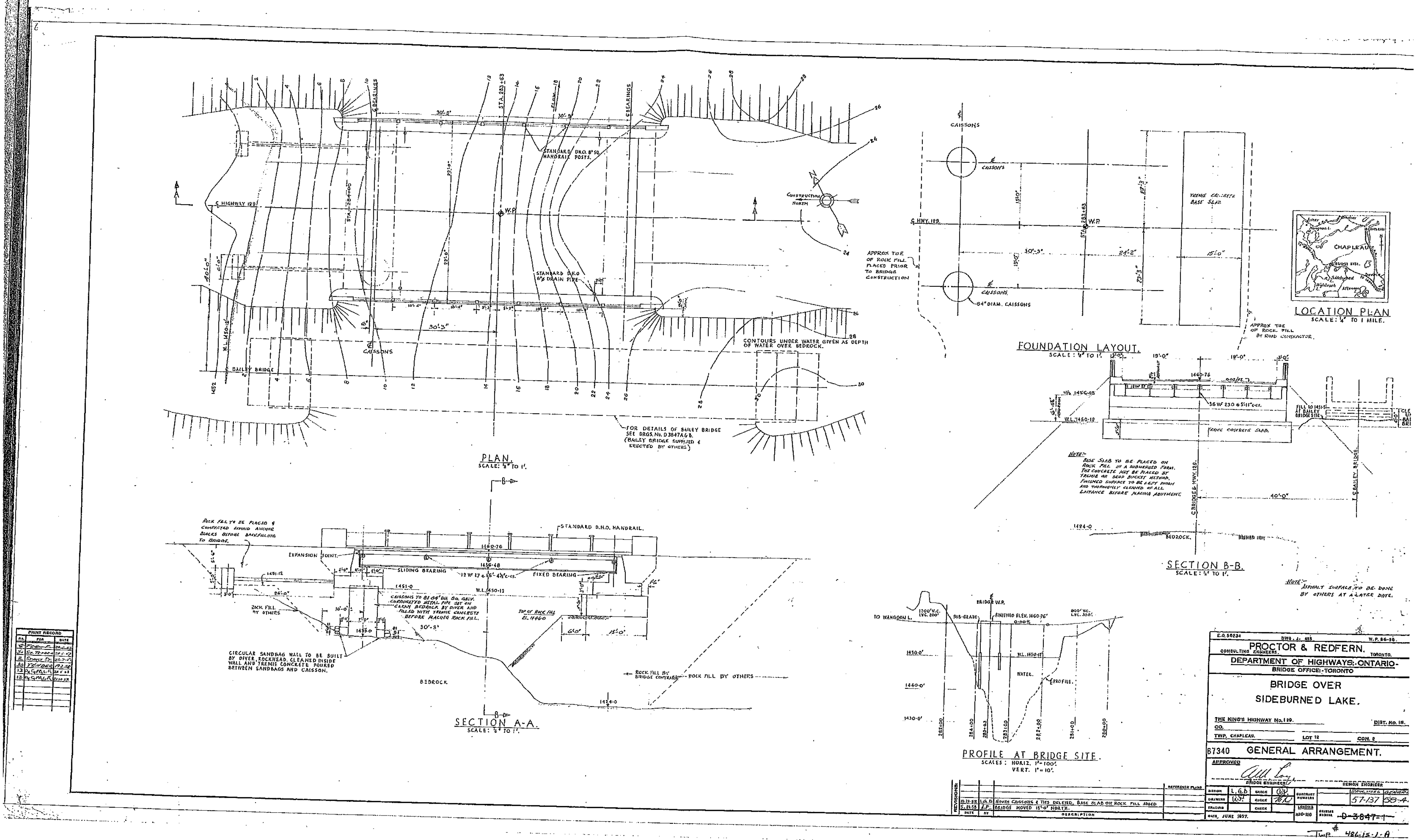

PLAN.
SCALE: 1/8" TO 1'.
℄ HIGHWAY 129
STA. 283+63
STA. 284+00
℄ BEARINGS
W.P.
STANDARD D.H.O. 8" SQ. HANDRAIL POSTS.
STANDARD D.H.O. 6" ⌀ DRAIN PIPE
CAISSONS
BAILEY BRIDGE
CONSTRUCTION NORTH
CONTOURS UNDER WATER GIVEN AS DEPTH OF WATER OVER BEDROCK.
FOR DETAILS OF BAILEY BRIDGE SEE DRGS. No. D3847A & B. (BAILEY BRIDGE SUPPLIED & ERECTED BY OTHERS)
FOUNDATION LAYOUT.
SCALE: 1/8" TO 1'.
CAISSONS
84" DIAM. CAISSONS
TREMIE CONCRETE BASE SLAB
APPROX TOE OF ROCK FILL PLACED PRIOR TO BRIDGE CONSTRUCTION
APPROX TOE OF ROCK FILL BY ROAD CONTRACTOR.
LOCATION PLAN
SCALE: 1/4" TO 1 MILE.
CHAPLEAU
SECTION B-B.
SCALE: 1/4" TO 1'.
36 W 230 @ 5'11" c-c.
TREMIE CONCRETE SLAB.
BEDROCK.
NOTE:- BASE SLAB TO BE PLACED ON ROCK FILL IN A SUBMERGED FORM. THE CONCRETE MAY BE PLACED BY TREMIE OR DROP BUCKET METHOD. FINISHED SURFACE TO BE LEFT ROUGH AND THOROUGHLY CLEANED OF ALL LAITANCE BEFORE PLACING ABUTMENT.
NOTE:- ASPHALT SURFACE TO BE DONE BY OTHERS AT A LATER DATE.
SECTION A-A.
SCALE: 1/8" TO 1'.
STANDARD D.H.O. HANDRAIL.
EXPANSION JOINT.
SLIDING BEARING
FIXED BEARING
W.L. 1450-12
ROCK FILL TO BE PLACED & COMPACTED AROUND ANCHOR BLOCKS BEFORE BACKFILLING TO BRIDGE.
CAISSONS TO BE 84" DIA. 8 G. GALV. CORRUGATED METAL PIPE SET ON CLEAN BEDROCK BY DIVER AND FILLED WITH TREMIE CONCRETE BEFORE PLACING ROCK FILL.
CIRCULAR SANDBAG WALL TO BE BUILT BY DIVER. ROCKHEAD CLEANED INSIDE WALL AND TREMIE CONCRETE POURED BETWEEN SANDBAGS AND CAISSON.
ROCK FILL BY OTHERS
ROCK FILL BY BRIDGE CONTRACTOR
BEDROCK
PROFILE AT BRIDGE SITE.
SCALES: HORIZ. 1"=100'. VERT. 1"=10'.
TO WANGOON L.
FINISHED ELEV. 1460-76'
WATER.
PROFILE.
PRINT RECORD
REVISIONS
SOUTH CAISSONS & TIES DELETED, BASE SLAB ON ROCK FILL ADDED
BRIDGE MOVED 15'-0" NORTH.
E.O. 56234
DWG. J- 455
W.P. 86-56.
PROCTOR & REDFERN.
CONSULTING ENGINEERS. TORONTO.
DEPARTMENT OF HIGHWAYS:-ONTARIO-
BRIDGE OFFICE:-TORONTO
BRIDGE OVER
SIDEBURNED LAKE.
THE KING'S HIGHWAY No. 129.
DIST. No. 18.
CO.
TWP. CHAPLEAU.
LOT 12
CON. 2
67340 GENERAL ARRANGEMENT.
APPROVED
BRIDGE ENGINEER
DESIGN ENGINEER
DESIGN L.G.B
CHECK
DRAWING
TRACING
CONTRACT NUMBERS
57-137
58-4
LOADING H20-S16
DATE, JUNE 1957.
D-3847-1
TWP. # 486-15-1-A

APPENDIX B

RECORD OF BOREHOLE SHEETS

THURBER

SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

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

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

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

RECOVERY:

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

N-VALUE:

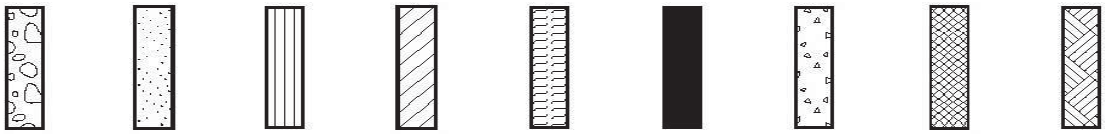
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented,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

DYNAMIC CONE PENETRATION TEST (DCPT):

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

THURBER

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



Boulders
Cobbles
Gravel

Sand

Silt

Clay

Organics

Asphalt

Concrete

Fill

Bedrock

TEXTURING CLASSIFICATION OF SOILS

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

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

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

SAMPLE TYPES

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

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

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

THURBER

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L= Liquid Limit

THURBER

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

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

TERMS

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

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

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

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THURBER

RECORD OF BOREHOLE No 16-14 1 OF 1 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 164.3 E 343 042.0 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / CME 75 Truck Mount COMPILED BY JM

DATUM Geodetic DATE 2016.10.30 - 2016.10.30 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
444.5											
0.0	**200 mm ASPHALT**										
0.2	SAND with Silt and Gravel Brown Very Dense		1	SS	100/ 200mm		444		○		41 52 7 (SI+CL)
443.7	**FILL**		2	SS	100/ 50mm						
0.8	- Very difficult augering below 0.3 m **ROCK FILL** - Auger refusal at 0.8 m, switch to NW Casing - Boulder from 0.8 m to 1.2 m - Boulder from 1.5 to 1.7 m						443				
	GRAVEL infill from 1.7 m to 2.4 m, grey, compact		3	SS	11						
	- Boulder from 2.4 m to 2.6 m						442				
	- Boulder from 2.9 m to 3.2 m										
	- Boulder from 3.4 m to 3.7 m					▽	441				
	GRAVEL with Sand infill from 3.7 m to 5.2 m, brown, loose		4	SS	5				○		
							440				
	- Boulder from 5.2 m to 5.4 m										
438.7			5	SS	100/ 150mm		439				
5.8	End of borehole at 5.8 m on probable boulder in rockfill Groundwater level was measured at 3.5 m BGS (Elev. 441.0) on 2016.11.01										

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

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

ONTMT4S 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 2012TEMPLATE(MTO).GDT 24/10/18

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THURBER

RECORD OF BOREHOLE No 16-14B 1 OF 1 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 161.4 E 343 046.1 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / CME 75 Truck Mount COMPILED BY JM

DATUM Geodetic DATE 2016.11.01 - 2016.11.01 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
444.5											
0.0	**210 mm ASPHALT**										
0.2	SAND with Silt and Gravel										
444.1	Brown		1	AS					○		
0.5	Dense						444				
	FILL										
	GRAVEL with Silt and Sand										
	Brown										
	Very Dense		2	AS					○		62 30 8 (SI+CL)
	FILL										
	- Frequent cobbles and boulders below 0.9 m						443				
442.6											
1.9	End of Borehole Auger refusal on probable boulder Borehole backfilled with cuttings										

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

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

ONTMT4S 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 2012TEMPLATE(MTO).GDT 24/10/18

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Ontario

THURBER

RECORD OF BOREHOLE No 16-15 1 OF 2 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 174.6 E 343 031.7 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / HW Casing / NW Casing / NQ Coring COMPILED BY JM

DATUM Geodetic DATE 2016.10.30 - 2016.11.01 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
444.4											
0.0	**130mm ASPHALT**										
0.1	SAND with Silt and Gravel Brown Dense		1	SS	44		444		○		
443.8											
0.6	**FILL**		2	SS	100/250mm						
	ROCK FILL - Auger Refusal at 0.6 m, switch to HW Casing - Boulder from 1.0 m to 1.4 m - Boulder from 1.5 m to 1.8 m						443				
	- Boulder from 2.1 m to 2.4 m						442				
	- Boulder from 2.6 m to 2.8 m - Cobbles from 2.9 m to 3.2 m					▽					
	- Boulder from 3.2 m to 3.4 m - Boulder from 3.5 m to 3.7 m - Frequent cobbles from 3.7 m to 4.4 m						441				
	- Boulder from 4.6 m to 5.1 m						440				
	- Frequent cobbles from 5.2 m to 6.0 m						439				
			3	SS	14		438				
	GRAVEL with Sand infill from 6.0 m to 8.5 m, dark brown, compact		4	SS	16		437				
	- Frequent cobbles from 8.5 m to 8.8 m - Switch to NW casing - Boulder from 9.0 m to 9.3 m						436				
							435				

Continued Next Page

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No 16-15 2 OF 2 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 174.6 E 343 031.7 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / HW Casing / NW Casing / NQ Coring COMPILED BY JM

DATUM Geodetic DATE 2016.10.30 - 2016.11.01 CHECKED BY SP

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										
	- Boulder from 10.1 m to 10.3 m										
433.9							434				
10.5	**Sandy SILT (ML)** some Gravel trace Organics Grey Loose		5	SS	7				o		10 24 58 8
	- Boulder from 11.3 m to 11.5 m						433				
432.2											
12.2	**SILTY SAND (SM)** with Gravel, frequent Cobbles and Boulders Grey Very Dense - Boulder from 12.7 m to 13.0 m		6	SS	100/ 225mm		432		o		Chemical Testing
	- Frequent cobbles from 13.0 m to 13.4 m						431				
	- Boulder from 13.6 m to 13.9 m										
	- Boulder from 13.9 m to to 14.1 m - Boulder from 14.2 m to 14.4 m						430				
429.2											
15.2	Casing refusal						429				
	Bedrock Granite Fresh Moderately Bedded Grey		1	RUN							RUN #1 TCR=100% SCR=100% RQD=86%
			2	RUN			428				RUN #2 TCR=100% SCR=95% RQD=82%
							427				
			3	RUN							RUN #3 TCR=100% SCR=100% RQD=72%
							426				
425.3											
19.1	End of Borehole Groundwater level was measured in piezometer at 3.1 m BGS (Elev. 441.3) on 2016.11.04										

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

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

ONTMT4S 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 2012TEMPLATE(MTO).GDT 24/10/18

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THURBER

RECORD OF BOREHOLE No 16-16 1 OF 2 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 168.2 E 343 026.6 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / HW Coring / CME 75 Truck Mount COMPILED BY JM

DATUM Geodetic DATE 2016.11.01 - 2016.11.01 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
444.5											
0.0	**150mm ASPHALT**										
0.2	SAND with Silt and Gravel Brown Dense **FILL**		1	SS	41		444		○		
443.4	Difficult augering below 0.6 m, switch to HW Casing at 1.0 m		2	SS	100/250mm				○		
1.0	**ROCK FILL** - Boulder from 1.0 m to 1.6 m						443				
	- Boulder from 1.8 m to 2.3 m										
	- Boulder from 2.6 m to 3.0 m						442				
	- Frequent cobbles from 3.0 m to 3.8 m GRAVEL infill from 3.0 m to 3.8 m, grey, compact		3	SS	13	▽	441				
	- Boulder from 3.8 m to 4.0 m										
	- Boulder from 4.1 m to 4.3 m						440				
	- Boulder from 4.5 m to 4.8 m										
	- Boulder from 5.1 m to 5.3 m						439				
	- Frequent cobbles from 5.5 m to 6.1 m										
	Gravel infill from 6.1 m to 6.9 m, grey, compact		4	SS	10		438				
	- Boulder from 6.9 m to 7.1 m										
	- Boulder from 7.2 m to 7.5 m						437				
	- Boulder from 7.6 to 8.0 m										
	- Boulder from 8.2 m to 9.1 m						436				
	- Switch to NW Casing										
	- Boulder from 9.5 m to 9.8 m						435				
434.7											
9.8	**SILT (ML)**										

Continued Next Page

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

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

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No 16-16 2 OF 2 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 168.2 E 343 026.6 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / HW Coring / CME 75 Truck Mount COMPILED BY JM

DATUM Geodetic DATE 2016.11.01 - 2016.11.01 CHECKED BY SP

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										
	SILT (ML) Grey Stiff										
			5	SS	3		434		○ H		0 1 82 17
	- Clayey						433	+ 4.0 + 2.5			
			6	SS	29		432		○		0 5 76 19
	- Boulder from 13.1 m to 13.3 m - Boulder from 13.6 m to 14.2 m - Frequent cobbles from 14.3 m to 14.9 m						431 430				
429.3			7	SS	100/ 125mm		429				
15.1	**Bedrock** Granite Fresh Moderately Bedded Grey		1	RUN							RUN #1 TCR=100% SCR=0.96% RQD=91%
428.2											
16.2	End of Borehole Groundwater level was measured at 3.2 m BGS (Elev. 441.3) on 2016.11.02										

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

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

ONTMT4S 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 2012TEMPLATE(MTO).GDT 24/10/18

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THURBER

RECORD OF BOREHOLE No 16-17 1 OF 1 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 191.1 E 343 006.7 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / NW Casing / NQ Coring COMPILED BY JM

DATUM Geodetic DATE 2016.11.04 - 2016.11.04 CHECKED BY SP

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
444.7								20 40 60 80 100	20 40 60		
0.0	**165mm ASPHALT**										
0.2	SAND with Silt and Gravel Very Dense Brown **FILL**		1	SS	100/ 200mm		444		○		30 58 12 (SI+CL)
443.8											
0.9	**ROCK FILL** - Auger refusal at 0.9 m, switch to NW Casing		2	SS	100/ 125mm				○		
			3	SS	100/ 200mm		443				
	- Boulder from 2.3 m to 2.5 m - Boulder from 2.6 m to 2.9 m - Boulder from 3 m to 3.2 m						442				
441.5											
3.2	**Silty SAND (SM)** with Gravel Brown Very Dense - Wood fragments		4	SS	100/ 200mm				○		
441.0							441				
3.7	**Bedrock** Granite Fresh Moderately Bedded Grey		1	RUN							RUN #1 TCR=100% SCR=100% RQD=100%
			2	RUN			440				RUN #2 TCR=100% SCR=97% RQD=88%
							439				
			3	RUN							RUN #3 TCR=100% SCR=97% RQD=80%
437.6							438				
7.2	End of Borehole										

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

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

ONTMT4S 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 2012TEMPLATE(MTO).GDT 24/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-18 1 OF 1 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 186.5 E 343 003.5 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / NW Casing / NQ Coring COMPILED BY JM

DATUM Geodetic DATE 2016.11.03 - 2016.11.03 CHECKED BY SP

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
444.7											
0.0	**150mm ASPHALT**										
0.2 / 444.2	SAND with Silt and Gravel Grey Very Dense **FILL**		1	SS	100/ 200mm		444				23 66 11 (SI+CL)
0.5	GRAVEL with Silt and Sand Very Dense to Loose Grey **FILL** - Very difficult augering from 0.5 m to 0.8 m		2	SS	60						
442.9	- Switch to NW Casing at 1.5 m		3	SS	84		443				
1.8	**ROCKFILL** - Boulder from 1.8 m to 2.1 m GRAVEL infill 2.1 m to 3.4 m, grey, loose		4	SS	6		442				
			5	SS	100/ 225mm	▽					
	- Boulder from 3.4 m to 4.1 m						441				
440.6											
4.1	**Silty SAND (SM)** with Gravel Dense Grey		6	SS	36		440				Chemical Testing
439.3											
5.4	**Bedrock** Granite Fresh Moderately Weathered Grey		1	RUN			439				RUN #1 TCR=100% SCR=100% RQD=100%
			2	RUN			438				RUN #2 TCR=98% SCR=98% RQD=81%
			3	RUN			437				RUN #3 TCR=100% SCR=100% RQD=94%
436.0											
8.7	End of borehole Groundwater level was measured at 3.44 m BGS (Elev. 441.3) on 2016.11.03										

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

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

ONTMT4S 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 2012TEMPLATE(MTO).GDT 24/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 16-19 1 OF 1 METRIC

GWP# 5144-10-00 LOCATION Hwy 101 - Sideburned Lake Bridge N 5 293 196.0 E 342 992.2 ORIGINATED BY CM

HWY 101 BOREHOLE TYPE HSA / CME 75 Truck Mount COMPILED BY JM

DATUM Geodetic DATE 2016.11.03 - 2016.11.03 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
444.7											
0.0	**165 mm ASPHALT**										
0.2	SAND with Silt and Gravel Very Dense Brown **FILL** - Difficult Augering from 0.5 m to 0.7 m		1	SS	100/ 200mm		444		○		
			2	SS	100/ 250mm				○		25 63 12 (SI+CL)
			3	SS	100/ 200mm		443		○		
	- Difficult Augering from 1.8 m to 2.2 m										
			4	SS	100/ 175mm				○		
	Auger refusal at 2.6 m						442				
441.8	- Boulder from 2.6 m to to 2.7 m										
2.9	**Bedrock** Granite Moderately weathered Fresh Grey		1	RUN			441				
			2	RUN			440				
			3	RUN			439				
438.2											
6.5	End of borehole Borehole dry prior to coring										

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

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

ONTMT4S 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 2012TEMPLATE(MTO).GDT 24/10/18

APPENDIX C

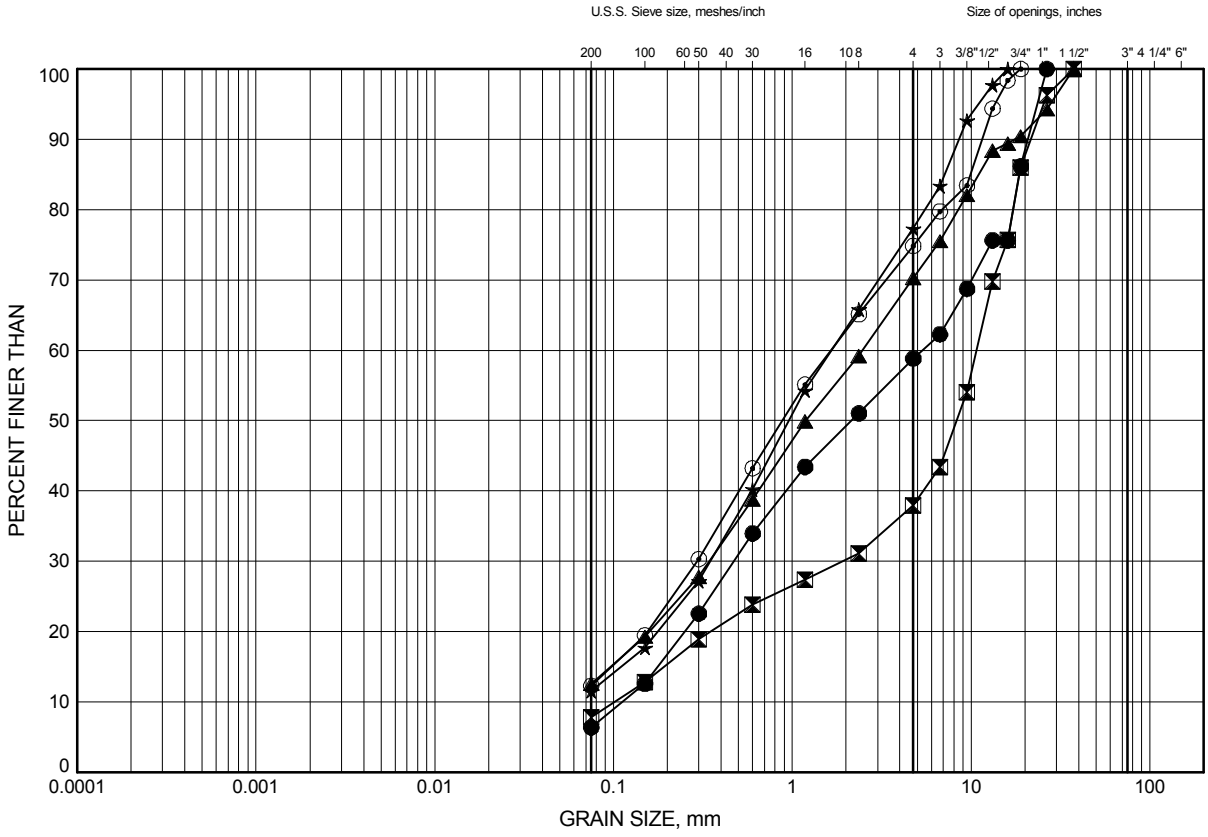
LABORATORY TEST RESULTS

Sideburned Lake Bridge

GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-14	0.40	444.11
⊠	16-14B	1.22	443.30
▲	16-17	0.46	444.29
★	16-18	0.34	444.40
⊙	16-19	0.88	443.82

Date October 2018

GWP# 5144-10-00

THURBER

Prep'd CM

Chkd. SP

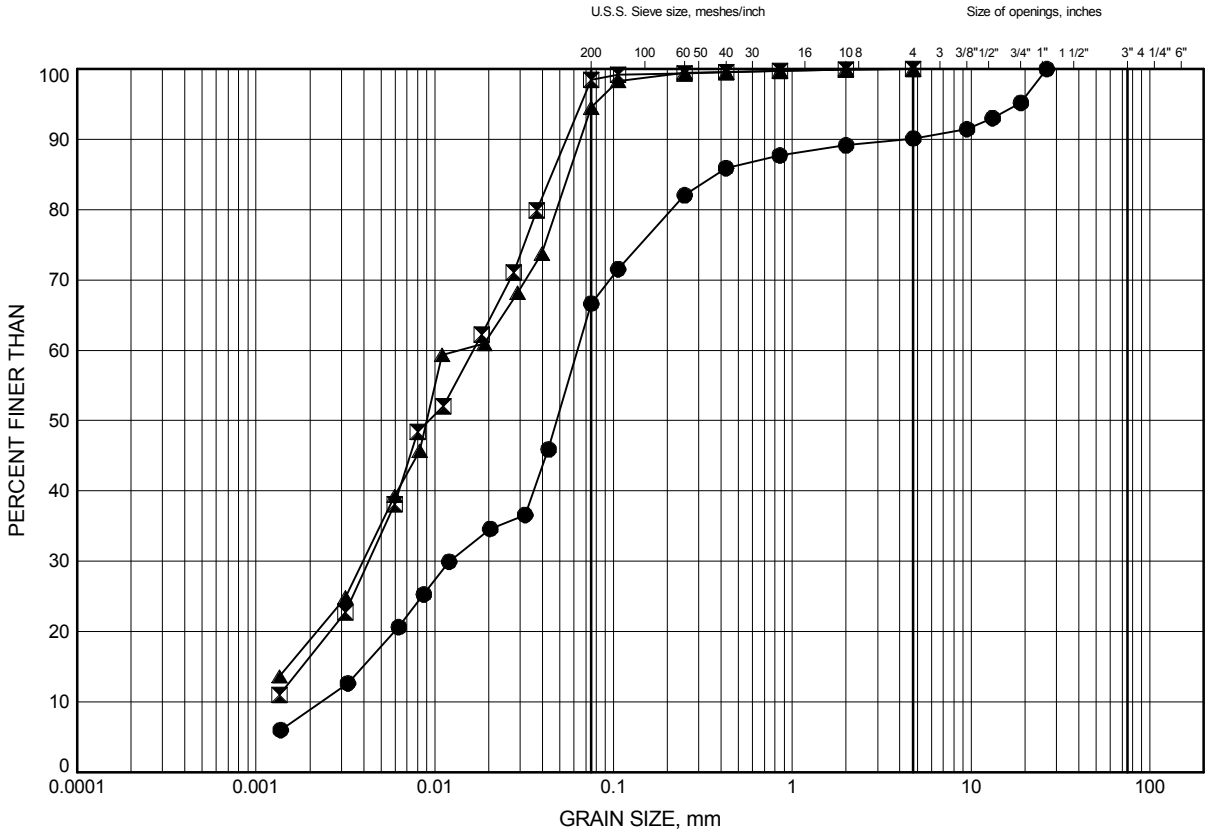
GRAIN SIZE DISTRIBUTION - THURBER 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 24/10/18

Sideburned Lake Bridge

GRAIN SIZE DISTRIBUTION

FIGURE C2

Silt to Sandy Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-15	10.82	433.62
⊠	16-16	10.67	433.78
▲	16-16	12.50	431.95

Date October 2018

GWP# 5144-10-00

THURBER

Prep'd CM

Chkd. SP

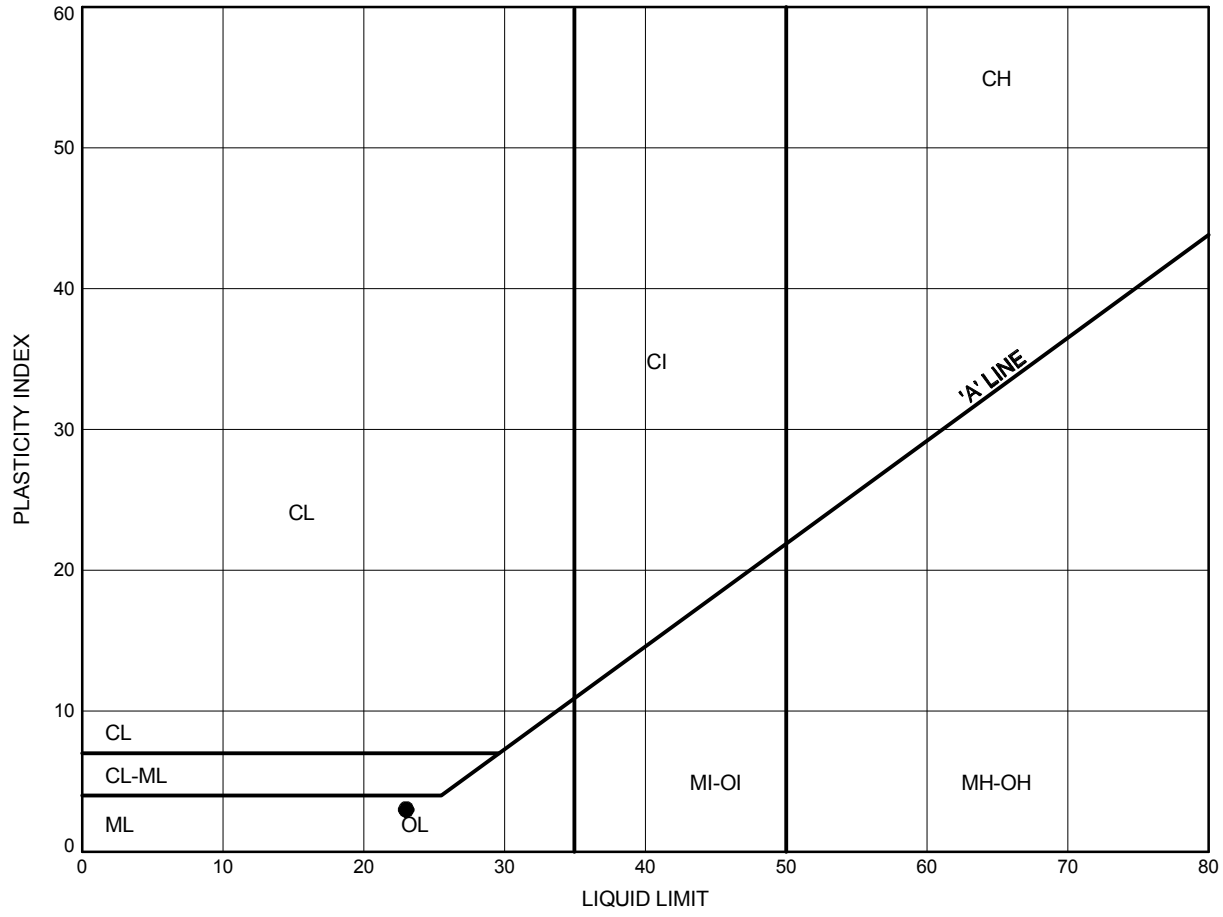
GRAIN SIZE DISTRIBUTION - THURBER 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 24/10/18

Sideburned Lake Bridge

ATTERBERG LIMITS TEST RESULTS

FIGURE C3

Silt to Sandy Silt



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-16	10.67	433.78

Date October 2018

GWP# 5144-10-00

THURBER

Prep'd CM

Chkd. SP

THURBALT 13624 - 101 AND 129 - SIDEBURNED LAKE.GPJ 24/10/18

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 17-Nov-2016
Order Date: 11-Nov-2016
Project Description: 13624

	Client ID:	16-1 SS2 (2'-4')	16-4 (1-4)	16-6 SS3 (5'-7')	16-8 SS4 (7'6-9'6)
	Sample Date:	21-Oct-16	23-Oct-16	27-Oct-16	28-Oct-16
	Sample ID:	1646369-01	1646369-02	1646369-03	1646369-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	81.8	85.3	96.7	92.0
General Inorganics					
Conductivity	5 uS/cm	109	109	385	728
pH	0.05 pH Units	7.41	6.41	7.89	7.89
Resistivity	0.10 Ohm.m	91.5	91.7	26.0	13.7
Anions					
Chloride	5 ug/g dry	16	15	159	346
Sulphate	5 ug/g dry	19	14	10	31

	Client ID:	16-15 SS6 (40-41-4)	16-18 SS6 (15-17)	-	-
	Sample Date:	31-Oct-16	03-Nov-16	-	-
	Sample ID:	1646369-05	1646369-06	-	-
	MDL/Units	Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	89.1	84.1	-	-
General Inorganics					
Conductivity	5 uS/cm	171	351	-	-
pH	0.05 pH Units	7.78	6.84	-	-
Resistivity	0.10 Ohm.m	58.4	28.5	-	-
Anions					
Chloride	5 ug/g dry	24	171	-	-
Sulphate	5 ug/g dry	54	18	-	-

Stantec Consulting Ltd
2781 Lancaster Rd, Suite 100 A&B
Ottawa, ON K1B 1A7
Tel: (613) 738-6075
Fax: (613) 722-2799

Stantec

January 18, 2017
File: 122410864

Attention: **Thurber Engineering Ltd., File #13624**

Reference: **ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core**

The table below summarizes four (4) Rock Core compressive strength results.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
BH16-15 RC-A	54'3"	65.1	One large diagonal crack through centre of core
BH16-16 RC-B	53'	125.7	One large diagonal crack through centre of core
BH16-17 RC-C	15'11'	206.4	No cones formed, vertical cracks throughout core
BH16-18 RC-D	22'4"	192.4	Well-formed cone on one end, vertical cracks through other

Sincerely,

Stantec Consulting Ltd

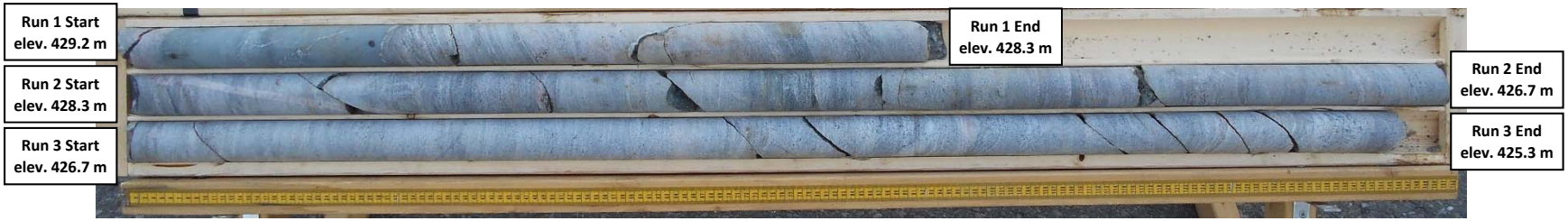
Brian Prevost

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
brian.prevost@stantec.com

Borehole 16-15

Run 1 to 3 (of 3)

Elevation 429.2 m to 425.3 m



THURBER ENGINEERING LTD.

Foundation Investigation
Highway 101 – Sideburned Lake Bridge
Site 46-015

GWP: 5144-10-00

Project No.: 13624

Borehole 16-16

Run 1 (of 1)

Elevation 429.3 m to 428.2 m

THURBER ENGINEERING LTD.

Foundation Investigation
Highway 101 – Sideburned Lake Bridge
Site 46-015

GWP: 5144-10-00

Project No.: 13624

Borehole 16-17

Run 1 to 3 (of 3)

Elevation 441.0 m to 437.6 m

THURBER ENGINEERING LTD.

Foundation Investigation
Highway 101 – Sideburned Lake Bridge
Site 46-015

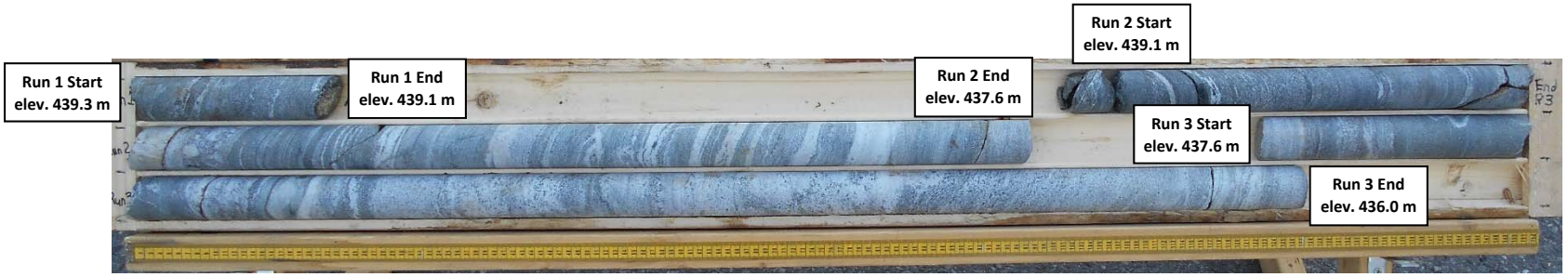
GWP: 5144-10-00

Project No.: 13624

Borehole 16-18

Run 1 to 3 (of 3)

Elevation 439.3 m to 436.0 m



THURBER ENGINEERING LTD.

Foundation Investigation
Highway 101 – Sideburned Lake Bridge
Site 46-015

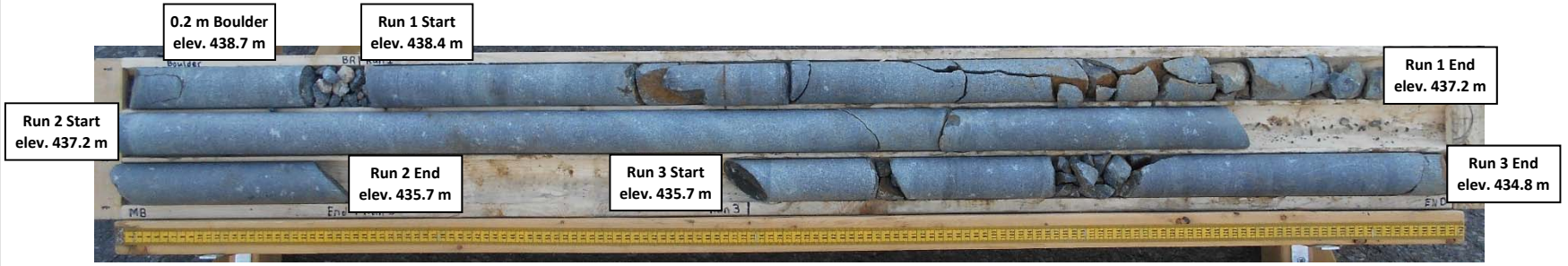
GWP: 5144-10-00

Project No.: 13624

Borehole 16-19

Run 1 to 3 (of 3)

Elevation 438.4 m to 434.8 m



THURBER ENGINEERING LTD.

Foundation Investigation
Highway 101 – Sideburned Lake Bridge
Site 46-015

GWP: 5144-10-00

Project No.: 13624

APPENDIX D

SELECTED PHOTOGRAPHS

Figure 1: Roadway Platform at Bridge 46-015 looking East [taken October 2016]

Figure 2: South Diversion Alignment looking West [taken October 2016]

Figure 3: Looking towards East Abutment [taken October 2016]

Figure 4: Looking west from South embankment slope [taken October 2016]