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

Culvert Replacement
Highway 65
Station 14+362 - Twp. of Kimberley
GWP 364-00-00

FINAL FOUNDATION INVESTIGATION REPORT

Date: February 3, 2015
Ref. Nº: 13/05/13073-F12

Geocres No. 41P-63

Submitted To AECOM Canada Ltd.
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Final Foundation Investigation Report

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TABLE OF CONTENTS

1 INTRODUCTION 1

2 SITE DESCRIPTION 1

2.1 Site Physiography and Surficial Geology 1

3 INVESTIGATION PROCEDURES 2

4 SUBSURFACE CONDITIONS 3

4.1 Culvert Station 14+362, Twp of Kimberley 3

4.1.1 Pavement Structure 3

4.1.2 Granular Fill 3

4.1.3 Sands and Gravels 3

4.1.4 Sands 4

4.2 Groundwater Data 4

Appendices

Appendix 1 Key Plan

Appendix 2 Subsurface Data

Appendix 3 Borehole Plan and Lab Data

Appendix 4 Photo Essay

Property and Confidentiality

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Attention: **Mr. Al Rose**

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1 INTRODUCTION

LVM-Melex, a Division of EnGlobe Corp., has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation at an existing centerline culvert site. The site is located at Station 14+362 in the Township of Kimberley on Highway 65, some 8 km south of Highway 66.

The foundation investigation location was specified by the MTO in the Memorandum titled "GWP 364-00-00 Resurfacing of Highway 65 and the Replacement of the Whiskey Jack Culvert on Highway 66, New Liskeard Area" dated May 22, 2014, under Agreement No. 5012-E-0025. The terms of reference for the scope of work are outlined in LVM-Merlex's Proposal 13/05/13073-F12-R, dated June 27, 2014. 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 Structural Plate Corrugated Steel Pipe Arch (SPCSPA) culvert is located on Highway 65 at Station 14+362 in the Township of Kimberley. The topography in the area of this site is generally low relief. The existing highway embankment currently supports two undivided lanes of highway, running in a north-south direction. The existing highway, at the culvert location, is constructed on a granular fill embankment some 2.5 m above culvert invert (1.6 m in height above creek bottom), with centerline elevation of 305.6 m at the culvert location. The existing embankment slopes in the area of the culvert have been established between angles of approximately 2.4H:1V to 3.0H:1V. The culvert at this location is a 2440 x 1750 mm diameter Structural Plate Corrugated Steel Pipe Arch (SPCSPA) culvert, some 13 m in length. Flow through the culvert is from west to east (right to left).

Infrastructure at the culvert location consists of overhead wires to the left (east) side of the highway embankment.

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 65 is generally low, slightly rolling. Significant layers of earth overlay the bedrock. Organic materials were also observed. Within the project area native overburden consists primarily of sands with varying gravel size content overlying bedrock.

Bedrock in the area, as indicated on OGS Map 2506, is of the Huron Supergroup, which consists of conglomerate, sandstone, siltstone and argillite.

3 INVESTIGATION PROCEDURES

The fieldwork for this investigation was carried out during the period of September 24th to October 9th, 2014 during which time four (4) sampled boreholes, were advanced. Two (2) boreholes were advanced through the embankment at the location of the culvert, and a single borehole was advanced at each of the inlet (west) and outlet (east) ends of the culverts.

The field investigation was carried out using a truck and bombardier mounted CME drilling rig equipped with hollow stem augers, standard augers, casing equipment and routine geotechnical sampling equipment. Soil samples were obtained at the borehole locations at regular intervals of depth using the standard 50 mm O.D. split spoon sampler advanced in accordance with the Standard Penetration Test (SPT) procedures (ASTM D-1586). The SPT method involves advancing a 50 mm O.D. split spoon sampler with the force of a 63.5 kg hammer freely dropping 760 mm. The number of blows per 300 mm penetration was recorded as the "N" value. At select 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. Two 19 mm diameter standpipes were installed in selected open boreholes prior to backfilling to allow for further monitoring of the shallow groundwater levels. All open boreholes were backfilled upon completion with compacted auger cuttings in the 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 asphalt surface.

The fieldwork 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. 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-3 and Table No. L-4).

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 which was established by others. The borehole elevations are based on a survey carried out by others.

4 SUBSURFACE CONDITIONS

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Records of Borehole Logs (Appendix 2) and on Drawing No. 2 (Appendix 3). Please note that stratigraphic delineation presented on the borehole logs and soil strata plot are the results of non-continuous sampling, response to drilling progress, the results of SPT, plus field observations. Typically such boundaries represent transitions from one zone to another and are not an exact demarcation of specific geological unit. Additional consideration should be given to the fact that subsurface conditions may vary markedly between adjacent boreholes and beyond any specific boring location, and are shown on the drawings for illustration purposes only.

4.1 CULVERT STATION 14+362, TWP OF KIMBERLEY

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 at the culvert outlet, and Borehole No. 4 advanced at the culvert inlet. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 4 were recorded at elevations 305.4, 305.4, 303.9, and 304.5 m, respectively.

4.1.1 Pavement Structure

Borehole Nos. 1 and 2 were advanced through the embankment where a pavement structure consisting of 50 to 75 mm asphalt and 100 to 150 mm crushed gravel was penetrated.

4.1.2 Granular Fill

Underlying the pavement structure at Borehole Nos. 1 and 2, a layer of granular fill consisting of brown sand and gravel trace silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 3 to 12%. Gradation analyses were carried out on three (3) sample of this deposit, the results of which indicated 43 to 46% gravel size particles, 50 to 53% sand size particles, and 4 to 7% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT ‘N’ values of 6 to 16 blows per 300 mm penetration, the compactness of this deposit was described as loose to compact. This deposit was encountered to depths of 2.1 m below grade at Borehole Nos. 1 and 2 (elevation 303.3 m).

4.1.3 Sands and Gravels

Underlying the granular fill at Borehole Nos. 1 and 2, at surface at Borehole Nos. 3 and 4, a deposit of sands and gravels described as brown to grey sands and gravels to gravelly sands, trace silt to sand and gravel trace silt was penetrated. Cobble and boulder size rock pieces were encountered in this deposit. The natural moisture content measured on samples of this

deposit was in the order of 10 to 24%. Gradation analyses were carried out on four (4) samples of this deposit, the results of which indicated 2 to 51% gravel size particles, 43 to 95% sand size particles, and 3 to 8% silt and clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 11 blows per 300 mm penetration and great than 50 blows per 50 mm penetration, this deposit was described as compact to very dense. This deposit was encountered to depths of 4.4, 4.4, 2.9, and 3.7 m below ground surface at Borehole Nos. 1 to 4, respectively (elevations 301.0, 301.0, 301.0, and 300.8 m, respectively).

4.1.4 Sands

Underlying the sands and gravels at Borehole Nos. 1 to 4, a deposit of grey sand trace to some gravel trace silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 17 to 26%. Gradation analyses were carried out on five (5) samples of this deposit, the results of which indicated 0 to 20% gravel size particles, 77 to 90% sand size particles, and 3 to 10% silt and clay size particles (Figure No. L-3, Appendix 3). Based on SPT 'N' values of 3 to 47 blows per 300 mm penetration, this deposit was described as very loose to dense, generally compact. Sampling was terminated in this deposit at depths of 15.7, 15.7, 9.8, and 9.8 m below ground surface at Borehole Nos. 1 to 4, respectively (elevations 289.7, 289.7, 294.1, and 294.7 m, respectively).

A Dynamic Cone Penetration Test (DCPT) was advanced from the bottom of Borehole No. 4. DCPT refusal was encountered at a depth of 19.9 m below grade (elevation 284.6 m).

4.2 GROUNDWATER DATA

At the time of this investigation (October 7, 2014), the creek water level in the culvert was measured at elevation 303.9 m.

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. 2 and 4 to obtain post borehole completion water levels. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix 2).

The water levels were measured at elevations 303.5, 304.0, and 304.2 m at Borehole Nos. 2 to 4, respectively. It should be noted that the groundwater level at Borehole No. 1 (elevation 305.0 m) likely had not stabilized at time of completion.

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

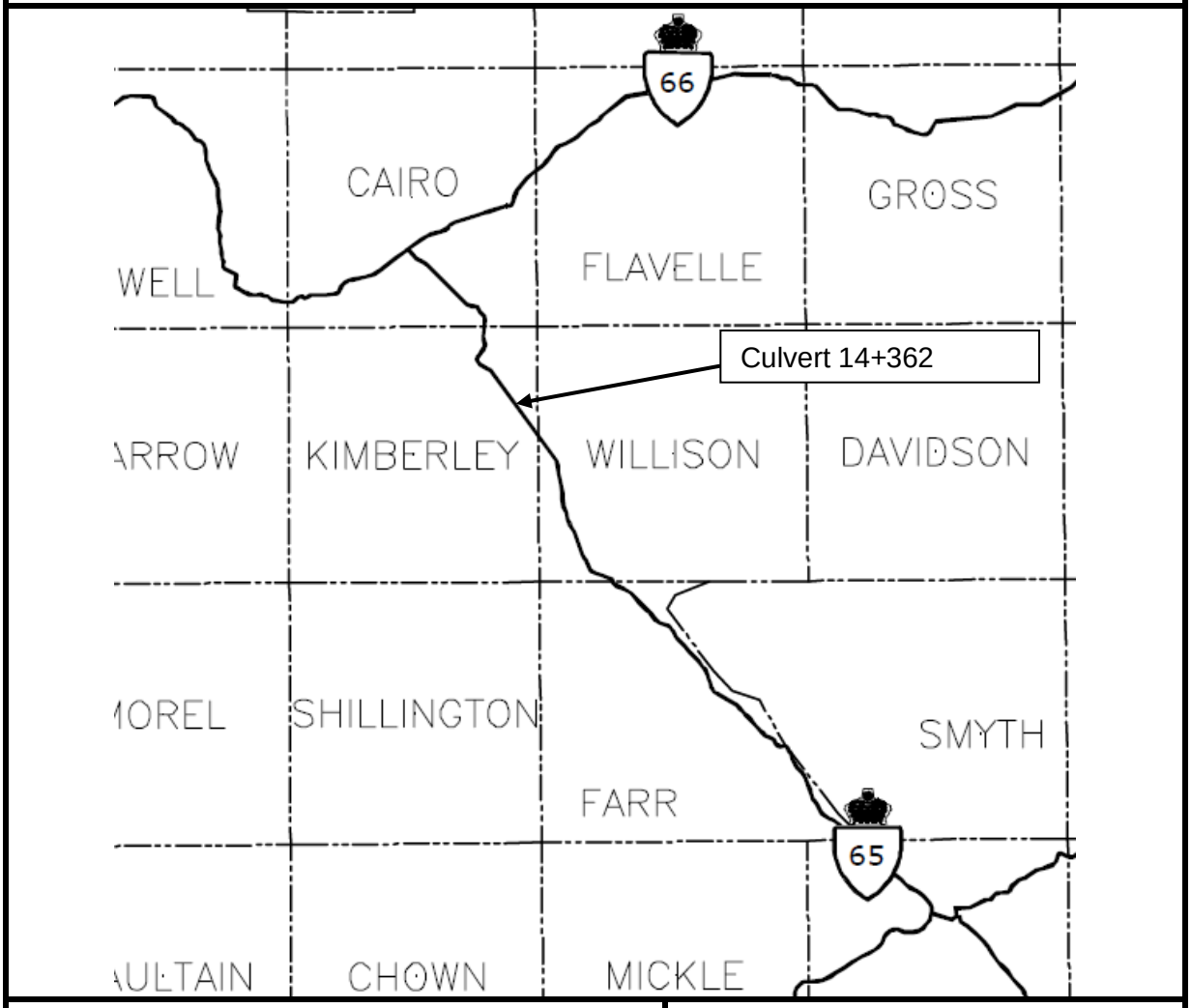
Appendix 1 Key Plan

Drawing No. 1 Key Plan

KEY PLAN

Drawing No. 1

NOT TO SCALE



FINAL
FOUNDATION INVESTIGATION REPORT
GWP 364-00-00
Highway 65

Culvert 14+362

Reference No: 13/05/13073-F12 February 2015

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Appendix 2 Subsurface Data

Enclosure No. 1	List of Abbreviations and Symbols
Enclosure Nos. 2 to 7	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
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 13/05/13073-F12 DATUM Geodetic LOCATION N 5306627.4 E 339263.4 - Township of Kimberley ORIGINATED BY JL

PROJECT GWP 364-00-00, Hwy 65 - Sta 14+362 Twp of Kimberley BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 24 September 2014 TIME (Completed) 4:20:00 PM CHECKED BY MAM

DATE (Completed) 24 September 2014

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
305.4	Ground Surface										
0.0	50 mm Asphalt 100 mm Crushed Gravel FILL - sand and gravel trace silt brown, dry (compact)		1	SS	16	▽	305		○		43 50 (7)
			2	SS	12				○		
			3	SS	14		304		○		46 50 (4)
303.3											
2.1	SAND - with gravel trace silt brown, moist cobble size rock pieces encountered (compact/very dense)		4	SS	23		303		○		
			5	SS	50/125 mm	▨	302		○		
			6	SS	38				○		30 62 (8)
301.0											
4.4	SAND - trace gravel trace silt grey, wet (loose/compact)		7	SS	21		301		○		
			8	SS	12		300		○		
			9	SS	7		299		○		
			10	SS	12		298		○		0 90 (10)
	Continued Next Page						297				
							296				

COMMENTS

Note: Water level on completion not stablized

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) 24/9/14 4:20:00 PM	0.4 ▽	3.6 ▨
2)	- ▽	-
3)	- ▼	-

MEL-GEO 13073-F12 - BOREHOL LOGS.GPJ MEL-GEO.GDT 22/1/15

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.:2 (Pg. 2 of 2)

METRIC

RECORD OF BOREHOLE NO. 1

LVM Merlex

REFERENCE 13/05/13073-F12 DATUM Geodetic LOCATION N 5306627.4 E 339263.4 - Township of Kimberley ORIGINATED BY JL

PROJECT GWP 364-00-00, Hwy 65 - Sta 14+362 Twp of Kimberley BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 24 September 2014 TIME (Completed) 4:20:00 PM CHECKED BY MAM

DATE (Completed) 24 September 2014

SOIL PROFILE			SAMPLES			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 (%)
ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60		GR SA (SI CL)
	Continued from Previous Page										
	SAND - trace gravel trace silt grey, wet (very loose/compact)		11	SS	22		295				
			12	SS	15		294				
			13	SS	5		293				
			14	SS	3		292				
289.7							291				
15.7	End of Borehole						290				

MEL-GEO 13073-F12 - BOREHOL LOGS.GPJ MEL-GEO.GDT 22/1/15

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ENCLOSURE NO.:3 (Pg. 1 of 2)

METRIC

RECORD OF BOREHOLE NO. 2

LVM Merlex

REFERENCE 13/05/13073-F12 DATUM Geodetic LOCATION N 5306633.0 E 339250.7 - Township of Kimberley ORIGINATED BY JL

PROJECT GWP 364-00-00, Hwy 65 - Sta 14+362 Twp of Kimberley BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 25 September 2014 TIME (Completed) 5:45:00 PM CHECKED BY MAM

DATE (Completed) 25 September 2014

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)
305.4	Ground Surface										
0.0	75 mm Asphalt 150 mm Crushed Gravel FILL - sand and gravel trace silt brown, dry (compact)		1	SS	11		305		○		
			2	SS	6				○		43 53 (4)
			3	SS	15		304		○		
303.3											
2.1	SAND AND GRAVEL - trace silt brown, moist cobble size rock pieces encountered (compact/very dense)		4	SS	48		303		○		
			5	SS	20		302		○		51 43 (6)
			6	SS	25/0 mm						
301.0											
4.4	SAND - trace gravel trace silt grey, wet (loose/compact)		7	SS	16		301		○		
			8	SS	15		300		○		1 90 (9)
			9	SS	8		299		○		
			10	SS	12		298		○		
	Continued Next Page						297				
							296				

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) 25/9/14 5:45:00 PM	0	2.5
2) 9/10/14 11:00:00 AM	1.9	-
3)	-	-

MEL-GEO 13073-F12 - BOREHOL LOGS.GPJ MEL-GEO.GDT 22/1/15

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. 2 of 2)

METRIC

RECORD OF BOREHOLE NO. 2

LVM Merlex

REFERENCE 13/05/13073-F12 DATUM Geodetic LOCATION N 5306633.0 E 339250.7 - Township of Kimberley ORIGINATED BY JL

PROJECT GWP 364-00-00, Hwy 65 - Sta 14+362 Twp of Kimberley BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 25 September 2014 TIME (Completed) 5:45:00 PM CHECKED BY MAM

DATE (Completed) 25 September 2014

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
	Continued from Previous Page										
	SAND - trace gravel trace silt grey, wet (loose/compact)		11	SS	26		295		○		
			12	SS	26		294				
			13	SS	13		293		○		
			14	SS	13		292				
289.7							291		○		
15.7	End of Borehole						290				

MEL-GEO 13073-F12 - BOREHOL LOGS.GPJ MEL-GEO.GDT 22/1/15

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 1)

METRIC

RECORD OF BOREHOLE NO. 3

LVM Merlex

REFERENCE 13/05/13073-F12 DATUM Geodetic LOCATION N 5306641.4 E 339262.1 - Township of Kimberley ORIGINATED BY JL

PROJECT GWP 364-00-00, Hwy 65 - Sta 14+362 Twp of Kimberley BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 8 October 2014 TIME (Completed) 10:00:00 AM CHECKED BY MAM

DATE (Completed) 8 October 2014

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)
303.9	Ground Surface										
0.0	SAND - gravelly, trace silt brown, wet (compact/very dense) cobble/boulder size rock pieces encountered		1	SS	21		303				38 57 (5)
			2	SS	11						
			3	SS	30/50 mm		302				
			4	SS	50/50 mm						
301.0							301				
2.9	SAND - trace to some gravel trace silt grey, wet (compact/dense)		5	SS	47						
			6	SS	18		300				20 77 (3)
			7	SS	16		299				
			8	SS	13		298				7 89 (4)
			9	SS	22		297				
			10	SS	43		296				
294.1							295				
9.8	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 (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1) 8/9/14 10:00:00 AM	-0.05	0.7
2) 8/9/14 2:30:00 PM	-0.05	3.1
3)	-	-

MEL-GEO 13073-F12 - BOREHOL LOGS.GPJ MEL-GEO.GDT 22/1/15

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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 13/05/13073-F12 DATUM Geodetic LOCATION N 5306616.14 E 339254.7 - Township of Kimberley ORIGINATED BY JL

PROJECT GWP 364-00-00, Hwy 65 - Sta 14+362 Twp of Kimberley BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 8 October 2014 TIME (Completed) 11:30:00 AM CHECKED BY MAM

DATE (Completed) 9 October 2014

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "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)
304.5	Ground Surface										
0.0	100 mm silty organic soil										
	SAND - trace gravel to gravelly trace silt		1	SS	48						
	brown, wet						304				
	(compact/very dense)		2	SS	25/0 mm						
	cobble/boulder size rock pieces encountered						303				
			3	SS	50/100 mm						
			4	SS	26		302				2 95 (3)
			5	SS	24						
300.8							301				
3.7	SAND - trace to some gravel trace silt		6	SS	15						
	grey, wet										
	(loose/compact)		7	SS	13		300				12 84 (4)
			8	SS	9		299				
			9	SS	7		298				
			10	SS	15		297				
294.8							296				
9.8	End of Sampling Start Depth Continued Next Page						295				

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) 8/10/14 4:20:00 PM	0.4	1.2
2) 9/10/14 11:30:00 AM	0.3	-
3)	-	-

MEL-GEO 13073-F12 - BOREHOL LOGS.GPJ MEL-GEO.GDT 22/1/15

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ENCLOSURE NO.:5 (Pg. 2 of 2)

METRIC

RECORD OF BOREHOLE NO. 4

LVM Merlex

REFERENCE 13/05/13073-F12 DATUM Geodetic LOCATION N 5306616.14 E 339254.7 - Township of Kimberley ORIGINATED BY JL

PROJECT GWP 364-00-00, Hwy 65 - Sta 14+362 Twp of Kimberley BOREHOLE TYPE Track Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 8 October 2014 TIME (Completed) 11:30:00 AM CHECKED BY MAM

DATE (Completed) 9 October 2014

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES						
	Continued from Previous Page							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA (SI CL)
							294 293 292 291 290 289 288 287 286 285				
284.6 19.9	DCPT Refusal End of Borehole										

MEL-GEO 13073-F12 - BOREHOL LOGS.GPJ MEL-GEO.GDT 22/1/15

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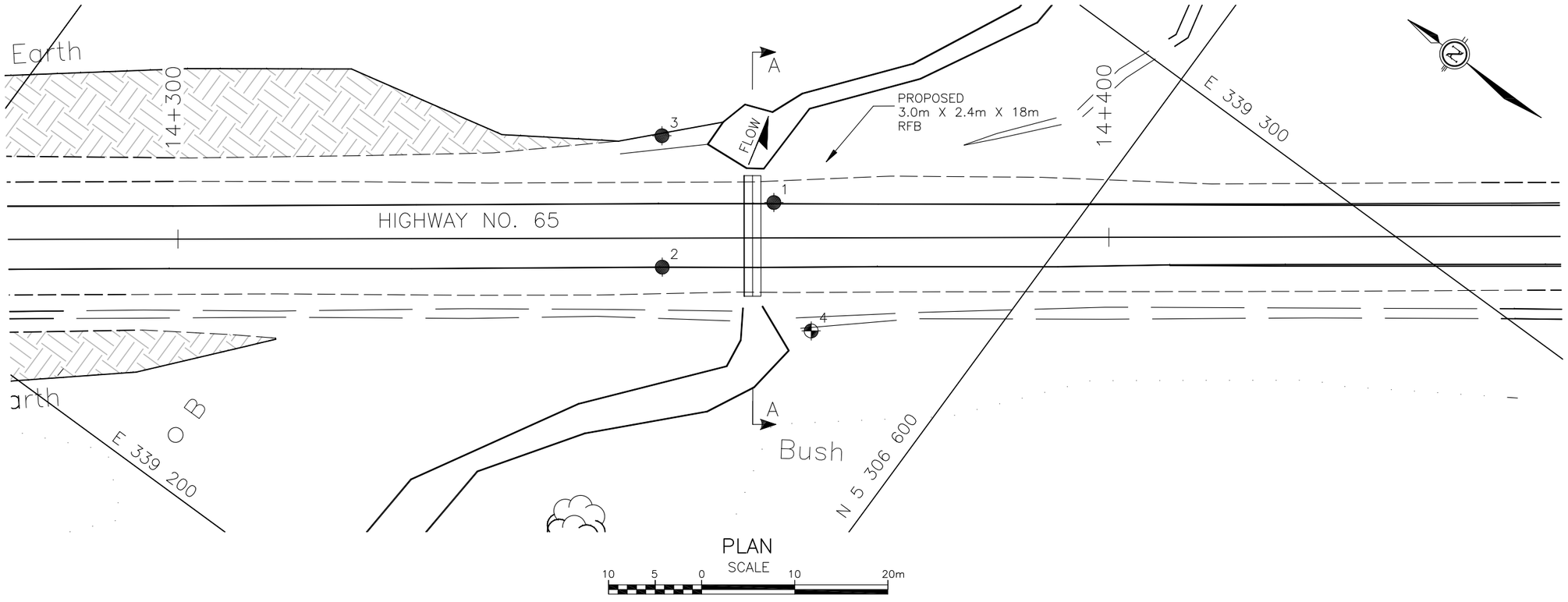
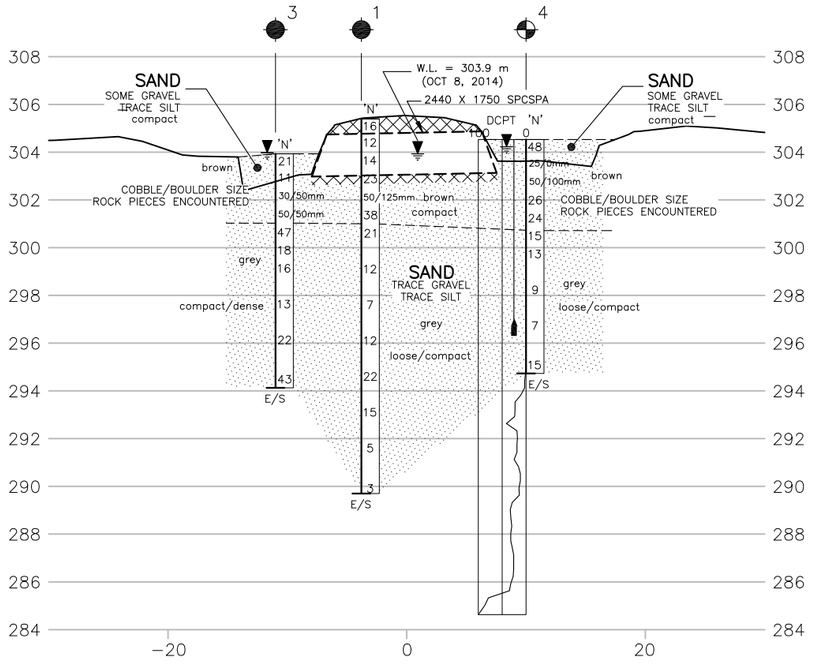
Appendix 3 Borehole Plan and Lab Data

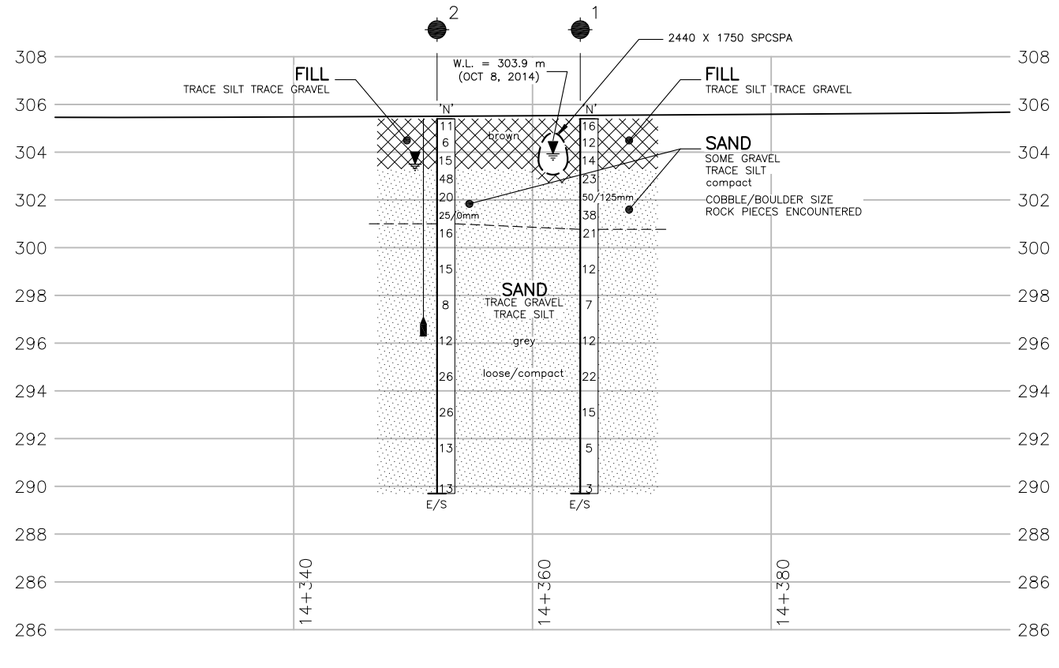
Drawing No. 2: Borehole Location and Soil Strata
Figure Nos. L-1 to L-3: Grain Size Distribution Curves
Figure No. L-4: Lab Test Summary Sheet



PLAN
SCALE
10 5 0 10 20m



A–A
SECTION
SCALE
HOR 10 5 0 10 20m
VERT 5 2.5 0 5 10m



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

CONT. No.
XXXX–XXXX

GWP. No.
364–00–00

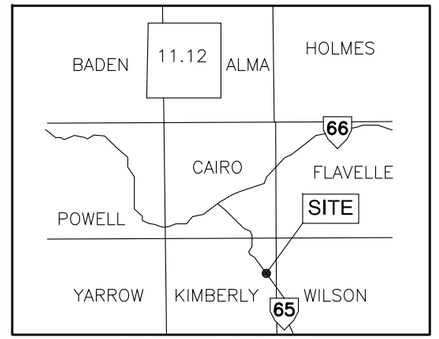
N

DRAWING
2

HWY 65
CULVERT AT STATION 14+362
TOWNSHIP of KIMBERLEY

BOREHOLE LOCATIONS & SOIL STRATA

LVM Merlex



KEY PLAN – NOT TO SCALE

LEGEND

- Borehole
- Borehole with Dynamic Cone Penetration Test
- 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
- Piezometer
- 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	305.4	3.8 m Lt	5306627.4	339263.4
Borehole No. 2	305.4	3.1 m Rt	5306633.0	339250.7
Borehole No. 3	303.9	11.0 m Lt	5306641.4	339262.1
Borehole No. 4	304.5	10.0 m Rt	5306616.1	339254.7

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
OCT 2014	RG	DRAFT
JAN 2015	RG	FINAL

HWY NO. 65 – KIMBERLEY TOWNSHIP

GEOCRES NO.: 41P–63

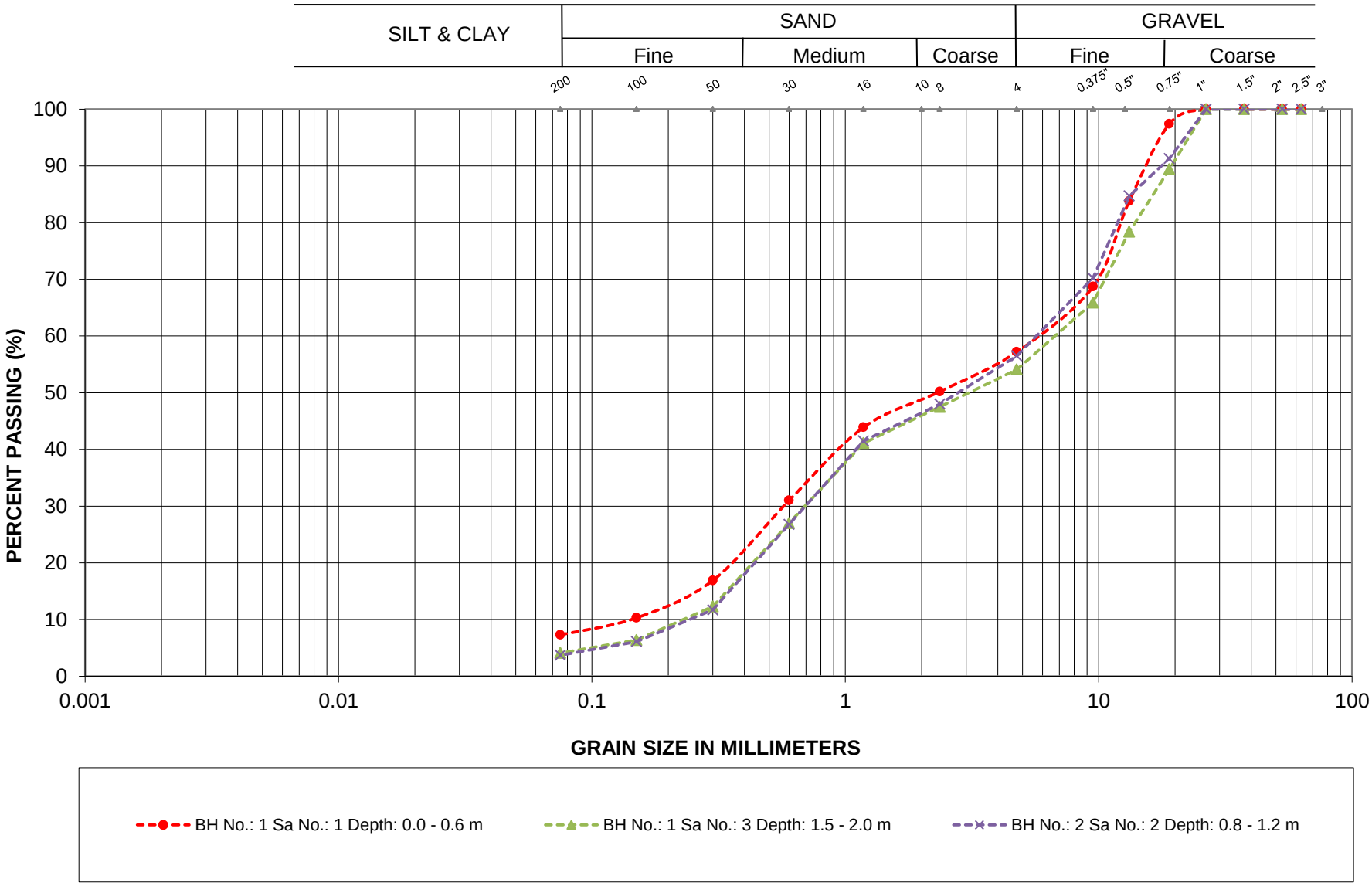
L|V|M REF. NO.: 13/05/13073–F12

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

Reference No.: 13/05/13073-F12
Date: February 2015

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 364-00-00
LOCATION: Hwy 65, Culvert Station 14+362, Twp of Kimberley GRANULAR FILL

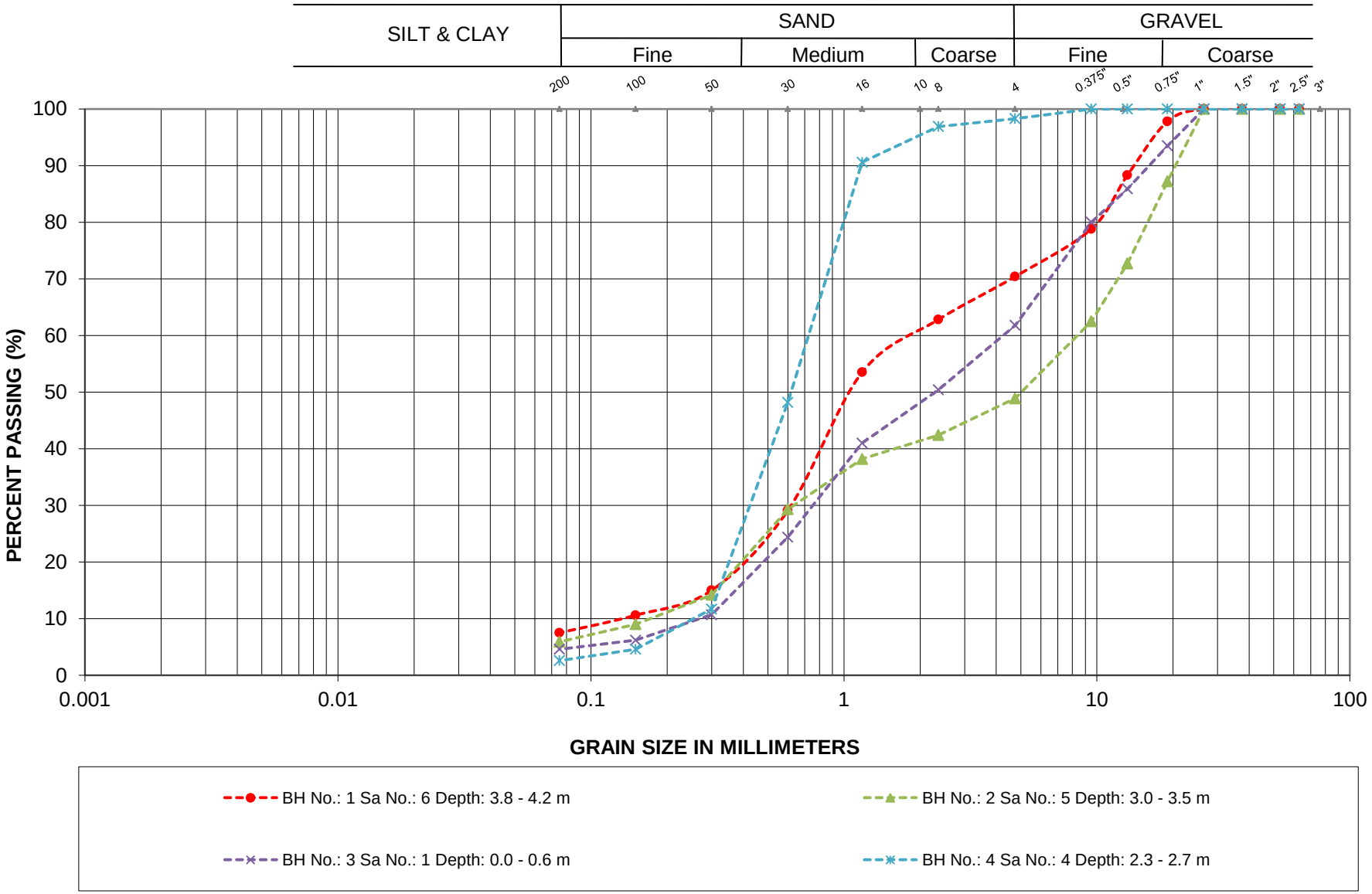
LVM | MERLEX

FIGURE L-1

Reference No.: 13/05/13073-F12
Date: February 2015

LVM | MERLEX

GRAIN SIZE ANALYSIS

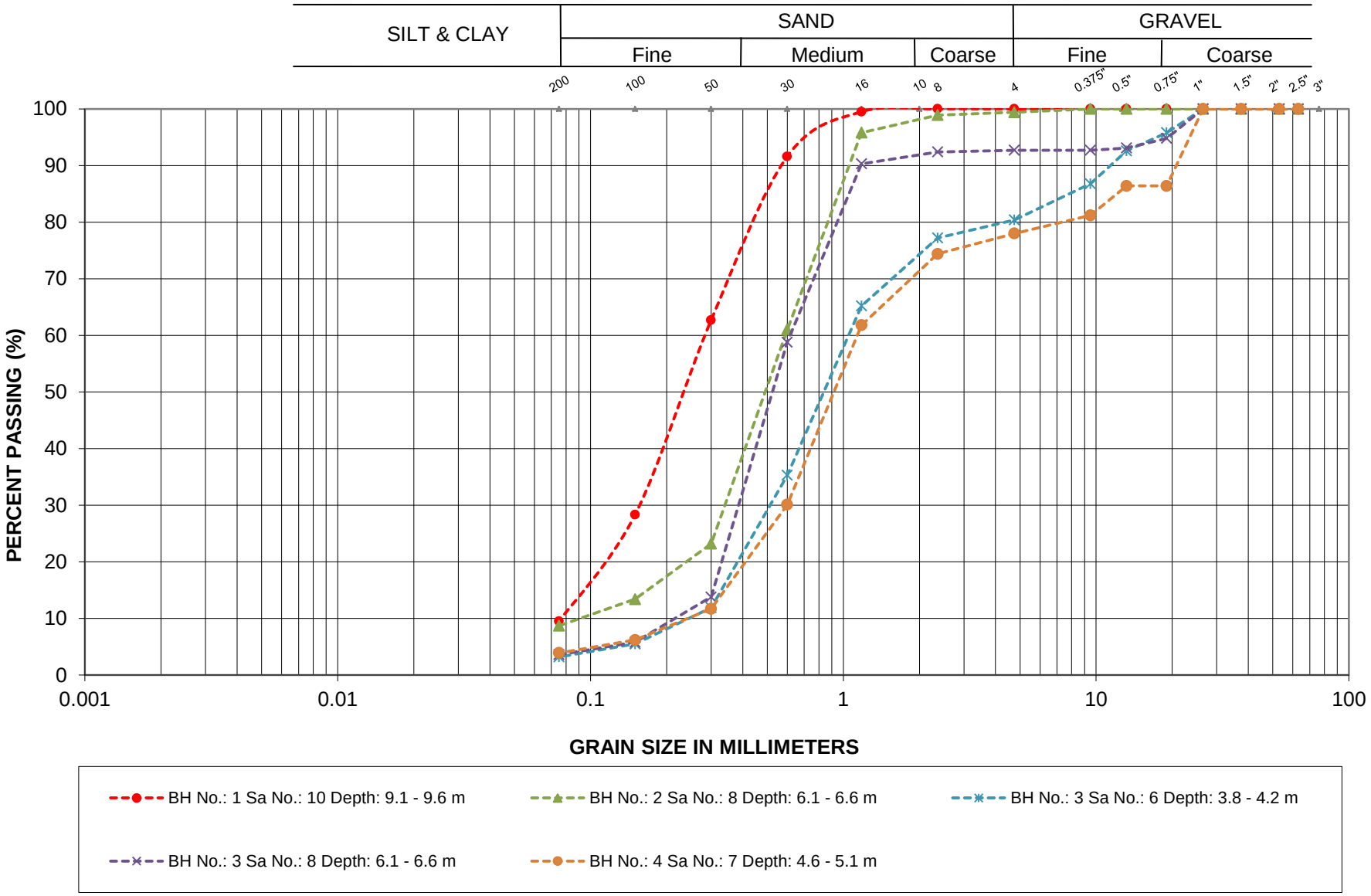


G.W.P.: 364-00-00
LOCATION: Hwy 65, Culvert Station 14+362, Twp of Kimberley SAND AND GRAVEL

Reference No.: 13/05/13073-F12
Date: February 2015

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 364-00-00
LOCATION: Hwy 65, Culvert Station 14+362, Twp of Kimberley SAND

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FIGURE L-3

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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	43	50	7		3.7				16			
	2	0.8					4.3				12			
	3	1.5	46	50	4		9.6				14			
	4	2.3					12.7				23			
	5	3.1					14.3				50/125 mm			
	6	3.8	30	62	8		13.1				38			
	7	4.6					20.2				21			
	8	6.1					18.4				12			
	9	7.6					24.5				7			
	10	9.1	0	90	10		25.7				12			
	11	10.7					24.0				22			
	12	12.2					24.3				15			
	13	13.7					24.7				5			
	14	15.2					24.7				3			
2	1	0.0					3.4				11			
	2	0.8	43	53	4		3.3				6			
	3	1.5					12.0				15			
	4	2.3					12.2				48			
	5	3.1	51	43	6		12.2				20			
	6	3.8									25/0 mm			
	7	4.6					21.3				16			
	8	6.1	1	90	9		27.0				15			
	9	7.62					22.1				8			
	10	9.1					22.4				12			
	11	10.7					23.6				26			
	12	12.2					24.4				26			

LVM | MERLEX

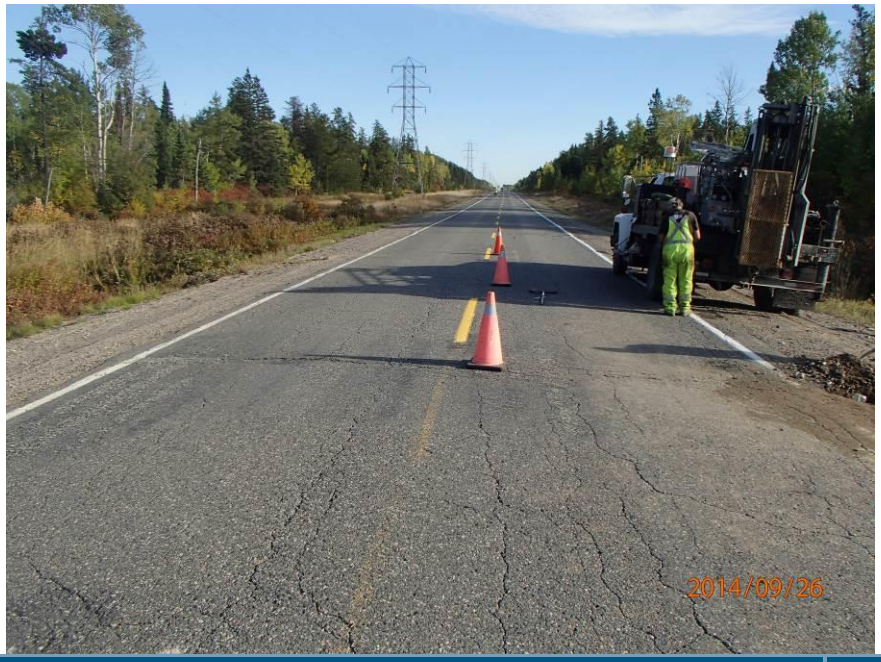
Laboratory Tests - Summary Sheet

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 (%)				
2	13	13.7					21.4				13			
	14	15.2					24.1				13			
3	1	0.0	38	57	5		11.4				21			
	2	0.8					12.1				11			
	3	1.5					16.1				30/50 mm			
	4	2.3					24.3				50/50 mm			
	5	3.1					22.3				47			
	6	3.8	20	77	3		20.2				18			
	7	4.6					20.2				16			
	8	6.1	7	89	4		22.9				13			
	9	7.6					23.3				22			
	10	9.1					24.7				43			
4	1	0.0					17.0				48			
	2	0.8					9.8				25/0 mm			
	3	1.5					10.2				50/100 mm			
	4	2.3	2	95	3		19.5				26			
	5	3.1					19.0				24			
	6	3.8					24.3				15			
	7	4.6	12	84	4		16.8				13			
	8	6.1					23.3				9			
	9	7.6					25.7				7			
	10	9.1					23.1				15			

Appendix 4 Photo Essay

Enclosure No. 6: Photo Essay

Embankment at Culvert Location – Looking South	Photo: 1



Culvert Inlet – Looking West	Photo: 2

Project: Hwy 65 – Culvert 14+362	Photos Provided By: LVM Date: September 2014

Culvert Outlet – Looking East	Photo: 3

Embankment at Culvert Location – Looking North	Photo: 4

Project: Hwy 65 – Culvert 14+362	Photos Provided By: LVM Date: September 2014