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 – Holledge Creek Culvert
Highway 11
Station 15+735 – Township of Owens
Site No. 39W-107
GWP 163-98-00

FINAL FOUNDATION INVESTIGATION REPORT

Date: February 23, 2016
Ref. N^{o}: 15/05/15059-F1

Geocres No. 42G-60

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Final Foundation Investigation Report

Prepared by:

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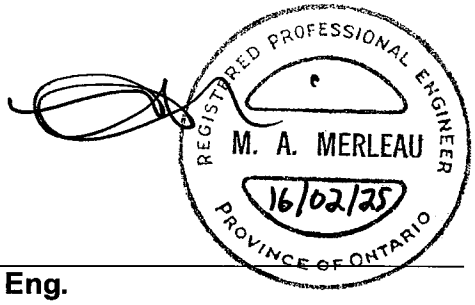

Reviewed by:

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Property and Confidentiality

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Attention: **Mr. Al Rose**

REVISION AND PUBLICATION REGISTER		
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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 culvert site. The site has been described as the Holledge Creek Culvert, Site No. 39W-107. The site is located on Highway 11 at Station 15+735 in the Township of Owens, some 0.6 km west of the intersection between Highway 11 and Owens Road North.

The foundation investigation location was specified by the MTO in the Terms of Reference for work under Agreement No. 5014-E-0001: GWP 163-98-00. The terms of reference for the scope of work are outlined in Englobe's Proposal Reference No. P-14-178 dated February 18, 2015. The purpose of this investigation was to determine the subsurface conditions in the area of the existing culvert. Englobe investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

Following completion of the field investigation, as outlined in the RFP, the MTO indicated that the proposed work at the culvert location would be changed from replacement to rehabilitation, based on the result of structural review. During September 2015, MTO instructed Englobe to proceed with the full foundation investigation and design report as outlined in the RFP.

2 SITE DESCRIPTION

The Corrugated Steel Pipe (CSP) culvert is located on Highway 11 at Station 15+735 in the Township of Owens. The topography of this site is generally flat. 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 granular fill embankment some 5.9 to 7.1 m in height, with centerline elevation of 215.1 m at the culvert location. The existing embankment slopes in the area of the culvert have been constructed at an angle of approximately 1.5H:1V. The culvert at this location is a 3.9 m diameter Corrugated Steel Pipe (CSP) culvert, some 30.5 m in length, as surveyed by others. The flow through the culvert is from the south to the north (right to left).

Infrastructure at this site consists of overhead and underground communication lines running parallel to the highway embankment. An Ontario Northland Rail Line runs adjacent to the south of the highway embankment.

2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

This project is located in the Geomorphic Sub-province known as the Cochrane Clay Plain. The topography on this section of Highway 11 is generally flat. Significant layers of soil overlay the bedrock. Within the project area native overburden primarily consists of silty clays, silts and tills.

Bedrock in the area, as indicated on OGS Map 2506, is of the Early Precambrian felsic igneous and metamorphic rocks consisting of granitic, metasedimentary, and minor metavolcanic migmatite.

3 INVESTIGATION PROCEDURES

The fieldwork for this investigation was carried out during the period between July 22nd and July 26th, 2015 during which time four (4) sampled boreholes were advanced. Two (2) boreholes were advanced through the embankment at the location of the culvert, and a single borehole was advanced adjacent to each of the inlet (south) and outlet (north) ends of the culverts.

The field investigation was carried out using a bombardier 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. 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 single 19 mm diameter standpipe was installed in selected open boreholes prior to backfilling to allow for post borehole completion monitoring of the shallow groundwater levels. All open boreholes were backfilled upon completion with compacted auger cuttings in the general order 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 borehole 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, who was responsible for locating the boreholes, clearing the borehole locations of underground services, in-situ sampling and testing operations, logging of the boreholes, labeling and preparation of samples for transport to our North Bay laboratory, plus overall drill supervision. All samples received a visual confirmatory inspection in our laboratory. Laboratory testing of select samples included routine testing for natural moisture content determination and particle size analysis. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix 2), with a summary of results presented on the laboratory sheets in Appendix 3 (Figures Nos. L-1 to L-8 and Table No. L-9).

The location of the individual boreholes was determined in the field using highway chainage (established by others) and offset relative to highway centerline. The MTO co-ordinates, northing and easting, were then established for the boring locations, using coordinates from MTM Zone 13, NAD 83 CSRS. The borehole elevations are based on coordinating the borehole locations with the Highway survey carried out by Callon Dietz Inc. Elevations contained in this report are referenced to a 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 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 15+735, TWP OF OWENS

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 adjacent to the culvert and Borehole Nos. 3 and 4 advanced adjacent to the culvert inlet and outlet, respectively. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 4, inclusive, were recorded at elevations 214.9, 215.0, 211.4, and 211.2 m, respectively.

4.1.1 Pavement Structure

Borehole No. 1 and 2 were advanced through the embankment shoulder where a layer of crushed gravel some 205 and 255 mm thick was penetrated, respectively.

4.1.2 Granular Fill

Underlying the pavement structure at Borehole Nos. 1 and 2, a layer of granular fill consisting of brown sand, trace to with gravel, trace to some silt and clay was penetrated. A mixture of brown sand and grey silty clay, trace gravel, was encountered at the bottom interface between the fill layer and the native soils at Borehole Nos. 1 and 2. The natural moisture content measured on samples of this deposit was in the order of 4 to 21%. Gradation analyses were carried out on five (5) samples of this deposit, the results of which indicated 4 to 23% gravel size particles, 67 to 87% sand size particles, and 7 to 11% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT ‘N’ values of 5 to 31 blows per 300 mm penetration, the compactness of this

deposit was described as loose to dense, generally compact. This granular fill layer was encountered to depths of 5.9 and 7.1 m below grade at Borehole Nos. 1 and 2, respectively (elevations 209.0, and 207.9 m, respectively).

4.1.3 Organic Soils

At ground surface at Borehole No. 3, a layer of silty organic soils was penetrated. This organic soil layer was encountered to an approximate depth of 0.2 m below ground surface at Borehole No. 3 (elevation 211.2 m).

4.1.4 Mixed Fills

Underlying the organic soils at Borehole No. 3, a layer of mixed fills consisting of a mixture of brown silty sands and grey silty clay, trace gravel, trace sand, containing organic soils, rootlets, and wood was penetrated. The natural moisture content measured on samples of this deposit was in the order of 3 to 38%. A gradation (hydrometer) analyses was carried out on one (1) sample of this deposit, the results of which indicated 0% gravel size particles, 19% sand size particles, 51% silt size particles and 30% clay size particles (Figure No. L-2, Appendix 3). Based on in-situ shear strengths of 80 kPa to greater than 100 kPa, the consistency of this deposit was described as stiff to very stiff. This fill layer was encountered to a depth of 2.9 m below grade at Borehole No. 3 (elevation 208.5 m).

4.1.5 Sandy Silt

Underlying the granular fills at Borehole No. 2 a deposit of grey sandy silt trace clay was penetrated. The natural moisture content measured on one sample of this deposit was in the order of 17%. A gradation (hydrometer) analysis was carried out on one (1) sample of this deposit, the results of which indicated 0% gravel size particles, 37% sand size particles, 54% silt size particles, and 9% clay size particles (Figure No. L-3, Appendix 3). Based on a SPT 'N' values of 49 blows per 300 mm penetration, the compactness state of this deposit was described as dense. This deposit was encountered to a depth of 9.4 m below grade at Borehole No. 2 (elevation 205.6 m).

4.1.6 Silty Clay

Underlying the granular fills at Borehole No. 1, underlying the sandy silt at Borehole No. 2, and underlying the mixed fills at Borehole Nos. 3, and at surface at Borehole No. 4, a deposit of grey silty clay, trace to some gravel, trace sand, was penetrated. Organic soils, rootlets and decayed wood were encountered in this deposit at Borehole No. 1 and 4. The natural moisture content measured on samples of this deposit was in the order of 18 to 55%. Gradation (hydrometer) analysis were carried out on two (2) samples of this deposit, the results of which indicated 0% gravel size particles, 6 to 13% sand size particles, 58 to 62% silt size particles, and 25 to 36% clay size particles (Figure No. L-4, Appendix 3). Atterberg Limits testing was carried out on two (2) samples of this deposit, the results of which indicated a Plastic Limit in the order of 13 to 14% and a Liquid Limit in the order of 23 to 30% (Figure No. L-8, Appendix

3). Based on in situ shear strengths of 52 to greater than 100 kPa, the consistency of this deposit was described as stiff to very stiff, generally very stiff. This deposit was encountered to depths of 8.6, 3.8, and 5.7 m below grade at Borehole Nos. 1, 3, and 4, respectively (elevations 206.3, 207.6, and 205.5 m, respectively). Sampling was terminated in this deposit at a depth of 9.8 m below grade at Borehole No. 2 (elevation 205.2 m).

A layer of silty clay was also encountered between silt layers at Borehole No 3. This silty clay deposit was encountered between depths of 5.6 to 7.2 m below grade (elevations 205.8 to 204.2 m). Based on in situ shear strengths of 52 kPa, the consistency of this layer was described as stiff.

4.1.7 Silt

Underlying/interbedded in the silty clay deposit at Borehole Nos. 1 and 3, a deposit of grey silt trace gravel trace to some sand trace clay was penetrated. The natural moisture content measured on samples of this deposit was in the order of 14 to 29%. A gradation (hydrometer) analysis was carried out on one (1) sample of this deposit, the results of which indicated 0% gravel size particles, 13% sand size particles, 80% silt size particles, and 7% clay size particles (Figure No. L-5, Appendix 3). Based on SPT 'N' values of 14 to 37 blows per 300 mm penetration, the compactness state of this deposit was described as compact to dense. At Borehole No. 1, sampling was terminated in this deposit at a depth of 9.8 m below grade (elevation 205.1 m). Two layers of the silt deposit were encountered at Borehole No. 3, from depths of 3.8 to 5.6 m below grade (elevations 207.6 to 205.8 m) and from depths of 7.2 to 8.6 m below grade (elevations 204.2 to 202.8 m).

4.1.8 Till

Underlying the silt at Borehole No. 3, and underlying the silty clay at Borehole No. 4, a deposit of grey clayey silt till, trace gravel, sandy was penetrated. The natural moisture content measured on samples of this deposit was in the order of 14 to 17%. Gradation (hydrometer) analysis were carried out on two (2) samples of this deposit, the results of which indicated 3 to 5% gravel size particles, 24 to 31% sand size particles, 54% silt size particles, and 12 to 17% clay size particles (Figure No. L-6, Appendix 3). Atterberg Limits testing was carried out on two (2) samples of this deposit, the results of which indicated a Plastic Limit in the order of 11 to 12% and a Liquid Limit in the order of 16 to 18% (Figure No. L-8, Appendix 3). Sampling was terminated in this deposit at a depth of 9.8 m below grade at Borehole No. 3 (elevation 201.6 m).

A transition from clayey silt till to sandy silt till was observed at a depth of some 7.1 m below grade at Borehole No. 4 (elevation 204.1 m). The natural moisture content measured on samples of the sandy silt deposit was in the order of 11 to 12%. Gradation (hydrometer) analysis were carried out on one (1) sample of this deposit, the results of which indicated 5% gravel size particles, 26% sand size particles, 61% silt size particles, and 8% clay size particles

(Figure No. L-7, Appendix 3). Sampling was terminated in this deposit at a depth of 9.8 m below grade at Borehole No. 4 (elevation 201.4 m).

4.2 GROUNDWATER DATA

During the period of investigation (July 22nd to 26th, 2015), the creek water level was measured at an elevation of some 210.6 m at the culvert outlet. The creek flows in a northerly direction.

Measurements of the water levels and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. Standpipes were 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 water levels were measured in the standpipes (between July 22th and 28th, 2015) and recorded at elevations 211.8 m and 207.2 m at Borehole Nos. 1 and 3, respectively. The water level in Borehole No. 3 may not have stabilized.

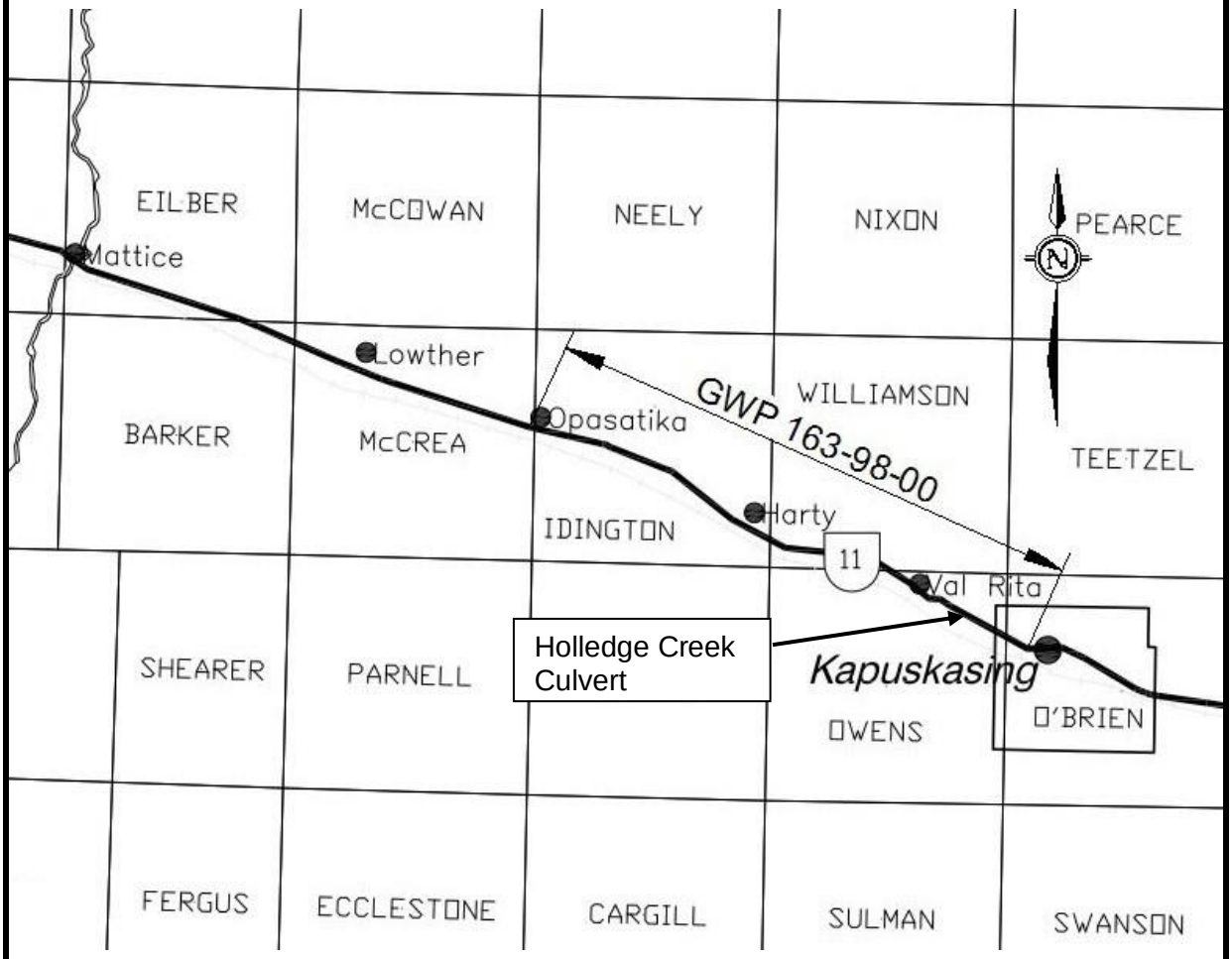
The groundwater and river water levels will fluctuate seasonally/yearly.

Appendix 1 Key Plan

Drawing No. 1 Key Plan

MACRO KEY PLAN Drawing No. 1

NOT TO SCALE



FOUNDATION INVESTIGATION REPORT
GWP 163-98-00
Highway 11
Station 15+735 Culvert
Township of Owens

Reference No: 15/05/15059-F1 February 2016

Englobe

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.

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

METRIC

RECORD OF BOREHOLE NO. 1

Englobe

REFERENCE 15/05/15059-F1 DATUM Geodetic LOCATION N 5477452.3 E 414722.9 - Owens Twp., Station 15+732 ORIGINATED BY JL

PROJECT GWP 163-98-00, Highway 11 BOREHOLE TYPE Track Mounted CME 45 - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 22 July 2015 TIME (Completed) 1:45:00 PM CHECKED BY MAM

DATE (Completed) 22 July 2015

ELEV / DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
214.9	Ground Surface										
0.0	205 mm Crushed Gravel GRANULAR FILL- sand, trace to with gravel, trace to some silt brown, moist (dense/loose)		1	SS	26		214				
			2	SS	23						23 67 (10)
			3	SS	31		213				
			4	SS	13						
			5	SS	5	▼	212				4 87 (9)
			6	SS	8		211				
			7	SS	15		210				17 72 (11)
209.3			8A	SS	7						
5.6	mixture of brown sand and grey silty clay, trace gravel		8B								
209.0							209				
5.9	silty CLAY - some sand, trace grass rootlets seams of sand brown to grey (very stiff/stiff)		9	SS	5			>100			
			10	SS	WH		208				
206.3							207	vane couldn't be advanced			0 13 62 25
8.6	SILT - trace silt trace clay (compact) grey		11	SS	28	▼	206				
205.1											
9.8	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) 22/7/15 1:45:00 PM	9.2	-
2) 26/7/15 10:00:00 AM	3.1	-
3)	-	-

MEL-GEO 15059 - F1 BOREHOL LOGS.GPJ MEL-GEO.GDT 12/2/16

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

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

METRIC

RECORD OF BOREHOLE NO. 2

Englobe

REFERENCE 15/05/15059-F1 DATUM Geodetic LOCATION N 5477442.3 E 414723.5 - Owens Twp., Station 15+737 ORIGINATED BY JL

PROJECT GWP 163-98-00, Highway 11 BOREHOLE TYPE Track Mounted CME 45 - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 22 July 2015 TIME (Completed) 4:45:00 PM CHECKED BY MAM

DATE (Completed) 22 July 2015

ELEV / DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
215.0	Ground Surface										
0.0	255 mm Crushed Gravel		1	SS	26						
	GRANULAR FILL- sand, trace to some gravel, trace to some silt										
	brown, moist		2	SS	15		214				
	(compact/loose)										
			3	SS	19		213				11 78 (11)
			4	SS	11		212				
			5	SS	9						
			6	SS	8		211				
	wet		7	SS	8		210				
209.1			8	SS	8						8 85 (7)
5.9	mixture of brown sand and grey silty clay, trace gravel		9	SS	5		209				
207.9							208				
7.1	sandy SILT, trace clay		10	SS	49		207				0 37 54 9 (NP)
	(dense)										
205.6							206				
9.4	silty CLAY - trace sand, seams of silt		11	SS	28			vane couldn't be advanced			
205.2	grey (very stiff)										
9.8	End of Sampling End of Borehole										

COMMENTS

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

$+^3$, $\times^3$: 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) 22/7/15 4:45:00 PM	Dry	4.4
2)	-	-
3)	-	-

MEL-GEO 15059 - F1 BOREHOL LOGS.GPJ MEL-GEO.GDT 12/2/16

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

ENCLOSURE NO.:4 (Pg. 1 of 1)

METRIC

RECORD OF BOREHOLE NO. 3

Englobe

REFERENCE 15/05/15059-F1 DATUM Geodetic LOCATION N 5477436.5 E 414709.3 - Owens Twp., Station 15+727 ORIGINATED BY JL

PROJECT GWP 163-98-00, Highway 11 BOREHOLE TYPE Track Mounted CME 45 - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 26 July 2015 TIME (Completed) 10:00:00 AM CHECKED BY MAM

DATE (Completed) 26 July 2015

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)
211.4	Ground Surface										
211.2 / 0.2	Topsoil- silty brown, wet		1	SS	3		211				
	MIXED FILL - mixture of brown silty sand and grey silty clay, trace gravel, with grass rootlets and decayed wood		2	SS	5						
	silty clay, with grass rootlets and decayed wood,trace sand						210	5			
	dark grey to grey		3	SS	4			>100			0 19 51 30
	(stiff/very stiff)		4A	SS	8		209				
208.5			4B								
2.9	silty CLAY - trace gravel, trace sand										
	moist		5	SS	5		208	>100			
207.6	(very stiff)										
3.8	SILT - some sand, trace clay		6	SS	37	▽					0 13 80 7 (NP)
	grey						207				
	wet		7	SS	21			>100			
	(dense/compact)						206				
205.8											
5.6	silty CLAY - trace sand										
	(stiff)		8	SS	WH		205	9			
204.2											
7.2	SILT - trace gravel, trace clay						204				
	grey		9	SS	14						
	wet						203				
	(compact)										
202.8											
8.6	clayey SILT TILL - trace gravel, with sand										
	grey		10	SS	7		202		PI		5 24 54 17
	(stiff)										
201.6											
9.8	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) 26/7/15 10:10:00 AM	Dry ▽	- ▨
2) 28/7/15 8:00:00 AM	4.25 ▽	-
3)	- ▼	-

MEL-GEO 15059 - F1 BOREHOL LOGS.GPJ MEL-GEO.GDT 12/2/16

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

ENCLOSURE NO.:5 (Pg. 1 of 1)

METRIC

RECORD OF BOREHOLE NO. 4

Englobe

REFERENCE 15/05/15059-F1 DATUM Geodetic LOCATION N 5477471.0 E 414737.9 - Owens Twp., Station 15+737 ORIGINATED BY JL

PROJECT GWP 163-98-00, Highway 11 BOREHOLE TYPE Track Mounted CME 45 - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 26 July 2015 TIME (Completed) 5:20:00 PM CHECKED BY MAM

DATE (Completed) 26 July 2015

ELEV / DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
211.2	Ground Surface										
0.0	silty CLAY - trace to with organics, grass rootlets and decayed wood, trace sand brown, moist (firm/very stiff)		1	SS	4		211				
			2	SS	WH						
			3	SS	5		210	3			
208.9								>100			
2.3	silty CLAY - trace gravel, trace sand grey, moist (very stiff)		4	SS	6		209	>100			
			5	SS	7		208	>100			0 6 58 36
			6	SS	9			>100			
			7	SS	9		207	>100			
205.5							206	>100			
5.7	clayey SILT TILL - trace gravel, sandy grey (very stiff)		8	SS	15		205				3 31 54 12
204.1											
7.1	sandy SILT TILL - trace gravel, trace clay grey moist (compact)		9	SS	17	▽	204				5 26 61 8 (NP)
						▨	203				
			10	SS	25		202				
201.4											
9.8	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) 26/7/15 5:20:00 PM	8.2 ▽	8.7 ▨
2)	- ▽	-
3)	- ▼	-

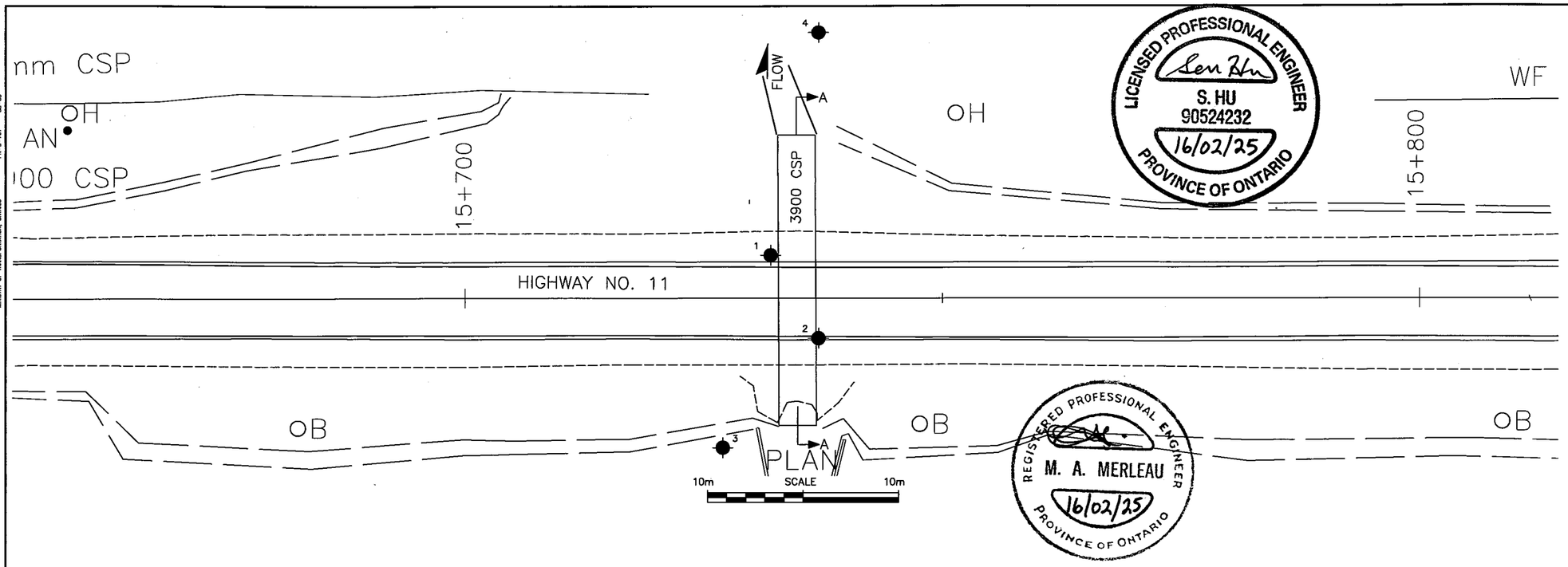
MEL-GEO 15059 - F1 BOREHOL LOGS.GPJ MEL-GEO.GDT 12/2/16

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

Appendix 3 Borehole Plan and Laboratory Data

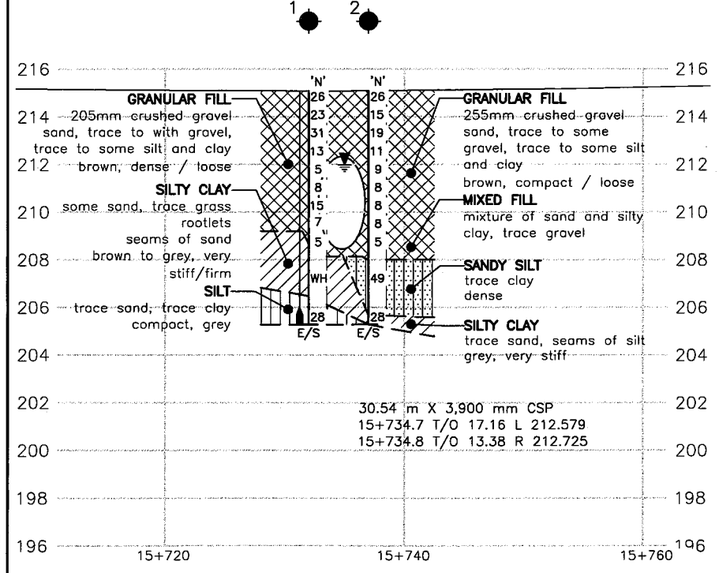
Drawing No. 2:	Borehole Location and Soil Strata
Figure Nos. L-1 to L-7:	Grain Size Distribution Curves
Figure No. L-8:	Atterberg Limits Summary
Table No. L-4:	Laboratory Test Summary Sheet

Englobe



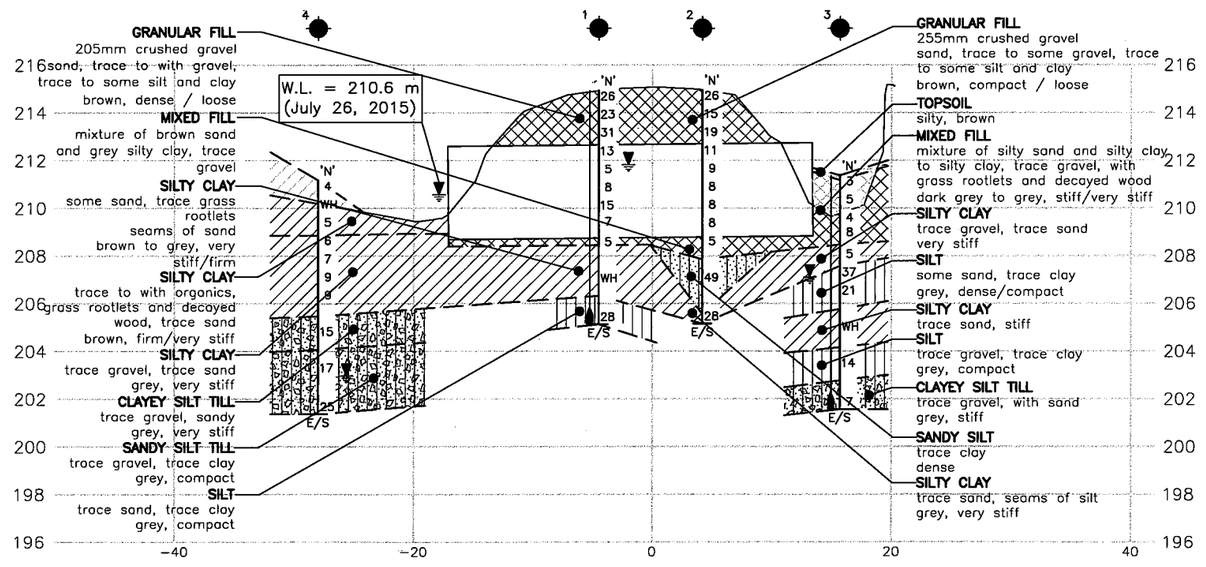
LICENSED PROFESSIONAL ENGINEER
S. HU
90524232
16/02/25
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
M. A. MERLEAU
16/02/25
PROVINCE OF ONTARIO



C/L PROFILE of HWY 11

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



CROSS SECTION A–A

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

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.

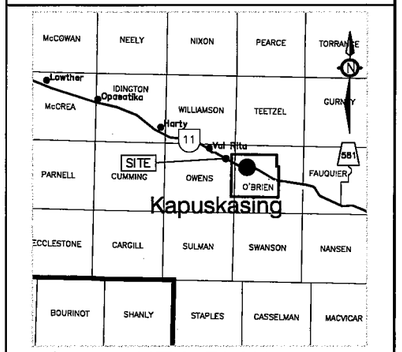
DISTRICT
CONT. No.
GWP No. 163-98-00

HWY11 HOLLEDGE CREEK CULVERT
STA. 15+735
SITE NO. 39W-107

BOREHOLE LOCATIONS
AND SOIL STRATIGRAPHY

DRAWING 2

Englobe



KEY PLAN
N.T.S.

LEGEND

	Borehole w/ DCPT
	Borehole
N	Blows/0.3 m (Std Pen Test, 475 J/blow)
DCPT	Blows/0.3 m (60° Cone, 475 J/blow)
▼	Water Level at Time of Investigation
A/R	Auger Refusal at Elevation
E/S	End of Sampling
	Piezometer

BOREHOLE No.	ELEVATION	O/S	NORTHING	EASTING
1	214.9	4.5m Lt	5477452.3	414722.9
2	215.0	4.2m Rt	5477442.3	414723.5
3	211.4	15.7m Rt	5477436.5	414709.3
4	211.2	28m Lt	5477471.0	414737.9

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 August 4, 2015

Coordinates based on MTM Zone 13 NAD83 CSRS

GEOCRES No. 42G-60

REVISIONS			
NOV/15	DM	DRAFT	
FEB/16	DM	FINAL	

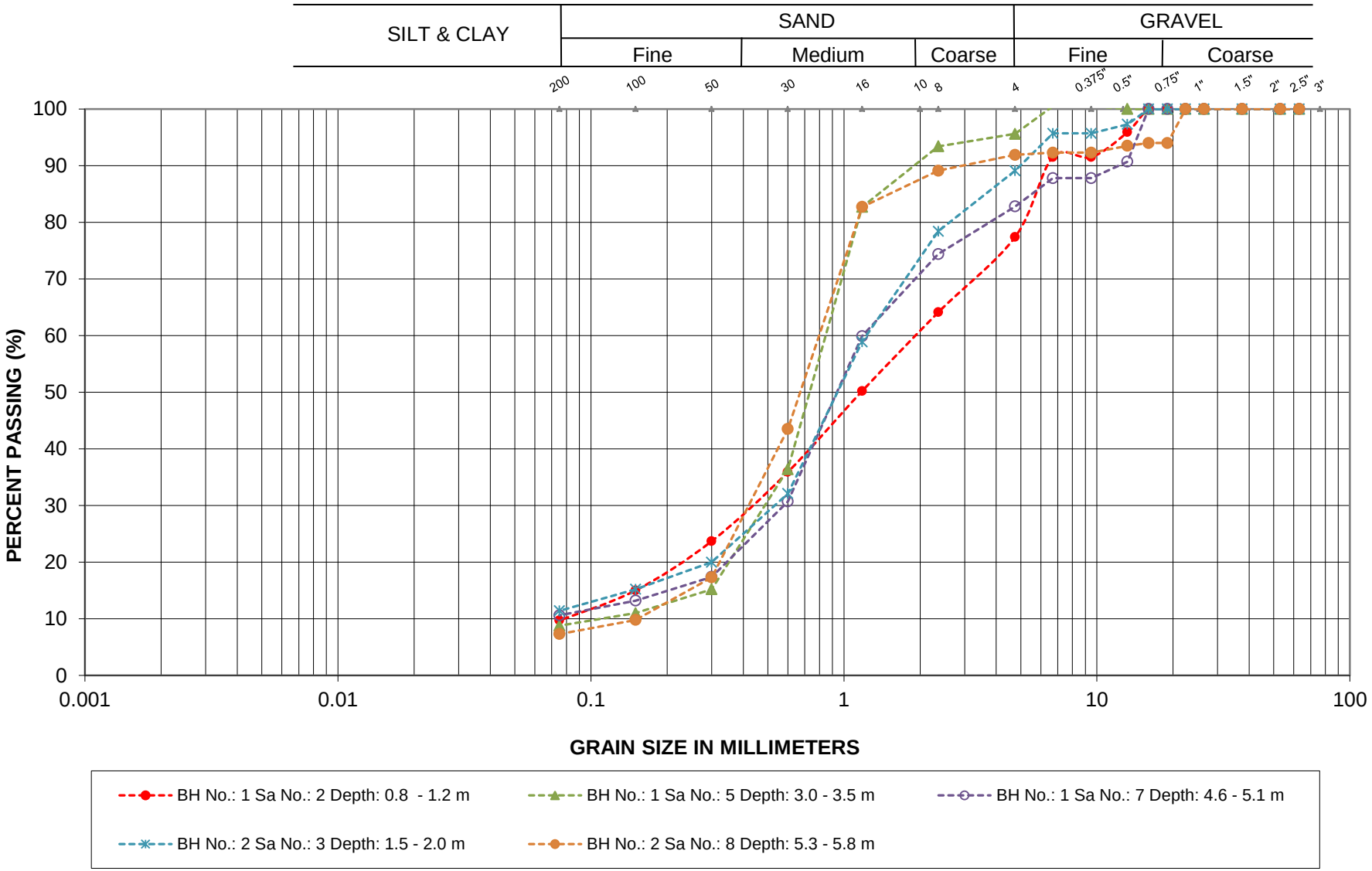
DESCRIPTION					
DESIGN	CHK	CODE	LOAD	DATE FEB/16	
DRAWN DM	CHK SH	SITE 39W-107	STRUCT	SCHEME	DWG 2

CAD FILE LOCATION AND NAME: G:\2015\15059 - PAW & FDN, Hwy 11 - 163-98-00 & 5145-05-00 (AECOM)\FOUNDATIONS\Drawings\Fl\15059 F1 - Holledge Creek Culvert.dwg
MODIFIED: 2/3/2016 4:33:51 PM BY: MITCDU
DATE PLOTTED: 2/11/2016 9:47:35 AM BY: DUNCAN MITCHELL

MINISTRY OF TRANSPORTATION, ONTARIO PR-D-707 88-05

Reference No.: 15/05/15059-F1
Date: September, 2015

GRAIN SIZE ANALYSIS



GRANULAR FILL

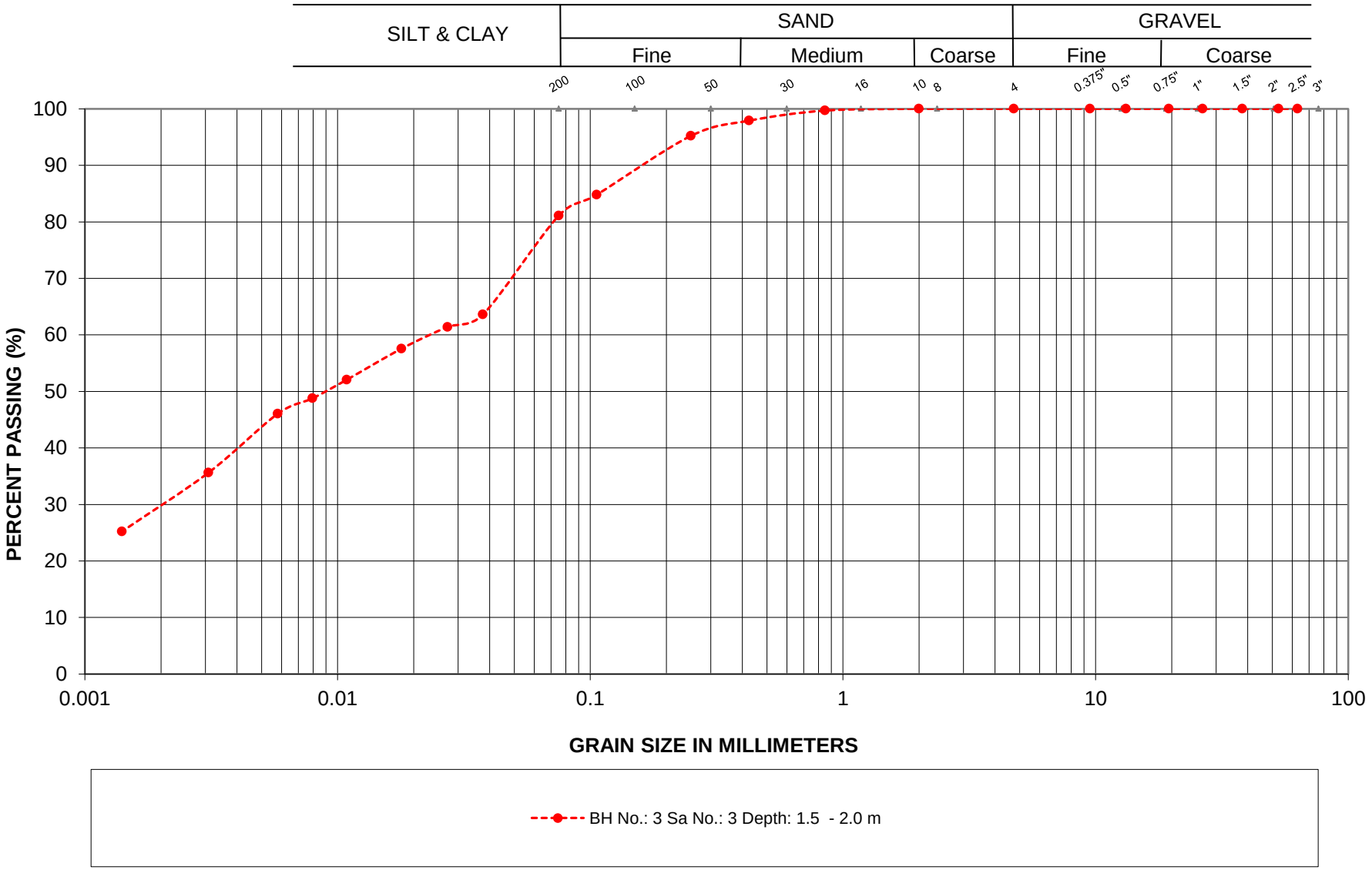
LOCATION: Hwy 11, Station 15+735
TWP of Owens

Englobe Corp.

FIGURE L-1

Reference No.: 15/05/15059-F1
Date: September, 2015

GRAIN SIZE ANALYSIS



MIXED FILL

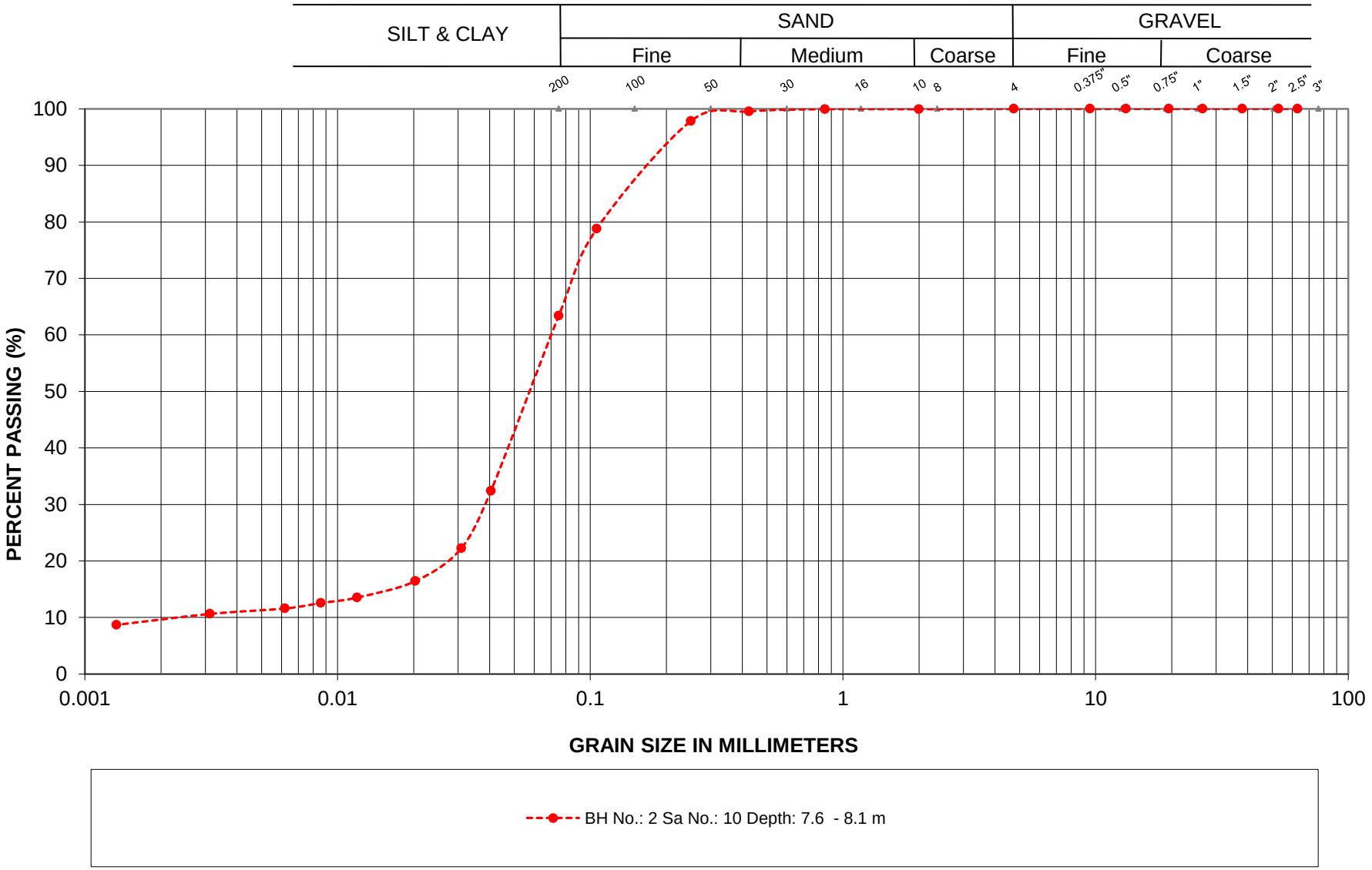
LOCATION: Hwy 11, Station 15+735
TWP of Owens

Englobe Corp.

FIGURE L-2

Reference No.: 15/05/15059-F1
Date: September, 2015

GRAIN SIZE ANALYSIS



SANDY SILT

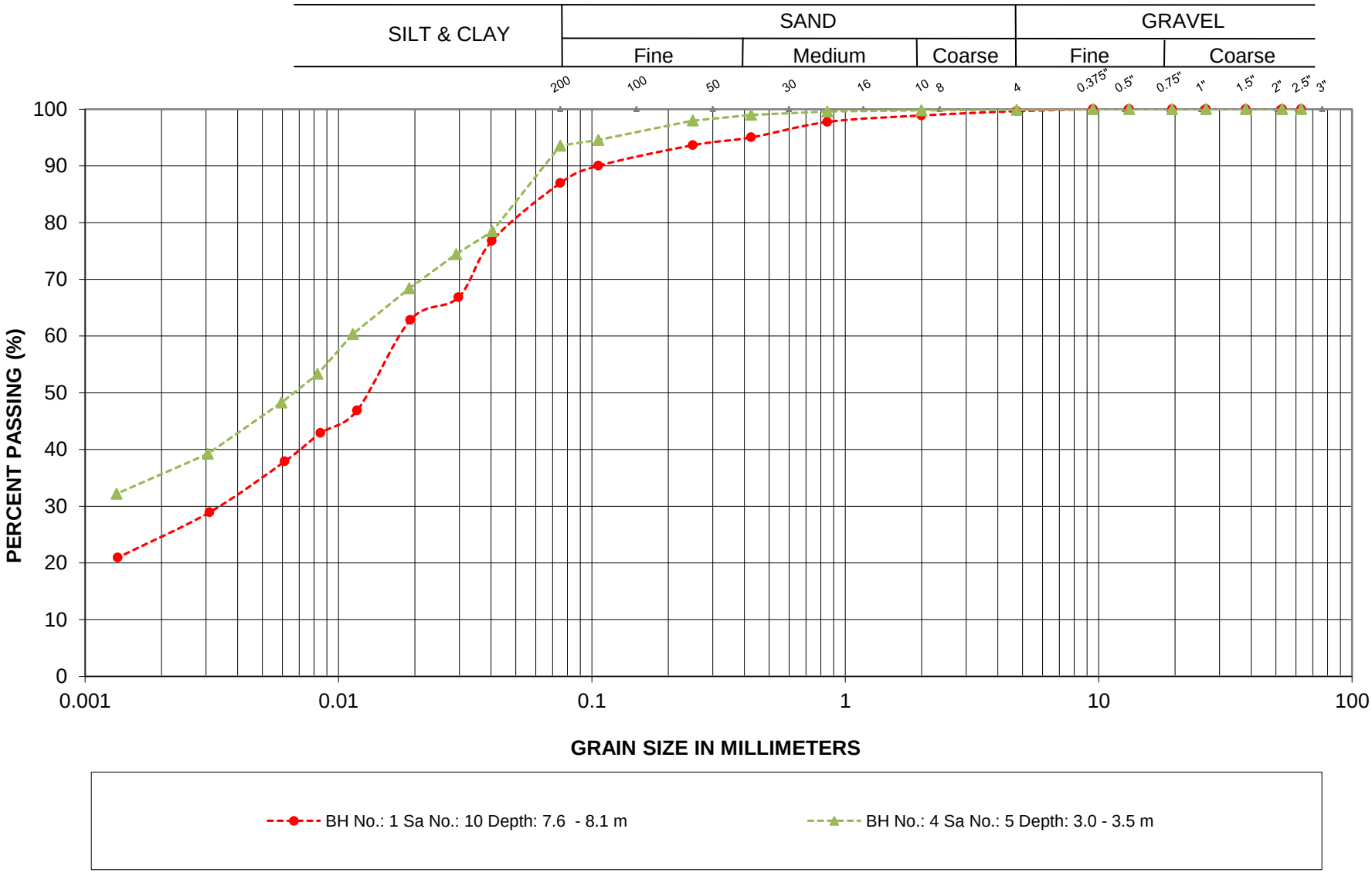
LOCATION: Hwy 11, Station 15+735
TWP of Owens

Englobe Corp.

FIGURE L-3

Reference No.: 15/05/15059-F1
Date: September, 2015

GRAIN SIZE ANALYSIS



SILTY CLAY

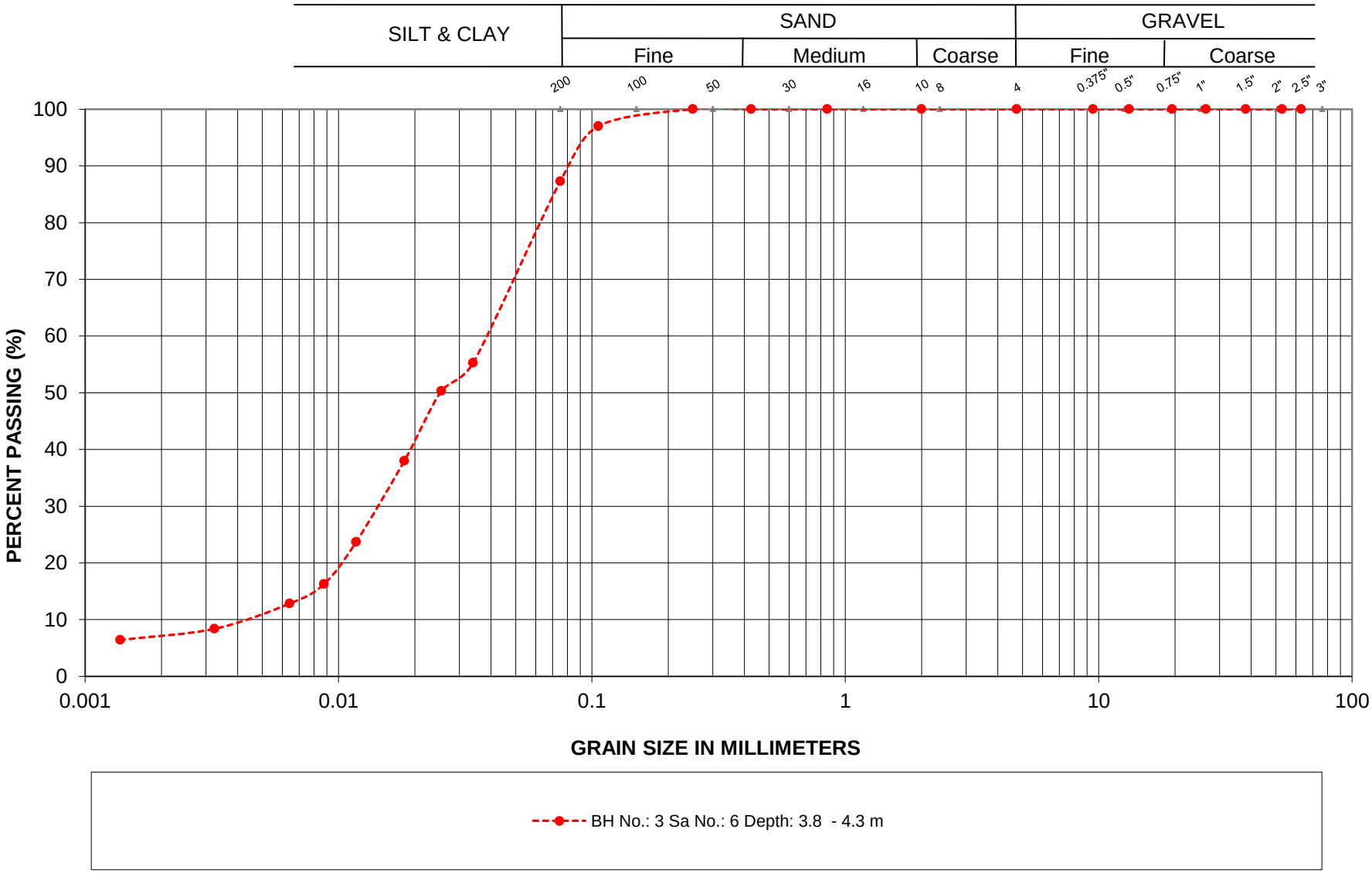
LOCATION: Hwy 11, Station 15+735
TWP of Owens

Englobe Corp.

FIGURE L-4

Reference No.: 15/05/15059-F1
Date: September, 2015

GRAIN SIZE ANALYSIS



SILT

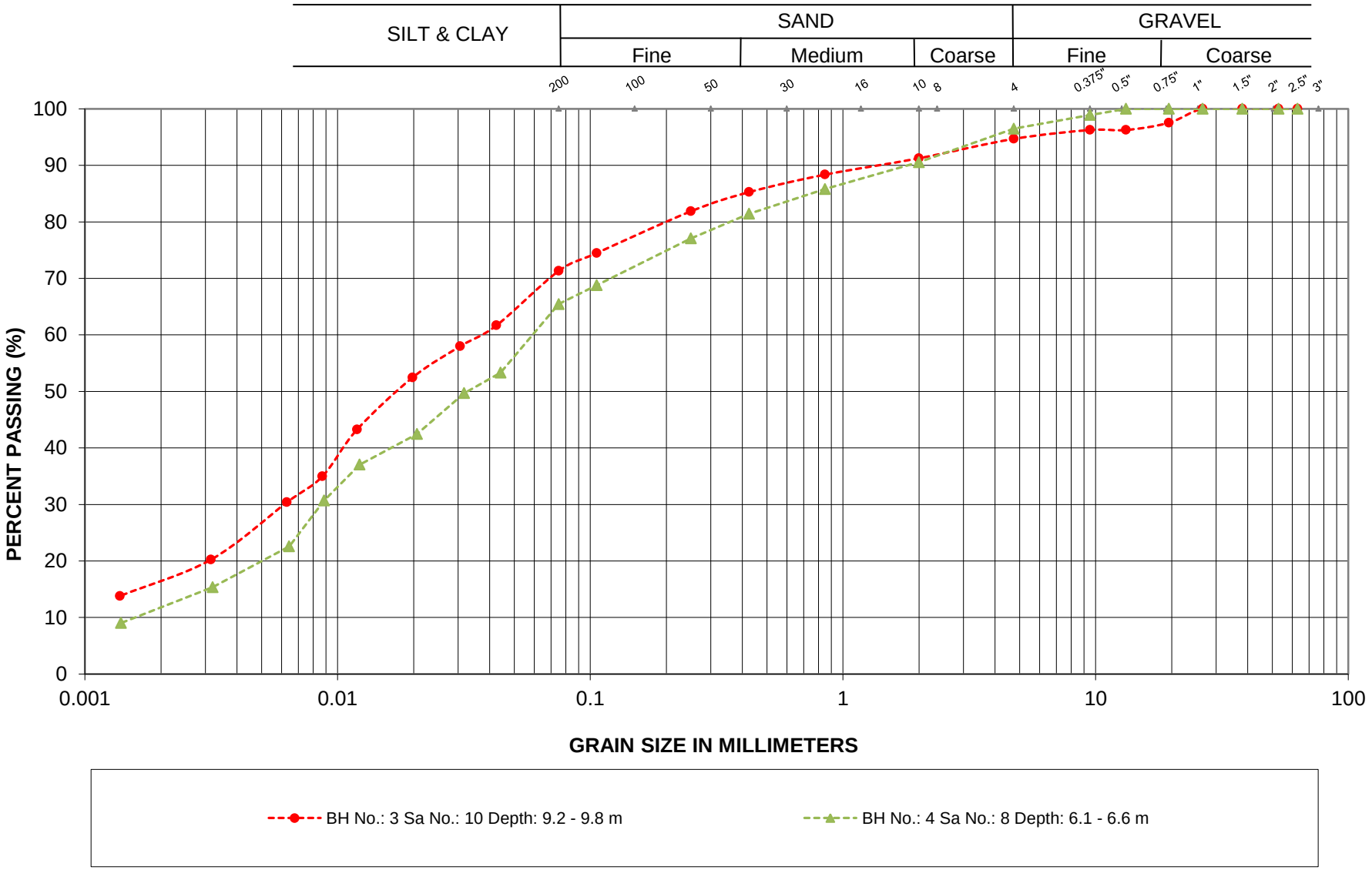
LOCATION: Hwy 11, Station 15+735
TWP of Owens

Englobe Corp.

FIGURE L-5

Reference No.: 15/05/15059-F1
Date: September, 2015

GRAIN SIZE ANALYSIS



clayey SILT TILL

LOCATION: Hwy 11, Station 15+735
TWP of Owens

Englobe Corp.

FIGURE L-6

Reference No.: 15/05/15059-F1
Date: September, 2015

GRAIN SIZE ANALYSIS

clayey SILT TILL

LOCATION: Hwy 11, Station 15+735
TWP of Owens

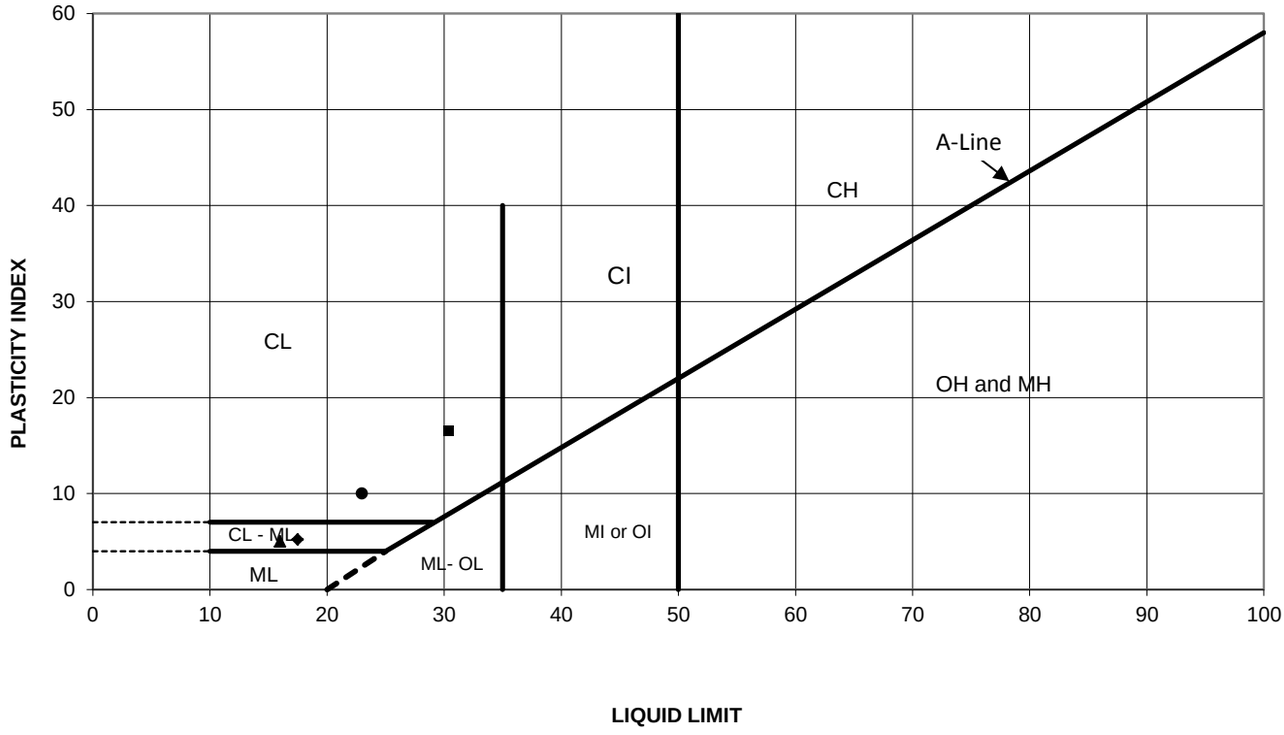
EnGlobe Corp.

FIGURE L-7

ATTERBERG LIMITS TEST RESULTS

FIGURE L-8

ATTERBERG INDICES



SYMBOL	BH	Sa. No.	Depth(m)	Elev.(m)	Liquid Limit	Plastic Limit	Plasticity Index	NMC %
●	1	10	7.9	207.0	23.0	13.0	10.0	18.1
◆	3	10	9.5	201.9	17.5	12.3	5.2	14.0
■	4	5	3.3	207.9	30.4	13.9	16.5	21.1
▲	4	8	6.3	204.9	16.0	11.0	5.0	17.1

Date: Sep-15 Prep'd: AT
Project: Hwy 11, Holledge Creek Culvert Chkd: MAM
Location: Sta. 15+735, TWP. of Owens Ref. No.: 15/05/15059-F1

Englobe Corp.

Reference No.: 15/05/15059-F1
Date: September 2015

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					5.0				26			
	2	0.8	23	67	10		3.9				23			
	3	1.5					4.9				31			
	4	2.3					4.7				13			
	5	3.1	4	87	9		4.6				5			
	6	3.8					4.9				8			
	7	4.6	17	72	11		12.0				15			
	8a	5.3					18.9				7			
	8b	5.6					19.1							
	9	6.1					18.5				5			
	10	7.6	0	13	62	25	18.1	23.0	13.0	10.0	WH			
	11	9.2					15.2				28			
2	1	0.0					4.5				26			
	2	0.8					5.3				15			
	3	1.5	11	78	11		5.2				19			
	4	2.3					5.4				11			
	5	3.1					5.2				9			
	6	3.8					5.6				8			
	7	4.6					17.0				8			
	8	5.3	8	85	7		16.0				8			
	9	6.1					21.4				5			
	10	7.6	0	37	54	9	17.0				49			Non-Plastic (NP)
	11	9.2					34.9				28			

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 (%)				
3	1	0.0					25.9				3			
	2	0.8					30.0				5			
	3	1.5	0	19	51	30	2.8				4			Non-Plastic (NP)
	4a	2.3					37.9				8			
	4b	2.4					23.3							
	5	3.1					16.9				5			
	6	3.8	0	13	80	7	29.0				37			Non-Plastic (NP)
	7	4.6					16.7				21			
	8	6.1					47.7				WH			
	9	7.6					13.7				14			
	10	9.2	5	24	54	17	14.0	17.5	12.3	5.2	7			
4	1	0.0					28.0				4			
	2	0.8					55.2				WH			
	3	1.5					48.4				5			
	4	2.3					19.5				6			
	5	3.1	0	6	58	36	21.1	30.4	13.9	16.5	7			
	6	3.8					17.3				9			
	7	4.6					35.7				9			
	8	6.1	3	31	54	12	17.1	16.0	11.0	5.0	15			
	9	7.6	5	26	61	8	11.8				17			Non-Plastic (NP)
	10	9.2					11.3				25			

Appendix 4 Photo Essay

Enclosure No. 6: Photo Essay

Embankment at Culvert Location – Looking South	Photo: 1

Culvert Inlet – Looking South	Photo: 2

Project: Hwy 11 – Holledge Creek Culvert	Photos Provided By:Englobe Date: July 2015

Culvert Outlet – Looking North	Photo: 3

View Through Culvert – Looking South	Photo: 4

Project: Hwy 11 – Holledge Creek Culvert	Photos Provided By:Englobe Date: July 2015