



# MERLEX ENGINEERING LTD.

CONSULTING GEOTECHNICAL ENGINEERS

**FINAL  
FOUNDATION INVESTIGATION REPORT  
SITE A  
CULVERT STATION 18+075 – TWP. OF SPRINGER  
GWP 5106-06-00**

**Highway 64, From 1.8 km North  
of Highway 17, Sturgeon Falls  
North Limit, Northerly 19.4 km**

MEL Ref. No.: 08/12/08180A

November 24, 2009

Submitted to:

AECOM Canada Ltd.  
189 Wyld Street  
North Bay, Ontario  
P1B 1Z2

**Geocres No. 31L-134**





## 1.0 INTRODUCTION

Merlex Engineering Ltd. (MEL) has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation at a culvert located at Station 18+075, Township of Springer. GWP 5106-06-00 on Highway 64 passes through parts of the Townships of Springer and Field. The project is located from 1.8 km north of Highway 17, Station 11+660 in Springer Township (LHRS 34380 - o/s 1.8) northerly a distance of 19.4 km to Station 21+165 in Field Township (LHRS 34390 - o/s 11.0). The chainage equation between the two townships is Station 20+087.427 Springer Township = Station 10+000 Field Township. This project involves the replacement of a single 1.5 m diameter CSP culvert in a 4.5 m high embankment, at Station 18+085 Township of Springer.

The foundation investigation location was specified by the MTO in the RFP/TPM documentation Agreement No. 5007-E-0061. The terms of reference for the scope of work are outlined in MEL's proposal P-08-078, dated July 2008. The purpose of the investigation was to determine the subsurface conditions in the area of the culvert and along a possible detour route to the east of the embankment. MEL investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

## 2.0 SITE DESCRIPTION

The CSP culvert is located on Highway 64, approximately 8.1 km north of Highway 17. The topography at the site is generally of moderate relief and the direction of flow in the culvert is from west to east. The existing highway embankment supports two undivided lanes of highway, running in a north south direction. The existing road embankment is some 4.5 m higher than the grade level to the west and east sides of the road.



The embankment , at the culvert location, crosses a relatively large wetland area and the culvert acts as an equalizer allowing flow from the west to east (left to right) (see Photo No. 1, Appendix C).

## **2.1 Site Physiography and Surficial Geology**

This Highway 64 project falls within the limits of the geomorphic sub-province known as the Eastern Sandy Uplands, skirted by the east edge of the North Shore - Sudbury Ridges and Pockets. The topography at the site is generally rolling. There are exposed bedrock ridges. At many locations, significant layers of earth overlay the bedrock. Within the project area the overburden conditions consist primarily of earth containing varying amounts of silt and clay.

Bedrock in the area is of the Late to Middle Precambrian Era. The southern part of the project area comprises of Felsic Igneous rocks (granitic rocks) whereas towards the northern part of the project area the rocks are Metasediments comprising of conglomerates, chert and iron formation.

## **3.0 INVESTIGATION PROCEDURES**

The field work for this investigation was carried out during the period of March 5 and 6, 2009, when boreholes along the detour and at the culvert ends were advanced, and July 21 and 22, 2009 and consisted of a total of eleven (11) sampled boreholes.

The field investigation was carried out using a Bombardier mounted CME 45B drilling rig equipped with hollow stem augers, standard augers, and routine geotechnical sampling equipment. Soil samples were obtained at regular intervals of depth using the standard 50 mm



O.D. split spoon sampler advanced in accordance with the Standard Penetration Test (SPT) procedures at the borehole locations.

Groundwater conditions in the open boreholes were observed during and immediately following completion of the individual boreholes. All open boreholes were backfilled upon completion with compacted auger cuttings, in the general order they were removed and, where necessary, additional granular backfill was added to the boreholes to bring them up to grade. At the borehole through the embankment, the upper portion of the hole, where necessary, was backfilled with a cold patch to seal the existing asphalt surface.

The field work for this investigation was under the full time direction of a senior member of our engineering staff, who was responsible for locating the boreholes, clearing the borehole locations of underground services, in-situ sampling and testing operations, logging of the boreholes, labeling and preparation of samples for transport to our North Bay laboratory, plus overall drill supervision. All samples received a visual confirmatory inspection in our laboratory. Laboratory testing of select samples included routine testing for natural moisture content determination and particle size analysis. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix B), with a summary of results presented on the laboratory sheets in Appendix C (Figures L-1 to L-2).

The location of the individual boreholes were determined in the field using highway chainage (established by others) and offset relative to highway centerline. Elevations contained in this report are referenced to a geodetic datum.



#### **4.0 SUBSURFACE CONDITIONS**

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Record of Borehole Logs (Appendix B) and on Figure No. A-1 (Appendix C). Please note that stratigraphic delineation presented on the borehole logs and soil strata plot are the results of non-continuous sampling, response to drilling progress, the results of SPT and Dynamic Cone Penetration Test (DCPT) plus field observations. Typically such boundaries represent transitions from one zone to another and are not an exact demarcation of specific geological unit. Additional consideration should be given to the fact that subsurface conditions may vary markedly between adjacent boreholes and beyond any specific boring location, and are shown on the drawings for design purposes only.

#### **4.1 Culvert, Station 18+075, Township of Springer- SITE A**

A plan and profile showing the borehole locations and stratigraphic sequences is shown on Figure No. A-1, Appendix C. During the course of the exploration program, eleven (11) sampled boreholes were put down at this site, with Borehole Nos. A9, A10, and A11 advanced from the surface of the existing highway embankment. Borehole Nos. A1 and A2 were advanced at the west and east ends of the existing culvert respectively. Borehole Nos. A3, A4, A5, A6, A7, and A8 were advanced east of the existing embankment for a possible detour.

At the culvert inlet and outlet, Borehole Nos. A1 and A2 respectively, a 300 to 500 mm thick deposit of black fibrous organics with some fine sand was penetrated. At Borehole No A1 this deposit was underlain by a dark grey sand with some gravel. A typical gradation curve of the portion of sand which was retained in the split spoon sampler (37 mm inside diameter) is found on Figure L-1 and indicates 28% gravel size particles, 68% sand size particles and 6 to 8% silt



and clay size particles. Based on the SPT value of 57 blows per 300 mm penetration, the compactness of the sand was described as very dense.

Borehole Nos. A9, A10, and A11 were advanced through the existing embankment. Underlying the pavement structure, which consisted of from 60 to 70 mm of asphalt and 170 to 250 mm of crushed gravel, a deposit of sand backfill with silt and some cobbles at depth was penetrated. Typical gradation curves of the portion of embankment fill which was retained in the split spoon sampler (37 mm inside diameter) are found on Figure L-2 and indicate 16 to 19% gravel size particles, 59 to 61% sand size particles, 17 to 25% silt size particles and 3 to 4% clay size particles. Based on the SPT values, which ranged from 14 to 62 blows per 300 mm penetration, the compactness of the embankment fill was described as compact to very dense. This deposit extended to the depth at which the boreholes were terminated on auger refusal and refusal on the DCPT, at depths of 3.7 m at Borehole Nos. A10 and A11. At Borehole No. A9 the embankment fill was underlain by a deposit of grey sands, some gravel and trace of silt, occasional cobble. This native deposit exhibited a till structure and based on the similarities with this deposit at Borehole No. A1 and resistance to drilling, the compactness of this deposit was considered as dense to very dense. Auger refusal was met in this deposit at a depth of 5.9 m below grade. It is considered that based on the drill reaction to further auger advance, the results of the shallow refusal of the boreholes advanced for the detour to the east and presence of exposed bedrock along the toe of the embankment, this auger refusal was probably due to the presence of bedrock at the borings advanced through the embankment.

Borehole Nos. A3, A4, A5, A6, A7, and A8 were advanced along the east toe of slope for a possible detour alignment. There is bedrock exposed along this alignment, as can be seen on the Borehole Location Plan, Figure A-1, however the bedrock was covered with 300 to 500 mm



of snow at the time the borings were advanced. Refusal to further auger penetration was encountered at shallow depths varying between 0 and 0.6 m below existing grade at all borehole locations with the exception of Borehole No. A3. At Borehole No. A3 a deposit of black fine fibrous organics was penetrated to a depth of 1.2 m below ground surface. The natural moisture content of the deposit was in the order of 70% and the SPT returned a value of 12 blows per 300 mm penetration indicating the deposit was in a compressed state. Underlying the peat, a deposit grey sand with some gravel and silt was penetrated to a depth of 2.2 m below ground surface where auger refusal was met, probably on bedrock.

#### **4.2 Groundwater Conditions**

Groundwater and cave-in levels in the open boreholes were taken during the advance of the individual borings and upon completion. These levels were recorded on the individual Record of Borehole Log Sheets (Appendix B). All boreholes were dry upon completion along the east toe of slope, where the boreholes met shallow refusal at depths varying between 0 to 0.6 m below grade. At Borehole No. A3 the water level was at a depth of 0.3 m below grade at the top of the peat layer. At Borehole Nos. A1 and A2 (inlet and outlet), the water level was recorded at the top of ice upon completion. At the boreholes advanced through the embankment, the water level/cave-in level was recorded at depths varying between 2.9 to 3.5 m below the top of the embankment. These groundwater levels will fluctuate seasonally.

#### **MERLEX ENGINEERING LTD.**

M. A. Merleau, P. Eng.  
Principal

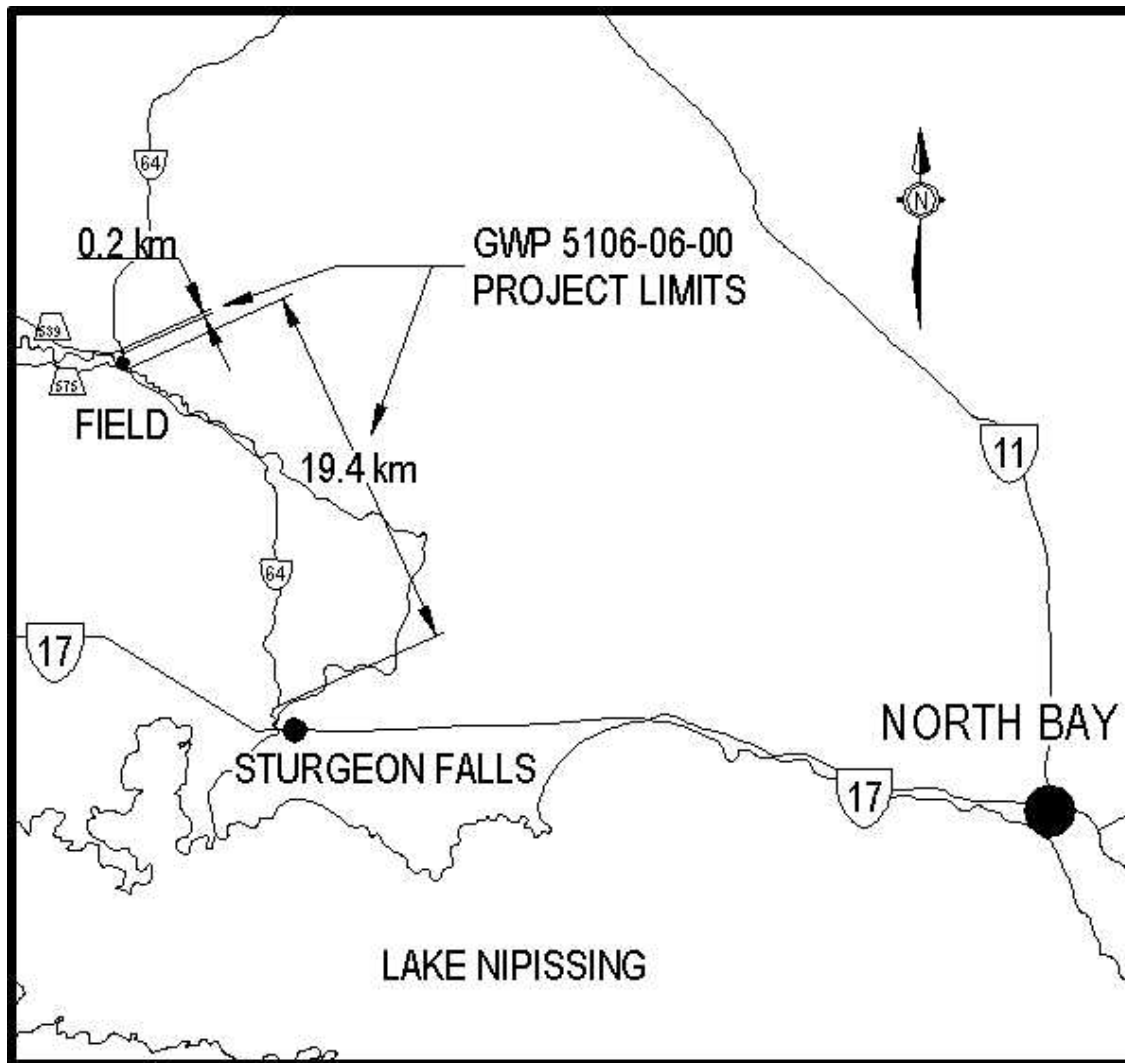
J. R. Berghamer, P. Eng.  
Project Engineer

## **APPENDIX A**

Figure No. 1: Key Plan

# KEY PLAN

NOT TO SCALE



**FINAL  
FOUNDATION INVESTIGATION REPORT**

**SITE A – CULVERT STATION 18+075  
GWP 5106-06-00**

Highway 64, From 1.8 km N of Highway 17,  
Sturgeon Falls North Limit, Northerly 19.4 km

MEL Ref. No.: 08/12/08180A      November 2009



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## **APPENDIX B**

Enclosure No. 1: List of Abbreviations and Symbols

Enclosure Nos. 2 to 12: Record of Borehole Sheets



## LIST OF ABBREVIATIONS & DESCRIPTION OF TERMS

The abbreviations and terms, used to describe retrieved samples and commonly employed on the borehole logs, on the figures and in the report are as follows:

### 1. ABBREVIATIONS

AS	Auger Sample
CS	Chunk Sample
DS	Denison type sample
FS	Foil Sample
HB	Hammer Bouncing
NFP	No Further Progress
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
RC	Rock core with size & percentage of recovery
SS	Split Spoon
ST	Slotted Tube
TO	Thin-walled, open
TP	Thin-walled, piston
WH	Sampler Advanced by static weight (weight of hammer and/or rods)
WS	Wash Sample

### 2. PENETRATION RESISTANCE/"N"

*Dynamic Cone Penetration Test (DCPT):*

A continuous profile showing the number of blows for each 300 mm of penetration of a 50 mm diameter 90° point cone driven by a 63 kg hammer falling 760 mm.

Plotted as 

*Standard Penetration Test (SPT) or "N" Values*

The number of blows of a 63 kg hammer falling 760 mm required to advance a 50 mm O.D. drive open sampler 300 mm.

### 3. SOIL DESCRIPTION

a) *Cohesionless Soils:*

"N" (blows/0.3 m)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

### 3. SOIL DESCRIPTION (Cont'd)

b) *Cohesive Soils:*

Undrained Shear Strength (kPa)	Consistency
Less than 12	very soft
12 to 25	soft
25 to 50	firm
50 to 100	stiff
100 to 200	very stiff
over 200	hard

c) *Method of Determination of Undrained Shear Strength of Cohesive Soils:*

+ 3.2 - Field Vane test in borehole.  
The number denotes the sensitivity to remoulding.

D - Laboratory Vane Test

.. - Compression test in laboratory

For a saturated cohesive soil the undrained shear strength is taken as one-half of the undrained compressive strength.

### 4. TERMINOLOGY

Terminology used for describing soil strata is based on the proportion of individual particle sizes present in the samples (please note that, with the exception of those samples subject to a grain-size analysis, all samples were classified visually and the accuracy of visual examination is not sufficient to determine exact grain sizing):

Trace, or occasional	Less than 10%
Some	10 to 20%
With	20 to 30%
Adjective (i.e. silty or sandy)	30 to 40%
And (i.e. sand and gravel)	40 to 60%

### 5. LABORATORY TESTS

P	Standard Proctor Test
A	Atterberg Limit Test
GS	Grain Size Analysis
H	Hydrometer Analysis
C	Consolidation



**SAMPLE DESCRIPTION NOTES:**

1. **FILL:** The term fill is used to designate all man-made deposits of natural soil and/or waste materials. The reader is cautioned that fill materials can be very heterogeneous in nature and variable in depth, density and degree of compaction. Fill materials can be expected to contain organics, waste materials, construction materials, shot rock, rip-rap, and/or larger obstructions such as boulders, concrete foundations, slabs, abandoned tanks, etc.; none of which may have been encountered in the borehole. The description of the material penetrated in the borehole therefore may not be applicable as a general description of the fill material on the site as boreholes cannot accurately define the nature of fill material. During the boring and sampling process, retrieved samples may have certain characteristics that identify them as 'fill'. Fill materials (or possible fill materials) will be designated on the Borehole Logs. If fill material is identified on the site, it is highly recommended that testpits be put down to delineate the nature of the fill material. However, even through the use of testpits defining the true nature and composition of the fill material cannot be guaranteed. Fill deposits often contain pockets or seams of organics, organically contaminated soils or other deleterious material that can cause settlement or result in the production of methane gas. It should be noted that the origins and history of fill material is frequently very vague or non-existent. Often fill material may be contaminated beyond environmental guidelines and the material will have to be disposed of at a designated site (i.e. registered landfill). Unless requested or stated otherwise in this report, fill material on this site has not been tested for contaminants however, environmental testing of the fill material can be carried out at your request. Detection of underground storage tanks cannot be determined with conventional geotechnical procedures.
2. **TILL:** The term till indicates a material that is an unstratified, glacial deposit, heterogeneous in nature and, as such, may consist of mixtures and pockets of clay, silt, sand, gravel, cobbles and/or boulders. These heterogeneous deposits originate from a geological process associated with glaciation. It must be noted that due to the highly heterogeneous nature of till deposits, the description of the deposit on the borehole log may only be applicable to a very limited area and therefore, caution must be exercised when dealing with a till deposit. When excavating in till, contractors may encounter cobbles/boulders or possibly bedrock even if they are not indicated on the borehole logs. It must be appreciated that conventional geotechnical sampling equipment does not identify the nature or size of any obstruction.
3. **BEDROCK:** Auger refusal may be due to the presence of bedrock, but possibly could also be due to the presence of very dense underlying deposits, boulders or other large obstructions. Auger refusal is defined as the point at which an auger can no longer be practically advanced. It must be appreciated that conventional geotechnical sampling equipment does not differentiate between nature and size of obstructions that prevent further penetration of the boring below grade. Bedrock indicated on the borehole logs will be labeled 'possibly' or 'probable' etc. based on the response of the boring and sampling equipment, surrounding topography, etc. Bedrock can be proven at individual borehole locations, at your request, by diamond core drilling operations or, possibly, by testpits. It must also be appreciated that bedrock surfaces can be, and most times are, very erratic in nature (i.e. sheer drops, isolated rock knobs, etc.) and caution must be used when interpreting subsurface conditions between boreholes. A bedrock profile can be more accurately estimated, at the clients' request, through a series of closely positioned unsampled auger probes combined with core drilling.
4. **GROUNDWATER:** Although the groundwater table may have been encountered during this investigation and the elevation noted in the report and/or on the record of boreholes, it must be appreciated that the elevation of the groundwater table will fluctuate based upon seasonal conditions, localized changes, erratic changes in the underlying soil profile between boreholes, underlying soil layers with highly variable permeabilities, etc. These conditions may affect the design and type and nature of dewatering procedures. Cave-in levels recorded in borings give a general indication of the groundwater level in cohesionless soils however, it must be noted that cave-in levels may also be due to the relative density of the deposit, drilling operations etc.

**METRIC**

**RECORD OF BOREHOLE NO. A1**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 March 5 TIME 10:30:00 AM CHECKED BY MAM  
 DATE (Completed) 2009 March 5

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
252.5 0.0	Ice Surface ±300 mm Ice														
252.2 0.3	±300 mm black organics trace sand		1	AS											
251.9 0.6	SANDS - dark grey sands some gravel, trace of silt (till structure)  (very dense)		2	SS	57									28 64 (8)	
251.3 1.2	Auger Refusal DCPT Refusal Probably Bedrock End of Borehole  Note: 1) Advanced auger probe 2m S. of Borehole. Auger refusal @ 1.1m depth 2) DCPT advanced 2m W. of Borehole. Refusal 1.2m depth														

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa  
 ○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS		
Date (yy/mm/dd) Time	Water Depth (m)	Cave In (m)
1) 09/5/3	0	▼ -
2)	-	▼ -
3)	-	▼ -

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. A2**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 March 6 TIME \_\_\_\_\_ CHECKED BY MAM  
 DATE (Completed) 2009 March 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
253.0 0.0	Ice Surface ±300 mm Ice														
252.7 0.3	±500 mm black fibrous organics some sand		1	AS											
252.2 0.8	Auger Refusal DCPT Refusal End of Borehole														

Note:  
 1) Advance auger probe 2m S. of Borehole. Refusal @ 0.9 m depth.  
 2) Advanced hand auger probe at 1m E. of Borehole. Refusal @ 0.8m depth.  
 3) DCPT advanced 1m S. of Borehole. Refusal @ 0.8m depth.

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa  
 ○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS			
Date (yy/mm/dd)Time	Water Depth (m)	Cave In (m)	
1) 09/6/3	0	▽	☒
2)	-	▽	-
3)	-	▽	-

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. A3**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 March 5 TIME 12:55:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 March 5

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
253.4 0.0	Ground Surface ±300 mm snow and ice cover													
253.1 0.3	ORGANICS - Black fine fibrous organics (peat) with occasional cobbles		1	AS		253								
			2	SS	12									
251.9 1.5	SANDS - grey fine sands some silt and gravel		3	SS	87									
251.2 2.2	Auger Refusal DCPT Refusal Probably Bedrock End of Borehole													

COMMENTS	+ <sup>3</sup> , × <sup>3</sup> : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE	WATER LEVEL RECORDS		
		Date (yy/mm/dd)Time	Water Depth (m)	Cave In (m)
		1)	0.3	▽

The stratification lines represent approximate boundaries. The transition may be gradual.

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. A4**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 March 6 TIME 10:00:00 AM CHECKED BY MAM  
 DATE (Completed) 2009 March 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
254.9 0.0	Ground Surface ±50 mm sandy organics/topsoil  SANDS - brown fine sand with silt		1	AS											
254.3 0.6	Auger Refusal DCPT Refusal Probably Bedrock End of Borehole  Note: 1) Advanced auger probe 3m S. of Borehole. Auger refusal @ 0.7m depth. 2) Advanced auger probe 1m N. of Borehole. Auger refusal @ 0.6m depth.						254								

COMMENTS

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa  
 ○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS		
Date (yy/mm/dd) Time	Water Depth (m)	Cave In (m)
1) 09/6/3	DRY	▼ -
2)	-	▼ -
3)	-	▼ -

The stratification lines represent approximate boundaries. The transition may be gradual.

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**MERLEX ENGINEERING LTD.**

**METRIC**

**RECORD OF BOREHOLE NO. A5**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 March 6 TIME 10:30:00 AM CHECKED BY MAM  
 DATE (Completed) 2009 March 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
257.5	Exposed Bedrock Surface																
250.0	Auger Refusal Probably Bedrock End of Borehole																
	Note: 1) Advanced auger probe 3m S. of Borehole. Auger refusal @ 0.05m depth.																

COMMENTS

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa  
 ○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS		
Date (yy/mm/dd)Time	Water Depth (m)	Cave In (m)
1)	-	▽ -
2)	-	▽ -
3)	-	▽ -

The stratification lines represent approximate boundaries. The transition may be gradual.

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. A6**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 March 6 TIME 9:30:00 AM CHECKED BY MAM  
 DATE (Completed) 2009 March 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
254.6	Ground Surface																
254.8	SANDS - fine sands some organics		1	AS													
0.2	Auger Refusal Probably Bedrock						254										
Note: 1) Advanced auger probe 2m N. of Borehole. Auger refusal @ 0.1 m depth.																	

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa  
 ○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS		
Date (yy/mm/dd) Time	Water Depth (m)	Cave In (m)
1)	-	▽
2)	-	▽
3)	-	▽

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. A7**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 March 6 TIME 9:45:00 AM CHECKED BY MAM  
 DATE (Completed) 2009 March 6

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	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
256.7	Ground Surface													
256.6	Black sandy organics		1	AS										
0.1	Auger Refusal Bedrock End of Borehole													
	Note: 1) Advanced auger probe 2m N. of Borehole. Auger refusal @ 0.08m depth. 2) Advanced auger probe 2m S. of Borehole. Auger refusal @ 0.08m depth.													

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa  
 ○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (yy/mm/dd) Time	Water Depth (m)	Cave In (m)
1)	-	▼ -
2)	-	▼ -
3)	-	▼ -

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. A8**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 March 6 TIME 9:50:00 AM CHECKED BY MAM  
 DATE (Completed) 2009 March 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
256.8	Exposed Bedrock Surface																
250.0	Auger Refusal Bedrock																
	Note: 1) Advanced auger probe 2m N. of Borehole. Auger refusal @ 0.1m depth.																

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa  
 ○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS		
Date (yy/mm/dd) Time	Water Depth (m)	Cave In (m)
1)	-	▽ -
2)	-	▽ -
3)	-	▽ -

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT\_09/12/2

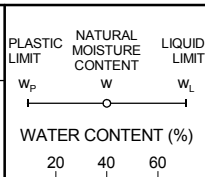
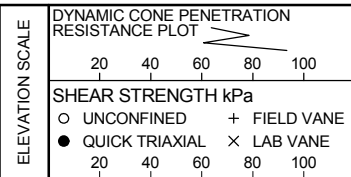
**METRIC**

**RECORD OF BOREHOLE NO. A9**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 21 TIME 9:00:00 AM CHECKED BY MAM  
 DATE (Completed) 2009 July 21

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80
256.6 0.0	Embankment Surface EMBANKMENT FILL		1	AS												
	±60 mm Asphalt ±250 mm Crushed Gravel		2	SS												
	SANDS- brown fine sands with gravel trace of silt		3	SS	33											
	higher silt content occasional cobbles with depth		4	SS	18											
			5	SS	7											
252.6 4.0	DCPT Refusal															
252.0 4.6	SANDS - Grey medium sands, some gravel trace silt occasional cobble (till structure)  (Dense)		6	SS	10/0"											
			7	AS												
250.7 5.9	Auger Refusal Probably Bedrock															



COMMENTS	+ <sup>3</sup> , × <sup>3</sup> : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE	WATER LEVEL RECORDS		
		Date (yy/mm/dd)Time	Water Depth (m)	Cave In (m)
		1) 09/7/21 11:30:00 AM	3.5	4.5
		-	-	
		-	-	

The stratification lines represent approximate boundaries. The transition may be gradual.

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MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. A10**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 21 TIME 2:10:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 July 21

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80
256.6 0.0	Embankment Surface EMBANKMENT FILL		1	AS												
	±70 mm Asphalt ±200 mm Crushed Gravel		2	SS	18											
	SANDS - Brown fine sands with silt and gravel  (compact)		3	SS	15											
	Occasional pockets coarse sand also dark brown silt pockets		4	SS	10/0"											
254.0 2.6	occasional cobbles DCPT Refusal		5	SS	14											19 61 17 3
252.9 3.7	Auger Refusal Possibly Bedrock															

WATER LEVEL RECORDS		
Date (yy/mm/dd)Time	Water Depth (m)	Cave In (m)
1) 09/7/21 2:15:00 PM	DRY	3.4
2)	-	-
3)	-	-

COMMENTS

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

The stratification lines represent approximate boundaries. The transition may be gradual.

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

**METRIC**

**RECORD OF BOREHOLE NO. A11**



REFERENCE 08/12/08180-A DATUM Geodetic LOCATION Springer Twp - Culvert Sta. 18+075 - Site A ORIGINATED BY JL  
 PROJECT Hwy 64 - GWP 5106-06-00 BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG  
 CLIENT AECOM Canada Inc. DATE (Started) 2009 July 21 TIME 3:30:00 PM CHECKED BY MAM  
 DATE (Completed) 2009 July 21

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
256.8 0.0	Embankment Surface EMBANKMENT FILL  ±70 mm Asphalt ±170 mm Crushed Gravel  SANDS - Brown sands some asphalt pieces some silt and gravel  (compact)  Occasional cobbles		1	AS											
			2	SS	62									12	59 25 4
			3	SS	26										
			4	SS	25/1"										
			5	SS	21										
253.1 3.7	DCPT Refusal Auger Refusal Probably Bedrock														

MEL-GEO\_08180-FDN - HWY 64.GPJ MEL-GEO.GDT 09/12/2

COMMENTS

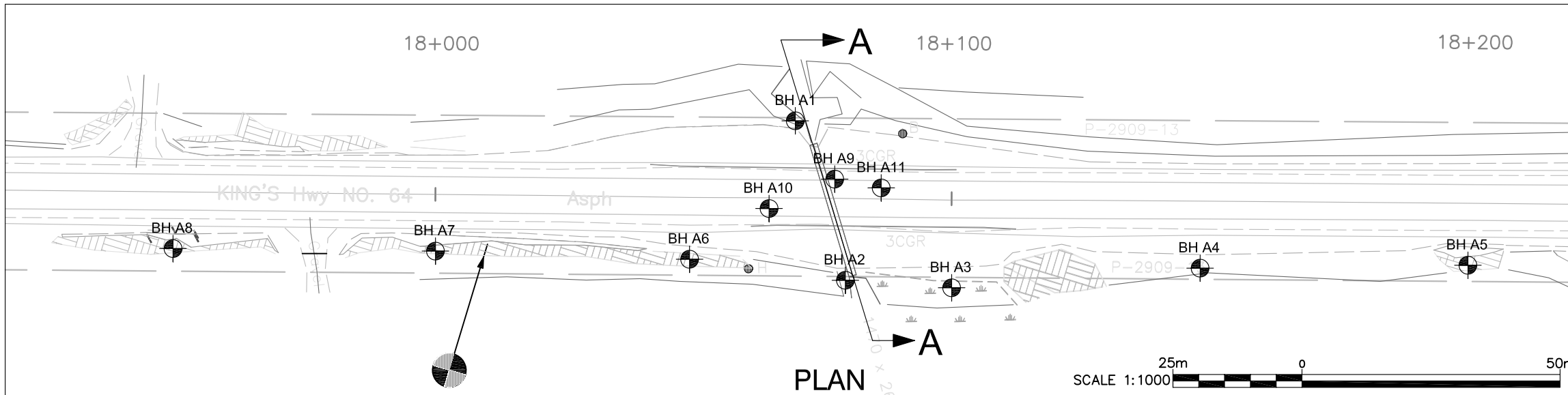
The stratification lines represent approximate boundaries. The transition may be gradual.

+<sup>3</sup>, ×<sup>3</sup>: Numbers on right refer to Sensitivity  
 Numbers on left refer to values greater than 120 kPa  
 ○ 3% STRAIN AT FAILURE

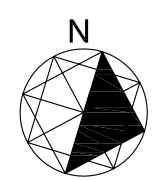
WATER LEVEL RECORDS		
Date (yy/mm/dd) Time	Water Depth (m)	Cave In (m)
1) 09/7/21 3:35:00 PM	DRY	2.9
2)	-	-
3)	-	-

## **APPENDIX C**

Figure A-1	Borehole Locations & Soil Strata
Figure L-1 and L-2	Summary Grain Size Analysis Graph
Enclosure No. 13	Photo Essay



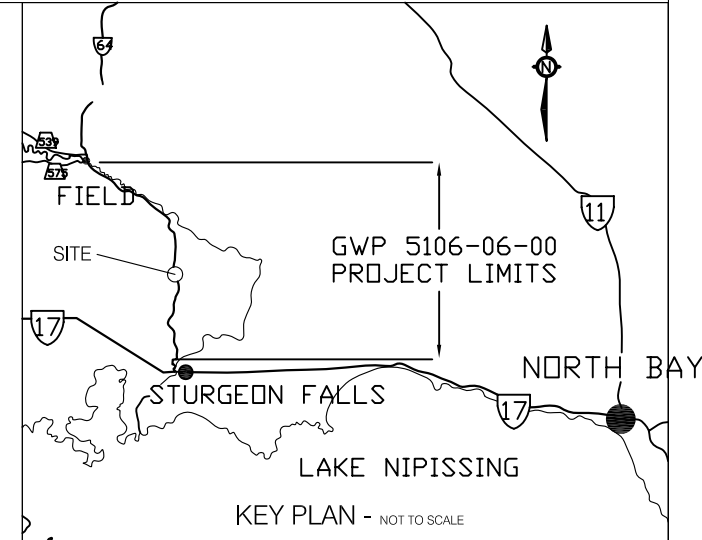
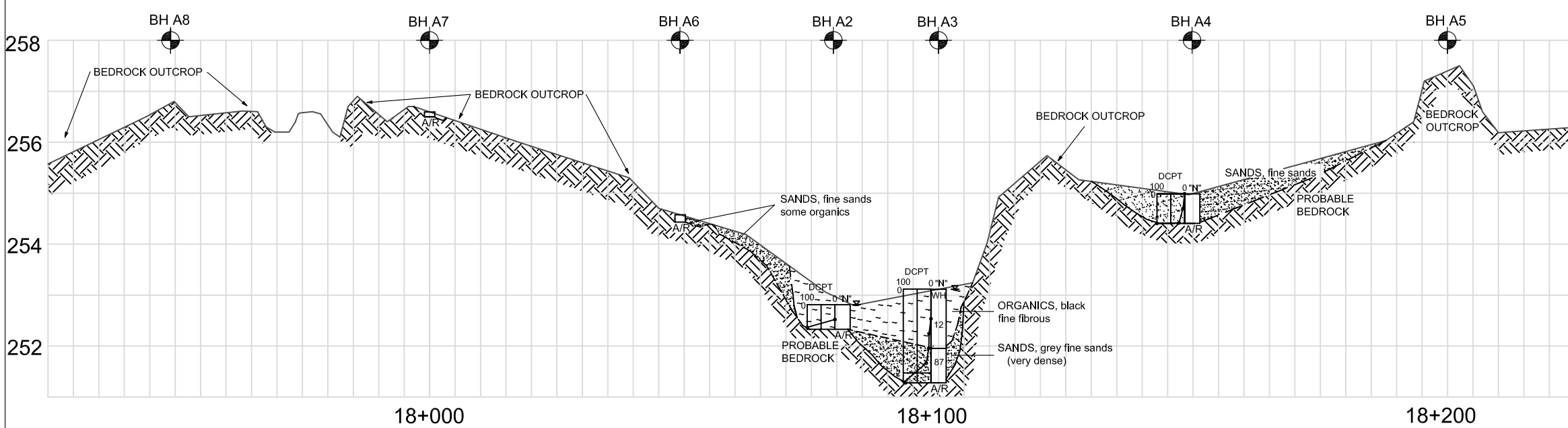
CONT No  
WP No 5106-06-00



HWY 64 Twp. of Springer  
Foundation Area Site A  
Culvert 18+075  
BOREHOLE LOCATIONS & SOIL STRATA

Figure  
A-1

**MERLEX ENGINEERING LTD.**  
Consulting Geotechnical Engineers



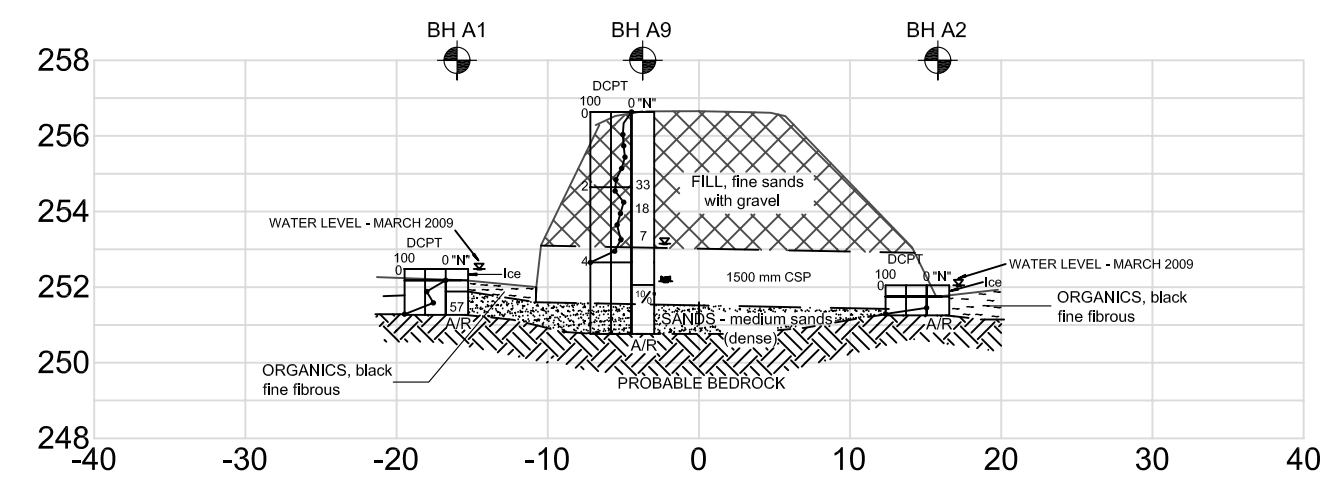
**LEGEND**

- Borehole and Dynamic Cone Penetration Test
- N Blows/0.3 m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3 m (60° Cone, 475 J/blow)
- Water Level at Time of Investigation
- A/R Auger Refusal at Elevation

Borehole No.	Co-ordinates		Elevation
	Station	Offset	
Borehole No. A1	18+073	16m Lt	252.5
Borehole No. A2	18+075	15m Rt	253.0
Borehole No. A3	18+100	17m Rt	252.4
Borehole No. A4	18+150	13m Rt	254.9
Borehole No. A5	18+200	12m Rt	257.5
Borehole No. A6	18+050	12m Rt	254.6
Borehole No. A7	18+000	11m Rt	256.7
Borehole No. A8	17+950	11m Rt	256.4
Borehole No. A9	18+076	3.7m Lt	256.6
Borehole No. A10	18+065	2m Rt	256.6
Borehole No. A11	18+085	2m Lt	256.8

**STRATIGRAPHY LEGEND**

- FILL, SAND
- SANDS
- BEDROCK
- ORGANICS



**NOTE 1:**  
The boundaries between soil strata have been established at the borehole locations only. The boundaries between boreholes are assumed based on borehole data and may vary and are intended for design only.

REVISIONS	DATE	BY	DESCRIPTION
		09/11/19	RG

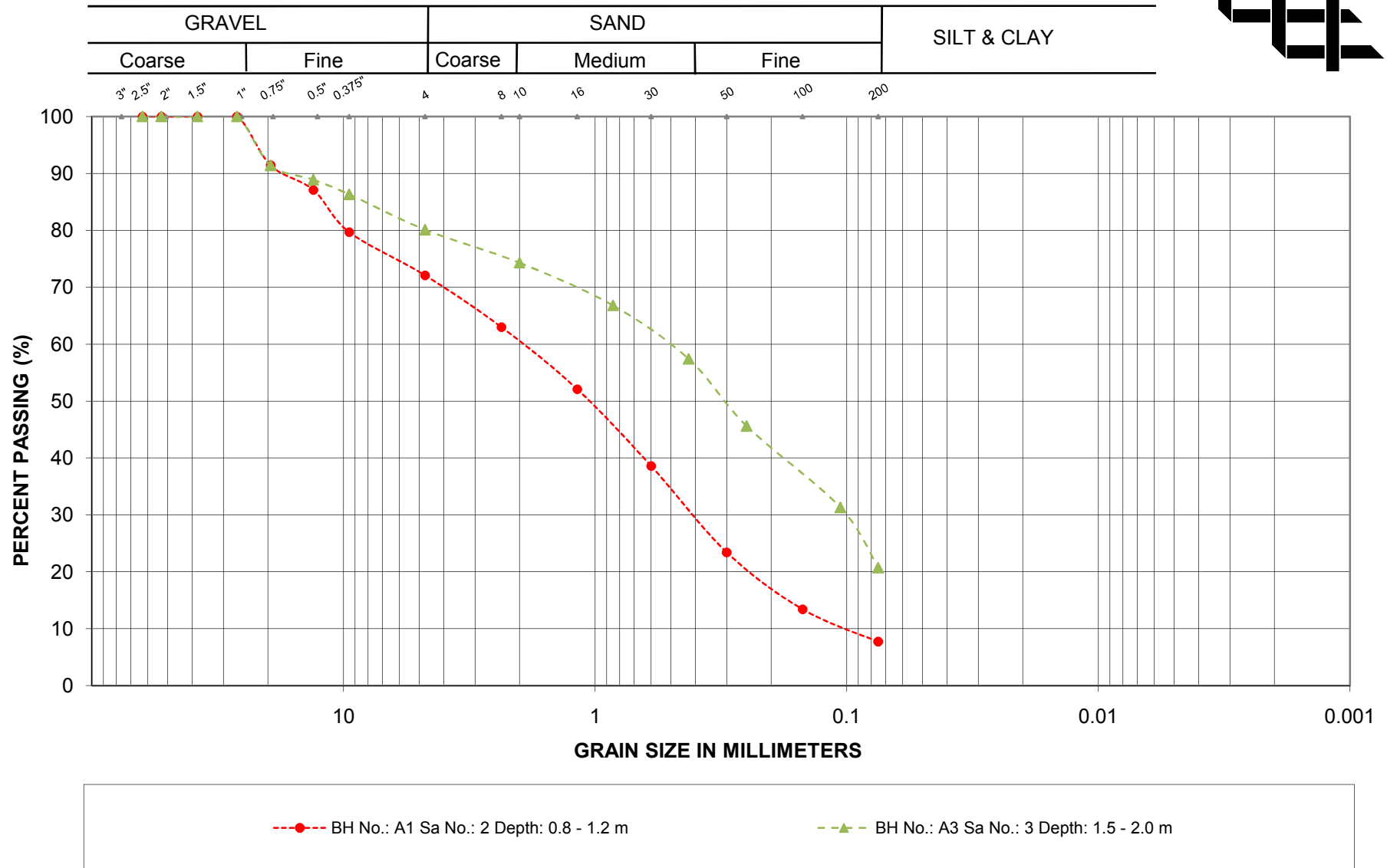
  

HWY No. 64 FOUNDATION SITE A -CULVERT 18+075	DIST
SUBM'D	DATE 00/00/00
DRAWN RG	CHK MAM
	DATE 09/07/31
	FIG A-1

**CROSS SECTION A-A**

SCALE HORT 1:500  
SCALE VERT 1:200

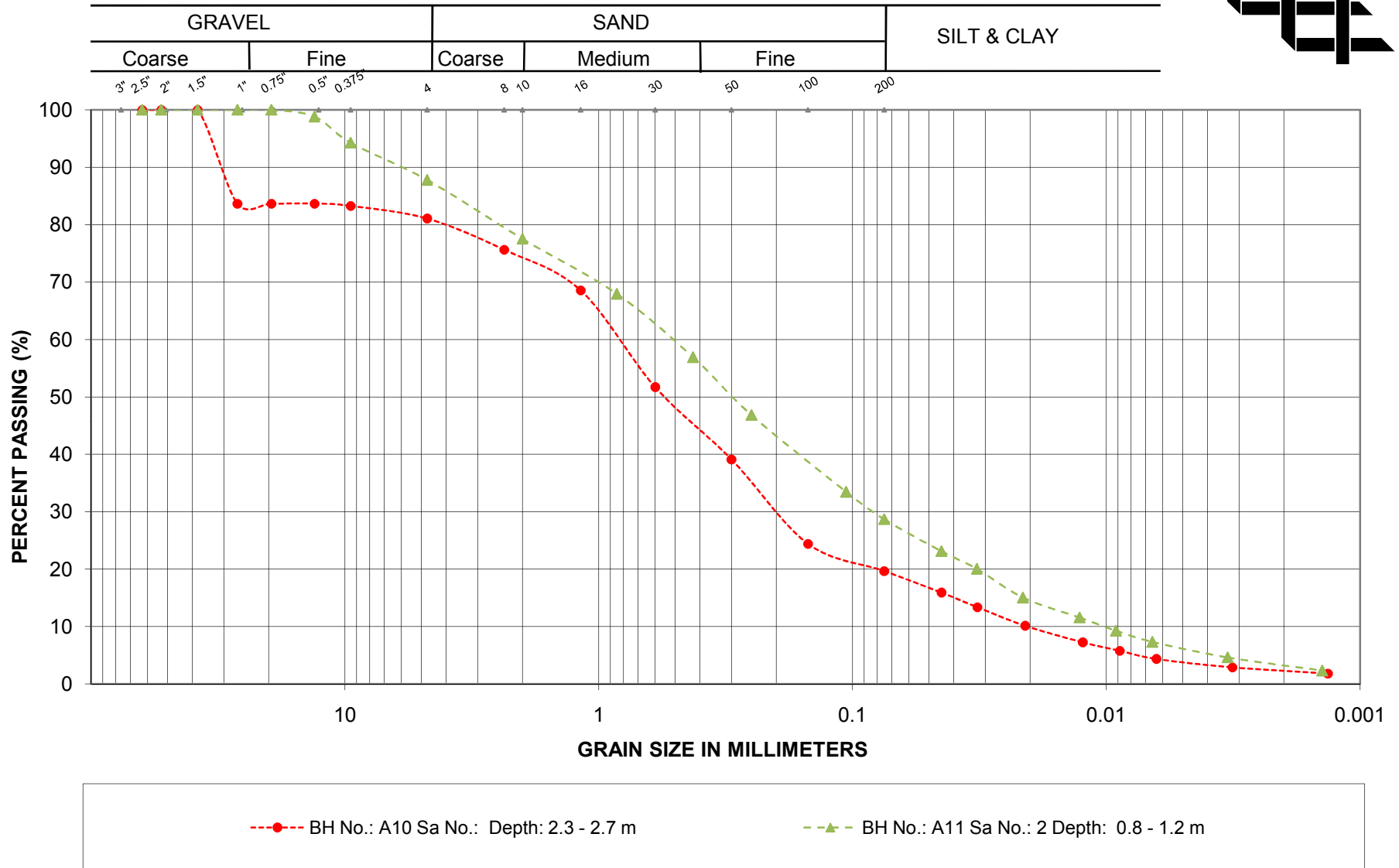
### GRAIN SIZE ANALYSIS



PROJECT: Hwy 64 - GWP 5106-06-00,  
 Culvert Sta. 18+075  
 LOCATION: Twp. of Springer

NATIVE SANDS with gravel trace to some silt

### GRAIN SIZE ANALYSIS



PROJECT: Hwy 64 - GWP 5106-06-00,  
 Culvert Sta. 18+075  
 LOCATION: Twp. of Springer

EMBANKMENT FILL

MERLEX ENGINEERING LTD.

FIGURE L-2



Top: Looking west of the culvert.  
Bottom: Looking east of the culvert.

Photos: 1 - 2



Reference No.: 08/12/08180A

Project: Foundation Investigation and Design Report, Highway 64 from 1.8 km north of Highway 17, Sturgeon Falls north limit, northerly 19.4 km.  
GWP 5106-06-00

Provided By: MEL

Date: August 2009