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

Burford Creek Culvert Rehabilitation
Highway 94
Site No. 44-316
Station 11+652 - Township of North Himsworth
GWP 5090-06-00

FINAL FOUNDATION INVESTIGATION REPORT

Date: December 23, 2016
Ref. N^{o}: 16/02/16014-F3

Geocres No. 31L-199

Englobe

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Highway 94
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Station 11+652 - Township of North Himsworth
GWP 5090-06-00

Final Foundation Investigation Report

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Pavement Technology & Geotechnical Engineering
MTO Designated Contact

2016-12-28

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Property and Confidentiality

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P1B 1Z2
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1 hard copy	File

1 INTRODUCTION

Englobe Corp. (Englobe) 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 culvert (Burford Creek Culvert) structure. The site is located at Station 11+652 in the Township of North Himsworth on Highway 94, about 1.7 km north of Highway 654 (see Drawing No. 1, Appendix 1).

The foundation investigation location was specified by the MTO in the Terms of Reference for work under Agreement No. 5014-E-0055: GWP 5090-06-00 for Detail Design. The terms of reference for the scope of work are outlined in Englobe's Proposal P-15-168, dated November 20, 2015. The purpose of this investigation was to determine the subsurface conditions in the area of the inlet end of the existing culvert for the contract preparation of the Detail 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

An existing Structural Plate Corrugated Steel Pipe (SPCSP) Culvert, Burford Creek Culvert (Site No. 44-316), is located on Highway 94 at Station 11+652 in the Township of North Himsworth, Ontario. It is our understanding that the culvert was built in 1970 and, to our knowledge, has not undergone any rehabilitation since then. The local topography at the site is generally slightly rolling. The existing highway embankment currently supports two undivided lanes of highway, running in a south-north direction. The existing highway, at the culvert location, is constructed on an embankment some 14.1 m in height, above the culvert invert, with centreline elevation of 208.8 m at the culvert location. The culvert at this location is a 2200 mm diameter SPCSP culvert, approximately 100.6 m in length. The invert at the culvert inlet is at approximately Elevation 197.1 m and the invert at the culvert outlet is at approximately Elevation 196.7 m. Flow through the culvert is from right to left (i.e. east to west).

There is no known infrastructure underground in the area of the culvert.

2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The topography on this section of Highway 94 is generally slightly 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, overlying bedrock.

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

3 INVESTIGATION PROCEDURES

The fieldwork for this investigation was carried out on May 10th, 2016 during which time two (2) sampled boreholes were advanced. The two (2) boreholes were advanced adjacent to the culvert inlet.

The field investigation was carried out using a track mounted CME drilling rig 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. When cohesive deposits were encountered, the in-situ strength was measured using an "N" size field vane, vane collar, and calibrated torque meter. 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 No. 2 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-5, and Table No. L-6).

Section 6.8.2.2 of the RFP states that a minimum of one (1) chemical test package (including PH, water soluble sulphate, chloride, resistivity and electrical conductivity analyses) is required at the foundation element of the culvert. In accordance with requirements stated in the RFP, one set of soil chemical tests was carried out by AGAT Laboratories in Mississauga. The results of the chemical tests are presented in Appendix 3.

The location of the individual borehole was determined in the field using highway chainage established by Tulloch Engineering (Tulloch) 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 Tulloch. 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 BURFORD CREEK CULVERT, SITE NO. 44-316

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, two (2) sampled boreholes were put down at this site, with Borehole Nos. 1 and 2 advanced adjacent to the culvert inlet. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 and 2 were recorded at Elevations 197.2 and 197.5 m, respectively.

4.1.1 Fill

At surface at Borehole Nos. 1 and 2, a layer of fill described as of brown sand, trace gravel, some silt was penetrated. The natural moisture contents measured on samples recovered from this deposit were approximately 36%. A gradation (sieve) analysis was carried out on one (1) sample of this deposit, the results of which indicated 0% gravel size particles, 83% sand size particles, and 17% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT 'N' values of 0 (static weight of hammer) to 2 blow per 300 mm penetration, the relative density/compactness of this deposit was described as very loose. This fill was encountered to

a depth of 0.6 m below grade at Borehole Nos. 1 and 2 (Elevations 196.6 and 196.9 m, respectively).

4.1.2 Upper Sand

Underlying the fill at Borehole Nos. 1 and 2, an upper deposit of sand, some to trace gravel, with to some silt, trace clay was penetrated. Trace decayed wood and organics were encountered in this deposit. The natural moisture content measured on samples recovered from this deposit ranged from 20 to 35%. Gradation (hydrometer) analyses were carried out on two (2) samples of this deposit, and the results indicated 0 to 19% gravel size particles, 55 to 78% sand size particles, 20 to 21% silt size particles and 2 to 5% clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 3 to 64 blows per 300 mm penetration, the relative density/compactness of this deposit was described as very loose to very dense. This deposit was encountered to depths of 1.4 and 2.6 m below grade at Borehole Nos. 1 and 2, respectively (Elevations 195.8 and 194.9 m, respectively).

4.1.3 Silty Clay

Underlying the upper sand stratum at Borehole Nos. 1 and 2, a deposit of silty clay, trace sand was penetrated. The natural moisture content measured on samples recovered from this deposit ranged from 24 to 53%. Gradation (hydrometer) analyses were carried out on two (2) samples of this deposit, and the results indicated 0% gravel size particles, 3 to 8% sand size particles, 40 to 46% silt size particles and 46 to 57% clay size particles (Figure No. L-3, Appendix 3). Atterberg Limits testing was carried out on two (2) samples of this deposit. The Atterberg Limits testing indicated a Liquid Limit ranging from 35 to 46% and a Plastic Limit ranging from 11 to 16% to result in Plastic Index ranging from 24 to 30% (Figure No. L-5, Appendix 4). Based on in-situ shear strengths of 52 to 60 kPa, the consistency of this deposit was described as stiff. This deposit was encountered to depths of 2.3 and 3.7 m below grade at Borehole Nos. 1 and 2, respectively (Elevations 194.9 and 193.8 m, respectively).

4.1.4 Lower Sand

Underlying the silty clay at Borehole Nos. 1 and 2, a lower deposit of sand, with to trace gravel, some to trace silt, trace clay was penetrated. The natural moisture content measured on samples recovered from this deposit ranged from 9 to 36%. Gradation (sieve) analyses were carried out on two (2) samples of this deposit, and the results indicated 6 to 30 gravel size particles, 51 to 87% sand size particles, and 7 to 19% silt and clay size particles (Figure No. L-4, Appendix 3). A gradation (hydrometer) analysis was carried out on one (1) sample of this deposit, the results of which indicated 15% gravel size particles, 59% sand size particles, 19% silt size particles and 7% clay size particles (Figure No. L-4, Appendix 3). Based on SPT 'N' values of 0 (static weight of hammer) to 49 blows per 300 mm penetration, the relative density/compactness of this deposit was described as very loose to dense, generally compact on average. This deposit was encountered to depths of 6.9 and 9.1 m below grade at Borehole

Nos. 1 and 2, respectively (Elevations 190.3 and 188.4 m, respectively), where auger refusal was met.

4.1.5 Bedrock

Underlying the lower sand deposit at Borehole Nos. 1 and 2, bedrock was proven by diamond core drilling. The bedrock was described as pink granite. Based on RQD values of 18 to 40%, the bedrock was described as very poor to poor quality. Based on visual review, the bedrock generally showed negligible weathering. Sampling in the bedrock was terminated at depths of 10.0 and 10.7 m below grade at Borehole Nos. 1 and 2, respectively (Elevations 187.2 and 186.8 m, respectively). Photos of rock cores recovered at Borehole Nos. 1 and 2 are shown in Enclosure No. 4, 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 surface water was measured at Elevation 197.4 m on May 10, 2016.

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 No. 2 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 196.8 m and 197.3 m at Borehole Nos. 1 and 2, respectively, on May 10, 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 5090-06-00

Highway 94

Burford Creek Culvert

Station 11+652

Township of North Himsworth

Reference No: 16/02/16014-F3 December 2016

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Appendix 2 Subsurface Data

Enclosure No. 1	List of Abbreviations and Symbols
Enclosure Nos. 2 and 3	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.

ENCLOSURE NO.:2 (Pg. 1 of 1)

METRIC

RECORD OF BOREHOLE NO. 1

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REFERENCE 16/02/16014-F3 DATUM Geodetic LOCATION N 5119099.6 E 315768.1 - Ferris Twp., Culvert at Station 11+652 ORIGINATED BY JL

PROJECT GWP 5090-06-00, Highway 94 BOREHOLE TYPE Track Mounted CME 45 - Hollow Stem Augers COMPILED BY DM

CLIENT AECOM DATE (Started) 2016 May 10 TIME (Completed) CHECKED BY SH

DATE (Completed) 2016 May 10

ELEV / DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
197.2	Ground Surface										
0.0 / 196.6	FILL - sand, trace gravel, some silt, some grass rootlets, dark brown, very loose		1	SS	2		197				0 83 (17)
0.6 / 195.8	SAND - trace gravel, with silt, some grass rootlets and decayed wood, dark brown		2	SS	64						
1.4 / 194.9	(very dense) SILTY CLAY - trace sand, seams of grey silt, reddish brown		3	SS	2		196	9			0 3 40 57
2.3	(stiff) SAND - with to trace gravel, some silt, trace clay, grey, wet, (compact/dense)		4	SS	10		195				15 59 19 7
			5	SS	18		194				
			6	SS	27		193				
			7	SS	33		192				30 51 (19)
			8	SS	49		191				
190.3											
6.9	Auger Refusal, Start Rock Coring, BEDROCK - pink granite with thin black gneiss, (poor quality)		9	RC	REC= 92% RQD= 35%		190				
			10	RC	REC= 100% RQD= 40%		189				
187.2							188				
10.0	End of Sampling, End of Borehole										

COMMENTS

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) 16/5/10 11:10:00 AM	0.8	2.5
2) 16/5/10 2:00:00 PM	0.4	2.6
3)	-	-

MEL-GEO 16014 - BOREHOLE LOGS - F3.GPJ MEL-GEO.GDT 16/12/20

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ENCLOSURE NO.:3 (Pg. 1 of 1)

METRIC

RECORD OF BOREHOLE NO. 2

Englobe

REFERENCE 16/02/16014-F3 DATUM Geodetic LOCATION N 5119106.3 E 315769.5 - Ferris Twp., Culvert at Station 11+652 ORIGINATED BY JL

PROJECT GWP 5090-06-00, Highway 94 BOREHOLE TYPE Track Mounted CME 45 - Hollow Stem Augers COMPILED BY DM

CLIENT AECOM DATE (Started) 2016 May 10 TIME (Completed) CHECKED BY SH

DATE (Completed) 2016 May 10

ELEV / DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
197.5	Ground Surface						
0.0	FILL - sand, some silt, some grass rootlets		1	SS	WH		
196.9	dark brown (very loose)						
0.6	SAND - some to trace gravel, with to some silt, trace clay, trace organics and grass rootlets		2	SS	7		
	dark brown to brown		3	SS	12		
	(loose/compact)						
194.9			4A	SS	3		
2.6	SILTY CLAY - trace sand seams of grey silt		4B				
	reddish brown, wet		5	SS	WH		
193.8	(stiff)						
3.7	SAND - trace gravel, trace silt		6	SS	5		
	grey, wet						
	(very loose/compact)		7	SS	WH		
			8	SS	22		
			9	SS	3		
188.4			10	SS	20/0mm		
9.1	Auger Refusal Start Rock Coring						
	BEDROCK - pink granite, highly jointed		11	RC	REC= 83% RQD= 18%		
	(very poor quality)						
186.8							
10.7	End of Sampling End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa 20 40 60 80 100

○ UNCONFINED + FIELD VANE

● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	(SI	CL)
0	78	20	2
19	55	21	5
0	8	46	46
6	87		(7)

COMMENTS

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) 16/5/10 4:30:00 PM	0.8	3.1
2) 16/5/10 6:40:00 PM	0.15	2.9
3)	-	-

MEL-GEO 16014 - BOREHOLE LOGS - F3.GPJ MEL-GEO.GDT 16/12/20

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Appendix 3 Borehole Plan and Lab Data

Drawing No. 2:	Borehole Location and Soil Strata
Figure Nos. L-1 and L-4:	Grain Size Distribution Curves
Figure No. L-5:	Atterberg Limits
Table No. L-6:	Shear Strength Summary
Table No. L-7:	Lab Test Summary Sheet
	Soil Chemical Tests

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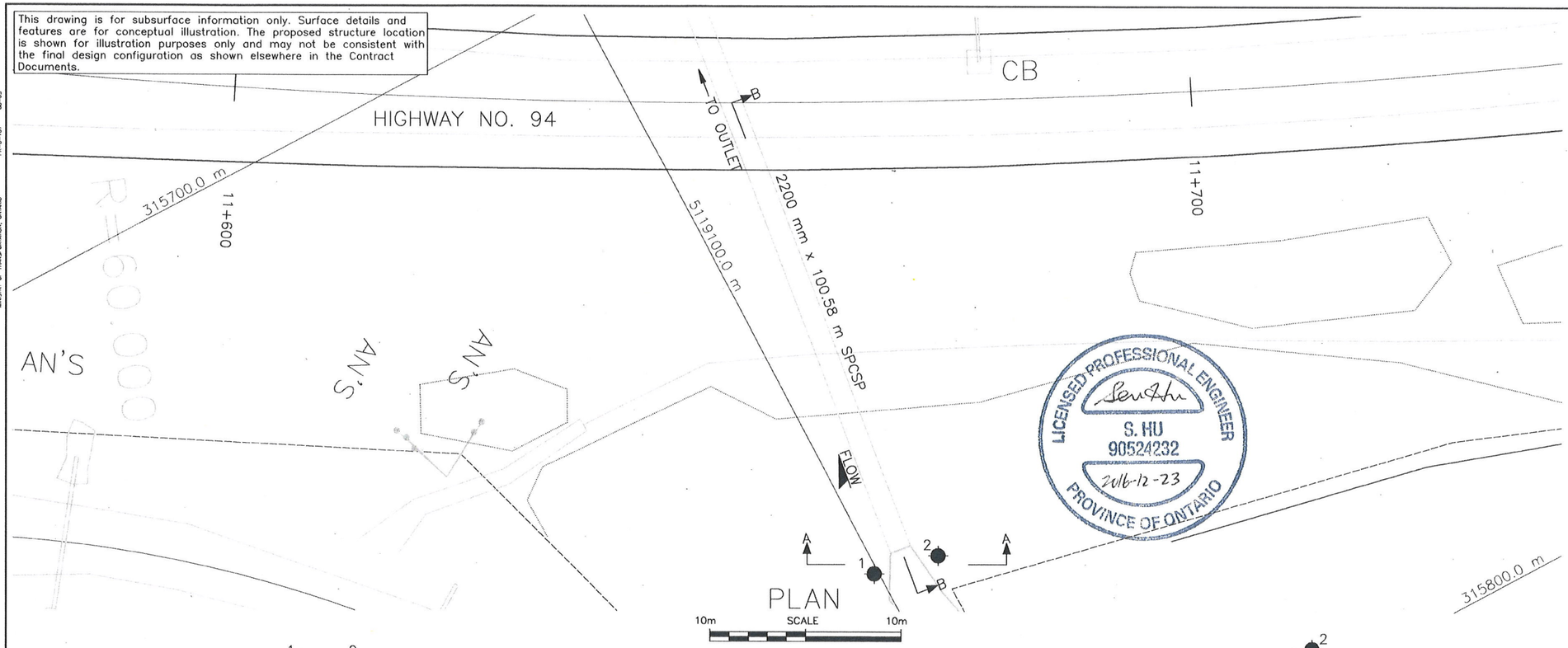
This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The proposed structure location is shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.



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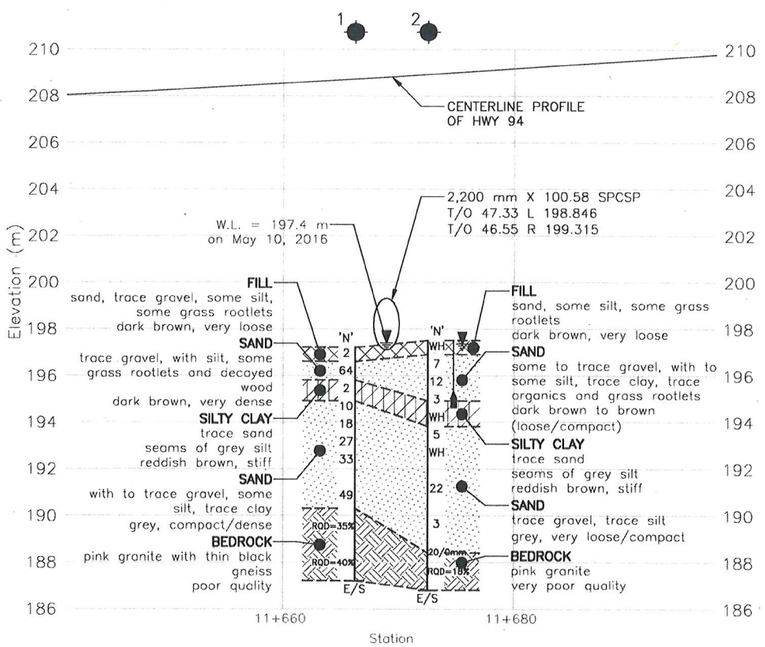

CROSS SECTION A–A

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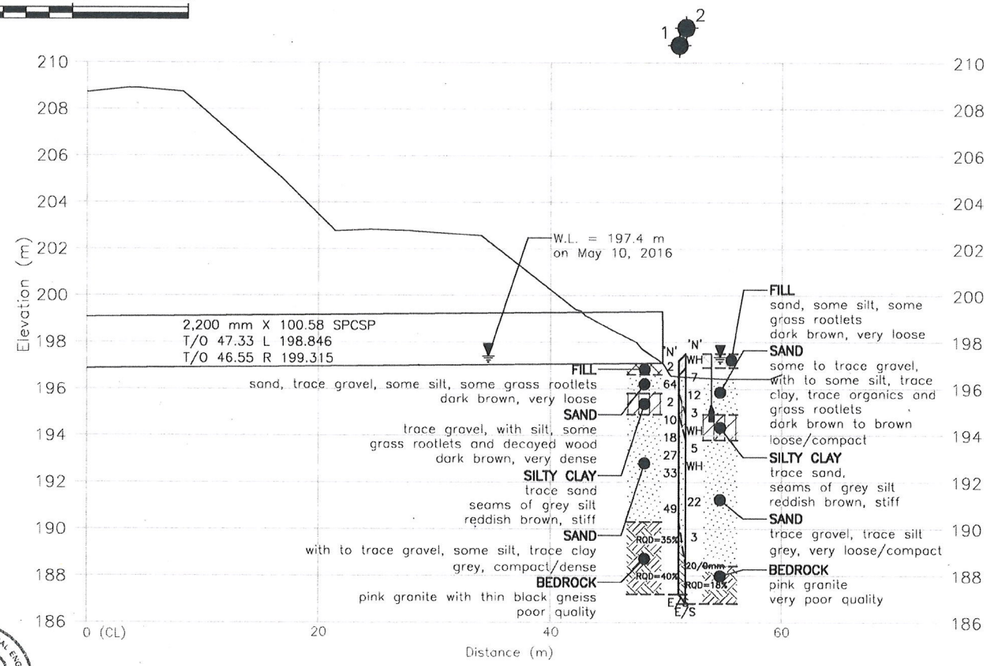
VERT 5 2.5 0 5 10m



CROSS SECTION B–B

SCALE
HOR 10 5 0 10 20m
VERT 5 2.5 0 5 10m

REGISTERED PROFESSIONAL ENGINEER
M. H. MacKAY
PROVINCE OF ONTARIO

2016-12-28

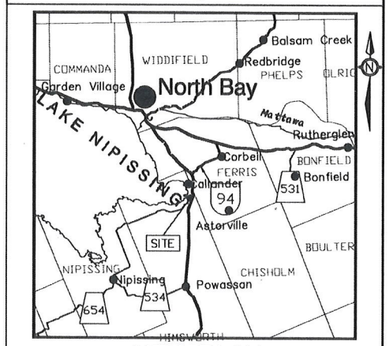
DISTRICT
CONT. No.
GWP No. 5090-06-00

HWY 94 CULVERT
STA. 11+652
BURFORD CREEK

BOREHOLE LOCATIONS AND SOIL STRATIGRAPHY

DRAWING 2

Englobe



KEY PLAN
N.T.S.

LEGEND

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

BOREHOLE No.	ELEVATION	O/S	NORTHING	EASTING
1	197.2	49.1 Rt	5119099.6	315768.1
2	197.5	47.3 Rt	5119106.3	315769.5

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 Aecom on June 29, 2016

Coordinates based on MTM Zone 10 NAD83 CSRS

GEOCRES No. 31L-199

REVISIONS			
JUL/16	DM	DRAFT	
DEC/16	DM	FINAL	
		DESCRIPTION	

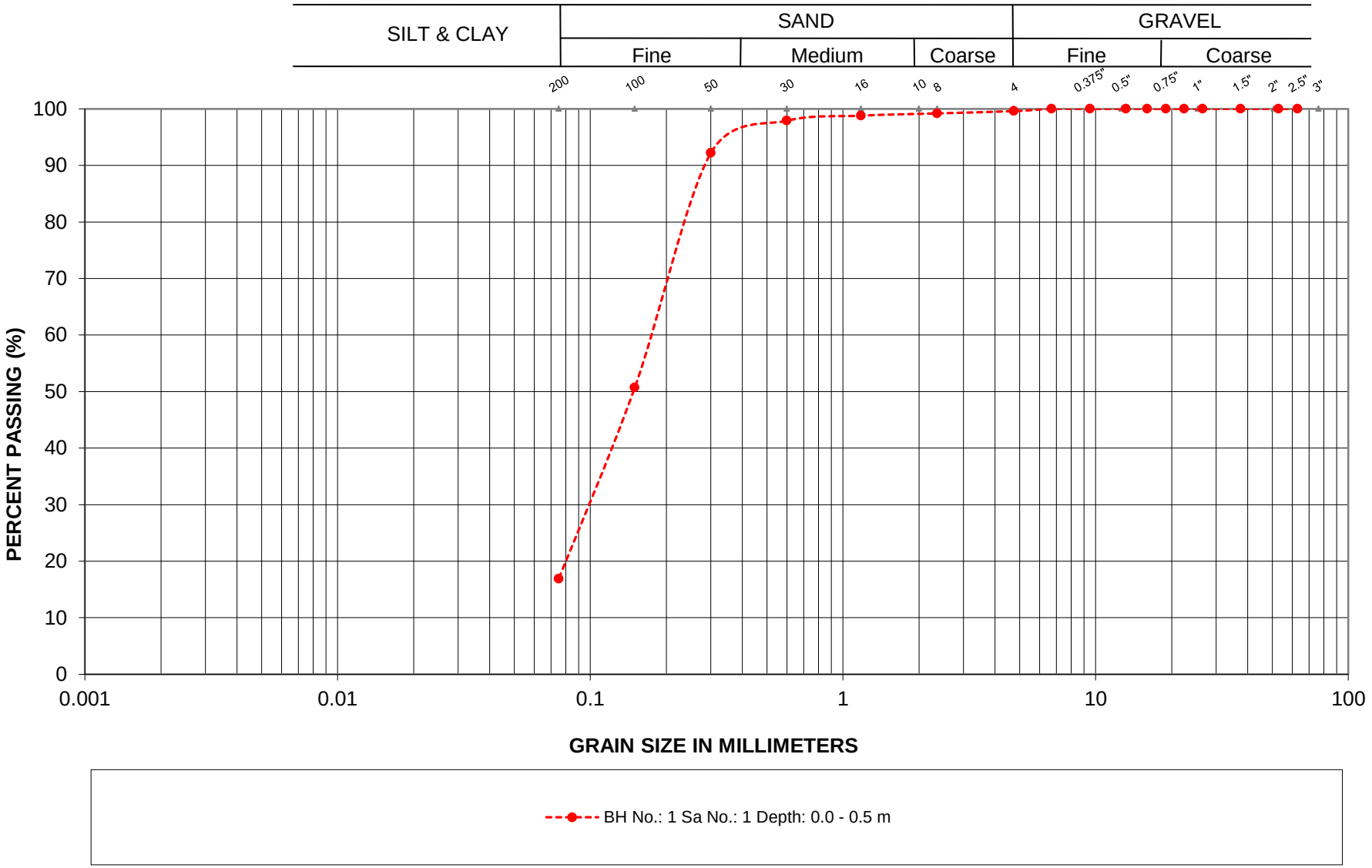
DESIGN	CHK	CODE	LOAD	DATE DEC/16
DRAWN DM	CHK SH	SITE	STRUCT SCHEME	DWG 2

MINISTRY OF TRANSPORTATION, ONTARIO
RR-0-707 88-05

CAD FILE LOCATION AND NAME=\2016\16014 - PAV & FDN. Hwy 94 & 63 (AECOM)\FOUNDATIONS\Drawings\F3\16014 F3 - 11+652.dwg
MODIFIED=12/9/2016 11:35:29 AM BY MTCDU
DATE PLOTTED=12/9/2016 11:39:45 AM BY: DUNCAN MITCHELL

Reference No.: 16/02/16014-F3
Date: July 2016

GRAIN SIZE ANALYSIS



FILL

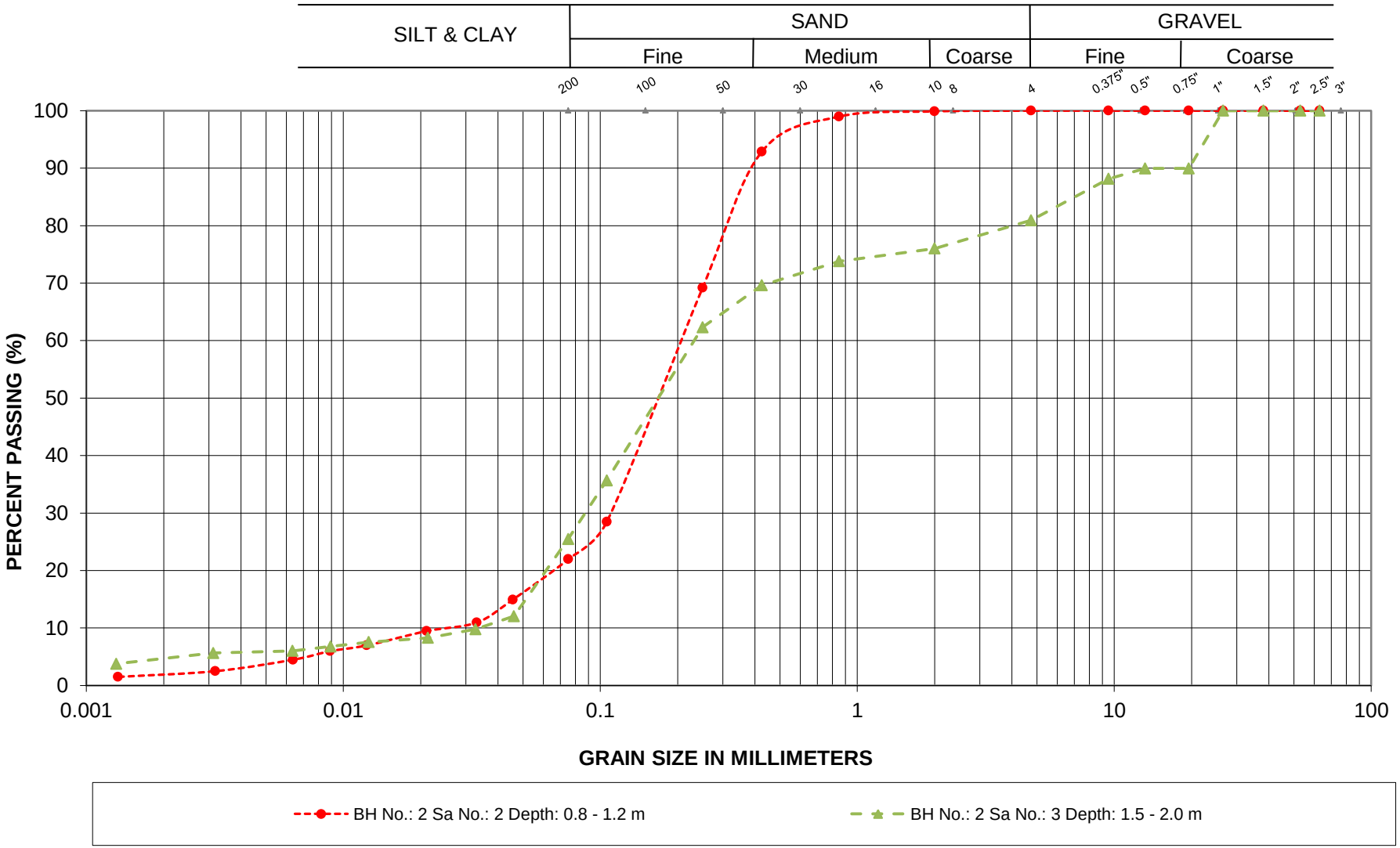
LOCATION: Hwy 94, Station 11+652
TWP of North Himsworth

Englobe Corp.

FIGURE L-1

Reference No.: 16/02/16014-F3
Date: July 2016

GRAIN SIZE ANALYSIS



SAND (upper)

LOCATION: Hwy 94, Station 11+652
TWP of North Himsworth

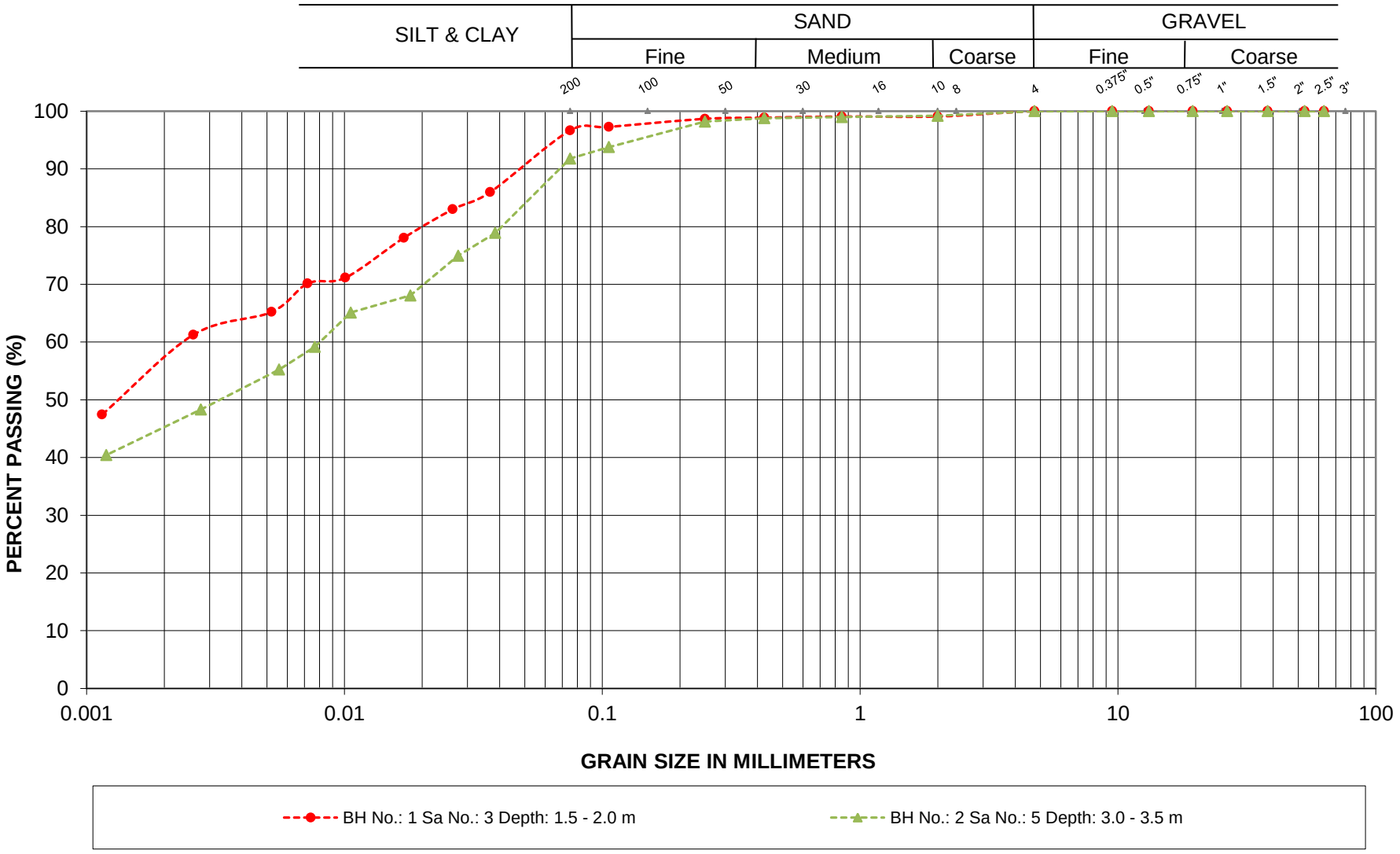
Englobe Corp.

FIGURE L-2

Reference No.: 16/02/16014-F3
Date: July 2016

Englobe

GRAIN SIZE ANALYSIS



SILTY CLAY

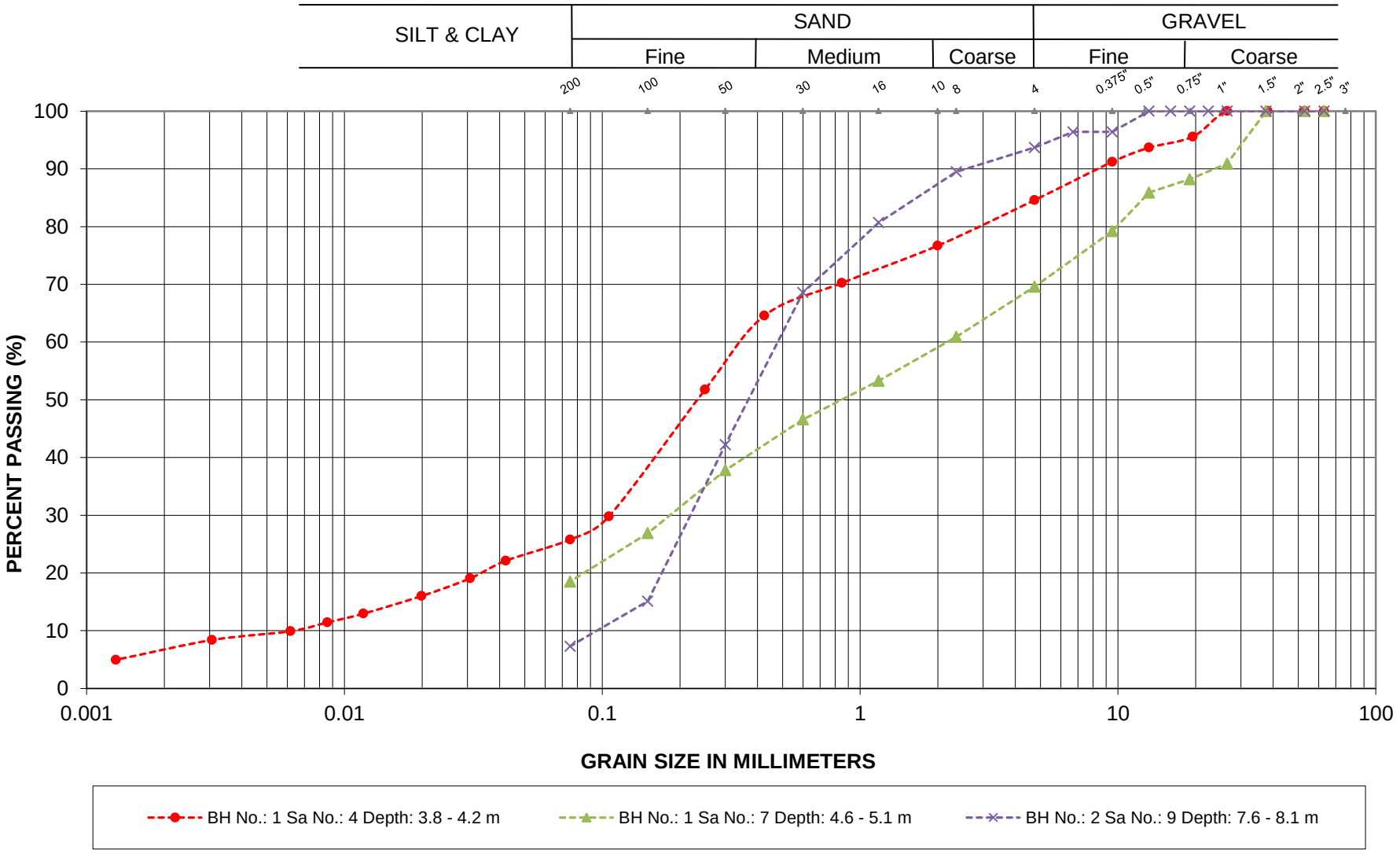
LOCATION: Hwy 94, Station 11+652
TWP of North Himsworth

Englobe Corp.

FIGURE L-3

Reference No.: 16/02/16014-F3
Date: July 2016

GRAIN SIZE ANALYSIS



SAND (lower)

LOCATION: Hwy 94, Station 11+652
TWP of North Himsworth

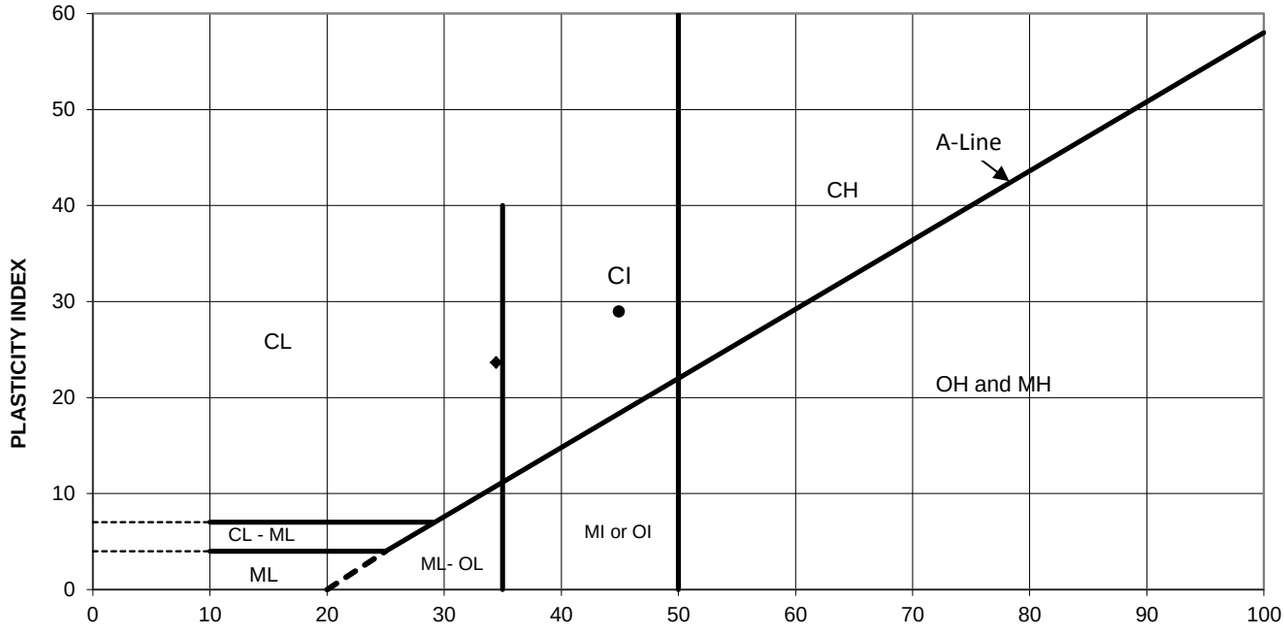
Englobe Corp.

FIGURE L-4

ATTERBERG LIMITS TEST RESULTS

FIGURE L-5

ATTERBERG INDICES



SYMBOL	BH	Sa. No.	Depth(m)	Elev.(m)	Liquid Limit	Plastic Limit	Plasticity Index	NMC %
●	1	3	1.8	195.4	45.0	16.0	28.9	53.1
◆	2	5	3.3	194.2	34.5	10.8	23.6	23.8

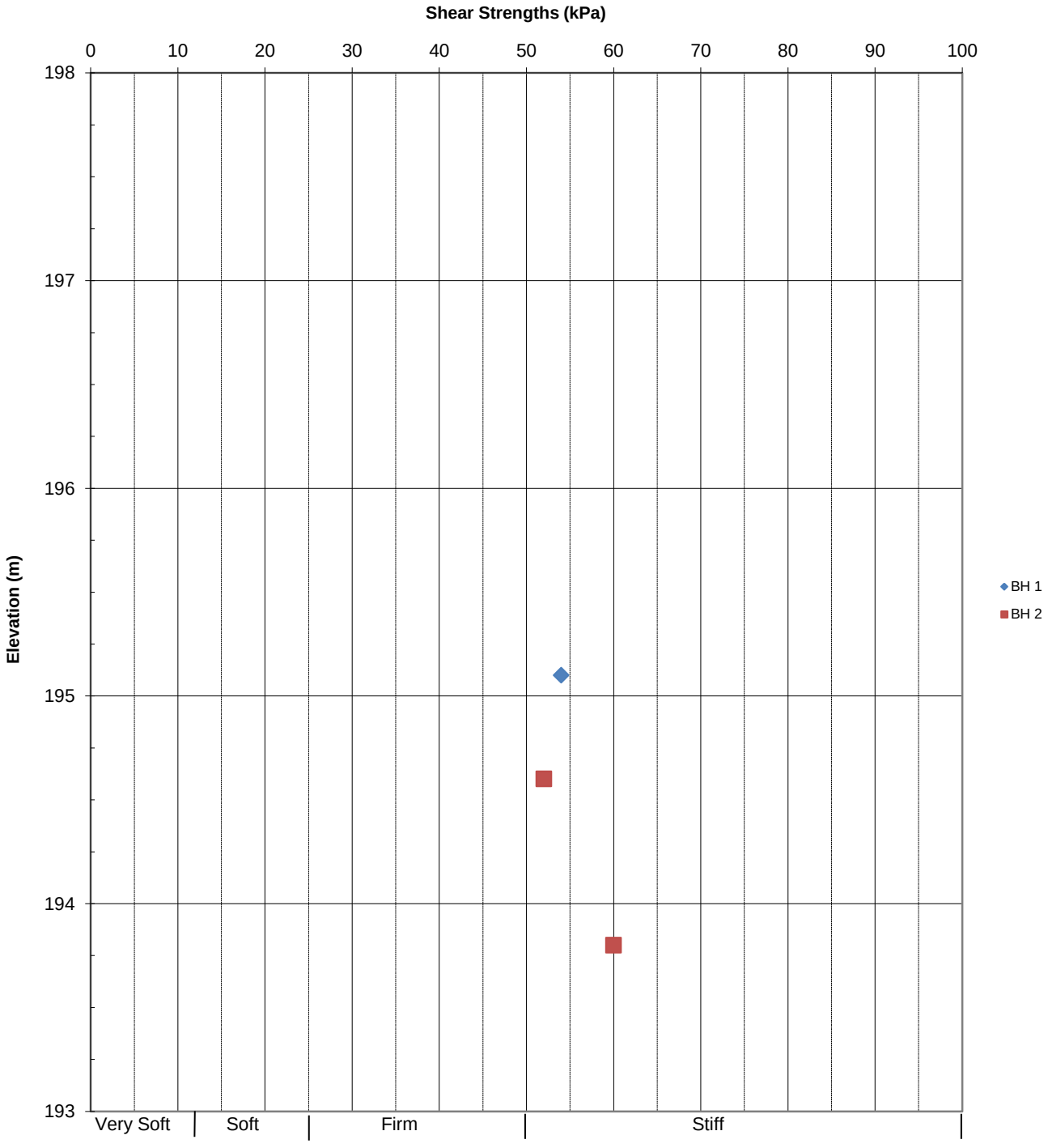
Date: Aug-16
Project: Hwy 94
Location: Sta. 11+652, Twp. of North Himsworth

Prep'd: AT
Chkd: SH
Ref. No.: 16/02/16014-F3

Englobe Corp.

IN-SITU SHEAR STRENGTHS	Figure No. L-6

In-Situ Shear Strengths vs. Elevation



Ref No.:16/02/16014-F3
Project: Hwy 94 Station 11+652,
Twp of North Himsworth

Englobe Corp.

Date: July 2016

Reference No.: 16/02/16014-F3
Date: July 2016

Laboratory Tests - Summary Sheet

Englobe

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	0	83	17		36.1				2			
	2	0.8					34.5				64			
	3	1.5	0	3	40	57	53.1	46.0	16.0	30.0	2			
	4	2.3	15	59	19	7	16.9				10			
	5	3.1					13.5				18			
	6	3.8					12.8				27			
	7	4.6	30	51	19		8.8				33			
	8	6.1					15.5				49			
	9	6.9												Rec= 92%, RQD= 35%
	10	8.5												Rec= 100%, RQD= 40%
2	1	0.0					35.8				WH			
	2	0.8	0	78	20	2	23.1				7			
	3	1.5	19	55	21	5	20.2				12			
	4A	2.3					21.9				3			
	4B	2.6					31.8							
	5	3.1	0	8	46	46	23.8	34.5	10.8	23.7	WH			
	6	3.8					35.8				5			
	7	4.6					24.6				WH			
	8	6.1					16.3				22			
	9	7.6	6	87	7		16.9				3			
	10	9.1									20/0mm			
	11	9.1												Rec= 83%, RQD= 18%

Project: Hwy 94, Sta. 11+652, Township of North Himsworth

Table No. L-7

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: ENGLOBE CORP
120 PROGRESS CRT.
NORTH BAY , ON P1A0C2
(705) 476-2550

ATTENTION TO: Victoria Steuernol

PROJECT: 16014

AGAT WORK ORDER: 16T117690

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Jul 27, 2016

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 16T117690

PROJECT: 16014

CLIENT NAME: ENGLOBE CORP

ATTENTION TO: Victoria Steuernol

SAMPLING SITE:

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2016-07-20

DATE REPORTED: 2016-07-27

SAMPLE DESCRIPTION:				F6, BH 1, Sa 8	F3, BH 2, Sa4-B	F4, BH 4, Sa 2	F1, BH 1, Sa 9		F5, BH 2, Sa 6
SAMPLE TYPE:				Soil	Soil	Soil	Soil		Soil
DATE SAMPLED:				7/18/2016	7/18/2016	7/18/2016	7/18/2016		7/18/2016
Parameter	Unit	G / S	RDL	7717962	7718034	7718036	7718038	RDL	7718040
Sulphide*	%		0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Chloride (2:1)	µg/g		2	133	12	<2	61	4	868
Sulphate (2:1)	µg/g		2	271	61	<2	19	4	37
pH (2:1)	pH Units		NA	6.70	7.93	6.88	7.42	NA	8.26
Electrical Conductivity (2:1)	mS/cm		0.005	0.567	0.188	0.047	0.164	0.005	1.54
Resistivity (2:1)	ohm.cm		1	1760	5320	21300	6100	1	649
Redox Potential (2:1)	mV		5	370	292	357	354	5	286

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7717962-7718038 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

7718040 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

Elevated RDL indicates the degree of sample dilution prior to the analysis for Anions in order to keep analyte within the calibration range of the instrument and to reduce matrix interference.

Certified By: Amanjot Bhela

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: ENGLOBE CORP

AGAT WORK ORDER: 16T117690

PROJECT: 16014

ATTENTION TO: Victoria Steuernol

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: Jul 27, 2016			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Corrosivity Package															
Sulphide*	7717962	7717962	<0.05	<0.05	NA	< 0.05	110%	80%	120%	NA			NA		
Chloride (2:1)	7718040	7718040	868	860	0.9%	< 2	97%	80%	120%	100%	80%	120%	105%	70%	130%
Sulphate (2:1)	7718040	7718040	37	36	2.7%	< 2	94%	80%	120%	100%	80%	120%	108%	70%	130%
pH (2:1)	7718040	7718040	8.26	8.34	1.0%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	7718040	7718040	1.54	1.54	0.0%	< 0.005	99%	90%	110%	NA			NA		
Redox Potential (2:1)	7718040	7718040	286	286	0.0%	< 5	100%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: ENGLOBE CORP

AGAT WORK ORDER: 16T117690

PROJECT: 16014

ATTENTION TO: Victoria Steuernol

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulphide*	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario
L4Z 1Y2
www.agatlabs.com · webearth.agatlabs.com
Ph.: 905.712.5100 · Fax: 905.712.5122 · Toll Free: 800.856.6261

Chain of Custody Record

Laboratory Use Only
Arrival Temperature: 16.1 117690
AGAT WO #:
Lab Temperature: 86849
Notes:

Client Information:

Company: Englobe Corp
Contact:
Address: 2- 120 Progress Court
North Bay, Ontario, P1A 0C2
Phone: 705-476-2550 Fax: 705-476-8882
Project: 16014 PO:
AGAT Quotation #:

Please note, if quotation number is not provided, client will be billed full price for analysis.

Regulatory Requirements:

☐ **Regulation 153/09** (reg. 511 Amend.)
Table ____ *Indicate one*
☐ Ind/Com
☐ Res/Park
☐ Agriculture
Soil Texture *(check one)*
☐ Coarse ☐ Fine

☐ **Sewer Use**
Region ____ *Indicate one*
☐ Sanitary
☐ Storm

☐ **Regulation 558**
☐ **CCME**
☐ **Other** *(specify)*
☐ **Prov. Water Quality Objectives (PWQO)**
☐ **None**

Turnaround Time Required (TAT) Required*

Regular TAT
☑ 5 to 7 Working Days
Rush TAT (please provide prior notification)
Rush Surcharges Apply
☐ 3 Working Days
☐ 2 Working Days
☐ 1 Working Day
OR
Date Required (Rush surcharges may apply):
**TAT is exclusive of weekends and statutory holidays*

Invoice To:

Same: Yes ☑ No ☐
Company: Same
Contact:
Address:

Is this a drinking water sample? (potable water intended for human consumption) ☐ Yes ☑ No
If "Yes", please use the *Drinking Water Chain of Custody Form*

Is this submission for a **Record of Site Condition?** ☐ Yes ☑ No

Legend Matrix

GW Ground Water **O** Oil
SW Surface Water **P** Paint
SD Sediment **S** Soil

Report Information – reports to be sent to:

1. Name: Victoria Steuernol
   Email: Victoria.Steuernol@englobecorp.com
2. Name: Sen Hu
   Email: sen.hu@englobecorp.com

Sample Identification	Date Sampled	Time Sampled	Sample Matrix	# of Containers	Comments Site/Sample Information	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	ORPs: ☐ B-HWS ☐ Cl- ☐ CN- ☐ EC ☐ FOC ☐ Cr+6- ☐ SAR ☐ NO_3/NO_2 ☐ N-Total ☐ Hg ☐ pH	Nutrients: ☐ TP ☐ NO_3 ☐ NO_2 ☐ NH_3 ☐ NO_3/NO_3 ☐ TKN	VOC: ☐ VOC ☐ THM ☑ BTEX	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	TCLP: PHC F1 to F4	Sewer Use	Corrosivity Package
F6, BH 1, Sa 8			s	1																	X
F3, BH 2, Sa4-B			s	1																	X
F4, BH 4, Sa 2			s	1																	X
F1, BH 1, Sa 9			s	1																	X
F5, BH 2, Sa 6			s	1																	X

Samples Relinquished by (print name & sign):	Date/Time	Samples Received by (Print name & sign):	Date/Time
Victoria Steuernol	07/1/16 4pm	Sina	16/7/20 10:30
Samples Relinquished by (print name & sign):	Date/Time	Samples Received by (Print name & sign):	Date/Time

Pink Copy – Client
Yellow + Golden Copy – AGAT
White Copy – AGAT

Page ____ of ____
NO:

Document ID: DIV-78-1511.006
Date Issued: July 20, 2011

Appendix 4 Photo Essay

Enclosure No. 4: Photo Essay

Existing Culvert Inlet – Looking West	Photo: 1

Project: Hwy 94 – Burford Creek Culvert, Station 11+652, Township of North Himsworth	Photos Provided By: Englobe Date: May 2016

Rock Cores – Borehole 1 (left) and Borehole 2 (right)	Photos: 2 and 3

Project: Hwy 94 – Burford Creek Culvert, Station 11+652, Township of North Himsworth	Photos Provided By: Englobe Date: May 2016