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**FOUNDATION INVESTIGATION REPORT
MAYFIELD ROAD UNDERPASS
HIGHWAY 410 EXTENSION
G.W.P. 101-00-00**

Submitted to:

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TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION	2
3.0 INVESTIGATION PROCEDURES	3
4.0 SITE GEOLOGY AND STRATIGRAPHY	5
4.1 Regional Geological Conditions	5
4.2 Site Stratigraphy	5
4.2.1 Fill	6
4.2.2 Peat	6
4.2.3 Silty Clay to Clayey Silt.....	6
4.2.4 Sand and Silty Sand to Sandy Silt.....	7
4.2.5 Clayey Silt Till	7
4.2.6 Silty Sand to Silt Till.....	8
4.3 Groundwater Conditions	8
5.0 CLOSURE	10

In Order
Following
Page 10

Lists of Abbreviations and Symbols
Lithological and Geotechnical Rock Description Terminology
Records of Boreholes / Drillholes M-1 to M-5
Figures 1 to 8
Appendix A

LIST OF FIGURES

Figure 1	Plasticity Chart – Silty Clay to Clayey Silt
Figure 2	Grain Size Distribution Test Results – Silty Clay to Clayey Silt
Figure 3A/B	Oedometer Test Results – Borehole M-3, Sample 9
Figure 4A/B	Oedometer Test Results – Borehole M-5, Sample 8
Figure 5	Grain Size Distribution Test Results – Silty Sand to Sandy Silt
Figure 6	Plasticity Chart – Clayey Silt Till
Figure 7	Grain Size Distribution Test Results – Clayey Silt Till
Figure 8	Grain Size Distribution Test Results – Silty Sand to Silt Till

LIST OF APPENDICES

Appendix A	Records of Boreholes – Previous Investigations
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1.0 INTRODUCTION

Golder Associates Ltd. has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the following components associated with the Phase 2 extension of Highway 410 from Sandalwood Parkway to Mayfield Road in Brampton, Ontario:

- Underpass structures at Countryside Drive and Mayfield Road;
- New structural culverts;
- High fill embankments along Highway 410, on Mayfield Road and Countryside Drive, and on the Mayfield Road interchange ramps;
- High mast light poles; and
- Overhead signs.

This report addresses the new Mayfield Road underpass structure on Highway 410. A foundation investigation has been carried out to determine the subsurface conditions at the site. In addition, use has been made of previous borehole investigation data for this site, as follows:

- A report titled “Highway 410 Route Planning Study, Bovaird Drive Northerly to Highway 10, W.P. 22-99-00” (GeoCres 30M12-208) was prepared by the Ministry of Transportation Ontario (MTO) in January of 1989. A total of six boreholes and two dynamic cone penetration tests were completed as part of this study.

The terms of reference for the scope of work are outlined in Golder Associates’ Proposal No. P01-1228, dated August, 2000.

2.0 SITE DESCRIPTION

The site is located on Mayfield Road approximately 500 m east of the intersection of Mayfield Road and Heart Lake Road in Brampton, Ontario.

The planned location of the Mayfield Road underpass structure is in a topographic low transected from north to south by a swamp. The ground surface within the swamp is at approximately Elevation 248 m to 250 m. There are farm fields along the northwest side of Mayfield Road with ground surface typically at about Elevation 254 m to 258 m adjacent to the road. Mayfield Road is at about Elevation 252 m in the area of the bridge and is constructed in partial cut on both sides of the swamp areas to the east and west.

3.0 INVESTIGATION PROCEDURES

A subsurface investigation was carried out for the Highway 410 underpass structure at Mayfield Road in November and December 2003, at which time a total of five boreholes (Boreholes M-1 to M-5) were advanced in the vicinity of the proposed structure foundations and immediate approach embankments. Records of Borehole sheets for these boreholes are included within this report. Other boreholes were drilled during previous investigations in the proposed underpass area and the records for these boreholes are included in Appendix A to this report.

The boreholes were drilled using a bombardier-mounted drill rig supplied and operated by Geo-Environmental Drilling Inc. of Milton, Ontario. All of the boreholes were advanced using hollow stem augers to depths between 15.7 m and 30.7 m below the existing ground surface. Samples of the overburden were obtained at 0.75 m and 1.5 m intervals of depth using 50 mm outside diameter split-spoon samplers driven with an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedure. The water level in the open boreholes was observed throughout the drilling operations, and a total of three piezometers were installed into the overburden to monitor the groundwater level(s) at the site.

The field work was supervised on a full-time basis by members of Golder's staff who located the boreholes in the field, directed the drilling, sampling, and in-situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for testing. Index and classification tests consisting of water content determinations, oedometer testing and grain size distribution analyses were carried out on selected soil samples. Laboratory test data is included on the Record of Borehole sheets and on Figures 1 through 7.

The borehole locations and ground surface elevations were established by surveyors or were determined by Golder personnel relative to points staked in the field by the Callon Dietz Ltd., Ontario. The borehole locations, including MTM NAD83 northing and easting coordinates and ground surface elevations referenced to geodetic datum, are summarized in the following table and are shown on the Borehole Location and Soil Strata drawings contained in the Contract Documents.

<i>Borehole Number</i>	<i>Borehole Location</i>	<i>MTM NAD83 Northing (m)</i>	<i>MTM NAD83 Easting (m)</i>	<i>Ground Surface Elevation (m)</i>
M-1	West approach	4846298	280719	248.8 m
M-2	West abutment	4846317	280700	251.6 m
M-3	Centre pier	4846343.1	280753.6	249.3 m
M-4	East abutment	4846386	280758	251.1 m
M-5	East approach	4846397	280798	249.0 m

It should be noted that the locations and coordinates of boreholes completed during previous investigations (as summarized) are considered accurate to within about 5 m. The boreholes completed prior to this were surveyed using an alternative datum and the coordinates have been converted to the present Northing and Easting system for the site.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

The Mayfield Road structure site is located in the physiographic region known as the Peel Plain. The Peel Plain is generally composed of clayey soils covering the central portion of York, Peel and Halton Regions, as delineated in *The Physiography of Southern Ontario*¹. The surface topography of the Peel Plain slopes gradually and fairly uniformly towards Lake Ontario. The local physiography is characterized by relatively thick overburden soils consisting mainly of silty clay underlain by sands, silts and gravel. Terrain with organic deposits was encountered in lower lying areas of the site. There is a partially buried esker within the general area of the site. The soils are underlain by shale bedrock of the Georgian Bay Formation.

4.2 Site Stratigraphy

As part of the subsurface investigation at this site, five boreholes were advanced at the proposed foundation elements and immediate approach embankments. The borehole locations and ground surface elevations are shown on the Borehole Location and Soil Strata drawings contained in the Contract Documents.

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in-situ and laboratory testing are given on the Record of Borehole sheets and on Figures 1 to 8. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the soils encountered at this site consist of layers of fill and peat between 3.1 m and 7.6 m thick, overlying interlayered silty clay and sand, in turn, overlying an extensive deposit of silty sand to sand and silt glacial till and clayey silt glacial till. As illustrated on the Borehole Location and Soil Strata drawings, the interlayered silty clay, clayey silt, and silty sand to sandy silt deposit thins to the north where the soils are more consistently granular (composed of silt and sand). A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections, and stratigraphic profiles and sections of this site are shown on the Borehole Location and Soil Strata drawings contained in the Contract Documents.

¹ Chapman, L.J. and D.F. Putnam. *The Physiography of Southern Ontario*, Ontario Geological Survey Special Volume 2, Third Edition, 1984. Accompanied by Map P.2715, Scale 1:600,000.

4.2.1 Fill

Fill material was encountered in Boreholes M-2 to M-5, inclusive, at the ground surface to a depth of about 0.8 m to 2.6 m. Boreholes M-2 and M-4 on Mayfield Road encountered about 600 mm to 800 mm of sand and gravel fill. Measured 'N' values, as determined from standard penetration testing carried out within the sand and gravel fill were 12 and 14 blows per 0.3 m of penetration. Clayey silt fill, varying in thickness from about 0.8 m to 2.0 m, was encountered at ground surface in Borehole M-3 and below the sand and gravel fill material in Boreholes M-2 and M-4. Measured 'N' values obtained in the clayey silt fill ranged from 2 to 9 blows per 0.3 m of penetration. The water content of two samples of clayey silt fill material were about 15 and 17 per cent. Borehole M-5 encountered a silty sand fill material at ground surface to a depth of 1.4 m. A single measured 'N' value in the silty sand was 1 blow per 0.3 m. The water content of the silty sand was about 121 per cent, indicating a high organic content.

4.2.2 Peat

Peat was present at ground surface in Borehole M-1 and underlies the fill material at the remaining borehole locations, in turn overlying the native soil deposits at the site. The peat was encountered to depths of about 3.1 m to 7.6 m (about Elevation 242 m to Elevation 249 m) and ranged in thickness from 1.0 to 6.8 m. Measured 'N' values in the peat ranged from 0 to 6 blows per 0.3 m of penetration. In situ vane testing carried out within the peat in Borehole M-3 gave undrained shear strengths ranging between 8 and 27 kilopascals. The natural water content of the samples of peat obtained from the boreholes varied from about 109 to 432 per cent.

4.2.3 Silty Clay to Clayey Silt

Deposits of clayey silt and silty clay were encountered below the peat in Boreholes M-1, M-3 and M-4 and below the sandy silt in Borehole M-5. The layers range in thickness from 0.4 m to 2.8 m with base at about Elevation 239 m to Elevation 247 m. Measured 'N' values of the silty clay varied from 0 (i.e. split spoon advanced by weight of hammer) to 4 blow per 0.3 m. In situ vane testing carried out within the silty clay to clayey silt yielded undrained shear strengths ranging from about 24 to 58 kPa with sensitivities typically less than 3.

Atterberg limit testing on samples of the clayey silt indicated liquid limit values of about 19 to 34 per cent with corresponding plasticity index values of about 6 to 15 per cent, indicating a clayey silt of low plasticity. These values are summarized on a plasticity chart on Figure 1. The measured water content of samples of the clayey silt ranges from 26 to 40 per cent. These water content values are at or slightly above the liquid limit. The measured organic content on one sample from Borehole M-3 was about 1.7 per cent. The results of grain size distribution testing carried out on two samples of the clayey silt from Boreholes M-3 and M-5 are provided on Figure 2.

Oedometer testing was carried out on specimens from two of the three thin-walled Shelby tube samples that were retrieved during the present investigation. The following table summarises the engineering parameters interpreted for this soil type as interpreted from the oedometer test results as shown on Figures 3 and 4.

Borehole/ Sample No.	Sample Depth/Elev. (m)	Unit Wt. (kN/m ³)	σ_{vo}' (kPa)	σ_p' (kPa)	Cc	Cr	e _o	OCR
M-5 / 8	6.1 / 242.9	23.0	137.6		0.06	0.018	0.307	
M-3 / 9	8.2 / 241.1	18.0	69.2	70	0.261	0.049	1.054	1.0

Notes:

σ_p'	Apparent preconsolidation pressure	σ_{vo}'	Computed existing vertical effective stress
Cc	Compression index	Cr	Recompression index
e _o	Initial void ratio	OCR	Overconsolidation ratio

Within the above table, values for apparent preconsolidation pressure and overconsolidation ratio (OCR) have not been provided for sample 8 from Borehole M-5. The nature of this material, having a void ratio between 0.15 and 0.31 over the tested range of stresses, renders an interpretation of these parameters meaningless although it is considered that this portion of the deposit is a relatively highly overconsolidated glacial till that has been subject to some degree of softening since glaciation.

4.2.4 Sand and Silty Sand to Sandy Silt

In Boreholes M-1, M-2, M-4 and M-5, interlayered cohesionless soils were encountered with a total thickness of between 0.7 m and 7.0 m. Measured Standard Penetration Test (SPT) “N” values in this deposit range from 0 to 18 blows per 0.3 m of penetration, but are typically between 4 and 10 blows. The natural water content of samples of sandy silt to silty sand varied from 15 to 55 per cent, but is typically between 16 and 22 per cent. Four grain size distribution test results on samples obtained from Boreholes M-1, M-2 and M-4 are shown on Figure 5 following the text of this report.

4.2.5 Clayey Silt Till

The silty clay to clayey silt and the interlayered sands and clays in all boreholes are underlain by a clayey silt till deposit which was found to range in thickness from 6.8 m to 9.8 m (deposit base at about Elevation 230 m to Elevation 234 m). Measured SPT ‘N’ values in the deposit varied typically between 13 and 46 blows in the boreholes located along the south side of Mayfield Road. In the boreholes along the north side of Mayfield Road, the SPT ‘N’ values typically ranged from 20 to 46 blows in this upper portion of the till with one low value of 7 blows at depth in Borehole M-3. At the locations of Boreholes M-2, M-3 and M-4, a lower deposit of clayey silt

till was encountered below the silt till interlayer (see Section 4.2.6). At these borehole locations, the measured SPT 'N' values are greater than 100 blows per 0.3 m of penetration.

Atterberg limit testing on samples of the clayey silt till indicated liquid limit values of about 17 to 33 per cent with corresponding plasticity index values of about 7 to 14 per cent, indicating a clayey silt material of low plasticity. These values are summarized on a plasticity chart on Figure 6. The measured water content of the clayey silt till ranges from 7 to 17 per cent. The results of grain size distribution testing carried out on five samples of the clayey silt till are provided on Figure 7.

4.2.6 Silty Sand to Silt Till

The clayey silt till in Boreholes M-2 to M-4 contains an essentially granular till interlayer which was found to range in thickness from 4 m to 8.5 m. This deposit grades in composition from silty sand to sand and silt, containing some gravel and trace clay. Grain size distribution test results obtained on five samples of this till are shown on Figure 8 following the text of this report. The granular till is typically compact to very dense, based on SPT "N" values of 22 to greater than 100 blows per 0.3 m of penetration with one value of 7 blows in Borehole M-3. Natural water contents of the samples of silty sand to sand and silt till vary from 9 to 19 per cent.

4.3 Groundwater Conditions

Standing water was present during the November 2003 field investigation in the low-lying area south of Mayfield Road. Water was encountered in all of the boreholes during drilling with water level depths ranging from about ground surface to 4.6 m below the existing ground surface (about Elevation 244.4 m to 248.8 m). Three piezometers were installed within the overburden soil deposits to monitor the groundwater level(s) at the site.

The water level measured in the piezometers on December 11, 2003 varied from Elevation 249.0 m to 249.6 m, typically about 0.2 m to 0.3 m above ground surface. The piezometer in Borehole M-2 was found to be plugged and the water level measured is not considered representative of the site conditions. The measured water levels are summarized in the following table:


<i>Borehole No.</i>	<i>Borehole Location</i>	<i>Water Level on Dec 11, 2003</i>	
		<i>Elevation</i>	<i>Depth</i>
M-1	West Approach	249.0 m	0.2 m above surface
M-2	West Abutment	232.6 m	Blocked at 19 m
M-3	Centre Pier	249.6 m	0.3 m above surface

These measurements reflect a groundwater table at about Elevation 249 m to 249.6 m. It should be noted that groundwater levels are expected to fluctuate seasonally and are expected to rise during wet periods of the year.

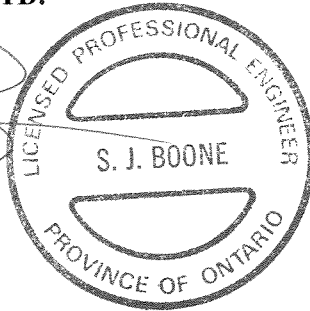
5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Storer Boone, P.Eng., an Associate and Senior Engineer with Golder, and reviewed by Ms. Anne Poschmann, a Principal with Golder. Mr. Fintan Heffernan, a Designated MTO Contact for Golder, conducted an independent review of the report.

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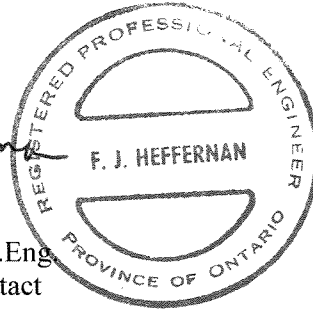
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Designated MTO Contact



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LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Consistency

	<u>kPa</u>	<u>psf</u>
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

(b) Cohesive Soils

c_u, s_u

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. General

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity index $= (w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 + \sigma_3)/2$ or $(\sigma'_1 + \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 + \sigma_3)$
S_t	sensitivity

- Notes:**
- 1 $\tau = c' + \sigma' \tan \phi'$
 - 2 shear strength $= (\text{compressive strength})/2$
 - * density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	> 2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	1 - 3 m
Moderately close	0.3 - 1 m
Close	50 - 300 mm
Very close	< 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 - 60 mm
Medium Grained	60 microns - 2 mm
Fine Grained	2 - 60 microns
Very Fine Grained	< 2 microns

Note: * Grains > 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B - Bedding	P - Polished
FO - Foliation/Schistosity	S - Slickensided
CL - Cleavage	SM - Smooth
SH - Shear Plane/Zone	R - Ridged/Rough
VN - Vein	ST - Stepped
F - Fault	PL - Planar
CO - Contact	FL - Flexured
J - Joint	UE - Uneven
FR - Fracture	W - Wavy
MF - Mechanical Fracture	C - Curved
- Parallel To	
⊥ - Perpendicular To	

PROJECT <u>001-1159-1</u>		RECORD OF BOREHOLE No M-1		1 OF 2	METRIC
W.P. <u>101-00-00</u>	LOCATION <u>N 4846298.0 : E 280719.0</u>	ORIGINATED BY <u>SB</u>			
DIST <u>HWY 410</u>	BOREHOLE TYPE <u>CME 55 Bombardier, 108 mm ID Hollow Stem Augers</u>	COMPILED BY <u>KG</u>			
DATUM <u>Geodetic</u>	DATE <u>November 6 to 7, 2003</u>	CHECKED BY <u>SP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L			
248.8 0.0	Ground Surface Peat, containing wood fragments, shells, and layers of organic silt Fibrous to amorphous Very soft Dark brown to black		1	SS	2										
			2	SS	WH										
			3	SS	WH										
			4	SS	WH										
			5	SS	WH										
			6	SS	WH										
			7	SS	WH										
242.3 6.5	Clayey Silt, trace sand Soft to firm Grey Moist		8	SS	WH										
241.3 7.5	Sand, trace silt Loose Grey-brown Moist		9	TO											
240.6 8.2	Silty Clay, trace sand Firm to stiff Grey Moist														
239.7 9.1	Silty Sand, trace gravel to Sand, some silt, some gravel Very loose to loose Grey Wet		10	SS	7									1 70 26 3	

MISS. MTO 001-1159-1-MTO.GPJ CN MOT.GDT 23/12/03

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

PROJECT	001-1159-1	RECORD OF BOREHOLE No M-1		2 OF 2	METRIC
W.P.	101-00-00	LOCATION	N 4846298.0 ; E 280719.0		ORIGINATED BY SB
DIST	HWY 410	BOREHOLE TYPE	CME 55 Bombardier, 108 mm ID Hollow Stem Augers		COMPILED BY KG
DATUM	Geodetic	DATE	November 6 to 7, 2003		CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE LIQUID LIMIT CONTENT CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L				
— CONTINUED FROM PREVIOUS PAGE —														
	Silty Sand, trace gravel to Sand, some silt, some gravel Very loose to loose Grey Wet		11	SS	2		238							
							237							
236.3 12.5	Silty Clay, trace sand and gravel Firm Grey Moist		12	SS	7		236							
235.4 13.4	Clayey Silt with sand, trace to some gravel (TILL), containing silty sand layers Very stiff Grey Moist		13	SS	15		235							10 51 28 11
							234							
233.0 15.9	End of Borehole		14	SS	26		233							
Notes: 1. Water level at ground surface during drilling operations. 2. Water level in piezometer at 0.15 m above ground surface (i.e. at Elevation 248.6 m) on Dec 11, 2003.														

MISS MTO 001-1159-1-MTO.GPJ ON_MOT.GDT 23/12/03

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

PROJECT 001-1159-1		RECORD OF BOREHOLE No M-2		1 OF 4	METRIC
W.P. 101-00-00		LOCATION N 4846317.0 E 280700.0		ORIGINATED BY <u>PKS</u>	
DIST _____ HWY 410		BOREHOLE TYPE CME 55 Bombardier, 108 mm ID Hollow Stem Augers		COMPILED BY <u>KG</u>	
DATUM Geodetic		DATE November 10 to 12, 2003		CHECKED BY <u>SP</u>	




SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED					WATER CONTENT (%) w _p w w _L				GR	SA	SI	CL
251.6 0.0	Ground Surface Sand and gravel, some silt and clay (FILL) Compact Brown Moist		1	SS	12															
250.8 0.8	Clayey silt, some sand and gravel, trace organics (FILL) Firm Grey-brown Moist		2	SS	7															
			3	SS	7															
249.5 2.1	Peat, trace sand Firm Dark brown Moist		4	SS	6															
248.6 3.1	Silty Sand to Sand and Silt, trace clay and gravel Loose to compact Grey Moist to wet		5	SS	10														5 34 57 4	
			6	SS	10															
			7	SS	7															
			8	SS	8														1 71 28 0	

MISS MTO 001-1159-1-MTO.GPJ ON MOT.GDT 23/12/03

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>001-1159-1</u>		RECORD OF BOREHOLE No M-2		2 OF 4	METRIC
W.P. <u>101-00-00</u>	LOCATION <u>N 4846317.0 : E 280700.0</u>	ORIGINATED BY <u>PKS</u>			
DIST <u> </u> HWY <u>410</u>	BOREHOLE TYPE <u>CME 55 Bombardier 108 mm ID Hollow Stem Augers</u>	COMPILED BY <u>KG</u>			
DATUM <u>Geodetic</u>	DATE <u>November 10 to 12, 2003</u>	CHECKED BY <u>SP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× REMOULDED		
— CONTINUED FROM PREVIOUS PAGE —																		
241.1 10.1	Sand and Silt, some gravel, trace clay (TILL) Compact Grey Moist		11	SS	18													
240.0 11.6	Clayey Silt, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		12	SS	22													
			13	SS	34													
			14	SS	35													
			15	SS	36													
			16	SS	46													
232.4 19.2	Silty Sand, trace to some gravel, trace clay (TILL) Compact Grey Wet																	

Continued Next Page

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

MISS MTO 001 1159-1-MTO GPJ ON MOT GDT 23/12/03


PROJECT <u>001-1159-1</u>		RECORD OF BOREHOLE No M-2		3 OF 4	METRIC
W.P. <u>101-00-00</u>	LOCATION <u>N 4846317.0 E 280700.0</u>	ORIGINATED BY <u>PKS</u>			
DIST <u>HWY 410</u>	BOREHOLE TYPE <u>CME 55 Bombardier, 108 mm ID Hollow Stem Augers</u>	COMPILED BY <u>KG</u>			
DATUM <u>Geodetic</u>	DATE <u>November 10 to 12, 2003</u>	CHECKED BY <u>SP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								UNCONFINED ● QUICK TRIAXIAL	FIELD VANE + REMOULDED X					
	— CONTINUED FROM PREVIOUS PAGE —													
	Silty Sand, trace to some gravel, trace clay (TILL) Compact Grey Wet		17	SS	25									
			18	SS	22									
			19	SS	22									
227.8 23.8	Silty Sand to Sand and Silt, trace gravel, trace clay (TILL) Very dense Grey Wet													
			20	SS	72									
			21	SS	58									
			22	SS	134									8 48 39 5
			23	SS	100/18									
221.7 29.9														

Continued Next Page

+ ³ X ³: Numbers refer to Sensitivity ○ ³% STRAIN AT FAILURE

MISS MTO 001-1159-1-MTO.GPJ ON MOT.GDT 23/12/03

PROJECT 001-1159-1		RECORD OF BOREHOLE No M-2		4 OF 4		METRIC						
W.P. 101-00-00		LOCATION N 4846317.0 ; E 280700.0		ORIGINATED BY PKS								
DIST HWY 410		BOREHOLE TYPE CME 55 Bombardier, 108 mm ID Hollow Stem Augers		COMPILED BY KG								
DATUM Geodetic		DATE November 10 to 12, 2003		CHECKED BY SP								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES	SHEAR STRENGTH kPa				WATER CONTENT (%)
— CONTINUED FROM PREVIOUS PAGE —												
220.9 30.7	Clayey Silt with sand, some gravel (TILL) Hard Grey Moist		24	SS	100/20	22.1						
	End of Borehole											
	Notes: 1. Water level in open borehole at 4.5 m depth (Elev. 247.1 m) during drilling operations. 2. Piezometer blocked and dry at 19 m depth (Elev. 232.6 m) on November 26, 2003.											

MISS_MTO_001-1159-1-MTO.GPJ ON_MOT.GDT 23/12/03

RECORD OF BOREHOLE No M-3

1 OF 3

METRIC

PROJECT 001-1159-1

W.P. 101-00-00

LOCATION N 4846343 1 E 280753 6

ORIGINATED BY PKS

DIST HWY 410

BOREHOLE TYPE CME 55 Bombardier 108 mm ID Hollow Stem Augers

COMPILED BY KG

DATUM Geodetic

DATE November 3 to 5 2003

CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
249.3 0.0	Ground Surface Clayey silt, some sand, some organics (FILL) Soft Brown Moist		1	SS	2									GR SA SI CL
248.5 0.8	PEAT, containing wood fragments, shells, and layers of organic silt Very soft to soft Fibrous to amorphous Dark brown to black		2	SS	1									
			3	SS	3									
			4	SS	WH									
			5	SS	WH									
			6	TO	-									
			7	SS	WH									
241.7 7.6	Clayey Silt, trace organics, containing sand seams Firm Grey Moist to wet		8	SS	WH									
			9	TO	-									

Continued Next Page

+ 3 X 3

Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

MISS_MTO_001-1159-1-MTO.GPJ ON_MOT.GDT 28/1/04

PROJECT 001-1159-1		RECORD OF BOREHOLE No M-3		2 OF 3	METRIC
W.P. 101-00-00		LOCATION N 4846343 1 E 280753 6		ORIGINATED BY PKS	
DIST HWY 410		BOREHOLE TYPE CME 55 Bombardier 108 mm ID Hollow Stem Augers		COMPILED BY KG	
DATUM Geodetic		DATE November 3 to 5, 2003		CHECKED BY SP	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p — w — w _L WATER CONTENT (%) 40 80 120	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES						
238.9	-- CONTINUED FROM PREVIOUS PAGE -- Clayey Silt, some sand, trace to some gravel, containing sand seams (TILL) Firm to very stiff Grey Moist to wet		10	SS	13	239					
10.4						238	X	+			
			11	SS	18	237					
			12	SS	22	236					
			13	SS	24	235					
			14	SS	17	234					
			15	SS	7	233					
230.1	Sand and Silt to Silt, trace gravel and clay (TILL) Loose to very dense Grey Moist to wet					232					
19.2						231					
						230					

6 22 49 33

Continued Next Page

+³ X³ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

MISS_MTO 001 1159-1-MTO GPJ ON MOT GDT 28/1/04

MISS MTO 001-1159-1-MTO.GPJ ON MOT GDT 28/1/04

+³ X³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

PROJECT <u>001-1159-1</u>		RECORD OF BOREHOLE No M-4		1 OF 3		METRIC	
W.P. <u>101-00-00</u>		LOCATION <u>N 4846386.0 E 280758.0</u>		ORIGINATED BY <u>PKS</u>			
DIST <u>HWY 410</u>		BOREHOLE TYPE <u>CME 55 Bombardier 108 mm ID Hollow Stem Augers</u>		COMPILED BY <u>KG</u>			
DATUM <u>Geodetic</u>		DATE <u>November 7 to 10, 2003</u>		CHECKED BY <u>SP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED						
251.1 0.0	Ground Surface Sand and gravel, some silt and clay (FILL) Compact Brown Moist		1	SS	14										
250.5 0.6	Clayey silt, some sand, trace gravel, trace organics (FILL) Soft to firm Brown to black Moist		2	SS	4										
			3	SS	4										
248.5 2.6	Peat, trace sand Firm Dark brown Moist		4	SS	9										
			5	SS	6										
247.4 3.7	Silty Clay, some sand, trace organics and shells Soft to firm Brown Wet		6	SS	4										
247.0 4.1	Sand, some silt to Silty Sand, trace to some gravel, trace clay Loose to compact Brown Wet		7	SS	7										
			8	SS	15										
			9	SS	5										
242.6 8.5	Clayey Silt, with sand, trace to some gravel (TILL) Very stiff to hard Grey-brown to grey Moist		10	SS	20										

Continued Next Page

+ 3 X 3 Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

MSS_MTO_001-1159-1-MTO.GPJ ON MOT.GDT 28/1/04

RECORD OF BOREHOLE No M-4

2 OF 3

METRIC

PROJECT 001-1159-1

W.P. 101-00-00

LOCATION N 4846386.0 E 280758.0

ORIGINATED BY PKS

DIST HWY 410

BOREHOLE TYPE CME 55 Bombardier 108 mm ID Hollow Stem Augers

COMPILED BY KG

DATUM Geodetic

DATE November 7 to 10, 2003

CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	w _p			w	w _L	GR	SA	SI
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa			WATER CONTENT (%)									
								○ UNCONFINED + FIELD VANE			● QUICK TRIAXIAL X REMOULDED									
								20	40	60	80	100	40	80	120					
	Clayey Silt, with sand, trace to some gravel (TILL) Very stiff to hard Grey-brown to grey Moist		11	SS	18												6	40	37	17
			12	SS	20															
			13	SS	100/15															
			14	SS	34															
			15	SS	36															
			16	SS	45															
232.9 18.3	Sand and Silt to Silt, trace gravel, sand and clay (TILL) Dense to Very Dense Grey Wet																7	39	48	6

Continued Next Page

+ 3 X 3

Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

PROJECT <u>001-1159-1</u>		RECORD OF BOREHOLE No M-4		3 OF 3	METRIC
W.P. <u>101-00-00</u>	LOCATION <u>N 4846386 0 E 280758 0</u>	ORIGINATED BY <u>PKS</u>			
DIST <u> </u> HWY <u>410</u>	BOREHOLE TYPE <u>CME 55 Bombardier 108 mm ID Hollow Stem Augers</u>	COMPILED BY <u>KG</u>			
DATUM <u>Geodetic</u>	DATE <u>November 7 to 10, 2003</u>	CHECKED BY <u>SP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT <div style="text-align: center;"> </div>	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
	--- CONTINUED FROM PREVIOUS PAGE ---												
	Sand and Silt to Silt, trace gravel, sand and clay (TILL) Dense to Very Dense Grey Wet		17	SS	25		23.1						
							230						
			18	SS	46								
							220						
			19	SS	80		228						0 5 89 6
							227						
			20	SS	110								
							226						
			21	SS	100/20		225						
224.3 26.8	Clayey Silt, some sand and gravel (TILL) Hard Grey Moist						224						
			22	SS	100/18								
222.5 28.7	Gravelly Sand, trace silt and clay Very dense Grey Wet						223						
222.1 29.0	End of Borehole		23	SS	100/15								

MISS_MTO_001-1159-1-MTO.GPJ ON MOT.GDT 28/1/04

RECORD OF BOREHOLE No M-5

1 OF 2

METRIC

PROJECT 001-1159-1

W.P. 101-00-00

LOCATION N 4846397 0 E 280798 0

ORIGINATED BY GPD

DIST HWY 410

BOREHOLE TYPE CME 55 Bombardier, 108 mm ID Hollow Stem Augers

COMPILED BY KG

DATUM Geodetic

DATE November 11, 2003

CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
249.0 0.0	Ground Surface Silty Sand, containing wood fragments and organics (FILL) Very loose Dark brown Wet		1	SS	1		20 40 60 80 100	20 40 60 80 100	40 80 120	kN/m ³	GR SA SI CL						
			2	SS	1												
247.6 1.4	Peat, containing wood fragments and layers of organic silt Fibrous to amorphous Very soft Brown to black Wet		3	SS	WH							247					
			4	SS	WH							246					
			5	SS	WH												
245.3 3.7	Sandy Silt, some clay, trace gravel Very loose Brown to grey Wet		6	SS	WH							245					
			7	SS	1							244					
244.1 4.9	Clayey Silt with sand, trace gravel Firm Grey Moist		8	TO	-							243	X +				
			9	SS	15							241					
241.7 7.3	Clayey Silt with sand, some gravel (TILL) Very stiff Grey Moist		10	SS	22							240					

Continued Next Page

+ 3 X 3

Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

MISS MTO 001-1159-1-MTO GPJ ON MOT GDT 28/1/04

RECORD OF BOREHOLE No M-5

2 OF 2

METRIC

PROJECT 001-1159-1

W.P. 101-00-00

LOCATION N 4846397.0 E 280798.0

ORIGINATED BY GPD

DIST HWY 410

BOREHOLE TYPE CME 55 Bombardier 108 mm ID Hollow Stem Augers

COMPILED BY KG

DATUM Geodetic

DATE November 11, 2003

CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		GR
	— CONTINUED FROM PREVIOUS PAGE —																		
	Clayey Silt with sand, some gravel (TILL) Very stiff Grey Moist		11	SS	26		238												
							237												
			12	SS	23		236									17	29	39	15
			13	SS	21		235												
234.4																			
14.6	Silty Sand, trace gravel and clay Loose Grey Wet						234												
			14	SS	6														
233.3	End of Borehole																		
15.7	Note: 1. Water level in open borehole at 4.6 m depth (Elev. 244.4 m) during drilling																		

+ 3 X 3

Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

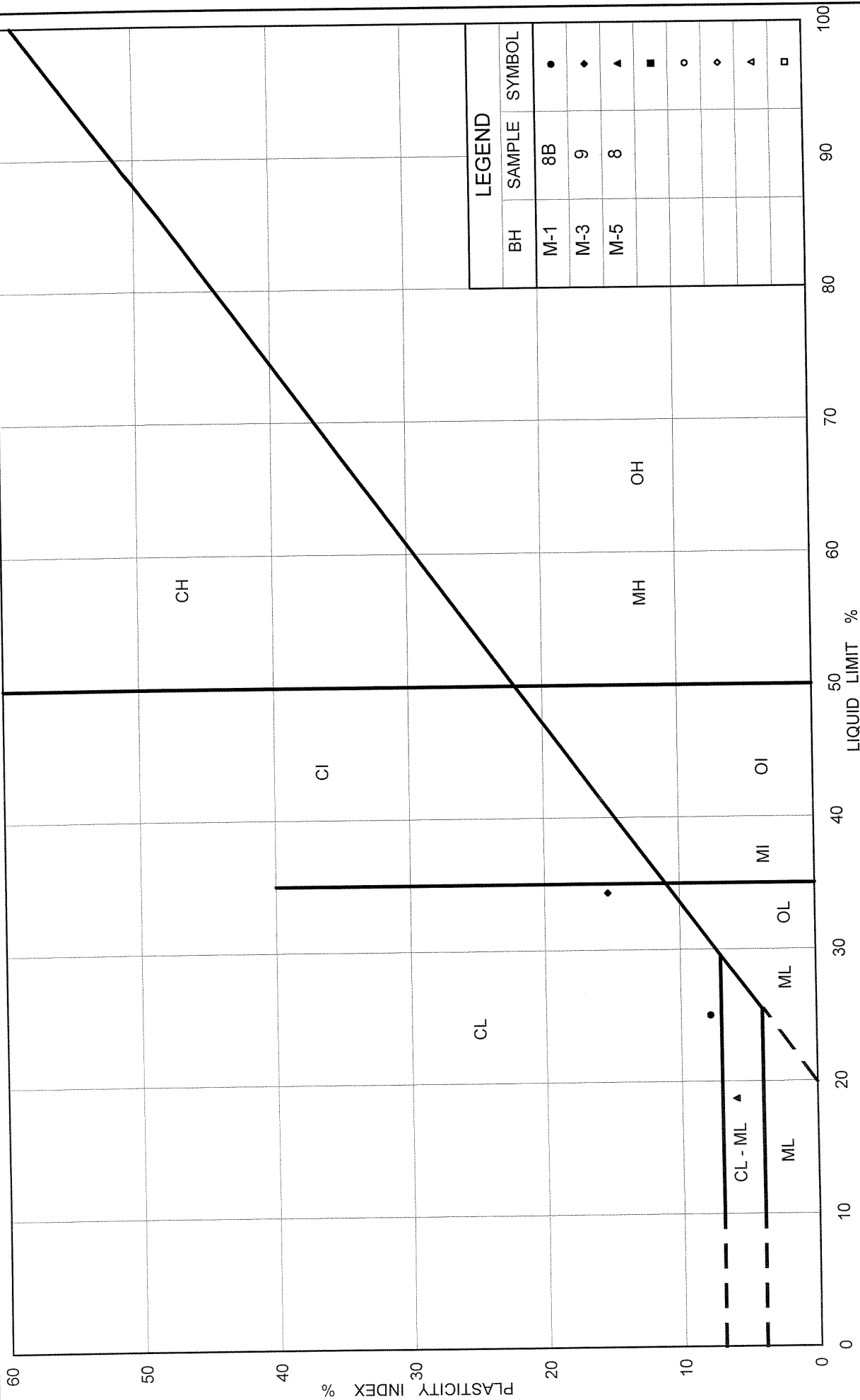


FIG No. 1

PLASTICITY CHART

Silty Clay to Clayey Silt

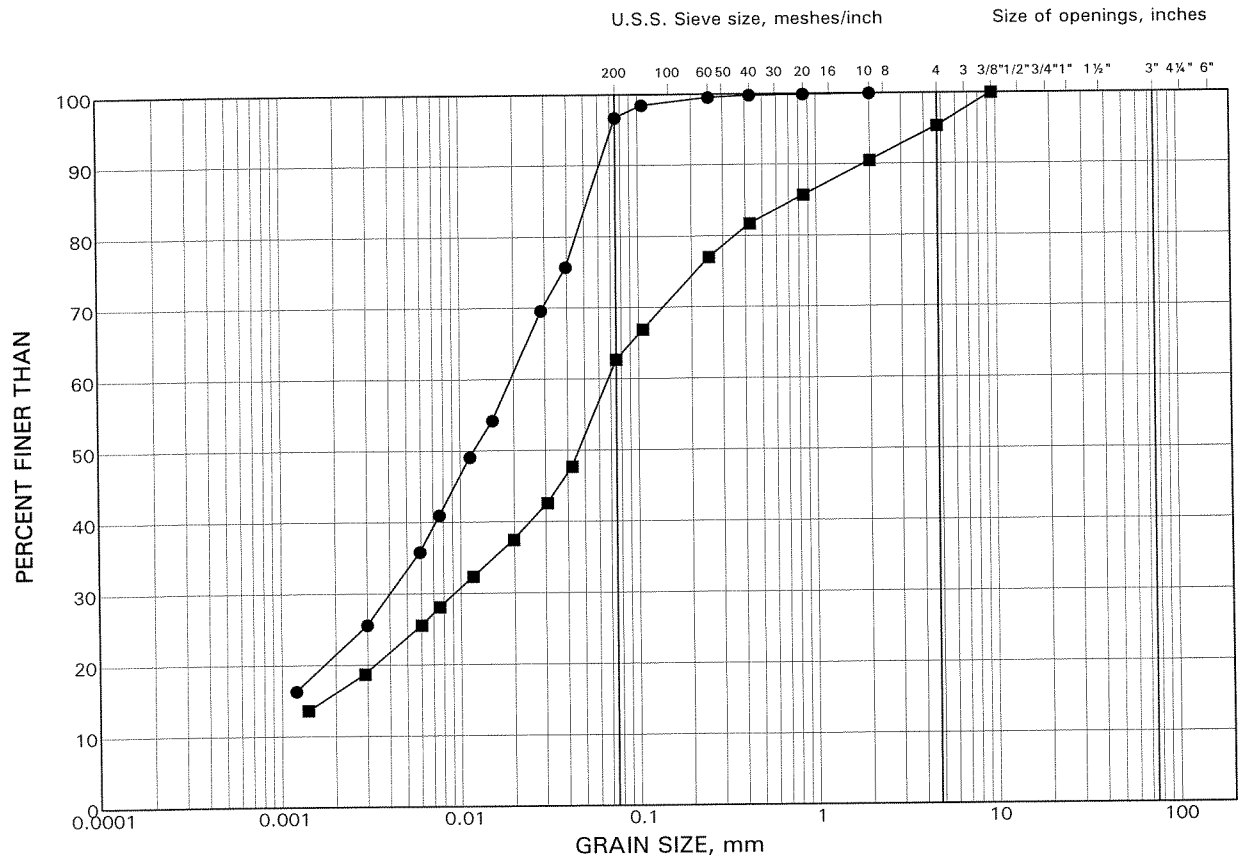
Ministry of Transportation

Project No. 001-1159-1

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silty Clay to Clayey Silt

FIGURE 2



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	M-3	9	240.8
■	M-5	8	242.6

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	001-1159-1	Sample Number	9
Borehole Number	M-3	Sample Depth, m	8.2-8.8

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	5		
Date Started	11/26/2003		
Date Completed	12/06/2003		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.91	Unit Weight, kN/m ³	17.95
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	12.94
Area, cm ²	31.67	Specific Gravity, measured	2.71
Volume, cm ³	60.49	Solids Height, cm	0.930
Water Content, %	38.74	Volume of Solids, cm ³	29.45
Wet Mass, g	110.71	Volume of Voids, cm ³	31.04
Dry Mass, g	79.8	Degree of Saturation, %	99.6

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv, cm ² /s	mv m ² /kN	k cm/s
0.00	1.910	1.054	1.910				
4.70	1.878	1.020	1.894	960	7.92E-04	3.56E-03	2.77E-07
9.54	1.863	1.004	1.871	551	1.35E-03	1.62E-03	2.14E-07
19.29	1.835	0.974	1.849	413	1.75E-03	1.50E-03	2.59E-07
38.71	1.794	0.929	1.815	338	2.07E-03	1.11E-03	2.24E-07
77.44	1.739	0.870	1.767	271	2.44E-03	7.44E-04	1.78E-07
154.67	1.673	0.799	1.706	197	3.13E-03	4.47E-04	1.37E-07
309.92	1.604	0.725	1.639	225	2.53E-03	2.33E-04	5.77E-08
619.28	1.533	0.649	1.569	94	5.55E-03	1.20E-04	6.53E-08
1238.23	1.457	0.567	1.495	68	6.97E-03	6.46E-05	4.41E-08
2475.16	1.384	0.488	1.420	85	5.03E-03	3.07E-05	1.52E-08
1238.23	1.389	0.494	1.387				
309.92	1.406	0.512	1.398				
77.44	1.428	0.536	1.417				
19.29	1.450	0.559	1.439				
4.70	1.483	0.595	1.467				

Notes:

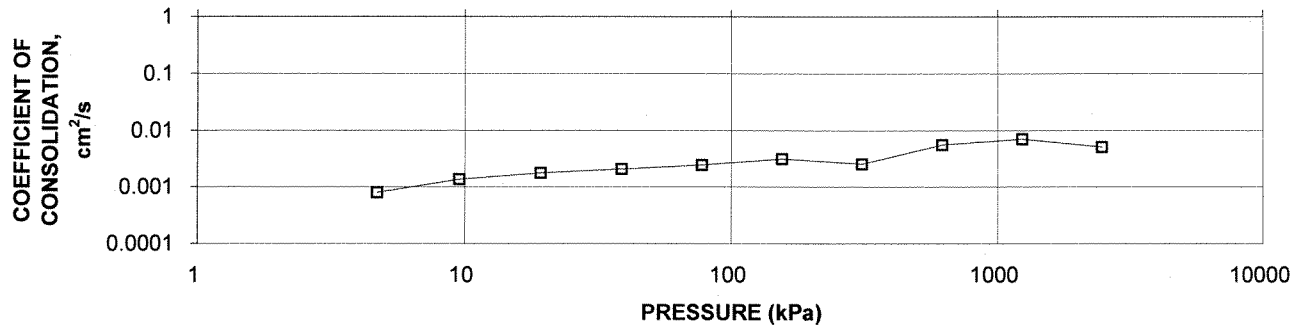
k calculated using cv based on t₉₀ values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

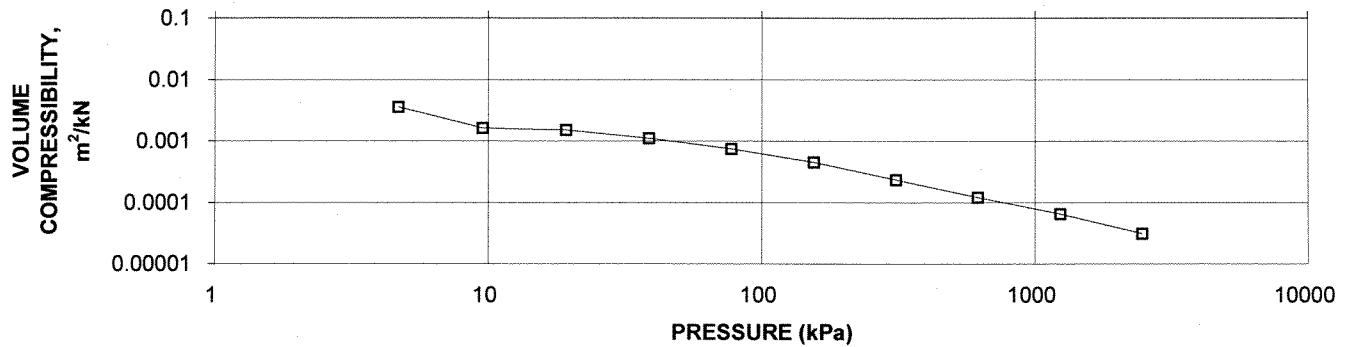
Sample Height, cm	1.48	Unit Weight, kN/m ³	20.43
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	16.66
Area, cm ²	31.67	Specific Gravity, measured	2.71
Volume, cm ³	46.97	Solids Height, cm	0.930
Water Content, %	22.63	Volume of Solids, cm ³	29.45
Wet Mass, g	97.86	Volume of Voids, cm ³	17.52
Dry Mass, g	79.8		

OEDOMETER CONSOLIDATION SUMMARY

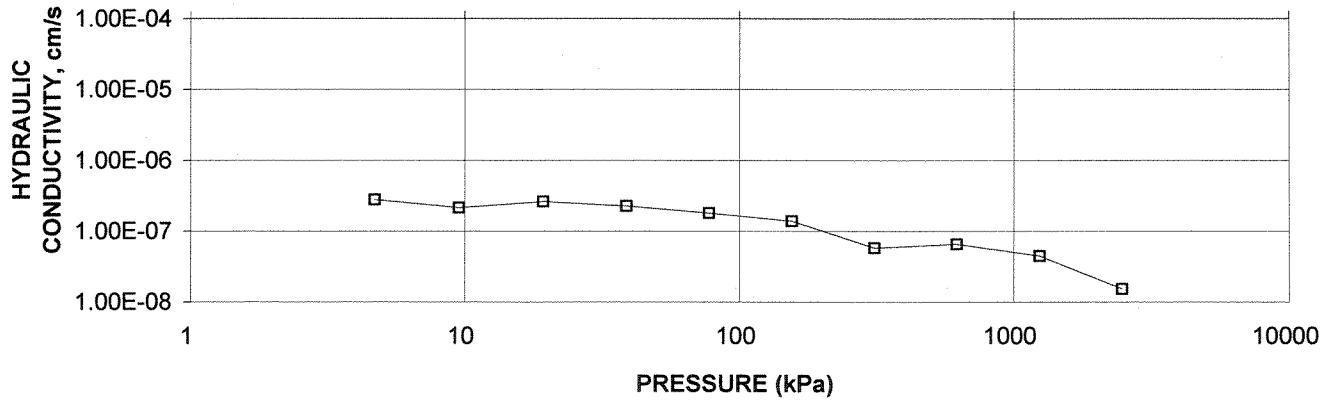
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH M-3 SA 9



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH M-3 SA 9



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH M-3 SA 9



CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE

FIGURE 3A

CONSOLIDATION TEST
VOID RATIO vs PRESSURE
BH M-3 SA 9

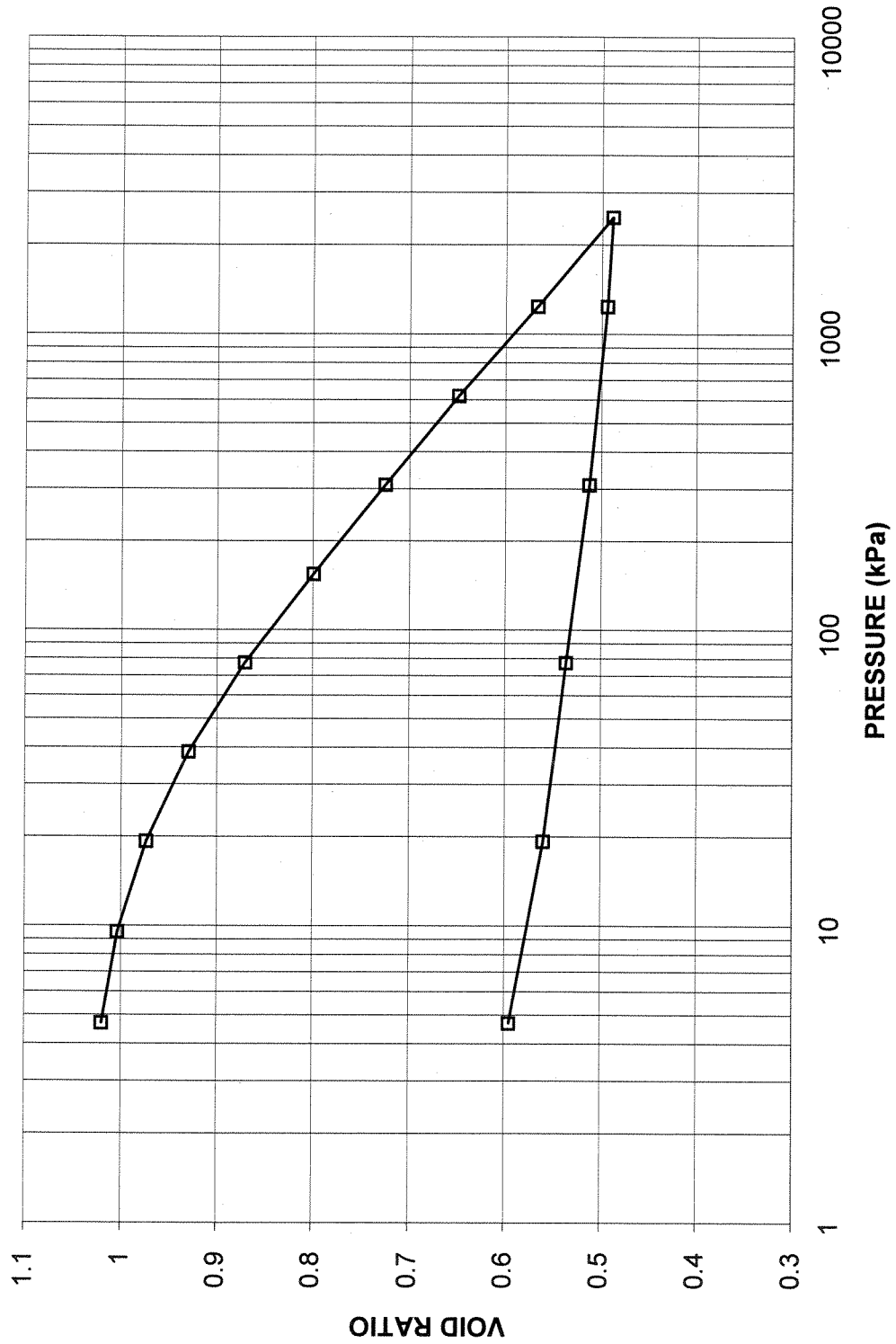
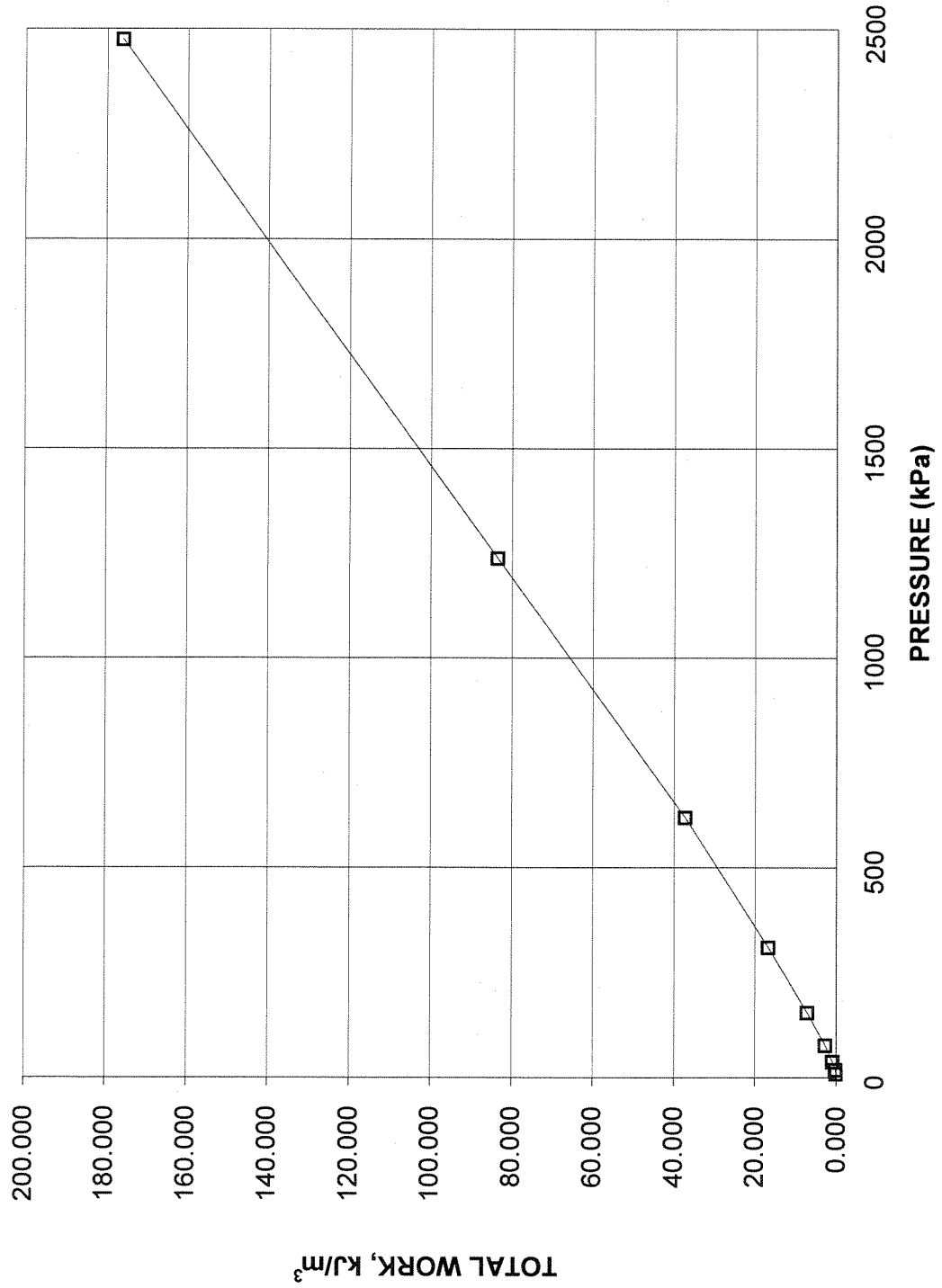


FIGURE 3B

CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs PRESSURE
BH M-3 SA 9



OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	001-1159-1	Sample Number	8
Borehole Number	M-5	Sample Depth, m	6.1-6.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	6		
Date Started	11/26/2003		
Date Completed	12/06/2003		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m ³	22.97
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	20.55
Area, cm ²	31.67	Specific Gravity, measured	2.74
Volume, cm ³	60.17	Solids Height, cm	1.453
Water Content, %	11.74	Volume of Solids, cm ³	46.03
Wet Mass, g	140.92	Volume of Voids, cm ³	14.14
Dry Mass, g	126.12	Degree of Saturation, %	104.7

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	1.900	0.307	1.900				
4.75	1.865	0.283	1.883	5415	1.39E-04	3.88E-03	5.27E-08
9.54	1.858	0.278	1.862	1898	3.87E-04	7.69E-04	2.92E-08
19.25	1.847	0.271	1.853	2027	3.59E-04	5.96E-04	2.10E-08
38.68	1.830	0.259	1.839	816	8.78E-04	4.60E-04	3.96E-08
77.38	1.810	0.245	1.820	394	1.78E-03	2.72E-04	4.75E-08
154.68	1.788	0.230	1.799	240	2.86E-03	1.50E-04	4.20E-08
309.73	1.763	0.213	1.776	152	4.40E-03	8.49E-05	3.66E-08
617.92	1.737	0.195	1.750	113	5.75E-03	4.44E-05	2.50E-08
1235.94	1.706	0.174	1.722	76	8.27E-03	2.64E-05	2.14E-08
2473.12	1.667	0.147	1.687	94	6.41E-03	1.66E-05	1.04E-08
1235.94	1.676	0.153	1.672				
309.73	1.692	0.164	1.684				
77.38	1.703	0.172	1.698				
19.25	1.719	0.183	1.711				
4.75	1.740	0.197	1.730				

Notes:

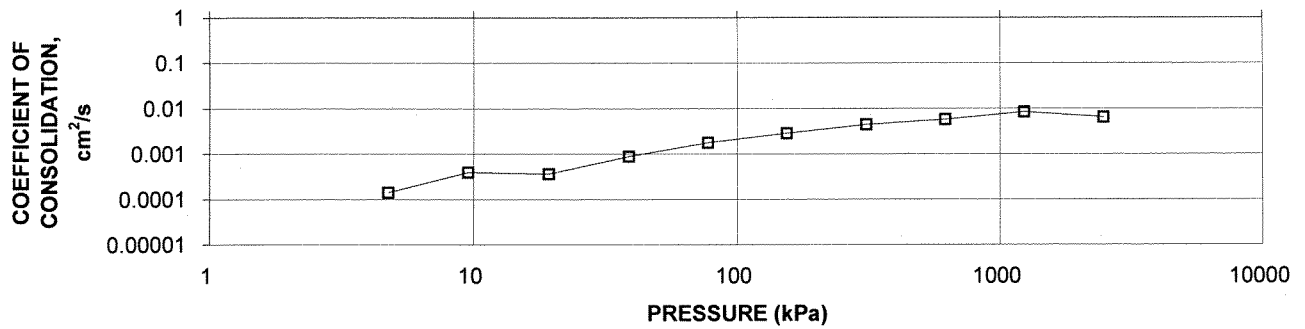
k calculated using cv based on t₉₀ values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

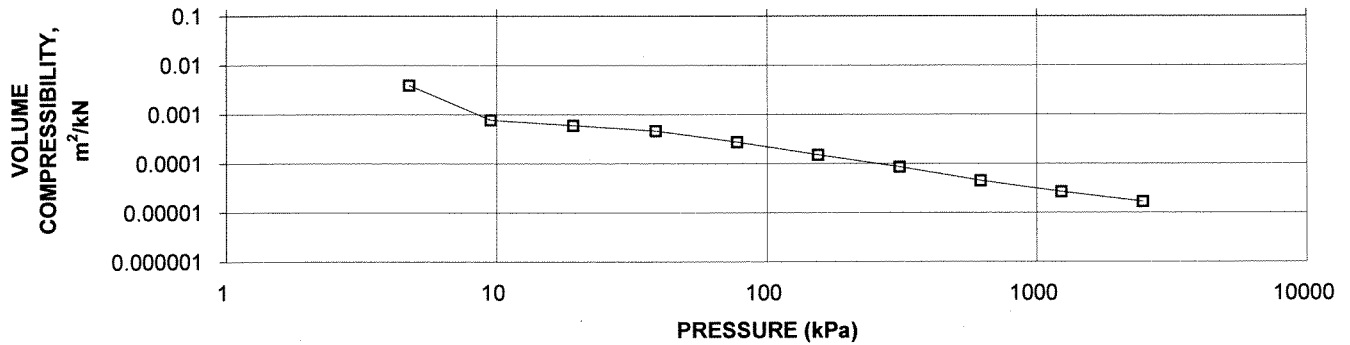
Sample Height, cm	1.74	Unit Weight, kN/m ³	24.85
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	22.44
Area, cm ²	31.67	Specific Gravity, measured	2.74
Volume, cm ³	55.10	Solids Height, cm	1.453
Water Content, %	10.72	Volume of Solids, cm ³	46.03
Wet Mass, g	139.64	Volume of Voids, cm ³	9.08
Dry Mass, g	126.12		

OEDOMETER CONSOLIDATION SUMMARY

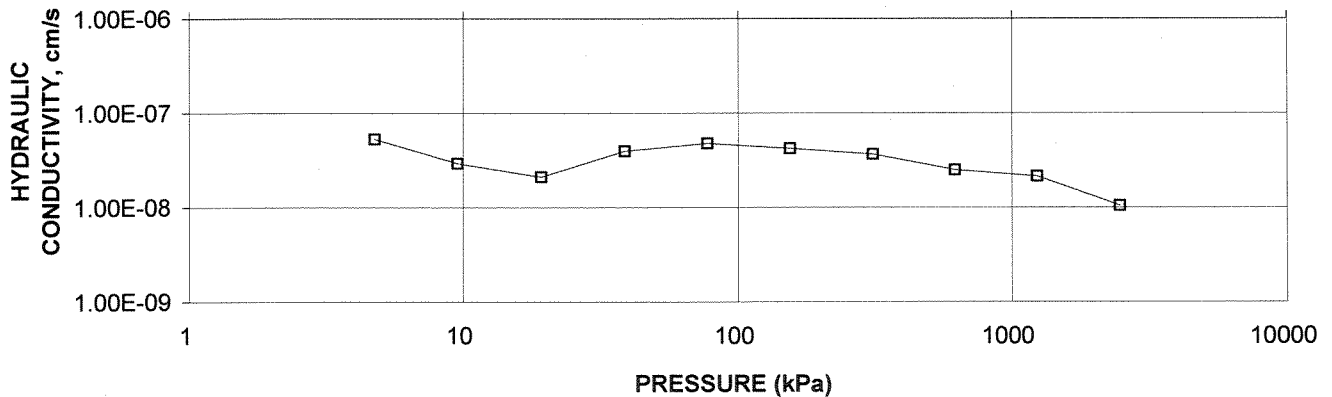
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH M-5 SA 8



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH M-5 SA 8



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH M-5 SA 8



CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE

FIGURE 4A

CONSOLIDATION TEST
VOID RATIO vs PRESSURE
BH M-5 SA 8

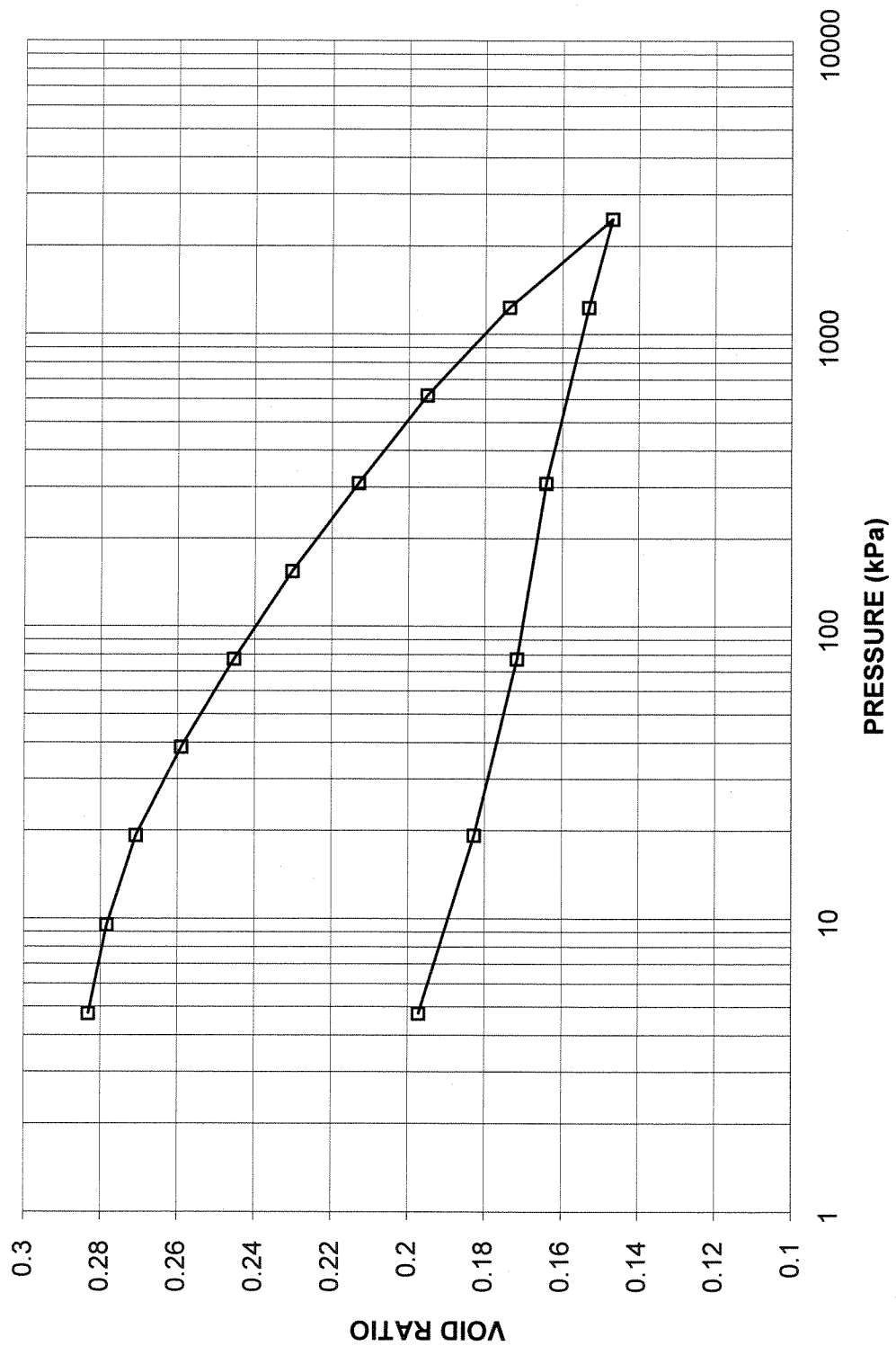
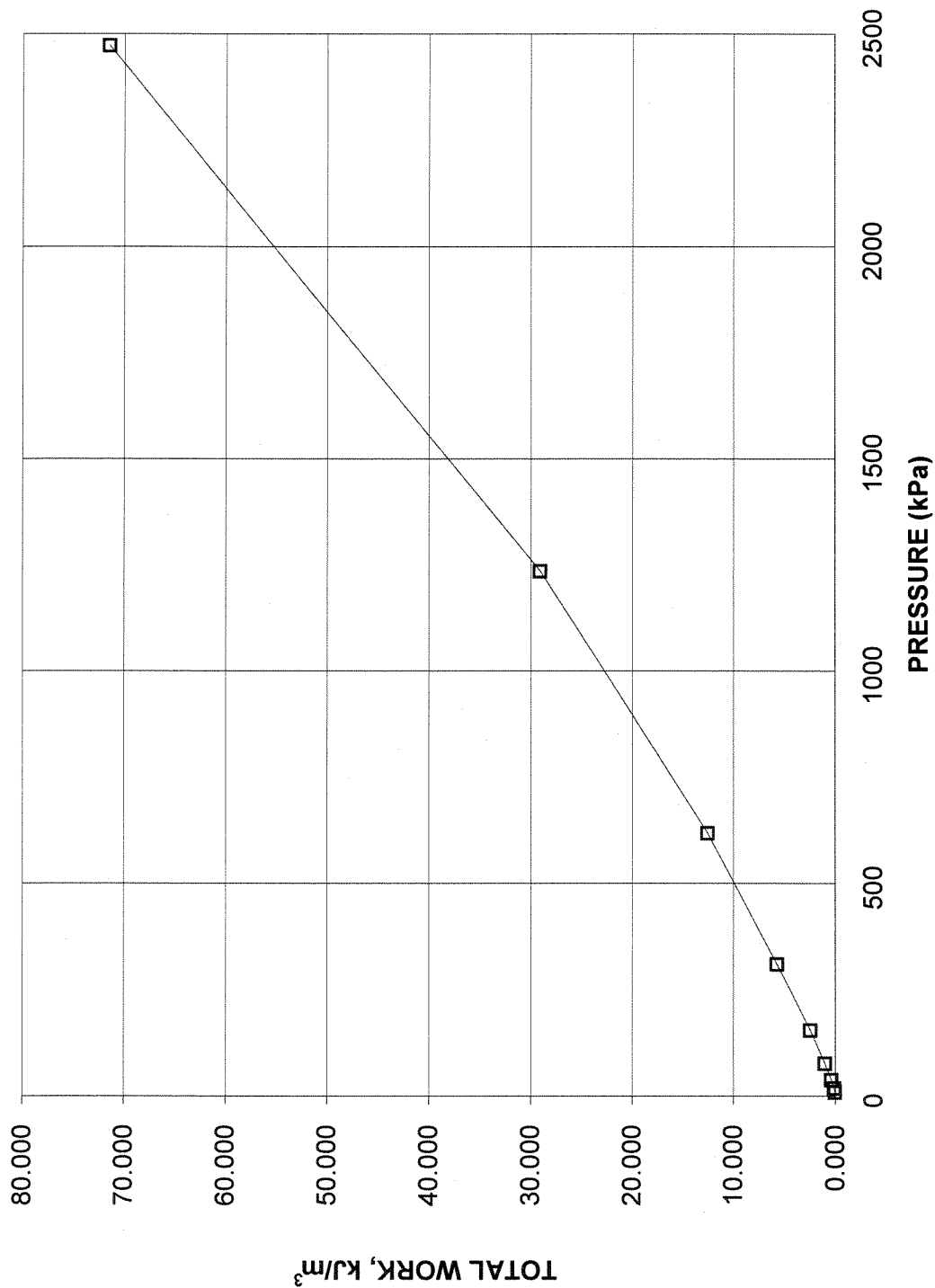


FIGURE 4B

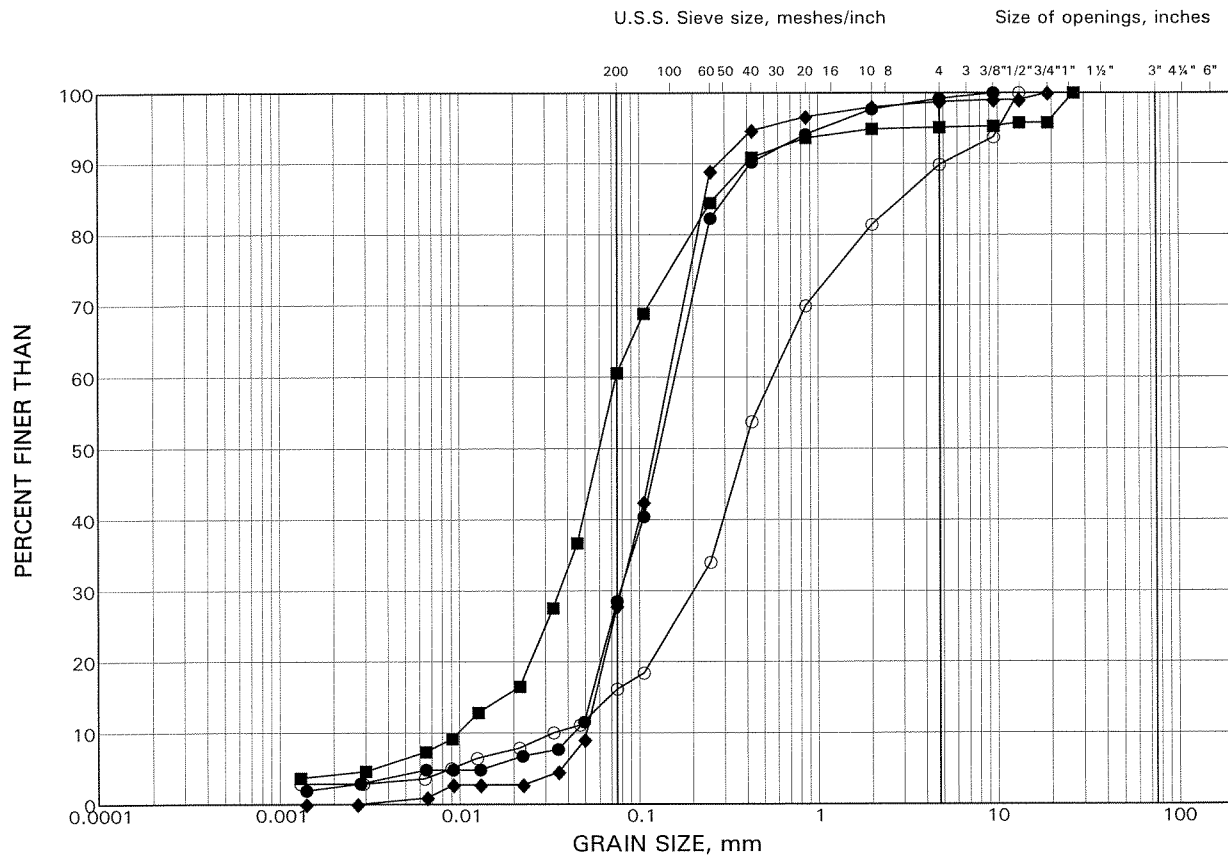
CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs PRESSURE
BH M-5 SA 8



GRAIN SIZE DISTRIBUTION TEST RESULTS

Silty Sand to Sandy Silt

FIGURE 5



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	M-1	10	239.4
■	M-2	5	248.4
◆	M-2	8	245.3
○	M-4	7	246.3

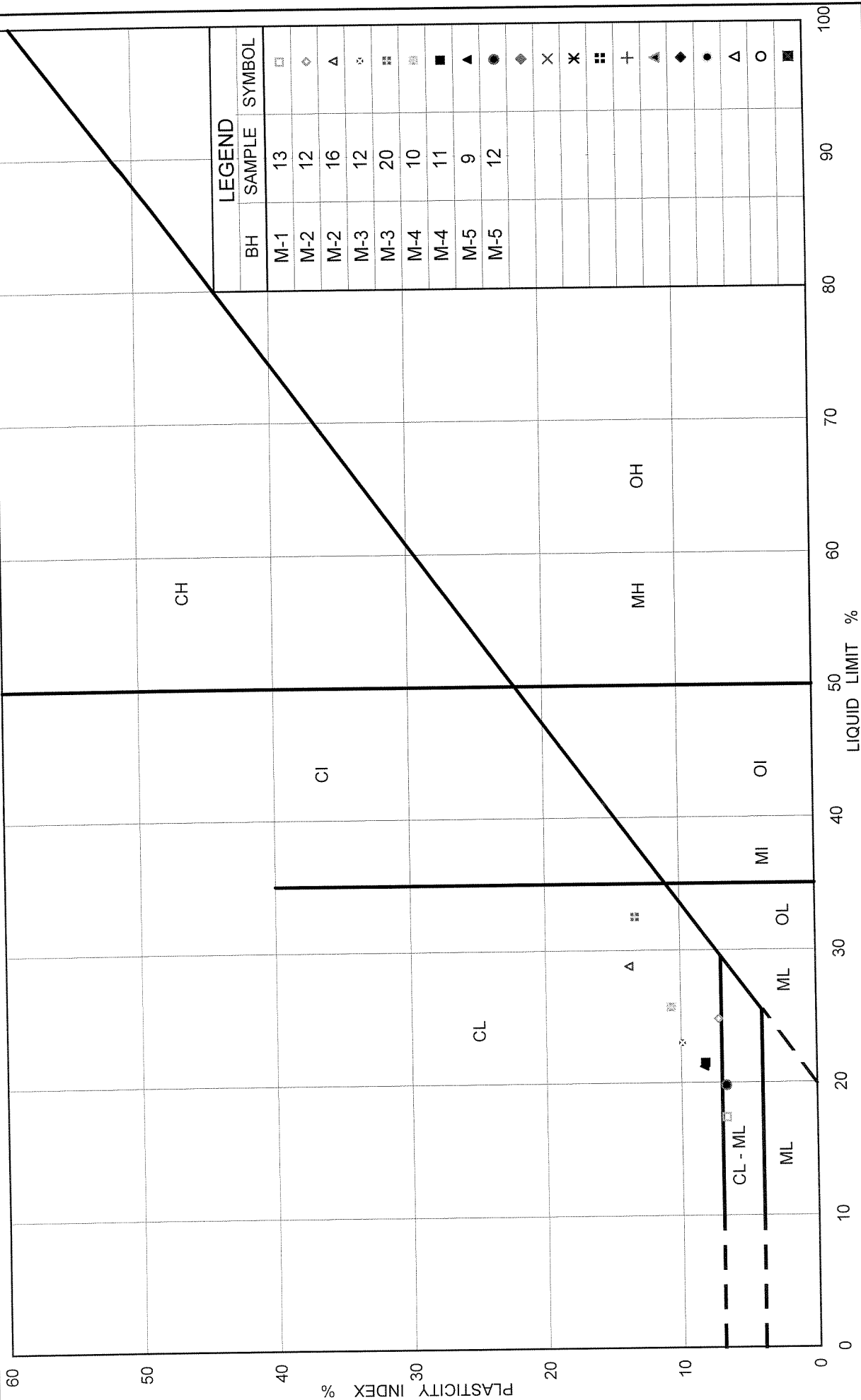


FIG No. 6

PLASTICITY CHART

Clayey Silt Till

Ministry of Transportation



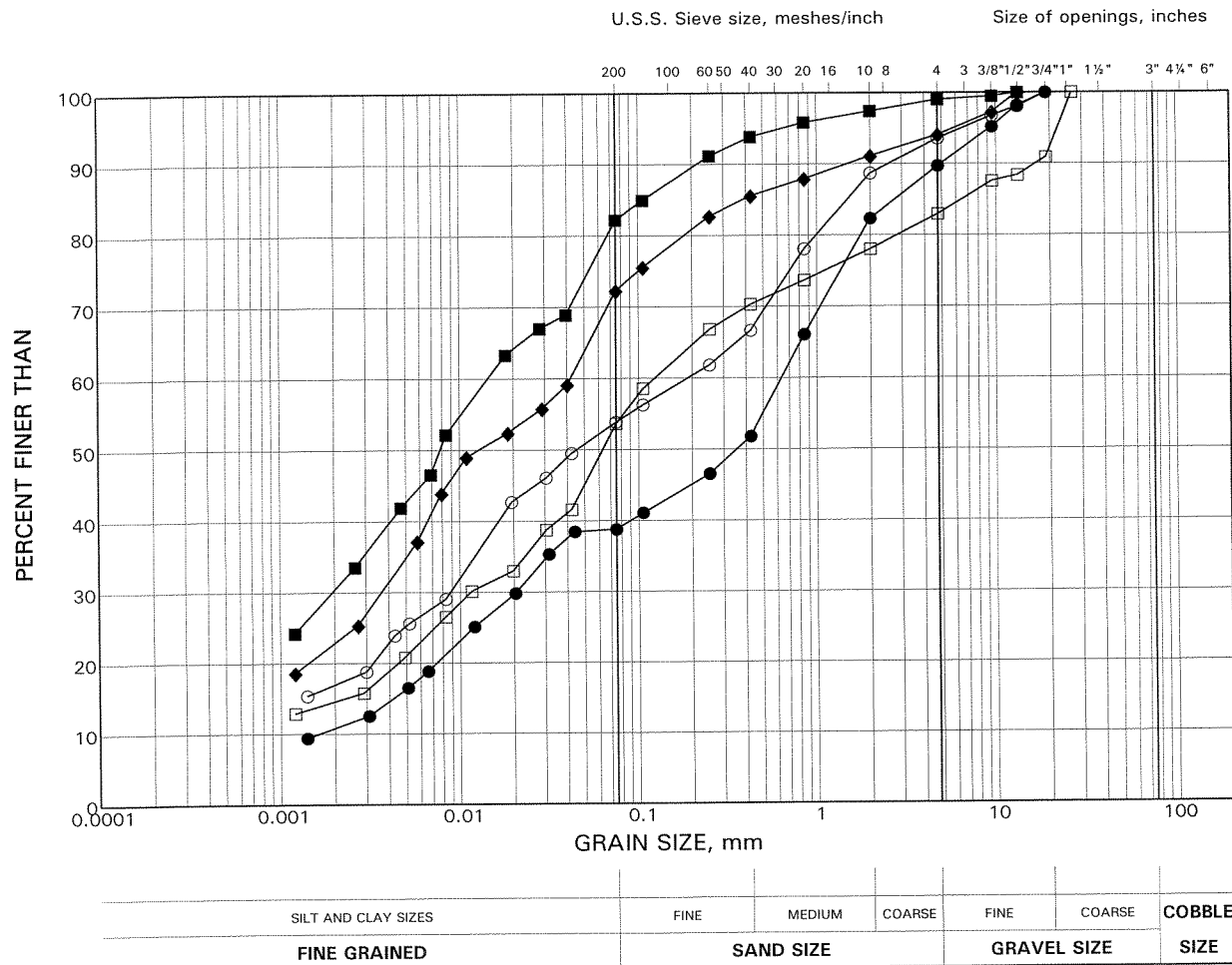
Ontario

Project No. 001-1159-1

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till

FIGURE 7



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	M-1	13	234.8
■	M-2	12	239.2
◆	M-3	12	235.4
○	M-4	11	240.2
□	M-5	12	236.6

Date December, 2005

Project 001-1159-1

Golder Associates

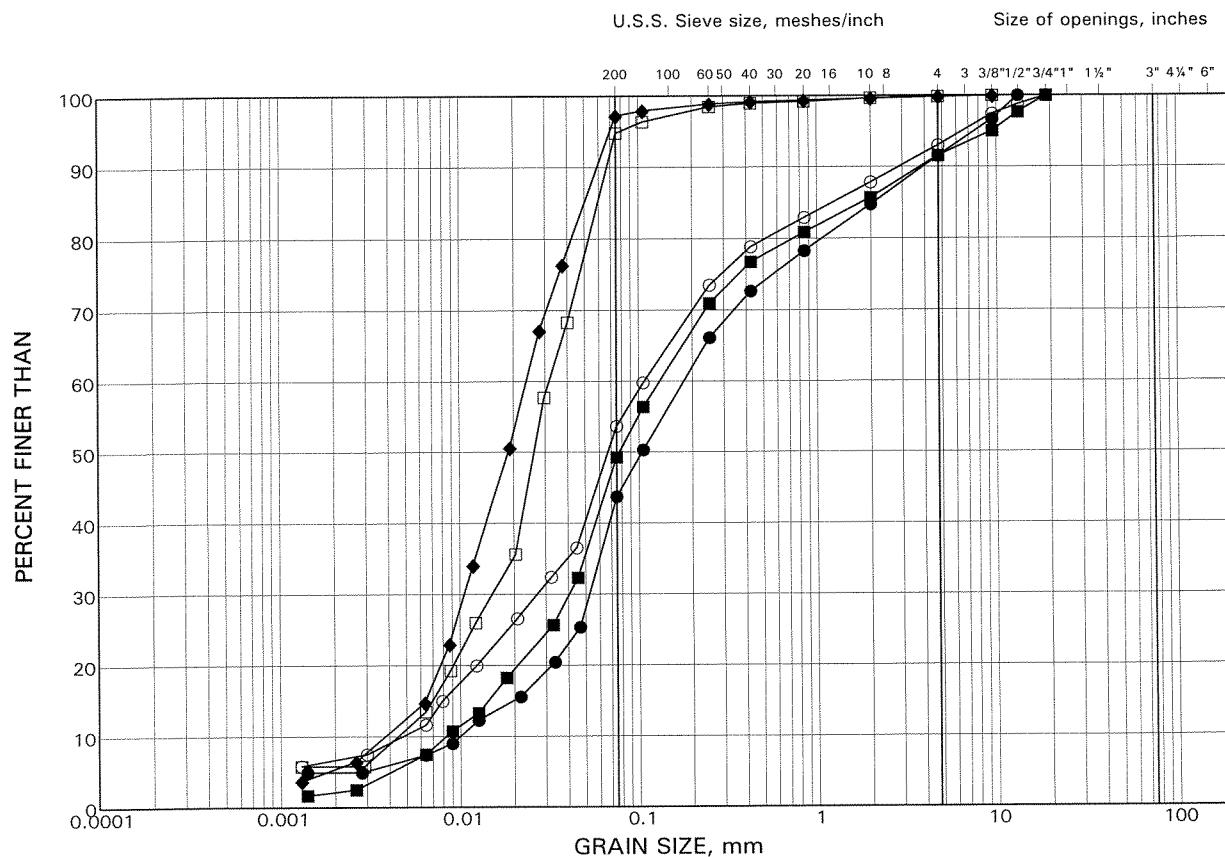
Prepared by LG

Checked by

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Silt to Silt Till

FIGURE 8



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	M-2	22	224.0
■	M-3	16	229.3
◆	M-3	18	226.4
○	M-4	16	232.6
□	M-4	19	228.0

APPENDIX A

RECORDS OF BOREHOLES PREVIOUS INVESTIGATIONS

PROJECT 001-1159-1 **RECORD OF BOREHOLE No C-M4-1-1** 1 OF 2 **METRIC**
W.P. 101-00-00 LOCATION N 4846354.8 E 280760.5 ORIGINATED BY PKS
DIST HWY 410 BOREHOLE TYPE CME 55 Bombardier, 108 mm ID Hollow Stem Augers COMPILED BY KG
DATUM Geodetic DATE June 11/12, 2001 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80	100	20
249.5 0.0	Ground Surface Peat, containing shells and layers of marl Fibrous to amorphous Very soft to soft Dark brown to black Wet		1	SS	3													
			2	SS	3													
			3	SS	2												435.6	
			4	SS	2													
			5	SS	2													
			6	SS	3												277.6	
			7	SS	2													
			8	TO	PH													
243.4 6.1	Organic Silty Clay Soft Grey-brown Moist to wet		9	SS	3												O.C. 7.9%	
241.7 7.8	Silty Clay containing fine sand seams Very soft to soft Grey Wet		10	SS	WH													
			11	TO	PH													
			12	SS	2													

PROJECT <u>001-1159-1</u>		RECORD OF BOREHOLE No C-M4-1-1		2 OF 2	METRIC
W.P. <u>101-00-00</u>	LOCATION <u>N 4846354.8 ; E 280760.5</u>	ORIGINATED BY <u>PKS</u>			
DIST <u>HWY 410</u>	BOREHOLE TYPE <u>CME 55 Bombardier, 108 mm ID Hollow Stem Augers</u>	COMPILED BY <u>KG</u>			
DATUM <u>Geodetic</u>	DATE <u>June 11/12, 2001</u>	CHECKED BY <u>SP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
	— CONTINUED FROM PREVIOUS PAGE —							20 40 60 80 100		W _p W W _L				
238.8	Silty Clay containing fine sand seams Very soft to soft Grey Wet							20 40 60 80 100		40 80 120				
10.7	Clayey Silt with sand, trace gravel (TILL) Stiff to very stiff Grey Wet		13	SS	10									
			14	SS	20									
			15	SS	24									
			16	SS	20									
233.7	End of Borehole													
15.9	Notes: 1. Approximately 75 mm of standing water present at ground surface prior to drilling. 2. Water level in open borehole at 6.1 m depth (Elev. 243.4 m) upon completion of drilling.													

MISS_MTO_001-1159-1-MTO.GPJ ON MOT.GDT 23/12/03

Continued Next Page

+³, X³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

PROJECT 001-1159-1

RECORD OF BOREHOLE No C-M4-1-2

2 OF 2

METRIC

W.P. 101-00-00

LOCATION N 4846328.3 ; E 280738.0

ORIGINATED BY PKS

DIST HWY 410


BOREHOLE TYPE CME 55 Bombardier, 108 mm ID Hollow Stem Augers

COMPILED BY KG

DATUM Geodetic

DATE June 12, 2001

CHECKED BY SP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W			W _L			
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED					WATER CONTENT (%)									
						20	40	60	80	100	20	40	60	80	100	40	80	120		
— CONTINUED FROM PREVIOUS PAGE —																				
	Clayey Silt with sand, trace gravel (TILL) Firm to hard Grey Wet		11	SS	33															
237.0			12	SS	36															
12.8	End of Borehole																			
	Notes: 1. Approximately 25 mm of standing water present at ground surface prior to drilling. 2. Water level in open borehole at 7.6 m depth (Elev. 242.2 m) upon completion of drilling.																			

METRIC

CONCRETE REPORT ON SOIL EXPLORATION

* 3, x 5 : Numbers refer to Sensitivity

RECORD OF BOREHOLE No 8 (SITE 3) METRIC

W P 22-79-00 LOCATION Co-ords. N 4 846 112 E 280 752 ORIGINATED BY BB
 DIST 6 HWY 410 BOREHOLE TYPE Cone Penetration Test COMPILED BY BB
 DATUM Geodetic DATE 88 10 26 CHECKED BY BB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLAST. C LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
248.3	Ground Surface						248										
0.0							246										
	Probable Peat						244										
242.3							242										
6.0							240										
	Probable Clayey Silt to Silt						238										
235.8							236										
12.5	End of Cone Test						234										

OFFICE REPORT ON SOIL EXPLORATION

3, x 5 : Numbers refer to Sensitivity
 20
 15
 10
 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 9 (SITE 3)

METRIC

W P 22-79-00 LOCATION Co-ords. N 4 846 140 E 280 768 ORIGINATED BY BB
 DIST 6 HWY 410 BOREHOLE TYPE Cone Penetration Test, RS Auger COMPILED BY BB
 DATUM Geodetic DATE 88 10 26 - 27 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
248.2 0.0	Ground Surface						248							
	Peat		1	SS	3									
	Varying proportions of Sand and Silt		2	SS	2									
			3	SS	1									
	Very Loose/ Very Soft		4	SS	1									
			5	SS	1									
			6	SS	0									
242.4 5.8	Clayey Silt to Silt		7	TW	PM		242							
	Some/With Sand		8	SS	7									
	Trace/Some Gravel		9	SS	10									
	Very Soft to Hard		10	SS	23									
			11	SS	41									
			12	SS	39									
			13	SS	22									
231.7 16.5	Silt to Sandy Silt		14	SS	18									
	Trace/Some Gravel													
	Compact to Very Dense		15	SS	60	15 cm								
228.3 19.9	End of Borehole													

3, 5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13 (SITE 3) METRIC

W P 22-79-00 LOCATION Co-ords. N 4 846 132 E 280 704 ORIGINATED BY BB
 DIST 6 HWY 410 BOREHOLE TYPE Cone, HS Auger, BX Casing, Washbore COMPILED BY FP
 DATUM Geodetic DATE 88 10 31 - 88 11 04 CHECKED BY /

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
249.8	Ground Surface											GR SA SI CL
0.0	Silty Sand to Sandy Silt Trace Gravel Occasional Clayey Silt Zones Compact	1 SS 11										5 46 (49)
		2 SS 16										7 35 (38)
		3 SS 20										
		4 SS 19										
246.0												
3.8	Sand Trace/Some Silt Trace Clay Loose	5 SS 6										0 81 (19)
		6 SS 9										
243.2												
6.6	Silty Sand Trace Gravel Trace Clay Loose to Compact	7 SS 29										
		8 SS 17										
		9 SS 24										
		10 SS 16										
		11 SS 18										
		12 SS 8										0 49 (51)
233.6												
16.2	Sand Some Silt Loose to Compact	13 SS 12										0 92 (8)
		14 SS 6										
230.3												
19.5	Sand, Silt and Gravel Mixture Trace Clay. Compact to Very Dense	15 SS 12										
		16 SS 64										
		17 SS 48										9 48 (43)
		18 SS 77										
224.0	Boulder											
25.8	End of Borehole											

3, 5 Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 14 (SITE 3) METRIC

W P 22-79-00 LOCATION Co-ords. N 4 846 110 E 280 684 ORIGINATED BY BB
 DIST 5 HWY 410 BOREHOLE TYPE Cone Penetration Test COMPILED BY BB
 DATUM Geodetic DATE 88 11 04 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
251.01	Ground Surface															GR SA SI CL
0.01																
	Probable Silty Sand to Sand															
233.0																
18.0	End of Cone Test															

OFFICE REPORT ON SOIL EXPLORATION

3, x 5: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE