



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 11B
CULVERT REPLACEMENT, 11+188 COLEMAN TWP
NEW LISKEARD AREA
G.W.P. 5421-04-00**

GEOCRES Number: 31M-106

Report to

MMM GROUP LIMITED

5013-E-0031, Assignment 1

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19-5161-208



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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) at a culvert replacement site on Highway 11B near Cobalt, Ontario.

No previous foundation investigation information near the subject culvert was available.

The purpose of this investigation was to obtain subsurface information at the site and, based on the data obtained, to provide a model of the subsurface conditions including borehole location plans, stratigraphic profiles, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber was retained by MMM Group Limited to carry out this foundation investigation under MTO Agreement Number 5013-E-0031.

2 SITE DESCRIPTION

The culvert site is located on Highway 11B, approximately 1.2 kilometres east of Highway 11 in the Township of Coleman. A 2.47 m span by 1.66 m rise by 30.7 m long concrete rigid box culvert is present at the site and covered with approximately 5.4 m of fill. The culvert conveys water under Highway 11B from north to south between two separated sections of Gillies Lake. The invert elevations are 288.1 m at the inlet on the north side and 287.9 m at the outlet on the south side, indicating an average gradient of approximately 0.7%.

The culvert is located within a fill section. The grade of the existing Highway 11B in the vicinity of the culvert is at 295.1 m geodetic. The cross-section includes two 3.3 m wide lanes and shoulders ranging in width from 2.9 m to 3.3 m. Three cable guide rail is present on both sides of the highway. The highway embankment is constructed with side slopes ranging from approximately 1.5H:1V to 1.7H:1V. The slopes are sparsely vegetated with brush and small trees. Cobbles and boulders are also present on the slopes. No evidence of slope instability or erosion was noted during the field investigation.

The embankment fill height is approximately 7 m from culvert invert to roadway surface. The site is located in a rural area with lakes, forests, swamps, and creeks. Local topography is generally flat with rolling hills. Selected photographs of the culvert site are attached in Appendix D. The highway appears to have been re-aligned at some point in the past. The remnants of the old alignment appear to the north of the current highway.

The surficial geology of the area is typical of the Wisconsin glaciation. Soil cover consists primarily of organic soils, and glaciofluvial (sand and gravel) deposits.

3 SITE INVESTIGATION AND FIELD TESTING

This borehole investigation and field testing program was carried out between September 30, 2014 and October 9, 2014. The program consisted of drilling and sampling six boreholes (numbered 14-1, 14-2, 14-3, 14-4, 14-5 and 14-6) to depths ranging from 8.2 to 15.8 m. Of these boreholes, one was located near the culvert inlet (14-1), one located near the culvert outlet (14-4), two (14-5 and 14-6) were located through the embankment (one within each shoulder) on opposite sides of the culvert, and two were located off the highway to the north (14-2 west of the culvert and 14-3 east of the culvert).

Prior to the start of drilling, the borehole locations were established in the field and utility clearances were obtained. The stationing with offsets and elevations of the as-drilled boreholes were subsequently surveyed by Thurber. The top of the right end of the box culvert at approximate Station 11+188 was used as a benchmark. Contract Drawings for 85-221 indicate the elevation at this location to be 289.51 m Geodetic.

A rubber track-mounted drill rig was used to drill and sample the boreholes on the roadway (14-5 and 14-6) as well as Boreholes 14-1 and 14-3, and a portable tripod drill rig was used to drill and sample the culvert inlet and outlet boreholes (14-2 and 14-4). Hollow stem augers and/or NW casing were used to advance the boreholes. Soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in

conjunction with Standard Penetration Testing (SPT). A Dynamic Cone was driven to extend Boreholes 14-2, 14-4 and 14-5 below the sampled depth.

Results of the field drilling and sampling are presented on the Record of Borehole sheets in Appendix B.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, secured the recovered soil samples in labelled containers, and transported the samples to Thurber's laboratory for further examination and testing.

The boreholes were backfilled with soil cuttings mixed with bentonite and topped to surface with the existing granular material or, where required, 100 mm of premium cold patch asphalt.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification and to Natural Moisture Content determination. Selected soil samples were subjected to Grain Size Distribution analyses (sieve). The results of this laboratory testing program are shown on the Record of Borehole sheets in Appendix B and on the Figures in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the existing culvert alignment is presented on the Borehole Locations and Soil Strata Drawing in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs, however, the factual data presented in the record of boreholes governs any interpretation of the site conditions.

In general, the subsurface conditions encountered in the boreholes consist of granular embankment fill overlying sand deposits. More detailed descriptions of the individual strata are presented below.

5.2 Pavement Structure

One borehole was advanced through the old highway pavement structure (14-3). In this borehole 80 mm of asphalt was found at the surface. Beneath the old highway asphalt, a

gravelly sand fill extended to a depth of 0.6 m or elevation 291.7 m. The moisture content of this material was 6%.

A layer of asphalt 80 mm in thickness was encountered at ground surface in Boreholes 14-5 and 14-6 which were drilled through the current highway shoulders.

Gravelly sand fill, likely placed as part of the pavement structure, extended to a depth of 1.4 m below surface (elevations 294.1 m and 293.7 m in Boreholes 14-5 and 14-6 respectively).

The moisture content of the pavement granulars sample ranged from 2% to 4%. The results of grain size analysis conducted on two samples of the granular material are presented on Fig. No 1 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	27 to 41
Sand	48 to 64
Silt and Clay	9 to 11

5.3 Embankment Fill

Embankment fill was encountered below the pavement granulars in Boreholes 14-5 and 14-6 and at ground surface in Boreholes 14-1 and 14-4. The thickness of the embankment fill in these boreholes ranged from 2.0 to 8.0 m. The base of the embankment fill was encountered at elevations ranging from 285.4 to 286.9 m.

The fill was observed to vary from silty sand to gravel and sand. The fill included cobbles at some intervals. Boulders were noted in Borehole 14-4. The upper 200 mm in thickness in Borehole 14-4, drilled near the outlet included roots and rootlets; the water content of one sample of this layer was 39%. Wood was noted at the base of the embankment fill in Borehole 14-1 and 14-5 and may be remnants of old cribwork.

The SPT N-value for the granular fill ranged from 3 to 86 blows per 0.3 m penetration, indicating a very loose to very dense state. The fill is generally in a compact state. The water content of the recovered embankment fill samples ranged between 3% and 34%. The colour of the embankment fill is brown.

The results of grain size analyses conducted on eight samples of the fill are presented on Fig. No 2 and 3 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	1 to 56
Sand	43 to 90
Silt and Clay	1 to 19

5.4 Fill

Fill was also noted in Boreholes 14-2 and 14-3 which were located to the north of the current highway alignment. The fill extended to depths of 2.9 m and 7.0 m in these two boreholes respectively, (elevation 287.9 m and 285.3 m).

The fill was observed to vary from sand to gravelly sand. The fill included cobbles at some intervals. Boulders were noted at a depth of approximately 2 m in Borehole 14-2; coring was required to advance the borehole through the boulder. Traces of organic material and wood were noted at the base of the fill in Borehole 14-3.

The SPT N-value for the fill ranged from 3 to 14 blows per 0.3 m penetration, indicating a very loose to compact state. The water content of the recovered fill samples ranged between 6% and 25%. The colour of the fill is brown.

The results of grain size analyses conducted on five samples of the fill are presented on Fig. No 4 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	9 to 32
Sand	61 to 86
Silt and Clay	3 to 9

5.5 Sand

Below the fill materials, a native sand deposit was encountered in all boreholes. All six boreholes were terminated within this deposit at depths ranging from 8.2 m to 15.8 m (elevation 281.0 m to 279.2 m). The SPT N-value for this deposit was weight-of-hammer (WH) to 25 blows per 0.3 m penetration, indicating a very loose to compact state. The water contents of the recovered samples ranged between 13% and 24%. The colour of this deposit is grey. Grain size analyses conducted on nine samples of the soil are

presented on Fig. No 5 and 6 in Appendix C. These results are summarized in the following table.

Soil Particles	%
Gravel	0 to 8
Sand	33 to 99
Silt and Clay	1 to 67

5.6 Bedrock

Bedrock was not encountered within the depth of this investigation.

5.7 Groundwater Conditions

At the time of drilling, free water was observed in Boreholes 14-1, 14-4, 14-5 and 14-6 at depths ranging from 0.39 m to 7.9 m. The elevation of the observed free water ranged from 287.2 m to 288.4 m. Water level in the lake was surveyed to be at elevation 288.5m near the culvert inlet and 287.7 m near the outlet on September 29, 2014.

It is noted during drilling that running sands were observed in all boreholes at elevations ranging from 282 m to 285 m.

Where surface water is present, the groundwater level should be assumed to coincide with the local surface water level. Local high water levels and the effects of precipitation must also be taken into consideration.

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. The borehole locations and elevations were surveyed by Thurber

George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, supplied and operated a track-mounted CME 45 drill rig as well as the portable tripod drill rig to carry out the drilling, sampling and in-situ testing operations. The drilling and sampling operations in the field were supervised on a full time basis by Mr. Justin Gray of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory.

Overall project management and direction of the field program was provided by Dr. Fred Griffiths, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Justin Gray and Dr. Fred Griffiths P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Justin Gray
Geotechnical E.I.T.



Fred J. Griffiths, P.Eng.
Associate, Senior Foundations Engineer

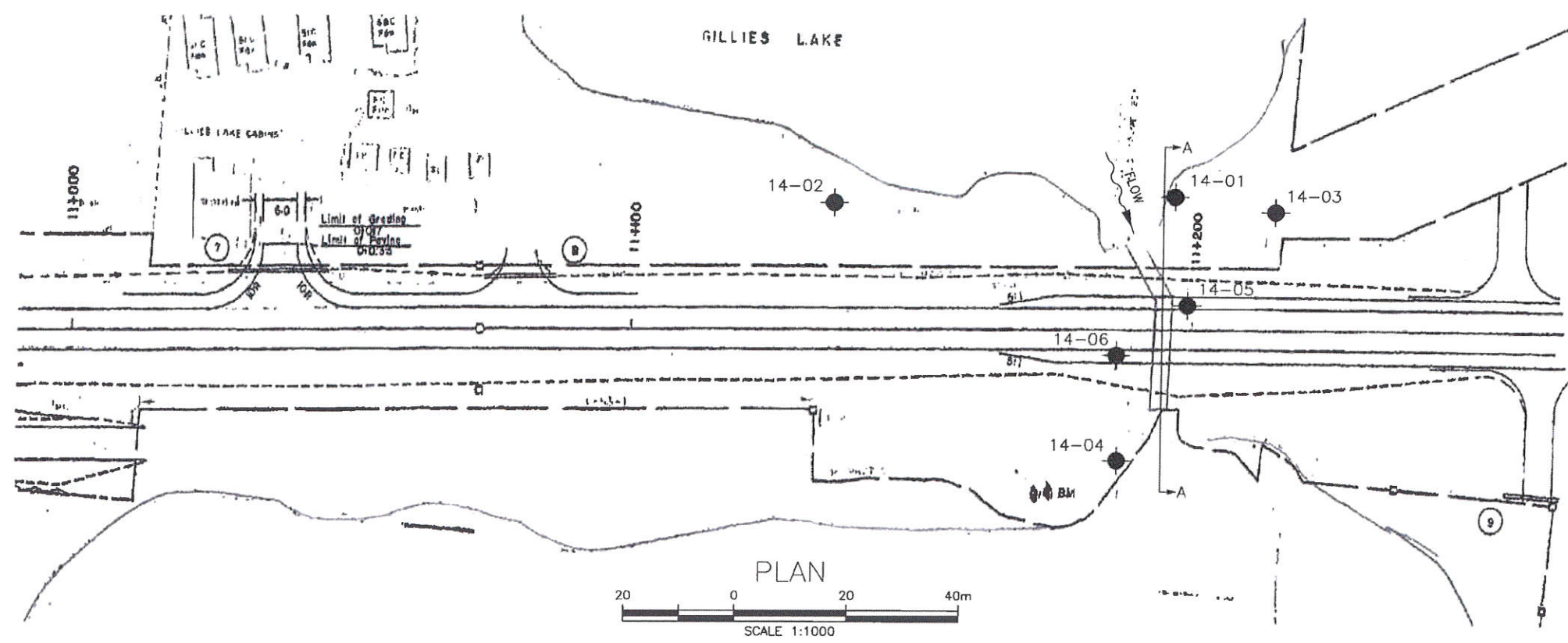


P. K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact

Appendix A

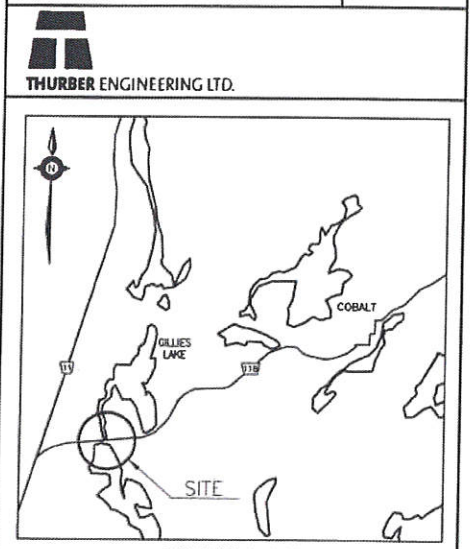
Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



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

CONT No	SHEET
WP No	
HIGHWAY 11B CULVERT REPLACEMENT BOREHOLE LOCATIONS AND SOIL STRATA	



KEYPLAN

LEGEND

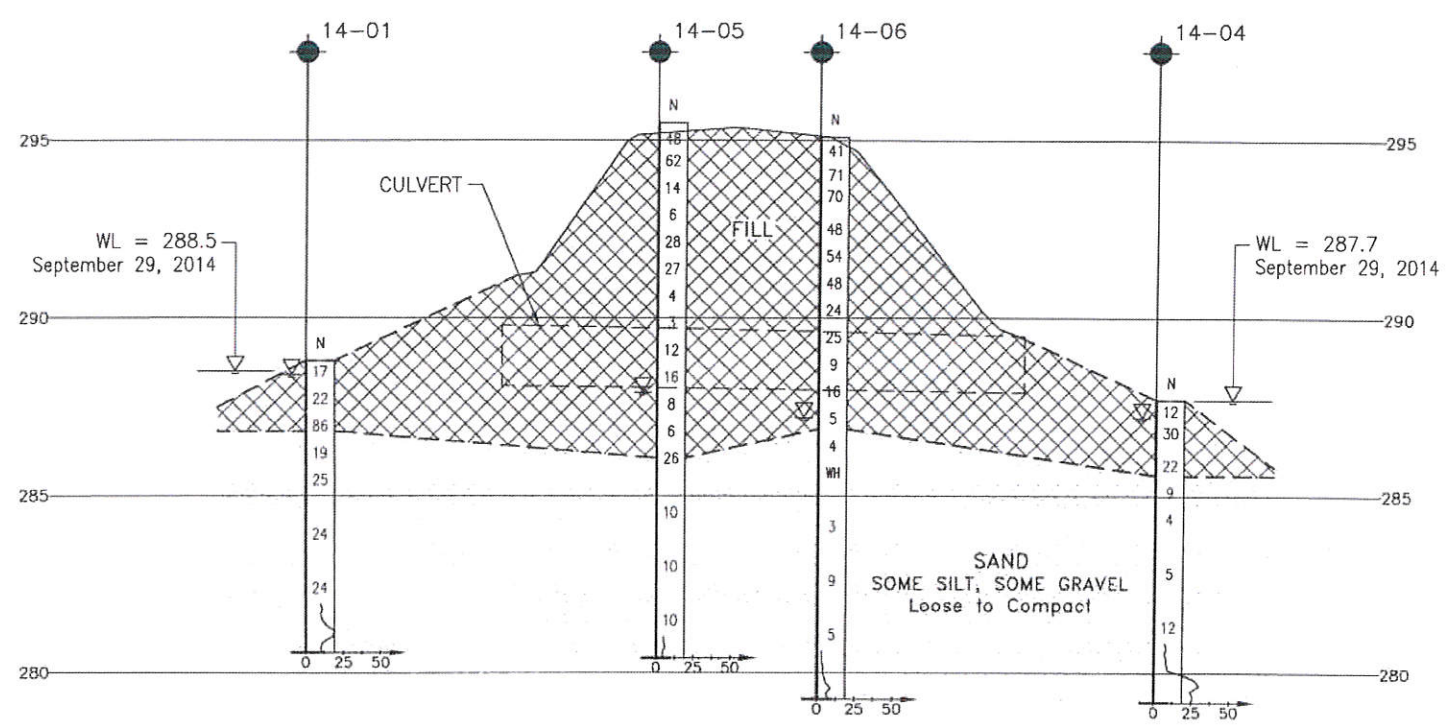
- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	CHAINAGE	OFFSET
14-01	288.8	11+194	23L
14-02	290.8	11+135	22L
14-03	292.3	11+212	21L
14-04	287.7	11+187	24R
14-05	295.5	11+199	3.7L
14-06	295.1	11+186	3.6R

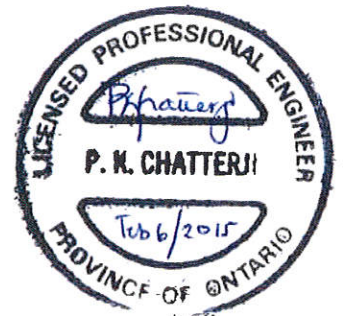
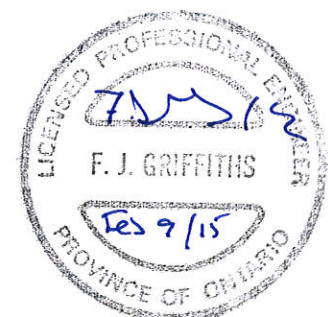
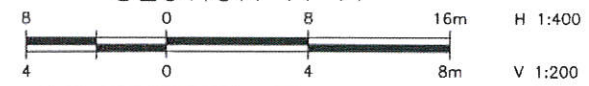
-NOTES-

- 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. 31M-106



SECTION A-A



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	JG	CHK	PC
DRAWN	MFA	CHK	JG
DATE	FEB 2015	DATE	FEB 2015
STRUCT	DWG	1	

FILENAME: H:\Projects\15151\208_NER_DE_Retainer\Design 1 Hwy 11B\CA\15-02-02\1508-PlanProfile.dwg
PLOTDATE: 2/2/2015 1:15 PM

Appendix B

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

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


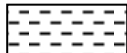



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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






<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>			
Fresh (FR)	No visible signs of weathering.				
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE		
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE		
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE		
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL		
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)		
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa) (psi)	Field Estimation of Hardness*	
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				
Thinly bedded	60mm to 0.2m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
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				
<u>TERMS</u>	Total Core Recovery: (TCR)	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
	Solid Core Recovery: (SCR)	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
	Rock Quality Designation: (RQD)	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
	Uniaxial Compressive Strength (UCS)	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
	Fracture Index: (FI)				

RECORD OF BOREHOLE No 14-1

1 OF 1

METRIC

19-5161-208 LOCATION 11+194 23 LT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Casing COMPILED BY JG
DATUM geodetic DATE 2014.10.07 - 2014.10.08 CHECKED BY FG

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 (%)				GR	SA	SI	CL	
								20 40 60 80 100					w _p w w _L								
288.8																					
0.0	Gravelly SAND Compact Brown (FILL)		1	SS	17																
	random cobbles between 0 to 1.5m		2	SS	22																
286.8	Wood		3	SS	86																
2.0	SAND Compact Grey																				
			4	SS	19																
			5	SS	25																

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

RECORD OF BOREHOLE No 14-2

1 OF 2

METRIC

19-5161-208 LOCATION 11+135 22 LT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
DATUM geodetic DATE 2014.10.01 - 2014.10.02 CHECKED BY FG

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 (%)				GR	SA	SI	CL
								20	40	60	80	100	W _P	W	W _L					
290.8																				
0.0	Gravelly SAND Loose to compact Brown (FILL) a few random cobbles throughout		1	SS	9										○				25 66 9 (SI+CL)	
			2	SS	10															
	cobbles and boulders 0.9 to 2.4m		3	SS	14															
			4	RUN																
			4	SS	3									○				32 61 7 (SI+CL)		
287.9																				
2.9	SAND Very loose to compact Grey		5	SS	14										○					
			6	SS	4											○			8 89 3 (SI+CL)	
			7	SS	5											○				
			8	SS	8											○				
	running sands																			
			9	SS	11											○				
			10	SS	5															

Continued Next Page

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

RECORD OF BOREHOLE No 14-2

2 OF 2

METRIC

19-5161-208 LOCATION 11+135 22 LT CL ORIGINATED BY JG
 HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
 DATUM geodetic DATE 2014.10.01 - 2014.10.02 CHECKED BY FG

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	WATER CONTENT (%)					
	Continued From Previous Page BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTONITE													

RECORD OF BOREHOLE No 14-3

1 OF 2

METRIC

19-5161-208 LOCATION 11+212 21 LT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
DATUM geodetic DATE 2014.10.01 - 2014.10.01 CHECKED BY FG

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						
								20 40 60 80 100						
292.3	80mm ASPHALT (old highway)													
0.0	Gravelly SAND Compact Brown (FILL)		1	SS	10		292							
291.7	SAND Very loose to compact Brown (FILL)		2	SS	8		291							9 85 6 (SI+CL)
0.6			3	SS	11		290							
			4	SS	5		289							
			5	SS	4		288							
			6	SS	3		287							
			7	SS	7		286							
	becoming gravelly		8	SS	7		285							30 63 7 (SI+CL)
	trace organic material		9	SS	6		284							11 86 3 (SI+CL)
	trace wood						283							
285.3														
7.0	SAND Very loose to loose Grey		10	SS	4									
	running sands		11	SS	5									

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-3

2 OF 2

METRIC

19-5161-208 LOCATION 11+212 21 LT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
DATUM geodetic DATE 2014.10.01 - 2014.10.01 CHECKED BY FG

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									
	Continued From Previous Page																
281.0	SAND Very loose to loose Grey		12	SS	7		282										
11.3	END OF BOREHOLE AT 11.28m BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTONITE																

RECORD OF BOREHOLE No 14-4

1 OF 1

METRIC

19-5161-208

LOCATION

11+187 24 RT CL

ORIGINATED BY JG

HWY 11B

BOREHOLE TYPE Casing



COMPILED BY JG

DATUM geodetic

DATE

2014.10.08 - 2014.10.09

CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL				
								20	40	60	80	100	W _P	W		W _L							
287.7																							
0.0	SAND with organics, roots and rootlets Compact Blackish brown Moist Gravelly SAND to GRAVEL and SAND , frequent cobbles and boulders Compact to loose Brown (FILL) a few random cobbles and boulders between 0.3 and 1.2m		1	SS	12		287											43	51	6 (SI+CL)			
0.2			2	SS	30																		
			3	SS	22																		
285.4																							
2.3	SAND Very loose to compact Brown to grey Wet 																						

+³, ×³: Numbers refer to Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-5

1 OF 2

METRIC

19-5161-208 LOCATION 11+199 3.7 LT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
DATUM geodetic DATE 2014.09.30 - 2014.09.30 CHECKED BY FG

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				W _p	W	W _L			WATER CONTENT (%)	GR	SA
295.5								20	40	60	80	100							
0.0	80mm ASPHALT SHOULDER																		
	Gravelly SAND Dense Brown (FILL)		1	SS	48		295												
			2	SS	62														27 64 9 (SI+CL)
294.1																			
1.4	Silty SAND , occasional cobble Loose to compact Brown (FILL)		3	SS	14		294												
			4	SS	6		293												
			5	SS	28		292												
			6	SS	27														
	a few random cobbles between 3.0 and 4.6m		7	SS	4		291												
			8	SS	3		290												5 81 14 (SI+CL)
			9	SS	12		289												
			10	SS	16														
			11	SS	8		288												
			12	SS	6		287												
	Trace organics, wood		13	SS	26		286												11 83 6 (SI+CL)
286.1																			
9.4	Sandy SILT to SAND Compact Grey																		0 33 67 (SI+CL)

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5 10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-5

2 OF 2

METRIC

19-5161-208 LOCATION 11+199 3.7 LT CL ORIGINATED BY JG
 HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
 DATUM geodetic DATE 2014.09.30 - 2014.09.30 CHECKED BY FG

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								
Continued From Previous Page							<div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div> <div><div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</div><div>W_P W W_L</div><div>WATER CONTENT (%)</div><div>20 40 60</div></div>									
280.4	SAND Compact Grey 															

RECORD OF BOREHOLE No 14-6

1 OF 2

METRIC

19-5161-208 LOCATION 11+186 3.6 RT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
DATUM geodetic DATE 2014.10.01 - 2014.10.01 CHECKED BY FG

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					W P W W L			GR	SA	SI	CL	
								20 40 60 80 100					20 40 60							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)							
295.1							20	40	60	80	100									
0.0		80mm ASPHALT SHOULDER																		
		Gravelly SAND Dense to very dense Brown (FILL)		1	SS	41							○							
				2	SS	71							○						41 48 11 (SI+CL)	
293.7																				
1.4		Gravelly SAND to Gravelly SAND some Silt, frequent cobbles Compact to very dense Brown (FILL)		3	SS	70														
				4	SS	48							○						26 65 9 (SI+CL)	
				5	SS	54							○							
		a few random cobbles throughout		6	SS	48							○							
				7	SS	24							○						28 53 19 (SI+CL)	
				8	SS	25							○							
289.0																				
6.1		SAND Loose to compact Brown (FILL)		9	SS	9							○							
				10	SS	16							○						1 90 9 (SI+CL)	
				11	SS	5							○							
286.9																				
8.2		SAND Very loose to compact Grey		12	SS	4							○							
				13	SS	WH							○						1 95 4 (SI+CL)	

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5 10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-6

2 OF 2

METRIC

19-5161-208 LOCATION 11+186 3.6 RT CL ORIGINATED BY JG
 HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
 DATUM geodetic DATE 2014.10.01 - 2014.10.01 CHECKED BY FG

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	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			w _P w w _L							
	Continued From Previous Page							20 40 60 80 100				20 40 60							
279.3 <																			

ONTMT4S 19-5161-208.GPJ 2012TEMPLATE(MTO).GDT 5/2/15

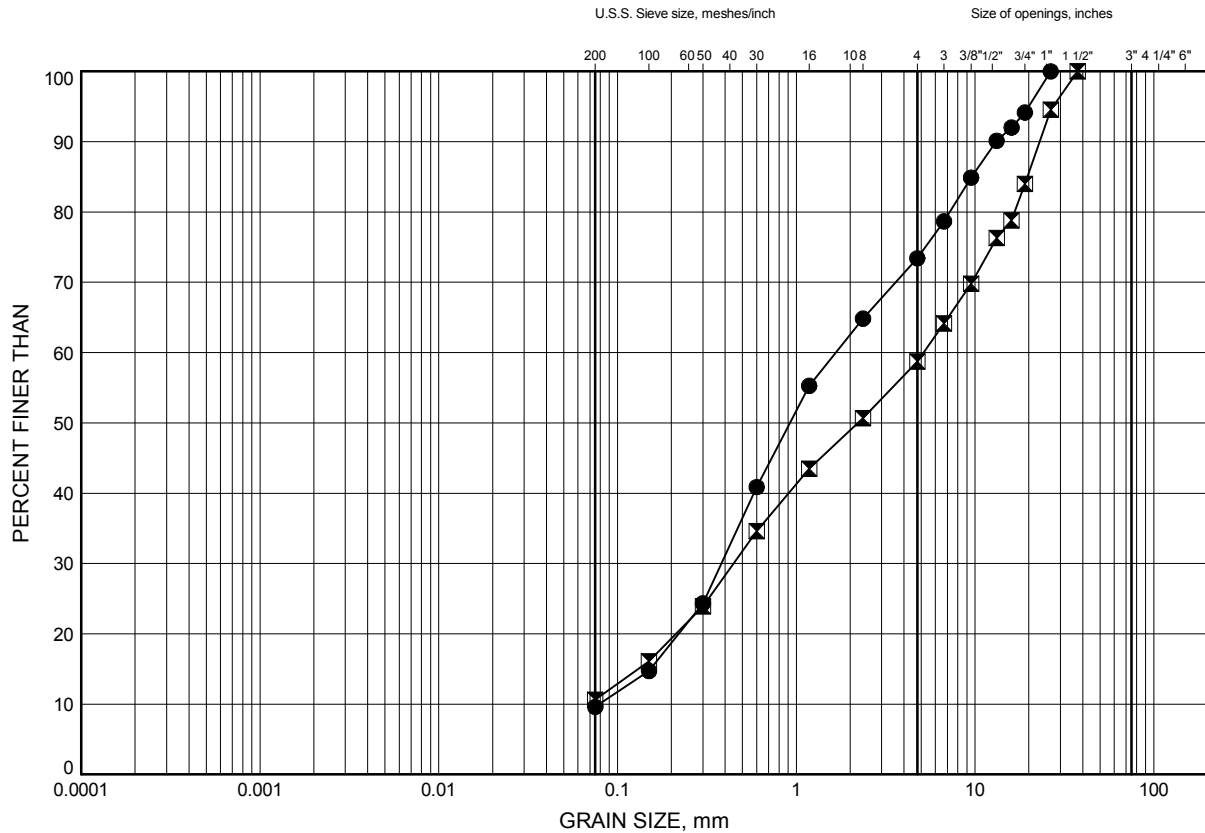
Appendix C

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE 1

Pavement Granulars



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-5	1.07	294.43
⊠	14-6	0.91	294.19

Date December 2014
19-5161-208

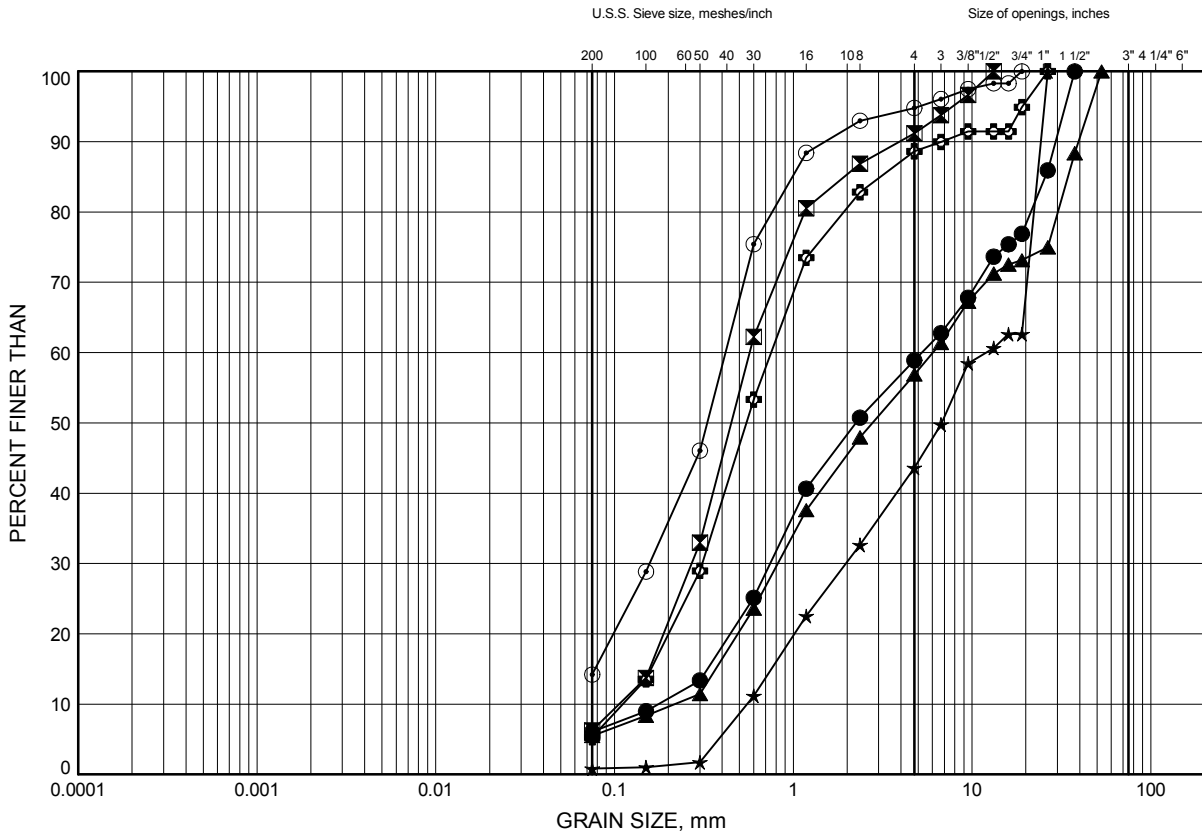


Prep'd JG
Chkd. FG

GRAIN SIZE DISTRIBUTION

FIGURE 2

Embankment Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-1	0.30	288.50
⊠	14-3	1.07	291.23
▲	14-4	0.41	287.29
★	14-4	1.83	285.87
⊙	14-5	5.64	289.86
⊞	14-5	9.30	286.20

Date December 2014
19-5161-208

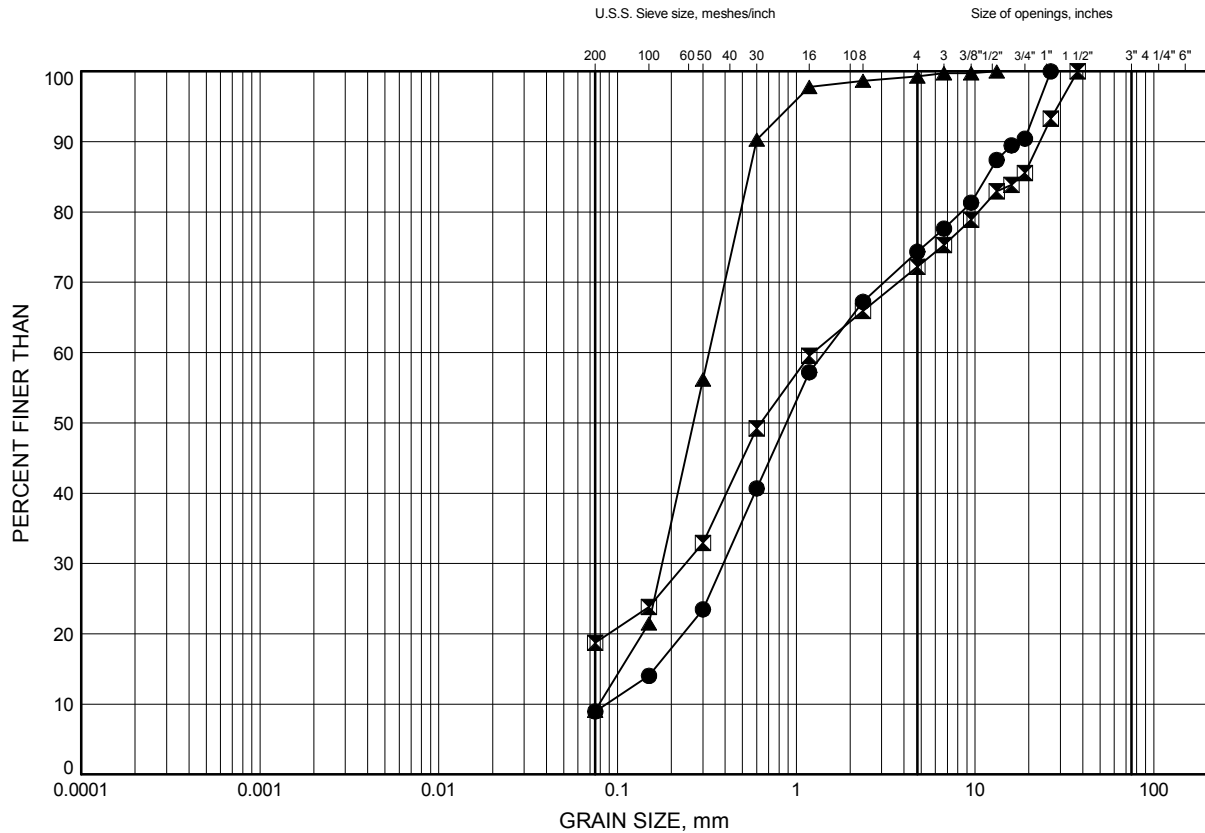


Prep'd JG
Chkd. FG

GRAIN SIZE DISTRIBUTION

FIGURE 3

Embankment Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-6	2.59	292.51
⊠	14-6	4.88	290.22
▲	14-6	7.16	287.94

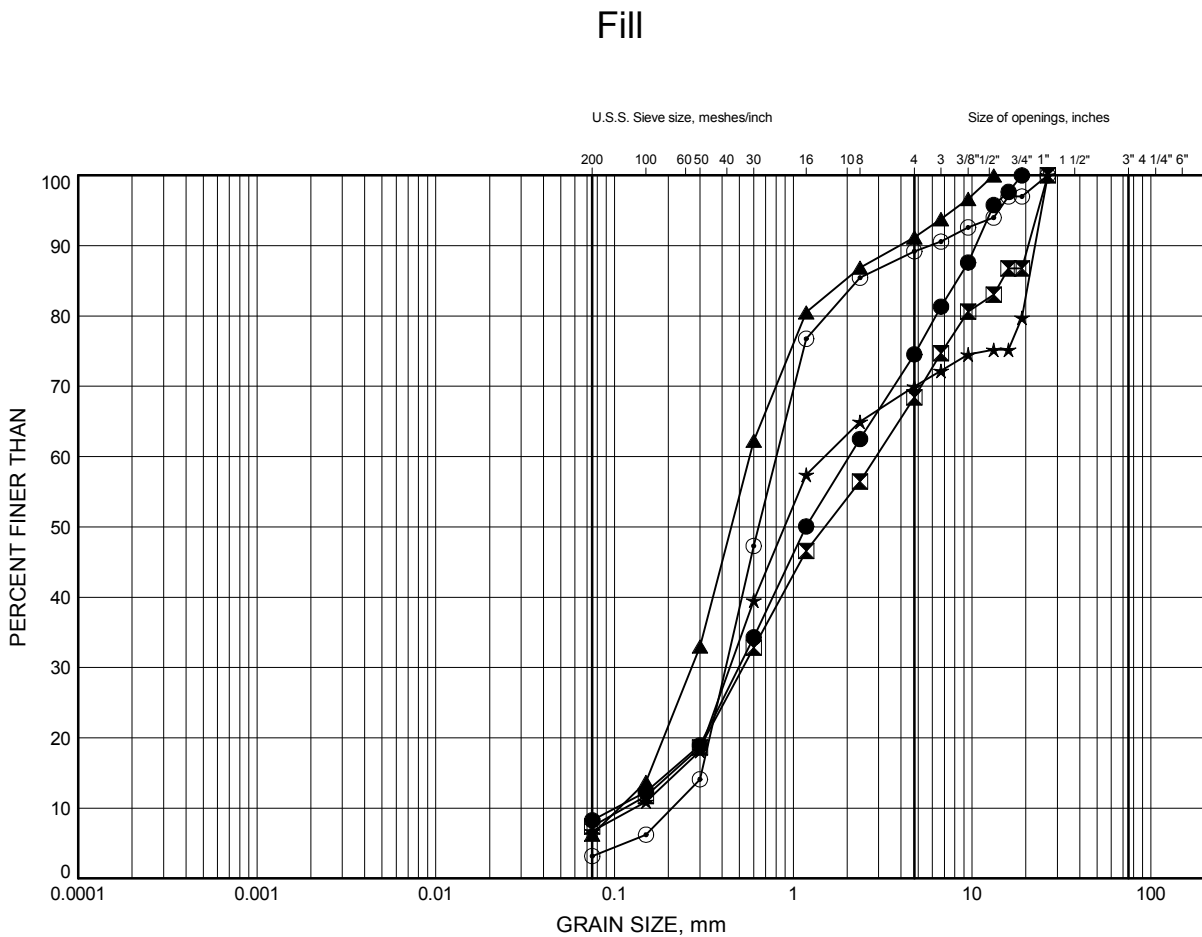
Date December 2014
19-5161-208



Prep'd JG
Chkd. FG

GRAIN SIZE DISTRIBUTION

FIGURE 4



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-2	0.30	290.50
⊠	14-2	2.59	288.21
▲	14-3	1.07	291.23
★	14-3	5.64	286.66
⊙	14-3	6.40	285.90

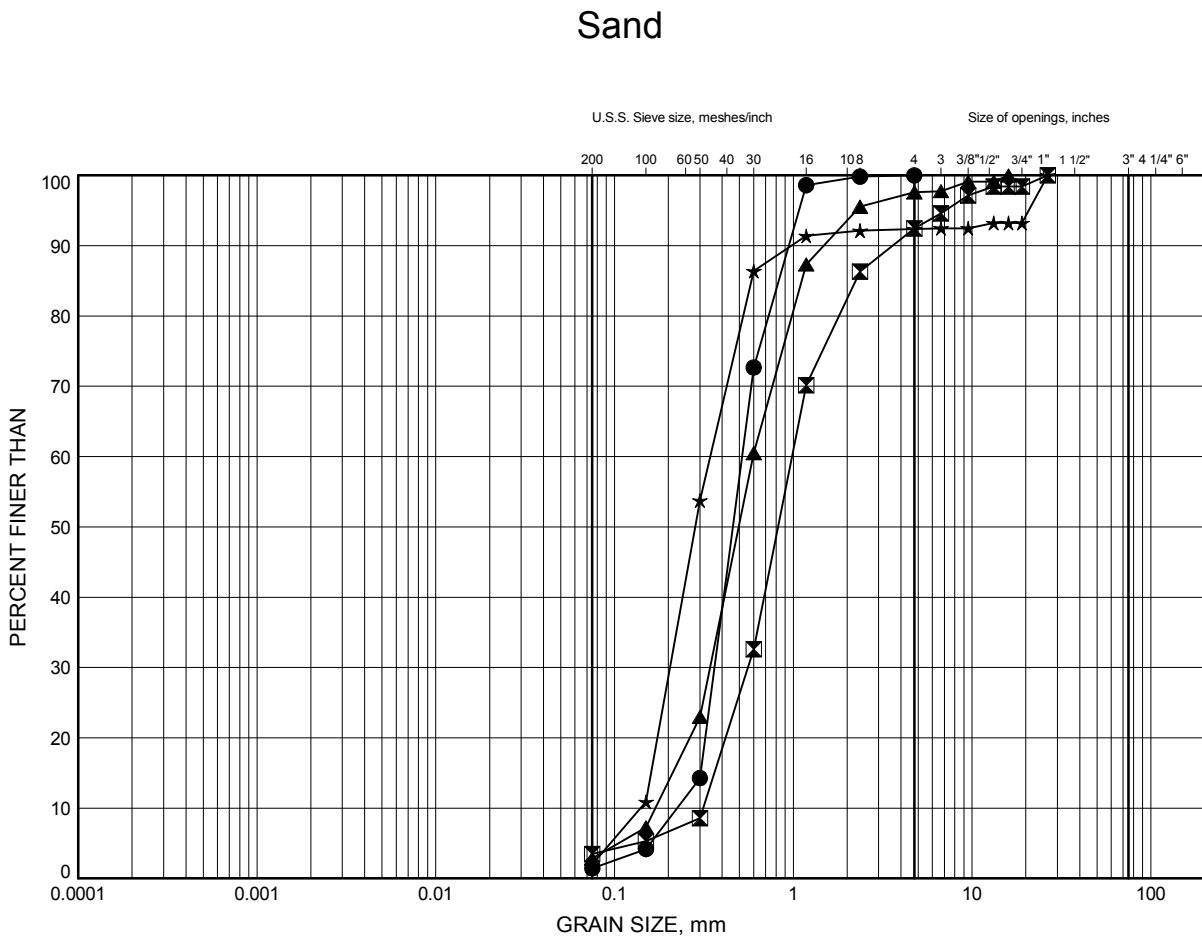
Date December 2014
19-5161-208



Prep'd JG
Chkd. FG

GRAIN SIZE DISTRIBUTION

FIGURE 5



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-1	4.88	283.92
⊠	14-2	4.11	286.69
▲	14-2	9.45	281.35
★	14-4	4.88	282.82

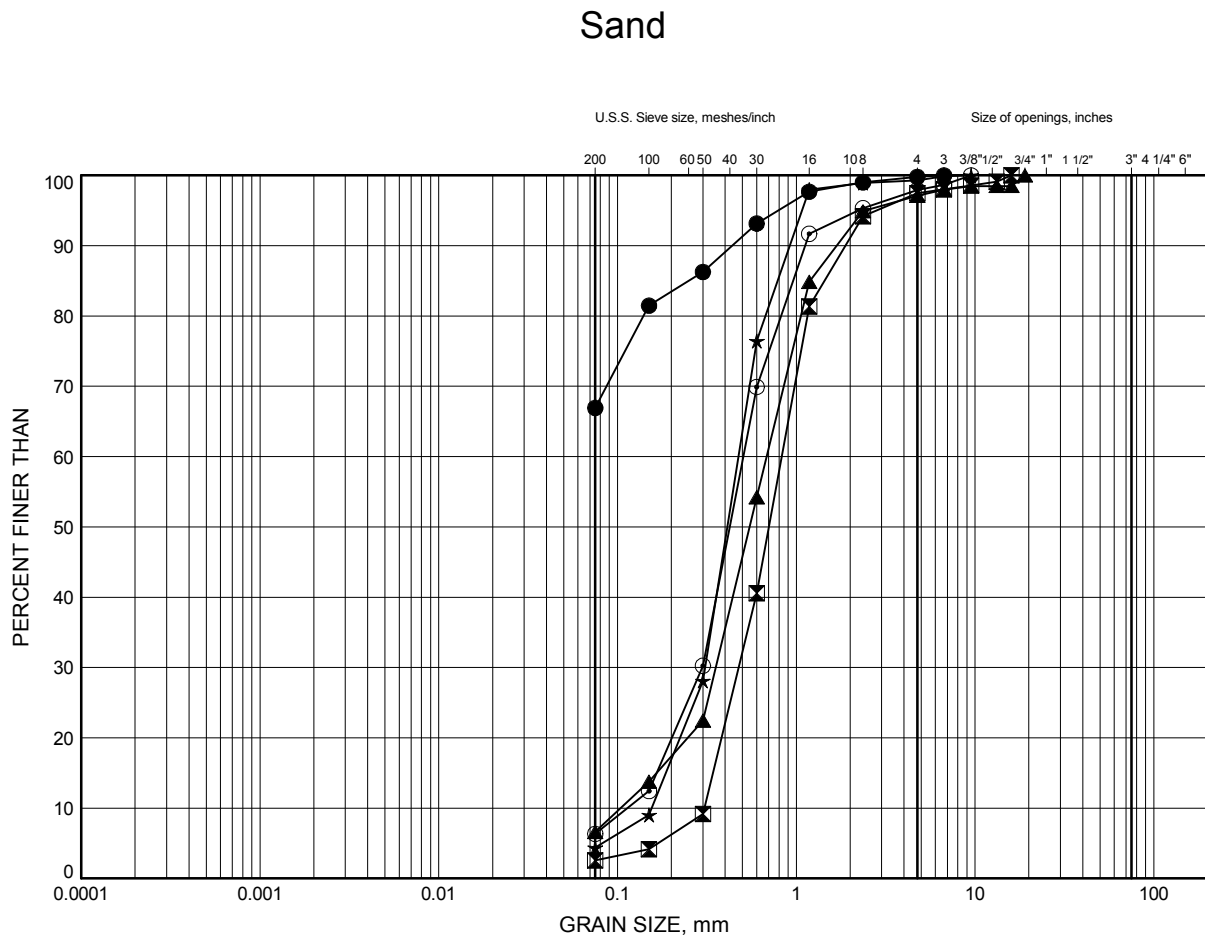
Date December 2014
19-5161-208



Prep'd JG
Chkd. FG

GRAIN SIZE DISTRIBUTION

FIGURE 6



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-5	9.60	285.90
⊠	14-5	10.97	284.53
▲	14-5	12.50	283.00
★	14-6	9.45	285.65
⊙	14-6	14.02	281.08

Date December 2014
19-5161-208



Prep'd JG
Chkd. FG

Appendix D

Selected Photographs



Photo 1: Looking east along Hwy 11B, (above Culvert 1)



Photo 2: Looking west along Hwy 11B (above Culvert 1)



Photo 3: Culvert 1 inlet (north embankment)



Photo 4: Culvert 1 outlet (south embankment)