

**FOUNDATION INVESTIGATION REPORT
CEDAR CREEK BRIDGE REHABILITATION
HIGHWAY 17
DISTRICT OF THUNDER BAY, ONTARIO**

G.W.P. 6068-09-00, Site No: 48E-27

Geocres Number: 42C-33

Report to:

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the Cedar Creek Bridge on Highway 17, in the District of Thunder Bay, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

2 SITE DESCRIPTION

The Cedar Creek Bridge is located on Highway 17, between Marathon and White River, Ontario, approximately 1.8 km west of the intersection of Highways 614 and 17. The existing bridge over Cedar Creek is a single span structure with a span of about 13.7 m, a skew of 25°, and a width of 13.4 m. The approach embankments are approximately 4 to 5 m high.

Cedar Creek flows out of Little Cedar Lake and meanders in a north westerly direction. The lands immediately surrounding the bridge site are generally forested. Gold mining operations including an open pit are located approximately 2 km west of the site.

Photographs in Appendix C show the general nature of the site and the existing bridge.



The site lies at the boundary between the Quetico and Wawa Subprovinces of the Superior Province of the Canadian Shield. The site is underlain by metasedimentary rocks primarily comprising wacke and siltstone. The bedrock is overlain by silty to sandy till and thin drift deposits.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between July 7 and 9, 2013 and consisted of drilling and sampling four boreholes, identified as Boreholes CED-01 to CED-04. The boreholes were advanced to depths of 6.6 to 10.4 m, including recovery of 3.1 to 3.3 m of bedrock core from Boreholes CED-02 to CED-04 and 1.6 m from Borehole CED-01. Dynamic Cone Penetration Tests (DCPTs) were carried out adjacent to Boreholes CED-02 and CED-03.

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing in Appendix D.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling. The coordinates and ground surface elevations for the boreholes were estimated from topographic plans provided by MMM Group Limited.

A truck-mounted CME 75 drill rig was used to advance the boreholes using a combination of NW casing/ wash boring techniques and NQ coring. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). All rock cores were logged in the field and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and Fracture Indices (FI) were determined.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and rock samples for transporting to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Groundwater conditions observed after completion of drilling were not representative of site conditions as water was introduced into the boreholes during wash boring and coring operations. Standpipe piezometers were installed in two boreholes to monitor the groundwater level after drilling. The piezometers were subsequently decommissioned and the boreholes without piezometers were backfilled in general accordance with MOE Regulation 903. Completion details of the piezometers and boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Boreholes	Piezometer Tip Depth/ Elevation (m)	Completion Details
West Approach	CED-01	None installed	Borehole backfilled with holeplug to 0.1 m, then asphalt to surface.
West Abutment	CED-02	10.4/ 305.1	Sand from 10.4 m to 6.6 m, holeplug from 6.6 m to 0.15 m, then asphalt to surface.
East Abutment	CED-03	9.9/ 305.7	Sand from 9.9 m to 6.4 m, holeplug from 6.4 m to 0.2 m, then asphalt to surface.
East Approach	CED-04	None installed	Borehole backfilled with holeplug to 0.1 m, then asphalt to surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer). The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and on the figures presented in Appendix B.

Bedrock core samples were subjected to geological logging. Point load tests were carried out on selected samples of intact bedrock in the laboratory to evaluate the unconfined compressive strength (UCS) of the bedrock. The UCS values of the rock assessed from the point load test data are reported on the borehole logs in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented in these sheets and on the “Borehole Locations and Soil Strata” drawing included in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

The site stratigraphy typically comprises asphalt pavement overlying existing granular embankment fill underlain by relatively thin native deposits of gravelly sand and silty sand till, which in turn overlie bedrock. More detailed descriptions of the individual strata are presented below.

5.1 Asphalt

Asphalt was encountered at the roadway surface in all boreholes. The asphalt layer was between 100 and 200 mm thick.

5.2 Embankment Fill

The existing embankment fill encountered in the boreholes comprises brown gravelly sand to sand and gravel with trace to some silt and occasional cobbles. The fill is between 2.9 and 4.9 m thick, with a lower boundary at depths ranging from 3.0 to 5.0 m (Elev. 312.5 to 310.5).

SPT 'N' values recorded in the fill ranged from 13 to 57 blows for 0.3 m penetration, indicating a compact to very dense relative density. SPT 'N' values of 100 blows for 0.0 to 0.225 m of penetration were recorded in Borehole CED-02, indicative of cobbles or possible boulders in the fill. Moisture contents ranged from 6% to 23%, typically 6% to 12%.

Samples of fill underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A and on the grain size distribution curves shown on Figure B1 of Appendix B.

Soil Particles	Sand and Gravel Fill (%)
Gravel	23 to 40
Sand	43 to 68
Silt & Clay	6 to 17

5.3 Gravelly Sand

A native deposit of gravelly sand with occasional cobbles and boulders was encountered beneath the embankment fill in Boreholes CED-01, CED-03 and CED-04. The thickness of the gravelly sand deposit was between 2.0 and 2.1 m, with the lower boundary at depths of 5.0 and 6.2 m (Elev. 310.5 and 309.4). The native sand and overlying fill are similar in composition and identification of the boundary between fill and native materials is subject to interpretation.

SPT 'N' values recorded in the gravelly sand ranged from 21 blows for 0.3 m of penetration to 100 blows for no penetration, indicating a compact to very dense relative density. The higher values also reflect the presence of cobbles and boulders. Moisture contents of 11% and 22% were measured.

5.4 Silty Sand to Sand and Silt Till

A layer of till comprising silty sand to sand and silt was encountered underlying the fill in Borehole CED-02 and the gravelly sand in Boreholes CED-03 and CED-04. The till contained trace to some gravel, trace clay and occasional cobbles and boulders. The till layer has a thickness between 0.6 and 2.1 m, and a lower boundary at depths of 6.8 to 7.1 m (Elev. 308.8 to 308.4).

SPT "N" values of 26 to 49 blows for 0.3 m penetration were recorded, indicating a compact to very dense relative density. An N-value of 100 blows/0.025 m was recorded on a probable

boulder in Borehole CED-02. Moisture contents of 9% and 10% were measured in Boreholes CED-03 and CED-04, and 30% in one sample from Borehole CED-02.

Three samples of till underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A, and the grain size distribution curves are shown on Figure B2 of Appendix B.

Soil Particles	Silty Sand to Sand and Silt Till (%)
Gravel	1 to 19
Sand	51 to 62
Silt	25 to 39
Clay	4 to 8

5.5 Bedrock

Metasedimentary bedrock comprising wacke and siltstone was encountered below the gravelly sand and silty sand till in all boreholes. The depths and elevations of the bedrock surface, proven by coring in all boreholes, are summarized in Table 5.1.

Table 5.1 – Depths and Elevations of Bedrock

Borehole	Top of Bedrock	
	Depth (m)	Elevation
CED-01	5.0	310.5
CED-02	7.1	308.4
CED-03	6.8	308.8
CED-04	7.0	308.6

Rock core lengths between 1.6 m to 3.3 m were recovered from the boreholes. Total core recovery in the bedrock was generally 100%. A lower recovery of 74% was recorded in Run 3 of Borehole CED-04.

The Rock Quality Designation (RQD) was typically between 74% and 100%, indicating good to excellent rock quality. Lower RQD values of 44% and 58% were recorded in the initial core runs in Boreholes CED-02 and CED-04, indicating a poor to fair rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m core, generally ranged from 0 to 5. Fracture indices greater than 10 were noted in Run 1 of Borehole CED-04.

The unconfined compressive strength of rock cores estimated from point load tests ranged from 86 to 158 MPa, indicating a strong to very strong rock. The results are presented on the Record of Borehole Sheets in Appendix A (as average per run).

5.6 Water Levels

Wash boring and rock coring methods were used to advance the boreholes and therefore water levels during or upon completion of drilling may not reflect natural groundwater levels. Standpipe piezometers were installed in two boreholes to monitor the groundwater level after completion. The water levels measured in the piezometers are summarized in Table 5.2.

Table 5.2 – Water Level Measurements

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
CED-02	May 2, 2014	3.2	312.3	In piezometer
CED-03	May 2, 2014	3.1	312.5	In piezometer

The preliminary GA drawing indicates a creek water level at Elev. 310.9 and a high water level at Elev. 312.4.

The above values are short-term readings and seasonal fluctuations of the groundwater and river level are to be expected. In particular, the water levels may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. The coordinates and the ground surface elevations for the boreholes were established based on topographic survey information provided by MMM Group Limited.

Thurber obtained utility clearances for the borehole locations prior to drilling.

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied a truck mounted CME-75 drill rig and conducted the drilling, sampling and in-situ testing operations. The drilling operations were supervised by Ms. Eckie Siu of Thurber.

Overall supervision of the field program was conducted by Mr. Mark Farrant P.Eng. Interpretation of the data and preparation of the report were carried out by Ms. Mei Cheong., P.Eng.

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

Thurber Engineering Ltd.

Murray R. Anderson, M.Eng., P.Eng.
Senior Foundations Engineer



P.K. Chatterji, P.Eng., Ph.D.
Review Principal



Appendix A
Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

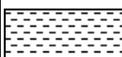
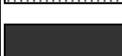
ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
	(MPa)	(psi)	
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS

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

RECORD OF BOREHOLE No CED-01

1 OF 1

METRIC

WP# 6068-09-00 LOCATION Cedar Creek Bridge N 5 395 921.0 E 387 202.6 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.07.08 - 2013.07.08 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
315.5															
0.0	ASPHALT: (125mm)														
0.1	SAND and GRAVEL , some silt, occasional cobbles Dense to Compact Brown Damp to Wet (FILL)		1	SS	40										
			2	SS	46									40 43 17 (SI+CL)	
			3	SS	25										
312.5															
3.0	Gravelly SAND , occasional cobbles Compact Brown Wet		4	SS	21										
	Cobbles and boulders (cored from 4.6 to 5.0m)		5	SS	100/0.0										
310.5															
5.0	METASEDIMENTARY BEDROCK (wacke and siltstone), grey														
308.9															
6.6	END OF BOREHOLE AT 6.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.														

ONTMT4S_1197.GPJ 2012TEMPLATE(MTO).GDT 6/25/14

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

RECORD OF BOREHOLE No CED-02

1 OF 2

METRIC

WP# 6068-09-00 LOCATION Cedar Creek Bridge N 5 395 933.5 E 387 205.1 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.07.08 - 2013.07.08 CHECKED BY MEF

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60					
315.5														
0.0	ASPHALT: (175mm)													
0.2	Gravelly SAND , some silt, occasional cobbles Dense to Very Dense Brown Moist to Wet (FILL)	1	SS	31										23 64 13 (SI+CL)
		2	SS	44										
		3	SS	101/ 0.225										
		4	SS	50/ 0.125										
		5	SS	100/ 0.0										
310.5														
5.0	Silty SAND , trace clay, trace gravel, occasional cobbles Compact Dark Brown Wet (TILL) Boulder from 6.2 to 6.6m	6	SS	26										5 62 29 4
		7	SS	100/ 0.025										
308.4														
7.1	METASEDIMENTARY BEDROCK (wacke and siltstone), grey Sub-vertical fractures (50mm) at 7.2m Strong Quartz vein (25mm) at 9.0m Sub-vertical fracture (25mm) at 9.5m, (75mm) at 9.7m, (150mm) at 10.0m	1	RUN											FI 5 0 1 1 0 0 0 1 5 RUN #1 TCR=100% SCR=58% RQD=58% UCS=126MPa (Average) RUN #2 TCR=100% SCR=100% RQD=100% UCS=102MPa (Average) RUN #3 TCR=100% SCR=100%
		2	RUN											
		3	RUN											

ONTMT4S_1197.GPJ 2012TEMPLATE(MTO).GDT 6/25/14

Continued Next Page

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

RECORD OF BOREHOLE No CED-02

2 OF 2

METRIC

WP# 6068-09-00 LOCATION Cedar Creek Bridge N 5 395 933.5 E 387 205.1 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.07.08 - 2013.07.08 CHECKED BY MEF

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
	Continued From Previous Page							20	40	60	80	100	W _p	W	W _L					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
305.1																				
10.4	END OF BOREHOLE AT 10.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2014.05.12 3.2 312.3																			

ONTMT4S_1197.GPJ 2012TEMPLATE(MTO).GDT 6/25/14

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

RECORD OF BOREHOLE No CED-03

1 OF 2

METRIC

WP# 6068-09-00 LOCATION Cedar Creek Bridge N 5 395 938.5 E 387 231.9 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.07.09 - 2013.07.09 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			
							20	40	60	80	100	20	40	60	GR	SA	SI	CL	
315.6																			
0.0	ASPHALT: (200mm)																		
0.2	Gravelly SAND, some silt Dense to Compact Brown Moist to Wet (FILL)		1	SS	37														
	Occasional cobbles		2	SS	17														32 58 10 (SI+CL)
	No recovery		3	SS	30														
			4	SS	16														
311.5																			
4.1	Gravelly SAND, occasional cobbles Very Dense Grey Wet		5	SS	61														
309.4																			
6.2	Silty SAND, some gravel, trace clay Dense Grey Moist (TILL)		6	SS	43														19 51 25 5
308.8																			
6.8	METASEDIMENTARY BEDROCK (wacke and siltstone), grey Quartz vein (50mm) at 7.3m Sub-vertical fracture (25mm) at 7.4m, (50mm) at 7.5m		1	RUN															RUN #1 TCR=100% SCR=94% RQD=94% UCS=99MPa (Average)
			2	RUN															RUN #2 TCR=100% SCR=100% RQD=100% UCS=113MPa (Average)
			3	RUN															RUN #3 TCR=100% SCR=100% RQD=100% UCS=98MPa (Average)
305.7																			

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/25/14

Continued Next Page

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

RECORD OF BOREHOLE No CED-03

2 OF 2

METRIC

WP# 6068-09-00 LOCATION Cedar Creek Bridge N 5 395 938.5 E 387 231.9 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.07.09 - 2013.07.09 CHECKED BY MEF

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100	W _p	W	W _L			
								○ UNCONFINED	+	FIELD VANE								
								● QUICK TRIAXIAL	×	LAB VANE								
								20	40	60	80	100		20	40	60		
9.9	Continued From Previous Page END OF BOREHOLE AT 9.9m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2014.05.02 3.1 312.5																	

ONTMT4S_1197.GPJ 2012TEMPLATE(MTO).GDT 6/25/14

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

RECORD OF BOREHOLE No CED-04

1 OF 2

METRIC

WP# 6068-09-00 LOCATION Cedar Creek Bridge N 5 395 950.9 E 387 234.6 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.07.07 - 2013.07.07 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W P W W L WATER CONTENT (%) 20 40 60			
315.6														
0.0	ASPHALT: (100mm)													
0.1	Gravelly SAND , trace silt, occasional cobbles Very Dense to Compact Brown Damp to Moist (FILL)		1	SS	49									
			2	SS	57									
			3	SS	13								26 68 6 (SI+CL)	
			4	SS	28									
311.5														
4.1	Gravelly SAND , occasional cobbles Grey Wet		5	SS	100/0.050									
309.5														
6.1	SAND and SILT , trace gravel, trace clay Dense Grey Moist (TILL)		6	SS	49								1 52 39 8	
308.6														
7.0	METASEDIMENTARY BEDROCK (wacke and siltstone), grey Sub-vertical fractures (25mm to 75mm) at 7.1m, 7.2m, 7.4m, 8.0m, 8.1m Highly broken zone (50mm to 100mm) at 7.3m, 7.7m, 8.0m, 8.3m, 8.4m, 8.9m Quartz veins (25mm) at 8.9m, 9.2m 100mm at 9.0m Sub-vertical fracture (50mm) at 9.5m, 9.7m		1	RUN									RUN #1 TCR=100% SCR=60% RQD=44% UCS=158MPa (Average) RUN #2 TCR=100% SCR=100% RQD=100% UCS=113MPa (Average) RUN #3 TCR=74% SCR=74% RQD=74% UCS=86MPa (Average)	
			2	RUN										
			3	RUN										

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/25/14

Continued Next Page

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

RECORD OF BOREHOLE No CED-04

2 OF 2

METRIC

WP# 6068-09-00 LOCATION Cedar Creek Bridge N 5 395 950.9 E 387 234.6 ORIGINATED BY ES
 HWY 17 BOREHOLE TYPE Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.07.07 - 2013.07.07 CHECKED BY MEF

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20	40	60	80	100	W _p	W	W _L					
305.5	Continued From Previous Page																			
10.1	END OF BOREHOLE AT 10.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.																			

ONTMT4S_1197.GPJ 2012TEMPLATE(MTO).GDT 6/25/14

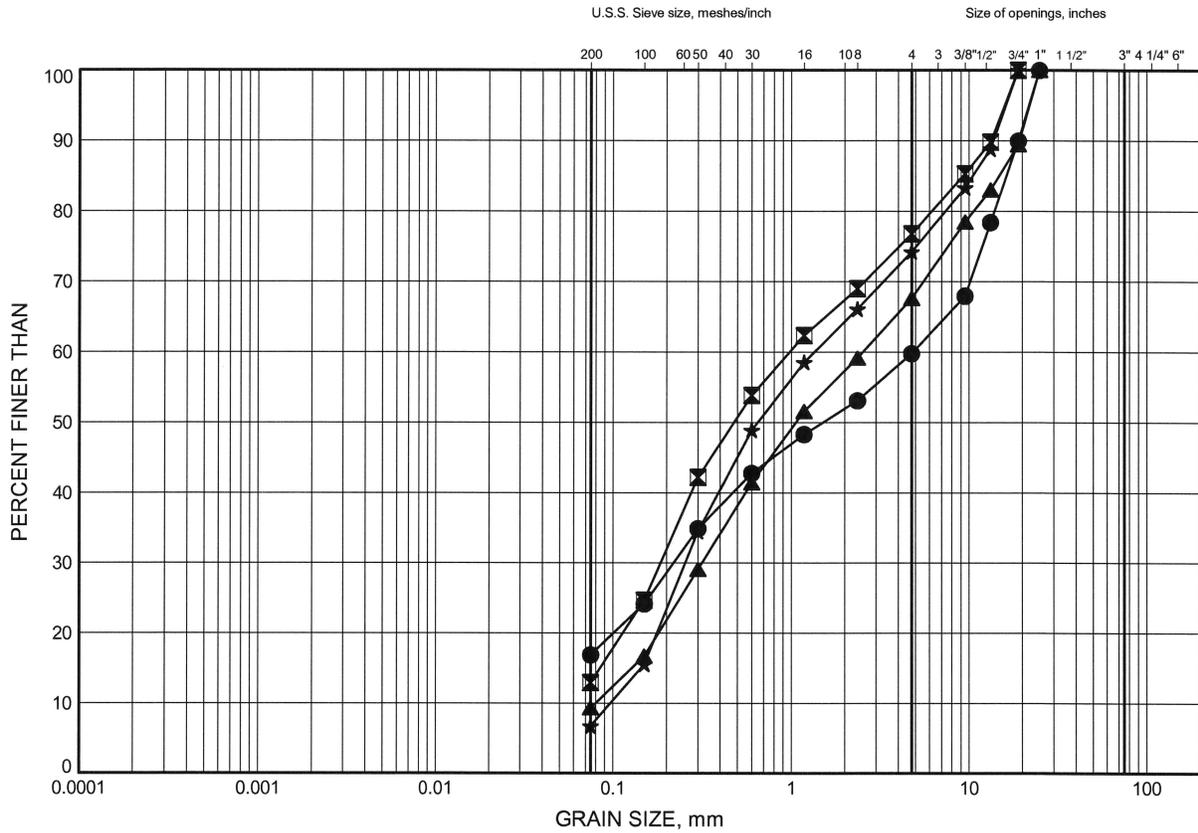
+³, ×³: Numbers refer to Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

Appendix B
Laboratory Test Results

Cedar Creek Bridge
GRAIN SIZE DISTRIBUTION

FIGURE B1

GRAVELLY SAND TO SAND & GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CED-01	1.83	313.67
◻	CED-02	1.07	314.43
▲	CED-03	1.83	313.77
★	CED-04	2.59	313.01

Date June 2014
WP# 6068-09-00

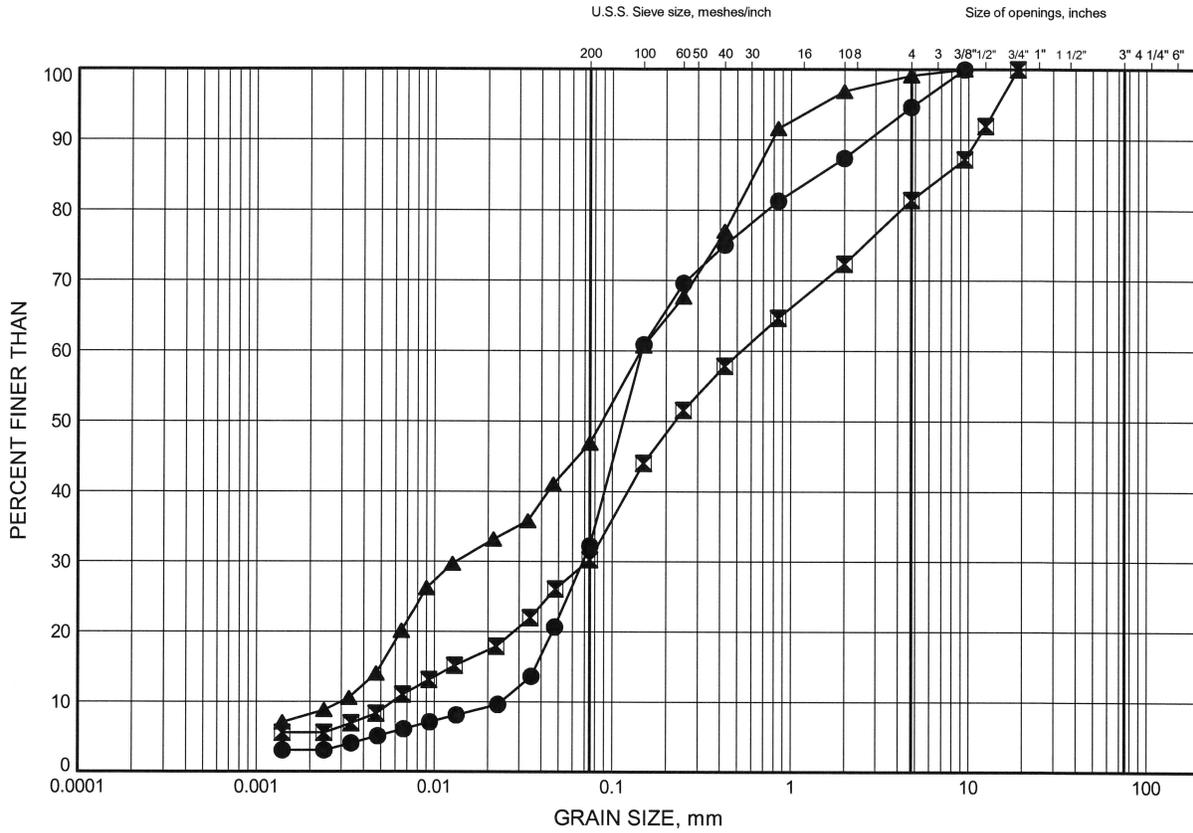


Prep'd AN
Chkd. MRA

Cedar Creek Bridge
GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY SAND TO SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CED-02	5.64	309.86
☒	CED-03	6.40	309.20
▲	CED-04	6.40	309.20

GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 6/24/14

Date June 2014
WP# 6068-09-00



Prep'd AN
Chkd. MRA

Appendix C
Site Photographs



Photograph 1 – Cedar Creek Bridge Looking East



Photograph 2 – Cedar Creek Bridge Looking West



Photograph 3 – Cedar Creek Looking North



Photograph 4 – Cedar Creek Looking South



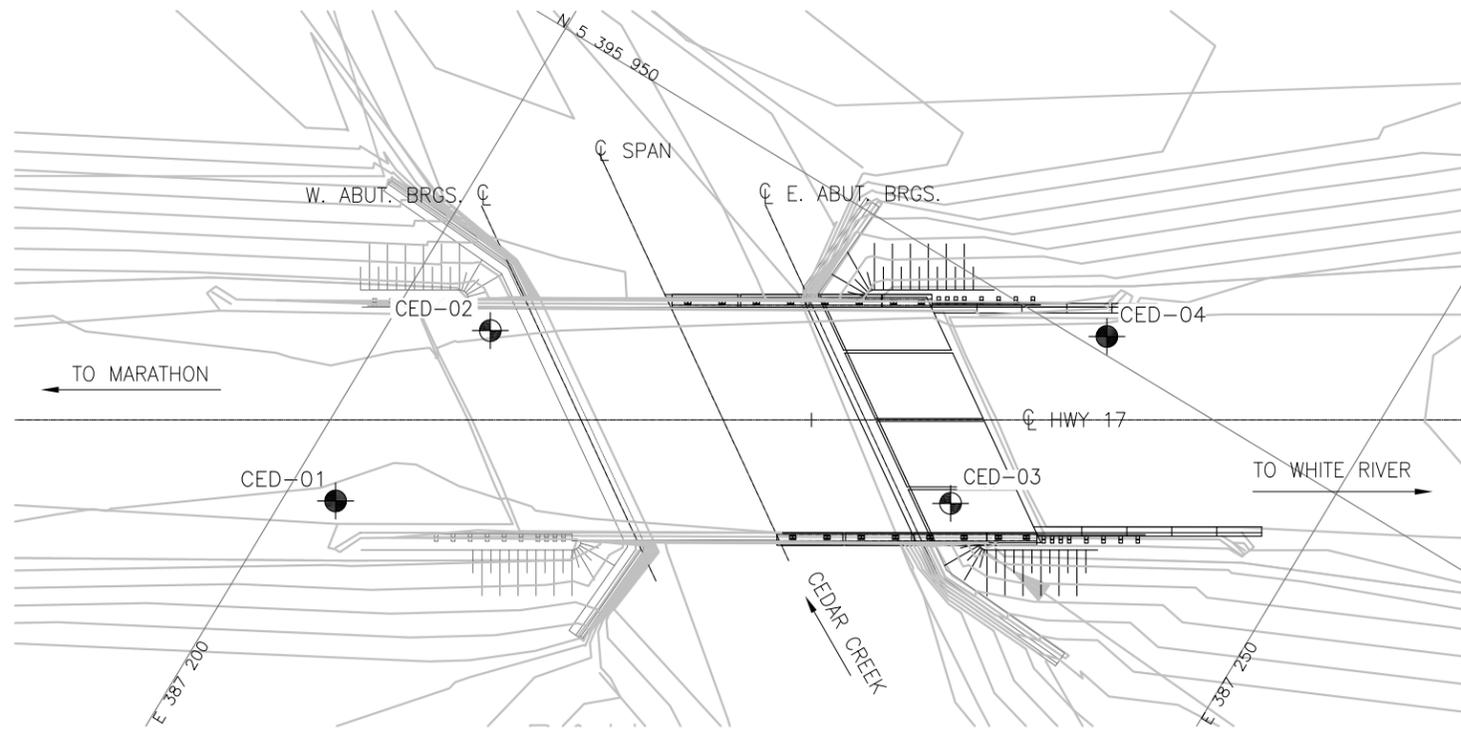
Photograph 5 – West Abutment



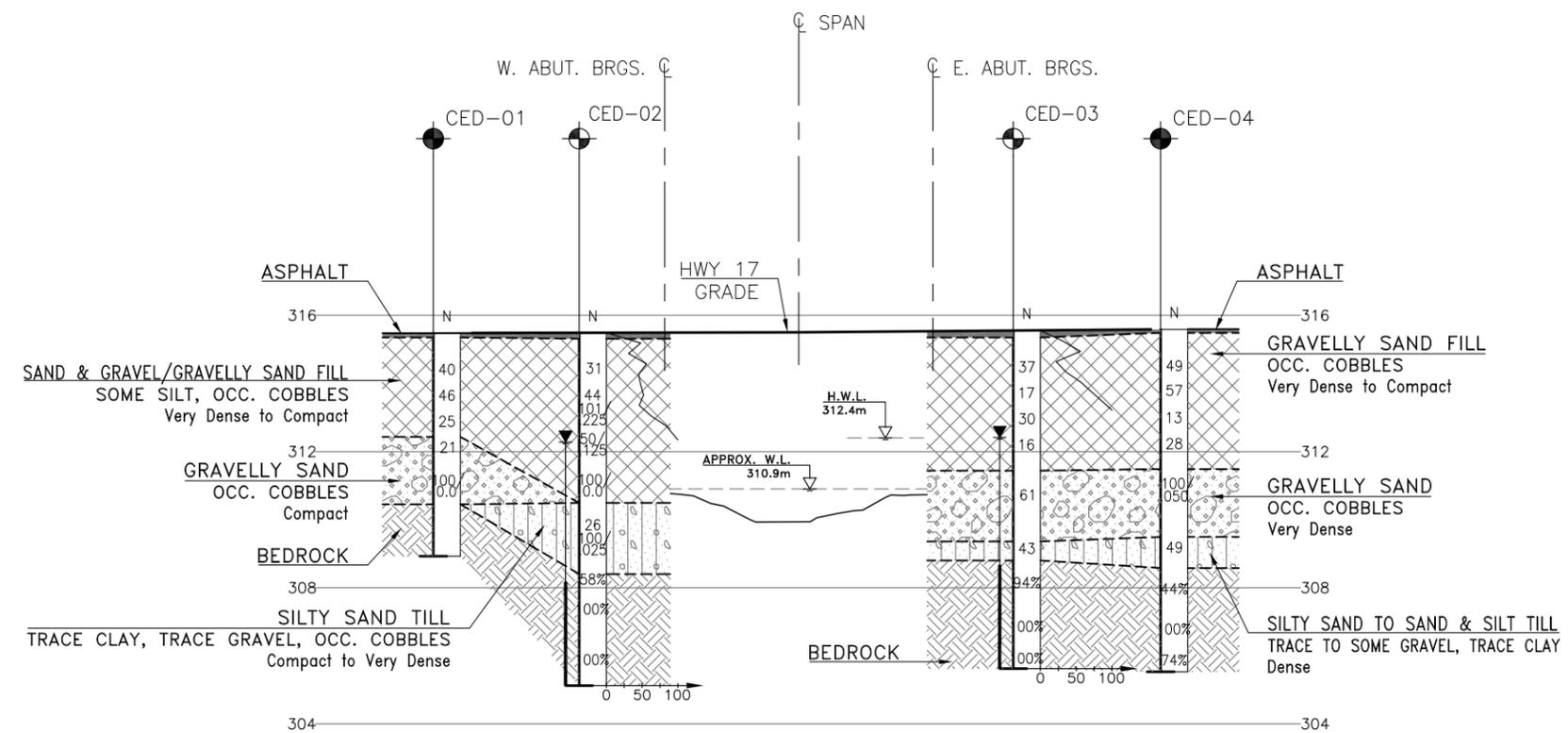
Photograph 6 – Southeast Wingwall

Appendix D

Borehole Locations and Soil Strata Drawing



PLAN
SCALE 1:400



PROFILE ALONG \bar{C} HWY 17
H 1:400
V 1:200

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

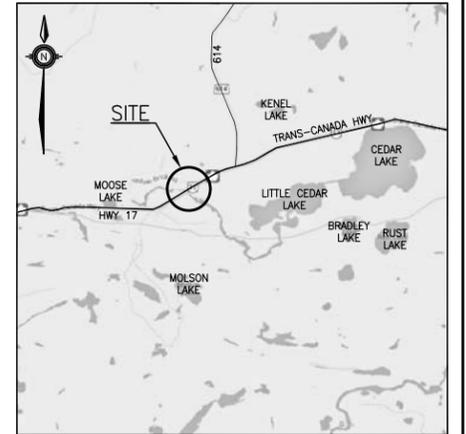


CONT No
WP No 6068-09-00



HIGHWAY 17
CEDAR CREEK
BRIDGE REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level During Drilling
- Water Level In Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
CED-01	315.5	5 395 921.0	387 202.6
CED-02	315.5	5 395 933.5	387 205.1
CED-03	315.6	5 395 938.5	387 231.9
CED-04	315.6	5 395 950.9	387 234.6

-NOTES-

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

GEOGRES No. 42C-33

DATE	BY	DESCRIPTION

DESIGN	MC	CHK	MC	CODE	LOAD	DATE	AUG 2014
DRAWN	AN	CHK	SITE	48E-27	STRUCT	DWG	1