



FOUNDATION INVESTIGATION REPORT  
RETAINED SOIL SYSTEM (RSS) WALLS AND CULVERT EXTENSION  
HWY 40 AT WOLFE CREEK (SITE 13-391-C),  
TWP OF HARWICH, ONTARIO

ASSIGNMENT #11 – PART B  
MTO WEST REGION CONTRACT #3006-E-0083  
GWP 52-00-00

GEOCRES No. 40J8-50

Submitted to:

**Ministry of Transportation**  
West Region  
3rd Floor Geotechnical Section  
659 Exeter Road, 1st Floor Lobby  
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April 2009  
TB7210011-B

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## 1.0 INTRODUCTION

AMEC Earth & Environmental, a division of AMEC Americas Limited (AMEC), Consulting Geotechnical, Construction Quality Control and Environmental Engineers, was retained by the Ministry of Transportation (Western Region) to conduct a foundation investigation for the design of a Retained Soil System (RSS) and culvert extension on Highway 40 at Wolfe Creek (Site 13-391-C), Harwich Township, Ontario. The project site is located approximately 2 km southeast of Chatham. The site location is shown on Figure 1 in Appendix A.

Authorization to proceed with this investigation was given by Mr. Robert Mount, Project Soils Engineer for the West Region, MTO, dated February 8, 2009. The work was carried out by AMEC according to the MTO Western Region Terms of Reference Agreement #3006-E-0083 Assignment #11; Hwy 40 RSS Walls and Culvert Extensions, Foundation Engineering. Four (4) boreholes were specified by the MTO in the vicinity of the existing culvert.

Subsurface information from previous projects that were available was reviewed prior to carrying out the fieldwork for this project. The following information was reviewed at the MTO Foundation Library (GEOCRES), in Downsview, and used in preparing this report wherever applicable.

- ***“Soil Site Investigation – Proposed Underpass, County Road, Chatham to Charing Crossing, Hwy 401, W.P. 56-59, District #1 - Harwich & Raleigh”***, Prepared by E.M. Peto Associates Limited, Dated December 1959.  
(GEOCRES Report #59-F-201C)
- ***“Soil Investigation – English Sideroad Bridge, McGregor’s Creek, Lot 5, Con 3 & 4”***  
Prepared by E.M. Peto Associates Limited, Dated March 1964.  
(GEOCRES Report #64-F-251M)

This investigation was carried out by means of a limited number of boreholes, in-situ tests and laboratory tests on selected samples. The factual results of the soil conditions encountered in the boreholes and laboratory tests are presented in this report."

## 2.0 SITE DESCRIPTION

The area surrounding the project site can best be described as agricultural. The adjacent lands consist of fields used for farming purposes. Typical site photographs of the culvert location can be found in Appendix B.

The project site is located adjacent to the existing concrete culvert at Wolfe Creek (Station 15+130) which is located approximately 2 km southeast of Chatham, in Harwich Township.

Based on the field investigation, the structure crosses under Hwy 40 and is a concrete box culvert with dimensions for width, height and length of 4.90 x 3.40 x 25.73m. The road at this location is a two lane asphalt paved road and runs on top of an embankment built up above the surrounding grade. The culvert lies across Hwy 40 near the base of the embankment. The embankment slopes were covered with snow overlying tall grasses and other low vegetation at the time of the fieldwork. The existing and proposed embankment heights and side slopes were provided by the MTO in the following table.

Side	Existing Height (m)	Existing Slope	Proposed Height (m)	Proposed Slope
East	± 2.5	~ 2.7:1	3.2	3:1
West	1.2 2	8.8:1 1.8:1	4.2	3:1

The proposed works include a 4.5m extension to the outlet (west side) and a 3.0m extension to the inlet (east side).

During field investigations, the direction of flow was observed to be east to west. The water level appeared to lie approximately 0.1m above the base of the creek.

### 3.0 GEOLOGY

The Physiography of Southern Ontario by Chapman and Putnam (1984) indicates that the project site in Harwich Township lies within the St. Clair Clay Plains. Covered by glacial Lake Whittlesey and Lake Warren, much of the area around Chatham is covered by deep stratified beds of sediment underlain by clay till which is further underlain by black shale. More specifically, the project site is located within the Chatham Flats, where beds of silt appear immediately south and east of the city of Chatham.

A previous foundation investigation (GEOCRETS Report #64-F-251M) for a bridge located approximately 3 km northeast of Wolfe Creek, indicate the following subsurface soils: fills and organic soils to approximately 4.5m, overlying very stiff to hard grey clayey silt till, with varying layers of silt and sand throughout.

### 4.0 INVESTIGATION PROCEDURES

#### 4.1 Field Investigation

In accordance with the Terms of Reference for this investigation, four borehole locations (BH 1 to BH 4) were staked and cleared.

Borehole 1 was put down at the edge of a farmers field on the east side of Hwy 40 adjacent to the south east culvert end. Borehole 2 was also put down at the edge of a farmers field on the east side of Hwy 40 adjacent to the north east culvert end. Borehole 3 was drilled at the road shoulder on Hwy 40 through the existing road embankment adjacent to the north west culvert end. Borehole 4 was put down at the edge of the farmers field on the west side of Hwy 40, adjacent to the north west culvert end. The boreholes were completed to verify soil conditions below the existing culvert, and to obtain sufficient foundation information needed to construct the proposed retaining walls and culvert extensions. Boreholes 1, 2, 3 and 4 extended to depths of 6.9, 7.6, 9.8 and 6.9 m, respectively.

Borehole locations were adjusted as required based on the proximity of overhead utilities, as well as drill rig access to steep slopes, ditches and swampy areas. The borehole locations are presented in Figure 1 in Appendix A.

The fieldwork was performed on February 24<sup>th</sup> and 25<sup>th</sup>, 2009 under the full-time supervision of experienced geotechnical personnel from AMEC. Prior to drilling, utility locates were carried out. Drilling operations were performed using a track-mounted drilling rig, outfitted with hollow-stem augers.

Ground surface elevations at the borehole locations were also surveyed by AMEC personnel. The elevations were related to a geodetic benchmark (BM) which is "the top of the centre of the culvert at Wolfe Creek, at the east end". The BM has an elevation of 180.575m, which was provided by the MTO.

Soil samples were taken at 0.75m intervals during the performance of Standard Penetration Test (SPT) in accordance with ASTM D1586. This consisted of freely dropping a 63.5kg hammer for a vertical distance of 0.76m to drive a 51mm diameter O.D. split-barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30m was recorded as SPT 'N' value of the soil which indicated the consistency of cohesive soils or the relative density of non-cohesive soils. Where appropriate, other in-situ measurements were performed (e.g. field vane, dynamic cone penetration).

Combustible soil headspace vapour readings were measured for each soil sample recovered from the boreholes, using a portable vapour meter (GasTechtor™ 1238ME).

The groundwater levels were monitored during, and upon completion of the drilling operations. Upon completion of drilling, Boreholes BH 2, 3 and 4 were backfilled with bentonite in accordance with the general requirements of Ont. Regulation 903. In accordance with the Terms of Reference, a standpipe piezometer was installed in Borehole BH 1. The piezometer was constructed to a depth of 5.2m by placing 3.0m of screen with sandpack, then a solid riser with sandpack up to ground surface, as indicated on the borehole log. The standpipe piezometer construction was intended to detect any groundwater within the borehole. The

standpipe was decommissioned the day following installation. Therefore no casing or bentonite seal were installed.

The results of the in-situ and laboratory tests are presented in the corresponding Records of Boreholes (Appendix A) and Laboratory Test Results (Appendix C).

AMEC will retain the soil samples for a period of one year after completion of the Project, unless otherwise advised in writing by the Ministry.

## **4.2 Laboratory Tests**

In accordance with the Terms of Reference for this investigation, the following tests were conducted:

- In-situ water content determination (27);
- Grain size distribution analysis (8);
- Atterberg Limits (4);
- Soil Corrosivity Testing: pH, sulphate, chlorides, electrical conductivity, resistivity and Redox potential (4);
- Groundwater testing: sulphides, sulphates, chlorides and pH (2).

The results of the routine laboratory tests are included in the Record of Boreholes in Appendix A. The Grain Size Distribution curves and Plasticity Chart are shown in Appendix C.

## **4.3 Miscellaneous**

The boreholes were drilled by Determination Drilling and Soil Investigation Holdings Ltd, who are licensed well drillers. They were also responsible for decommissioning the standpipe piezometer. The drilling operations were supervised by Laura Wiebe, E.I.T. of AMEC.

Upon completion of drilling, the soil samples were transported to AMEC's Laboratory in Hamilton for further examination and routine laboratory testing. Testing to determine the corrosivity of the soils and groundwater to various materials was subcontracted to AGAT Laboratories, an accredited CAEL laboratory.

## **5.0 SUB-SURFACE CONDITIONS**

The general soil profile consisted of sand, silt and silty clay fill, underlain by a shallow deposit of silt or sand. The base soils consisted of silty clay to clayey silt till with some sand layering. Topsoil comprised the surficial material at three borehole locations, whereas the surficial material through the road embankment consisted of granular road base fill.

The stratigraphic units and groundwater conditions at the borehole locations are discussed in

the following sections. Detailed information is provided in the Record of Boreholes (Appendix A).

The following summary is to assist the designers of the project with an understanding of the anticipated soil conditions across the site. However, it should be noted that the soil and groundwater conditions may vary between the borehole locations.

## 5.1 Stratigraphy

### Surficial Materials / Fill

From ground surface in Boreholes 1, 2 and 4, sandy silt topsoil extended to a depth of between 0.3 and 0.9m. In Borehole 3, granular road base was encountered to a depth of 0.8m.

Underlying surficial materials in Boreholes 1, 3 and 4, fill was encountered to depths of between 1.4 and 2.1m. The fill comprised silty sand, sandy silt, sand and gravel, and silty clay.

The fill was loose to compact and stiff, with 'N' values ranging from 4 to 21 blows for 30cm. Moisture contents ranged from 11 to 27%.

### Silt / Sand

Underlying the surficial materials and / or fill, a shallow layer of silt or sand was encountered in each borehole, extending to between 1.6 and 2.9m below existing grade.

The silt / sand were very loose to compact, with 'N' values ranging from 1 to 18 blows for 30cm. The soils were moist to saturated and moisture contents ranged from 23 to 24%.

### Silty Clay Till / Clayey Silt Till with Sand Layers

Underlying the silt / sand in each Borehole, silty clay till to clayey silt till was encountered. This deposit is interlayered with moist to saturated sand seams. Boreholes 1, 2 and 3 were terminated within the till, while Borehole 4 was terminated within a sand layer.

Based on grain size/hydrometer analyses carried out and the MTO Classification system, the material category ranged coarse-grained soils more than 50% retained on 0.075 mm (No. 200) sieve to fine grained soils 50% or more passes 0.075 mm (No. 200) sieve illustrated in the Table below.

**Summary of Index Testing**

	%				Atterberg Limits	Classification
	>4.75mm	75µm to 4.75mm	2µm to 75µm	<2µm		
<b>BH1-SS4</b>	4	19	45	32	-	Clayey Silt some Sand Trace of Gravel
<b>BH1-SS5</b>	1	52	27	20	LL= 16, PL= 12, PI= 4	CL-ML Clay-Silt of Low Plasticity
<b>BH2-SS4</b>	1	11	28	60	LL= 37, PL= 21, PI= 16	CI Clay of Medium Plasticity

	%				Atterberg Limits	Classification
	>4.75mm	75µm to 4.75mm	2µm to 75µm	<2µm		
<b>BH2-SS6</b>	2	15	35	48	-	Silty Clay, some Sand Trace of Gravel
<b>BH3-SS4</b>	4	12	27	57	-	Clay with Silt some Sand Trace of Gravel
<b>BH3-SS7</b>	3	25	41	31	LL= 26, PL= 16, PI= 10	CL Clay of Low Plasticity
<b>BH4-SS3</b>	6	33	34	26	-	Silt & Sand with Clay, Trace of Gravel
<b>BH4-SS4</b>	2	29	39	30	LL= 25, PL= 16, PI= 9	CL Clay of Low Plasticity

The SPT 'N' values of the silty clay till to clayey silt till varied from 4 blows for 30cm to 50 blows for 13cm. One field vane test carried out at a depth of 2.8m in Borehole 2 resulted in an undrained shear strength of 43kPa. Natural moisture contents ranged from 9 to 32%.

Through the sand layers, 'N' values ranged from 51 to 60 blows for 30 cm. Below a depth of 6.6m in Borehole 4, the sand was saturated and caving. Dynamic Cone Penetration was subsequently carried out to advance the borehole to a depth of 6.9m. Dynamic Cone test results of 84 and 150 blows for 15cm were recorded. Also, caving was occurring from the sand layers encountered in Boreholes 1 and 2. Natural moisture contents through the sand layers ranged from 13 to 17%.

Split spoon #1 (0.8 to 1.2m) from Borehole BH 1, SS#3 (1.5 to 2.0 m) from BH 2, SS#3 (2.3 to 2.7 m) from BH 3 and SS#1 (0.8 to 1.2 m) from BH 4 were submitted for testing to determine the corrosivity of the soils to various materials. The laboratory test certificates can be found in Appendix C, and are summarized below.

Soil Characteristic	Test Results for Soil			
	BH1-SS1	BH2-SS3	BH3-SS3	BH4-SS1
Sulphide	0.19	0.11	0.02	<0.01
Sulphate	445 µg/g	98.2 µg/g	83.8 µg/g	11.5 µg/g
Chloride	13.0 µg/g	56.6 µg/g	33.8 µg/g	6.6 µg/g
pH	7.87	8.04	8.09	7.91
Electrical Conductivity	0.618 mS/cm	0.400 mS/cm	0.793 mS/cm	0.173 mS/cm
Resistivity	1620 ohms-cm	2500 ohms-cm	1260 ohms-cm	5780 ohms-cm
Redox potential	290 mV	274 mV	279 mV	276 mV

## 5.2 Groundwater

Groundwater conditions in the boreholes were observed during drilling and upon completion of drilling. Boreholes 2 through 4 were caved at depths of between 4.6 and 6.0m below ground surface, upon completion.

A piezometer was installed in Borehole BH 1, and the water level was measured the following day at 1.8m (elev. 178.8m). After water level measurements and sampling, the piezometer was decommissioned, in accordance with Ministry of Environment Regulation 903.



Two groundwater samples from Borehole 1 were submitted for testing to determine the corrosivity of the groundwater to various materials. The laboratory test certificates can be found in Appendix B, and are summarized below.

Groundwater Parameters	Test Results for Water	
	BH1A	BH1B
Sulphide (mg/L)	-	<0.1
Sulphate (mg/L)	134	-
Chloride (mg/L)	36.5	-
pH	7.93	-

### 5.3 Organic Vapour Measurements

No staining or petroleum odours were noted in the boreholes. Combustible soil headspace vapour readings were measured using a portable vapour meter (GasTector™ 1238ME), calibrated to hexane and operated in methane exclusion mode. Combustible soil vapour headspace measurements for all of the soil samples recovered from the Boreholes BH 1, 2, 3 and BH 4 ranged from non-detectable to 100 parts per million ("ppm").

## 6.0 CLOSURE

The sub-soil information and recommendations contained in this report should be used solely for the purpose of foundation assessment of this site.

The Limitations of Report, as quoted on the following page, is an integral part of this report.

The information presented in this report is complete within MTO terms of reference. If there are any further questions concerning this report, please do not hesitate to contact the undersigned.

Sincerely,

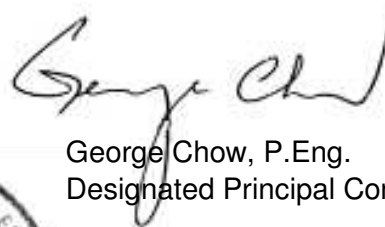
**AMEC Earth & Environmental,  
A division of AMEC Americas Limited**



Laura Wiebe, B.Eng.  
Geotechnical EIT



Jane Doucette, P.Eng.  
Associate Geotechnical Engineer



George Chow, P.Eng.  
Designated Principal Contact



## **LIMITATIONS OF REPORT**

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the testholes.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report relating to potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

The benchmark and elevations mentioned in this report were obtained strictly for use by this office in the geotechnical design of the project. They should not be used by any other party for any other purpose.

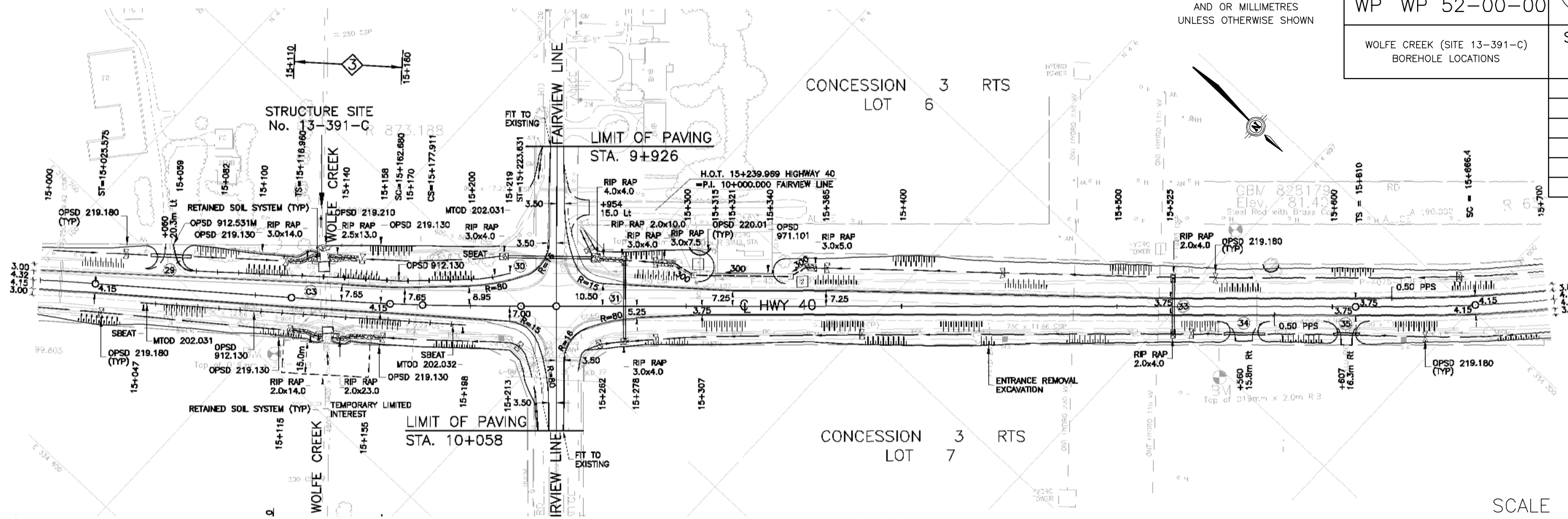
## APPENDIX FIGURES

METRIC  
DIMENSIONS ARE IN METRES  
AND OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

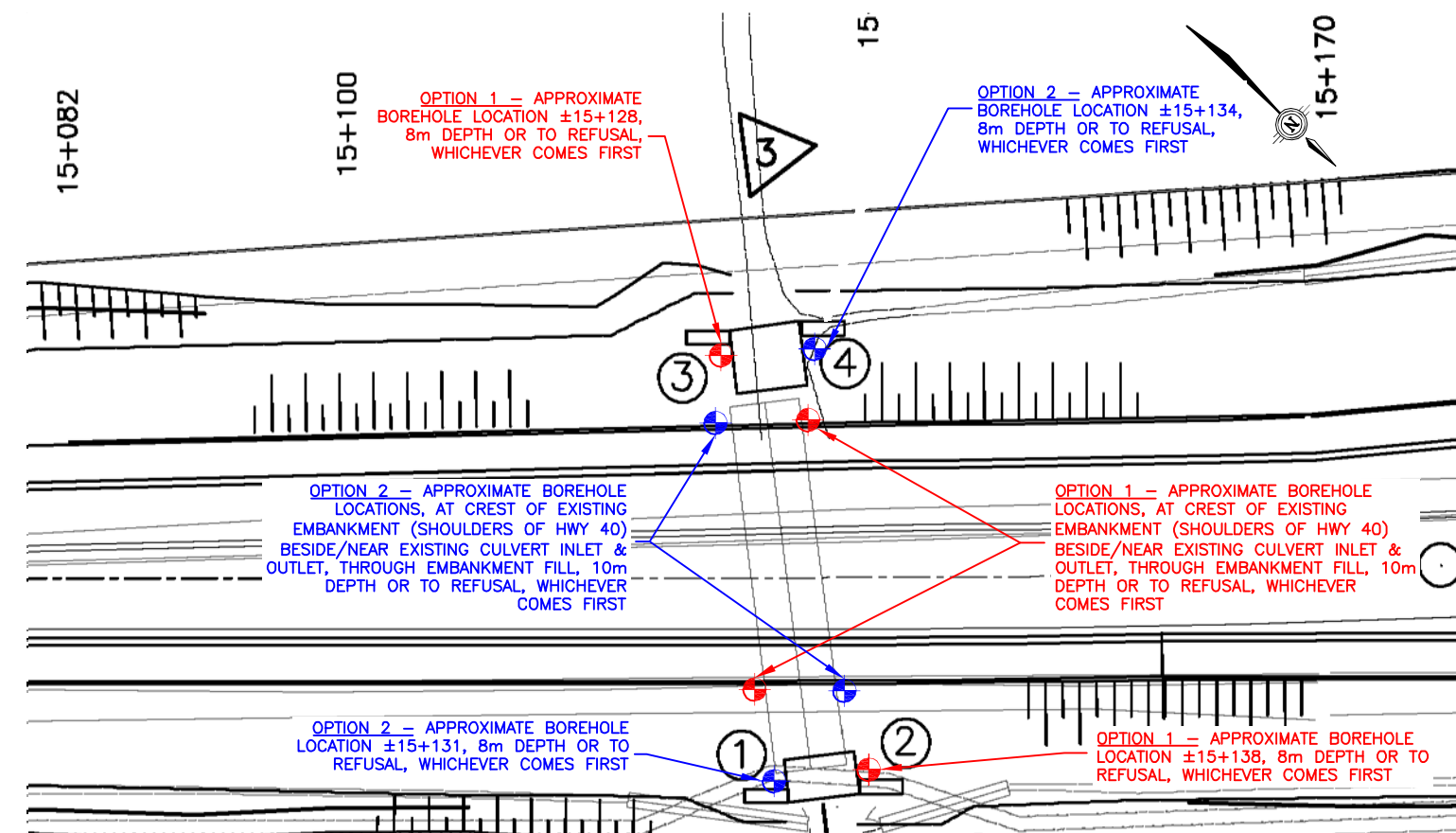
CONT  
WP WP 52-00-00

WOLFE CREEK (SITE 13-391-C)  
BOREHOLE LOCATIONS

SHEET  
1



SITE LOCATION — SCALE 1:2000m



NOTE: BOREHOLES MAY EITHER BE  
AT OPTION 1 OR OPTION 2,  
WHICHEVER LOCATION IS EASIER TO  
ACCESS.

BOREHOLE LOCATIONS — SCALE 1:500m

**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

AGREEMENT No. **3006-E-0083**  
GWP No. **52-00-00**



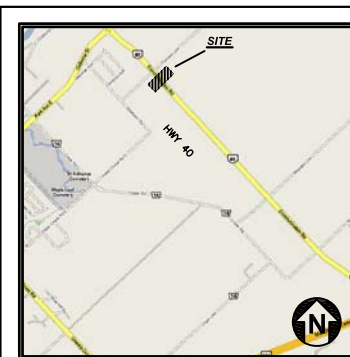
**Geocres No. 40J8-50**

FOUNDATION INVESTIGATION  
PROPOSED RETAINING WALL STRUCTURE  
HWY 40 - WOLFE CREEK  
CHATHAM, ONTARIO  
ASSIGNMENT 11

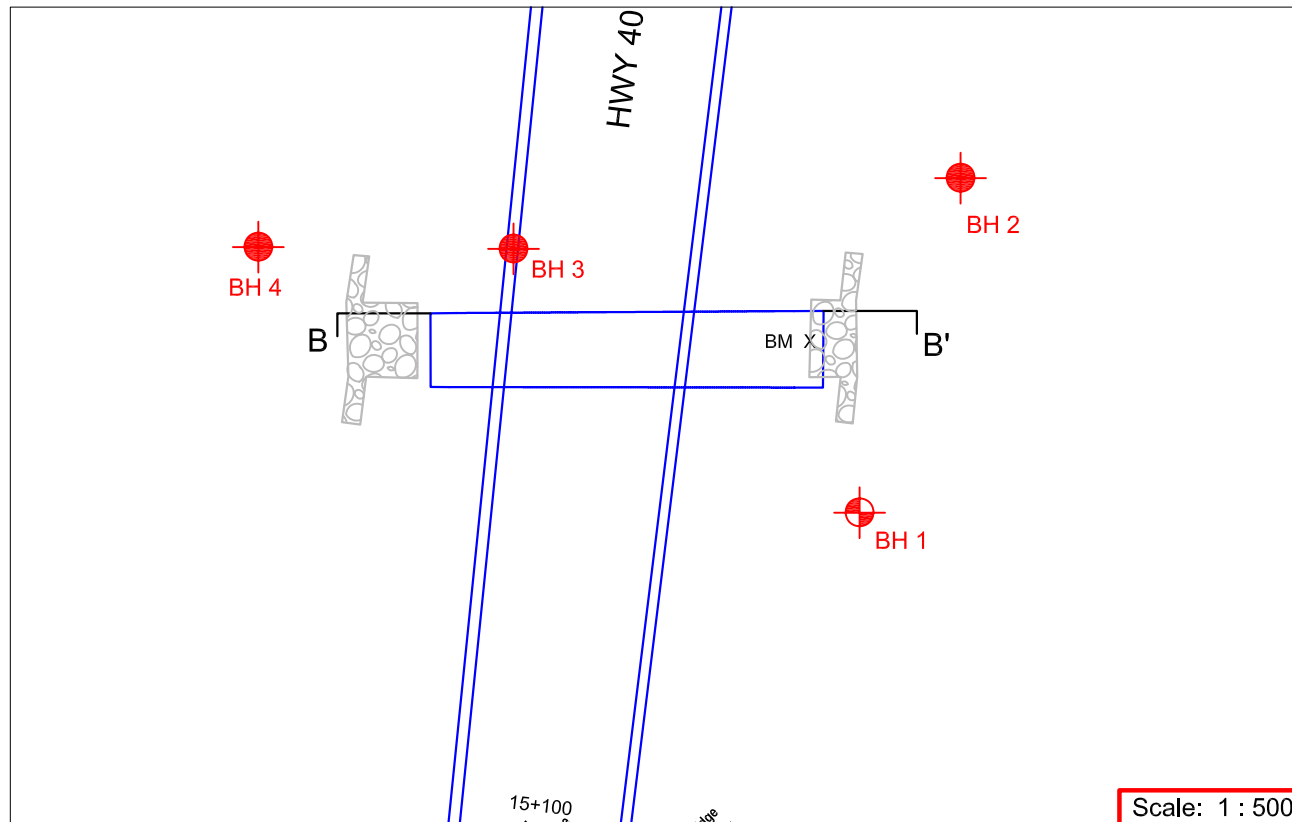
**TB7210011-B**  
**FIGURE**  
**1**

Dwg. Title:  
Borehole Location Plan / Cross Section B-B'

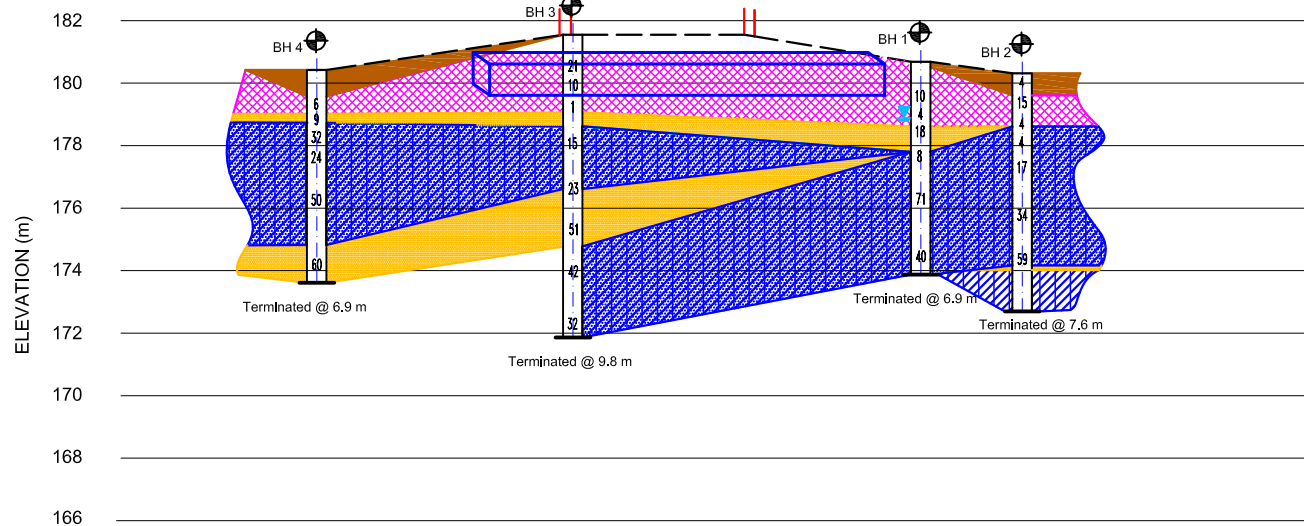
**amec** AMEC Earth & Environmental,  
a Division of AMEC Americas Limited



KEY PLAN



Scale: 1 : 500



PROFILE

Scale: Horizontal 1 : 500  
Vertical 1 : 250

LEGEND

- BOREHOLE
- BOREHOLE (Equipped with Piezometer)
- WATER LEVEL
- Existing Culvert
- Existing Roadway
- Proposed Culvert/Retaining Structure
- SPT 'N'

BOREHOLE	LOCATION		COORDINATE (NAD 83)		ELEVATION (m)
	STATION	OFFSET	NORTHING	EASTING	
BH1	15 + 120	18 m RT of CL	4697210.4	334682.3	180.632
BH2	15 + 150	21.8 m RT of CL	4697236.2	334666.0	180.317
BH3	15 + 140	6.5 m LT of CL	4697210.4	334650.7	181.445
BH4	15 + 138	22 m LT of CL	4697199.1	334639.9	180.422

NOTES:

- The boundaries between soil strata have been established only at borehole locations. Between boreholes, the boundaries are assumed from geological evidence and may be subject to considerable error.
- All elevations shown are referred to a geodetic benchmark of 180.575 m which was provided to AMEC by the MTO.  
(BM - top of culvert on east side of Hwy 40)  
Coordinates shown have also been provided by the MTO and are referenced to the NAD83 MTM Zone 11 coordinate system.
- 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.

SOIL STRATIGRAPHY

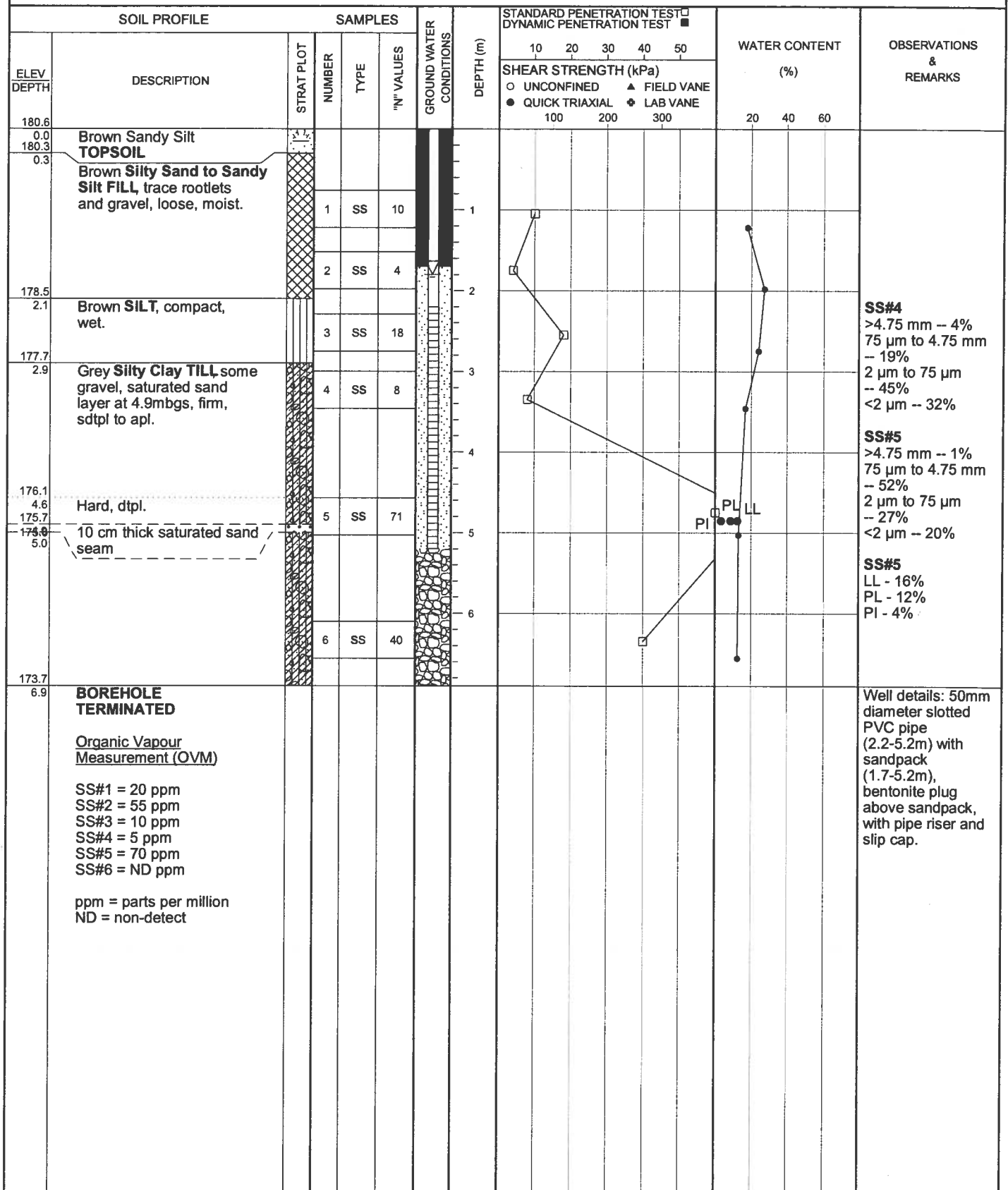
- Sand (Possible Fill)
- Sand / Silt and Sand
- Silt/Silty Clay Till
- Topsoil

## APPENDIX A

# RECORD OF BOREHOLE No 1

1 OF 1

PROJECT Hwy 40 at Wolfe Creek RSS Wall LOCATION Wolfe Creek, east of Hwy 40. ORIGINATED BY LW  
 CLIENT MTO Western Region Sta(15+120); o/s 18.0m Rt of Hwy 40 CL COMPILED BY LW/JW  
 JOB NO. TB7210011 DATE 25 February 2009 CHECKED BY JD





## 1 OF 1

PROJECT Hwy 40 at Wolfe Creek RSS Wall

LOCATION Wolfe Creek, east of Hwy 40.

ORIGINATED BY LW

CLIENT MTO Western Region

Sta(15+150); o/s 21.8m Rt of Hwy 40 CL

COMPILED BY LW/JW

JOB NO. TB7210011

DATE 25 February 2009

CHECKED BY JD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST □ DYNAMIC PENETRATION TEST ■		WATER CONTENT (%)	OBSERVATIONS & REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
								○ UNCONFINED	▲ FIELD VANE			● QUICK TRIAXIAL	✱ LAB VANE	10	20	30	40	50																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
180.3 0.0	Brown Sandy Silt <b>TOPSOIL</b> , trace rootlets and organics, loose, moist.		1	SS	4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

# RECORD OF BOREHOLE No 3

1 OF 1

PROJECT Hwy 40 at Wolfe Creek RSS Wall LOCATION Wolfe Creek, west of Hwy 40. ORIGINATED BY LW  
 CLIENT MTO Western Region Sta(15+140); o/s 6.5m Lt of Hwy 40 CL COMPILED BY LW/JW  
 JOB NO. TB7210011 DATE 24 February 2009 CHECKED BY JD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST DYNAMIC PENETRATION TEST					WATER CONTENT (%)			OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)								
								10	20	30	40	50	20	40	60	
							UNCONFINED      FIELD VANE QUICK TRIAXIAL      LAB VANE									
181.4 0.0	Granular base FILL															
180.6 0.8	Brown Sand & Gravel FILL, compact, moist.		1	SS	21		1									
180.1 1.3	Grey Silt to Silty Clay FILL, trace sand and gravel, loose and stiff, moist to wet and sdtp.		2	SS	10		2									
179.1 2.4	Grey SILT & SAND trace clay layers, rootlets and shell pieces, very loose, wet.		3	SS	1		3									
178.5 2.9	Grey Silty Clay TILL, trace sand and silt seams, trace rootlets, stiff to very stiff, dtp.		4	SS	15		4								SS#4 >4.75 mm – 4% 75 µm to 4.75 mm – 12% 2 µm to 75 µm – 27% <2 µm – 57%	
176.5 4.9	Grey SAND, some gravel, very dense, moist to wet.		5	SS	23		5									
			6	SS	51		6									
174.3 7.1	Grey Silty Clay TILL, hard, dtp.		7	SS	42		7								SS#7 >4.75 mm – 3% 75 µm to 4.75 mm – 25% 2 µm to 75 µm – 41% <2 µm – 31%	
			8	SS	32		8								SS#7 LL - 26% PL - 16% PI - 10%	
171.6 9.8	BOREHOLE TERMINATED														Borehole caved to 6.0mbgs upon completion.	
	Organic Vapour Measurement (OVM)															
	SS#1 = 35 ppm SS#2 = 25 ppm SS#3 = 40 ppm SS#4 = 35 ppm SS#5 = 5 ppm SS#6 = 5 ppm SS#7 = 5 ppm SS#8 = ND															
	ppm = parts per million ND = non-detect															

**SS#4**  
 >4.75 mm -- 4%  
 75 µm to 4.75 mm -- 12%  
 2 µm to 75 µm -- 27%  
 <2 µm -- 57%

**SS#7**  
 >4.75 mm -- 3%  
 75 µm to 4.75 mm -- 25%  
 2 µm to 75 µm -- 41%  
 <2 µm -- 31%

**SS#7**  
 LL - 26%  
 PL - 16%  
 PI - 10%

Borehole caved to 6.0mbgs upon completion.

# RECORD OF BOREHOLE No 4

1 OF 1

PROJECT Hwy 40 at Wolfe Creek RSS Wall LOCATION Wolfe Creek, west of Hwy 40. ORIGINATED BY LW  
 CLIENT MTO Western Region Sta(15+138); o/s 22.0m Lt of Hwy 40 CL COMPILED BY LW/JW  
 JOB NO. TB7210011 DATE 25 February 2009 CHECKED BY JD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST DYNAMIC PENETRATION TEST					WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			10	20	30	40	50		
180.4 0.0	Brown Sandy Silt <b>TOPSOIL</b>													
179.6 0.9	Brown <b>Sand FILL</b> , trace organics, loose, wet.		1	SS	6		1							
179.1 1.4	Light Brown <b>SAND</b> , trace silt, moist to wet.		2	SS	9		2							
178.8 1.6	Brown to Grey <b>Silty Clay TILL</b> , trace rootlets and silt zones, some gravel, stiff to hard, dtpl. (possible stone at tip of split spoon at 4.5mbgs)		3	SS	32		3							
			4	SS	24		4							
			5	SS	50/13cm		5							
174.9 5.5	Grey <b>SAND</b> , some gravel, dense to very dense, saturated.		6	SS	60		6							
173.6 6.9	Dynamic Cone Penetration Test				84/15cm 150/15cm									
	<b>BOREHOLE TERMINATED</b>													
	Organic Vapour Measurement (OVM)													
	SS#1 = 30 ppm SS#2 = 65 ppm SS#3 = 30 ppm SS#4 = 45 ppm SS#5 = 80 ppm SS#6 = 55 ppm  ppm = parts per million ND = non-detect													

**SS#3**  
 >4.75 mm -- 6%  
 75 µm to 4.75 mm -- 33%  
 2 µm to 75 µm -- 34%  
 <2 µm -- 26%

**SS#4**  
 >4.75 mm -- 2%  
 75 µm to 4.75 mm -- 29%  
 2 µm to 75 µm -- 39%  
 <2 µm -- 30%

**SS#4**  
 LL - 25%  
 PL - 16%  
 PI - 9%

Borehole caved to 5.0mbgs upon completion.

## APPENDIX B

## APPENDIX B - PHOTOGRAPHIC RECORD

**PROJECT NO.** TB7210011

**PROJECT** Retaining Soil System Wall Construction and Culvert Extension at Wolfe Creek Culvert

**LOCATION** Hwy 40, Chatham

**ENCLOSURE** 1



**PHOTOGRAPH**

**1**

### Wolfe Creek

East Side of Hwy 40  
Culvert Inlet, looking  
towards BH 1 location on  
south side of culvert  
(Jan 19/09)



**PHOTOGRAPH**

**2**

### Wolfe Creek

East side of Hwy 40,  
looking north towards  
BH 2 location (Jan 19/09)


## APPENDIX B - PHOTOGRAPHIC RECORD

**PROJECT NO.** TB7210011

**PROJECT** Retaining Soil System Wall Construction and Culvert Extension at Wolfe Creek Culvert

**LOCATION** Hwy 40, Chatham

**ENCLOSURE** 1

	<b>PHOTOGRAPH</b>	<b>3</b>
	<b>Wolfe Creek</b>	
	<p>West Side of Hwy 40 Culvert Outlet, looking south towards BH 3 location on shoulder (Jan 19/09)</p>	

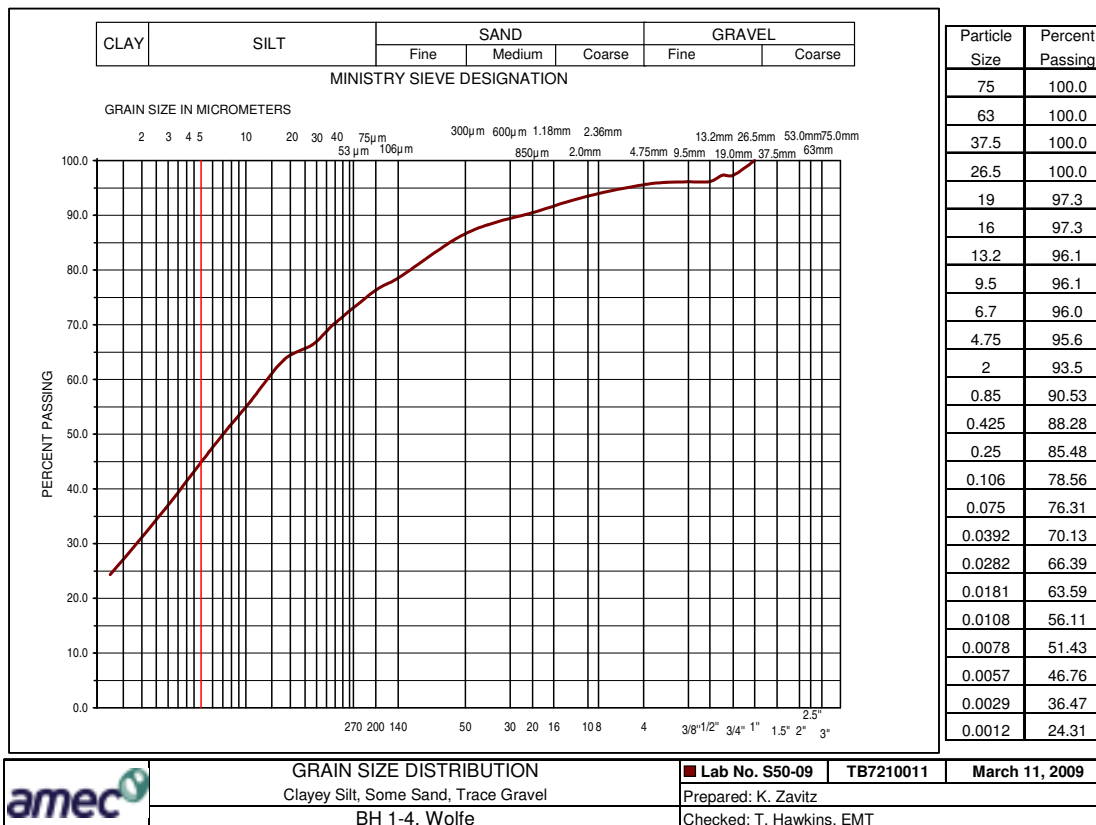
	<b>PHOTOGRAPH</b>	<b>4</b>
	<b>Wolfe Creek</b>	
	<p>West Side of Hwy 40 Culvert Outlet, looking west towards BH 4 location, from Hwy 40 (Feb 11/09)</p>	

## **APPENDIX C**

### **Laboratory Results**

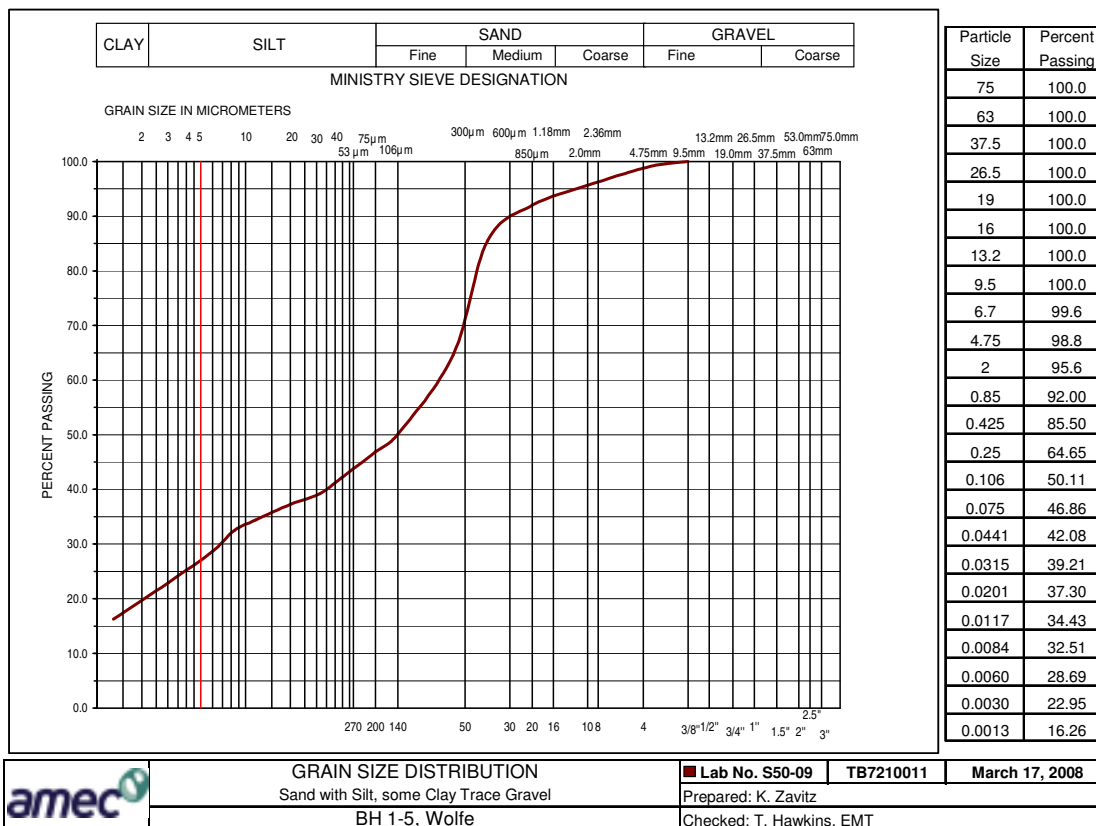
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 1



UNIFIED SOIL CLASSIFICATION SYSTEM

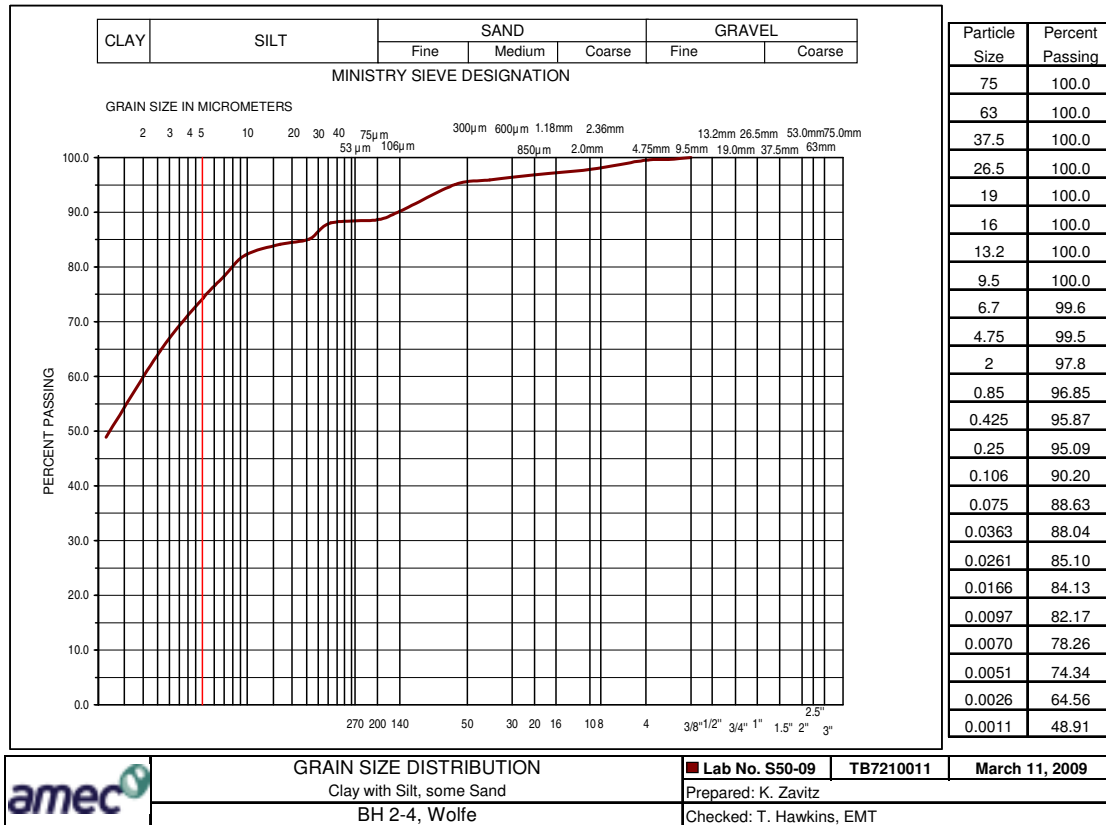
Enclosure: 2





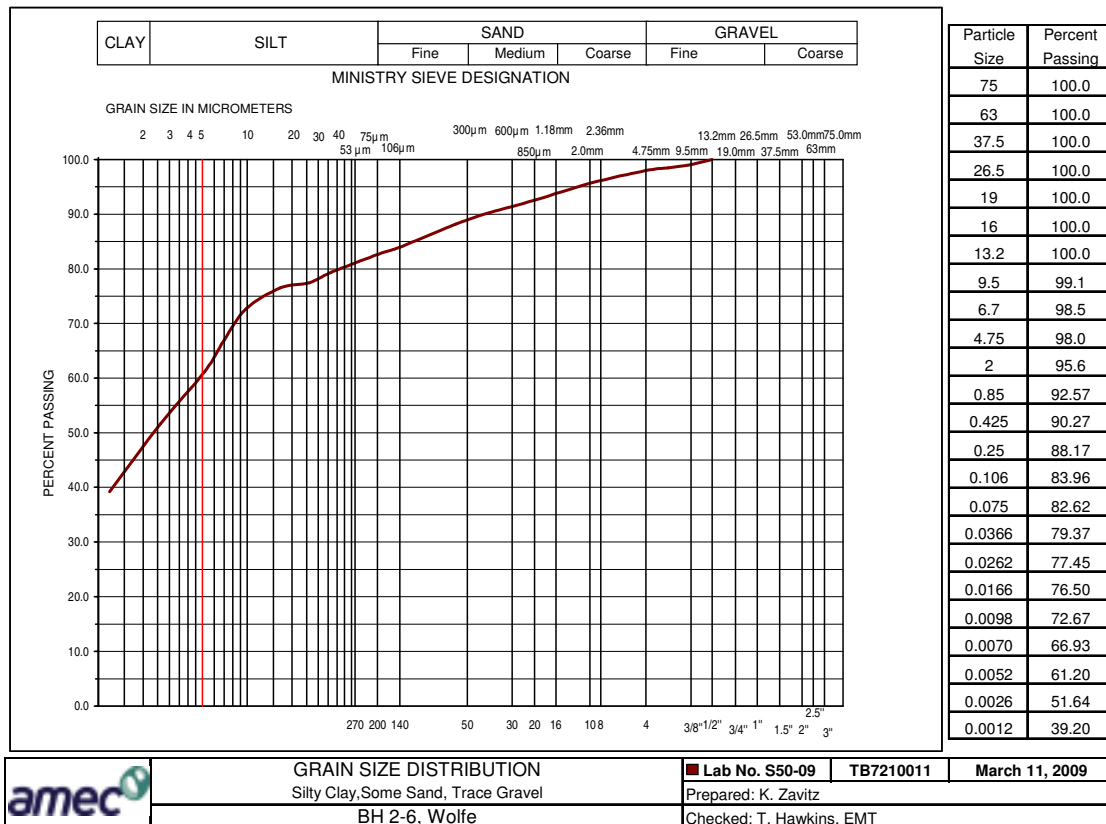
### UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 3



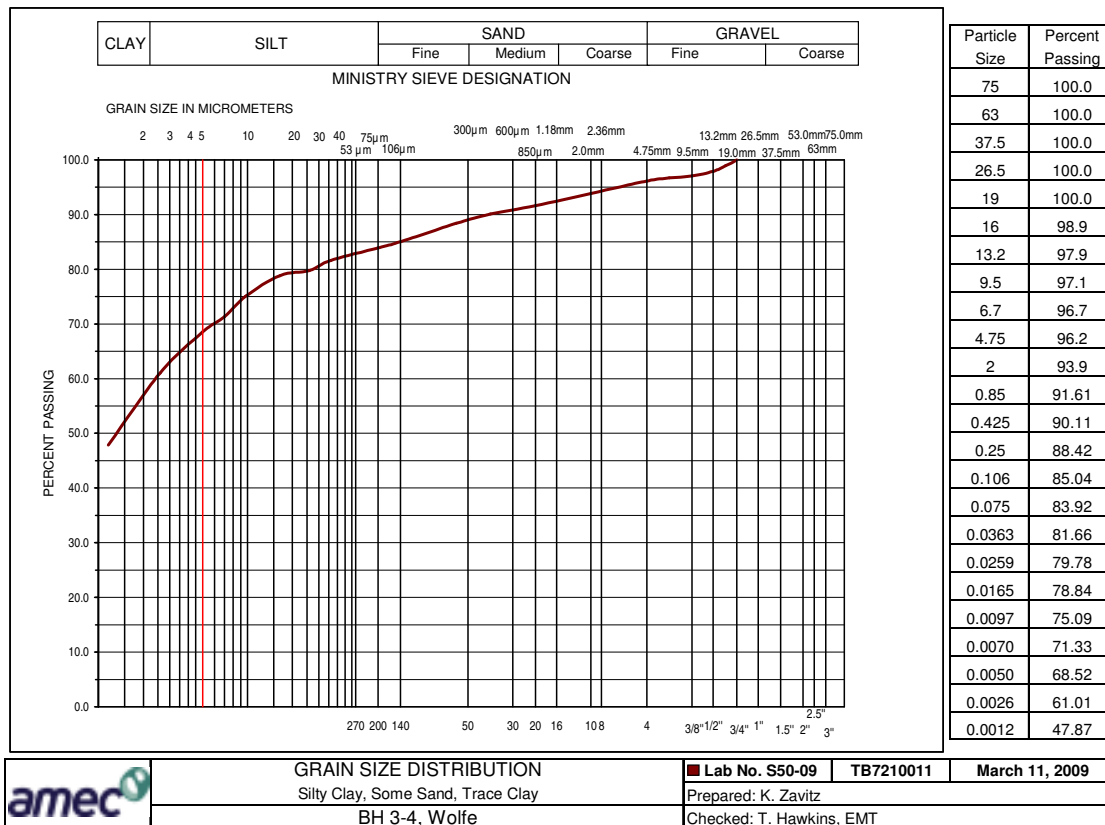
### UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 4



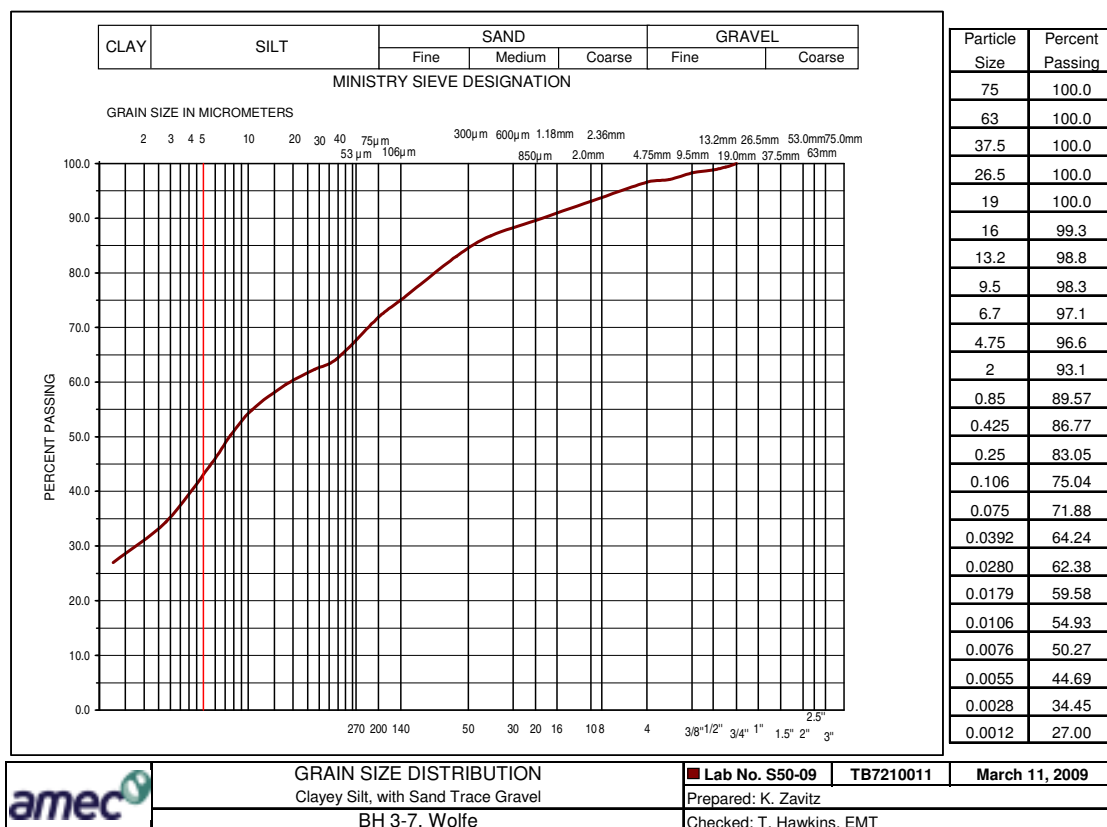
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 5



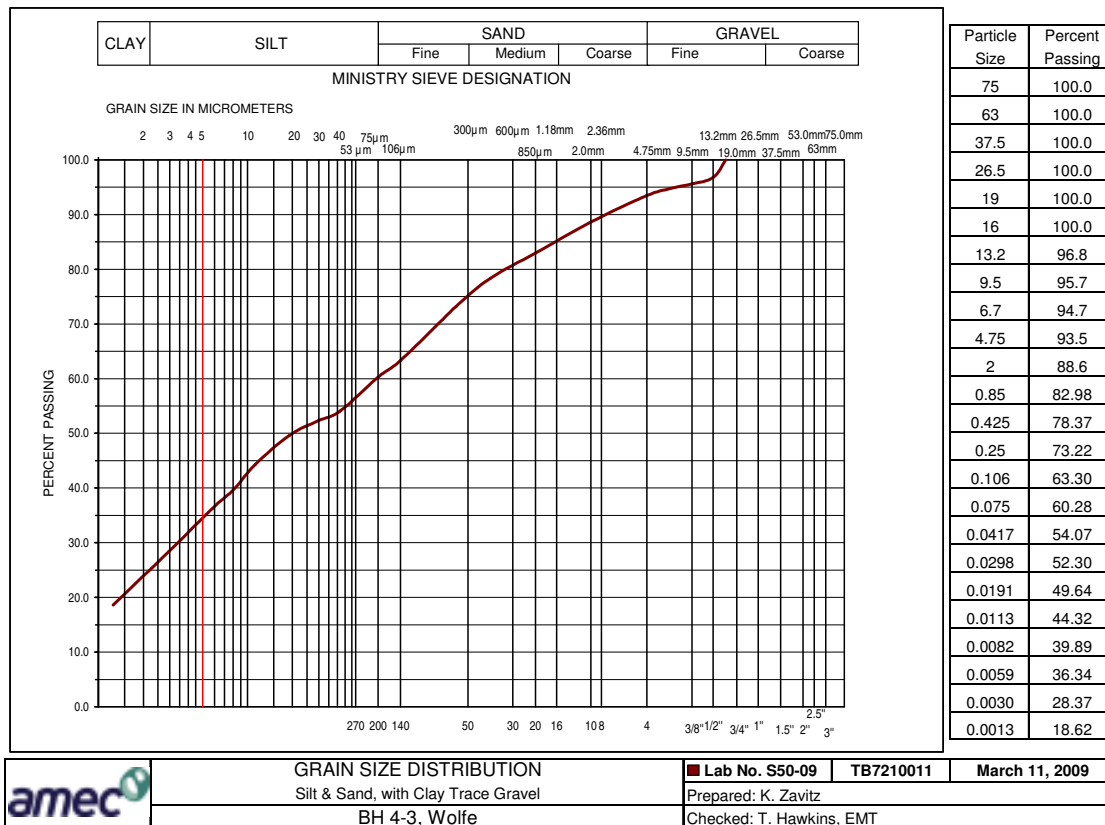
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 6



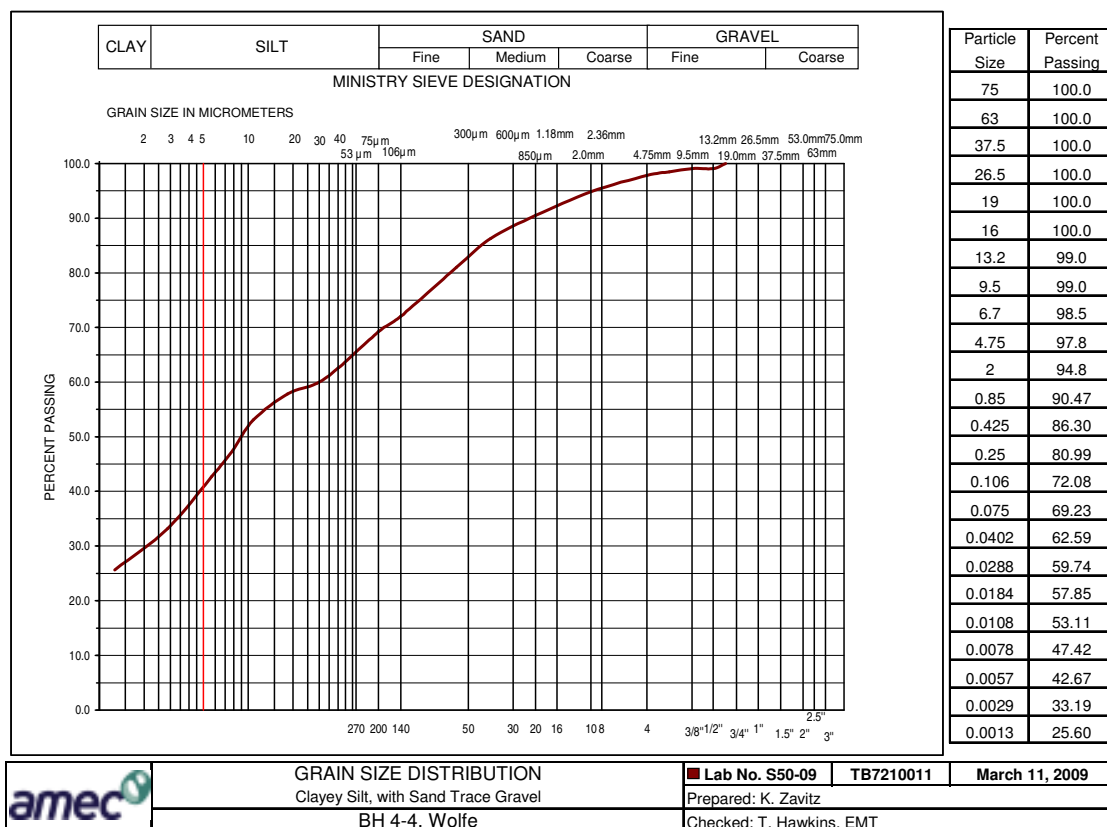
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 7



UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 8



# **PLASTICITY CHART**

Wolfe Creek

BH 2-4: LL=37, PL=21, PI=16  
 BH 1-5: LL=16, PL=12, PI=4

BH 3-7: LL=26, PL=16, PI=10  
 BH 4-4: LL=25, PL=16, PI=9

