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FOUNDATION INVESTIGATION REPORT
STRUCTURAL CULVERT - SITE 14-487C/W
STATION 19+550, TOWNSHIP OF WARWICK
HIGHWAY 402 AND LAMBTON COUNTY ROAD 79 IMPROVEMENTS
GWP 3158-06-00
WATFORD, ONTARIO

Submitted to:

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February 12, 2008

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Geocres No. 40I13-52

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Delcan Corporation (Delcan) on behalf of Waste Management (WM) to carry out foundation investigations as part of the design of the improvements for the Highway 402/Lambton County Road 79 (Nauvoo Road) interchange and Lambton County Road 79 south of the interchange to the new entrance of the WM Warwick Landfill in the Township of Warwick, Ontario.

The proposed works are being undertaken in conjunction with the Warwick Landfill Expansion Project. The design package is to be completed in accordance with Ministry of Transportation, Ontario (MTO) standards. The scope of work for this project consists of the geotechnical field investigation and design of the following components of the project:

- rehabilitation of the Lambton County Road 79 Underpass Structure (Site 14-355);
- profile grade adjustments (filling) on Lambton County Road 79;
- profile grade adjustments on portions of the existing E-N/S, S-W, N-E and W-N/S ramps;
- replacement of the existing S-E and N-W ramps with new ramps;
- possible pavement upgrades on the existing E-N/S ramp;
- paved shoulders along Lambton County Road 79 from Highway 402 to the landfill entrance;
- roadway improvements along Lambton County Road 79 at the new landfill entrance;
- culvert extensions on Lambton County Road 79; and
- culvert extension on Highway 402.

This report addresses the extension of the north end of the structural culvert (Site Number 14-487C/W) on Highway 402 at Station 19+550 under the westbound lane of Highway 402, Township of Warwick to accommodate the new N-W ramp. The foundation investigation and reporting was conducted in accordance with MTO standards for detail design.

The purpose of the foundation investigation is to determine the subsurface conditions at the locations of the proposed works by drilling boreholes and carrying out in situ testing and laboratory testing on selected samples. The terms of reference for the scope of work are outlined in the WM Project Terms of Reference, in our proposal P71-3118 dated June 26, 2007, and our letter pertaining to foundation engineering services (07-1130-128-4) dated September 10, 2007.

Delcan provided Golder Associates with a base plan for this project in digital format.

2.0 SITE DESCRIPTION

This project consists of the upgrading of the Highway 402/Lambton County Road 79 (Nauvoo Road) interchange with rehabilitation of the underpass structure, profile adjustments on Lambton County Road 79 and the affected ramps, construction of a new S-E ramp and N-W ramp and possible upgrading of the pavement on the E-N/S ramp. In addition, short span and structural culverts in the areas of the roadway improvements are to be extended and Lambton County Road 79 is to be upgraded in the vicinity of the new entrance to the Waste Management landfill. The structural culvert at Station 19+550 on Highway 402, Township of Warwick, is located approximately 630 metres west of the Lambton County Road 79 underpass structure. The location of the project site is shown on the Key Plan, Figure 1.

The surrounding area is predominantly agricultural lands with woodlots immediately north of the interchange. A former construction yard is located immediately north of the interchange and a former gas storage yard is located south of the interchange, both to the west of Lambton County Road 79. The adjacent topography is generally flat with a ground surface elevation ranging from 234 metres to 235 metres.

Lambton County Road 79 is a two lane road. The cross-section of the two span underpass structure over Highway 402 consists of a 18.29 metre wide deck, including curbs and guardrails with a total span length of 83.52 metres. The subject section of Highway 402 is a divided rural freeway with four 3.65 metre wide lanes together with on and off ramps and gravel shoulders.

Two structural culverts in alignment at Station 19+550, Township of Warwick, carry flow from the Morris Drain under the westbound and eastbound lanes of Highway 402. Flow in the culverts is from south to north. Photographs of the culvert under the Highway 402 westbound lanes are shown in Appendix B.

2.1 Site Geology

The project is located in the physiographic region of southern Ontario known as the Horseshoe Moraines, as identified in "The Physiography of Southern Ontario", by Chapman and Putnam (1984). The southwestern limb of the region consists of two, and in some places three, moraine ridges composed of pale brown, hard, calcareous, fine-textured till.

Based on the Ontario Department of Mines and Northern Affairs Preliminary Map P.1972 entitled "Quaternary Geology of the Strathroy Area", the project area is reportedly located in predominantly clayey silt to silty clay till.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on December 6, 2007 at which time two boreholes were drilled at the locations indicated on Drawing 1.

The as-drilled borehole locations, ground surface elevations and depths of boreholes are as follows:

BOREHOLE	LOCATION (m)		GROUND SURFACE ELEVATION (m)	BOREHOLE DEPTH (m)
	Northing	Easting		
101	4 761 579.5	354 776.7	227.58	6.55
102	4 761 572.8	354 753.8	229.46	8.84

The existing culvert has the following characteristics:

DIMENSIONS (m)	OBVERT ELEVATION (m)		CONSTRUCTION	MUNICIPAL DRAIN ID
	36.3m (Lt)	10.6m (Lt)		
4.88 x 1.22 x 25.70	228.67	228.73	Concrete, Rigid frame open footing (RFO)	Morris Drain

The soil stratigraphy encountered in the boreholes is shown on the attached Record of Borehole sheets. The investigation was carried out using an all terrain vehicle mounted CME 550 power auger supplied and operated by a specialist drilling contractor. Samples of the overburden were obtained at 0.75 and 1.5 metre intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. Groundwater conditions in the boreholes were observed throughout the drilling operations and the boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 903. A standpipe was installed in borehole 102 to monitor groundwater conditions.

The field work was supervised on a full-time basis by an experienced member of our engineering staff who directed the drilling, sampling and in situ testing operations, logged the boreholes and determined the ground surface elevations and borehole locations.

The samples were identified in the field, placed in labelled containers and transported to our London laboratory for further examination and routine classification testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg limits determinations were carried out on selected samples. The results of the testing are shown on the Record of Borehole sheets and in Appendix A.

4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the in situ testing and the laboratory testing carried out on selected samples, are given on the attached Record of Borehole sheets following the text of this report and in Appendix A. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous samples and observations of drilling resistance and, therefore, may represent transitions between soil types rather than exact planes of geological change. Further, the subsurface conditions will vary between and beyond the borehole locations.

The locations and elevations of the boreholes, together with an interpreted stratigraphic profile, are shown on the attached Drawing 1. A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and is summarized in the following sections.

The boreholes drilled at the site encountered rip rap or surficial granular fill and clayey silt fill overlying layers of silty clay, clayey silt, clayey silt till and silt.

4.1.1 Fill

A 0.2 metre thick rip-rap layer was encountered at ground surface in borehole 101.

Sand and gravel fill was encountered at ground surface in borehole 102 to a depth of 0.9 metres. The sand and gravel fill is granular roadbase material associated with the roadway shoulder.

A 0.5 metre thick layer of clayey silt fill was encountered beneath the sand and gravel fill in borehole 102 at elevation 228.6 metres. The clayey silt fill was firm with an N value of 6 blows per 0.3 metres.

4.1.2 Clayey Silt

Layers of clayey silt were encountered in both of the boreholes drilled at the site. The clayey silt was found beneath the silty clay at about elevation 225.5 metres in borehole 101 and beneath the clayey silt fill at about elevation 228.1 metres in borehole 102. The layers of clayey silt were 2.3 to 3.8 metres thick.

The clayey silt was stiff to very stiff with N values of 8 to 27 blows per 0.3 metres and had water contents of 15 to 22 per cent with an average water content of about 17 per cent. The average plastic and liquid limits, based on the results of two Atterberg limits determinations, were 16 and

30 per cent, respectively, with an average plasticity index of 14 per cent. The results of the plasticity testing indicate an inorganic clayey soil of low plasticity. The results of the Atterberg limits testing are presented on the Plasticity Chart, Figure A-4.

The results of grain size testing on two samples of clayey silt recovered from the standard penetration testing are presented on Figure A-1.

4.1.3 Silty Clay

Layers of silty clay were encountered in both of the boreholes drilled at the site. The silty clay was found beneath the rip rap at about elevation 227.3 metres in borehole 101 and beneath the clayey silt at about elevation 224.3 metres in borehole 102. The silty clay layers were 1.5 to 1.9 metres thick.

The silty clay was stiff to very stiff with N values of 9 to 20 blows per 0.3 metres and had water contents of 19 to 28 per cent with an average water content of about 23 per cent. The average plastic and liquid limits, based on the results of two Atterberg limits determinations, were 19 and 37 per cent, respectively, with an average plasticity index of 18 per cent. The results of the plasticity testing indicate an inorganic clayey soil of intermediate plasticity. The results of the Atterberg limits testing are presented on the Plasticity Chart, Figure A-4.

The results of grain size testing on two samples of silty clay recovered from the standard penetration testing are presented on Figure A-2.

4.1.4 Clayey Silt Till

Clayey silt till was encountered in both of the boreholes drilled at the site. The clayey silt till was found beneath the clayey silt at about elevation 223.2 metres in borehole 101 and beneath the silty clay at about elevation 222.8 metres in borehole 102. The clayey silt till was 1.2 metres thick where fully penetrated. Borehole 102 was terminated in a deposit of clayey silt till after exploring it for some 2.1 metres.

The clayey silt till was stiff with N values of 8 to 12 blows per 0.3 metres and had water contents of 13 to 16 per cent with an average water content of about 14 per cent. The shear strength of the softer zones of the clayey silt till is greater than 144 kilopascals based on a single in situ vane shear strength test. The plastic and liquid limits, based on the results of a single Atterberg limits determination, were 15 and 27 per cent, respectively, with a plasticity index of 12 per cent. The results of the plasticity testing indicate an inorganic clayey soil of low plasticity. The results of the Atterberg limits testing are presented on the Plasticity Chart, Figure A-4.

The results of grain size testing on a single sample of clayey silt till recovered from the standard penetration testing are presented on Figure A-3.

Although cobbles and boulders were not specifically encountered in the boreholes, the presence of these materials should be expected due to the depositional history of the glacial tills.

4.1.5 Silt

Borehole 101 encountered and was terminated in a layer of silt after exploring it for some 0.9 metres. The silt was found beneath the clayey silt till at about elevation 221.9 metres.

The silt was dense with an N value of 35 blows per 0.3 metres and had a water content of 17 per cent.

The results of grain size testing on a single sample of silt recovered from the standard penetration testing are presented on Figure A-5.

4.2 Groundwater Conditions

Groundwater conditions were observed during and on completion of drilling and sampling. Groundwater was encountered in borehole 101 at about 227.5 metres during drilling on December 6, 2007. Borehole 102 was dry during drilling. A standpipe was installed in borehole 102 to monitor the groundwater conditions. After installation on December 6, 2007, the water level in the standpipe was measured at elevation 222.9 metres or a depth of 6.6 metres. On December 19, 2007, the water level in the standpipe was measured at elevation 227.3 metres or a depth of 2.2 metres below the ground surface. On January 30, 2008, the water level in the standpipe was measured at elevation 227.4 metres or a depth of 2.1 metres below the ground surface.

Details of the groundwater conditions encountered and subsequently measured in the installation are provided on the Record of Borehole sheets and are summarized below.

		ENCOUNTERED GROUNDWATER LEVEL			MEASURED GROUNDWATER LEVEL					
					Dec. 6, 2007		Dec. 19, 2007		Jan. 30, 2008	
BOREHOLE	GROUND SURFACE ELEVATION (m)	Depth (m)	Elevation (m)	INSTALLATION	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
101	227.58	0.8	227.5	-	-	-	-	-	-	-
102	229.46	Dry	Dry	Standpipe	6.55	222.93	2.16	227.30	2.07	227.39

The water level at the outlet of the culvert at Station 19+550 was at elevation 227.5 metres on December 6, 2007.

The interface of the brown to grey clayey silt was at elevation 225.5 metres to 225.7 metres.

Based on the location of the interface of the brown and grey clayey silt, the measured drain water level and the measured water level in the standpipe, the groundwater level elevation is inferred to be near 227.5 metres.

The groundwater levels are expected to fluctuate seasonally and are expected to be higher during periods of sustained precipitation or during spring melt conditions.

5.0 MISCELLANEOUS

The investigation was carried out using equipment supplied and operated by B.U.D. Environmental Services., which is an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Michael Arthur under the direction of Mr. David J. Mitchell. The routine laboratory testing was carried out at Golder Associates' London laboratory under the direction of Mr. Chris M. Sewell. The laboratory is an accredited participant in the MTO Soil and Aggregate Proficiency Program and is certified by the Canadian Council of Independent Laboratories for testing Types C and D aggregates.

This report was prepared by Ms. Dirka U. Prout, P. Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P. Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

GOLDER ASSOCIATES LTD.

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Geotechnical Engineer

Philip R. Bedell, P. Eng.
Principal

Fintan J. Heffernan, P. Eng.
Designated MTO Contact

DB/DUP/PRB/FJH/cr
n:\active\2007\1130 - geotechnical\1130-1000\07-1130-128-4 delcan - fnds new n to w ramp - watford\reports\-1 structural culvert stn 19+550 watford\feb 12 08 - (final) part a - structural culvert sta 19+550 watford.doc

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

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.) split spoon 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, 60º 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) 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

(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.

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
v	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 l
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 = 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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 101

1 OF 1

METRIC

PROJECT 07-1130-128-4-1
G.W.P. 3158-06-00
DIST _____ HWY 402
DATUM GEODETIC

LOCATION N 4761579.5 ;E 354776.7
BOREHOLE TYPE POWER AUGER (UNCASED)
DATE December 6, 2007

ORIGINATED BY MA
COMPILED BY BRS
CHECKED BY _____

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
227.58	GROUND SURFACE										
0.00	RIP RAP										
0.24	SILTY CLAY, trace sand Very Stiff to Stiff Brown		1	SS	20		227				0 1 57 42
			2	SS	19		226				
225.45											
2.13	CLAYEY SILT, trace sand Stiff Grey		3	SS	14		225				
			4	SS	15						
223.92							224				
3.66	CLAYEY SILT, with silt layers Stiff Grey		5	SS	8						0 0 64 36
223.16							223				
4.42	CLAYEY SILT (TILL), trace sand, trace gravel Stiff to Very Stiff Grey		6	SS	8						
221.94							222	>144kpa			
5.64	SILT, some clay Dense Grey		7	SS	35						0 0 85 15
221.03											
6.55	END OF BOREHOLE Groundwater encountered at about elev. 227.5 m during drilling on December 6, 2007										

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

LDN_MTO_01 07-1130-128-4_1.GPJ LDN_MTO.GDT 2/13/08

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

PROJECT 07-1130-128-4-1
G.W.P. 3158-06-00
DIST _____ HWY 402
DATUM GEODETIC

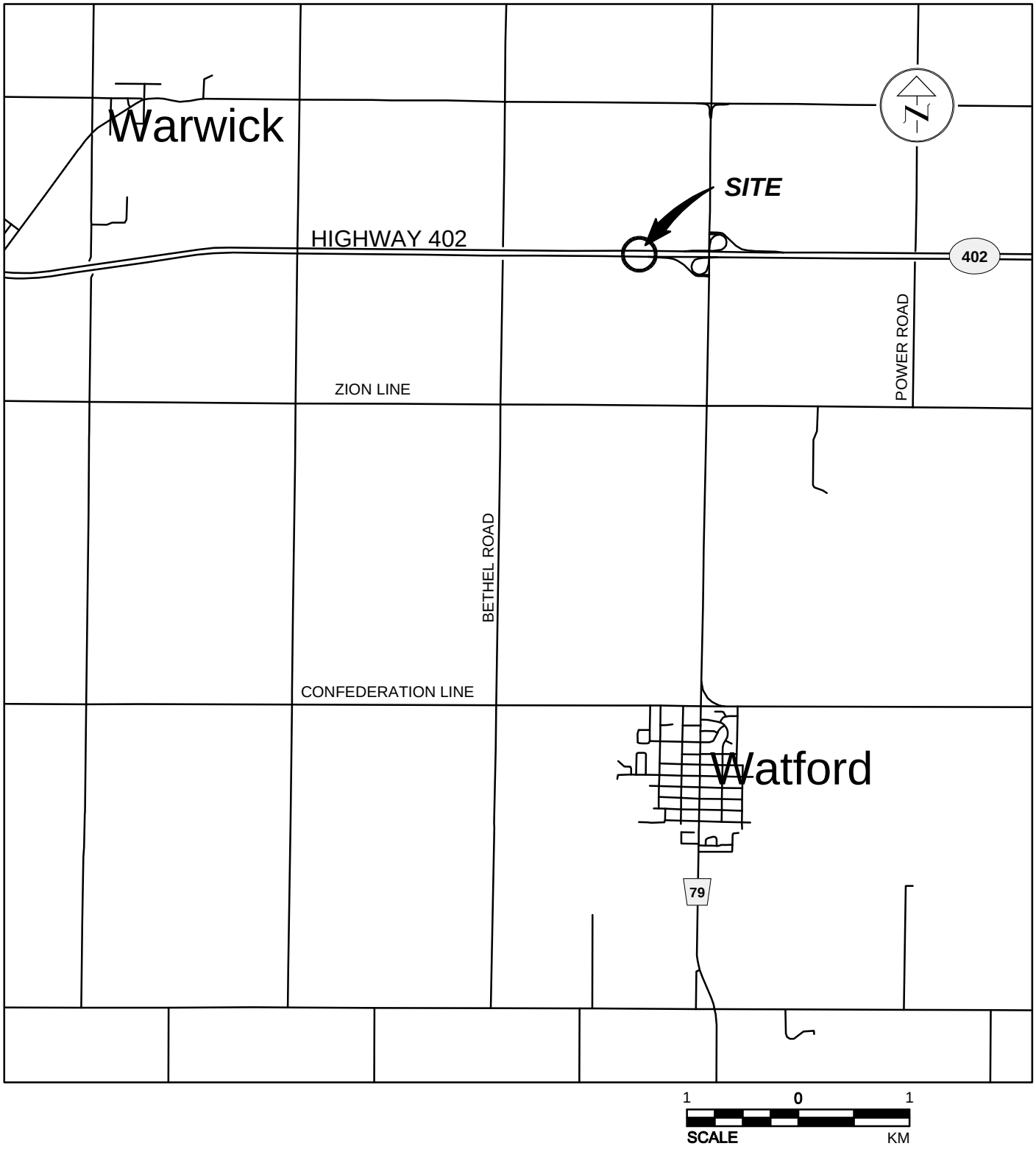
LOCATION N 4761572.8 ;E 354753.8
BOREHOLE TYPE POWER AUGER (UNCASED)
DATE December 6, 2007

ORIGINATED BY MA
COMPILED BY BRS
CHECKED BY _____

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 × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
229.46	GROUND SURFACE										
0.00	FILL, sand and gravel Crushed Brown						0.3m of Rip Rap				
0.24	FILL, sand and gravel, trace silt Compact Brown		1	SS	6		229 Auger Cuttings				
228.55 0.91	FILL, clayey silt, trace sand, trace gravel Firm Brown		2	SS	20		228				
228.09 1.37	CLAYEY SILT, trace sand Very Stiff to Stiff Brown becoming grey below about elev. 225.7m		3	SS	22		227 Bentonite				0 3 57 40
			4	SS	27		226				
			5	SS	11		225 Auger Cuttings				
224.28 5.18	SILTY CLAY, with silt layers Stiff Grey		6	SS	13						
			7	SS	9		224				0 0 39 61
222.75 6.71	CLAYEY SILT (TILL), some sand, trace gravel Stiff Grey		8	SS	12		223				
			9	SS	9						
			10	SS	11		222				5 14 67 14
			11	SS	12		221				
220.62 8.84	END OF BOREHOLE Borehole dry during drilling on December 6, 2007. Water level measured in standpipe at elev. 222.91m on December 6, 2007. Water level measured in standpipe at elev. 227.30m on December 19, 2007. Water level measured in standpipe at elev. 227.10m on January 7, 2008. Water level measured in standpipe at elev. 227.39m on January 30, 2008.										

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

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



REFERENCE

DRAWING BASED ON CANMAP STREETFILES V2005.4

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT

STRUCTURAL CULVERT 19+550
HIGHWAY 402 & LAMBTON COUNTY ROAD 79 IMPROVEMENTS
GWP 3158-06-00

TITLE

KEY PLAN

Golder Associates
LONDON, ONTARIO

PROJECT No.		07-1130-128-4	FILE No.	0711301284-1-R01001	
			SCALE	AS SHOWN	REV. 0
CADD	WDF	FEB 08/08	FIGURE 1		
CHECK					

Drawing file: 0711301284-1-R01001.dwg Feb 08, 2008 - 9:22am

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 3158-06-00

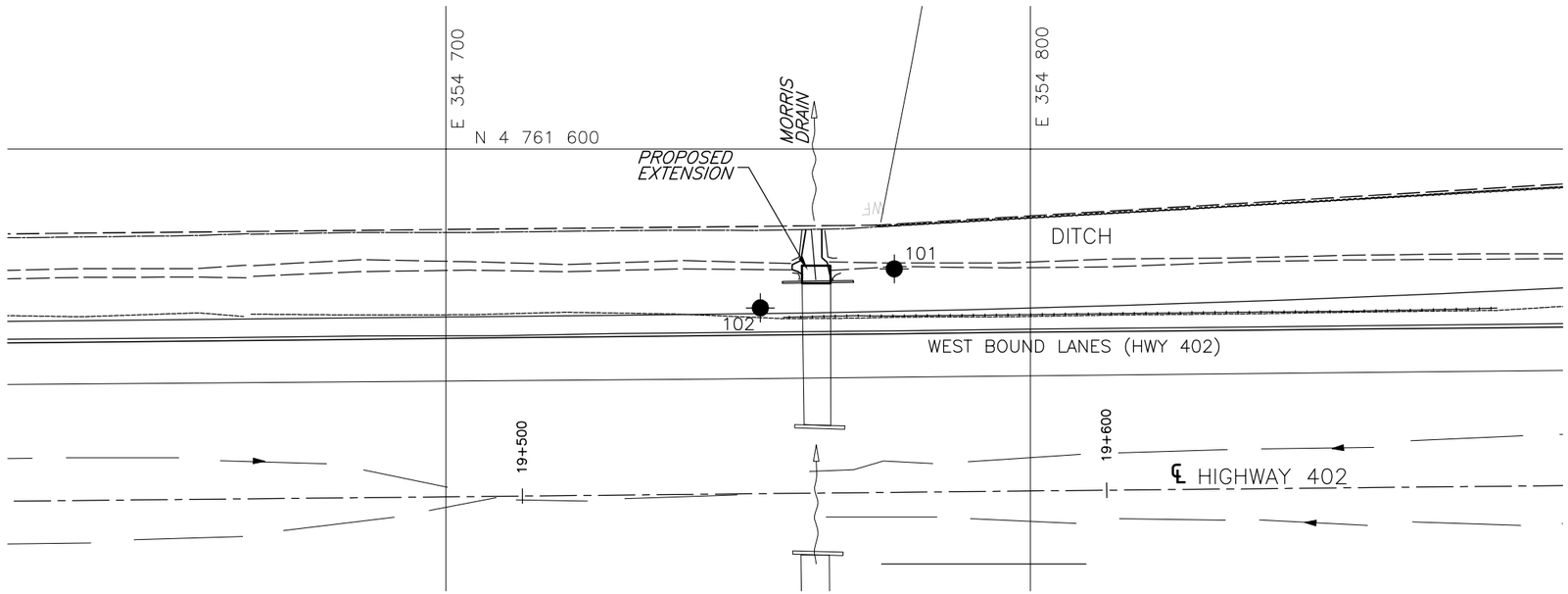
SHEET

HWY 402/LAMBTON CTY RD 79 IMPROVEMENTS

STUCTURAL CULVERT – STATION 19+550
TOWNSHIP OF WARWICK
BOREHOLE LOCATION AND SOIL STRATA

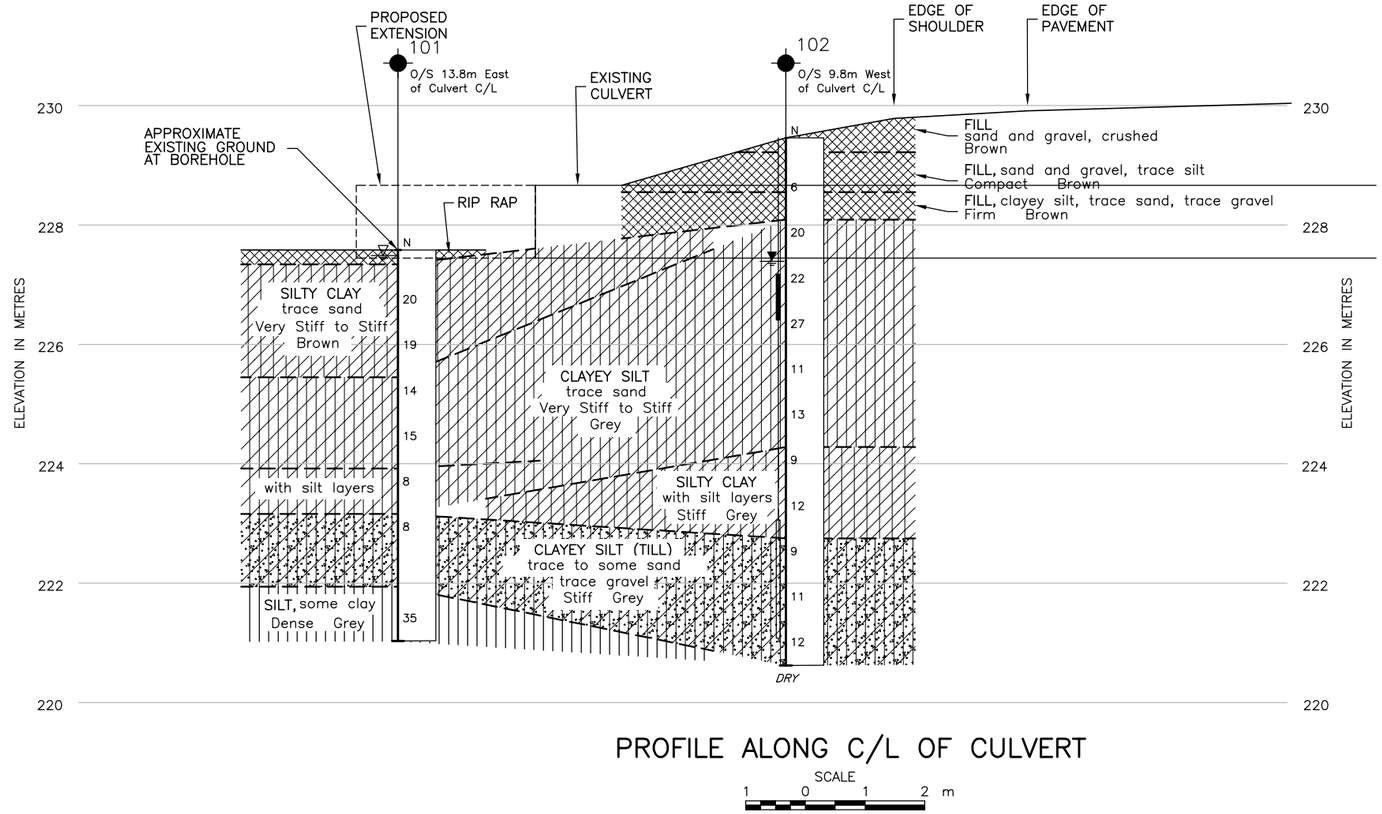
Golder Associates

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



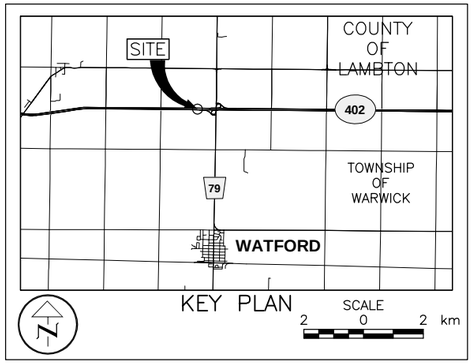
PLAN

SCALE
10 0 10 20 m



PROFILE ALONG C/L OF CULVERT

SCALE
1 0 1 2 m



LEGEND

- Borehole – Current Investigation
- Seal
- Standpipe
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in standpipe, measured on JAN 30, 2008.
- WL encountered during drilling
- *DRY* Borehole dry during drilling

No.	ELEVATION	CO-ORDINATES (MTM Zone 11)	
		NORTHING	EASTING
101	227.58	4 761 579.5	354 776.7
102	229.46	4 761 572.8	354 753.8

NOTES

This drawing is for subsurface information only. Surface details and features 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.

REFERENCE

Base plans provided in digital format by DELCAN

NO.	DATE	BY	REVISION

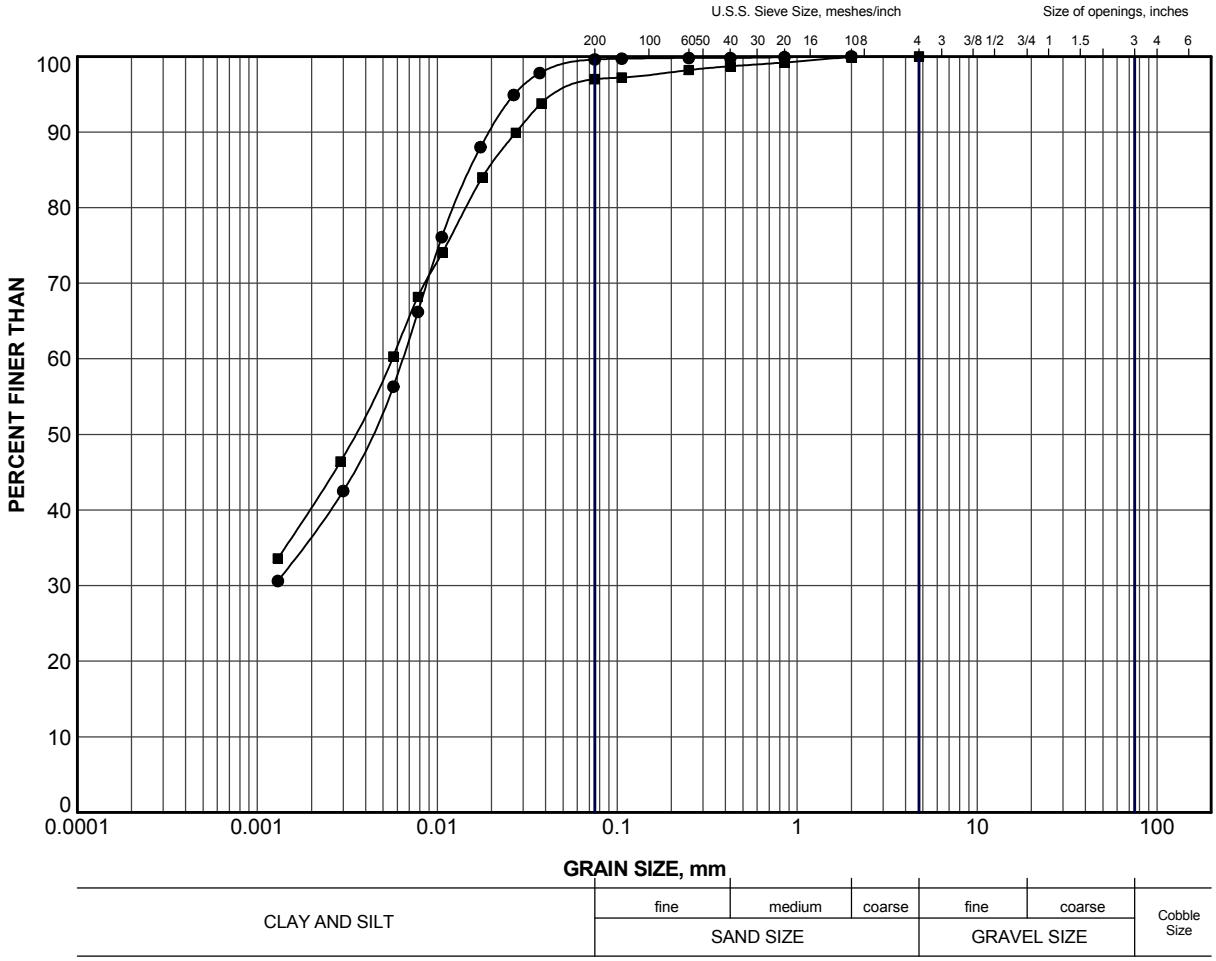
Geocres No. 40I13-52

HWY. 402	PROJECT NO. 07-1130-128-4		DIST.
SUBM'D. DB	CHKD. DUP	DATE: FEB 08/08	SITE: 14-487C/W
DRAWN: WDF	CHKD. DUP	APPD.	DWG. 1

PLOT DATE: February 06, 2008
FILENAME: N:\active\2007\1130 - Geotechnical\1130-1000\07-1130-128-4 DELCAN - FNDS NEW N TO W RAMP - WATFORD\Drafting\AutoCAD files\~4 - 1 Cu07113012B4-1-201001.dwg

APPENDIX A

LABORATORY TEST DATA



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	101	5	223.5
■	102	3	226.9

PROJECT

STRUCTURAL CULVERT 19+550
HIGHWAY 402 & LAMBTON COUNTY ROAD 79 IMPROVEMENTS
GWP 3158-06-00

TITLE

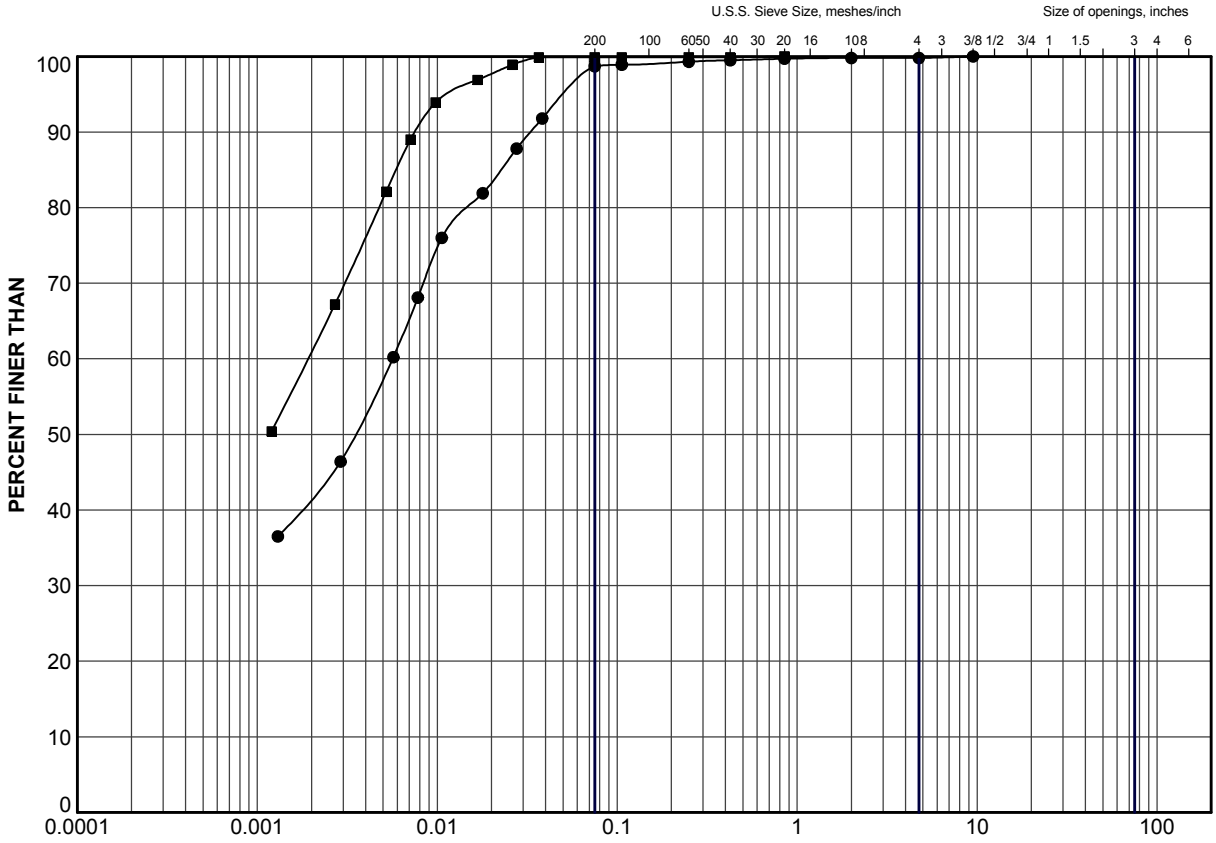
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.		07-1130-128-4	FILE No.	0711301284-1-R010A1
			SCALE	N/A REV.
DRAWN	BRS	Feb 08/08		
CHECK			**FIGURE A-1**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	101	1	226.6
■	102	7	223.9

PROJECT

STRUCTURAL CULVERT 19+550
HIGHWAY 402 & LAMBTON COUNTY ROAD 79 IMPROVEMENTS
GWP 3158-06-00

TITLE

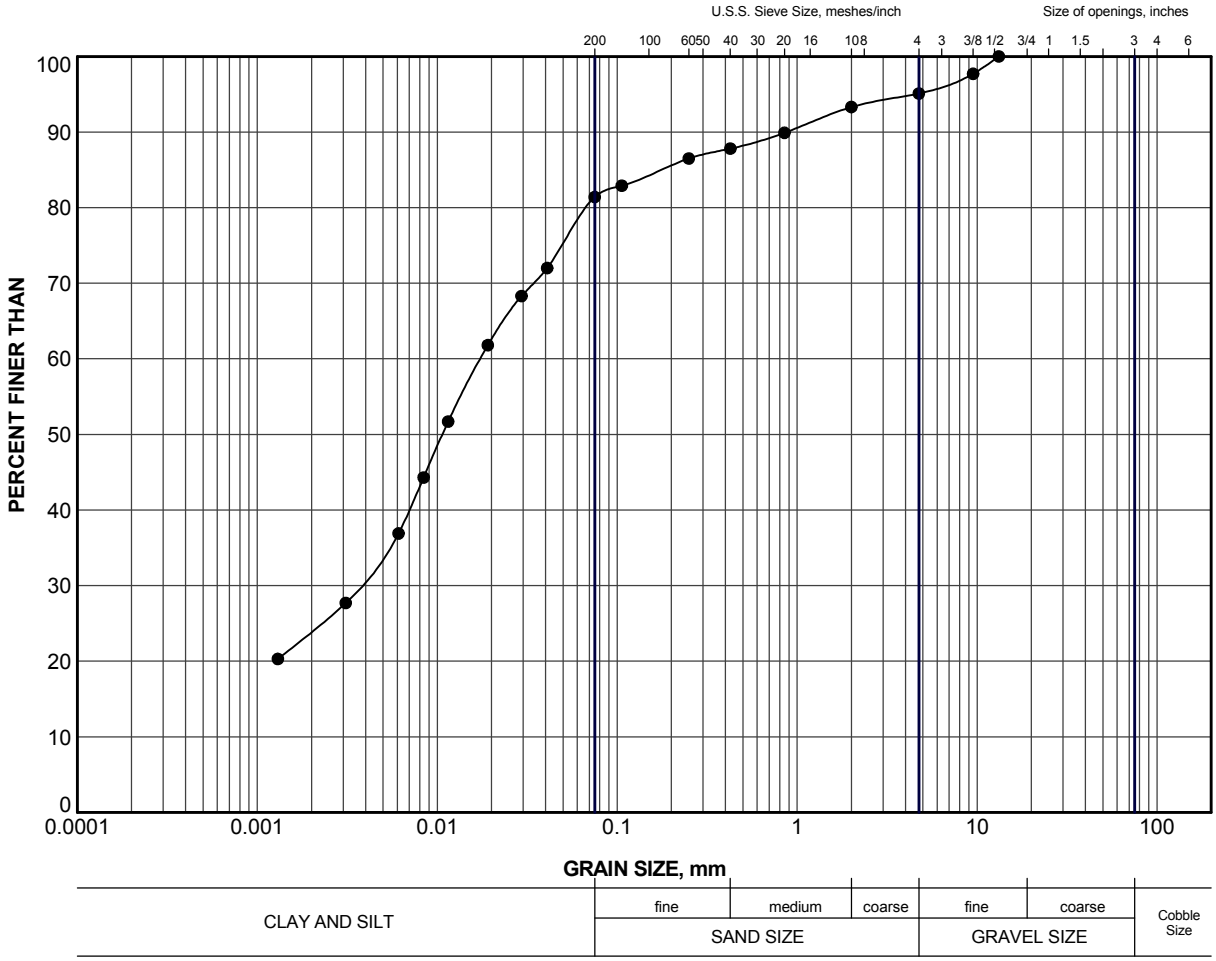
GRAIN SIZE DISTRIBUTION

SILTY CLAY

Golder Associates
LONDON, ONTARIO

PROJECT No.	07-1130-128-4		FILE No. 0711301284-1-R010A2
			SCALE N/A REV.
DRAWN	BRS	Feb 08/08	
CHECK			**FIGURE A-2**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	102	10	221.6

PROJECT

STRUCTURAL CULVERT 19+550
HIGHWAY 402 & LAMBTON COUNTY ROAD 79 IMPROVEMENTS
GWP 3158-06-00

TITLE

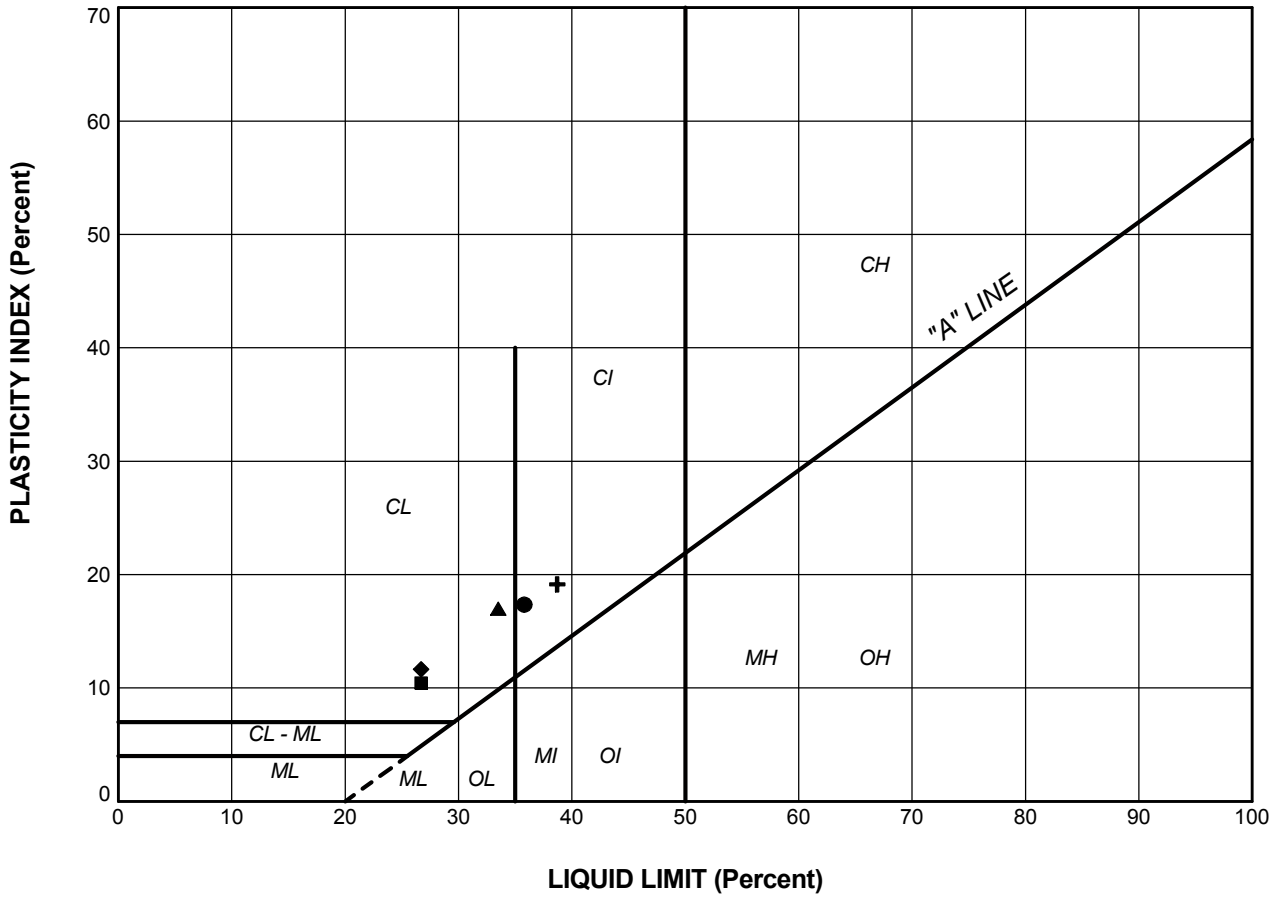
GRAIN SIZE DISTRIBUTION

CLAYEY SILT (TILL)

Golder Associates
LONDON, ONTARIO

PROJECT No.	07-1130-128-4		FILE No.	0711301284-1-R010A3
			SCALE	N/A REV.
DRAWN	BRS	Feb 08/08		
CHECK			**FIGURE**	**A-3**

LDN_MTO_NEW GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
SILTY CLAY					
●	101	1	35.8	18.5	17.4
✚	102	7	38.7	19.6	19.2
CLAYEY SILT					
■	101	5	26.7	16.3	10.5
▲	102	3	33.5	16.5	17.0
CLAYEY SILT (TILL)					
◆	102	10	26.7	15.1	11.7

PROJECT

STRUCTURAL CULVERT 19+550
HIGHWAY 402 & LAMBTON COUNTY ROAD 79 IMPROVEMENTS
GWP 3158-06-00

TITLE

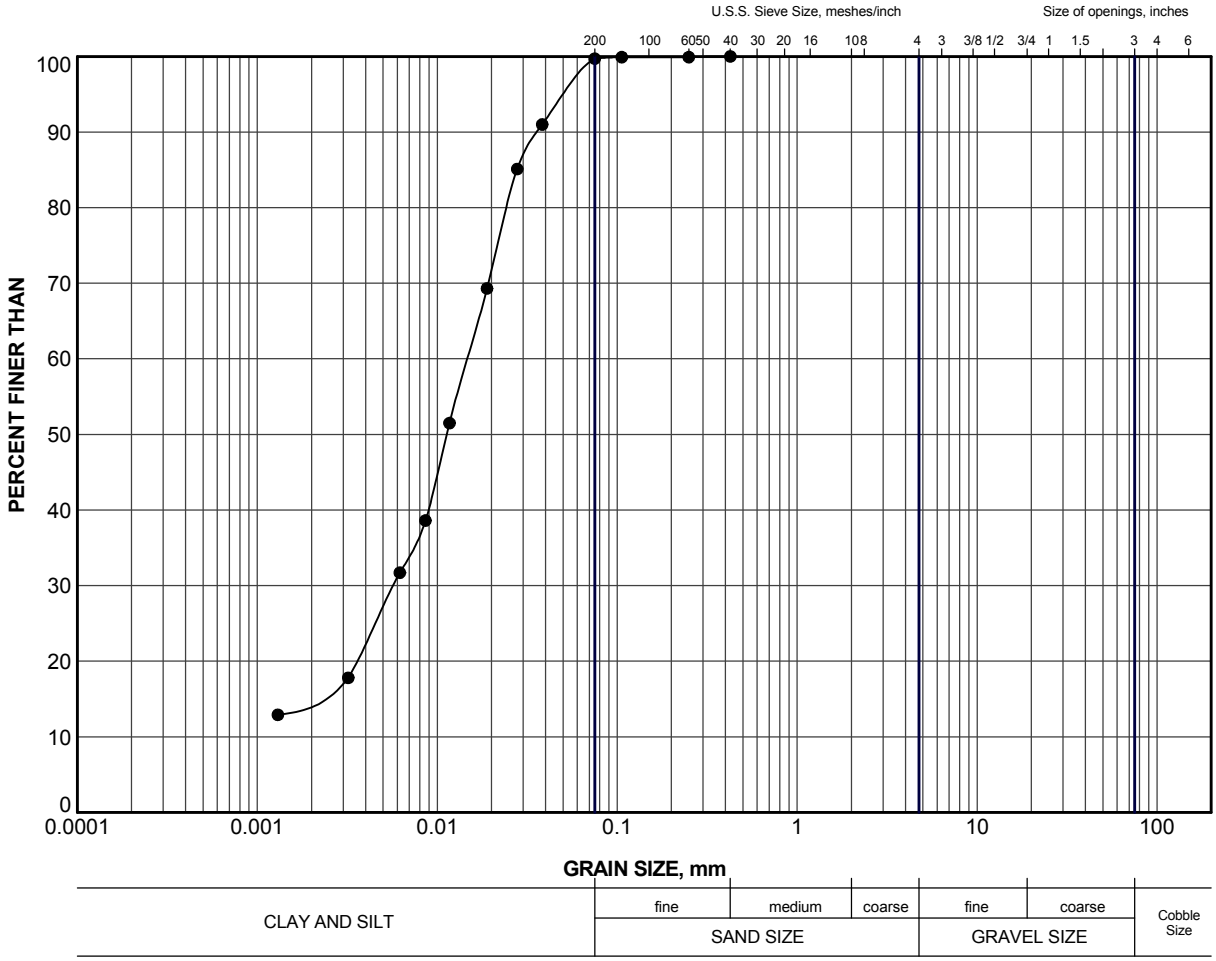
PLASTICITY CHART

Golder Associates
LONDON, ONTARIO

PROJECT No.	07-1130-128-4		FILE No.	0711301284-1-R010A4
			SCALE	N/A
DRAWN	BRS	Feb 08/08	REV.	
CHECK				

FIGURE A-4

MTO_PI GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	101	7	221.3

PROJECT

STRUCTURAL CULVERT 19+550
HIGHWAY 402 & LAMBTON COUNTY ROAD 79 IMPROVEMENTS
GWP 3158-06-00

TITLE

GRAIN SIZE DISTRIBUTION

SILT

Golder Associates
LONDON, ONTARIO

PROJECT No. 07-1130-128-4			FILE No. 0711301284-1-R010A5	
			SCALE N/A	REV.
DRAWN	BRS	Feb 08/08	FIGURE A-5	
CHECK				

LDN_MTO_NEW GLDR_LDN.GDT

APPENDIX B

SITE PHOTOGRAPHS

SITE PHOTOGRAPHS

Photo 1: Outlet end of structural culvert 19+550 Highway 402.

Photo 2: Outlet end of structural culvert 19+550 Highway 402.