



# 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 63  
Station 10+495 - Township of Clarkson  
GWP 5203-14-00**

## **FINAL FOUNDATION INVESTIGATION REPORT**

Date: December 23, 2016  
Ref. N°: 16/02/16014-F6

**Geocres No. 31L-200**



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GWP 5203-14-00

## Final Foundation Investigation Report

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2016-12-22

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

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

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## 1 INTRODUCTION

Englobe Corp. (Englobe), 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 culvert is located at Station 10+495 in the Township of Clarkson on Highway 63, about 1.8 km west of McConnell Lake Road (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 5203-14-00 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 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 1800 mm diameter Corrugated Steel Pipe (CSP) culvert is located on Highway 63 at Station 10+495 in the Township of Clarkson, 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 south-north direction. The existing highway at the culvert location is constructed on a fill embankment approximately 5.5 m in height above the culvert invert (at centreline), with centreline at Elevation 289.8 m at the culvert location. At the west slope, the maximum height of the embankment is approximately 5.3 m above the culvert invert below the centerline of highway. At the east slope, the maximum height of embankment fill is approximately 5.6 m above the culvert invert. The existing embankment slopes in the area of the culvert have been generally established at inclination angles of approximately 2.3H:1V to 2.5H:1V at the west and the east slopes, respectively. The culvert at this location is an 1800 mm diameter Corrugated Steel Pipe (CSP) culvert, some 34.2 m in length. Flow through the culvert is from the west to the east (left to right).

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

### 2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The topography on this section of Highway 63 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 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 May 12<sup>th</sup>, 16<sup>th</sup>, 17<sup>th</sup>, and 19<sup>th</sup>, 2016 during which time four (4) sampled boreholes were advanced. Two (2) boreholes were advanced through the embankment, and one (1) borehole was advanced adjacent to both the inlet (west) and the outlet (east) ends of the culvert (total of two (2) inlet and outlet boreholes).

The field investigation was carried out by Englobe's drilling team using both truck and 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. Dynamic Cone Penetration testing (DCPT) was carried out from the bottom of a sampled borehole to practical refusal (described as >100 blows per 300 mm penetration). 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 in accordance with requirements of Ontario Regulation 903. Where applicable, boreholes were backfilled 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. 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).

The location of the individual boreholes 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 CULVERT STATION 10+495, TWP OF CLARKSON**

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 289.8, 289.8, 286.0, and 285.2 m, respectively.

#### **4.1.1 Pavement Structure**

Borehole Nos. 1 and 2, were advanced through the embankment. Borehole Nos. 1 and 2 established that the pavement structure consisted of 200 to 280 mm asphalt concrete overlying a layer of crushed gravel base/subbase approximately 100 to 120 mm thick.

#### **4.1.2 Embankment Fill**

Underlying the pavement structure at Borehole Nos. 1 and 2, a layer of embankment fill described as brown sand, gravelly to trace gravel, with to some silt, trace clay was penetrated. A layer of asphalt concrete, 50 mm thick, was encountered within the embankment fill at a depth of 2.7 m below grade at Borehole No. 1. The natural moisture content measured on samples recovered from this deposit ranged from 3 to 17%. Gradation (sieve) analyses were

carried out on three (3) samples of this deposit, the results of which indicated 16 to 34% gravel size particles, 50 to 68% sand size particles, and 13 to 16% silt and clay size particles (Figure No. L-1, Appendix 3). Gradation (hydrometer) analyses were carried out on two (2) samples of this deposit, and the results indicated 8 to 10% gravel size particles, 59 to 61% sand size particles, 29% silt size particles 2% and clay size particles (Figure No. L-1, Appendix 3). Based on SPT 'N' values of 0 (static weight of hammer) to 60 blows per 300 mm penetration and 28 blows per 180 mm penetration, the relative density/compactness of this deposit was described as very loose to very dense, but generally compact on average. This embankment fill was encountered to depths of 5.3 and 4.7 m below grade at Borehole Nos. 1 and 2, respectively (Elevations 284.5 and 285.1 m, respectively).

#### 4.1.3 Organic Soils

Underlying the embankment fill at Borehole No. 2, and at surface at Borehole No. 4, a layer of silty to sandy organic soils trace gravel to fine fibrous organic soils was penetrated. The natural moisture content measured on samples recovered from this deposit ranged from 55 to 81%. The organic soils were encountered to depths of 5.1 and 0.3 m below grade at Borehole Nos. 2 and 4, respectively (Elevations 284.7 and 284.9 m, respectively).

#### 4.1.4 Silt and Sand

Underlying the embankment fill at Borehole No. 1, at surface at Borehole No. 3, and underlying the organic soils at Borehole No. 4, a deposit of silt and sand, some gravel, trace clay was penetrated. Trace organics and some grass rootlets were encountered in the deposit. The natural moisture content measured on samples of this deposit was in the order of 21 to 51%. A gradation (hydrometer) analysis was carried out on one (1) sample of this deposit, and the results indicated 0% gravel size particles, 47% sand size particles, 49% silt size particles, and 4% clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 15 to 60 blows per 300 mm penetration, the relative density/compactness of this deposit was described as compact to very dense, generally compact on average. This silt and sand layer was encountered to depths of 5.9, 0.6, and 1.4 m below grade at Borehole Nos. 1, 3, and 4, respectively (Elevations 283.9, 285.4, and 283.8 m, respectively).

#### 4.1.5 Sandy Gravel

Underlying the organic soils at Borehole No. 2, a deposit of sandy gravel, some silt was penetrated. The natural moisture content measured on samples recovered from this deposit were in the order of 10%. Cobble and boulder sized rock pieces were encountered within this deposit. A gradation (sieve) analysis was carried out on one (1) sample of this deposit, and the results indicated 55% gravel size particles, 31% sand size particles, and 14% silt and clay size particles (Figure No. L-3, Appendix 3). Based on a SPT 'N' value of 50 blows per 300 mm penetration, the relative density/compactness of this deposit was described as dense. This deposit was encountered to a depth of 7.3 m below grade at Borehole No. 2 (Elevation 282.5 m).



#### 4.1.6 Sand

Underlying the sand and silt deposit at Borehole Nos. 1, 3, and 4, a deposit of sand, with to trace gravel, with to trace silt, trace clay, was penetrated. The natural moisture content measured on samples of this deposit ranged from 8 to 20%. Gradation (sieve) analyses were carried out on four (4) samples of this deposit, and the results indicated 7 to 25% gravel size particles, 54 to 78% sand size particles, and 15 to 25% silt and clay size particles (Figure No. L-4, Appendix 3). Gradation (hydrometer) analyses were carried out on three (3) samples of this deposit, and the results indicated 6 to 23% gravel size particles, 56 to 69% sand size particles, 19 to 24% silt size particles and 1 to 2% and clay size particles (Figure No. L-4, Appendix 3). Based on SPT 'N' values of 15 to 58 blows per 300 mm penetration and 50 blows per 50 mm penetration, the relative density/compactness of this deposit was described as compact to very dense, but generally dense on average. The sand deposits were encountered to depths of 7.2 and 6.4 m below grade at Borehole Nos. 1 and 3, respectively (Elevations 282.6 and 279.6 m, respectively). Sampling was terminated in the sand deposit at a depth of 9.6 m below grade at Borehole No. 4 (Elevation 275.6 m).

#### 4.1.7 Sand to Silty Sand Till

Underlying the sand at Borehole No. 1 and underlying the sandy gravel at Borehole No. 2, a deposit of till described as sand, with to trace gravel, silty to some silt, trace clay, was penetrated. The natural moisture content measured on samples of this deposit ranged from about 4 to 13%. Gradation (hydrometer) analyses were carried out on three (3) samples of this deposit, and the results indicated 2 to 30% gravel size particles, 53 to 56% sand size particles, 16 to 40% silt size particles and 1 to 2% clay size particles (Figure No. L-5, Appendix 3). Based on SPT 'N' values of 80 to 104 blows per 300 mm penetration and 50 blows per 75 mm penetration, the relative density/compactness of this deposit was described as very dense. Sampling was terminated in the sand to silty sand till deposit at depths of 12.7 and 12.3 m below grade at Borehole Nos. 1 and 2, respectively (Elevations 277.1 and 277.5 m, respectively).

#### 4.1.8 DCPT

A Dynamic Cone Penetration Test (DPCT) was carried out from the end of sampling at Borehole No. 4. The DCPT practical refusal was encountered at a depth of 10.8 m below grade at Borehole No. 4 (Elevation 274.4 m).

#### 4.1.9 Bedrock

Underlying the sand at Borehole No. 3, bedrock was proven by diamond core drilling. The bedrock was described as pink granite. Based on RQD values of 58 to 71%, the bedrock was described as fair quality. Based on visual review, the bedrock generally showed negligible weathering. Sampling in the bedrock was terminated at a depth of 9.5 m below grade at Borehole No. 3 (Elevation 276.5 m). Photos of rock cores recovered at Borehole No. 3 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 (May 17, 2016), surface water was recorded at Elevation 284.9 m at the culvert inlet.

Measurements of the groundwater table and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. A standpipe was installed in Borehole Nos. 1 and 3 to obtain post borehole completion water levels. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix 2).

The groundwater level was measured at Elevation 285.0 m at Borehole Nos. 1 and 3 during the foundation investigation periods. The groundwater level was measured in the standpipes at Elevation 286.0 m at Borehole Nos. 1 and 3 before decommissioning on June 27<sup>th</sup>, 2016. The groundwater level was encountered at Elevation 288.2 and 285.2 m at Borehole Nos. 2 and 4, respectively, upon completion of sampling at the boreholes; however the groundwater level at Borehole No. 2 likely had not stabilized at the time of recording.

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

## Appendix 1   Key Plan

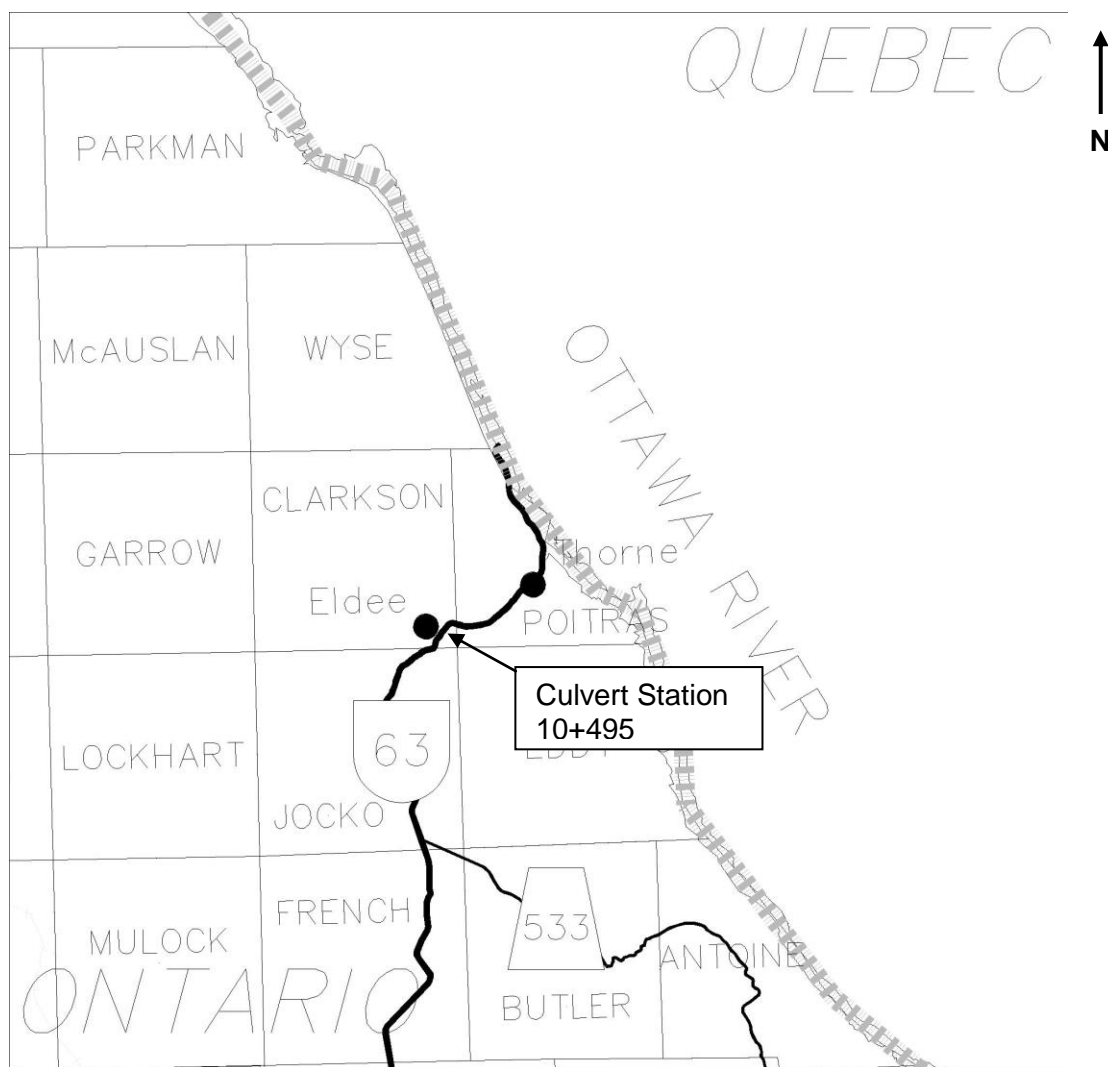
Drawing No. 1

Key Plan

# MACRO KEY PLAN

Drawing No.1

NOT TO SCALE



## FOUNDATION INVESTIGATION REPORT GWP 5203-14-00

Highway 63  
Stations 10+495  
Township of Clarkson



Reference No: 16/02/16014-F6

December 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 16/02/16014-F6 DATUM Geodetic LOCATION N 5165580.4 E 332179.2 - Clarkson Twp., Station 10+492 ORIGINATED BY AT

PROJECT GWP 5203-14-00, Highway 63 BOREHOLE TYPE Truck Mounted CME 75 - Hollow Stem Augers COMPILED BY DM

CLIENT AECOM DATE (Started) 2016 May 12 TIME  CHECKED BY SH

DATE (Completed) 2016 May 12 (Completed)

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40					
289.8	Asphalt Surface													
0.0	200 mm asphalt 100 mm crushed gravel		1	AS										
	EMBANKMENT FILL - sand, gravelly to with gravel, some silt		2	SS	28/180 mm									28 59 (13)
	brown to dark brown													
	(very dense/very loose)		3	SS	35									
			4	SS	36									
	asphalt layer, 50 mm thick, encountered at 2.7 m depth dark grey		5	SS	18									34 50 (16)
			6	SS	16									
			7	SS	1									
284.5														
5.3	SAND AND SILT - some gravel, trace organics		8	SS	60									
283.9	dark grey, wet													
5.9	(very dense)		9	SS	38									25 54 (21)
	SAND - with gravel, some silt													
	grey													
282.6	(dense)													
7.2	SAND TILL - with to trace gravel, silty to some silt, trace clay		10	SS	47/180 mm									
	grey													
	(very dense)		11	SS	104									30 53 16 1
	gravels and 110 mm to 290 mm cobble sized rock pieces encountered at depths of 10.7 m to 12.2 m		12	SS	24/75 mm									
277.1			13	SS	80									2 56 40 2
12.7	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						
The stratification lines represent approximate boundaries. The transition may be gradual.								WATER LEVEL RECORDS						
								Date (dd/mm/yy)/Time		Water Depth (m)		Cave In (m)		
								1) 16/5/12 3:00:00 PM		4.4		-		
2) 16/6/27 3:32:00 PM		3.8		-										
3)		-		-										

**Englobe Corp.**

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MEL-GEO 16014 - BOREHOLE LOGS - F6.GPJ MEL-GEO.GDT 16/12/22



**METRIC****RECORD OF BOREHOLE NO. 2**

REFERENCE 16/02/16014-F6 DATUM Geodetic LOCATION N 5165572.0 E 332179.0 - Clarkson Twp., Station 10+485 ORIGINATED BY ELS

PROJECT GWP 5203-14-00, Highway 63 BOREHOLE TYPE Truck Mounted CME 75 - Hollow Stem Augers COMPILED BY DM

CLIENT AECOM DATE (Started) 2016 May 16 TIME  CHECKED BY SH

DATE (Completed) 2016 May 16 (Completed)

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE			"N" VALUES	20					
289.8	Asphalt Surface												
0.0	280 mm asphalt 120 mm crushed gravel												
	EMBANKMENT FILL - sand, some to trace gravel, with to some silt, trace clay		1	AS									
	brown, damp		2	SS	33								16 68 (16)
	(very loose/very dense)		3a	SS	60								
			3b										
			3c										
			4	SS	6								8 61 29 2
			5	SS	4								
			6	SS	WH								10 59 29 2
285.1	ORGANIC SOIL - silty to sandy, trace gravel, trace grass rootlets		7a	SS	2								
4.7	black, wet		7b										
284.7	SANDY GRAVEL - some silt												
5.1	180 mm cobble sized rock pieces encountered at depth of 5.1 m to 5.7 m												
	grey, wet		8	SS	50								55 31 (14)
	(dense)												
282.5	300 mm boulder encountered at depth of 6.9 m												
7.3	SAND TILL - with to some gravel, with silt, trace clay		9	SS	50/90 mm								
	grey, wet												
	(very dense)												
	230 mm boulder sized rock pieces encountered at depth of 8.0 m												
	50 mm gravel and 100 mm to 125 mm cobble sized rock pieces encountered at depths of 9.1 m to 10.1 m		10	SS	65/150 mm								
			11	SS	50/75 mm								
			12	SS	50/0 mm								
			13	SS	63/150 mm								20 53 26 1
277.5	End of Sampling												
12.3	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					
Auger Refusal encountered at depth of 5.2 m, advanced with casing using wash boring method.								Date (dd/mm/yy)/Time		Water Depth (m)		Cave In (m)	
								1) 16/5/16 4:34:00 PM		1.6		4.5	
								2)		-		-	
								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 16014 - BOREHOLE LOGS - F6.GPJ MEL-GEO.GDT 16/12/22

**METRIC****RECORD OF BOREHOLE NO. 3**

REFERENCE 16/02/16014-F6 DATUM Geodetic LOCATION N 5165589.6 E 332169.9 - Clarkson Twp., Station 10+494 ORIGINATED BY JL

PROJECT GWP 5203-14-00, Highway 63 BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY DM

CLIENT AECOM DATE (Started) 2016 May 17 TIME  CHECKED BY SH

DATE (Completed) 2016 May 17 (Completed)

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
286.0	Ground Surface																
0.0	SAND AND SILT - some gravel, some grass rootlets brown, damp (compact)		1	SS	15												
285.4	SAND - some to trace gravel, with silt, trace clay		2	SS	23												
0.6	grey, wet (compact/very dense)		3	SS	64/230 mm												
			4	SS	35												
			5	SS	40												
			6	SS	44												
			7	SS	58												
279.6	Auger Refusal		8	SS	50/50mm												
6.4	Start Rock Coring																
	BEDROCK - pink granite fair quality		9	RC	REC=100% RQD=58%												
			10	RC	REC=100% RQD=71%												
276.5	End of Sampling																
9.5	End of Borehole																
COMMENTS							$+^3, \times^3$ : 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) 16/5/17 11:30:00 AM   0.9   $\nabla$   - 2) 16/5/19 11:38:00 AM   0.6   $\nabla$   - 3) 16/6/27 3:25:00 PM   0   $\nabla$   -					

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 16014 - BOREHOLE LOGS - F6.GPJ MEL-GEO.GDT 16/12/22

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

REFERENCE 16/02/16014-F6 DATUM Geodetic LOCATION N 5165574.6 E 332201.1 - Clarkson Twp., Station 10+500 ORIGINATED BY JL

PROJECT GWP 5203-14-00, Highway 63 BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY DM

CLIENT AECOM DATE (Started) 2016 May 19 TIME (Completed) CHECKED BY SH

DATE (Completed) 2016 May 19

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION (see Enclosure No. 1)	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
285.2	Ground Surface													
0.0														
284.9	ORGANIC SOIL - fine fibrous organics, some grass rootlets black, wet		1	SS	22/180 mm									
0.3	SILT and SAND - trace clay, trace organics													
	black		2	SS	22									0 47 49 4
283.8	(compact)													
1.4	SAND - with to trace gravel, with to some silt, trace clay		3	SS	21									
	grey, wet													
	occasional cobble sized rock pieces encountered		4	SS	35									23 56 19 2
	(compact/very dense)													
			5	SS	45									
			6	SS	21									
			7	SS	50/150 mm									
			8	SS	29									16 60 22 2
			9	SS	50/125 mm									
			10	SS	15									7 78 (15)
275.6	End of Sampling													
9.6														
274.4	End of Borehole													
10.8														
COMMENTS							$+3, \times 3$ : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa $\circ$ 3% STRAIN AT FAILURE		WATER LEVEL RECORDS Date (dd/mm/yy)/Time Water Depth (m) Cave In (m) 1) 16/5/19 6:00:00 PM 0 $\nabla$ 2.4 $\nabla$ 2) - $\nabla$ - 3) - $\nabla$ -					

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 16014 - BOREHOLE LOGS - F6.GPJ MEL-GEO.GDT 16/12/22

## **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  
   Soil Chemical Tests



10+400  
10+450  
10+500  
10+550  
HIGHWAY NO. 63  
Shoring Location  
1800 mm x 34.17 m CSP  
PLAN  
10m SCALE 10m  
5165500.0 m  
5165600.0 m  
332200.0 m

DISTRICT  
CONT. No.  
GWP No. 5203-14-00

HWY 63 CULVERT  
STA. 10+495  
TWP OF CLARKSON  
BOREHOLE LOCATIONS  
AND SOIL STRATIGRAPHY

DRAWING  
2



KEY PLAN  
N.T.S.

LEGEND

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

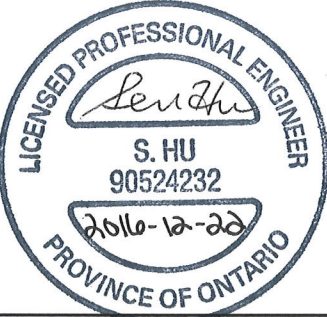
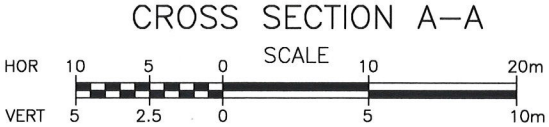
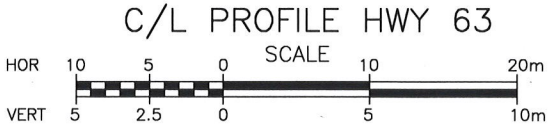
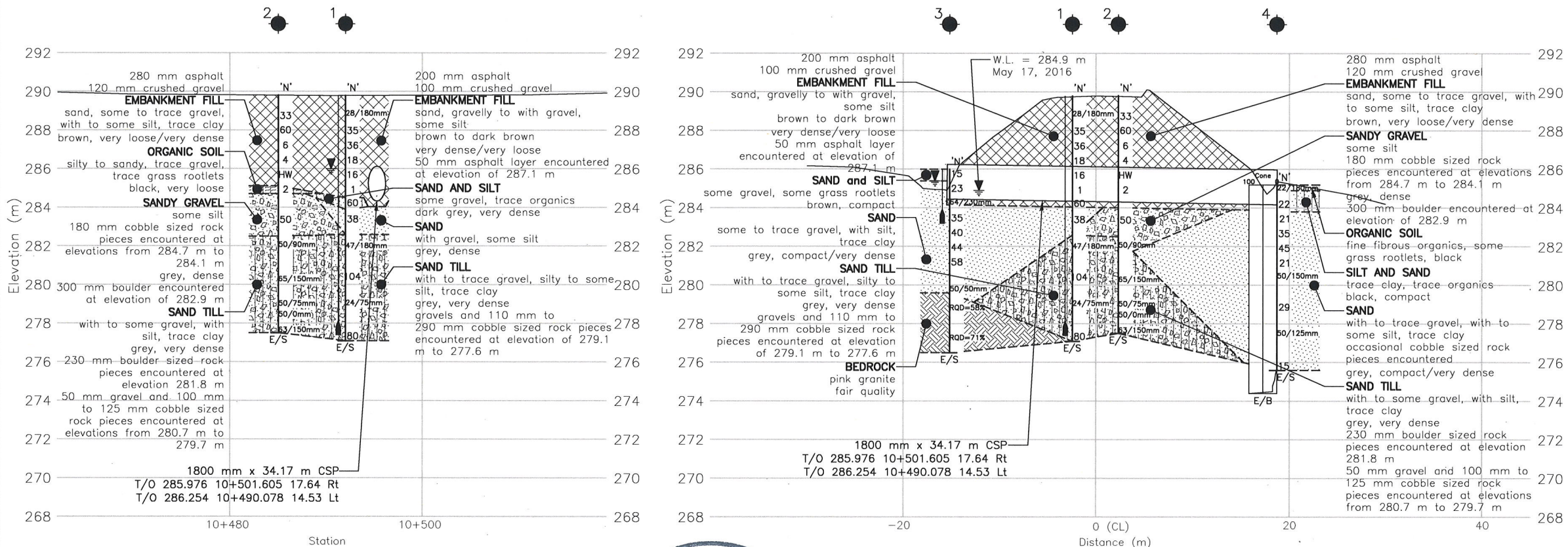
BOREHOLE No.	ELEVATION	O/S	NORTHING	EASTING
1	289.8	2.5m Lt	5165580.4	332179.2
2	289.8	2.3m Rt	5165572.0	332179.0
3	286.0	15.4m Lt	5165589.6	332169.9
4	285.2	18.7m Rt	5165574.6	332201.1

**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

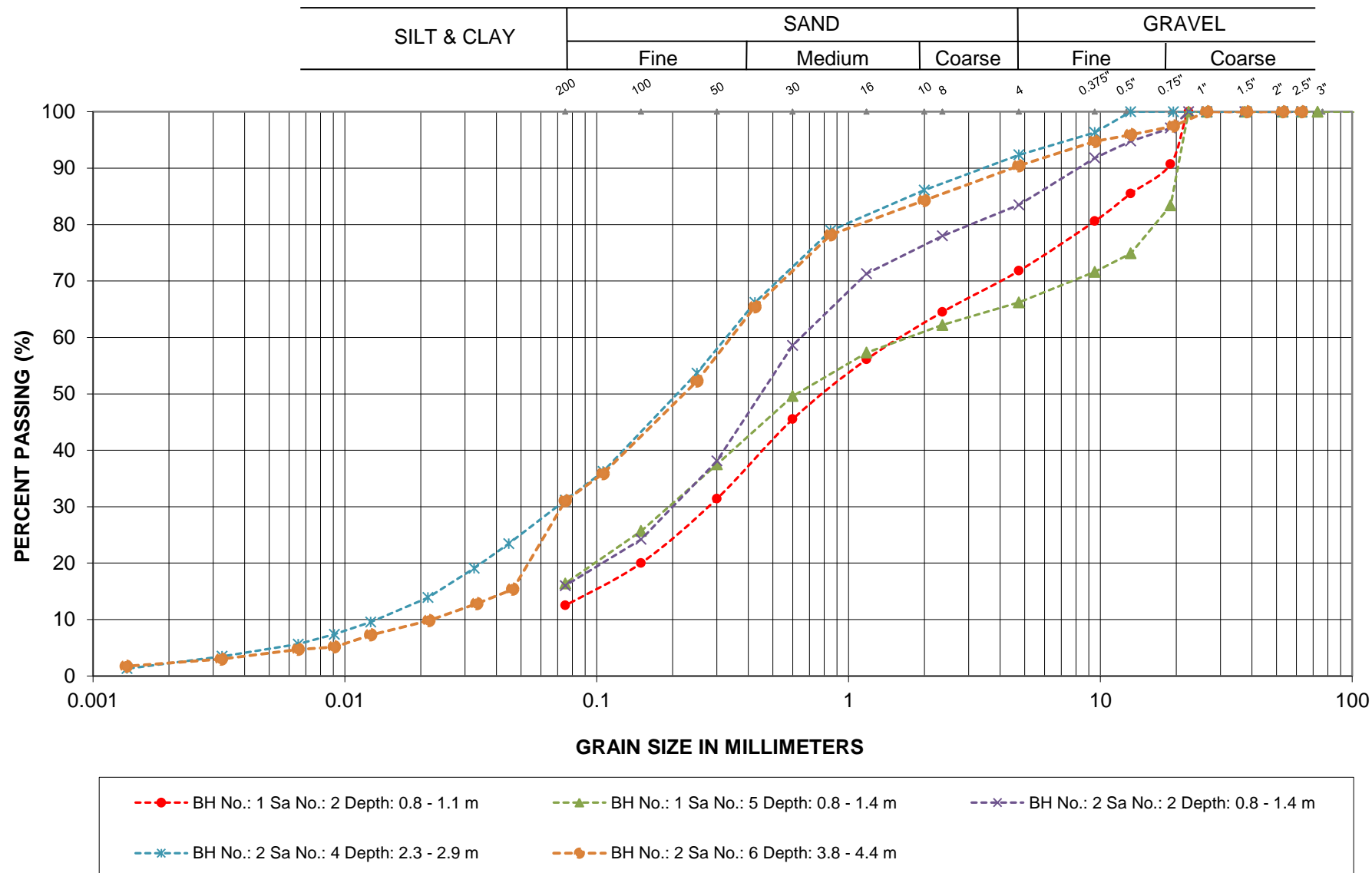
GEOCRES No. 31L-200



2016-12-22

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.

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

**GRAIN SIZE ANALYSIS**

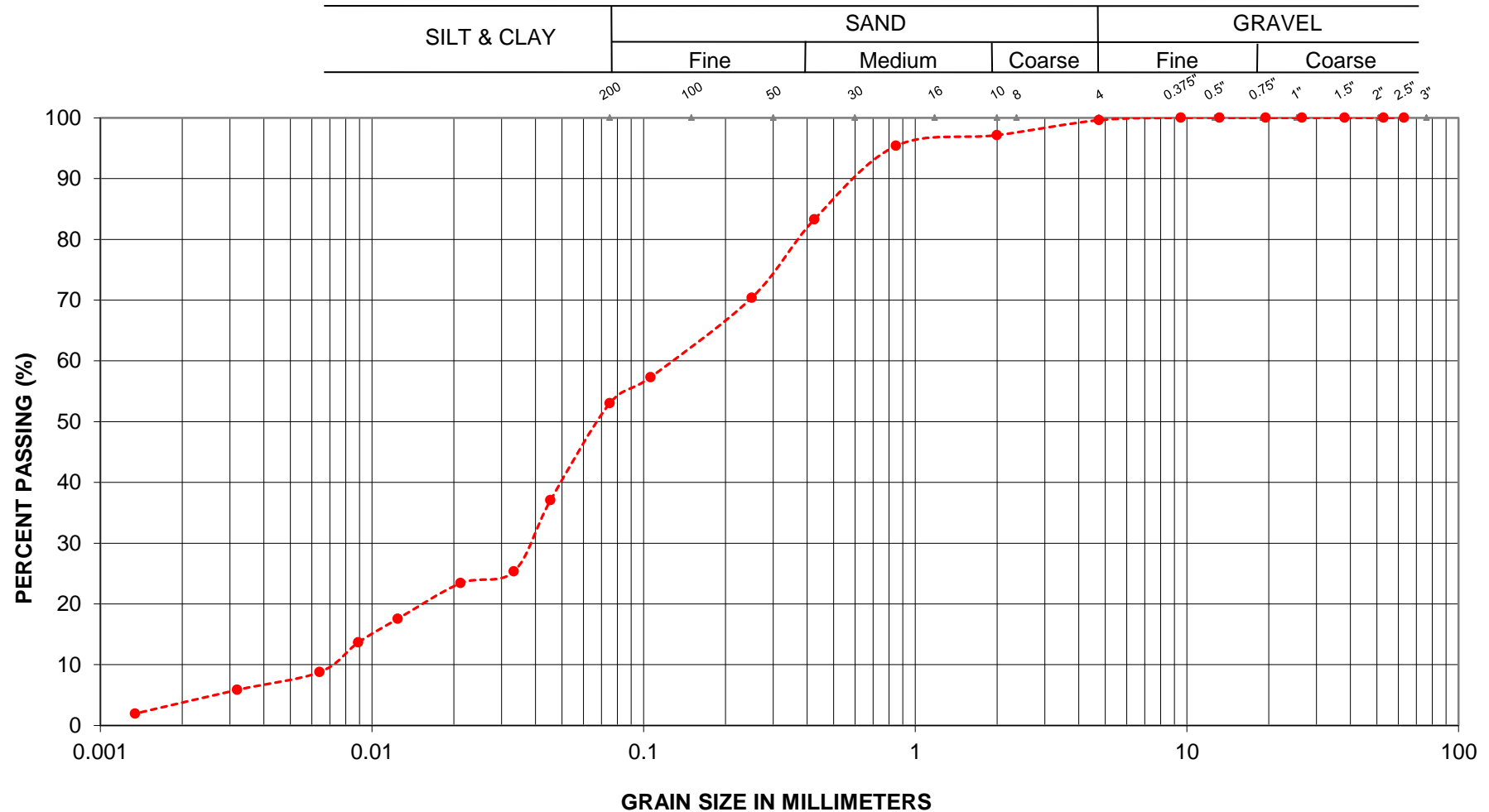
EMBANKMENT FILL

LOCATION: Hwy 63, Station 10+495  
TWP of Clarkson

Englobe Corp.

FIGURE L-1

## GRAIN SIZE ANALYSIS



---●--- BH No.: 4 Sa No.: 2 Depth: 0.8 - 1.2 m

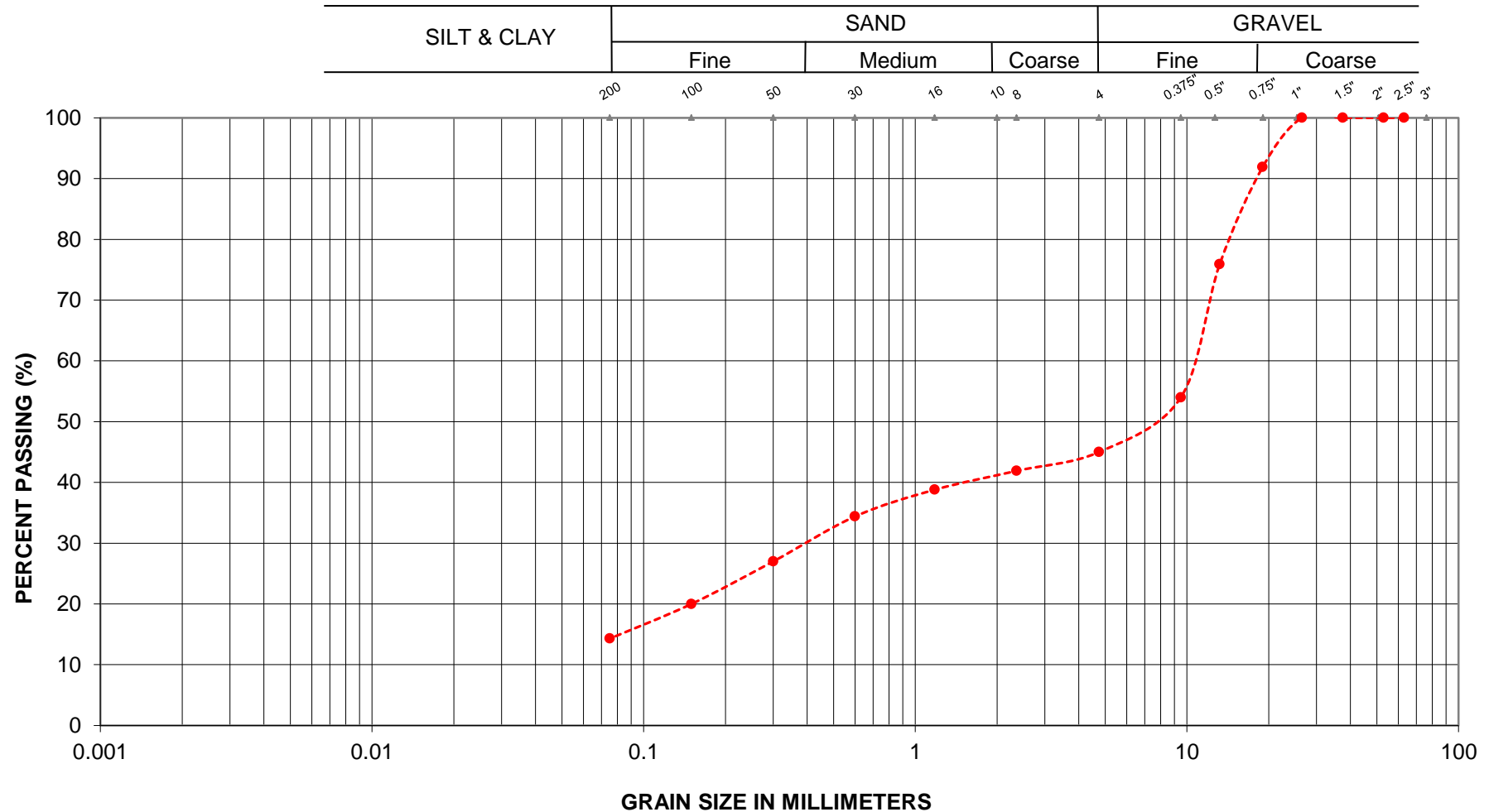
SILT AND SAND

LOCATION: Hwy 63, Station 10+495  
TWP of Clarkson

Englobe Corp.

FIGURE L-2

## GRAIN SIZE ANALYSIS



---●--- BH No.: 2 Sa No.: 8 Depth: 6.2 - 6.7 m

SANDY GRAVEL

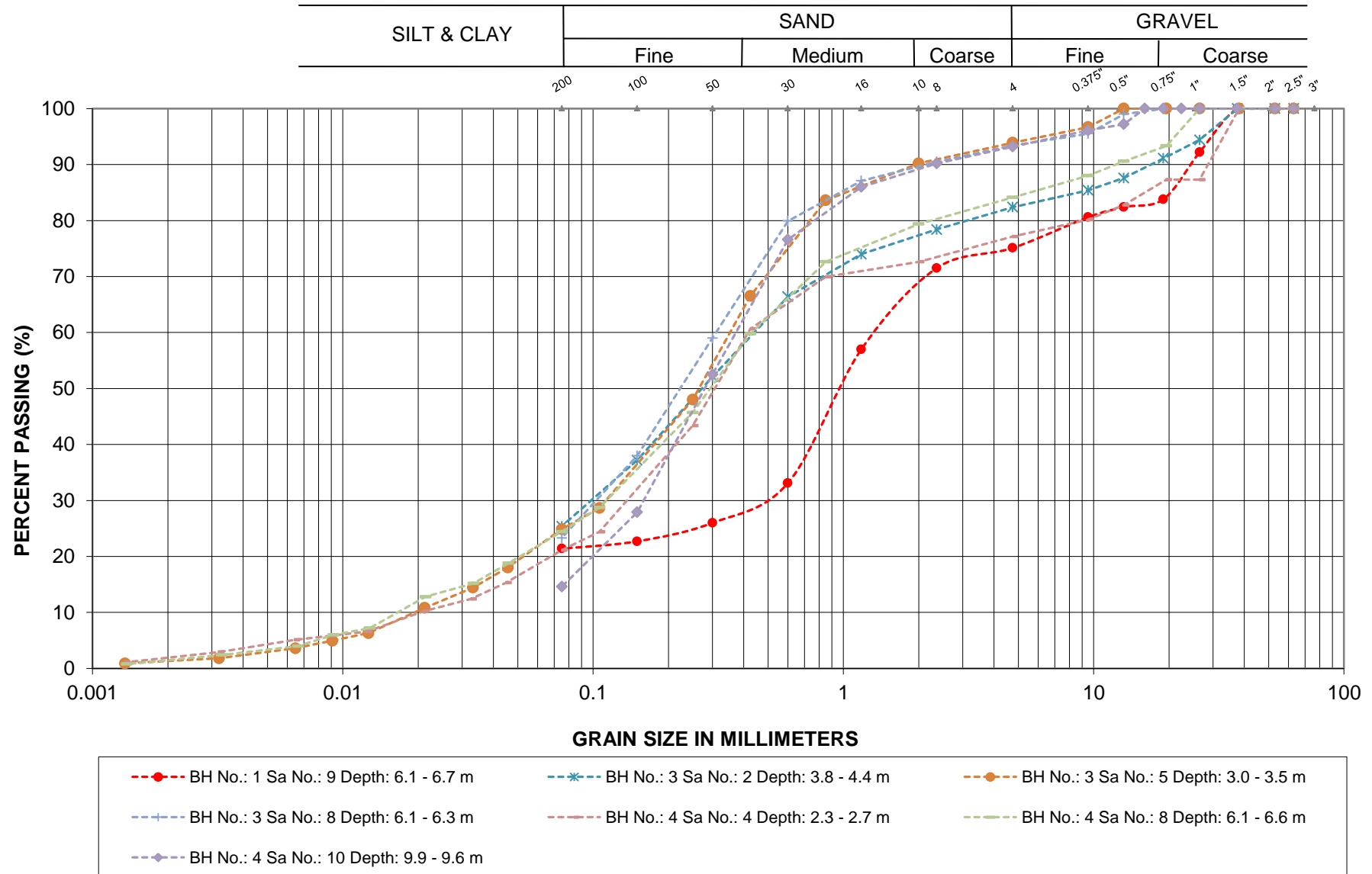
LOCATION: Hwy 63, Station 10+495  
TWP of Clarkson

Englobe Corp.

FIGURE L-3



## GRAIN SIZE ANALYSIS

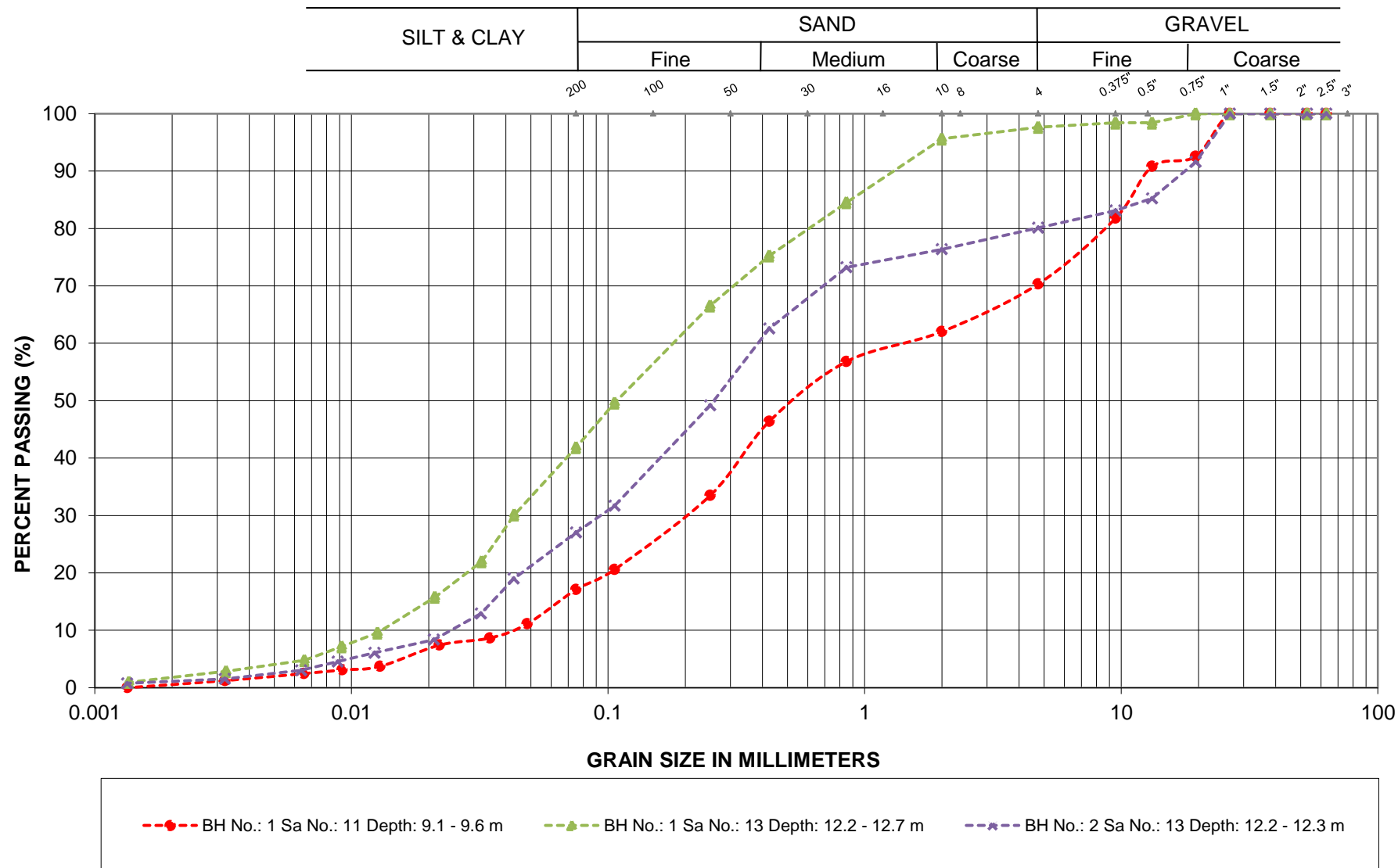


SAND

LOCATION: Hwy 63, Station 10+495  
TWP of Clarkson

Englobe Corp.

FIGURE L-4

**GRAIN SIZE ANALYSIS**

SAND to SILTY SAND TILL

LOCATION: Hwy 63, Station 10+495  
TWP of Clarkson

Englobe Corp.

FIGURE L-5

## Laboratory Tests - Summary Sheet



Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
1	1	0.0					2.7							
	2	0.8	28	59	13		5.0				28/180 mm			
	3	1.5					5.6				35			
	4	2.3					10.1				36			
	5	3.1	34	50	16		7.4				18			
	6	3.8					8.8				16			
	7	4.6									1			
	8	5.3					21.3				60			
	9	6.1	25	54	21		8.8				38			
	10	7.6					9.6				47/180 mm			
	11	9.1	30	53	16	1	8.4				104			
	12	10.7									24/75 mm			
	13	12.2	2	56	40	2	13.4				80			
2	1	0.5					2.9							
	2	0.8	16	68	16		6.3				33			
	3a	1.5					5.5				60			
	3b	1.7					2.8							
	3c	1.9					7.5							
	4	2.3	8	61	29	2	10.0				6			
	5	3.1					11.1				4			
	6	3.8	10	59	29	2	17.0				WH			
	7a	4.6					13.7				2			
	7b	4.8					54.8							
	8	6.17	55	31	14		9.8				50			
	9	7.62					7.6				50/90 mm			
	10	9.45					4.0				65/150 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	11	10.7					11.2				50/75 mm			
	12	11.3									50/0 mm			
	13	12.0	20	53	26	1	11.1				63/150mm			
3	1	0.0					29.2				15			
	2	0.8	18	57	25		11.5				23			
	3	1.5					10.6				64/230 mm			
	4	2.3					10.8				35			
	5	3.1	6	69	24	1	11.8				40			
	6	3.8					14.6				44			
	7	4.6					19.3				58			
	8	6.1	7	70	23		10.2				50/50mm			
	9	6.4												Rec= 100%, RQD= 58%
	10	8.0												Rec= 100%, RQD= 71%
4	1	0.0					80.6				22/180 mm			
	2	0.8	0	47	49	4	51.4				22			
	3	1.5					12.9				21			
	4	2.3	23	56	19	2	8.0				35			
	5	3.1					7.7				45			
	6	3.8					9.3				21			
	7	4.6					7.9				50/150 mm			
	8	6.1	16	60	22	2	9.8				29			
	9	7.6									50/125 mm			
	10	9.14	7	78	15		20.1				15			

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

## Certificate of Analysis

AGAT WORK ORDER: 16T117690

PROJECT: 16014

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

CLIENT NAME: ENGLOBE CORP

SAMPLING SITE:

ATTENTION TO: Victoria Steuernol

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
Sulphide*	%		0.05	<0.05	<0.05	<0.05	<0.05	0.05
Chloride (2:1)	µg/g		2	133	12	<2	61	4
Sulphate (2:1)	µg/g		2	271	61	<2	19	4
pH (2:1)	pH Units		NA	6.70	7.93	6.88	7.42	NA
Electrical Conductivity (2:1)	mS/cm		0.005	0.567	0.188	0.047	0.164	0.005
Resistivity (2:1)	ohm.cm		1	1760	5320	21300	6100	1
Redox Potential (2:1)	mV		5	370	292	357	354	5

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*



## Quality Assurance

CLIENT NAME: ENGLOBE CORP

PROJECT: 16014

SAMPLING SITE:

AGAT WORK ORDER: 16T117690

ATTENTION TO: Victoria Steuernal

SAMPLED BY:

### Soil Analysis

RPT Date: Jul 27, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		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*



## Method Summary

CLIENT NAME: ENGLOBE CORP

PROJECT: 16014

SAMPLING SITE:

AGAT WORK ORDER: 16T117690

ATTENTION TO: Victoria Steuernol

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





## Appendix 4    Photo Essay

Enclosure No. 6:

Photo Essay

Culvert Inlet – Looking West

Photo: 1



Culvert Outlet – Looking East

Photo: 2



Project: Hwy 63 – Culvert Station 10+495, Twp of Clarkson

Photos Provided By: Englobe

Date: May 2016

Rock Cores – Borehole 3 (left)

Photo: 3



Project: Hwy 63 – Culvert Station 10+495, Twp of Clarkson

Photos Provided By: Englobe

Date: May 2016