

**FOUNDATION INVESTIGATION REPORT
CULVERT REPLACEMENT AT KESAGAMI RIVER
SITE NO. 39N-011
HIGHWAY 652
COCHRANE DISTRICT, ONTARIO
G.W.P. No. 5193-13-00, W.P. No. 5038-12-01**

GEOCRES Number: 42H-59

Report to

URS Canada Ltd.

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

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Hwy 652 Kesagami Culverts FIR FINAL nov 14.doc

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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 the location of a culvert site on Highway 652 over the Kesagami River tributary, located approximately 144 km north of Highway 579 in Cochrane District.

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

Thurber was retained by URS Canada Inc. (URS) to carry out this foundation investigation under the MTO Agreement Number 5012-E-0033. The foundations terms of reference indicates that there is no record of any previous foundation investigation carried out at or near the subject culvert.

2 SITE DESCRIPTION

The culvert site is located on Highway 652, 144 km North of Highway 579 and to the northeast of the Town of Cochrane in Cochrane District, Ontario. This culvert carries a tributary of the Kesagami River under Highway 652.

The existing culvert is a 4.6 m span by 4.0 m high by 36 m long steel plate pipe arch (SPPA) constructed in 1982. According to the terms of reference, the structure is in fair condition with deterioration of several elements. The embankment fill height at the culvert is approximately 3.0 m.

The grade of the existing Highway 652 in the vicinity of the culvert ranges between approximately Elevations 298.5 and 299 m, with ground surface at the culvert inlet and outlet areas varying between approximately 295 and 297 m.

The site is located in a rural area adjacent to swamps, creeks and other watercourses. The surrounding area is heavily forested with low-lying areas featuring tall grasses and shrubs. Local

topography is generally of low relief with no visible bedrock outcrops. The Detour Lake Gold Mine is located approximately 20 km northeast of the site along Highway 652.

The terrain in the general vicinity of the site is moderately sloping moderately towards the river. Soil cover generally consists of glaciofluvial deposits of sands and silts with varying amounts of gravel overlying glacial tills. The underlying bedrock consists of mafic metavolcanic rocks. Rockfill, presumably used for erosion protection, is visible on the ground surface surrounding the culvert at its inlet and outlet areas.

3 SITE INVESTIGATION AND FIELD TESTING

This borehole investigation and field testing program was carried out between October 1st and 8th, 2013. The program consisted of drilling and sampling eight boreholes (numbered KR13-01 to KR13-08) to depths ranging from 6.7 m to 22.2 m (Elevations 290.5 to 276.5 m). Of the eight boreholes, two were located at the culvert inlet (KR13-07 and 13-08), two were located at the culvert outlet (KR13-01 and 13-02), two were located at the embankment crest adjacent to the culvert (KR-13-04 and 13-05), and two were located some distance away from the culvert (KR13-03 and 13-06).

DCPT's were conducted in four boreholes. In Boreholes KR13-01, KR13-02, KR13-07 and KR13-08, the DCPT was extended beyond the depth of sampling.

The borehole locations were staked in the field and utility clearances were obtained prior to commencement of drilling operations. The co-ordinates and elevations of the as-drilled boreholes were subsequently provided by Callon Dietz utilizing Digital Terrain Model (DTM), based on borehole location sketches provided by Thurber. The approximate locations and elevations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing included in Appendix C.

A truck-mounted drill rig was used to drill and sample the boreholes on the highway and shoulder, and a track-mounted drill rig was used to drill and sample the boreholes at the culvert inlet and outlet. Hollow stem augers and 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). Borehole KR13-06 was further advanced into bedrock using NQ size coring equipment in conjunction with NW casings. Two standpipe piezometers were installed, one at the culvert inlet and one at the culvert outlet. In addition, groundwater conditions in the open boreholes were observed throughout the drilling operations. The details of monitoring well installations and borehole completion are summarized in Table 3.1.

Two members of Thurber's technical staff, one at each rig, supervised the drilling and sampling operations on a full time basis. The supervisors logged the boreholes, secured the recovered soil samples in labelled containers, stored the rock core samples in wooden boxes, and transported the samples to Thurber's laboratory for further examination and testing.

Table 3.1
Borehole Completion and Monitoring Well Installation Details

Borehole Number	Monitoring Well Installations			Completion Details
	Screen Depth (m)	Screen Elevation (m)	Filter Stratum	
KR13-01		None Installed		Auger cuttings to surface
KR13-02	4.8 – 6.7	290.4 - 288.6	Sand	Bentonite above sand screen to surface
KR13-03		None Installed		Bentonite to 0.9 m, sand and asphalt to surface
KR13-04		None Installed		Bentonite to 0.9 m, sand to 0.1 m, asphalt to surface
KR13-05		None Installed		Bentonite to 1.2 m, sand to 0.1 m, asphalt to surface
KR13-06		None Installed		Bentonite mixed with cuttings to 1.8 m, bentonite to 0.6 m, sand to 0.1 m, asphalt to surface
KR13-07	2.4 – 6.7	293.3 - 289.0	Sand	Bentonite above sand screen to surface
KR13-08		None Installed		Bentonite to 2.4 m, bentonite mixed with cuttings to surface

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

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural water content determination. Selected soil samples were subjected to grain size distribution analyses (sieve and hydrometer). Point load testing was carried out on selected rock cores for unconfined compressive strength correlation. The results of this laboratory testing program are shown on the Record of Borehole sheets in Appendix A and on the figures in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile and selected cross-sections

for this culvert site are presented on the Borehole Locations and Soil Strata Drawings in Appendix C 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 located on the highway and shoulder consist of asphalt and/or cohesionless fill overlying native sand, silt, and till deposits. The native soils are underlain by proven bedrock at one of the borehole locations. Boreholes located at the culvert inlets and outlets encountered topsoil or rockfill overlying native sand and silt deposits. More detailed descriptions of the individual stratum are presented below.

5.2 Asphalt and Topsoil

A layer of asphalt between 25 and 40 mm in thickness was encountered at ground surface in Boreholes 13-03, 13-04, 13-05, and 13-06.

Topsoil 50 mm in thickness was encountered in Boreholes KR13-01, KR13-02, and KR13-08. The topsoil thickness may vary between and beyond the borehole locations, and the limited data is not suitable for estimating topsoil quantities. A 0.3 m thick rockfill was present at the surface of Borehole 13-07.

5.3 Fill

Embankment fill was encountered below the asphalt in Boreholes KR13-01, KR13-03, KR13-04, KR13-05, and KR13-06. This fill typically consists of layers of brown gravelly sand, sand and sandy silt. Where encountered, the fill was found extending to depths of 0.8 m to 4.4 m (Elevations 296.4 to 294.3 m).

SPT N-values measured in the cohesionless fill typically ranged from 8 to 100 blows per 0.3m penetration, with typical values ranging between 10 and 100 per 0.3 m penetration, indicating a compact to very dense state. Occasional loose to dense zones indicated by N-values of 7 to 8 blows 50 blows for less than 0.3 m penetration, were encountered in Boreholes KR-13-03 and KR13-04, respectively. Measured water contents of the recovered fill samples ranged between 2% and 25%. Results of grain size analyses conducted on samples of the fill are presented on Figures B1 to B3 in Appendix B and are summarized in the following table:

Soil Particles	%
<u>Sand to Gravelly Sand Fill</u>	
Gravel	20 to 30
Sand	55 to 62
Silt and Clay	12 to 20
<u>Silt to Sandy Silt Fill</u>	
Gravel	0 to 6
Sand	9 to 21
Silt	65 to 82
Clay	8 to 14

5.4 Peat

A layer of peat 50 mm in thickness was encountered in Borehole KR13-03 at Elevation 295.7 m beneath the embankment fill. Water content of the peat sample was found to be 52%. The peat was fibrous, wet, and black in colour.

5.5 Sand and Silty Sand

Deposits of brown to grey sand to silty sand containing trace to some gravel, occasional cobbles and trace clay were encountered in all boreholes except Borehole KR13-06. These deposits were encountered near the ground surface (below topsoil or fill) within the culvert inlet/outlet boreholes, and beneath the embankment fill within the highway and shoulder boreholes. Where fully penetrated, the thickness of these deposits ranged between 3.9 and 7.5 m in thickness, with base elevations varying from 290.5 to 287.0 m. Boreholes KR13-01 and KR-13-02 were terminated within the sand.

In Boreholes KR13-01, 13-02, 13-07 and 13-08 located at the inlet and outlet areas, most SPT N-values ranged between 0 and 8 blows per 0.3 m penetration indicating a typically very loose to loose state, with compact to dense zones present at depth as indicated by N-values of 14 to 33 blows. For Boreholes KR13-03, 13-04 and 13-07 through the embankment, SPT N-values generally varied from 4 to 52 blows indicating a loose to very dense state. The measured water contents of samples of these soils generally ranged from 10% to 30%.

Grain size analyses conducted on samples of the sand and silty sand are presented on Figures B4, B5 and B6 in Appendix B. The results are summarized in the following table.

Soil Particles	%
<u>Sand</u>	
Gravel	0 to 35
Sand	61 to 95
Silt and Clay	2 to 15
<u>Silty Sand</u>	
Gravel	0
Sand	71
Silt	24
Clay	5

5.6 Silt, Sandy Silt and Clayey Silt

Brown to grey silt, sandy silt and clayey silt deposits were encountered in all eight boreholes. These soils are generally interlayered with the sand to silty sand or present just above the underlying glacial till. Where fully penetrated, the thickness of these deposits ranged between 0.3 and 2.9 m in thickness, with base elevations varying from 295.3 to 289.4 m. Borehole KR13-07 was terminated within the clayey silt.

SPT N-values measured within the silt and sandy silt deposits at shallow depths ranged from 5 to 14 blows per 0.3 m penetration indicating loose to compact conditions. In Borehole KR13-06, an N-value of 67 blows was measured for a silt layer below the sand deposit indicating a very dense state. The water contents of the silt and sandy silt samples were typically in the order of 18 % to 22 %.

SPT N-values measured within the clayey silt layers ranged from 4 to 57 blows per 0.3 m penetration indicating a soft to hard consistency. Measured water contents of the clayey silt samples were in the order of 20 %.

Grain size analyses conducted on samples of these soils are presented in Figures B7 to B9 of Appendix B. These results are summarized in the following table.

Soil Particles	%
<u>Silt and Clayey Silt</u>	
Gravel	0 to 2
Sand	0 to 13
Silt	73 to 84
Clay	9 to 23

Grain size analyses conducted on two samples of these soils are presented in Figures B9 and B10 of Appendix B. These results are summarized in the following table.

Soil Particles	%
<u>Sandy Silt</u>	
Gravel	0 to 3
Sand	22 to 27
Silt	64 to 65
Clay	8 to 11

A 0.6 m thick layer of gravelly sand was encountered underlying the sandy silt layer in Borehole KR13-06. The base elevation of this layer is at Elevation 289.4 m. The measured water content of a sample was 16%. Results of grain size analyses conducted on a sample of this soil are presented in Figure B10 of Appendix B. These results are summarized in the following table.

Soil Particles	%
<u>Gravelly Sand</u>	
Gravel	25
Sand	62
Silt and Clay	13

5.7 Sand and Silt, Sandy Silt to Clayey Silt Till

Grey sand and silt to sandy silt glacial till deposits were encountered in all but Boreholes KR13-01, KR13-02 and KR13-07. Borehole KR13-06 was advanced through the till into bedrock. The till layer was found to be 9.5 m thick with its base elevation at 279.9 m. Boreholes KR13-03, 13-04 and 13-08 were all terminated within the till. A 1.5 m thick layer of clayey silt till was encountered in Borehole KR13-05 at 10.1 m depth.

SPT N-values measured within the till deposits ranged from 40 blows per 0.3 m penetration to greater than 100 blows for less than 0.3 m penetration, indicating dense to very dense conditions. Some of the higher 'N'-values may be attributed to the presence of cobbles or boulders. Measured water contents of the till samples were typically in the order of 6% to 20%.

Grain size analyses conducted on samples of the tills are presented in Figure B11 of Appendix B. These results are summarized in the following table.

Soil Particles	%
<u>Sand and Silt Till</u>	
Gravel	3 to 4
Sand	33 to 50
Silt	36 to 53
Clay	10 to 15
<u>Clayey Silt Till</u>	
Gravel	0
Sand	0 to 2
Silt	85 to 87
Clay	12 to 13

5.8 Bedrock

Bedrock was encountered and proven by coring in Borehole KR13-06 at a depth of 18.8m, or Elevation 279.9 m. The soils in Borehole KR13-06 were found to be underlain by granite, an Archean rock formation occurring as a felsic intrusive contact as part of the Pre-Cambrian Canadian Shield. The rock cores are generally in a fresh state with slight weathering at the joints. No exposed bedrock was observed in the general vicinity of the site.

The measured Total Core Recovery (TCR) was 100% in all three runs of the granite. The Rock Quality Designation (RQD) values ranged from 92 to 100% indicating excellent rock quality. The Fracture Indices (FI) were typically between 0 and 2 fractures per 0.3 m core run.

The estimated Unconfined Compressive Strength (UCS) for the cores ranged from 123 to 197 MPa indicating a very strong rock. These estimated rock strength values are based on point load tests that were conducted on selected rock cores recovered from Borehole KR13-06.

5.9 Groundwater Conditions

Free water was not observed in most of the boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes KR13-02 and 13-07. Water levels observed in the open boreholes and those measured in the two installed standpipe piezometers are presented below.

Borehole (screen location)	Date of Reading	Water Level Depth (m)	Water Level Elevation (m)
KR13-01	-	-	-

KR13-02 (sand)	October 2, 2013	1.4	293.8
	November 1, 2013	1.2	294.0
	November 7, 2013	1.1	294.1
KR13-03	October 8, 2013	4.2	295.0
KR13-04	October 7, 2013	5.4	293.5
KR13-05	-	-	-
KR13-06	-	-	-
KR13-07 (sand/clayey silt)	October 3, 2013	1.3	294.4
	November 1, 2013	1.0	294.7
	November 7, 2013	1.0	294.7
KR13-08	-	-	-

It is noted that all groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after heavy rainfalls. Based on the above readings, the groundwater level at this site ranges between 294 and 295 m. Local high water levels, spring snowmelt and periods of significant and/or prolonged precipitation events will affect the groundwater level.

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Callon Dietz obtained and provided the northing and easting coordinates, and ground surface elevations of the borehole locations from the DTM, based on borehole location sketches prepared by Thurber.

Downing Drilling of Hawkesbury, Ontario, supplied and operated a truck-mounted CME 75 rig, and a track-mounted CME 55 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. Stephane Loranger and Ms. Katrina Young of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory.

Overall project management was provided by Mr. Alastair Gorman, P.Eng. Direction of the field program was provided by Dr. Sydney Pang, P.Eng. Interpretation of the field data and preparation of this report was jointly completed by Ms. Katrina Young, E.I.T. and Dr. Sydney Pang, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

Sydney Pang, P.Eng.,
Senior Foundations Engineer



Alastair Gorman, P.Eng.
Project Manager, Senior Foundations Engineer



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



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

C_{pen}

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 KR13-01

1 OF 1

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 175.7 E 363 264.2 ORIGINATED BY KMY
 HWY 652 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.10.02 - 2013.10.02 CHECKED BY SKP

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 (%)				
								20 40 60 80 100							
								○ UNCONFINED + FIELD VANE							
								● QUICK TRIAXIAL × LAB VANE							
297.2	GROUND SURFACE														
0.0	TOPSOIL: (50 mm)		1	SS	8		297								
	SAND, trace rootlets Loose Dark Brown Moist														
296.4	(FILL)		2	SS	10									2 13 75 10	
0.8	SILT, some sand and clay, trace gravel Compact Brown Moist						296								
			3	SS	8									0 9 80 11	
295.3							295								
1.9	SAND, some gravel, trace silt Loose to Very Loose Light Brown Saturated		4	SS	3										
							294								
			5	SS	9										
							293								
			6	SS	6										
292.7							292								
4.5	Compact		7	SS	14									16 82 2 (SI+CL)	
							291								
	Trace gravel, trace cobbles		8	SS	14										
290.5							290								
6.7	END OF SAMPLING AND START OF DCPT AT 6.7 m.														
289.0							289								
8.2	END OF DCPT AND BOREHOLE AT 8.2 m. BOREHOLE BACKFILLED WITH AUGER CUTTINGS UPON COMPLETION.														

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

RECORD OF BOREHOLE No KR13-02

1 OF 1

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 190.6 E 363 278.7 ORIGINATED BY KMY
HWY 652 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2013.10.01 - 2013.10.01 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W _P W W _L	20 40 60	GR SA SI CL			
295.2	GROUND SURFACE													
0.0	TOPSOIL: (50 mm)													
	SAND Loose Light Brown Moist		1	SS	9		295							
294.4														
0.8	Sandy SILT, trace clay													0 27 65 8
294.1	Loose Light Brown Moist		2	SS	5		294							
1.1														
	Silty SAND, trace clay Very Loose Grey/Brown Wet													
	With organics													
			3	SS	2		293							
			4	SS	5		292							0 71 24 5
			5	SS	4		291							
291.3														
	Clayey SILT, trace sand Soft Light Brown		6	SS	4		290							0 4 73 23
290.6														
4.6	SAND, trace silt, trace gravel Loose Brown to Grey Saturated		7	SS	7		289							
			8	SS	5		288							3 92 5 (SI+CL)
288.5														
6.7	END OF SAMPLING AND START OF DCPT AT 6.0 m.													
287.6														
7.6	END OF DCPT AND BOREHOLE AT 7.6 m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 2/13 1.4 293.8 Nov. 1/13 1.2 294.0 Nov. 7/13 1.1 294.1													

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No KR13-03

1 OF 3

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 164.8 E 363 251.5 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing/NQ Core Barrel COMPILED BY AN
 DATUM Geodetic DATE 2013.10.07 - 2013.10.08 CHECKED BY SKP

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					
299.2	GROUND SURFACE												
0.0	ASPHALT: (40 mm)		1	SS	50/ 0.150		299						25 55 20 (SI+CL)
298.6	Gravelly SAND Very Dense Brown Moist (FILL)		2	SS	84		298						
0.6	SAND, some silt Very Dense to Compact Brown Moist (FILL)		3	SS	25		297						
297.0	SILT, trace sand and clay Loose Brown Moist (FILL)		4	SS	8		296						0 9 82 9
295.7	PEAT, black (50 mm)		5	SS	10		295						
295.8	SILT, some clay, trace sand and gravel Compact Brown Wet		6	SS	14		294						1 8 73 18
3.6			7	SS	14		293						
293.6	SAND, trace silt and gravel Compact Brown Wet		8	SS	27		292						
5.6			9	SS	25		291						
290.2	Gravelly SAND, trace silt		10	SS	28		290						35 61 4 (SI+CL)
9.0													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No KR13-03

2 OF 3

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 164.8 E 363 251.5 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing/NQ Core Barrel COMPILED BY AN
 DATUM Geodetic DATE 2013.10.07 - 2013.10.08 CHECKED BY SKP

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							20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L							
287.0	SAND , trace silt and gravel, occasional cobbles Very Dense Grey Wet		11	SS	52										
12.2	SILT and SAND , some clay, trace gravel, inferred cobbles and boulders Very Dense Grey Moist (TILL)		12	SS	100/ 0.275									3 38 45 14	
			13	SS	100/ 0.175									Used NQ Core Barrel for retrieving cobble/boulder fragments out of casing	
			14	SS	82										4 33 53 10
			15	SS	100/ 0.125										
	Occasional cobbles		16	SS	100/ 0.150										
			17	SS	100/ 0.125										

Continued Next Page

+³, x³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No KR13-03

3 OF 3

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 164.8 E 363 251.5 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing/NQ Core Barrel COMPILED BY AN
 DATUM Geodetic DATE 2013.10.07 - 2013.10.08 CHECKED BY SKP

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						
	Continued From Previous Page				0.125			<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div> <div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div><div>W P W W L</div><div>WATER CONTENT (%)</div><div>204060</div></div>						
279.1														
20.1	END OF BOREHOLE AT 20.1 m. BOREHOLE OPEN TO 4.4 m AND WATER LEVEL AT 4.2 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9 m, THEN SAND AND ASPHALT TO SURFACE.													

RECORD OF BOREHOLE No KR13-04

1 OF 2

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 174.7 E 363 278.1 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing/NQ Core Barrel COMPILED BY AN
 DATUM Geodetic DATE 2013.10.03 - 2013.10.07 CHECKED BY SKP

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 (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			
								20 40 60 80 100									20 40 60			
298.9	GROUND SURFACE																			
0.0	ASPHALT: (25 mm)																			
	Gravelly SAND, some silt Very Dense to Dense Brown Moist (FILL)		1	SS	50/ 0.125											30 57 13 (SI+CL)				
			2	SS	45		298													
297.5																				
1.4	Sandy SILT, trace clay and gravel Compact Brown Moist to Wet (FILL)		3	SS	20		297									6 21 65 8				
296.7																				
2.2	SAND, trace to some silt Compact Brown Moist (FILL)		4	SS	18		296									Split spoon wet				
			5	SS	23															
295.2																				
3.7	SAND, trace to some silt Loose Brown to Grey Wet		6	SS	9		295													
			7	SS	4		294													
			8	SS	7		293									0 92 8 (SI+CL)				
291.7							292													
7.2	Compact		9	SS	13		291													
	Trace gravel		10	SS	30		290													
288.9							289													

Continued Next Page

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

RECORD OF BOREHOLE No KR13-04

2 OF 2

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 174.7 E 363 278.1 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing/NQ Core Barrel COMPILED BY AN
 DATUM Geodetic DATE 2013.10.03 - 2013.10.07 CHECKED BY SKP

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							WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE							● QUICK TRIAXIAL × LAB VANE					
								20	40	60	80	100			20	40	60	80	100	
Continued From Previous Page																				
10.0	SILT , some clay Very Dense Grey Moist (TILL)		11	SS	93		288								0	0	87	13		
287.3																				
11.6			SAND and SILT , some clay, trace gravel, inferred cobbles and boulders Very Dense Grey Moist (TILL)		12	SS	81		287											
								286												
					13	SS	100		285								3	50	36	11
					14	SS	100/ 0.250		284											Used NQ Core Barrel for retrieving cobble/boulder fragments out of casing
									283											
							282													
							281													
280.5			16	SS	100/															
18.4	END OF BOREHOLE AT 18.4 m. BOREHOLE OPEN TO 5.6 m AND WATER LEVEL AT 5.4 m UPON COMPLETION. BORHEOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9 m, SAND TO 0.1 m, THEN ASPHALT TO SURFACE.				0.100															

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No KR13-05

1 OF 2

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 163.9 E 363 271.6 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.01 - 2013.10.01 CHECKED BY SKP

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	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE												
298.8	GROUND SURFACE							20	40	60	80	100									
0.0	ASPHALT: (35 mm)																				
	Gravelly SAND, some silt Dense Brown Moist (FILL)		1	SS	47									○				29	59	12 (SI+CL)	
			2	SS	30									○							
297.4																					
1.4	Sandy SILT, some clay Compact Brown Moist (FILL)		3	SS	17									○				0	15	71	14
296.2			4	SS	13									○							
2.6	SAND, trace to some silt Compact Brown Moist																				
			5	SS	18									○				0	95	5 (SI+CL)	
			6	SS	20									○							
			7	SS	10									○							
			8	SS	16									○				0	94	6 (SI+CL)	
			9	SS	10									○							
290.0																					
8.8	Some gravel, occasional cobbles Very Dense Grey Wet		10	SS	100/ 0.175									○							

Continued Next Page

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

RECORD OF BOREHOLE No KR13-05

2 OF 2

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 163.9 E 363 271.6 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.01 - 2013.10.01 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
								20 40 60 80 100			W _P W W _L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
288.7	Continued From Previous Page														
10.1	Clayey SILT , trace sand, occasional cobbles Hard Grey Moist (TILL)		11	SS	100/ 0.275		288							0 2 85 13	
287.2															
11.6	SAND , some silt, occasional cobbles and gravel Compact Grey Wet (TILL)						287								
286.3			12	SS	39										
12.5	SAND and SILT , trace gravel, inferred cobbles and boulders Very Dense Grey Moist (TILL)						286								
			13	SS	68		285								
							284								
			14	SS	100/ 0.150										
							283								
			15	SS	100/ 0.075		282								
							281								
280.3			16	SS	100/ 0.075										
18.5	END OF BOREHOLE AT 18.5 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2 m, THEN SAND TO 0.1 m, THEN ASPHALT TO SURFACE.				0.075										

ONTMT4S 4069.GPJ 2012TEMPLATE(MTO).GDT 1/7/15

RECORD OF BOREHOLE No KR13-06

1 OF 3

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 169.0 E 363 286.4 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing/NQ Core Barrel COMPILED BY AN
 DATUM Geodetic DATE 2013.10.02 - 2013.10.03 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)							
298.7	GROUND SURFACE						20 40 60 80 100									GR SA SI CL			
0.0 0.1	ASPHALT: (30 mm)						20 40 60 80 100												
	Gravelly SAND, some silt Very Dense to Dense Brown Moist (FILL)		1	SS	100								○			20 62 18 (SI+CL)			
			2	SS	33								○						
			3	SS	37														
296.0																			
2.7	SILT, some sand, trace clay Compact to Loose Grey Wet (FILL)		4	SS	19								○						
			5	SS	7								○			0 15 76 9			
294.3																			
4.4	Clayey SILT, some sand Firm Grey Moist to Wet		6	SS	6								○						
293.1																			
5.6	Stiff		7	SS	16								○						
291.4																			
7.3	Sandy SILT, trace gravel Very Dense Grey Moist		8	SS	67								○						
290.0																			
8.7	Gravelly SAND, trace silt Dense Grey Wet																		
289.4													○			25 62 13 (SI+CL)			
9.3	SAND and SILT, some clay, trace gravel Hard Grey		9	SS	100/ 0.275								○			2 41 40 17			
													</						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No KR13-06

2 OF 3

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 169.0 E 363 286.4 ORIGINATED BY SLL
 HWY 652 BOREHOLE TYPE NW Casing/NQ Core Barrel COMPILED BY AN
 DATUM Geodetic DATE 2013.10.02 - 2013.10.03 CHECKED BY SKP

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	20 40 60							
Continued From Previous Page																
288.3	Wet															
10.4	Sandy SILT , trace gravel Very Dense Grey Moist (TILL)		10	SS	105		288					○				
							287									
			11	SS	90		286					○				
							285					○				
285.3	SAND and SILT , some clay, trace gravel Very Dense Grey Moist (TILL)		12	SS	85		284									
							283					○				
			13	SS	83		282									
							281									
			14	SS	100/ 0.200		280					○				
							279									
			15	SS	100/ 0.250		278					○				
							277									
279.9	Casing refusal at 18.8 m															
18.8	GRANITE , with quartz		1	RUN												
			2	RUN												
	Horizontal joint at 19.2 m, 19.3 m, 19.8 m, 20.5 m															

Used NQ Core Barrel for retrieving cobble/boulder fragments out of casing

3 47 39 11

RUN #1
TCR=100%
SCR=100%
RQD=100%
UCS=192MPa

RUN #2
TCR=100%
SCR=100%
RQD=92%
UCS=152MPa

Used NQ Core
Barrel for
retrieving
cobble/boulder
fragments out of
casing

3 47 39 11

RUN #1
TCR=100%
SCR=100%
RQD=100%
UCS=192MPa

RUN #2
TCR=100%
SCR=100%
RQD=92%
UCS=152MPa

Continued Next Page


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

RECORD OF BOREHOLE No KR13-06

3 OF 3

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 169.0 E 363 286.4 ORIGINATED BY SLL
HWY 652 BOREHOLE TYPE NW Casing/NQ Core Barrel COMPILED BY AN
DATUM Geodetic DATE 2013.10.02 - 2013.10.03 CHECKED BY SKP

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						
	Continued From Previous Page							20 40 60 80 100						
	Sub-vertical joint (50 mm) at 20.2 m												1	RUN #3 TCR=100% SCR=100% RQD=97% UCS=142MPa
	Horizontal joint at 20.7 m, 21.4 m					278							2	
			3	RUN									1	
								277						
276.5													0	
22.2	END OF BOREHOLE AT 22.2 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG MIXED WITH CUTTINGS TO 1.8 m, THEN BENTONITE HOLEPLUG TO 0.6 m, THEN SAND TO 0.1 m, THEN ASPHALT TO SURFACE.													

RUN #3
TCR=100%
SCR=100%
RQD=97%
UCS=142MPa

RECORD OF BOREHOLE No KR13-07

1 OF 1

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 156.0 E 363 274.7 ORIGINATED BY KMY
HWY 652 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2013.10.02 - 2013.10.02 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p			NATURAL MOISTURE CONTENT W			LIQUID LIMIT W _L			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)										
295.7	GROUND SURFACE							20 40 60 80 100													
0.0	ROCKFILL							20 40 60 80 100													
295.4																					
0.3	SAND, some silt Very Loose Brown Saturated		1	SS	7		295														
			2	SS	3		294														
			3	SS	0		293														
			4	SS	0		292														
			5	SS	0		291														
292.0							290														
3.7	Trace gravel Loose		6	SS	4		289														
			7	SS	8																
289.5																					
6.2	Clayey SILT Hard Light Brown Saturated		8	SS	57																
289.0																					
6.7	END OF DCPT AND BOREHOLE AT 6.7 m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 3/13 1.3 294.4 Nov. 1/13 1.0 294.7 Nov. 7/13 1.0 294.7																				

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

RECORD OF BOREHOLE No KR13-08

1 OF 1

METRIC

GWP# 5193-13-00 LOCATION Kesagami River N 5 524 157.0 E 363 286.5 ORIGINATED BY KMY
 HWY 652 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.10.02 - 2013.10.02 CHECKED BY SKP

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			20 40 60 80 100	W _P W W _L	WATER CONTENT (%)				
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
295.1	GROUND SURFACE													
0.0	TOPSOIL: (50 mm)						295							
	Sandy SILT , some clay, trace gravel		1	SS	5									3 22 64 11
294.4	Very Loose													
	Brown													
0.7	Moist													
	SAND , some silt		2	SS	1		294							
	Very Loose													
	Brown													
	Wet													
			3	SS	1		293							
			4	SS	0									
292.1	Dense to Compact		5	SS	33		292							
3.0														
			6	SS	24		291							0 85 15 (SI+CL)
290.5														
4.6	SAND and SILT , some clay, trace gravel		7	SS	48		290							3 40 42 15
	Dense													
	Grey to Brown													
	Wet													
	(TILL)													
	END OF DCPT AT 6.4 m		8	SS	40		289							
288.4														
6.7	END OF BOREHOLE AT 6.7 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.4 m, THEN BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

Appendix B

Laboratory Test Results

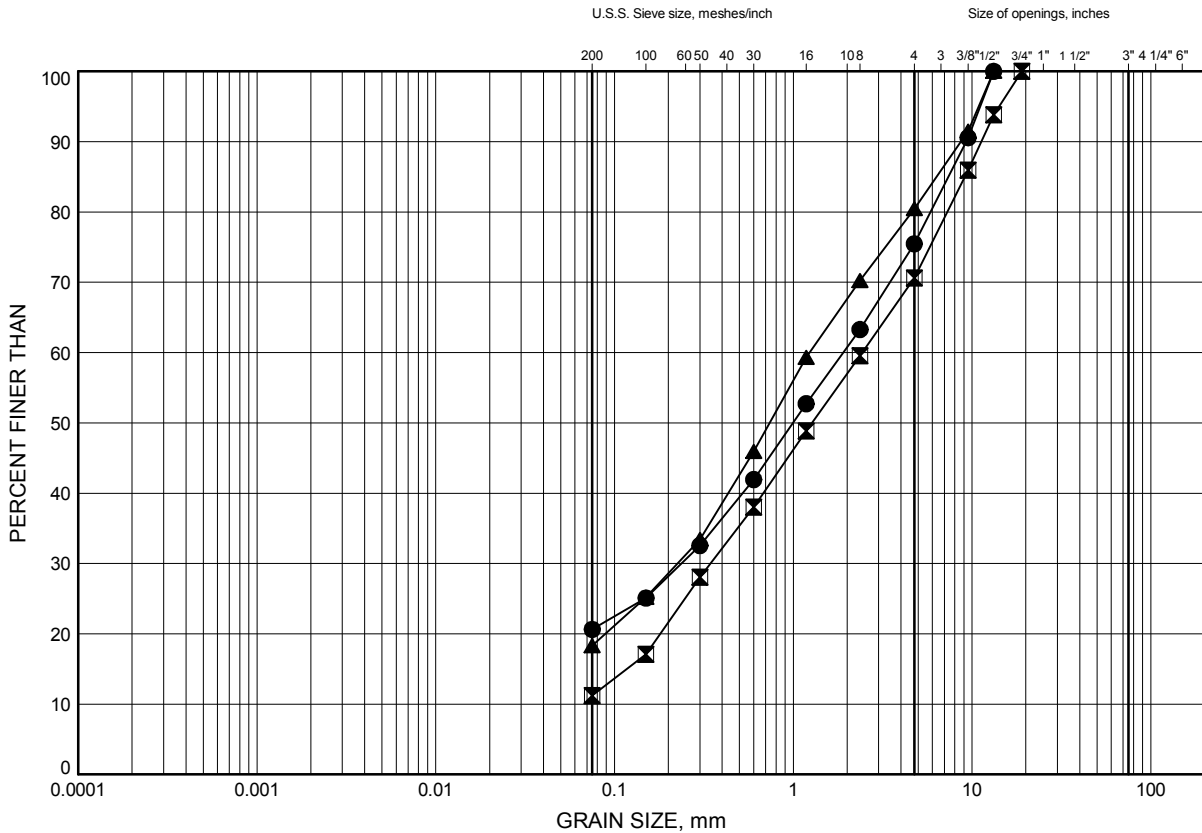
19-4406-9

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B1

GRAVELLY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-03	0.30	298.90
⊠	KR13-05	0.46	298.34
▲	KR13-06	0.30	298.40

Date December 2013

GWP# 5193-13-00



Prep'd AN

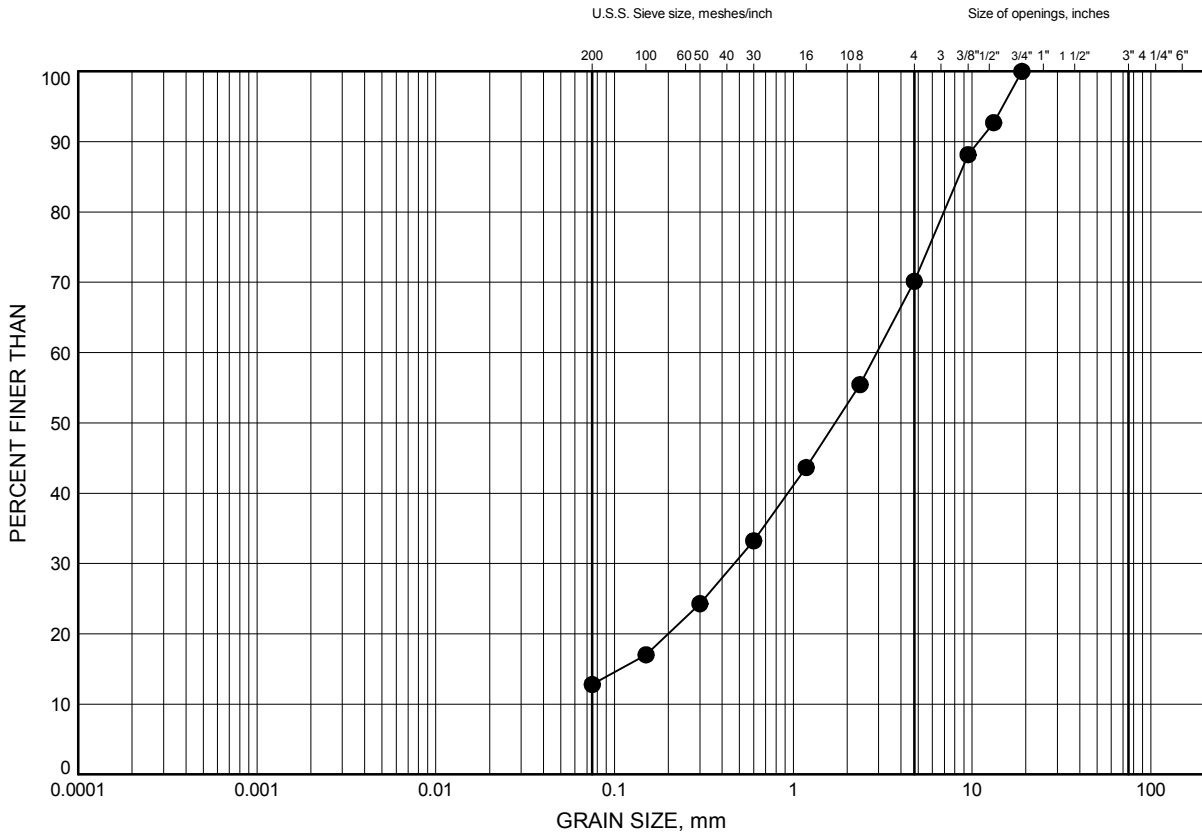
Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-04	0.30	298.60

Date December 2013
GWP# 5193-13-00



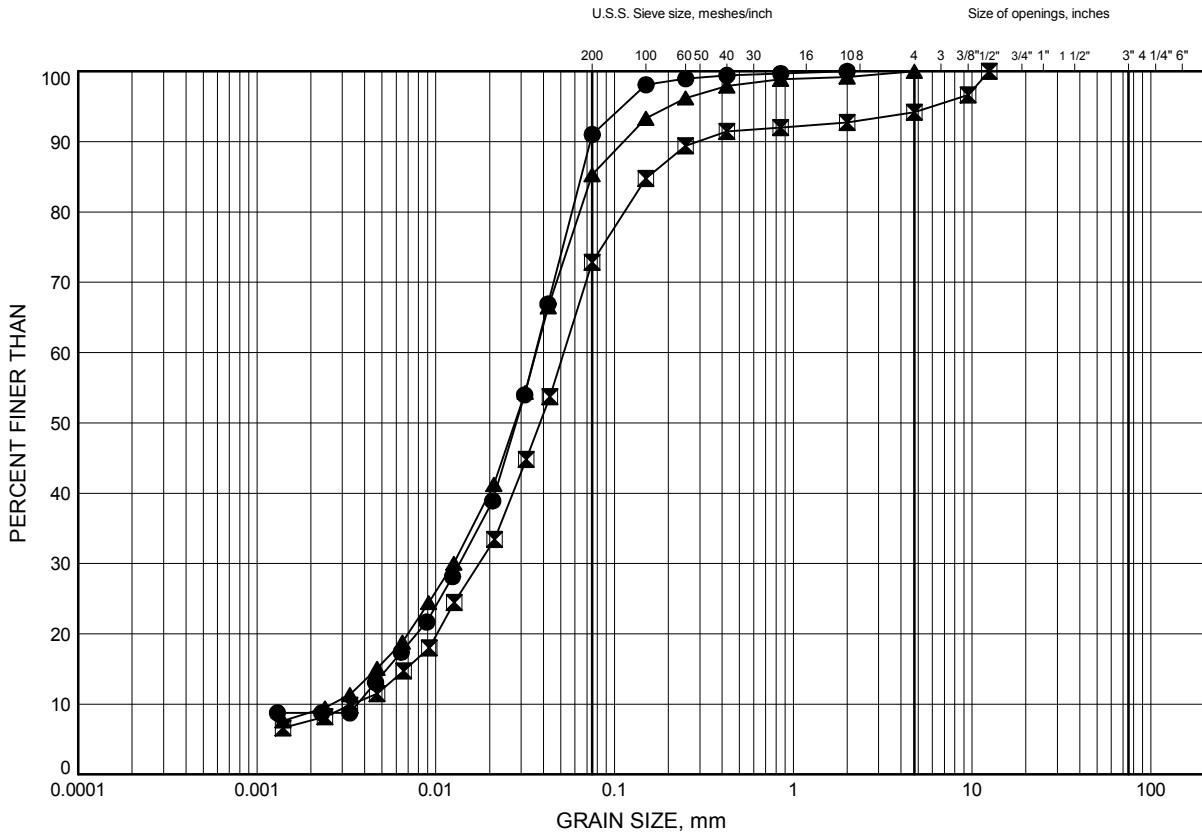
Prep'd AN
Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILT TO SANDY SILT FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-03	2.59	296.61
⊠	KR13-04	1.83	297.07
▲	KR13-06	4.11	294.59

Date December 2013

GWP# 5193-13-00



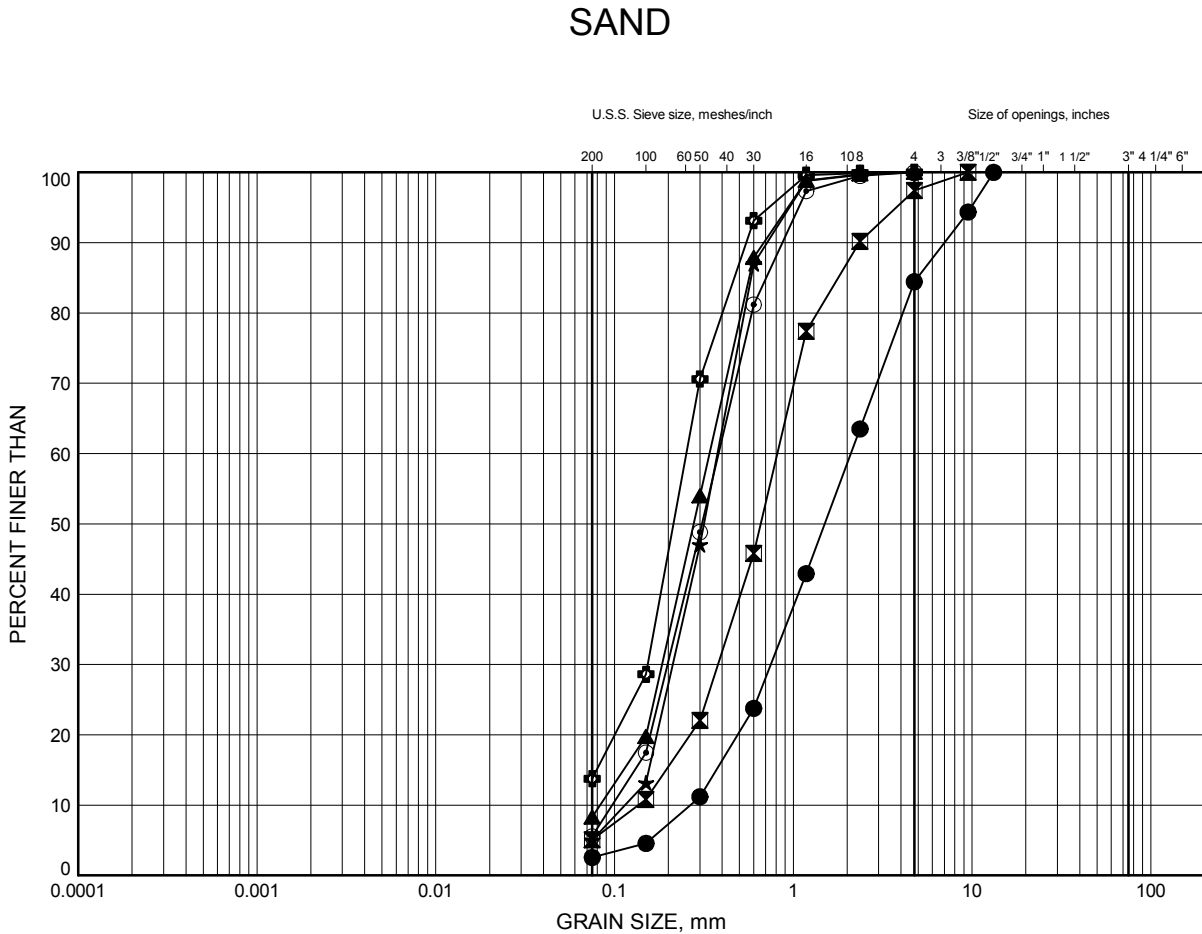
Prep'd AN

Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B4



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-01	4.88	292.32
⊠	KR13-02	6.28	288.92
▲	KR13-04	6.40	292.50
★	KR13-05	3.35	295.45
⊙	KR13-05	6.40	292.40
⊕	KR13-07	2.59	293.11

Date December 2013

GWP# 5193-13-00



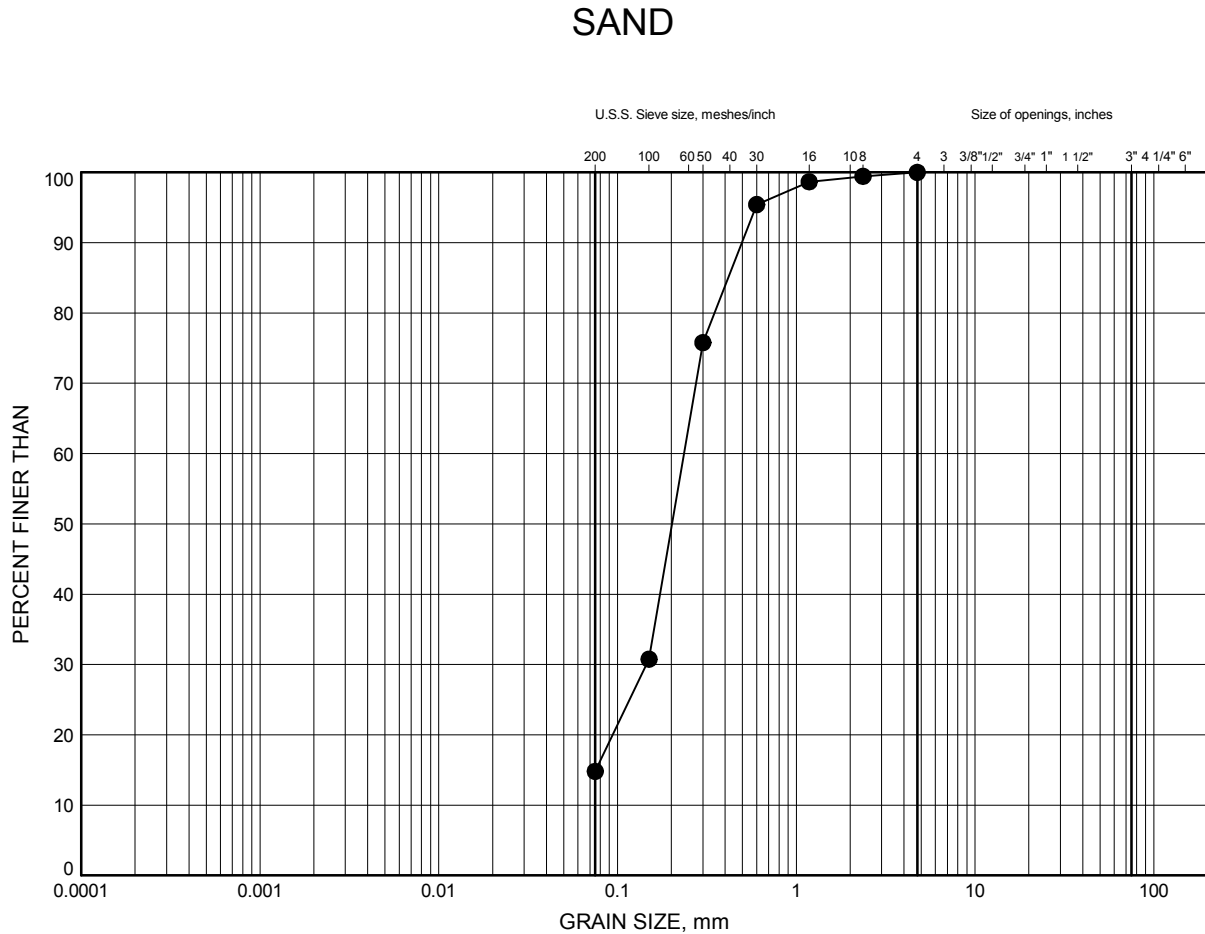
Prep'd AN

Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

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)
●	KR13-08	4.11	290.99

Date December 2013

GWP# 5193-13-00



Prep'd AN

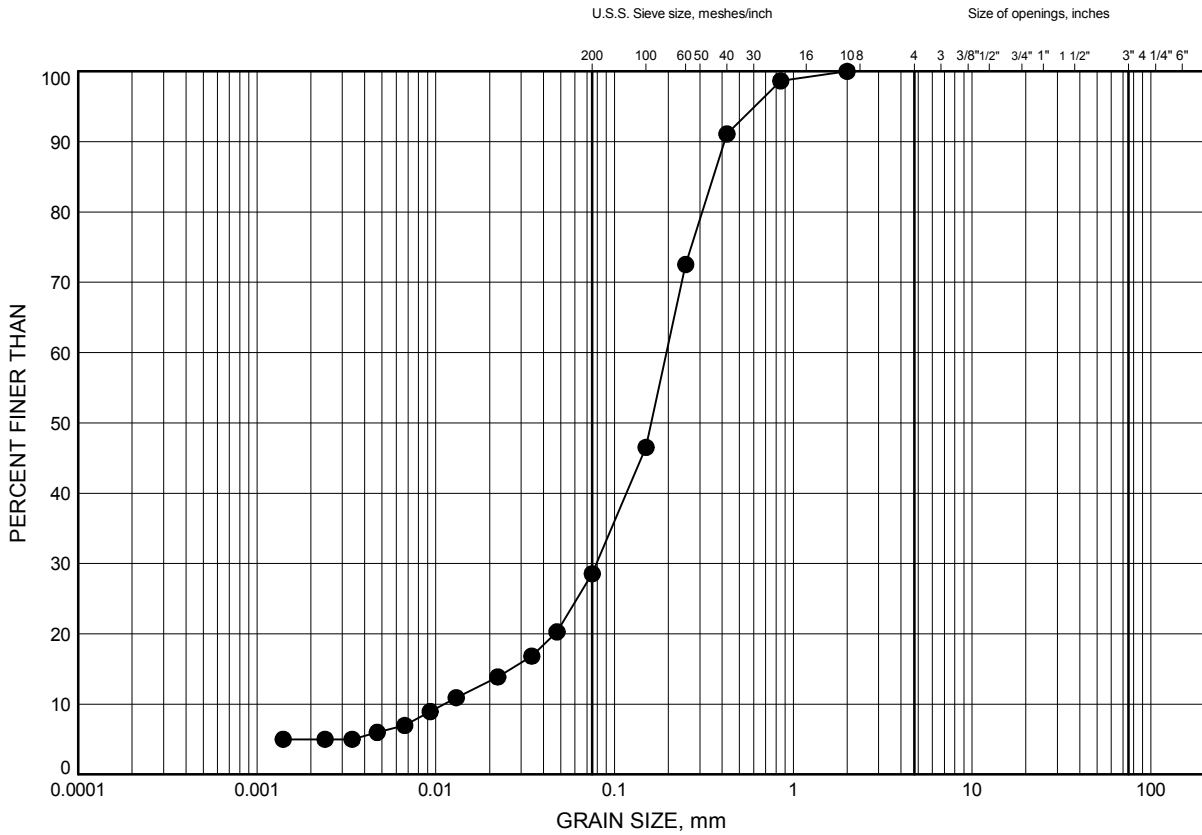
Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B6

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-02	2.59	292.61

Date December 2013

GWP# 5193-13-00



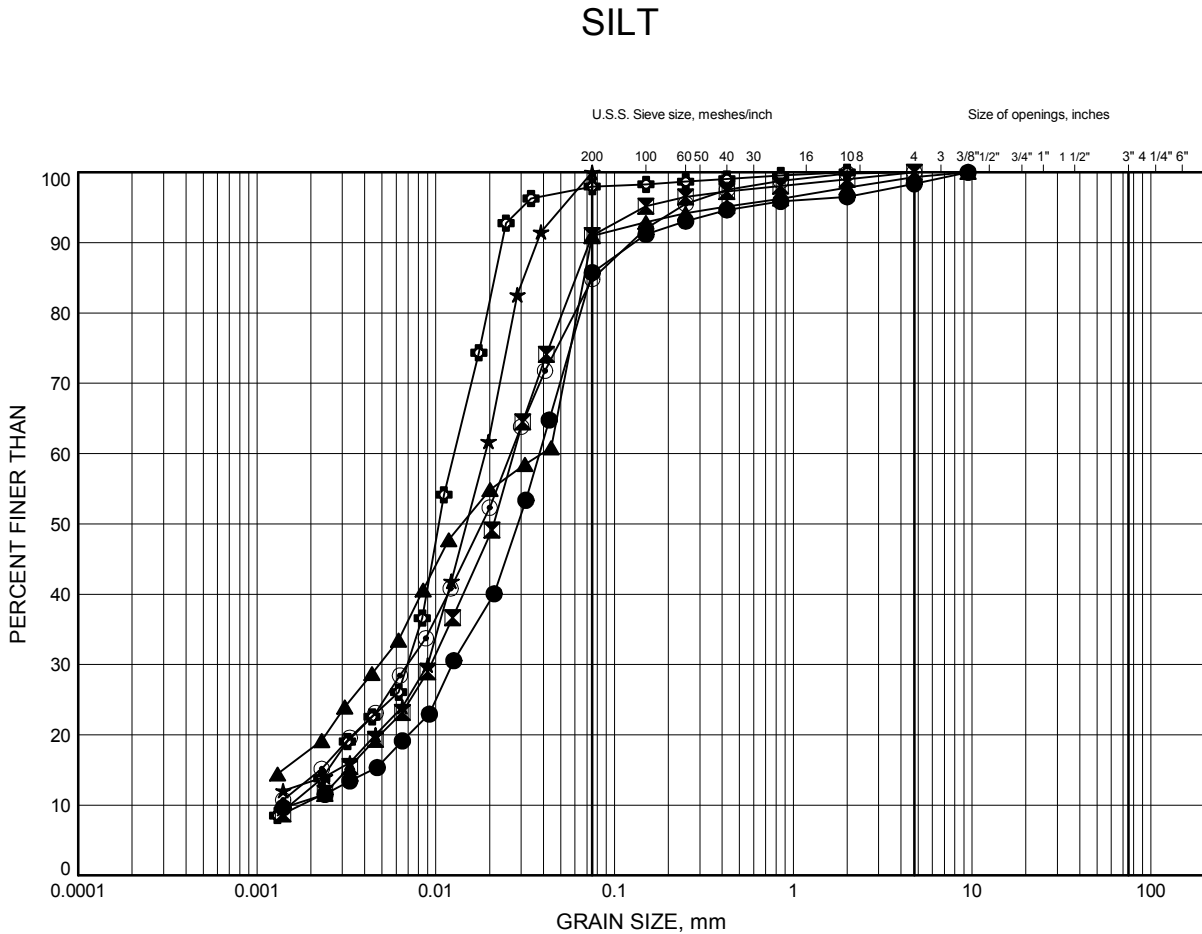
Prep'd AN

Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B7



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-01	0.94	296.26
⊠	KR13-01	1.70	295.50
▲	KR13-03	4.88	294.32
★	KR13-04	10.97	287.93
⊙	KR13-05	1.83	296.97
⊕	KR13-05	10.90	287.90

Date December 2013

GWP# 5193-13-00



Prep'd AN

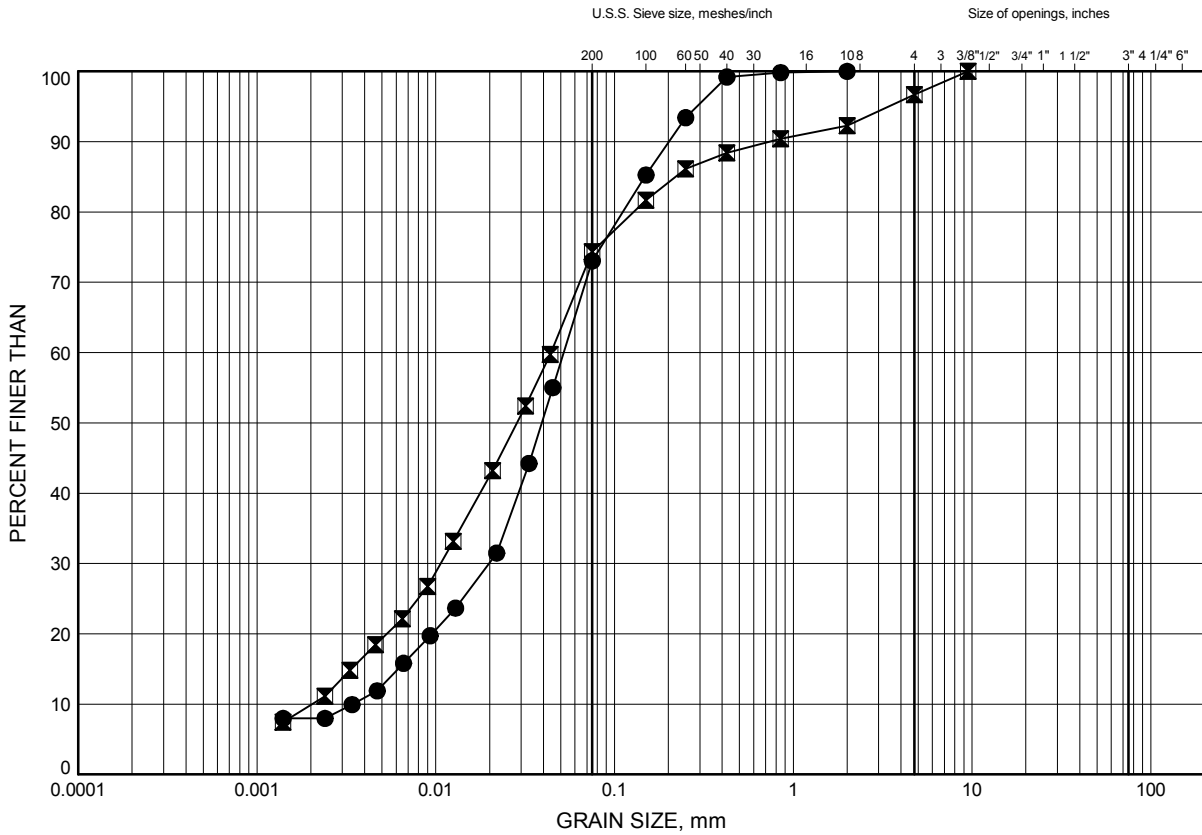
Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B8

SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-02	0.91	294.29
⊠	KR13-08	0.48	294.62

Date December 2013

GWP# 5193-13-00



Prep'd AN

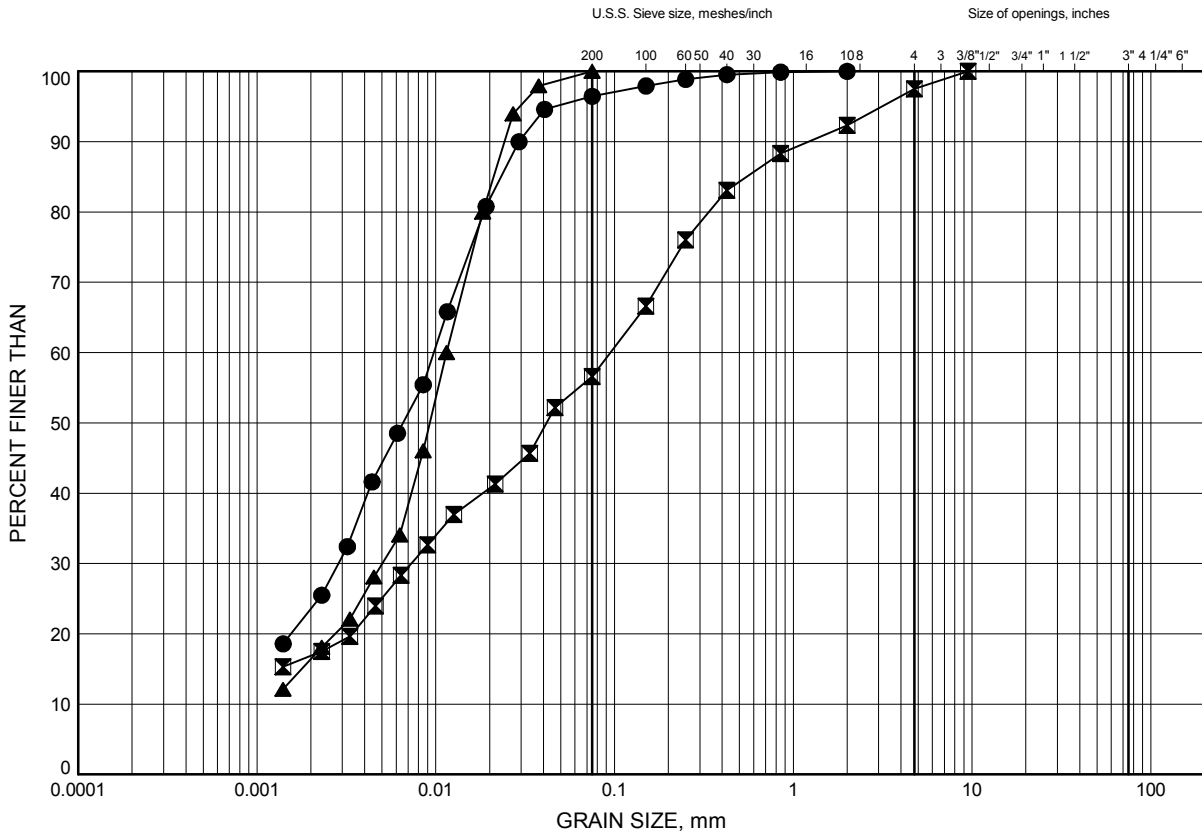
Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B9

CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-02	4.00	291.20
⊠	KR13-06	9.46	289.24
▲	KR13-07	6.34	289.36

Date December 2013

GWP# 5193-13-00



Prep'd AN

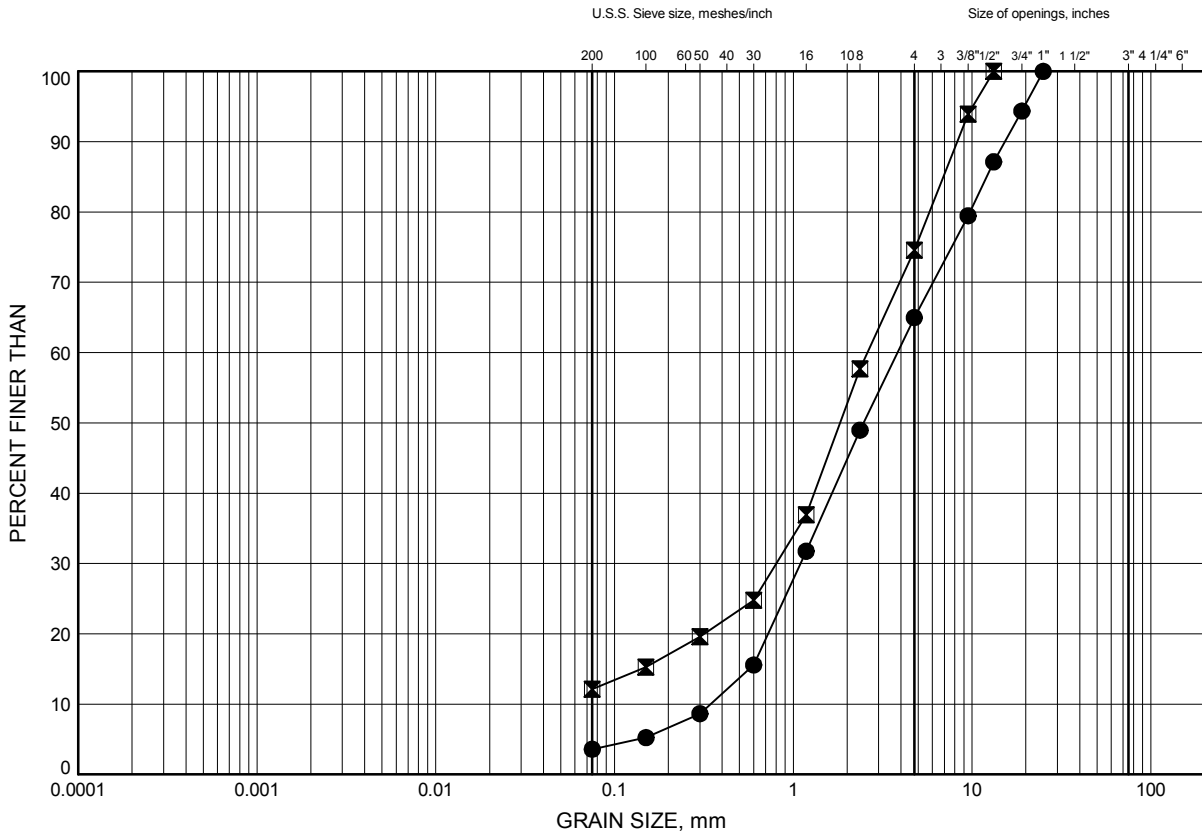
Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B10

GRAVELLY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-03	9.45	289.75
⊠	KR13-06	9.24	289.46

Date December 2013

GWP# 5193-13-00



Prep'd AN

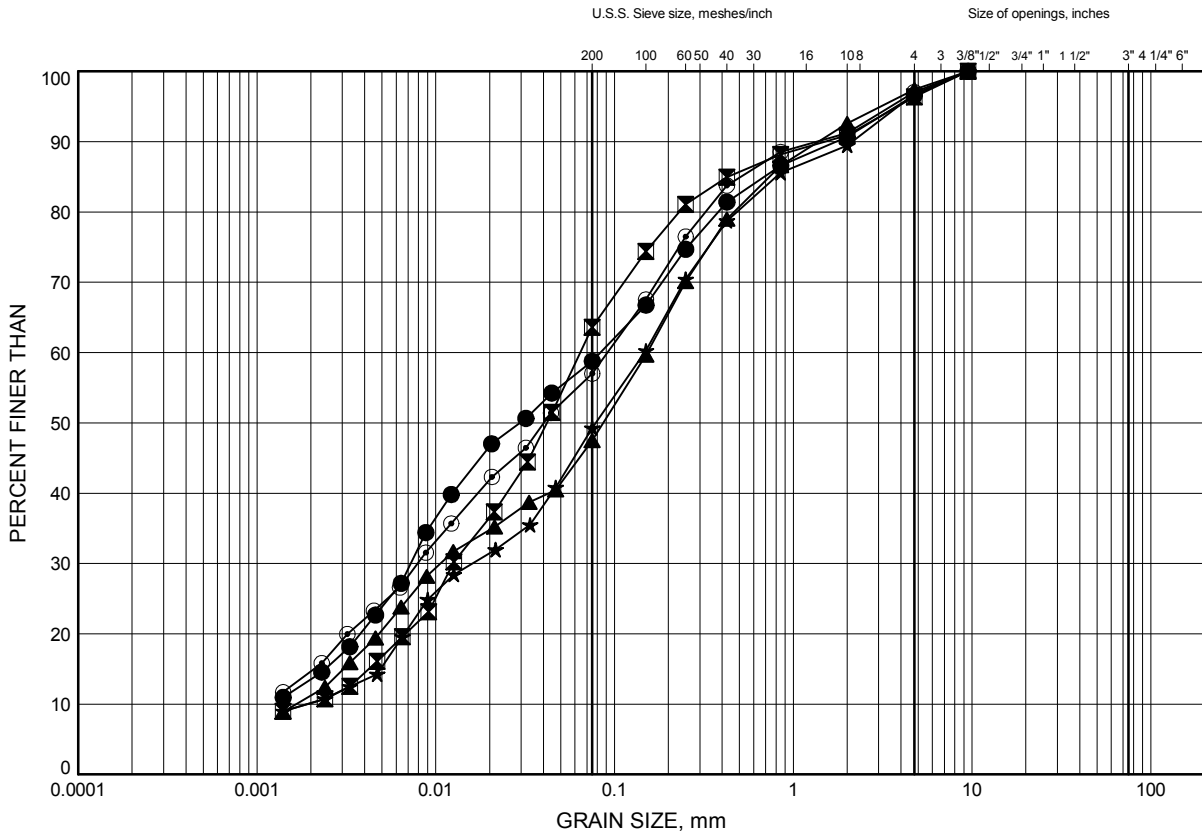
Chkd. SKP

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B11

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	KR13-03	12.41	286.79
⊠	KR13-03	15.54	283.66
▲	KR13-04	13.94	284.96
★	KR13-06	14.02	284.68
⊙	KR13-08	4.88	290.22

Date December 2013

GWP# 5193-13-00



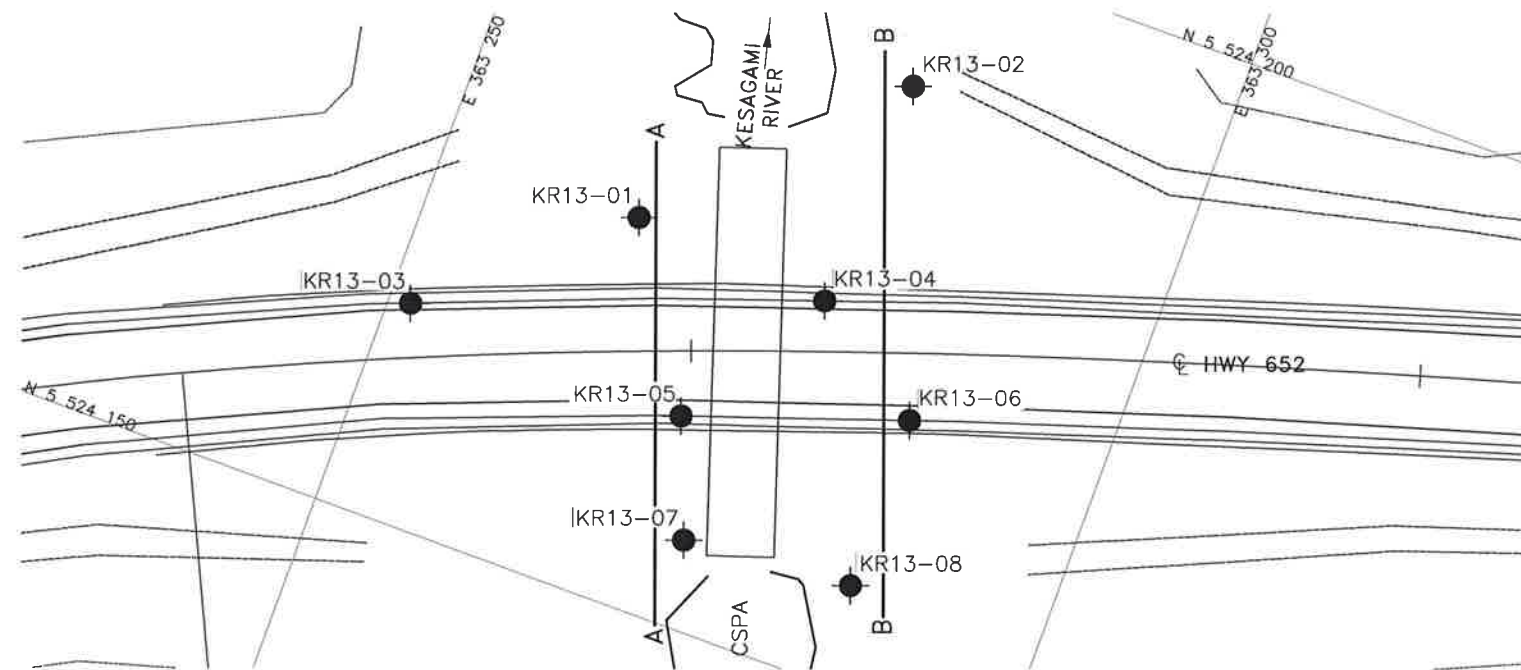
Prep'd AN

Chkd. SKP

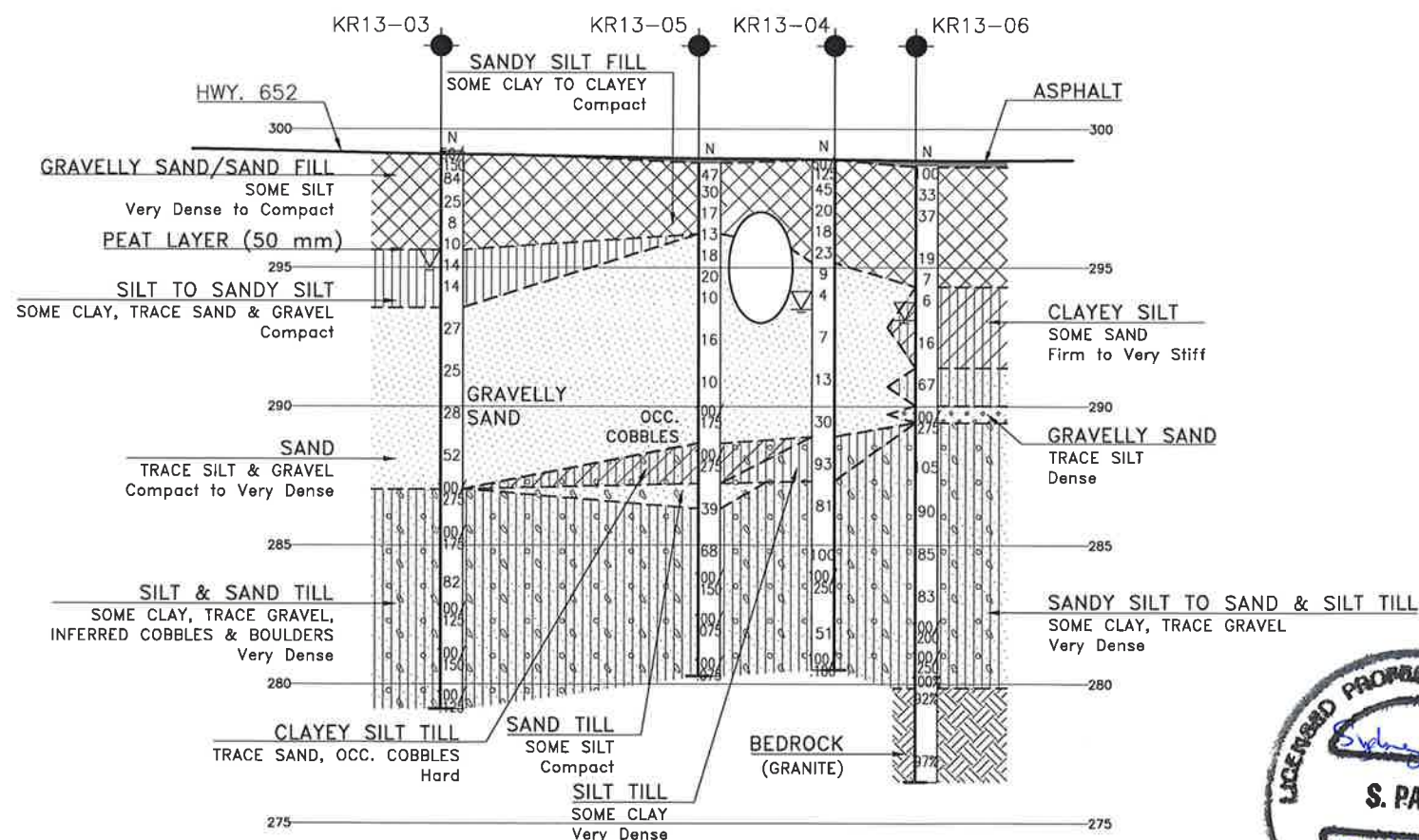
Appendix C

Borehole Locations and Soil Strata Drawings

19-4406-9



PLAN
SCALE 1:500



PROFILE ALONG C HWY 652

SCALE 1:500
V 1:250

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

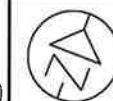
CONT No
GWP No 5193-13-00

HIGHWAY 652
KESAGAMI RIVER
CULVERT REPLACEMENT I
BOREHOLE LOCATIONS AND SOIL STRATA

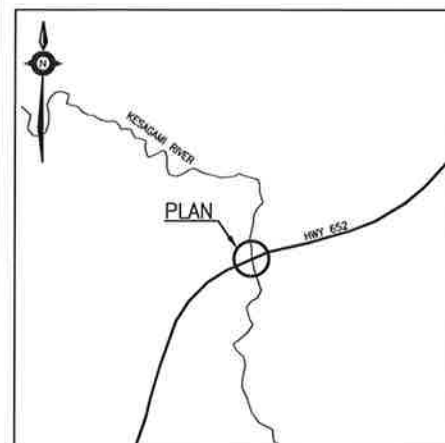
URS



THURBER ENGINEERING LTD.



SHEET



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
KR13-01	297.2	5 524 175.7	363 264.2
KR13-02	295.2	5 524 190.6	363 278.7
KR13-03	299.2	5 524 164.8	363 251.5
KR13-04	298.9	5 524 174.7	363 278.1
KR13-05	298.8	5 524 163.9	363 271.6
KR13-06	298.7	5 524 169.0	363 286.4
KR13-07	295.7	5 524 156.0	363 274.7
KR13-08	295.1	5 524 157.0	363 286.5

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.

GEOCRE No. 42H-59



DATE	BY	DESCRIPTION
DESIGN	SKP	CHK SKP
DRAWN	AN	CHK AEG
		SITE 39N-011C
		STRUCT
		DWG 2

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

CONT No
GWP No 5193-13-00

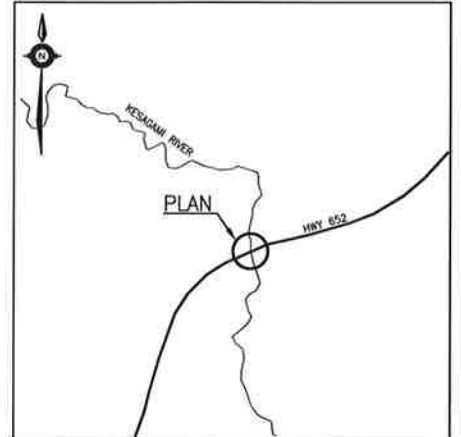
HIGHWAY 652
KESAGAMI RIVER
CULVERT REPLACEMENT II
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

URS



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
⊕	Head Artesian Water
⊕	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

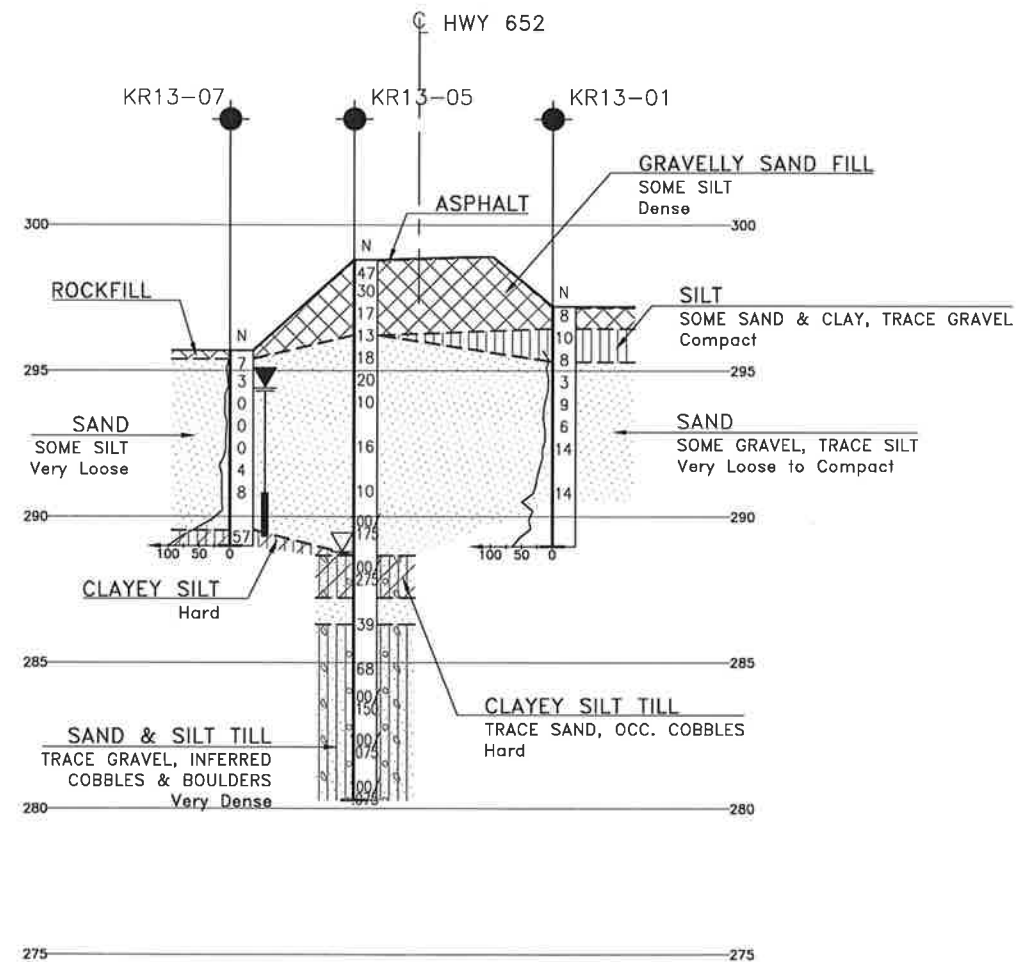
NO	ELEVATION	NORTHING	EASTING
KR13-01	297.2	5 524 175.7	363 264.2
KR13-02	295.2	5 524 190.6	363 278.7
KR13-03	299.2	5 524 164.8	363 251.5
KR13-04	298.9	5 524 174.7	363 278.1
KR13-05	298.8	5 524 163.9	363 271.6
KR13-06	298.7	5 524 169.0	363 286.4
KR13-07	295.7	5 524 156.0	363 274.7
KR13-08	295.1	5 524 157.0	363 286.5

-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. 42H-59

REVISIONS	DATE	BY	DESCRIPTION
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DRAWN	AN	CHK	AEG
SITE	39N-011C	STRUCT	DWG 3
DATE	NOV 2014		

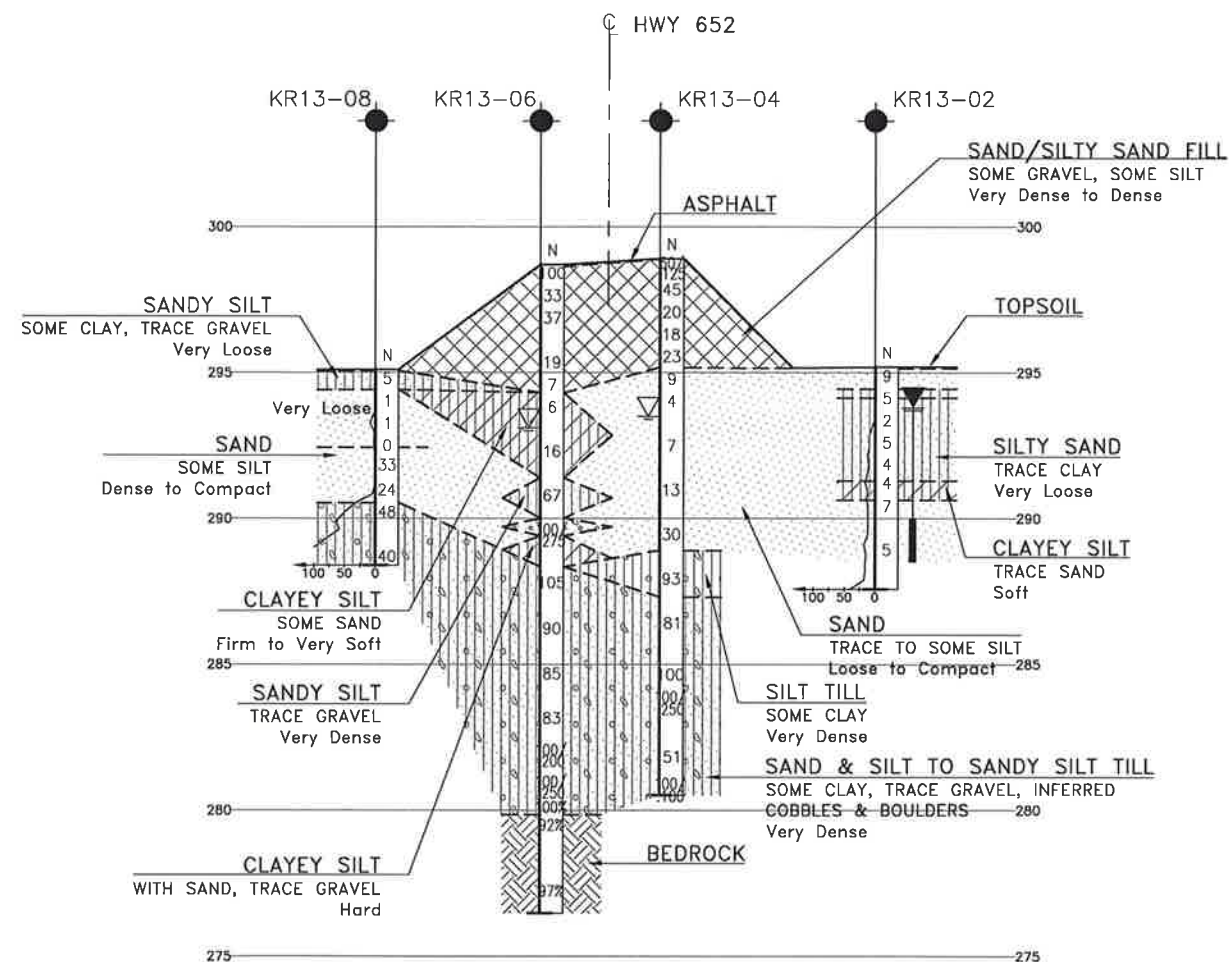


SECTION ALONG A-A



H 1:500

V 1:250



SECTION ALONG B-B

