



# Englobe

Soils Materials Environment

**Submitted to AECOM Canada Ltd.  
189 Wyld Street Suite 103, North Bay, Ontario P1B 1Z2  
On Behalf of the Ontario Ministry of Transportation**

**Culvert Replacement  
Highway 60  
Station 20+754 - Twp. of Airy  
GWP 5264-13-00**

## **FINAL FOUNDATION INVESTIGATION REPORT**

Date: November 2, 2016  
Ref. N°: 15/04/15020-F9

**Geocres No. 31E-373**


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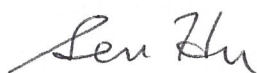
## Final Foundation Investigation Report

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Test results mentioned herein are only valid for the sample(s) stated in this report.

Englobe's subcontractors who may have accomplished work either on site or in laboratory are duly qualified as stated in our Quality Manual's procurement procedure. Should you require any further information, please contact your Project Manager."

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## 1 INTRODUCTION

Englobe Corp. (Englobe), formerly LVM-Merlex, a Division of EnGlobe Corp., has been retained by AECOM Canada Ltd. on behalf of the Ministry of Transportation of Ontario (MTO) to carry out a foundation investigation at an existing centreline culvert site. The site is located at Station 20+754 in the Township of Airy on Highway 60, about 470 m west of Old Highway 127.

The foundation investigation location was specified by the MTO in the Terms of Reference for work under Agreement No. 5014-E-0004: GWP 5264-13-00 for Detailed Design. The terms of reference for the scope of work are outlined in Englobe's Proposal P-14-199-R2, dated January 15, 2015. The purpose of this investigation was to determine the subsurface conditions in the area of the existing culvert for the contract preparation of the Detailed Design package. Englobe investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

## 2 SITE DESCRIPTION

A 1400 mm Corrugated Steel Pipe (CSP) culvert is located on Highway 60 at Station 20+754 in the Township of Airy, Ontario. The topography in the area of this site is generally rolling. The existing highway embankment currently supports two undivided lanes of highway, running in a west-east direction. The existing highway at the culvert location is constructed on a fill embankment approximately 4.9 m in height above the culvert invert (at centreline), with centreline at Elevation 415.1 m at the culvert location. At the north slope, the maximum height of the embankment is approximately 4.5 m above the culvert invert. At the south slope, the maximum height of embankment fill is approximately 5.1 m above the culvert invert. The existing embankment slopes in the area of the culvert have been generally established at an angle of approximately 2H:1V at the north and south slopes. The culvert at this location is a 1400 mm diameter Corrugated Steel Pipe (CSP) culvert, approximate 32.0 m in length. Flow through the culvert is from the north to the south (left to right).

Observed infrastructure at the culvert location includes overhead wires to the south of the highway embankment.

### 2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The topography on this section of Highway 60 is generally rolling. Layers of earth overlie bedrock. Organic materials were also observed in the region. Within the project area, the native overburden consists primarily of tills overlying bedrock.

Bedrock, based on Ontario Geologic Survey (OGS) Map MRD-126, in the area consists of magmatic rocks and gneisses.

### 3 INVESTIGATION PROCEDURES

The fieldwork for this investigation was carried out on December 16<sup>th</sup> to 18<sup>th</sup>, 2015, and April 20<sup>th</sup> to 22<sup>nd</sup>, 2016 during which time four (4) sampled boreholes, were advanced. Two (2) boreholes were advanced through the embankment, and one (1) borehole was advanced adjacent to each inlet (north) and outlet (south) end of the culvert, respectively (total of two (2) inlet and outlet boreholes).

The field investigation was carried out using a truck and a bombardier mounted CME drilling rigs equipped with hollow stem augers, standard augers, casing equipment and routine geotechnical sampling equipment. Soil samples were obtained at the borehole locations 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 (ASTM D-1586). The SPT method involves advancing a 50 mm O.D. split spoon sampler with the force of a 63.5 kg hammer freely dropping 760 mm. The number of blows per 300 mm penetration was recorded as the “N” value. If refusal to further advance of the augers was encountered within the proposed depth of borehole, the boring was advanced through diamond drilling using NQ size coring equipment. All samples taken during this investigation were stored in labeled airtight containers for transport to our North Bay laboratory for visual examination and select laboratory testing.

Groundwater conditions in the open boreholes were observed during the advancement of and immediately following completion of the individual boreholes. A 19 mm diameter standpipe was installed in Borehole Nos. 1 and 4 prior to backfilling to allow for further monitoring of the shallow groundwater levels. All open boreholes were backfilled upon completion with compacted auger cuttings in the same general order in which they were removed, and where necessary, bentonite pellet backfill was added to the boreholes to bring them up to grade in accordance with requirements of Ontario Regulation 903. At the boreholes through the embankment, the upper portion of the hole, where necessary, was backfilled with an asphalt cold patch to seal the existing asphalt surface.

The fieldwork for this investigation was under the full time direction of a senior member of the Englobe engineering staff (Jame Lavigne), 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 the Englobe North Bay laboratory, plus overall drill supervision. All samples received a visual confirmatory inspection in the 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 2), with a summary of results presented on the laboratory sheets in Appendix 3 (Figures Nos. L-1 to L-4 and Table No. L-6).

The location of the individual boreholes was determined in the field using highway chainage established by Callon Dietz Inc. (Callon Dietz) and offsets relative to highway centreline. The MTO co-ordinates, northing and easting, were then established for the boring locations using coordinates from MTM Zone 10, NAD 83 CSRS. The borehole elevations are based on coordinating the borehole locations with the highway survey carried out by Callon Dietz. Elevations contained in this report are referenced to geodetic datum.

## **4 SUBSURFACE CONDITIONS**

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Records of Borehole Logs (Appendix 2) and on Drawing No. 2 (Appendix 3). Please note that the 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, 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 illustration purposes only.

### **4.1 CULVERT STATION 20+754, TWP OF AIRY**

A plan and profile illustrating the borehole locations and stratigraphic sequences is shown on Drawing No. 2, Appendix 3. During the course of the exploration program, four (4) sampled boreholes were put down at this site, with Borehole Nos. 1 and 2 advanced through the embankment, Borehole No. 3 advanced adjacent to the culvert inlet, and Borehole No. 4 advanced adjacent to the culvert outlet. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 4 were recorded at Elevations 414.8, 415.2, 410.9, and 411.7 m, respectively.

#### **4.1.1 Pavement Structure**

Borehole Nos. 1 and 2, were advanced through the embankment. Borehole Nos. 1 and 2 confirmed the pavement structure consisted of 50 to 75 mm asphalt concrete overlying a layer of crushed gravel base/subbase approximately 200 to 250 mm thick. At Borehole No. 1, a layer of old asphalt, approximately 50 mm thick was encountered underlying the crushed gravel base/subbase layer.

#### **4.1.2 Embankment Fill**

Underlying the pavement structure at Borehole Nos. 1 and 2, a layer of embankment fill described as of brown sand and gravel to sand, with to trace gravel, silty to trace silt to sand and silt, trace clay was penetrated. Cobble/boulder sized rock pieces were encountered in the embankment fill layer at Borehole Nos. 1 and 2. The natural moisture content measured for recovered samples from this deposit was generally in the order of 2 to 13%, increasing to a

higher range of 25 to 30% on silty samples encountered near the bottom of embankment. Gradation (sieve) analyses were carried out on four (4) samples of this deposit, and the results indicated 14 to 43% gravel size particles, 46 to 66% sand size particles, and 9 to 26% silt and clay size particles (Figure No. L-1, Appendix 3). Additional gradation (hydrometer) analyses were carried out on two (2) samples recovered near the bottom of this layer, and the results indicated 5 to 8% gravel size particles, 44 to 51% sand size particles, 38 to 48% silt size particles, and 3% clay size particles (Figure No. L-1, Appendix 3). Based on SPT 'N' values of 2 to 34 blows per 300 mm penetration and 58 blows per 152 mm penetration, the relative density/compactness of this deposit was described as very loose to very dense, but generally compact on average. This embankment fill was 5.0 and 5.2 m thick and was encountered to depths of 5.0 and 5.2 m below grade at Borehole Nos. 1 and 2, respectively (Elevations 409.8 and 410.0 m, respectively).

#### 4.1.3 Sand and Gravel Fill

At surface at Borehole No. 4, a layer of fill described as of brown sand and gravel, some silt was penetrated. The natural moisture content measured for recovered samples from this deposit was generally in the order of 10 to 42%. A gradation (sieve) analysis was carried out on one (1) sample of this deposit, and the results indicated 40% gravel size particles, 50% sand size particles, and 10% silt and clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 22 blows per 300 mm penetration and 13 blows per 203 mm penetration, the relative density/compactness of this deposit was described as compact to very dense. This fill layer was 1.4 m thick and was encountered to a depth of 1.4 m below grade at Borehole No. 4 (Elevation 410.3 m).

#### 4.1.4 Organic Soils

At surface at Borehole No. 3, and underlying the sand and gravel fill at Borehole No. 4, a layer of black silty organic top soil to dark silty fibrous peat was encountered. The organic soils were 0.2 and 0.7 m thick and were encountered to depths of 0.2 and 2.1 m below grade at Borehole Nos. 3 and 4, respectively (Elevations 410.7 and 409.6 m, respectively).

#### 4.1.5 Sand and Silt

Underlying the organic soils at Borehole No. 4, a deposit of sand and silt, some gravel, trace clay was penetrated. The natural moisture content measured on a sample of this deposit was in the order of 11%. Gradation (hydrometer) analysis was carried out on one (1) sample of this deposit, and the result indicated 17% gravel size particles, 39% sand size particles, 39% silt size particles, and 5% clay size particles (Figure No. L-3, Appendix 3). Based on a SPT 'N' value of 32 blows per 300 mm penetration, the relative density/compactness of this deposit was described as dense. This deposit was 0.8 m thick and was encountered to a depth of 2.9 m below grade at Borehole No. 4 (Elevation 408.8 m).



#### 4.1.6 Sand

Underlying the embankment fill at Borehole Nos. 1 and 2, underlying the organic soils at Borehole No. 3, and underlying the sand and silt at Borehole No. 4, a deposit of sand, with to trace gravel, with to some silt, trace clay was penetrated. The natural moisture content measured on samples of this deposit was in the order of 9 to 21%. Gradation (sieve) analyses were carried out on two (2) samples of this deposit, the results of which indicated 11 to 14% gravel size particles, 61 to 71% sand size particles, and 15 to 28% silt and clay size particles (Figure No. L-4, Appendix 3). Additional gradation (hydrometer) analyses were carried out on two (2) samples of this deposit, the results of which indicated 10 to 13% gravel size particles, 60 to 62% sand size particles, 23 to 25% silt size particles and 3 to 4% clay size particles (Figure No. L-4, Appendix 3). Based on SPT 'N' values of 7 to 81 blows per 300 mm penetration and 50 blows per 51 mm penetration, the relative density/compactness of this deposit was described as loose to very dense, but generally very dense on average. This deposit was 2.6, 1.3, and 0.9 m thick and was encountered to depths of 7.6, 6.5 and 3.8 m below grade at Borehole Nos. 1, 2 and 4, respectively (Elevations 407.2, 408.7 and 407.9 m, respectively). Sampling encountered practical refusal and was terminated in this deposit at a depth of 9.2 m below grade at Borehole No. 3 (Elevation 401.7 m).

#### 4.1.7 Bedrock

Underlying the sand at Borehole Nos. 1, 2 and 4, bedrock was proven by diamond core drilling. The bedrock was described as black gneiss/pink granite. Based on RQD values of 13 to 92%, the bedrock was described as very poor to excellent quality, generally fair quality. Based on visual review, the bedrock generally showed negligible weathering. Sampling in the bedrock was terminated at depths of 10.7, 9.5, and 6.9 m below grade at Borehole Nos. 1, 2, and 4, respectively (Elevations 404.1, 405.7, and 404.8 m, respectively). Photos of rock cores recovered at Borehole Nos. 1, 2, and 4 are shown in Enclosure No. 6, Appendix 4. It should be noted that, when encountered, the underlying bedrock surfaces in this area can be very erratic in nature, varying substantially in elevation over short horizontal distances.

### 4.2 GROUNDWATER DATA

At the time of this investigation on April 21<sup>st</sup>, 2016, surface water was observed at Elevation 410.8 m at the culvert inlet.

Measurements of the groundwater table and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. A standpipe was installed in Borehole Nos. 1 and 4 to obtain post borehole completion water levels. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix 2).

The groundwater levels were measured at Elevations 410.8 and 410.5 m at Borehole Nos. 1 and 4, respectively. The groundwater level was encountered at Elevations 414.5 and 410.9 m



at Borehole Nos. 3 and 4 upon completion of sampling at the boreholes; however these water levels likely had not stabilized at the time of recording.

The groundwater and surface water levels will fluctuate seasonally/yearly.

## Appendix 1   Key Plan

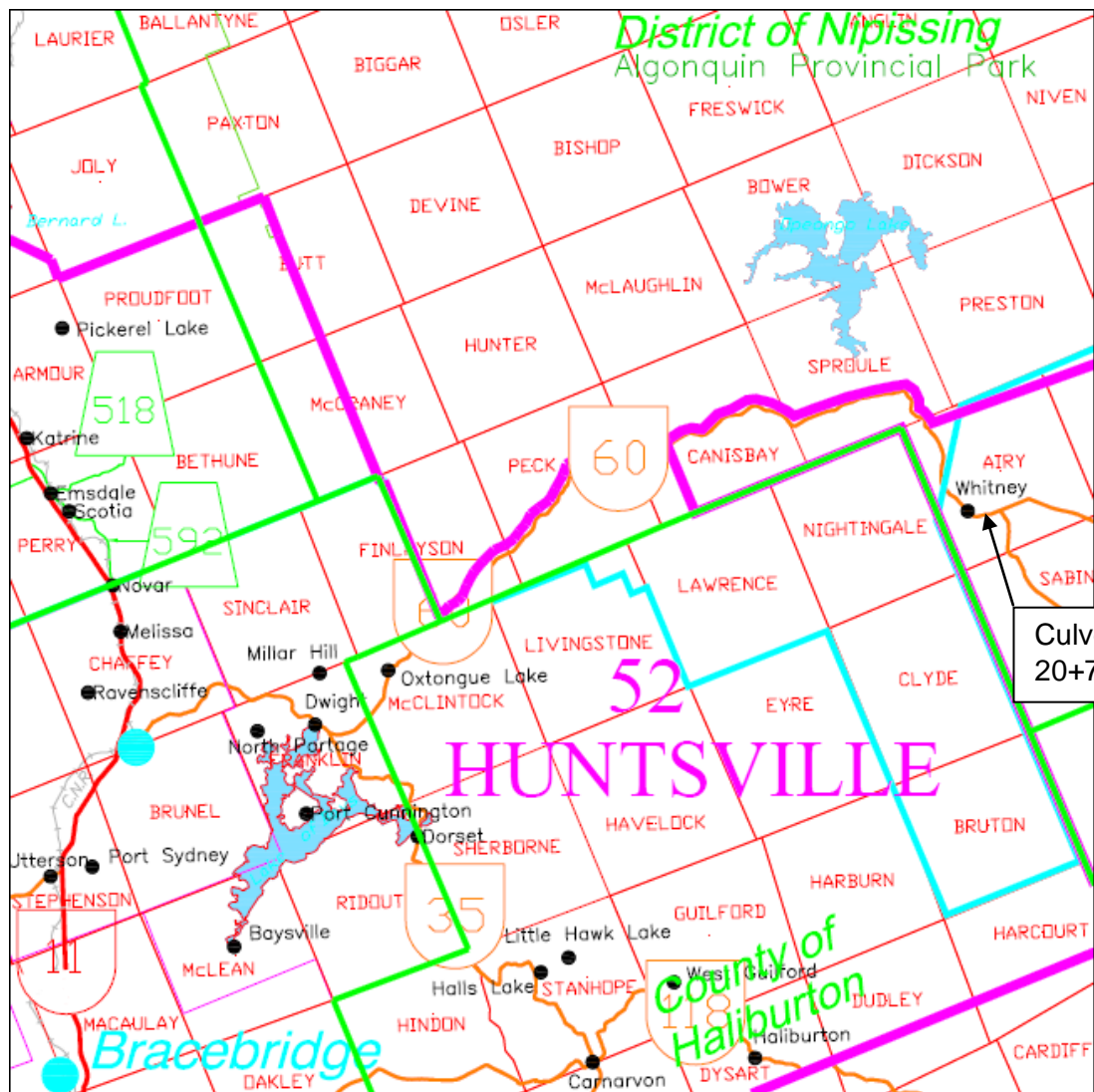
Drawing No. 1

Key Plan

# MACRO KEY PLAN

Drawing No. 1

NOT TO SCALE



## FOUNDATION INVESTIGATION REPORT

GWP 5264-13-00

Highway 60

Station 20+754 Culvert

Township of Airy



Reference No: 15/04/15020-F9

November 2016

## **Appendix 2    Subsurface Data**

Enclosure No. 1	List of Abbreviations and Symbols
Enclosure Nos. 2 to 5	Record of Borehole Sheet

## 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
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
WS	Wash Sample
WH	Sampler advanced by static weight of hammer and/or rods
Rec	% recovery from individual run of rock core
RQD	Rock quality designation (%)

### 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 60° cone attached to AW rod 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

#### 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

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

#### c) Bedrock:

RQD (%)	Classification
Less than 25	Very poor quality
25 to 50	Poor quality
50 to 75	Fair quality
75 to 90	Good quality
90 to 100	Excellent quality

#### d) 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.

#### e) Soil Moisture:

Moisture	Described as
Dry	Below optimum moisture content
Moist	Near optimum moisture content
Wet	Above optimum moisture content

### 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%

Terminology for cobbles and boulders is based on auger response and field observations:

Occasional	Obstructions encountered in borehole, however advance is not impeded
Numerous	Obstructions are essentially continuous over drilled length

**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. 1



REFERENCE 15/04/15020-F9 DATUM Geodetic LOCATION N 5039569.8 E 404317.3 - Airy Twp., Station 20+760 ORIGINATED BY JL  
 PROJECT GWP 5264-13-00, Highway 60 BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY DM  
 CLIENT AECOM DATE (Started) 2015 December 16 TIME  
 DATE (Completed) 2015 December 17 (Completed) CHECKED BY SH

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 (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
414.8	Ground Surface												
0.0	75 mm asphalt 200 mm crushed gravel 50 mm asphalt		1	SS	30								
	EMBANKMENT FILL - sand and gravel to sand, with to trace gravel, silty to trace silt, trace clay		2	SS	37/152 mm								43 46 (11)
	brown		3	SS	15								
	(very dense/loose)		4	SS	4								
			5	SS	17								23 51 (26)
	silty sand, trace gravel		6	SS	6								8 51 38 3
	auger refusal at depths of 4.3 m advanced with casing using wash boring method 735 mm boulder sized rock piece encountered												
409.8	SAND - with to trace gravel, some silt		7	SS	81								
5.0	brown to grey, wet		8	SS	50/76 mm								
	(very dense)												
407.2	Start Rock Coring												
7.6	BEDROCK - black gneiss with thin pink granite		9	RC	REC= 97% ROD= 47%								
	poor to fair quality		10	RC	REC= 98% ROD= 64%								
404.1	End of Sampling												
10.7	End of Borehole												
COMMENTS							+ 3, × 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE						
							WATER LEVEL RECORDS Date (dd/mm/yy)/Time      Water Depth (m)      Cave In (m) 1) 15/12/17 2:30:00 PM      3.7      - 2) 15/12/18 11:10:00 AM      4      - 3)      -      -						

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

Englobe Corp.

120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@englobecorp.com

MEL-GEO 15020 - BOREHOLE LOGS - F9.GPJ MEL-GEO.GDT 16/11/2



## METRIC

## RECORD OF BOREHOLE NO. 2



REFERENCE 15/04/15020-F9 DATUM Geodetic LOCATION N 5039559.7 E 404309.6 - Airy Twp., Station 20+749 ORIGINATED BY JL  
 PROJECT GWP 5264-13-00, Highway 60 BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY DM  
 CLIENT AECOM DATE (Started) 2015 December 18 TIME   
 DATE (Completed) 2016 April 20 (Completed)  CHECKED BY SH

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 (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
415.2	Ground Surface													
0.0	50 mm asphalt 200 mm crushed gravel		1	SS	34									30 61 (9)
	EMBANKMENT FILL - sand, with to some gravel, some to trace silt, trace clay		2	SS	58/152 mm									
	cobble sized rock pieces encountered at depths from 0.5 to 1.5 m													
	brown		3	SS	15									14 66 (20)
	(very dense/very loose)		4	SS	2									
			5	SS	16									
			6	SS	9									
			7	SS	13									5 44 48 3
410.0	sand and silt, trace gravel, trace clay, some decayed wood, some organics, dark grey		8	SS	11									10 62 25 3
5.2	SAND - trace gravel, with silt, trace clay, some decayed wood		9	SS	86/203 mm									
	grey, wet													
	(compact/very dense)													
408.7	Auger Refusal Start Rock Coring		10	RC	REC= 100% RQD= 92%									
6.5	BEDROCK - black gneiss with thin pink granite		11	RC	REC= 100% RQD= 13%									
	excellent to very poor quality jointly													
405.7	End of Sampling End of Borehole													
9.5														

COMMENTS

Borehole advanced to depth of 6.5 m below ground surface on Dec. 18, 2015; returned to site to start rock coring in bedrock on April 20, 2016

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

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

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS		
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 15/12/18 10:55:00 AM	5.5	5.8
2) 16/4/20 2:00:00 PM	0.7	2
3)	-	-

MEL-GEO 15020 - BOREHOLE LOGS - F9.GPJ MEL-GEO.GDT 16/11/2

## METRIC

## RECORD OF BOREHOLE NO. 3



REFERENCE 15/04/15020-F9 DATUM Geodetic LOCATION N 5039581.9 E 404315.2 - Airy Twp., Station 20+760 ORIGINATED BY JL  
 PROJECT GWP 5264-13-00, Highway 60 BOREHOLE TYPE Track Mounted CME 45 - Hollow Stem Augers COMPILED BY DM  
 CLIENT AECOM DATE (Started) 2016 April 21 TIME   
 DATE (Completed) 2016 April 21 (Completed)  CHECKED BY SH

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 (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							WATER CONTENT (%)											
						20	40	60	80	100	20	40	60													
410.9	Ground Surface																									
410.8	150 mm black silty organic soil		1	SS	7																					
0.2	SAND - some gravel, with to some silt, trace clay																									
	brown		2	SS	35									13 60 23 4												
	(loose/very dense)		3	SS	50/427 mm																					
			4	SS	50/402 mm																					
			5	SS	50/427 mm									11 61 (28)												
			6	SS	50/51 mm																					
	auger refusal at depth of 3.8 m advanced with casing using wash boring method		7	SS	50/51 mm																					
			8	SS	50/51 mm																					
			9	SS	50/51 mm									14 71 (15)												
	reddish brown																									
401.7	End of Sampling		10	SS	50/51 mm																					
9.2	End of Borehole																									
COMMENTS						+ 3, × 3 : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa			WATER LEVEL RECORDS																	
						○ 3% STRAIN AT FAILURE			<table border="1"> <thead> <tr> <th>Date (dd/mm/yy)/Time</th> <th>Water Depth (m)</th> <th>Cave In (m)</th> </tr> </thead> <tbody> <tr> <td>1) 16/4/21 4:00:00 PM</td> <td>0</td> <td>3.5</td> </tr> <tr> <td>2)</td> <td>-</td> <td>-</td> </tr> <tr> <td>3)</td> <td>-</td> <td>-</td> </tr> </tbody> </table>						Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)	1) 16/4/21 4:00:00 PM	0	3.5	2)	-	-	3)	-	-
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)																								
1) 16/4/21 4:00:00 PM	0	3.5																								
2)	-	-																								
3)	-	-																								
The stratification lines represent approximate boundaries. The transition may be gradual.																										

MEL-GEO 15020 - BOREHOLE LOGS - F9.GPJ MEL-GEO.GDT 16/11/2

Englobe Corp.

120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@englobecorp.com

**METRIC****RECORD OF BOREHOLE NO. 4**

REFERENCE 15/04/15020-F9 DATUM Geodetic LOCATION N 5039547.7 E 404316.6 - Airy Twp., Station 20+756 ORIGINATED BY JL  
 PROJECT GWP 5264-13-00, Highway 60 BOREHOLE TYPE Track Mounted CME 45 - Hollow Stem Augers COMPILED BY DM  
 CLIENT AECOM DATE (Started) 2016 April 22 TIME   
 DATE (Completed) 2016 April 22 (Completed)  CHECKED BY SH

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 (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40					
411.7	Ground Surface													
0.0	FILL - sand and gravel, some silt, trace grass rootlets brown (compact)		1	SS	13/203 mm									
			2	SS	22									
410.3														
1.4	ORGANIC SOIL - dark fibrous peat, some gravel, silty		3	SS	11									
409.6	(compact)													
2.1	SAND and SILT - some gravel, trace clay		4	SS	32									
408.8	brown													
2.9	(dense)													
	SAND - some gravel, some silt brown (dense)		5	SS	40									
407.9														
3.8	Auger Refusal Start Rock Coring													
	BEDROCK - black gneiss with thin pink granite good to excellent quality		6	RC	REC= 100% ROD= 83%									
			7	RC	REC= 100% ROD= 91%									
404.8														
6.9	End of Sampling End of Borehole													

WATER LEVEL RECORDS	
Date (dd/mm/yy)/Time	Water Depth (m)
1) 16/4/22 9:30:00 AM	2.1
2) 16/4/22 11:30:00 AM	1.2
3)	-

COMMENTS

+ 3, × 3 : 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.

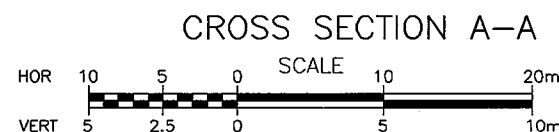
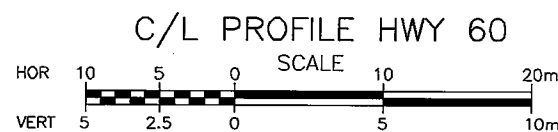
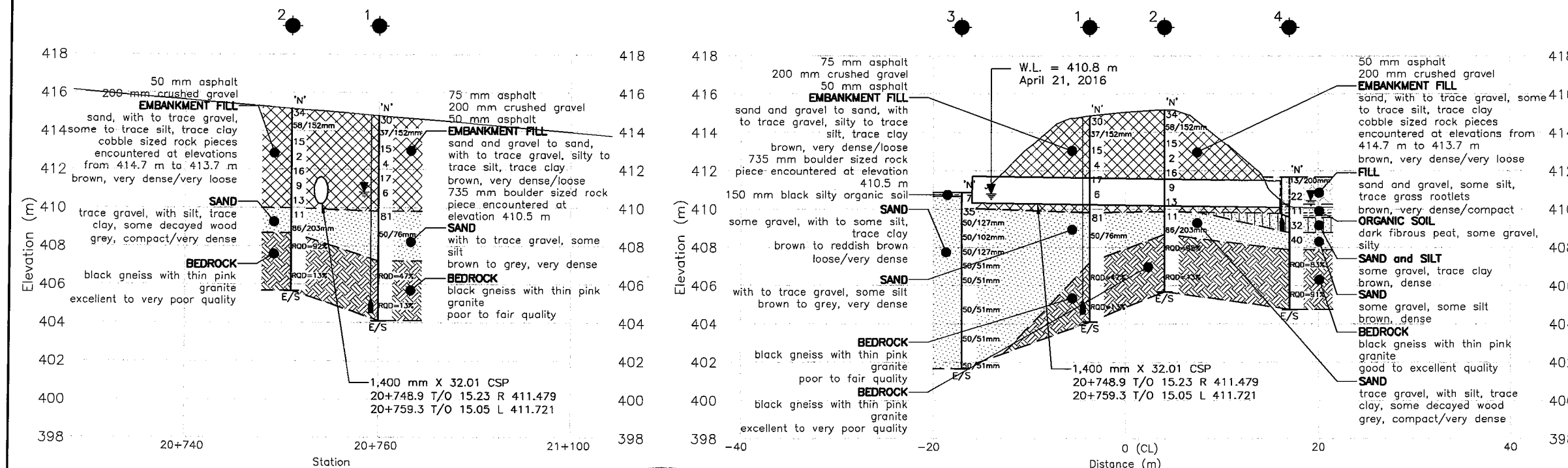
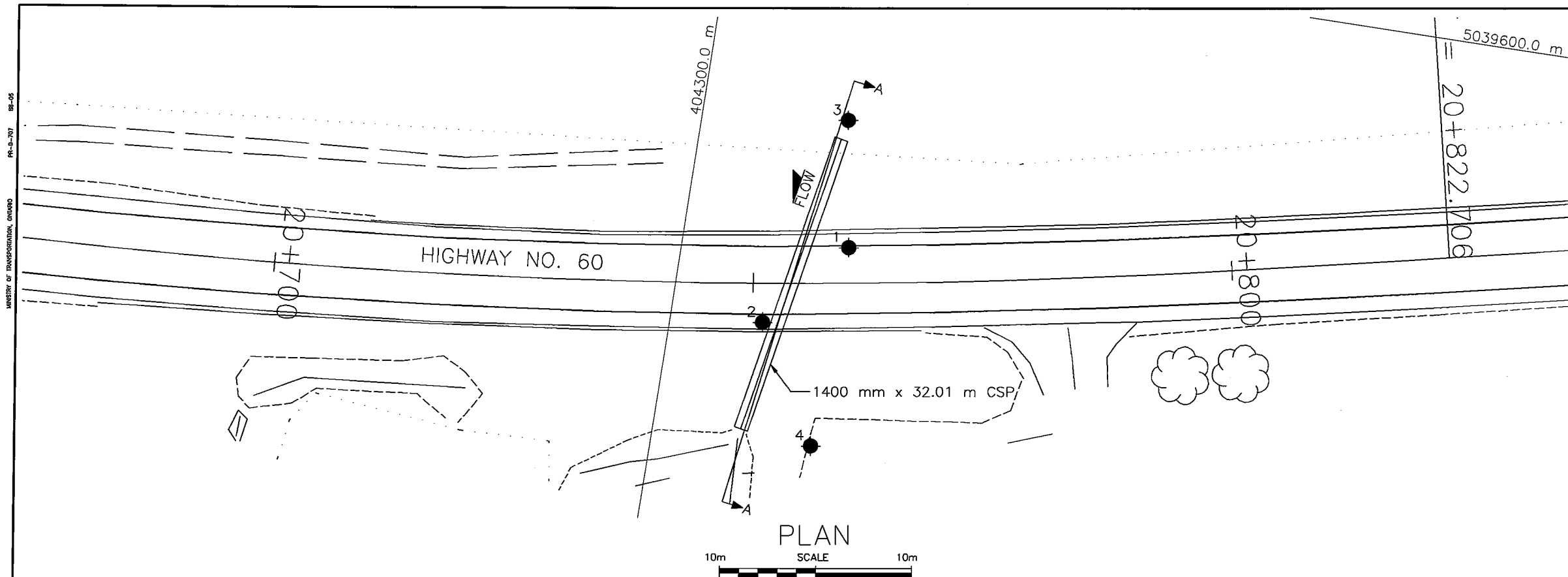
**Englobe Corp.**

120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@englobecorp.com

MEL-GEO 15020 - BOREHOLE LOGS - F9.GPJ MEL-GEO.GDT 16/11/2

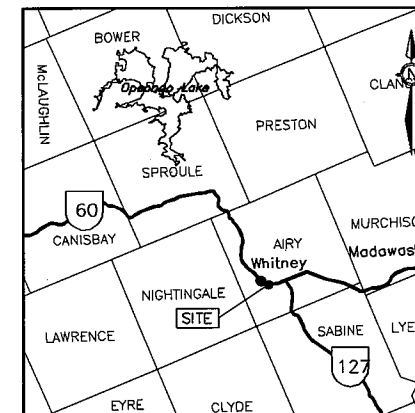
## **Appendix 3      Borehole Plan and Lab Data**

Drawing No. 2:              Borehole Location and Soil Strata  
Figure Nos. L-1 to L-4:      Grain Size Distribution Curves  
Table No. L-5:              Lab Test Summary Sheet



This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The proposed structure location is shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.

DISTRICT CONT. No. GWP No. 5264-13-00	
HWY 60 CULVERT STA. 20+754	
BOREHOLE LOCATIONS AND SOIL STRATIGRAPHY	DRAWING 2



KEY PLAN  
N.T.S.

LEGEND

- Borehole
- Blows/0.3 m (Std Pen Test, 475 J/blow)
- Water Level at Time of Investigation
- End of Sampling
- Piezometer

BOREHOLE No.	ELEVATION	O/S	NORTHING	EASTING
1	414.8	3.7m Lt	5039569.8	404317.3
2	415.2	4.1m Rt	5039559.7	404309.6
3	410.9	17m Lt	5039581.9	404315.2
4	411.7	17m Rt	5039547.7	404316.6

**NOTES:**  
The boundaries between soil strata have been established at the borehole locations only. The boundaries illustrated and stratigraphy between boreholes on this drawing are assumed based on borehole data and may vary. They are intended for design only.

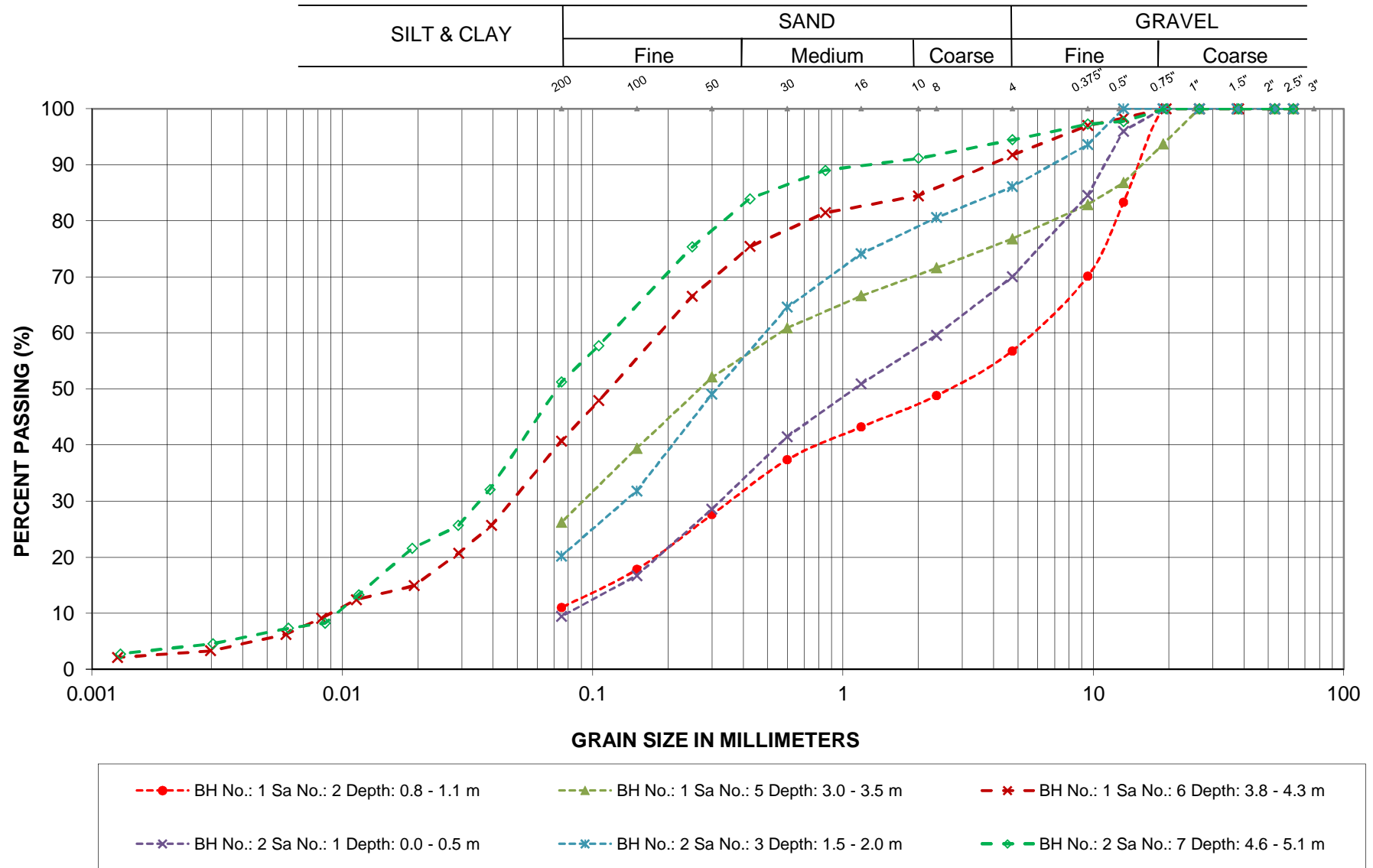
Base plan and alignment provided in digital format by Callan Dietz on July 6, 2016

Coordinates based on MTM Zone 10 NAD83 CSRS

GEOCRES No. 31E-373

DESIGN	CHK	CODE	LOAD	DATE NOV/16
DRAWN	DM	CHK SH	STRUCT	SCHEME
				DWG 2

## GRAIN SIZE ANALYSIS



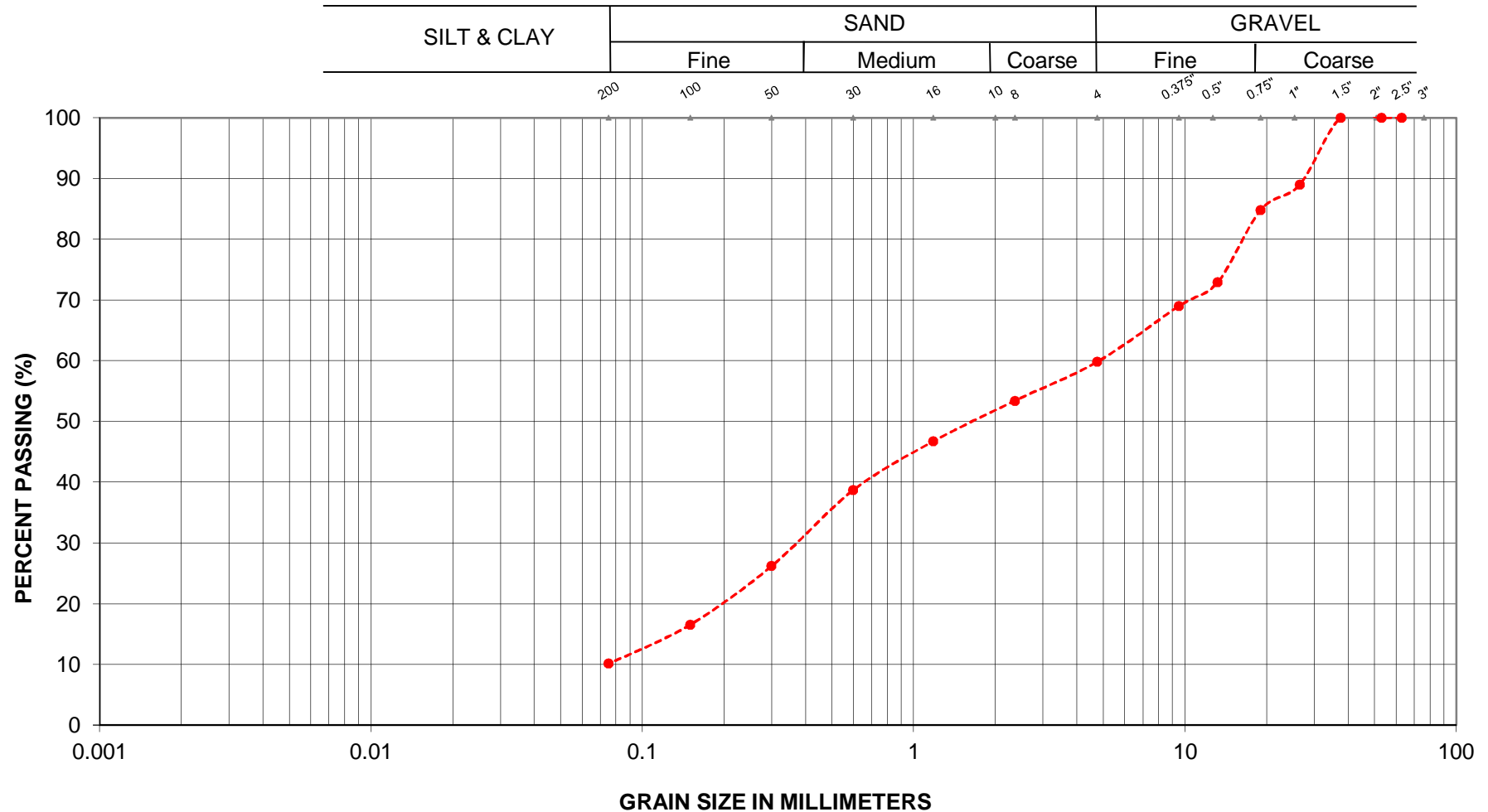
EMBANKMENT FILL

LOCATION: Hwy 60, Station 20+754  
TWP of Airy

Englobe Corp.

FIGURE L-1

# GRAIN SIZE ANALYSIS



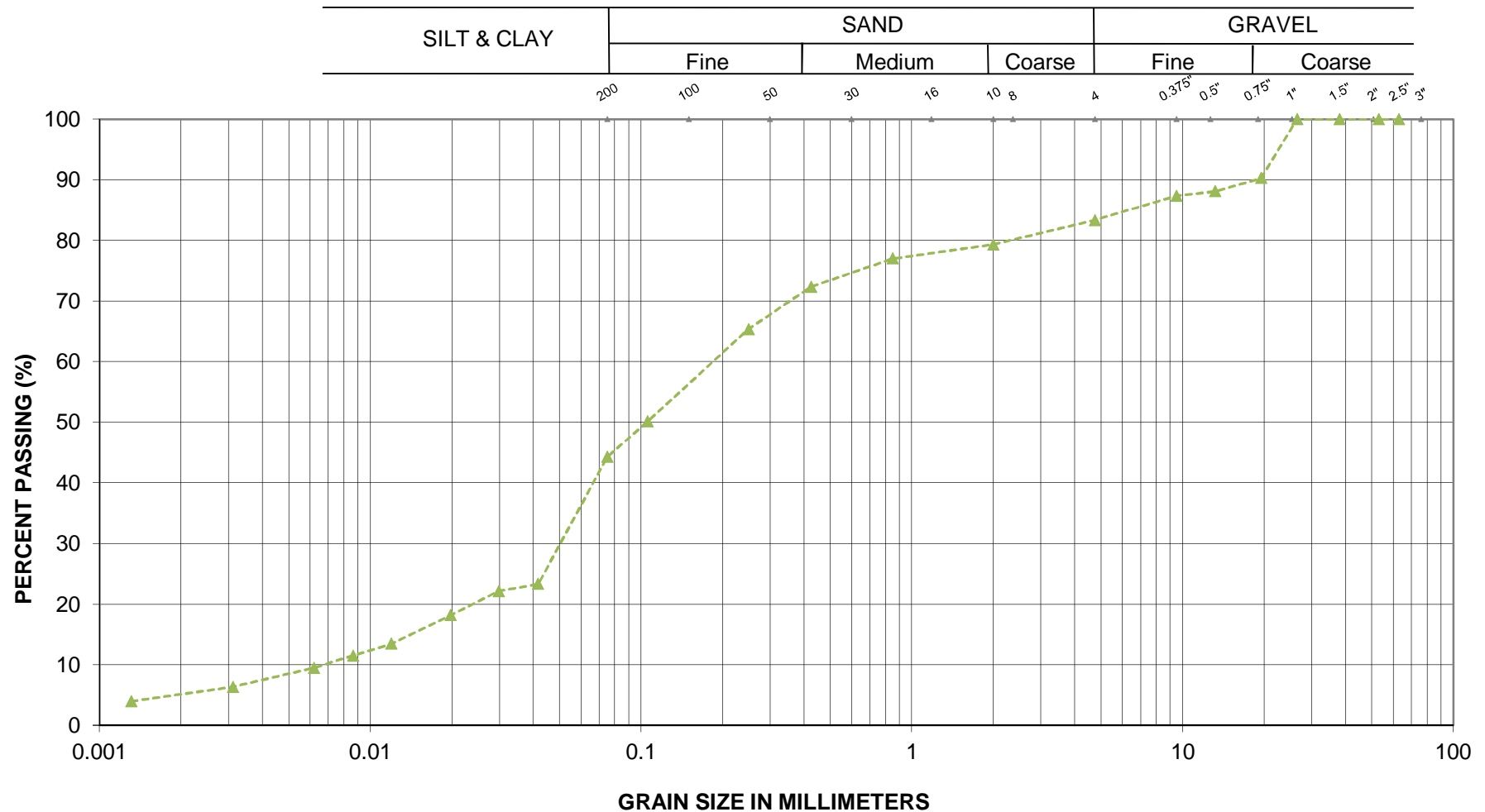
FILL - sand and gravel

LOCATION: Hwy 60, Station 20+754  
TWP of Airy

Englobe Corp.

FIGURE L-2

# GRAIN SIZE ANALYSIS



---▲--- BH No.: 4 Sa No.: 4 Depth: 2.3 - 2.7 m

SAND AND SILT

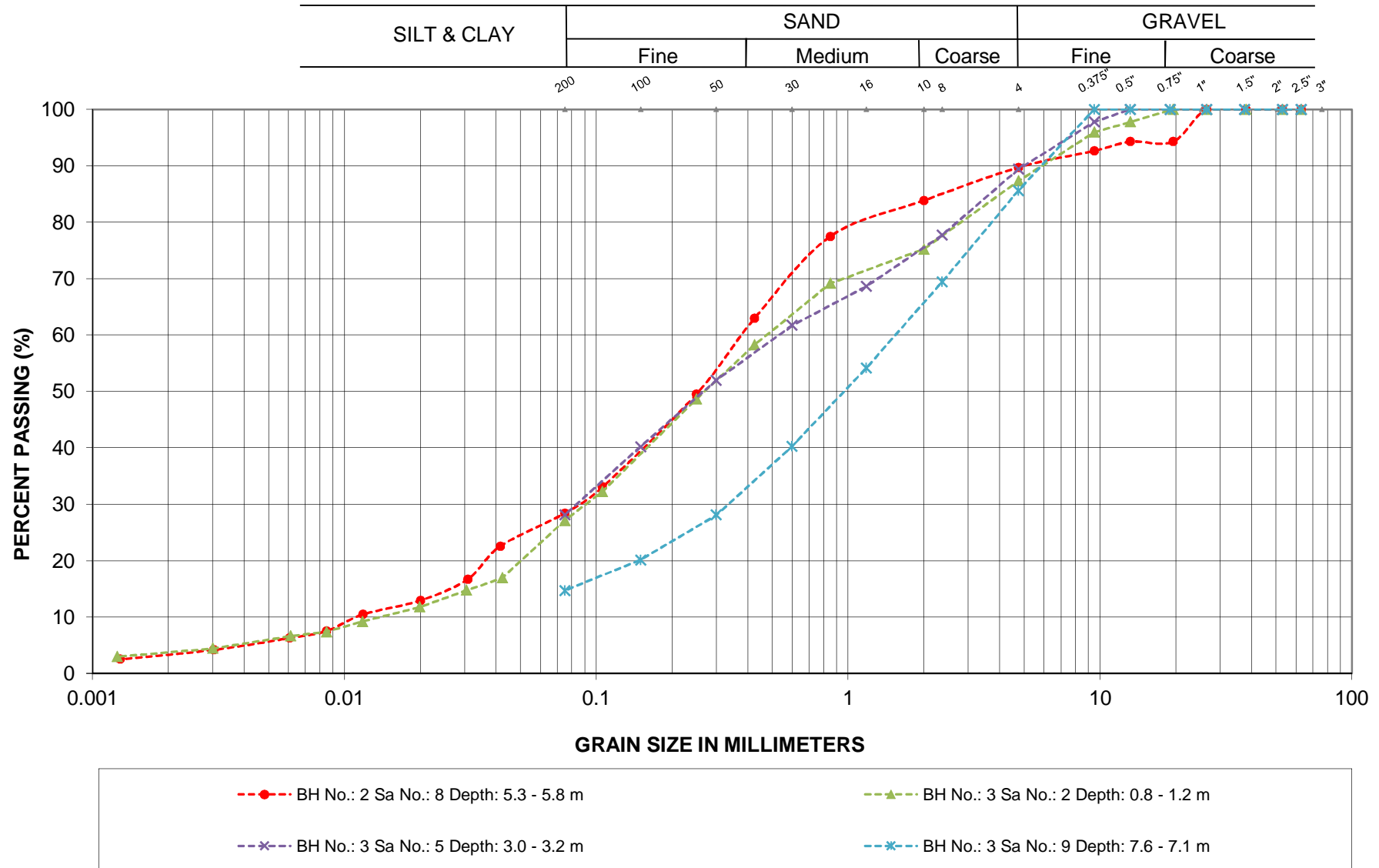
LOCATION: Hwy 60, Station 20+754  
TWP of Airy

Englobe Corp.

FIGURE L-3



## GRAIN SIZE ANALYSIS



SAND

LOCATION: Hwy 60, Station 20+754  
TWP of Airy

Englobe Corp.

FIGURE L-4

## Laboratory Tests - Summary Sheet



Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
1	1	0.0					3.8				30			
	2	0.8	43	46	11		2.0				37/152 mm			
	3	1.5					2.9				15			
	4	2.3					12.7				4			
	5	3.1	23	51	26		10.4				17			
	6	3.8	8	51	38	3	24.5				6			
	7	5.0					19.7				81			
	8	6.1					11.6				50/76 mm			
	9	7.6												Rec= 97%, RQD= 47%
	10	9.2												Rec= 98%, RQD= 64%
2	1	0.0	30	61	9		3.7				34			
	2	0.8					3.5				58/152 mm			
	3	1.5	14	66	20		5.1				15			
	4	2.3					7.4				2			
	5	3.1					6.1				16			
	6	3.8					11.3				9			
	7	4.6	5	44	48	3	30.2				13			
	8	5.3	10	62	25	3	21.1				11			
	9	6.1					12.3				86/203 mm			
	10	6.5												Rec= 100%, RQD= 92%
	11	8.0												Rec= 100%, RQD= 13%

## Laboratory Tests - Summary Sheet



Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
3	1	0.0					20.5				7			
	2	0.8	13	60	23	4	12.1				35			
	3	1.5					12.6				50/127 mm			
	4	2.3					9.2				50/102 mm			
	5	3.1	11	61	28		16.8				50/127 mm			
	6	3.8					9.5				50/51 mm			
	7	4.6					9.0				50/51 mm			
	8	6.1					8.5				50/51 mm			
	9	7.6	14	71	15		13.2				50/51 mm			
	10	9.2					12.2				50/51 mm			
4	1	0.0					10.1				13/203 mm			
	2	0.8	40	50	10		42.0				22			
	3	1.5					59.5				11			
	4	2.3	17	39	39	5	10.9				32			
	5	3.1					13.1				40			
	6	3.8												Rec= 100%, RQD= 83%
	7	5.4												Rec= 100%, RQD= 91%

## Appendix 4    Photo Essay

Enclosure No. 6:

Photo Essay

Culvert Outlet – Looking South

Photo: 1



Culvert Inlet – Looking Southeast

Photo: 2



Project: Hwy 60 – Culvert, Station 20+754, Township of Airy

Photos Provided By: Englobe

Date: April 2016



Rock Cores – Borehole 1 (left) and Borehole 2 (right)

Photos: 3 and 4



Project: Hwy 60 – Culvert, Station 20+754, Township of Airy

Photos Provided By: Englobe

Date: July 2016

Rock Cores – Borehole No. 4 (left)

Photos: 5



Project: Hwy 60 – Culvert, Station 20+754, Township of Airy

Photos Provided By: Englobe

Date: July 2016