



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
HEWITSON CREEK BRIDGE REPLACEMENT
HIGHWAY 7047 (LAKESHORE ROAD)
THUNDER BAY DISTRICT, ONTARIO
G.W.P. 6905-10-00, SITE NO. 48C-129
Geocres Number: 42D-41**

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 bridge carrying Highway 7047 (Lakeshore Road) over Hewitson Creek, located in the District of Thunder Bay (Unorganized), 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 and cross-sections, 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 Hatch Mott MacDonald (HMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 6013-E-0027, Work Item 5.

2 SITE DESCRIPTION

The Hewitson Creek Bridge is located on Highway 7047 (Lakeshore Road) in Selim, approximately 1.8 km east from the intersection of Lakeshore Road and Highway 11, and about 8 km east of Rossport. The existing bridge is a single span modular structure with a length of 30.7 m and width of 3.5 m, supported on timber crib abutments. The west approach to the bridge is relatively wide and low, and merges into a driveway on the south side. The east approach embankment is narrow and approximately 1.5 to 2.0 m in height above the flood plain of the creek.

Hewitson Creek flows from the north to south, from Whitesand Lake to Lake Superior about 150 m to the south of the bridge. The creek was approximately 15 m wide and up to 1 m deep at the bridge site during the time of the field investigation. The creek channel is lined with cobbles and boulders. The

surrounding lands are generally heavily wooded and undeveloped, with the exception of recreational and residential properties fronting on Lake Superior.

Photographs in Appendix C show the general nature of the site.

The site lies within the physiographic region known as the Wawa Subprovince of the Superior Province of the Canadian Shield. The region is characterized by massive to foliated granodiorite and granite rocks. Overlying bedrock are nearshore and beach deposits consisting of predominantly glacio-lacustrine silt, sand, gravelly sand and gravel.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between November 3 and 6, 2015. The field testing consisted of drilling and sampling five boreholes, identified as Boreholes BH-01 to BH-05. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

Boreholes BH-01, BH-02 and BH-04 were drilled near the proposed abutments and were terminated at depths ranging from 14.9 to 19.4 m, including coring 3.2 to 4.6 m into bedrock. Dynamic cone penetration tests were advanced at a distance of approximately 1.5 m west and 2 m east of Boreholes BH-02 and BH-04, respectively, to supplement the sampled borehole information. Boreholes BH-03 and BH-05 were drilled to a depth of 5.2 m at the west and east approaches, respectively.

Details of the drilling program, including borehole locations, drilling depths, and completion details are summarized in Table 3.1 below.

Table 3.1 – Details of Boreholes

Location	Boreholes	Borehole Depth/ Base of Hole Elevation (m)	Completion Details
West Approach	BH-03	5.2 / 181.7	Borehole backfilled with bentonite holeplug and cuttings to surface.
West Abutment	BH-01	17.9 / 169.1	Borehole backfilled with bentonite holeplug and cuttings to surface.
	BH-02 DCPT	19.4 / 167.4 15.8 / 171.0	Boreholes backfilled with bentonite holeplug and cuttings to surface.
East Abutment	BH-04 DCPT	14.9 / 172.1 12.1 / 174.9	Borehole backfilled with bentonite holeplug and cuttings to surface.
East Approach	BH-05	5.2 / 181.8	Borehole backfilled with bentonite holeplug and cuttings to surface.

All boreholes were advanced using a CME55 truck-mounted drill rig in combination with hollow stem augers and NW casing/coring methods. Samples of the encountered soils were obtained from the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths using MTO Standard “N” size vane and a calibrated torque wrench.

Core samples of the underlying bedrock were recovered from three boreholes using NQ rock coring equipment. All rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

A member of Thurber’s technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber’s laboratory for further examination and testing. The ground surface elevations at the borehole locations were obtained from the drawings provided by HMM.

Groundwater conditions in the open boreholes were observed during the drilling operations.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets included in Appendix A. Selected samples were also subjected to grain size analysis and Atterberg Limits testing, and the results of this testing program are summarized on the Record of Borehole sheets in Appendix A, and are shown on the figures included in Appendix B.

Point load tests (PLT) were performed on selected intact rock core samples. Unconfined compressive strengths (UCS) of the rock cores correlated from the PLT results are shown on the Record of Borehole sheets 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 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.

In summary, the subsurface stratigraphy encountered below the existing embankment fill at the site consists of cohesionless glaciofluvial deposits of sand and gravel, overlying silty sand to sandy silt, underlain by a layer of silty clay, which in turn is underlain by bedrock. Descriptions of the individual strata are presented below.

5.1 Sand Fill

Fill forming the existing roadway embankment was encountered in all boreholes. The fill consists of sand with trace to some gravel, trace silt, and occasional to frequent cobbles. A 30 mm thick asphaltic surface treatment was noted in Borehole BH-04. The sand fill extended to depths of 0.8 to 2.0 m (Elev. 186.1 to 185.0).

SPT 'N' values recorded in the embankment fill at the west abutment ranged from 3 to 7 blows per 0.3 m penetration, indicating a very loose to loose relative density. At the east abutment and west approach, N-values of 10 to 21 blows per 0.3 m were recorded, indicating a compact condition.

Moisture contents of the sand fill ranged from 1% to 8%, locally 11% and 16% near the water level at the east abutment.

The results of grain size analyses conducted on fill samples are provided on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B1 of Appendix B. The results are also summarized below:

Gravel %	2 to 5
Sand %	90 to 94
Silt and Clay %	4 to 5

5.2 Sand and Gravel

A cohesionless deposit of sand and gravel was encountered underlying the sand fill in all boreholes. The sand and gravel contained trace to some silt and occasional to frequent cobbles. In this regard, it was noted that the creek channel and banks are lined with cobbles and boulders. The deposit was 1.5 to 2.3 m thick, with a lower boundary encountered between 2.3 and 3.8 m depth (Elev. 184.6 and 183.1).

SPT 'N' values recorded in the sand and gravel typically varied from 15 to 45 blows per 0.3 m penetration, indicating a compact to dense relative density. Two values of 100 blows for less than 0.3 m penetration were also obtained, indicative of the presence of cobbles in the deposit.

Moisture contents of the sand and gravel ranged from 1% to 15%, typically less than 7%.

The results of grain size analyses conducted on three samples of this deposit are provided on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B2 of Appendix B. The results are also summarized below:

Gravel %	39 to 54
Sand %	43 to 47
Silt and Clay %	3 to 14

5.3 Silty Sand to Sandy Silt

A cohesionless deposit consisting of various proportions of sand and silt underlies the sand and gravel in all boreholes. The deposit was classified as silty sand to sandy silt with trace gravel and trace clay. Occasional sand layers were encountered in this deposit.

Where fully penetrated in Boreholes BH-01, BH-02 and BH-04, the thickness of the deposit ranged from 6.0 to 9.2 m, with the lower boundary sloping down from 9.7 m depth (Elev. 177.3) in Borehole BH-04 on the east side of the creek, to approximately 13.0 m depth (Elev. 174.0) in Boreholes BH-01 and BH-02 on the west side of the creek. Boreholes BH-03 and BH-05 located at the approaches were terminated in this deposit at a depth of 5.2 m (Elev. 181.7 and 181.8).

SPT 'N' values recorded in the silty sand to sandy silt varied from zero (Weight of Hammer) to 29 blows per 0.3 m of penetration, indicating a very loose to compact relative density. Natural moisture contents ranged from 18% to 25%.

The results of grain size analyses conducted on samples of this deposit are provided on the Record of Borehole sheets in Appendix A, and are illustrated in Figures B3 to B5 of Appendix B. The results of the grain size analyses are summarized below:

	<u>Sandy Silt to Silty Sand</u>	<u>Sand Layer</u>
Gravel %	0 to 2	0
Sand %	24 to 67	94
Silt %	28 to 71	6
Clay %	3 to 6	

5.4 Silty Clay

A layer of grey silty clay with trace sand underlies the sand/silt deposit in Boreholes BH-01, BH-02 and BH-04. The clay deposit was 1.5 to 2.0 m in thickness and extended to the bedrock surface at depths of 11.3 to 14.8 m (Elev. 175.7 to 172.0). Occasional silty sand seams were noted in the deposit, and a 200 mm thick layer of very dense silty sand was noted immediately above the bedrock surface in Borehole BH-01.

SPT 'N' values of zero (Weight of Hammer) and 3 blows per 0.3 m of penetration were recorded in the silty clay. Field vane shear tests (VST) conducted in Borehole BH-02 measured undrained shear strengths of 80 to 85 kPa. Based on the SPT and VST data, the consistency of the deposit varied from soft to stiff.

The results of grain size analyses conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B6 of Appendix B. The results are summarized as follows:

Gravel %	0
Sand %	0
Silt %	53 to 55
Clay %	45 to 47

The results of Atterberg Limits testing are provided on the Record of Borehole sheets in Appendix A and are illustrated on the Plasticity Chart (Figure B7). Liquid limits ranged from 31 to 35 and the plasticity index ranged from 14 to 18, indicating low to medium plasticity.

Natural moisture contents of the silty clay ranged from 21% to 35%.

5.5 Bedrock

Bedrock was encountered below the silty clay in Boreholes BH-01, BH-02 and BH-04 at depths of 11.3 to 14.8 m (Elev. 175.7 to 172.0). The rock was proved by coring and details of rock coring are presented on the Record of Borehole sheets in Appendix A. The bedrock was described as slightly weathered to fresh, grey to reddish brown granite to granodiorite with occasional light grey quartz inclusions.

Table 5.1, below, summarizes the depth to bedrock and bedrock surface elevations determined at the borehole locations.

Table 5.1 - Depths and Elevations of Bedrock Surface

Nearest Foundation Unit	Borehole Number	Top of Bedrock	
		Depth (m)	Elevation (m)
West Abutment	BH-01	14.7	172.3
	BH-02	14.8	172.0
East Abutment	BH-04	11.3	175.7

Variations in the bedrock surface within short distances from the borehole locations should be anticipated.

Total Core Recovery (TCR) in the bedrock ranged from 97% to 100%, locally 68% in the initial run in Borehole BH-02. The Rock Quality Designation (RQD) determined from the recovered cores was typically 80 to 100%, indicating a good to excellent rock quality. The upper 1.5 m of bedrock in Borehole BH-02 was of fair quality with fractures and a measured RQD of 52%. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 4.

The unconfined compressive strength (UCS) of the rock, estimated from the results of point load tests conducted on the rock core samples, ranges from 175 to 233 MPa, indicating a very

strong intact rock. The point load test results (average values) carried out for rock samples are included on the Record of Borehole sheets in Appendix A.

5.6 Water Levels

Water levels in the boreholes were observed during drilling operations and upon completion of drilling. No standpipe piezometers were installed at this site. Water was used during the drilling and coring operations, and therefore the water levels measured on completion may not reflect prevailing groundwater levels at the site.

The water levels measured in the open boreholes are summarized in Table 5.2.

Table 5.2 - Water Level Measurements

Borehole Number	Date	Water Level (m)		Comments
		Depth	Elev.	
BH-01	Nov. 4, 2015	2.1	184.9	Water level in borehole during drilling.
BH-02	Nov. 5, 2015	2.1	184.7	Water level in borehole during drilling.
BH-03	Nov. 6, 2015	3.6	183.3	Water level on completion of drilling.
BH-04	Nov. 3, 2015	2.1	184.9	Water level on completion of drilling.
BH-05	Nov. 4, 2015	1.4	185.6	Water level on completion of drilling.

In light of cohesionless deposits overlying the site, the groundwater level will be governed by the water level in the Hewitson Creek. The preliminary General Arrangement drawing indicates the water level in Hewitson Creek was at Elev. 184.7 on Aug. 16, 2012.

The water level in the creek and groundwater levels are expected to fluctuate seasonally and subject to precipitation patterns, and therefore may vary from the levels presented herein.

6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. in consultation with HMM. The coordinates and the ground surface elevations for the boreholes were established based on topographic survey information provided by HMM. Thurber obtained utility clearances for the borehole locations prior to drilling.

RPM Drilling Inc. of Thunder Bay, Ontario supplied a track-mounted CME-55 drill rig and conducted the drilling, sampling and in-situ testing operations for the boreholes.

The drilling operations were supervised by Mr. Chris Murray of Thurber. Overall supervision of the field program was carried out by Mr. Stephane Loranger of Thurber.

The report was prepared by Ms. Anna Piascik, P.Eng and 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.

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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.

EXPLANATION OF ROCK LOGGING TERMS


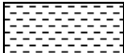



ROCK WEATHERING CLASSIFICATION

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.

UNIFIED SOILS CLASSIFICATION



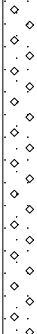
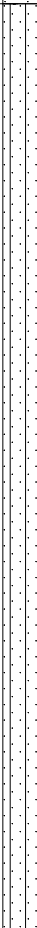
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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			

RECORD OF BOREHOLE No BH-01

1 OF 2

METRIC

W.P. 6905-10-00 LOCATION N 5 410 901.2 E 274 605.5 ORIGINATED BY CAM
 HWY 7047 BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2015.11.04 - 2015.11.04 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)												
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					w _p w w _L												
187.0	GROUND SURFACE						20	40	60	80	100						GR	SA	SI	CL					
0.0	SAND , trace gravel, trace silt Very Loose to Loose Brown Moist (FILL)		1	SS	7								○				5	90	5	(SI+CL)					
			2	SS	3								○												
185.5																									
1.5	SAND and GRAVEL , occasional cobbles Compact to Very Dense Brown Moist		3	SS	100/ 0.250									○								Water level at 2.1m			
	Frequent cobbles from 1.5m to 2.1m and from 3.0m to 3.6m		4	SS	19									○											
			5	SS	17									○											
183.2																						0	43	53	4
3.8	Silty SAND to Sandy SILT , trace gravel, trace clay, occasional sand seams Loose to Compact Grey Wet		6	WH										○											
			7	SS	4								○												
			8	SS	22								○												
			9	SS	10								○												

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH-01

2 OF 2

METRIC

W.P. 6905-10-00 LOCATION N 5 410 901.2 E 274 605.5 ORIGINATED BY CAM
 HWY 7047 BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2015.11.04 - 2015.11.04 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								20	40	60	80	100			W _P	W	W _L
	Continued From Previous Page																
			10	SS	5									0 41 53 6			
							176										
			11	SS	10												
							175										
174.0																	
13.0	Silty CLAY , trace sand, occasional silty sand seams Soft Grey Wet		12	SS	3		174							0 0 53 47			
							173										
172.5																	
14.5	Silt SAND , with gravel Very Dense Grey Wet		13	SS	91/ 0.050												
172.3							172						FI				
14.7	GRANITE TO GRANODIORITE with light grey quartz inclusions, slightly weathered to fresh, grey to reddish brown, occasional mechanical breaks throughout		1	RUN			171						2	RUN #1 TCR=100% SCR=100% RQD=100% UCS=183MPa			
													0				
													2				
													2				
			2	RUN			170						0	RUN #2 TCR=100% SCR=81% RQD=81% UCS=205MPa			
													1				
169.1													2				
17.9	END OF BOREHOLE AT 17.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

ONTMT4S 5220.GPJ 2015TEMPLATE(MTO).GDT 2/9/16

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No BH-02

2 OF 2

METRIC

W.P. 6905-10-00 LOCATION N 5 410 895.1 E 274 603.9 ORIGINATED BY CAM
 HWY 7047 BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2015.11.05 - 2015.11.05 CHECKED BY AMP

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 (%)								
								○ UNCONFINED + FIELD VANE	W P W W L									
							● QUICK TRIAXIAL × LAB VANE											
	Continued From Previous Page		10	SS	1		176							0 24 71 5				
			11	SS	5		175											
			12	SS	9		174											
174.0			13	AS			173	8.5 +						0 0 54 46				
12.8	Silty CLAY , trace sand, occasional silty sand seams Stiff Grey Wet						172	8.0 +										
172.0			1	RUN			171					FI						
14.8	GRANITE TO GRANODIORITE with light grey quartz inclusions, slightly weathered to fresh, grey to reddish brown, occasional mechanical breaks throughout		2	RUN			170					4	RUN #1 TCR=68% SCR=68% RQD=52% UCS=175MPa					
			3	RUN			169					3						
							168					4	RUN #2 TCR=100% SCR=89% RQD=89% UCS=233MPa					
												2						
												1	RUN #3 TCR=97% SCR=90% RQD=90% UCS=205MPa					
												3						
												1						
167.4																		
19.4	END OF BOREHOLE AT 19.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																	

ONTMT4S 5220.GPJ 2015TEMPLATE(MTO).GDT 2/9/16



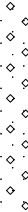

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH-03

1 OF 1

METRIC

W.P. 6905-10-00 LOCATION N 5 410 899.1 E 274 594.6 ORIGINATED BY CAM
 HWY 7047 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2015.11.06 - 2015.11.06 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa													
186.9	GROUND SURFACE							20	40	60	80	100									
0.0	SAND , trace to some gravel Compact Brown Moist (FILL)		1	SS	11		186														
186.1																					
0.8	SAND and GRAVEL , trace silt, occasional cobbles Compact Brown Wet		2	SS	20																
			3	SS	30				185												
184.6																					
2.3	Silty SAND to Sandy SILT , trace gravel, trace clay, occasional sand seams Loose Grey Wet		4	SS	7				184												
			5	SS	8																
			6	SS	5		183														
			7	SS	4		182														
181.7																					
5.2	END OF BOREHOLE AT 5.2m. WATER LEVEL AT 3.6m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																				

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

RECORD OF BOREHOLE No BH-04

1 OF 2

METRIC

W.P. 6905-10-00 LOCATION N 5 410 889.7 E 274 639.9 ORIGINATED BY CAM
HWY 7047 BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2015.11.03 - 2015.11.03 CHECKED BY AMP

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					
								○ UNCONFINED	+ FIELD VANE				
								● QUICK TRIAXIAL	× LAB VANE				
187.0	GROUND SURFACE								20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
0.0	SURFACE TREATMENT (30mm)									WATER CONTENT (%)			
	SAND , some gravel Compact Brown Moist (FILL)		1	SS	21				20 40 60 80 100				
			2	SS	17								
185.0			3	SS	19								39 47 14 (SI+CL)
2.0	SAND and GRAVEL , some silt, frequent cobbles Compact to Dense Brown Wet		4	SS	34								
183.3													
3.7	Silty SAND to Sandy SILT , trace clay, occasional sand seams Loose to Compact Brown Wet		5	SS	4								0 53 44 3
			6	SS	16								
			7	SS	29								
			8	SS	3								Probable hydraulic disturbance
177.3													
9.7	Silty CLAY , trace sand, occasional silty sand seams												

Continued Next Page

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

RECORD OF BOREHOLE No BH-04

2 OF 2

METRIC

W.P. 6905-10-00 LOCATION N 5 410 889.7 E 274 639.9 ORIGINATED BY CAM
 HWY 7047 BOREHOLE TYPE Hollow Stem Augers/Casing/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2015.11.03 - 2015.11.03 CHECKED BY AMP


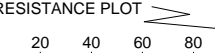


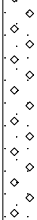
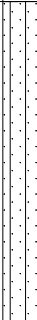
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
	Continued From Previous Page		9	WH			20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
175.7	Silty CLAY , trace sand, occasional silty sand seams Soft Grey Wet							W _p	W	W _L		0 0 55 45
11.3	GRANITE TO GRANODIORITE with light grey quartz inclusions, slightly weathered to fresh, grey to reddish brown, occasional mechanical breaks throughout		1	RUN							FI	RUN #1 TCR=100% SCR=100% RQD=86% UCS=200MPa
			2	RUN							1	RUN #2 TCR=100% SCR=100% RQD=100% UCS=194MPa
											1	
											1	
											0	RUN #3 TCR=100% SCR=80% RQD=80% UCS=178MPa
172.1			3	RUN							0	
14.9	END OF BOREHOLE AT 14.9m. WATER LEVEL AT 2.1m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										2	

RECORD OF BOREHOLE No BH-05

1 OF 1

METRIC

W.P. 6905-10-00 LOCATION N 5 410 887.0 E 274 641.2 ORIGINATED BY CAM
 HWY 7047 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2015.11.04 - 2015.11.04 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
187.0	GROUND SURFACE						186							
0.0	SAND , trace gravel, trace silt, occasional cobbles Compact Dark Brown Moist (FILL)		1	SS	18			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
			2	SS	10			WATER CONTENT (%)						
185.5														
1.5	SAND and GRAVEL , trace silt, frequent cobbles Dense Brown Moist		3	SS	45									
			4	SS	100/ 0.125									
184.0														
3.0	Silty SAND to sandy SILT , trace clay Very Loose to Loose Grey Wet		5	SS	2	183	184						0 47 50 3	
			6	SS	6									
			7	SS	5									
181.8						182								
5.2	END OF BOREHOLE AT 5.2m. WATER LEVEL AT 1.4m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

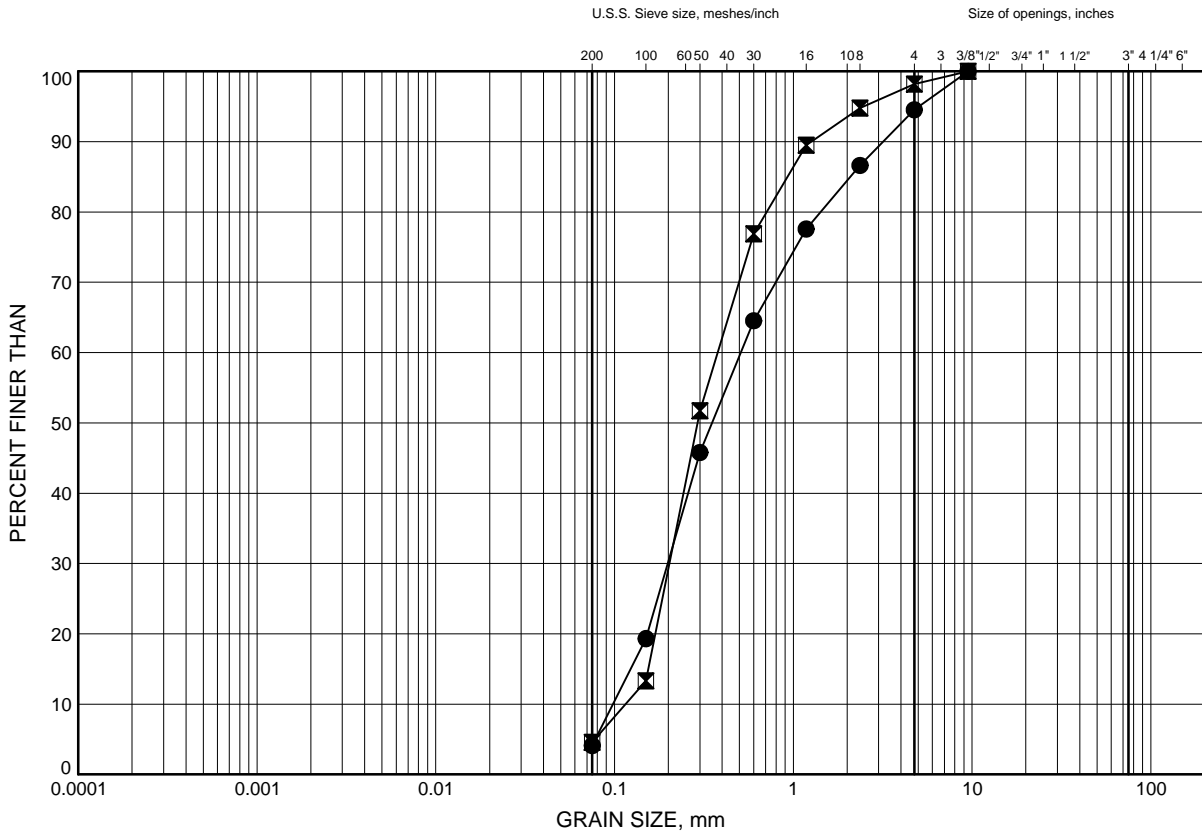
Appendix B
Laboratory Test Results

Hewitson River Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-01	0.50	186.50
⊠	BH-05	0.38	186.62

Date February 2016
W.P. 6905-10-00



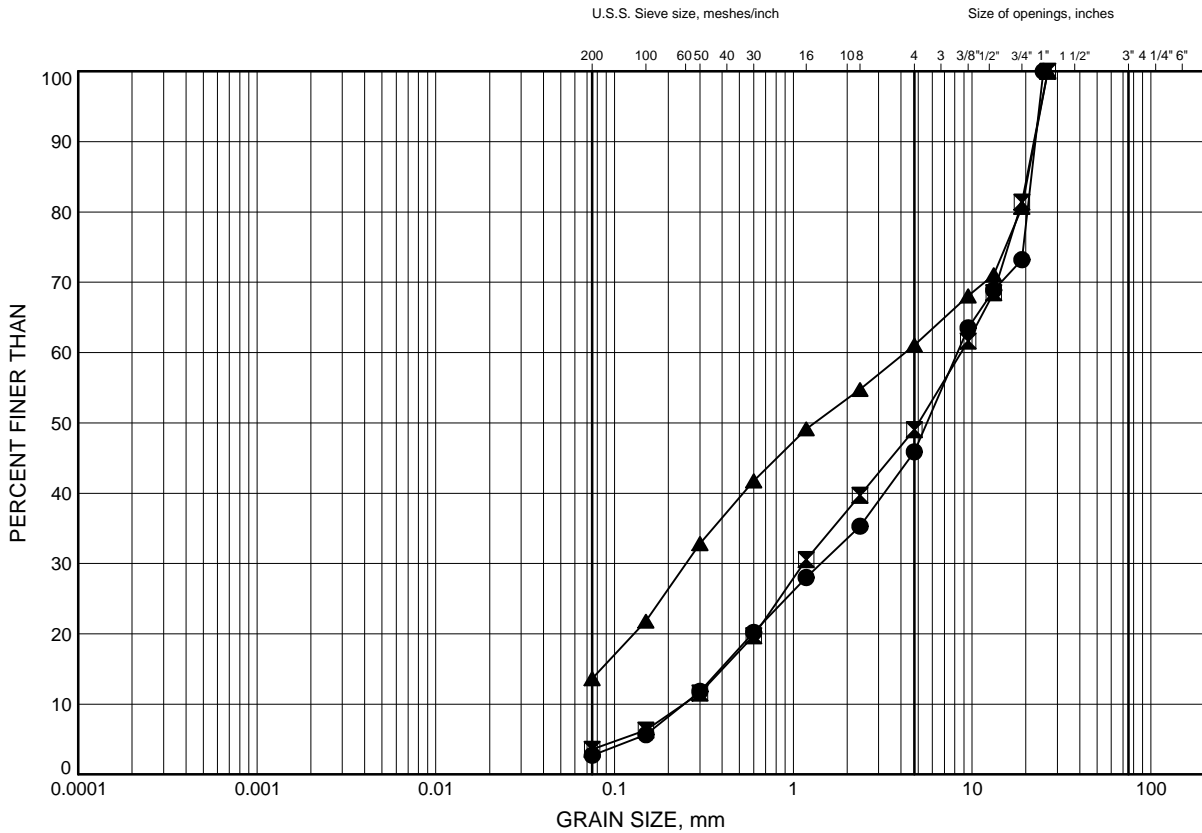
Prep'd AN
Chkd. AMP

Hewitson River Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-02	2.59	184.21
⊠	BH-03	1.07	185.83
▲	BH-04	1.75	185.25

Date February 2016
W.P. 6905-10-00



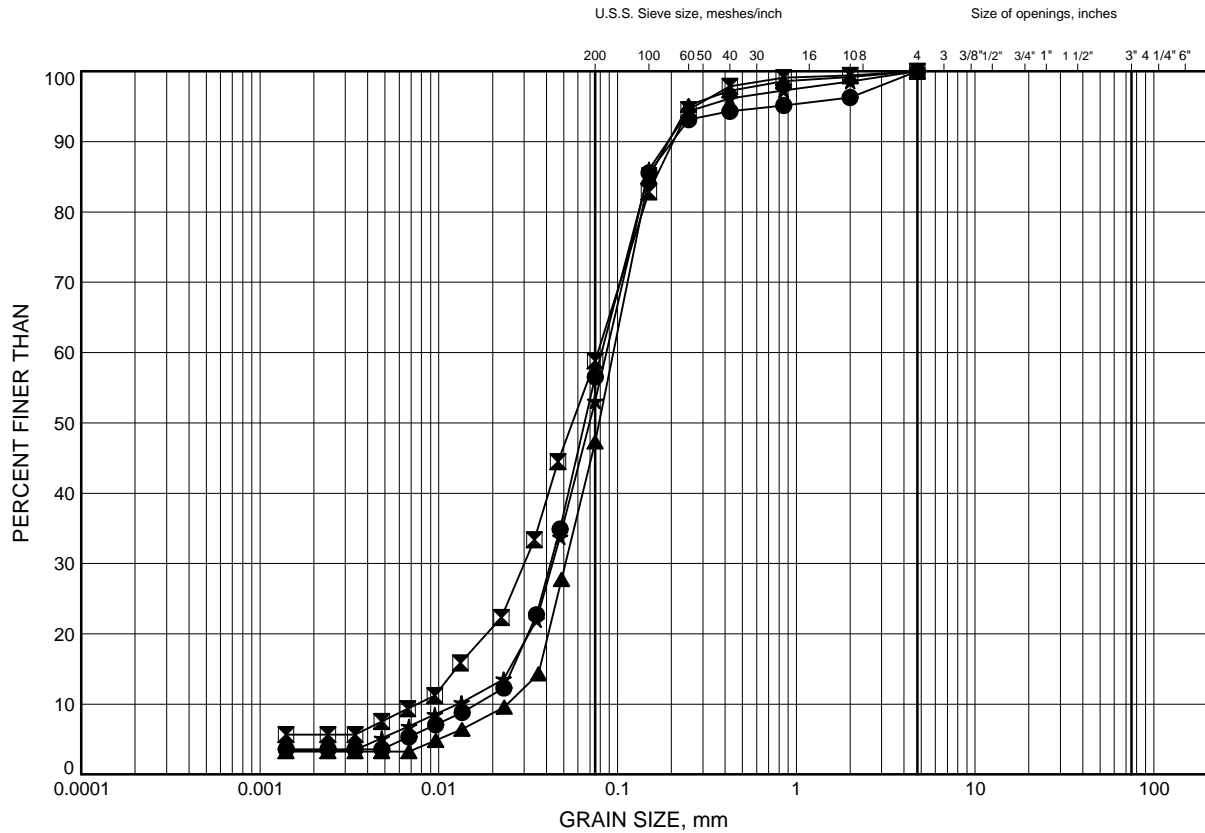
Prep'd AN
Chkd. AMP

Hewitson River Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND & SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-01	4.11	182.89
⊠	BH-01	10.21	176.79
▲	BH-04	4.11	182.89
★	BH-05	3.35	183.65

Date February 2016
W.P. 6905-10-00



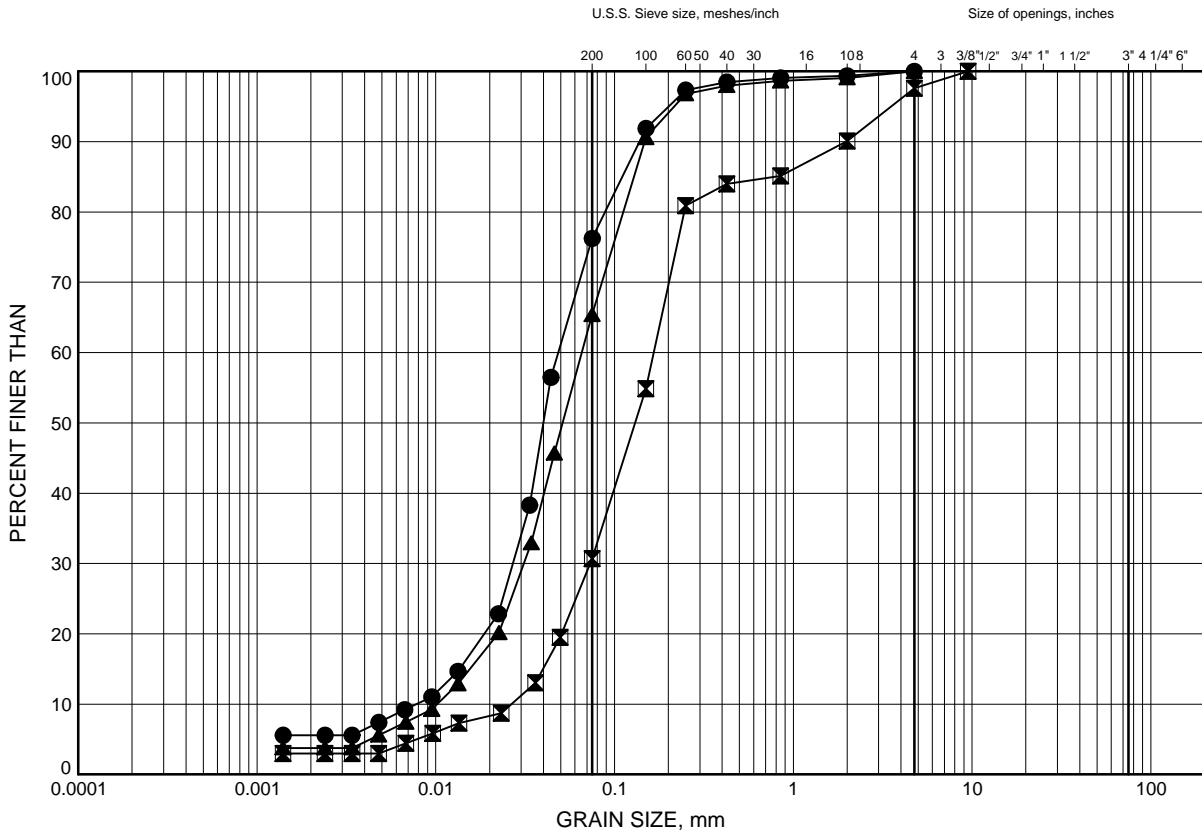
Prep'd AN
Chkd. AMP

Hewitson River Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B4

Silty SAND to Sandy SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-02	10.21	176.59
⊠	BH-03	3.35	183.55
▲	BH-03	4.88	182.02

Date February 2016
W.P. 6905-10-00

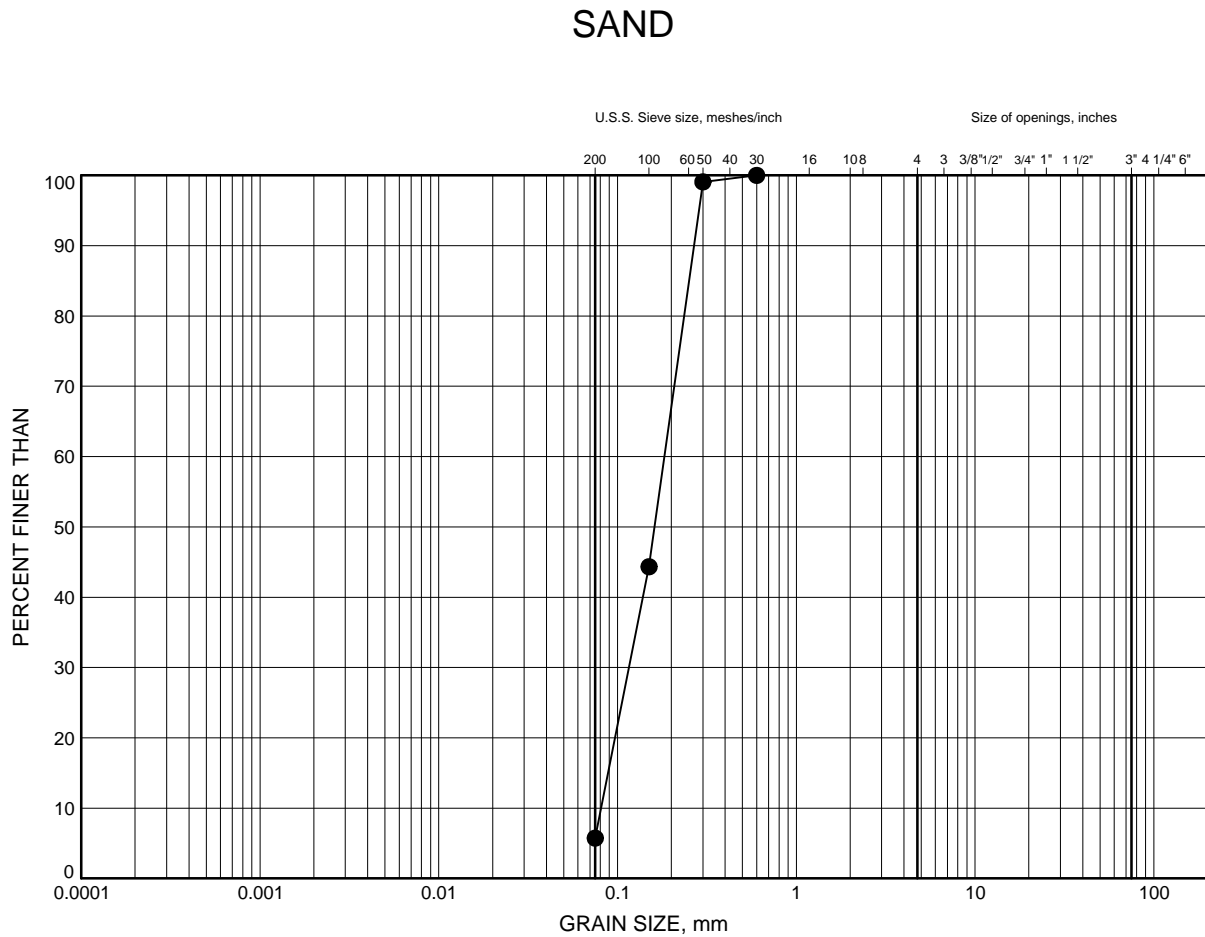


Prep'd AN
Chkd. AMP

Hewitson River Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B5



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-02	7.16	179.64

Date February 2016
W.P. 6905-10-00



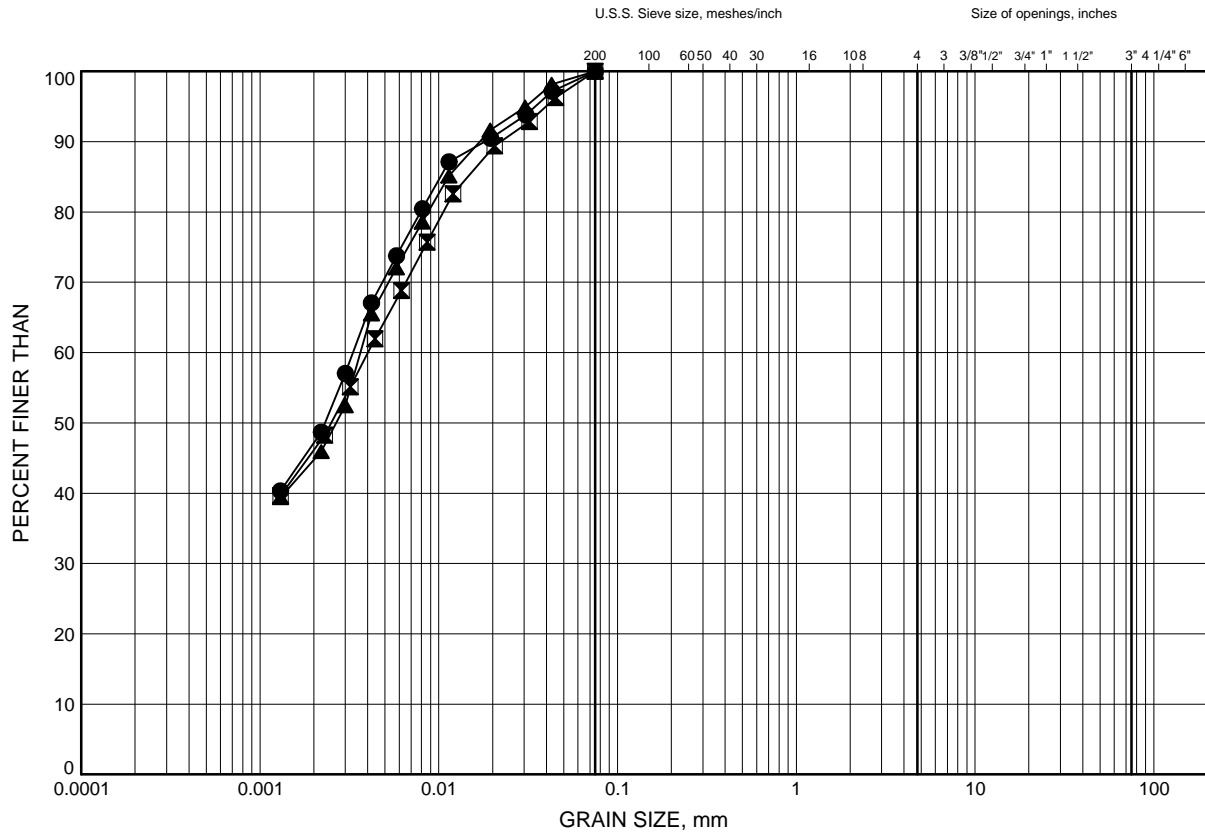
Prep'd AN
Chkd. AMP

Hewitson River Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B6

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-01	13.26	173.74
⊠	BH-02	13.26	173.54
▲	BH-04	10.21	176.79

Date February 2016
W.P. 6905-10-00



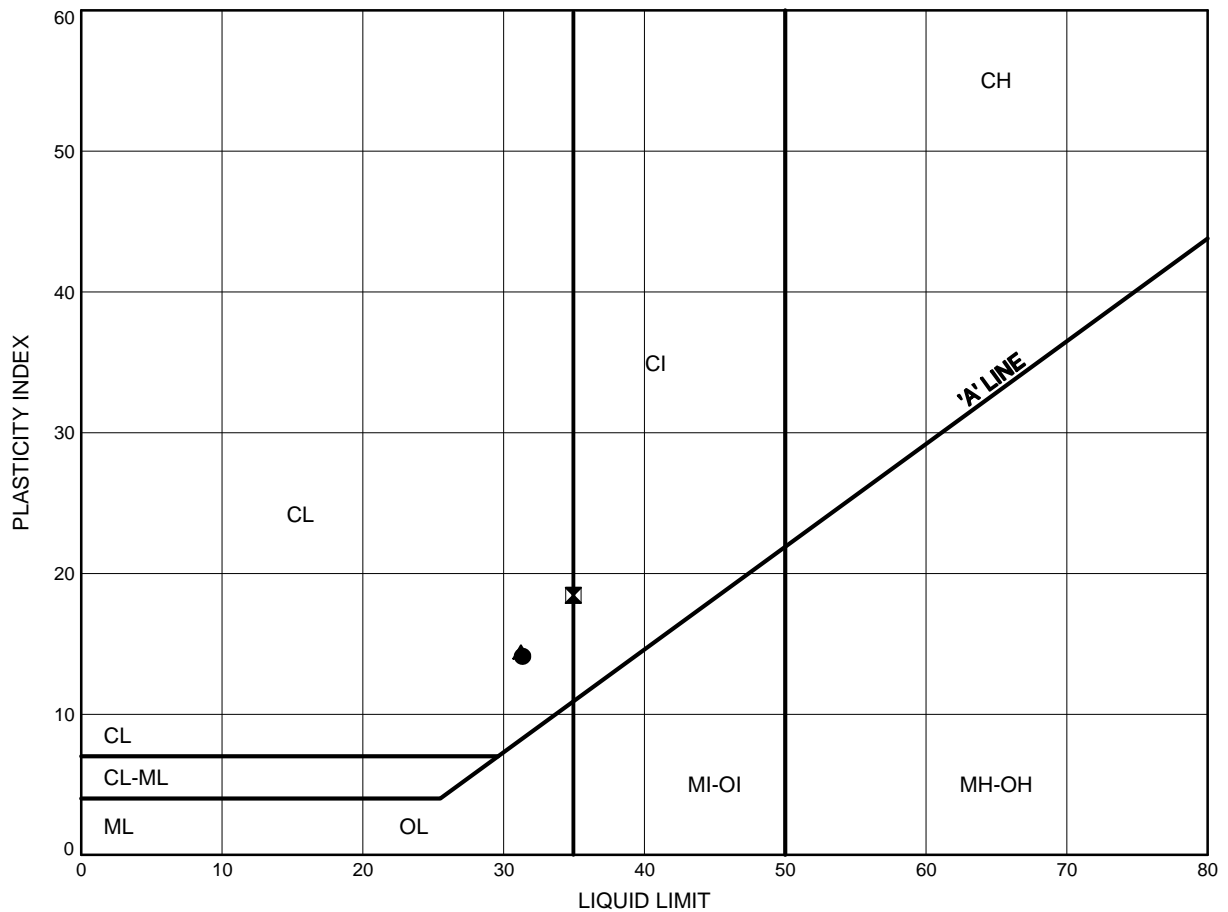
Prep'd AN
Chkd. AMP

Hewitson River Bridge Replacement

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-01	13.26	173.74
⊠	BH-02	13.26	173.54
▲	BH-04	10.21	176.79

Date February 2016
W.P. 6905-10-00



Prep'd AN
Chkd. AMP

Appendix C
Site Photographs



Photograph 1 - Hewitson Creek Bridge – looking north



Photograph 2 – Looking at the east abutment from west bank of creek



Photograph 3 – East abutment and view of timber crib



Photograph 4 – Looking at the west abutment

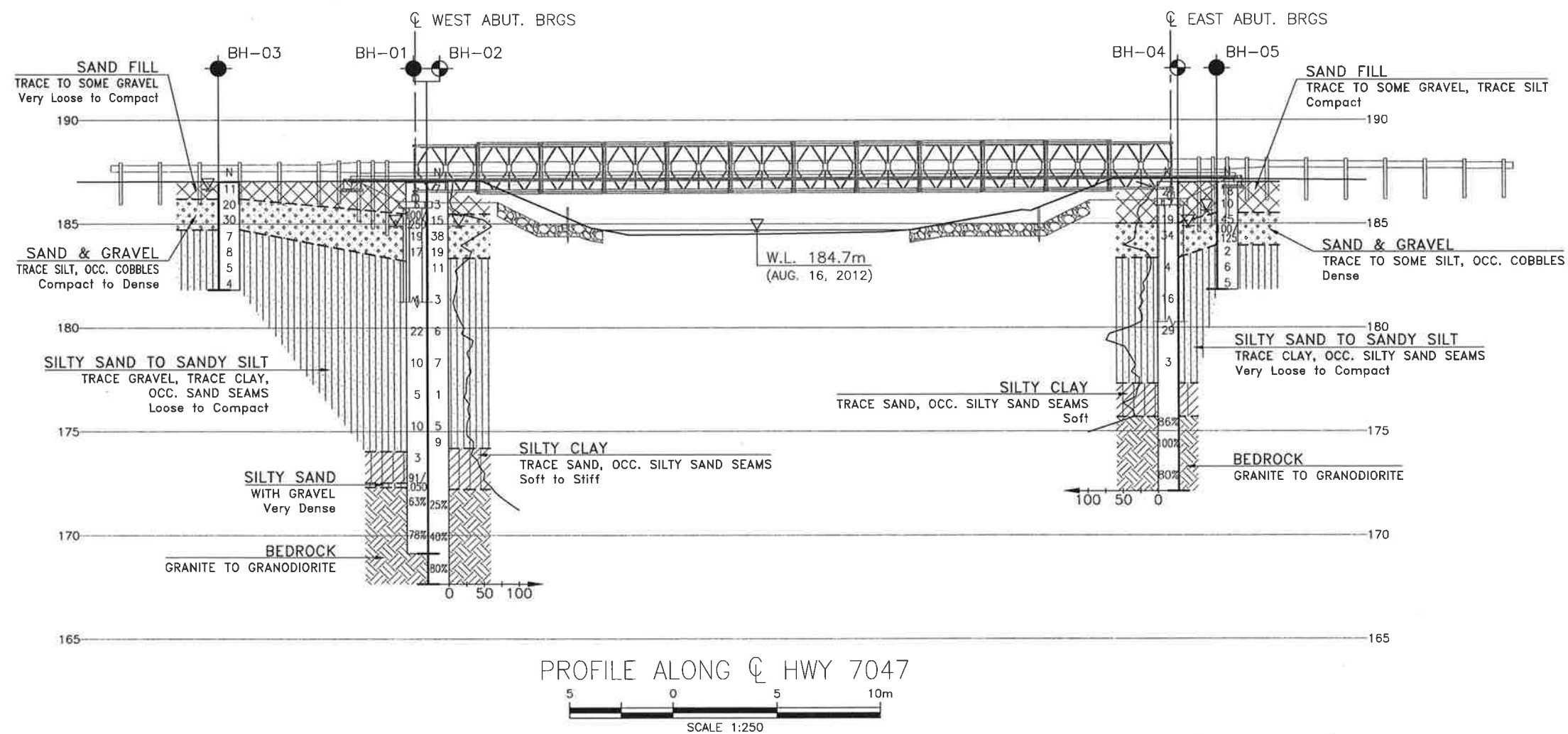
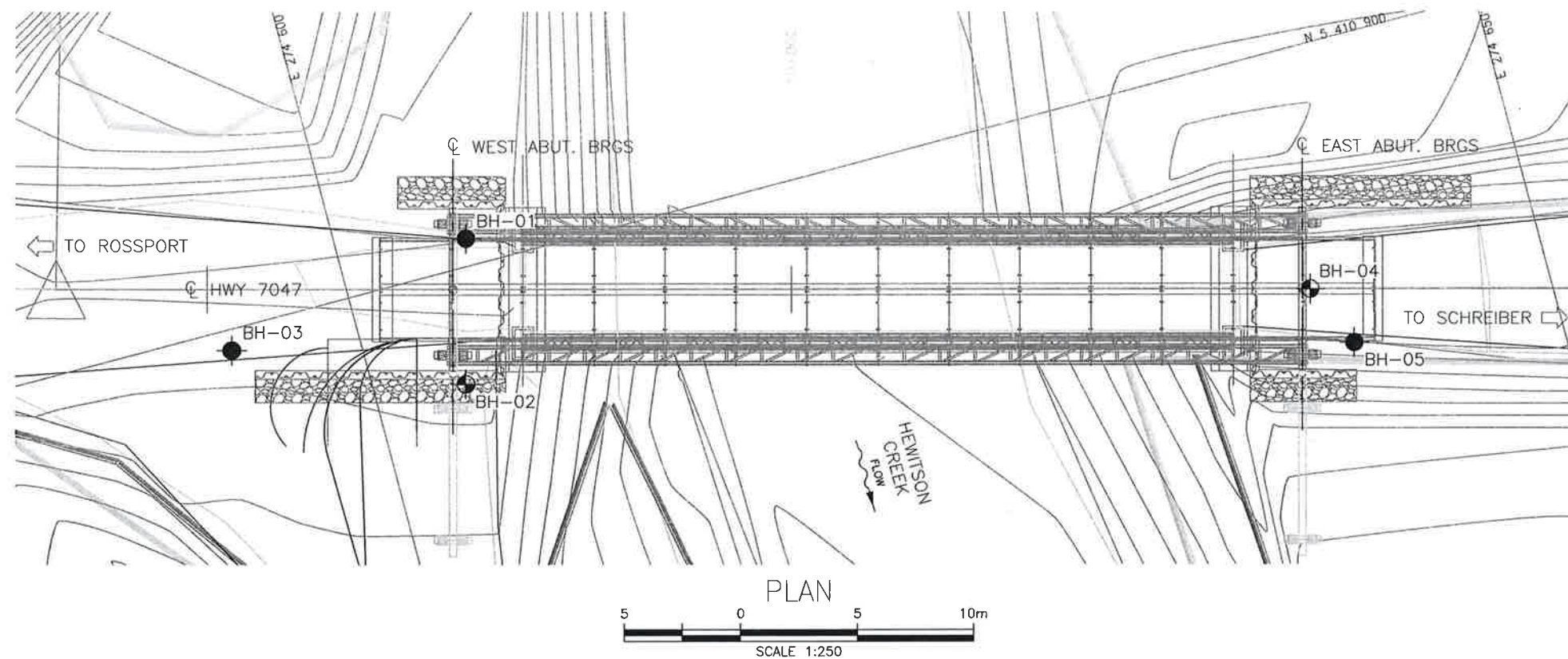


Photograph 5 – Looking at the west approach

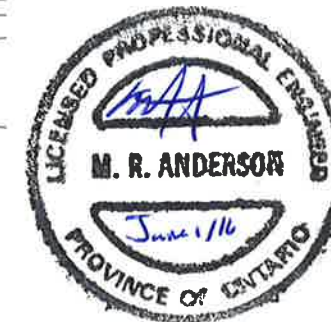


Photograph 6 – Looking at the east approach

Appendix D
Borehole Locations and Soil Strata Drawing



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



CONT No
GWP No 6905-10-00

HIGHWAY 7047
HEWITSON CREEK BRIDGE
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

HIGHWAY 7047
HEWITSON CREEK BRIDGE
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

HATCH

100





11

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
BH-01	187.0	5 410 901.2	274 605.5
BH-02	186.8	5 410 895.1	274 603.9
BH-03	186.9	5 410 899.1	274 594.6
BH-04	187.0	5 410 889.7	274 639.9
BH-05	187.0	5 410 887.0	274 641.2

-NOTES-

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

GEOCRES No. 42D-41

REVISIONS							
DATE		BY		DESCRIPTION			
DESIGN	AMP	CHK	MRA	CODE	LOAD	DATE	MAY 2016
DRAWN	AN	CHK	AMP	SITE	48C-129 ISTRUCT	LOWG	2

FILENAME: H:\Drafting\19\1605\220\Ted5220-BoreholePlan&Profile.dwg
PLOTDATE: 5/31/2016 4:22 PM