



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 25+108 - Twp. of Sproule
GWP 5264-13-00**

FINAL FOUNDATION INVESTIGATION REPORT

Date: November 2, 2016
Ref. N°: 15/04/15020-F7

Geocres No. 31E-376

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Final Foundation Investigation Report

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2016-11-02

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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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Attention: **Mr. Jason Wright**

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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 25+108 in the Township of Sproule on Highway 60, about 4.7 m east of Opeongo Lake Road. 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 2550 mm Corrugated Steel Pipe (CSP) culvert is located on Highway 60 at Station 25+108 in the Township of Sproule, 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 9.1 m in height above the culvert invert (at centreline), with centreline at Elevation 440.6 m at the culvert location. At the north slope, the maximum height of the embankment is approximately 10.1 m above the culvert invert. At the south slope, the maximum height of embankment fill is approximately 8.0 m above the culvert invert. The existing embankment slopes in the area of the culvert have been generally established at an angle of approximately 1.5H:1V at the north slope and 2.1H:1V at the south slope. The culvert at this location is a 2550 mm diameter Corrugated Steel Pipe (CSP) culvert, approximately 43 m in length. Flow through the culvert is from the south to the north (right to left).

Observed infrastructure at the culvert location includes overhead wires to the north 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 sands and 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 September 22nd to 24th, 2015 and April 12th to 13th, 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 (south) and outlet (north) 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 3 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-6 and Table No. L-7).

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 25+108, TWP OF SPROULE

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 440.4, 440.8, 435.2, and 431.9 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 75 to 100 mm asphalt concrete overlying a layer of crushed gravel base/subbase approximately 200 to 300 mm thick.

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 sandy gravel to sand, some gravel, some to trace silt was penetrated. Cobble/boulder sized rock pieces were encountered in the embankment fill layer. The natural moisture content measured for recovered samples from this deposit was generally in the order of 1 to 17%. Gradation (sieve) analyses were carried out on six (6) samples of this deposit, the results of which indicated 9 to 53% gravel size particles, 36 to 83% sand size particles, and 5 to 11% silt and clay size particles (Figure No. L-1, Appendix 3).

Based on SPT 'N' values of 3 to 73 blows per 300 mm penetration and 25 blows per 0 mm penetration, the relative density/compactness of this deposit was described as very loose to very dense, but generally loose on average. This embankment fill was encountered to depths of 8.6 and 10.0 m below grade at Borehole Nos. 1 and 2, respectively (Elevations 431.8 and 430.8 m, respectively).

4.1.3 **Fill**

At surface at Borehole Nos. 3 and 4, a layer of fill described as brown to dark brown sand, gravelly to some gravel, with to trace silt, trace clay was penetrated. Cobble sized rock pieces were encountered in the fill layer. The natural moisture content measured for recovered samples from this deposit was generally in the order of 9 to 26%. Gradation (sieve) analyses were carried out on two (2) samples of this deposit, and the results indicated 38 to 43% gravel size particles, 51 to 58% sand size particles, and 4 to 6% silt and clay size particles (Figure No. L-2, Appendix 3). Additional gradation (hydrometer) analyses were carried out on two (2) samples of this deposit, and the results indicated 14 to 15% gravel size particles, 56 to 61% sand size particles, 22 to 25% silt size particles, and 3 to 4% clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 6 to 14 blows per 300 mm penetration and 76 blows per 225 mm penetration, the relative density/compactness of this deposit was described as loose to very dense, but generally compact on average. This fill was encountered to depths of 3.2 and 2.1 m below grade at Borehole Nos. 3 and 4, respectively (Elevations 432.0 m and 429.8 m, respectively).

4.1.4 **Sand**

Underlying the embankment fills at Borehole Nos. 1 and 2, underlying the gravelly sand to sand fills at Borehole Nos. 3 and 4, a deposit of sand, with to some gravel, with to trace silt, trace clay was penetrated. Cobble and boulder sized rock pieces were encountered in the sand layer. The natural moisture content measured on samples of this deposit was in the order of 7 to 14%. Gradation (sieve) analyses were carried out on two (2) samples of this deposit, and the results indicated 14 to 29% gravel size particles, 64 to 65% sand size particles, and 5 to 22% silt and clay size particles (Figure No. L-3, Appendix 3). Additional gradation (hydrometer) analyses were carried out on three (3) samples of this deposit, and the results indicated 17 to 29% gravel size particles, 27 to 57% sand size particles, 13 to 22% silt size particles, and 3 to 5% clay size particles (Figure No. L-3, Appendix 3). Based on SPT 'N' values of 62 to 73 blows per 300 mm penetration and 50 blows per 75 mm penetration, the relative density/compactness of this deposit was described very dense. This deposit was encountered to depths of 13.3, 14.5, 5.3, and 3.4 m below grade at Borehole Nos. 1 to 4, respectively (Elevations 427.1, 426.3, 429.9, and 428.5 m, respectively).

4.1.5 **Sand Till**

Underlying the sand at Borehole Nos. 1 and 2, a deposit of till described as sand, some to trace gravel, silty to some silt was penetrated. The natural moisture content measured for recovered

samples from this deposit was generally in the order of 8 to 12%. Gradation (sieve) analyses were carried out on two (2) samples of this deposit, and the results indicated 5 to 15% gravel size particles, 54 to 60% sand size particles, and 31 to 35% silt and clay size particles (Figure No. L-4, Appendix 3). Based on SPT 'N' values of 25 blows per 0 mm penetration to 50 blows per 75 mm penetration, the relative density/compactness of this deposit was described as very dense. This deposit was encountered to a depth of 16.9 m below grade at Borehole No. 2 (Elevation 423.9 m). Sampling was terminated in this deposit at a depth of 18.1 m below grade at Borehole No. 1 (Elevation 422.3 m).

4.1.6 Gravel and Sand to Sandy Gravel Till

Underlying the sand at Borehole Nos. 3 and 4, a deposit of till described as gravel and sand to sandy gravel, some to trace silt was penetrated. The natural moisture content measured for recovered samples from this deposit was generally in the order of 6 to 17%. A Gradation (sieve) analysis was carried out on one (1) sample of this deposit, and the results indicated 50% gravel size particles, 41% sand size particles, and 9% silt and clay size particles (Figure No. L-5, Appendix 3). Based on SPT 'N' values of 25 blows per 0 mm penetration to 50 blows per 50 mm penetration, the relative density/compactness of this deposit was described as very dense. This till was encountered to a depth of 5.2 m below grade at Borehole No. 4 (Elevation 426.7 m). Sampling was terminated in this deposit at a depth 8.9 m below grade at Borehole No. 3 (Elevation 426.3 m).

4.1.7 Bedrock

Underlying the sand at Borehole No. 2, and underlying the till at Borehole No. 4, bedrock was proven by diamond core drilling. The bedrock was described as black gneiss to pink granite. Based on RQD values of 77 to 100%, the bedrock was described as good to excellent quality. Based on visual review, the bedrock generally showed negligible weathering. Sampling in the bedrock was terminated at depths of 19.6 and 8.3 m below grade at Borehole Nos. 2 and 4, respectively (Elevations 421.2 and 423.6 m, respectively). Photos of rock cores recovered at Borehole Nos. 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 (April 13, 2016) the surface water was at elevation 430.9 m at the culvert outlet.

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 3 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 433.5 and 433.8 m at Borehole Nos. 1 and 3 during the site investigation period, respectively. The groundwater level was encountered at Elevation 434.9 and 431.7 m at Borehole Nos. 2 and 4, respectively, upon completion of sampling at the boreholes; however these water levels likely had not stabilized at the time of recording.

The groundwater was measured at Elevations 432.8 and 433.9 m at Borehole No. 1 and 3, respectively, at the time of decommissioning on August 16, 2016.

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

Appendix 1 Key Plan

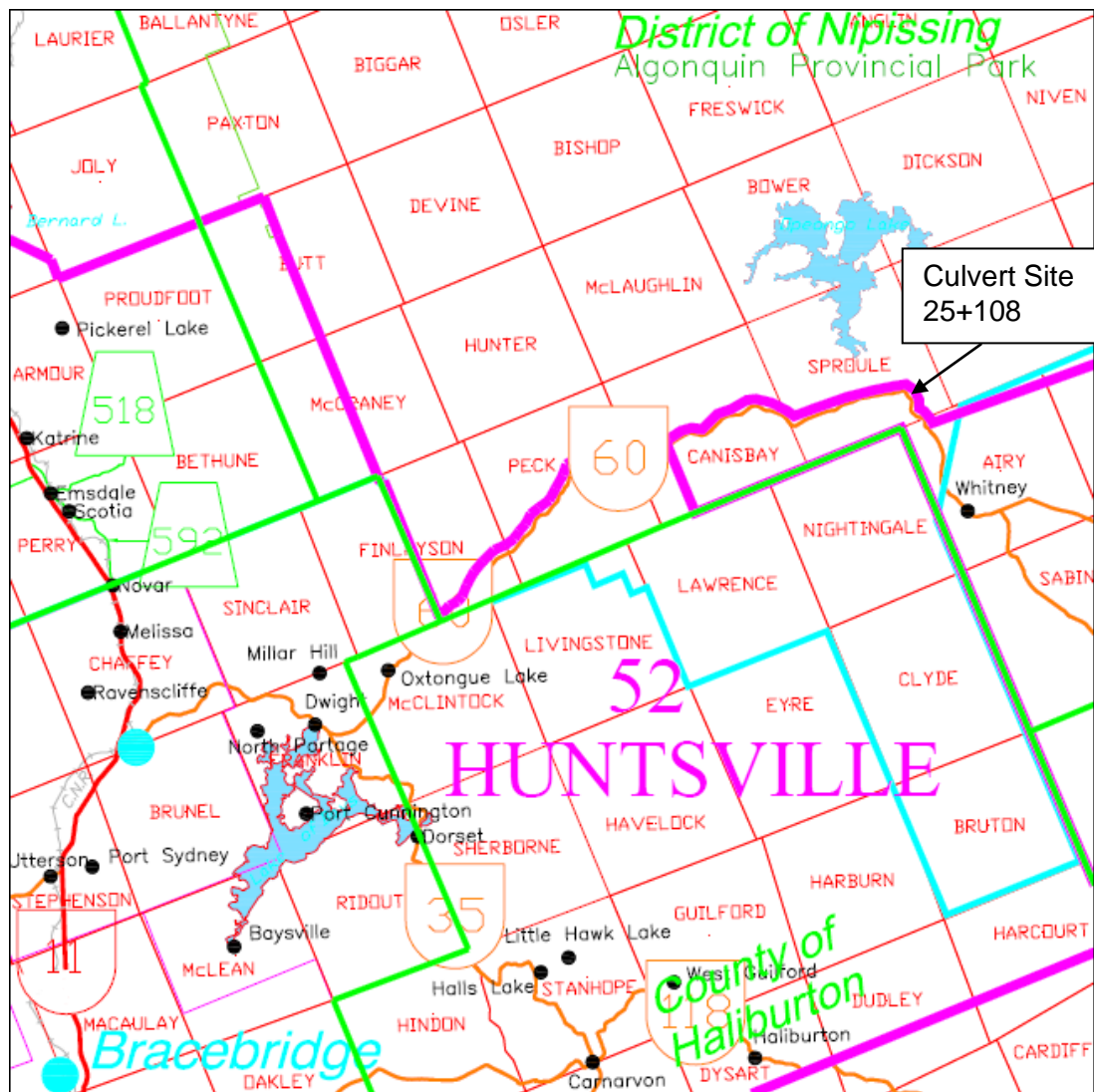
Drawing No. 1

Key Plan

MACRO KEY PLAN

Drawing No. 1

NOT TO SCALE



FOUNDATION INVESTIGATION REPORT

GWP 5264-13-00

Highway 60

Station 25+108 Culvert

Township of Sproule



Reference No: 15/04/15020-F7

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-F7 DATUM Geodetic LOCATION N 5048756.6 E 399510.7 - Sproule Twp., Station 25+111 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 September 22 TIME
 DATE (Completed) 2015 September 23 (Completed) CHECKED BY SH

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
440.4	Ground Surface												
0.0	100 mm Asphalt 300 mm crushed gravel		1	SS	36								
	EMBANKMENT FILL - sand and gravel to sand some gravel, trace silt brown (dense/loose/very dense)		2	SS	23								45 50 (5)
	Auger refusal at depths of 1.2 m advanced with casing using wash boring method		3	SS	12								
	gravel to cobble sized rock pieces encountered		4	SS	15								
	sample losses at depths from 2.3 m to 4.6 m		5	SS	7								
			6	SS	6								
	450 mm void encountered at depth of 3.5 m		7	SS	25/0 mm								
			8	SS	5								20 73 (7)
			9	SS	6								
			10	SS	4								
			11	SS	4								9 83 (8)
431.8													
8.6	SAND, with to some gravel, with to trace silt, trace clay brown, wet		12	SS	25/0 mm								
	770 mm boulder sized rock piece encountered at depth of 9.3 m												
	grey (very dense)		13	SS	73								17 57 22 4
			14	SS	62								29 65 (5)
	Continued Next Page												
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 1) 15/9/23 2:30:00 PM 2) 16/8/16 3)					
The stratification lines represent approximate boundaries. The transition may be gradual.								Water Depth (m) 6.9 7.6 -		Cave In (m) - - -			

MEL-GEO 15020 - BOREHOLE LOGS - F7.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. 1**

REFERENCE 15/04/15020-F7 DATUM Geodetic LOCATION N 5048756.6 E 399510.7 - Sproule Twp., Station 25+111 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 September 22 TIME
 DATE (Completed) 2015 September 23 (Completed) CHECKED BY SH

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
ELEV DEPTH	DESCRIPTION (see Enclosure No. 1) Continued from Previous Page	STRATA PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _p W W _L						
						20	40	60	80	100	20	40	60				
427.1 13.3	SAND TILL, some gravel, silty to some silt grey, wet (very dense) 75 mm sized cobble encountered at depth of 16.5 m		15	SS	50/75 mm												
			16	SS	50/75 mm												
			17	SS	50/75 mm												
			18	SS	25/0 mm												
422.3 18.1	End of Sampling End of Borehole																

MEL-GEO 15020 - BOREHOLE LOGS - F7.GPJ MEL-GEO.GDT 16/11/2

METRIC**RECORD OF BOREHOLE NO. 2**

REFERENCE 15/04/15020-F7 DATUM Geodetic LOCATION N 5048765.7 E 399505.7 - Sproule Twp., Station 25+104 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 September 23 TIME
 DATE (Completed) 2015 September 24 (Completed) CHECKED BY SH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							× LAB VANE
	Continued from Previous Page					20	40	60	80	100	20	40	60	kN/m ³	GR SA (SI CL)		
			16	SS	25/0 mm												
426.3 14.5	SAND TILL, trace gravel, silty grey, wet (very dense)		17	SS	50/75 mm						○				5 60 (35)		
423.9 16.9	Start Rock Coring		18	SS	25/0 mm												
	BEDROCK - black gneiss / pink granite good to excellent quality		19	RC	REC=95% RQD=77%												
			20	RC	REC=99% RQD=96%												
421.2 19.6	End of Sampling End of Borehole																

MEL-GEO 15020 - BOREHOLE LOGS - F7.GPJ MEL-GEO.GDT 16/11/2

METRIC

RECORD OF BOREHOLE NO. 3



REFERENCE 15/04/15020-F7 DATUM Geodetic LOCATION N 5048738.4 E 399503.1 - Sproule Twp., Station 25+108 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 12 TIME
 DATE (Completed) 2016 April 12 (Completed) CHECKED BY SH

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
							20 40 60 80 100		20 40 60				
435.2	Ground Surface		1	SS	6								
0.0	FILL - sand, some gravel, with silt, trace clay, trace wood pieces and grass rootlets brown to dark brown (loose/dense)		2	SS	13							14 61 22 3	
	cobble sized rock pieces encountered at depths from 0.5 m to 0.9 m		3a	SS	11								
			3b										
			4	SS	25							15 56 25 4	
			5	SS	49								
432.0			6	SS	64							29 47 19 5	
3.2	SAND, with gravel, some silt, trace clay grey, wet (very dense)		7	SS	50/125 mm								
	auger refusal at depth of 5.3 m advanced with casing using wash boring method												
429.9			8	SS	50/75 mm							50 41 (9)	
5.3	SAND and GRAVEL TILL, trace silt grey (very dense)		9	SS	50/75 mm								
			10	SS	50/50 mm								
426.3													
8.9	End of Sampling 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) 16/4/12 3:30:00 PM 1.3 - 1.3 2) 16/4/14 2:00:00 PM 1.4 - 1.4 3) 16/8/16 1.3 - 1.3						

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 - F7.GPJ MEL-GEO.GDT 16/11/2

METRIC**RECORD OF BOREHOLE NO. 4**

REFERENCE 15/04/15020-F7 DATUM Geodetic LOCATION N 5048783.2 E 399514.2 - Sproule Twp., Station 25+108 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 13 TIME
 DATE (Completed) 2016 April 13 (Completed) CHECKED BY SH

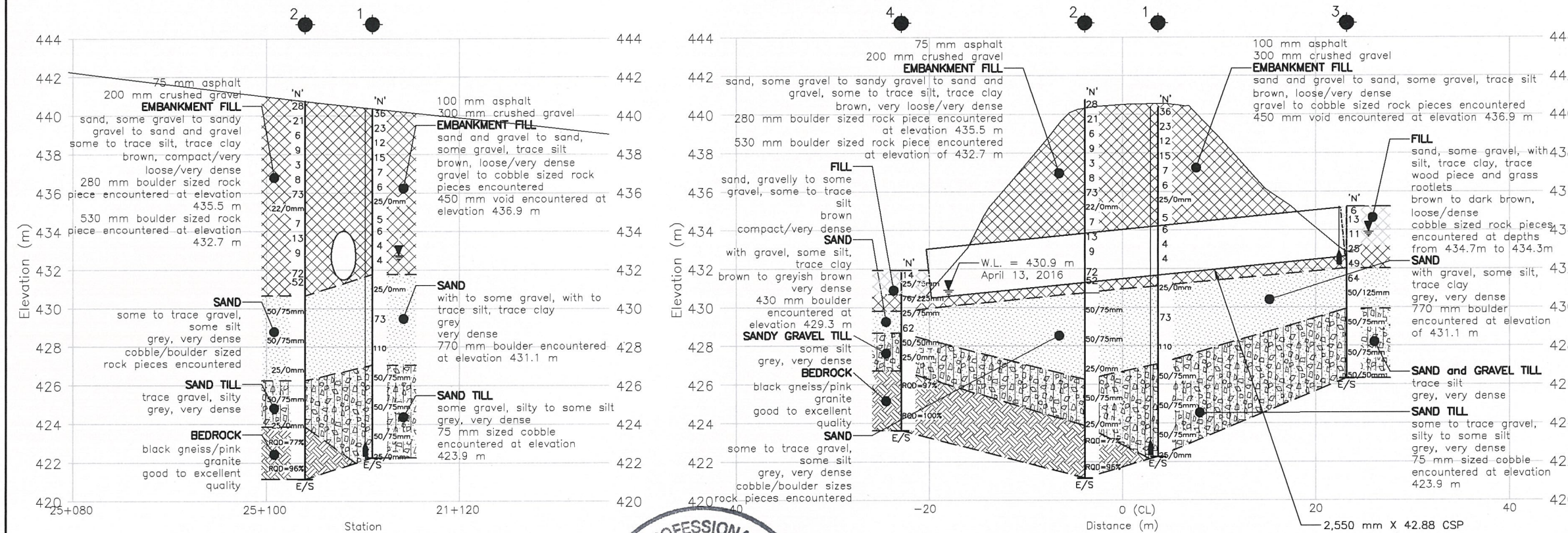
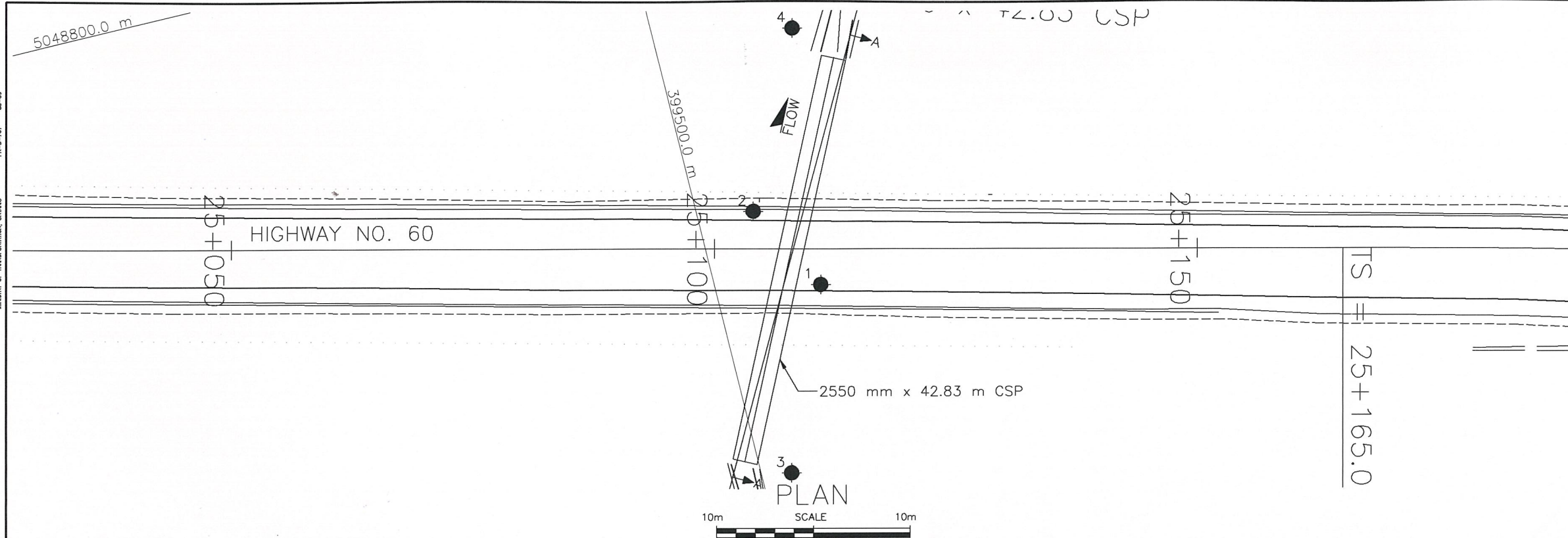
SOIL PROFILE		STRATA PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)												
ELEV. DEPTH	DESCRIPTION (see Enclosure No. 1)		NUMBER	TYPE			"N" VALUES	20						40	60	80	100	20	40	60					
431.9	Ground Surface		1	SS	14																				
0.0	FILL - sand, gravelly to some gravel, some to trace silt brown, wet (compact/very dense) auger refusal at depth of 1.9 m advanced with casing using wash boring method		2	SS	25/75 mm								38 58 (4)												
429.8			3	SS	76/225 mm								43 51 (6)												
429.8			4	SS	25/75 mm																				
2.1	SAND - with gravel, some silt, trace clay 430 mm boulder encountered at depth of 2.6 m brown to greyish brown, wet		5	SS	62								29 56 13 3												
428.5	(very dense)		6	SS	50/50 mm																				
3.4	sandy GRAVEL TILL - some silt grey, wet (very dense)		7	SS	25/0 mm																				
426.7			8	RC	Rec= 100% ROD= 100%																				
5.2	Start Rock Coring BEDROCK - black gneiss / pink granite excellent quality		9	RC	Rec= 98% ROD= 97%																				
423.6																									
8.3	End of Sampling 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 <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) 16/4/14</td> <td>0.2</td> <td>1.9</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) 16/4/14	0.2	1.9	2)	-	-	3)	-	-
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)																							
1) 16/4/14	0.2	1.9																							
2)	-	-																							
3)	-	-																							

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

MEL-GEO 15020 - BOREHOLE LOGS - F7.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-5: Grain Size Distribution Curves
Table No. L-6: Lab Test Summary Sheet



DISTRICT
CONT. No.
GWP No. 5264-13-00

HWY 60 CULVERT
STA. 25+108

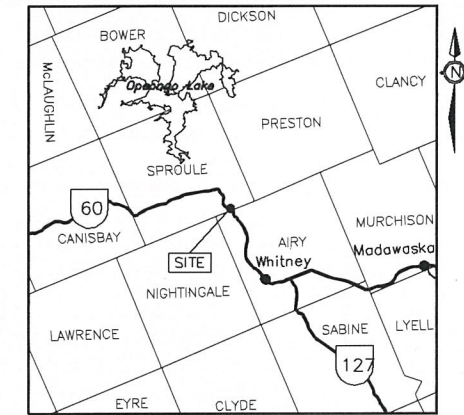
BOREHOLE LOCATIONS
AND SOIL STRATIGRAPHY



DRAWING

2

Englobe



LEGEND

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

BOREHOLE No.	ELEVATION	O/S	NORTHING	EASTING
1	440.4	3.7 Rt	5048756.6	399510.7
2	440.8	3.9 Lt	5048765.7	399505.7
3	435.2	23.2 Rt	5048738.4	399503.1
4	431.9	22.9 Lt	5048783.2	399514.2

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 Callon Dietz on July 6, 2016

Coordinates based on MTM Zone 10 NAD83 CSRS

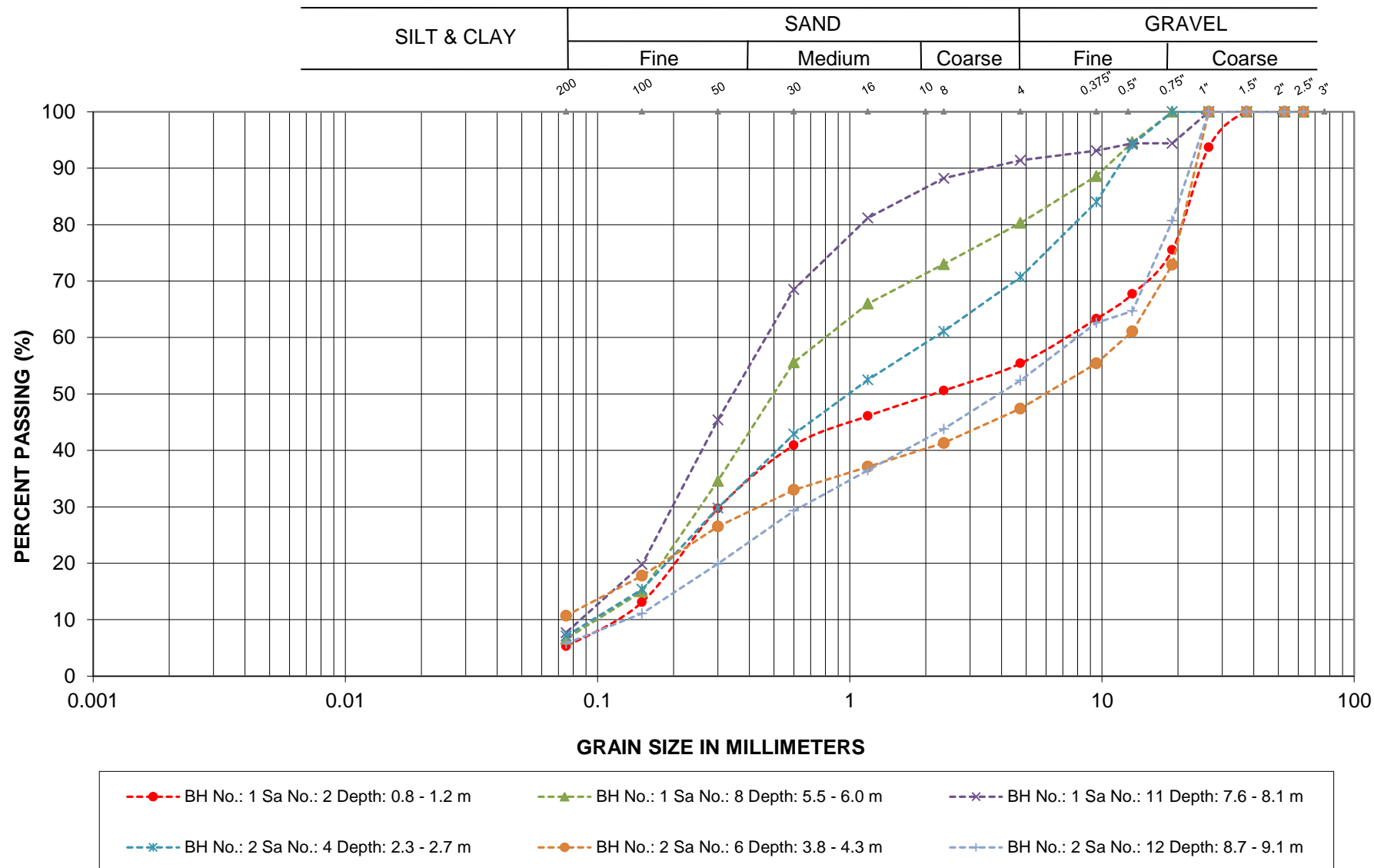
GEOCRETS No. 31E-376



REVISIONS	DATE	BY	DESCRIPTION
JUL/16	DM	DRAFT	
NOV/16	DM	FINAL	
DESIGN	CHK	CODE	LOAD
DRAWN	DM	CHK SH	SITE
			STRUCT
			SCHEME
			DWG

2016-11-02

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.

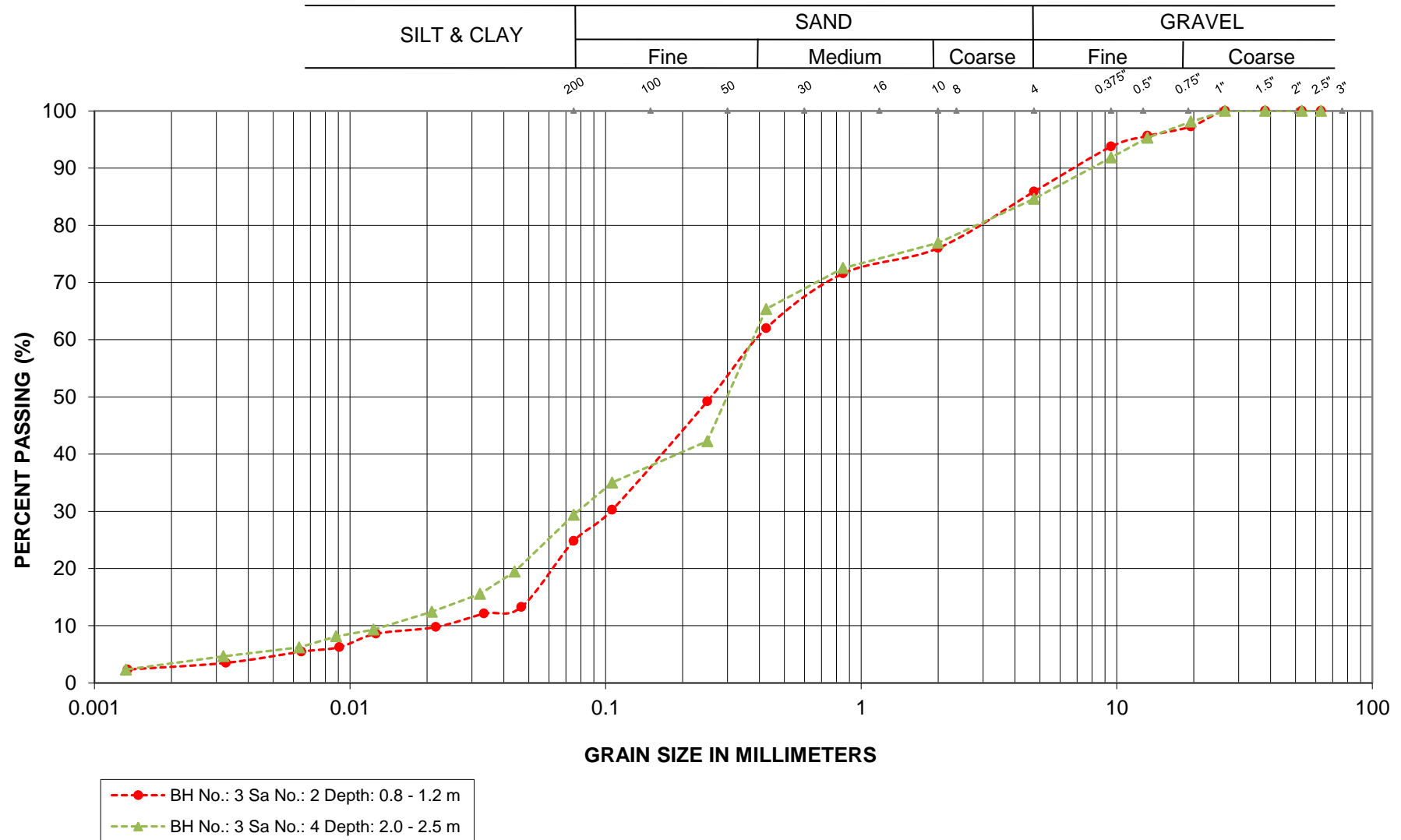
GRAIN SIZE ANALYSIS

EMBANKMENT FILL

LOCATION: Hwy 60, Station 25+108
TWP of Sproule

Englobe Corp.

FIGURE L-1

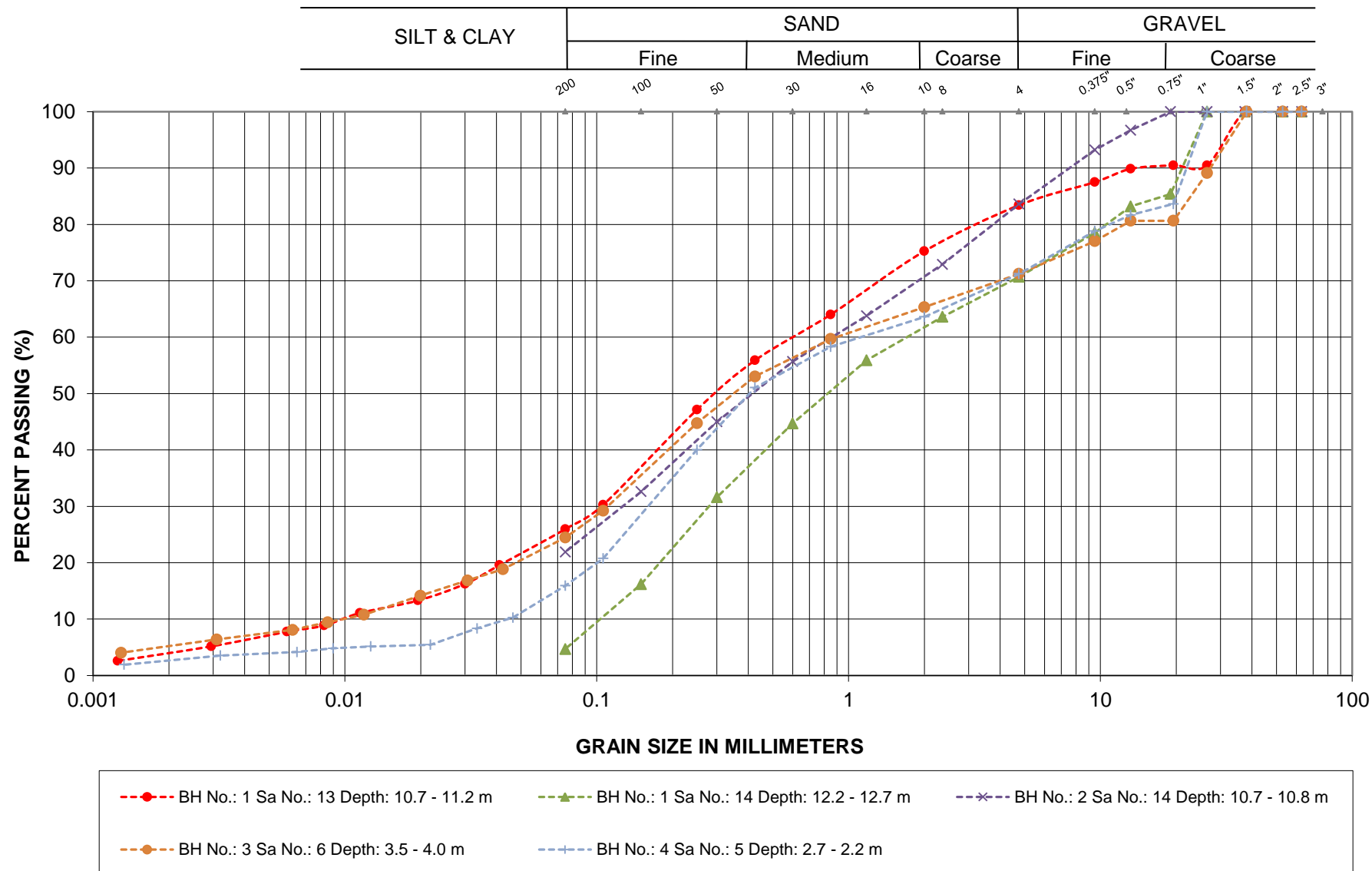
GRAIN SIZE ANALYSIS

FILL

LOCATION: Hwy 60, Station 25+108
TWP of Sproule

Englobe Corp.

FIGURE L-2

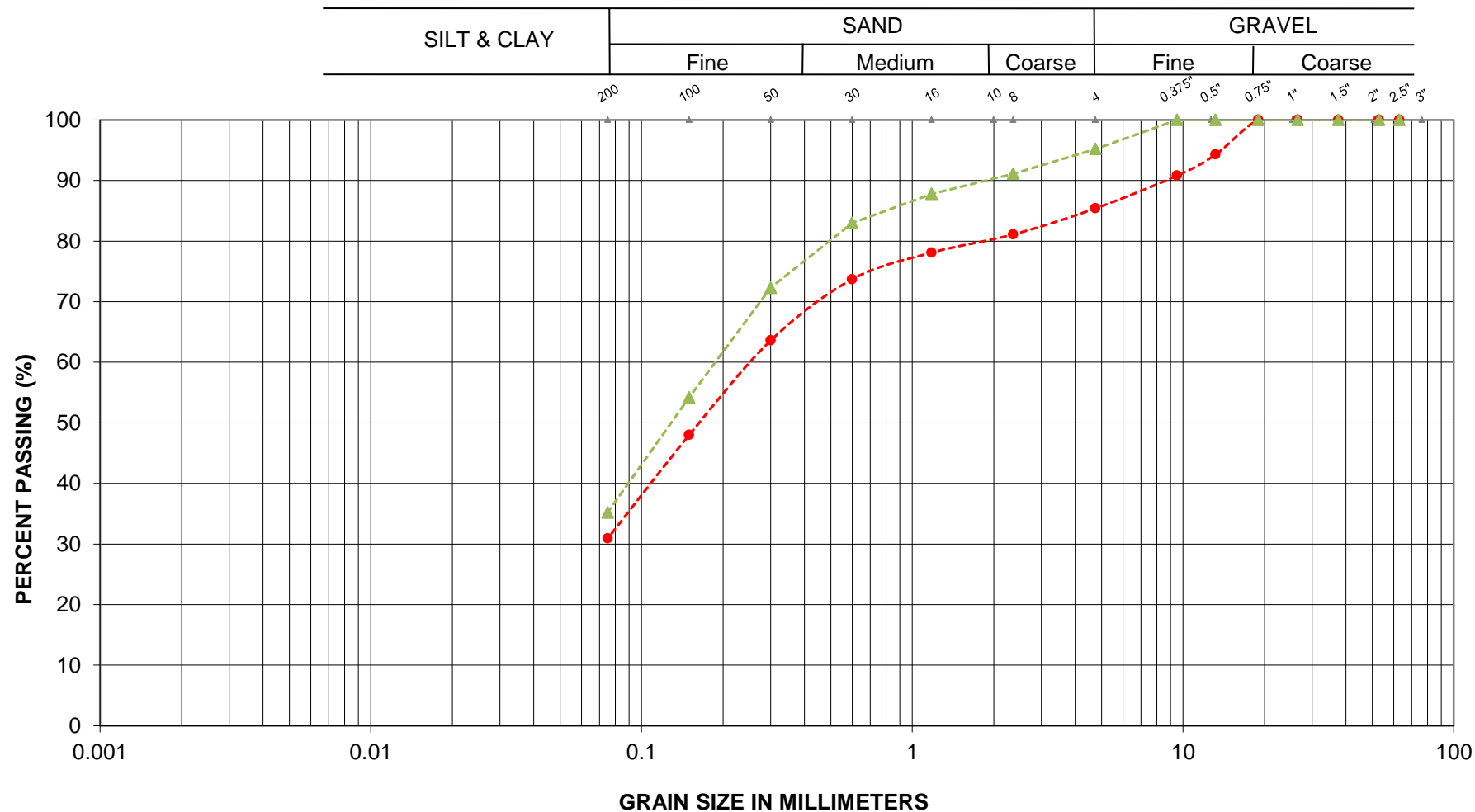
GRAIN SIZE ANALYSIS

SAND

LOCATION: Hwy 60, Station 25+108
TWP of Sproule

Englobe Corp.

FIGURE L-4

GRAIN SIZE ANALYSIS

---●--- BH No.: 1 Sa No.: 17 Depth: 16.8 - 16.9 m

---▲--- BH No.: 2 Sa No.: 17 Depth: 15.2 - 15.3 m

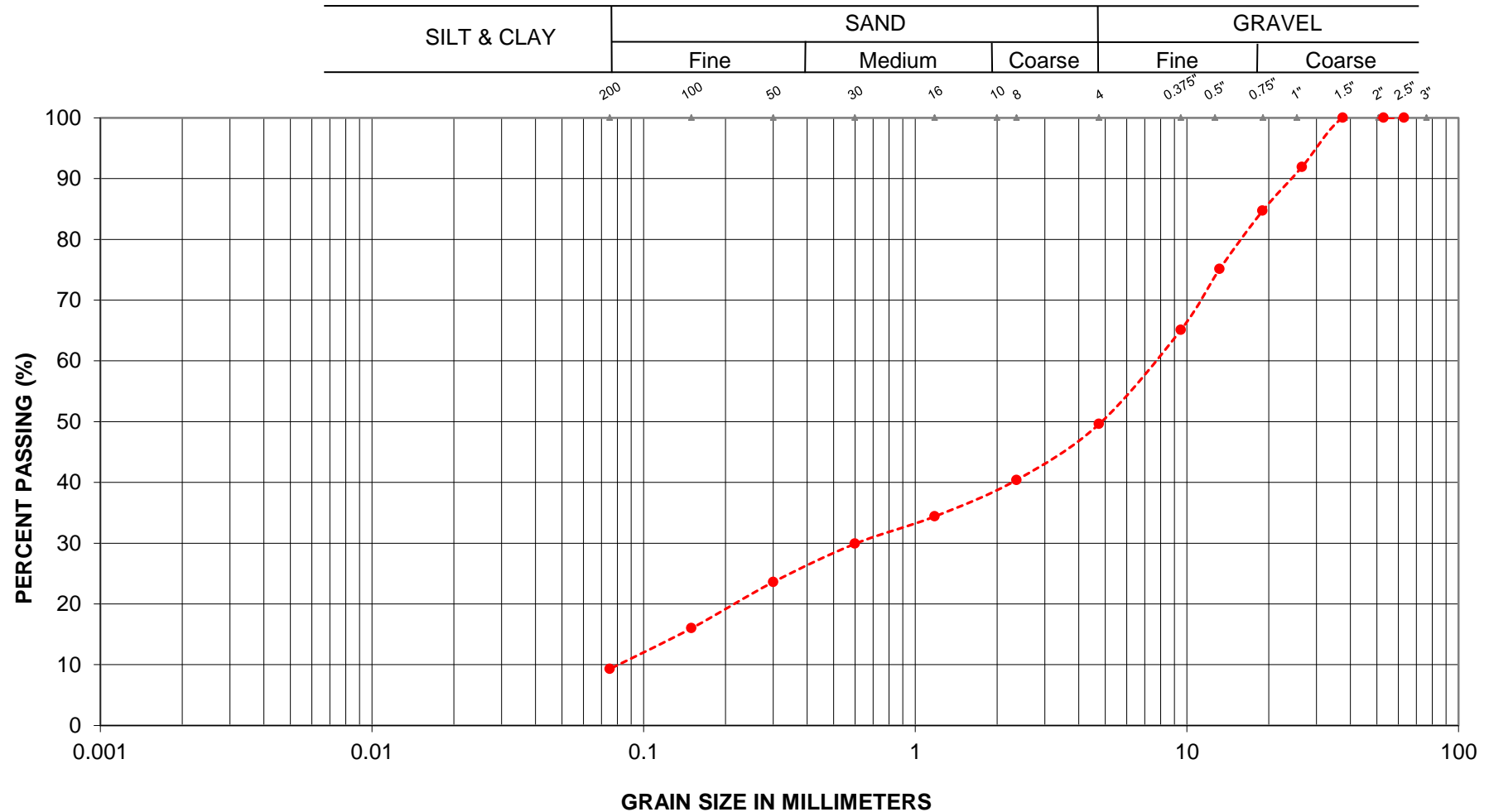
SAND TILL

LOCATION: Hwy 60, Station 25+108
TWP of Sproule

Englobe Corp.

FIGURE L-5

GRAIN SIZE ANALYSIS



---●--- BH No.: 3 Sa No.: 8 Depth: 5.8 - 6.0 m

SAND AND GRAVEL TILL

LOCATION: Hwy 60, Station 25+108
TWP of Sproule

Englobe Corp.

FIGURE L-6

Laboratory Tests - Summary Sheet



Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m ³)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
1	1	0.0					2.7				36			
	2	0.8	45	50	5		2.3				23			
	3	1.5					0.8				12			
	4	2.3									15			
	5	3.1									7			
	6	3.8									6			
	7	4.6									25/0 mm			
	8	5.5	20	73	7		13.7				5			
	9	6.1					14.8				6			
	10	6.9					14.4				4			
	11	7.6	9	83	8		16.9				4			
	12	9.1					9.6				25/0 mm			
	13	10.7	17	57	22	3	13.5				73			
	14	12.2	29	65	5		8.9				62			
	15	13.7					8.7				50/75 mm			
	16	15.2					8.3				50/75 mm			
	17	16.8	15	54	31		11.8				50/75 mm			
	18	18.0									25/0 mm			
2	1	0.0					4.3				28			
	2	0.8					2.1				21			
	3	1.5					4.9				6			
	4	2.3	29	64	7		2.4				9			
	5	3.1					4.2				3			
	6	3.81	53	36	11		4.4				8			
	7	4.57					1.0				73			
	8	5.33									25/0 mm			

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 (%)				
2	9	6.1									7			
	10	6.9									13			
	11	7.6					0.3				9			
	12	8.7	48	46	6		7.6				72			
	13	9.1					15.3				50			
	14	10.7	14	64	22		9.4				50/75 mm			
	15	12.2					11.8				50/75 mm			
	16	13.7									25/0 mm			
	17	15.2	5	60	35		10.4				50/75 mm			
	18	16.9									25/0 mm			
	19	16.9												Rec= 95%, RQD= 77%
	20	18.5												Rec=99%, RQD= 96%
3	1	0.0					21.7				6			
	2	0.5	14	61	22	3	16.1				13			
	3a	1.2					16.1				11			
	3b	1.4					16.1							
	4	2.0	15	56	25	4	10.6				25			
	5	2.7					8.9				49			
	6	3.5	28	47	19	5	7.1				64			
	7	4.3					8.0				50/125 mm			
	8	5.8	50	41	9		7.8				50/75 mm			
	9	7.3					5.8				50/75 mm			
	10	8.9					9.0				50/50 mm			

Englobe

Project: Hwy 60, Culvert Sta. 25+108, Township of Sproule

Table No. L-7
Sheet 3 of 3

Appendix 4 Photo Essay

Enclosure No. 6:

Photo Essay

Culvert Outlet – Looking South

Photo: 1



Culvert Inlet – Looking North

Photo: 2



Project: Hwy 60 – Culvert, Station 25+108, Township of Sproule

Photos Provided By: Englobe

Date: April 2016

Rock Cores – Borehole 2 (left) and Borehole 4 (right)

Photos: 3 and 4



Project: Hwy 60 – Culvert, Station 25+108, Township of Sproule

Photos Provided By: Englobe

Date: July 2016