MERLEX ENGINEERING LTD.

CONSULTING GEOTECHNICAL ENGINEERS

FINAL
FOUNDATION INVESTIGATION and DESIGN REPORT

CULVERT STATION 14+148 – TWP. OF GRENFELL
GWP 162-98-00
MEL SITE B

Highway 11, From 0.3 km South of the Highway 11/66 Intersection
Northerly 11.7 km to 3.5 km South of Highway 570

MEL Ref. No.: 09/10/09181B November 12, 2010

Submitted to:

AECOM Canada Ltd.
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Geocres No. 42A-79

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1.0 INTRODUCTION

Merlex Engineering Ltd. (MEL) has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation Ontario (MTO), to carry out a foundation investigation at a culvert located at Station 14+148, Township of Grenfell. GWP 162-98-00 on Highway 11 passes through parts of the Townships of Eby and Grenfell and the location is described as: from 0.3 km South of the Highway 11/66 intersection Northerly 11.7 km to 3.5 km South of Highway 570. This project involves the extension of the east end of a single 1370 mm x 1220 mm CTC culvert in an embankment that is 4.0 m high above the culvert invert at centerline.

The foundation investigation location was specified by the MTO in the RFP/TPM documentation Agreement No. 5008-E-0067. The terms of reference for the scope of work are outlined in MEL's proposal P-09-037, dated May 2009. The purpose of the investigation was to determine the subsurface conditions in the area of the culvert. MEL investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

2.0 SITE DESCRIPTION

The CTC culvert is located on Highway 11, at Station 14+148, Township of Grenfell. The topography at the site is generally of moderate relief and the direction of flow through the culvert is from east (inlet) to west (outlet). The existing highway embankment, at the culvert location, supports two undivided lanes of highway running in a north south direction. The existing highway embankment at the culvert location is some 4.0 m higher than the culvert invert at centerline, with the paved surface at elevation 320.0 m and the culvert invert at 316.0 m (See Photos, Appendix D). The embankment slopes at the culvert location are currently 2.7H:1.0V left of centerline and 2.3H:1.0V right of centerline. At the culvert location, a visual review

indicated no signs of embankment instability, and there were no obvious signs of settlement of the pavement structure at the culvert location. The culvert ends are solid with a slight sag in the middle.

2.1 Site Physiography and Surficial Geology

This project is located in the Geomorphic Sub-provinces known as the Eastern Sandy Uplands. The topography on this section of Highway 11 is generally rolling. There are exposed bedrock cuts along this section of highway. At many locations, significant layers of earth overlay the bedrock and organic terrain was also observed. Within this foundation project area overburden consists generally of a surficial deposit of sand underlain by compact silts followed by sands overlying bedrock at an average depth of 10.5 m (elevation 305.5 m).

Bedrock in the area, as indicated on OGS Map 2440, is of the Early Precambrian Era. At the culvert site, the bedrock comprises of Metavolcanics including basaltic and andesitic flows, tuffs and breccias.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on January 22 and 23, 2010, when two sampled boreholes were advanced. The two boreholes were advanced at the culvert end to the east of the embankment.

The field investigation was carried out using a Bombardier mounted CME 45B drilling rig equipped with hollow stem augers, standard augers, and routine geotechnical sampling equipment. Soil samples were obtained 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) at the borehole locations. The SPT method involves advancing a 50 mm diameter 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 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.

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. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix B), with a summary of results presented on the laboratory sheets Figure Nos. L-1 and L-2, Appendix C.

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.

4.0 SUBSURFACE CONDITIONS

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Record of Borehole Logs (Appendix B) and on Figure No. B-1 (Appendix C). 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 DCPT 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. At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. B-1 and B-2 were recorded at 316.2 and 315.8 m, respectively.

4.1 Culvert, Station 14+148, Twp of Grenfell – MEL SITE B

A plan and section showing the borehole locations and stratigraphic sequences is shown on Figure No. B-1, Appendix C. During the course of the exploration program, two (2) sampled boreholes were put down at this site, with Borehole Nos. B-1 and B-2, advanced at the east end of the existing culvert.

4.1.1 Sand

At the east end of the culvert (Borehole Nos. B-1 and B-2), a deposit of brown fine sand trace silt trace gravel, some ±0.6 to 0.8 m in thickness, was penetrated. The natural moisture content from samples of this deposit was in the order of 22.8 to 30.0%. This deposit was encountered down to elevations 315.6 to 315.0 m at Borehole Nos. B-1 and B-2 respectively.

4.1.2 Silt

Underlying the sand, a deposit of grey silt containing trace to with sand trace clay was penetrated. Sand content generally increased with depth in this deposit. The natural moisture content from samples of this deposit was in the order of 27 to 36%. Hydrometer analyses were carried out on five (5) samples of this deposit which were retained in the spilt spoon sampler (37 mm inside diameter), the results of which indicated 0% gravel size particles, 0 to 27% sand size particles, 69 to 92% silt size particles, and 3 to 10% clay size particles (Figure No. L-1, Appendix C). Atterberg limits testing was undertaken on the samples from this deposit, which resulted in the deposit being classified as non-plastic. Based on SPT values of 3 to 27 blows per 300 mm penetration, the compactness of this deposit was described as loose to compact, generally compact. This deposit was encountered to depths of 7.0 m below ground surface at both Boreholes Nos. B-1 and B-2 (elevations 309.2 and 308.8 m).

4.1.3 Sand

Underlying the silt a deposit of grey fine to medium sand containing trace gravel trace silt was penetrated. The natural moisture content from samples of this deposit was in the order of 22 to 31%. Gradation analyses were carried out on two (2) samples of this deposit which were retained in the spilt spoon sampler, results of which indicated 0 to 7% gravel size particles, 89 to 95% sand size particles, and 4 to 5% silt and clay size particles (Figure No. L-2, Appendix C).

Based on the SPT values of 6 to 33, the compactness of this deposit was described as loose to dense, generally compact. Auger refusal was encountered at depth of 10.6 and 10.4 m, at Borehole Nos. B-1 and B-2, respectively (elevations 305.6 and 305.4 m, respectively).

4.2 Groundwater Conditions

Groundwater and cave-in levels in the open boreholes were measured during the advance of the individual borings and upon completion. These levels were recorded on the individual Record of Borehole Log Sheets (Appendix B). The water level was measured at a depth of 2.0 and 2.5 m below ground surface at Borehole Nos. B-1 and B-2, respectively (elevations 314.2 and 313.3 m, respectively). Water was not observed in the drainage course at the culvert location during the field operations. These groundwater levels will fluctuate seasonally.

MERLEX ENGINEERING LTD.

M. A. Merleau, P. Eng.
Principal

J. R. Berghamer, P. Eng.
Project Engineer

5.0 DESIGN COMMENTS AND RECOMMENDATIONS

5.1 General

The existing 1370 mm x 1220 mm CTC culvert, located at Station 14+148 in the Township of Grenfell, was identified as requiring an extension to the east end of the culvert in the RFP. The embankment at this location is some 4.0 m in height above the culvert invert and will be widened for construction of a north bound passing lane. Based on data from the geotechnical investigation, which was also carried out by MEL, embankment fill in the area of the culvert consists of granular pavement structure over granular fills (see Geotechnical Borehole Logs, Appendix D). The culvert connects a deep ditch on the left side (east) of the embankment to a shallow ditch on the right (west) where the extension is required (See Photos, Appendix D). The culvert ends are solid with only a slight sag in the middle of the culvert.

It is anticipated that the culvert extension will be constructed using either a rigid or flexible culvert of similar section and capacity to the existing culvert. The decision on the type of culvert to be used will be made at the construction stage.

5.2 Foundation Consideration

At the culvert location, a visual review indicated no signs of embankment instability, and there were no obvious signs of settlement of the pavement structure at the culvert location. The native soil, at the culvert end/toe of slope, consists of a thin deposit of fine sand deposit overlying a generally compact silt trace to with sand trace clay overlying a fine to medium sand, trace gravel, trace silt. Auger refusal was encountered at depths between 10.4 to 10.6 m (elevations 305.4 to 305.6 m). The founding mineral soils are considered good for culvert support and for a conventional highway embankment foreslope of this height, and bearing resistance and/or embankment stability should not be an issue as discussed in the following.

5.3 Design Bearing Pressure

Based on the natural soil conditions (thin layer of sands overlying compact silt), the response of the existing embankment, and a foundation elevation similar to that of the right end of the existing culvert (invert elevation 316.0 m), a factored bearing resistance at ULS of 450 kPa for the native fine sand over silt subgrade is applicable. A geotechnical reaction at SLS of 150 kPa reflects a settlement estimate of less than 25 mm, and the assumption that a stable subgrade is maintained with proper groundwater control during excavation and construction.

5.4 Bedding/Embedment and Subgrade Preparation

The results of this investigation indicate that the native soils at the toe of slope, east end of the existing culvert, (Borehole Nos. B-1 and B-2) consists of a thin layer of sand, underlain by compact silt with varying sand content, underlain by sand containing trace silt trace gravel, with auger refusal at depths between 10.6 and 10.4 m below ground surface, respectively (elevations 305.6 and 305.4 m, respectively).

The existing culvert will be left in place and an extension will be connected to the east end. The connection between the existing CTC end and the pipe extension (circular/pipe arch) should be made tight and permanent at the joint, to prevent infiltration of fines from the backfills (see section 5.6). The end segment of the existing CTC is sound.

Embedment material, for flexible pipe, can consist of Granular B Type I placed in accordance with OPSD 802.010. However, if a rigid pipe is used provide Class B bedding as per OPSD 802.031 with a Granular A bedding material. Cover material can consist of a Granular B Type I placed as per OPSD 802.031. Since the decision on the type of culvert to be used will be made at the construction stage, not at detailed design, specifying Granular A material for cover and

embedment material would be prudent considering the minimal quantities involved. The backfill for the culvert extension should consist of a Granular B Type I and the foreslope above the extension should be constructed to a 2H:1V slope.

Lateral earth pressures should be computed in accordance with the Canadian Highway Bridge Design Code (CHBDC). The design parameters are as follows:

	Granular A	Granular B Type I
Angle of Internal Friction (degrees)	35	30
Unit weight (KN/m^3)	22	20
Active earth pressure (Ka)	0.27	0.33
At-rest earth pressure (Ko)	0.43	0.50

For rigid structures, such as precast concrete culverts, deflection cannot occur, as such the “at-rest” condition (Ko) applies. For flexible structures, such as CSP culverts, deflection can occur, as such the “active” condition (Ka) applies.

5.5 Excavation and Embankment Reconstruction

All excavations greater than 1.2 m in depth must be sloped or shored in accordance with the Occupational Health and Safety Act Regulations for Construction Projects. If excavation is required to cut back the existing foreslope to connect the extension, it will penetrate the existing embankment fills, which consist of sands with gravel based on the geotechnical boreholes (Appendix D) in this area. Temporary open excavations will be stable above the groundwater table at an angle of 1H:1V, as the embankment soils are considered a Type 3 soil as defined in the Occupational Health and Safety Act and Regulations for Construction.

Bedrock was not encountered within the anticipated depth of excavation, therefore bedrock excavation and/or blasting operations are not anticipated.

The ground water table was encountered in the boreholes between elevations 314.0 to 313.3 m, whereas the culvert invert at the right end is at elevation 315.8 m. These groundwater levels will fluctuate seasonally however, it is not anticipated that groundwater control will be a major consideration during construction of the extension. If groundwater is encountered, dewatering, in accordance with OPSS 517, must be carried out.

The existing right foreslope is at a 2.3H:1V slope. Once the extension has been installed the foreslope should be reconstructed at the minimum standard 2H:1V slope with Granular B Type I material. To prevent erosion, topsoil and seed should be applied as soon as practical after slope extension.

5.6 Extension Connection

The end members of the existing 1370x1220 CTC are in good condition and sound. A metal flange plate connection of width adequate to cover the timber end opening should be lag bolted to the CTC. This flange must be designed to collar the pipe extension securely to the CTC. The connection should be covered with a 2 m wide strip of geotextile centered on the joint between the existing culvert and new culvert extension. Considering the similar permeability characteristics of the embankment fill and bedding material, as well as the size of the culvert, there is no requirement for clay seals or cut off walls.

5.7 Settlement

The native soils that will support the proposed extension are compact cohesionless soils, as such any settlement that will develop will occur almost immediately upon new loading. The new load will consist of a maximum of 2.5 m of embankment fill and it has been estimated that, provided the subgrade is not unduly disturbed during construction, settlement will be less than 10 mm.

5.8 Slope Stability During Construction

An open cut excavation may be required around the existing culvert to allow connection of the extension. This temporary slope can be cut back at an angle of 1H:1V, as previously noted. A slope stability analysis on this temporary slope configuration was carried out using the program Slope/W. This analysis established that the stability of a temporary 1H:1V slope, 4.0 m high and underlain by a compact silt, results in a minimum factor of safety of 1.6 against a circular failure (see Figure No. S-1, Appendix E). This factor or safety would be reduced to approximately 1.2 if the groundwater table rises to the existing grade at the culvert inlet.

As anticipated a shallow slip surface on the slope face has a lower factor of safety. This slope configuration will be temporary, as such, the above factors of safety are considered acceptable for these conditions.

5.9 Construction Considerations

Considering the existing embankment slope (2.3H:1V), anticipated low groundwater table at the site, and competent bearing stratum, it is not anticipated that there will be any construction issues in constructing the culvert extension.

6.0 CLOSURE

Information provided in this report is valid only at the locations described above. Any assumptions of continuity of soil stratigraphy between boreholes, as shown on the enclosed cross-sections, is intended as an aid for design purposes only and does not constitute a statement of existing conditions for contractual or construction purposes. Field investigation was carried out using a CME drill rig mounted on a Bombardier carrier owned by Chrisdamat Management Ltd. The report was prepared by Mr. J. R. Berghamer, P. Eng and reviewed by the firm's principal and MTO designate Mr. M. A. Merleau, P. Eng.

Details of the investigation, the material analysis and recommendation in this report are considered to be complete. However, should any questions arise, please do not hesitate to contact the undersigned.

MERLEX ENGINEERING LTD.

M. A. Merleau, P. Eng.
Principal

J. R. Berghamer, P. Eng.

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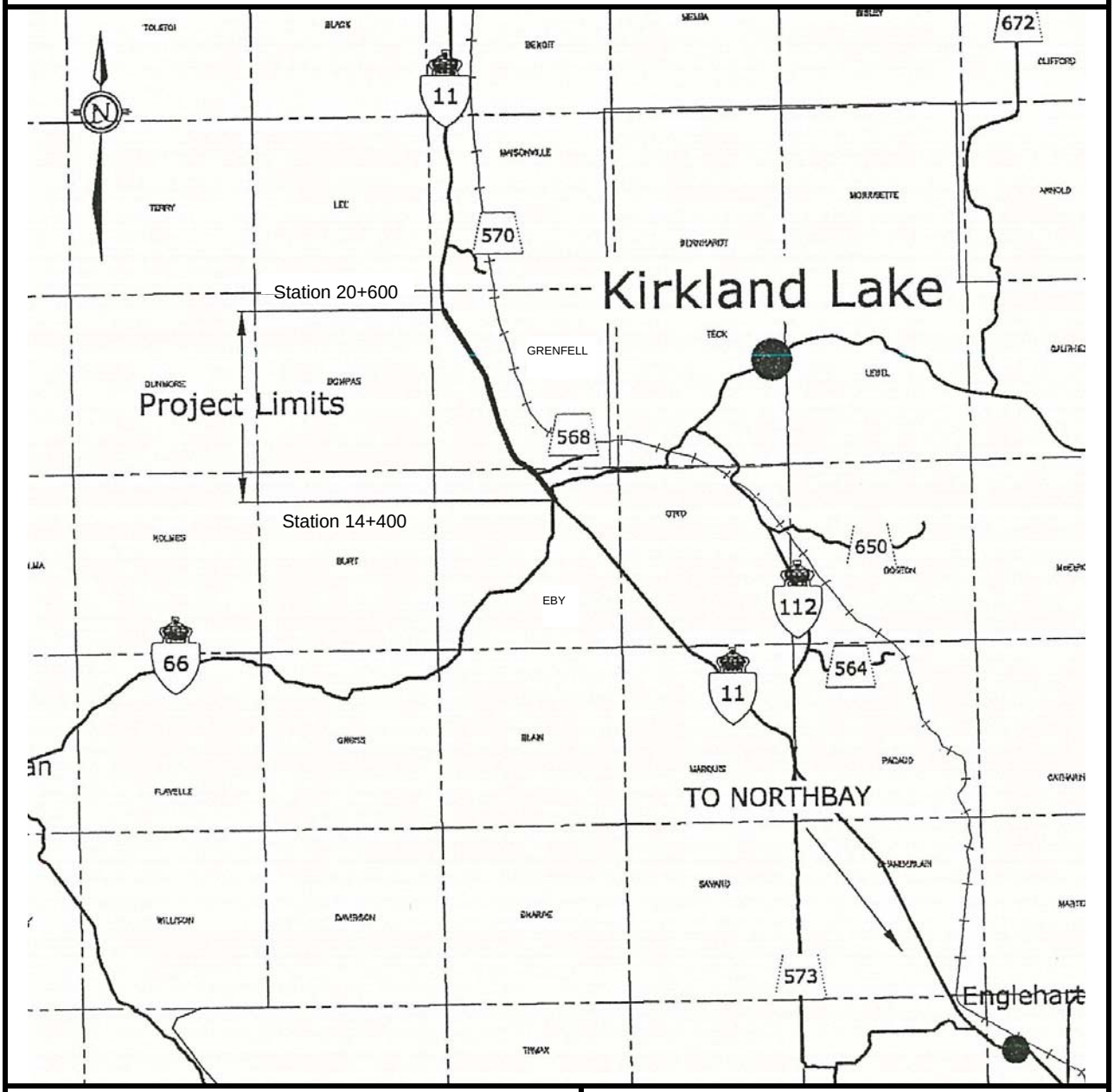
APPENDIX A

Figure No. 1: Key Plan

KEY PLAN

Figure No. 1

NOT TO SCALE



FINAL
FOUNDATION INVESTIGATION
AND DESIGN REPORT
GWP 162-98-00

Highway 11, From 0.3 km South of Highway 66, Northerly 11.7 km to 3.5 km South of Highway 570

MEL Ref. No.: 09/10/09181B November 2010

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APPENDIX B

Enclosure No. 1: List of Abbreviations and Symbols

Enclosure Nos. 2 and 3: Record of Borehole Sheets

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
HB Hammer Bouncing
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
WH Sampler Advanced by static weight (weight of hammer and/or rods)
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 90° point cone 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

3. SOIL DESCRIPTION (Cont'd)

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

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%

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

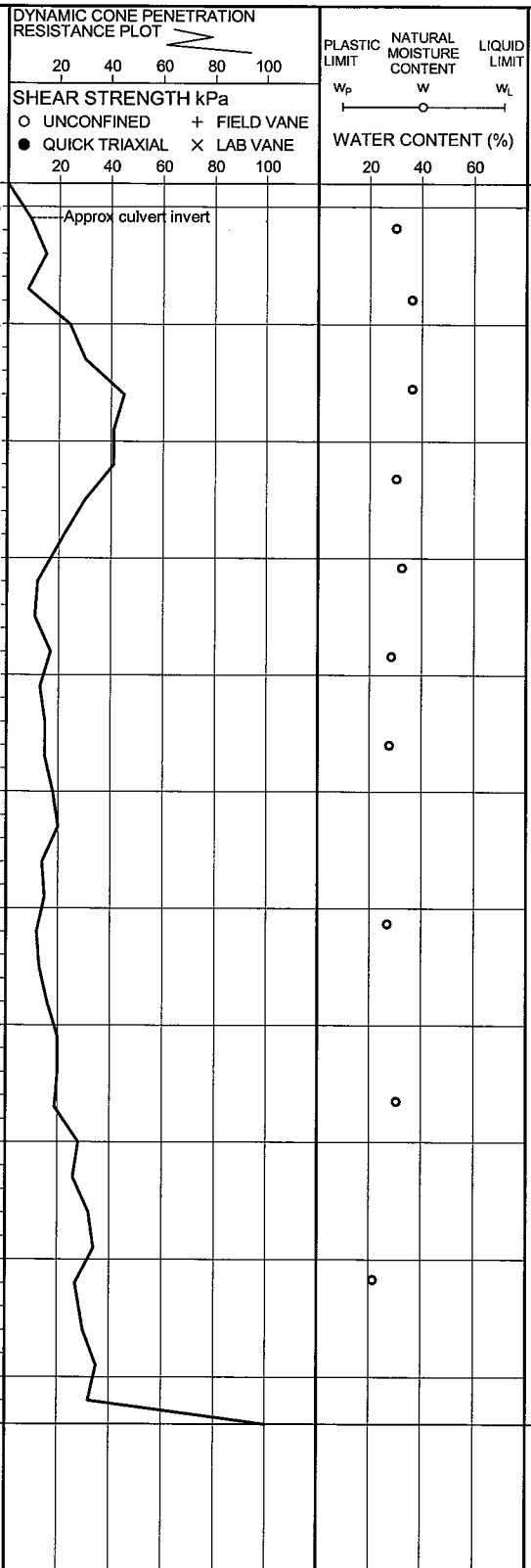
RECORD OF BOREHOLE NO. B-1

REFERENCE 09181 DATUM Geodetic LOCATION N 5332981.30 E 362355.07 - Grenfell Township ORIGINATED BY JL

PROJECT GWP 162-98-00, Highway 11 North - Site B BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG

CLIENT AECOM Inc. DATE (Started/Completed) 10/2/22 - 10/2/23 TIME 9:00:00 AM CHECKED BY MAM

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	GR	SA	SI	CL
316.2	Ground Surface								
0.0	SAND - brown fine sand trace silt trace gravel	1	AS	N/A					
315.6									
0.6	SILT - grey silt trace to with sand trace clay	2	SS	11		0	3	92	5
	(very loose/compact)	3	SS	21		0	0	91	9
		4	SS	13					
	Sand content increases with depth	5	SS	3		0	27	69	4
		6	SS	11					
		7	SS	17		0	22	75	3
		8	SS	16					
309.2									
7.0	SAND - grey fine to medium sand trace gravel trace silt								
	(loose/dense)	9	SS	6		0	95	(5)	
		10	SS	33		7	89	(4)	
305.6									
10.6	Auger Refusal DCPT Refusal End of Borehole								



GROUND WATER CONDITIONS

REMARKS & GRAIN SIZE DISTRIBUTION (%)

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) 10/2/23 10:00:00 AM	2.2	2.5
2) 10/2/23 12:30:00 PM	2	2.1
3) 10/2/23 1:40:00 PM	2	2.1

MERLEX ENGINEERING LTD.
2-120 Progress Court, P1B-8G4 Phone: 1-705-476-2550 Fax: 1-705-476-8882 Email: merlex@merlex.ca

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

METRIC

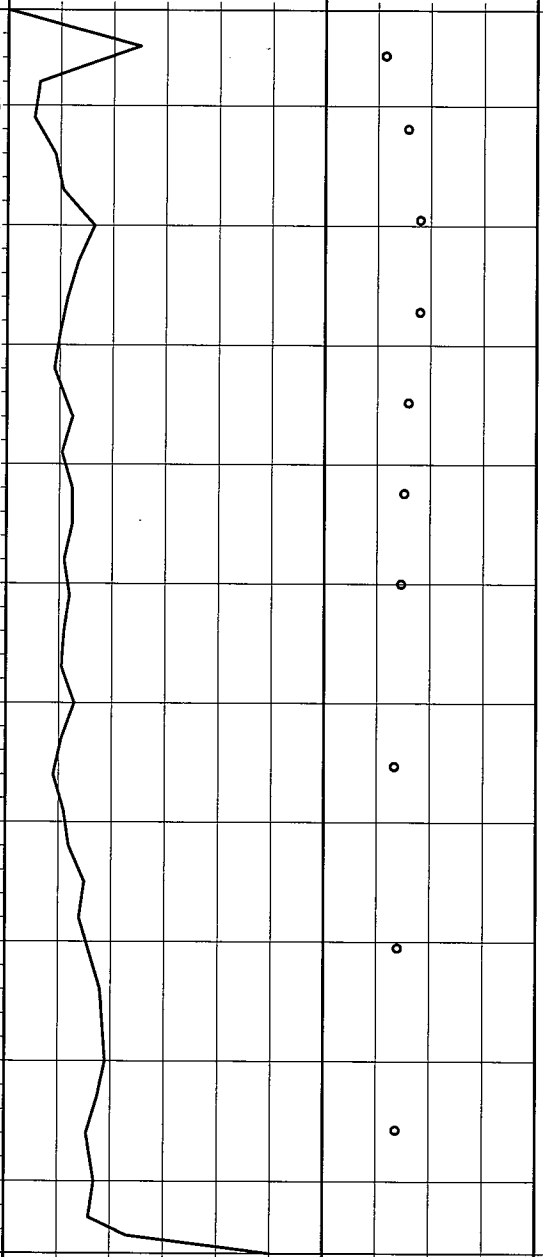
RECORD OF BOREHOLE NO. B-2

REFERENCE 09181 DATUM Geodetic LOCATION N 5332982.94 E 362360.84 - Grenfell Township ORIGINATED BY JL

PROJECT GWP 162-98-00, Highway 11 North - Site B BOREHOLE TYPE CME 45B - Hollow Stem Augers COMPILED BY RG

CLIENT AECOM Inc. DATE (Started/Completed) 10/2/23 - 10/2/23 TIME 1:00:00 PM CHECKED BY MAM

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	GR	SA	SI	CL
315.8	Ground Surface								
0.0	SAND - brown fine sand trace silt trace gravel	1	AS	N/A					
315.0									
0.8	SILT - grey silt trace to with sand trace clay	2	SS	7		0	4	86	10
		3	SS	27					
	(very loose/compact)	4	SS	12					
	Sand content increases with depth	5	SS	19					
		6	SS	12					
		7	SS	15					
		8	SS	3					
308.8									
7.0	SAND - grey fine to medium sand trace gravel trace silt	9	SS	8					
	(loose/compact)	10	SS	17					
305.4									
10.4	Auger Refusal DCPT 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) 10/2/23 1:00:00 PM	2.6	4.9
2) 10/2/23 1:40:00 PM	2.5	3.2
3)	-	-

MEL-GEO 09181 - SITE B - BOREHOLE LOGS.GPJ MEL-GEO.GDT 10/11/12

MERLEX ENGINEERING LTD.

2-120 Progress Court, P1B-8G4 Phone: 1-705-476-2550 Fax: 1-705-476-8882 Email: merlex@merlex.ca

APPENDIX C

Figure No. B-1:	Borehole Locations & Soil Strata
Figure Nos. L-1 and L-2:	Summary Grain Size Analysis Graph

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

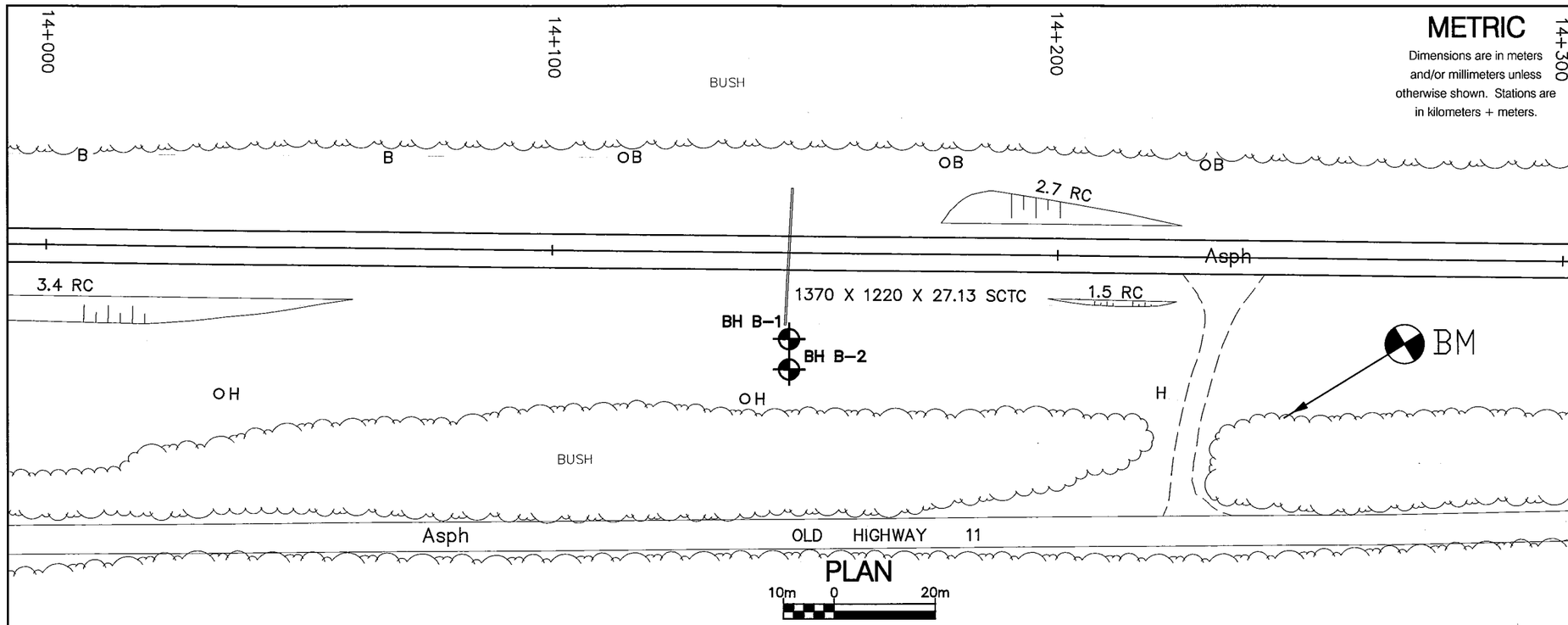
Geo Cres No 42A-79
WP No 162-98-00

N

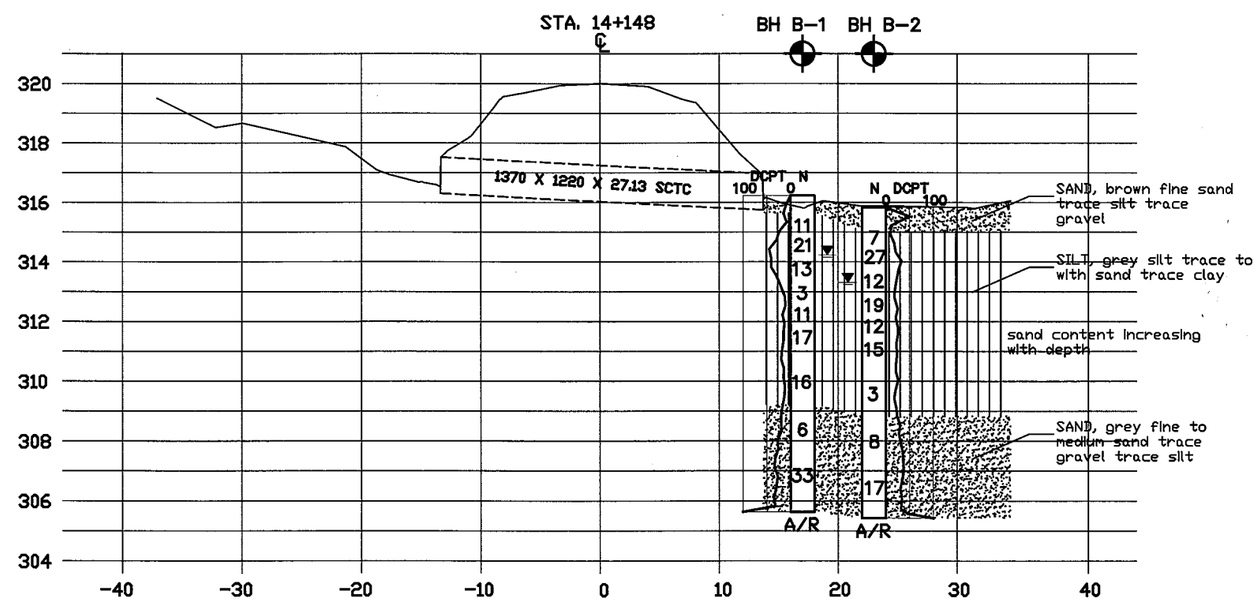
HWY 11 - Township of Grenfell
Sta. 14+148 - MEL Site B
Culvert Extension
BOREHOLE LOCATIONS & SOIL STRATA

Figure B-1

MERLEX ENGINEERING LTD.
Consulting Geotechnical Engineers

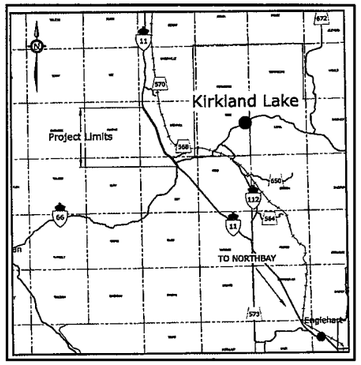


PLAN



EXTENSION PROFILE

Hort 5m 0 10m
Vert 2m 0 4m



KEY PLAN - NOT TO SCALE

LEGEND

- Borehole
- N Blows/0.3 m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3 m (60° Cone, 475 J/blow)
- Water Level at Time of Investigation
- A/R Auger Refusal at Elevation
- E/S End of Sampling
- O/S Offset from ℄

Borehole No.	O/S	Co-ordinates Northerly	Co-ordinates Easterly	Elev.
B-1	17.0 Rt	5332981.3	362355.1	316.2
B-2	23.0 Rt	5332982.9	362360.8	315.8

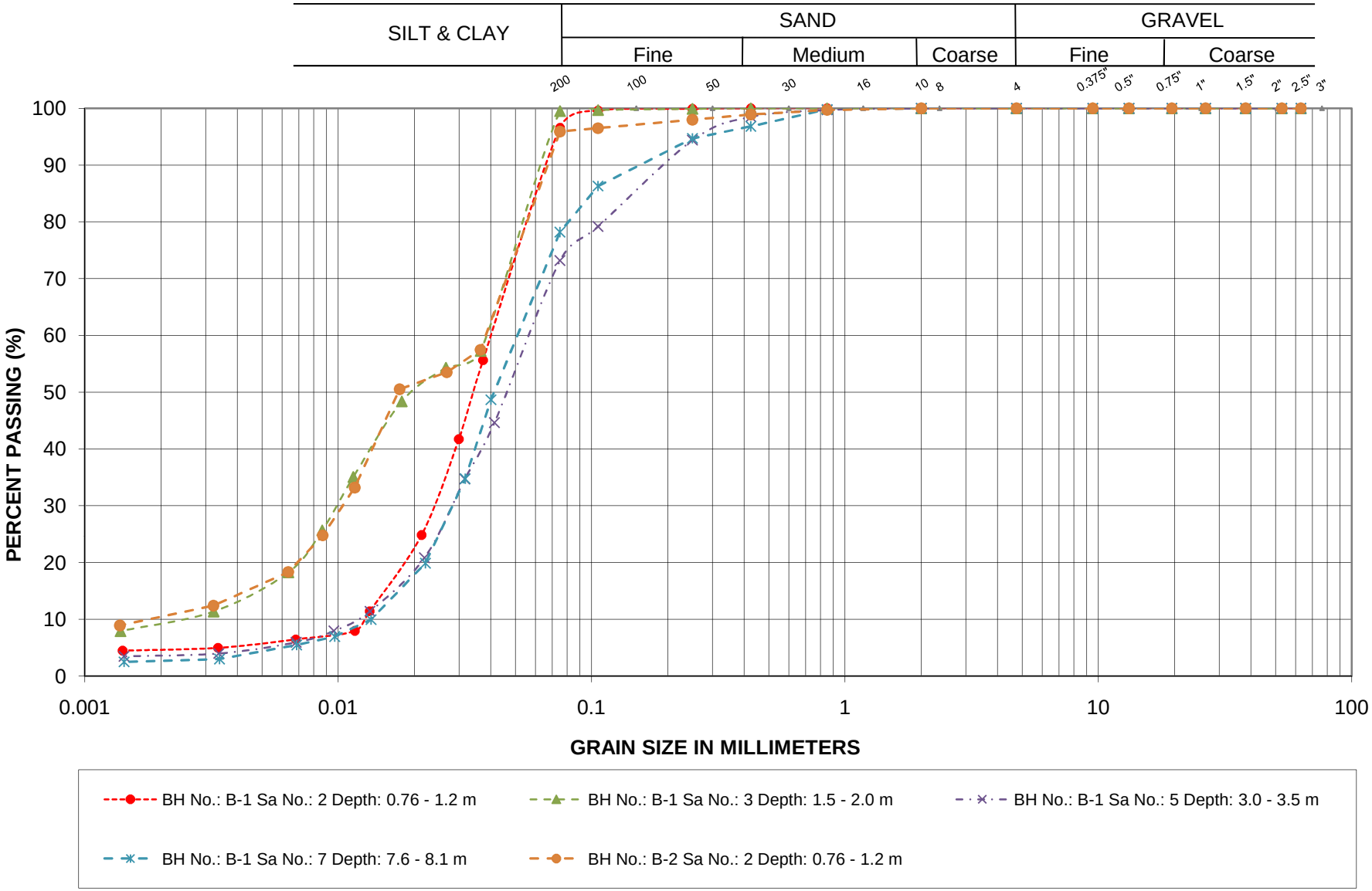
NOTE 1:
The boundaries between soil strata have been established at the borehole locations only. The boundaries illustrated and stratigraphy between boreholes on this drawing are assumed based on borehole data and may vary. They are intended for design only.

REVISIONS	DATE	BY	DESCRIPTION
	NOV/10	MCM	FORMATTING

HWY No. 11 – CULVERT EXTENSION – 14+148			REF NO. 09181 B
SUBM'D			SITE B
DRAWN RG	CHK MAM	DATE SEPTEMBER 2010	FIG B-1

Reference No.: 09/10/09181B
Date: November 2010

GRAIN SIZE ANALYSIS



PROJECT: G.W.P. 162-98-00
LOCATION: Hwy 11 MEL Site B

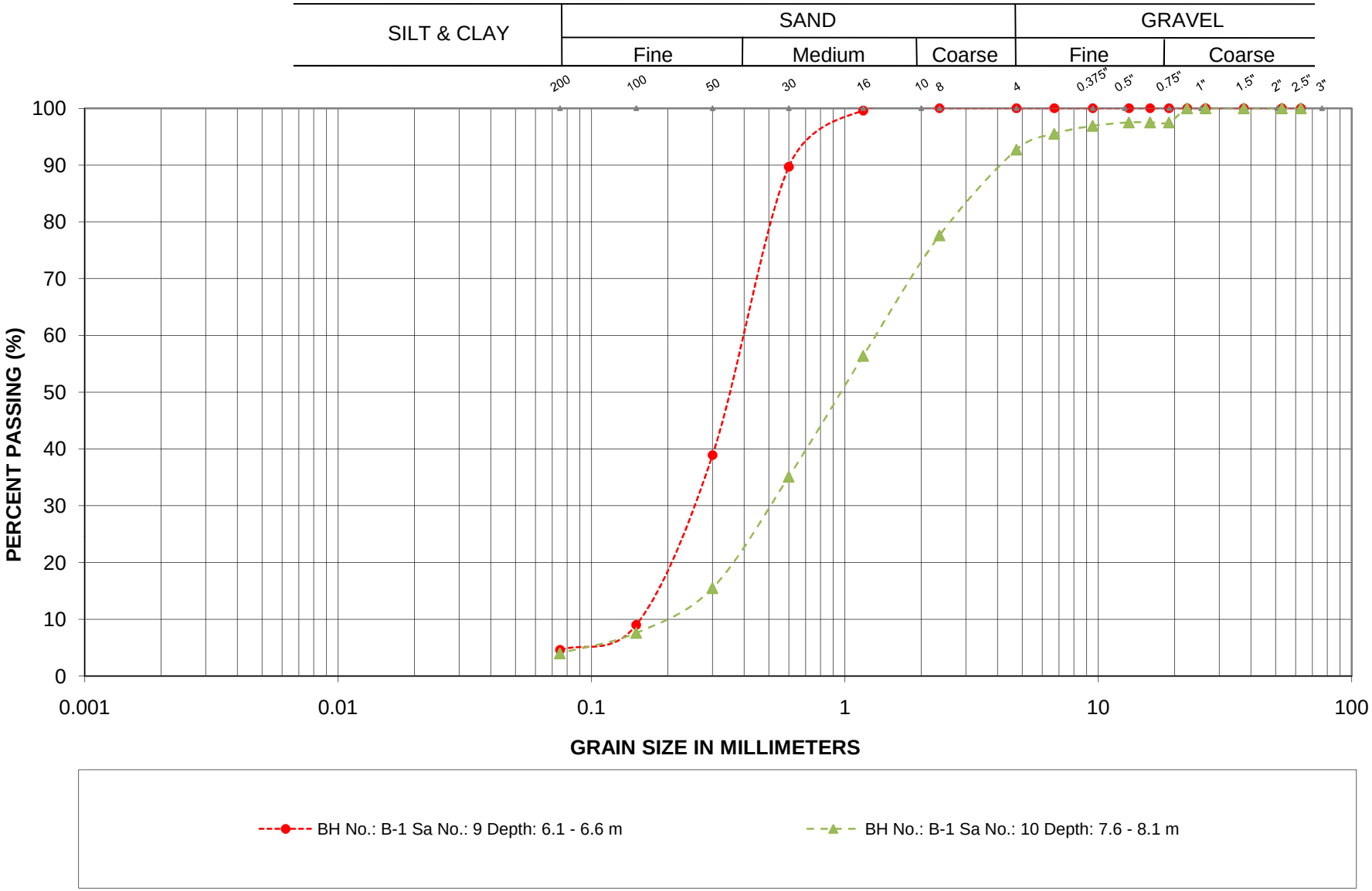
SILTS - Silt, Trace to With Sand, Trace Clay

MERLEX ENGINEERING LTD.

FIGURE L-1

Reference No.: 09/10/09181B
Date: November 2010

GRAIN SIZE ANALYSIS



PROJECT: G.W.P. 162-98-00
LOCATION: Hwy 11 MEL Site B

SANDS - Sand, Trace Gravel, Trace Silt

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FIGURE L-2

APPENDIX D

Photos Nos. 1 and 2:	Culvert Photos
Enclosure No. 4:	Geotechnical Borehole Logs with Abbreviations

Culvert End – East end, looking west – Site B	Photo: 1

Culvert End – West end, looking east – Site B	Photo: 2

Reference No.: 09/10/09181B	Originated By: JL
Project: GWP 162-98-00 – Township of Grenfell, Culvert Extension Station 14+148, MEL Site B	Date: September 14, 2010

ABBREVIATIONS FOR BOREHOLE SURVEY DATA SHEETS

Accep	Acceptable
Agg	Aggregate
Amor	Amorphous
Asph	Asphalt
AP	Auger Probe
BR	Bedrock
Blk	Black
Bl	Blue
BH	Borehole
Bld (y)	Boulder (y)
Blds	Boulders
BU	Break Up
Br	Brown
CF	Channel Face
Cl	Clay
Co	Coarse
Cob	Cobbles
Comp	Compact
Conc	Concrete
Contam	Contaminated
Cord	Corduroy
Cr	Crushed
Dk	Dark
Decomp	Decomposed
D	Datum
E	Earth
Fib	Fibrous
w	Field Moisture Content
F	Fine
Fr Wat	Free Water
FB	Frost Boil
FH	Frost Heave
Gran	Granular
Gr	Gravel (ly)
Grn	Green
Gry	Grey
H	Heavy
Hi	Highly
HP	High Plasticity
HM	Hot Mix
Lt	Light
Liq	Liquid
W_L	Liquid Limit
Lo	Loam
L	Loose
Mrl	Marl
Matl	Material
Max	Maximum
MDD	Maximum Dry Density
MWD	Maximum Wet Density
Med	Medium
MP	Medium Plasticity
Mod	Moderate
Mott	Mottled
Mul	Mulch
NFP	No Further Progress
NFP (Blds)	No Further Progress (Boulders)
Num	Numerous
Occ	Occasional
Wopt	Optimum Moisture Content
Ora	Orange
Org	Organic
Org M	Organic Matter
Ob	Overburden
Pavt	Pavement
Pedo	Pedological
Pen Mac	Penetration Macadam
Wp	Plastic Limit
Ip	Plasticity Index
Psty	Polystyrene
Poss	Possible
PST	Prime & Surface Treated
Quant	Quantity
Reinf	Reinforced
RSS	Remoulded Shear Strength
RF	Rock Fill
Sa	Sand
Sat	Saturated
SH	Shale
St	Sensitivity
SSM	Select Subgrade Material
Sh Rk	Shot Rock
Si (y)	Silt (y)
Sl (y)	Slight (ly)
SP	Slight Plasticity
Stn (y)	Stoney
D_R	Relative Density
Stks	Streaks
Surf	Surface
Temp	Temperature
TH	Test Hole
TP	Test Pit
Tps	Topsoil
Tr	Trace
USS	Undisturbed Shear Strength
Unreinf	Unreinforced
Varv	Varved
VF	Very Fine
WT	Water Table
Weath	Weathered
W	With
Wd (y)	Wood (y)
Yel	Yellow

14+100 4.1 Rt C/L

0 - 70 Asph
70 - 300 Cr Gr
300 - 1.5 Med Sa W Gr Occ Cobs

14+100 6.5 Rt C/L

0 - 230 Cr Gr
230 - 1.2 Med Sa W Gr
1.2 NFP RF

14+125 4.1 Rt C/L

0 - 70 Asph
70 - 300 Cr Gr
300 - 1.3 F-Med Sa W Gr
1.3 - 1.5 F Sa Tr Si

14+125 6.1 Rt C/L

0 - 200 Cr Gr
200 - 1.5 Med Sa W Gr Occ Cobs

14+140 4.1 Rt C/L

0 - 70 Asph
70 - 280 Cr Gr
280 - 1.6 Med Sa W Gr
1.6 NFP RF

14+150 4.1 Rt C/L

0 - 70 Asph
70 - 300 Cr Gr
300 - 1.5 F-Med Sa W Gr

14+150 6.7 Rt C/L

0 - 270 Cr Gr
270 - 1.5 F-Med Sa W Gr

14+175 4.1 Rt C/L

0 - 70 Asph
70 - 350 Cr Gr
350 - 1.5 F-Med Sa Some Gr

14+175 5.6 Rt C/L

0 - 210 Cr Gr
210 - 1.5 F-Med Sa Some Gr

14+178 5.8 Lt C/L

0 - 100 Cr Gr
100 - 1.2 F-Med Sa W Gr Occ Cob
1.2 - 1.5 F Sa W Si

14+178 1.7 Lt C/L

0 - 255 Asph
255 - 500 F-Med Sa W Gr **10DBR387**
NOT Accep Granular B Type I
10% Passing 75 µm
Accep Granular C
500 - 1.5 F Sa Tr Gr **10DBR388**
Accep Granular B Type I
1.5 NFP Sh Rk/BR

14+190 4.1 Rt C/L

0 - 70 Asph
70 - 300 Cr Gr
300 - 1.2 F-Med Sa W Gr
1.2 NFP Sh Rk/BR

14+190 6.9 Rt C/L

0 - 270 Cr Gr
270 - 1.3 F-Med Sa W Gr
1.3 NFP Sh Rk/BR

14+200 4.1 Rt C/L

0 - 80 Asph
80 - 330 Cr Gr
330 - 1.4 F-Med Sa W Gr
1.4 NFP Sh Rk/BR

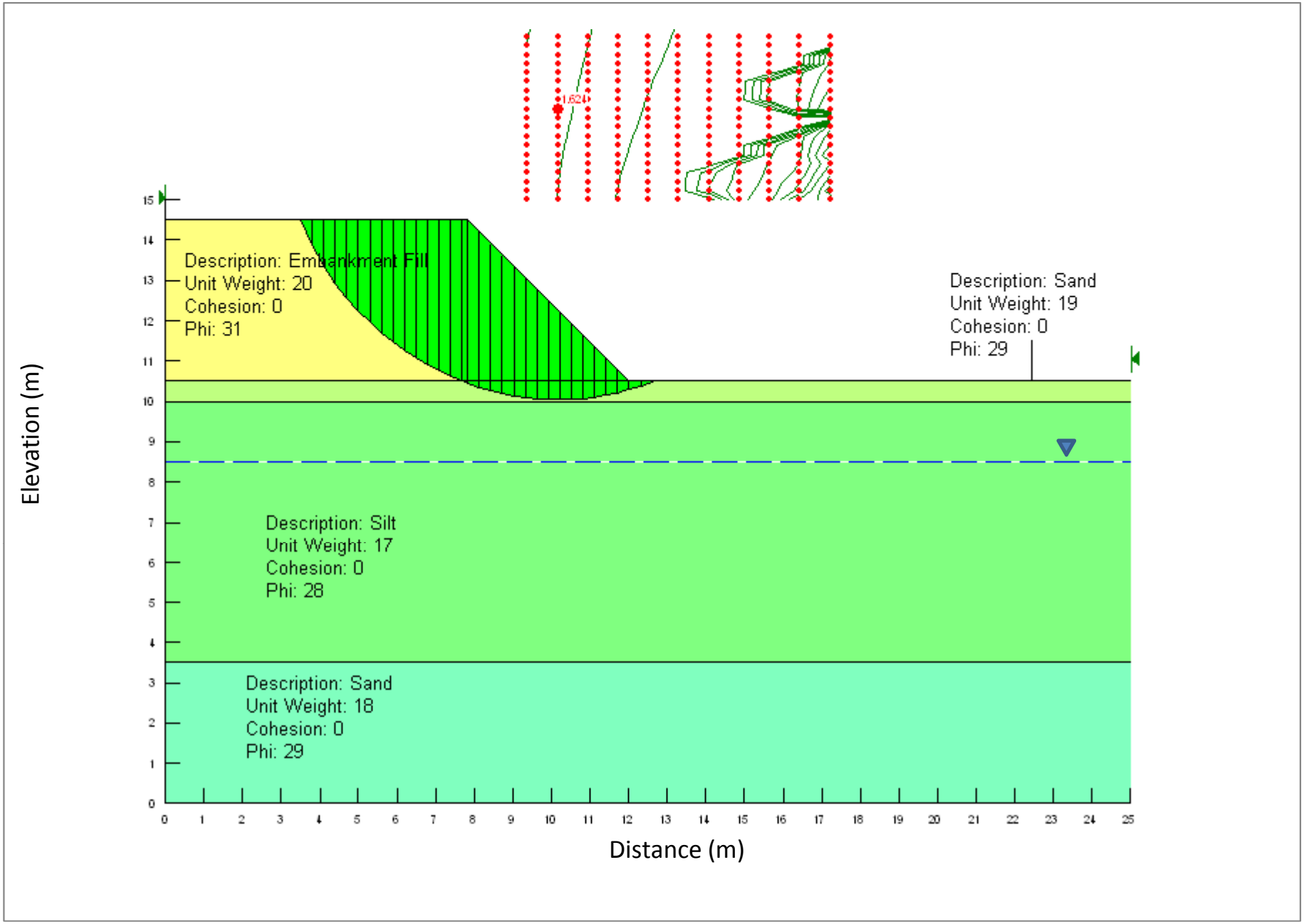
14+200 5.2 Rt C/L

0 - 200 Cr Gr
200 - 1.2 F-Med Sa W Gr Occ Cobs
1.2 NFP Sh Rk/BR

APPENDIX E

Figure No. S-1: Stability Analysis

Reference No.: 09/10/09181B
Date: November 2010



Stability Analysis
Temporary Open Excavation
1H:1V

Project: G.W.P 162-98-00
Location: Hwy 11, MEL Site B

Figure No. S-1