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 Rehabilitation - GWP 5580-04-00
Bridge Rehabilitation – Site No. 46-051
Whitson Creek Bridge

FINAL FOUNDATION INVESTIGATION REPORT

Date: March 21, 2014
Ref. Nº: 12/11/12218

Geocres No. 41I-304

LVM | MERLEX

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Final Foundation Investigation Report

Prepared by:

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MTO Designate

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LVM | Merlex – Regional Manager

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Property and Confidentiality

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AECOM Canada Ltd.
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North Bay, Ontario
P1B 1Z2
Attention: **Mr. Al Rose**

REVISION AND PUBLICATION REGISTER		
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1 hard copy and 1 electronic copy	MTO Pavements and Foundations Section, Foundations Group

1 INTRODUCTION

LVM | Merlex Ltd. has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation to supply subsurface data for the design of a protection system to be implemented at the Whitson Creek Bridge during the proposed rehabilitation. The bridge is located on Highway 144, some 20 km north of Highway 17, in the Township of Balfour. The existing bridge is a single span concrete girder structure some 25 m in length.

The foundation investigation location was specified by the MTO. The terms of reference for the scope of work are outlined in LVM | Merlex Ltd.'s Proposal for Foundation Engineering P-12-103, dated July 5, 2012. The purpose of this investigation was to determine the subsurface conditions in the area of the bridge approaches in order to provide design recommendations for a protection system to be implemented during rehabilitation activities. LVM | Merlex Ltd. 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 Whitson Creek Bridge is located on Highway 144, between Stations 12+419.5 to 12+444.5, Township of Balfour (Site No. 46-051). The topography at the site is generally of low relief. The existing highway embankment currently supports two undivided lanes of highway, locally running in an east-west direction. Whitson Creek flows from north to south at the bridge location. A visual review of the highway at the east and west approaches indicates that, in general, the approaches are in poor condition.

The existing 25 m single span concrete girder bridge was constructed in 1961 and rehabilitated in 1995 on the existing highway alignment. It is understood that the structure is in poor condition.

Infrastructure at the bridge location consists of overhead wires on the north and south 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 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 during the period of August 19th to 21st, 2013, during which time four (4) sampled boreholes were advanced. Two boreholes were advanced at each end of the bridge: one through the existing approach slab and the second a short distance beyond the end of the approach slab.

The field investigation was carried out using a truck mounted CME drilling rig equipped with hollow stem augers, standard augers, and routine geotechnical sampling equipment. Prior to mobilizing the auger drill to the site, the concrete approach slabs were core drilled, where required, with an electric core drill. 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. When cohesive deposits were encountered, the in-situ strength was measured using an "N" size field vane, vane collar, and calibrated torque meter. When shallow refusal was encountered, NQ size diamond coring equipment was used to determine the nature of shallow refusal. 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 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 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 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 and 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 WHITSON CREEK BRIDGE

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, as follows;

- Borehole No. 1 was advanced to the east of the east approach slab right of centerline;
- Borehole No. 2 was advanced behind the west abutment right of centerline;
- Borehole No. 3 was advanced behind the east abutment to the left of centerline, and
- Borehole No. 4 was advanced to the west of the west approach slab, left of centerline.

At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 4 were recorded at 268.5, 268.8, 268.6, and 268.9 m, respectively.

4.1.1 Pavement Structure

At surface at Borehole Nos. 1 and 4, a pavement structure consisting of 100 to 150 mm of asphalt and 200 to 300 mm crushed gravel was penetrated. At Borehole Nos. 2 and 3, a pavement structure consisting of 75 to 100 mm of asphalt overlying a concrete approach slab some 250 to 300 mm thick was encountered. A layer of crushed gravel some 250 to 300 mm thick was encountered underlying the concrete approach slab at Borehole Nos. 2 and 3.

4.1.2 Embankment Fill

Underlying the pavement structure at Borehole Nos. 1 to 4, a deposit of 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 2 to 6%. Gradation analyses were carried out on eight (8) samples of this deposit, the results of which indicated 29 to 48% gravel size particles, 46 to 60% sand size particles, and 6 to 8% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT ‘N’ values of 7 to 78 blows per 300 mm penetration, the compactness of this deposit was described as loose to very dense, generally dense. This deposit was encountered

to depths of 3.4, 4.4, 5.2, and 3.0 m below grade at Borehole Nos. 1 to 4, respectively (elevations 265.1, 264.4, 263.4, and 265.9 m, respectively).

4.1.3 Sand Fill

Underlying the embankment fill at Borehole Nos. 2 and 3, a deposit of fill described as brown to grey sand some silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 8 to 25%, indicating a moist to wet moisture condition relative to optimum moisture content. A gradation analysis was carried out on one (1) sample of this deposit, the results of which indicated 0% gravel size particles, 89% sand size particles, and 11% silt and clay size particles (Figure No. L-2, Appendix 3). Based on SPT 'N' values of 1 to 17 blows per 300 mm penetration, the compactness of this deposit was described as very loose to compact, generally loose. This deposit was encountered to a depth of 8.1 m below grade at Borehole Nos. 2 (elevation 260.7 m). Auger refusal was encountered in this deposit at a depth of 10.1 m below grade at Borehole No. 3 (elevation 258.5 m).

4.1.4 Mixed Fill

Underlying the embankment fill at Borehole No. 4, a deposit of fill described as a mix of cobble and boulder sizes mixed with a grey sand with silt was penetrated. Pieces of wood and concrete were encountered in this deposit. The natural moisture content measured on samples of this deposit was in the order of 21%, indicating a wet condition relative to optimum moisture content. This deposit was encountered to a depth of 4.4 m below grade (elevation 264.5 m).

4.1.5 Sand

Underlying the embankment fill at Borehole No. 1, a deposit of grey sand with silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 9 to 31%, indicating a moist to wet moisture condition, relative to optimum moisture content. A gradation analysis was carried out on one (1) sample of this deposit, the results of which indicated 0% gravel size particles, 75% sand size particles, and 25% silt and clay size particles (Figure No. L-3, Appendix 3). Based on STP 'N' values of 2 blows per 300 mm penetration, this deposit was described as very loose. This deposit was encountered to a depth of 6.7 m below grade (elevation 261.8 m).

4.1.6 Silt

Underlying the fill at Borehole No. 4, a deposit of grey silt trace clay was penetrated. The natural moisture content measured on a sample of this deposit was in the order of 20%, indicating a wet moisture condition, relative to optimum moisture content. A gradation analysis was carried out on one (1) sample of this deposit, the results of which indicated 0% gravel size particles, 0% sand size particles, 95% silt size particles, and 5% clay size particles (Figure No. L-4, Appendix 3). Based on STP 'N' values of 28 blows per 300 mm penetration, this deposit was described as compact. This deposit was encountered to a depth of 5.8 m below grade (elevation 263.1 m).

4.1.7 Silty Clay

Underlying the sand at Borehole No. 1 and underlying the silt at Borehole No. 4, a deposit of grey silty clay was penetrated. The natural moisture content measured on samples of this deposit was in the order of 36 to 51%, indicating a wet moisture condition relative to optimum moisture content. Based on in situ shear strength of 64 to 88 kPa, the consistency of this deposit was described as stiff. Auger refusal was encountered in this deposit at depths of 11.4 and 8.8 m below grade at Borehole Nos. 1 and 4, respectively (elevations 257.1 and 260.1 m, respectively).

4.1.8 Concrete

A layer of concrete was encountered below the sand fill at Borehole No. 2. This concrete is likely part of the abutment footing. The borehole was terminated at a depth of 9.3 m below grade at Borehole No. 2 (elevation 259.5 m).

4.1.9 Bedrock

Underlying the above described silty clay at Borehole No. 4, bedrock was proven by diamond core drilling. The bedrock was described as black slate. Based on Rock Quality Designation (RQD) values of 74 to 98% the bedrock was described as fair to excellent quality. Sampling in the bedrock was terminated at a depth of 12.2 m below grade (elevation 256.7 m). It should be noted that, when encountered, the underlying bedrock surfaces in this area are very erratic in nature, varying substantially in elevation over short horizontal distances.

4.2 GROUNDWATER DATA

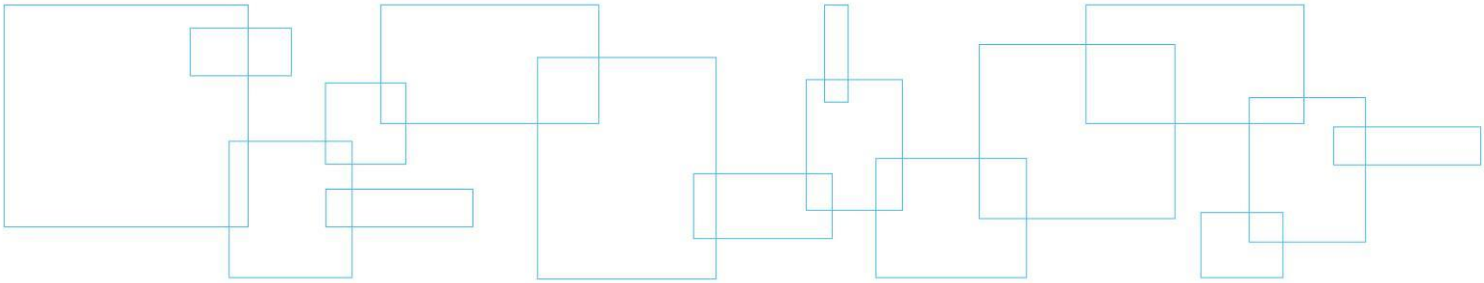
Measurements of the groundwater table and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. Piezometers were installed at Borehole Nos. 1 and 2 to determine stabilized water levels. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix B).

The groundwater levels in Borehole Nos. 1 and 2 were measured at elevations between 261.8 to 262.2 m, some two days after completion of the field program. Borehole No. 3 was dry immediately following completion of the borehole. The groundwater was encountered at a depth of 0.5 m below grade at Borehole No. 4 immediately following completion of coring, however this water level was not stabilized and was likely elevated due to the water used during coring operations. The water level in Whitson Creek was measured at elevation 262.7 m in August 2013.

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

Appendix 1 Key Plan

Drawing No. 1 Key Plan



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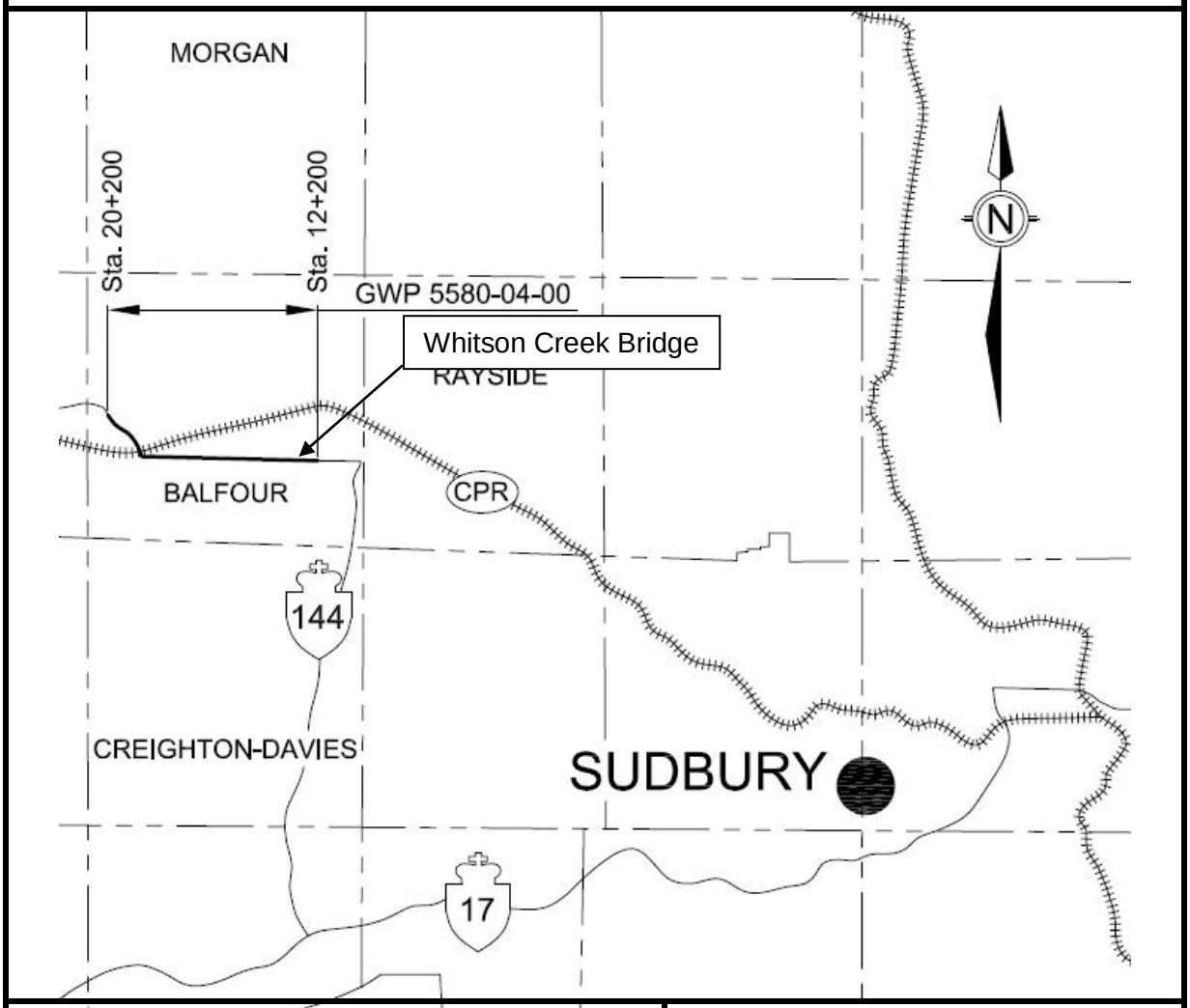
KEY PLAN

Drawing No. 1

NOT TO SCALE



FINAL
FOUNDATION INVESTIGATION REPORT
GWP 5580-04-00
Highway 144
Whitson Creek

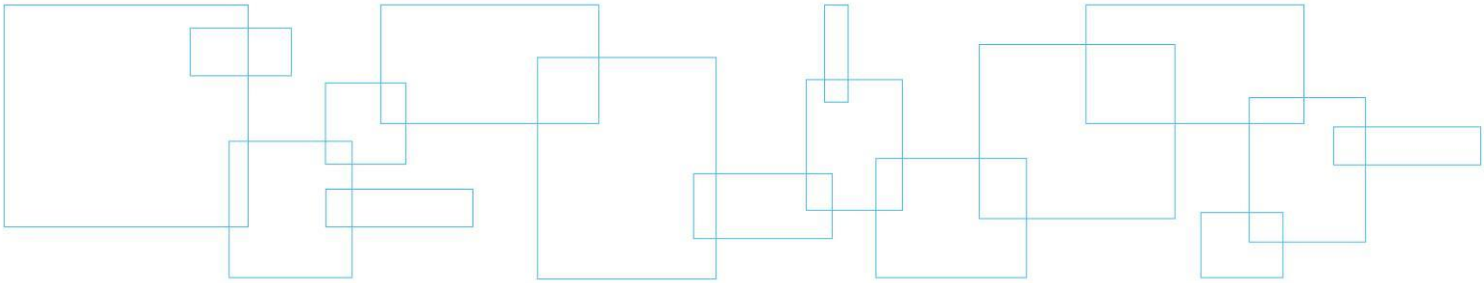
LVM | MERLEX

Reference No: 12/11/12218

March 2014

Appendix 2 Subsurface Data

Enclosure No. 1	List of Abbreviations and Symbols
Enclosure Nos. 2 to 5	Record of Borehole Sheet



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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 1)

METRIC

RECORD OF BOREHOLE NO. 1

L|V|M

REFERENCE 12/11/12218 DATUM Geodetic LOCATION N 5158833.8 E 288452.9 - Station 12+401.7 Balfour Township ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-051 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 2013 August 19 TIME (Completed) 5:00:00 PM CHECKED BY MAM

DATE (Completed) 2013 August 19

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
268.5	Ground Surface								
0.0	150 mm Asphalt 300 mm Crushed Gravel FILL - sand and gravel trace silt brown, dry (compact/very dense)		1	SS	72		268		
			2	SS	69				47 47 (6)
			3	SS	17		267		
			4	SS	41		266		
265.1			5	SS	19				
3.4	SAND - with silt brown, dry (very loose) moist		6	SS	2		265		0 75 (25)
			7	SS	2		264		
261.8			8	SS	2	▽▽▼	263		
6.7	SILTY CLAY grey, wet 6 mm silt varves at 25 mm spacing (stiff)		9	SS	WH		262		
			10	SS	PM		261		
			11	SS	PM		260		
257.1							259		
11.4	Auger Refusal End of Borehole						258		

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

+5 (at 260 m); +5 (at 259 m); +6 (at 257.1 m)

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) 13/8/19 5:00:00 PM	6.7 ▽	-
2) 13/8/21 5:05:00 PM	6.7 ▽	-
3) 13/8/22 8:40:00 AM	6.7 ▼	-

MEL-GEO 12218 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/3/21

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

REFERENCE 12/11/12218 DATUM Geodetic LOCATION N 5158834.6 E 288407.6 - Station 12+447 Balfour Township ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-051 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 2013 August 20 TIME (Completed) DATE (Completed) 2013 August 20 CHECKED BY MAM

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)
268.8	Ground Surface										
0.0	100 mm Asphalt 250 mm Concrete 300 mm Crushed Gravel		1	SS	29						
268.2											
0.6	FILL - sand and gravel trace silt brown, dry (compact/dense)		2	SS	30		268				48 46 (6)
			3	SS	27		267				
			4	SS	50						39 55 (6)
							266				
			5	SS	18						
			6	SS	45	▽	265				37 54 (9)
264.4											
4.4	FILL - sand some silt brown, dry (loose/compact)		7	SS	17		264				0 89 (11)
			8	SS	8		263				
	grey, wet					▽▼	262				
			9	SS	15		261				
260.7	creosote treated wood in tip										
8.1	CONCRETE (probably footing)						260				
259.5											
9.3	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) 13/8/20 3:30:00 PM	4.1 ▽	- ▩
2) 13/8/21 5:00:00 PM	6.6 ▽	-
3) 13/8/22 8:35:00 AM	6.6 ▼	-

MEL-GEO 12218 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/3/21

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

LVM

REFERENCE 12/11/12218 DATUM Geodetic LOCATION N 5158829.0 E 288438.5 - Station 12+416 Balfour Township ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-051 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 2013 August 21 TIME (Completed) 11:30:00 AM CHECKED BY MAM

DATE (Completed) 2013 August 21

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)
268.6	Ground Surface										
0.0	75 mm Asphalt 300 mm Concrete 250 mm Crushed Gravel										
268.0			1	SS	27		268				
0.6	FILL - gravelly sand trace silt brown, dry (loose/very dense)		2	SS	17						33 60 (7)
			3	SS	7		267				
			4	SS	29		266				
			5	SS	42						32 60 (8)
			6	SS	35		265				
			7	SS	61		264				29 63 (8)
263.4											
5.2	FILL - sand some silt grey, moist (very loose/loose)		8	SS	6		263				
			9	SS	5		262				
			10	SS	1		261				
							260				
258.5							259				
10.1	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) 13/8/21 11:30:00 AM	DRY	6.4
2)	-	-
3)	-	-

MEL-GEO 12218 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/3/21

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 12/11/12218 DATUM Geodetic LOCATION N 5158830.0 E 288397.5 - Station 12+457 Balfour Township ORIGINATED BY JL

PROJECT GWP 5580-04-00, Highway 144, Site No. 46-051 BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM DATE (Started) 2013 August 21 TIME (Completed) 8:10:00 PM CHECKED BY MAM

DATE (Completed) 2013 August 21

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
268.9	Ground Surface						
0.0	100 mm Asphalt 200 mm Crushed Gravel FILL - sand and gravel trace silt brown, dry (dense/very dense)		1	SS	45		268
			2	SS	78		
			3	SS	44		267
			4	SS	51		
265.9							266
3.0	FILL - cobbles/boulder size rock mixed with sand with silt grey, wet		5	SS	50/75 mm		
			6	SS	25/25 mm		265
264.5	pieces of wood and concrete						
4.4	SILT trace sand grey, wet (compact)		7	SS	28		264
263.1							
5.8	SILTY CLAY grey, wet (stiff)		8	SS	WH		263
			9	SS	PM		262
260.1							261
8.8	BEDROCK - black slate fair to excellent to quality		10	RC	Rec= 100% RQD= 74%		260
			11	RC	Rec= 100% RQD= 98%		259
256.7			12	RC	Rec= 100% RQD= 98%		258
12.2	End of Borehole						257

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)

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	(SI	CL)
47	47		(6)	
0	0	95	5	

COMMENTS

Note: Groundwater level in borehole at 0.5 m depth below grade upon completion. Water level NOT Stabilized.

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

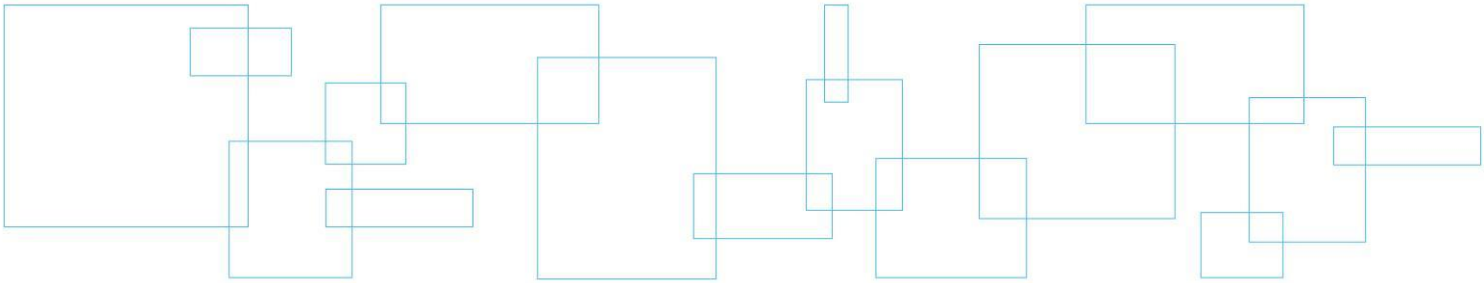
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1)	-	-
2)	-	-
3)	-	-

MEL-GEO 12218 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/3/21

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-4:	Grain Size Distribution Curves
Figure No. L-5:	Shear Strength Summary Chart
Figure No. L-6:	Lab Test Summary Sheet



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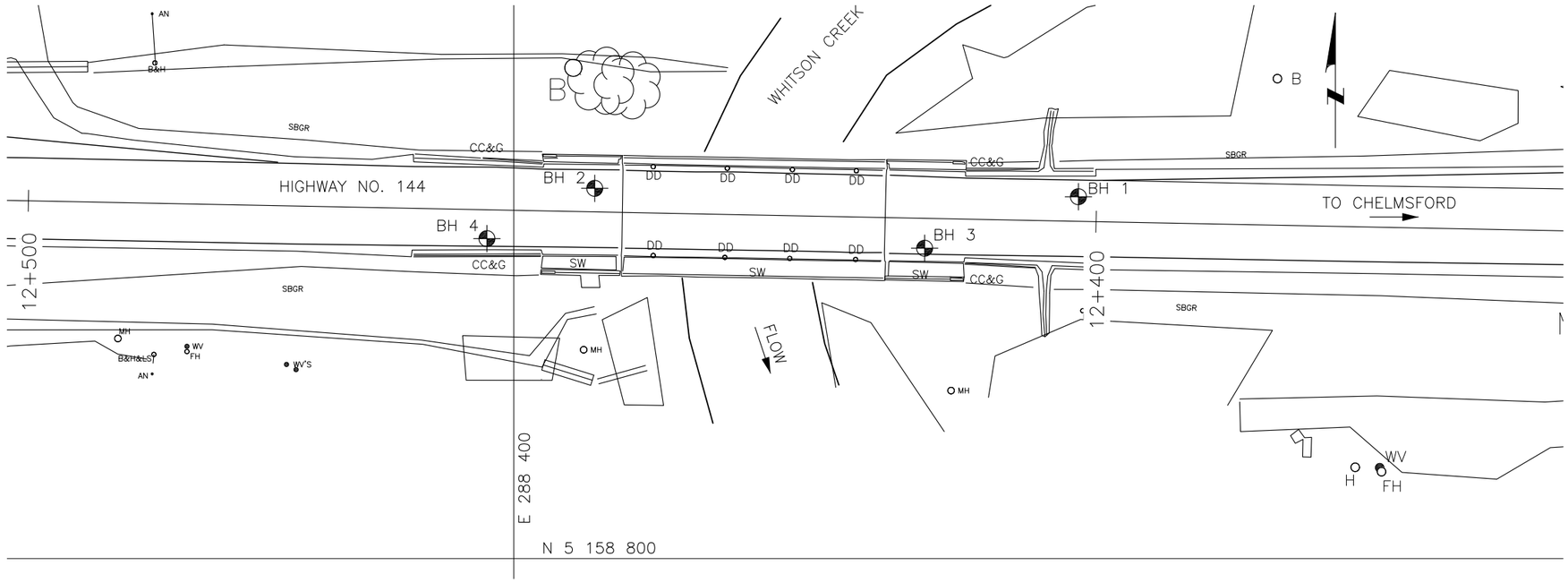
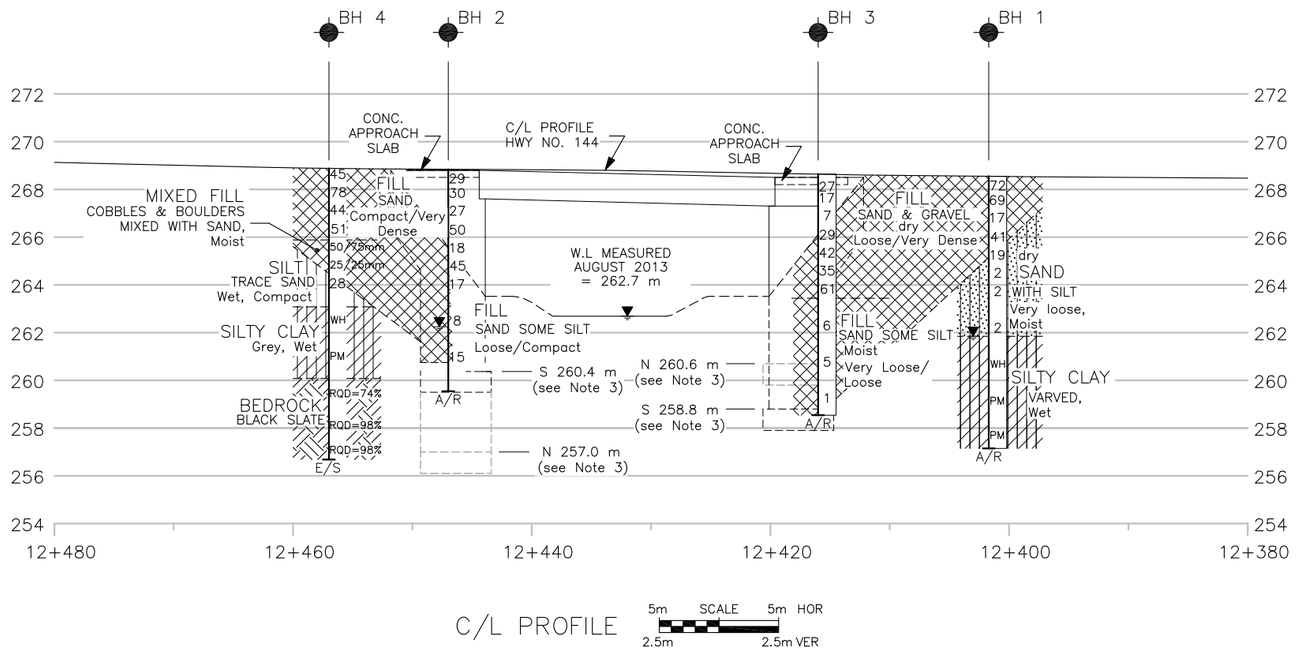


PLAN

5m SCALE 5m



C/L PROFILE

5m SCALE 5m HOR
2.5m 2.5m VER

CONT. No.
XXXX–XXXX

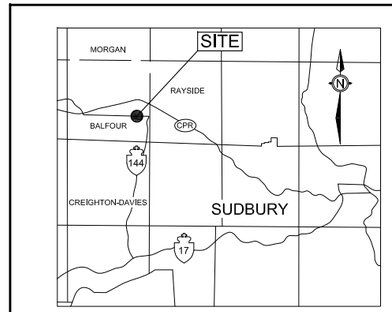
GWP. No.
5580–04–00

N

DRAWING
2

HWY 144
WHITSON CREEK BRIDGE (SITE 46–051)
BALFOUR TOWNSHIP
BOREHOLE LOCATIONS & SOIL STRATA

L|V|M



KEY PLAN – NOT TO SCALE

LEGEND

- Borehole
- Borehole w/ DCPT
- Dynamic Cone Penetration Test (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
- E/S — End of Sampling

Borehole No.	Elev.	O/S	Co–ordinates	
			Northerly	Easterly
Borehole No. 1	268.5	2.3 m Rt	5158833.8	288452.9
Borehole No. 2	268.8	2.2 m Rt	5158834.6	288407.6
Borehole No. 3	268.6	2.8 m Lt	5158829.0	288438.5
Borehole No. 4	268.9	2.7 m Lt	5158830.0	288397.5

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.

NOTE 3: Top of footing elevations illustrated in the profile were derived from elevations shown in the General Arrangement Drawing D–4476/1 dated March 1960.

REVISIONS	DATE	BY	DESCRIPTION
	Mar 2014	IK	REVISION 1

HWY NO. 144 – BALFOUR TOWNSHIP

GEOCRES NO.: 41I–304

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

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

Reference No.: 12/11/12218
Date: March 2014

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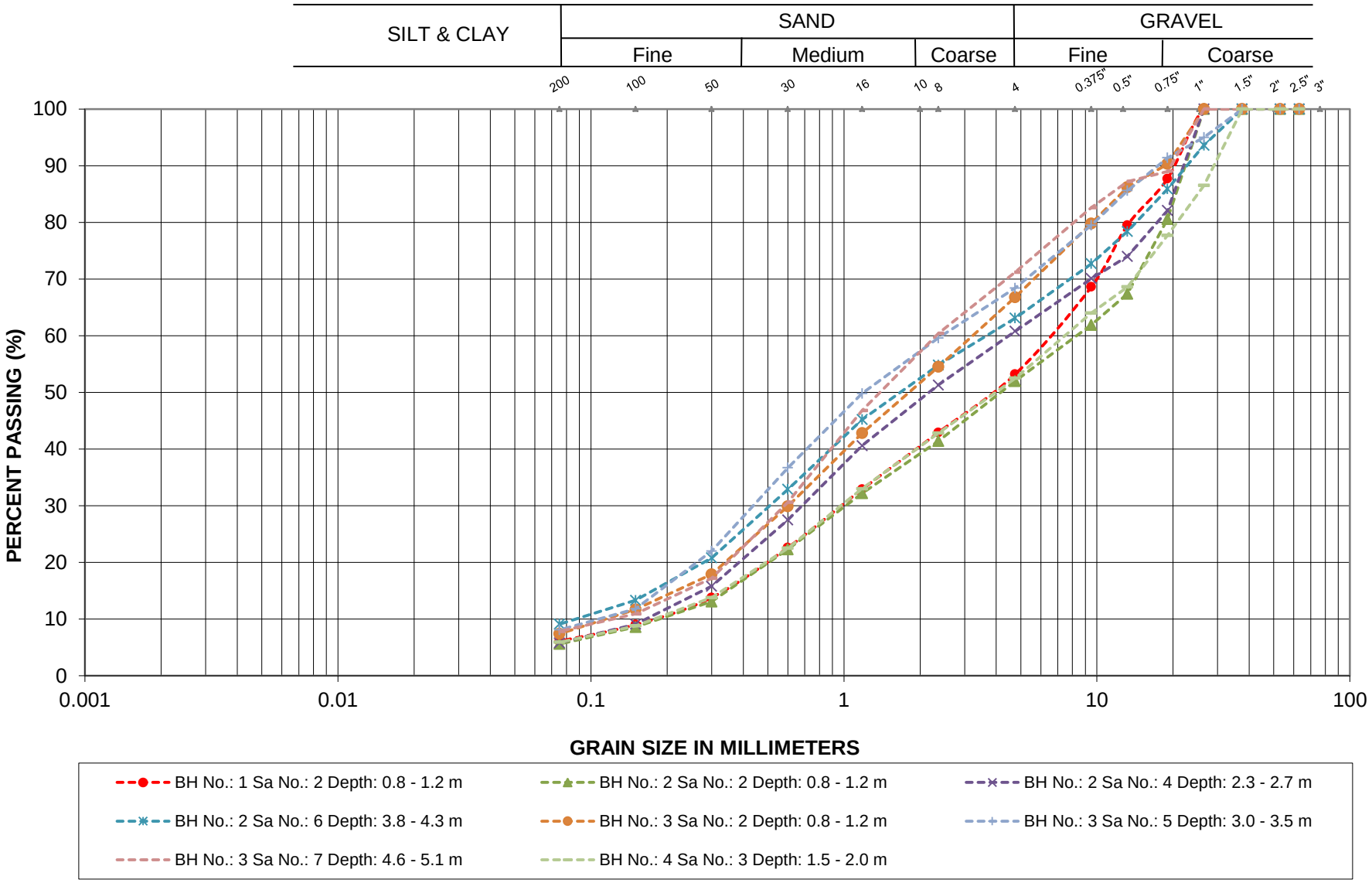
GRAIN SIZE ANALYSIS



G.W.P.: 5580-04-00
LOCATION: Hwy 144, Whitson Creek Culvert

EMBANKMENT FILL

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FIGURE L-1

Reference No.: 12/11/12218
Date: March 2014

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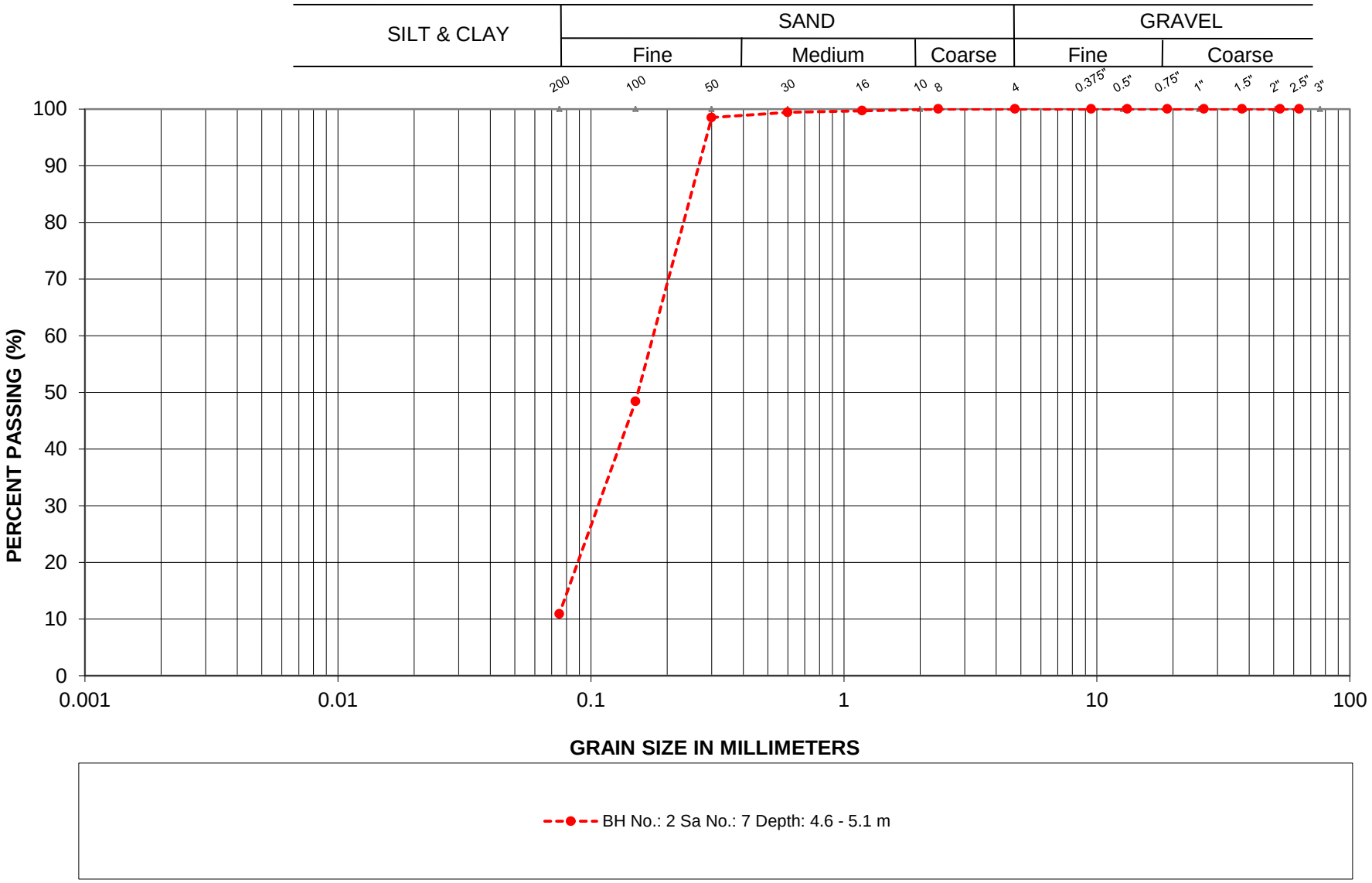
GRAIN SIZE ANALYSIS



G.W.P.: 5580-04-00
LOCATION: Hwy 144, Whitson Creek Culvert

SAND FILL

LVM | MERLEX

FIGURE L-2

Reference No.: 12/11/12218
Date: March 2014

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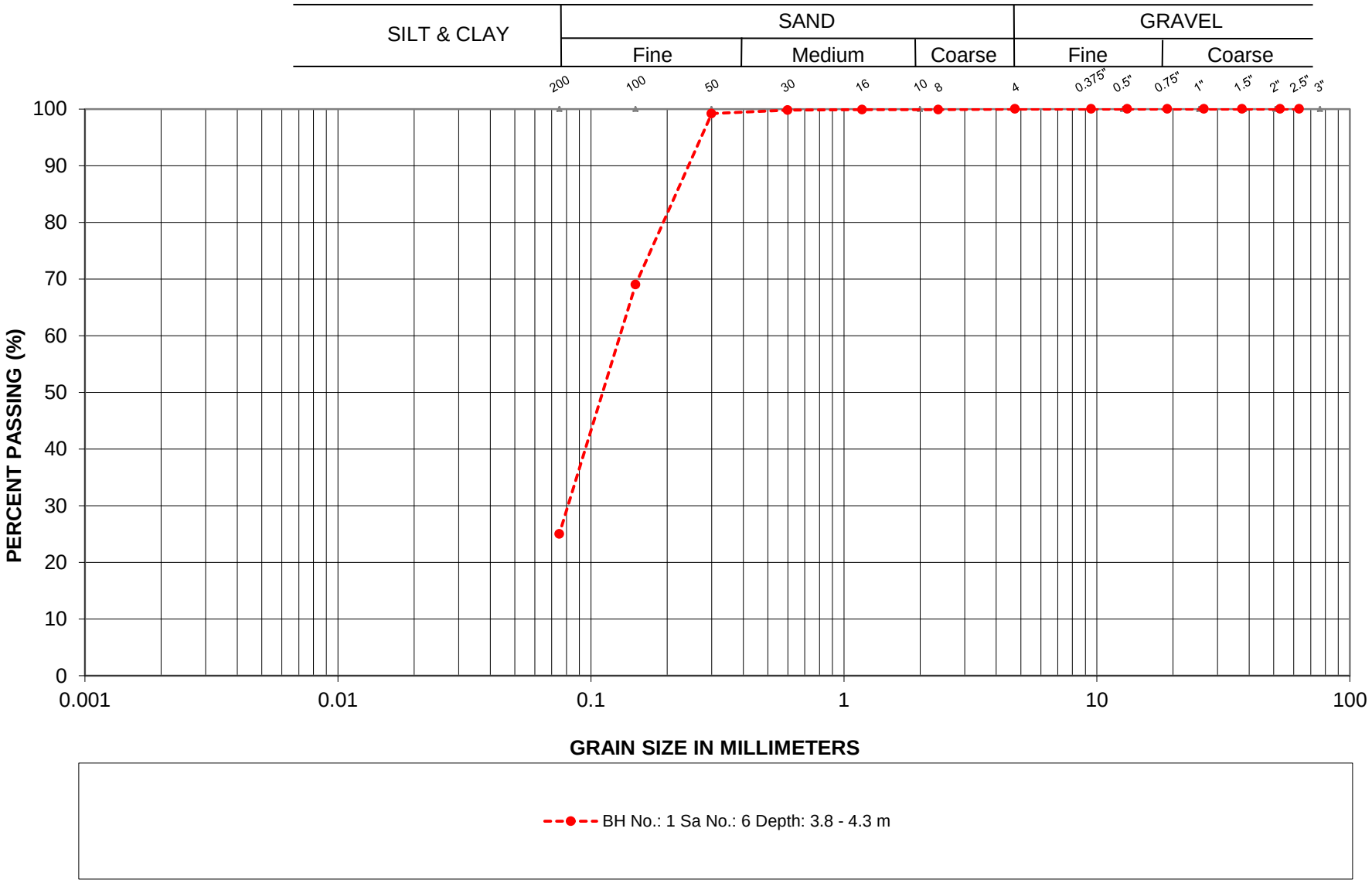
GRAIN SIZE ANALYSIS



G.W.P.: 5580-04-00
LOCATION: Hwy 144, Whitson Creek Culvert

SAND

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FIGURE L-3

Reference No.: 12/11/12218
Date: March 2014

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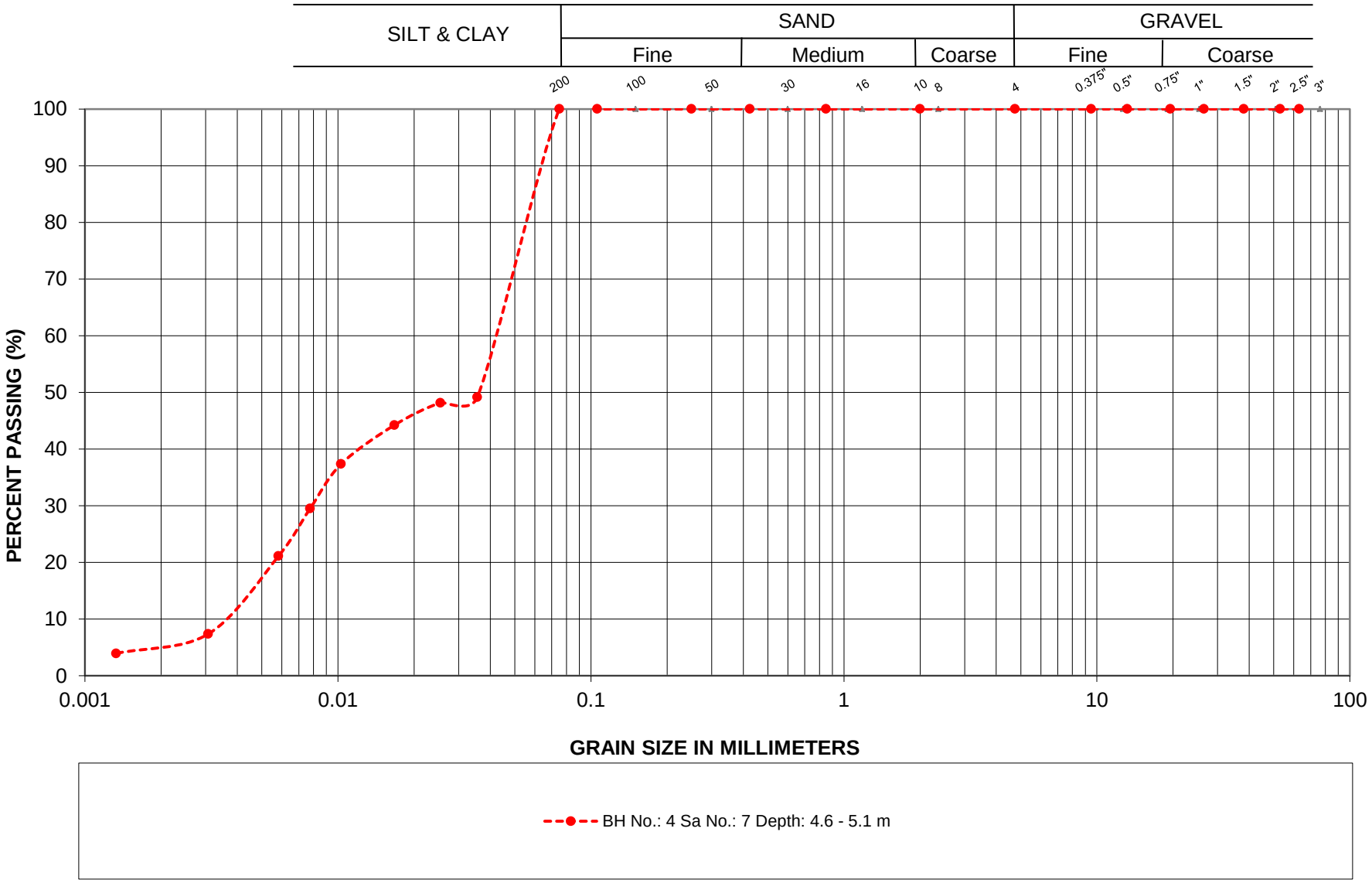
GRAIN SIZE ANALYSIS



G.W.P.: 5580-04-00
LOCATION: Hwy 144, Whitson Creek Culvert

SILT

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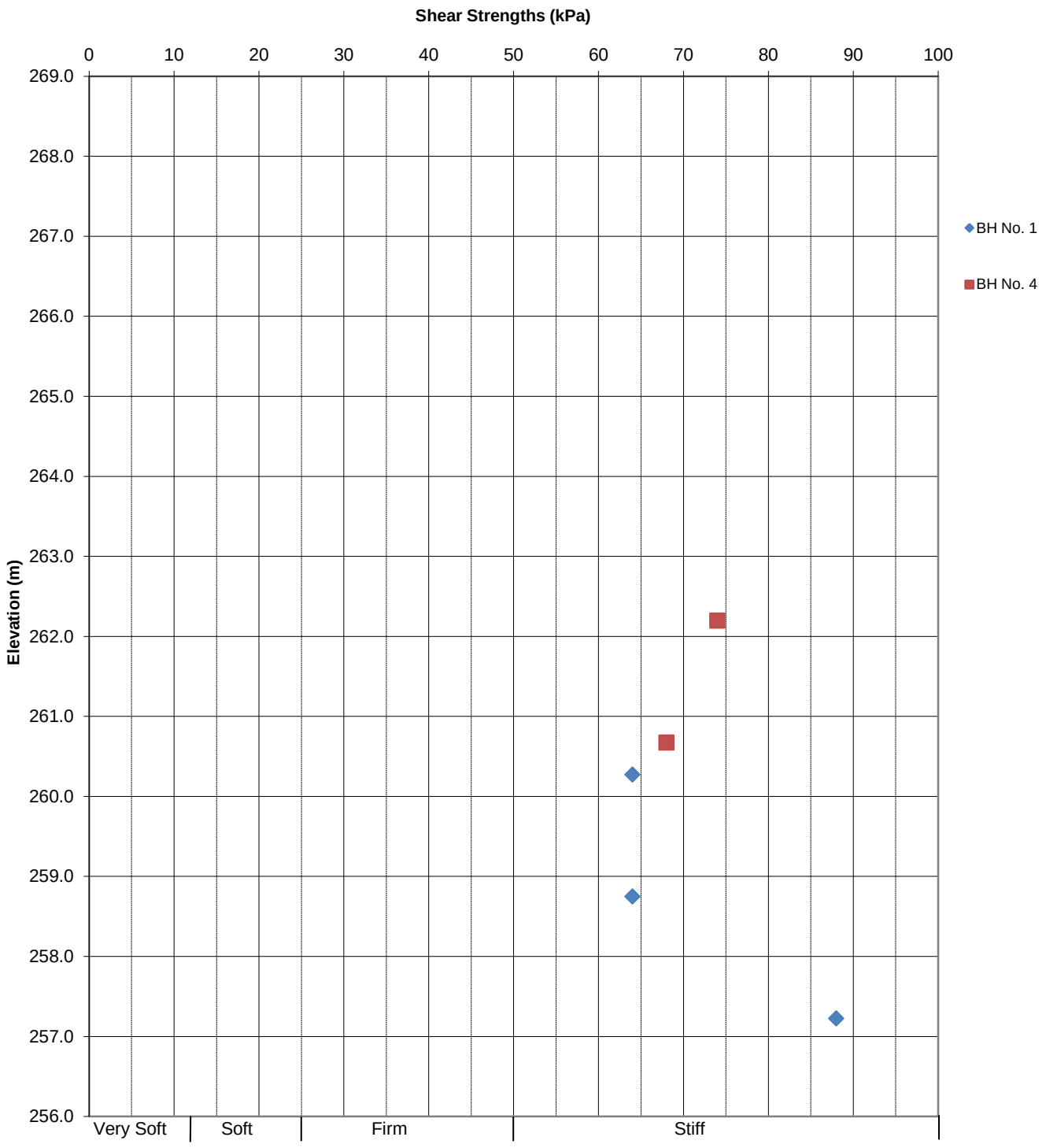
FIGURE L-4

IN-SITU SHEAR STRENGTHS	Figure No. L-5

In-Situ Shear Strengths vs. Depth



Project: 12/11/12218
GWP: 5580-04-00
Location: Hwy 144, Whitson Creek

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Date: March 2014

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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	0.2					2.0				72			
	2	0.8	47	47	6		2.1				69			
	3	1.5					2.8				17			
	4	2.3					4.7				41			
	5a	3.1					3.8				19			
	5b	3.1					8.6				19			
	6	3.8	0	75	25		16.6				2			
	7	4.6					17.9				2			
	8	6.1					30.8				2			
	9	7.6					51.3				WH			
	10	9.1					41.9				PM			
	11	10.7					35.7				PM			
2	1	0.0					3.6				29			
	2	0.8	48	46	6		1.5				30			
	3	1.5					1.6				27			
	4	2.3	39	55	6		2.5				50			
	5	3.1					3.4				18			
	6	3.8	37	54	9		4.6				45			
	7	4.6	0	89	11		7.7				17			
	8	6.1					21.6				8			
	9	7.6					21.0				15			
3	1	0.3					3.3				27			
	2	0.8	33	60	7		2.6				17			
	3	1.5					2.2				7			
	4	2.3					4.5				29			

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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 (%)				
3	5	3.1	32	60	8		3.6				42			
	6	3.8					4.5				35			
	7	4.6	29	63	8		4.0				61			
	8	6.1					18.5				6			
	9	7.6					22.0				5			
	10	9.1					24.6				1			
4	1	0.0					3.2				45			
	2	0.8					2.8				78			
	3	1.5	47	47	6		2.5				44			
	4	2.3					5.8				51			
	5	3.1									50/75 mm			
	6	3.8					21.2				25/25 mm			
	7	4.6	0	0	95	5	19.6				28			
	8	6.1					47.8				WH			
	9	7.62									PM			
	10	9									RC			Rec= 100%, RQD= 74%
	11	10.4									RC			Rec= 100%, RQD= 98%
	12	11.6									RC			Rec= 100%, RQD= 98%