FOUNDATION INVESTIGATION AND DESIGN REPORT

for

MAGNETAWAN RIVER SOUTHBOUND BRIDGE
HIGHWAY 69
SITE NO. 44-457/2
W.P. 5135-08-01
MAGNETAWAN FIRST NATION, ONTARIO

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PML Ref.: 09TF042-MRS
Index No.: 360FIR and 361FDR
GEOCRES No.: 41H-141
October 29, 2014

Peto MacCallum Ltd.
CONSULTING ENGINEERS

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Magnetawan River Southbound Bridge
Highway 69
Site No. 44-457/2
W.P. 5135-08-01
Magnetawan First Nation, Ontario

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1. INTRODUCTION

This report summarises the results of a foundation investigation carried out for the proposed construction of a bridge to carry Highway 69 (New) southbound traffic over the Magnetawan River in Magnetawan First Nation, Ontario. The investigation was conducted for AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation of Ontario (MTO).

The bridge is at approximate Station 21+645, Highway 69 chainage, in Magnetawan First Nation (ref. General Arrangement Drawing 1 'Hwy. 69 – SBL Magnetawan River Crossing' prepared by AECOM in May 2012).

The report provides subsurface information pertaining to the proposed structure and approaches within about 20 m of the abutments.

All elevations in this report are expressed in meters.

2. SITE DESCRIPTION AND GEOLOGY

The site is situated about 90 km south of Sudbury in a wooded region with open swampy areas. Land use includes limited farming and forestry exploration. Highway 69 (New) is oriented in the south-north direction at the bridge location, about 230 m east of the existing Highway 69. The main activity near the Magnetawan River crossing is related to tourism and recreation, with numerous fishing and hunting lodges, camps, marinas and hotels. Site photographs are included in Appendix A.

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BARRIE, HAMILTON, KITCHENER, TORONTO

The Magnetawan River is about 65 m wide and flows to the west at the site. The water level in the river is normally near elevation 179.0. Subject to seasonal variations and weather dependent precipitation, this water level was measured at elevation 177.3 on July 4 and at elevation 176.1 on August 21, 2013. The top of the bridge deck is at approximate elevation 194.0, some 15 m above the river level.

The study area is located in the physiographic region known as the Georgian Bay Fringe that includes a bedrock plain comprising exposed bedrock knobs, subordinate glacial till moraine and a peat / muck organic terrain over bedrock.

The topography is irregular in detail with extensive rock outcrops. Soil cover over the rock outcrops is typically less than 1 m. The soils were deposited by glacial Lake Algonquin and later partly by Lake Nipissing. Numerous boulders are present at the site.

Metasedimentary rocks of the Huronian Supergroup and gneisses of the Grenville Province underlie the alignment. The area has undergone considerable folding, intrusive activity, regional metamorphism and faulting. The bedrock in the immediate vicinity of the site is at shallow depths ranging from the surface to about 1.0 m.

3. INVESTIGATION PROCEDURES

The field work for this study was carried out during the period of June 25 to October 8, 2013 and comprised 38 boreholes drilled to depths of 0.0 to 7.8 m at the locations shown on the attached Drawing MRS-1. It is noted that the boreholes put down at each foundation element have a prefix reflecting the corresponding working point shown on the General Arrangement drawing. Further details are summarised in the following table.

LOCATION	BOREHOLE No.	DEPTH (m)		
		AUGER / CONE	ROCK CORE	TOTAL
South Approach	S-1	1.5	–	1.5
South Abutment	1S-1	0.1	–	0.1
	1S-2	0.2	3.0	3.2
	1S-3	0.9	–	0.9
	1S-4	0.1	3.0	3.1
	1S-5	0.2	–	0.2
	1S-6	0.0	3.2	3.2
	1S-7	0.1	–	0.1
	1S-8	0.8	3.0	3.8
	1S-9	0.6	–	0.6
South Pier	2S-1	0.0	–	0.0
	2S-2	0.0	7.8	7.8
	2S-3	0.0	–	0.0
	2S-4	0.6	4.4	5.0
	2S-5	0.0	–	0.0
	2S-6	0.4	3.8	4.2
	2S-7	0.3	–	0.3
	2S-8	0.1	3.5	3.6
	2S-9	0.3	–	0.3
North Pier	3S-1	0.0	3.4	3.4
	3S-2	0.3	–	0.3
	3S-3	0.0	3.4	3.4
	3S-4	0.0	–	0.0
	3S-5	0.2	–	0.2
	3S-6	0.0	–	0.0
	3S-7	0.8	4.3	5.1
	3S-8	0.2	–	0.2
	3S-9	0.5	3.7	4.2
North Abutment	4S-1	0.0	–	0.0
	4S-2	0.0	3.3	3.3
	4S-3	0.2	–	0.2
	4S-4	0.6	4.5	5.1
	4S-5	0.3	7.4	7.7
	4S-6	0.0	3.3	3.3
	4S-7	0.0	–	0.0
	4S-8	0.0	3.6	3.6
	4S-9	0.2	–	0.2
North Approach	S-2	0.0	–	0.0

The working points of the structure were staked in the field and surveyed by exp Services Inc. The locations of and ground surface elevations at the boreholes were established in relation to the working points by Peto MacCallum Ltd.

Most boreholes were advanced manually, using Hilti equipment or continuous flight solid stem augers, powered by a track-mounted D-53 drill rig, supplied and operated by specialist drilling contractors, working under the full-time supervision of a member of our engineering staff. A total of 17 boreholes (within the foundation elements) were extended 3.0 to 7.8 m into bedrock using NQ diamond rock coring equipment supplemented by wash boring techniques.

Representative samples of the soils were recovered at 0.75 m depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. The results of the field tests and observations are reported on the Record of Borehole sheets.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open borehole. Upon completion of drilling, the boreholes were backfilled with bentonite/cement grout in accordance with the MTO guidelines and MOE Regulation 903 for borehole abandonment procedures.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. The soil samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determination.

4. SUMMARISED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, bedrock descriptions, inferred stratigraphy, standard penetration test data and groundwater observations.

The borehole locations, stratigraphic profile and cross-sections prepared from the borehole data are shown on Drawings MRS-1 and MRS-2. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised surficial topsoil, sandy/silty soils and/or silty clay / clayey silt over bedrock or exposed bedrock. Cobbles and boulders were encountered in 9 boreholes. The bedrock surface was contacted at depths of 0.0 to 1.5 m (elevation 178.4 to 196.0). The water level in the river was measured at elevation 177.3 on July 4 and at elevation 176.1 on August 21, 2013.

It is noted that the steep rock faces present at the site may have a negative impact on the precision of the founding surfaces. The strata encountered are summarised below.

4.1 Topsoil

Surficial topsoil was present in boreholes S-1, 1S-1 to 1S-5, 1S-7 to 1S-9, 2S-4, 2S-7 to 2S-9, 3S-2, 3S-7 to 3S-9, 4S-3, 4S-4 and 4S-9 (removed from the location of borehole 3S-1 before drilling). The silty/sandy topsoil was 100 to 300 mm thick and penetrated at elevation 179.0 to 195.0.

4.2 Sandy/Silty Soils

Cohesionless soils of varying granulometric composition (sand, silty sand, sand and silt, silt) were present at the surface in boreholes 2S-6, 3S-5, 4S-5 and overlain by the topsoil at depths of 0.1 to 0.3 m (elevation 180.0 to 195.0) in boreholes S-1, 1S-3, 1S-9, 2S-4, 3S-2, 3S-7 to 3S-9, 4S-3, 4S-4 and 4S-9. The sandy/silty soils were 100 to 600 mm in thickness and penetrated at depths of 0.2 to 0.8 m (elevation 178.4 to 194.9). It is noteworthy that cobbles and boulders were encountered in the sandy soils in boreholes 2S-4, 2S-6, 3S-2, 3S-5, 3S-7 to 3S-9, 4S-4 and 4S-5.

4.3 Silty Clay / Clayey Silt

Underlying the silt at 0.3 m depth (elevation 187.6) in borehole S-1 or the topsoil / silty sand at a depth of 0.2 m (elevation 187.4 and 186.8) in boreholes 1S-3 and 1S-8 was a cohesive deposit of silty clay / clayey silt. This deposit was 0.6 to 1.2 m thick and penetrated at depths of 0.8 to 1.5 m (elevation 186.2 to 186.7).

The results of grain size distribution analysis performed on a sample of the clayey silt are presented in Figure MRS-GS-1.

4.4 Bedrock

Bedrock was contacted or inferred by refusal at depths of 0.0 to 1.5 m (elevation 178.4 to 196.0). The bedrock comprises a grey and pink granitic gneiss.

The measured core recovery varied between 44 and 100%. The RQD determined from the rock cores was in a range of 28 to 100%, thus indicating a poor to excellent quality rock. The rock quality was very poor (RQD of 0 to 20%) in a number of samples in boreholes 2S-2, 2S-4, 3S-3, 3S-7, 3S-9, 4S-2, 4S-4, 4S-5 and 4S-8.

The rock cores retrieved from boreholes 1S-2, 1S-4, 1S-6, 1S-8, 2S-2, 2S-4, 2S-6, 2S-8, 3S-1, 3S-3, 3S-7, 3S-9, 4S-2, 4S-4 to 4S-6 and 4S-8 are described on the corresponding Record of Borehole sheets. A detailed description of the rock cores in boreholes 1S-6, 2S-4, 4S-4 and 4S-5 is given in Table A, appended. Photographs of the rock cores are shown in Appendix B.

4.4.1 South Abutment

The bedrock surface was contacted or inferred at depths of 0.0 to 0.9 m (elevation 186.2 to 188.5) in boreholes 1S-1 to 1S-9. The depth to and surface elevation of the bedrock identified in the boreholes drilled at the west abutment are summarised in the following table:

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
South Abutment	1S-1	0.1	188.3
	1S-2	0.2	188.0*
	1S-3	0.9	186.7
	1S-4	0.1	186.8*
	1S-5	0.2	187.3
	1S-6	0.0	188.5*
	1S-7	0.1	187.9
	1S-8	0.8	186.2*
	1S-9	0.6	186.6

* confirmed by rock coring

The bedrock surface has a maximum relief of 2.3 m and slopes down to the east at angles of 1 to 7° (up to 14° on the east side of the abutment between boreholes 1S-5 and 1S-8). The bedrock comprises a dark grey to pink unweathered to slightly weathered high strength granitic gneiss.

The measured core recovery varied between 92 and 100%. The RQD determined from the rock cores was in a range of 92 to 100%, thus indicating an excellent quality rock.

4.4.2 South Pier

The bedrock surface was contacted or inferred at depths of 0.0 to 0.6 m (elevation 178.4 to 182.9) in boreholes 2S-1 to 2S-9. The depth to and surface elevation of the bedrock identified in the boreholes drilled at the pier are summarised in the following table:

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
South Pier	2S-1	0.0	182.5
	2S-2	0.0	182.3*
	2S-3	0.0	182.9
	2S-4	0.6	181.1*
	2S-5	0.0	181.4
	2S-6	0.4	178.4*
	2S-7	0.3	179.0
	2S-8	0.1	179.8*
	2S-9	0.3	179.6

* confirmed by rock coring

The bedrock surface has a maximum relief of 4.5 m and slopes down to the north at angles of 5 to 14° (up to 49° at the west end of the pier between borehole 2S-1 and 2S-6). The bedrock comprises a light grey to pink slightly to moderately weathered high strength granitic gneiss.

The measured core recovery varied between 63 and 100%. The RQD determined from the rock cores was in a range of 50 to 100%, thus indicating a fair to excellent quality rock, with the exception of a 0.1 m core sample at 2.7 m depth (elevation 179.9) in borehole 2S-2 and the upper 0.3 m core sample in borehole 2S-4 where the rock quality was very poor (RQD of 0%).

4.4.3 North Pier

The bedrock surface was contacted or inferred at depths of 0.0 to 0.8 m (elevation 179.8 to 181.5) in boreholes 3S-1 to 3S-9. The depth to and surface elevation of the bedrock identified in the boreholes drilled at the pier are summarised in the following table:

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
North Pier	3S-1	0.0	180.1*
	3S-2	0.3	179.8
	3S-3	0.0	180.1*
	3S-4	0.0	180.8
	3S-5	0.2	180.4
	3S-6	0.0	180.7
	3S-7	0.8	180.8*
	3S-8	0.2	181.5
	3S-9	0.5	180.6*

* confirmed by rock coring

The bedrock surface has a maximum relief of 1.7 m and slopes down to the south at angles of 1 to 4° (up to 26° between boreholes 3S-2 and 3S-8). The bedrock comprises a grey to pink moderately to slightly weathered high strength granitic gneiss.

The measured core recovery varied between 44 and 100%. The RQD determined from the rock cores was in a range of 42 to 100%, thus indicating a poor to excellent quality rock, with the exception of the core samples in the upper 0.6 to 2.4 m thick zones in boreholes 3S-3, 3S-7 and 3S-9 where the rock quality was very poor (RQD of 0 to 14%).

4.4.4 North Abutment

The bedrock surface was contacted or inferred at depths of 0.0 to 0.6 m (elevation 194.1 to 194.9) in boreholes 4S-1 to 4S-9. The depth to and surface elevation of the bedrock identified in the boreholes drilled at the east abutment are summarised in the following table:

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
North Abutment	4S-1	0.0	194.1
	4S-2	0.0	194.3*
	4S-3	0.2	194.3
	4S-4	0.6	194.1*
	4S-5	0.3	194.1*
	4S-6	0.0	194.5*
	4S-7	0.0	194.3
	4S-8	0.0	194.7*
	4S-9	0.2	194.9

* confirmed by rock coring

The bedrock surface has a maximum relief of 0.8 m and slopes down to the south at angles of 1 to 3° (up to 11° at the east end of the abutment between boreholes 4S-4 and 4S-9). The bedrock comprises a light grey to pink slightly weathered to unweathered medium to high strength granitic gneiss.

The measured core recovery varied between 50 and 100%. The RQD determined from the rock cores was in a range of 28 to 100%, thus indicating a poor to excellent quality rock, with the exception of a few core samples in boreholes 4S-2, 4S-4, 4S-5 and 4S-8 where the rock quality was very poor (RQD of 0 to 20%) – most notably the upper 1.8 m thick zone of very poor to poor quality rock down to elevation 192.2 in borehole 4S-4 and the upper 0.4 to 0.7 m thick zones in boreholes 4S-5 and 4S-8.

4.4.5 Approaches

Bedrock was at 1.5 m depth (elevation 186.4) in borehole S-1 and at the ground surface (elevation 196.0) in borehole S-2 put down at the south and north approaches, respectively.

4.5 Groundwater

No groundwater was observed in any of the boreholes during and upon completion of drilling. The groundwater levels at the site are subject to seasonal fluctuations and precipitation patterns.

The water level in the Magnetawan River was measured at elevation 177.3 on July 4 and at elevation 176.1 on August 21, 2013. The normal water level in the river is at elevation 179.0.

5. CLOSURE

The field work was carried out under the supervision of Mr. F. Portela, Senior Technician, and direction of Mr. A. DeSira, MEng, P.Eng., Project Engineer. The equipment was supplied by Walker Drilling Ltd. and Landcore.

This report was prepared by Mr. G.O. Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. B.R. Gray, MEng, P.Eng., MTO Designated Principal Contact. Mr. C.M.P. Nascimento, P.Eng., Project Manager, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

Grigory O. Degil, PhD, P.Eng.
Senior Foundation Engineer

Carlos M.P. Nascimento, P.Eng.
Project Manager

Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

GD/CN/BRG:ak

TABLE A
ROCK CORE DESCRIPTIONS

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	**CORE NO.**	**DEPTH (m)**	**RECOVERY (%)**	**RQD (%)**	**DEPTH (m)**	**DESCRIPTION**
1S-6	1	0.0 – 1.7	98	95	0.0 – 3.2	GRANITIC GNEISS: Dark grey and pink, fine to medium crystalline, garnetiferous, banded with occ. black layers (biotite and/or hornblende),with iron coloured oxidation, high strength, unweathered to slightly weathered, close to moderate spaced flat to dipping partings, rough planar, tight to oxidized, with dipping to vertical joints, excellent quality
	2	1.7 – 3.2	97	93		
2S-4	1	0.6 – 0.9	100	0	0.6 – 5.0	GRANITIC GNEISS: Light grey and pink, fine to medium crystalline, garnetiferous, banded with occ. black layers (biotite), with iron coloured oxidation and/or dark green encrustation on partings, high strength, slightly weathered to moderately weathered, close to moderate spaced dipping partings, rough planar, tight to oxidized, with dipping to vertical joints, very poor becoming fair to excellent quality
	2	0.9 – 2.3	89	71		
	3	2.3 – 3.1	100	92		
	4	3.1 – 3.9	97	69		
	5	3.9 – 5.0	98	78		
4S-4	1	0.6 – 1.0	50	0	0.6 – 5.1	GRANITIC GNEISS: Light grey and pink, fine to medium crystalline, garnetiferous, banded with occ. dark green to black layers (biotite and/or hornblende),with iron coloured oxidation, medium to high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping partings, rough planar, tight to oxidized, with dipping to vertical joints, very poor to poor becoming fair to excellent quality
	2	1.0 – 1.8	100	28		
	3	1.8 – 2.4	61	20		
	4	2.4 – 3.2	100	53		
	5	3.2 – 4.3	83	83		
	6	4.3 – 5.1	100	100		

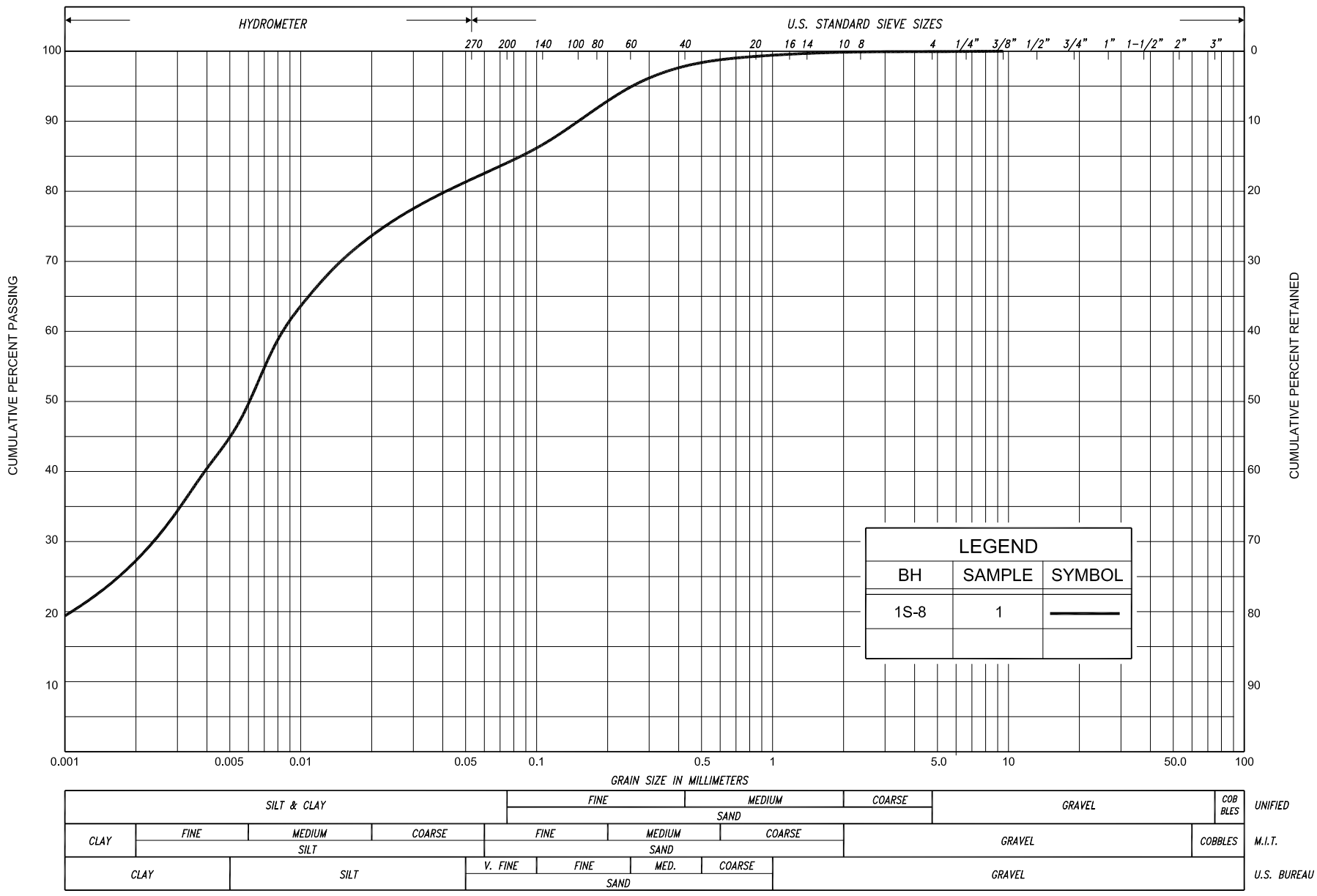
Originated: JO/SAT
Compiled: FP/SA
Checked: MA/

TABLE A
ROCK CORE DESCRIPTIONS

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	**CORE NO.**	**DEPTH (m)**	**RECOVERY (%)**	**RQD (%)**	**DEPTH (m)**	**DESCRIPTION**
4S-5	1	0.3 – 0.5	76	0	0.3 – 7.7	GRANITIC GNEISS: Light grey and pink, fine to medium crystalline, garnetiferous banded with occ. black layers (biotite), high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping partings, rough planar, tight, with dipping joints, very poor to excellent quality
	2	0.5 – 1.0	97	0		
	3	1.0 – 1.8	98	67		
	4	1.8 – 2.3	97	97		
	5	2.3 – 3.5	98	97		
	6	3.5 – 4.4	100	100		
	7	4.4 – 5.2	100	100		
	8	5.2 – 6.4	99	99		
	9	6.4 – 6.6	87	44		
	10	6.6 – 7.1	95	85		
	11	7.1 – 7.6	100	100		
	12	7.6 – 7.7	100	0		

NOTE: RQD = Rock Quality Designation

Originated: JO/SAT
Compiled: FP/SA
Checked: MA/



Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, some sand

FIG No.	MRS-GS-1
HWY:	69
G.W.P. No.	5112-07-00

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 – 10	10 – 20	20 – 30	30 – 40	> 40
	TRACE	*SOME*	*WITH*	*ADJECTIVE (SILTY)*	*AND (AND SILT)*

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. S-1 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+534.5 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 931.8 N; 227 739.2 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** September 23, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
187.9	Ground surface										
187.8 0.0	Topsoil										
0.1 187.6	Silt, some clay trace sand, organics Brown Moist										
0.3	Silty clay, trace sand Brown Moist		1	AS	-		187				
186.4 1.5	End of borehole Refusal on probable bedrock										

* Borehole dry

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. 1S-1 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+554.5, o/s 8.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 949.0 N; 227 726.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 22, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
189.2	Ground surface					*					
0.0 189.1	Topsoil										
0.1	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:06:51 AM

+, ×: Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 1S-2 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+553.2, o/s 4.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 948.8 N; 227 730.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 18, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
189.0	Ground surface										
188.8	Topsoil										
0.2	Granitic Gneiss bedrock Slightly weathered High strength Excellent quality		1	RC NQ	REC 100%		188				RQD 100%
			2	RC	REC 100%						RQD 100%
			3	RC NQ	REC 98%		187				RQD 98%
185.8							186				
3.2	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

15 — 10 — 5 (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. 1S-3 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+550.8, o/s 4.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 948.6 N; 227 738.9 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 22, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.5	Ground surface										
188.4 / 0.1	Topsoil										
188.3 / 0.2	Silty sand, organics Brown Moist						188				
187.6 / 0.9	Clayey silt, some sand organics Mottled Moist brown/grey										
	End of borehole Refusal on probable bedrock										

* Borehole dry

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. 1S-4 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+549.5, o/s 8.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 948.4 N; 227 743.1 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 19, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
187.8	Ground surface										
0.0 187.7	Topsoil										
0.1	Granitic Gneiss bedrock Slightly weathered High strength Excellent quality		1	RC NQ	REC 92%		187				RQD 92%
			2	RC NQ	REC 98%		186				RQD 98%
184.7							185				
3.1	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

15 10 5 (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. 1S-5 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+554.5 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 951.2 N; 227 734.0 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 24, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
188.3	Ground surface					*					
188.1	Topsoil										
0.2	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:06:53 AM

+, ×: Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 1S-6 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+558.5, o/s 8.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 952.9 N; 227 725.2 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 18, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
189.4 0.0	Ground surface Granitic Gneiss bedrock Unweathered to slightly weathered High strength Excellent quality		1	RC NQ	REC 98%	*	189				RQD 95%
							188				
			2	RC NQ	REC 97%		187				RQD 93%
186.2 3.2	End of borehole * Borehole charged with drilling water										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:06:54 AM

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 1S-7 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+557.2, o/s 4.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 952.7 N; 227 729.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 22, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
188.9	Ground surface					*					
0.0 188.8	Topsoil										
0.1	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

15 — 10 — 5 (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 1S-8 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+554.8, o/s 4.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 952.5 N; 227 737.8 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 19, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
187.9	Ground surface										
187.7 / 0.2	Topsoil										
	Clayey silt, some sand organics		1	SS	7						0 16 57 27
187.1 / 0.8	Firm Brown Moist										
	Granitic Gneiss bedrock						187				
	Slightly weathered		2	RC NQ	REC 100%						RQD 100%
	High strength						186				
	Excellent quality										
			3	RC NQ	REC 97%		185				RQD 97%
184.1 / 3.8	End of borehole										

* Borehole charged with drilling water

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 3/25/2014 2:25:47 PM

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 1S-9 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+553.5, o/s 8.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 952.3 N; 227 742.0 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 22, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
188.0	Ground surface					*					
0.0 / 187.7	Topsoil										
0.3 / 187.4	Silty sand, organics										
0.6	Brown Moist										
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 2S-1 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+604.8, o/s 6.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 997.1 N; 227 714.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 27, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
182.7 / 0.0	Ground surface Bedrock at surface					*					
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:18:25 AM

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 2S-2 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+604.8, o/s 3.5m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 997.5 N; 227 717.0 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 22 to 27, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.6	Ground surface							
0.0	Granitic Gneiss bedrock Slightly weathered to moderately weathered High strength Fair to excellent locally very poor quality		1	RC NQ	REC 100%		182	RQD 100%
			2	RC NQ	REC 84%			RQD 74%
			3	RC	REC 100%			RQD 64%
			4	RC NQ	REC 100%		181	RQD 100%
			5	RC NQ	REC 93%			RQD 73%
			6	RC	REC 63%		180	RQD 0%
			7	RC	REC 92%			RQD 92%
			8	RC NQ	REC 100%			RQD 95%
			9	RC NQ	REC 100%		179	RQD 100%
			10	RC NQ	REC 100%		178	RQD 83%
			11	RC NQ	REC 91%		177	RQD 81%
			12	RC NQ	REC 100%		176	RQD 100%
174.8							175	
7.8	End of borehole							

* Borehole charged with drilling water

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%) (20 40 60)

UNIT WEIGHT γ kN/m³

+7, ×5 : Numbers refer to Sensitivity

15 — ○ — 5 (%) STRAIN AT FAILURE

10

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 2S-3 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+601.5, o/s 3.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 996.9 N; 227 724.0 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 27, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
183.2	Ground surface					*					
0.0	Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:18:27 AM

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 2S-4 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+600.4, o/s 6.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 996.4 N; 227 727.2 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 20, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.0	Ground surface										
181.8	Topsoil										
0.2	Sand, trace gravel cobbles										
181.4											
0.6	Brown Moist		1	RC NQ	REC 100%						RQD 0%
	Granitic Gneiss bedrock Slightly weathered to moderately weathered High strength Very poor becoming fair to excellent quality		2	RC NQ	REC 89%		181				RQD 71%
							180				
			3	RC NQ	REC 100%						RQD 92%
							179				
			4	RC NQ	REC 97%						RQD 69%
							178				
			5	RC NQ	REC 98%						RQD 78%
177.0							177				
5.0	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

15 — 10 — 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 2S-5 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+605.1 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 999.2 N; 227 720.2 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 27, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
181.7	Ground surface					*					
0.0	Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:18:28 AM

+, ×: Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 2S-6 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+608.4, o/s 6.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 000.6 N; 227 713.4 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 21, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.1	Ground surface										
0.0 / 178.7	Sand, trace gravel cobbles						179				
0.4	Brown Moist		1	RC	REC 67%						RQD 50%
	Granitic Gneiss bedrock Moderately weathered to slightly weathered High strength Fair to excellent quality		2	RC NQ	REC 71%		178				RQD 65%
			3	RC NQ	REC 98%		177				RQD 98%
			4	RC NQ	REC 97%		176				RQD 83%
174.9			5	RC NQ	REC 100%		175				RQD 100%
4.2	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

15 — 10 — 5 (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 2S-7 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+608.6, o/s 3.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 001.7 N; 227 716.2 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 27, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
179.6	Ground surface					*					
0.0 / 179.3	Topsoil										
0.3	End of borehole Refusal on probable bedrock										
	* Borehole dry										

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 2S-8 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+606.5, o/s 3.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 001.4 N; 227 722.6 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 20, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.2	Ground surface					*					
180.1	Topsoil										
0.1	Granitic Gneiss bedrock Slightly weathered to moderately weathered High strength Good to excellent quality		1	RC	REC 100%		180				RQD 100%
			2	RC NQ	REC 98%						RQD 98%
			3	RC NQ	REC 98%		179				RQD 82%
							178				
			4	RC NQ	REC 100%						RQD 100%
176.6							177				
3.6	End of borehole										

* Borehole charged with drilling water

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. 2S-9 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+605.3, o/s 6.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 001.2 N; 227 725.9 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 27, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
180.2	Ground surface					*					
0.0 / 179.9	Topsoil						180				
0.3	End of borehole Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:18:31 AM

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. 3S-1 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+684.8, o/s 5.8m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 072.1 N; 227 689.9 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** June 26 and 27, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
180.1	Ground surface										
0.0	Granitic Gneiss bedrock Moderately weathered to slightly weathered High strength Good locally poor quality		1	RC NQ	REC 97%	*	180				RQD 81%
			2	RC NQ	REC 83%		179				RQD 46%
			3	RC NQ	REC 100%		178				RQD 89%
			4	RC NQ	REC 93%		177				RQD 83%
176.7											
3.4	End of borehole										

* Borehole charged with drilling water

Note: about 150mm of topsoil wss stripped prior to rock coring.

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 3S-2 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+683.4 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 072.7 N; 227 695.8 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** October 08, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.1	Ground surface										
180.0 / 0.1	Topsoil						180				
179.8 / 0.3	Sand, trace gravel cobbles Brown Moist										
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:26:53 AM

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 3S-3 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+683.5, o/s 5.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 074.1 N; 227 700.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti ('N' Core) **COMPILED BY** G.D.

DATUM Geodetic **DATE** June 25, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
180.1	Ground surface										
0.0	Granitic Gneiss bedrock Moderately weathered to slightly weathered High strength Very poor becoming good to excellent quality		1	RC NQ	REC 54%		180				RQD 0%
			2	RC NQ	REC 100%		179				RQD 88%
			3	RC	REC 100%						RQD 100%
			4	RC NQ	REC 99%		178				RQD 98%
176.7							177				
3.4	End of borehole * Borehole charged with drilling water										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:26:54 AM

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 3S-4 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+685.9, o/s 5.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 073.4 N; 227 690.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** October 08, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
180.8	Ground surface					*					
0.0	Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:26:54 AM

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 3S-5 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+685.9 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 075.1 N; 227 695.0 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** October 08, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.6	Ground surface										
180.4 / 0.2	Sand, trace gravel cobbles and boulders Brown Moist										
	End of borehole Refusal on probable bedrock										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No. 3S-6 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+685.9, o/s 5.8m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 077.0 N; 227 700.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** October 08, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
180.7	Ground surface					*					
0.0	Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:26:56 AM

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 3S-7 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+688.5, o/s 5.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 075.8 N; 227 689.4 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti ('N' Core) **COMPILED BY** G.D.

DATUM Geodetic **DATE** June 25 and 26, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
181.6	Ground surface										
181.4 0.2	Topsoil										
180.8 0.8	Silty sand, trace gravel cobbles and boulders Brown Moist										
	Granitic Gneiss bedrock Moderately weathered to slightly weathered High strength Very poor to poor becoming fair to good quality		1	RC NQ	REC 50%		181				RQD 0%
			2	RC NQ	REC 44%		180				RQD 0%
			3	RC NQ	REC 56%						RQD 0%
			4	RC NQ	REC 98%		179				RQD 0%
			5	RC NQ	REC 79%		178				RQD 42%
			6	RC	REC 100%						RQD 60%
			7	RC NQ	REC 82%						RQD 82%
176.5			8	RC NQ	REC 100%		177				RQD 67%
5.1	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

15 — 10 — 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 3S-8 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+687.0 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 076.1 N; 227 694.6 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** October 08, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.7	Ground surface										
181.6 / 0.1	Topsoil										
181.5 / 0.2	Sand, trace gravel cobbles and boulders Brown Moist										
	End of borehole Refusal on probable bedrock										

* Borehole dry

+7, ×5 : Numbers refer to Sensitivity

15 10 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 3S-9 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+687.1, o/s 5.8m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 078.1 N; 227 700.1 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti ('N' Casing) **COMPILED BY** G.D.

DATUM Geodetic **DATE** June 27, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.1	Ground surface					*	181				
181.0 / 0.1	Topsoil		1	BS	-						
180.8 / 0.3	Silty sand, trace gravel rootlets		2	BS	-						
180.6 / 0.5	Sand and silt, some gravel cobbles and boulders		3	RC NQ	REC 100%						RQD 0%
	Granitic Gneiss bedrock Moderately weathered to slightly weathered		4	RC NQ	REC 100%		180				RQD 14%
	High strength Very poor becoming fair to excellent quality		5	RC NQ	REC 94%		179				RQD 65%
			6	RC NQ	REC 76%		178				RQD 55%
176.9			7	RC NQ	REC 100%		177				RQD 100%
4.2	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

15 — 10 — 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-1 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+736.5, o/s 8.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 119.0 N; 227 670.0 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 19, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
193.9	Ground surface					*					
0.0	Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:44:15 AM

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-2 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+734.5, o/s 3.5m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 118.8 N; 227 674.9 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 15, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
194.1	Ground surface					*					
0.0	Granitic Gneiss bedrock		1	RC	REC 100%		194				RQD 86%
	Unweathered to slightly weathered		2	RC	REC 100%						RQD 0%
	High strength		3	RC NQ	REC 84%		193				RQD 72%
	Fair to excellent locally very poor quality		4	RC NQ	REC 100%		192				RQD 96%
190.8			5	RC NQ	REC 77%		191				RQD 75%
3.3	End of borehole										

* Borehole charged with drilling water

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-3 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+732.8, o/s 4.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 119.9 N; 227 682.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 19, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.3	Ground surface										
194.2 / 0.1	Topsoil										
194.1 / 0.2	Sand, trace silt organics Brown Moist										
	End of borehole Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:44:16 AM

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-4 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+732.0, o/s 8.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 120.6 N; 227 686.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 16, 2013 **CHECKED BY** C.N.

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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.6	Ground surface										
194.4	Topsoil										
0.2	Sand, trace gravel cobbles										
194.0							194				
0.6	Brown Moist		1	RC NQ	REC 50%						RQD 0%
	Granitic Gneiss bedrock Slightly weathered to unweathered Medium to high strength Very poot to poor becoming fair to excellent quality		2	RC NQ	REC 100%		193				RQD 28%
			3	RC NQ	REC 61%						RQD 20%
			4	RC NQ	REC 100%		192				RQD 53%
			5	RC NQ	REC 83%		191				RQD 83%
			6	RC NQ	REC 100%		190				RQD 100%
189.5											
5.1	End of borehole										

* Borehole charged with drilling water

+ , × : Numbers refer to Sensitivity

15 — 5 — 10

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-5 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+736.2 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 121.6 N; 227 677.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** September 04 to 06, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
194.2	Ground surface										
0.0 / 193.9	Sand, trace gravel boulders						194				
0.3	Brown Moist		1	RC	REC 76%						RQD 0%
	Granitic Gneiss bedrock		2	RC NQ	REC 97%						RQD 0%
	Slightly weathered to unweathered		3	RC NQ	REC 98%		193				RQD 67%
	High strength		4	RC NQ	REC 97%						RQD 97%
	Very poor to excellent quality		5	RC NQ	REC 98%		192				RQD 97%
			6	RC NQ	REC 100%		191				RQD 100%
			7	RC NQ	REC 100%		190				RQD 100%
			8	RC NQ	REC 99%		189				RQD 99%
			9	RC	REC 87%		188				RQD 44%
			10	RC NQ	REC 95%						RQD 85%
			11	RC NQ	REC 100%		187				RQD 100%
186.5			12	RC	REC 100%						RQD 0%
7.7	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

15 — 10 — 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-6 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+740.5, o/s 8.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 123.3 N; 227 668.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 14, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.3	Ground surface					*		20 40 60 80 100	20 40 60		
0.0	Granitic Gneiss bedrock		1	RC NQ	REC 100%		194				RQD 100%
	Unweathered to slightly weathered		2	RC NQ	REC 83%						RQD 65%
	High strength						193				
	Excellent to fair quality		3	RC NQ	REC 91%						RQD 83%
							192				
191.0			4	RC NQ	REC 91%		191				RQD 60%
3.3	End of borehole										

* Borehole charged with drilling water

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-7 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+737.7, o/s 4.0m Lt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 121.6 N; 227 673.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 19, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
194.1	Ground surface					*					
0.0	Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:44:20 AM

+7, ×5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-8 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+736.8, o/s 4.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 123.7 N; 227 681.1 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 15, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.5	Ground surface										
0.0	Granitic Gneiss bedrock Slightly weathered to unweathered High strength Very poor becoming fair to excellent quality		1	RC NQ	REC 55%						RQD 0%
			2	RC NQ	REC 81%		194				RQD 67%
			3	RC NQ	REC 100%		193				RQD 96%
			4	RC NQ	REC 88%		192				RQD 65%
190.9			5	RC NQ	REC 94%		191				RQD 88%
3.6	End of borehole * Borehole charged with drilling water										

+7, ×5 : Numbers refer to Sensitivity

15 — ○ — 5 (%) STRAIN AT FAILURE

10

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 4S-9 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+735.5, o/s 8.0m Rt.

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 123.9 N; 227 685.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 19, 2013 **CHECKED BY** C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.9	Ground surface										
194.8 / 0.1	Topsoil										
194.7 / 0.2	Sand trace silt, trace gravel organics Brown Moist										
	End of borehole Refusal on probable bedrock										
	* Borehole dry					*					

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 2/25/2014 11:44:21 AM

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. S-2 1 of 1 METRIC

Hwy 69 SBL, Sta. 21+756.5 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 071 140.5 N; 227 670.0 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** September 23, 2013 **CHECKED BY** C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
196.0 / 0.0	Ground surface Bedrock at surface					*					
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-MAGNETAWAN RIVER STRUCTURE.GPJ ON_MOT.GDT 7/21/2014 2:31:27 PM

+7, ×5 : Numbers refer to Sensitivity

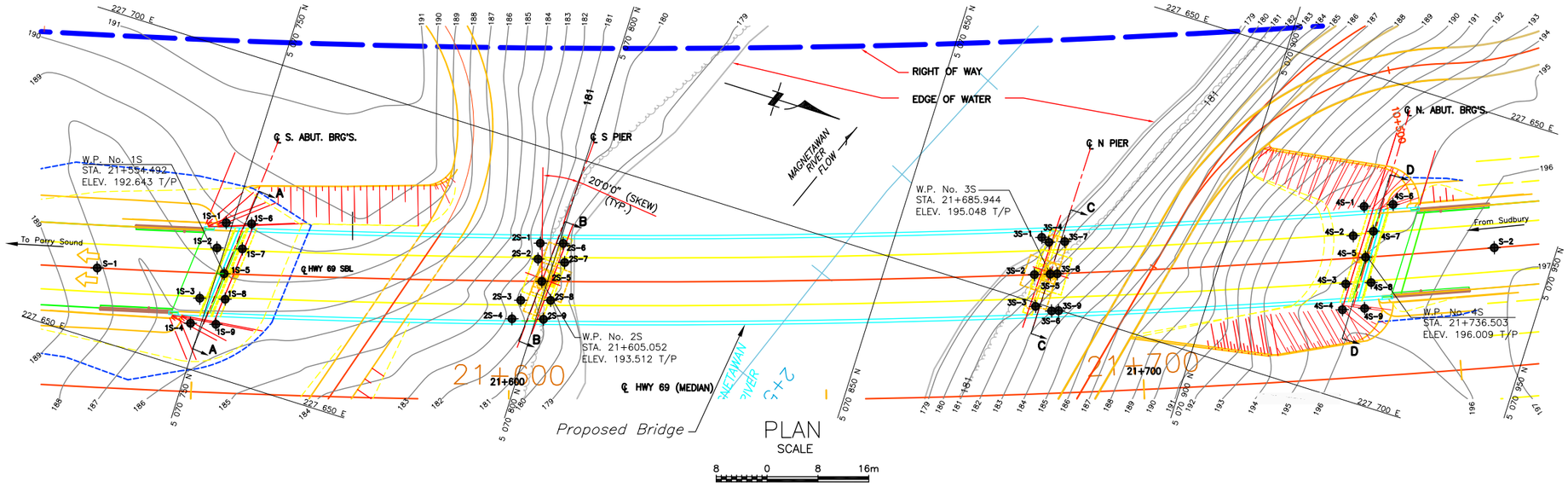
20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

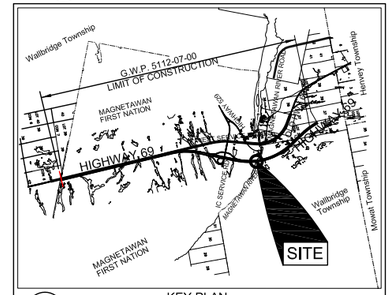
CONT No
WP No 5135-08-01

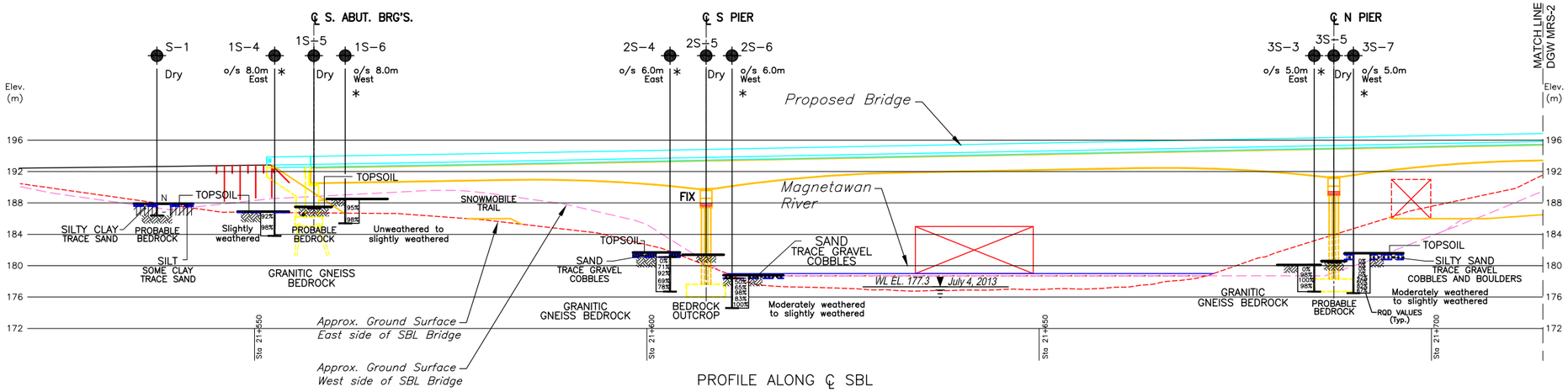
MAGNETAWAN RIVER BRIDGE
HIGHWAY 69 SBL
BOREHOLE LOCATIONS & SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS







NOTES:

1. DRAWINGS MRS-1 AND MRS-2 SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
2. REFER TO DRAWING MRS-2 FOR ℄ SBL PROFILE (Continued) SECTIONS A-A TO D-D.
3. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
4. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

(Legend Continued)

BH No	ELEVATION	CO-ORDINATES NORTHINGS	CO-ORDINATES EASTINGS
2S-6	178.8	5 071 000.6	227 713.4
2S-7	179.3	5 071 001.7	227 716.2
2S-8	179.9	5 071 001.4	227 722.6
2S-9	179.9	5 071 001.2	227 725.9
3S-1	180.1	5 071 072.1	227 689.9
3S-2	180.1	5 071 072.7	227 695.8
3S-3	180.1	5 071 074.1	227 700.5
3S-4	180.8	5 071 073.4	227 690.3
3S-5	180.6	5 071 075.1	227 695.0
3S-6	180.7	5 071 077.0	227 700.5
3S-7	181.6	5 071 075.8	227 689.4
3S-8	181.7	5 071 076.1	227 694.6

(Legend Continues)

(Legend Continued)

BH No	ELEVATION	CO-ORDINATES NORTHINGS	CO-ORDINATES EASTINGS
3S-9	181.1	5 071 078.1	227 700.1
4S-1	194.1	5 071 119.0	227 670.0
4S-2	194.3	5 071 118.8	227 674.9
4S-3	194.5	5 071 119.9	227 682.5
4S-4	194.7	5 071 120.6	227 686.5
4S-5	194.4	5 071 121.6	227 677.5
4S-6	194.5	5 071 123.3	227 668.3
4S-7	194.3	5 071 121.6	227 673.3
4S-8	194.7	5 071 123.7	227 681.1
4S-9	195.1	5 071 123.9	227 685.3
S-2	196.0	5 071 140.5	227 670.0

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60°Cone, 475 J/blow)
- WH Penetration due to weight of rods and hammer
- * Borehole charged with drilling water
- WL at time of investigation June to Oct. 2013
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	CO-ORDINATES NORTHINGS	CO-ORDINATES EASTINGS
S-1	187.9	5 070 931.8	227 739.2
1S-1	188.4	5 070 949.0	227 726.3
1S-2	188.2	5 070 948.8	227 730.5
1S-3	187.6	5 070 948.6	227 738.9
1S-4	186.9	5 070 948.4	227 743.1
1S-5	187.5	5 070 951.2	227 734.0
1S-6	188.5	5 070 952.9	227 725.2
1S-7	188.0	5 070 952.7	227 729.5
1S-8	187.0	5 070 952.5	227 737.8
1S-9	187.2	5 070 952.3	227 742.0
2S-1	182.5	5 070 997.1	227 714.5
2S-2	182.3	5 070 997.5	227 717.0
2S-3	182.9	5 070 996.9	227 724.0
2S-4	181.7	5 070 996.4	227 727.2
2S-5	181.4	5 070 999.2	227 720.2

(Legend Continues)

- NOTE -

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

REGISTERED PROFESSIONAL ENGINEER B. R. GRAY Oct. 24, 2014 PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER C M P Nascimento Oct. 24, '14 PROVINCE OF ONTARIO

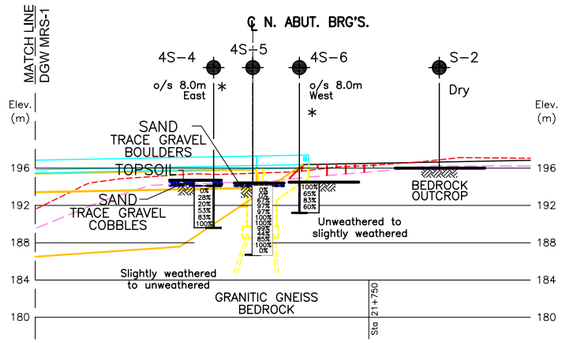
REVISIONS

DATE	BY	DESCRIPTION

Geocres No. 41H-141

REF No. AECOM Drawings: C6-Hwy69 Base-PDR.dwg; C6-Hwy69 Des.dwg;

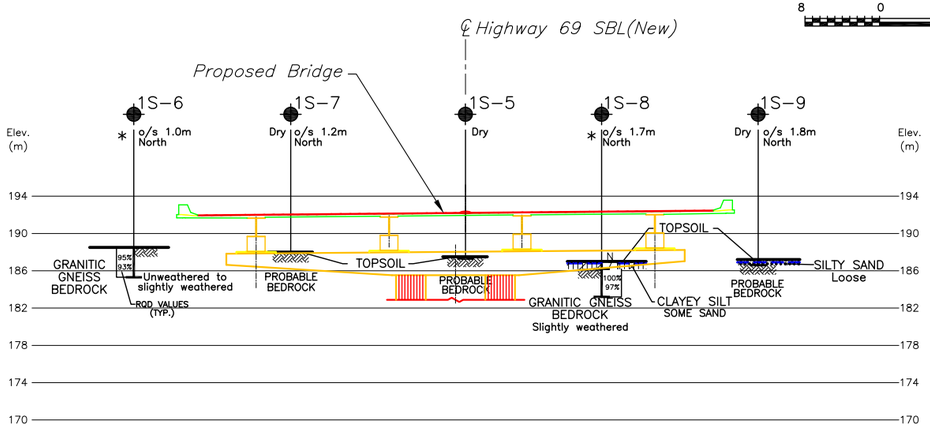
HWY No	69			DIST	54
SUBM'D	NA	CHECKED GD	DATE OCT. 24, 2014	SITE	44/457-2
DRAWN	NA	CHECKED BRG	APPROVED CN	DWG	MRS-1



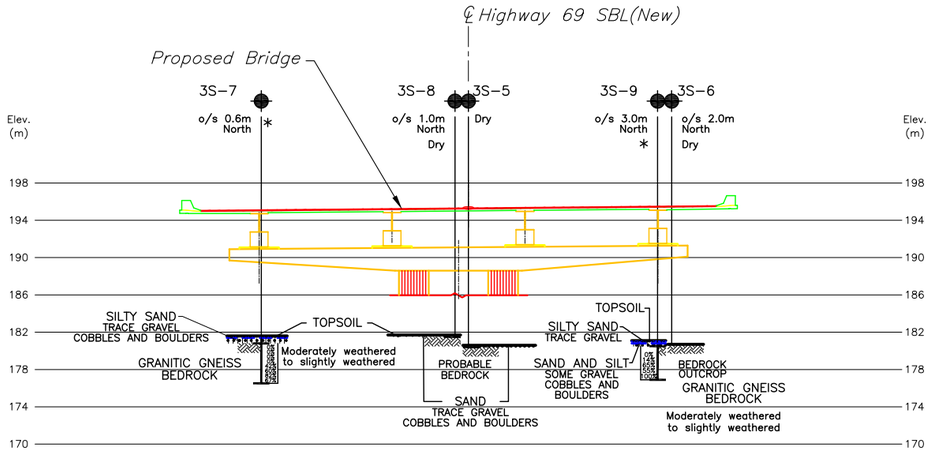
PROFILE ALONG ℄ SBL (Continued)

SCALE

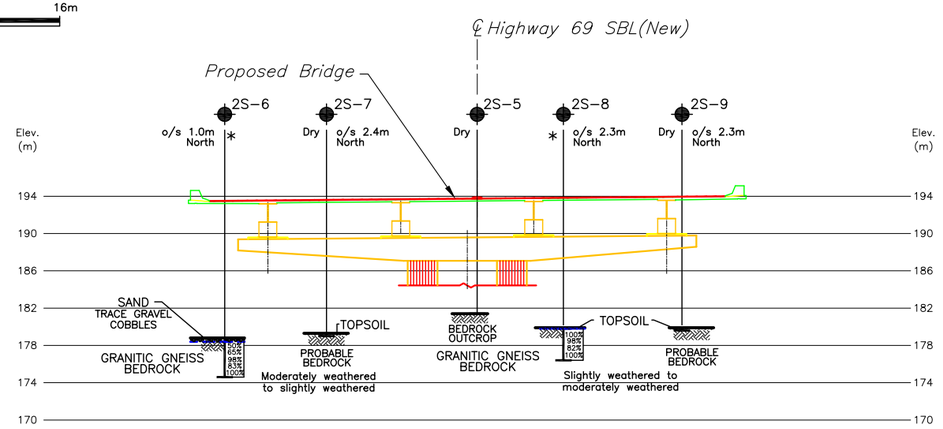
8 0 8 16m



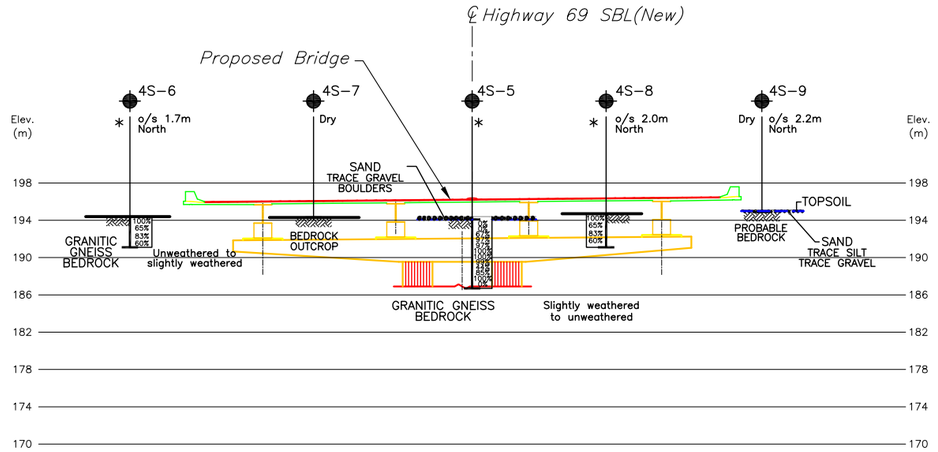
SECTION A–A



SECTION C–C



SECTION B–B



SECTION D–D

NOTES:

1. DRAWINGS MRS–1 AND MRS–2 SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
2. REFER TO DRAWING MRS–1 FOR BOREHOLE AND SECTION LOCATIONS AND CENTRELINE PROFILE.
3. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
4. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

SCALE

HORIZONTAL

2 0 2 4m

VERTICAL

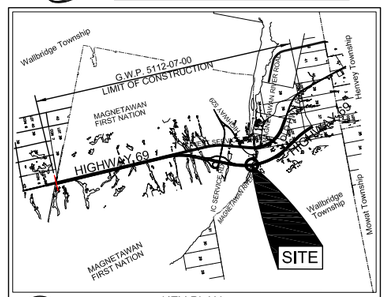
8 0 8 16m

CONT No
WP No 5135–08–01

MAGNETAWAN RIVER BRIDGE
HIGHWAY 69 SBL
SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
1.0 0 1.0 2.0 km

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60°Cone, 475 J/blow)
- WH Penetration due to weight of rods and hammer
- * Borehole charged with drilling water
- WL at time of investigation June to Oct. 2013
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	CO–ORDINATES NORTHINGS	EASTINGS

REFER TO DWG. MRS–1 FOR DETAILS

– NOTE –

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

REVISIONS			
DATE	BY	DESCRIPTION	

Geocres No. 41H–141

HWY No	69			DIST	54
SUBM'D	NA	CHECKED	GD	SITE	44/457–2
DRAWN	NA	CHECKED	BRG	DWG	MRS–2
		DATE	OCT. 24, 2014		
		APPROVED	CN		

REF No. AECOM Drawings: C6-Hwy69 Base-PDR.dwg; C6-Hwy69 Des.dwg;

APPENDIX A

Site Photographs

Photograph 1: Drilling at the south abutment of the SBL structure. (July 22, 2013)

Photograph 2: Facing southeast at the location of borehole 2S-8 at the south pier of the SBL structure. (August 20, 2013)

Photograph 3: Difference in elevations at the south pier of the SBL structure. (August 20, 2013)

Photograph 4: Drilling at the location of borehole 3S-7 at the north pier of the SBL structure. Borehole 3S-3 is staked at right. (June 25, 2013)

Photograph 5: Exposed bedrock with moss covering at the north abutment of the SBL structure, facing north. (August 19, 2013)

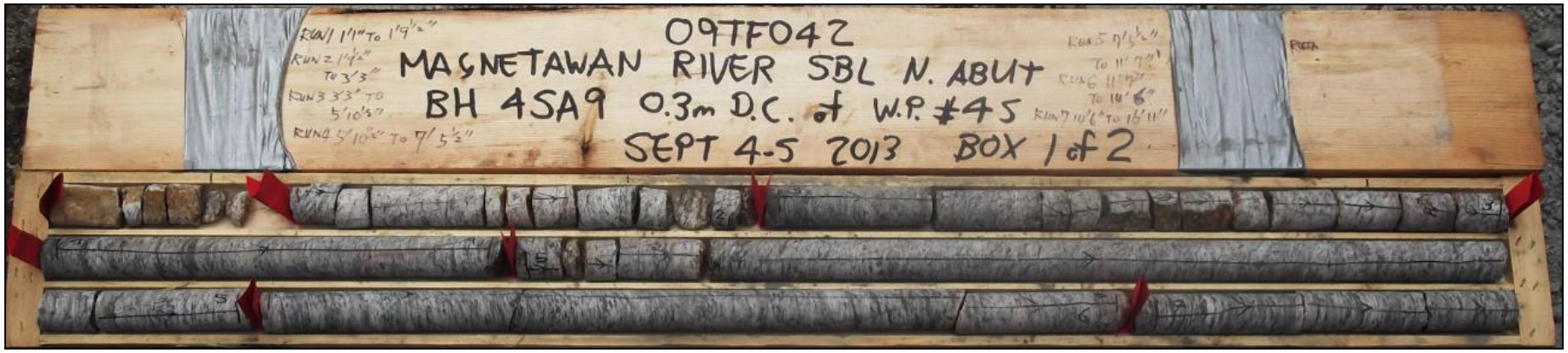
APPENDIX B

Rock Core Photographs

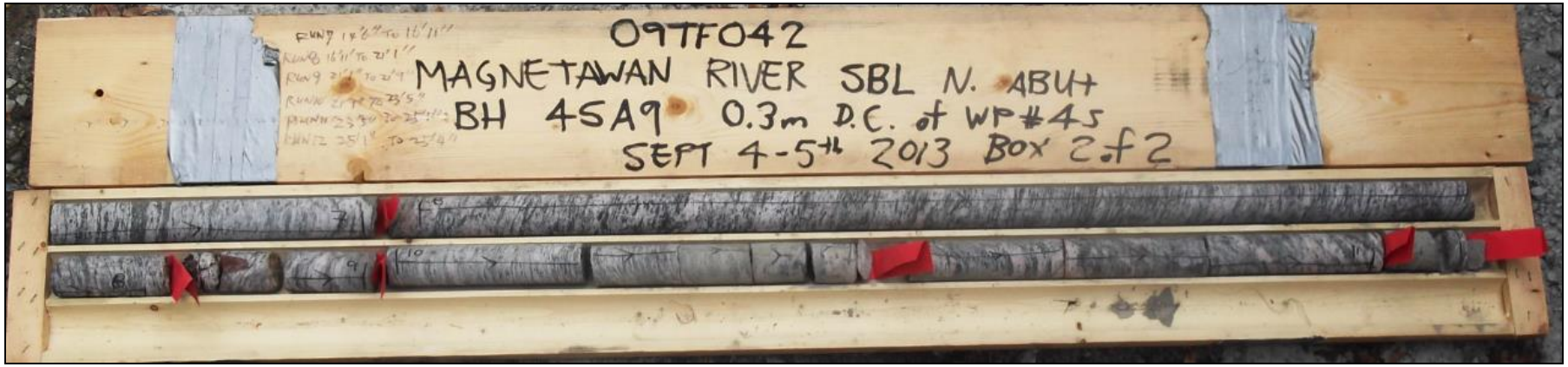
Photograph 1: Cores retrieved from borehole 1S-6. Rock cores 1 and 2 from 0.0 to 3.2 m depth. RQD values were 95 and 93%, indicating excellent rock quality.

Photograph 2: Cores retrieved from borehole 2S-4. Rock cores 1 to 5 from 0.6 to 5.0 m depth. RQD values ranged from 0 to 92%, indicating very poor becoming fair to excellent rock quality.

Photograph 3: Cores retrieved from borehole 4S-4. Rock cores 1 to 6 from 0.6 to 5.1 m depth. RQD values ranged from 0 to 100%, indicating very poor to poor becoming fair to excellent rock quality.



Photograph 4: Cores retrieved from borehole 4S-5 (box 1 of 2). Rock cores 1 to 7 from 0.3 to 4.8 m depth. RQD values ranged from 0 to 100%, indicating very poor becoming fair to excellent rock quality.



Photograph 5: Cores retrieved from borehole 4S-5 (box 2 of 2). Rock cores 7 to 12 from 4.8 to 7.7 m depth. RQD values ranged from 0 to 100%, indicating good to excellent locally poor and very poor rock quality.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION DESIGN REPORT

for

MAGNETAWAN RIVER SOUTHBOUND BRIDGE
HIGHWAY 69
SITE NO. 44-457/2
W.P. 5135-08-01
MAGNETAWAN FIRST NATION, ONTARIO

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October 29, 2014

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION DESIGN REPORT
for
Magnetawan River Southbound Bridge
Highway 69
Site No. 44-457/2
W.P. 5135-08-01
Magnetawan First Nation, Ontario

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1. INTRODUCTION

This report provides foundation engineering comments and recommendations regarding design and construction of the foundations and approach embankments for the proposed construction of a bridge to carry Highway 69 (New) southbound traffic over the Magnetawan River in Magnetawan First Nation, Ontario. The investigation was conducted for AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation of Ontario (MTO).

The bridge is at approximate Station 21+645, Highway 69 chainage, in Magnetawan First Nation, about 90 km south of Sudbury. The bridge is proposed to be a 3-span structure with a total length of 180 m and width of 14 m (ref. General Arrangement Drawing 1 'Hwy. 69 – SBL Magnetawan River Crossing' prepared by AECOM in May 2012).

The road grade on Highway 69 (New) at the bridge location is planned to be at elevation 192.6 at the south abutment and elevation 196.0 at the north abutment, some 14.5 to 16.0 m above the normal water level in the Magnetawan River. The approach embankments to the structure are envisaged to be 3 to 5 m high at the south abutment and 1 to 2 m high at the north abutment (interpolated from ground surface elevations and the proposed road grade).

In summary, the site is located about 230 m east of the existing Highway 69 on a rock outcrop where the subsurface stratigraphy revealed in the boreholes generally comprised surficial topsoil, sandy/silty soils and/or silty clay / clayey silt over bedrock or exposed bedrock. Cobbles and boulders were encountered in 9 boreholes. The bedrock surface was contacted/inferred at depths of 0.0 to 1.5 m (elevation 178.4 to 196.0). Subject to seasonal variations and weather dependent precipitation, the water level in the river is normally near elevation 179.0. This water level was at elevation 177.3 on July 4 and at elevation 176.1 on August 21, 2013. The Magnetawan River is normally about 65 m wide and flows to the west at the site.

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The depth to and surface elevation of the bedrock identified in the boreholes drilled at this site are summarised in the following table:

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
South Approach	S-1	1.5	186.4
South Abutment	1S-1	0.1	188.3
	1S-2	0.2	188.0*
	1S-3	0.9	186.7
	1S-4	0.1	186.8*
	1S-5	0.2	187.3
	1S-6	0.0	188.5*
	1S-7	0.1	187.9
	1S-8	0.8	186.2*
	1S-9	0.6	186.6
South Pier	2S-1	0.0	182.5
	2S-2	0.0	182.3*
	2S-3	0.0	182.9
	2S-4	0.6	181.1*
	2S-5	0.0	181.4
	2S-6	0.4	178.4*
	2S-7	0.3	179.0
	2S-8	0.1	179.8*
	2S-9	0.3	179.6
North Pier	3S-1	0.0	180.1*
	3S-2	0.3	179.8
	3S-3	0.0	180.1*
	3S-4	0.0	180.8
	3S-5	0.2	180.4
	3S-6	0.0	180.7
	3S-7	0.8	180.8*
	3S-8	0.2	181.5
	3S-9	0.5	180.6*
North Abutment	4S-1	0.0	194.1
	4S-2	0.0	194.3*
	4S-3	0.2	194.3
	4S-4	0.6	194.1*
	4S-5	0.3	194.1*
	4S-6	0.0	194.5*
	4S-7	0.0	194.3
	4S-8	0.0	194.7*
	4S-9	0.2	194.9
North Approach	S-2	0.0	196.0

* confirmed by rock coring

In view of the very small depth of the bedrock below the ground surface and the planned grades of the bridge deck, it is considered that integral abutments will require deep trenches or coring of large diameter deep holes to install the piles and this is not economical. The structure may be designed with semi-integral or conventional abutments.

It is noteworthy that the very poor rock quality conditions may require local remediation to adequately withstand the lateral load transferred from spread footings. These measures include rock bolting or grouting and should be evaluated and determined at the time of construction. These remedial measures should be paid out of a contingency allowance in the contract. A NSSP should be included in the tender documents to alert the contractor of the possible local remediation necessity to adequately withstand the lateral forces.

The "red flag" issues outlined in the preceding paragraphs and the recommended methods of overcoming these issues noted in the following sections of the report are intended to alert and aid the designer and the contractor. These comments and recommendations are based on the conditions revealed during the investigations and no responsibility is assumed by the consultants or the MTO for alerting the contractor to all critical issues for each foundation alternative. The requirements to deliver acceptable construction quality remain the responsibility of the contractor.

2. FOUNDATIONS

2.1 General

The design road grade at the bridge location is at elevation 192.6 to 196.0, about 1 to 5 m and 11 to 15 m above the ground surface at the abutments and piers respectively.

It is recommended that the abutment and pier foundations be supported by spread footings founded on bedrock.

Spread footings founded on bedrock are considered to be the preferred foundation system due to the shallow depth to bedrock at the locations of the abutments and piers (less than 2 m). It is noteworthy that boulders present at the site should be removed prior to placing the footings or fill. The need to remove boulders should be specified in contract documentation as a notice to the contractor.

The seismic coefficient for the conditions at this site is 1.0 (Type I soil profile as per clause 4.4.6 of the Canadian Highway Bridge Design Code (CHBDC), CAN/CSA-S6-00). The zonal acceleration ratio is 0.05. The bridge site is located in Seismic Performance Zone 1.

All footings subject to frost action should be provided with 2.0 m of earth cover or equivalent thermal insulation. A 25 mm thick layer of polystyrene insulation is thermally equivalent to 600 mm of soil cover. Footings bearing directly on bedrock do not require protection from frost.

Construction of the footings should be performed and monitored in accordance with OPSS 902 to verify the competency of the founding surface. In addition, a rock engineering specialist should be retained to examine the integrity and/or impact on bedrock below the footings, should blasting be required near the bridge foundations.

Further comments and recommendations for design of the foundations are provided in the following sections. A summary of the advantages, disadvantages and the preferred foundation type from a foundation engineering perspective is given in Table 1. The standard specifications referenced in this report are listed in Table 2.

2.2 Spread Footings

As discussed in section 2.1, the foundations for the abutments and piers may be constructed as footings on bedrock. The anticipated depth and elevation to bedrock at each borehole location are tabulated in section 1.0. The bedrock surface level within the footprints of the foundation elements ranges from elevation 186.2 to 188.5 at the south abutment, from elevation 178.4 to 182.9 at the south pier, from elevation 179.8 to 181.5 at the north pier and from elevation 194.1 to 194.9 at the north abutment. The inferred surface of the bedrock generally slopes down to the east at inclinations of 1 to 7° at the south abutment, to the north at angles of 5 to 14° at the south pier, to the south at angles of 1 to 4° at the north pier and to the south at inclinations of 1 to 3° at the north abutment, locally dipping at maximum angles of 14°, 49°, 26° and 11° respectively.

The bedrock generally comprises a moderately weathered to unweathered high strength granitic gneiss and is classified as poor to excellent quality (RQD of 28 to 100%) with a core recovery in excess of 44%. Very poor quality rock was identified in a number of samples in boreholes 2S-2, 2S-4, 3S-3, 3S-7, 3S-9, 4S-2, 4S-4, 4S-5 and 4S-8 – most notably the upper 0.3 to 2.4 m thick

zones in boreholes 2S-4, 3S-3, 3S-7, 3S-9, 4S-4, 4S-5 and 4S-8. It is considered that the rock is capable of adequately supporting the foundation loads.

Footings bearing on the high strength bedrock should be designed using a factored geotechnical bearing resistance of 10 MPa at ultimate limit states (ULS). In case of the footings founded on the very poor quality bedrock that has been remediated, the factored geotechnical bearing resistance at ULS of 5 MPa may be used. The geotechnical reaction at serviceability limit states (SLS) allows for 25 mm compression of the founding medium. Considering the bedrock to be non-yielding, the design will not be governed by settlement criteria since the loading required to produce 25 mm deformation would be much larger than the factored geotechnical resistance at ULS. Consequently the geotechnical reaction at SLS should be taken the same as the factored geotechnical resistance at ULS for computation purposes. The geotechnical bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.7.4 of the CHBDC.

Mass concrete could be placed to provide a level founding surface for the footings where required. Mass concrete could also be employed to raise the subgrade to the design level of the footings. The need to expand the plan area at the base of the mass concrete to provide for stress distribution (2V:1H), place reinforcing steel in the mass concrete and/or use high strength concrete to prevent overstressing will be dictated by structural design considerations including the actual thickness of the mass concrete.

Subject to these comments, the bearing resistance provided for footings bearing on bedrock is considered to be appropriate for mass concrete with an unconfined compressive strength of at least 35 MPa. If the actual bearing pressure is less than 8 MPa, the unconfined compressive strength of the concrete could be reduced in direct linear proportion to the actual bearing stress to a minimum of 25 MPa.

Comments concerning excavation of bedrock to enable construction of the footings are provided in section 5 of this report.

The horizontal force imposed on the foundations will be resisted in part by the friction force developed between the underside of the footing and the bedrock. An unfactored friction factor of

0.7 is recommended for footings constructed on rough bedrock surfaces (asperity height of at least 25 mm).

The need to install anchors / dowels to resist sliding if the slope of the bedrock surface referred to previously is unfavourably inclined relative to the direction of the force imposed by the foundation loads should be considered by the structural engineer. Design, installation and testing of the anchors subjected to tensile stresses should be conducted in accordance with SP 999S26 and clause 6.10.4 of the CHBDC.

A NSSP should be included in the tender documents for inspection of the footing subgrade by a specialist rock mechanics engineer. Based on the inspection, rock bolts or grouting and/or local scaling may be required. Refer to Appendix 1 for an example of the NSSP “Inspection of Footings by a Specialist Rock Mechanics Engineer”.

The lateral resistance of footings founded on bedrock could be increased by means of a shear key and/or by installing anchors into the bedrock (SP 999S26). The increased lateral resistance will be provided by the shear strength of steel dowels if used, the horizontal resistance of the bedrock, the horizontal component of tensile forces developed in any inclined anchors and/or a greater frictional resistance between the footing and rock if the anchors are prestressed to increase the vertical pressure. The factored horizontal resistance at ULS of the bedrock is considered to be 5000 kPa.

If dowels into concrete are employed, a NSSP should be included in the tender documents to provide specific direction for the contractor during installation and testing of the dowels.

If anchors are installed, a factored bond stress at the rock/grout interface of 1.4 MPa at ULS (a resistance factor of 0.4 is applied for a minimum 35 MPa grout) is recommended for design. The anchors should extend at least 30 bar diameters into sound bedrock and be spaced at a distance of at least four times the diameter of the anchor hole. The total capacity of a group of closely spaced anchors may be less than the summed capacities of the individual anchors; the impact of anchor interaction should be assessed if the spacing is less than one-fifth of the anchor length.

2.3 Piles

Taking into account the shallow depth to bedrock at the locations of the abutments and piers (less than 2 m), use of steel H-piles driven to bedrock through the embankment fill is not considered to be a suitable method of supporting the south and north abutment foundations. Based on the proposed abutment grades, it is very likely that local bedrock excavation or large diameter coring to provide for the structurally required minimum 3 to 5 m free pile length for integral abutments would be necessary as well. It is therefore not recommended to use steel H-piles to support the foundation loads at the site.

3. ABUTMENT WALLS

The abutment walls should be designed to resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the wall. The lateral earth pressure may be computed using the equivalent fluid pressure diagrams presented in Section 6.9 of the CHBDC or employing the following equation, assuming a triangular pressure distribution:

$p = K(\gamma h + q) + Cp + Cs$

where K = coefficient of lateral earth pressure (dimensionless)
γ = unit weight of free-draining granular material, kN/m^3
h = depth below final grade, m
q = surcharge load, kPa, if present
Cp = compaction pressure, kPa (refer to clause 6.9.3 of CHBDC)
Cs = earth pressure induced by seismic events, kPa (refer to clause 4.6.4 of CHBDC)
where $Ø$ = angle of internal friction of retained soil (35º for Granular B Type II)
δ = angle of friction between the soil and wall (23.5º for Granular B Type II)

The seismic site coefficient and zonal acceleration ratio for the conditions at this site were provided in section 2.1.

Free-draining granular material or rockfill should be used as backfill behind the walls. The following parameters are recommended for design:

Parameters	Granular A or Granular B Type II	Rockfill
Angle of Internal Friction, degrees	35	42
Unit Weight, kN/m^3	22.8	18.0

Parameters	Granular A or Granular B Type II	Rockfill
Coefficient of Active Earth Pressure K_a	0.27	0.20
Coefficient of Earth Pressure At-Rest K_o	0.43	0.33
Coefficient of Passive Earth Pressure K_p	3.69	5.04

The coefficient of earth pressure at-rest should be used for design of rigid and unyielding walls, the active earth pressure coefficient for unrestrained structures. The earth pressure coefficients should be reviewed if the slope of the backfill exceeds 10° to the horizontal. Alternatively, the material above the top of the wall could be treated as a surcharge load (q in the preceding equation).

A weeping tile system (OPSS 405 and OPSD 3190.100) should be installed to minimise the build-up of hydrostatic pressure behind the walls. The weeping tiles should be surrounded by a properly designed granular filter or geotextile to prevent migration of fines into the system. The drainage pipe should be placed on a positive grade.

Backfilling adjacent to retaining structures should be carried out in conformance to Ontario Provincial Standards specifications for granular or rock backfill at abutments (OPSD 3101.150 and 3101.200).

Operation of compaction equipment adjacent to retaining structures should be restricted to limit the compaction pressure noted in clause 6.9.3 of the CHBDC. Refer to OPSS 501 for additional information in this regard.

4. APPROACH EMBANKMENTS

The height of fill embankments will be 3 to 5 m at the south approach and 1 to 2 m at the north approach. It is anticipated that the approach embankments will be constructed with earth borrow, granular material or rockfill. Construction of the fill on bedrock is considered to be feasible.

The topsoil identified at the abutment locations and along the alignment of the approach fills within 20 m of the abutments should be stripped prior to placement of the embankment fill. All loose boulders should be removed from each approach embankment footprint.

The embankments should be constructed in accordance with OPSD 201.020, 202.010 and SP 206S03. The side slopes of the approach embankments should be inclined no steeper than 2H:1V for earth fill and 1.25H:1V for rockfill. A 2 m wide mid-height berm for erosion control and slope maintenance purposes is not necessary at the site.

Where slope flattening is proposed, a drainage gap should be provided in accordance with OPSD 202.020. Where slopes are flattened to eliminate the need for a guiderail, a granular infilled drainage gap should be provided in accordance with the Northeastern Region Pavement Design Practices and Guidelines as shown in Figure 1, appended. OPSS Granular B Type II should be used for the drainage gaps.

Where the bedrock surface slopes in the direction transverse to the roadway alignment, it should be benched in accordance with OPSD 208.010 to provide stable conditions.

It is considered that the approach embankments constructed in accordance with these recommendations will be stable. Settlement of the road surface will only be governed by 'consolidation' of the newly placed fill (settlement of the embankment fill due to consolidation of the bedrock at both embankments is negligible).

The backfill placed adjacent to the abutments will be about 1 to 5 m thick. The magnitude of 'consolidation' of this fill will be dependent on the workmanship employed by the contractor and, if placed in 200 to 300 mm thick lifts compacted to 100% of the standard Proctor maximum dry density in accordance with the requirements of OPSS 902 and OPSS 501 (Method A), should be in the order of 15 mm at the south abutment and about 5 mm at the north abutment. The settlement of the approach fill surface near the abutments should be essentially complete within 2 to 3 months after placement of the fill.

The settlement of the approach embankments made up of rockfill if used beyond the granular fill zone at the abutments is estimated to be 20 to 30 mm at the south approach and some 10 mm at the north approach. The settlement remaining after 6 and 12 months following fill placement is 5 to 10 mm and about 5 mm respectively. These values have been assessed using "Post-construction rock fill settlement and guidelines for estimating rock fill quantity" issued by MTO on September 14, 2010.

The embankment platform founded on bedrock should be widened by 1 m in accordance with the Northeastern Region Engineering Directive (NRE 98-200).

Earth fill slopes where employed should be protected against surface erosion by sodding and suitable vegetation. Refer to OPSS 803 or 804 for time constraints and the type of seed and mulch required.

5. EXCAVATION AND GROUNDWATER CONTROL

It is expected that excavation for construction of spread footings founded on bedrock will extend through the sandy/silty soils and/or silty clay / clayey silt to a depth not exceeding 2 m at the abutments and piers.

The loose sandy/silty soils and firm to stiff silty clay / clayey silt are classified as Type 3 soils according to the Occupational Health and Safety Act (Ontario Regulation 213/91) criteria. Temporary cut slopes in earth over the full depth of excavation should therefore be inclined at an angle of 45° to the horizontal. The need to excavate flatter sideslopes if very loose sandy/silty soils, soft to very soft silty clay / clayey silt, excessively soft/wet materials or concentrated seepage zones are encountered locally during construction should be considered.

It is noted that steep rock faces are present at the locations of the bridge piers. Bedrock is classified as Type 1 soil. In general, near vertical sidewalls may be utilised for excavations in bedrock. However, where the rock quality is poor to very poor, the resulting excavation slope may need to be flatter subject to local site inspections during construction. Examination of the sidewalls and removal of any loosened rock fragments should be carried out continually for the safety of workmen.

Mechanical means such as a large excavator equipped with a tiger-toothed bucket in conjunction with a jack-hammer or hoe ram is the preferred method of excavation to shallow depths in rock scaling at foundation locations (SP 299F03). Conventional rock excavation techniques such as blasting (OPSS 120), controlled blasting (SP 299F06) and trim blasting (SP 299F04) are likely to be required as well. The actual equipment required and method of excavation within the bedrock will be dependent upon the geometry of cut and the relative depth of excavation into the bedrock. Mass concrete could be employed to level minor variations in the bedrock surface.

If blasting is required, a NSSP should be prepared to provide specific direction to the contractor to control the blasting / rock excavation activities to prevent fracturing and/or disturbance of the bedrock surface on which footings will be founded; require that a blasting specialist be retained to establish the charge to minimise overbreak; advise the contractor that any overblasting / overexcavation will be the sole responsibility of the contractor and require that loosened rock resulting from blasting operations be removed by mechanical means. It should also be specified that the vertical faces of the bedrock behind the pier footings are load bearing and the integrity of these faces should be preserved by carefully controlled rock excavation. Refer to Appendix 1 for an example of the NSSP “Rock Blasting / Excavation for Footings Construction”.

In addition, the Department of Fisheries Guideline for use of explosives in or near Canadian Fisheries Water (Canadian Technical Report of Fisheries and Aquatic Sciences 2107, dated 1998) should be followed when conventional rock excavation techniques such as blasting are required near the Magnetawan River to protect the water environment and fish habitat.

No groundwater was observed in any of the boreholes during and upon completion of drilling. The stabilised groundwater level is expected to be consistent with the water level in the Magnetawan River, normally near elevation 179.0. The water level was at elevation 177.3 on July 4 and at elevation 176.1 on August 21, 2013. It is anticipated that conventional sump pumping techniques will be sufficient to control seepage of groundwater into the foundation excavations. Groundwater levels are subject to seasonal fluctuations and precipitation patterns.

All work should be carried out in accordance with the Occupational Health and Safety Act (Ontario Regulation 213/91) and with local/MTO regulations.

6. CLOSURE

This report was prepared by Mr. G.O. Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. B.R. Gray, MEng, P.Eng., MTO Designated Principal Contact. Mr. C.M.P. Nascimento, P.Eng., Project Manager, conducted an independent review of the report.

Yours very truly,

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GD/CN/BRG:ak

TABLE 1

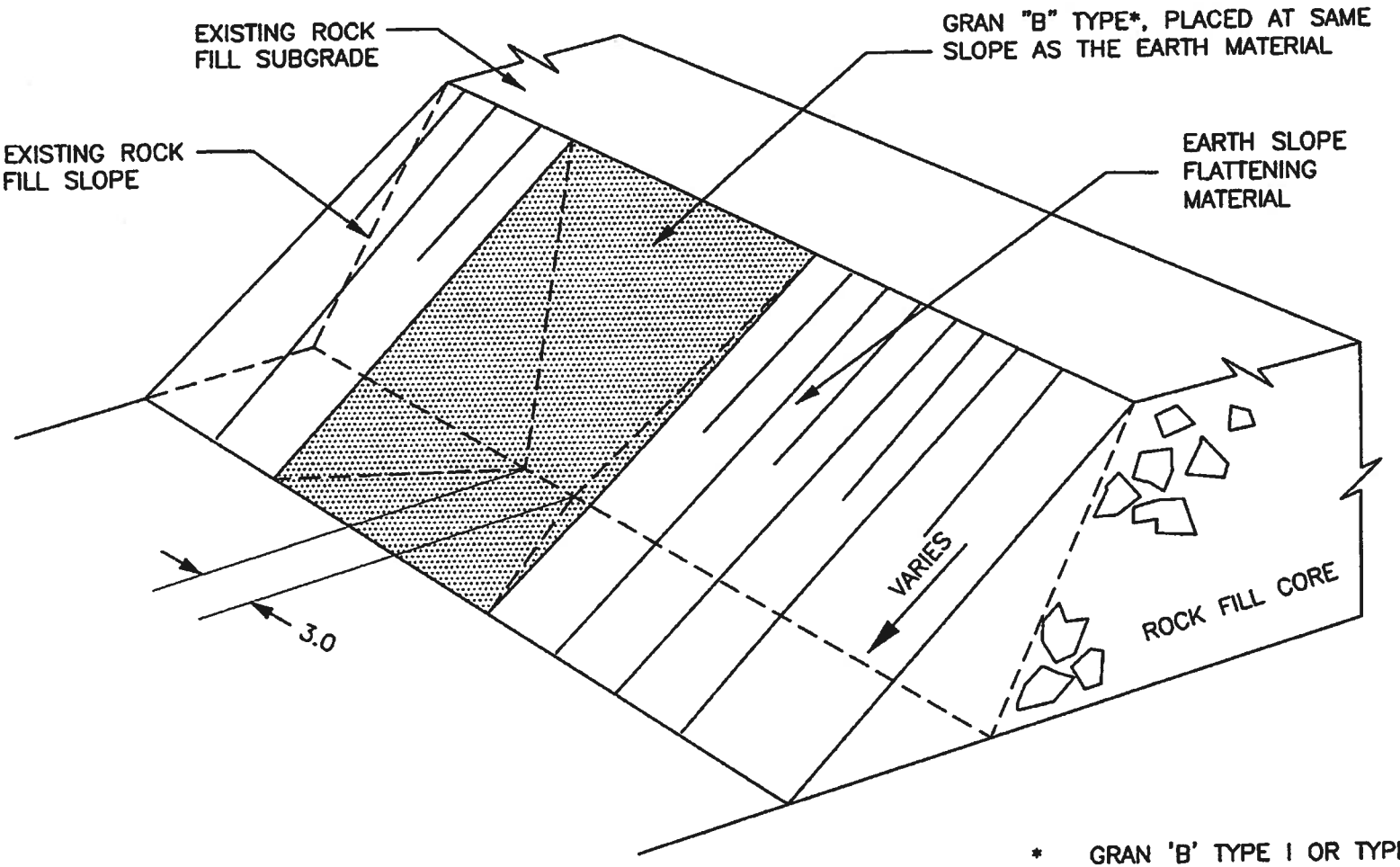
SUMMARY OF ADVANTAGES, DISADVANTAGES AND RECOMMENDED FOUNDATIONS

FOUNDATION TYPE	ADVANTAGES	DISADVANTAGES	RECOMMENDED FOUNDATION TYPE
SOUTH AND NORTH ABUTMENTS			
Spread footings on rock	• Ease of construction • Minimal requirement for rock excavation • No requirement to provide erosion protection	• Need to place mass concrete to provide a level surface	Spread footings
Spread footings on engineered fill pad	Not appropriate		
Driven piles	• High capacity • Allows for integral abutments	• Too short piles; would require rock trenches or large diameter drilled holes • High cost relative to footings	
Caissons	• High capacity	• Special construction methods on sloping bedrock • High cost relative to other alternatives	

TABLE 2

LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE
OPSS 120	General Specification for the Use of Explosives
OPSS 405	Construction Specification for Pipe Subdrains
OPSS 501	Construction Specification for Compacting
OPSS 803	Construction Specification for Sodding
OPSS 804	Construction Specification for Seed and Cover
OPSS 902	Construction Specification for Excavation and Backfilling - Structures
SP 206S03	Construction Specification for Grading
SP 299F03	Rock Excavation (Machine Scaling)
SP 299F04	Rock Excavation (Trim Blasting)
SP 299F06	Rock Excavation (Controlled Blasting)
SP 999S26	Requirements for Design, Installation and Testing of Temporary and Permanent Pre-Stressed Anchors in Soil and Rock
OPSD-201.020	Rock Grading-Divided Rural
OPSD-202.010	Slope Flattening Using Excess Material on Earth or Rock Embankment
OPSD-202.020	Drainage Gap for Slope Flattening on Rock or Granular Embankment
OPSD-208.010	Benching of Earth Slopes
OPSD-3101.150	Minimum Granular Backfill Requirements - Abutments
OPSD-3101.200	Walls Abutment, Backfill Rock
OPSD-3190.100	Retaining Wall and Abutment Wall Drain Detail
NRE 98-200	Northeastern Region Directive - Platform Widening



* GRAN 'B' TYPE I OR TYPE II AS RECOMMENDED FOR PROJECT.

FIGURE 1: ROCK FILL DRAINAGE IN SLOPE FLATTENED AREAS

NOT TO SCALE

APPENDIX 1

Non-Standard Special Provisions:

- Inspection of Footings by a Specialist Rock Mechanics Engineer
- Rock Blasting / Excavation for Footings Construction

INSPECTION OF FOOTINGS BY A SPECIALIST ROCK MECHANICS ENGINEER

Non-Standard Special Provision

The bedrock footing subgrade shall be inspected by a Specialist Rock Mechanics Engineer. The Engineer shall report on the acceptance of the footing subgrade.

ROCK BLASTING / EXCAVATION FOR FOOTINGS CONSTRUCTION

Non-Standard Special Provision

Blasting / rock excavation shall be controlled to prevent fracturing and/or disturbance of the bedrock footing subgrade. A rock blasting specialist should be retained to establish the charge to minimise overbreak. Any overblasting / overexcavation shall be the sole responsibility of the Contractor.

The impact on bedrock by blasting at the foundation locations and the integrity of the footing subgrade shall be inspected by a Specialist Rock Mechanics Engineer.

The Contractor must be aware that the vertical faces of the bedrock behind the pier footings are load bearing and the integrity of these faces should be preserved by carefully controlled rock excavation.

Loosened rock resulting from blasting operations should be removed by mechanical means. Local remediation may be required at the footings based on the inspection by a Specialist Rock Mechanics Engineer. The remedial methods shall be provided to the Contractor by the Specialist Rock Mechanics Engineer.