Submitted To Triton Engineering Services Limited
18 Robb Blvd Unit 8, Orangeville, Ontario L9W 3L2
On Behalf of the Ontario Ministry of Transportation

Highway 144 Grading and Resurfacing
Culvert Replacement
Station 22+343 - TWP of Dowling
GWP 5081-06-00

Highway 144
GWP 5081-06-00
From 1.5 km South of Sudbury Municipal Road 8, Northerly 18.1 km to Cartier West Entrance (Center Street)

FINAL FOUNDATION INVESTIGATION REPORT

Date: October 7, 2013
Ref. N^{o}: 11/11/11209-F2

Geocres No. 41I-298

LVM | MERLEX

2-120 PROGRESS COURT, NORTH BAY (ONTARIO) CANADA P1A 0C2 – T 705.476.2550 | F 705.476.8882 – NORTHBAY@LVM.CA - WWW.LVM.CA

Submitted To Triton Engineering Services Limited
On Behalf of the Ontario Ministry of Transportation

Highway 144 Grading and Resurfacing
Culvert Replacement
Station 22+343 - TWP of Dowling
GWP 5081-06-00

Final Foundation Investigation Report

Prepared by:

A. Tepylo, EIT
LVM | Merlex – Geotechnical Assessor

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

Reviewed by:

Jake Berghamer, P. Eng.
LVM | Merlex – Regional Manager

TABLE OF CONTENTS

Appendices

Property and Confidentiality

Client:
Triton Engineering Services Limited
18 Robb Blvd., Unit 8
Orangeville, Ontario
L9W 3L2
Attention: **Mr. Howard Wray, P.Eng.**

REVISION AND PUBLICATION REGISTER		
Revision N°	**Date**	**Modification And/Or Publication Details**
00	2013-03-13	DRAFT Report Issued
01	2013-10-07	Final Report Issued

REPORT DISTRIBUTION	
5 hard copies, 1 electronic copy	MTO Project Manager
1 hard copy, 1 electronic copy	MTO Pavement & Foundations Section, Foundation Group

1 INTRODUCTION

LVM | MERLEX has been retained by Triton Engineering Services Limited, on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation for the proposed replacement of an existing culvert and design of a protection system. This culvert replacement is located on Highway 144, some 500 m South of Regional Road 8, in the Township of Dowling.

The foundation investigation location was specified by the MTO in the RFP/TPM documentation Agreement No. 5010-E-0051. The terms of reference for the scope of work are outlined in LVM | MERLEX's Proposal P-11-023, dated June, 2011. The purpose of this investigation was to determine the subsurface conditions in the area of the culvert in order to provide geotechnical design recommendations. 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 foundation investigation for this CSP culvert is located at Station 22+343, Township of Dowling. The topography at the site is a low wet land area with flooded organic terrain to the west (left) and east (right) of the embankment. The existing highway embankment currently supports three undivided lanes of highway, two in the northbound direction and one in the southbound direction. The existing highway, at the culvert locations, is constructed on a fill embankment some 3.7 m in height, with centerline elevation of 372.3 m at the culvert location. The culvert at this location is a 910 mm diameter CSP culvert, some 27.6 m in length. Flow through the culvert is from left (west) to right (east) (see Photo Essay, Appendix 4).

Infrastructure at the culvert location consists of overhead power and communication wires on both the west (left) and east (right) sides of the highway.

2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

This project is located in the Geomorphic Sub-province known as the Eastern Sandy Uplands. The topography on this section of Highway 144 is generally rolling. There are a few exposed bedrock ridges. At many locations, significant layers of earth overlay the bedrock. Organic terrain was also observed. Within the project area, overburden consists primarily of sands.

Bedrock in the area, as indicated on OGS Map 2506, is of the Early Precambrian Era. At the location of this culvert foundation investigation, the bedrock comprises of Felsic Igneous and Metamorphic Rocks including: granitic, metasedimentary and minor metavolcanic migmatite.

3 INVESTIGATION PROCEDURES

The field work for this investigation was carried out during the period of March 19th to April 11th, 2012, during which time five (5) sampled boreholes, and DCPTs, were advanced. For the purposes of foundation design for the culvert replacement, one borehole was advanced through the embankment slightly up chainage from the culvert, and one borehole was advanced at each the inlet and outlet ends of the culverts. Two boreholes were advanced through the embankment, one up and down chainage from the culverts, to provide subsurface data to support the design of a protection system.

The field investigation was carried out using a Bombardier and a truck 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. At the boreholes, a Dynamic Cone Penetration Test (DCPT) was carried out to give a continuous plot of the soil resistance with depth. When cohesive deposits were encountered, the in-situ strength was measured using an “N” size field vane, vane collar, and calibrated torque meter. All samples taken during this investigation were stored in labeled airtight containers for transport to our North Bay laboratory for visual examination and select laboratory testing.

Groundwater conditions in the open boreholes were observed during the advancement of, and immediately following, completion of the individual boreholes. 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. 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 asphalt surface.

The field work for this investigation was under the full time direction of a senior member of our 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, as well as Atterberg Limit testing and specific gravity. 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 C (Figures Nos. L-1 to L-6).

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 co-ordinates, northing and easting, were then established for the boring locations. Elevations contained in this report are referenced to a geodetic datum.

4 SUBSURFACE CONDITIONS

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Record of Borehole Logs (Appendix 2) and on Figure 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 and Dynamic Cone Penetration Test (DCPT) plus field observations. Typically such boundaries represent transitions from one zone to another and are not an exact demarcation of a 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 22+343, TWP OF DOWLING

A plan and profile illustrating the borehole locations and stratigraphic sequences is shown on Figure 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. Boreholes No. 3 to 5 were advanced through the existing embankment. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 5 were recorded at 369.6, 368.8, 371.9, 372.6, and 372.2 m, respectively.

4.1.1 Pavement Structure

At surface at Borehole Nos. 3 to 5, a layer of asphalt some 150 mm thick was penetrated. The asphalt was underlain by a base layer of crushed gravel some 175 to 200 mm thick.

4.1.2 Embankment Fill

Underlying the surficial pavement structure at Borehole Nos. 3 to 5, a deposit of fill described as brown to grey sand trace to with gravel, trace to with silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 3 to 20%. Gradation analyses were carried out on five (5) samples of this deposit, the results of which indicated 1 to 27% gravel size particles, 43 to 92% sand size particles, and 3 to 30% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT ‘N’ values of 2 to 48 blows per 300 mm penetration, the compactness of this deposit was described as very loose to dense. This deposit was encountered to depths of 3.4 m below grade at Borehole Nos. 3 to 5 (elevations 368.5, 369.2, and 368.8 m, respectively).

4.1.3 Fill

At surface at Borehole No. 1, a deposit of fill consisting of brown sand and gravel to gravelly sand, trace silt was penetrated. Trace organics were encountered in this deposit. Occasional cobbles and boulders were encountered in this deposit. The natural moisture content measured on samples of this deposit was in the order of 13 to 19%. Gradation analyses were carried out on two (2) samples of this deposit, the results of which indicated 29 to 43% gravel size particles, 49 to 54% sand size particles, and 8 to 17% silt and clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 8 to 16 blows per 300 mm penetration, the compactness of this deposit was described as loose to compact. This deposit was encountered to a depth of 1.9 m below grade (elevation 367.7 m).

4.1.4 Organics

At surface at Borehole No. 2, and underlying the fill at Borehole No. 1, a deposit of black silty organics was penetrated. The natural moisture content measured on samples of this deposit was in the order of 77 to 227%. This deposit was encountered to depths of 2.6 and 1.4 m below existing grade at Borehole Nos. 1 and 2, respectively (elevations 367.0 and 367.4 m, respectively).

4.1.5 Sand and Gravel

Underlying the silty organics at Borehole No. 2, and underlying the embankment fill at Borehole Nos. 3, 4, and 5, a deposit of grey sand and gravel, to gravelly sand, trace silt was penetrated. Occasional cobbles and boulders were encountered in this deposit. Trace organics were encountered in this deposit at Borehole No. 3. The natural moisture content measured on samples of this deposit was in the order of 11 to 20%. Gradation analyses were carried out on two (2) samples of this deposit, the results of which indicated 37 to 47% gravel size particles, 44 to 54% sand size particles, and 9% silt and clay size particles (Figure No. L-3, Appendix 3). Based on SPT 'N' values of 17 to 37 blows per 300 mm penetration, the compactness of this deposit was described as compact to dense. This deposit was encountered to depths of 2.7, 4.6, 5.8, and 4.3 m below grade at Borehole Nos. 2 to 5, respectively (elevations 366.1, 367.3, 366.8, and 367.9 m, respectively).

4.1.6 Sand

Underlying the silty organics at Borehole No. 1, and underlying the sand and gravel at Borehole Nos. 3 and 5, a deposit of sand, some to with gravel, some to with silt was penetrated. Occasional cobbles and boulders were encountered in this deposit at Borehole No. 1. The natural moisture content measured on samples of this deposit was in the order of 9 to 18%. Gradation analyses were carried out on three (3) samples of this deposit, the results of which indicated 16 to 21% gravel size particles, 53 to 68% sand size particles, and 16 to 30% silt and clay size particles (Figure No. L-4, Appendix 3). Based on SPT 'N' values of 15 to 40 blows per 300 mm penetration, the compactness of this deposit was described as compact to dense. This deposit was encountered to a depth of 6.1 m below grade at Borehole No. 5 (elevation 366.1

m). Auger refusal was encountered in this deposit at depths of 4.4 and 7.1 m below grade at Borehole Nos. 1 and 3, respectively (elevations 365.2 and 364.8 m, respectively).

4.1.7 Silt

Underlying the sand and gravel at Borehole Nos. 2 and 4, and underlying the sand at Borehole No. 5, a deposit of grey silt, some to with sand, trace gravel, trace clay was penetrated. The natural moisture content measured on samples of this deposit was in the order of 14 to 30%. Gradation analyses were carried out on two (2) samples of this deposit, the results of which indicated 0 to 5% gravel size particles, 15 to 25% sand size particles, 63 to 78% silt size particles, and 7% clay size particles (Figure No. L-5, Appendix 3). Based on SPT 'N' values of 15 to 43 blows per 300 mm penetration, the compactness of this deposit was described as compact to dense. Auger refusal was encountered in this deposit at depths of 3.0, 8.2, and 7.1 m below grade at Borehole Nos. 2, 4, and 5, respectively (elevations 365.8, 364.4, and 365.1 m, respectively).

4.1.8 DCPT

Dynamic Cone Penetration Tests were advanced at all five borehole locations. The DCPT plots are graphically illustrated on the individual borehole logs. DCPT refusal was encountered at depths of 1.4, 1.5, 6.6, 8.0, and 7.1 m below grade at Borehole Nos. 1 to 5, respectively (elevations 368.2, 367.3, 365.3, 364.6, and 365.1 m, respectively).

4.2 GROUNDWATER DATA

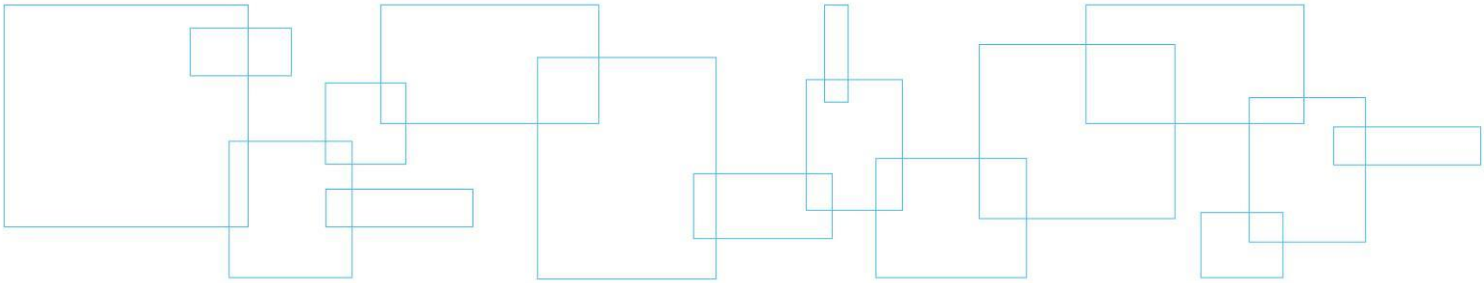
The water level in the culvert was measured at an elevation of 369.4 m, at the time of this investigation.

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. These levels are presented on the individual Record of Borehole Log Sheets (Appendix 2). The water levels in the boreholes were measured at elevations 368.7, 368.8, 368.9, 368.3, and 369.0 m upon completion at Borehole Nos. 1 to 5, respectively.

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

Appendix 1 Key Plan

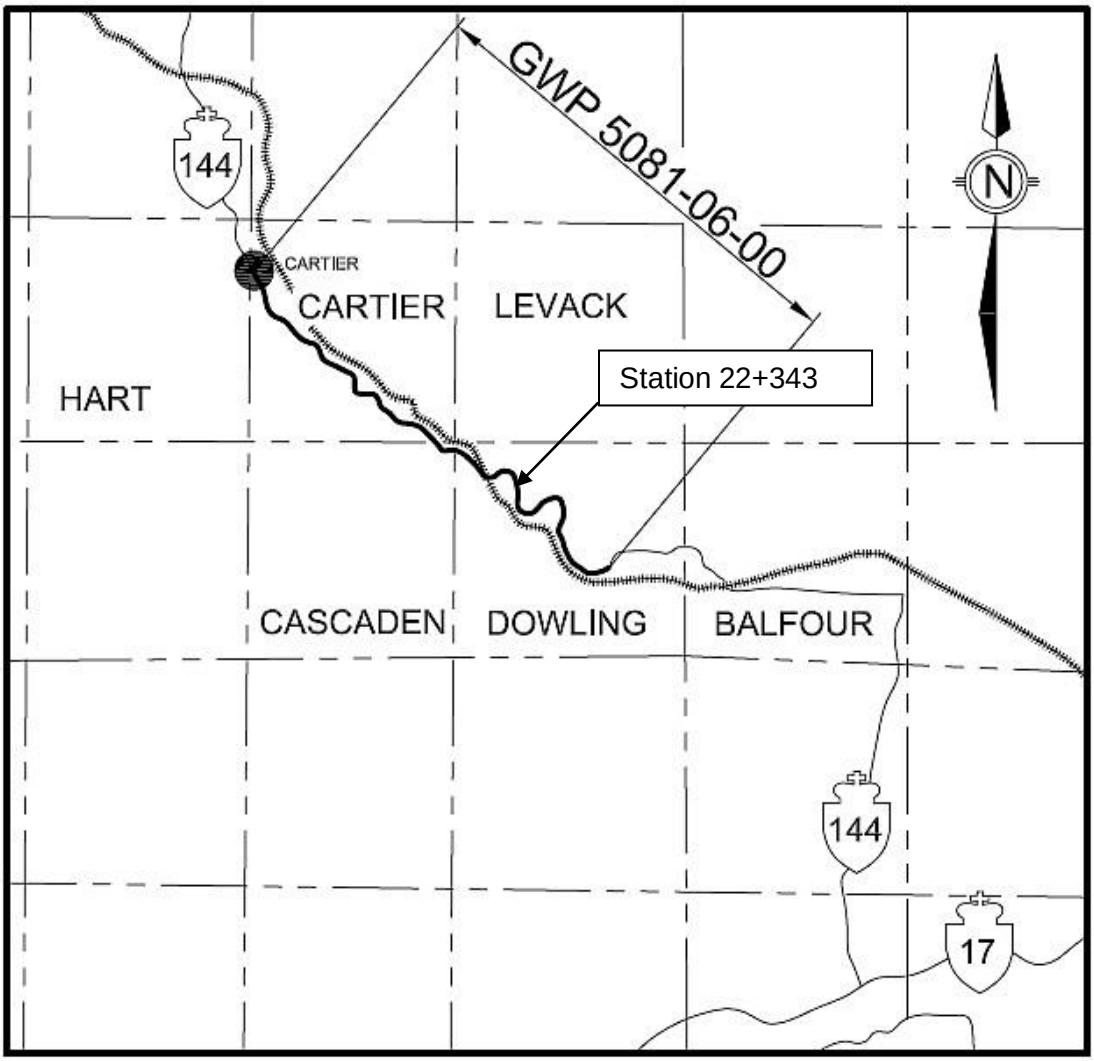
Drawing No. 1 Key Plan



LVM | MERLEX

KEY PLAN Drawing No. 1

NOT TO SCALE



FINAL
FOUNDATION INVESTIGATION REPORT
GWP 5081-06-00

Highway 144 – Station 22+343, TWP of Dowling

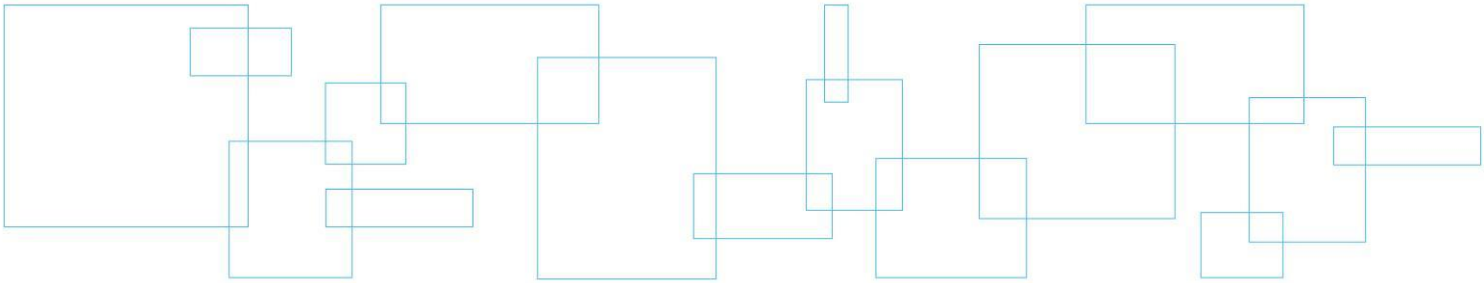
From 1.5 km South of Sudbury Municipal Road 8, Northerly 18.1 km To Cartier West Entrance (Center Street)

MEL Ref. No.: 11/11/11209-F2 October 2013

LVM | MERLEX

Appendix 2 Subsurface Data

Enclosure No. 1 List of Abbreviations and Symbols
Enclosure Nos. 2 to 6 Record of Borehole Sheet



LVM | MERLEX

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

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) *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.

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/or boulders frequency is an estimate based on drill response and field observations:

Occasional	Obstructions encountered in borehole, however advance is not severely impeded
Numerous	Obstructions appear essentially continuous over drilled length

5. LABORATORY TESTS

P Standard Proctor Test
A Atterberg Limit Test
GS Grain Size Analysis
H Hydrometer Analysis
C Consolidation

SAMPLE DESCRIPTION NOTES:

1. **FILL:** The term fill is used to designate all man-made deposits of natural soil and/or waste materials. The reader is cautioned that fill materials can be very heterogeneous in nature and variable in depth, density and degree of compaction. Fill materials can be expected to contain organics, waste materials, construction materials, shot rock, rip-rap, and/or larger obstructions such as boulders, concrete foundations, slabs, abandoned tanks, etc.; none of which may have been encountered in the borehole. The description of the material penetrated in the borehole therefore may not be applicable as a general description of the fill material on the site as boreholes cannot accurately define the nature of fill material. During the boring and sampling process, retrieved samples may have certain characteristics that identify them as 'fill'. Fill materials (or possible fill materials) will be designated on the Borehole Logs. If fill material is identified on the site, it is highly recommended that testpits be put down to delineate the nature of the fill material. However, even through the use of testpits defining the true nature and composition of the fill material cannot be guaranteed. Fill deposits often contain pockets or seams of organics, organically contaminated soils or other deleterious material that can cause settlement or result in the production of methane gas. It should be noted that the origins and history of fill material is frequently very vague or non-existent. Often fill material may be contaminated beyond environmental guidelines and the material will have to be disposed of at a designated site (i.e. registered landfill). Unless requested or stated otherwise in this report, fill material on this site has not been tested for contaminants however, environmental testing of the fill material can be carried out at your request. Detection of underground storage tanks cannot be determined with conventional geotechnical procedures.

2. **TILL:** The term till indicates a material that is an unstratified, glacial deposit, heterogeneous in nature and, as such, may consist of mixtures and pockets of clay, silt, sand, gravel, cobbles and/or boulders. These heterogeneous deposits originate from a geological process associated with glaciation. It must be noted that due to the highly heterogeneous nature of till deposits, the description of the deposit on the borehole log may only be applicable to a very limited area and therefore, caution must be exercised when dealing with a till deposit. When excavating in till, contractors may encounter cobbles/boulders or possibly bedrock even if they are not indicated on the borehole logs. It must be appreciated that conventional geotechnical sampling equipment does not identify the nature or size of any obstruction.

3. **BEDROCK:** Auger refusal may be due to the presence of bedrock, but possibly could also be due to the presence of very dense underlying deposits, boulders or other large obstructions. Auger refusal is defined as the point at which an auger can no longer be practically advanced. It must be appreciated that conventional geotechnical sampling equipment does not differentiate between nature and size of obstructions that prevent further penetration of the boring below grade. Bedrock indicated on the borehole logs will be labeled 'possibly' or 'probable' etc. based on the response of the boring and sampling equipment, surrounding topography, etc. Bedrock can be proven at individual borehole locations, at your request, by diamond core drilling operations or, possibly, by testpits. It must also be appreciated that bedrock surfaces can be, and most times are, very erratic in nature (i.e. sheer drops, isolated rock knobs, etc.) and caution must be used when interpreting subsurface conditions between boreholes. A bedrock profile can be more accurately estimated, at the clients' request, through a series of closely positioned unsampled auger probes combined with core drilling.

4. **GROUNDWATER:** Although the groundwater table may have been encountered during this investigation and the elevation noted in the report and/or on the record of boreholes, it must be appreciated that the elevation of the groundwater table will fluctuate based upon seasonal conditions, localized changes, erratic changes in the underlying soil profile between boreholes, underlying soil layers with highly variable permeabilities, etc. These conditions may affect the design and type and nature of dewatering procedures. Cave-in levels recorded in borings give a general indication of the groundwater level in cohesionless soils however, it must be noted that cave-in levels may also be due to the relative density of the deposit, drilling operations etc.

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

METRIC

RECORD OF BOREHOLE NO. 1

L|V|M

REFERENCE 11/11/11209-F2 DATUM Geodetic LOCATION N 5163656.3 E 273381.1 - Dowling Township Station 22+340.5 ORIGINATED BY JL

PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY MCM

CLIENT Triton Engineering Services Limited DATE (Started) 2012 March 19 TIME (Completed) 2:40:00 PM CHECKED BY JRB

DATE (Completed) 2012 March 19

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)
369.6	Ground Surface										
0.0	FILL - brown sand and gravel to gravelly sand trace to some silt trace organics ocassional cobbles/boulders (loose/compact)		1	AS			369				
			2	SS	16						43 49 (8)
368.2											
1.4	DCPT Refusal		3	SS	8		368				29 54 (17)
367.7											
1.9	ORGANICS - dark brown silty organics		4	SS	34		367				
367.0											
2.6	SAND - grey sand with gravel with silt occasional cobbles/boulders (compact/dense)		5	SS	45						21 54 (25)
							366				
			6	SS	23						
365.2											
4.4	Auger Refusal End of Borehole										

COMMENTS

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

+ 3, × 3 : Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 12/3/14 2:30:00 PM	0.4	3.3
2) 12/3/22 2:50:00 PM	0.9	-
3)	-	-

MEL-GEO 11209 - AREA 2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 13/10/4

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

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

METRIC

RECORD OF BOREHOLE NO. 2

L|V|M

REFERENCE 11/11/11209-F2 DATUM Geodetic LOCATION N 5163664.4 E 273406.1 - Dowling Township Station 22+344 ORIGINATED BY JL

PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT Triton Engineering Services Limited DATE (Started) 2012 April 10 TIME (Completed) 10:45:00 AM CHECKED BY JRB

DATE (Completed) 2012 April 10

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)
368.8	Ground Surface							20 40 60 80 100	20 40 60		
0.0	Organics - black silty organics		1	AS					131		
							368				
			2	SS	WH				227		
367.4											
367.3 1.4 1.5	SAND and GRAVEL - sand and gravel occasional cobbles/boulders DCPT Refusal		3	SS	25/0 mm		367				
366.1			4	SS	25/0 mm						
2.7 365.8	SILT - grey silt with sand trace gravel trace clay		5	AS			366				5 25 63 7
3.0	Auger Refusal End of Borehole										

COMMENTS

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

+ 3, × 3 : Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 12/4/10 10:45:00 AM	0	1.2
2)	-	-
3)	-	-

MEL-GEO 11209 - AREA 2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 13/10/4

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

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

METRIC

RECORD OF BOREHOLE NO. 3

L|V|M

REFERENCE 11/11/11209-F2 DATUM Geodetic LOCATION N 5163651.1 E 273401.9 - Dowling Township Station 22+333 ORIGINATED BY JL

PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT Triton Engineering Services Limited DATE (Started) 2012 April 9 TIME (Completed) 3:35:00 PM CHECKED BY JRB

DATE (Completed) 2012 April 9

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)
371.9	Ground Surface										
0.0	150 mm Asphalt 200 mm Crushed Gravel										
	FILL - brown to grey sand with gravel trace to with silt		1	AS							
	(dense/very loose)		2	SS	38		371				26 67 (7)
			3	SS	12		370				27 43 28 2
			4	SS	12		369				
368.5			5	SS	2	▽					
3.4	SAND and GRAVEL - grey sand and gravel trace silt trace organics										
	(compact)		6	SS	26		368				47 44 (9)
367.3											
4.6	SAND - grey sand some gravel with silt		7	SS	25		367				17 53 28 2
	(compact)										
			8	SS	20		366				
365.3											
6.6	DCPT Refusal						365				
364.8											
7.1	Auger Refusal End of Borehole										

COMMENTS

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

$+^3$, $\times^3$: Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

$\circ^{3\%}$ STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 12/4/9 3:30:00 PM	3 ▽	3.4 ▨
2)	- ▽	-
3)	- ▼	-

MEL-GEO 11209 - AREA 2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 13/10/4

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

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

METRIC

RECORD OF BOREHOLE NO. 4

LVM

REFERENCE 11/11/11209-F2 DATUM Geodetic LOCATION N 5163670.2 E 273396.1 - Dowling Township Station 22.353 ORIGINATED BY JL

PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT Triton Engineering Services Limited DATE (Started) 2012 April 10 TIME (Completed) 3:45:00 PM CHECKED BY JRB

DATE (Completed) 2012 April 10

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)
372.6	Ground Surface										
0.0	150 mm Asphalt 200 mm Crushed Gravel FILL - brown sand trace silt trace gravel to sand and silt trace silt (very loose/dense)		1	AS			372				
			2	SS	48						
			3	SS	19		371				1 51 45 3
			4	SS	6		370				
369.2			5	SS	2						3 92 (5)
3.4	SAND AND GRAVEL - grey sand and gravel to gravelly sand trace gravel occasional cobbles/boulders (compact/dense)		6	SS	17	▽	369				
			7	SS	37	▨	368				37 54 (9)
366.8							367				
5.8	SILT - grey silt some sand trace clay (compact/dense)		8	SS	24		366				0 15 78 7
364.6			9	SS	43		365				
8.0 364.4	DCPT Refusal										
8.2	Auger Refusal End of Borehole										

COMMENTS

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

+ 3, × 3 : Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 12/4/10 3:40:00 PM	4.3 ▽	4.7 ▨
2)	- ▽	-
3)	- ▼	-

MEL-GEO 11209 - AREA 2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 13/10/4

L|V|M
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 1)

METRIC

RECORD OF BOREHOLE NO. 5

LVM

REFERENCE 11/11/11209-F2 DATUM Geodetic LOCATION N 5163656.3 E273389.8 - Dowling Township Station 22+341.5 ORIGINATED BY JL

PROJECT GWP 5081-06-00, Highway 144 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT Triton Engineering Services Limited DATE (Started) 2012 April 11 TIME (Completed) 11:42:00 AM CHECKED BY JRB

DATE (Completed) 2012 April 11

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
372.2	Ground Surface							
0.0	150 mm Asphalt 175 mm Crushed Gravel							
	FILL - brown sand some to with gravel some silt		1	AS				
	(very loose/compact)		2	SS	18			23 62 (15)
			3	SS	24			
			4	SS	3			
368.8			5	SS	8			
3.4	SAND and GRAVEL - grey sand and gravel trace silt occasional cobbles/boulders		6	SS	50/125 mm			
367.9								
4.3	SAND - grey sand some silt some gravel							
	(compact)		7	SS	15			16 68 (16)
366.1								
6.1	SILT - grey silt some sand trace gravel		8	SS	15			
	(compact)							
365.1								
7.1	Auger Refusal DCPT Refusal End of Borehole							

ELEVATION SCALE: 372, 371, 370, 369, 368, 367, 366

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa 20 40 60 80 100
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

COMMENTS

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

+3, ×3 : Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa
○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

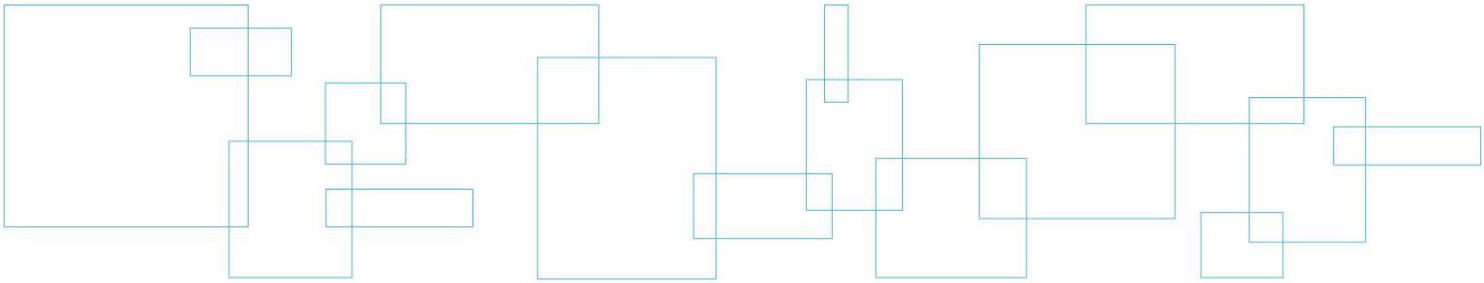
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 12/4/11 11:36:00 AM	3.2	3.2
2)	-	-
3)	-	-

MEL-GEO 11209 - AREA 2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 13/10/4

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

Appendix 3 Lab Data

Drawing No. 2: Borehole Location and Soil Strata
Figure Nos. L-1 to L-5: Grain Size Distribution Curves
Figure No. L-6: Lab Test Summary Sheet



LVM | MERLEX

METRIC

Dimensions are in meters and/or millimeters unless otherwise shown. Stations are in kilometers + meters.

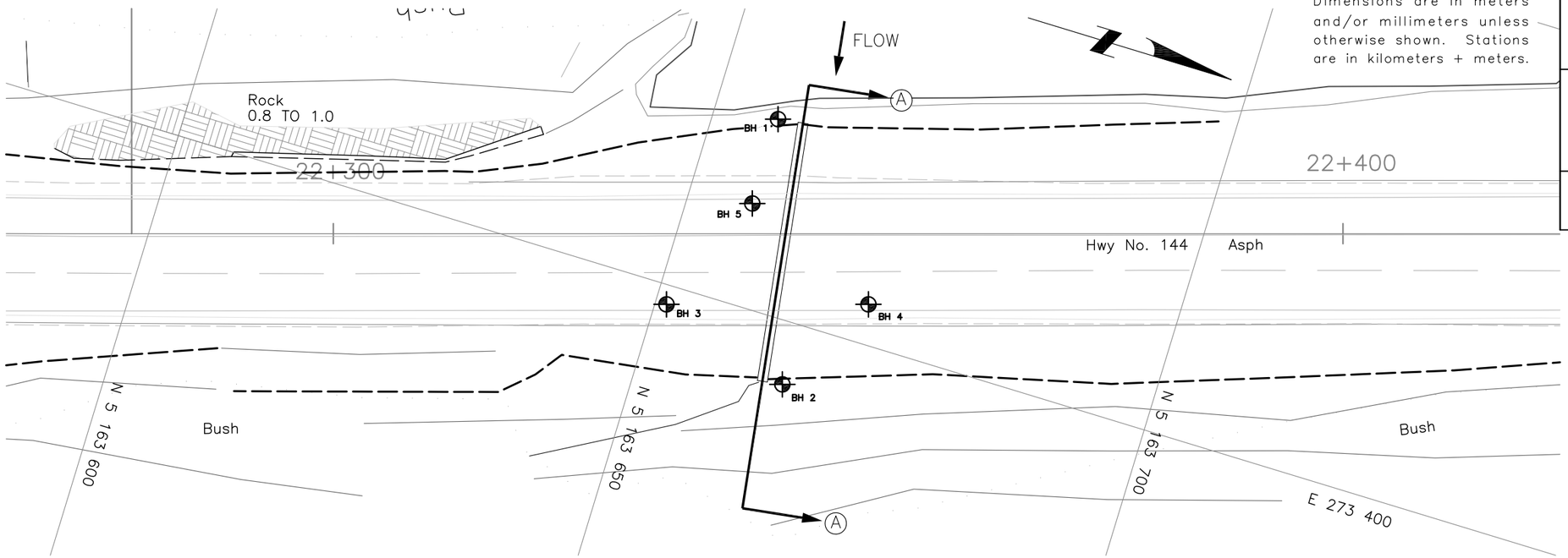
CONT No
GWP No 5081-06-00

N

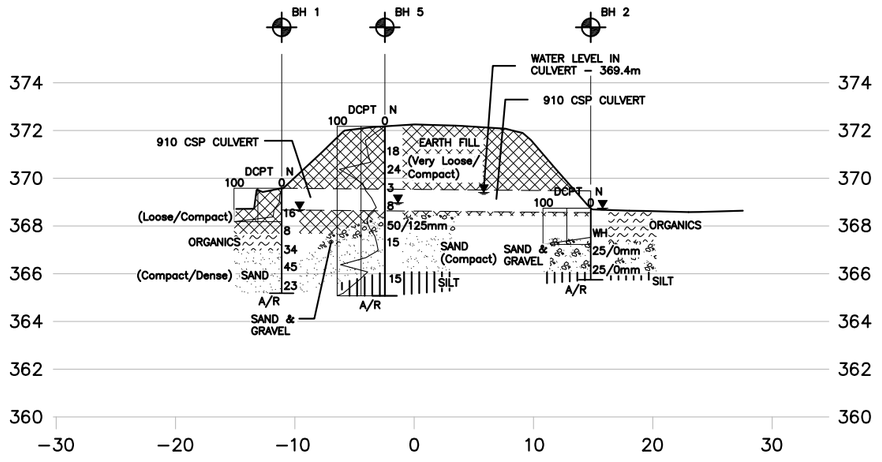
HWY NO. 144 – Township of Dowling
Culvert at Station 22+343
BOREHOLE LOCATIONS & SOIL STRATA

Drawing 2

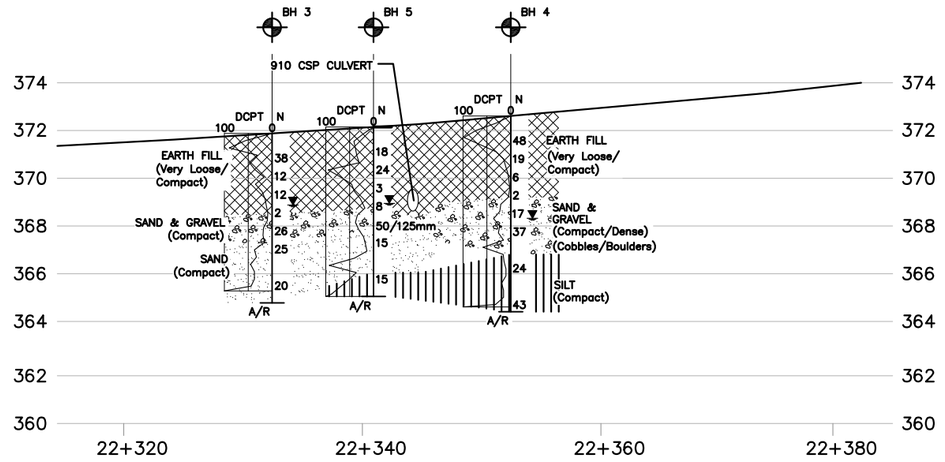
LVM | MERLEX



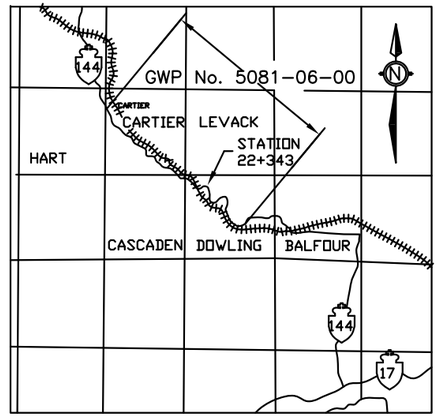
PLAN
SCALE
5m 5m



SECTION AT CULVERT (A) – (A)
SCALE
5m 5m HOR
2.5m 2.5m VER



℄ PROFILE
SCALE
5m 5m HOR
2.5m 2.5m VER



KEY PLAN – NOT TO SCALE

LEGEND

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

Borehole No.	Elev.	O/S	Co-ordinates Northerly	Co-ordinates Easterly
Borehole No. 1	369.6	11.4m Lt	5163656.3	273381.1
Borehole No. 2	368.8	14.9m Rt	5163664.4	273406.1
Borehole No. 3	371.9	7.0m Rt	5163651.1	273401.9
Borehole No. 4	372.6	7.0m Rt	5163670.2	273396.1
Borehole No. 5	372.2	3.0m Lt	5163656.3	273389.8

NOTE 1:
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.

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.

REVISIONS

DATE	BY	DESCRIPTION
Dec 2012	MCM	DRAFT
Oct 2013	RG	FINAL

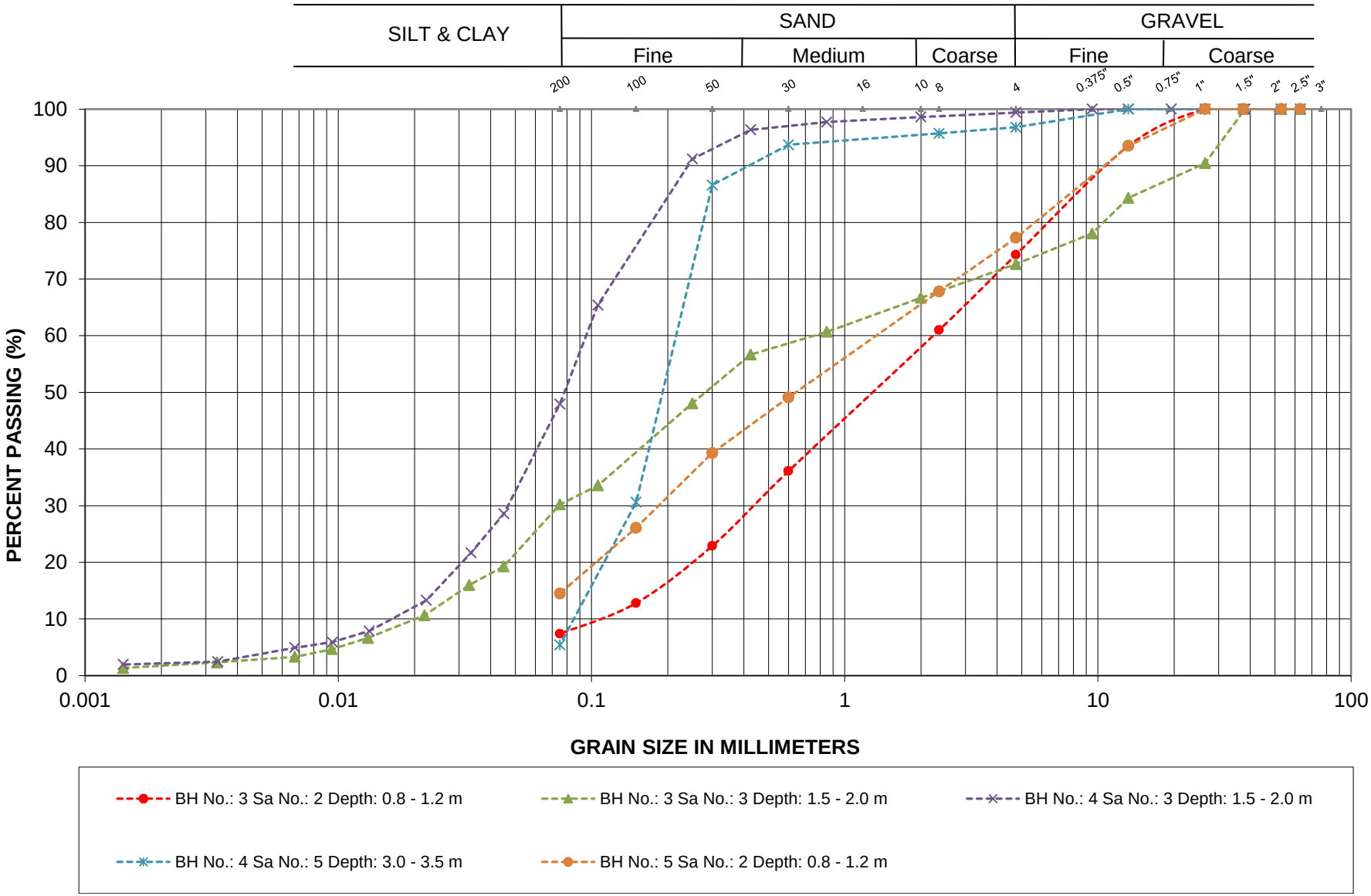
HWY No. 144 – Dowling Twp – Culvert at Station 22+343

SUBM'D	REF 11209-F2	GEOCRES 41I-298	SITE
DRAWN MCM	CHK MAM	DATE Aug 2012	FIG 2

Reference No.: 11/11/11209-F2
Date: October 2013

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 5081-06-00
LOCATION: Hwy 144

EMBANKMENT FILL
Sand with Gravel trace to with SILT

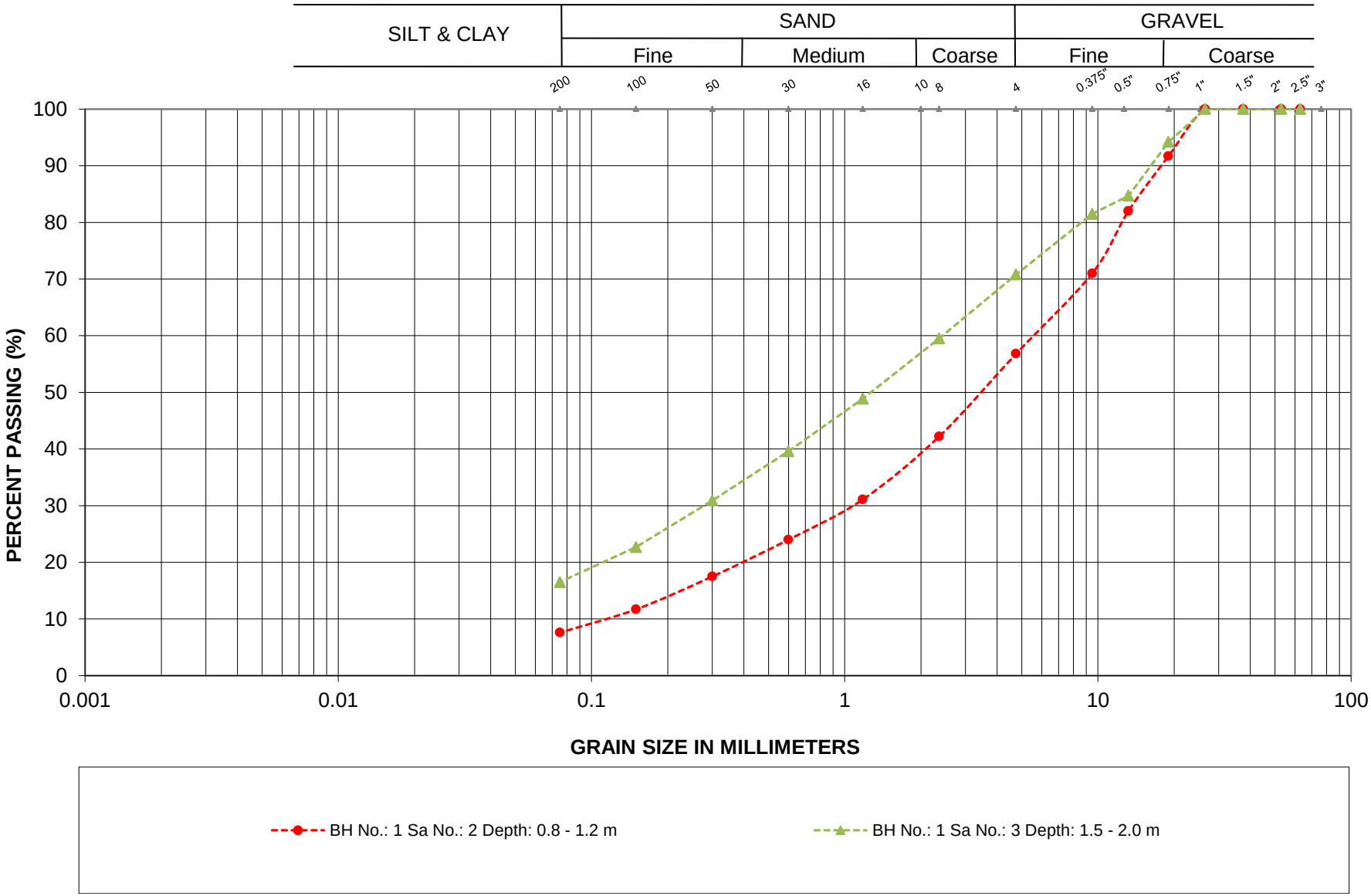
LVM | MERLEX

FIGURE L-1

Reference No.: 11/11/11209-F2
Date: October 2013

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 5081-06-00
LOCATION: Hwy 144

FILL
Sand and Gravel - Gravelly Sand

LVM | MERLEX

FIGURE L-2

Reference No.: 11/11/11209-F2
Date: October 2013

LVM | MERLEX

GRAIN SIZE ANALYSIS

G.W.P.: 5081-06-00
LOCATION: Hwy 144

SAND AND GRAVEL

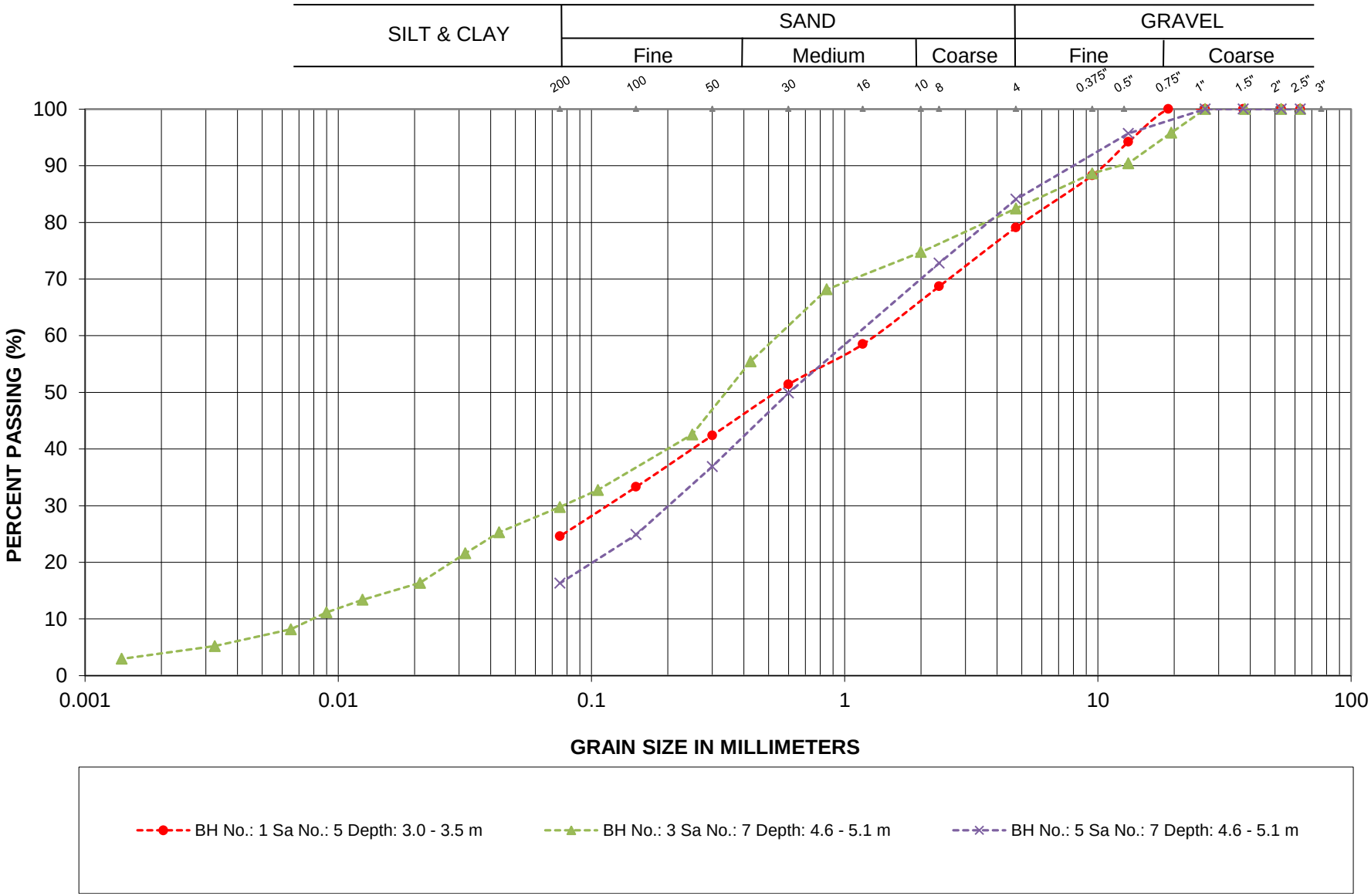
LVM | MERLEX

FIGURE L-3

Reference No.: 11/11/11209-F2
Date: October 2013

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 5081-06-00
LOCATION: Hwy 144

SAND

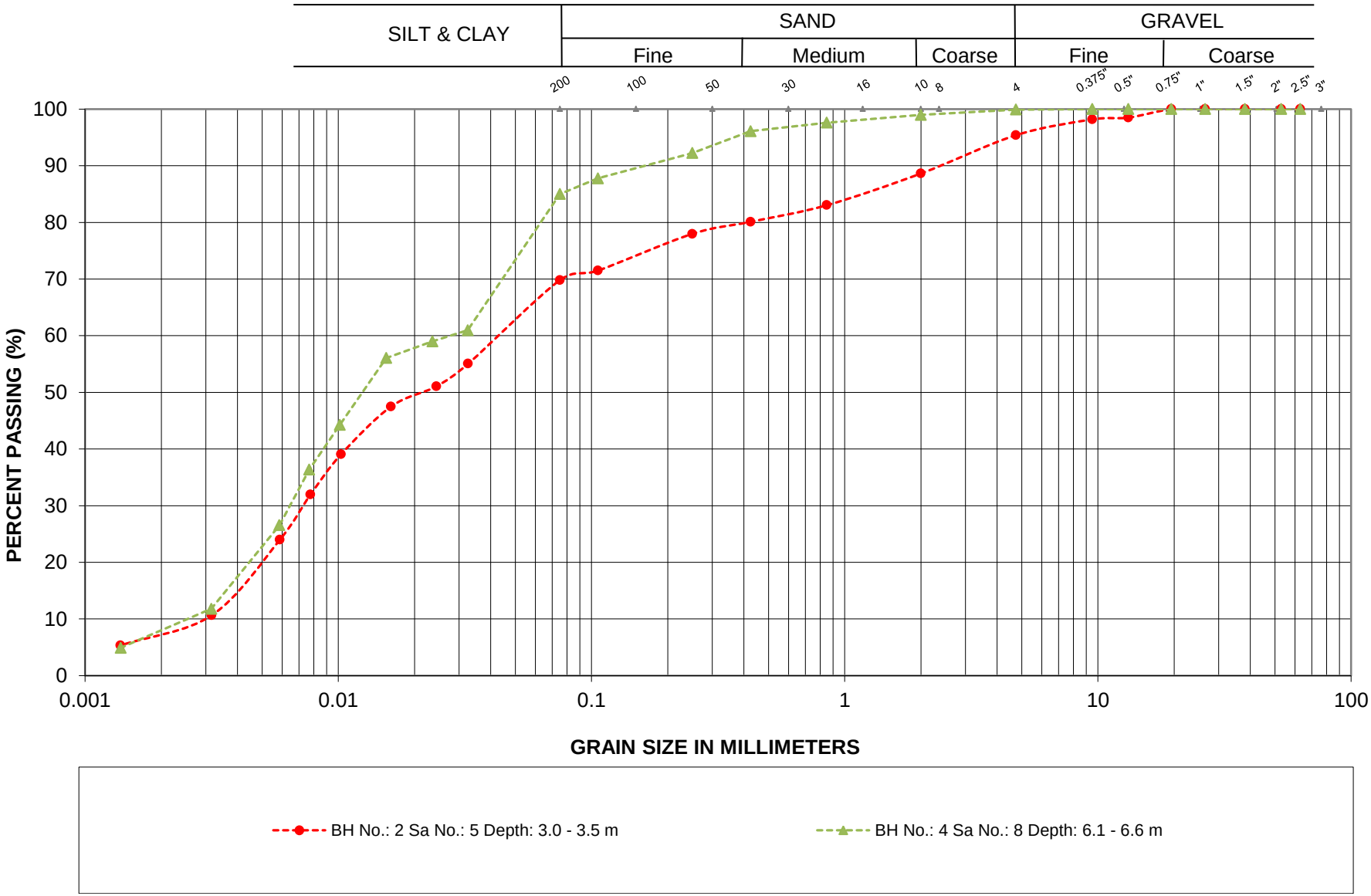
LVM | MERLEX

FIGURE L-4

Reference No.: 11/11/11209-F2
Date: October 2013

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 5081-06-00
LOCATION: Hwy 144

SILT

LVM | MERLEX

FIGURE L-5

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					15.9				N/A			
	2	0.8	43	49	8		12.6				16			
	3	1.5	29	54	17		20.0				8			
	4a	2.3					77.5				34			
	4b	2.5					10.8				34			
	5	3.0	21	54	25		12.7				45			
	6	3.8					9.1				23			
2	1	0.0					131.0				N/A			
	2	0.8					227.0				WH			
	3	1.5									25/0 mm			
	4	2.3									25/0 mm			
	5	3.0	5	25	63	7	20.7							
3	1	0.0					3.0				N/A			
	2	0.8	26	67	7		2.8				38			
	3	1.5	27	43	28	2	11.4				12			
	4	2.3					5.1				12			
	5	3.1					14.7				2			
	6	3.8	47	44	9		19.5				26			
	7	4.6	17	53	28	2	18.0				25			
	8	6.1					10.3				20			
4	1	0.0					2.7				N/A			
	2	0.8					3.2				48			
	3	1.5	1	51	45	3	12.8				19			
	4	2.29					6.2				6			
	5	3.05	3	92	5		12.3				2			
	6	3.8					10.9				17			
	7	4.6					12.7				37			

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 (%)				
4	8	6.1	0	15	78	7	29.8				24			
	9	7.6					16.4				43			
5	1	0.0					4.5				N/A			
	2	0.8	23	62	15		6.2				18			
	3	1.5					5.8				24			
	4	2.3					5.1				3			
	5	3.1					5.2				8			
	6	3.8					11.5				50/125 mm			
	7	4.6	16	68	16		11.6				15			
	8	6.1					14.4				15			

Appendix 4 Photo Essay

Enclosure No. 7: Photo Essay

LVM | MERLEX

Existing Embankment, Left (West) Side - Looking North	Photo: 1

Culvert Inlet – Looking North	Photo: 2

Project: Hwy 144 – Station 22+343, Twp of Dowling	Photos Provided By: LVM Date: March 2012

Existing Embankment, Right (East) Side - Looking South	Photo: 3

Culvert Outlet – Looking South	Photo: 4

Project: Hwy 144 – Station 22+343, Twp of Dowling	Photos Provided By: LVM Date: March 2012

View Through Culvert – Looking East	Photo: 5

Project: Hwy 144 – Station 22+343, Twp of Dowling	Photos Provided By: LVM Date: March 2012