



# **MERLEX ENGINEERING LTD.**

CONSULTING GEOTECHNICAL ENGINEERS

**FINAL  
FOUNDATION INVESTIGATION REPORT  
CULVERT SITE NO. 46-392 – Twp of Hagar  
GWP 372-00-00**

**Highway 17, From Highway 535 (Hagar)  
Easterly To Highway 539 (Warren), 8.4 km and  
Highway 539, From Highway 17 Northerly 0.5 km**

MEL Ref. No.: 06/11/06160      July 16, 2007

Submitted to:

Earth Tech (Canada) Inc.  
189 Wyld Street  
North Bay, Ontario  
P1B 1Z2

**Geocres No.: 41I-209**



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## **1.0 INTRODUCTION**

Merlex Engineering Ltd. (MEL) has been retained by Earth Tech (Canada) Inc., on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation at Culvert Site No. 46-392 on Highway 17 (GWP 372-00-00). The limits of GWP 372-00-00 are described as: Highway 17 from Highway 535 in Hagar, Easterly 8.4 km to Highway 539 in Warren, and Highway 539 from Highway 17 northerly a distance of 0.5 km (see Enclosure No. 2, Key Plan, Appendix A). This project involves the replacement of two (2) culvert structures. Culvert Site No. 46-392 is situated outside the western limits of the above noted project some 2.8 km west of Hwy 535 in the Township of Hagar.

The foundation investigation location was specified by the MTO in the RFP/TPM documentation Agreement No. 5005-E-0011. The terms of reference for the scope of work are outlined in MEL's proposal P-06-103R dated August 24, 2006. The purpose of the investigation was to determine the subsurface conditions in the area of the culverts. 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**

Culvert Site No. 46-392 is located on Highway 17, some 2.8 km west of the intersection with Highway 535 in Hagar. The topography at the site is generally of low relief and the culvert flows from south to north into the Veuve River. The Veuve River meanders easterly along the north side of the highway embankment and south of the embankment for the CPR. The existing highway embankment supports two undivided lanes of highway, running in an east west direction, and the existing road embankment is some 4 to 5 m higher than the ditch level along the north side of the road.



## **2.1 Site Geology**

Bedrock in the area is late to middle Precambrian comprising of metasediment deposits of conglomerate, sand stone, silt stone, chert, and iron formation. The rock units exist as metamorphosed equivalent of the rock types (OGS Map 2440). For the project area, the surficial geology maps indicate that surficial conditions generally consist of bedrock at shallow depth and overburdened soils comprising of glaciolacustrine plain deposits of silts/clays and sands through which the Veuve River meanders in an easterly direction. Sand and gravel deposits are identified in the glaciolacustrine raised beaches north of Warren. Frequent organic deposits are encountered between the rock outcrops (OGS Map 5003).

## **3.0 INVESTIGATION PROCEDURES**

The field work for this investigation was carried out during the period of December 20 and 21, 2006, and February 8 and 9, 2007, and consisted of a total of three (3) sampled boreholes, with accompanying Dynamic Cone Penetration Test (DCPT).

The field investigation was carried out using a Bombardier mounted CME 45B drilling rig equipped with hollow stem augers and routine geotechnical sampling equipment. The boreholes were advanced using 165 mm O.D. continuous flight hollow stem augers and/or 110 mm O.D. continuous flight standard augers. 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 at all borehole locations. A DCPT was advanced from grade to establish a general indication of resistance characteristics of the overburden at the boring locations. In-situ field vane testing, using an MTO "N" size vane, was carried out where appropriate and possible.



Groundwater conditions in the open boreholes were observed during and immediately following completion of the individual boreholes and, if required, a temporary standpipe was installed for the duration of the drilling operation. All open boreholes were backfilled upon completion with the auger cuttings, in the general order they were removed, using reverse augering techniques. Where necessary imported bentonite (hole plug) was used to seal the hole at 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, Atterberg Limits determination, grain size analysis (sieve and/or hydrometer), and specific gravity testing. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix B) with a summary of select results presented on the laboratory sheets in Appendix C (Figures L-1 to L-5).

The location of the individual boreholes were established in the field using highway chainage and offset relative to highway centerline chainage.

#### **4.0 SUBSURFACE CONDITIONS**

Details of subsurface conditions revealed by the investigation program are presented on the enclosed Record of Borehole Logs (Appendix B) and on Figure No. 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, and 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.

#### **4.1 Culvert Site No. 46-392, Station 20+146.6, West of the Town of Hagar**

A plan and profile showing the borehole locations and stratigraphic sequences is shown on Figure No. 1. During the course of our exploration program, three (3) sampled boreholes (Borehole Nos. 1A, 2, and 3) were put down at this site, with Borehole No. 1A advanced through the existing highway embankment, along the south shoulder. Borehole Nos. 2 and 3 were advanced on the south and north ends of the existing culvert respectively.

At the location of Borehole No. 1A, advanced through the embankment, a layer of granular fill consisting of some 325 mm of crushed gravel was encountered. This stratum was underlain by a fine and medium sand fill with a trace of gravel and varying silt content which was penetrated to a depth of approximately 1.6 m below grade. At this point, fill consisting of predominately rockfill was penetrated between elevations  $\pm$  207.3 to 206.2 m. Below this elevation, a fill deposit consisting of silty clay and sand mixed with some rockfill was penetrated down to approximately 203.9 m (5 m depth). At this elevation, a dark grey to grey silty clay mixed with sands and a trace of gravel was penetrated to approximately elevation 202.6 m (see Grain Size Analysis, Figure L-1). This latter deposit could comprise of the natural silty clay stratum, intermixed with imported granular materials used as bedding. At approximately elevation 202.6 m, a grey fine and medium sand with some silt was penetrated down to approximately an 8.2 m depth (elevation 200.7 m). Based on the resistance to sampling, this sand deposit has a compactness of very loose. Underlying the natural sand deposits, a stratum of grey silty clay with fine seams of silty sand (generally some  $\pm$  50 mm thick) was penetrated down to elevation 196.4 m. This silty clay deposit was of a firm consistency with in-situ shear strength values



measured at 36 to 40 kPa. An atterberg limits test carried out on the silty clay portion returned a liquid limit of 37.2%, a plastic limit of 20.6%, and a natural moisture content of 41.4%. The silty clay deposit plots above the A line and is described as a plastic clay. Typical particle size analysis of this deposit is shown on Figure L-2, Appendix C. Below a depth of some 12.5 m (elevation 196.4 m), a grey gravelly sand with some silt was encountered. Based on the SPT value of 8 blows per 300 mm penetration, the compactness of this deposit is described as loose. A particle size analysis test was carried out on this deposit and indicated 36% gravel size particles, 49% sand size particles, 9% silt size particles, and 6% clay size particles (see Figure L-4, Appendix C). Sampling at the borehole was discontinued at a depth of some 14.2 m below grade and a DCPT was advanced from the bottom of the borehole. The DCPT met refusal at a short distance below the end of sampling (ie. 14.7 m below grade).

At Borehole Nos. 2 and 3, advanced at the south and north end of the culverts respectively, a thin surficial layer of black silty clay/silty sand organics some 75 to 150 mm thick was encountered. This thin surficial layer was underlain by a tan silty clay of firm consistency. This silty clay extended to approximately elevation 204.0 m, where a deposit of grey fine and medium sand with frequent silt rich seams, with a trace of clay, was penetrated. Based on the SPT values, which ranged from weight of hammer (0 blows) to 3 blows per 300 mm penetration and DCPT values which ranged from 5 to 12 blows per 300 mm penetration, the compactness of this sand deposit is described as very loose to compact, generally loose. These sands extended to a depth of some 4.7 m (elevation 200.8 m) at Borehole No. 2 and 5.9 m (elevation 199.5 m) at Borehole No. 3. Typical particle size analysis is shown on Figure L-3, Appendix C.

Underlying these sands a grey silty clay was encountered. At Borehole No. 2, this silty clay deposit exhibited a varved structure with depth and was some 3.7 m in thickness, whereas at Borehole No. 3, the silty clay deposit was only encountered over a depth of some 1.1 m. Based



on in-situ field vane tests, which returned values ranging between 32 to 38 kPa, the consistency of the clay deposit was described as firm. Underlying the clay, a deposit of grey silty sand was penetrated and based on the SPT values the compactness of the deposit is described as compact. At Borehole No. 2, cobbles and boulders were encountered in the lower reaches of the sand deposit (ie. around elevation 195.9 m) with refusal on augers and DCPT encountered at elevation 195.7 m (Borehole No. 2) and 192.8 m (DCPT refusal, Borehole No. 3).

#### **4.2 Groundwater Conditions**

Groundwater levels in the open boreholes were taken during the advance of the individual borings and upon completion. These water levels were recorded on the individual Record of Borehole Log Sheets (Appendix B) and are considered to give an indication of the stabilized groundwater level at the time of the investigation. At Borehole No. 2 (inlet location), the groundwater level was measured at approximately elevation 204.8 m, whereas at Borehole No. 3 (outlet location), the groundwater level was measured at approximately elevation 204.7 m. During advance of the borehole (Borehole No. 1) through the embankment, the groundwater level was measured at approximately elevation 205.0 m during the field drilling operation. These groundwater levels will fluctuate seasonally.

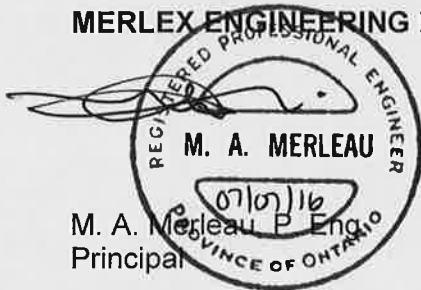
At the time that the foundation field drilling program was carried out, the water level flowing through the culvert was at a depth of approximately 150 mm. As can be seen from the enclosed Photo No. 1, the culvert is dry at various times during the year. It was observed by others that the flow of the creek was "short cutting" through the embankment (presumed rockfill) immediately west of the existing culvert.





Upon completion of the field work, all boreholes were backfilled with the auger cuttings installed generally in the order in which they were removed using reverse augering techniques. If temporary standpipes were installed, they were removed on completion and the void grouted with a bentonite mix.

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\\Dell7bd18c1\DATA\PROJECT FILES\2006\06160 - GI & FDN - Hwy 17, Hagar (ET)\FOUNDATION\Report\Final - Culvert 46-392\06160 - Final FIR, Hwy 17, GWP 372-00-00 - Culvert Site No 46-392.doc

## **APPENDIX A**

Enclosure No. 1: List of Abbreviations and Symbols

Enclosure No. 2: Key Plan



## 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

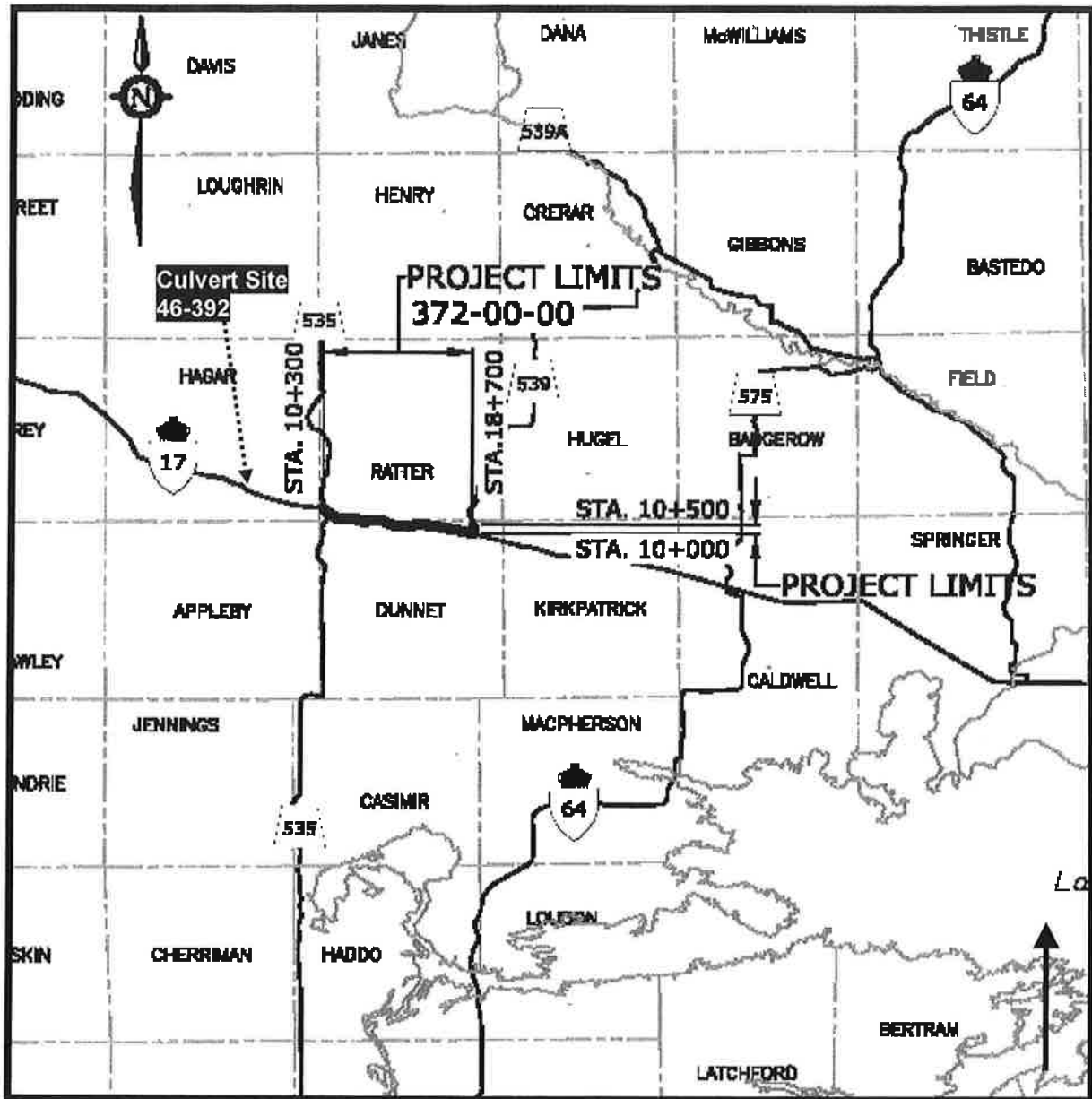


**SAMPLE DESCRIPTION NOTES:**

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.

# KEY PLAN

Enclosure No. 2



Not to Scale

## FINAL FOUNDATION INVESTIGATION AND DESIGN REPORT GWP 372-00-00

Culvert Site No. 46-392 – Twp. of Hagar  
Highway 17, From Highway 535 (Hagar)  
Easterly To Highway 539 (Warren), 8.4 km and  
Highway 539, From Highway 17 Northerly 0.5 km



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MEL Reference No. 06/11/06160

July 2007

## **APPENDIX B**

Enclosure Nos. 3 to 5: Record of Borehole Sheets



# METRIC

## RECORD OF BOREHOLE No. 1A - Culvert 46-392

REFERENCE 06/11/06160 DATUM Geodetic LOCATION 4.2 m West of C/L of Culvert - 5.1 m South of C/L of Road. ORIGINATED BY ELS  
 PROJECT Hwy 17 - Township of Hagar - Site 46-392 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration Test COMPILED BY DVL  
 CLIENT Earth Tech (Canada) DATE (Started/Completed) 12/21/06 - 12/20/06 TIME 9:53:00 AM CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
208.9	Ground Surface													
0.0	±325 mm Crushed Gravel		1a	AS										
	FILL													
	Fine and Medium Sand, Trace of Gravel, Trace to Some Silt with Depth		2a	AS										
207.3	Refusal - See Comment No.1		3a	SS	100/4"									
1.6	FILL													
	Rockfill													
206.2	FILL													
2.7	Silty Clay and Sand With/Some Rockfill (Firm/Soft)		1	SS	11									
			2	SS	14									
203.9	FILL													
5.0	Dark Grey to Grey Silty Clay Mixed with Sand trace of Gravel (Firm)		3	SS	7									
202.6	SANDS		4	SS	WH									
6.3	Grey Fine and Medium Sand some Silt (Very Loose)													
			5	SS	WH									
	Continued Next Page													

COMMENTS  
 1) Initially borehole located 3.0 m West of Culvert C/L, South Shoulder, refusal on DCPT and Auger at 1.6 m depth. Relocated borehole to 4.2 m West of culvert C/L, South Shoulder.

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

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)
1) 12/21/06	3.9	
2)		
3)		



MEL-GEO 06160 - HWY 17 HAGAR 46-392.GPJ MEL-GEO.GDT 7/16/07

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**METRIC****RECORD OF BOREHOLE No. 1A - Culvert 46-392**

REFERENCE 06/11/06160 DATUM Geodetic LOCATION 4.2 m West of C/L of Culvert - 5.1 m South of C/L of Road ORIGINATED BY ELS  
 PROJECT Hwy 17 - Township of Hagar - Site 46-392 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration Test COMPILED BY DVL  
 CLIENT Earth Tech (Canada) DATE (Started/Completed) 12/21/06 - 12/20/06 TIME 9:53:00 AM CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI C...	
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	×						
								● QUICK TRIAXIAL	×	LAB VANE						
	Continued from Previous Page							20 40 60 80 100	20 40 60 80 100	20 40 60 80 100						
200.7 8.2	CLAY															
	Grey Silty Clay with Occasional 50 mm Thick Silty Sand and Sand Layers  (Firm)															
			6	SS	6											
			7	SS	PM											
196.4 12.5	SANDS		8	SS	PM											
	Grey Gravelly Sand, some Silt  (Loose)															

MEL-GEO 06160 - HWY 17 HAGAR 46-392.GPJ MEL-GEO.GDT 7/16/07

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## METRIC

## RECORD OF BOREHOLE No. 2 - Culvert 46-392



REFERENCE 06/11/06160 DATUM Geodetic LOCATION 5.4 m West of C/L of Culvert - 16.5 m South of C/L of Hwy 17 ORIGINATED BY ELS  
 PROJECT Hwy 17 - Township of Hagar - Site 46-392 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration Test COMPILED BY DVL  
 CLIENT Earth Tech (Canada) DATE (Started/Completed) 2/8/07 - 2/8/07 TIME 3:00:00 PM CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)												
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES																				
205.5 0.0	Ground Surface 75 mm Black Silty Sand  CLAY Tan Silty Clay (Grey at ±1.0 m) (Firm)		1	AS								7 75 (18) 2 72 (26)  5 77 (18)													
204.0 1.5	SANDS Grey Fine and Medium Sands with Frequent Silt Trace to With Clay Seams (Very Loose)		3	SS	3																				
			4	SS	3																				
			5	SS	1																				
			6	TO	PM																				
200.8 4.7	CLAY Grey Silty Clay, Varved Structure Apparent at Depth (Firm)		7	SS	1																				
			7A	TO	PM																				
			8	SS	WH																				
			9	SS	WH																				
Continued Next Page																									
COMMENTS 1) DCPT advanced 1.1 m East of Borehole.							+ <sup>3</sup> , × <sup>3</sup> : Numbers on right refer to Sensitivity Numbers on left refer to values greater than 120 kPa ○ 3% STRAIN AT FAILURE	WATER LEVEL RECORDS <table border="1"> <thead> <tr> <th>Date (dd/mm/yy)/Time</th> <th>Water Depth (m)</th> <th>Cave In (m)</th> </tr> </thead> <tbody> <tr> <td>1) 2/9/07</td> <td>0.7</td> <td>-</td> </tr> <tr> <td>2)</td> <td>-</td> <td>-</td> </tr> <tr> <td>3)</td> <td>-</td> <td>-</td> </tr> </tbody> </table>						Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)	1) 2/9/07	0.7	-	2)	-	-	3)	-	-
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In (m)																							
1) 2/9/07	0.7	-																							
2)	-	-																							
3)	-	-																							

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

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MEL-GEO 06160 - HWY 17 HAGAR 46-392.GPJ MEL-GEO.GDT 7/16/07

**METRIC****RECORD OF BOREHOLE No. 2 - Culvert 46-392**

REFERENCE 06/11/06160 DATUM Geodetic LOCATION 5.4 m West of C/L of Culvert - 16.5 m South of C/L of Hwy 17 ORIGINATED BY ELS  
 PROJECT Hwy 17 - Township of Hagar - Site 46-392 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration Test COMPILED BY DVL  
 CLIENT Earth Tech (Canada) DATE (Started/Completed) 2/8/07 - 2/8/07 TIME 3:00:00 PM CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES								
	Continued from Previous Page												
197.1 8.4	SANDS												
	Grey Silty Sands (Compact)												
	Cobbles and Boulders		10	SS	13/275mm 50/25mm								DCPT Refusal
195.7 9.8	Auger Refusal Probably Boulders/Possible Bedrock End of Borehole												

MEL-GEO 06160 - HWY 17 HAGAR 46-392.GPJ MEL-GEO GDT 7/16/07

**MERLEX ENGINEERING LTD.**

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# METRIC

## RECORD OF BOREHOLE No. 3 - Culvert 46-392

REFERENCE 06/11/06160 DATUM Geodetic LOCATION 4.0 m East of C/L of Culvert - 19.2 m North of C/L of Hwy 17 ORIGINATED BY ELS  
 PROJECT Hwy 17 - Township of Hagar - Site 46-392 BOREHOLE TYPE Hollow Stem Augers & Dynamic Cone Penetration Test COMPILED BY DVL  
 CLIENT Earth Tech (Canada) DATE (Started/Completed) 2/9/07 - 2/9/07 TIME 1:40:00 PM CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40					
205.4	Ground Surface													
0.0	150 mm Black Silty Clay with Organics		1	AS										
	CLAY													
	Tan Silty Clay (Firm)		2	SS	4									
204.0														
1.4	SANDS		3	SS	2									3 76 (21)
	Grey Fine and Medium Sands with Occasional Silty Seams (Very Loose)		4	SS	WH									1 89 (10)
			5	SS	WH									
			6	SS	WH									
199.5														
5.9	CLAY		7	TO	PM									
	Grey Silty Clay (Firm)													
198.4														
7.0	SANDS		8	SS	29									
	Grey Silty Sand (Compact)													
Continued Next Page														
COMMENTS							+ 3, X 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) 2/9/07 0.7 1.5 1.5 2) - 1.5 1.5 3) - 1.5 1.5							

MEL-GEO 06160 - HWY 17 HAGAR 46-392.GPJ MEL-GEO.GDT 7/16/07

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

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ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			20	40					
	Continued from Previous Page													
	SANDS Grey Sands, some Silty to Silty (Compact)													
195.7 9.7	Auger Refusal End of Sampling  Probably Sands with Cobbles/Boulders		9	SS	26									
192.6 12.8	End of DCPT End of Borehole													

MEL-GEO 06160 - HWY 17 HAGAR 46-392.GPJ MEL-GEO.GDT 7/16/07

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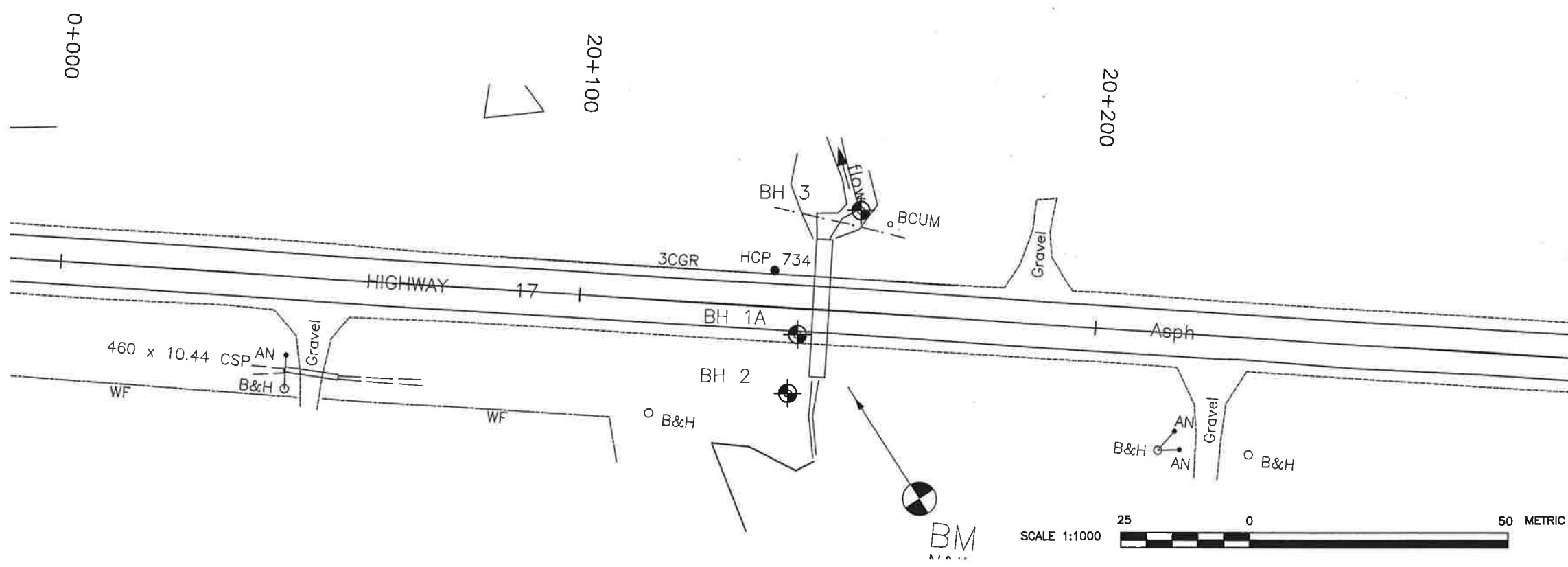
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## **APPENDIX C**

Figure 1: Borehole Locations and Soil Strata Plan

Figures L-1 to L-4: Summary Grain Size Analysis Graph

Figure L-5: Atterberg Limits



**CONT No** 0

**WP No** 372-00-00

**Geocres No.:** 411-209

HWY 17 Twp. Hagar

Culvert Site No. 46-392

Section 20+146.6

**BOREHOLE LOCATIONS & SOIL STRATA**

**Figure**

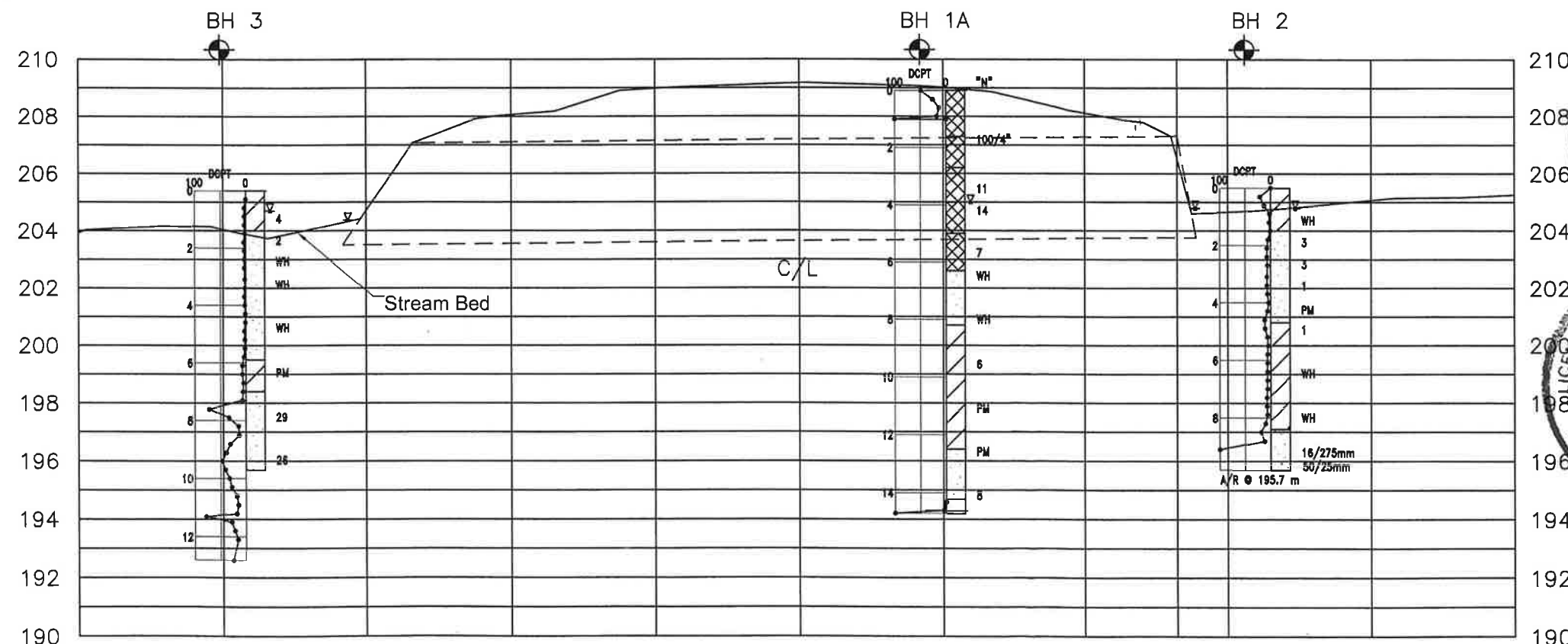
1

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Consulting Geotechnical Engineers

**STRATIGRAPHY LEGEND**

<div style="display: flex; flex-direction: column; gap: 5px;"> <div></div> TOPSOIL           <div></div> PEAT           <div></div> VARVED/ INTERLAYERED CLAYS &amp; SILTS           <div></div> FILL           <div></div> ASPHALT COATED         </div>	<div style="display: flex; flex-direction: column; gap: 5px;"> <div></div> SAND           <div></div> SAND &amp; GRAVEL           <div></div> CLAY           <div></div> TILL           <div></div> ORGANIC SILTS         </div>	<div style="display: flex; flex-direction: column; gap: 5px;"> <div></div> SILTY SAND/ SANDY SILT           <div></div> SILT           <div></div> SILTY CLAY           <div></div> CRUSHED GRAVEL         </div>
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CULVERT SECTION AT 20+146.6

**LEGEND**

- Borehole and Dynamic Cone Penetration Test
- Borehole
- Dynamic Cone Penetration Test
- Blows/0.3 m (Std Pen Test, 475 J/blow)
- Blows/0.3 m (60° Cone, 475 J/blow)
- Water Level at Time of Investigation
- Auger Refusal at Elevation

Borehole No.	Co-ordinates		Elevation
	Station	Offset	
Borehole No.1A	20+143.5	5.0 m Rt	208.9
Borehole No.2	20+142	16.0 m Rt	205.5
Borehole No.3	20+151	19.0 m Lt	205.4

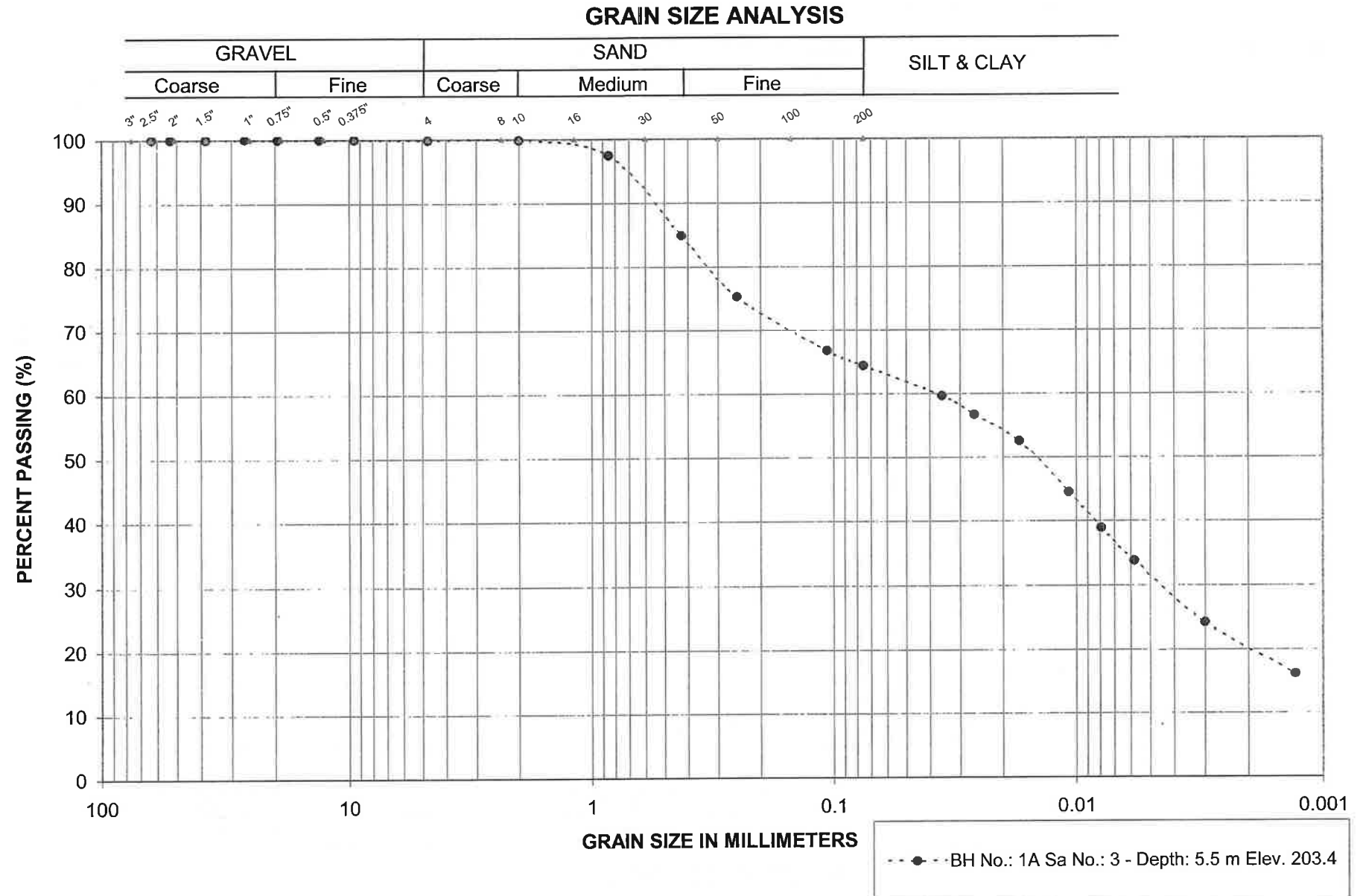
**NOTE 1:**  
The boundaries between soil strata have been established at the borehole locations only. The boundaries between boreholes are assumed based on borehole data.

DATE	BY	REV	DESCRIPTION
00/00/03	DVL	REV 0 -	
00/00/03	DVL	REV 1 -	
00/00/03	DVL	REV 3 -	
00/00/03	DVL	REV 4 -	

HWY No. 17 Culvert 46-392 - MEL Reference No. 06160 DIST			
SUBM'D		DATE 07/05/01	SITE
DRAWN DVL	CHK MAM	DATE 07/04/30	FIG 1



Reference No.: 06160  
Date: May 2007

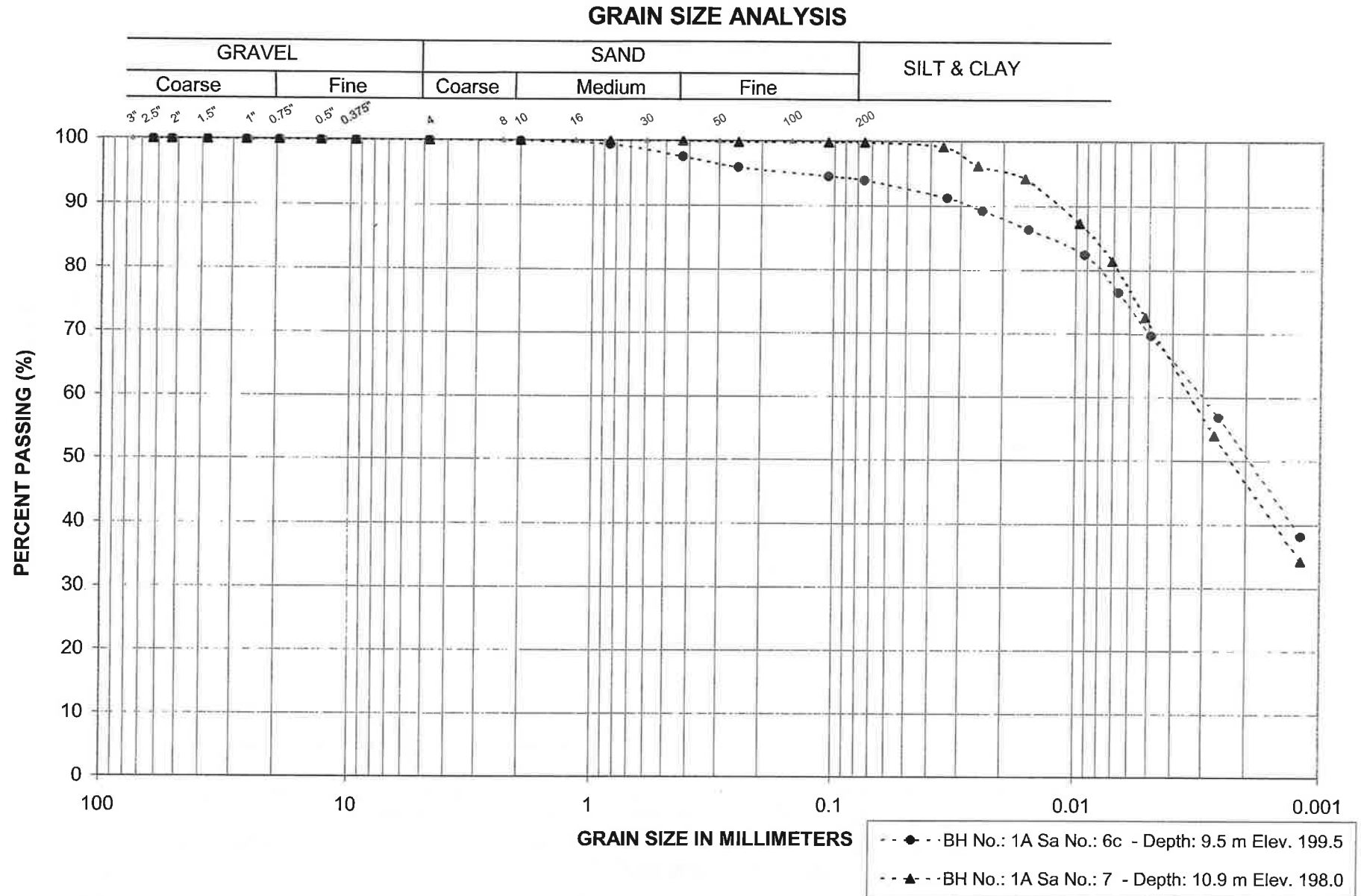


PROJECT: Hwy 17 - Culvert 46-392  
LOCATION: Hagar Twp.

SILTY CLAY FILL  
MERLEX ENGINEERING LTD.

FIGURE L-1

Reference No.: 06160  
Date: May 2007



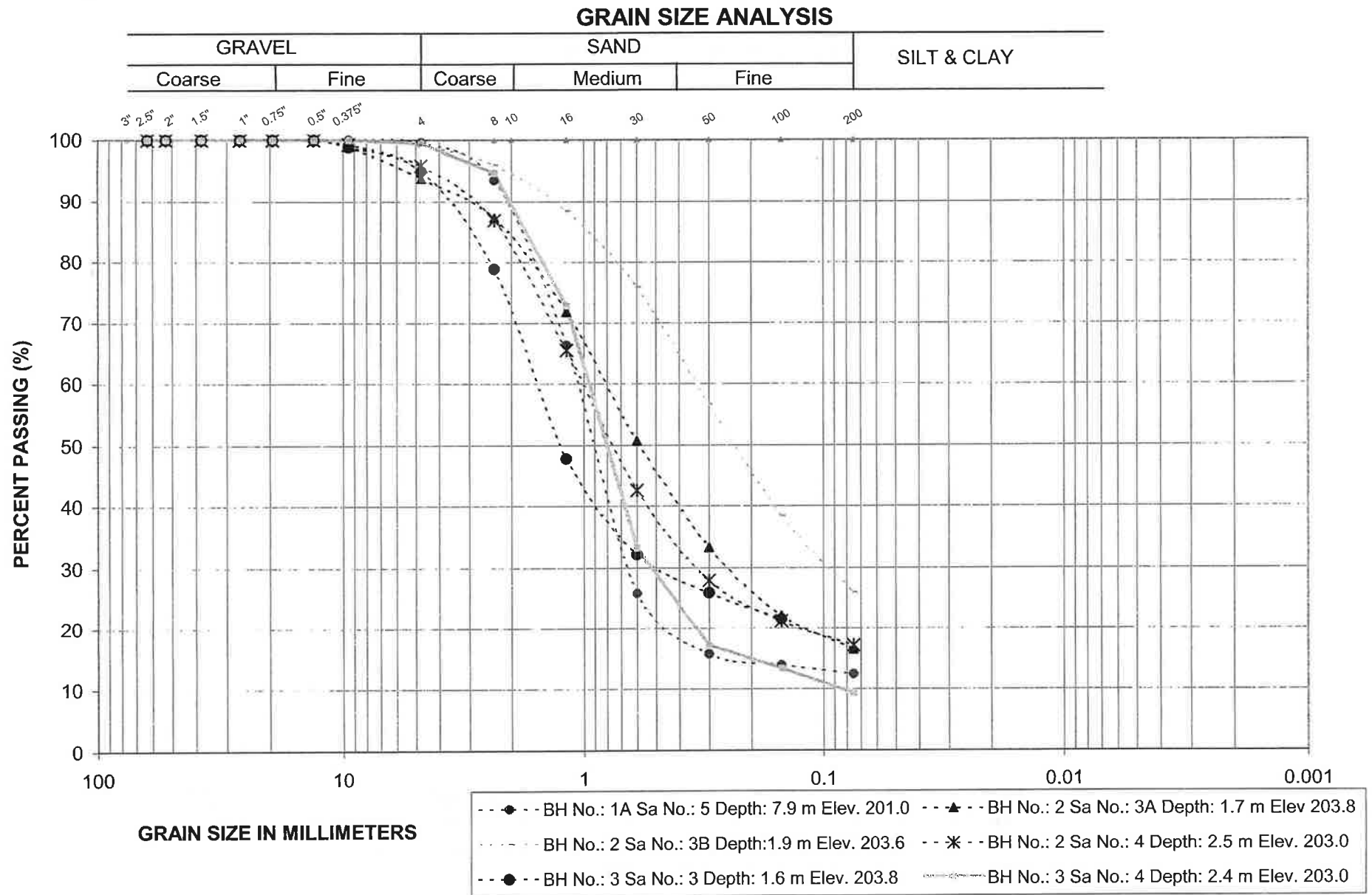
PROJECT: Hwy 17 - Culvert 46-392  
LOCATION: Hagar Twp.

CLAY  
MERLEX ENGINEERING LTD.

FIGURE L-2



Reference No.: 06160  
 Date: May 2007



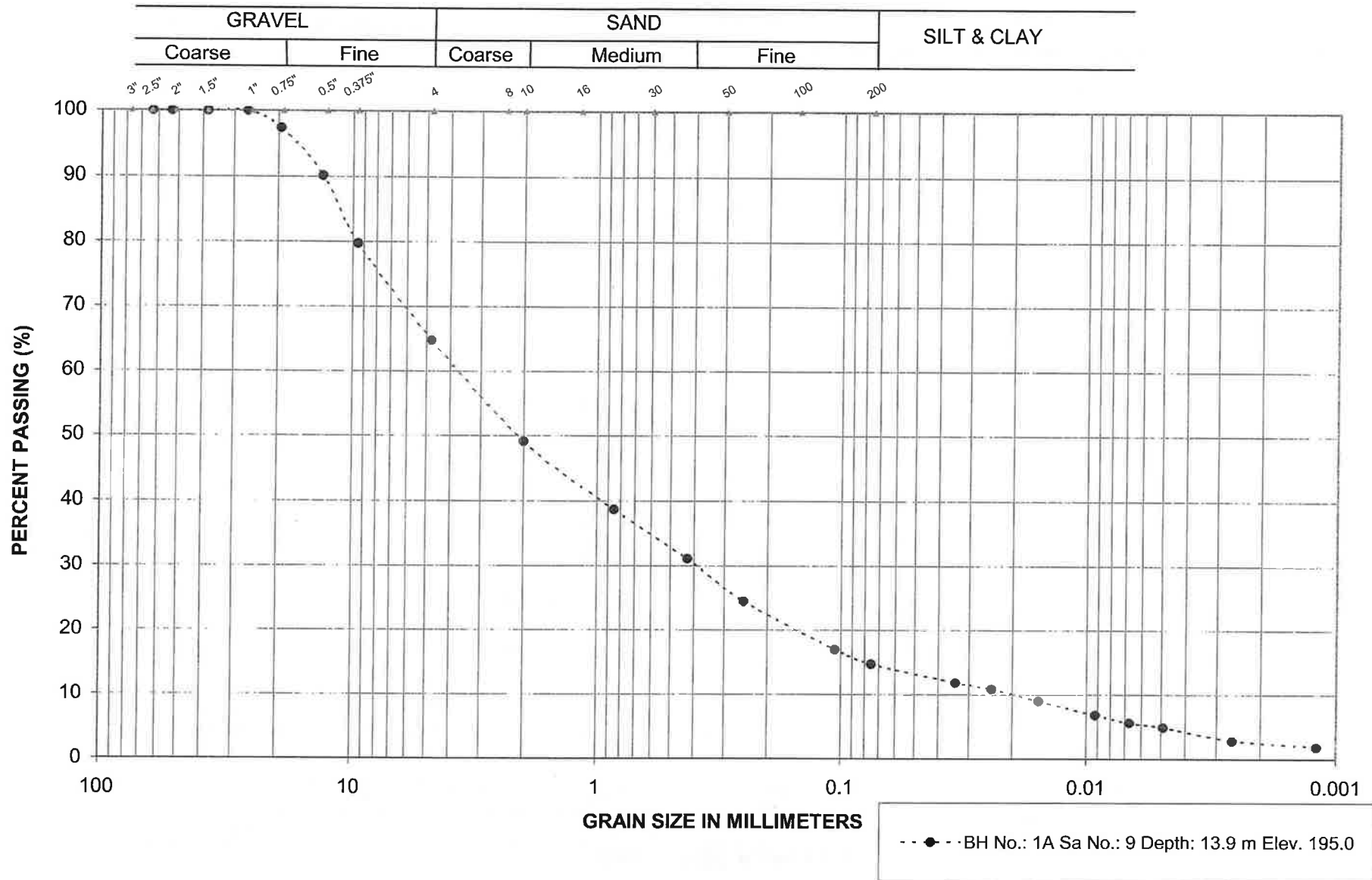
PROJECT: Hwy 17 - Culvert 46-392  
 LOCATION: Hagar Twp.

SANDS some SILT  
 MERLEX ENGINEERING LTD.

FIGURE L-3

Reference No.: 06160  
Date: May 2007

## GRAIN SIZE ANALYSIS



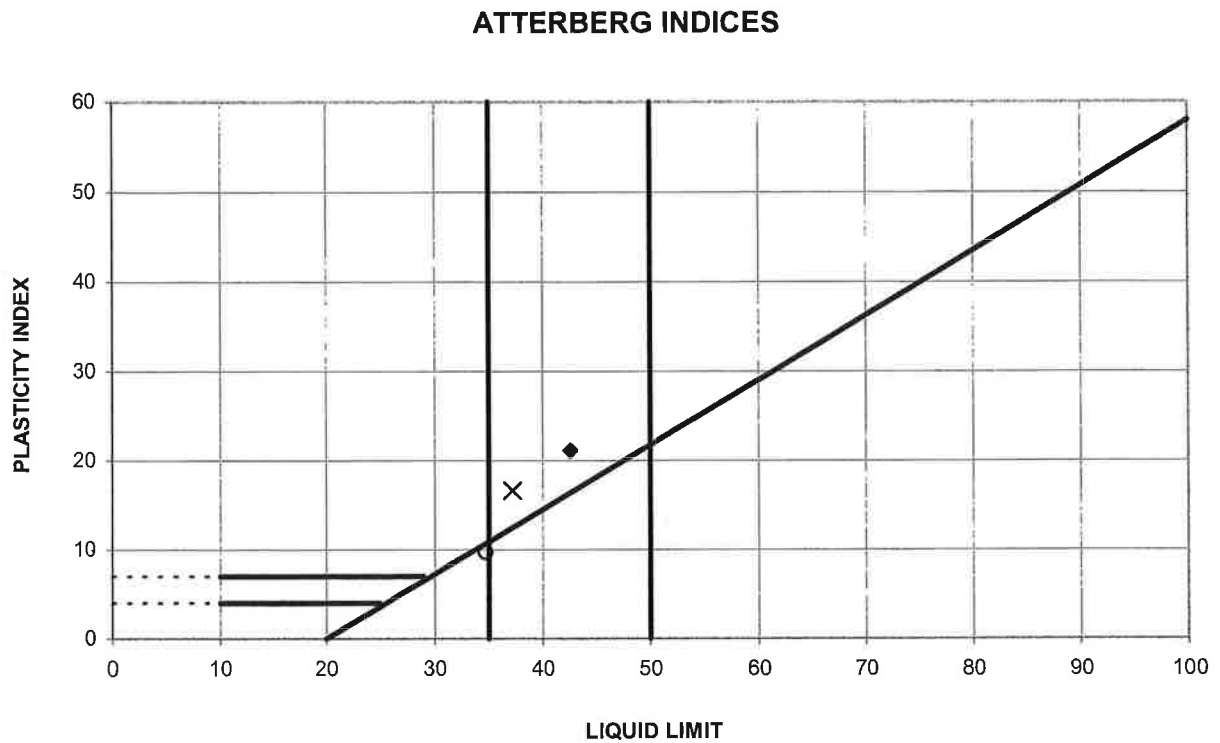
PROJECT: Hwy 17 - Culvert 46-392  
LOCATION: Hagar Twp.

GRAVELLY SANDS  
MERLEX ENGINEERING LTD.

FIGURE L-4

# ATTERBERG LIMITS TEST RESULTS

FIGURE L-5



SYMBOL	BH	Sa. No.	Depth(m)	Elev.(m)	Liquid Limit	Plasticity Index
o	1A	3	5.5	203.4	34.7	9.7
x	1A	7	10.9	198.0	37.2	16.6
◆	2	8	6.4	199.1	42.6	21.1

Date: May-07  
 Project: Hwy 17 - Culvert 46-392

Prep'd: DVL  
 Chkd: MAM

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## **APPENDIX D**

Enclosure No. 6: Photo Essay

Enclosure No. 7: List of OPSS Referenced in Report



Photo: 1 and 2



Left: Photo showing no flow along culvert, north (outlet) end (photo received from MTO on November 23, 2006).  
 Right: Flow through the north end of the culvert was at a depth of some 100 to 150 mm (photo taken on October 26, 2006).

MEL Ref. No.: 06/11/06160

Photo: 3 and 4



Left: Flow through the culvert (inlet) was at a depth of some 100 to 150 mm (photo taken on October 26, 2006).  
 Right: Wetland pond south of inlet (photo taken December 2006).

MEL Ref. No.: 06/11/06160



## Ontario Provincial Standard Specifications (OPSS) Referenced in Report

### Specification

### Title

SP No. 110F13  
(March 2004)

Amendment to OPSS 1010, November 2003  
Aggregates for Granular O, A, B, M, and SSM

OPSS 422  
(April 2004)

Construction Specification For Precast Reinforced  
Concrete Box Culverts and Box Servers in Open Cut

