

**FOUNDATION INVESTIGATION REPORT  
ALDER CREEK CULVERT REPLACEMENT  
HIGHWAY 17, EAST OF MARATHON, ONTARIO  
SITE 48E-82/C  
G.W.P. 6026-07-00**

**Geocres Number: 42C-24**

**Report to**

**GENIVAR**

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**FOUNDATION INVESTIGATION AND DESIGN REPORT  
ALDER CREEK CULVERT REPLACEMENT  
HIGHWAY 17, EAST OF MARATHON, ONTARIO  
SITE 48E-82/C**

**G.W.P. 6026-07-00**

**Geocres Number: 42C-24**

**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted at the location of a proposed culvert replacement at Alder Creek east of Marathon, Ontario. The existing culvert carries Alder Creek under Highway 17 in the Wabikoba Lake Area, 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, laboratory test results and written descriptions 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 Genivar, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0012.

**2 SITE DESCRIPTION**

The Alder Creek culvert is located on Highway 17, approximately 46.5 km east of the Town of Marathon, Ontario. The site is approximately 6.5 km east of the intersection of Highway 17 and Highway 614.

The existing highway is a two-lane paved road and crosses the creek on approach embankments about 3.0 m to 4.0 m high.

Currently a CSP elliptical arch culvert carries Alder Creek under Highway 17. The culvert is approximately 4.0 m wide, 2.5 m high and 29.2 m long. Alder Creek flows to the south.

At the time of the investigation, the north and south ends of the culvert were flooded and the culvert was almost submerged. Water was observed at the toe of the highway embankment.

Lands surrounding the culvert site consist of forested areas with open swamps.

Photographs in Appendix C show the general nature of the surrounding land.

The site lies within the Michipicoten greenstone belt part of the Canadian Shield, characterized by low, rounded hills of Pre-Cambrian bedrock mantled by varying thicknesses of overburden. At this site, the overburden primarily consists of glaciolacustrine silts and clays.

### **3 SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field testing for this project were carried out between May 1 and 3, 2011 and consisted of drilling and sampling a total of three boreholes (identified as AL11-01 to AL11-03) in the area of the existing culvert. One borehole was drilled at each end of the culvert and one borehole was drilled from the south shoulder of the Highway 17 embankment. Borehole advancement within the overburden soils extended to 15.8 m depth (elevations 83.9 to 86.2).

A dynamic cone penetration test (DCPT) was conducted adjacent to Borehole AL11-03 from ground surface to 22.3 m depth (elevation 79.7). In Borehole AL11-02, a DCPT was conducted from the base of the borehole to 30.5 m depth (elevation 71.5).

The approximate borehole locations are shown on the attached 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.

Drilling was carried out using a track mounted CME 55 drill rig and hollow-stem augers were used to advance the boreholes. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). In situ vane shear testing was carried out to assess the undrained shear strength of soft to firm cohesive deposits.

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 samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions were observed in the open boreholes upon completion of the drilling operations. One standpipe piezometer consisting of 19 mm PVC pipe with a slotted screen was installed in Borehole AL11-01 and enclosed in filter sand to permit longer term groundwater level monitoring. The boreholes were backfilled in accordance with O.Reg. 903 upon completion. The locations and completion details of the boreholes are shown in Table 3.1.

**Table 3.1 – Borehole Decommissioning Details**

<b>Borehole</b>	<b>Piezometer Tip Depth/ Elevation (m)</b>	<b>Decommissioning Details</b>
AL11-01	15.2 / 84.5	Piezometer with 1.5 m slotted screen installed with sand filter to 13.4 m, bentonite from 13.4 m to surface.
AL11-02	None installed	Backfilled with bentonite holeplug from 15.8 m to 0.6 m, then sand and gravel to surface.
AL11-03	None installed	Backfilled with bentonite holeplug to surface.

#### **4 LABORATORY TESTING**

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis. The results of these tests are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B.

#### **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented 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.

In general terms, the site was found to be underlain by a native upper layer of silt overlying a deposit of varved clayey silt which in turn is underlain by a lower layer of silt. A thin layer of sandy silt was found at surface on the south side of the culvert. A layer of sand fill was encountered surficially at the borehole drilled through the highway embankment. More detailed descriptions of the individual strata are presented below.

##### **5.1 Sand Fill**

Brown sand fill containing some gravel and some silt and clay was encountered surficially in Borehole AL11-02, drilled at the south highway shoulder. The thickness of the sand fill was 4.0 m.

The depth to the base of the fill was 4.0 m (elevation 98.0).

Standard Penetration tests performed in the sand fill layer gave SPT N-values ranging from 9 to 23 blows per 0.3 m penetration, indicating a loose to compact relative density.

The moisture content in sand fill generally varies between 5% and 12%.

A sample of the sand fill underwent gradation analysis testing, the results of which are presented below. These results are also summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curve for this sample is included in Figure B1 of Appendix B.

Soil Particles	Percentage (%)
Gravel	15
Sand	64
Silt and Clay	21

## 5.2 Sandy Silt

A thin layer of sandy silt mixed with organics was encountered surficially in Borehole AL11-01. This layer was 0.6 m thick.

A SPT N-value of 3 blows for 0.3 m penetration, indicating a very loose relative density, was recorded in this layer. The moisture content of a sample of the sandy silt was 35%.

## 5.3 Upper Silt Layer

An upper layer of brown to grey silt was encountered below the sandy silt in Borehole AL11-01, below the sand fill in Borehole AL11-02, and at surface in Borehole AL11-03.

The silt contains trace to some clay and trace sand. Occasional rootlets were observed in the upper silt layer near the surface.

The thickness of the upper silt layer varied from 2.1 m to 5.5 m. The depths to the base of the upper silt layer ranged from 4.6 m to 6.1 m (elevations 93.6 to 95.9).

Standard Penetration Tests recorded in the upper silt layers gave SPT N-values of 5 to 15 blows per 0.3 m of penetration, indicating a loose to compact relative density.

The moisture content of samples from the upper silt layer generally varies between 19% and 38%. A moisture content of 53% was measured in Borehole AL11-03.

Grain size distribution curves for samples of silt tested are presented on the Record of Borehole sheets and on Figure B2 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 6
Silt	87 to 91
Clay	7 to 13

#### 5.4 Clayey Silt

A layer of grey clayey silt was encountered between the upper and lower silt layers. This clayey silt deposit is varved. The thickness of the clayey silt layer varied from 4.6 m to 7.6 m.

The depths to the base of the clayey silt ranged from 10.7 m to 13.7 m (elevations 88.3 to 89.8).

Standard Penetration Tests recorded in the clayey silt layer gave SPT N-values of 4 to 15 blows per 0.3 m of penetration, indicating a soft to stiff consistency. Shear Vane Tests were also performed where low N-values were recorded. The shear strength of the clayey silt ranges from 20 to 40 kPa.

The moisture content of samples from the clayey silt layer generally varies between 22% and 40%.

Grain size distribution curves for samples of the clayey silt tested are presented on the Record of Borehole sheets and on Figure B3 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	0
Silt	75 to 78
Clay	22 to 25

The DCPT conducted from the base of Borehole AL11-02 and adjacent to Borehole AL11-03 recorded 100 blows at about 30.5 m and 22.3 m depth (elevations 71.5 and 79.7), respectively.

#### 5.5 Lower Silt Layer

A lower silt layer was encountered below the clayey silt at depths ranging from 10.7 m to 13.7 m (elevations 88.3 to 89.8) in all the boreholes. The silt contains trace to some clay and trace sand.

All the boreholes were terminated within the lower silt layer at 15.8 m depth (elevations 83.9 to 86.2).

Standard Penetration Tests recorded in the lower silt layer gave SPT N-values of 6 to 20 blows per 0.3 m of penetration, indicating a loose to compact relative density.



The moisture content of samples from the lower silt layer generally varies between 19% and 22%.

Grain size distribution curves for samples of silt tested are presented on the Record of Borehole sheets and on Figure B2 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 1
Silt	86 to 93
Clay	7 to 13

## 5.6 Water Levels

Water levels were observed in the open boreholes upon completion of the drilling operations. One standpipe piezometer was installed in Borehole AL11-01 to monitor water levels after completion of drilling. The water levels measured in the open boreholes and piezometer are summarized in Table 5.1.

**Table 5.1 – Water Level Measurements**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
AL11-01	May 1, 2011	2.7	97.0	Open borehole
	May 3, 2011	1.0	98.7	Piezometer
	May 4, 2011	1.0	98.7	Piezometer
	May 5, 2011	1.0	98.7	Piezometer
AL11-02	May 2, 2011	3.9	98.1	Open borehole
AL11-03	May 3, 2011	1.3	99.2	Open borehole

The piezometric readings indicate that the groundwater level is near elevation 98.7.

The GA indicates that the water level of Alder Creek at this site on July 20, 2011 was at elevation 99.1.

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

## 6 MISCELLANEOUS

Borehole locations were selected and marked in the field by Thurber Engineering Ltd. Upon completion of drilling, the borehole elevations were established from a contour plan provided by Genivar.

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

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied a track mounted CME 55 drill rig and conducted the drilling, sampling and in-situ testing operations.

The field program was supervised on a full time basis by Mr. George Azzopardi of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T. Interpretation of the data and preparation of this report were carried out by Ms. Lindsey Blaine, E.I.T. and Ms. R. Palomeque Reyna, P.Eng.

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

Thurber Engineering Ltd

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P. K. Chatterji, P.Eng.  
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## **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 <sup>(1)</sup> '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		SYMBOLS	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
<b>TERMS</b>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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 AL11-01

1 OF 2

METRIC

W.P. 6026-07-00 LOCATION N 539 553.1 E 590 118.4 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2011.05.01 - 2011.05.01 CHECKED BY LRB

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 <sup>3</sup>	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					Wp      W      W <sub>L</sub>				
						● QUICK TRIAXIAL      × LAB VANE											
99.9								20	40	60	80	100	20	40	60		
0.0	Sandy SILT, with organics Very Loose Brown Moist		1	SS	3									○			
99.3																	
0.6	SILT, some clay, trace sand, occasional rootlets Loose to Compact Brown to Grey Damp		2	SS	7		99							○			
			3	SS	7		98							○			
	Wet		4	SS	13		97							○			0   0   89   11
			5	SS	5		96							○			
			6	SS	6		95							○			
							94										
93.8																	
6.1	Clayey SILT, varved Firm to Stiff Grey		7	SS	5									○			0   0   78   22
			8	SS	15		92							○			
			9	SS	11		91							○			
							90										

Continued Next Page

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No AL11-01

2 OF 2

METRIC

W.P. 6026-07-00 LOCATION N 539 553.1 E 590 118.4 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2011.05.01 - 2011.05.01 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page													
89.2	Clayey SILT, varved Firm to Stiff Grey													
10.7	SILT, trace clay Loose to Compact Grey Wet		10	SS	6									
			11	SS	18									
			12	SS	16									0 0 93 7
			13	SS	17									
84.1														
15.8	END OF BOREHOLE AT 15.8m. WATER LEVEL OBSERVED AT 2.7m UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May03/ 11 1.0 98.9 May04/ 11 1.0 98.9 May05/ 11 1.0 98.9													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No AL11-02

1 OF 4

METRIC

W.P. 6026-07-00 LOCATION N 539 564.7 E 590 117.0 Alder Creek Culvert ORIGINATED BY GA  
 HWY 617 BOREHOLE TYPE Hollow Stem Augers/DCPT COMPILED BY AN  
 DATUM Geodetic DATE 2011.05.02 - 2011.05.02 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
101.9 0.0	SAND, some gravel, some silt and clay Compact to Loose Brown Damp (FILL)		1	SS	19									
			2	SS	23		101							
			3	SS	23		100							15 64 21 (SI+CL)
			4	SS	9		99							
			5	SS	13		98							
97.9 4.0	SILT, some clay Compact Grey Wet		6	SS	13		97							0 0 87 13
95.8 6.1	Clayey SILT, varved Stiff to Firm Grey		7	SS	10		96							
			8	SS	8		95							
			9	SS	6		94							0 0 75 25
							93							
							92							

Continued Next Page

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No AL11-02

2 OF 4

METRIC

W.P. 6026-07-00 LOCATION N 539 564.7 E 590 117.0 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Hollow Stem Augers/DCPT COMPILED BY AN  
DATUM Geodetic DATE 2011.05.02 - 2011.05.02 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page											
	Clayey SILT, varved Stiff to Firm Grey		10	SS	12		91					
			11	SS	6		90					
88.2							89					
13.7	SILT, trace clay Compact Grey Wet		12	SS	20		88					
							87					
86.1			13	SS	18		86					
15.8	End of sampling and start DCPT at 15.8m						85					
							84					
							83					
							82					

Continued Next Page

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

RECORD OF BOREHOLE No AL11-02

3 OF 4

METRIC

W.P. 6026-07-00 LOCATION N 539 564.7 E 590 117.0 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Hollow Stem Augers/DCPT COMPILED BY AN  
DATUM Geodetic DATE 2011.05.02 - 2011.05.02 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60					
							81							
							80							
							79							
							78							
							77							
							76							
							75							
							74							
							73							
							72							

Continued Next Page

+<sup>3</sup> × 3<sup>3</sup>: Numbers refer to Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No AL11-02

4 OF 4

METRIC

W.P. 6026-07-00 LOCATION N 539 564.7 E 590 117.0 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Hollow Stem Augers/DCPT COMPILED BY AN  
DATUM Geodetic DATE 2011.05.02 - 2011.05.02 CHECKED BY LRB

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)	W <sub>p</sub>	W	W <sub>L</sub>		
	Continued From Previous Page													
71.4														
30.5	END OF BOREHOLE AT 30.5m. WATER LEVEL AT 3.9m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG FROM 15.8m TO 0.6m, THEN SAND AND GRAVEL TO SURFACE.						71							

RECORD OF BOREHOLE No AL11-03

1 OF 2

METRIC

W.P. 6026-07-00 LOCATION N 539 584.6 E 590 125.2 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2011.05.02 - 2011.05.03 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
100.1												
0.0	SILT, trace sand, trace clay, occasional rootlets Loose to Compact Brown Damp		1	SS	7		100					
			2	SS	12		99					
			3	SS	6		98					
			4	SS	15		97					
			5	SS	14		96					
95.5												
4.6	Clayey SILT, varved Soft to Firm Grey		6	SS	5		95					
							94					
			7	SS	4		93					
			8	SS	5		92					
							91					
			9	SS	5							

Continued Next Page

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No AL11-03

2 OF 2

METRIC

W.P. 6026-07-00 LOCATION N 539 584.6 E 590 125.2 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2011.05.02 - 2011.05.03 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$  kN/m <sup>3</sup>	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	● QUICK TRIAXIAL						
	Continued From Previous Page						20	40	60	80	100					
89.4	Clayey <b>SILT</b> , varved Soft to Firm Grey															
10.7	<b>SILT</b> , some clay, trace sand Compact Grey Wet		10	SS	10										0 1 86 13	
			11	SS	18											
			12	SS	19											
			13	SS	17											
84.3																
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.8m AND WATER LEVEL AT 1.3m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															

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

RECORD OF BOREHOLE No DCPT-AL11-03

1 OF 3

METRIC

W.P. 6026-07-00 LOCATION N 539 584.6 E 590 125.2 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN  
DATUM Geodetic DATE 2011.05.03 - 2011.05.03 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
102.0													
0.0	Start DCPT from surface.						102						
							101						
							100						
							99						
							98						
							97						
							96						
							95						
							94						
							93						

Continued Next Page

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

RECORD OF BOREHOLE No DCPT-AL11-03

2 OF 3

METRIC

W.P. 6026-07-00 LOCATION N 539 584.6 E 590 125.2 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN  
DATUM Geodetic DATE 2011.05.03 - 2011.05.03 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	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    x LAB VANE					WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>
Continued From Previous Page								20 40 60 80 100	20 40 60				
							92						
							91						
							90						
							89						
							88						
							87						
							86						
							85						
							84						
							83						

Continued Next Page

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity 20  
15 10 5  
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No DCPT-AL11-03

3 OF 3

METRIC

W.P. 6026-07-00 LOCATION N 539 584.6 E 590 125.2 Alder Creek Culvert ORIGINATED BY GA  
HWY 617 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN  
DATUM Geodetic DATE 2011.05.03 - 2011.05.03 CHECKED BY LRB

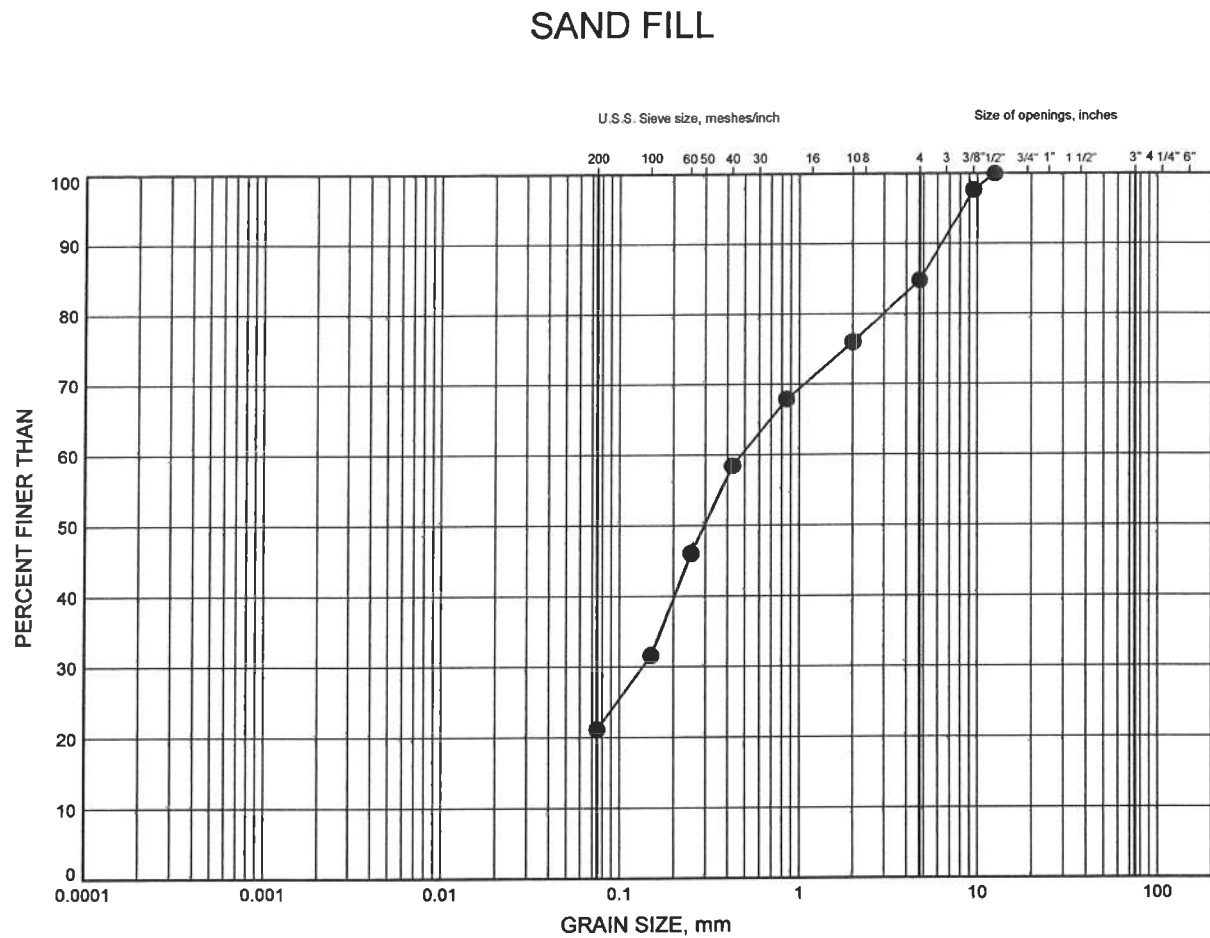
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
	Continued From Previous Page							20 40 60 80 100	20 40 60				
							82						
							81						
79.7 22.3	END OF DCPT AT 22.3m.						80						

**Appendix B**  
**Laboratory Test Results**

# NWR HWY 11 Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE B1



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

### LEGEND

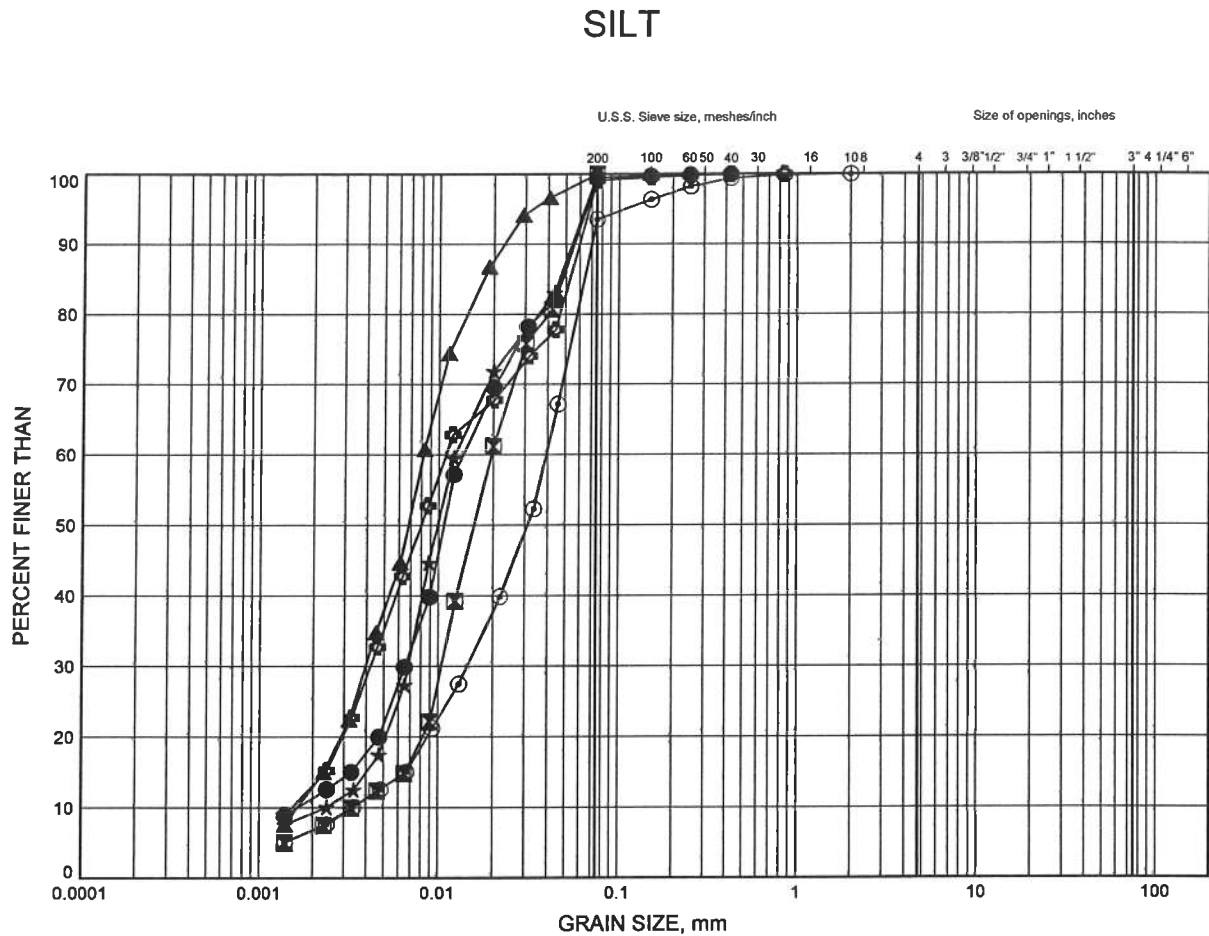
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	AL11-02	1.83	100.17



W.P.# 19-5308-40  
Prepared By AN  
Checked By LRB

NWR HWY 11 Bridge  
GRAIN SIZE DISTRIBUTION

FIGURE B2



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	AL11-01	2.57	97.13
⊠	AL11-01	14.02	85.68
▲	AL11-02	4.88	97.12
★	AL11-03	2.59	97.91
⊙	AL11-03	3.35	97.15
⊕	AL11-03	10.97	89.53

GRAIN SIZE DISTRIBUTION - THURBER 0840.GPJ 7/11/11

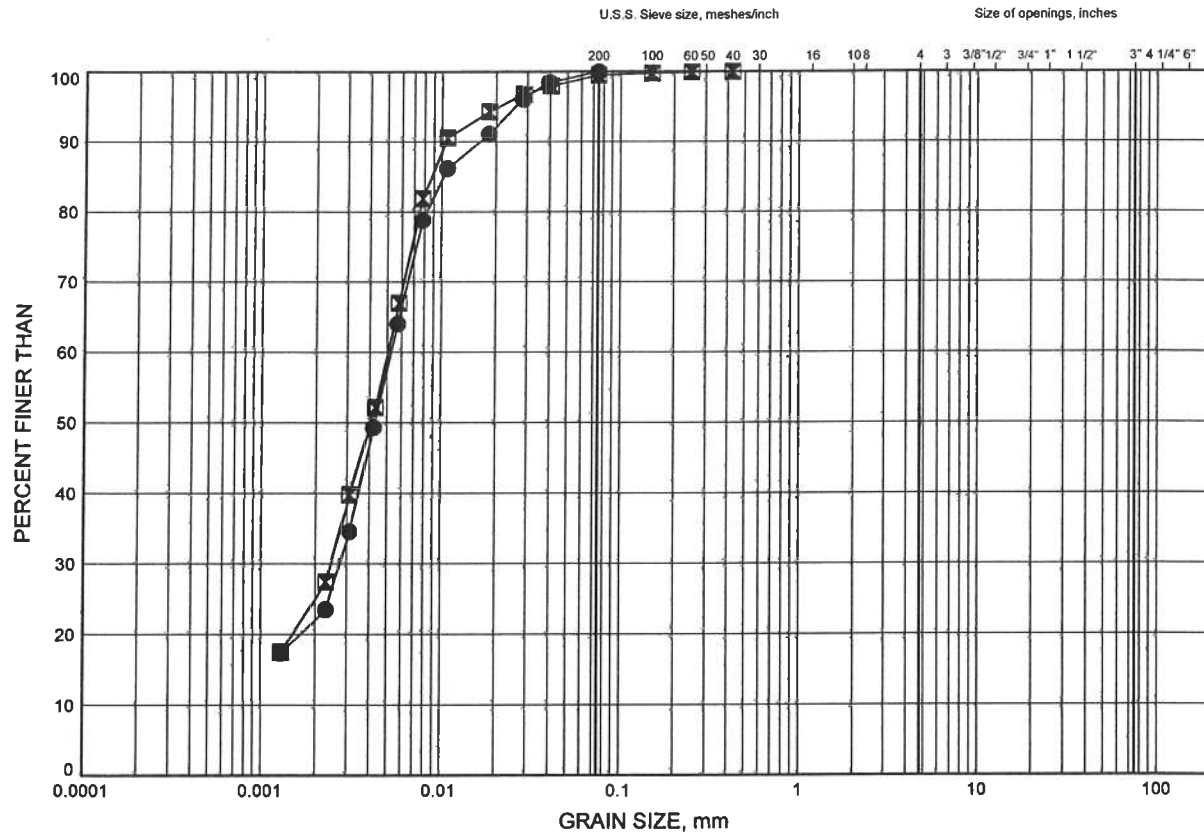
W.P.# .19-5308-40.....  
Prepared By .AN.....  
Checked By .LRB.....



# NWR HWY 11 Bridge GRAIN SIZE DISTRIBUTION

FIGURE B3

## CLAYEY SILT



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	AL11-01	6.40	93.30
■	AL11-02	9.45	92.55



W.P.# 19-5308-40  
Prepared By AN  
Checked By LRB

**Appendix C**  
**Site Photographs**



**Photograph 1 – Alder Creek Culvert**

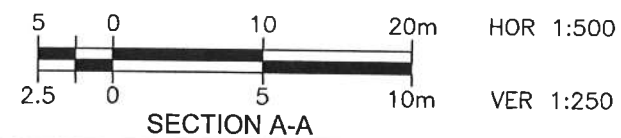
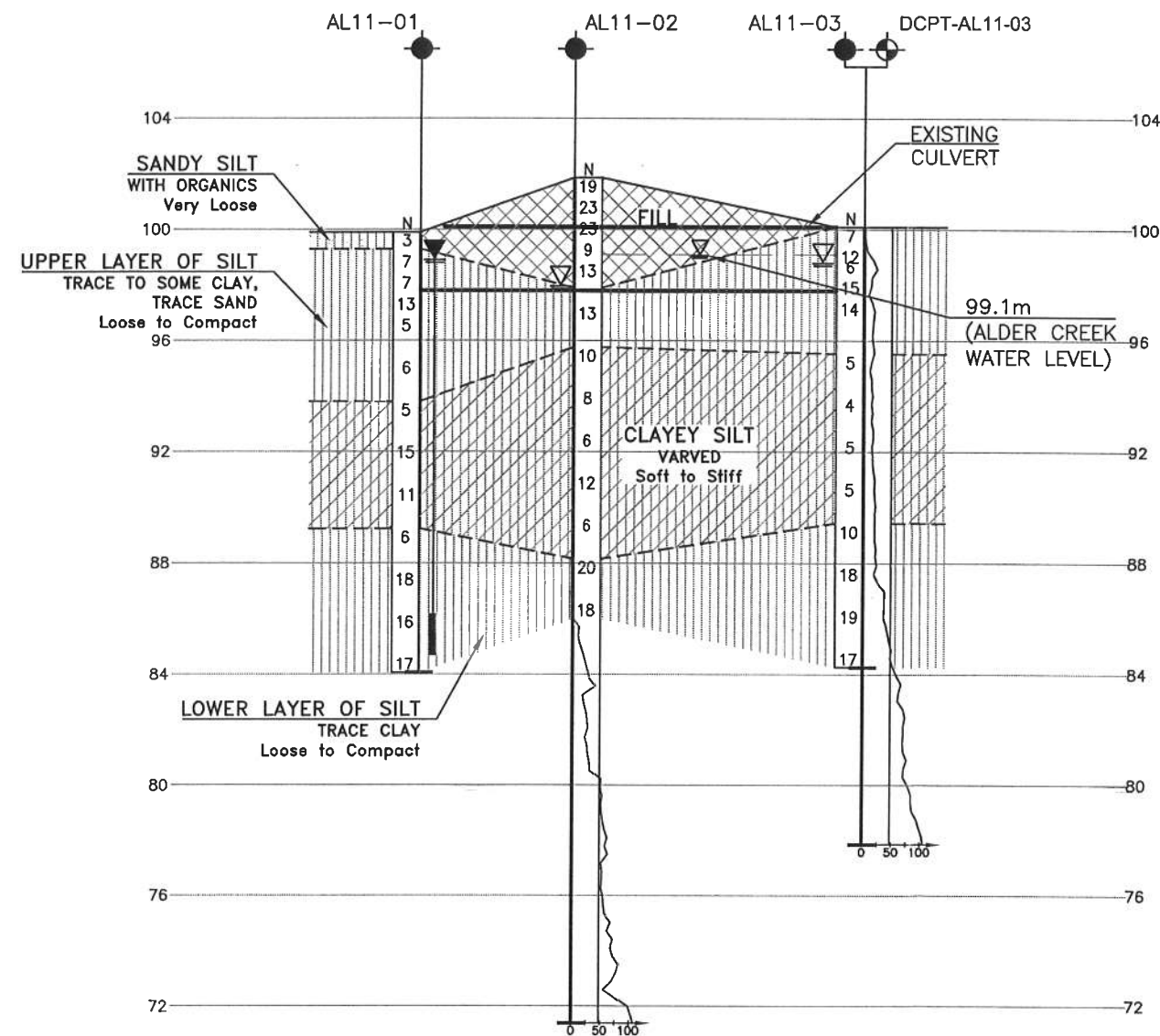
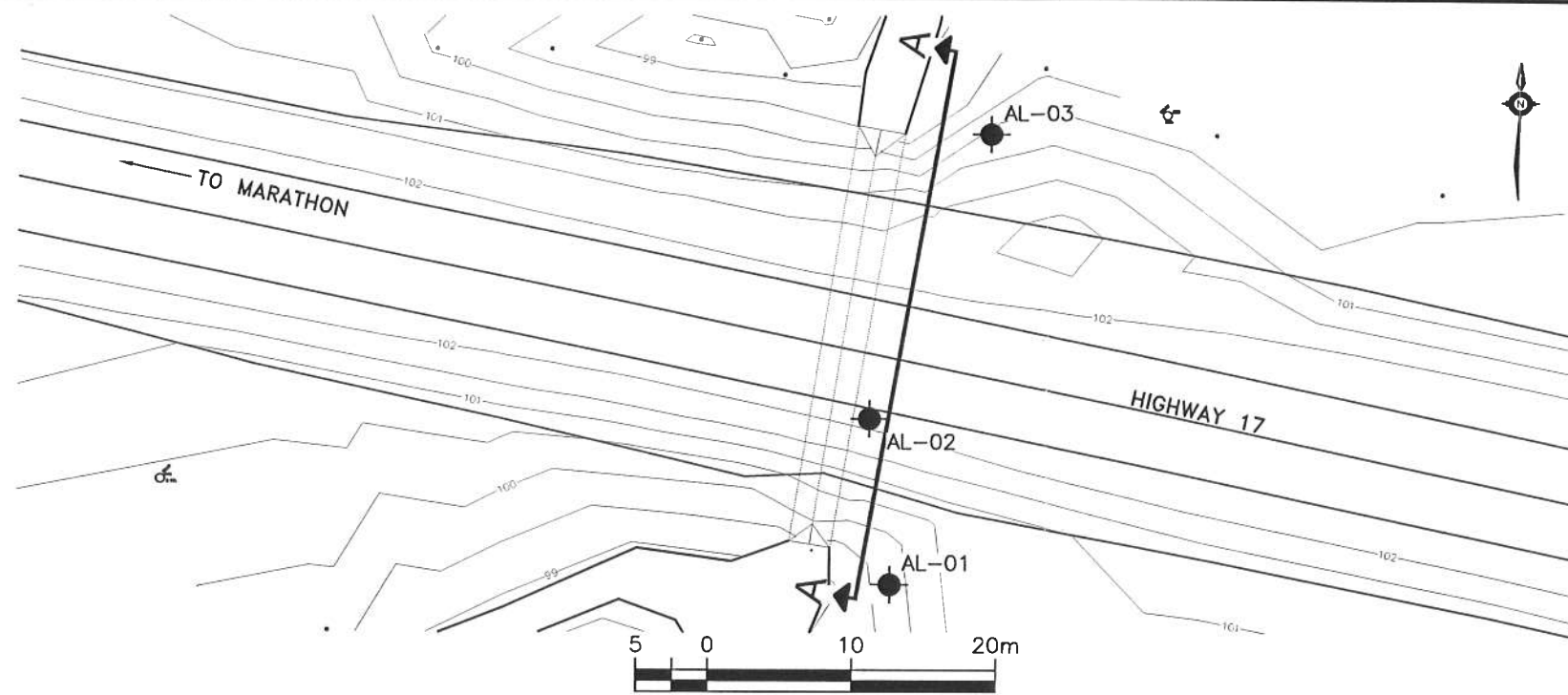


**Photograph 2 – Alder Creek Culvert**

## **Appendix D**

### **Drawing Borehole Locations and Soil Strata**





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

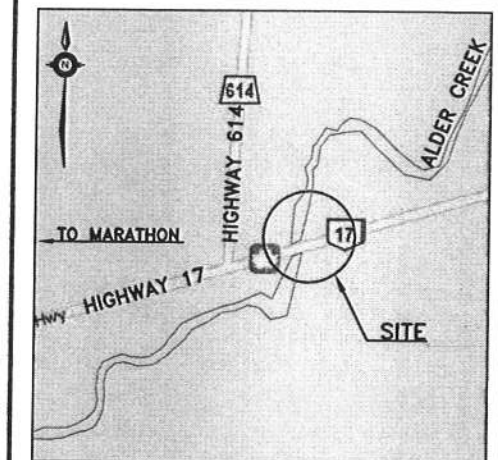
CONT No 2011-6025  
GWP No 6026-07-00  
WP No 6026-07-02

ALDER CREEK CULVERT  
REPLACEMENT  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET  
26

**GENIVAR**

**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
W	Water Level
W	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
AL11-01	99.9	539 553.1	590 118.4
AL11-02	101.9	539 564.7	590 117.0
AL11-03	100.1	539 584.6	590 125.2
DCPT-AL11-03	100.1	539 584.6	590 125.2

**-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.

**GEOCRES No. 42C-24**

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LRB	CHK	LRB
DRAWN	AN	CHK	SITE
			STRUCT
			DWG 1
			DATE DEC. 2011