



FOUNDATION INVESTIGATION REPORT  
RETAINED SOIL SYSTEM (RSS) WALLS  
HWY 40 AT DOWNIE DRAIN (SITE 13-390-C),  
TWP OF HARWICH, ONTARIO

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

GEOCRES No. 40J8-49

Submitted to:

**Ministry of Transportation**  
West Region  
3rd Floor Geotechnical Section  
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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) on Highway 40 at Downie Drain (Site 13-390-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 20, 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. Two (2) boreholes were specified by the MTO in the vicinity of the existing culvert.

Subsurface information from previous projects that were available, were 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 Downie Drain (Station 14+380) which is located approximately 2 km southeast of Chatham, in Harwich Township.

Based on the field investigation and drawings provided by the MTO, the structure crosses under Hwy 40 and is a concrete box culvert with dimensions for width, height and length of approximately 4.9 x 3.4 x 28.3m. 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	± 3.0	~ 2.6:1	2.8	3:1
West	± 3.2	~ 2.6:1	4.0	3:1

During field investigations, the direction of flow was observed to be east to west. The water level appears to be approximately 0.3m above the base of creek level at the inlet/outlet.

### 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 (GEOCRE Report #64-F-251M) for a bridge located approximately 3 km northeast of Downie Drain, indicates 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, two borehole locations (BH 1 and BH 2) were staked and cleared.

Borehole 1 was put down through the embankment on the east side of Hwy 40 adjacent to the culvert inlet. Borehole 2 was put down at the southbound shoulder along Hwy 40 through the existing road embankment adjacent to the culvert outlet. The boreholes were completed in

order to verify soil conditions below the existing culvert, and to obtain sufficient foundation information needed to construct the proposed retained soil system walls. Boreholes 1 and 2 extended to depths of 7.6 and 8.4 m below ground surface, respectively.

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

The fieldwork was performed on February 11<sup>th</sup> and 24<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 and truck-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 culvert at Downie Drain, at the east end". The BM has an elevation of 181.562.0m, 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, in-situ shear vane testing (MTO vane) was carried out through soft, cohesive soils.

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 was 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 5.5m by placing 3.0m of screen with sandpack. A riser pipe extended to ground surface. The bottom 0.5m of the riser was surrounded by sandpack, then bentonite up to ground surface, as indicated on the borehole log. The standpipe piezometer construction was intended to detect any groundwater levels within the borehole. The conditions at the time the fieldwork was carried out were dry and the standpipe was decommissioned fourteen days following installation.

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 (12);
- Grain size distribution analysis (4)
- Atterberg Limits (1)
- Soil Corrosivity Testing; pH, sulphate, chloride, electrical conductivity, resistivity and Redox potential (2)
- Groundwater testing; sulphide, sulphate, chloride and pH (1).

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. All soil and ground water samples were submitted for chemical analysis to AGAT Laboratories located in Mississauga, Ontario, to determine the corrosivity of the soils and groundwater to various materials. AGAT is accredited by the CALA (Canadian Association for Laboratory Accreditation).

## **5.0 SUB-SURFACE CONDITIONS**

The general soil profile through the embankment consisted of sand or granular fill, overlying sand. In BH 2, silt to silty clay was encountered underlying the sand.

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

Through the embankment in Borehole BH 1, approximately 0.3m of topsoil was encountered overlying sand (possible fill) to a depth of 1.4 m± below ground surface. In Borehole 2, granular road base fill extended to an approximate depth of 1.5m.

The sand fill was very loose. A single Standard Penetration test resulted in an 'N' value of 1 blow for 30cm, with a corresponding moisture content of 25%.

### Sand

Underlying the surficial fill, sand was encountered in each borehole. In Borehole 1, the sand extended to at least the maximum depth investigated. In Borehole 2, the sand extended to a depth of 4.4m.

Based on grain size/hydrometer analyses carried out and the MTO Classification system, the material category was coarse-grained soils with more than 50% retained on 0.075 mm (No. 200) sieve.

**Summary of Index Testing**

	%				Atterberg Limits	Classification
	>4.75mm	75µm to 4.75mm	2µm to 75µm	<2µm		
<b>BH1-SS3</b>	0	85.0	12.0	3.0		Fine Sand some Silt Trace of Clay
<b>BH1-SS6</b>	0	77.7	14.8	7.5	Non-Plastic	Fine Sand some Silt Trace of Clay
<b>BH2-SS1</b>	0	52.3	40.0	7.7		Silt & Fine Sand Trace of Clay

The sand was very loose to compact, with 'N' values ranging from 1 to 38 blows for 30cm. The soils were wet to saturated and moisture contents ranged from 13 to 28%. The very loose N values below a depth of 4m in Borehole 1 likely reflect disturbance of the saturated soils due to the drilling. Also, it was not possible to sample below a depth of 7m, due to the sands boiling up into the augers.

Split spoon sample #4 (3.0 to 3.4m) from Borehole BH 1 and sample #2 (2.3 to 2.7m) from Borehole BH 2 was submitted for testing to determine the corrosivity of the soils to various materials. The laboratory test certificates can be found in Appendix B, and are summarized in the following table.

Soil Characteristic	Test Results for Soil	
	BH 1-4	BH 2-2
Sulphide	<0.01%	<0.01%
Sulphate	46.4 µg/g	21.5 µg/g
Chloride	162 µg/g	179 µg/g
pH	7.52	8.84
Electrical Conductivity	0.371mS/cm	0.351mS/cm
Resistivity	2700 ohms-cm	2850 ohms-cm
Redox potential	283mV	283mV

### Silt to Silty Clay

Underlying the sand in Borehole 2, layered silt and silty clay extended to at least the maximum depth investigated.

This deposit was very loose and very soft, with Standard Penetration testing giving 'N' values of 1 blow for 30cm, and natural moisture contents of 26 to 43%. One field vane test carried out at a depth of 8.2m in Borehole 2 resulted in an undrained shear strength of 19kPa.

Based on grain size/hydrometer analyses carried out and the MTO Classification system, the material category was fine grained soils, with more than 50% passing the 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>BH2-SS7</b>	1.0	5.3	25.7	68.0	LL= 42 PL= 22, PI= 20	CI - Clay of Medium Compressibility and Plasticity

## **5.2 Groundwater**

Groundwater conditions in the boreholes were observed during drilling and upon completion of drilling. Borehole 2 was caved to 6.1 mbgs upon completion.

A piezometer was installed in Borehole BH 1, and the water level was measured on February 23, 2009. A water level at 4.0m (elev. 177.6m) was recorded. The piezometer was decommissioned fourteen days after installation, on February 23<sup>th</sup>, 2008, in accordance with Ministry of Environment Regulation 903.

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



Groundwater Characteristic	Test Results for Water	
	BH1A	BH1B
Sulphide (mg/L)	-	<0.1
Sulphate (mg/L)	49.3	-
Chloride (mg/L)	619	-
pH	7.70	-

### 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 and BH 2 ranged from non-detect to 30 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,

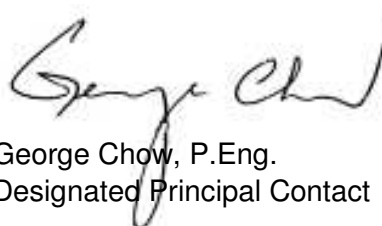
AMEC Earth & Environmental,  
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Laura Wiebe, B.Eng.  
Geotechnical EIT



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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.

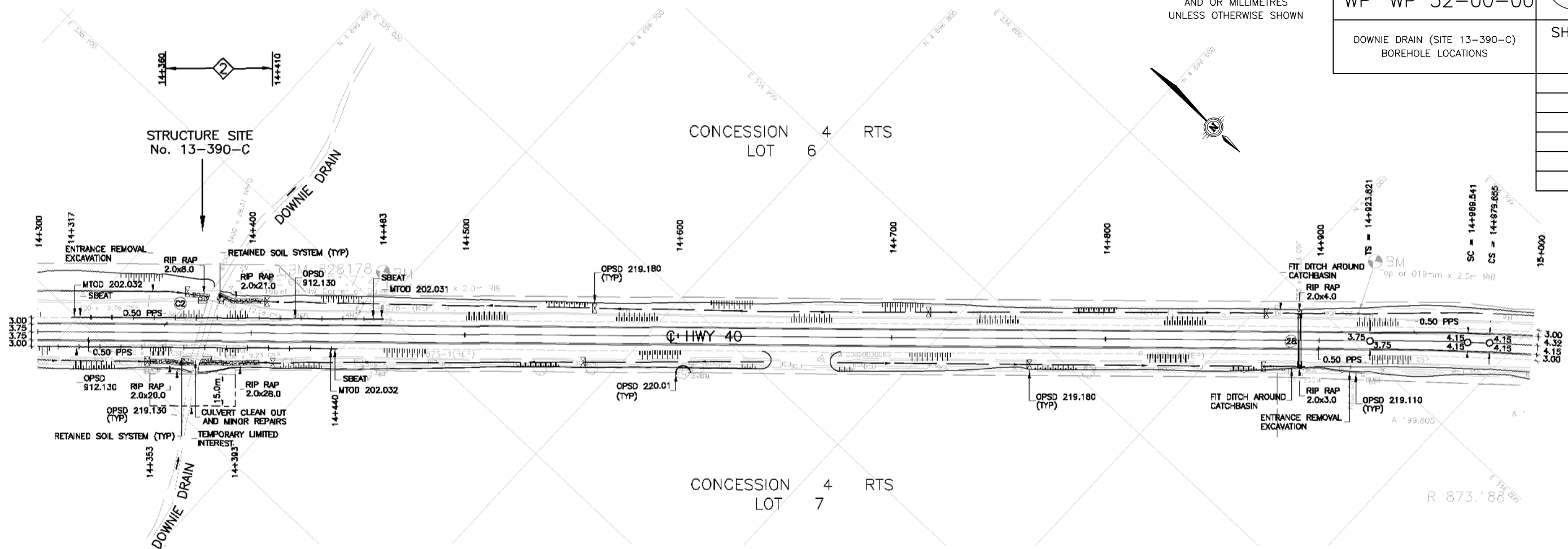
The benchmark and elevations mentioned in this report were obtained strictly for use by this office in the geotechnical design of the project. They should not be used by any other party for any other purpose.

## APPENDIX FIGURES

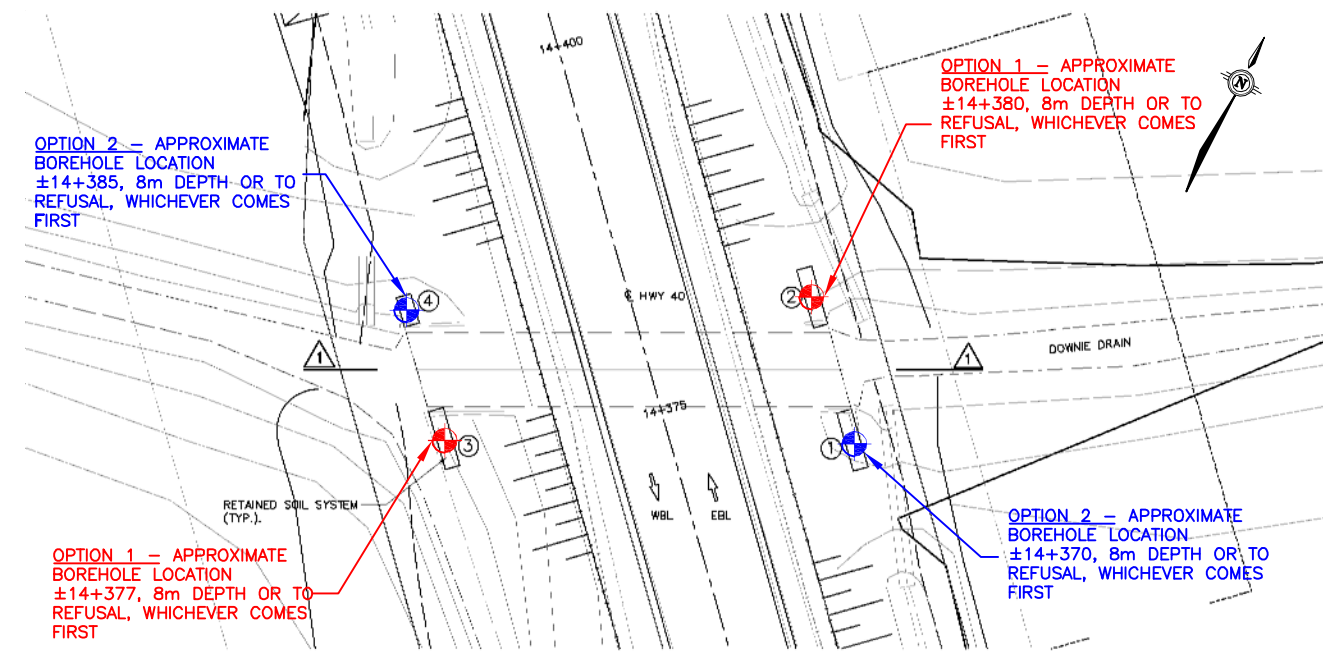
METRIC  
DIMENSIONS ARE IN METRES  
AND OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT
WP WP 52-00-00
DOWNIE DRAIN (SITE 13-390-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. 40J8-49**

FOUNDATION INVESTIGATION  
PROPOSED RETAINING WALL STRUCTURE  
HWY 40 - DOWNIE DRAIN  
CHATHAM, ONTARIO  
ASSIGNMENT 11

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

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



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



**KEY PLAN**

**LEGEND**

- BH1** BOREHOLE
- BH2** BOREHOLE (Equipped with Piezometer)
- WATER LEVEL
- Existing Culvert
- Existing Roadway
- Proposed Culvert/Retaining Structure
- SPT 'N'

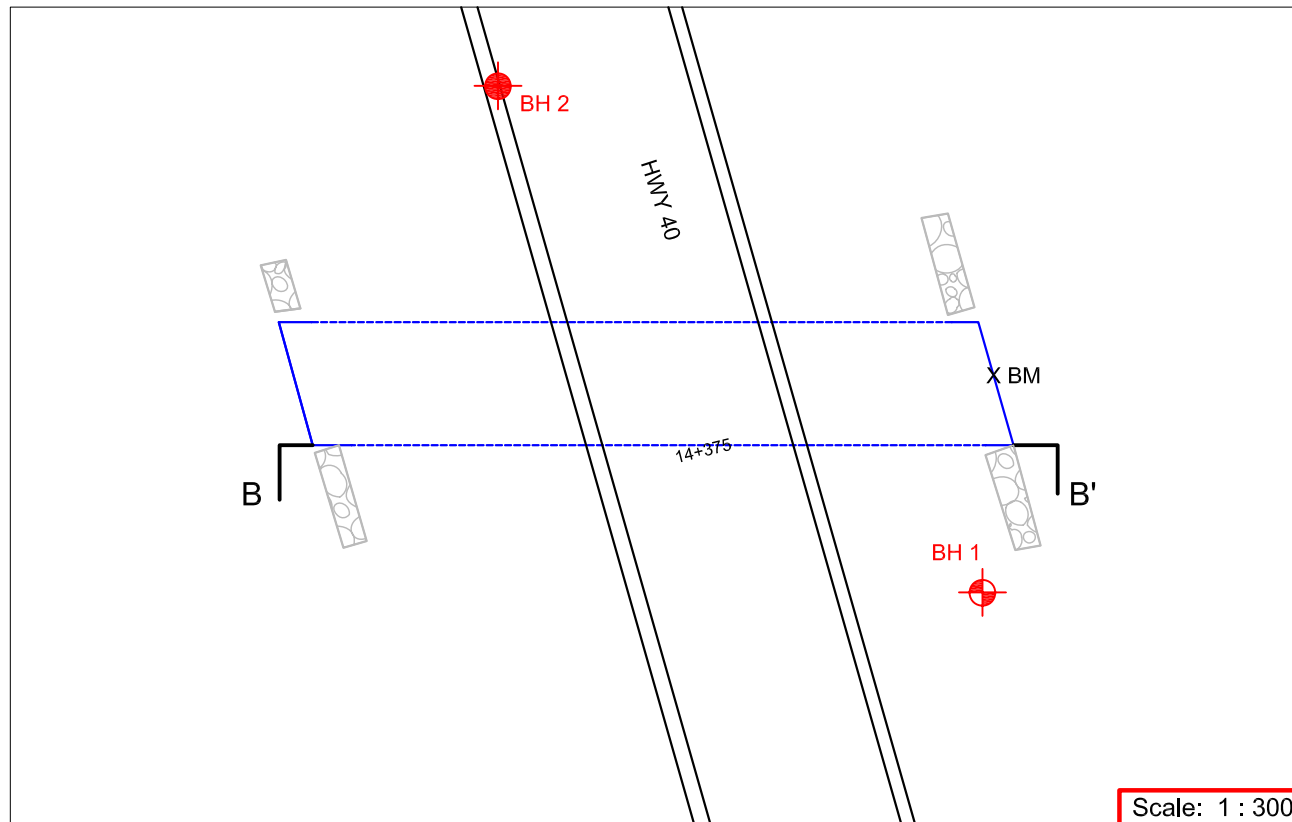
BOREHOLE	LOCATION		COORDINATE (NAD 83)		ELEVATION (m)
	STATION	OFFSET	NORTHING	EASTING	
BH1	14 + 369	8.7 m RT of CL	4696647.1	335177.2	181.639
BH2	14 + 390	3.6 m LT of CL	4696654.2	335153.9	182.499

**NOTES:**

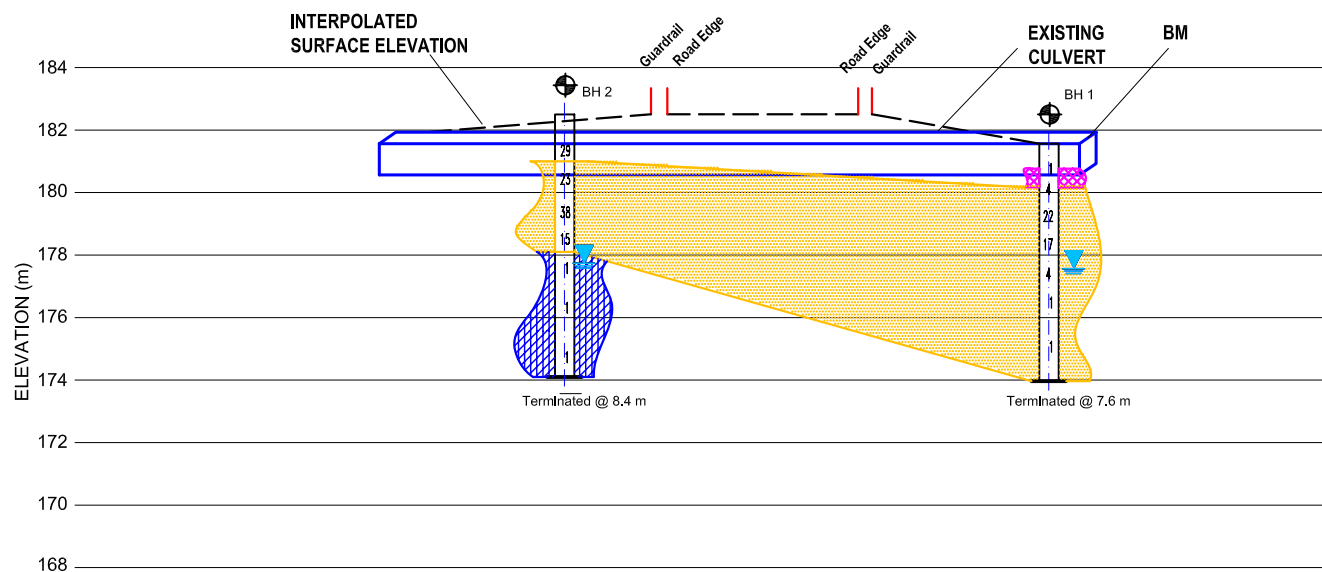
- The boundaries between soil strata have been established only at borehole locations. Between boreholes, the boundaries are assumed from geological evidence and may be subject to considerable error.
- All elevations shown are referred to a geodetic benchmark of 181,562 m, which was provided to AMEC by the MTO.  
(BM - top of culvert [centre] at east end of culvert)  
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/Silty Clay
- Unknown



Scale: 1 : 300



**PROFILE**

Scale: Horizontal 1 : 300  
Vertical 1 : 250

## APPENDIX A

# RECORD OF BOREHOLE No 1

1 OF 1

PROJECT Hwy 40 at Downie Drain RSS Wall LOCATION Downie Drain, East side of Hwy 40. ORIGINATED BY LW  
 CLIENT MTO Western Region Sta(14+369), o/s 8.7m Rt of Hwy 40 CL COMPILED BY LW/JW  
 JOB NO. TB7210011 DATE 11 February 2009 CHECKED BY JD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST <input type="checkbox"/> DYNAMIC PENETRATION TEST <input checked="" type="checkbox"/>		WATER CONTENT (%)	OBSERVATIONS & REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH (kPa)		
181.6 0.0	<b>TOPSOIL</b>						10 20 30 40 50		20 40 60	
181.3 0.3	Brown <b>SAND</b> (Possible <b>Fill</b> ), trace silt and shells, very loose, wet.		1	SS	1	1				
180.3 1.4	Light Brown to Grey <b>SAND</b> , trace rootlets and organics, very loose to compact, wet to saturated. <b>Silt to Silty Clay</b> layers throughout, mwtpl.		2	SS	4	2				
			3	SS	22	3				<b>SS#3</b> 75 µm to 4.75 mm – 85% 2 µm to 75 µm – 12% <2 µm – 3%
			4	SS	17	4				
			5	SS	4	5				
			6	SS	1	6				<b>SS#6</b> 75 µm to 4.75 mm – 78% 2 µm to 75 µm – 14% <2 µm – 8%
			7	SS	1	7				<b>SS#6</b> Non-Plastic
174.0 7.6	<b>BOREHOLE TERMINATED</b>  <u>Organic Vapour Measurement (OVM)</u>  SS#1 = 20 ppm SS#2 = 20 ppm SS#3 = 10 ppm SS#4 = 5 ppm SS#5 = ND SS#6 = ND SS#7 = ND  ppm = parts per million ND = non-detect									Well details: 50mm diameter slotted PVC pipe (2.5-5.5m) with sandpack (2.0-5.5m), bentonite plug above sandpack, with pipe riser and slip cap.

1 OF 1

PROJECT Hwy 40 at Downie Drain RSS Wall

LOCATION Downie Drain, West side of Hwy 40.

ORIGINATED BY LW

CLIENT MTO Western Region

Sta(14+390), o/s 3.6m 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			○ UNCONFINED	▲ FIELD VANE
182.5 0.0	Augered to 1.5mbgs. Granular base fill was observed in auger cuttings.											20	40	60		
181.0 1.5	Brown to Grey <b>SAND</b> , trace silt, compact to dense, moist to wet.		1	SS	29											<b>SS#1</b> 75 µm to 4.75 mm – 52% 2 µm to 75 µm – 40% <2 µm – 8% No recovery SS2
			2	SS	23											
			3	SS	38											
			4	SS	15											
178.1 4.4	Layered grey <b>SILT to SILTY CLAY</b> , trace sand, very loose and very soft, moist and wtpl to mwtpl.		5	SS	1											No recovery SS4
			6	SS	1											
			7	SS	1											
174.1 8.4	<b>BOREHOLE TERMINATED</b>  <u>Organic Vapour Measurement (OVM)</u>  SS#1 = 30 ppm SS#2 = 10 ppm SS#3 = 10 ppm SS#4 = 10 ppm SS#5 = 10 ppm SS#7 = ND ppm  ppm = parts per million ND = non-detect															<b>SS#7</b> >4.75 mm – 1% 75 µm to 4.75 mm – 5% 2 µm to 75 µm – 26% <2 µm – 68%  <b>SS#7</b> LL - 42% PL - 22% PI - 20%



## APPENDIX B

## APPENDIX B - PHOTOGRAPHIC RECORD

**PROJECT NO.** TB7210011

**PROJECT** Retaining Soil System Wall Construction at Downie Drain Culvert

**LOCATION** Hwy 40, Chatham

**ENCLOSURE** 1



**PHOTOGRAPH**

**1**

### Downie Drain

Culvert Inlet, looking north-west (Feb 11/09)



**PHOTOGRAPH**

**2**

### Downie Drain

East side of Hwy 40, looking north towards BH1. (Feb 11/09)

## APPENDIX B - PHOTOGRAPHIC RECORD

**PROJECT NO.** TB7210011

**PROJECT** Retaining Soil System Wall Construction at Downie Drain Culvert

**LOCATION** Hwy 40, Chatham

**ENCLOSURE** 1



**PHOTOGRAPH**

**3**

**Downie Drain**

West side of Hwy 40,  
looking north towards BH2  
location. (Jan 19/09)



**PHOTOGRAPH**

**4**

**Downie Drain**

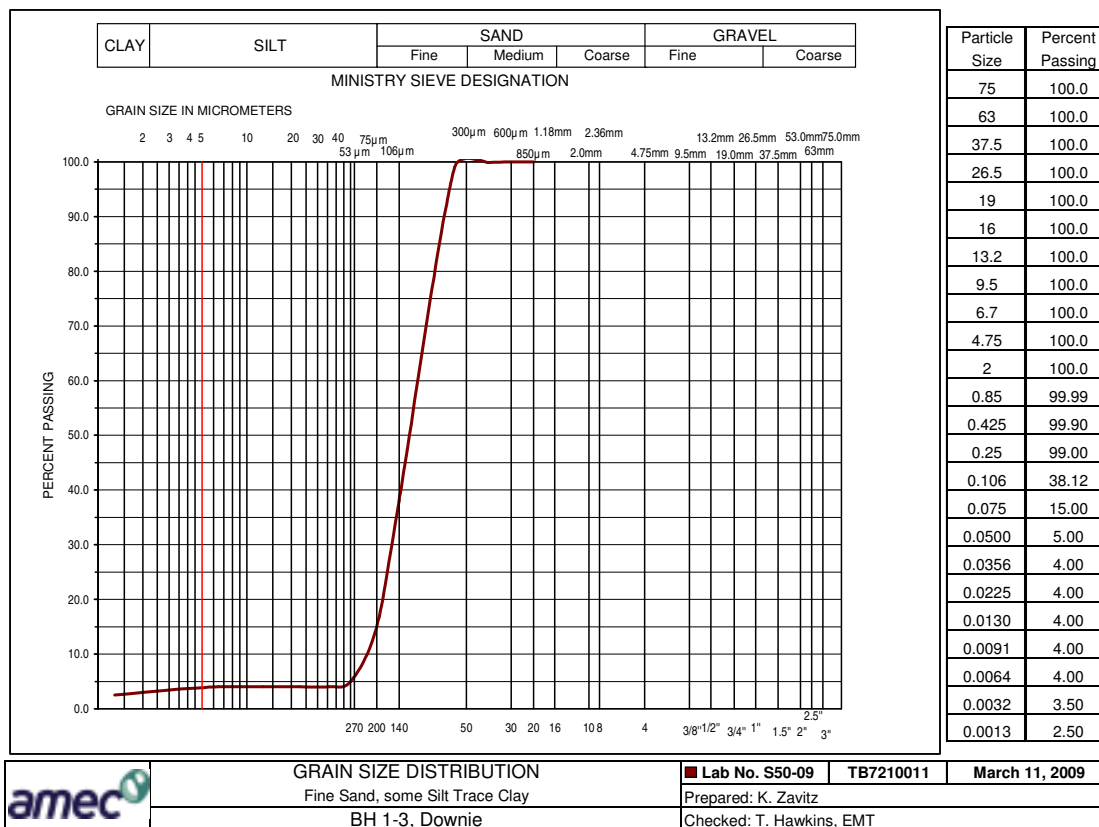
Culvert Outlet, looking  
west from Hwy 40 (Jan  
19/09)

## **APPENDIX C**

### **Laboratory Results**

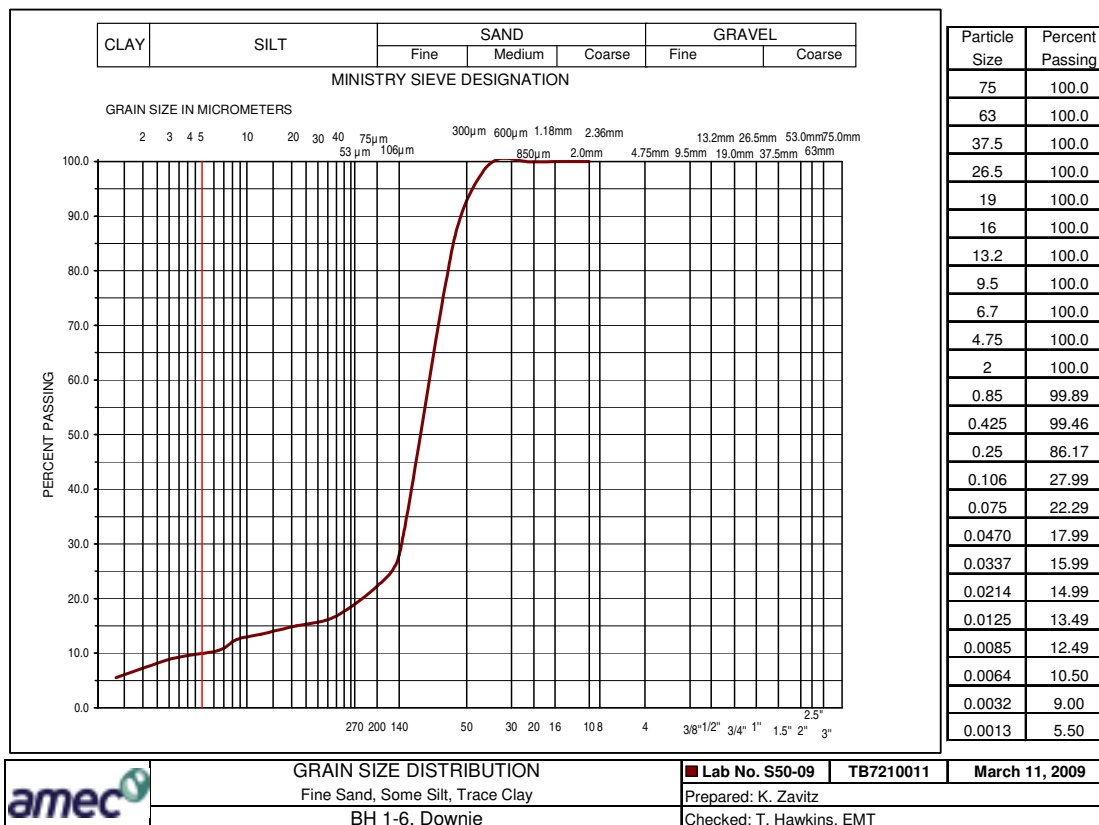
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 1



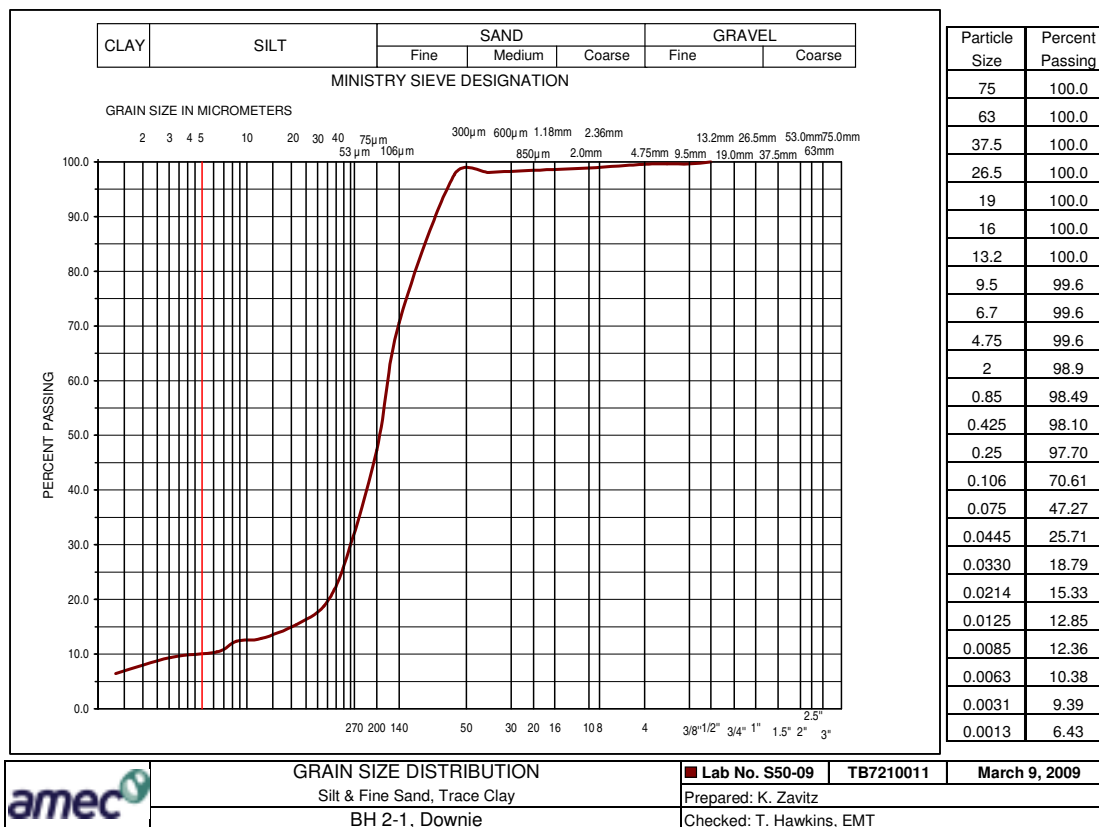
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 2



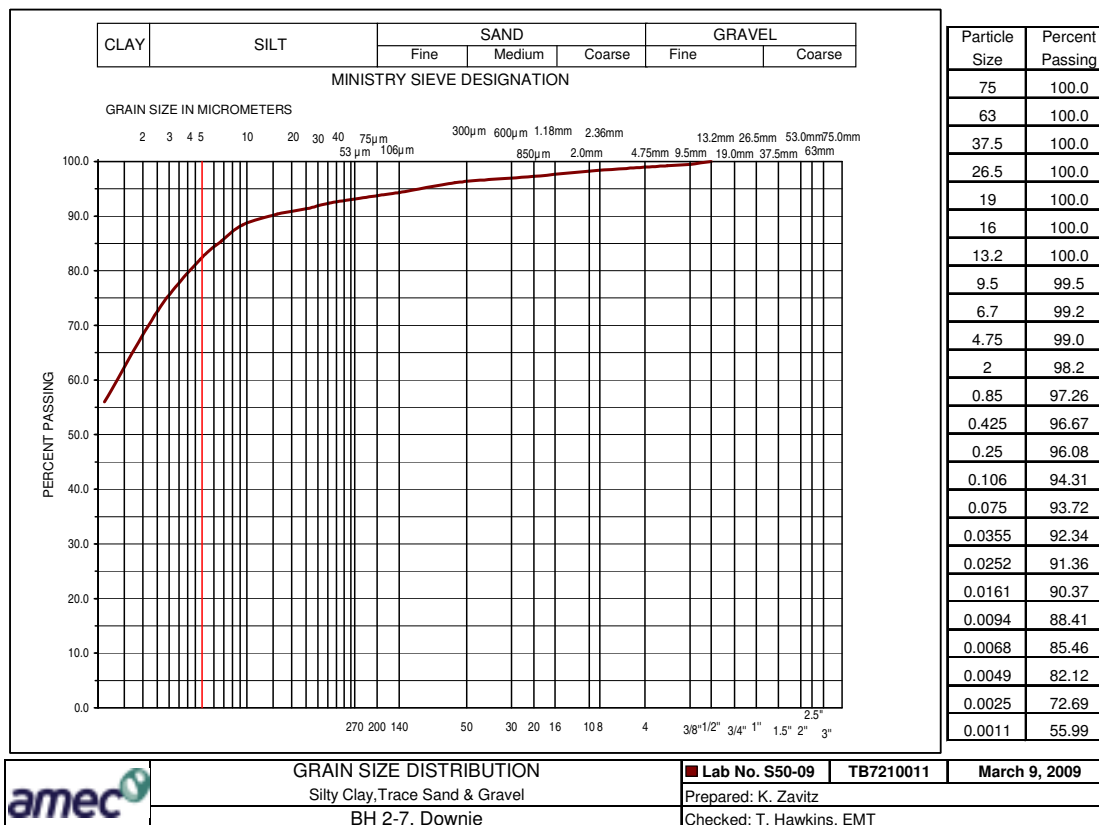
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 3



UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: 4



**PLASTICITY CHART**

DOWNIE, BH 2-7: LL=42, PL=22, PI=20  
BH 1-6: Non-Plastic

