LVM Merlex

Geotechnical, Materials and Environmental Engineering

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

Highway 144
Vermillion River Tributary Culvert – Site No. 46-408/C
Station 16+945 - Twp. of Balfour
GWP 5580-04-00

FINAL FOUNDATION INVESTIGATION REPORT

Date: October 21, 2014
Ref. N°: 12/11/12218-F2

Geocres No. 41I-319

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

Highway 144
Vermillion River Tributary Culvert – Site No. 46-408/C
Station 16+945 - Twp. of Balfour
GWP 5580-04-00

Final Foundation Investigation Report

Prepared by:

Alexander Tepylo, P.Eng.
LVM | Merlex – Project Engineer

Reviewed by:

Sen Hu, P. Eng.
LVM | Merlex – Senior Geotechnical Engineer

M.A. Merleau, P. Eng.
LVM | Merlex – Principal Engineer
MTO Designate

TABLE OF CONTENTS

Appendices

Property and Confidentiality

Client:
AECOM Canada Ltd.
189 Wyld Street, Suite 103
North Bay, Ontario
P1B 1Z2
Attention: **Mr. Al Rose**

REVISION AND PUBLICATION REGISTER		
Revision N°	Date	Modification And/Or Publication Details
00	2014-09-18	Draft Report Issued
01	2014-10-21	Final Report Issued

REPORT DISTRIBUTION	
5 hard copies and 1 electronic copy	MTO Project Manager
1 hard copy and 1 electronic copy	MTO Pavements and Foundations Section, Foundations Group
1 hard copy	File

1 INTRODUCTION

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 the site of an existing centerline culvert. The site is located on Highway 144, some 24.5 km north of Highway 17, in the Township of Balfour.

The foundation investigation location was specified by the MTO in the Terms of Reference for additional work under Agreement No. 5011-E-0030. The terms of reference for the scope of work are outlined in LVM | Merlex Ltd.'s Proposal 12/11/12218-144, dated November, 2013. The purpose of this investigation was to determine the subsurface conditions in the area of the culvert. LVM-Merlex investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

2 SITE DESCRIPTION

The site of this foundation investigation is located on Highway 144 some 24.5 km north of Highway 17, in the Township of Balfour. The local topography at the site is a low wetland to the left and right of the embankment. The existing highway embankment currently supports two undivided lanes of highway, locally running in a west to east direction. The existing highway, at the culvert location, is constructed in a granular fill embankment some 3.6 m in height above the stream bed, with centerline elevation of 267.0 m at the culvert location. The culvert at this location has been described as a 4.6 x 2.4 m reinforced concrete rigid frame open (RFO) culvert, some 22.7 m in length. The depths of the existing culvert foundations are unknown at this time. However, old DHO Standard DD-801 indicates that RFO culverts would have a minimum depth of footing at 1.2 m below creek bottom, which would put the underside of footing at approximately elevation 262.2 m. Flow through the culvert is from north to south (right to left) (see Photo Essay, Appendix 4).

Infrastructure at the culvert location consists of overhead wires and underground infrastructure on the left and right (south and north) sides of the highway and overhead wire were crossing the highway directly at the culvert location, which impacted boring locations. This infrastructure must be taken into consideration during construction.

2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

This project is located in the Geomorphic Sub-province known as the Eastern Sandy Uplands. The topography along this section of Highway 144 is generally flat to slightly rolling. Within the specific project area overburden consists primarily of sands with silts overlying silty clays overlying bedrock.

Bedrock in the area, as indicated on OGS Map 2506, is of the Middle Precambrian Animikie Group which consists of sandstone, shale, argillite, iron formation, tuff, basalt, and limestone.

3 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between March 11th, 2014 and June 17th, 2014. Three (3) boreholes were advanced through the embankment, one located adjacent to the culvert, and the other two located up and down chainage from the culvert location. One borehole was advanced at each of the inlet and outlet ends of the existing culvert.

The field investigation was carried out using a Truck and Bombardier mounted CME drilling rig equipped with hollow stem augers, standard augers, 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 mounted in a trip (automatic) hammer. The number of blows per 300 mm penetration was recorded as the "N" value. 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. Standpipes were installed in select open boreholes prior to backfilling. 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(s) through the embankment, the upper portion of the hole, where necessary, was backfilled with an asphalt cold patch to seal the existing surface treatment.

The field work for this investigation was under the full time direction of a senior member of the LVM-Merlex 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, an Atterberg Limits Testing, as well as specific gravity testing. 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-7 and Table L-8).

The location of the individual boreholes were determined in the field using highway chainage (established by others) and offset relative to highway centerline. The MTO coordinates, northing and easting, were then established for the boring locations. Elevations contained in this report are referenced to a geodetic datum and established by others.

4 SUBSURFACE CONDITIONS

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Record 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 16+945, TWP OF BALFOUR

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, five (5) sampled boreholes were put down at this site, with Borehole Nos. 1 and 2 advanced at the culvert ends (inlet (right/north) and outlet (left/south), respectively), and Borehole Nos. 3, 4, and 5 advanced through the embankment. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 5 were recorded at 264.6, 264.8, 266.9, 266.9, and 267.0 m, respectively.

4.1.1 Pavement Structure

Borehole Nos. 3, 4, and 5 were advanced through the embankment where a layer of asphalt some 100 to 300 mm thick was penetrated. The asphalt layer was underlain by some 300 mm of crushed gravel at Borehole Nos. 4 and 5.

4.1.2 Sand Fill

Underlying the pavement structure, at Borehole Nos. 3, 4, and 5, a layer of brown granular fill consisting of sand some gravel, trace silt was penetrated. The cobble size rock was encountered at shallow depths in this deposit at Borehole No. 3, 4, and 5. The natural moisture content measured on samples of this deposit was in the order of 3 to 16%. A gradation analyses was carried out on one (1) sample of this deposit, the results of which indicated 18% gravel size particles, 72% sand size particles, and 10% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT 'N' values of 7 to 32 blows per 300 mm penetration, the compactness of this deposit was described as loose to dense. This deposit was encountered to depths of 1.1, 2.1, and 1.4 m below ground surface at Borehole Nos. 3, 4, and 5, respectively (elevations 265.8, 264.8, and 265.6 m, respectively).

4.1.3 Sand and Gravel Fill

Underlying the sand fill at Borehole No. 3, a layer of granular fill consisting of brown to grey sand and gravel, trace silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 2 to 3%. A gradation analysis was carried out on one (1) sample of this deposit, the results of which indicated 51% gravel size particles, 43% sand size

particles, and 6% silt and clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 21 to 36 blows per 300 mm penetration, the compactness of this deposit was described as compact to dense. This layer was encountered to a depth of 2.9 m below grade at Borehole No. 3 (elevation 264.0 m).

4.1.4 Silt Fill

At surface, at Borehole Nos. 1 and 2, underlying the sand and gravel fill at Borehole No. 3, and underlying the sand fill at Borehole Nos. 4 and 5, a layer of fill consisting of silt, trace to with sand, trace gravel, trace clay, mixed with organic soils was penetrated. Shattered rock was encountered at various depths in this deposit at Borehole Nos. 3, 4, and 5. The natural moisture content measured on samples of this deposit was in the order of 4 to 57%. Hydrometer analyses were carried out on four (4) samples of this deposit, the results of which indicated 0 to 10% gravel size particles, 1 to 25% sand size particles, 59 to 92% silt size particles, and 5 to 7% clay size particles (Figure No. L-3, Appendix 3). Atterberg Limits Testing was carried out on four (4) samples of this fill layer, however the majority of the samples were generally found to be non-plastic (NP) except at one (1) sample of this layer, which indicated a Plastic Limit in the order of 43% and a Liquid Limit in the order of 58%, indicating a plastic silt (MH) (Figure No. L-6, Appendix 3). Based on SPT 'N' values of 3 to 54 blows per 300 mm penetration, the compactness of this deposit was described as very loose to very dense, generally loose. This layer was encountered to depths of 2.1, 2.1, 5.6, 4.0, and 2.9 m below grade at Borehole Nos. 1 to 5, respectively (elevations 262.5, 262.7, 261.3, 262.9, and 264.1 m, respectively).

4.1.5 Silt

Underlying the silt fill at Borehole Nos. 1, 3, 4, and 5, a deposit of grey silt trace to some clay was penetrated. The natural moisture content measured on samples of the silt deposit was in the order of 23 to 28%. Hydrometer analyses were carried out on three (3) samples of this deposit, the results of which indicated 0% gravel size particles, 0% sand size particles, 93 to 94% silt size particles, and 6 to 7% clay size particles (Figure No. L-4, Appendix 3). Atterberg Limits Testing was attempted on samples of this fill layer, however samples were generally found to be non-plastic (NP). Based on SPT 'N' values of 4 to 17 blows per 300 mm penetration, this deposit was described as loose to compact, generally compact. This deposit was encountered to depth of 4.4, 7.1, 7.1, and 7.1 m below grade at Borehole Nos. 1 to 5, respectively (elevations 260.2, 259.8, 259.8, and 259.9 m, respectively).

4.1.6 Clayey Silt to Silty Clay

Underlying the silt at Borehole Nos. 1, 3, 4, and 5, and underlying the silt fill at Borehole No. 2, a deposit of grey clayey silt to silty clay was penetrated. The clay content generally increased with depth in this deposit. The natural moisture content measured on samples of the sand deposit was in the order of 29 to 53%. Hydrometer analyses were carried out on seven (7) samples of this deposit, the results of which indicated 0% gravel size particles, 0 to 2% sand size particles, 51 to 88% silt size particles, and 12 to 47% clay size particles (Figure No. L-5,

Appendix 3). Atterberg Limits testing carried out on six (6) samples of this deposit, the results of which indicated a Plastic Limit in the order of 17 to 22% and a Liquid Limit in the order of 27 to 33%, indicating a clayey silt to silty clay of low plasticity (ML-CL to CL) (Figure No. L-6, Appendix 3). Based on in-situ shear strengths of 62 to greater than 100 kPa, the consistency of this deposit was described as stiff to very stiff. Sampling was terminated in this deposit at depths of 8.4, 8.4, 16.0, and 16.0 m below grade at Borehole Nos. 1 to 4, respectively (elevations 256.2, 256.4, 250.9, and 250.9 m, respectively).

Based on auger response, the silty clay deposit was encountered to a depth of 14.3 m below grade at Borehole No. 5 (elevation 252.7 m), where a dense deposit, likely sands was encountered. Auger refusal was encountered at a depth of 15.2 m below grade (elevation 251.8 m).

4.1.7 Dynamic Cone Penetration Tests

Dynamic cone penetration tests (DCPT) were advanced from the surface at the location of Borehole Nos. 1 and 2. DCPT refusal was encountered at depths of 15.2 and 14.2 m below grade at Borehole Nos. 1 and 2, respectively (elevations 249.4 and 250.6 m, respectively).

4.2 GROUNDWATER DATA

At the time of this investigation, the water level at the culvert outlet was measured at elevation 263.5 m on June 17, 2014.

Measurements of the groundwater and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix 2). The water levels in Borehole Nos. 1 to 5 were measured at elevations 259.5 to 264.7 m. It should be noted that water levels may not have stabilized at the time of measurement.

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

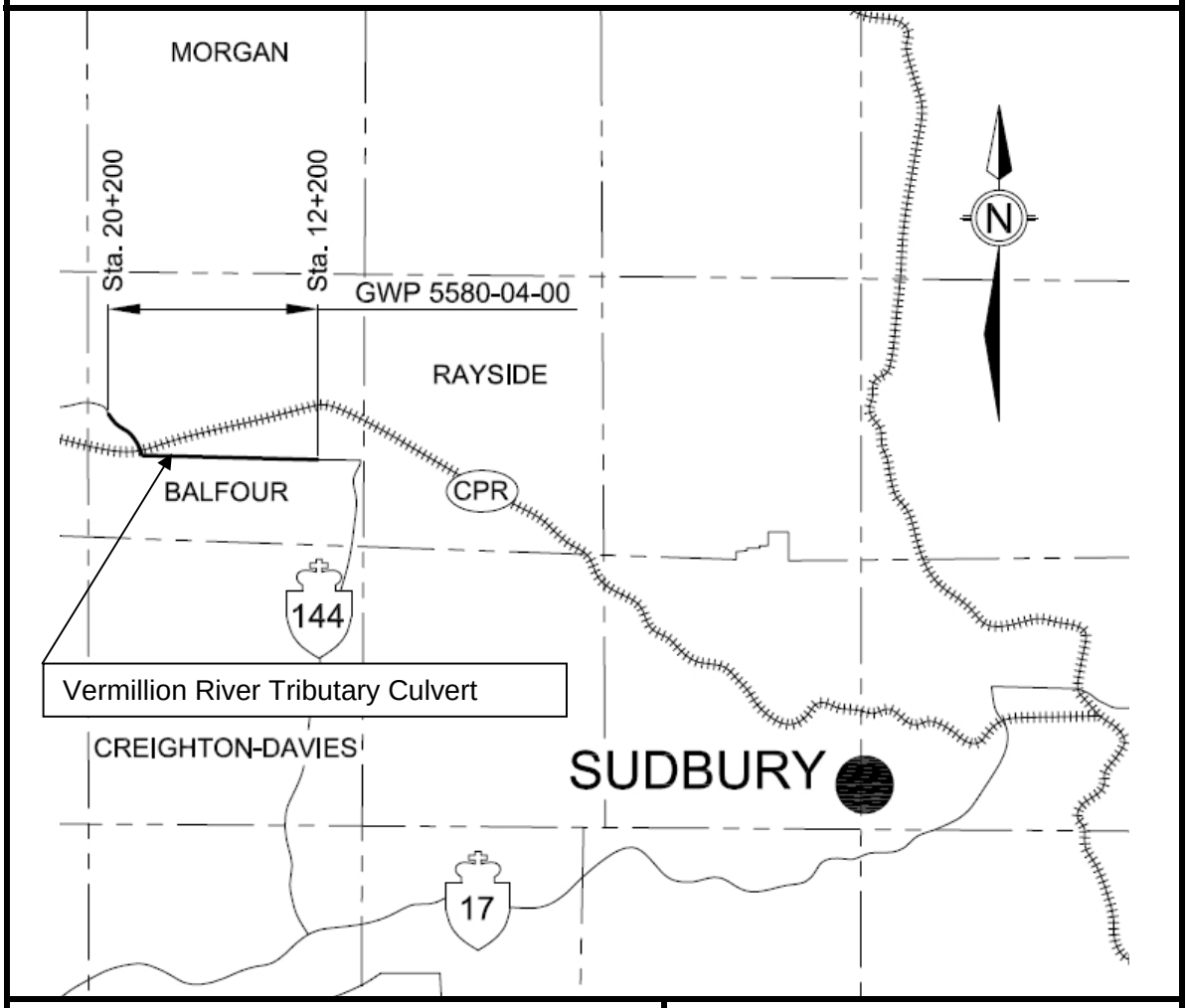
Appendix 1 Key Plan

Drawing No. 1 Key Plan

KEY PLAN

Drawing No. 1

NOT TO SCALE



FINAL
FOUNDATION INVESTIGATION
AND DESIGN REPORT
GWP 5580-04-00
Highway 144

Vermillion River Tributary Culvert

Reference No: 12/11/12218-F2 October 2014

LVM Merlex

Appendix 2 Subsurface Data

Enclosure No. 1	List of Abbreviations and Symbols
Enclosure Nos. 2 to 6	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) Cohesive Soils:

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 2)

METRIC

RECORD OF BOREHOLE NO. 1

LVM Merlex

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158970.2 E 283922.0 - Balfour Twp, Station 16+935, 15.0 m Rt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2014 March 11 TIME (Completed) 11:50:00 AM CHECKED BY MAM

DATE (Completed) 2014 March 11

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	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)
264.6	Ground Surface										
0.0	100 mm organics soils		1	AS							
	FILL - silt, trace to with sand trace gravel trace clay trace decayed wood										
	brown/grey, moist		2	SS	5						
	(loose)										
262.5			3	SS	7						
2.1	SILT										
	grey, wet		4	SS	11						0 0 94 6 (NP)
	(compact)										
	dark grey clay varves <5 mm thick		5	SS	17						0 0 93 7 (NP)
260.2			6	SS	14						
4.4	CLAYEY SILT to SILTY CLAY - trace sand		7	SS	13						0 0 83 17
	grey, wet										
	(very stiff)										
	dark grey clay varves <5 mm thick										
	clay content generally increases with depth		8	SS	10			>100			0 0 67 33
256.2			9	SS	9						
8.4	End of Sampling										

Continued Next Page

COMMENTS
Piezometer installed to 0.5 m above grade.

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 (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1) 14/3/11 11:50:00 AM	7.3	7.6
2) 14/3/12 7:50:00 AM	4.4	-
3) 14/6/13 11:00:00 AM	0.4	-

MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

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

METRIC

RECORD OF BOREHOLE NO. 1

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158970.2 E 283922.0 - Balfour Twp, Station 16+935, 15.0 m Rt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2014 March 11 TIME (Completed) 11:50:00 AM CHECKED BY MAM

DATE (Completed) 2014 March 11

ELEV / DEPTH	DESCRIPTION	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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
	Continued from Previous Page						251				
							250				
249.4											
15.2	DCPT Refusal End of Borehole										

LVM-Merlex, a Division of 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 2)

METRIC

RECORD OF BOREHOLE NO. 2

LVM Merlex

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158939.9 E 283904.8 - Balfour Twp, Station 16+931, 16.0 m Lt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2014 March 11 TIME (Completed) 4:25:00 PM CHECKED BY MAM

DATE (Completed) 2014 March 11

ELEV / DEPTH	DESCRIPTION	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)
264.8	Ground Surface										
0.0	FILL - silt, trace to with sand trace gravel trace clay trace decayed wood		1	SS	3						
	brown/grey, moist		2	SS	5						
	(loose)		3	SS	4						0 12 81 7
262.7											
2.1	CLAYEY SILT		4	SS	13						0 0 88 12
	grey, wet										
	(very stiff)		5	SS	13						
	dark grey clay varves <5 mm thick										
			6	SS	10						
			7	SS	10			>100			0 0 70 30 (NP)
	clay content generally increases with depth					▽					
			8	SS	8			>100			0 0 69 31
	(stiff)					▣					
			9	SS	5			3			
256.4											
8.4	End of Sampling										
	Continued Next Page										

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 (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1) 14/3/11 4:25:00 PM	5.3 ▽	7.5 ▣
2)	- ▽	-
3)	- ▼	-

MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

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

METRIC

RECORD OF BOREHOLE NO. 2

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158939.9 E 283904.8 - Balfour Twp, Station 16+931, 16.0 m Lt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2014 March 11 TIME (Completed) 4:25:00 PM CHECKED BY MAM

DATE (Completed) 2014 March 11

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES						
	Continued from Previous Page										
250.6							251				
14.2	DCPT Refusal End of Borehole										

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/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)

MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

LVM-Merlex, a Division of 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 2)

METRIC

RECORD OF BOREHOLE NO. 3

LVM Merlex

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158959.9 E 283903.6 - Balfour Twp, Station 16+953, 4.0 m Rt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY RG

CLIENT AECOM Inc. DATE (Started) 2014 June 11 TIME (Completed) 12:30:00 PM CHECKED BY MAM

DATE (Completed) 2014 June 11

ELEV / DEPTH	DESCRIPTION	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)
266.9	Asphalt Surface										
0.0	± 300 mm Asphalt										
	FILL - sand some gravel trace silt cobbles encountered		1	AS	N/A						18 72 (10)
	brown, dry		2	SS	32		266				
265.8											
1.1	(dense)										
	FILL - gravel and sand trace silt										
	brown, dry		3	SS	21		265				
	(compact/dense)										
			4	SS	36						51 43 (6)
264.0							264				
2.9	FILL - silt, trace to with sand trace gravel trace clay		5	SS	25						0 1 92 7 (NP)
	brown/grey, moist										
	(compact)		6	SS	27		263				
	shattered rock encountered at 4.6 m depth		7	SS	12	▽	262				
261.3											
5.6	SILT						261				
	grey, wet		8	SS	12						
	(compact)						260				
259.8											
7.1	CLAYEY SILT to SILTY CLAY - trace sand										
	grey, wet		9	SS	7		259	>100			
	(very stiff)										
	dark grey clay varves <15 mm thick						258				
	clay content generally increases with depth		10	SS	6			>100			0 2 65 33
	(stiff)						257				
			11	SS	4		256	5			
							255				
			12	SS	WH						
	Continued Next Page						254	4			

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 (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1) 14/6/13 12:30:00 PM	13.5	-
2) 14/6/16	4.4	-
3)	-	-

MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

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

METRIC

RECORD OF BOREHOLE NO. 3

LVM Merlex

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158959.9 E 283903.6 - Balfour Twp, Station 16+953, 4.0 m Rt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY RG

CLIENT AECOM Inc. DATE (Started) 2014 June 11 TIME (Completed) 12:30:00 PM CHECKED BY MAM

DATE (Completed) 2014 June 11

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
	Continued from Previous Page										
			13	SS	PM		253				
								4			
							252				
			14	SS	PM						
250.9							251	3			
16.0	End of Sampling End of Borehole										

MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

LVM-Merlex, a Division of 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 2)

METRIC

RECORD OF BOREHOLE NO. 4

LVM Merlex

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158950.7 E 283918.3 - Balfour Twp, Station 16+938, 4.6 m Lt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY RG

CLIENT AECOM Inc. DATE (Started) 2014 June 16 TIME (Completed) 4:30:00 PM CHECKED BY MAM

DATE (Completed) 2014 June 16

ELEV / DEPTH	DESCRIPTION	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)
266.9	Asphalt Surface										
0.0	100 mm Asphalt 300 mm Crushed Gravel FILL - sand some gravel trace silt cobbles encountered brown, dry (loose/compact)		1	AS	N/A		266				
			2	SS	13						
			3	SS	7		265				
264.8											
2.1	FILL - silt, trace to with sand trace gravel trace clay brown/grey, moist (loose/compact) shattered rock encountered at 3.0 m depth		4	SS	5		264				0 18 77 5 (NP)
			5	SS	21						
262.9											
4.0	SILT grey, wet (compact) clay content generally increases with depth		6	SS	10		263				
			7	SS	12		262				0 0 94 6 (NP)
			8	SS	11		261				
259.8							260				
7.1	CLAYEY SILT to SILTY CLAY - trace sand grey, wet (very stiff) dark grey clay varves <15 mm thick		9	SS	6		259	>100			
	clay content generally increases with depth (stiff)		10	SS	4		258				
							257	>100			
			11	SS	3		256	>100			
			12	SS	WH		255				0 2 51 47
	Continued Next Page						254	6			

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 (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1)	-	-
2)	-	-
3)	-	-

MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

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

METRIC

RECORD OF BOREHOLE NO. 4

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158950.7 E 283918.3 - Balfour Twp, Station 16+938, 4.6 m Lt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY RG

CLIENT AECOM Inc. DATE (Started) 2014 June 16 TIME (Completed) 4:30:00 PM CHECKED BY MAM

DATE (Completed) 2014 June 16

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
	Continued from Previous Page										
			13	SS	PM		253				
							252				
			14	SS	PM						
250.9							251				
16.0	End of Sampling End of Borehole										

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

WATER CONTENT (%): 20 40 60

MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

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

ENCLOSURE NO.:6 (Pg. 1 of 2)

METRIC

RECORD OF BOREHOLE NO. 5

LVM Merlex

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158951.7 E 283898.3 - Balfour Twp, Station 16+958, 4.4 m Lt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY RG

CLIENT AECOM Inc. DATE (Started) 2014 June 17 TIME (Completed) 2:30:00 PM CHECKED BY MAM

DATE (Completed) 2014 June 17

ELEV / DEPTH	DESCRIPTION	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)
267.0	Asphalt Surface										
0.0	100 mm Asphalt 300 mm Crushed Gravel		1	AS	N/A		266				
	FILL - sand some gravel trace silt cobbles encountered brown, dry		2	SS	19						
265.6	(loose/compact)										
1.4	FILL - silt, trace to with sand trace gravel trace clay brown/grey, moist		3	SS	9	▽	265				10 25 59 6 (NP)
	(loose/compact) shattered rock encountered at 2.4 m depth		4	SS	54						
264.1											
2.9	SILT		5	SS	4		264				
	grey, wet (loose/compact)										
	clay content generally increases with depth		6	SS	8		263				
			7	SS	17		262				
			8	SS	9		261	>100			
259.9							260				
7.1	CLAYEY SILT to SILTY CLAY										
	grey, wet (very stiff)		9	SS	5		259	>100			
	dark grey clay varves <15 mm thick						258				
	clay content generally increases with depth		10	SS	3			>100			
	(stiff)						257				
			11	SS	WH		256	7			
			12	SS	PM		255	6			
	Continued Next Page										

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 (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1) 14/6/17 7:10:00 PM	2.3 ▽	-
2)	- ▽	-
3)	- ▽	-

MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

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

METRIC

RECORD OF BOREHOLE NO. 5

REFERENCE 12/11/12218-F2 DATUM Geodetic LOCATION N 5158951.7 E 283898.3 - Balfour Twp, Station 16+958, 4.4 m Lt ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-408/C BOREHOLE TYPE Truck Mounted CME 45 - Hollow Stem Augers COMPILED BY RG

CLIENT AECOM Inc. DATE (Started) 2014 June 17 TIME (Completed) 2:30:00 PM CHECKED BY MAM

DATE (Completed) 2014 June 17

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES						
	Continued from Previous Page										
			13	SS	WH		253				
252.7											
14.3	Augers grinding - likely dense sands										
251.8							252				
15.2	Auger Refusal End of Borehole										

20 40 60 80 100

○ UNCONFINED + FIELD VANE

● QUICK TRIAXIAL × LAB VANE

W_P W W_L

20 40 60

kN/m³

GR SA (SI CL)

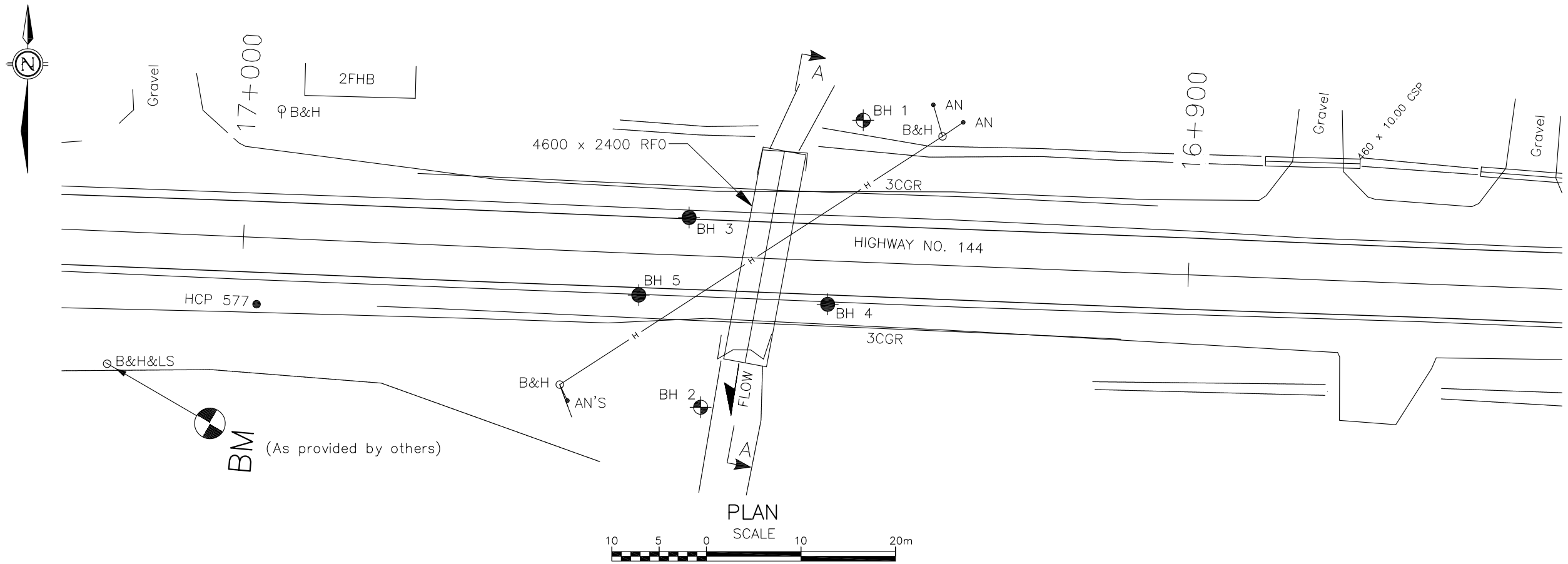
MEL-GEO 12218 - BOREHOL LOGS - VERMILLION RIVER.GPJ MEL-GEO.GDT 14/9/18

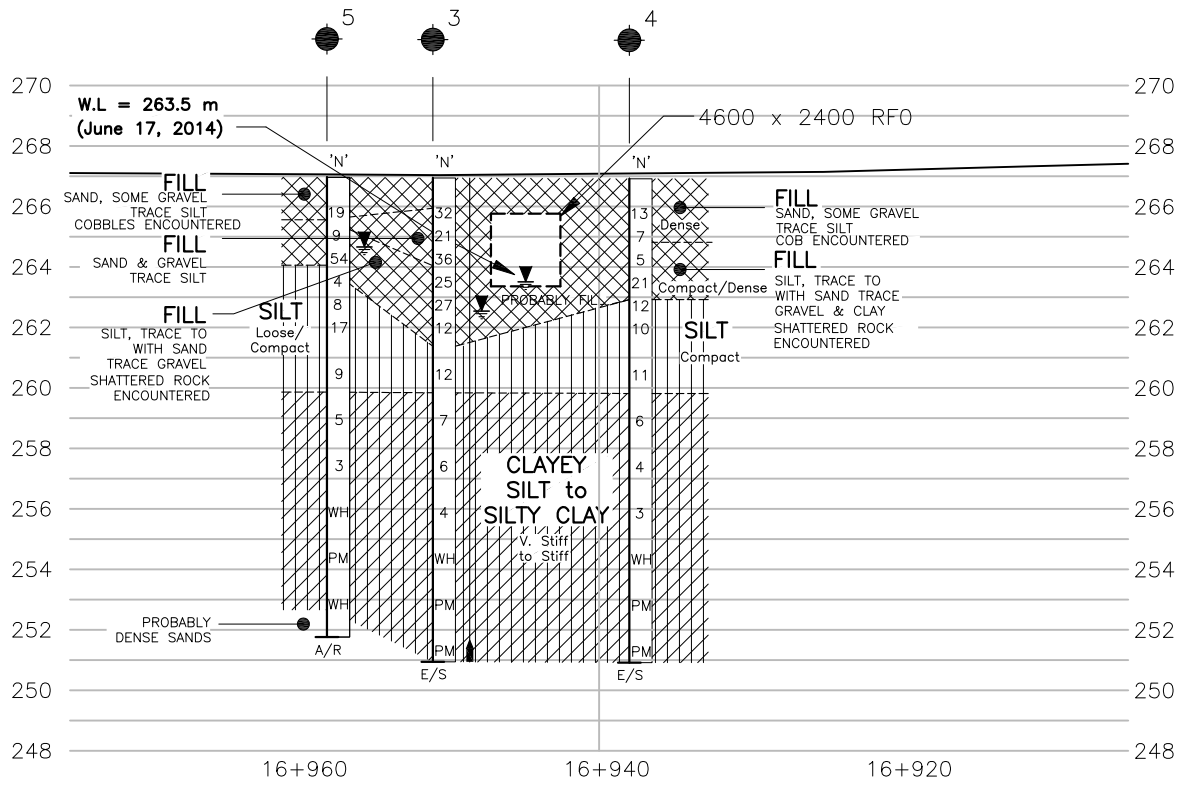
LVM-Merlex, a Division of EnGlobe Corp.

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-5:	Grain Size Distribution Curves
Figure No. L-6:	Atterberg Limits Summary
Figure No. L-7:	Shear Strength Summary
Table No. L-8:	Lab Test Summary Sheet





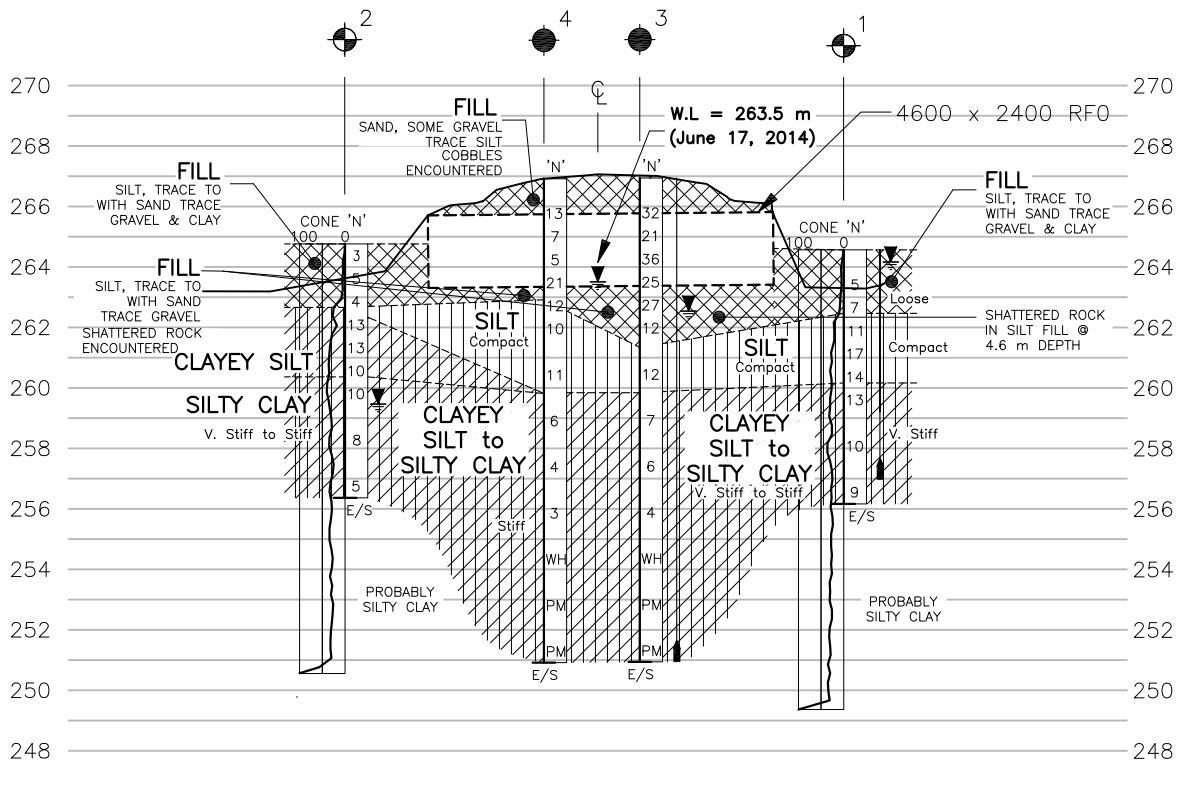
CENTERLINE

PROFILE

SCALE

HOR 10 5 0 10 20m

VERT 5 2.5 0 5 10m



A–A

SECTION

SCALE

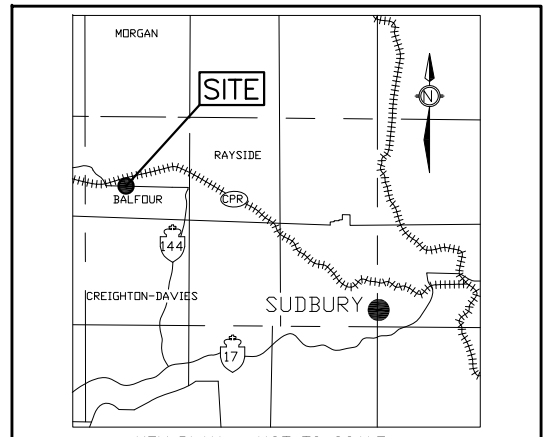
HOR 10 5 0 10 20m

VERT 5 2.5 0 5 10m

CONT. No.	N
XXXX–XXXX	
GWP. No. 5580–04–00	DRAWING 2

HWY 144
VERMILLION CREEK TRIBUTARY CULVERT
(SITE 46–408/C)
TOWNSHIP OF BALFOUR
BOREHOLE LOCATIONS & SOIL STRATA

LVM Merlex



KEY PLAN – NOT TO SCALE

LEGEND

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

Borehole No.	Elev.	O/S	Co–ordinates	
			Northerly	Easterly
Borehole No. 1	264.6	15.0 m Rt	5158970.2	283922.0
Borehole No. 2	264.8	16.0 m Lt	5158939.9	283904.8
Borehole No. 3	266.9	4.0 m Rt	5158959.9	283903.6
Borehole No. 4	266.9	4.6 m Lt	5158950.7	283918.3
Borehole No. 5	267.0	4.4 m Lt	5158951.7	283898.3

NOTE 1: 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.

NOTE 2: 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.

REVISIONS	DATE	BY	DESCRIPTION
	AUG 2014	RG	DRAFT
	OCT 2014	AT	FINAL

HWY NO. 144 – BALFOUR TOWNSHIP

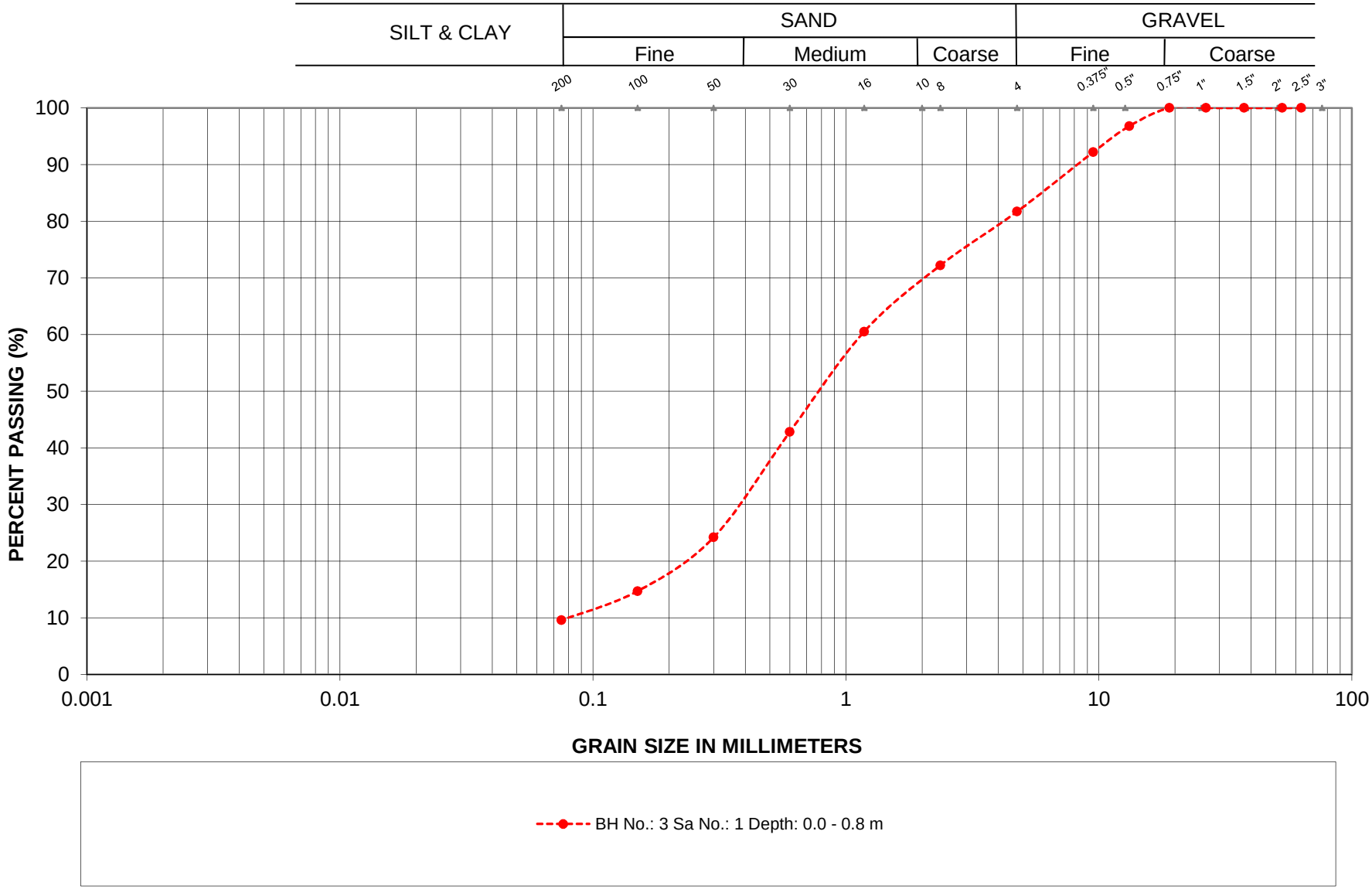
GEOCRES NO.: 41I–319

L|V|M REF. NO.: 12/11/12218

DRAWN: RG | CHECKED: AT | DATE: OCTOBER 2014

Reference No.: 12/11/12218-F2
Date: October 2014

GRAIN SIZE ANALYSIS



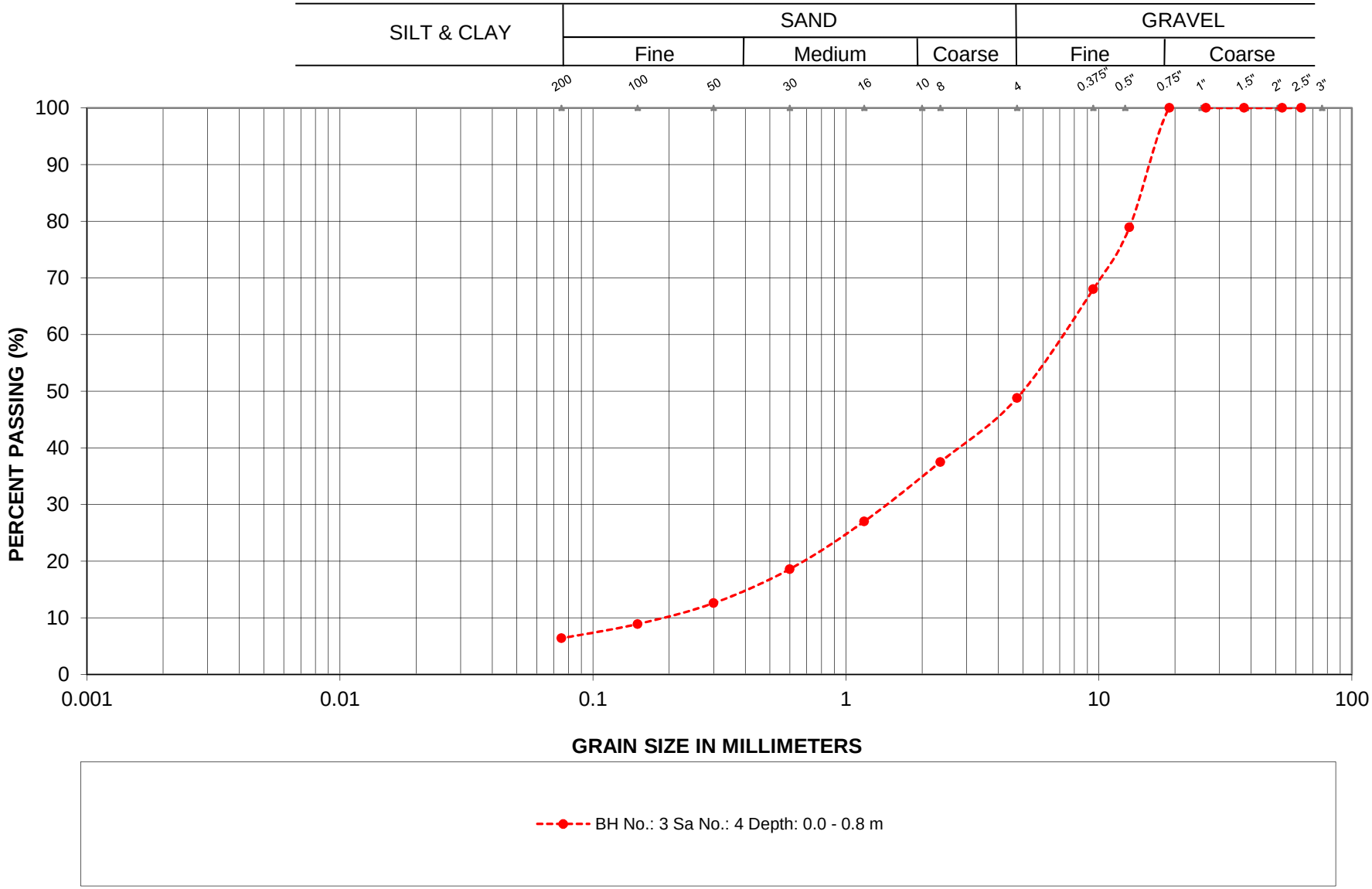
G.W.P.: 5580-04-00
LOCATION: Hwy 144, Vermillion River Tributary Culvert SAND FILL

LVM | MERLEX

FIGURE L-1

Reference No.: 12/11/12218-F2
Date: October 2014

GRAIN SIZE ANALYSIS



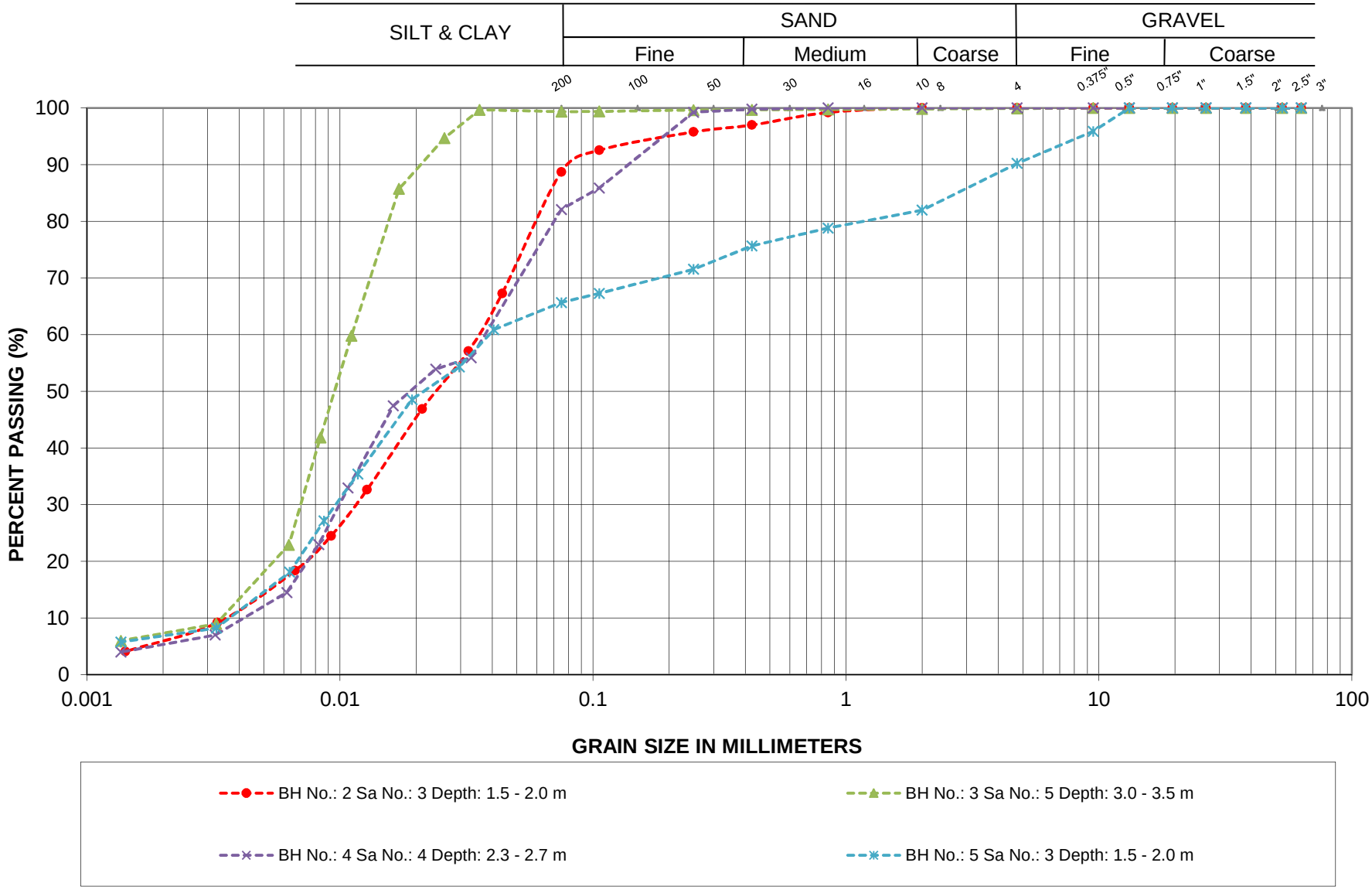
G.W.P.: 5580-04-00
LOCATION: Hwy 144, Vermillion River Tributary Culvert SAND AND GRAVEL FILL

LVM | MERLEX

FIGURE L-2

Reference No.: 12/11/12218-F2
Date: October 2014

GRAIN SIZE ANALYSIS



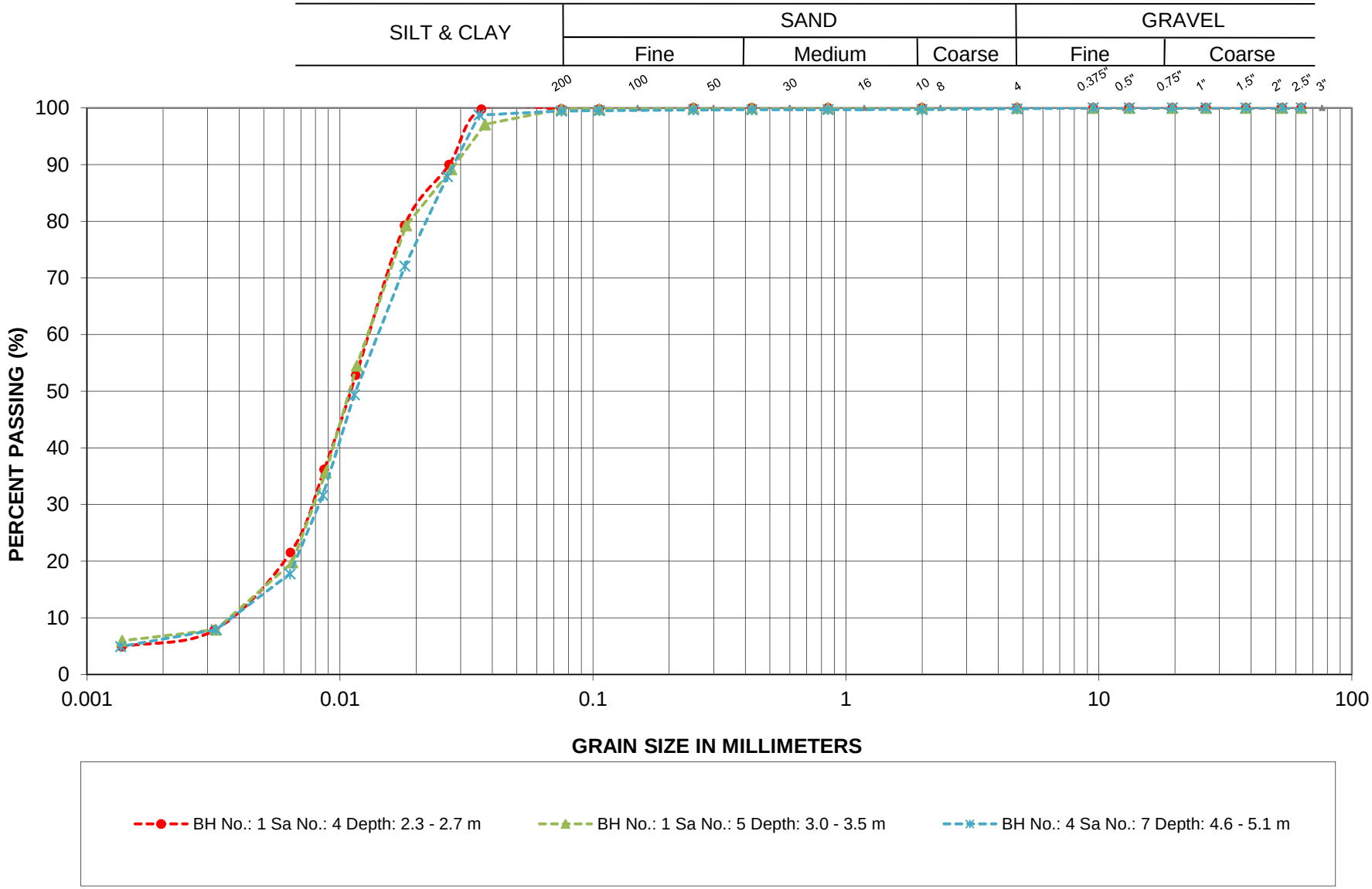
G.W.P.: 5580-04-00
LOCATION: Hwy 144, Vermillion River Tributary Culvert SILT FILL

LVM | MERLEX

FIGURE L-3

Reference No.: 12/11/12218-F2
Date: October 2014

GRAIN SIZE ANALYSIS



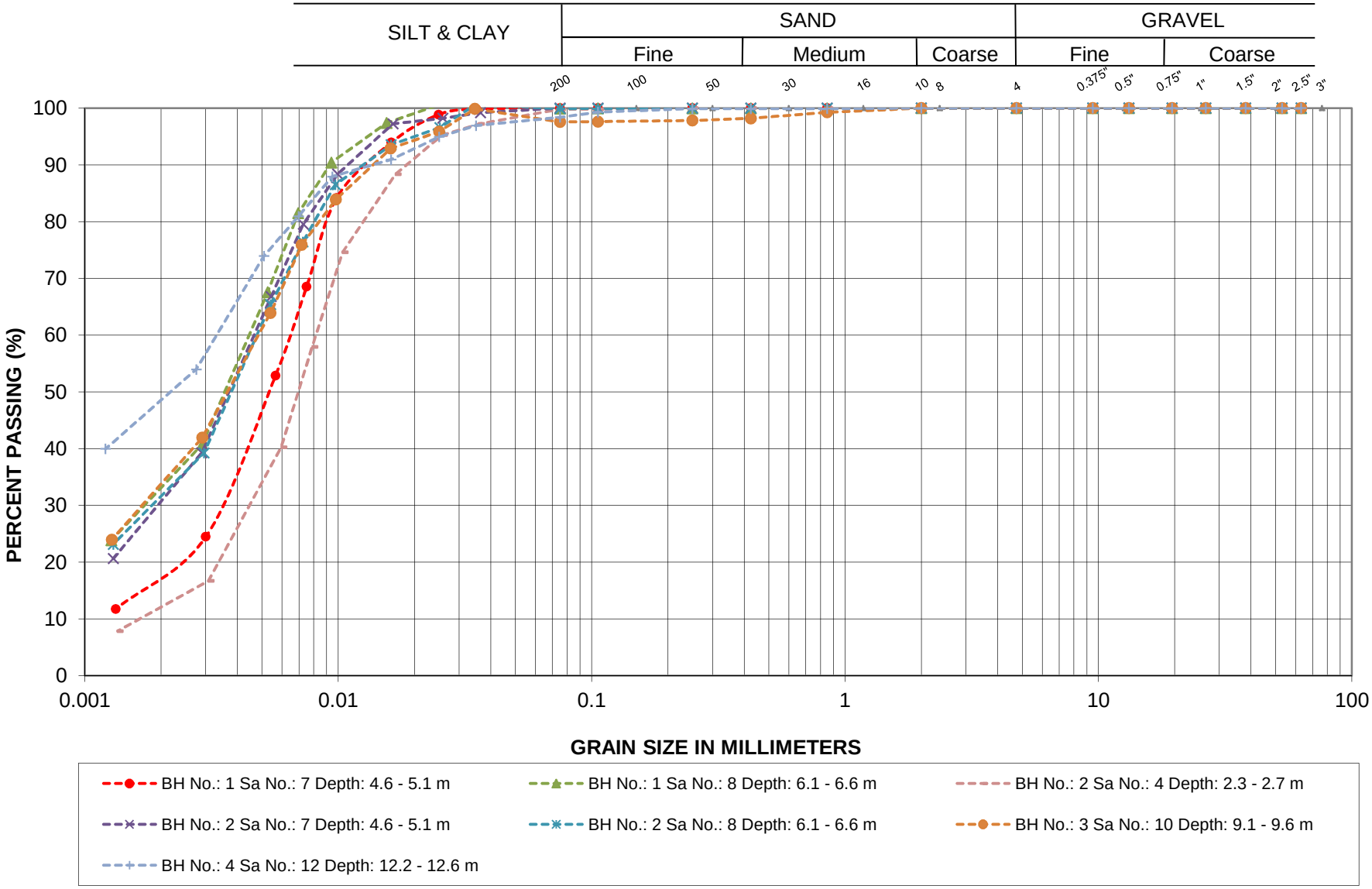
G.W.P.: 5580-04-00
LOCATION: Hwy 144, Vermillion River Tributary Culvert SILT

LVM | MERLEX

FIGURE L-4

Reference No.: 12/11/12218-F2
Date: October 2014

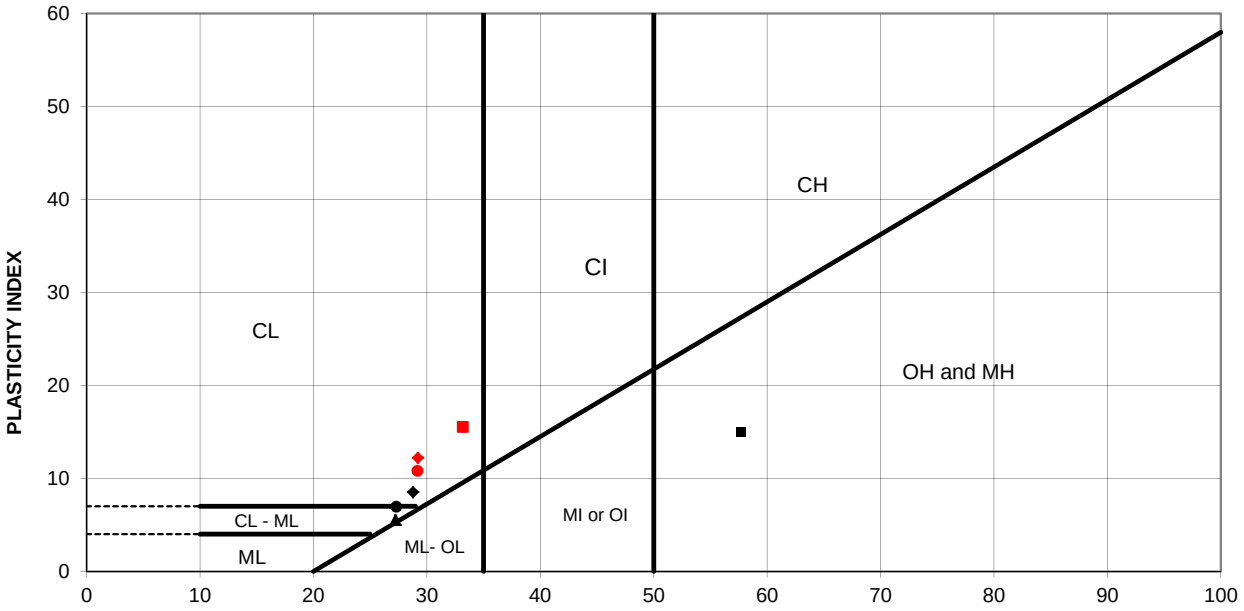
GRAIN SIZE ANALYSIS



G.W.P.: 5580-04-00
LOCATION: Hwy 144, Vermillion River Tributary Culvert CLAYEY SILT to SILTY CLAY

ATTERBERG LIMITS TEST RESULTS	FIGURE L-6

ATTERBERG INDICES



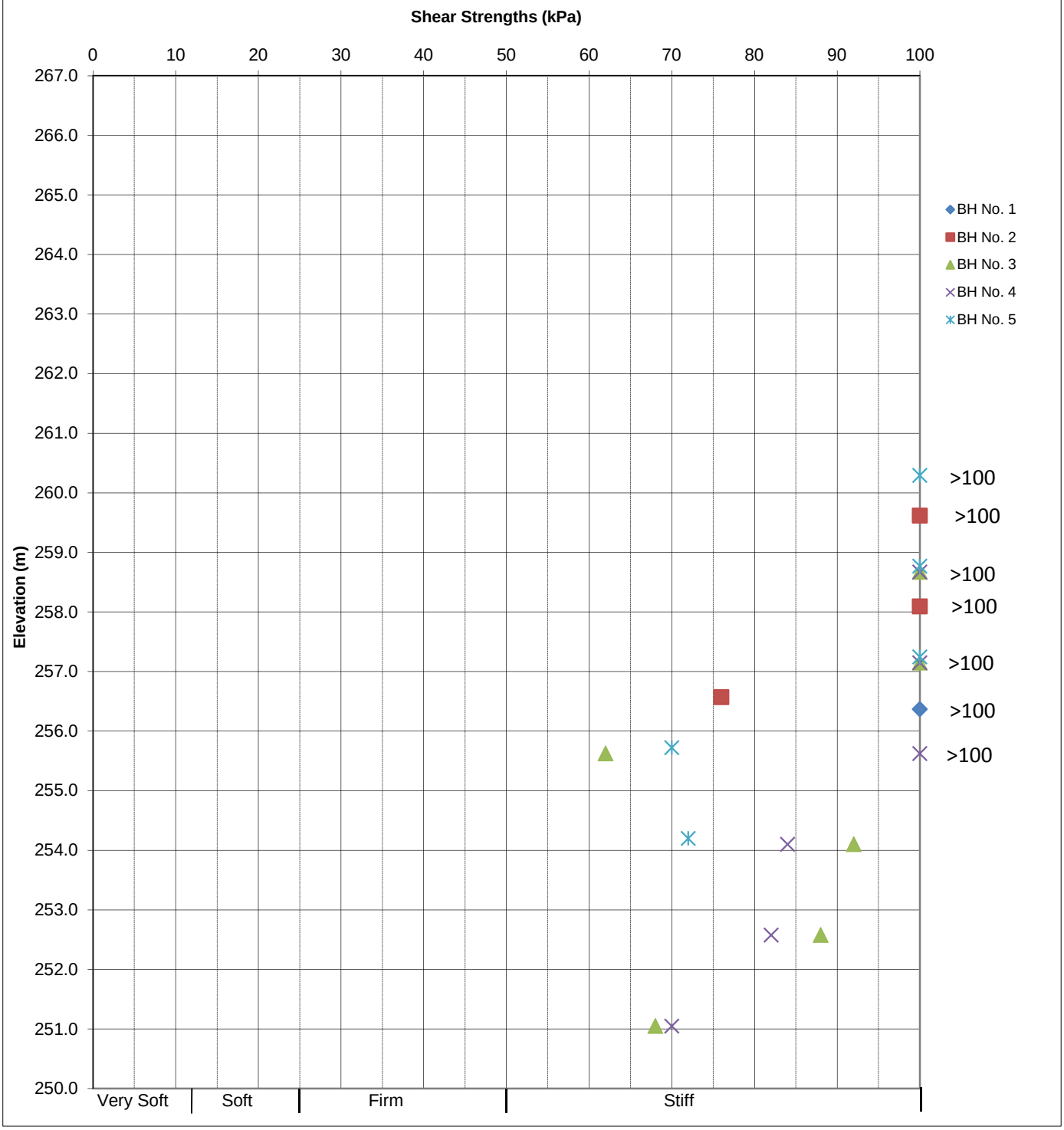
SYMBOL	BH	Sa. No.	Depth(m)	Elev.(m)	Liquid Limit	Plastic Limit	Plasticity Index	NMC %
●	1	7	4.6	260.0	27.3	20.3	7.0	28.7
◆	1	8	6.1	258.5	28.8	20.2	8.5	30.0
■	2	3	1.5	263.3	57.8	42.8	15.0	57.3
▲	2	4	2.3	262.5	27.2	21.7	5.5	26.1
●	2	8	6.1	258.7	29.2	18.4	10.8	31.5
◆	3	10	9.1	257.8	29.2	17.0	12.2	33.3
■	4	12	12.2	254.7	33.2	17.7	15.5	37.4

Date: Oct-14 Prep'd: AT
Project: Hwy 144, Vermillion River Tributary Chkd: MAM
G.W.P: 5580-04-00 Ref. No.: 12/11/12218-F2

LVM-MERLEX, a division of EnGlobe corp.

IN-SITU SHEAR STRENGTHS	Figure No. L-7

In-Situ Shear Strengths vs. Depth



Project: 12/11/12218-F2
GWP: 5580-04-00
Location: Hwy 144, Vermillion River Tributary **LVM-MERLEX**

Date: October 2014

LVM Merlex

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					28.5							
	2	0.8					22.7				5			
	3	1.5					46.7				7			
	4	2.3	0	0	94	6	27.7				11			Non Plastic (NP)
	5	3.1	0	0	93	7	23.4				17			Non Plastic (NP)
	6	3.8					28.2				14			
	7	4.6	0	0	83	17	28.7	27.3	20.3	7.0	13			
	8	6.1	0	0	67	33	30.0	28.8	20.2	8.6	10			
	9	7.6					33.5				9			
2	1	0.0					45.7				3			
	2	0.8					50.0				5			
	3	1.5	0	12	81	7	57.3	57.8	42.8	15.0	4			
	4	2.3	0	0	88	12	26.1	27.2	21.7	5.5	13			
	5	3.1					27.4				13			
	6	3.8					28.2				10			
	7	4.6	0	0	70	30	30.8				10			Non Plastic (NP)
	8	6.1	0	0	69	31	31.5	29.2	18.4	10.8	8			
	9	7.6					33.2				5			
3	1	0.0	18	72	10		4.2							
	2	0.8					10.6				32			
	3	1.52					2.9				21			
	4	2.29	51	43	6		2.1				36			
	5	3.1	0	1	92	7	24.0				25			Non Plastic (NP)
	6	3.8					21.3				27			
	7	4.6					4.2				12			

LVM Merlex

Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
3	8	6.1					26.6				12			
	9	7.6					30.4				7			
	10	9.1	0	2	65	33	33.3	29.2	17.0	12.2	6			
	11	10.7					35.8				4			
	12	12.2					35.4				WH			
	13	13.7					53.6				PM			
	14	15.2					34.0				PM			
4	1	0.0					3.3							
	2	0.8					16.0				13			
	3	1.5					10.5				7			
	4	2.3	0	18	77	5	23.6				5			Non Plastic (NP)
	5	3.1					22.3				21			
	6	3.8					36.8				12			
	7	4.57	0	0	94	6	22.8				10			Non Plastic (NP)
	8	6.1					25.9				11			
	9	7.62					31.1				6			
	10	9.14					31.9				4			
	11	10.67					35.2				3			
	12	12.19	0	2	51	47	37.4	33.2	17.7	15.5	WH			
	13	13.72					47.7				PM			
	14	15.24					52.6				PM			
5	1	0					3.5							
	2	0.76					5.3				19			
	3	1.52	10	25	59	6	17.3				9			Non Plastic (NP)
	4	2.29					3.6				54			

Appendix 4 Photo Essay

Enclosure No. 7: Photo Essay

Existing Embankment – Looking West	Photo: 1

Existing Embankment – Looking East	Photo: 2

Project: Hwy 144 – Vermillion River Tributary Culvert	Photos Provided By: LVM Date: June 2014

Culvert Inlet – Looking North	Photo: 3

Culvert Outlet – Looking North	Photo: 4

Project: Hwy 144 – Vermillion River Tributary Culvert	Photos Provided By: LVM Date: June 2014