February 2017

REPORT ON

Foundation Investigation
Merivale Road Overpass Bridge Widening
Structure 3-47
Highway 417
W.P. 4058-01-00

Submitted to:
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Ottawa, Ontario
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REPORT

Geocres Number: 31G5-271

Report Number: 05-1120-210-2000-5

Distribution:

1 copy - MMM Group Limited, Ottawa
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PART A

FOUNDATION INVESTIGATION REPORT

MERIVALE ROAD OVERPASS BRIDGE WIDENING

STRUCTURE SITE 3-47

HIGHWAY 417

W.P. 4058-01-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by MMM Group Limited (MMM) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations associated with the rehabilitation of five bridges on Highway 417 in the City of Ottawa. The section of Highway 417 included in this assignment (W.P. 4058-01-00) extends from Maitland Avenue to Island Park Drive.

Foundation investigation services were required for the following components under W.P. 4058-01-00:

- Bridge widenings at Clyde Avenue, Carling Avenue Eastbound (EB), Kirkwood Avenue, Carling Avenue Westbound (WB), and Merivale Road.
- Eighteen retaining walls, including both new walls as well as replacement of some existing walls.

The bridge widenings at Clyde Avenue, Carling Avenue EB, Kirkwood Avenue and Carling Avenue WB were constructed in 2008, 2010, and 2013 under separate bridge rehabilitation contracts. Rehabilitation of the Merivale Road Structure and construction of the retaining walls is part of the remaining work under W.P. 4058-01-00.

This report addresses the proposed widening of the bridge over Merivale Road including the bridge retaining walls and approach embankment widening. A separate report addresses the retaining walls located outside of the bridge approaches.

The terms of reference for the original scope of work are outlined in the MTO's Request for Proposal (RFP) dated January 2005. The work was carried out in accordance with Golder's Quality Control Plan for this project dated December 7, 2005.

2.0 SITE DESCRIPTION

The Merivale Road bridge is an overpass structure for Highway 417 and is located within a commercial area of Ottawa.

Merivale Road is a two lane road with an urban cross-section and sidewalks on both sides. The surrounding land on either side of Highway 417 is relatively flat and level.

The existing bridge is a rigid frame concrete structure supported on piles founded on bedrock. The bridge consists of two separate bridges (one for each of the eastbound and westbound lanes of Highway 417) with the two abutments separated by a 25 mm joint.

It is understood that the abutment stem walls are in good condition with spalls and delaminations covering less than 1 percent of the exposed face. From a foundation perspective, the existing bridge is performing adequately.

The existing approach embankments are 4 to 5 m high relative to the surrounding ground surface, with 2H:1V side slopes. At the present time the highway profile at the approaches does not seem to indicate that significant differential settlement of the roadway relative to the bridge has occurred, although the maintenance history at this location is not currently known.

There are numerous utilities in the area of the bridge structure, including (but not limited to) a 2,100 mm diameter storm sewer tunnel in the rock to the west of the bridge which crosses under the southwest abutment footing, an 1,800 mm diameter storm sewer located east of the structure, a 1,050 mm sanitary sewer and a number of hydro ducts (to be relocated) beneath Merivale Road, and a decommissioned 1,220 mm diameter watermain in the area of the south abutment.

A previous investigation was conducted for the design of the existing bridge by McRostie & Associates for MTO in 1958. The results of that investigation are contained in the report titled “Report on Foundation Investigation at Ottawa Queensway and Merivale Rd., Bridge No. 36, to Deleuw, Cather and Company of Canada Limited” (Geocres No. 58-F-229-C).

3.0 INVESTIGATION PROCEDURES

The field work for this subsurface investigation was carried out on May 10 and 11, 2006. On those days, two boreholes (Boreholes 06-17 and 06-18) were put down at the locations shown on Drawing 1. The boreholes were drilled near or at the approximate locations of the ends of the proposed abutment widenings. The boreholes were advanced using a truck mounted drill rig supplied and operated by Marathon Drilling Company Ltd. of Ottawa, Ontario. The boreholes were advanced to depths of 11.6 and 10.2 m below present ground surface.

Samples of the overburden were obtained at 0.6 to 1.2 m intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedure. The bedrock was cored for depths of 3.5 and 3.0 m, after practical refusal to augering had been reached. One standpipe was installed (in Borehole 06-18) to monitor the groundwater level at the site. The standpipe consists of 20 mm outside diameter HDPE tubing with a 0.6 m long slotted tip. The boreholes were backfilled with bentonite mixed with soil cuttings. The site conditions were restored following completion of the field work.

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 and bedrock samples were identified in the field, placed in labelled containers and transported to Golder Associates' laboratory in Ottawa for further examination, and to Golder Associates' laboratory in Mississauga for testing. Index and classification tests consisting of water content determinations, Atterberg Limit testing, and grain size distribution analyses were carried out on selected soil samples.

The groundwater level was measured in the standpipe in Borehole 06-18 on June 12, 2006, about one month after completion of drilling.

The borehole locations were determined by Golder relative to existing site features. The borehole elevations were determined by MMM from a digital terrain model based on the locations provided by Golder. 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 Drawing 1 in Appendix A.

Borehole Number	Borehole Location	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)
06-17	South-west abutment	5027932.3	364740.8	74.1
06-18	South-east abutment	5027945.9	364749.6	73.7

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

The study area for this assignment lies within the minor physiographic region known as the Ottawa Valley Clay Plain, as delineated in *The Physiography of Southern Ontario*[1] that lies within the major physiographic region of the Ottawa-St. Lawrence Lowland.

The Ottawa Valley Clay Plain region is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock.[2] This region is underlain by a series of sedimentary rocks, consisting of sandstones, dolostones, limestones and shales that are, in turn, underlain by igneous and metamorphic bedrock of the Precambrian Shield.

4.2 Site Stratigraphy

As part of the subsurface investigation at this site, two boreholes were advanced within or near the limits of the foundation elements for the proposed widening of the Merivale Road bridge. The borehole locations are shown on Drawing 1 in Appendix A. Soil stratigraphy sections projected along the highway centreline and across the abutment foundation areas are shown on Drawing 2 in Appendix A.

The detailed subsurface soil, bedrock, and groundwater conditions encountered in the boreholes and the results of the in-situ and laboratory testing are given on the Record of Borehole sheets in Appendix B and on Figures 1 to 3 in Appendix C. 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.

Six boreholes had been previously advanced at the present bridge abutment locations on behalf of the Ministry in 1958, as previously noted, (Geocres No. 58-F-229-C) and the Record of Borehole sheets from that investigation are also attached in Appendix D.

Golder Associates carried out an investigation in the area of this site, the results of which are included in a report to MMM titled “Foundation Investigation and Design, Retaining Walls, Maitland Ave to Island Park Drive, Highway 417, W.P. 4058-01-00” dated January 2008 (report number 05-1121-210-2000-6). Borehole location plans, select record of boreholes sheets (i.e., BH 06-141 and 06-143A), and the results of two consolidation tests from the previous investigation are presented in Appendix F, and are used herein solely to describe the silty clay conditions. The two relevant boreholes are located about 140 and 50 m to the west and east of the Merivale bridge structure, respectively. Very similar ground conditions were encountered and the results of the consolidation testing on the silty clay deposit are representative of the silty clay deposit located at the Merivale overpass structure.

In summary, the soils encountered during the current investigation within the limits of the widening consist of topsoil and fill materials extending to depths of about 1.2 to 1.3 m, underlain by some 5.5 to 6 m of clay, over 1.3 m of glacial till at Borehole 06-17, with the overburden extending to depths of about 7.2 to 8.1 m. These overburden materials are underlain by limestone bedrock.

[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.

[2] Belanger, J.R. “Urban Geology of Canada’s National Capital Area”, in *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White, 1998.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections. In the following discussion, emphasis is placed on the subsurface conditions indicated in the boreholes from the present investigation. The Geocres information, which reflects conditions prior to construction of the existing bridge, is referenced only in regard to the bedrock surface elevation.

4.2.1 Fill

Topsoil (fill) exists at the ground surface at both Boreholes 06-17 and 06-18 and is about 0.1 and 0.3 m thick, respectively.

Fill materials associated with previous uses of the site and roadway construction underlies the topsoil at both boreholes.

The fill materials at Boreholes 06-17 and 06-18 extend to depths of about 1.0 and 1.2 m, respectively, below ground surface. At Borehole 06-18, the upper 0.2 m of fill is composed of sand with some gravel. The remaining fill materials at both boreholes are composed of silty clay with traces of sand or gravel. An SPT "N" value of 9 blows per 0.3 m of penetration was measured in the silty clay fill at Borehole 06-18.

4.2.2 Topsoil

A buried layer of topsoil, about 0.3 m thick, was also encountered beneath the fill materials at Borehole 06-17 at a depth of about 1.0 m.

4.2.3 Silty Clay to Clay

The buried topsoil layer at Borehole 06-17 and the fill materials at Borehole 06-18 are underlain by a deposit of silty clay to clay, which is about 5.5 and 6.0 m thick (including a thin sand layer at Borehole 06-18), respectively. The upper portion of the deposit has been weathered to depths below the clay surface of about 2.3 and 2.4 m to a grey-brown colour. Measured SPT "N" values in this weathered zone ranged from 1 to 15 blows per 0.3 m of penetration. These test results indicate that the weathered portion of the deposit has a stiff to very stiff consistency.

The results of Atterberg limit testing on one selected sample of the weathered portion of the deposit indicate a plasticity index of 52 percent and a liquid limit of 79 percent. These results, shown on the plasticity chart on Figure 1, confirm that this material is a clay of high plasticity. The measured natural water contents of two samples of the weathered silty clay to clay were 51 and 61 percent.

The silty clay to clay below the depth of weathering at both boreholes is grey in colour and extends to depths of about 6.8 and 7.2 m below ground surface. In situ vane testing carried out within this unweathered deposit measured undrained shear strengths generally ranging between 42 and 61 kPa. These test results indicate that the unweathered silty clay to clay has a firm to stiff consistency. In situ vane testing carried out on remoulded grey silty clay to clay gave undrained shear strengths ranging from 5 to 10 kPa, reflecting a sensitive material (sensitivities ranging from 6 to 8).

The results of a grain size distribution test carried out on a sample of the unweathered silty clay from Borehole 06-17 are shown on Figure 2.

The results of Atterberg limit testing on two selected samples of the unweathered silty clay to clay indicate plasticity index values of 28 and 37 percent and liquid limit values of 48 and 58 percent. These results, also shown on the plasticity chart on Figure 3, confirm that this material is a silty clay to clay of intermediate to high plasticity. The measured natural water content of the unweathered silty clay ranged from 55 to 61 percent, which is generally in excess of the measured liquid limit.

The results of two oedometer consolidation tests carried out on samples from nearby boreholes (06-141 and 06-143A) which bracket the Merivale Road site indicate the clay deposit is preconsolidated by about 75 to 125 kPa above the existing overburden pressure. The results of the oedometer consolidation tests are shown in Appendix F.

A summary of the measured engineering properties of the silty clay to clay with depth is presented on Figure 4, which includes the measured undrained shear strengths, natural water contents and Atterberg limits.

4.2.4 Sand

A thin layer of sand, about 0.2 m thick, separates the weathered silty clay and the unweathered clay at Borehole 06-18 at a depth of about 3.5 m.

4.2.5 Silty Sand to Sandy Silt Till

A deposit of glacial till was encountered below the unweathered silty clay in Borehole 06-17. The surface of this till deposit was encountered at about elevation 67.3 m in this borehole (at a depth below ground surface of about 6.8 m) and the glacial till deposit is about 1.3 m thick.

The deposit was not encountered in Borehole 06-18.

Based on local experience and observations of the drilling resistance, the glacial till consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of silty sand to sandy silt, with a trace of clay. Rotary diamond drilling techniques were required to penetrate the boulders in the in the till.

4.2.6 Limestone Bedrock

The bedrock encountered at the abutment widenings consists of limestone with thin shale interbeds.

The following table summarizes the bedrock surface depths and elevations as encountered at the locations of Boreholes 06-17 and 06-18, and as encountered at the previous boreholes 1 to 6. The bedrock was cored in all eight of these boreholes.

Borehole Location	Borehole Number	Ground Surface Elevation (m)	Depth to Bedrock (m)	Bedrock Surface Elevation (m)
West Abutment	06-17	74.1	8.1	66.0
	6	75.2	8.7	66.5
	4	74.5	8.9	65.6
	2	73.3	8.4	64.9
East Abutment	06-18	73.7	7.2	66.5
	5	73.5	6.9	66.6
	3	74.5	8.5	66.0
	1	73.6	8.6	65.0

The limestone bedrock at the site is a member of the Gull River Formation; it is medium-strong and thinly to medium-bedded. Thin shale interbeds were also present in the rock core. Rock Quality Designation (RQD) values measured on recovered bedrock core samples typically ranged from about 25 to 94 percent, generally increasing with depth. The lowest RQD values were recorded for the upper 0.5 and 1.5 m in Boreholes 06-17 and 06-18, respectively. The discontinuities observed in the rock core are typically horizontal to sub-horizontal, associated with the bedding planes, although some vertical fracturing was noted. A description of some of the terms used in the description of the bedrock samples from this site is provided on the *Lithological and Geotechnical Rock Description Terminology* sheet which precedes the Record of Borehole sheets included with this report.

4.3 Groundwater Conditions

A piezometer was installed in Borehole 06-18, sealed within the bedrock. The water level measured in that piezometer is summarized in the following table:

Borehole Number	Borehole Location	Date	Depth (m)	Elevation (m)
06-18	East abutment	June 12, 2006	3.0	70.7

It should be expected that the groundwater levels will fluctuate seasonally.

5.0 CLOSURE

The report was prepared by Ms. Kim Lesage, P.Eng., under the direction of the Project Manager, Mr. Michael Cunningham, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng, the designated MTO contact for this project.

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APPENDIX A

Drawing 1 – Merivale Road, Borehole Locations

Drawing 2 – Merivale Road, Soil Strata

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

HWY. 417

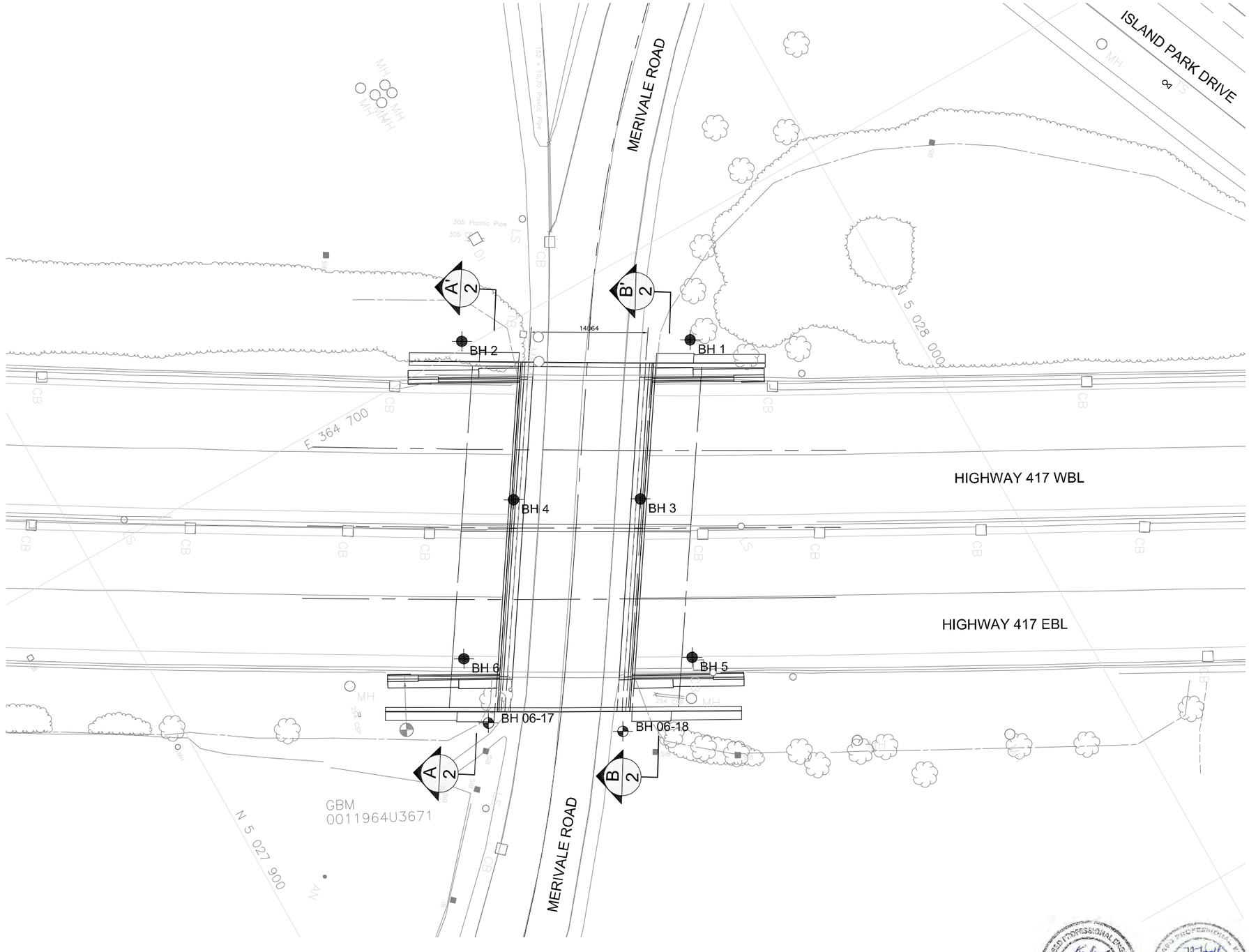
WP No. WP 4058-01-00

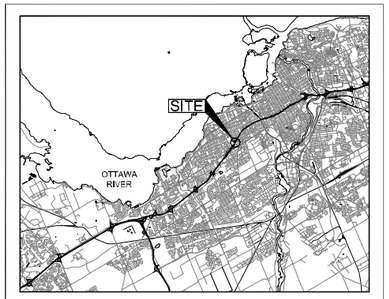
SHEET

MERIVALE ROAD
BOREHOLE LOCATIONS

Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA





KEY PLAN

LEGEND

- Borehole – Current Golder Associates Ltd. Investigation
- Borehole – Previous MTO Investigation Goecres No. 58-F-229-C
- A 2 — Location of cross-section

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
06-17	74.1	5027932.3	364740.8
06-18	73.7	5027945.9	364749.6
1	73.6	5027975.0	364716.5
2	73.3	5027952.0	364701.6
3	74.5	5027959.6	364729.2
4	74.5	5027946.8	364720.9
5	73.5	5027954.4	364748.5
6	75.2	5027931.3	364733.6

NOTES

This drawing is for subsurface information only. Any surface details are for conceptual illustration.
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

Base plan provided in electronic format by McCormick Rankin Corporation

5 0 5 10
SCALE METRES

LICENSED PROFESSIONAL ENGINEER K. S. LEVESQUE 100131598 PROVINCE OF ONTARIO 26/10/17

REGISTERED PROFESSIONAL ENGINEER F. J. SEYFERTH PROVINCE OF ONTARIO 26/10/17

NO.	DATE	BY	REVISION

Geocres No. 31G5-271

HWY. 417	PROJECT NO. 05-1120-210-2000		DIST. EASTERN
SUBM'D. W.C.	CHKD. K.S.L.	DATE: SEPTEMBER 2006	SITE:
DRAWN: J.M.	CHKD. W.C.	APPD. F.J.H.	DWG. 1

05-1120-210-5000-01.dwg

HWY. 417

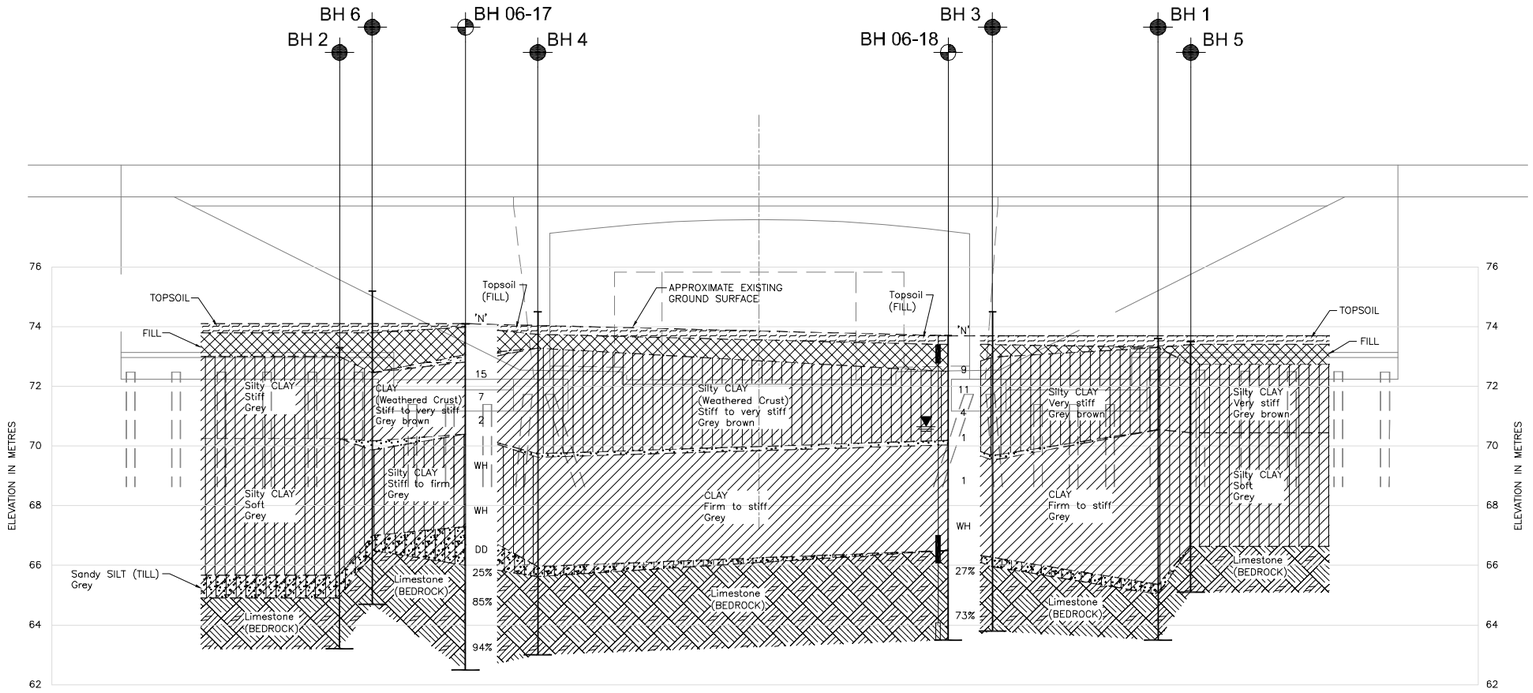
WP No. WP 4058-01-00

MERIVALE ROAD
SOIL STRATA

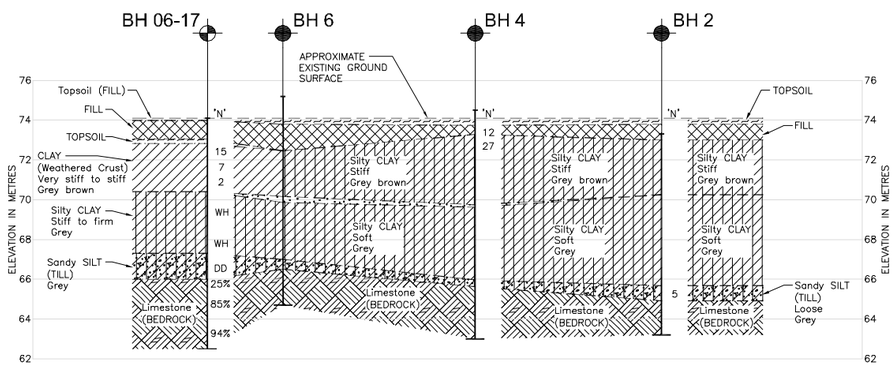
SHEET

Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



PROFILE ALONG ℄ HIGHWAY 417



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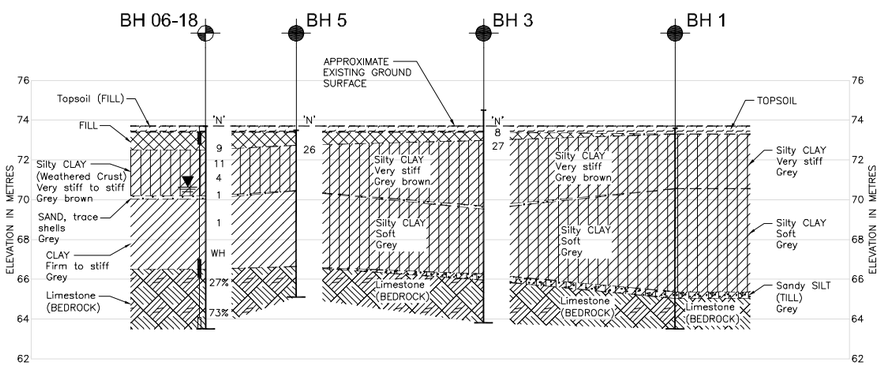

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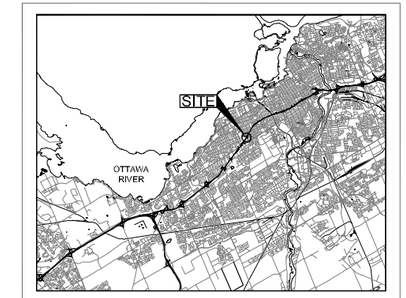

KEY PLAN

LEGEND

- Borehole – Current Golder Associates Ltd. Investigation
- Borehole – Previous MTO Investigation Goecres No. 58-F-229-C
- Seal
- Piezometer
- N — Standard Penetration Test value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- WL in piezometer, measured on June 12, 2006

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
06-17	74.1	5027932.3	364740.8
06-18	73.7	5027945.9	364749.6
1	73.6	5027975.0	364716.5
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3	74.5	5027959.6	364729.2
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5	73.5	5027954.4	364748.5
6	75.2	5027931.3	364733.6

METRIC

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Base plan provided in electronic format by McCormick Rankin Corporation

NO.	DATE	BY	REVISION

Geocres No. 31G5-271

HWY. 417		PROJECT NO. 05-1120-210-2000	DIST. EASTERN
SUBM'D. W.C.	CHKD. K.S.L.	DATE: SEPTEMBER 2006	SITE:
DRAWN: J.M.	CHKD. W.C.	APPD. F.J.H.	DWG. 2

05-1120-210-5000-02.dwg

APPENDIX B

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Records of Boreholes 06-17 to 06-18

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
FoS	factor of safety

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
υ	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

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	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_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{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 δ
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 = (compressive strength)/2

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

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.)

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 cm^2 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.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	**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

(b) Cohesive Soils

Consistency

	c_u, s_u kPa	c_u, s_u psf
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

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.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS 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 and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
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	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

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

CORE CONDITION

Total Core Recovery (TCR)

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 varied 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 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 abbreviation 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

JN Joint
FLT Fault
SH Shear
VN Vein
FR Fracture
SY Stylolite
BD Bedding
FO Foliation
CO Contact
AXJ Axial Joint
KV Karstic Void
MB Mechanical Break

PL Planar
CU Curved
UN Undulating
IR Irregular
K Slickensided
PO Polished
SM Smooth
SR Slightly Rough
RO Rough
VR Very Rough

Golder Associates

RECORD OF BOREHOLE No 06-17

SHEET 1 OF 1

METRIC

PROJECT 05-1120-210-2000

G.W.P. 4058-01-00 LOCATION N 5027932.3; E 364740.8 ORIGINATED BY D.J.S.

DIST Eastern HWY BOREHOLE TYPE Power Auger 108 mm I.D. Hollow Stem Auger COMPILED BY J.M.

DATUM Geodetic DATE May 11, 2006 CHECKED BY M.I.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.1	GROUND SURFACE						74				
0.0	Topsoil (FILL)										
0.1	Silty clay, trace gravel (FILL) Grey brown										
73.1	TOPSOIL						73				
1.3	CLAY (Weathered Crust) Very stiff to stiff Grey brown Moist to wet		1	SS	15						
			2	SS	7		72				
			3	SS	2		71				
70.4											
3.7	Silty CLAY Stiff to firm Grey Wet		4	SS	WH		70				0 2 37 61
			5	SS	WH		69				
67.3											
6.8	Sandy SILT, some gravel, trace clay with cobbles and boulders (TILL) Grey Wet		6	NQ RC	DD		68				
66.0							67				
8.1	Limestone with thin shale interbed (BEDROCK) Slightly weathered to fresh Grey Medium strong Bedrock cored between 8.1m 11.6m depth. For bedrock coring details refer to Record of Drillhole 06-17.		7	NQ RC	DD		66				
			8	NQ RC	DD		65				
			9	NQ RC	DD		64				
62.5							63				
11.6	End of Borehole										

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

GTA-MTO 001 N:\ACTIVE\2005\1120\GEOTECHNICAL\05-1120-210 MRC HWY 417 BRIDGES MAITLAND TO ISLAND PARK DRIVE\FOUNDATIONS\GINT\PHASE 2000\TASK 5000\05-1120-210-5000.GPJ GAL-GTA.GDT 02/10/17

PROJECT: 05-1120-210-2000

RECORD OF DRILLHOLE: 06-17

SHEET 1 OF 1

LOCATION: N 5027932.3; E 364740.8

DRILLING DATE: May 11, 2006

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
		ROCK SURFACE		66.00													
9	Rotary Drill / NQ Core	Limestone with occasional thin shale interbed (BEDROCK) Slightly weathered to fresh Grey Medium strong		8.10	1												
10					2												
11				62.50	3												
		End of Drillhole		11.60													
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: D.J.S.
CHECKED: W.C.

MIS-RCK 001 05-1120-210-5000-ROCK.GPJ GAL-MISS.GDT 02/10/17 JM

Golder Associates

RECORD OF BOREHOLE No 06-18

SHEET 1 OF 1 **METRIC**

PROJECT 05-1120-210-2000
G.W.P. 4058-01-00
LOCATION N 5027945.9; E 364749.6
ORIGINATED BY D.G.
DIST Eastern HWY
BOREHOLE TYPE Power Auger 108 mm I.D. Hollow Stem Auger
COMPILED BY J.M.
DATUM Geodetic
DATE May 10, 2006
CHECKED BY M.I.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
73.7	GROUND SURFACE					
0.0 / 73.4	Topsoil (FILL)					
	Sand, some gravel (FILL)		1	A.S.		
0.5	Brown Moist					
	Silty clay, trace sand (FILL)		2/3	SS	9	
72.5	Grey brown Moist					
1.2	Silty CLAY (Weathered Crust) Stiff to very stiff Grey brown Moist to wet		4	SS	11	
			5	SS	4	
70.2			6/7	SS	1	
	SAND, trace shells					
3.7	Grey Wet					
	CLAY Firm to stiff Grey Wet		8	SS	1	
			9	SS	WH	
66.5						
7.2	Limestone with thin shale interbeds (BEDROCK) Fresh Grey Medium strong Bedrock cored between 7.2m 10.2m depth. For bedrock coring details refer to Record of Drillhole 06-18.		10	NQ RC	DD	
			11	NQ RC	DD	
63.5						
10.2	End of Borehole Note: Water level in standpipe at 3.0m depth below ground surface on June 12, 2006					

ELEVATION SCALE: 73, 72, 71, 70, 69, 68, 67, 66, 65, 64

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
25 50 75

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

$+^3$, $\times^3$: Numbers refer to Sensitivity
$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 N:\ACTIVE\2005\1120\GEOTECHNICAL\05-1120-210 MRC HWY 417 BRIDGES MAITLAND TO ISLAND PARK DRIVE\FOUNDATIONS\GINT\PHASE 2000\TASK 5000\05-1120-210-5000.GPJ GAL-GTA.GDT 02/10/17

PROJECT: 05-1120-210-2000

RECORD OF DRILLHOLE: 06-18

SHEET 1 OF 1

LOCATION: N 5027945.9; E 364749.6

DRILLING DATE: May 10, 2006

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Marathon Drilling

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
		ROCK SURFACE		66.50													
8	Rotary Drill / NQ Core	Limestone with thin shale interbeds (BEDROCK) Fresh Grey Medium strong		7.20	1												
9					2												
10				63.50													
		End of Drillhole		10.20													
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	

DEPTH SCALE
1 : 75

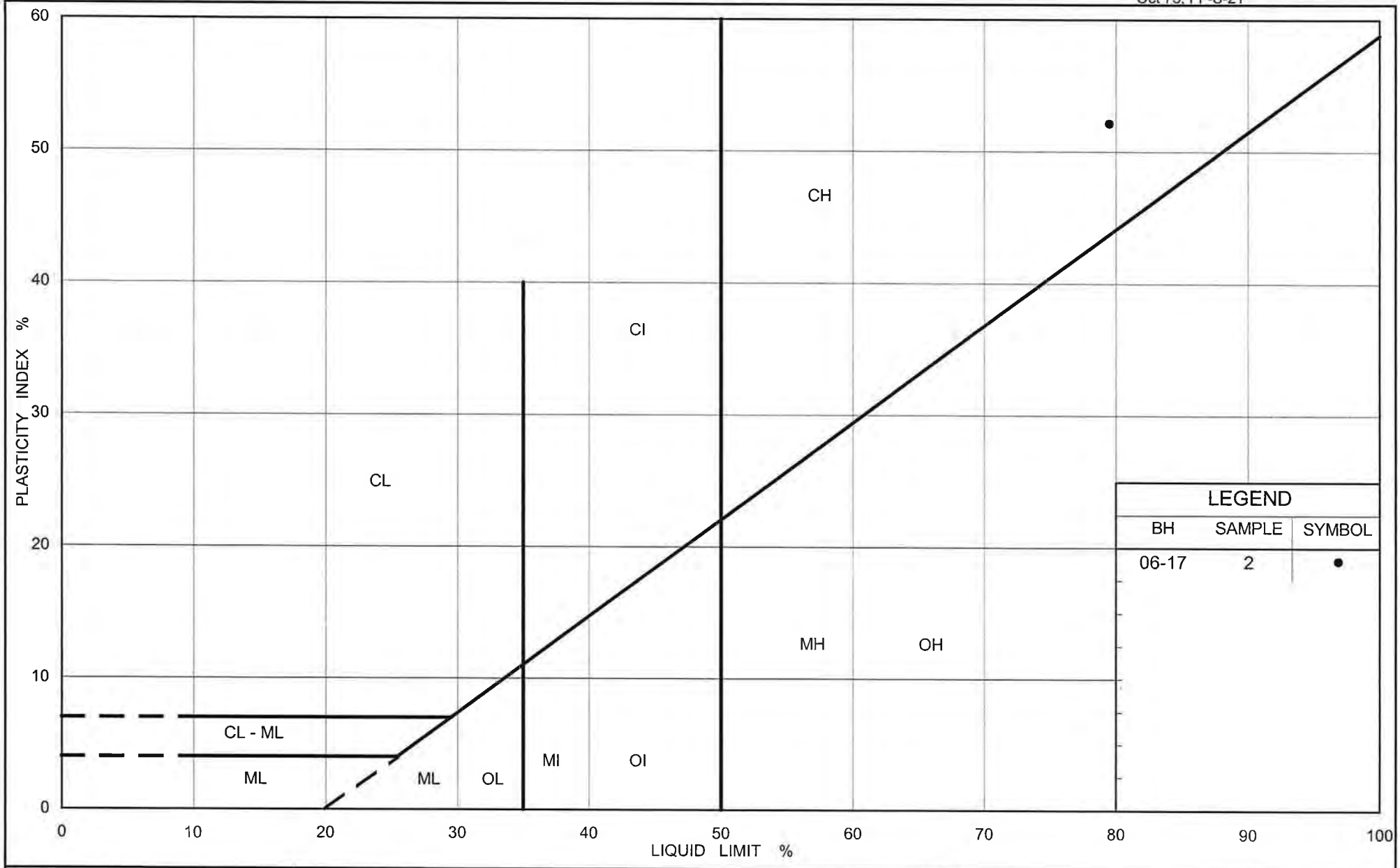
Golder Associates

LOGGED: D.G.
CHECKED: W.C.

MIS-RCK 001 05-1120-210-5000-ROCK.GPJ GAL-MISS.GDT 02/10/17 JM

APPENDIX C

Oct 75, FF-S-21



Ministry of Transportation

Ontario

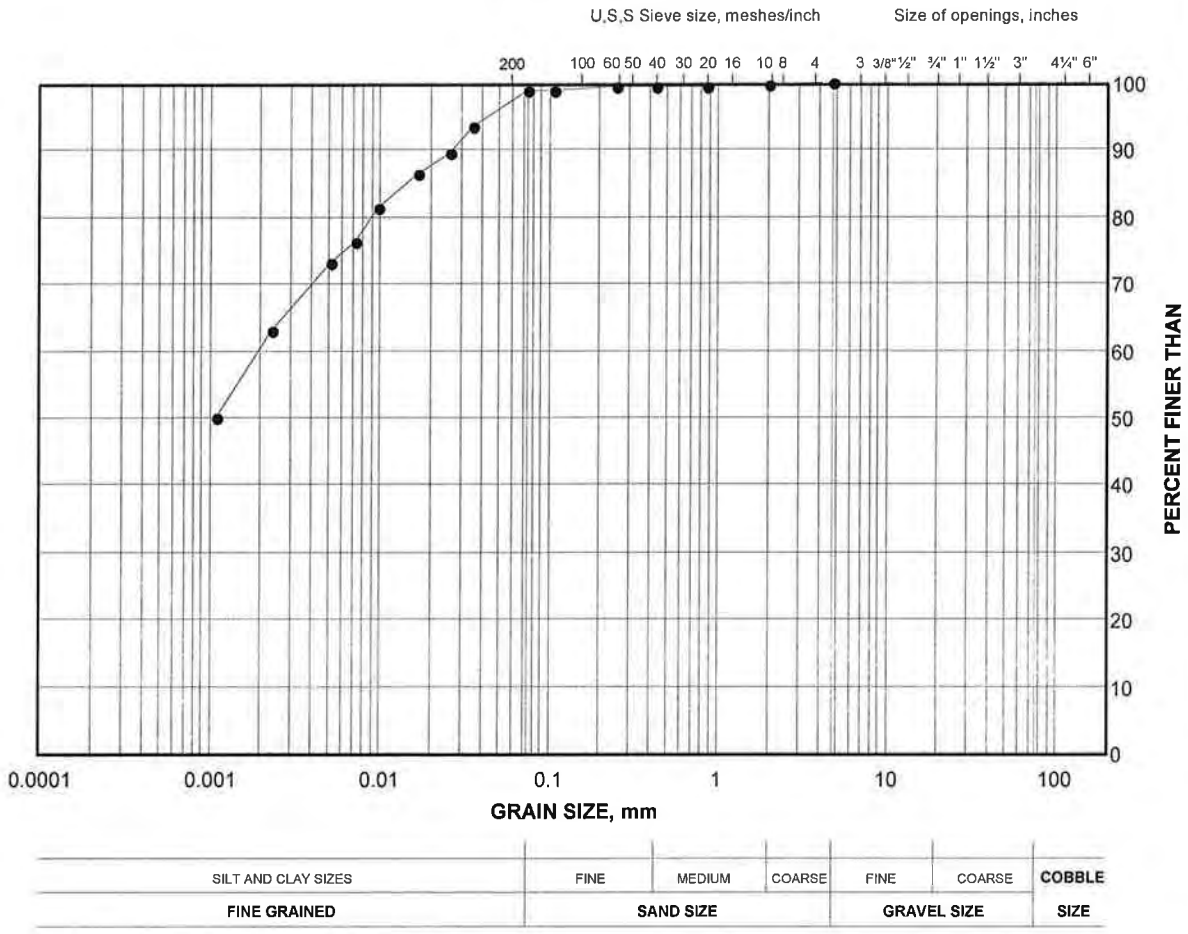
PLASTICITY CHART
Weathered Clay

FIG No. 1

Project No. 05-1120-210 - ~~2700~~ 2000

GRAIN SIZE DISTRIBUTION
Silty Clay

FIGURE 2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	06-17	4	4.4-5.0

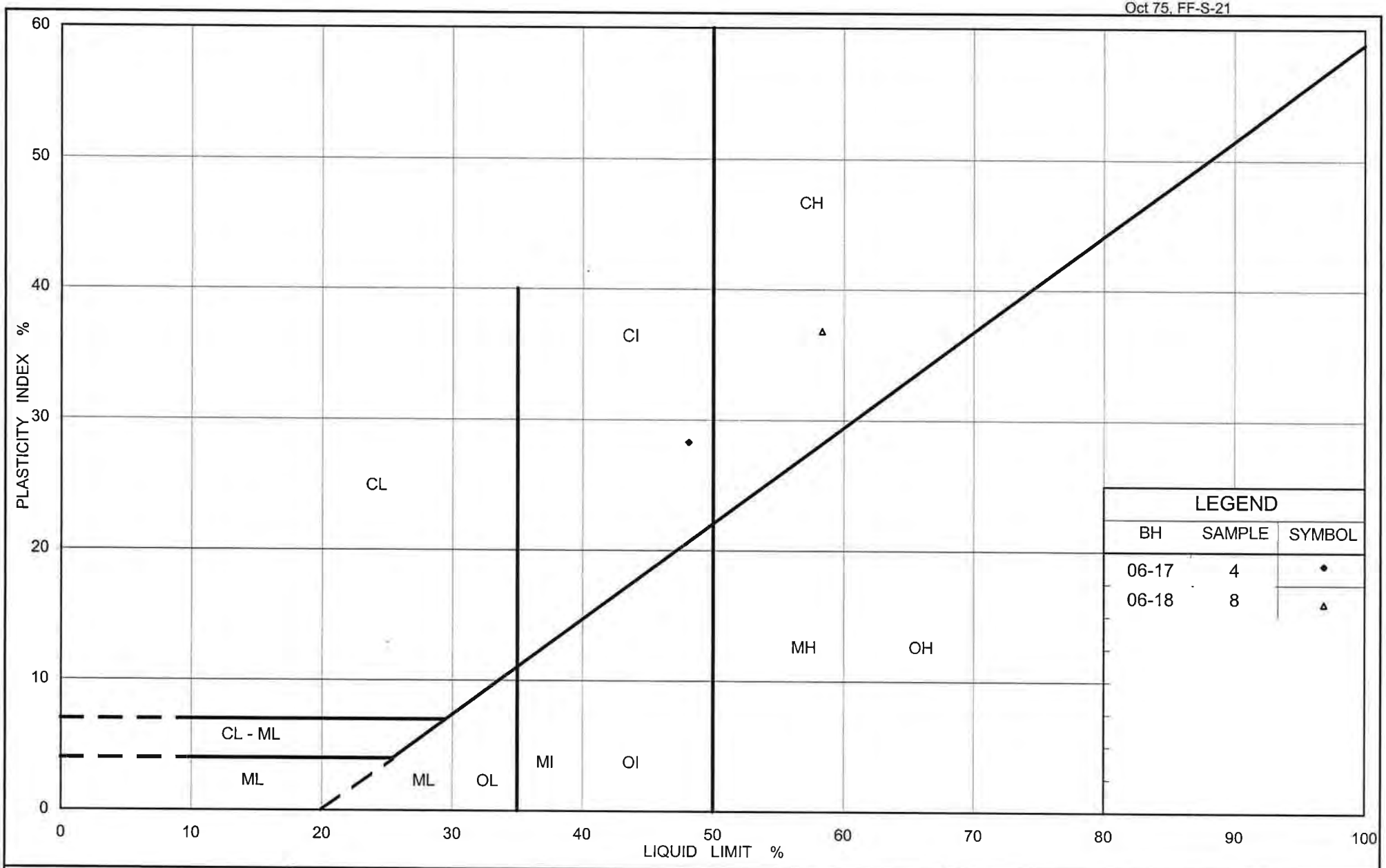
Project Number: 05-1120-210

Checked By: _____

Golder Associates

Date: 08-Jun-06

Oct 75, FF-S-21



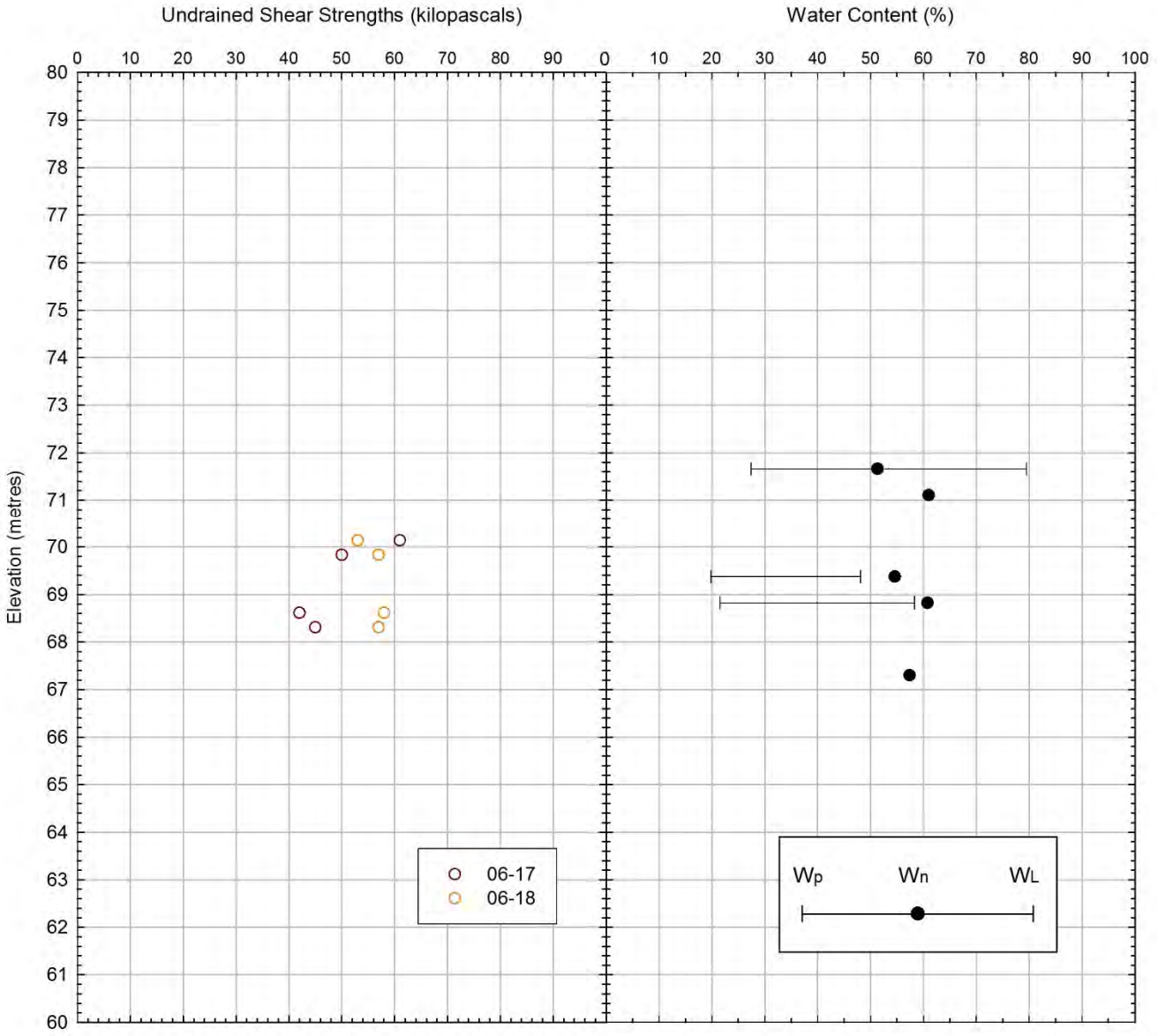
Ministry of Transportation

Ontario

PLASTICITY CHART
Clay to Silty Clay

FIG No. 3

Project No. 05-1120-210 - ~~2700~~ 2000



Golder Associates

Summary of Engineering Properties

Silty Clay to Clay

Project No.	05-1120-210
Drawn:	WAM
Date:	2/8/2017
Checked:	KSL
Review:	WC

Figure 4

APPENDIX D

Records of Previous Boreholes 1 to 6 (Geocres No. 58-F-229-C)

FORM S-10-2

McROSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF LABORATORY TESTS

QWY & MERIVALE RD.

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 241.2' Geodetic Datum

REMARKS B.M. ef. 235.8' Top of Sewer Manhole Cover Intersection of ℄'s of Clarendon & Clarendon Crescent

DATE Oct. 158

HOLE NO. 1

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION
				GROUND SURFACE		
				TOPSOIL 1.0'	0.0	241.2
5.5	9.0-9.1-9.0 R-4.0		1-1	HARD BROWNISH GRAY CLAY 4.0'		
3.9	5.5-6.8-6.3 R-1.0		1-2	VERY STIFF BROWNISH GRAY CLAY 6.5'		
1.4	2.3-3.4-3.3 R-0.4		1-3	STIFF BROWNISH GRAY CLAY	10.0	231.2
1.2	1.4-1.2-1.3 R-0.		1-4			
1.3	1.3-1.1-1.0 R-0		1-5			
1.3	1.3-1.0-1.4 R-0		1-6	MEDIUM SOFT SILTY GRAY CLAY		
1.5	1.1-1.2-1.7 1.5 R-0.		1-7		20.0	221.2
1.5	1.3-1.5-0.9 1.1 R-0		1-8	22.0'		
0.7	0.2-0.5-0.2 R-0		1-9	VERY SOFT FISSURED SILTY GRAY CLAY & SILT IN LAYERS WITH THIN SAND LAYERS & A FEW PEBBLES 27.0'		
				LOOSE TILL 28.1		
				SHALEY LIMESTONE (CORE RECOVERY 93%) DROP DROP	30.0	211.2
				DROP 33.0		208.2
				BOTTOM of HOLE		

RENOULDED = R

PENETRATION TEST

.....LB. HAMMER NO CASING

.....INCH DROP .....INCH DIA. ROD

BLOWS PER FOOT

OVERNIGHT WATER LEVEL 2.0

SILT CLAY

0 20 40 60 80 100

% WATER CONTENT

⊙ Water Content

PLATE 2

FORM S-10-2

McROSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF LABORATORY TESTS

QWY. & MERIVALE RD.

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 240.2'

REMARKS See: plate #2

DATE 30/10/58

HOLE NO. 2

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION
				GROUND SURFACE	0.0	240.2
				TOPSOIL 1.0'		
				VERY STIFF		
4.5	6.6 - 7.2 7.3-R-4.8		2-1	BROWNISH GRAY CLAY, 4.0'		
				STIFF BROWNISH		
3.1	3.2 - 4.0 7.2-R-1.8		2-2	GRAY CLAY 6.5'		
				MEDIUM SOFT		
1.1	2.8 - 1.6 1.7 R-0.2		2-3	BROWNISH GRAY CLAY	10.0	230.2
	1.4 - 1.1		2-4	MEDIUM SOFT		
4.2	1.6-R-0			FISSURED GRAY		
	1.3 - 1.6		2-5	SILTY CLAY		
1.5	0.5 - 1.0 1.4-R-0			15.0'		
	1.0 - 0.6		2-6	MEDIUM SOFT		
1.6	1.1 - 1.2 1.0-R-0			GRAY CLAY		
	1.0 - 0.9		2-7	WITH SANDY	20.0	220.2
1.6	0.6 - 1.3 1.4-R-0			CLAY LAYERS		
	0.9 - 1.3		2-8	AND SILTY		
1.4	1.3 - 1.3 1.0 R-0			CLAY LAYERS 25.0'		
		5		LOOSE TILL 26.5'		
		14 for 6"	2-9	MEDIUM DENSE TILL 27.5		
				SHALEY LIMESTONE (CORE RECOVERY 92 %) DROP	30.0	210.2
				33.1		207.1
				BOTTOM OF HOLE		

REMOULDED = R

PENETRATION TEST

.....LB. HAMMER
.....INCH DROP
NO CASING
.....INCH DIA. ROD
BLOWS PER FOOT

OVERNIGHT WATER LEVEL 0.0'

0 20 40 60 80 100

% WATER CONTENT
⊙ WATER CONTENT

PLATE 3

L.-M. CO.—A26553

FORM S-10-2

McROSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF LABORATORY TESTS

QWY ; MERIVALE RD.

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 244.2'

REMARKS See: plate #2

DATE Nov 5/58

HOLE No. 3

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION
				GROUND SURFACE	0.0	244.2
		8	3-1	FILL (BROWNISH GRAY CLAY WITH SAND)		
					5.0'	
		27	3-2	HARD BROWNISH GRAY CLAY		
					7.5'	
1.7	6.7-6.7 6.5-R1.6		3-3	VERY STIFF FISSURED BROWNISH GRAY CLAY WITH SOME SILT	10.0	234.2
1.8	5.2-4.2 3.8-1.7 R-0.4		3-4	VERY STIFF BROWNISH GRAY CLAY WITH SOME SILT	12.5'	
1.1	1.8-1.6 1.5-1.7 R-0.0		3-5	MEDIUM SOFT FISSURED BROWNISH GRAY SILTY CLAY	15.8	
	1.2-1.3			SAND & SILT	16.3	
1.3	1.8-2.0 1.6-R-0.0		3-6	MEDIUM SOFT FISSURED GRAY SILTY CLAY	17.5	
	1.6-1.3					
0.9	1.6-1.5 1.5-R-0.0		3-7	MEDIUM SOFT GRAY SILTY CLAY	20.0	224.2
	0.8-1.3					
1.3	1.5-1.4 1.3-1.6 R-0.0		3-8			
0.5	0.9-1.4 1.2-1.4 R-0.0		3-9	MEDIUM SOFT FISSURED GRAY CLAY & SILT IN LAYERS	26.0 27.0	
				TILL	28.0	
				SHALEY LIMESTONE 89%	28.7	
					30.0	214.2
			CROP	SHALEY LIMESTONE (CORE RECOVERY 98%)		
					34.9'	209.3
				BOTTOM OF HOLE		

PENETRATION TEST

.....LB. HAMMER
.....INCH DROP
NO CASING
.....INCH DIA. ROD
BLOWS PER FOOT

OVERNIGHT WATER LEVEL 4.8'

0 20 40 60 80 100

% WATER CONTENT
⊙ MOISTURE CONTENT

PLATE 4

I.-M CO.—A26553

FORM S-10-2

McROSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF LABORATORY TESTS

QWY. & MERIVALE RD.

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 244.3'

REMARKS See plate #2 FOR MECHANICAL ANALYSIS SEE PLATES 8, & 9

HOLE No. 4

DATE

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION
				GROUND SURFACE	0'	244.3
		12	4-1	FILL		
				4.0'		
		27	4-2	HARD BROWNISH GRAY CLAY WITH		
3.7	8.9 - 7.8 R-2.0		4-3	A LITTLE SILT	10'	234.3
2.1	4.0 - 3.5 2.6 R-0.4		4-4	STIFF SILTY BROWNISH GRAY CLAY	12.5	
	1.9 - 2.1			MEDIUM SOFT BROWNISH		
1.2	2.5 - 0.8 R-0.0	STIFF FISSURED BROWNISH GRAY CLAY	4-5	GRAY CLAY WITH A LITTLE SILT	15.0'	
	3.0 - 1.3				15.8'	
	1.8 - 0.7				16.0'	
0.8	3.1 - 1.8 R-0.0	GRAVEL 1/4" Ø AND LAYER OF SAND	4-6	SOFT TO MEDIUM SOFT GRAY SILTY CLAY WITH TRACES OF SAND	17.5	
	1.5 - 1.0			MEDIUM SOFT GRAY		
1.1	1.8 - 1.8		4-7	SILTY CLAY WITH		
	1.5 - R-0.0			TRACES OF SAND	20.0	224.3
	1.6 - 1.5			MEDIUM SOFT GRAY		
1.8	0.8 - 1.0		4-8	SILTY CLAY WITH		
	1.3 - 1.5 R-0.0			SANDY SILT LAYERS AND A FEW STONES	25.0	
				GRAY		
			4-9	SILTY CLAY		
				WITH A LITTLE SAND	28.0	
				LOOSE TILL	29.1	
				SHALEY LIMESTONE (CORE RECOVERY 62%)	30	214.3
					31.1	
				SHALEY LIMESTONE (CORE RECOVERY 81%)		
					37.7	206.6
				BOTTOM OF HOLE		

REMOULDED = R

PENETRATION TEST

.....LB. HAMMER
.....INCH DROP
NO CASING
.....INCH DIA. ROD
BLOWS PER FOOT

⊙ OVERNIGHT WATER LEVEL 5.9'

0 20 40 60 80 100

% WATER CONTENT
⊙ MOISTURE CONTENT

PLATE 5

FORM S-10-3

McROSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF FIELD AND LABORATORY TESTS

QWY & MERIVALE RD.

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 240.9 DATE NOV. 5 '58

REMARKS See plate #2, FOR MECH ANALYSIS SAMPLES 5-4, 5-7 see PLATES 10, 11.

HOLE No. 5

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION
				GROUND SURFACE	0	240.9
				FILL		
				2.5'		
		26	5-1	HARD BROWNISH GRAY CLAY		
				5.0'		
2.7	7.5 -7.1 5.2-R-2.2		5-2	VERY STIFF BROWNISH GRAY CLAY WITH SOME SILT		
				7.5'		
1.4	2.8 -4.0 2.5-R-0.1		5-3	STIFF BROWNISH GRAY CLAY WITH SOME SILT	10'	230.9
1.2	1.5 -2.1 1.3-R0.0		5-4	MEDIUM SOFT BROWNISH GRAY SILTY CLAY WITH SOME SAND & SAND POCKETS & SAND LAYERS		
				12.5'		
1.4	0.7 -1.1 1.1 -1.8 1.1-R-0.0		5-5	MEDIUM SOFT		
1.4	1.1 -0.9 1.1 -1.5 R-0.0		5-6			
1.2	1.3 -1.0 1.3 -1.4 R-0.0		5-7	GRAY SILTY CLAY		
				20'	20'	220.9
0.5	1.4-0.8 0.7-0.6 R-0.0		5-8	SOFT FISSURED GRAY SILTY CLAY AND SILT IN LAYERS		
				22.5'		
				SHALEY LIMESTONE (CORE RECOVERY 93%)		
				DROP	27.5'	213.4
				BOTTOM OF HOLE		

PROBING OR VANE TEST

.....LB. HAMMER
.....INCH DROP
NO CASING
.....INCH DIA. ROD

BLOWS PER FOOT OR SHEAR STRENGTH IN KIPS PER FT.²

OVERNIGHT WATER LEVEL 2.0'

SAND

0 20 40 60 80 100

% WATER CONTENT
NATURAL ⊙
LIQUID LIMIT □
PLASTIC LIMIT △

PLATE 6

L.-M. CO.—A30614

FORM S-10-2

McROSTIE & ASSOCIATES
CONSULTING ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY OF LABORATORY TESTS

QWY. F' MERIVALE RD.

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 246.5'

REMARKS See: plate #2 - FOR CONSOLIDATION & MECHANICAL ANALYSIS
SEE PLATES - 12, 13, 14, 15

DATE Oct. 22/58

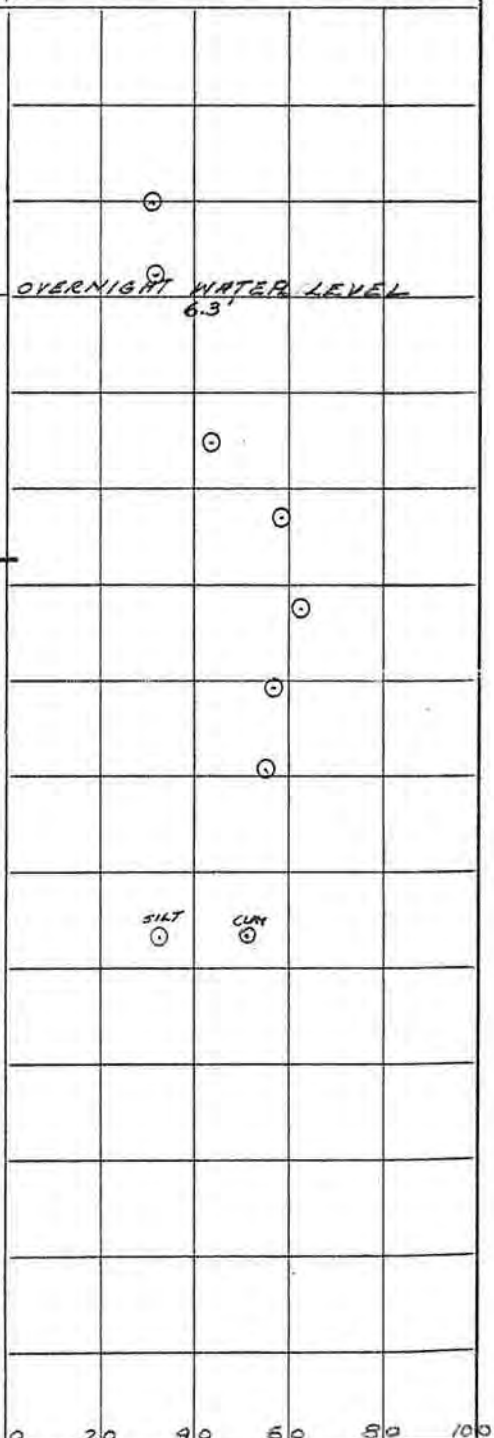
HOLE No. 6

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT.²	SMALL SCALE PENETROMETER KIPS/FT.²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION
				GROUND SURFACE	0.0	246.5
		8	6-1	FILL		
	6.2-2.5		6-2A	(BROWNISH GRAY CLAY WITH SAND)		
					9.0'	
				VERY STIFF BROWNISH	10.0	236.5
2.9	7.8-7.1 R-2.0		6-4	GRAY CLAY WITH SOME SILT	11.5'	
2.0	2.5-2.7-2.4 R-0.3		6-5	STIFF BROWNISH GRAY CLAY WITH A LITTLE SILT	15.0'	
				STIFF SILTY		
1.1	2.1-2.1-2.3 R-0.0		6-6	FISSURED GRAY CLAY	16.5'	
				SILTY FINE SAND	17.5'	
				MEDIUM TO SOFT		
0.7	1.5-1.0-1.5 R-0.0		6-7	FISSURED SILTY GRAY CLAY	20.0'	
				SOFT GRAY CLAY WITH	20.0	226.5
1.5	0.5-0.9-0.7 R-0.0		6-8	SOME SILT AND LAYERS OF FINE SAND	22.0	
				SOFT SILTY FISSURED GRAY CLAY and		
0.5	0.5-0.0 R-0.0		6-9	SILT IN LAYERS	27.0'	
				LOOSE TILL	28.5'	
				SHALEY LIMESTONE (CORE RECOVERY - 14.7%)	29.7'	
					30.0	216.5
				SHALEY LIMESTONE (CORE RECOVERY 84%)		
					34.4	212.1
				BOTTOM OF HOLE		

RENOULDED = R

PENETRATION TEST

.....LB. HAMMER
.....INCH DROP
NO CASING
.....INCH DIA. ROD
BLOWS PER FOOT



% WATER CONTENT
⊙ MOISTURE CONTENT

PLATE 7

L.-M. CO.—A26553

APPENDIX F

Drawings 9B and 10 (Report Number 05-1120210-6)

Record of Borehole 06-141

Consolidation Test Results – BH 06-141

Record of Borehole 06-143

Record of Borehole 06-143A

Consolidation Test Results – BH 06-143A

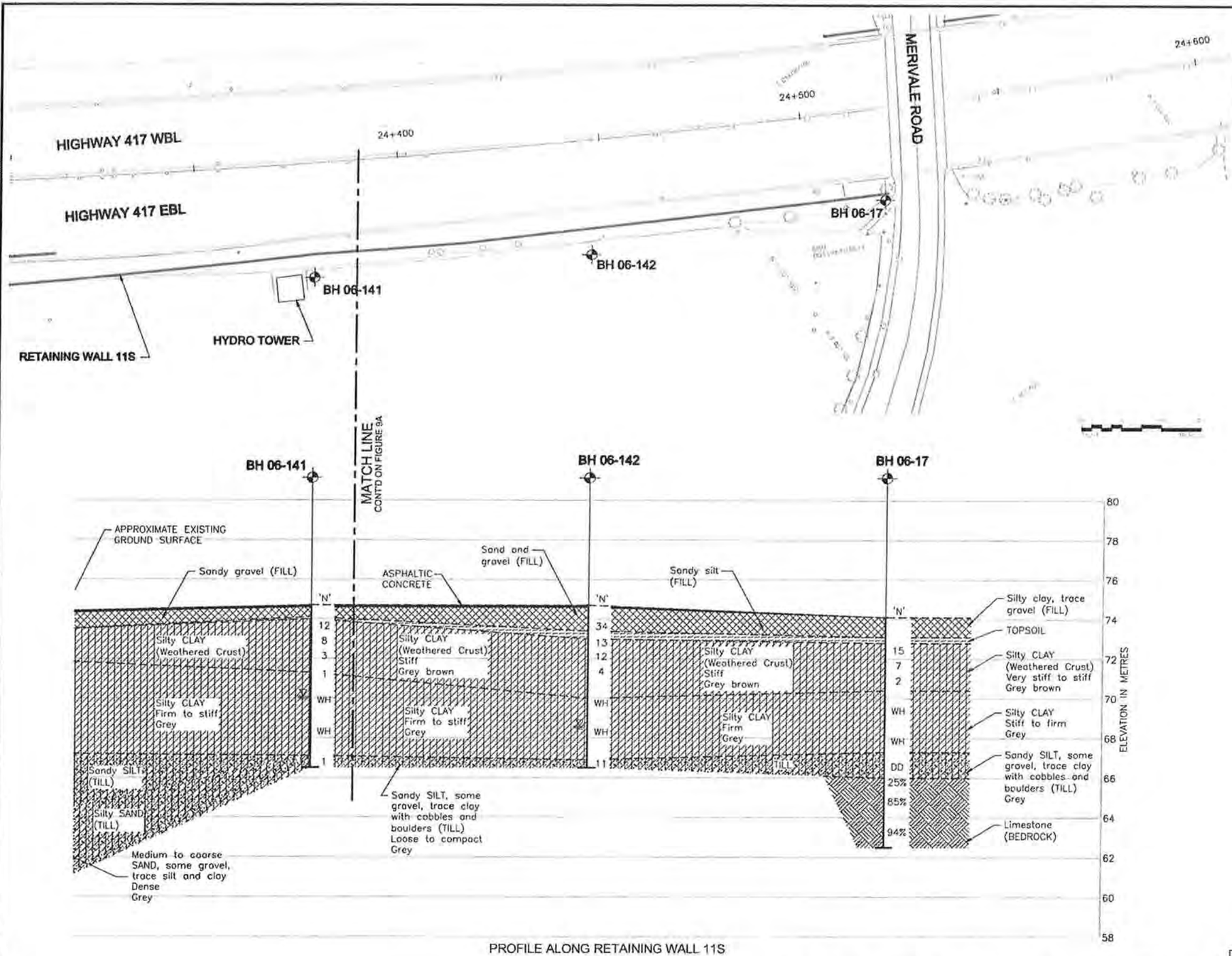
HWY. 417

WP No. WP 4058-01-00

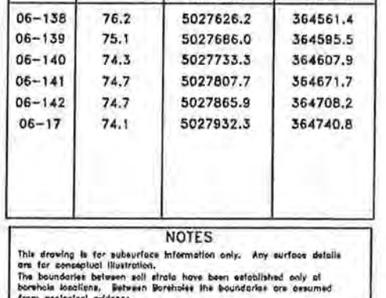
HIGHWAY 417 RETAINING WALL 11S
PLAN AND PROFILE

SHEET 2 of 2

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



PROFILE ALONG RETAINING WALL 11S



KEY PLAN

LEGEND

- Borehole – Current Golder Associates Ltd. Investigation
- Seal
- Piezometer
- N — Standard Penetration Test value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 J/blow)
- 100% — Rock Quality Designation (RQD)
- WL in piezometer
- WL upon completion of drilling

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
06-138	76.2	5027626.2	364561.4
06-139	75.1	5027686.0	364585.5
06-140	74.3	5027733.3	364607.9
06-141	74.7	5027807.7	364671.7
06-142	74.7	5027865.9	364708.2
06-17	74.1	5027932.3	364740.8

NOTES

This drawing is for subsurface information only. Any surface details are for conceptual illustration.
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
Base plan provided in electronic format by McCormick Rankin Corporation

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

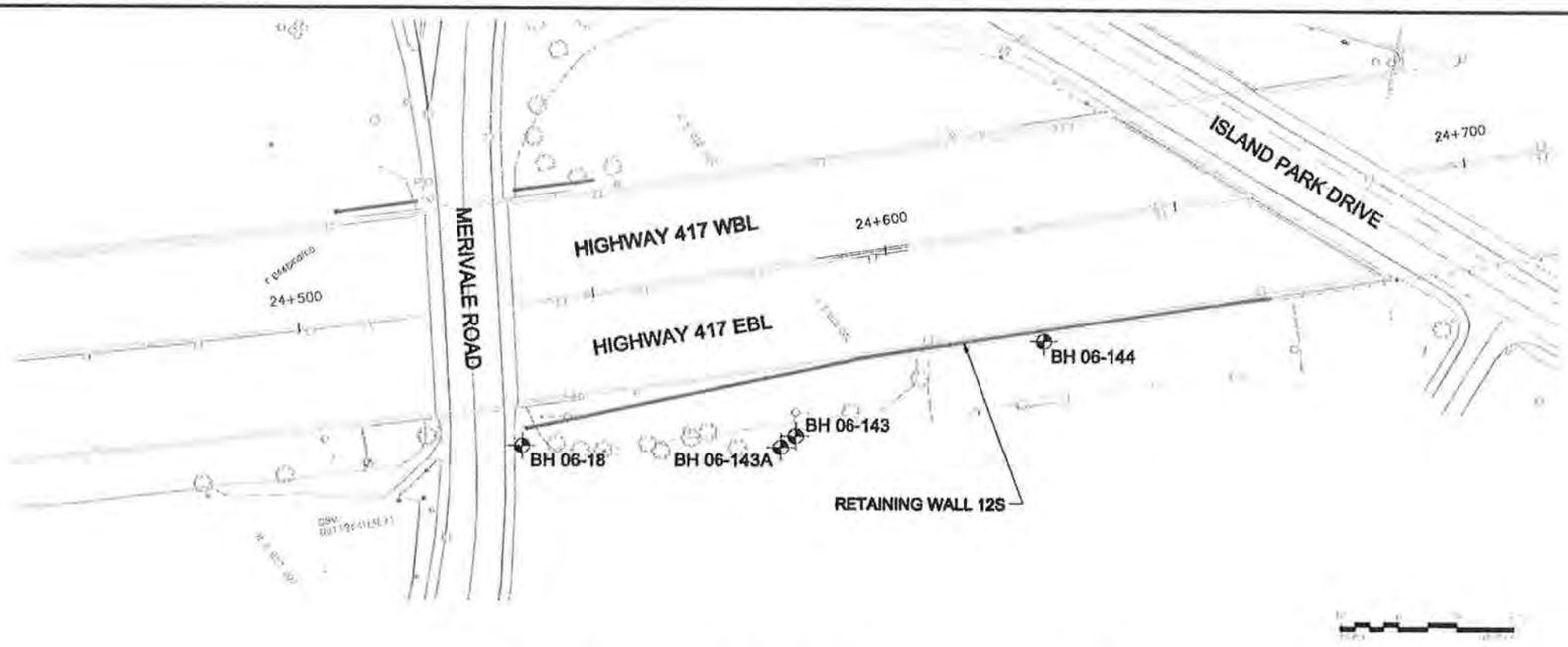
NO.	DATE	BY	REVISION

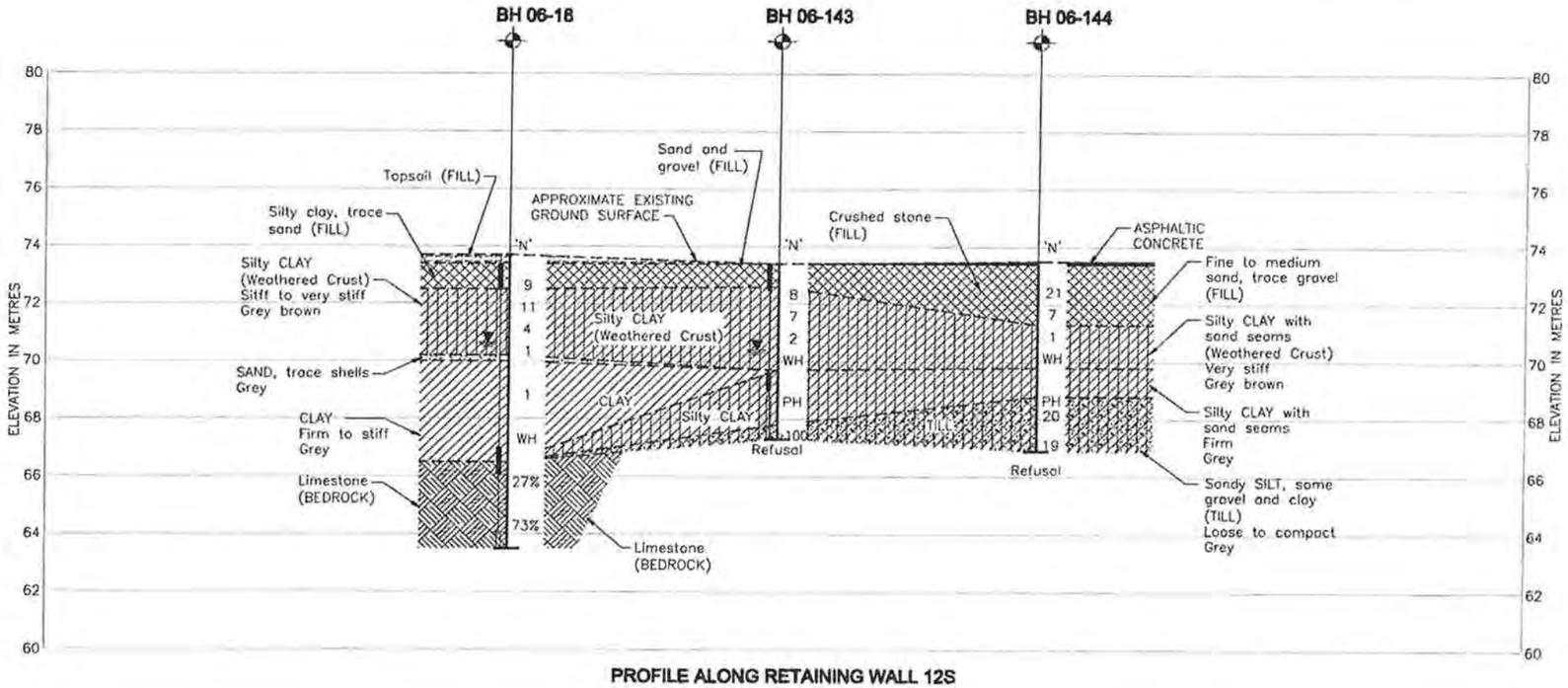
Geocres No. 31G5-218

HWY. 417		PROJECT NO. 05-1120-210-2000	DIST.
SUBM'D. W.C.	CHKD. M.I.C.	DATE: OCTOBER 2006	SITE:
DRAWN: J.M.	CHKD. W.C.	APPD.	DWG. 9B

05-1120-210-6000-01.dwg

1:1





PROFILE ALONG RETAINING WALL 12S

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

HWY. 417

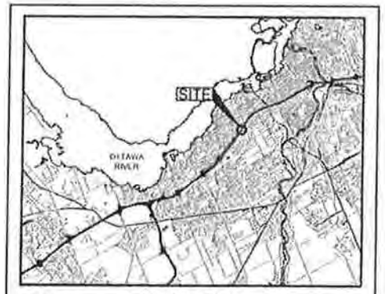
WP No. WP 4058-01-00

HIGHWAY 417 RETAINING WALL 12S
PLAN AND PROFILE

SHEET

Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN

LEGEND

- Borehole – Current Golder Associates Ltd. Investigation
- Seal
- Piezometer
- N — Standard Penetration Test value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 J/blow)
- 100% — Rock Quality Designation (RQD)
- WL in piezometer
- WL upon completion of drilling

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
06-143	73.4	5027983.9	364775.9
06-143A	73.4	5027980.8	364776.0
06-144	73.5	5028028.8	364786.5
06-18	73.7	5027945.9	364749.6

NOTES

This drawing is for subsurface information only. Any surface details are for conceptual illustration.
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
Base plan provided in electronic format by McCormick Rankin Corporation

NO.	DATE	BY	REVISION

Geocres No. 31G5-218

HWY. 417		PROJECT NO. 05-1120-210-2000	DIST.
SUBM'D. W.C.	CHKD. M.I.C.	DATE: OCTOBER 2006	SITE:
DRAWN: J.M.	CHKD. W.C.	APPD.	DWG. 10

05-1120-210-6000-01.dwg

Golder Associates

RECORD OF BOREHOLE No 06-141

1 OF 1

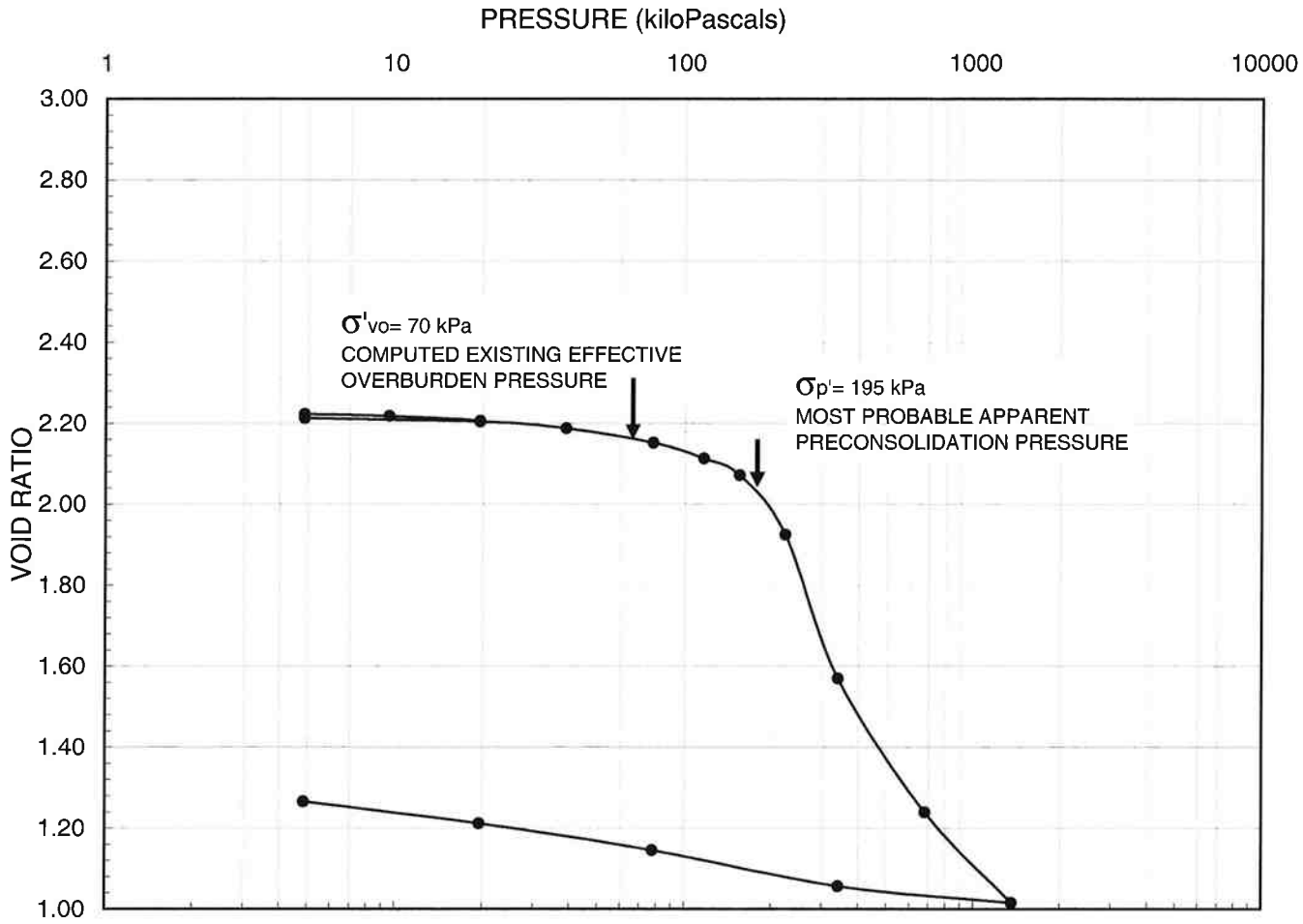
METRIC

PROJECT 05-1120-210-2000
W.P. 4058-01-00
DIST HWY 417
DATUM Geodetic
LOCATION N 5027807.7; E 364671.7
BOREHOLE TYPE Power Auger 108 mm I.D. Hollow Stem Auger
DATE Aug. 3, 2006
ORIGINATED BY D.G.
COMPILED BY J.M
CHECKED BY M.I.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
	Medium gravel (BASE) Brown										
0.2	Silty clay (FILL) Grey brown										
74.1	TOPSOIL										
0.7	Silty CLAY (Weathered Crust) Stiff Grey brown Moist		1	SS	12		74				
			2	SS	8		73				
			3	SS	3		72				
71.4											
3.4	Silty CLAY Firm to stiff Grey Moist to wet		4	SS	1		71	× + × +	o		
			5	TP	WH	▽	70	× +	c		
			6	SS	WH		69	× + × +			
67.1							68	× + × +			
7.6	Sandy SILT, some gravel, trace clay with cobbles and boulders (TILL) Very loose Grey		7	SS	1		67				
66.5	Wet										
8.2	End of Borehole										
	Note: Water level in open borehole at 4.6m depth below ground surface upon completion of drilling										

$+^3, \times^3$: Numbers refer to Sensitivity

$\bigcirc^{3\%}$ STRAIN AT FAILURE



LEGEND

Borehole:	06-141	w_i = 73.4%	S_o = 95%
Sample:	5	w_f = 44.0%	C_c = 1.95
Depth (m):	4.90	w_l = 58.1%	C_r = 0.012
		w_p = 28.8%	

Golder Associates		SCALE: AS SHOWN	TITLE: **CONSOLIDATION TEST RESULTS**
		DATE: 10/10/07	
		DESIGN: NA	
		CADD: NA	
FILE No.: Consolidation summary		CHECK:	
PROJECT No.: 0	REV.: 0	REVIEW:	**Retaining Wall 11S**
			FIGURE: **18**

RECORD OF BOREHOLE No 06-143

1 OF 1 **METRIC**

PROJECT 05-1120-210-2000 | W.P. 4058-01-00 | DIST HWY 417 | DATUM Geodetic

LOCATION N 5027983.9; E 364775.9 | BOREHOLE TYPE Power Auger 108 mm I.D. Hollow Stem Auger | DATE July 4, 2006

ORIGINATED BY D.J.S. | COMPILED BY J.M. | CHECKED BY M.I.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
73.4	GROUND SURFACE						73				
0.0 / 73.2	Sand and gravel (FILL) Brown										
72.9	Silty clay, trace gravel (FILL) Grey brown										
	TOPSOIL										
72.6	Sandy SILT Light brown										
0.8	Moist										
	Silty CLAY (Weathered Crust) Very stiff Grey brown Moist to wet		1	SS	8						
			2	SS	7		72				
70.7			3	SS	2		71				
2.7 / 70.4	Silty CLAY, some sand (Weathered Crust) Stiff Grey brown					▽					
3.1	Wet		4	SS	WH		70	× +			
69.7	Silty CLAY (Weathered Crust) Firm Grey brown							× +			
3.7	Wet						69				
	Silty CLAY Firm Grey Wet		5	TP	PH				⊢ ○		
67.9							68	× +			
5.6 / 67.3	Sandy SILT, some gravel and clay (TILL) Grey Wet		6	SS	>100						
6.1	End of Borehole Auger Refusal										

Note:
Water level in well screen at 3.0m depth below ground surface on Aug. 22, 2006.

$+^{3}, \times^{3}$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

PROJECT 05-1120-210-2000

RECORD OF BOREHOLE No 06-143A 1 OF 1 METRIC

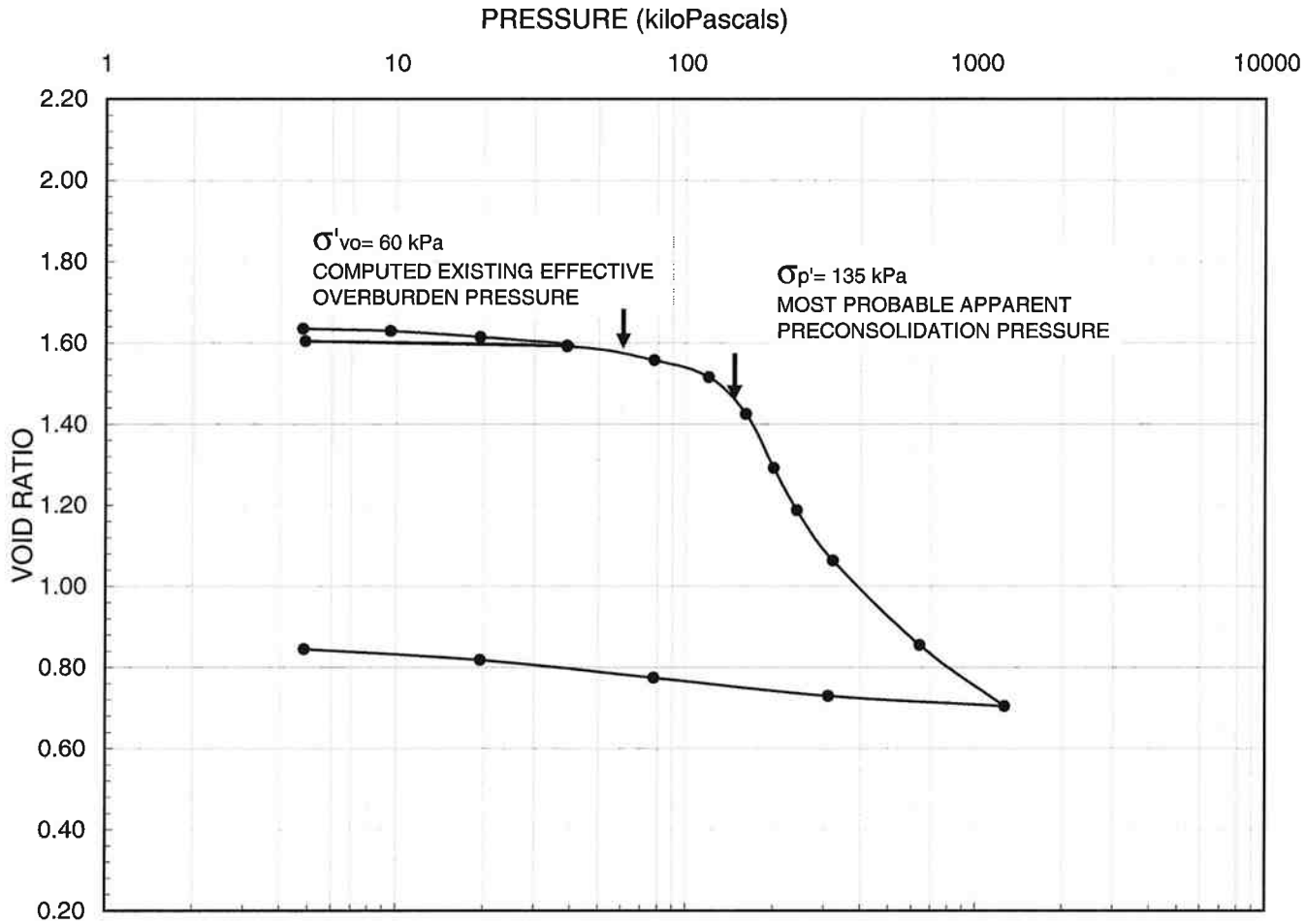
W.P. 4058-01-00 LOCATION N 5027980 8; E 364776 0 ORIGINATED BY J A S.

DIST HWY 417 BOREHOLE TYPE Power Auger 108 mm I.D. Hollow Stem Auger COMPILED BY J.M.

DATUM Geodetic DATE Feb. 2, 2007 CHECKED BY M.I.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
73.4	GROUND SURFACE										
0.0	See Record of Borehole 06-143 for soil description.						73				
							72				
							71				
							70				
			1	73 TP	PH						
							69				
			2	73 TP	PH						
							68				
67.6											
5.8	End of Borehole										

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE



LEGEND

Borehole:	06-143A	w_i = 58.6%	S_o = 100%
Sample:	1	w_f = 32.1%	C_c = 1.38
Depth (m):	3.9m	w_l = 57.1%	C_r = 0.013
		w_p = 21.6%	

Golder Associates	SCALE: AS SHOWN	TITLE: **CONSOLIDATION TEST RESULTS**	
	DATE: 10/10/07		
	DESIGN: NA		
	CADD: NA		
FILE No.: Consolidation summary	CHECK:		
PROJECT No.: 0 REV.: 0	REVIEW:	**Retaining Wall 12S**	FIGURE: **22**

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