

**FOUNDATION INVESTIGATION AND DESIGN REPORT
STRUCTURAL CULVERT
SITE 6-406-C
HIGHWAY 3 WIDENING
GWP 315-98-00
MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION**

Submitted to:

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TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
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PART A – FOUNDATION INVESTIGATION REPORT

1.0	INTRODUCTION.....	1
2.0	SITE DESCRIPTION.....	2
2.1	Site Geology	2
3.0	INVESTIGATION PROCEDURES.....	3
4.0	SUBSURFACE CONDITIONS.....	5
4.1	Site Stratigraphy.....	5
4.1.1	Topsoil and Fill	5
4.1.2	Clayey Silt Till.....	5
4.2	Groundwater Conditions.....	6
5.0	MISCELLANEOUS.....	7

PART B – FOUNDATION DESIGN REPORT

6.0	ENGINEERING RECOMMENDATIONS.....	8
6.1	General	8
6.2	Foundations	8
6.2.1	Frost Protection	9
6.3	Backfill	9
6.4	Lateral Earth Pressures for Design.....	9
6.5	Construction Considerations	10
6.6	Excavations and Temporary Cut Slopes	11
7.0	MISCELLANEOUS.....	13

LIST OF ABBREVIATIONS

LIST OF SYMBOLS

RECORD OF BOREHOLE SHEETS

FIGURE 1 - Key Plan

DRAWING 1 - Borehole Locations and Soil Strata

APPENDIX A - Laboratory Test Data

APPENDIX B - Site Photograph

PART A
FOUNDATION INVESTIGATION REPORT

STRUCTURAL CULVERT
SITE 6-406-C
HIGHWAY 3 WIDENING
GWP 315-98-00
MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION

1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Delcan Corporation (Delcan) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detail design work for GWP 315-98-00. The project involves the first phase of the reconstruction and widening of Highway 3 (Talbot Trail) between Windsor and Leamington. The project limits extend along Highway 3 from just west of Essex Road 34 (Talbot Street North) easterly to just east of Essex Road 8 (Maidstone Avenue West) in Essex County, Ontario.

In conjunction with the widening, the scope of work for this project includes:

- Rehabilitation or replacement of selected culverts within the project limits;
- Slotted left turn lanes at all intersections;
- Revision or upgrading of illumination at four intersections;
- Revision or upgrading of traffic signals at two intersections;
- Replacement or relocation of existing traffic counting stations;
- Drainage improvements; and,
- Upgrading of existing signage.

Five structural culverts and four short span culverts are to be widened and two short span culverts are to be replaced.

This report addresses the foundation investigation for the extension of the south end of the structural culvert located on Highway 3 at Station 17+810 South Sandwich (Site 6-406-C). This culvert is to be extended by up to 5 metres.

The purpose of the foundation investigation is to determine the subsurface conditions at the location 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 MTO's Request for Proposal, in Golder Associates' proposal P61-3113-1 dated August 17, 2006 and our letter dated November 14, 2006. The work was carried out in accordance with our Quality Control Plan for Foundations Engineering dated September 18, 2006.

Delcan provided Golder Associates with a base plan and profile for this project in digital format which included the top elevations of the culverts.

2.0 SITE DESCRIPTION

GWP 315-98-00 extends along Highway 3 from 0.5 kilometres west of Essex Road 34 (Talbot Street North) within the Town of Tecumseh easterly to 0.6 kilometres east of Essex Road 8 (Maidstone Avenue West) in the Town of Essex. West of Manning Road, Highway 3 is within South Sandwich Township. East of Manning Road, it is within Maidstone Township. The chainage equation at Manning Road is $20+981.675 \text{ South Sandwich (SS)} = 10+000.000 \text{ Maidstone (M)}$. The west project limit is located at Station 17+700 SS and the east project limit is situated at Station 13+600 M.

Culvert Site 6-406-C is located at Station 17+810 SS on Highway 3 approximately 380 metres east of Essex Road 34. This culvert conveys flows of the West Branch of the Delisle Drain from the left/north side of Highway 3 to the right/south side. The location of the project is shown on the Key Plan, Figure 1, and in the photograph in Appendix B.

The land use in the vicinity of the site is predominantly agricultural. The adjacent topography is generally flat to slightly rolling with a ground surface elevation between 191 and 195 metres.

2.1 Site Geology

The site is situated on the Essex Clay Plain, a subregion of the physiographic region of southern Ontario known as the St. Clair Clay Plain.¹ This subregion is described as a beveled till plain with little relief that has been locally smoothed by shallow deposits of lacustrine clay deposited in depressions in the till. The prevailing soil type is reported to be the Brookston clay loam.

The available surficial geology mapping for the project area indicates that the predominant surficial soils are clayey silt till.² The till is reportedly underlain by limestone, dolomite and shale of the Middle Devonian era and by dolomite of the Upper Silurian era. The overburden thickness within the project area ranges from 27 to 41 metres.³

¹ L.J. Chapman and D.F. Putnam, 1984. *The Physiography of Southern Ontario*. Third Edition. Ontario Geological Survey, Special Volume 2.

² Vagners, U. J., 1972. *Quaternary Geology of the Windsor-Essex Area, (Western and Eastern Parts) Southern Ontario*. Ontario Department of Mines and Northern Affairs, Preliminary Maps P. 749 and P.750, Geological Series.

³ Vagners, U.J., Sado, E.V., and Yundt, S.E. 1973. *Drift Thickness of the Windsor-Essex Area (Western and Eastern Parts), Southern Ontario*, Ontario Division of Mines, Preliminary Maps P.814 and P.815, Drift Thickness Series.

3.0 INVESTIGATION PROCEDURES

The field work for this portion of the investigation was carried out on November 29 and 30, 2006, at which time two boreholes, numbered 9 and 10, were drilled in the area of the proposed culvert extension. Borehole 9 was advanced to a depth of 9.0 metres and borehole 10 to a depth of 7.5 metres.

The investigation for these two boreholes was carried out using a Deitrich 50 track-mounted power auger supplied and operated by a specialist drilling contractor. Samples of the overburden were obtained at intervals of 0.75 metres up to a depth of 4.6 metres and at 1.5 metre intervals below this 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 these observations are provided on the corresponding Record of Borehole sheets. A standpipe piezometer was installed in borehole 10 to monitor the groundwater levels at this location. Boreholes were backfilled in accordance with current regulations, MTO recommended procedures and Ontario Regulation 128/03.

The field work was supervised on a full-time basis by an experienced member of our engineering staff who arranged for utility locates, directed the drilling, sampling and in-situ testing operations, logged the boreholes, and cared for the samples obtained. The soil samples were identified in the field, placed in labeled containers and transported to Golder Associates' London laboratory for further examination and 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 field and laboratory testing are given on the Record of Borehole sheets and in Appendix A.

Temporary traffic control was carried out in accordance with the Ontario Traffic Manual, Temporary Conditions, Book 7, dated March 2001.

The as-drilled borehole locations and ground surface elevations are shown on the Record of Borehole sheets and on Drawing 1.

The table below summarizes the culvert location and the coordinates, ground surface elevations and depths of the associated boreholes.

<u>BOREHOLE</u>	<u>LOCATION (m)</u>		<u>GROUND SURFACE ELEVATION</u>	<u>BOREHOLE DEPTH</u>
	<u>Northing</u>	<u>Easting</u>	(m)	(m)
9	4 674 988.1	271 188.7	189.20	8.99
10	4 674 978.2	271 196.9	189.03	7.47

The existing culvert has the following characteristics:

<u>DIMENSIONS (m)</u>	<u>TOP ELEVATION (m)</u>		<u>CONSTRUCTION</u>
	(Lt)	(Rt)	
3.05 x 1.20 x 42.57	189.33	189.31	Concrete, rigid frame open footing

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 and 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 sampling and observations of drilling resistance and represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

In general, the boreholes drilled at the proposed culvert extension typically encountered topsoil and fill materials underlain by an extensive deposit of clayey silt till.

The locations of the boreholes 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.

4.1.1 Topsoil and Fill

Topsoil layers with an average thickness of 80 millimetres were encountered at ground surface in boreholes 9 and 10.

The topsoil layer at borehole 10 was underlain by a 1.3 metre thick layer of clayey silt fill from elevation 189.0 metres. The fill was firm with an N value of 7 blows per 0.3 metres.

4.1.2 Clayey Silt Till

Clayey silt till was encountered beneath the topsoil layer in borehole 9 from elevation 189.1 metres and beneath the fill layer in borehole 10 from elevation 187.7 metres. The results of particle size analyses conducted on three samples obtained from the standard penetration testing are shown in Figure A-1 in Appendix A.

The clayey silt till is stiff to hard with N values ranging from 13 blows to 46 blows per 0.3 metres. Water contents in the fill ranged from 15 to 21 per cent. The clayey silt till is of low plasticity based on an average plastic and liquid limits of 16 per cent and 30 per cent, respectively, and an average plasticity index of 14 per cent. The results of the Atterberg limits testing are shown on the Plasticity Chart, Figure A-2.

Although cobbles and boulders were not specifically encountered in either of the boreholes for this investigation, the presence of cobbles and boulders should be anticipated in the clayey silt till.

4.2 Groundwater Conditions

Groundwater conditions were observed during and on completion of drilling and sampling. Both boreholes were dry during and upon completion of drilling.

A standpipe piezometer was installed in borehole 10 to monitor the groundwater conditions. Two weeks after installation, on December 14, 2006, the groundwater level was measured at elevation 188.1 metres or at a depth of 0.9 metres below the ground surface. The most recent reading was obtained on February 26, 2007. On this date the groundwater level was at elevation 188.0 metres or 1.0 metres below the ground surface.

The water level in the West Branch of the Delisle Drain was at elevation 188.03 metres on November 30, 2006.

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

5.0 MISCELLANEOUS

The investigation was carried out using equipment supplied and operated by London Soil Test Limited which is an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Mike Arthur under the direction of Mr. David J. Mitchell. The 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 of 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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hwy 3.doc

PART B
FOUNDATION DESIGN REPORT

STRUCTURAL CULVERT
SITE 6-406-C
HIGHWAY 3 WIDENING
GWP 315-98-00
MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides our recommendations on the foundation aspects of the design of the proposed extension of the structural culvert situated in the project area on Highway 3 at Station 17+810 SS (Site 6-406-C). The existing culvert is a rigid frame, open footing (RFO) structure with a span of 3.05 metres, a height of 1.2 metres and a length of 42.57 metres.

It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

6.2 Foundations

A series of improvements is planned for Highway 3 from 0.5 kilometres west of Essex County Road 34 (Talbot Road) to 0.6 kilometres east of Essex County Road 8 (Maidstone Avenue West). The major improvement will be widening of Highway 3 from 2 lanes to 4 lanes. This will require drainage improvements within the project limits including extension of the right/outlet side of the culvert at Station 17+810 SS.

The subsoils encountered in the boreholes advanced during the investigation typically consist of topsoil and surficial fills over very stiff to hard clayey silt till. The groundwater level was estimated to be at about elevation 188.1 metres. The water level in the West Branch of the Delisle Drain was measured at elevation 188.0 metres on November 30, 2006.

The culvert extension should be designed to withstand the appropriate weight of fill and traffic loading. Footing excavations should penetrate all existing fill and topsoil so that foundations bear directly on the native soils. Based on the soil conditions found at the boreholes locations and the culvert invert at approximately elevation 188.1 metres, the culvert extension can be founded on spread footings founded at or below elevation 186.9 metres in the very stiff to hard clayey silt till. Minimal groundwater inflow into the excavations is anticipated.

The recommended factored geotechnical resistance at Ultimate Limit States (ULS) and the geotechnical resistance at Serviceability Limit States (SLS) are 500 kilopascals and 350 kilopascals, respectively, assuming a maximum allowable settlement of 25 millimetres and a 1.5 metre footing width for design of the culvert foundations. An unfactored coefficient of sliding of 0.53 may be used for design.

6.2.1 Frost Protection

All footings should be provided with a minimum of 1.2 metres of earth cover or thermal equivalent for frost protection purposes.

6.3 Backfill

Backfill around the culvert extension should be carried out in accordance with Ontario Provincial Standard Drawing (OPSD) 3101.150. Culvert backfill material should consist of free-draining, non-frost susceptible granular materials such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B.

Heavy compaction equipment should not be used immediately adjacent to the walls and roof of the culvert. The height of backfill adjacent to the culvert walls should be maintained equal on both sides of the structure during all stages of backfill placement. Adequate erosion protection as recommended in Section 6.5 should be provided at the outlet.

6.4 Lateral Earth Pressures for Design

The lateral pressures acting on the proposed culvert extension will depend on the backfill soils and, where used, the type and method of placement of the backfill materials behind the wall, as well as the subsequent lateral movement of the structure. The following recommendations are made concerning the design of the culvert walls in accordance with the Canadian Highway Bridge Design Code (CHBDC).

Backfill behind the culvert walls should consist of select, free-draining granular fill meeting the specifications of OPSS Granular A or Granular B but with less than 5 per cent passing the No. 200 sieve.

Where backfill soils are placed and compacted behind the walls, a compaction surcharge equal to 12 kilopascals should be included in the lateral earth pressures for structural design in accordance with the CHBDC. Compaction equipment should be used in accordance with OPSS 501.06.

For walls backfilled using granular materials as noted above, the following parameters (unfactored) may be assumed:

Fill unit weight:	22 kN/m ³
Coefficients of lateral earth pressure:	
‘active’ or unrestrained, K_a	0.31
‘at rest’ or restrained, K_o	0.47

If the wall support allows lateral yielding (unrestrained structure), active earth pressures may be used in the geotechnical design of the structure. The granular fill should be placed in a zone greater than 1.2 metres wide at the footing level against a cut slope which begins at the footing level and extends upwards at a maximum inclination of 1 horizontal to 1 vertical. If the culvert wall support does not allow lateral yielding (restrained structure), at-rest pressures should be assumed for geotechnical design. The granular fill should be placed in a zone with a width equal to at least 1.2 metres behind the culvert walls.

The resistance to sliding, for a cast-in-place concrete culvert with a concrete working slab, may be based on an unfactored angle of friction of 28 degrees between the very stiff to hard clayey silt till and concrete interface. The factored horizontal geotechnical resistance, H_{ri} , should be based on CHBDC 6.7.5 as follows:

$$H_{ri} = 0.8A'c' + 0.8V\tan\phi' > H_f$$

Where:

A'	-	effective contact area, square metres
c'	=	0
ϕ'	=	28 degrees
V	-	unfactored vertical force, kilonewtons
H_f	-	factored horizontal load, kilonewtons

The unfactored coefficient of passive pressure for the portion of the culvert wall and footing below the invert may be taken as 3.0.

6.5 Construction Considerations

The founding soils are sensitive to disturbance and softening due to water seepage and/or ponding. If cast-in-place culverts are to be constructed, placement of a working slab of lean concrete will be required at the base of the culvert excavations for the footing area. Exposure without protection of the working slab will result in softening of the founding soils. The cleaned excavation base should be inspected by qualified geotechnical personnel prior to placing the working slab. It is recommended that the footing excavation be carried out such that the final 0.5 metres of excavation is completed with the geotechnical personnel on site and the working slab placed immediately after footing inspection.

Inlet seals, outlet cutoffs and filters are not considered necessary as the potential for uplift and piping is low. The provision of camber for the culvert extension is not required since the height of the overlying fill is minimal and the very stiff to hard foundation soils are such that excessive post-construction or differential settlements are not anticipated.

Erosion and scour protection for the culvert backfill should be provided, as appropriate. Consideration could be given to using suitable non-woven geotextile and rip rap, as required, to provide erosion protection based on hydraulic requirements. Rip-rap treatment at the culvert outlet should be provided in accordance with OPSD 810.010. In addition, sediment control such as silt fences and erosion control blankets may be required during construction and diversion of the watercourse to mitigate migration of fine soil particles.

Subgrade preparation should be performed and monitored in accordance with SP902S01.

6.6 Excavations and Temporary Cut Slopes

Excavations for the culvert extensions will encounter surficial topsoil and fills and the very stiff to hard clayey silt till. The presence of cobbles and boulders which may be present in the clayey silt till should be anticipated. Excavations are expected to intercept the groundwater table. Temporary open cut slopes should be maintained no steeper than 1 horizontal to 1 vertical.

Surficial water seepage into the excavations should be expected and will be heavier during periods of sustained precipitation. In addition to diverting the existing culvert flows, pumping from well filtered sumps located at the base of the excavations may be required to provide groundwater control during foundation excavations. However, the overall amount of groundwater inflow is expected to be minimal.

The considerations with respect to protection of the founding soils, as given in Section 6.5 under the heading Construction Considerations, must be recognized. Sumps should be maintained outside of the actual footing limits. Surface water runoff should be directed away from the excavations at all times. The appropriate Non Standard Special Provision (NSSP) should be included in the contract documents.

Where space is restricted and will not permit open cuts, a temporary support system should be installed to support the sides of the excavation and permit the use of vertical cuts. The temporary support system could consist of soldier piles and lagging where the H-piles would be driven to a suitable depth and horizontal lagging installed as the excavation proceeds. Support to the soldier pile and lagging wall system could be in the form of struts and walers in the case of footing excavations or rakers and anchors in the case of roadway protection excavations.

The design of braced soldier pile and lagging walls should be based on a rectangular earth pressure distribution using the design parameters given below. Where the support to the wall is provided by anchors or rakers, the wall design should be based on a triangular earth pressure distribution using the design parameters given below. The raker/anchor support must be designed to accommodate the loads applied from pressures and surcharge pressures from area, line or point loads as well as the impact of sloping ground behind the system.

In the cohesive soils, the unfactored triangular earth pressure distribution (p in kN/m^2 ; increasing with depth), can be calculated as follows:

$$p = K_a (\gamma H + q)$$

where H = the height of the excavation at any point in metres
 K_a = 0.4 for level ground behind excavation
 γ = soil unit weight = 20 kN/m^3
 q = surcharge loads

In granular soils, such as backfill to the existing culvert, the unfactored rectangular earth pressure distribution (p in kN/m^2 ; constant with depth), can be calculated as follows:

$$p = 0.65K_a (\gamma' H + q)$$

where H = the height of the excavation
 K_a = 0.3 for level ground behind excavation
 γ = soil unit weight = 20 kN/m^3
 $\gamma' = \gamma - \gamma_w$ where $\gamma_w = 9.8 \text{ kN/m}^3$
 q = surcharge loads

Passive toe restraint to the soldier piles may be determined using a triangular pressure distribution acting over an equivalent width equal to three times the pile socket diameter. The coefficient of passive lateral earth pressure, K_p , for the socket within the very stiff to hard clayey soils may be taken as 2.8. The soil unit weight should be taken as 20 kN/m^3 and the unit weight of water should be taken as 9.8 kN/m^3 . A groundwater level at ground surface should be assumed for design.

The temporary excavation support system should be designed and constructed in accordance with MTO's Special Provision 105S19. The lateral movement of the temporary shoring system should meet Performance Level 2 as specified in SP 105S19.

All excavations should be carried out in accordance with the current edition of the Ontario Occupational Health and Safety Act and Regulations For Construction Projects. The fill materials at this site would be classified as Type 3 soils as would any cohesionless materials below the groundwater level. The native clayey silt till materials would be classified as Type 2 soils. The potential presence of cobbles and boulders in the clayey silt till should be anticipated.

7.0 MISCELLANEOUS

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.

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hwy 3.doc

RECORD OF BOREHOLE No 9

1 OF 1

METRIC

PROJECT 06-1130-177 LOCATION N 4674988.1 ; E 271188.7 ORIGINATED BY MA
G.W.P. 315-98-00 DIST HWY 3 BOREHOLE TYPE Power Auger, Solid Stem COMPILED BY LMK
DATUM GEODETIC DATE November 29, 2006 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE						
189.20	GROUND SURFACE						20 40 60 80 100										
0.08	TOPSOIL, clayey Brown CLAYEY SILT, some sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 185.6m																
			1	SS	13												
			2	SS	37												
			3	SS	46												
			4	SS	37												
			5	SS	23												
			6	SS	25												
			7	SS	17												
			8	SS	16												
			9	SS	17												
180.21	END OF BOREHOLE																
8.99	Borehole dry during drilling November 29, 2006.																

RECORD OF BOREHOLE No 10

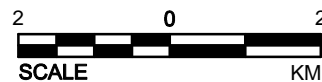
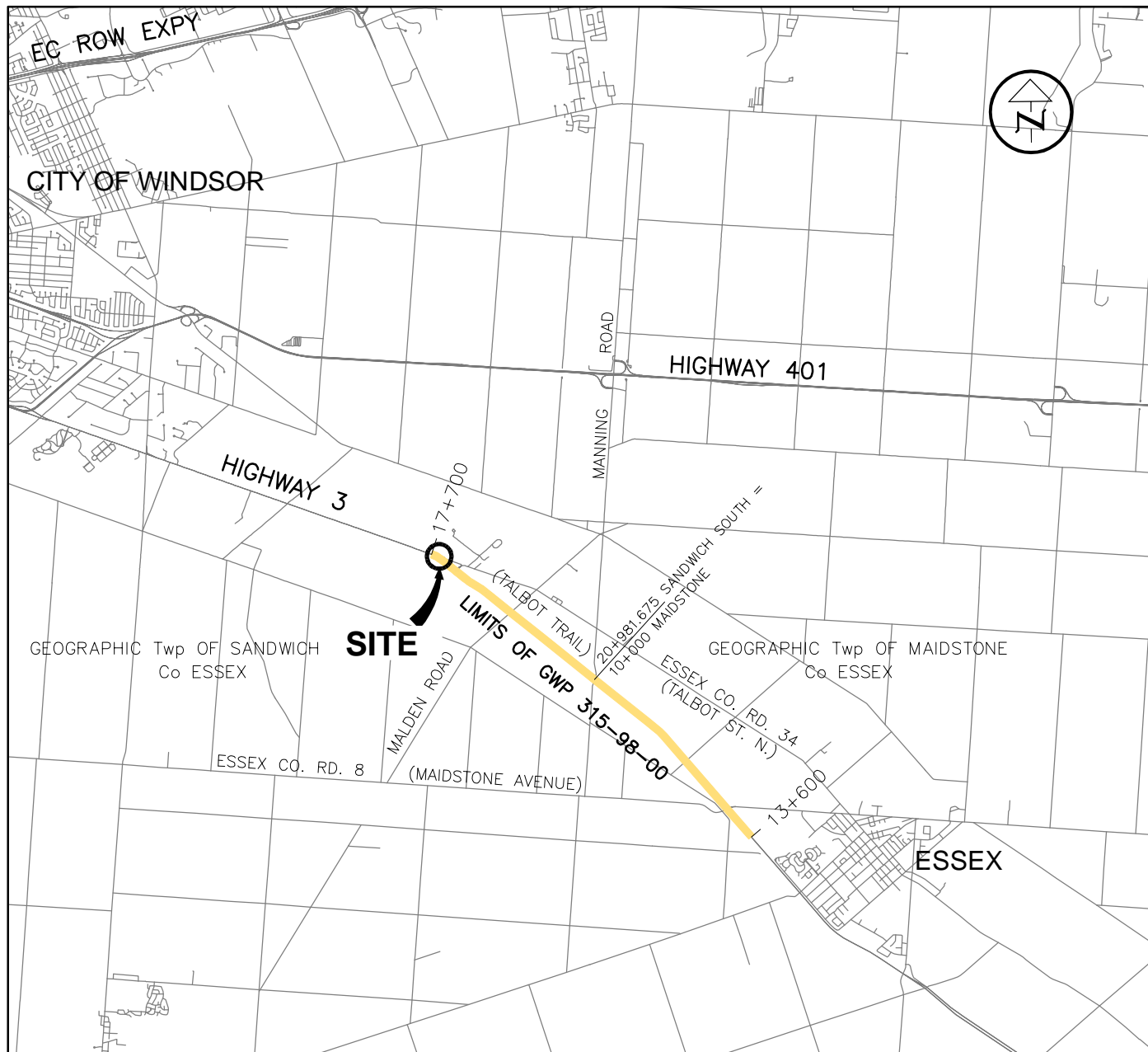
1 OF 1

METRIC

PROJECT 06-1130-177 G.W.P. 315-98-00 LOCATION N 4674978.2 ; E 271196.9 ORIGINATED BY MA
DIST HWY 3 BOREHOLE TYPE Power Auger, Solid Stem COMPILED BY LMK
DATUM GEODETIC DATE November 30, 2006 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				
								20 40 60 80 100					10 20 30				
189.03	GROUND SURFACE															GR SA SI CL	
0.08	TOPSOIL, clayey Brown																
	FILL, clayey silt, trace sand, trace gravel and topsoil																
	Firm Brown		1	SS	7												
187.66																	
1.37	CLAYEY SILT, some sand, trace gravel (TILL)		2	SS	20												
	Stiff to Hard																
	Brown becoming Grey at about elev. 185.7m		3	SS	35												
			4	SS	30												
			5	SS	23												
			6	SS	24												
			7	SS	18												
			8	SS	15												
181.56	END OF BOREHOLE																
7.47	Borehole dry during drilling November 30, 2006. and Standpipe dry to elev. 181.56m November 30, 2006 Water level measured in Standpipe at elev. 188.12m Dec. 14, 2006.																

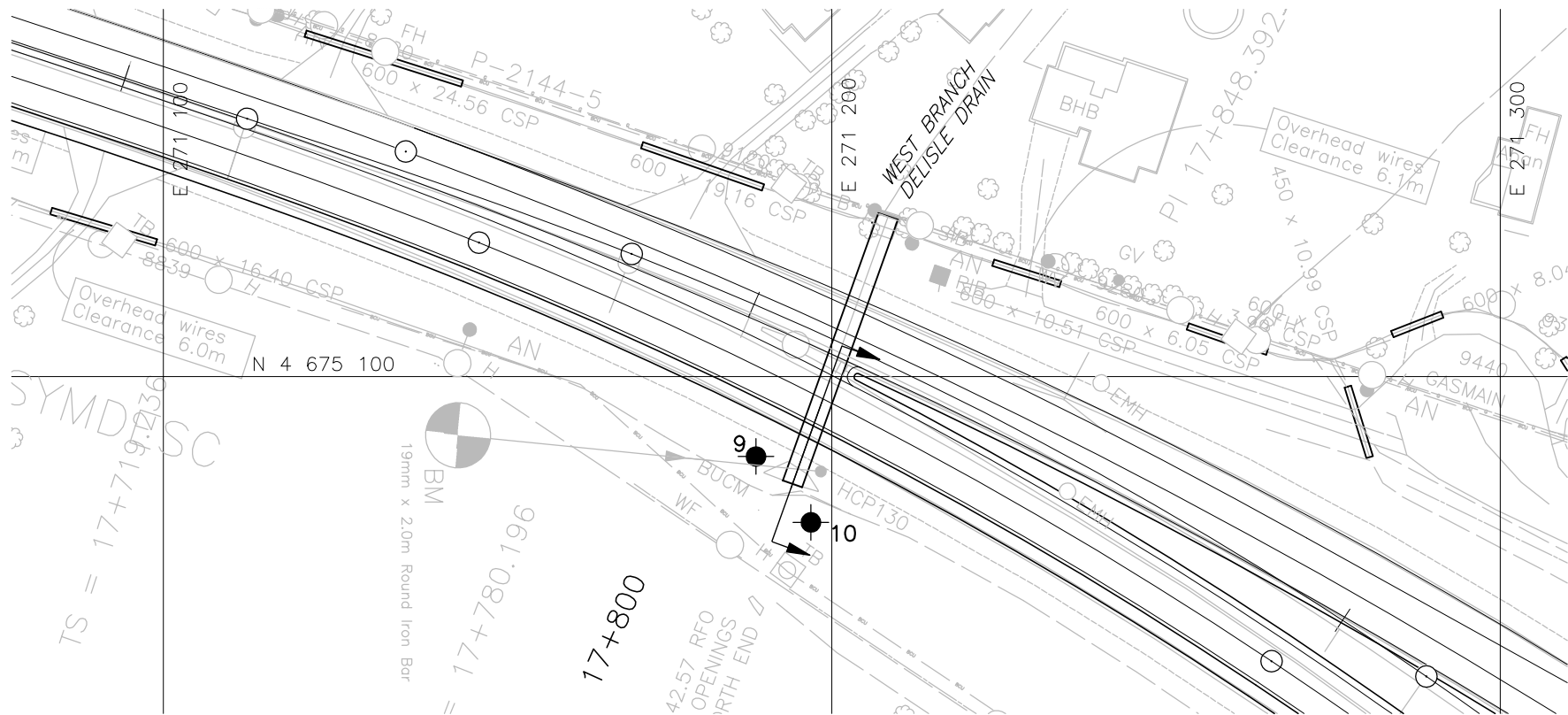
ONL_MTO 06-1130-177-AA.GPJ LDN_MTO.GDT 12/19/06



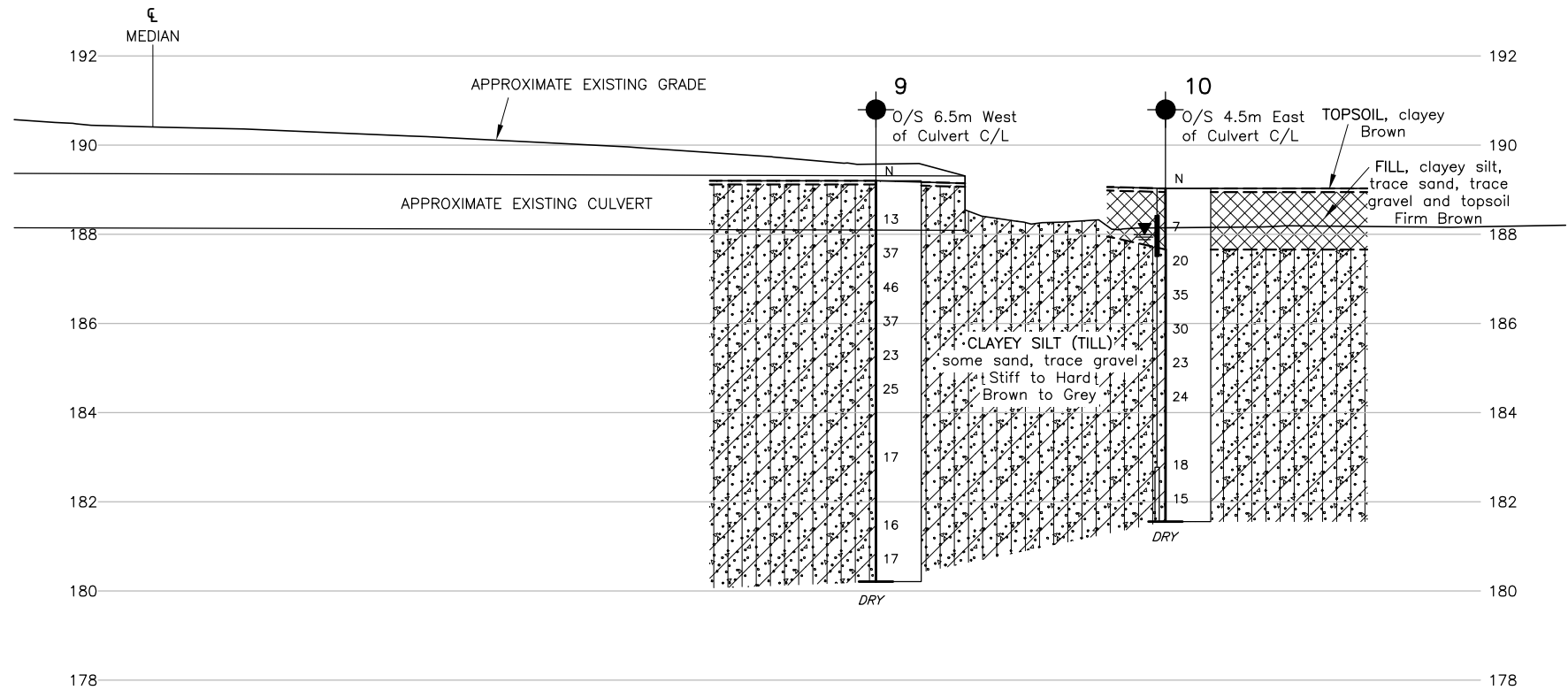
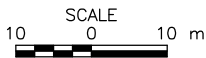
NOTE

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

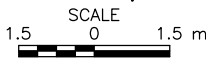
PROJECT		STRUCTURAL CULVERT - SITE-6-406-C HIGHWAY 3 WIDENING GWP 315-98-00			
TITLE		KEY PLAN			
 Golder Associates LONDON, ONTARIO		PROJECT No. 06-1130-177-0-1		FILE No. 061130177-AA001	
		CADD	WDF	Dec. 13/06	SCALE AS SHOWN
		CHECK			REV. 0
FIGURE 1					



PLAN



PROFILE ALONG C/L OF CULVERT



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

CONT No.
WP No. 315-98-00

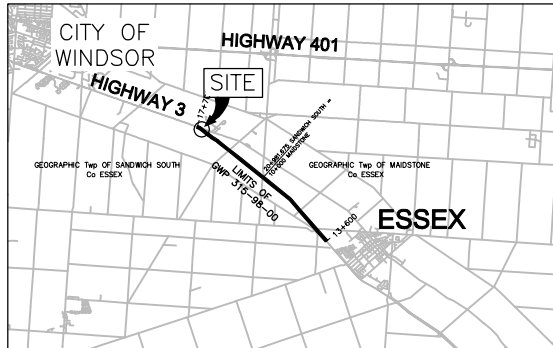
STRUCTURAL CULVERT
SITE 6-406-C
HIGHWAY 3 WIDENING
BOREHOLE LOCATION AND SOIL STRATA



SHEET



Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN



LEGEND

- Borehole - Current Investigation
- Standard Penetration Test Value
- Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Seal
- Standpipe
- WL in standpipe, measured on Feb. 26, 2007.
- Borehole dry during drilling

No.	ELEVATION	CO-ORDINATES (MTM Zone 11)	
		NORTHING	EASTING
9	189.20	4 674 988.1	271 188.7
10	189.03	4 674 978.2	271 196.9

NOTES

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

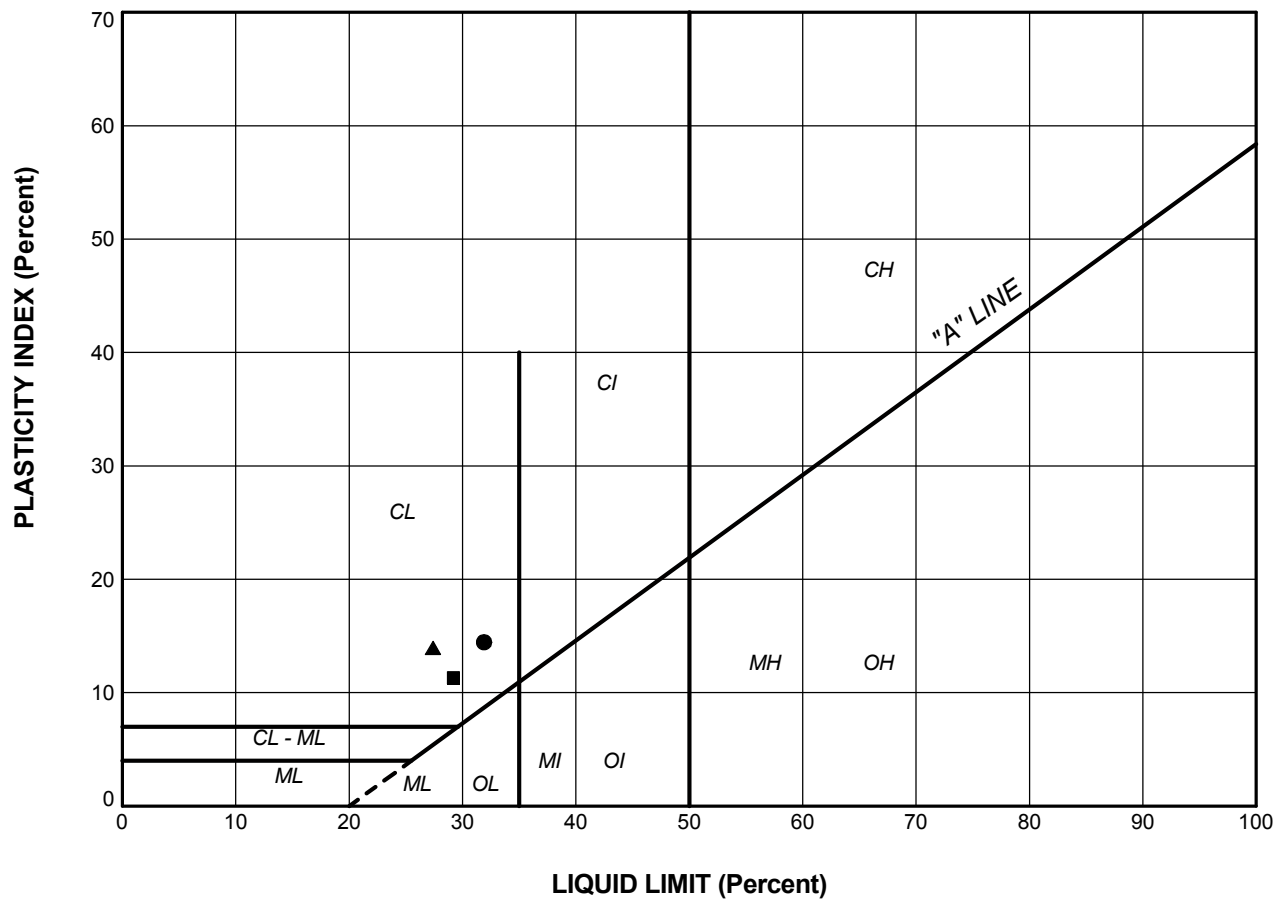
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by DELCAN.

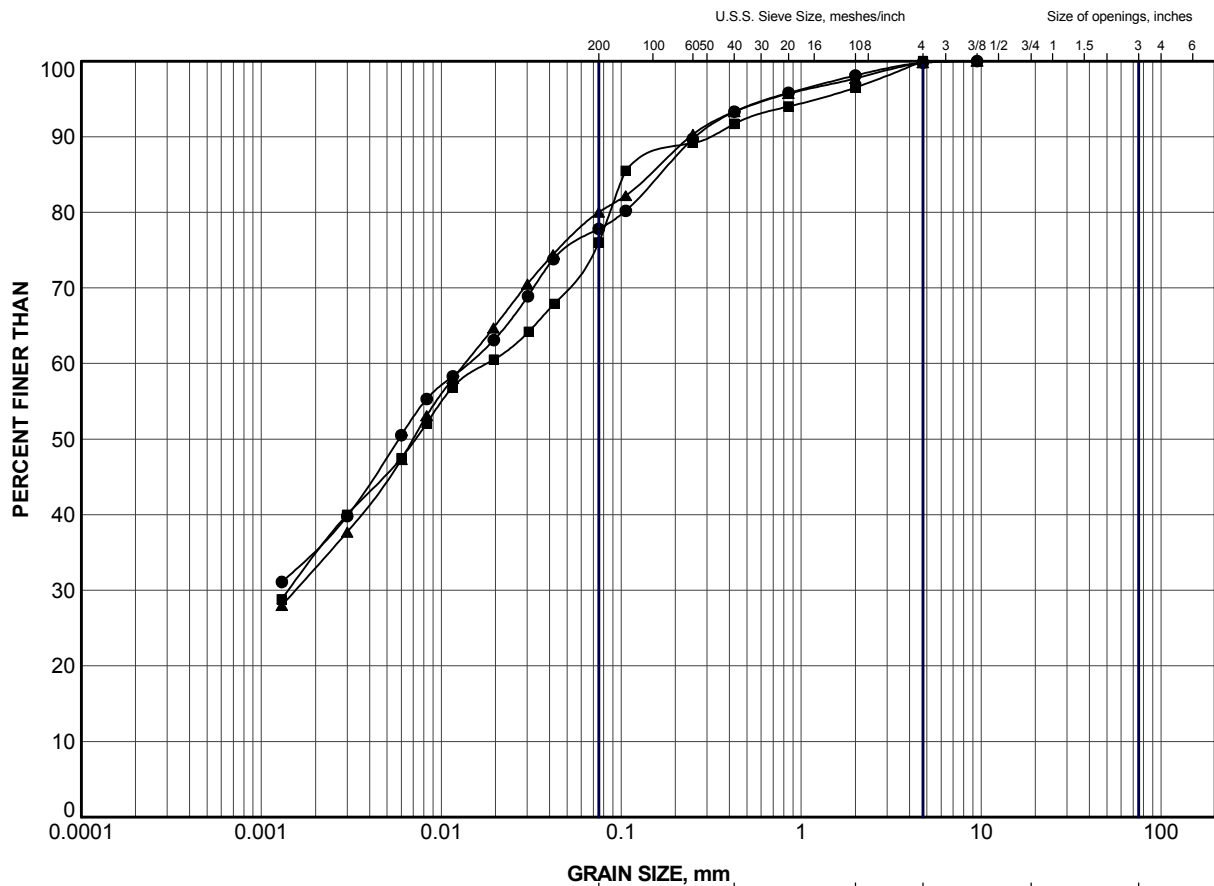
NO.	DATE	BY	REVISION
Geocres No.	40J2-92		
HWY.	3	PROJECT NO.	06-1130-177-0-1
SUBM'D.	DUP	CHKD.	DATE: Dec. 18/06
DRAWN:	WDF	CHKD.	APPD.
			DWG. 1

APPENDIX A
LABORATORY TEST DATA



PROJECT				STRUCTURAL CULVERT - SITE 6-406-C HIGHWAY 3 WIDENING GWP 315-98-00			
TITLE				PLASTICITY CHART			
PROJECT No.		06-1130-177		FILE No.		06-1130-177.GPJ	
DRAWN	WDF	Dec 12/06	SCALE		N/A	REV.	
CHECK			FIGURE		A-2		






GRAVEL SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	9	4	185.9
■	9	8	181.4
▲	10	6	184.2

PROJECT					STRUCTURAL CULVERT - SITE 6-406-C HIGHWAY 3 WIDENING GWP 315-98-00				
TITLE					GRAIN SIZE DISTRIBUTION CLAYEY SILT (TILL)				
PROJECT No.		06-1130-177		FILE No.		06-1130-177.GPJ			
DRAWN		WDF		Dec 12/06		SCALE		N/A	
CHECK						REV.			
 Golder Associates LONDON, ONTARIO					FIGURE A-1				

APPENDIX B
SITE PHOTOGRAPH

March 2007

06-1130-177-0-1

SITE PHOTOGRAPH



Photo 1: Culvert Site 6-406-C (Station 17+810 SS). View of inlet and area of proposed extension.