

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
ADDITIONAL GROUND MOUNTED SIGN SUPPORTS  
SCHEEL DRIVE TO DIVISION STREET  
HIGHWAY 17/417 WIDENING  
ARNPRIOR, ONTARIO  
G.W.P. 4067-03-00**

**GEOCRES NO. 31F-183**

Submitted

To

**MMM Group Limited**

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**PART 1 FACTUAL INFORMATION**

**1.0 INTRODUCTION**

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the design of seven (7) additional ground mounted sign supports at locations along the Highway 17/417 four laning corridor between Scheel Drive and Division Street in Arnprior, Ontario. Thurber has been retained by MMM Group Limited (MMM) to carry out this investigation on behalf of the Ministry of Transportation Ontario (MTO).

The purpose of this investigation was to determine the subsurface conditions at and in close proximity to the proposed sign supports and, based on this data, to provide a borehole location plan, records of boreholes, laboratory test results and a written description of the subsurface conditions.

**2.0 SITE DESCRIPTION**

In general, the ground mounted signs are located within the physiographic region known as the Ottawa Valley Clay Plains. This area is located between the Laurentian upland to the north and west, and the Ottawa lowland to the south and east. Native soil deposits typically consist of glacio-lacustrine clayey silts to silty clays that were deposited when the Champlain Sea inundated the Ottawa – St. Lawrence lowland. Bedrock in the site area mainly consists of crystalline limestone of the Ordovician Period that had been subjected to faulting, weathering and erosion. Occasional volcanic or metamorphic intrusions are also present.

The ground mounted signs are to be located at various locations along Highway 17/417. To the west and south of Arnprior, the highway runs through relatively flat terrain in the vicinities of Scheel Drive, Campbell Drive and Division Street. Open fields with some rock outcrops are present along both sides of the existing highway alignment. The adjacent land is lightly vegetated with grass, shrubs and small patches of trees.

### 3.0 INVESTIGATION PROCEDURES

#### 3.1 Field Investigation

The borehole investigation for the proposed ground mounted signs was carried out between July 8 and 11, 2013. The boreholes are listed as follows:

**Table 3.1 Borehole Depths**

Site Location	Borehole	Drilling Date	Depth (m)
Hwy. 417 EBL Between Campbell Drive and Scheel Drive	BH-01	July 9, 2013	5.3
Hwy. 417 EBL Between Campbell Drive and Scheel Drive	BH-02	July 9, 2013	6.1
Hwy. 417 EBL Between Campbell Drive and Division Street	BH-03	July 10, 2013	9.1
Hwy. 417 EBL Between Campbell Drive and Division Street	BH-04	July 10, 2013	8.5
Hwy. 417 EBL Between Campbell Drive and Division Street	BH-05	July 11, 2013	5.3
Hwy. 417 WBL East of Division Street	BH-06	July 8, 2013	7.7
Hwy. 417 WBL East of Division Street	BH-07	July 8, 2013	9.3

The approximate locations of the above boreholes are shown on Drawing 1. The investigation was carried out using a track mounted drill rig supplied and operated by a specialist drilling contractor.

In these boreholes, soil drilling was carried out using hollow stem augers and all soil samples were obtained using a 50 mm outside diameter split spoon sampler advanced in accordance with the Standard Penetration Test (SPT). Bedrock was cored using an NQ core barrel in conjunction with NW casings. Groundwater conditions in the open boreholes were observed throughout the

drilling operations. Standpipe piezometers were installed in four selected boreholes for longer term water level monitoring. The borehole and piezometer completion details are shown in Table 3.2 below.

**Table 3.2 – Borehole Completion Details**

<b>Borehole Location</b>	<b>Piezometer Tip Depth / Elevation (m)</b>	<b>Completion Details</b>
BH-01	2.1 / 123.7	Borehole caved from 5.3 m to 2.2 m, then backfilled with bentonite holeplug from 2.2 m to 2.1 m, sand filter from 2.1 m to 0.3 m, then bentonite holeplug to surface
BH-02	None Installed	Borehole backfilled with bentonite holeplug to surface
BH-03	7.4 / 105.8	Borehole backfilled with bentonite holeplug from 9.1 m to 7.5 m, sand filter from 7.5 m to 5.1 m, then bentonite holeplug to surface
BH-04	None Installed	Borehole backfilled with bentonite holeplug to surface
BH-05	3.1 / 110.4	Borehole caved from 5.3 m to 3.2 m, then backfilled with sand filter from 3.2 m to 0.6 m, then bentonite holeplug to surface
BH-06	None Installed	Borehole backfilled with bentonite holeplug to surface
BH-07	6.1 / 102.3	Borehole backfilled with bentonite holeplug from 9.3 m to 6.1 m, sand filter from 6.1 m to 3.1 m, then bentonite holeplug to surface

The field work was supervised on a full-time basis by a member of our field staff who located the boreholes in the field, cleared borehole locations of underground utilities, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The soil and rock samples were identified in the field, placed in appropriately labelled containers and core boxes, respectively, and transported back to Thurber's laboratory for further examination and testing. Borehole elevations were estimated from drawings provided by MMM.

### **3.2 Laboratory Testing**

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size distribution analysis and Atterberg Limits tests were conducted on selected samples. All rock core samples were logged and subjected to Rock Quality Designation (RQD) and core recovery

measurements. Point load tests were conducted on selected rock cores to provide correlation with unconfined compressive strength. The laboratory test results are presented on the records of boreholes in Appendix A and the figures in Appendix B.

## **4.0 SUBSURFACE STRATIGRAPHY**

### **4.1 General**

This section presents a generalized summary of the subsurface conditions encountered in the boreholes. The detailed subsurface soil, rock and groundwater conditions encountered in all seven boreholes are presented on the Records of Boreholes in Appendix A.

In general, the subsurface conditions encountered in the boreholes consist of topsoil or fill overlying native silty clay and clayey silt which are underlain by bedrock. A Borehole Locations Drawing is included in Appendix C to illustrate the approximate locations of the seven boreholes.

#### **4.1.1 Topsoil**

Topsoil 75 mm thick was encountered at ground surface in Borehole BH-05 directly overlying gravelly sand fill. Topsoil is anticipated to exist elsewhere in the vicinity of the sites and its thickness will vary between and beyond the borehole locations.

#### **4.1.2 Fill**

Fill was encountered at ground surface in Boreholes BH-01 to BH-04 and BH-06 to BH-07. Borehole BH-01 consists of sand and gravel fill above silty sand fill with a combined thickness of 2.3 m (base Elevation 123.5 m). Borehole BH-02 consists of sand with gravel, sandy gravel and clayey silt fill with a combined thickness of 2.2 m (base Elevation 122.8 m). Boreholes BH-03 and BH-04 consist of silty sand fill with thickness ranging from 0.1 m to 0.8 m (base Elevations 113.8 m and 112.4 m, respectively). In Borehole BH-05 underlying the topsoil, gravelly sand fill of 1.1 m in thickness (base Elevation 112.4 m) was encountered. Boreholes BH-06 and BH-07 consist of sand and gravel fill with a thickness of 0.8 m (base Elevations of 108.8 and 107.6 m, respectively).

The granular fill was typically in a compact to dense state as indicated by SPT 'N' values ranging from 11 to 50 blows per 0.3 m penetration, except for the silty sand fill in Boreholes BH-03 and BH-04 where it was in a loose state as indicated by SPT 'N' values ranging between 3 and 7 blows per 0.3 m penetration. The silty clay to clayey silt fill in Borehole BH-02 had a stiff to very stiff consistency as indicated by 'N' values of 11 to 23 blows per 0.3 m of penetration. Measured moisture contents of the granular materials ranged from 2% to 26%, whereas the measured values for the cohesive fill ranged from 20% to 25%.

Grain size distribution analyses were carried out on samples of the cohesionless and cohesive fill. The results of these analyses are shown on Figures B1 to B3 in Appendix B. Atterberg limits tests were also conducted on the clayey silt fill and the results plotted on a plasticity chart shown on Figure B7 in Appendix B. The results are also summarized in the tables below.

Soil Particles	%
<b>Sand and Gravel, Gravelly Sand Fill</b>	
Gravel	24 to 69
Sand	25 to 69
Silt and Clay	6 to 15
<b>Silty Sand Fill</b>	
Gravel	1
Sand	61
Silt	30
Clay	8
<b>Clayey Silt Fill</b>	
Gravel	1
Sand	46
Silt	32
Clay	21

Index Property	%
<b>Clayey Silt Fill</b>	
Liquid Limit	32
Plastic Limit	18
Plasticity Index	14

The above results show that the clayey silt fill is of low plasticity with a group symbol of CL.

#### 4.1.3 Silty Clay

Deposits of native cohesive silty clay were encountered below the fill in Boreholes BH-02 and BH-04, below the native clayey silt in BH-03, BH-06 and BH-07. Where encountered, these cohesive deposits extend to variable depths ranging from 3.1 m to 9.3 m or Elevations 99.1 to 121.9 m. The silty clay is typically brown in colour becoming grey with depth at some locations. Cobbles or boulders are inferred in this deposit at elevations just above probable bedrock.

Measured SPT 'N' values within the silty clay deposit typically range between 0 and 15 blows per 0.3 m of penetration. In conjunction with field vane test results ranging between 25 and 42 kPa, it is assessed that the silty clay has a typical soft to firm and occasionally stiff consistency. Occasional 'N' values of >50 blows for <0.3 m of penetration in Boreholes BH-06 and BH-7 infer the presence of a boulder or probably bedrock. Measured moisture contents of samples of the silty clay ranged between 12% and 52%.

Grain size distribution analyses were carried out on selected silty clay samples. The results of these analyses are presented in Figures B4 and B5 in Appendix B. Atterberg limits tests were also conducted and the results plotted on a plasticity chart shown on Figure B8 in Appendix B. The results are also summarized in the tables below.

Soil Particles	%
<b>Silty Clay</b>	
Gravel	0
Sand	1 to 37
Silt	33 to 46
Clay	30 to 58

Index Property	%
<b>Silty Clay</b>	
Liquid Limit	33 to 53
Plastic Limit	17 to 21
Plasticity Index	18 to 32

The above results show that the silty clay is typically of medium plasticity with a group symbol of CI.



#### 4.1.4 Clayey Silt

Deposits of native cohesive clayey silt with sand were encountered below the fill and interlayered with the silty clay in Boreholes BH-03, BH-04, BH-06 and BH-07. Where encountered, the clayey silt is typically brown in colour and extends to depths between 1.4 and 5.8 m, or between Elevations 110.9 and 106.5 m. A 0.7 m thick silt layer with a base elevation at 110.9 m was observed between the silty clay and clayey silt layers in Borehole BH-04.

Measured 'N' values within the clayey silt ranged from 1 to 11 blows per 0.3 m indicating a very soft to stiff consistency. Moisture contents of the clayey silt ranged between 9% and 42%.

Grain size distribution analyses were carried out on selected clayey silt samples. The results of these analyses are presented in Figure B6 in Appendix B. Atterberg limits tests were also conducted and the results plotted on a plasticity chart shown on Figure B9 in Appendix B. The results are also summarized in the tables below.

Soil Particles	%
<b>Clayey Silt</b>	
Gravel	1 to 3
Sand	50 to 51
Silt	29 to 31
Clay	17 to 18

Index Property	%
<b>Clayey Silt</b>	
Liquid Limit	18
Plastic Limit	12
Plasticity Index	8

The above results show that the clayey silt is of low plasticity with a group symbol of CL.

#### 4.1.5 Bedrock

The overburden soils are underlain by bedrock which was proven by coring beyond the augered depths in five boreholes. The following table summarizes the depth to bedrock encountered at the borehole locations.

**Table 4.1 Depths and Elevations of Bedrock**

<b>Borehole Number</b>	<b>Depth to Bedrock (m)</b>	<b>Top of Bedrock or Auger Refusal Elevation (m)</b>
BH-01	2.3*	123.5*
BH-02	3.1*	121.9*
BH-03	5.8*	107.4*
BH-04	5.2*	108.7*
BH-05	1.1*	112.4*
BH-06	7.7	101.8
BH-07	9.3	99.1

\* Proven by coring

The bedrock encountered in Boreholes BH-01 to BH-05 is a grey crystalline limestone with dark grey, black and occasionally white banding. The bedrock is typically in a fresh state with slight weathering at the joints occurring at shallow depths. Many of the bandings and joints are horizontal to sub-vertical in orientation.

Total Core Recovery (TCR) of the bedrock was 100%, except for 85% encountered in Run 1 of BH-05. The Rock Quality Designation (RQD) values were typically 62% to 92%, indicating a fair to excellent rock quality, except for Run 1 in BH-05 where an RQD of 0% indicates a very poor rock quality. The Fracture Indices (FI) of the rock, expressed as fractures per 0.3 m of core, were generally between 0 and 5, except for the frequent rubble zones in BH-05 and occasional rubble zones in Boreholes BH-01 and BH-04 where FI is greater than 10. The FI in BH-05 improved to between 2 and 3 below a depth of 4 m.

Point load tests were carried out on selected rock cores. The Unconfined Compressive Strengths (UCS) of the rock cores, as inferred from the point load test results, range from 52 MPa to 186 MPa indicating that the rock is strong to very strong.

#### **4.1.6 Groundwater Conditions**

Groundwater conditions were observed during and upon completion of drilling. Standpipe piezometers were installed in four of the boreholes. The depths and elevations of water level readings observed in the open boreholes and piezometers are presented in the following table.

**Table 4.2 Water Level Readings**

<b>Borehole</b>	<b>Installation</b>	<b>Date</b>	<b>Water Level Depth (m)</b>	<b>Water Level Elevation (m)</b>
BH-01	Standpipe	August 14, 2013	1.9	123.9
BH-02	Open Hole	July 9, 2013	Dry	Dry
BH-03	Standpipe	August 14, 2013	1.5	111.7
BH-04	Open Hole	July 10, 2013	3.2	110.7
BH-05	Standpipe	August 14, 2013	2.2	111.3
BH-06	Open Hole	July 9, 2013	2.3	107.2
BH-07	Standpipe	July 8, 2013	8.7	99.7
		August 14, 2013	2.8	105.6

It should be noted that these observed levels are based on short term observations and groundwater levels are subject to seasonal fluctuations and severe climatic events.

## **5.0 MISCELLANEOUS**

The borehole locations were marked in the field by Thurber. Borehole co-ordinates were measured using a hand-held GPS and borehole elevations were obtained from MMM's base map drawing. Thurber obtained utility clearances prior to drilling. Eastern Ontario Diamond Drilling Limited of Hawkesbury, Ontario supplied the drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Ms. Katrina Young of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved Oakville laboratory. Dr. Sydney Pang, P.Eng. directed the field operations and Mr. Lukasz Gilarski P.Eng. prepared this report.

Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

THURBER ENGINEERING LTD.



Lukasz Gilarski, P.Eng.  
Geotechnical Engineer



Sydney Pang, P.Eng.  
Associate, Senior Foundations Engineer



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

## **Appendix A**

### **Record of Boreholes**

19-1351-242

# RECORD OF BOREHOLE No BH-01

1 OF 1

METRIC

GWP# 4067-03-00 LOCATION N 5 032 927.4 E 310 093.7 ORIGINATED BY KMY  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2013.07.09 - 2013.07.09 CHECKED BY SKP

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 (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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ONTMT4S 1242.GPJ 2012TEMPLATE(MTO).GDT 1/8/14

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

## METRIC

[illegible]

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

# RECORD OF BOREHOLE No BH-03

1 OF 2

METRIC

GWP# 4067-03-00 LOCATION N 5 032 686.9 E 313 076.0 ORIGINATED BY KMY  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2013.07.10 - 2013.07.10 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5 0  
(%) STRAIN AT FAILURE



## METRIC

[illegible]

# RECORD OF BOREHOLE No BH-04

1 OF 1

METRIC

GWP# 4067-03-00 LOCATION N 5 032 604.6 E 313 255.0 ORIGINATED BY KMY  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2013.07.10 - 2013.07.10 CHECKED BY SKP

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			SHEAR STRENGTH kPa						
113.9								20 40 60 80 100						
0.0								20 40 60 80 100						
0.1	Silty <b>SAND</b> , with gravel, trace organics Loose Brown Moist (FILL)		1	SS	7									
	Silty <b>CLAY</b> , with sand Firm Light Brown Moist		2	SS	6		113							0 22 40 38
			3	SS	6		112							
111.6														
2.3	<b>SILT</b> , occasional gravel, occasional sand lenses Loose Light Brown Moist		4	SS	6		111							
110.9														
3.0	Clayey <b>SILT</b> , with sand, trace gravel Soft to Firm Light Brown Moist		5	SS	6		110							3 51 29 17
			6	SS	9									
			7	SS	3		109							
108.7														
5.2	<b>CRYSTALLINE LIMESTONE</b> (BEDROCK), fresh, slightly weathered at joints, thinly to medium bedded, grey with dark grey and white horizontal banding  Granitic gneiss intrusion, pinkish grey between 6.3m to 6.5m and between 7.9m and 8.5m Some greenish grey banding between 6.5m and 7.5m		1	RUN			108							RUN #1 TCR=100% SCR=100% RQD=100% UCS=136MPa
			2	RUN			107							RUN #2 TCR=100% SCR=63% RQD=62% UCS=85MPa
			3	RUN			106							RUN #3 TCR=100% SCR=70% RQD=75% UCS=126MPa
105.4														
8.5	END OF BOREHOLE AT 8.5m. AUGER REFUSAL AT 5.2m. WATER LEVEL IN OPEN BOREHOLE AT 3.2m DEPTH UPON COMPLETION OF AUGERING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S 1242.GPJ 2012TEMPLATE(MTO).GDT 1/8/14

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

# RECORD OF BOREHOLE No BH-05

1 OF 1

METRIC

GWP# 4067-03-00 LOCATION N 5 032 491.5 E 313 418.1 ORIGINATED BY KMY  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2013.07.11 - 2013.07.11 CHECKED BY SKP

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)
113.5								20	40	60	80	100					
0.0	<b>TOPSOIL:</b> (75mm)																
0.1	Gravelly <b>SAND</b> , trace silt Compact Light Brown Moist (FILL)		1	SS	15		113										24 69 7 (SI+CL)
112.4			2	SS	20												
1.1	<b>CRYSTALLINE LIMESTONE</b> (BEDROCK), highly weathered to moderately weathered, grey with dark grey and white banding, some iron staining and clay infilling to 4.0m, some calcite veins		3	SS	50/ 0.300		112									FI	
			1	RUN			111									>10	RUN #1 TCR=85% SCR=9% RQD=0% UCS=68MPa
	Rubble zones: 250mm at 3.1m 300mm at 3.7m		2	RUN			110									>10	RUN #2 TCR=100% SCR=62% RQD=62% UCS=138MPa
	Becoming fresh at 4.0 m Rubble zone 75mm at 4.4m		3	RUN			109									>10	RUN #3 TCR=100% SCR=81% RQD=81% UCS=163MPa
108.2																2	
5.3	END OF BOREHOLE AT 5.3m. AUGER REFUSAL AT 1.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE        DEPTH (m)    ELEV. (m) Aug 14, 2013    2.2        111.3																







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

# RECORD OF BOREHOLE No BH-06

1 OF 1

METRIC

GWP# 4067-03-00 LOCATION N 5 032 106.3 E 313 874.4 ORIGINATED BY KMY  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2013.07.08 - 2013.07.09 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
109.5								20	40	60	80	100								
0.0	<b>SAND</b> and <b>GRAVEL</b> , trace silt Compact Brown Dry (FILL)		1	SS	19		109													54 38 8 (SI+CL)
108.8																				
0.8	Clayey <b>SILT</b> , with gravel, some oxidation stains Stiff to firm Brown Moist		2	SS	11		108													
	Some sand lenses		3	SS	10		107													
106.5																				
3.0	Silty <b>CLAY</b> , trace sand Soft Light Brown Moist		5	SS	4		106													
			6	SS	3	105													0 5 40 55	
			7	SS	2	104														
	Firm Wet		8	SS	WH	103													Vane would not turn 0 7 46 47	
																		</		

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

# RECORD OF BOREHOLE No BH-07

1 OF 2

METRIC

GWP# 4067-03-00 LOCATION N 5 031 958.2 E 314 008.6 ORIGINATED BY KMY  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2013.07.08 - 2013.07.08 CHECKED BY SKP

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
108.4														
0.0	<b>SAND</b> and <b>GRAVEL</b> , trace to some silt Compact Brown Dry (FILL)		1	SS	17		108							43 47 10 (SI+CL)
107.6														
0.8	Clayey <b>SILT</b> Firm Light Brown Moist		2	SS	5		107							
106.9														
1.4	Silty <b>CLAY</b> , trace sand Firm Brown Moist		3	SS	4		106							
106.2														
2.2	Stiff		4	SS	14		105							0 1 41 58
105.4														
3.0			5	SS	7		104							Attempted field vane at 2.3m, would not turn
			6	SS	4		103							
	Soft to Firm		7	SS	3		102							
	Grey Wet		8	SS	1		101							
			9	SS	WH		100							0 4 44 52

Continued Next Page

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

# RECORD OF BOREHOLE No BH-07

2 OF 2

METRIC

GWP# 4067-03-00 LOCATION N 5 031 958.2 E 314 008.6 ORIGINATED BY KMY  
 HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2013.07.08 - 2013.07.08 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 $\gamma$ 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 (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page																
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. DATE DEPTH (m) ELEV. (m) Aug 14, 2013 2.8 105.6																

## **Appendix B**

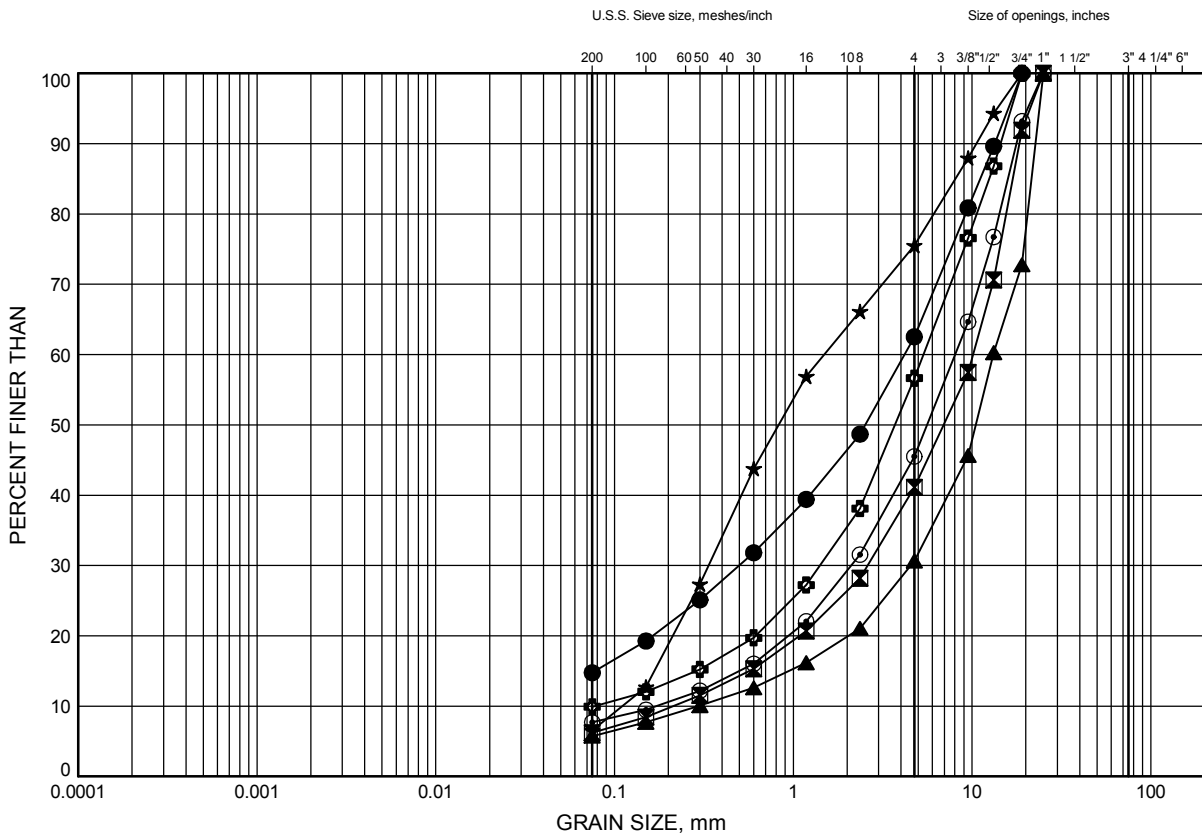
### **Geotechnical Laboratory Test Results**

19-1351-242

# GRAIN SIZE DISTRIBUTION

FIGURE B1

## GRAVELLY SAND TO SAND & GRAVEL FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-01	0.23	125.56
⊠	BH-01	1.03	124.76
▲	BH-02	0.46	124.54
★	BH-05	0.30	113.20
⊙	BH-06	0.30	109.21
⊕	BH-07	0.30	108.08

Date January 2014

GWP# 4067-03-00



Prep'd MFA

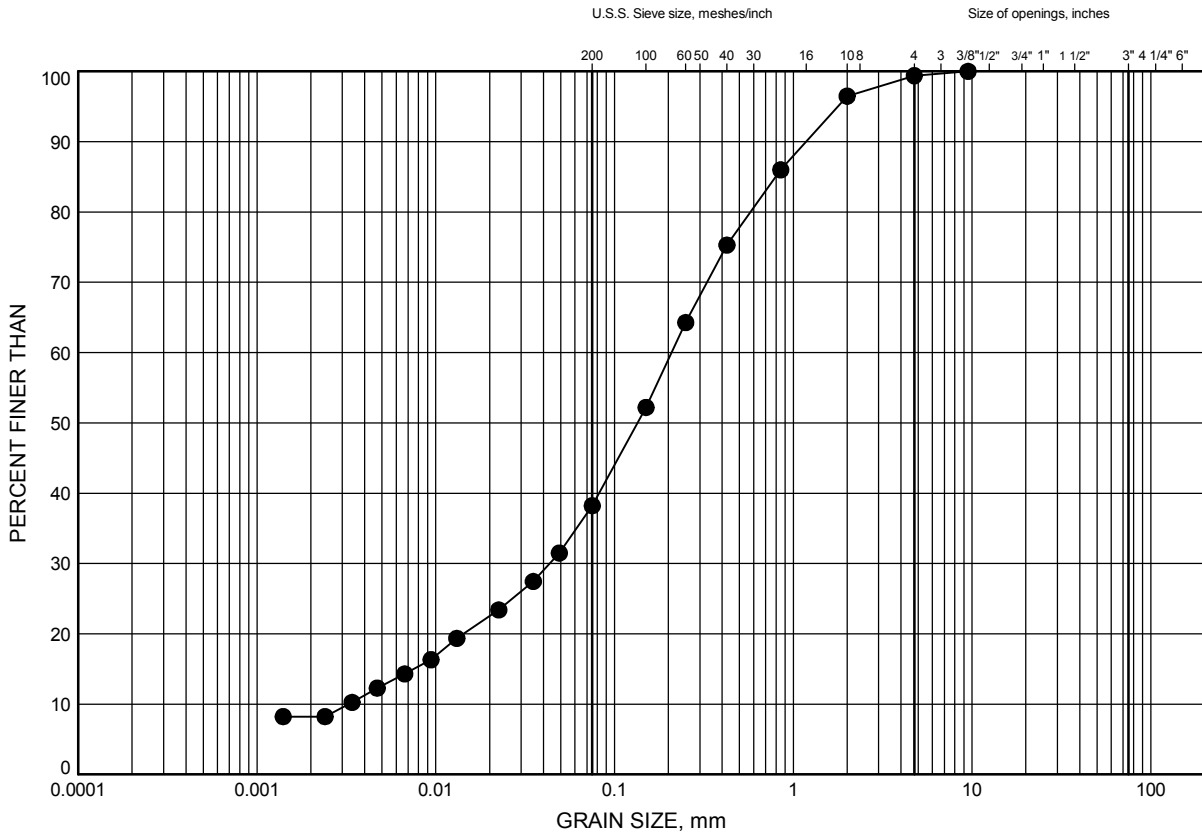
Chkd. SKP



# GRAIN SIZE DISTRIBUTION

FIGURE B2

## SILTY SAND FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-03	0.30	112.90

Date January 2014

GWP# 4067-03-00



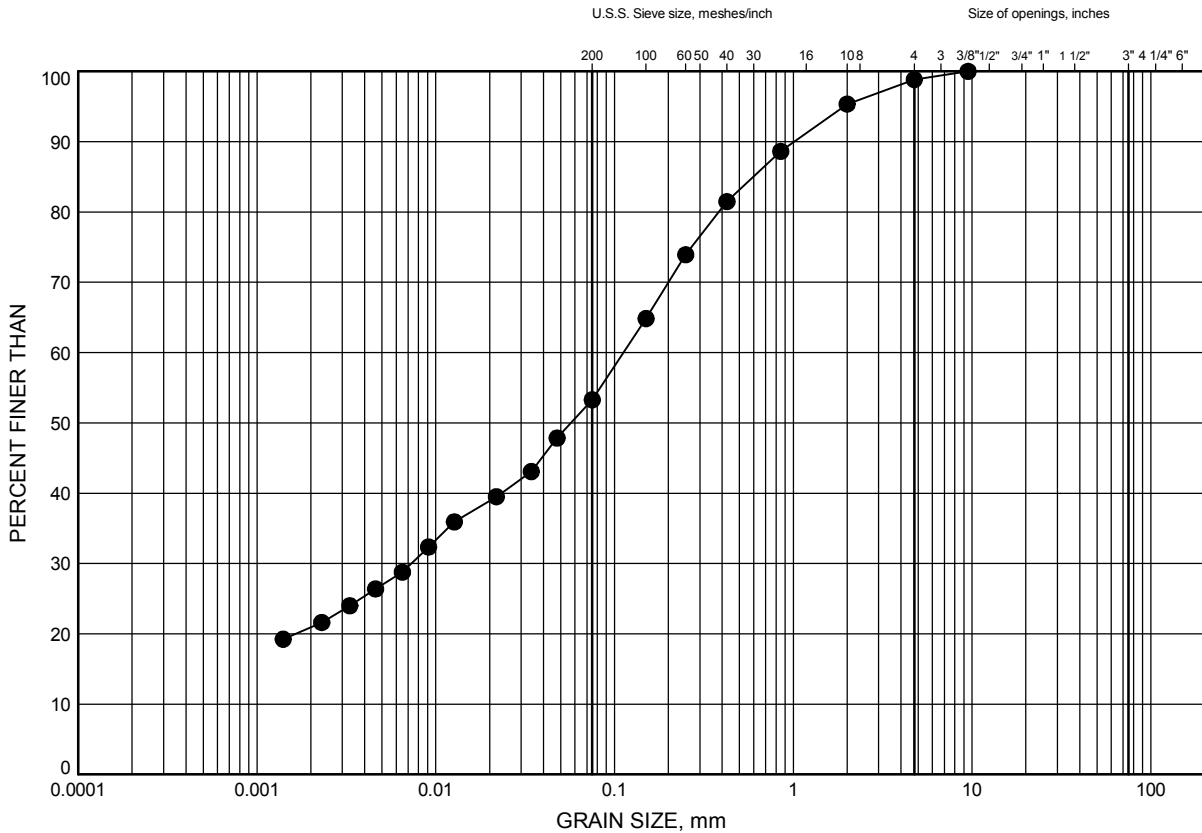
Prep'd MFA

Chkd. SKP

# GRAIN SIZE DISTRIBUTION

FIGURE B3

## CLAYEY SILT FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-02	1.07	123.93

Date January 2014

GWP# 4067-03-00



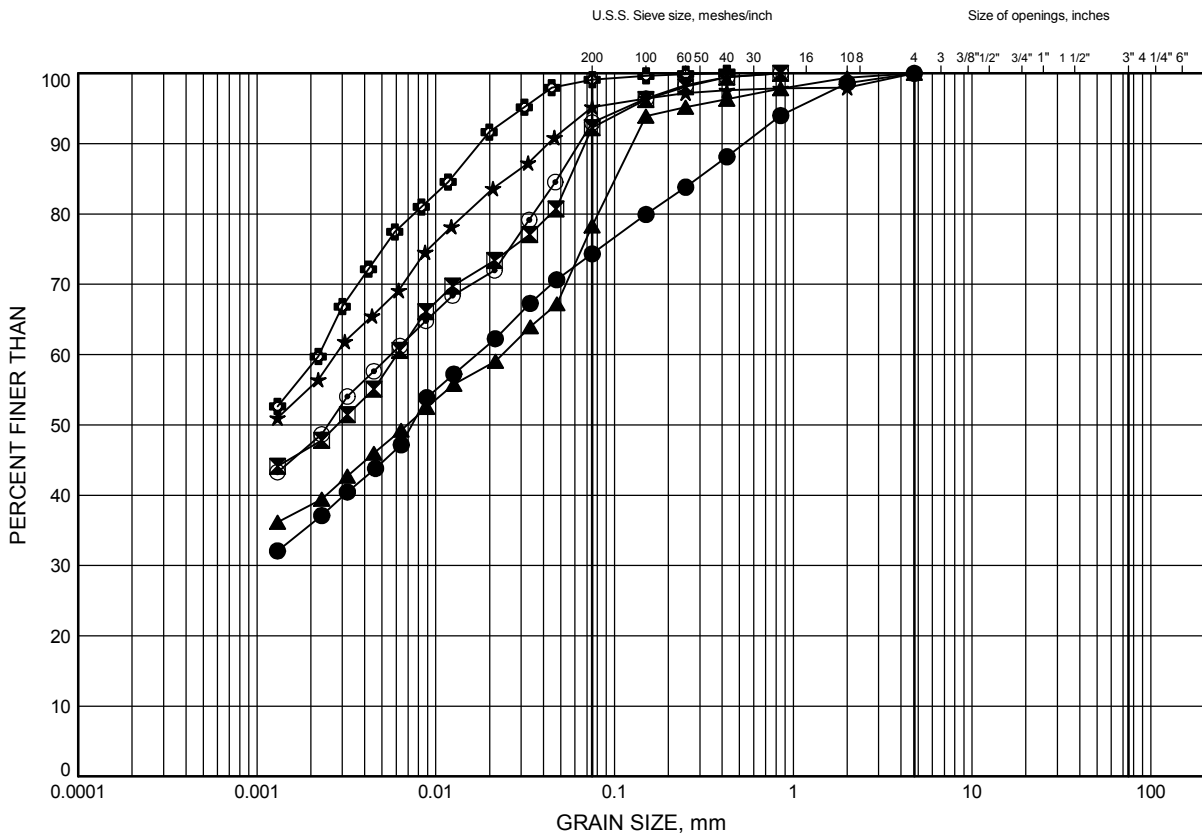
Prep'd MFA

Chkd. SKP

# GRAIN SIZE DISTRIBUTION

FIGURE B4

## SILTY CLAY



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-02	2.59	122.41
⊠	BH-03	2.59	110.61
▲	BH-04	1.07	112.84
★	BH-06	4.11	105.40
⊙	BH-06	6.02	103.49
⊕	BH-07	2.59	105.80

Date January 2014

GWP# 4067-03-00



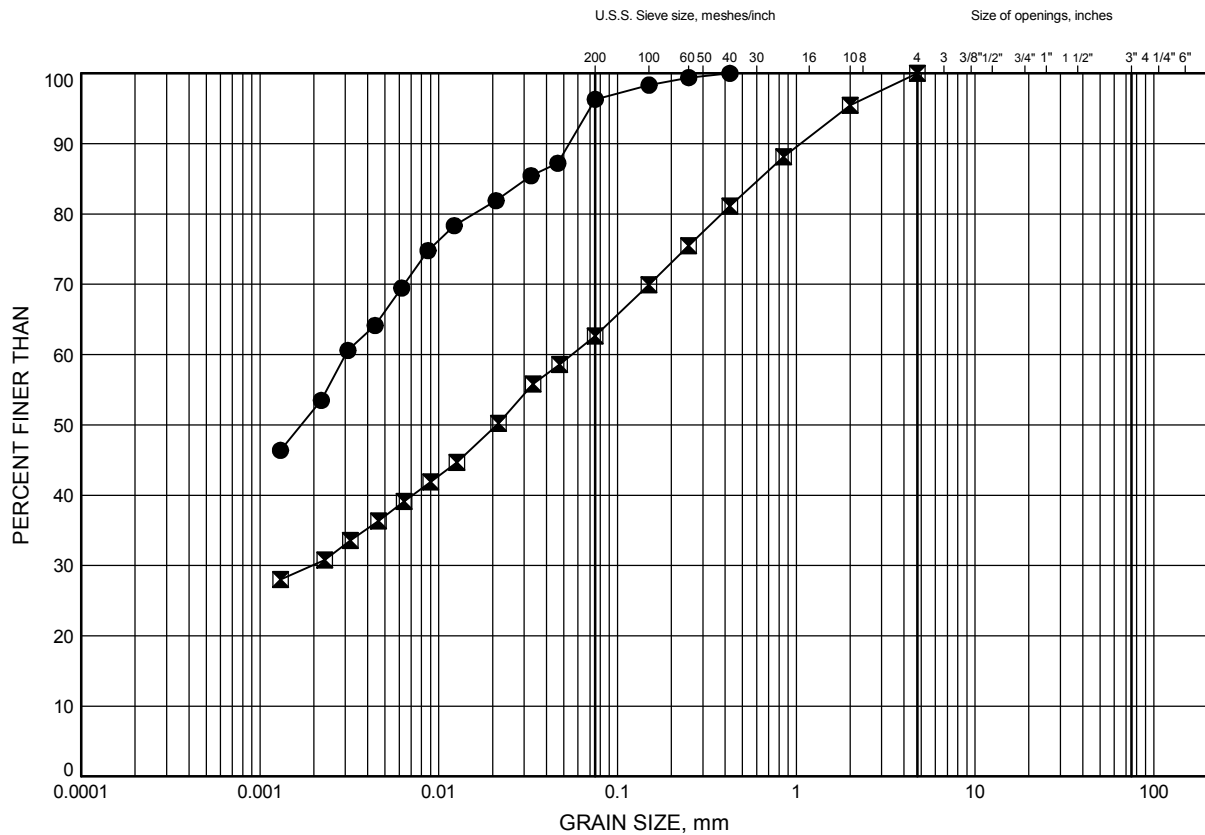
Prep'd MFA

Chkd. SKP

# GRAIN SIZE DISTRIBUTION

FIGURE B5

## SILTY CLAY



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-07	7.92	100.46
⊠	BH-07	9.21	99.18

Date January 2014

GWP# 4067-03-00



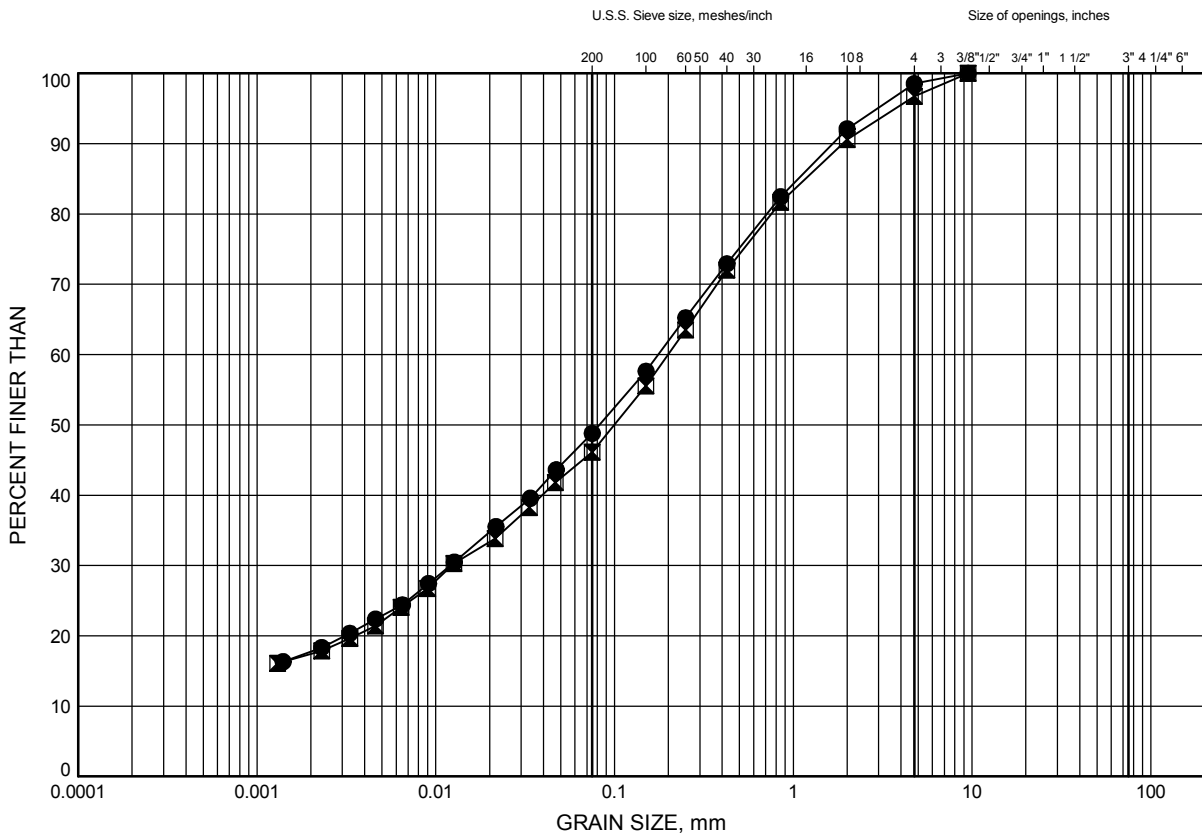
Prep'd MFA

Chkd. SKP

# GRAIN SIZE DISTRIBUTION

FIGURE B6

## CLAYEY SILT with SAND



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-03	4.88	108.33
⊠	BH-04	3.35	110.55

Date January 2014

GWP# 4067-03-00



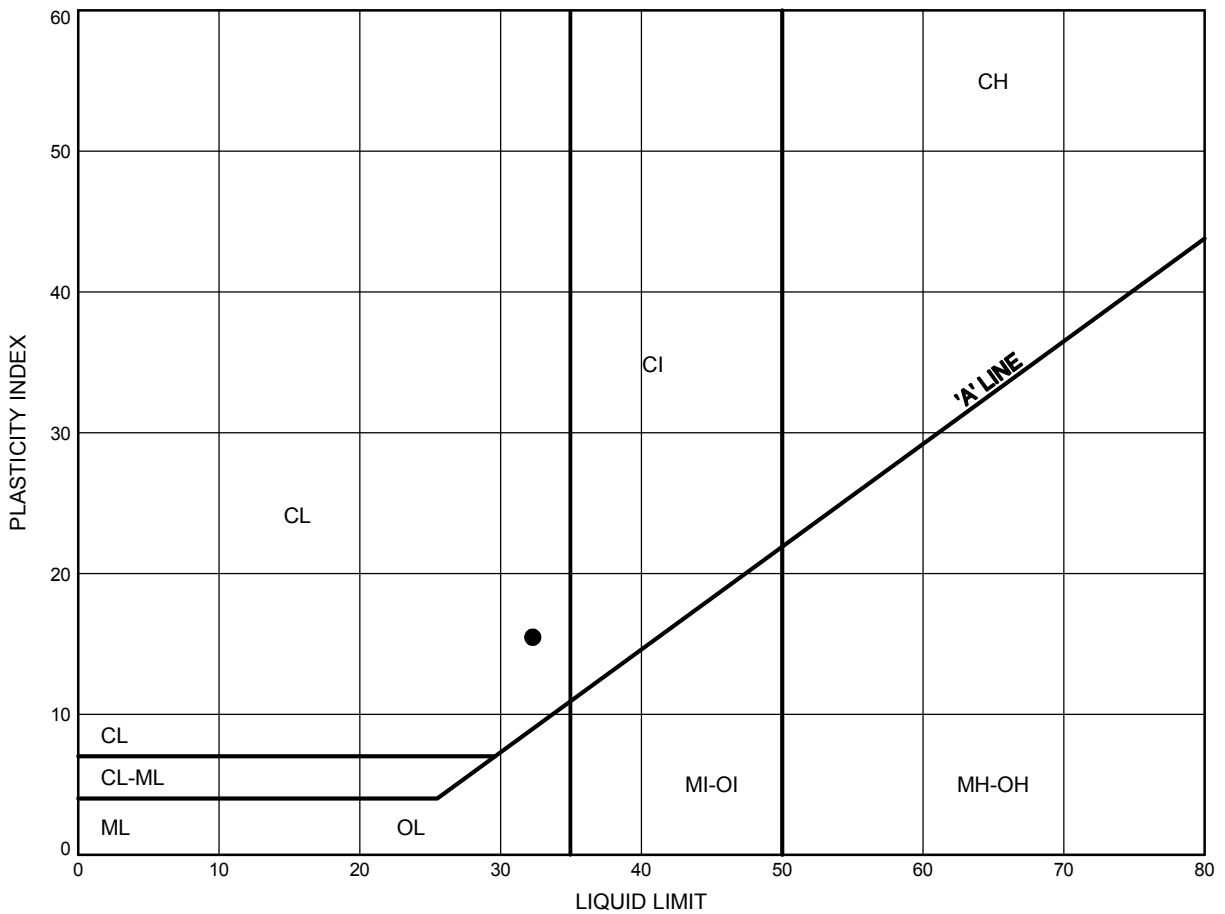
Prep'd MFA

Chkd. SKP

# ATTERBERG LIMITS TEST RESULTS

FIGURE B7

## CLAYEY SILT FILL



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-02	1.07	123.93

Date January 2014

GWP# 4067-03-00



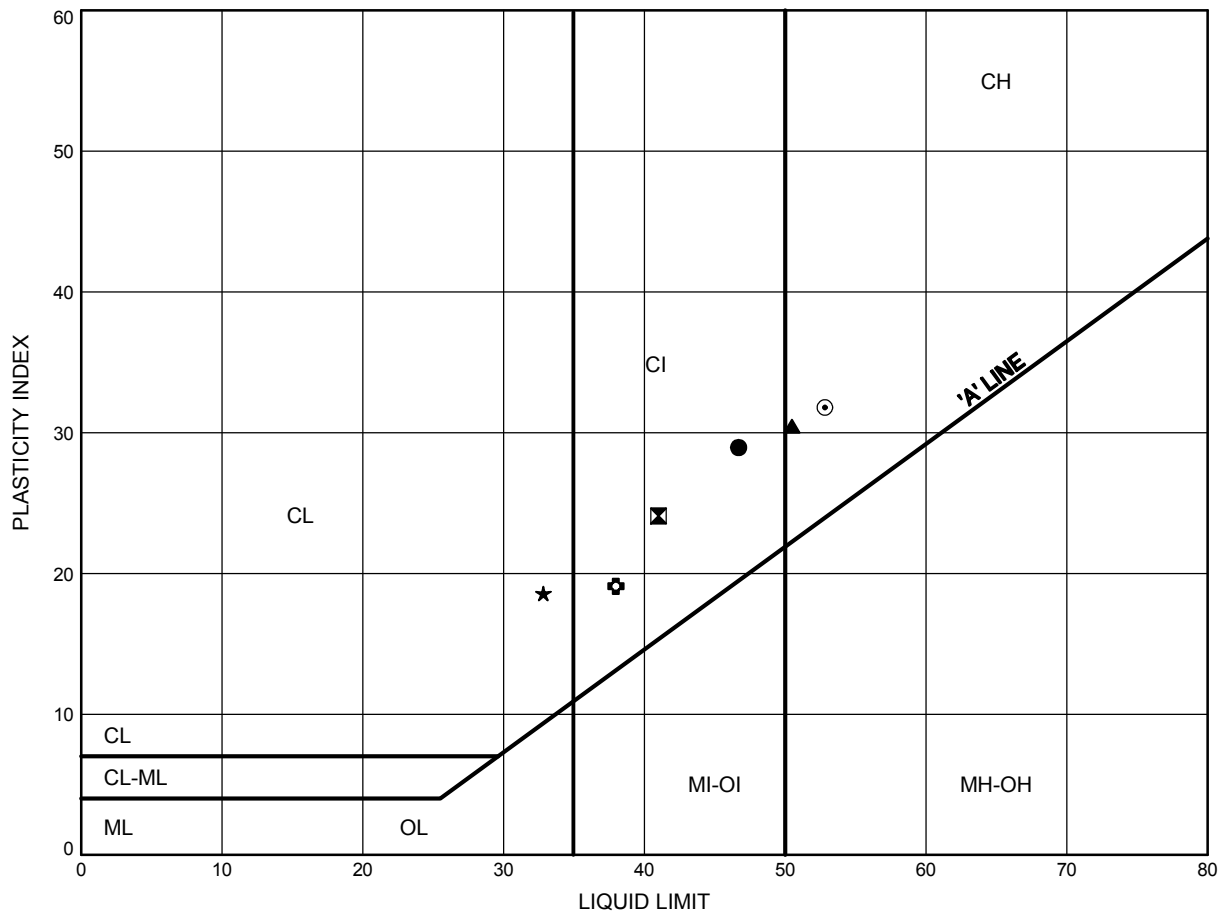
Prep'd MFA

Chkd. SKP

# ATTERBERG LIMITS TEST RESULTS

FIGURE B8

## SILTY CLAY



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-03	2.59	110.61
⊠	BH-04	1.07	112.84
▲	BH-06	4.11	105.40
★	BH-06	6.02	103.49
⊙	BH-07	2.59	105.80
⊕	BH-07	7.92	100.46

Date January 2014

GWP# 4067-03-00



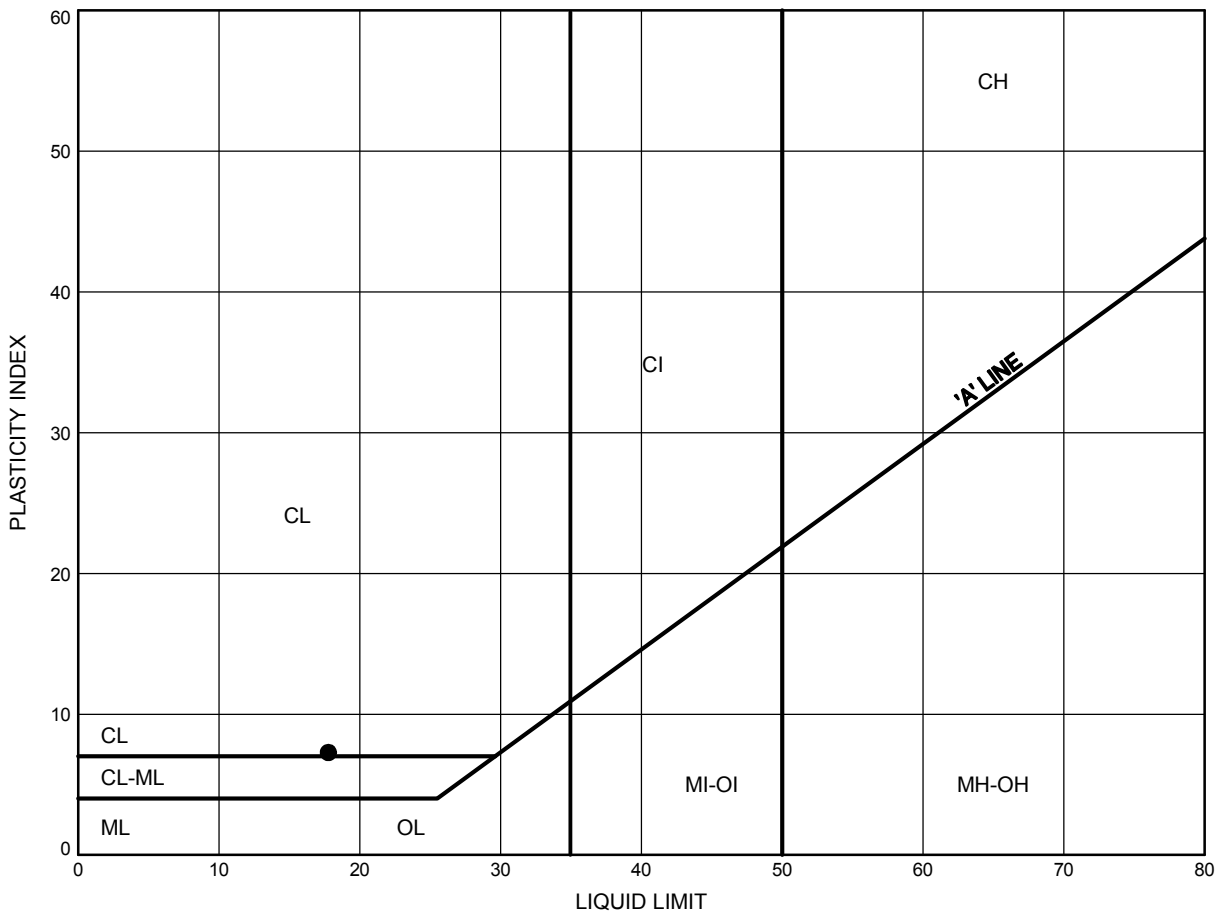
Prep'd MFA

Chkd. SKP

# ATTERBERG LIMITS TEST RESULTS

FIGURE B9

## CLAYEY SILT with SAND



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-04	3.35	110.55

Date January 2014

GWP# 4067-03-00



Prep'd MFA

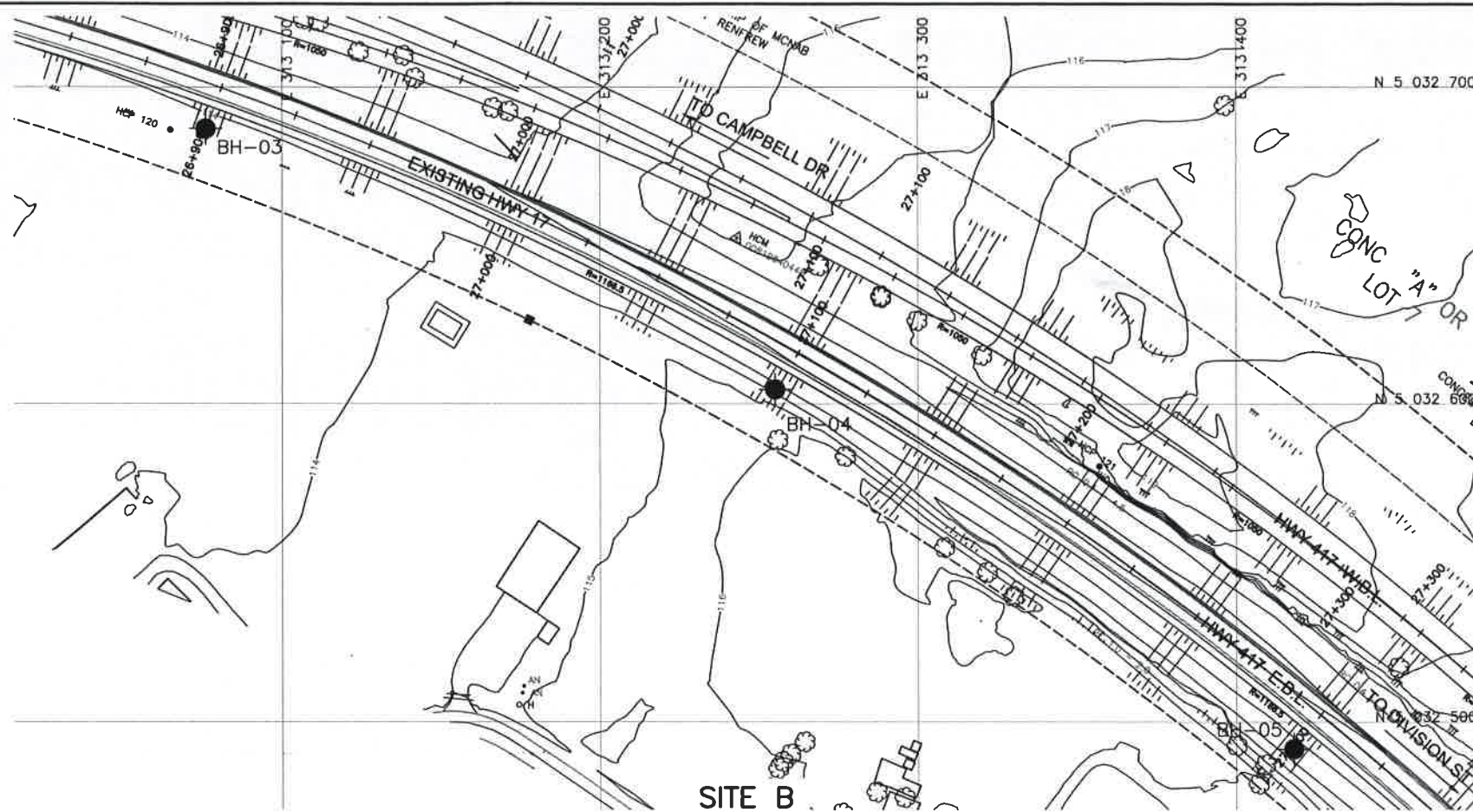
Chkd. SKP



## **Appendix C**

### **Borehole Locations Drawing**

19-1351-242



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

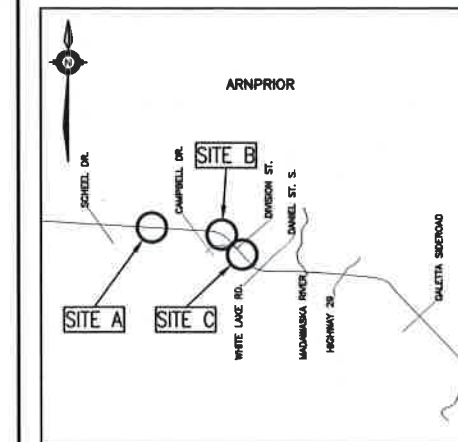


CONT No  
GWP No 4067-03-00

HIGHWAY 417 TWINNING  
ADDITIONAL GROUND MOUNTED SIGNS  
SCHEEL DR TO DIVISION ST  
BOREHOLE LOCATIONS PLAN



SHEET



# KEYPLAN LEGEND

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

NO	ELEVATION	NORTHING	EASTING
BH-01	125.8	5 032 927.4	310 093.7
BH-02	125.0	5 032 914.2	310 293.0
BH-03	113.2	5 032 686.9	313 076.0
BH-04	113.9	5 032 604.6	313 255.0
BH-05	113.5	5 032 491.5	313 418.1
BH-06	109.5	5 032 106.3	313 874.4
BH-07	108.4	5 031 958.2	314 008.6

## -NOTES-

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

GEOCRES No. 31F-183

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	LPG	CHK SKP	CODE
DRAWN	MFA	CHK PKC	SITE
		STRUCT	DWG 1
			DATE JAN. 2014