REPORT

April 4, 2018

FOUNDATION INVESTIGATION REPORT

WEST BEATON RIVER BRIDGE - SITE NO. 38N-008
HIGHWAY 631, ALGOMA DISTRICT
TOWNSHIP OF BEATON
MINISTRY OF TRANSPORTATION, ONTARIO
G.W.P. 5569-09-00, W.P. 5569-09-01

Submitted to:
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1 PDF Copy: Golder Associates Ltd., Sudbury, Ontario

Golder Associates

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FOUNDATION INVESTIGATION REPORT
WEST BEATON RIVER BRIDGE REHABILITATION - SITE NO. 38N-008
HIGHWAY 631 ALGOMA DISTRICT
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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by LEA Consulting Ltd. (LEA), on behalf of the Ministry of Transportation, Ontario (MTO) to provide detail foundation engineering services for the rehabilitation of West Beaton River Bridge (Site No. 38N-008), located on Highway 631, 73.4km North of Highway 17 in White River, Beaton Township. The key plan showing the general location of this section of Highway 631 and the location of the investigated area are shown on Drawing 1.

The purpose of this investigation is to establish the subsurface soil conditions at the existing bridge location by borehole drilling and laboratory testing on selected soil and samples.

The Terms of Reference and Scope of Work for the Foundation Investigation are outlined in MTO's Request for Proposal dated April 2016. Golder's proposal for foundation engineering services associated with rehabilitation of the West Beaton River Bridge structure is contained in Section 17.8 of LEA's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundations engineering services for this project, dated November 1, 2016.

2.0 SITE DESCRIPTION AND BACKGROUND INFORMATION

The existing West Beaton River Bridge consists of an approximately 26 m long and 10 m wide three-span structure that was constructed in 1968. In general, the topography of the site and surrounding area is relatively flat, with gently rolling terrain beyond the river. The area is surrounded by dense tree cover beyond the highway right-of-way.

Based on LEA's current General Arrangement dated August 2017, the existing abutments and piers are supported on driven steel tube piles. Based on the survey drawing provided by LEA (drawing 17197-West Beaton GA-S1.dwg) on October 16, 2017, the bridge deck is at Elevations 322.9 m and 323.0 m at the north and south abutments, respectively. The existing approach embankments are between about 4 m and 5 m high relative to the toe of slope at the river level. Views at the bridge site are shown on Photographs 1 to 2, following the text of this report.

3.0 INVESTIGATION PROCEDURE

The field work was carried out on August 19 and August 20, 2017, during which time two boreholes (WB-1 and WB-2) were advanced at the locations shown on Drawing 1.

The boreholes were advanced from the existing roadway platform using a Boart Longyear LF-70 DD drill rig supplied and operated by Downing Drilling Inc. (Downing) of Grenville-sur-la-Rouge, Quebec. The boreholes were advanced using 76 mm inside diameter hollow stem augers, and NW casing and wash boring techniques. Where coring through cobbles, boulders or bedrock was required, an NQ-size core barrel was used. Soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter split-spoon sampler operated by an automatic hammer, in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). The groundwater level in the open boreholes was observed during the drilling operations as described on the borehole records in Appendix A. The boreholes were backfilled and grouted upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The field work was supervised on a full-time basis by a member of Golder's staff, who located the boreholes in the field, cleared the site for buried services, directed the drilling and sampling operations and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder's Sudbury Laboratory for further examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Index and classification tests consisting of water content and grain size distribution were carried out on selected soil samples. The results of the laboratory testing on samples from the boreholes are presented on the borehole records in Appendix A, and on the grain size distribution figures in Appendix B. An unconfined compressive strength test was carried out on a specimen of the bedrock core obtained in Borehole WB-1.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) and UCS are described based on Table 3.10 and Table 3.5, respectively, of the Canadian Foundation Engineering Manual (CFEM, 2006[1]). The degree of weathering of the bedrock samples (i.e., fresh to slightly weathered) and the strength classification of the intact rock mass based on field identification (i.e., strong to very strong) are described in accordance with Table B.3 and Table B.6, respectively, of the International Society for Rock Mechanics (ISRM[2]) standard classification system.

The borehole locations and elevations were measured and surveyed by a member of our technical staff, referenced to HCP100 Survey point. The borehole locations (referenced to the MTM NAD83, Zone 13 co-ordinate system), ground surface elevations (referenced to Geodetic datum) and borehole depths are presented on the borehole records in Appendix A, and summarized below.

Borehole	Location (MTM NAD 83, Zone 13)		Location World Geodetic System 84		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting	Latitude	Longitude		
WB-1	5429809.1	249204.1	49.004012	-84.759939	322.8	8.8*
WB-2	5429761.1	249206.1	49.003580	-84.759905	323.0	9.8

* Includes 3.2 m of bedrock core.

4.0 SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain (NOEGTS)[3] mapping, the West Beaton River Bridge site is located within a glaciolacustrine plain deposit consisting primarily of sands and silts, bordered by bedrock knobs to the north and south of the site.

Based on geological mapping by the Ontario Ministry of Northern Development and Mines (MNDM)[4], the site is underlain by gneissic tonalite rocks with minor supracrustal inclusions.

[1] Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

[2] International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech. Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

[3] Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping.

[4] Ontario Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2543

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are presented on the borehole records in Appendix A and the laboratory test sheets in Appendix B. The results of the in situ field tests (i.e., SPT 'N' values) as presented on the borehole records and in Section 4 are uncorrected. The stratigraphic boundaries shown on the borehole records sheets and on the interpreted stratigraphic profile on Drawing 1 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations. A summary of the subsurface conditions as encountered in Boreholes WB-1 and WB-2 is presented below.

4.2.1 Subsoil Conditions

The soil deposits encountered in the boreholes are summarized below.

Deposit/Layer Description	Boreholes	Deposit Surface Elevation (m)	Deposit Thickness (m)	"N" – Values (blows) Relative Density	Laboratory Testing
Asphalt	WB-1, WB-2	323.0 and 322.8	0.05	n/a	n/a
(FILL) Sand and gravel; sand to gravelly sand[1]	WB-1, WB-2	322.9 and 322.7	0.7 – 1.4; 2.1 – 3.8	N = 66 – 87; N = 17 – 50 **Very dense; Compact to Dense**	w = 6% and 25% 2 – M (Fig. B1)
Silt to Sandy Silt to Silt and Sand	WB-1, WB-2	320.0 and 317.8	2.8 – 4.6 (borehole terminated in deposit in WB-2)	N = 16 – 82 **Compact to very dense**	w = 11% – 50% 3 – MH (Fig. B2)

Where:
N = SPT 'N'–values; number of blows for 0.3 m of penetration
w = natural moisture content
M = sieve analysis
MH = combined sieve and hydrometer analysis

Notes:

1) Cobbles and/or boulder were encountered within the gravelly sand deposit between 1.4 m and 1.9 and from 2.6 m to 2.8 m depths in Borehole WB-1.

4.2.2 Bedrock

Bedrock was cored in Borehole WB-1 and the depth/elevation of the actual/inferred bedrock surface is presented below.

Borehole No.	Depth to Bedrock Surface (below ground surface at borehole location) (m)	Bedrock Surface Elevation (m)	Refusal Condition (m)
WB-1	5.6	317.4	3.2 m length of bedrock core

The retrieved bedrock core from the borehole is described as foliated, medium grained, grey gneiss. More detailed descriptions of the bedrock core are presented on the Record of Drillhole WB-1 in Appendix A, including data regarding the discontinuity frequency and type. A photograph of the bedrock core samples is shown on Figure B3 in Appendix B. The bedrock properties, as encountered in the cored borehole, are summarized below. The results of unconfined compressive strength (UCS) testing are presented in Table B1 in Appendix B.

Borehole No.	Total Core Recovery (TCR)	Rock Quality Designation (RQD)	Quality Classification (Table 3.10 of CFEM 2006[5])	UCS (MPa)	Strength Classification (Table 3.5 of CFEM 2006[3])
WB-1	100%	94% - 100%	Excellent	57	(R4) Strong

4.2.3 Groundwater Conditions

The unstabilized groundwater levels measured in the open boreholes upon completion of NW casing and wash boring techniques, prior to and after NQ coring, was at ground surface; however, this is not considered representative of the in situ groundwater condition. Water levels should be expected to vary depending on the time of year and precipitation events.

The river water level was surveyed by others at Elevation 318.9 m, in November, 2016.

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Mat Riopelle. This Foundation Investigation Report was prepared by Mr. Tibor Berecz, and the technical aspects were reviewed by Mr. André Bom, P.Eng., a geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., and Ms. Lisa Coyne, P.Eng., both Designated MTO Foundations Contacts for Golder, conducted an independent quality control review and technical audit of this report.

[5] Canadian Geological Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

Report Signature Page

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TB/AB/JMAC/LCC/kp

n:\active\2016\3 proj\1661607 lea_5015-e-0049_ne region\foundations\reporting\r05-west beaton\final\1661607-r05 rev0 lea west beaton river bridge rehabilitation fir 04apr_18.docx

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5569-09-01

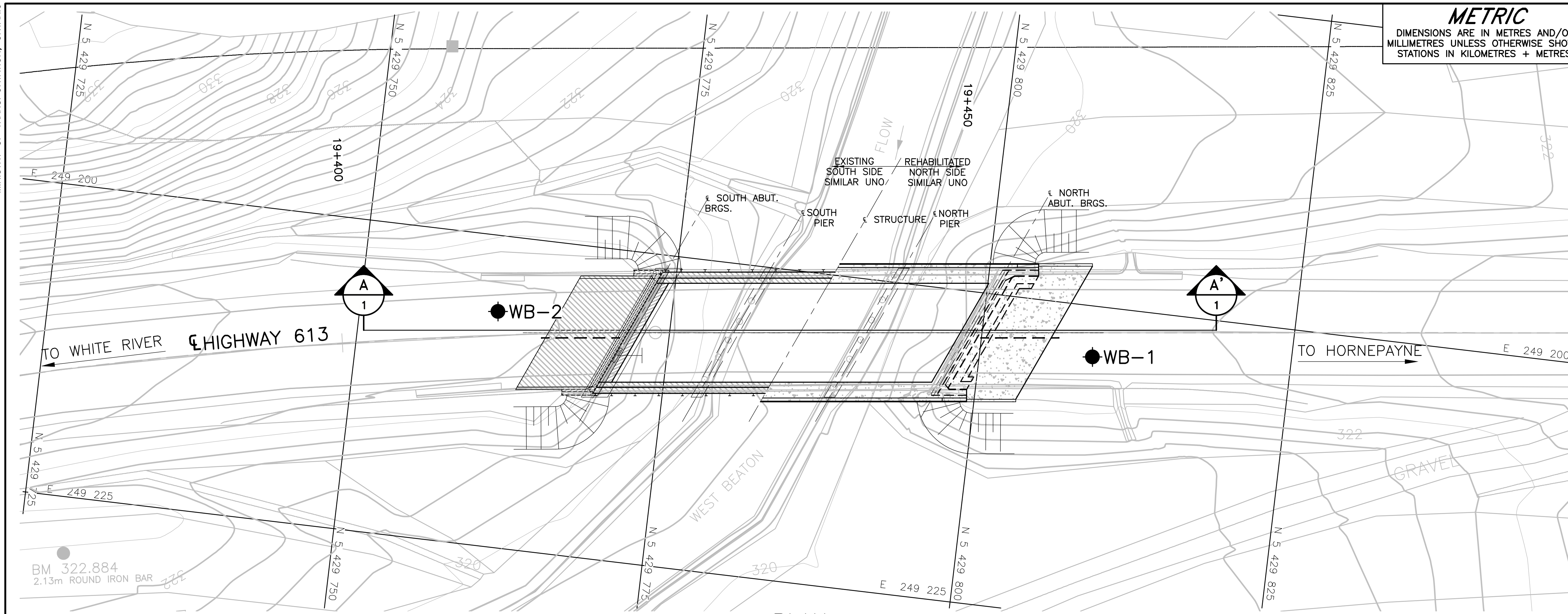
SHEET

HWY 631

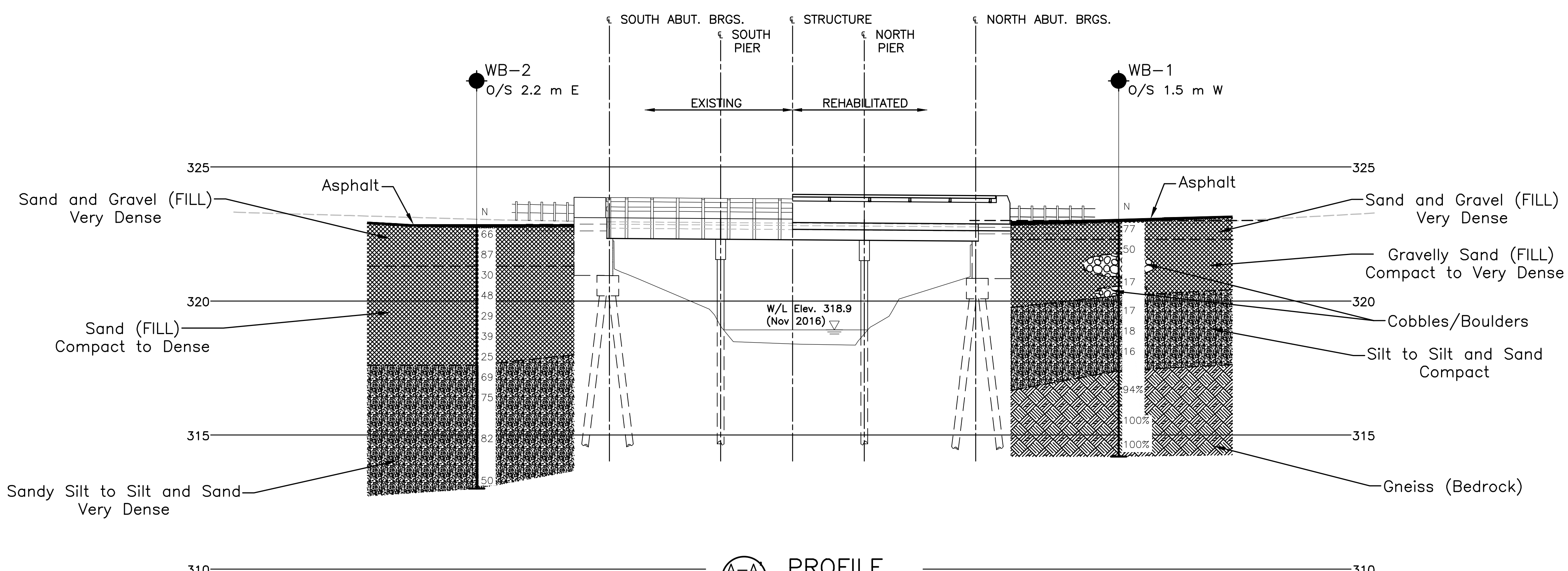
WEST BEATON RIVER BRIDGE
LAT. 49.003801, LONG. −84.759927

BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER

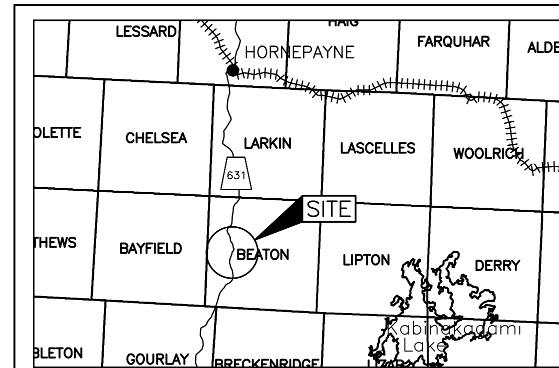


PLAN
SCALE
4 0 4 8 m



A-A
1
PROFILE

HORIZONTAL SCALE
4 0 4 8 m
2 0 2 4 m
VERTICAL SCALE



KEY PLAN
SCALE
10 0 10 20 km

LEGEND

●	Borehole – Current Investigation
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
100%	Rock Quality Designation (RQD)
▽	WL upon completion of drilling

BOREHOLE CO-ORDINATES (NAD83 MTM ZONE 13)

No.	ELEVATION	NORTHING	EASTING
WB-1	322.8	5429809.1	249204.1
WB-2	323.0	5429761.1	249206.1

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by LEA Consulting LTD., drawing file nos. 17197-West Beaton GA-S1.dwg, received OCT 16, 2017. General arrangement plan file no. 17197-West Beaton-R01-General Arrangement.dwg, received APR 04, 2018.

LICENSED PROFESSIONAL ENGINEER A.J.K. BOM 100075715 APR 04, 2018 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A. COSTA APR 04, 2018 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 42F-52

HWY. 631		PROJECT NO. 1661607	DIST.
SUBM'D. TB	CHKD.	DATE: 4/4/2018	SITE: 38N-008
DRAWN: TB	CHKD. AB	APPD. JMAC	DWG. 1

Photograph 1: West Beaton River Bridge
North Approach Looking South (August 2017)

Photograph 2: West Beaton River Bridge
North Approach Looking North (August 2017)

APPENDIX A

Record of Boreholes

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index $= (w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes:
1. $\tau = c' + \sigma' \tan \phi'$
2. shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60º cone attached to “A” size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Density Index **Relative Density**	**N** **Blows/300 mm or Blows/ft**
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils
Consistency

	c_u, s_u **kPa**	c_u, s_u **psf**
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	**Modifier**	**Example**
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or	Sand and Gravel
	With (cohesive)	Silty Clay with sand / Clayey Silt with sand

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index
A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^o angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

Golder Associates

RECORD OF BOREHOLE No WB-1

 METRIC

PROJECT 1661607
W.P. 5569-09-01
LOCATION N 5429809.1; E 249204.1 MTM ZONE 13 (LAT. 49.004012; LONG. -84.759939)
ORIGINATED BY MR
DIST ____ HWY 631
BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring
COMPILED BY TB
DATUM GEODETIC
DATE August 19, 2017
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.8	TOP OF ASPHALT						
0.0	ASPHALT (50 mm)						
0.1	Sand and gravel to gravelly sand (FILL) Very dense Brown Moist	1	SS	77			
322.1 / 0.7	Gravelly sand (FILL) Compact to very dense Brown Moist to wet. Cobbles and/or boulder encountered between 1.4 m and 1.9 m depth and between 2.6 m and 2.8 m depth.	2	SS	50	322	○ (plastic limit region)	22 70 (8)
		-	RC	-	321		
		3	SS	17			
		-	RC	-			
320.0 / 2.8	SILT, trace sand, trace gravel Compact Grey Wet	4	SS	17	320		
		5	SS	18	319	○	0 5 88 7
318.2 / 4.6	SILT and SAND, trace gravel Compact Grey Wet	6	SS	16	318		
317.2 / 5.6	GNEISS (BEDROCK). Bedrock cored from 5.6 m depth to 8.8 m depth. For coring details see Record of Drillhole WB-1.	1	RC	REC 100%	317		RQD = 94%
		2	RC	REC 100%	316		RQD = 100%
		3	RC	REC 100%	315		RQD = 100%
314.0 / 8.8	END OF BOREHOLE. Note: 1. Wash water level at ground surface (Elev. 323.0 m) inside casing before bedrock coring. Not representative of stabilized condition.				314		

Column headings: SOIL PROFILE (ELEV DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 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

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

RECORD OF DRILLHOLE: WB-1

PROJECT: 1661607
LOCATION: N 5429809.1; E 249204.1
MTM ZONE 13 (LAT. 49.004012; LONG. -84.759939)
INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: August 19, 2017
DRILL RIG: LF-70
DRILLING CONTRACTOR: George Downing Estate Drilling Ltd

DATUM: GEODETIC

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	DISCONTINUITY TYPE AND SURFACE DESCRIPTION	NOTES
		REFER TO PREVIOUS PAGE					
5.6–8.8	LF-70, NQ Coring (NW casing)	GNEISS Strong Medium grained, foliated Grey	317.2 5.6	1	GREY 100%	JNIRRo JNIRRo JNIRRo	UCS = 57 MPa
				2	GREY 100%	JNIRRo JNIRRo JNIRRo	
			314.0 8.8	3	GREY 100%	JNIRRo	
		END OF DRILLHOLE					

Column headings: RECOVERY (TOTAL CORE %, SOLID CORE %), R.Q.D. %, FRACT. INDEX PER 0.25 METRES, DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn), HYDRAULIC CONDUCTIVITY k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}), Diametral Point Load Index (MPa), RMC -Q' AVG.

Depth scale: 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

DEPTH SCALE
1 : 60

Golder Associates

LOGGED: MR
CHECKED: AB

Golder Associates

RECORD OF BOREHOLE No WB-2

 METRIC

PROJECT 1661607
W.P. 5569-09-01
LOCATION N 5429761.1; E 249206.1 MTM ZONE 13 (LAT. 49.00358; LONG. -84.759905)
ORIGINATED BY MR
DIST
HWY 631
BOREHOLE TYPE NW Casing and Wash Boring
COMPILED BY TB
DATUM GEODETIC
DATE August 20, 2017
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	GR	SA	SI	CL
323.0	TOP OF ASPHALT									
0.0	ASPHALT (50 mm)									
0.1	Sand and gravel (FILL) Very dense Brown Moist	1	SS	66						
		2	SS	87	322					
321.5 1.5	Sand, trace silt, trace gravel (FILL) Compact to dense Brown Moist to wet	3	SS	30		○	1	91	(8)	
					321					
		4	SS	48						
					320					
		5	SS	29						
		6	SS	39	319					
		7	SS	25	318					
317.8 5.2	Sandy SILT to SILT and SAND, trace gravel Very dense Grey Wet	8	SS	69		○	1	24	70	5
					317					
		9	SS	75						
					316					
		10	SS	82	315	○	2	34	60	4
					314					
		11	SS	50						
313.2 9.8	END OF BOREHOLE									

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED; 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 (%)

Note:

1. Wash water level at ground surface (Elev. 322.8 m) inside casing before bedrock coring. Not representative of stabilized condition.

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

APPENDIX B

Laboratory Test Results

Golder Associates Ltd.
33 Mackenzie Street, Suite 100
Sudbury, Ontario, Canada P3C 4Y1
Telephone: (705) 524-6861
Fax: (705) 524-1984

TABLE B1 - SUMMARY OF ROCK CORE TEST DATA

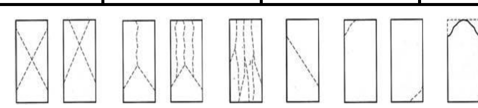
PROJECT NO.: 1661607

JOB NAME: West Beaton River Bridge

TYPE OF UNIT: Bedrock Core

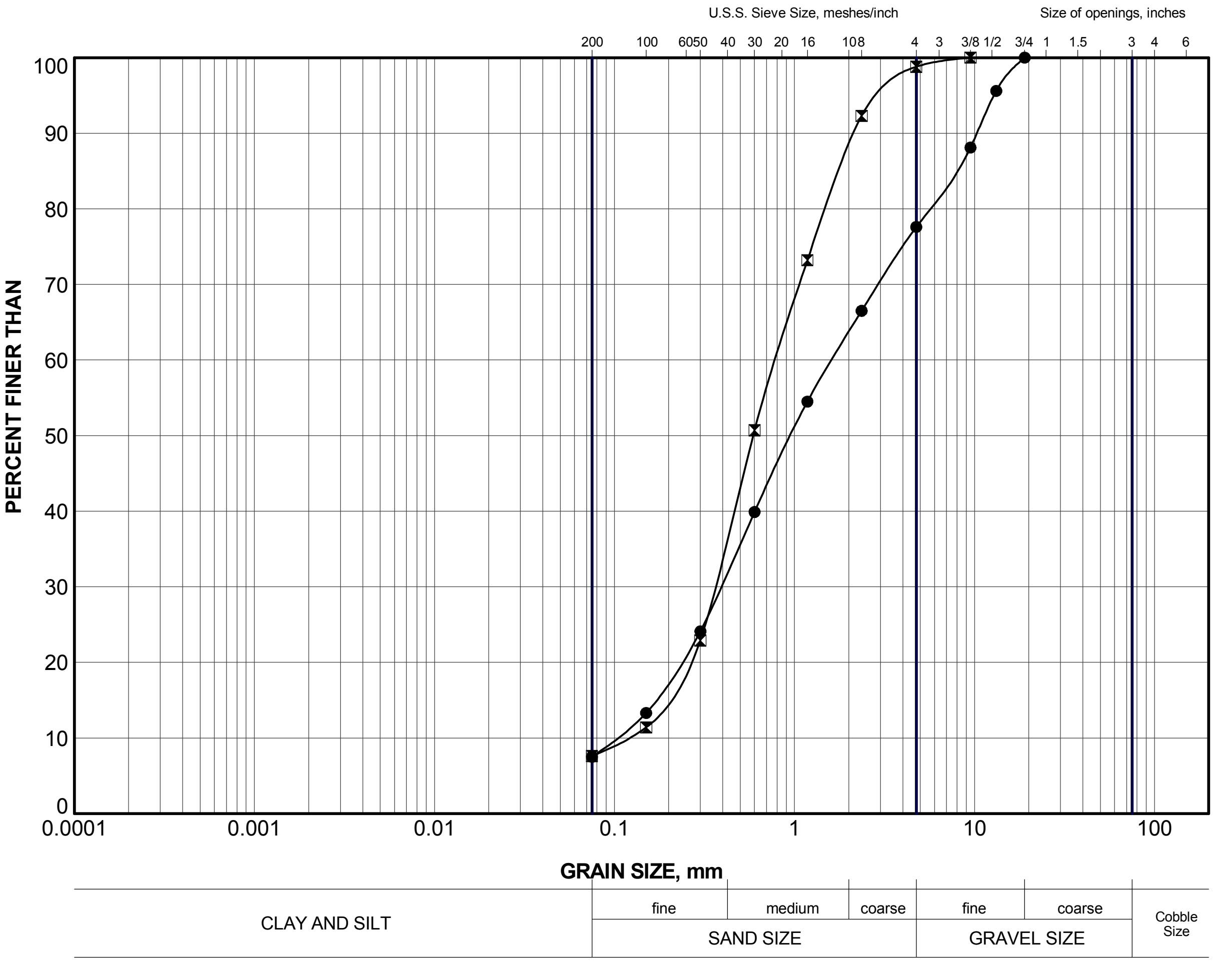
BOREHOLE	WB-1					
GOLDER LAB #	C1535					
DATE TESTED	Sept. 19, 2017					
TESTED BY	JP					
DEPTH OF TESTED CORE (m)	6.6					
LENGTH (mm)	100.2					
DIAMETER (mm)	47.0					
DENSITY (kg/m3)	2704					
COMPRESSIVE STRENGTH (MPa)	56.9					
TYPE OF FRACTURE	3					

Type of Fracture



1 2 3 4 5 6

Checked by : AB



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	WB-1	2	321.7
⧗	WB-2	3	321.2

PROJECT

HIGHWAY 631
WEST BEATON RIVER BRIDGE

TITLE

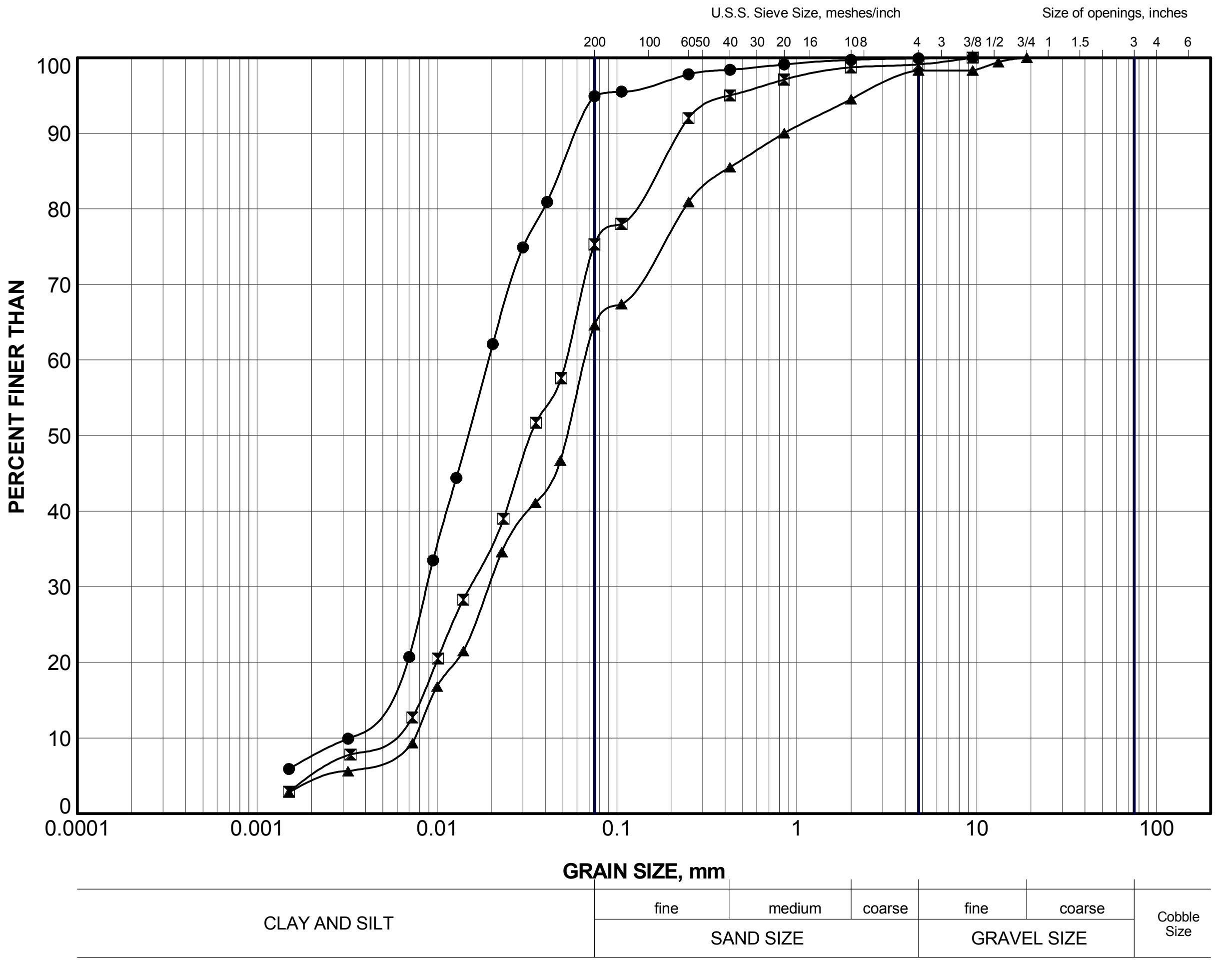
GRAIN SIZE DISTRIBUTION

SAND (FILL); and SAND and GRAVEL (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.		1661607	FILE No.	1661607.GPJ
DRAWN	TB	Oct 2017	SCALE N/A	REV.
CHECK	AB	Oct 2017		
APPR	JMAC	Oct 2017	FIGURE B1	

SUD-MTO GSD (2016) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	WB-1	5	318.7
⧗	WB-2	8	317.4
▲	WB-2	10	315.1

PROJECT

HIGHWAY 631
WEST BEATON RIVER BRIDGE

TITLE

GRAIN SIZE DISTRIBUTION

SILT to SILT and SAND

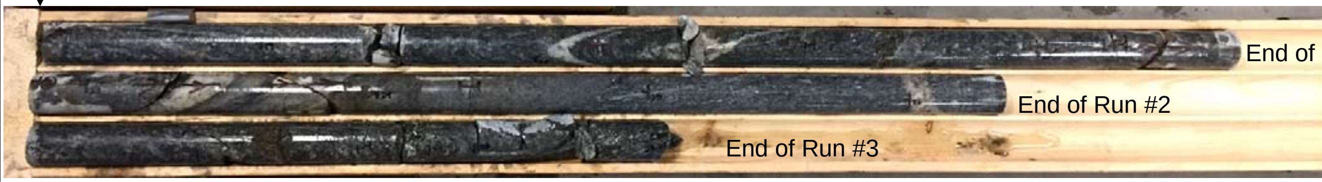
Golder Associates
SUDBURY, ONTARIO

PROJECT No.		1661607	FILE No.	1661607.GPJ
DRAWN	TB	Oct 2017	SCALE N/A	REV.
CHECK	AB	Oct 2017	FIGURE B2	
APPR	JMAC	Oct 2017		

SUD-MTO GSD (2016) GLDR_LDN.GDT

Borehole WB-1

TOR (5.6 m)



Box 1: 5.6 m – 8.8 m

0 m 0.25 m 0.5 m 0.75 m 1.0 m 1.25 m 1.5 m

0 ft 1 ft 2 ft 3 ft 4 ft 5 ft

Scale

PROJECT

Highway 631
West Beaton River Bridge

TITLE

Bedrock Core Photograph

Golder Associates

PROJECT No.	1661607-R05		FILE No.	----	
DESIGN	TB	OCT 17	SCALE	NTS	REV.
CADD	-- --		**FIGURE B3**		
CHECK	AB	OCT 17			
REVIEW	JMAC	OCT 17			

REVISION DATE: Oct, 2017 BY: AB Project: 1661607-R05

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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