



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
NAMAKAN RIVER DETOUR BRIDGE
FLANDERS ROAD
RAINY RIVER DISTRICT, ONTARIO
LATITUDE: 48.4469°, LONGITUDE: -92.3909°**

G.W.P. 6853-14-00, SITE No. 45X-0265/B0

GEOCRES Number: 52C-60

Report

to

Hatch

Date: February 26, 2019
File: 23476



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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 Namakan River Detour Bridge, as part of the replacement of the Namakan River Bailey Bridge on Flanders Road, located in Rainy River District, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the proposed detour bridge location 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-0022-004.

A previous investigation for replacement of the existing bailey bridge was conducted by Thurber, and is described in the following report:

- Preliminary Foundation Investigation and Design Report, Namakan River Bailey Bridge Replacement, Flanders Road, District of Rainy River, Ontario, GEOCRES Number 52C-57, prepared by Thurber Engineering Ltd., Date: May 1, 2018, File: 18356.

The borehole logs from the previous investigation are included in this report for reference.



2. SITE DESCRIPTION

The site is located on Flanders Road, approximately 50 km southwest of the Highway 11 and Flanders Road junction, in the Rainy River District, Ontario. Two existing bridges separated by an island carry Flanders Road over the Namakan River at this location; a Bailey Bridge crossing the north channel of the river and an Acrow Bridge crossing the south channel. The distance between the bridge abutments on the island is approximately 30 m. Namakan River flows in an east to west direction towards Namakan Lake approximately 40 km west of the site. Flanders Road generally runs in a north to south direction at the site.

The Ontario Structure Inspection Manual (Inspection Form) prepared by MTO on November 2, 2015 indicates that the existing bailey bridge structure is a three-span steel bailey panel bridge built in 1980. The inspection report indicates that the bridge deck is 45.7 m long and 4.3 m wide with an overall width of 6 m. The timber bridge deck is supported on rock-filled timber crib abutments. Additional support is provided by two timber crib piers situated in the river. The existing bridge deck has an approximate elevation of 345.1 m. Beneath the bridge, the water level of the Namakan River in November 2015 was measured at Elevation 340.44 m.

The lands surrounding the bridge site predominantly consist of heavily forested areas with lakes, swamps, rivers, and creeks. Local topography consists of knobby terrain with moderate relief. 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 sandy till and peat subsurface soils overlying shallow bedrock with a knobby profile. Based on local geological maps, the bedrock in the area is identified as metasedimentary wacke and siltstone.

3. INVESTIGATION PROCEDURES

The current investigation and field testing program for the detour bridge project was carried out between October 12 and October 17, 2018 and consisted of drilling and sampling twelve (12) boreholes, designated as Boreholes 18-01 to 18-12, to depths ranging from approximately 1.7 m to 7.1 m (Elevation 337.3 to 342.5). Boreholes 18-01 to 18-05 were drilled near the footprint of the proposed south abutment of the detour bridge, east of the existing bailey bridge south abutment, and Boreholes 18-06 to 18-10 were drilled near the footprint of the proposed north abutment of the detour bridge, east of the existing bailey bridge north abutment. Boreholes 18-11 and 18-12 were drilled near the proposed approach embankment and crane pad locations on the south and north side of the detour bridge respectively.



The Record of Borehole sheets are included in Appendix A. The approximate locations of the boreholes from the investigation are shown on the Borehole Locations and Soil Strata Drawings included in Appendix D. Boreholes 17-01 and 17-02 from the previous investigation at the existing bailey bridge are also included in Appendix A and shown on the drawings in Appendix D for reference.

Utility clearances were obtained prior to the start of drilling. The proposed borehole locations were surveyed and staked on site by Hatch. The horizontal coordinates and ground surface elevations for the boreholes were based on the surveyed data provided by Hatch, field measurements with respect to the staked locations, and cross sections and topographic drawings provided by Hatch. The coordinate system MTM NAD 83, Zone 16 was used for the boreholes.

A portable Hilti drill was used to advance Boreholes 18-01 to 18-12 using BW casing. Soil samples were obtained in the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). NQ coring methods were used to advance the borehole 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 cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions were observed in the open boreholes throughout the drilling operations and in the open boreholes upon completion of drilling. The boreholes were backfilled in general accordance with Ontario Regulation 903, as amended.

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
18-01	7.1 / 337.8	Cement and sand slurry to surface
18-02	3.9 / 338.7	Cement and sand slurry to surface
18-03	3.7 / 339.0	Bentonite holeplug to surface



Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
18-04	5.2 / 337.6	Bentonite holeplug to surface
18-05	5.1 / 337.3	Bentonite holeplug and cement to surface
18-06	4.5 / 339.3	Bentonite holeplug to surface
18-07	5.2 / 339.3	Bentonite holeplug to surface
18-08	4.1 / 339.0	Bentonite holeplug to surface
18-09	4.1 / 337.8	Bentonite holeplug to surface
18-10	3.7 / 339.0	Bentonite holeplug to surface
18-11	1.7 / 340.8	Cement to surface
18-12	2.7 / 342.5	Bentonite holeplug 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). Selected bedrock core specimens were also subjected to point load strength index testing. 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.

5. DESCRIPTION OF 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 stratigraphic conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered in the boreholes consisted of a surficial layer of sandy topsoil underlain by a thin layer of cobbles and boulders, and shallow greywacke bedrock on the north side of the detour bridge, and a thin topsoil layer underlain by bedrock at shallow depth on the south side of the detour bridge. At the boreholes near the existing bailey bridge foundations, surficial gravelly sand embankment fill was also encountered. Descriptions of the individual strata are presented below.



5.1 Gravelly Sand Fill to Sand Fill

Gravelly sand fill to sand fill with some gravel, containing some silt, trace clay and trace organics, was encountered at the ground surface in Boreholes 18-01, 18-02, 18-06, 18-07, and 18-11. The top 600 mm of the fill in Borehole 18-07 was mixed with topsoil. The fill extended to depths of between 0.4 m and 2.4 m (Elevation 341.9 m to 343.1 m).

SPT 'N' values in the fill ranged from 5 to 31 blows for 0.3 m penetration, indicating a loose to dense relative density. The measured moisture content in the fill ranged from 3 to 71 percent, with the higher moisture content due to the presence of organics in the fill.

The results of grain size analyses conducted on samples of the gravelly sand fill from Boreholes 18-01 and 18-02 are illustrated in Figure B1 of Appendix B. Results of the grain size analysis for the sand fill found in Borehole 18-11 are illustrated in Figure B2 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage
Gravel	13 to 28
Sand	59 to 69
Silt & Clay	13 to 18

5.2 Topsoil

A topsoil layer containing some sand to sandy and some gravel to gravelly, as well as trace to some silt was encountered at the ground surface in Boreholes 18-03, BH18-04, 18-08 to 18-10 and 18-12. The topsoil ranged in thickness from 50 to 600 mm, with base Elevations ranging from 341.9 m to 344.6 m.

SPT 'N' values in the topsoil ranged from 2 to 3 blows for 0.3 m penetration, indicating a very loose relative density. The measured moisture content in the topsoil ranged from 20 to 145 percent.

5.3 Silty Sand

A silty sand layer containing some gravel and trace clay was encountered below the topsoil in Borehole 18-12 at a depth of 0.6 m. The silty sand was 0.5 m thick and extended to a depth of 1.1 m (Elevation 344.1 m).



An SPT 'N' value of 7 blows for 0.3 m penetration was measured in the sand, indicating a loose relative density. The measured moisture content in the silty sand layer was 10 percent.

The results of a grain size analysis conducted on a sample of the silty sand is illustrated in Figure B3 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage
Gravel	12
Sand	56
Silt & Clay	32

5.4 Cobbles and Boulders

A deposit of cobbles and boulders was encountered overlying the bedrock in Boreholes 18-01, 18-06, 18-07, 18-09, 18-10 and 18-12. The deposit at Borehole 18-06 also contained some organics, trace sand and trace gravel. The cobbles and boulders deposit ranged in thickness from 0.1 to 1.0 m and extended to depths from 0.4 to 3.4 m (Elevation 341.2 to 343.7 m).

5.5 Bedrock

The overburden soils described above are underlain by greywacke bedrock. The bedrock was grey and is generally described as slightly to moderately weathered. Bedrock was proved by coring in all boreholes. The bedrock surface is sloping, particularly at the north abutment, and dips gradually from the north abutment to the south abutment. Table 5.1 summarizes the depths and elevations to the top of bedrock. Photographs of the rock cores are included in Appendix B.

Table 5.1 - Depths and Elevations of Top of Bedrock

Borehole	Location	Top of Bedrock	
		Depth (m)	Elevation (m)
18-01	South Abutment	3.4	341.6
18-02	South Abutment	0.7	341.9
18-03	South Abutment	0.2	342.5
18-04	South Abutment	0.2	342.5
18-05	South Abutment	0.0	342.3
18-06	North Abutment	1.0	342.8
18-07	North Abutment	2.1	342.4
18-08	North Abutment	0.4	342.7
18-09	North Abutment	0.7	341.2
18-10	North Abutment	0.4	342.3
18-11	South Approach	0.4	342.1
18-12	North Approach	1.5	343.7

Total Core Recovery (TCR) in the bedrock ranged from 67 to 100% (typically 100%) and Solid Core Recovery (SCR) ranged between 0% and 98%. The Rock Quality Designation (RQD) determined from the recovered cores ranged between 0% and 98%, which indicates a poor to excellent rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to >10.

Average unconfined compressive strengths (UCS) of the rock ranged between 26 and 198 MPa, indicating the rock is medium to very strong, but typically between 60 and 198 MPa (strong to very strong). These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. A summary of the point load tests results presented in Appendix B.

5.6 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. A summary of the water level measurements is provided in Table 5.2 below:



Table 5.2 - Groundwater Measurements

Borehole	Date	Water Level (m)	
		Depth	Elevation
18-02	October 17, 2018	1.6	341.0
18-04	October 15, 2018	1.1	341.6
18-05	October 16, 2018	1.9	340.4
18-06	October 14, 2018	1.6	342.2
18-07	October 14, 2018	1.8	342.6
18-08	October 12, 2018	0.4	342.7
18-09	October 12, 2018	1.4	340.5
18-11	October 17, 2018	0.2	342.3
18-12	October 14, 2018	1.6	343.6

The water level measured in the boreholes may reflect the presence of water added to the boreholes for rock coring operations.

The groundwater level should be assumed to reflect the local river water level. The water level of Namakan River at the proposed bridge was measured at Elevation 340.44 m in November 2015, as shown on drawings provided by Hatch.

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. MISCELLANEOUS

OGS Drilling of Almonte, 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. Liam Steers, EIT 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. Liam Steers, EIT and 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.

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Appendix A

Record of Borehole Sheets (Current and Previous Investigation)

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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


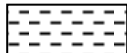



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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

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

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				
<u>TERMS</u>		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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.				

RECORD OF BOREHOLE No 18-01

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 712.2 E 349 827.7 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.17 - 2018.10.17 LATITUDE 48.446446 LONGITUDE -92.391285 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m 3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
344.9	GROUND SURFACE							20	40	60	80	100		
0.0	Gravelly SAND , some silt, trace clay, occasional organics, trace to some cobbles Loose to Compact Brown Moist (FILL)		1	SS	5									
			2	SS	16									
			3	SS	13									
			4	SS	10									
342.5														
2.4	COBBLES and BOULDERS													
341.6														
3.4	BEDROCK (GREYWACKE) , slightly weathered, medium to very strong, grey sub horizontal fracture (25mm) at 3.4m and (50mm) at 3.5m horizontal fracture at 3.4m sub horizontal fracture (50mm) at 3.7m sub horizontal fracture (25mm) at 3.8m, (50mm) at 4.0m and (100mm) at 4.1m sub horizontal fracture (25mm) at 4.5m, (50mm) at 4.7, (75mm) at 5.1m and (25mm) at 5.3m sub horizontal fracture (25mm) at 5.4m, (50mm) at 5.4m, 5.6m, 5.8m, 5.9m sub horizontal fracture (25mm) at 5.9m, 6.0m, 6.2m, (100mm) at 6.4m, (25mm) at 6.8m, 6.9m		1	RUN										
			2	RUN										
			3	RUN										
			4	RUN										
			5	RUN										
			6	RUN										
337.8														
7.1	END OF BOREHOLE AT 7.1m. BOREHOLE OPEN UPON COMPLETION. BOREHOLE BACKFILLED WITH CEMENT AND SAND SLURRY TO SURFACE.													

ONTMT452 23476.GPJ 2017TEMPLATE(MTO).GDT 1/16/19

RECORD OF BOREHOLE No 18-02

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 715.4 E 349 830.2 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.16 - 2018.10.17 LATITUDE 48.446474 LONGITUDE -92.391250 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-03

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 711.2 E 349 832.3 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.15 - 2018.10.16 LATITUDE 48.446436 LONGITUDE -92.391222 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								20 40 60 80 100				w _p w w _L				
342.7	GROUND SURFACE															
0.0	TOPSOIL, some silt, trace roots Brown Moist		1	SS	3/										FI	
0.2	BEDROCK (GREYWACKE) , moderately to slightly weathered, medium to very strong, grey rubble zone from 0.2m to 0.6m sub horizontal fracture (50mm) at 0.7m, (75mm) at 0.7m, (150mm) at 0.9m and (50mm) at 1.1m sub horizontal fracture (50mm) at 1.6m, 1.7m, 1.9m, 2.1m and 2.4m, horizontal fracture at 2.1m sub horizontal fracture (50mm) at 2.5m, 2.7m, (75mm) at 3.5m and (50mm) at 3.6m		1	RUN	0.025										>10	
			2	RUN												2
			3	RUN												2
			4	RUN												2
339.0															1	
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.															

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-04

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 709.9 E 349 834.9 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.15 - 2018.10.15 LATITUDE 48.446425 LONGITUDE -92.391187 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
342.7	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL , some sand, some gravel, trace roots Brown Moist BEDROCK (GREYWACKE) , moderately to slightly weathered, medium to very strong, grey sub horizontal fracture (75mm) at 0.2m rubble zone (75mm) at 0.4m and (50mm) at 0.7m sub horizontal fracture (25mm) at 0.6m and (50mm) at 0.6m rubble zone (175mm) at 0.7m sub horizontal fracture at (50mm) at 0.9m rubble zone (75mm) at 1.0m, 1.2m sub horizontal fracture (75mm) at 1.0m, (25mm) at 1.2m, 1.4m, 1.6m horizontal fracture at 1.4m sub horizontal fracture (25mm) at 2.0m, 2.1m, 2.4m and 2.6m sub horizontal fracture (25mm) at 2.8m, at3.4m, 3.5m, (25mm) at 3.7m horizontal fracture at 3.1m		1	GS										
0.2			1	RUN										
			2	RUN										
			3	RUN										
			4	RUN										
			5	RUN										
			6	RUN										
			7	RUN										
			8	RUN										
337.6	sub horizontal fracture (50mm) at 5.1m													
5.2	END OF BOREHOLE AT 5.2m. WATER LEVEL AT 1.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-05

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 711.7 E 349 835.7 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.16 - 2018.10.16 LATITUDE 48.446441 LONGITUDE -92.391177 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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0.0	BEDROCK (GREYWACKE) , moderately to slightly weathered, very strong, grey rubble zone (75mm) at 0.0m rubble zone (300mm) at 0.2m vertical fracture (125mm) at 0.5m sub horizontal fracture (25mm) at 0.6m, (75mm) at 0.6m, (25mm) at 0.8m, (75mm) at 0.8m, (25mm) at 0.9m, 1.0m and (50mm) at 1.1m rubble zone (100mm) at 1.2m sub horizontal fracture (75mm) at 1.8m, (25mm) at 2.1m, (50mm) at 2.1m, (75mm) at 2.3m sub horizontal fracture (50mm) at 2.4m, (25mm) at 2.6m, (75mm) at 2.6m, (25mm) at 2.8m, 3.0m and (75mm) at 3.2m horizontal fracture at 3.1m sub horizontal fracture (25mm) at 3.5m, 3.6m, (75mm) at 3.8m and (25mm) at 4.0m		1	RUN			342																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							

+³, ×³: Numbers refer to
Sensitivity

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(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 18-07

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 758.2 E 349 852.0 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.12 - 2018.10.14 LATITUDE 48.446858 LONGITUDE -92.390951 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)							
								20 40 60 80 100							20 40 60							
344.4	GROUND SURFACE																					
0.0	Gravelly SAND , mixed with topsoil, trace silt		1	SS	6		344															
343.8	Loose Brown Moist (FILL)		2	SS	7																	
0.6	Gravelly SAND , trace silt, trace organics, occasional cobbles		3	SS	31																	
342.8	Loose to Dense Brown Moist (FILL)																					
1.7	COBBLES and BOULDERS																					
342.4																						
2.1	BEDROCK (GREYWACKE) , slightly weathered, strong to very strong, grey sub horizontal fracture (50mm) at 2.3m, (25m) at 2.3m, (50mm) at 2.4m, 2.5m, (75mm) at 2.5m, 2.6m, (25mm) at 2.7m, 2.8m, 2.9m, 3.0m	1	RUN																			
	sub horizontal fracture (25mm) at 3.0m, (50mm) at 3.2m, (25mm) at 3.7m, (50mm) at 3.8m, (25mm) at 4.0m and (50mm) at 4.0m	2	RUN																			
	horizontal fracture at 4.2m sub horizontal fracture (50mm) at 4.3m, (75mm) at 4.4m, (25mm) at 4.5m, 4.6m	3	RUN																			
339.3																						
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN AND WATER LEVEL AT 1.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CEMENT TO SURFACE.																					

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

RECORD OF BOREHOLE No 18-08

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 756.9 E 349 853.9 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.12 - 2018.10.12 LATITUDE 48.446846 LONGITUDE -92.390926 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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343.1	GROUND SURFACE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0.0	TOPSOIL , sandy, some gravel, trace silt Very Loose Brown Moist BEDROCK (GREYWACKE) , slightly weathered, medium to very strong, grey sub horizontal fracture (50mm) at 0.5m and (25mm) at 0.6m sub horizontal fracture (75mm) at 0.7m, (50mm) at 0.9m, (25mm) at 1.1m, (50mm) at 1.6m, (25mm) at 1.7m, 1.8m horizontal fracture at 1.3m sub horizontal fracture (25mm) at 1.8m, (50mm) at 2.0m, (25mm) at 2.4m, 2.8m sub horizontal fracture (50mm) at 3.1m, (25mm) at 3.5m, (50mm) at 3.8m and (75mm) at 4.0m		1	SS	3	∇	343																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				

RECORD OF BOREHOLE No 18-09

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 753.2 E 349 855.8 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.12 - 2018.10.12 LATITUDE 48.446812 LONGITUDE -92.390900 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20 40 60 80 100								
341.9	GROUND SURFACE															
0.0	TOPSOIL: (50mm), sandy, some gravel, trace silt Brown Moist			SS	50/											
0.0				0.050												
341.2	COBBLES and BOULDERS															
0.7	BEDROCK (GREYWACKE), slightly weathered, vey strong, grey sub horizontal fracture (25mm) at 0.8m, 0.9m, 1.1m and (50mm) at 1.3m sub horizontal fracture (25mm) at 1.3m, 1.5m, (50mm) at 1.6m, 1.7m, (25mm) at 1.9m, 2.0m and (50mm) at 2.2m horizontal fracture at 2.1m sub horizontal fracture (50mm) at 2.3m, 2.5m, 2.6m, 2.7m, (25mm) at 2.9m, 3.0m horizontal fracture at 3.3m sub horizontal fracture (25mm) at 3.5m, 3.7m, 4.0m, 4.1m		1	RUN												
			2	RUN												
			3	RUN												
			4	RUN												
337.8																
4.1	END OF BOREHOLE AT 4.1m. BOREHOLE OPEN AND WATER LEVEL AT 1.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-10

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 755.6 E 349 856.7 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.13 - 2018.10.13 LATITUDE 48.446834 LONGITUDE -92.390888 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
342.7	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL, sandy, some gravel, trace silt		1	SS	50/									
342.4	Brown Moist				0.175									
342.3														
0.4	COBBLES and BOULDERS		1	RUN			342							
	BEDROCK (GREYWACKE), slightly weathered, medium to very strong, grey		2	RUN										
	sub horizontal fracture (25mm) at 0.5m, 0.7m, 0.9m, 1.0m and 1.1m													
	horizontal fracture at 1.0m													
	horizontal fracture at 1.2m and 1.4m		3	RUN			341							
	sub horizontal fracture (75mm) at 1.5m													
	horizontal fracture at 1.6m, 1.8m and 1.9m													
	sub horizontal fracture (25mm) at 1.7m, 2.1m, 2.2m		4	RUN										
	sub horizontal fracture (50mm) at 2.6m, (25mm) at 2.9m						340							
	horizontal fracture at 3.3m		5	RUN										
339.0	sub horizontal fracture (25mm) at 3.6m, 3.7m						339							
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													
										</				

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

RECORD OF BOREHOLE No 18-11

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 704.9 E 349 829.2 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.17 - 2018.10.17 LATITUDE 48.446380 LONGITUDE -92.391265 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
342.5	GROUND SURFACE							20	40	60	80	100						
0.0	SAND , some gravel, some silt, trace clay, trace organics		1	SS	50/ 0.250		342										FI	13 69 18 (SI+CL)
342.1	Brown Moist (FILL)																	2
0.4	BEDROCK (GREYWACKE) , slightly weathered, strong, grey sub horizontal fracture (75mm) at 0.5m, (25mm) at 0.6m, 0.7m, 0.8m, (50mm) at 0.9m and (25mm) at 1.3m horizontal fracture at 1.3m, 1.4m and 1.5m		1	RUN													3	RUN #2 TCR=100% SCR=38% RQD=0% UCS=61.2MPa (Average)
340.8	rubble zone (150mm) at 1.5m		2	RUN			341										>10	
1.7	END OF BOREHOLE AT 1.7m. WATER LEVEL AT 0.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH CEMENT TO SURFACE.																	

RECORD OF BOREHOLE No 18-12

1 OF 1

METRIC

GWP# 6853-14-00 LOCATION Namakan River Detour Bridge, MTM NAD83 Zone 16: N 5 367 764.3 E 349 858.4 ORIGINATED BY LS
 DIST Rainy River HWY Flanders Road BOREHOLE TYPE BW Casing/NQ Coring COMPILED BY MP
 DATUM Geodetic DATE 2018.10.14 - 2018.10.14 LATITUDE 48.446912 LONGITUDE -92.390864 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)									
345.2	GROUND SURFACE							20	40	60	80	100					GR	SA	SI	CL	
0.0	TOPSOIL, gravelly, some sand, trace silt		1	SS	2		345										FI 1 3 1 2	12	56	32 (SI+CL)	
344.6	Very Loose Brown Moist																				
0.6	Silty SAND, some gravel, trace clay		2	SS	7		344														
344.1	Loose Brown Moist																				
343.7	COBBLES and BOULDERS		3	SS	50/																
1.5	BEDROCK (GREYWACKE), slightly weathered, strong, grey sub horizontal fracture (175mm) at 1.7m, (25mm) at 1.9m, 2.0m				0.175																
			1	RUN			343														
342.5	horizontal fracture at 2.4m, 2.5m and 2.6m																				
2.7	END OF BOREHOLE AT 2.7m. BOREHOLE OPEN AND WATER LEVEL AT 1.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																				




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

RECORD OF BOREHOLE No 17-01

1 OF 1

METRIC

W.P. 18356 LOCATION Namakan River Bridge N 5 367 714.6 E 349 823.8 ORIGINATED BY AHF
 HWY Flanders Road BOREHOLE TYPE HQ/NQ Coring, HW Casing COMPILED BY MP
 DATUM Geodetic DATE 2017.09.26 - 2017.09.26 CHECKED BY CZ

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	W _P W W _L	WATER CONTENT (%)								
							SHEAR STRENGTH kPa											
							○ UNCONFINED + FIELD VANE											
							● QUICK TRIAXIAL × LAB VANE											
345.5	GROUND SURFACE						20	40	60	80	100					GR SA SI CL		
0.0	SAND and GRAVEL , some silt, with cobbles Dense to Very Dense Brown Moist (FILL) 25 to 75mm rock fragments		1	SS	43	▽							○			35 52 13 (SI+CL)		
																		TCR=29%
			2	SS	100/ 0.075													
							CORE											
			3	SS	31										○			
			4	SS	100/ 0.100										○			TCR=100%
							CORE											
			5	SS	59										○			49 42 9 (SI+CL)
340.9					6		SS	100/ 0.075										
4.6			ROCK FRAGMENTS															
340.4																		
5.1	BEDROCK (Greywacke), slightly weathered, grey With fractures near horizontal and 60° from horizontal.		1	RUN												RUN #1 TCR=89% SCR=56% RQD=50% UCS=155MPa (average)		
			2	RUN												RUN #2 TCR=89% SCR=49% RQD=49% UCS=185MPa (average)		
337.5																		
8.0	END OF BOREHOLE AT 8.0m. WATER LEVEL IN TEMPORARY STANDPIPE AT 4.2m AFTER 4.5 HRS. BOREHOLE BACKFILLED WITH BENTONITE.																	

ONTMT4S MTO-18356.GPJ 2017TEMPLATE(MTO).GDT 2/21/19

RECORD OF BOREHOLE No 17-02

1 OF 1

METRIC

W.P. 18356 LOCATION Namakan River Bridge N 5 367 761.0 E 349 846.5 ORIGINATED BY AHF
 HWY Flanders Road BOREHOLE TYPE NQ Coring, NW Casing COMPILED BY MP
 DATUM Geodetic DATE 2017.09.26 - 2017.09.26 CHECKED BY CZ

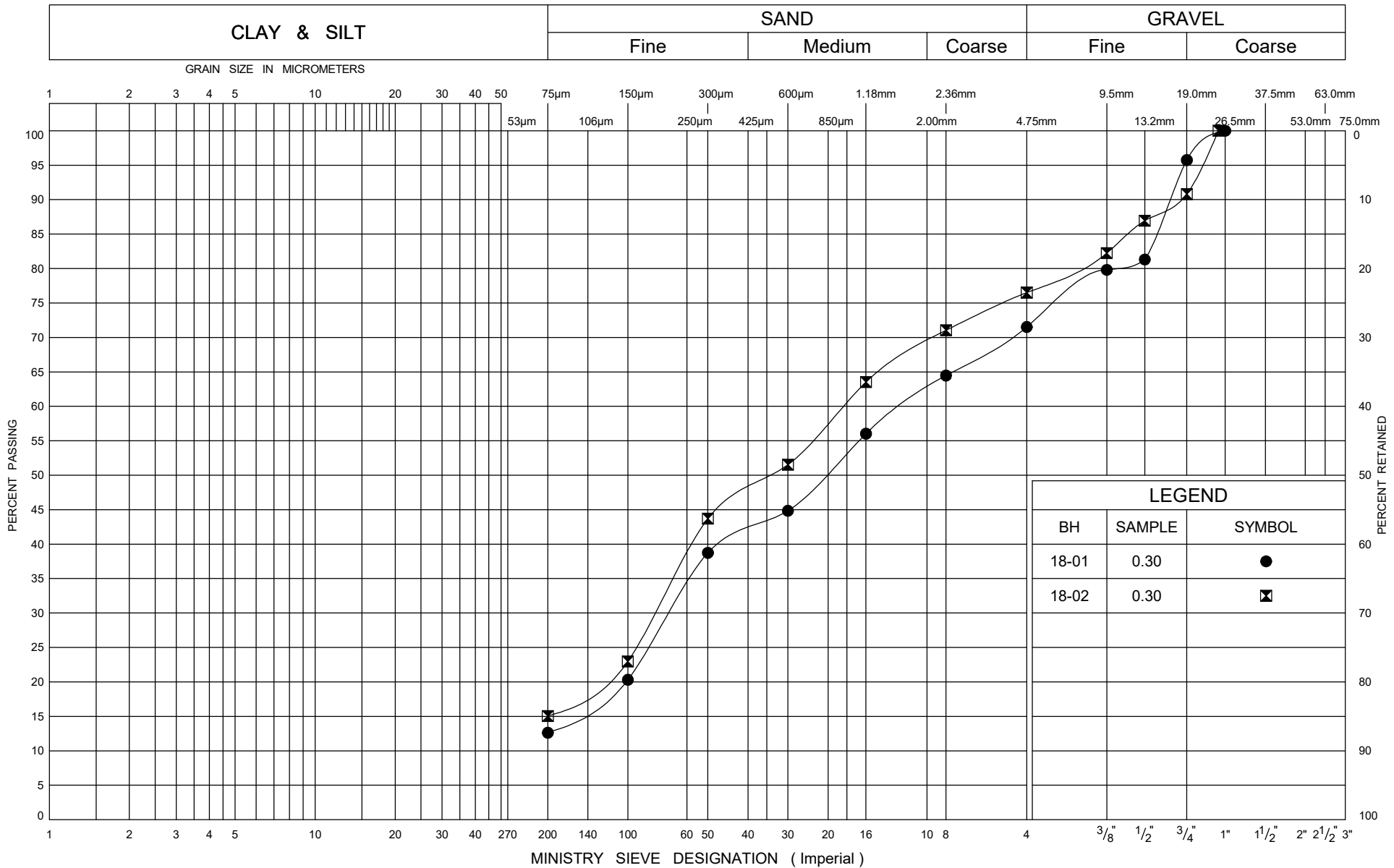
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
345.6	GROUND SURFACE																
0.0	SAND and GRAVEL , some silt, occasional cobbles Compact to Dense Brown Moist (FILL)		1	SS	37		345									48 42 10 (SI+CL)	
			2	SS	16												
			3	SS	22												
343.2			4	SS	100/												
2.4	ROCK FRAGMENTS , 5 to 75mm size				0.100		343										
342.6	BEDROCK (Greywacke), slightly weathered, grey With fractures near horizontal and 60° from horizontal.		1	RUN			342									RUN #1 TCR=100% SCR=38% RQD=8% UCS=190MPa	
			2	RUN			341									RUN #2 TCR=100% SCR=56% RQD=79% UCS=159MPa (average)	
			3	RUN			340									RUN #3 TCR=100% SCR=62% RQD=94% UCS=147MPa (average)	
339.4																	
6.2	END OF BOREHOLE AT 6.2m. WATER LEVEL AT 2.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE BOREPLUG.														2		

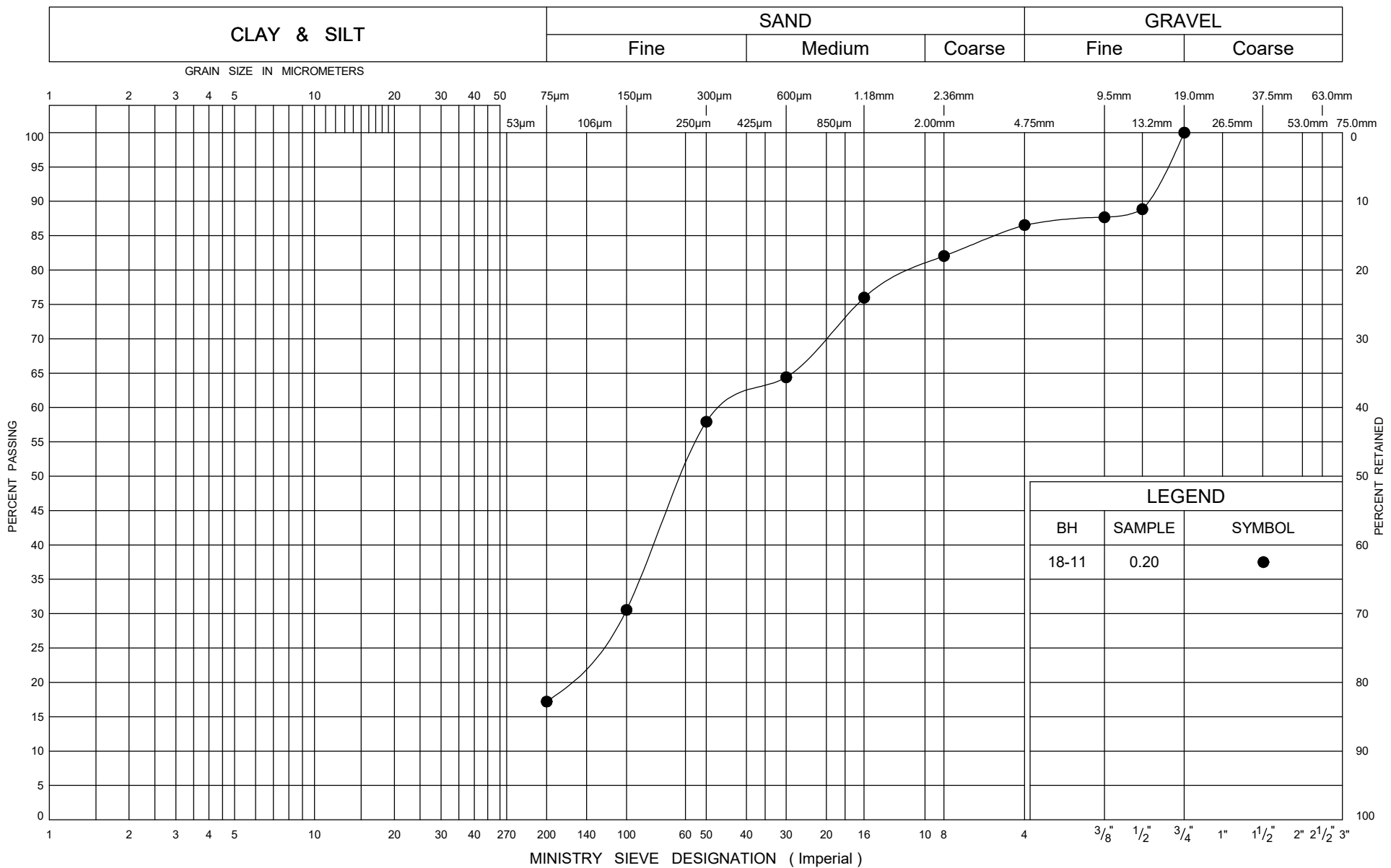
ONTMT4S MTO-18356.GPJ 2017TEMPLATE(MTO).GDT 2/21/19

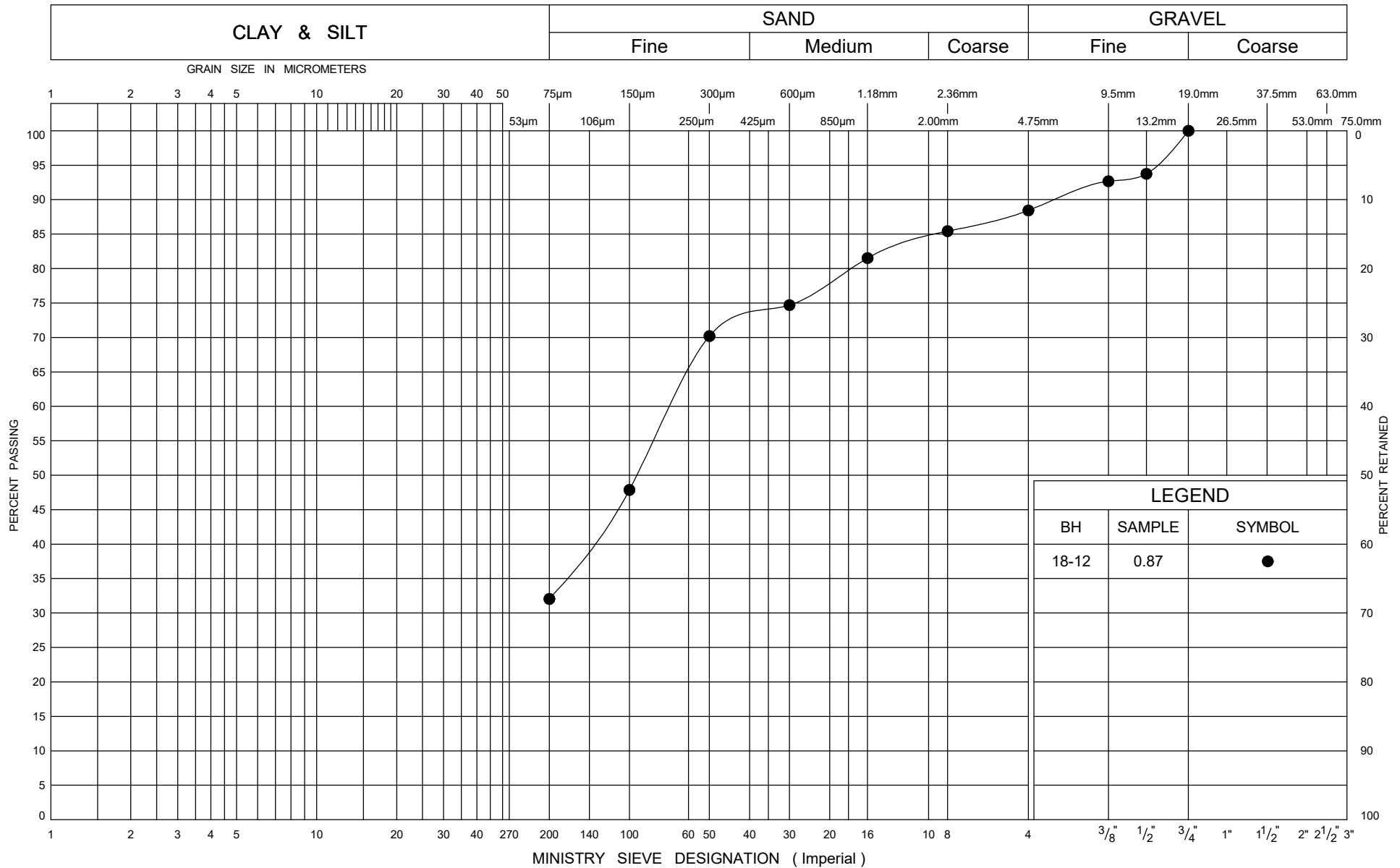


Appendix B

Geotechnical Laboratory Test Results







Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

Silty Sand, some gravel

FIG No B3

W P 6853-14-00

Namakan River Detour Bridge



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-01

Date Drilled: 18-Oct-18
 Date Tested: 05-Nov-18
 Tester: BS
 Reviewed by: LS

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	3.5	D	2.9	48.1	53.6	1.2	28.4	Greywacke	Medium Strong
2	2								Greywacke	Not Enough Sample
3	3	3.9	D	3.3	48.9	70.3	1.3	30.9	Greywacke	Medium Strong
4	4	4.2	D		49.05	68.55			Greywacke	Did Not Break
5	4	4.5	D	16.7	49.3	66.9	6.5	155.3	Greywacke	Very Strong
6	4	5.0	D	18.4	49.2	71.8	7.2	172.1	Greywacke	Very Strong
7	5	5.6	D	9.5	49.3	69.7	3.7	88.5	Greywacke	Strong
8	6	6.0	D	19.4	49.4	58.9	7.5	179.7	Greywacke	Very Strong
9	6	6.3	D	5.7	49.5	64.9	2.2	52.7	Greywacke	Strong
10	6	6.7	D	8.6	49.5	65.5	3.3	79.4	Greywacke	Strong
11	6	7.0	D	17.5	49.7	74.0	6.7	160.9	Greywacke	Very Strong
12										
13										
14										
15										
16							RUN#1 AVG=	28.4		Medium Strong
17							RUN#3 AVG=	30.9		Medium Strong
18							RUN#4 AVG=	163.7		Very Strong
19							RUN#5 AVG=	88.5		Strong
20							RUN#6 AVG=	118.2		Very Strong
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* 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 $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.

**THURBER ENGINEERING LTD.****POINT LOAD TEST SHEET****ASTM D5731-08**

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-02

Date Drilled: 17-Oct-18
 Date Tested: 06-Nov-18
 Tester: BS
 Reviewed by: LS

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	2	1.1	D	1.5	50.5	55.4	0.6	13.4	Greywacke	Weak
2	2	1.4	D	5.4	49.7	52.6	2.1	49.3	Greywacke	Medium Strong
3	3	2.0	D	3.6	50.6	53.0	1.3	32.2	Greywacke	Medium Strong
4	3	2.3	D	4.9	50.3	66.5	1.9	44.5	Greywacke	Medium Strong
5	4	2.6	D	2.2	50.3	55.7	0.8	20.0	Greywacke	Weak
6	4	3.0	D	2.5	50.5	55.4	0.9	22.8	Greywacke	Weak
7	4	3.2	D	7.6	50.5	62.0	2.9	68.4	Greywacke	Strong
8	5	3.6	D	12.7	50.9	62.1	4.7	112.5	Greywacke	Very Strong
9	7	4.1	D	22.7	50.9	63.1	8.4	201.4	Greywacke	Very Strong
10	7	4.4	D		50.5	65.2			Greywacke	Did Not Break
11	7	4.7	D	16.2	50.5	62.9	6.0	145.1	Greywacke	Very Strong
12	7	5.0	D	27.6	50.5	61.9	10.3	247.5	Greywacke	Very Strong
13										
14										
15										
16							RUN#2 AVG=	31.4		Medium Strong
17							RUN#3 AVG=	38.3		Medium Strong
18							RUN#4 AVG=	37.1		Medium Strong
19							RUN#5 AVG=	112.5		Very Strong
20							RUN#7 AVG=	198.0		Very Strong
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

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**THURBER ENGINEERING LTD.****POINT LOAD TEST SHEET****ASTM D5731-08**

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-03

Date Drilled: 16-Oct-18
 Date Tested: 05-Nov-18
 Tester: BS
 Reviewed by: LS

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								Greywacke	Broken Sample
2	2	0.9	D	4.8	50.4	65.2	1.8	43.2	Greywacke	Medium Strong
3	2	1.3	D	4.2	50.2	65.1	1.6	38.0	Greywacke	Medium Strong
4	3	1.6	D	9.0	50.0	76.8	3.4	81.9	Greywacke	Strong
5	3	2.1	D	18.8	50.2	69.3	7.1	170.5	Greywacke	Very Strong
6	4	2.8	D	14.3	50.3	78.8	5.4	129.1	Greywacke	Very Strong
7	4	3.1	D	17.8	50.3	70.0	6.7	160.9	Greywacke	Very Strong
8	4	3.6	D	16.4	50.2	60.1	6.2	148.0	Greywacke	Very Strong
9										
10										
11										
12										
13										
14										
15										
16							RUN#2 AVG=	40.6		Medium Strong
17							RUN#3 AVG=	126.2		Very Strong
18							RUN#4 AVG=	146.0		Very Strong
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

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* Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-04

Date Drilled: 15-Oct-18
 Date Tested: 07-Nov-18
 Tester: BS
 Reviewed by: LS

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	2	0.5	D	2.9	50.2	70.5	1.1	26.2	Greywacke	Broken Sample
2	5	1.3	D	18.7	40.8	65.4	9.7	233.2	Greywacke	Very Strong
3	5	1.6	D	21.2	49.0	67.9	8.3	198.9	Greywacke	Very Strong
4	5	1.9	D	16.9	49.8	74.0	6.5	154.9	Greywacke	Very Strong
5	6	2.1	D	17.5	50.0	71.9	6.6	158.8	Greywacke	Very Strong
6	6	2.4	D	15.8	49.8	61.5	6.0	144.7	Greywacke	Very Strong
7	6	2.7	D	17.4	49.3	63.0	6.7	161.5	Greywacke	Very Strong
8	7	3.1	D	25.9	49.4	63.0	10.0	240.9	Greywacke	Very Strong
9	7	3.4	D	14.3	50.2	66.1	5.4	129.9	Greywacke	Very Strong
10	7	3.7	D	18.7	50.1	59.7	7.1	169.9	Greywacke	Very Strong
11	8	4.1	D	18.3	50.1	62.6	6.9	165.8	Greywacke	Very Strong
12	8	4.4	D	22.7	50.1	67.6	8.6	206.1	Greywacke	Very Strong
13	8	4.7	D	12.2	50.2	66.1	4.6	110.9	Greywacke	Very Strong
14	8	5.1	D	16.6	50.2	60.6	6.3	150.4	Greywacke	Very Strong
15										
16							RUN#2 AVG=	26.2		Medium Strong
17							RUN#5 AVG=	195.7		Very Strong
18							RUN#6 AVG=	155.0		Very Strong
19							RUN#7 AVG=	149.9		Very Strong
20							RUN#8 AVG=	158.3		Very Strong
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* 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 $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-05

Date Drilled: 16-Oct-18
 Date Tested: 05-Nov-18
 Tester: BS
 Reviewed by: LS

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								Greywacke	Broken Sample
2	2								Greywacke	Broken Sample
3	3	1.1	D	15.2	50.2	64.0	5.7	137.1	Greywacke	Very Strong
4	4	1.5	D	14.4	50.35	63.41	5.4	129.5	Greywacke	Did Not Break
5	4	1.8	D	9.5	50.3	73.6	3.6	85.7	Greywacke	Strong
6	4	2.0	D	15.7	50.3	69.5	5.9	141.2	Greywacke	Very Strong
7	5	2.5	D		49.3	69.7			Greywacke	Did Not Break
8	5	2.9	D	28.6	50.2	74.5	10.8	258.1	Greywacke	Extremely Strong
9	5	3.2	D	15.3	50.3	67.7	5.7	137.8	Greywacke	Very Strong
10	6	3.6	D	17.9	50.3	71.6	6.7	161.2	Greywacke	Very Strong
11	6	3.9	D	17.4	50.4	73.5	6.5	156.6	Greywacke	Very Strong
12										
13										
14										
15										
16										
17							RUN#3 AVG=	137.1		Very Strong
18							RUN#4 AVG=	118.8		Very Strong
19							RUN#5 AVG=	197.9		Very Strong
20							RUN#6 AVG=	158.9		Very Strong
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* 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

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* Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-06

Date Drilled: 14-Oct-18
 Date Tested: 06-Nov-18
 Tester: BS
 Reviewed by: LS

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	1.2	D	14.88	50.1	66.9	5.6	135.0	Greywacke	Very Strong
2	1	1.5	D	16.98	49.8	58.6	6.5	155.6	Greywacke	Very Strong
3	2	1.9	D		50.0	73.6			Greywacke	Did Not Break
4	2	2.4	D	15.4	50.0	68.1	5.8	140.1	Greywacke	Very Strong
5	3	2.8	D	20.0	50.0	72.6	7.6	181.5	Greywacke	Very Strong
6	3	3.2	D	21.1	50.2	74.2	8.0	191.0	Greywacke	Very Strong
7	3	3.6	D	20.1	50.2	66.6			Greywacke	Did Not Break
8	4	4.0	D	14.9	50.5	67.4	5.5	133.2	Greywacke	Very Strong
9	4	4.3	D	2.4	50.4	65.8	0.9	21.7	Greywacke	Weak
10										
11										
12										
13										
14										
15										
16										
17							RUN#1 AVG=	145.3		Very Strong
18							RUN#2 AVG=	140.1		Very Strong
19							RUN#3 AVG=	186.3		Very Strong
20							RUN#4 AVG=	77.5		Strong
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

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Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

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**THURBER ENGINEERING LTD.****POINT LOAD TEST SHEET****ASTM D5731-08**

Job No: 23476
Client: Hatch
Project Name: Namakan River Bailey Bridge
Core Size: NQ **BH No :** BH18-07

Date Drilled: 14-Oct-18
Date Tested: 05-Nov-18
Tester: BS
Reviewed by: LS

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	2.4	D	6.54	50.0	78.6	2.5	59.5	Greywacke	Strong
2	1	2.8	D	12.48	50.0	70.2	4.7	113.5	Greywacke	Very Strong
3	2	3.1	D	2.3	49.9	75.6	0.9	20.8	Greywacke	Weak
4	2	3.5	D	7.3	50.0	71.4	2.8	66.0	Greywacke	Strong
5	2	4.0	D	13.2	50.0	71.3	5.0	120.1	Greywacke	Very Strong
6	3	4.4	D	10.5	50.1	67.3	4.0	95.6	Greywacke	Strong
7	3	4.7	D	18.9	49.8	69.4	7.2	173.0	Greywacke	Very Strong
8	3	5.1	D	16.7	49.8	73.6	6.4	153.1	Greywacke	Very Strong
9										
10										
11										
12										
13										
14										
15										
16										
17							RUN#1 AVG=	86.5		Strong
18							RUN#2 AVG=	69.0		Strong
19							RUN#3 AVG=	140.6		Very Strong
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* 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

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THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-08

Date Drilled: 13-Oct-18
 Date Tested: 05-Nov-18
 Tester: BS
 Reviewed by: LS

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	0.6	D	5.62	47.8	59.6	2.3	54.8	Greywacke	Strong
2	1	0.8	D	3.72	50.1	65.7	1.4	33.7	Greywacke	Medium Strong
3	2	1.2	D	8.2	50.2	65.6	3.1	73.9	Greywacke	Strong
4	2	1.6	D	13.1	50.1	71.3	4.9	118.7	Greywacke	Very Strong
5	3	1.9	D	8.7	50.0	71.3	3.3	79.0	Greywacke	Strong
6	3	2.2	D	12.5	50.1	77.0	4.7	112.9	Greywacke	Very Strong
7	3	2.6	D	22.7	50.2	68.0	8.6	205.4	Greywacke	Very Strong
8	3	2.9	D	15.9	50.1	71.1	6.0	144.4	Greywacke	Very Strong
9	4	3.3	D	13.9	50.1	70.5	5.3	126.3	Greywacke	Very Strong
10	4	3.7	D	21.3	50.1	70.7	8.1	193.9	Greywacke	Very Strong
11	4	4.0	D	11.5	50.0	73.7	4.4	104.9	Greywacke	Very Strong
12										
13										
14										
15										
16										
17							RUN#1 AVG=	44.3		Medium Strong
18							RUN#2 AVG=	96.3		Strong
19							RUN#3 AVG=	135.4		Very Strong
20							RUN#4 AVG=	141.7		Very Strong
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* 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 $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-09

Date Drilled: 12-Oct-18
 Date Tested: 06-Nov-18
 Tester: BS
 Reviewed by: LS

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	0.8	D	15.72	47.7	57.8	6.4	154.0	Greywacke	Very Strong
2	1	1.2	D	14.5	47.8	58.6	5.9	141.5	Greywacke	Very Strong
3	2	1.5	D	11.0	50.0	50.3	4.2	99.8	Greywacke	Strong
4	2	1.8	D	14.2	49.4	53.5	5.5	131.5	Greywacke	Very Strong
5	3	2.1	D	17.5	49.9	71.8	6.6	159.3	Greywacke	Very Strong
6	3	2.4	D	8.6	50.1	63.3	3.2	77.8	Greywacke	Strong
7	3	2.8	D	12.4	50.0	63.0	4.7	113.2	Greywacke	Very Strong
8	4	3.3	D	14.6	50.0	50.0	5.5	132.8	Greywacke	Very Strong
9	4	3.6	D	15.4	50.0	56.8	5.9	140.4	Greywacke	Very Strong
10	4	3.9	D	16.0	50.2	63.4	6.1	145.2	Greywacke	Very Strong
11										
12										
13										
14										
15										
16										
17							RUN#1 AVG=	147.7		Very Strong
18							RUN#2 AVG=	115.7		Very Strong
19							RUN#3 AVG=	116.8		Very Strong
20							RUN#4 AVG=	139.5		Very Strong
21										
22										
23										
24										
25										
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27										
28										
29										
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31										
32										
33										
34										
35										

* 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 $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.

**THURBER ENGINEERING LTD.****POINT LOAD TEST SHEET****ASTM D5731-08**

Job No: 23476

Client: Hatch

Project Name: Namakan River Bailey Bridge

Core Size: NQ **BH No :** BH18-10

Date Drilled: 13-Oct-18

Date Tested: 05-Nov-18

Tester: BS

Reviewed by: LS

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	0.4	D	9.28	47.8	62.9	3.8	90.7	Greywacke	Strong
2	1	0.8	D	5.5	50.3	63.5	2.1	49.6	Greywacke	Medium Strong
3	2	1.1	D	5.9	50.0	74.8	2.3	54.1	Greywacke	Strong
4	2	1.5	D	27.3	50.2	72.8	10.3	247.4	Greywacke	Very Strong
5	3	1.9	D	14.6	50.2	73.0	5.5	131.8	Greywacke	Very Strong
6	3	2.2	D	6.9	50.1	77.2	2.6	62.7	Greywacke	Strong
7	4	2.4	D	24.5	50.2	65.7	9.2	221.1	Greywacke	Very Strong
8	4	2.7	D	16.5	50.3	64.2	6.2	149.2	Greywacke	Very Strong
9	5	3.1	D		50.2	72.5			Greywacke	Did Not Break
10	5	3.4	D	6.5	50.2	65.9	2.4	58.5	Greywacke	Strong
11	5	3.6	D	4.4	50.3	64.2	1.7	40.1	Greywacke	Medium Strong
12										
13										
14										
15										
16										
17							RUN#1 AVG=	70.1		Strong
18							RUN#2 AVG=	150.8		Very Strong
19							RUN#3 AVG=	97.2		Strong
20							RUN#4 AVG=	185.1		Very Strong
21							RUN#5 AVG=	49.3		Medium Strong
22										
23										
24										
25										
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30										
31										
32										
33										
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35										

* 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 $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.

**THURBER ENGINEERING LTD.****POINT LOAD TEST SHEET****ASTM D5731-08**

Job No: 23476
Client: Hatch
Project Name: Namakan River Bailey Bridge
Core Size: NQ **BH No :** BH18-11

Date Drilled: 17-Oct-18
Date Tested: 06-Nov-18
Tester: BS
Reviewed by: LS

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	0.6	D	3.84	49.1	76.0	1.5	36.0	Greywacke	Medium Strong
2	1	1.1	D	15.9	49.0	74.0	6.2	149.5	Greywacke	Very Strong
3	2	1.5	D	6.4	48.5	80.9	2.5	61.2	Greywacke	Strong
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14										
15										
16										
17							RUN#1 AVG=	92.8		Strong
18							RUN#2 AVG=	61.2		Strong
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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 $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 23476
 Client: Hatch
 Project Name: Namakan River Bailey Bridge
 Core Size: NQ BH No : BH18-12

Date Drilled: 15-Oct-18
 Date Tested: 06-Nov-18
 Tester: BS
 Reviewed by: LS

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	1.6	D	7.38	50.3	70.0	2.8	66.6	Greywacke	Strong
2	1	2.0	D	11.72	50.0	75.4	4.5	106.8	Greywacke	Very Strong
3	1	2.4	D	14.2	50.2	81.9	5.4	128.5	Greywacke	Very Strong
4	1	2.6	D	4.9	50.0	77.8	1.9	44.7	Greywacke	Medium Strong
5										
6										
7							RUN#1 AVG=	86.7		Strong
8										
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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 $0.7 \times D$ on either side of test point.

* Correlation factor to obtain UCS values is 24.



Photo B1: Borehole 18-01 core photo. Run 1 to Run 5 start.



Photo B2: Borehole 18-01 core photo. Run 5 end to Run 6 start.



Photo B3: Borehole 18-01 core photo. Run 6 end.



Photo B4: Borehole 18-02 core photo. Run 1 to Run 4 start.



Photo B5: Borehole 18-02 core photo. Run 4 end to Run 5.



Photo B6: Borehole 18-03 core photo. Run 1 to Run 3.



Photo B7: Borehole 18-03 core photo. Run 4



Photo B8: Borehole 18-04 core photo. Run 1 to Run 6 start.



Photo B9: Borehole 18-04 core photo. Run 6 end to Run 7.



Photo B10: Borehole 18-04 core photo. Run 8.



Photo B11: Borehole 18-05 core photo. Run 1 to Run 4 start.



Photo B12: Borehole 18-05 core photo. Run 4 end to Run 6.

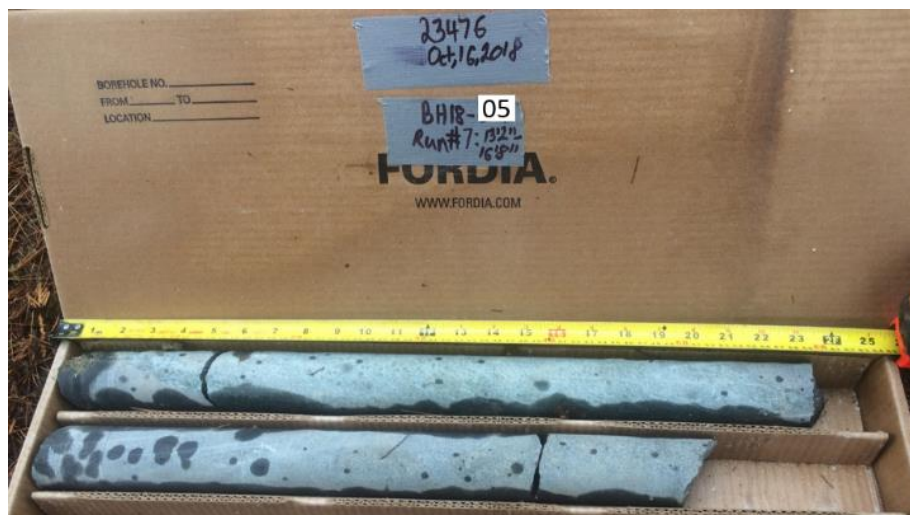


Photo B13: Borehole 18-05 core photo. Run 7.



Photo B14: Borehole 18-06 core photo. Run 1 to Run 3 start.



Photo B15: Borehole 18-06 core photo. Run 3 end to Run 4.



Photo B16: Borehole 18-07 core photo. Run 1 to Run 2.



Photo B17: Borehole 18-07 core photo. Run 3.



Photo B18: Borehole 18-08 core photo. Run 1 to Run 3 start.



Photo B19: Borehole 18-08 core photo. Run 3 end to Run 4.



Photo B20: Borehole 18-09 core photo. Run 1 to Run 3 start.



Photo B21: Borehole 18-09 core photo. Run 3 end to Run 4.



Photo B22: Borehole 18-10 core photo. Run 1 to Run 3.



Photo B23: Borehole 18-10 core photo. Run 4 to Run 5



Photo B24: Borehole 18-11 core photo. Run 1 to Run 2.



Photo B25: Borehole 18-12 core photo. Run 1.



Appendix C

Site Photographs



Photo C1: Parking on Flanders Road near north detour approach facing north

(Photo Date: October 12, 2018)



Photo C2: Facing west towards existing bailey bridge from north detour abutment

(Photo Date: October 12, 2018)



Photo C3: Facing east towards existing bailey bridge

(Photo Date: October 17, 2018)



Photo C4: North detour approach facing east

(Photo Date: October 12, 2018)



Photo C5: North detour abutment facing north

(Photo Date: October 12, 2018)



Photo C6: North detour abutment facing southwest

(Photo Date: October 12, 2018)



Photo C7: North detour abutment facing south

(Photo Date: October 12, 2018)



Photo C8: South detour abutment facing north

(Photo Date: October 12, 2018)



Photo C9: South detour abutment facing east

(Photo Date: October 12, 2018)



Photo C10: South detour abutment facing northwest

(Photo Date: October 12, 2018)



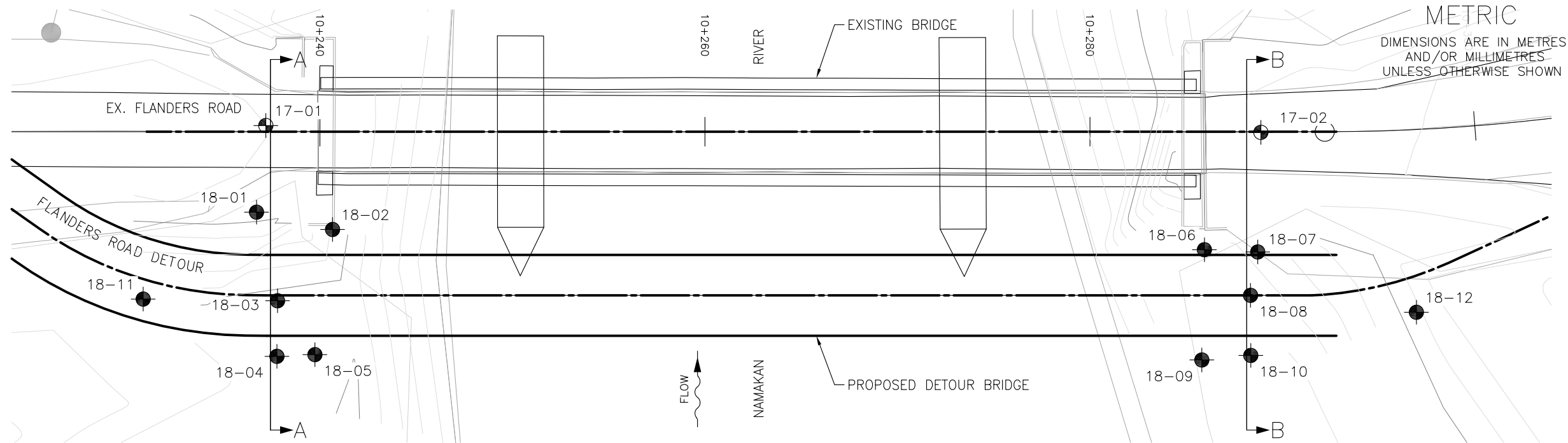
Photo C11: South detour approach facing west

(Photo Date: October 12, 2018)

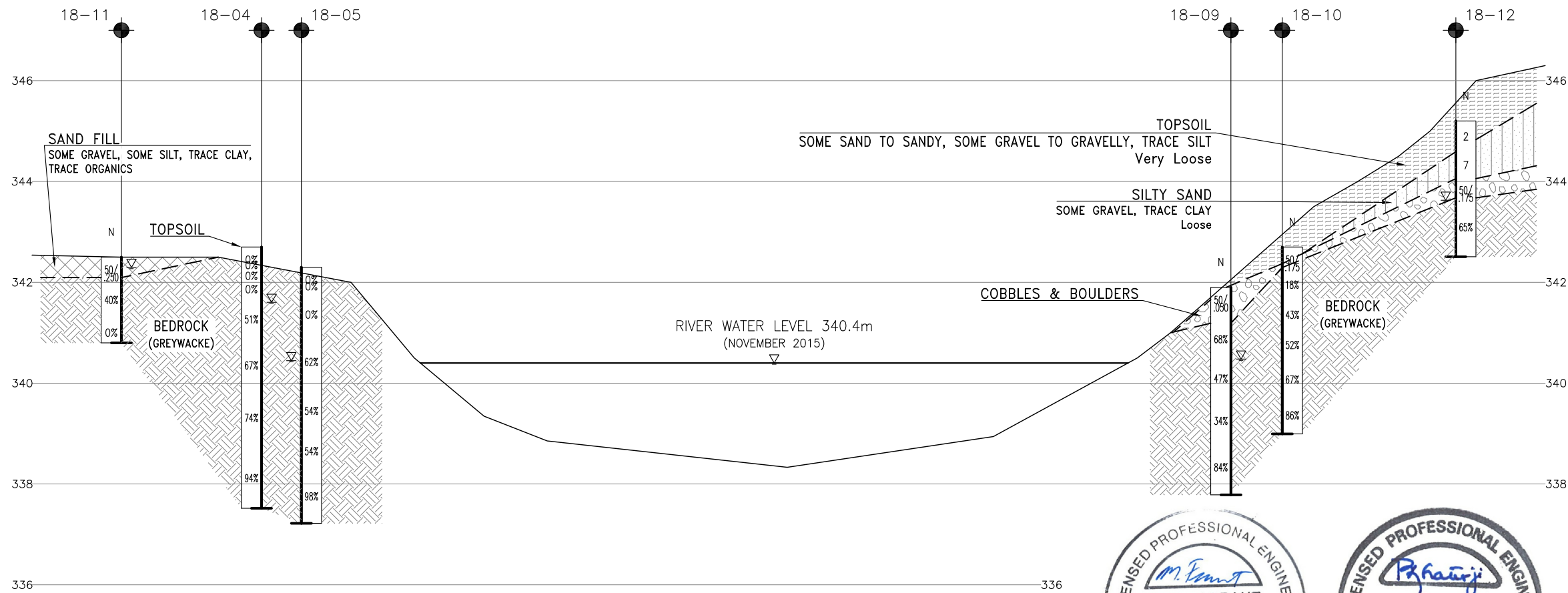


Appendix D

Borehole Locations and Soil Strata Drawing



NO	ELEVATION	NORTHING	EASTING
17-01	345.5	5 367 714.6	349 823.8
17-02	345.6	5 367 761.0	349 846.5



PROFILE ALONG FLANDERS ROAD DETOUR



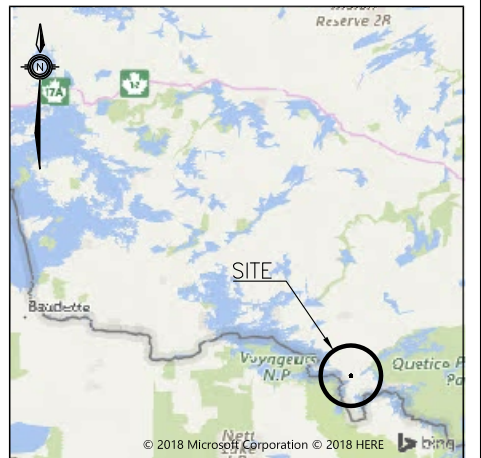
CONT No 2019-6005
GWP No 6853-14-00

FLANDERS ROAD
NAMAKAN RIVER
DETOUR BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

HATCH



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Borehole (2018 Investigation)
○	Borehole (2017 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▽	Head Artesian Water
—	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

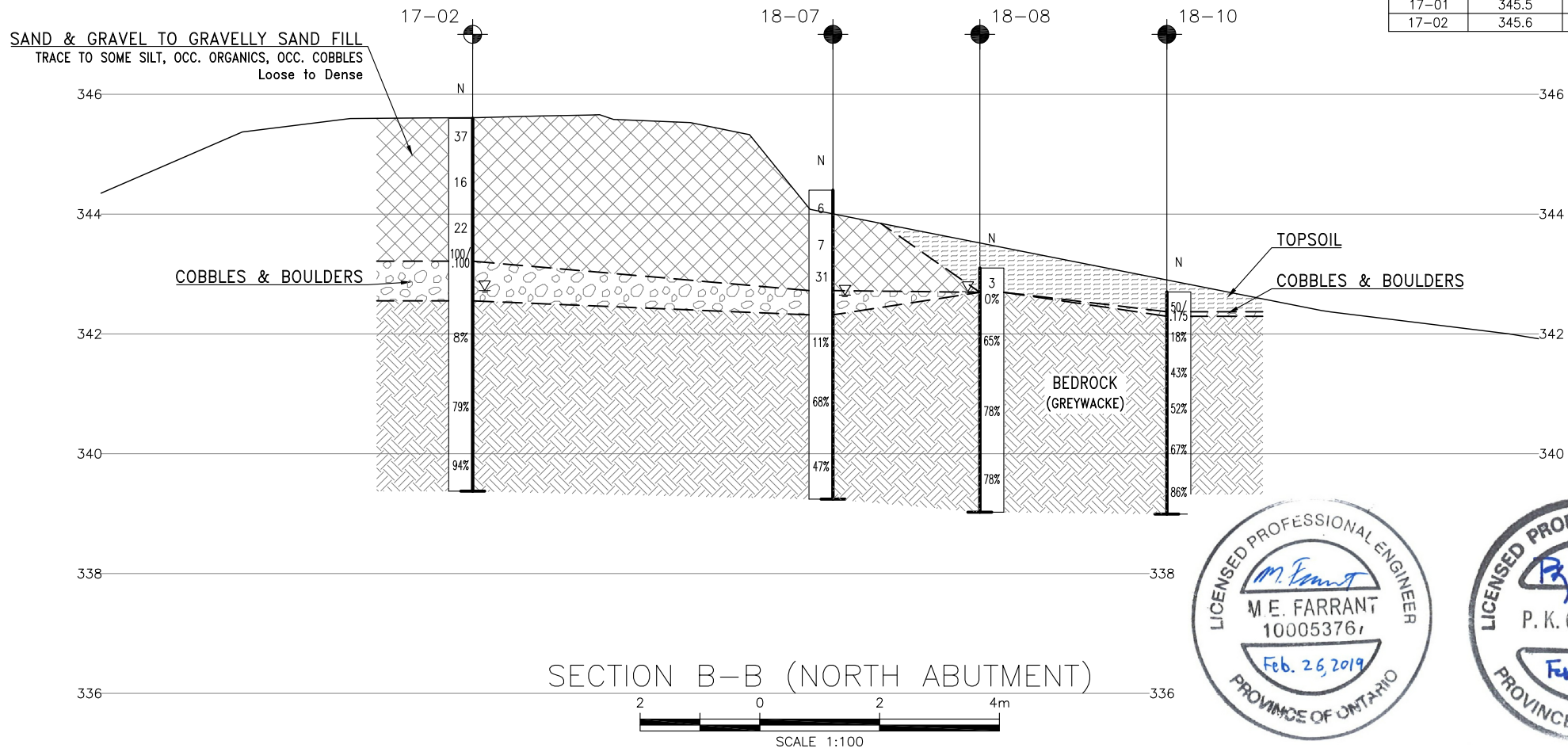
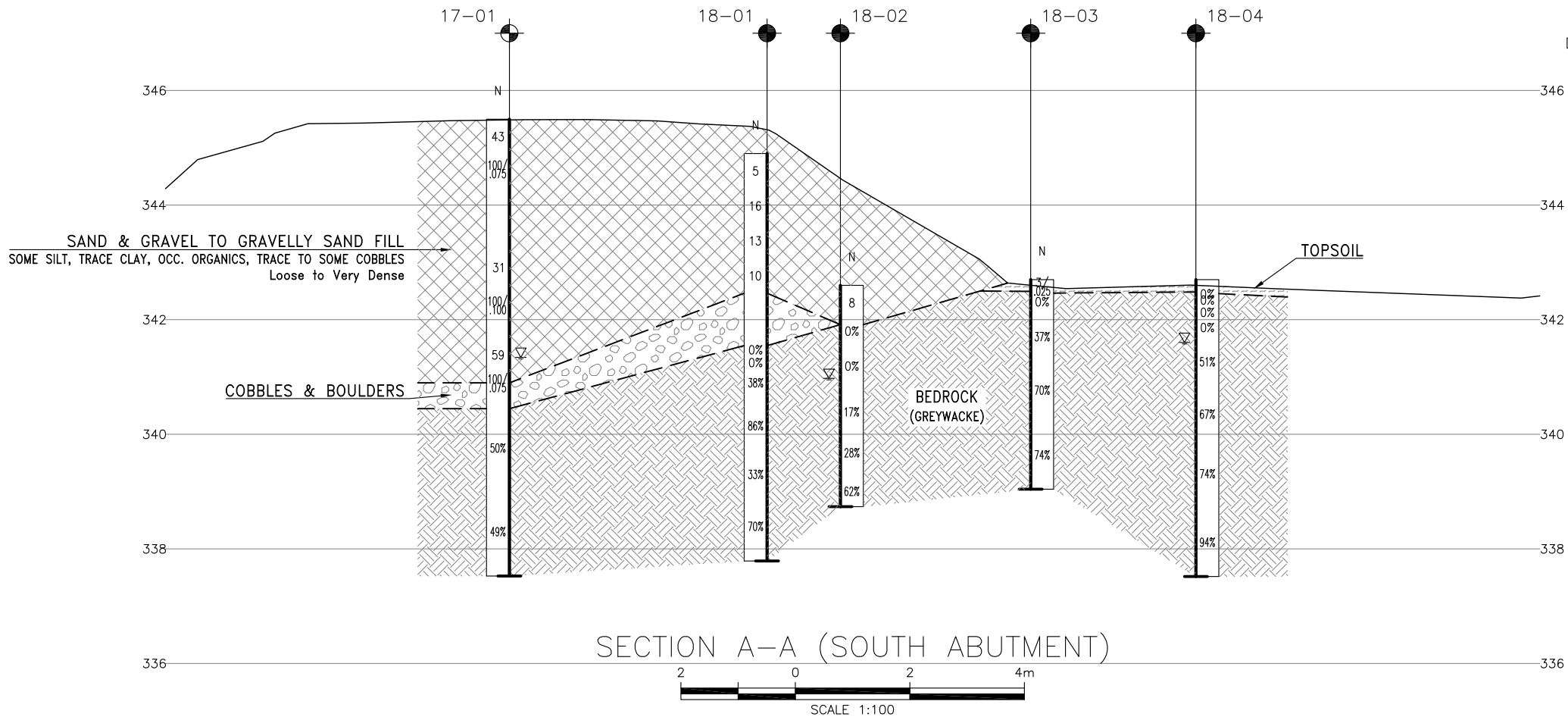
NO	ELEVATION	NORTHING	EASTING
18-01	344.9	5 367 712.2	349 827.7
18-02	342.6	5 367 715.4	349 830.2
18-03	342.7	5 367 711.2	349 832.3
18-04	342.7	5 367 709.9	349 834.9
18-05	342.3	5 367 711.7	349 835.7
18-06	343.8	5 367 755.8	349 850.7
18-07	344.4	5 367 758.2	349 852.0
18-08	343.1	5 367 756.9	349 853.9
18-09	341.9	5 367 753.2	349 855.8
18-10	342.7	5 367 755.6	349 856.7
18-11	342.5	5 367 704.9	349 829.2
18-12	345.2	5 367 764.3	349 858.4

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 16.

GEOCRES No. 52C-60

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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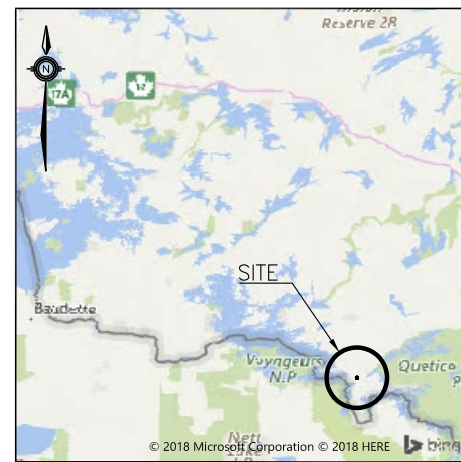
NO	ELEVATION	NORTHING	EASTING
17-01	345.5	5 367 714.6	349 823.8
17-02	345.6	5 367 761.0	349 846.5

CONT No 2019-6005
GWP No 6853-14-00

FLANDERS ROAD
NAMAKAN RIVER
DETOUR BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
11

HATCH



KEYPLAN

LEGEND

●	Borehole (2018 Investigation)
○	Borehole (2017 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
⌵	Head Artesian Water
⌵	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
18-01	344.9	5 367 712.2	349 827.7
18-02	342.6	5 367 715.4	349 830.2
18-03	342.7	5 367 711.2	349 832.3
18-04	342.7	5 367 709.9	349 834.9
18-05	342.3	5 367 711.7	349 835.7
18-06	343.8	5 367 755.8	349 850.7
18-07	344.4	5 367 758.2	349 852.0
18-08	343.1	5 367 756.9	349 853.9
18-09	341.9	5 367 753.2	349 855.8
18-10	342.7	5 367 755.6	349 856.7
18-11	342.5	5 367 704.9	349 829.2
18-12	345.2	5 367 764.3	349 858.4

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 16.

GEOCRES No. 52C-60



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LS	CHK	PKC
DRAWN	MFA	CHK	MEF
CODE	LOAD	DATE	FEB 2019
SITE	45X-0265/BQ	STRUCT	DWG 2