March 2011

FOUNDATION INVESTIGATION AND DESIGN REPORT

Proposed Noise Barrier Wall 1B
Widening of Highway 7/8
From 1.9 km West of Fischer-Hallman Road Interchange
Easterly to 0.8 km East of Courtland Avenue Interchange
Kitchener
GWP 131-98-00
Ministry of Transportation, Ontario - West Region

Submitted to:
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REPORT

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FOUNDATION INVESTIGATION REPORT

PROPOSED NOISE BARRIER WALL 1B
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FROM 1.9 KM WEST OF FISCHER-HALLMAN ROAD
INTERCHANGE EASTERLY TO 0.8 KM EAST OF
COURTLAND AVENUE INTERCHANGE, KITCHENER
GWP 131-98-00
MINISTRY OF TRANSPORTATION, ONTARIO - WEST REGION

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out the foundation investigations as part of the detail design work for GWP 131-98-00, the reconstruction and widening of Highway 7/8. This report presents the results of the foundation investigation conducted for proposed noise barrier wall 1B, located along the Fischer-Hallman Road N/S-W Ramp between Stations 10+168 to 10+393 Rt Fischer-Hallman Road N/S-W Ramp.

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 MTO's Request for Proposal, Golder Associates' proposal P81-3002 dated April 8, 2008, our letters dated July 21 and 22, 2008 and our revised scope of work letter dated April 13, 2010. The work was carried out in accordance with our Quality Control Plan for Foundations Engineering dated July 4, 2008.

Dillon provided Golder Associates with the location and extent of the noise barrier wall in plan for this project in digital format.

2.0 SITE DESCRIPTION

2.1 General

The project area of Highway 7/8 is located in the south-central area of Kitchener, Ontario. The site extends from 1.9 km west of Fischer-Hallman Road easterly to 0.8 km east of Courtland Avenue. The location of the project is shown on the Key Plan, Figure 1. The location of proposed noise barrier wall 1B is shown on the Key Plan, Figure 1, and is detailed on the Noise Barrier Wall Location Plan, Figure 2. It should be noted that the noise wall numbering system is consistent with that used in the Preliminary Design Report prepared for the project.

This section of Highway 7/8 is currently a four lane divided highway oriented generally east-west. Four overpass structures for Westmount Road, Homer Watson Boulevard, Ottawa Street South and Courtland Avenue East, one underpass structure for Fischer-Hallman Road and an overhead structure for the Canadian National Rail (CNR) tracks are situated within the project limits.

Proposed noise barrier wall 1B is to be located along the shoulder of the Fischer-Hallman Road N/S-W Ramp between Stations 10+168 to 10+393 Rt. The Fischer-Hallman Road Ramp stationing ends at 10+393 which is equivalent to Station 12+771 Highway 7/8 chainage. Mostly residential developments are located within the immediate vicinity of the site. The topography along the alignment of the proposed noise barrier wall generally slopes westwards with elevations ranging from 350 metres near the intersection of the N/S-W Ramp with Fischer-Hallman Road to about 342 metres where the ramp exits onto Highway 7/8.

2.2 Site Geology

This project lies within the physiographic region of southwestern Ontario known as the Waterloo Hills[1]. The soils generally consist of sandy hills; some are ridges of sandy till while others are kames or kame moraines, with outwash sands deposited in the valleys. Adjoining the sandy hills is the Grand River spillway system comprised of alluvial terraces of sand and gravel.

Based on the Ministry of Natural Resources Map P.2559 entitled “Quaternary Geology, Stratford Area, Southern Ontario”, the site lies in an area of primarily Maryhill clayey till.

The Geologic Survey of Canada Map 1263A entitled “Geology, Toronto-Windsor Area, Ontario” indicates that the subcropping bedrock in the area of the site is dolomite and mudstone of the Salina formation of Upper Silurian age.

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

Based on the Ministry of Natural Resources Map P.168 entitled “Bedrock Topography Series, Stratford, Southern Ontario”, the bedrock surface in the vicinity of the Fischer-Hallman Road Interchange subcrops at about elevations 259 to 265 metres or some 80 to 85 metres below ground surface at Highway 7/8.

3.0 INVESTIGATION PROCEDURES

The foundation investigation for the design of proposed noise barrier wall 1B was carried out on April 27 and November 10, 2010 when eight boreholes were drilled along the proposed wall alignment. The borehole locations are shown on Drawing 1.

The boreholes, numbered 21 to 24 and 84 to 87, inclusive, were advanced to depths of 5.0 to 6.7 metres. The table below summarizes the borehole locations, ground surface elevations at the borehole locations and the borehole depths:

Borehole	Location (m)		Ground Surface Elevation	Borehole Depth
	Northing	Easting	(m)	(m)
21	4 809 165	222 354	344.70	5.18
22	4 809 210	222 413	344.48	5.79
23	4 809 278	222 438	346.09	5.03
24	4 809 350	222 447	347.93	5.03
84	4 809 318	222 424	346.35	5.18
85	4 809 256	222 413	343.69	5.18
86	4 809 186	222 363	342.98	5.18
87	4 809 153	222 300	342.67	6.71

The drilling was carried out using truck mounted and track mounted CME 45 power augers supplied and operated by a specialist drilling contractor. In the boreholes, samples of the overburden were obtained at 0.75 metre intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. The samplers used in the investigations limit the maximum particle size that can be sampled and tested to about 40 millimetres. Therefore, particles or objects that may exist within the soils that are larger than this dimension will not be sampled or represented in the grain size distributions. Larger particle sizes, including cobbles and boulders, are known to be present in the glacial till deposits as discussed in the text of this report. In addition, in situ shear vane tests were carried out in the softer cohesive deposits encountered in boreholes 22 and 24.

The groundwater conditions were observed throughout the drilling operations. The boreholes were backfilled in accordance with current Ontario Ministry of Transportation (MTO) procedures and Ontario Regulation 372/07.

The field work was monitored on a full-time basis by experienced members of our engineering staff who located the boreholes in the field, monitored the drilling, sampling and in situ testing operations, logged the boreholes and surveyed the borehole locations and elevations. The samples were identified in the field, placed in labelled containers and transported to our 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 testing are shown on the Record of Borehole sheets and in Appendix A.

The locations of the boreholes are shown on the Record of Borehole sheets and on Drawing 1, attached.

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.

The boreholes drilled along the noise barrier wall alignment generally encountered variable ground conditions consisting of surficial topsoil and/or layers of variable fill underlain by clayey silt, silt, silty sand, clayey silt till and sand and gravel.

The borehole locations are shown on Drawing 1. A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and is summarized below.

4.1.1 Topsoil

A layer of topsoil was encountered at the ground surface in boreholes 84 through 87. In borehole 22, a layer of topsoil was found underlying layers fill at elevation 341.6 metres. The thickness of the topsoil layers varied from 230 to 520 millimetres. Trace amounts of topsoil and organic material were found in the granular fill in boreholes 85, 86 and 87.

Materials designated as topsoil in this report were classified solely based on visual and textural evidence. Testing of organic content or for other nutrients was not carried out. Therefore, the use of materials classified as topsoil cannot be relied upon for support and growth of landscaping vegetation.

4.1.2 Fill

Layers of fill were encountered at the ground surface in boreholes 21, 22, 23 and 24. In boreholes 85, 86 and 87, fill layers were found underlying topsoil from elevations 342.2 to 343.5 metres.

Granular base and subbase, consisting of the north shoulder of the N/S-W Ramp, were found in boreholes 21, 22 through 24. The base and subbase layers were 400 to 550 millimetres in thickness. The fill beneath the base and subbase in boreholes 22, 23 and 24 generally consisted of 0.8 meters of cohesive fill underlain by 0.8 metres of granular fill which was, in turn, underlain by 0.8 to 1.8 metres of cohesive fill.

In general, granular fill layers were encountered in boreholes 21 and 85 through 87. The thickness of the granular fill layers in boreholes 21 and 85 to 87 varied from 0.7 to 2.4 metres. The granular fill in boreholes 85 through 87 contained trace amounts of topsoil and organic material.

The gradation of the granular fill is highly variable ranging from silty fine sand to silty sand and gravel to sandy silt and silt. The loose to compact granular fill had N values ranging between 4 and 29 blows per 0.3 metres with water contents varying from 10 to 24 per cent, with the exception of a water content of 39 per cent. The high water content for the granular fill was obtained from a silt fill sample that contained organic material.

The soft to very stiff cohesive fill typically comprised clayey silt and silty clay with N values of 2 to 21 blows per 0.3 metres. The cohesive fill had water contents of 10 to 26 per cent. The cohesive fill layer is of low to intermediate plasticity based on the results of Atterberg limits testing. The plastic limit, liquid limit and plasticity index ranges were 12 to 18, 20 to 40 and 8 to 22 per cent, respectively. The Atterberg limits results for the tests performed on the cohesive fill layer are presented on Figure A-5.

The results of the grain size testing conducted on samples of the fill materials are presented on Figure A-1.

4.1.3 Clayey Silt

Very soft to soft clayey silt was encountered beneath the fill in borehole 87 from elevation 339.8 metres. The 1.5 metre thick layer contained a trace amount of organic material. The clayey silt had N values of 1 and 2 blows per 0.3 metres and water contents of 15 and 29 per cent.

4.1.4 Silt

A 0.5 metre thick layer of silt was found underlying topsoil in borehole 84 at elevation 346.0 metres. The compact silt had an N value of 27 blows per 0.3 metres.

4.1.5 Silty Fine Sand

Silty fine sand was encountered underlying the granular fill in borehole 85 at elevation 341.6 metres and in borehole 21 from elevation 342.9 metres. The average thickness of the silty fine sand layer was 1.1 metres. The loose to compact silty fine sand had N values of 8 to 19 blows per 0.3 metres with water contents of 16 to 17 per cent. The results of grain size testing conducted on two samples of the silty fine sand obtained during standard penetration testing are presented on Figure A-2.

4.1.6 Clayey Silt Till

Clayey silt till layers were encountered in all boreholes from elevations varying from 338.3 and 347.5 metres. The clayey silt till was found underlying layers of topsoil, fill, clayey silt, silt and silty fine sand. The thickness of the clayey silt till layer in borehole 24 was 4.1 metres. The remaining boreholes were terminated in the clayey silt till after exploring the layer for 1.1 to 4.1 metres. Although not specifically encountered in the boreholes, cobbles and boulders should be anticipated in the clayey silt till due to the depositional history of this material.

The soft to hard clayey silt till had N values of 3 to 33 blows per 0.3 metres. In situ shear vane testing indicated the undrained shear strength of the clayey silt till to be 74 to over 144 kilopascals. Water contents of 12 to 16 per cent were measured on selected samples of clayey silt till. The Atterberg limits tests indicate that the clayey silt till is of low plasticity based on plastic limits ranging from 13 to 16 per cent, liquid limits ranging from 22 to 29 per cent, and plasticity indices ranging from 8 to 14 per cent as determined from the Atterberg limits tests. The Atterberg limits results for the tests performed on the clayey silt till are shown on Figure A-5.

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

4.1.7 Silty Sand and Gravel

A layer of silty sand and gravel was found underlying the clayey silt till in borehole 24 at elevation 343.5 metres. Borehole 24 was terminated in the sand and gravel after exploring the layer for 0.6 metres. The compact sand and gravel had an N value of 23 blows per 0.3 metres.

4.1.8 Sandy Silt

The silty fine sand in borehole 21 was underlain by a 0.8 metre thick layer of compact sandy silt. The sandy silt had an N value of 11 blows per 0.3 metres and a water content of 13 per cent.

4.1.9 Silty Clay

Borehole 21 encountered a layer of silty clay below the base of the sandy silt at elevation 341.0 metres. Borehole 21 was terminated in the silty clay after exploring some 1.4 metres. The silty clay contained silt seams.

The stiff to very stiff silty clay had N values of 14 and 16 blows per 0.3 metres. The silty clay had a water content of 23 per cent and is considered to be a clay of intermediate plasticity based on a plastic limit of 17 per cent, a liquid limit of 38 per cent and a plasticity index of 21 per cent. The results of the Atterberg limit determination are shown on Figure A-5.

The results of grain size testing conducted on a sample of the silty clay are presented on Figure A-4.

4.2 Groundwater Conditions

The groundwater conditions in the boreholes were monitored during drilling. The observed groundwater conditions are noted on the Record of Borehole sheets and are summarized in the following text and table.

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
21	344.70	1.8	342.9
22	344.48	1.4	343.1
23	346.09	Dry	Below 341.1
24	347.93	Dry	Below 342.9
84	346.35	Dry	Below 341.2
85	343.69	2.9	340.8
86	342.98	Dry	Below 337.8
87	342.67	Dry	Below 336.0

During the field work, groundwater was encountered at elevations 342.9 and 343.1 in boreholes 21 and 22 and at elevation 340.8 metres in borehole 85. The remaining boreholes were dry, were advanced to a depth of approximately 5 metres and terminated in clayey silt till and sand and gravel. Grey soils were not encountered in boreholes 21, 22 and 24 which were dry upon completion. As a result, the groundwater level is inferred to be at elevation 343 metres in boreholes 21 and 22 and below the bottom of boreholes 23, 24 and 84 to 87 which were found dry and did not intercept grey soils.

The groundwater level along the currently proposed wall alignment has been inferred to be at elevation 341 metres from Station 10+168 to Station 10+275 and at elevation 343 metres and from Station 10+275 to Station 10+393. The above noted water levels are not considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken for a short duration only. The groundwater levels are expected to fluctuate due to climatic and seasonal variations.

5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Aardvark Drilling Ltd., who is an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Michael Arthur and Mr. Matthew Rhody 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 Types C and D aggregates. This report was prepared by the Project Engineer, Ms. Dirka U. Prout, P.Eng., under the direction of the Team Leader, 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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PART B

FOUNDATION DESIGN REPORT

PROPOSED NOISE BARRIER WALL 1B
WIDENING OF HIGHWAY 7/8
FROM 1.9 KM WEST OF FISCHER-HALLMAN ROAD
INTERCHANGE EASTERLY TO 0.8 KM EAST OF
COURTLAND AVENUE INTERCHANGE, KITCHENER
GWP 131-98-00
MINISTRY OF TRANSPORTATION, ONTARIO - WEST REGION

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides geotechnical parameters and recommendations for the geotechnical aspects of the design for proposed noise barrier wall 1B along the Fischer-Hallman Road N/S-W Ramp between Stations 10+168 to 10+393 Rt. The proposed noise barrier wall is to be shoulder mounted. Noise barrier wall 1B will be contiguous with noise barrier wall 1A which extends to the west along the shoulder of the westbound lanes of Highway 7/8.

The design parameters and recommendations have been developed based on interpretation of the factual data obtained from the boreholes advanced at the site. The interpretation and recommendations provided are intended to provide the designers with sufficient information to design the proposed noise barrier wall foundations. Where comments are made on construction, they are provided in order to highlight those aspects that could affect the design, or for which special provisions or operational constraints may be required in the Contract Documents. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect the equipment selection, proposed construction methods, scheduling and the like.

6.2 Noise Barrier Wall Foundation Design

The noise barrier wall foundation should be designed and constructed in accordance with MTO's SP599F01. It is recommended that the noise barrier wall be supported using conventional augered caissons with a diameter of 0.6 to 0.9 metres. Geotechnical design parameters for design of the caisson foundations are provided in Table I following the text of this report based on the soil conditions encountered along the proposed noise barrier wall.

Where both an undrained shear strength, c_u, and an effective friction angle, ϕ', have been given for a specific stratum, the caisson design should be checked for both the drained and undrained condition and the larger of the two calculated caisson depths shall govern.

Portions of the caisson that will be embedded in organic materials, such as the buried topsoil layer found in borehole 22 at Station 10+310 Rt, should be neglected in the design. The passive resistance in the upper 1.4 metres below the ground should be neglected to account for frost action. It may be necessary to use deeper caissons at locations with deep fills containing zones of loose granular fill or soft cohesive fill as encountered in boreholes 22 and 23 at Stations 10+310 and 10+235, respectively. At these borehole locations, the fill and topsoil, where present, extend to elevation 341.3 metres or a depth of 3.2 metres in borehole 22, and to elevation 342.1 metres or a depth of 4.0 metres in borehole 23.

6.3 Construction Considerations

Excavation for the construction of the noise barrier wall foundations will penetrate the surficial fill and will extend through deposits of clayey silt till and silty sand and gravel. The clayey silt till at the site is susceptible to disturbance during caisson excavation and construction. In addition, excavation of granular fill materials containing perched water may be required in the vicinity of Station 10+310 Rt.

A temporary liner will be required to support the sides of the excavation and permit cleaning and inspection of the base. Careful cleaning of the base of the caissons should be carried out prior to placement of concrete to remove all loosened or disturbed materials. Alternatively, the foundations could be installed using mud drilling techniques (augered with the hole filled with bentonite slurry) and placement of concrete by tremie. Surface water run off should be directed away from the excavation. It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to alert the Contractor about the requirements for support of augered excavations and measures to deal with cobbles and boulders in the clayey silt till. The NSSP should include a note to the designer which indicates that deeper or larger diameter caissons will be required in the vicinity of boreholes 22 and 23.

The caissons should be constructed and inspected in accordance with Ontario Provisional Standard Specifications 903 and SP599F01. Following construction, the Quality Verification Engineer shall submit a Certificate of Conformance confirming that the noise barrier wall foundations have been constructed in general conformance with the Contract Documents.

7.0 MISCELLANEOUS

This report was prepared by Ms. Dirka U. Prout, P.Eng., under the direction of the Team Leader, 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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TABLE I

FOUNDATION DESIGN PARAMETERS
PROPOSED NOISE BARRIER WALL 1B

Widening of Highway 7/8
GWP 131-98-00

Station and Borehole	Soil Type	Elevation Interval (m)	Design Groundwater Elevation (m)	Undrained Shear Strength, c_u[1] (kPa)	Effective Angle of Friction, ϕ'[1] (°)	Coefficient of Passive Pressure, K_p Level Ground	Coefficient of Active Pressure, K_a Level Ground	Unit Weight[3] (kNm^{-3})	
								Bulk, γ	Effective, γ'
10+168 to 10+200	Stiff to very stiff clayey silt till	346.5 to 343.5	341	150	30	3.0	0.33	21.0	11.0
Borehole 24	Compact silty sand and gravel	Below 343.5		-	35	3.7	0.27	21.0	11.0
10+200 to 10+275	Compact granular fill	344.5 to 344.0	341	-	30	3.0	0.33	19.0	9.0
	Soft cohesive fill	344.0 to 342.0		20	26	2.6	0.39	18.5	8.5
Borehole 23	Stiff to very stiff clayey silt till	Below 332.0		150	30	3.0	0.33	21.0	11.0
	Loose granular fill	343.0 to 342.0	343	-	-	-	-	18.5	8.5
10+275 to 10+340	Firm cohesive fill	342.0 to 341.5		25	26	2.6	0.39	18.5	8.5
	Topsoil	341.5 to 341.0		-	-	-	-	18.0	8.0
Borehole 22	Soft to very stiff clayey silt till	Below 341.0		100	28	2.8	0.36	20.5	10.5
10+340 to 10+393	Compact silty sand to sandy silt	343 to 341	343	-	30	3.0	0.33	19.0	9.0
Borehole 21	Stiff to very stiff silty clay	Below 341		100	28	2.8	0.36	19.0	9.0

FOUNDATION DESIGN PARAMETERS
PROPOSED NOISE BARRIER WALL 1B

NOTES:

1. Where both c_u and ϕ' have been given for a specific stratum, the foundation design should be checked for both the drained and undrained conditions and the larger of the two calculated foundation depths shall govern.
2. Below the groundwater level, the effective unit weight of the soil (γ') should be used.
3. The loose granular fill and topsoil in borehole 22 and the soft cohesive fill in borehole 23 cannot be relied upon to provide lateral support of the caisson foundation.
4. This table is to be read in conjunction with the accompanying report.

Prepared By: MSWL

Checked By: DUP

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
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 21

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4809164.6 ;E 222353.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 3, 2010

ORIGINATED BY MR
COMPILED BY WDF/LMK
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
344.70	GROUND SURFACE										
0.00 / 344.15	FILL, sand and gravel, trace silt, crushed Brown										
0.55	FILL, sandy silt, with clayey silt layers Loose to compact Brown		1	SS	15		344		○		
342.87			2	SS	8	▽	343		○		
1.83	SILTY FINE SAND, some clay Loose to compact Brown		3	SS	17		342		○		0 50 40 10
341.80											
2.90	SANDY SILT, some clay, trace gravel Compact Brown		4	SS	11				○		
341.04							341				
3.66	SILTY CLAY, trace sand, with silt seams Stiff to very stiff Brown		5	SS	14				○—○—|		0 9 49 42
339.52			6	SS	16		340				
5.18	END OF BOREHOLE Groundwater encountered at about elev. 342.9m during drilling on May 3, 2010.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 22

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
LOCATION N 4809210.2 ;E 222413.2
ORIGINATED BY MR
DIST HWY 7/8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
COMPILED BY WDF/LMK
DATUM GEODETIC
DATE April 27, 2010
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
344.48	GROUND SURFACE										
0.00	FILL, sand and gravel, crushed, trace silt										
0.24 / 343.93	Brown										
0.55	FILL, sand and gravel										
	Brown		1	SS	12						
	FILL, clayey silt, trace sand, trace gravel					▽					
343.11	Stiff						344				
1.37	Brown		2	SS	5						
	FILL, silty fine sand										
342.35	Loose Brown						343				
2.13	FILL, silty clay, some sand, trace gravel		3	SS	5						3 18 46 31
	Firm						342				
341.58	Grey										
2.90	TOPSOIL, clayey										
3.20	Soft Black		4	SS	3						
	CLAYEY SILT TILL, trace sand, trace gravel Soft to very stiff Brown						341	+ 1.7			
								(>143.6)			
			5	SS	21		340				
338.69			6	SS	26		339				
5.79	END OF BOREHOLE										
	Groundwater encountered at about elev. 343.1m during drilling on April. 27, 2010.										

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

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 17/03/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 23

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4809278.4 ;E 222437.6
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE April 27, 2010
ORIGINATED BY MR
COMPILED BY WDF/LMK
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
346.09	GROUND SURFACE						346				
0.00	FILL, sand and gravel, crushed, trace silt, Brown										
0.24	FILL, sand and gravel, Brown										
0.52	FILL, clayey silt, some sand, trace gravel, Very stiff, Brown		1	SS	21		345		○		0 24 54 22
344.72	FILL, silty sand and gravel, Compact, Brown		2	SS	29						
1.37	FILL, clayey silt, some sand, trace gravel, Soft, Grey		3	SS	3		344				
343.96			4	SS	2		343		○		7 36 39 18
2.13	CLAYEY SILT TILL, trace sand, trace gravel, Stiff to very stiff, Brown		5	SS	14		342				
342.13			6	SS	23						
341.06	END OF BOREHOLE										
5.03	Borehole dry during drilling on April. 27, 2010.										

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 17/03/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 24

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4809350.0 ;E 222447.0
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE April 27, 2010

ORIGINATED BY MR
COMPILED BY WDF/LMK
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
347.93	GROUND SURFACE										
0.00 / 347.53	FILL, sand and gravel, trace silt Brown										
0.40	CLAYEY SILT TILL, some sand, trace to some gravel Stiff to very stiff Brown to grey at about elev. 345.0m		1	SS	11		347				
			2	SS	12		346				
			3	SS	14						1 23 50 26
			4	SS	9		345				
			5	SS	18		344	(>143.6)			
343.45											
4.48	SILTY SAND AND GRAVEL, trace clay Compact Brown		6	SS	23		343				
342.90											
5.03	END OF BOREHOLE Borehole dry during drilling on April. 27, 2010.										

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

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 17/03/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 84

1 OF 1 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | LOCATION N 4809317.7 ;E 222424.0 | ORIGINATED BY MA

DIST | HWY 7/8 | BOREHOLE TYPE POWER AUGER / HOLLOW STEM | COMPILED BY LMK

DATUM GEODETIC | DATE November 10, 2010 | 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
346.35	GROUND SURFACE										
0.00 345.98	TOPSOIL, silty Brown										
0.37	SILT, some sand, trace gravel, trace clay Compact Brown		1	SS	27		346				
345.13											
1.22	CLAYEY SILT TILL, trace to some sand, trace gravel Stiff to hard Brown to grey at about elev. 344.2m		2	SS	33		345		○		1 14 60 25
			3	SS	18		344				
			4	SS	16		343				
			5	SS	17		342				
341.17			6	SS	12						
5.18	END OF BOREHOLE Borehole dry during drilling on November 10, 2010.										

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 85

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4809256.3 ;E 222413.2
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE November 10, 2010

ORIGINATED BY MA
COMPILED BY LMK
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
343.69	GROUND SURFACE										
0.00	TOPSOIL, silty Brown										
0.23	FILL, sandy silt, some clay, trace gravel, trace topsoil Loose to compact Brown		1	SS	7		343		○		
			2	SS	15		342		○		1 22 59 18
341.56											
2.13	SILTY SAND, trace gravel, trace clay Compact Brown		3	SS	19	▽	341		○		7 55 32 6
340.49											
3.20	CLAYEY SILT TILL, trace to some sand, trace gravel Very stiff Brown to grey at about elev. 339.3m		4	SS	15						
			5	SS	21		340		⊖		1 24 52 23
			6	SS	17		339				
338.51											
5.18	END OF BOREHOLE Groundwater encountered at about elev. 340.8m during drilling on November 10, 2010.										

+ ³, × ³: Numbers refer to Sensitivity

○ ³% STRAIN AT FAILURE

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 17/03/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 86

1 OF 1 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | LOCATION N 4809185.5 ;E 222362.9 | ORIGINATED BY MA

DIST | HWY 7/8 | BOREHOLE TYPE POWER AUGER / HOLLOW STEM | COMPILED BY LMK

DATUM GEODETIC | DATE November 10, 2010 | 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
342.98	GROUND SURFACE									
0.00 / 342.58	TOPSOIL, silty, Black									
0.40 / 341.88	FILL, silt, trace sand, trace topsoil, Loose, Brown		1	SS	7		342			
1.10	CLAYEY SILT TILL, trace to some sand, trace gravel, Firm to very stiff, Brown to grey at about elev. 338.7m		2	SS	7		341			
			3	SS	22		340			
			4	SS	22					1 20 54 25
			5	SS	25		339			
337.80			6	SS	14		338			
5.18	END OF BOREHOLE Borehole dry during drilling on November 10, 2010.									

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 87

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4809153.4 ;E 222300.3
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE November 10, 2010

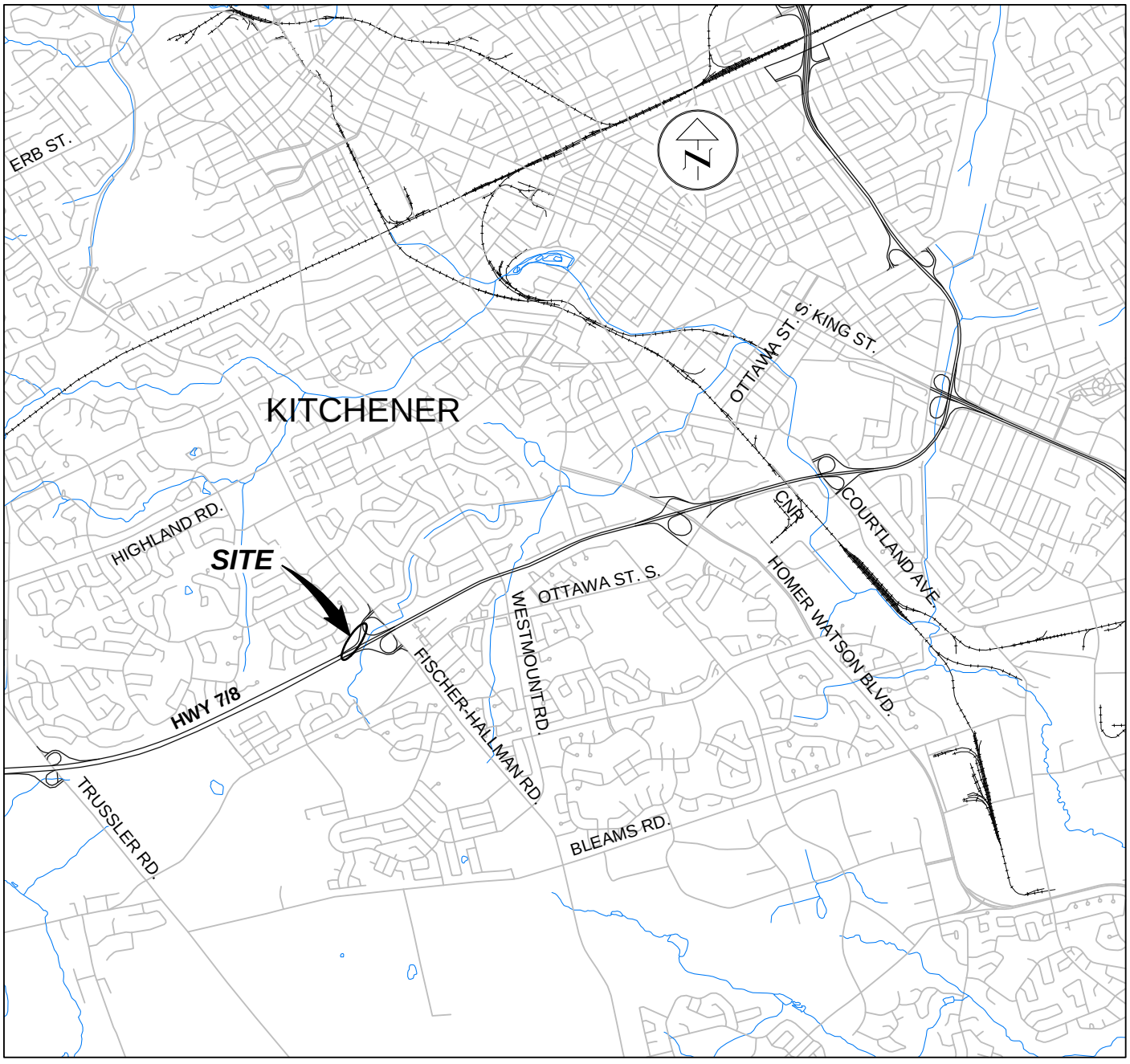
ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

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
342.67	GROUND SURFACE										
0.00 / 342.15	TOPSOIL, silty, Brown										
0.52 / 341.30	FILL, silt, some clay, some sand, trace topsoil, Loose, Brown		1	SS	9		342		○		
1.37 / 339.77	FILL, silt, some clay, trace sand, trace organic material, Loose, Black		2	SS	5		341		○		
			3	SS	4		340		○		
2.90 / 338.25	CLAYEY SILT, trace sand, trace organic material, Very soft to soft, Grey		4	SS	1		339		○		
			5	SS	2				○		
4.42 / 335.96	CLAYEY SILT TILL, trace to some sand, trace gravel, Firm to stiff, Grey		6	SS	9		338		⊢○⊣		1 13 50 36
			7	SS	6		337		○		
			8	SS	10		336		○		
6.71	END OF BOREHOLE Borehole dry during drilling on November 10, 2010.										

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

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 17/03/11



SCALE IN METRES

0 1000 2000

1:50000

REFERENCE

DRAWING BASED ON CANMAP STREETFILES V2005.4.

NOTE

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

PROJECT

PROPOSED NOISE BARRIER WALL 1B
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

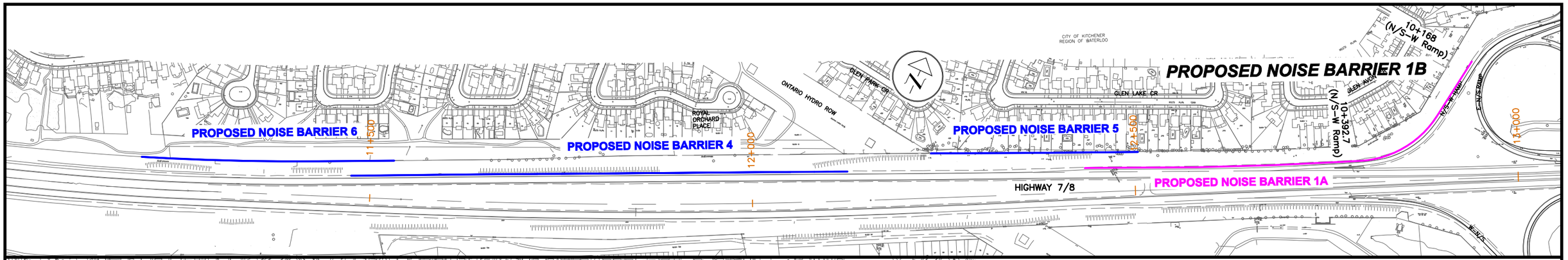
KEY PLAN

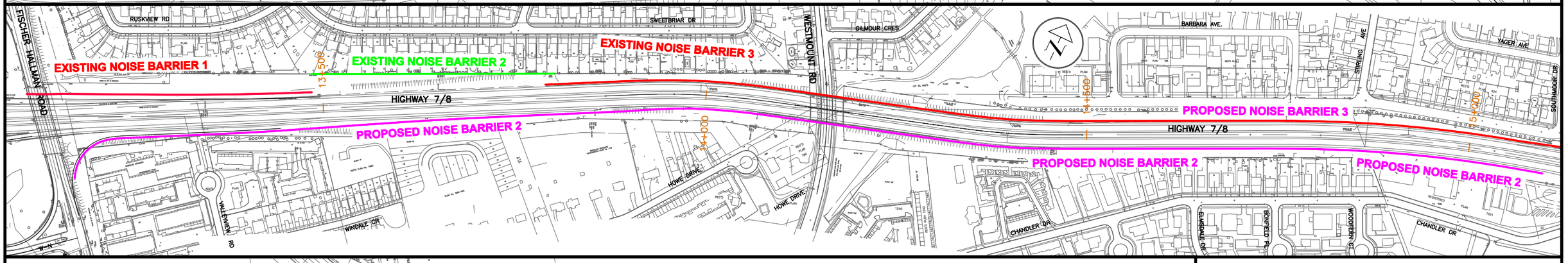
Golder Associates
LONDON, ONTARIO

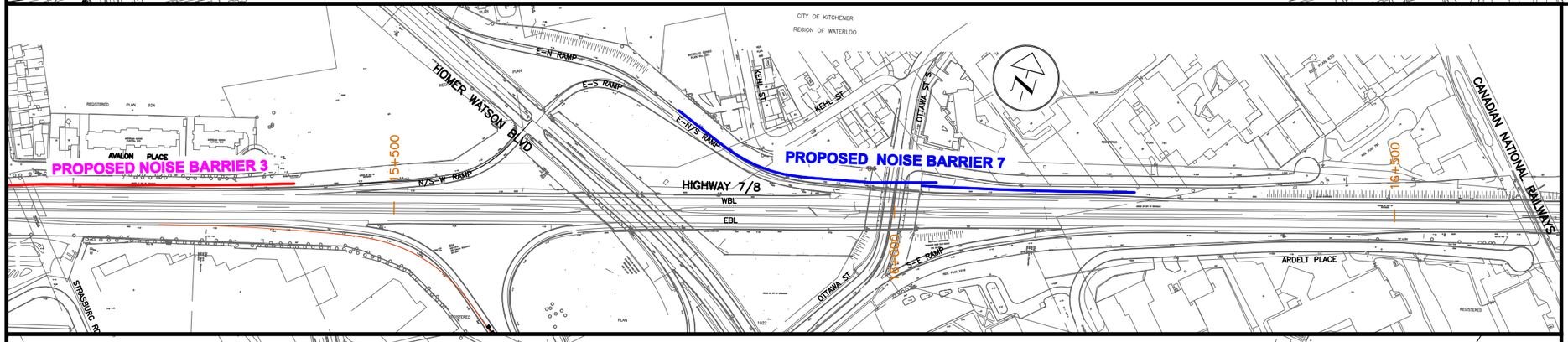
PROJECT No.	08-1132-084-1		FILE No.	0811320841-F11K001
			SCALE	AS SHOWN REV.
CADD	WDF	Dec. 08/10		
CHECK				

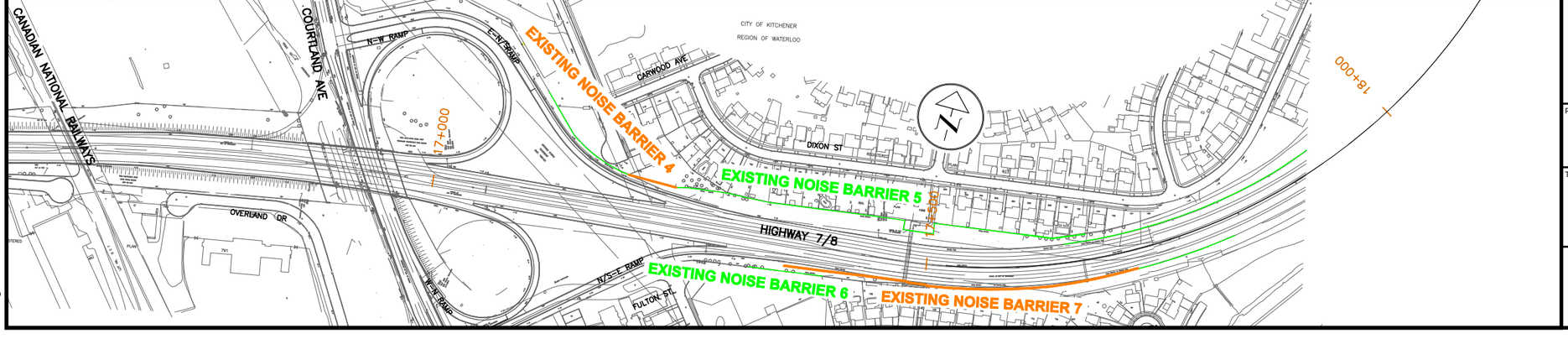
FIGURE 1

Drawing file: 0811320841-F11K001.DWG Mar 17, 2011 - 9:14am









SCALE IN METRES
0 100 200 m
1:5000

REFERENCE

BASE PLANS PROVIDED IN DIGITAL FORMAT
BY DILLON CONSULTING.

NOTE

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

PROJECT

PROPOSED NOISE BARRIER WALL 1B
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

NOISE BARRIER WALL LOCATION PLAN

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1		FILE No.	0811320841-F11K002	
			SCALE	AS SHOWN	REV. 0
CADD	WDF	Feb. 23/11			
CHECK					

FIGURE 2

Drawing file: 0811320841-F11K002.DWG Mar 17, 2011 - 9:16am

METRIC

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

CONT No.
WP No. 131-98-00

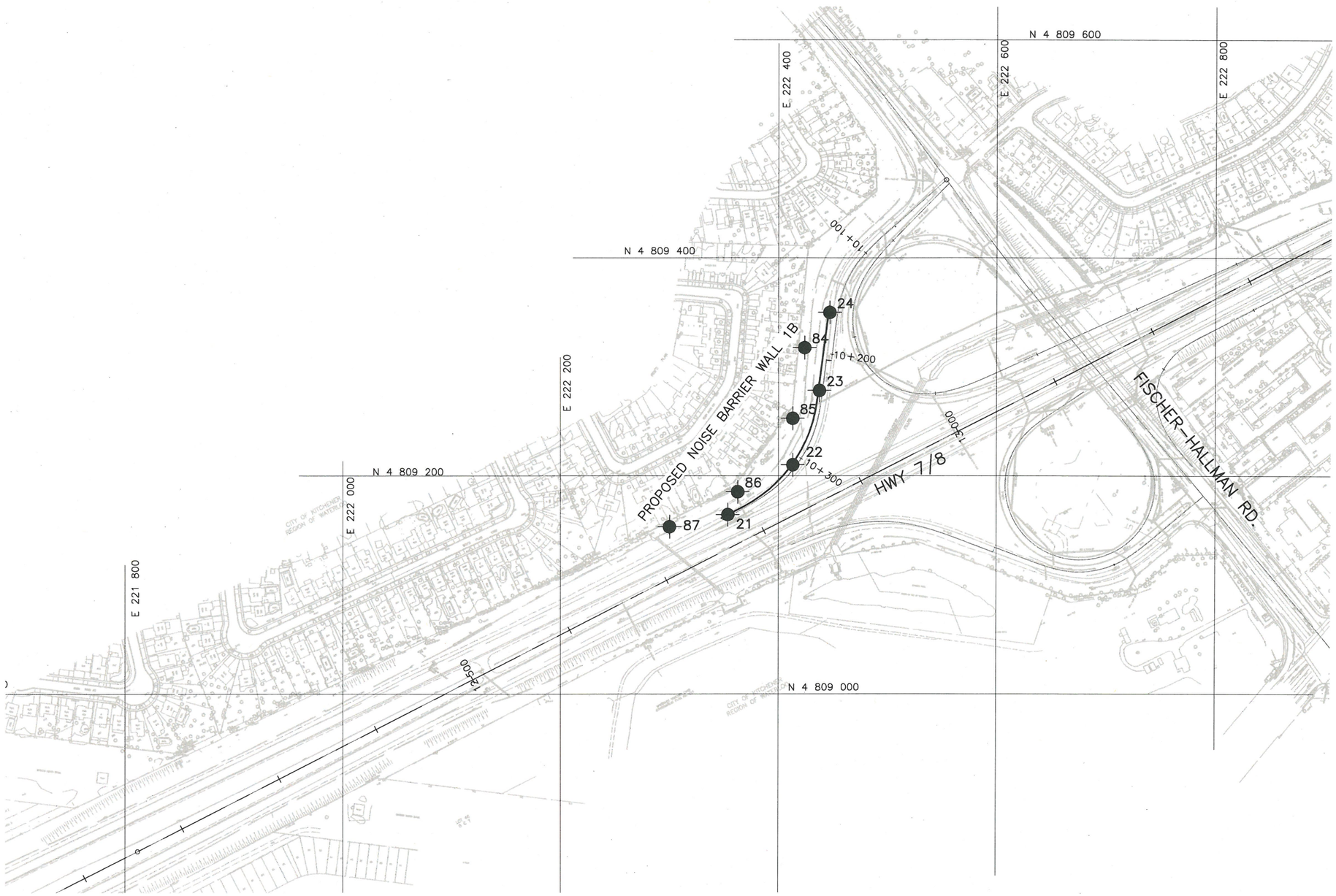
PROPOSED NOISE BARRIER WALL 1B

WIDENING OF HIGHWAY 7/8

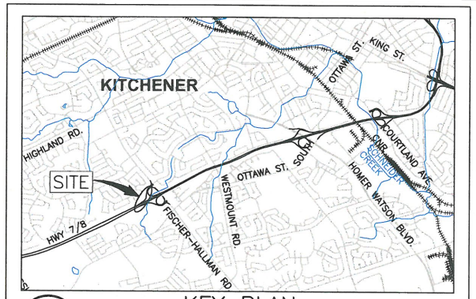
BOREHOLE LOCATIONS

SHEET

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



PLAN
SCALE
40 0 40 m



KEY PLAN
SCALE IN KILOMETRES 0 1 2

LEGEND

Borehole – Current Investigation

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10) NORTHING	EASTING
21	344.70	4 809 164.6	222 353.8
22	344.48	4 809 210.2	222 413.2
23	346.09	4 809 278.4	222 437.6
24	347.93	4 809 350.0	222 447.0
84	346.35	4 809 317.7	222 424.0
85	343.69	4 809 256.3	222 413.2
86	342.98	4 809 185.5	222 362.9
87	342.67	4 809 153.4	222 300.3

NOTES

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

REFERENCE

Base plans provided in digital format by Dillon Consulting.

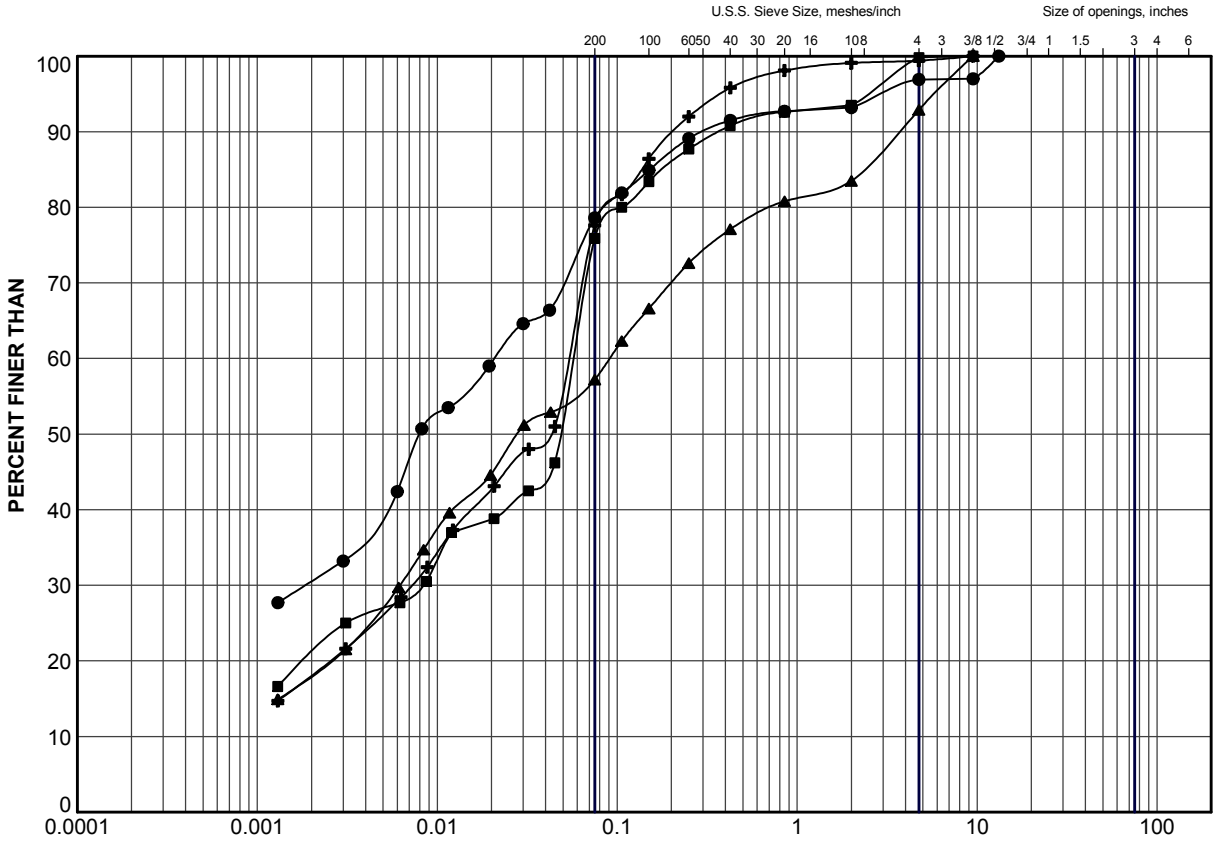
NO.	DATE	BY	REVISION

Geocres No. 40P7-65

HWY. 7/8	PROJECT NO. 08-1132-084-1		DIST.
SUBM'D. ML	CHKD.	DATE: Feb. 24/11	SITE:
DRAWN: WDF	CHKD.	APPD.	DWG. 1

APPENDIX A

Laboratory Test Data



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	22	3	342.0
■	23	1	345.1
▲	23	4	342.8
✚	85	2	341.9

PROJECT

PROPOSED NOISE BARRIER WALL 1B
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

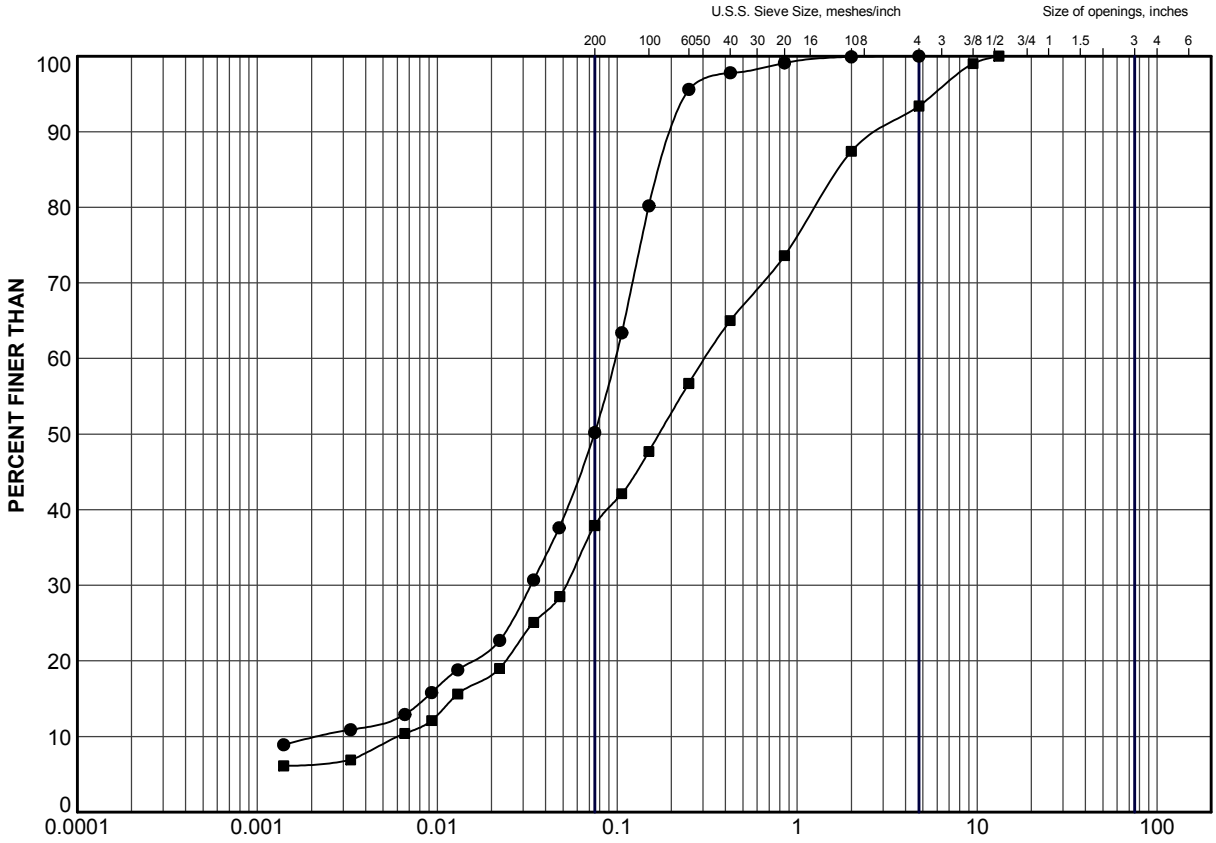
GRAIN SIZE DISTRIBUTION

FILL

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-084-1			FILE No. 0811320841-F11K0A1	
			SCALE N/A	REV.
DRAWN	WDF	Feb. 24/11	FIGURE A-1	
CHECK				

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	21	3	342.2
■	85	3	341.2

PROJECT

PROPOSED NOISE BARRIER WALL 1B
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

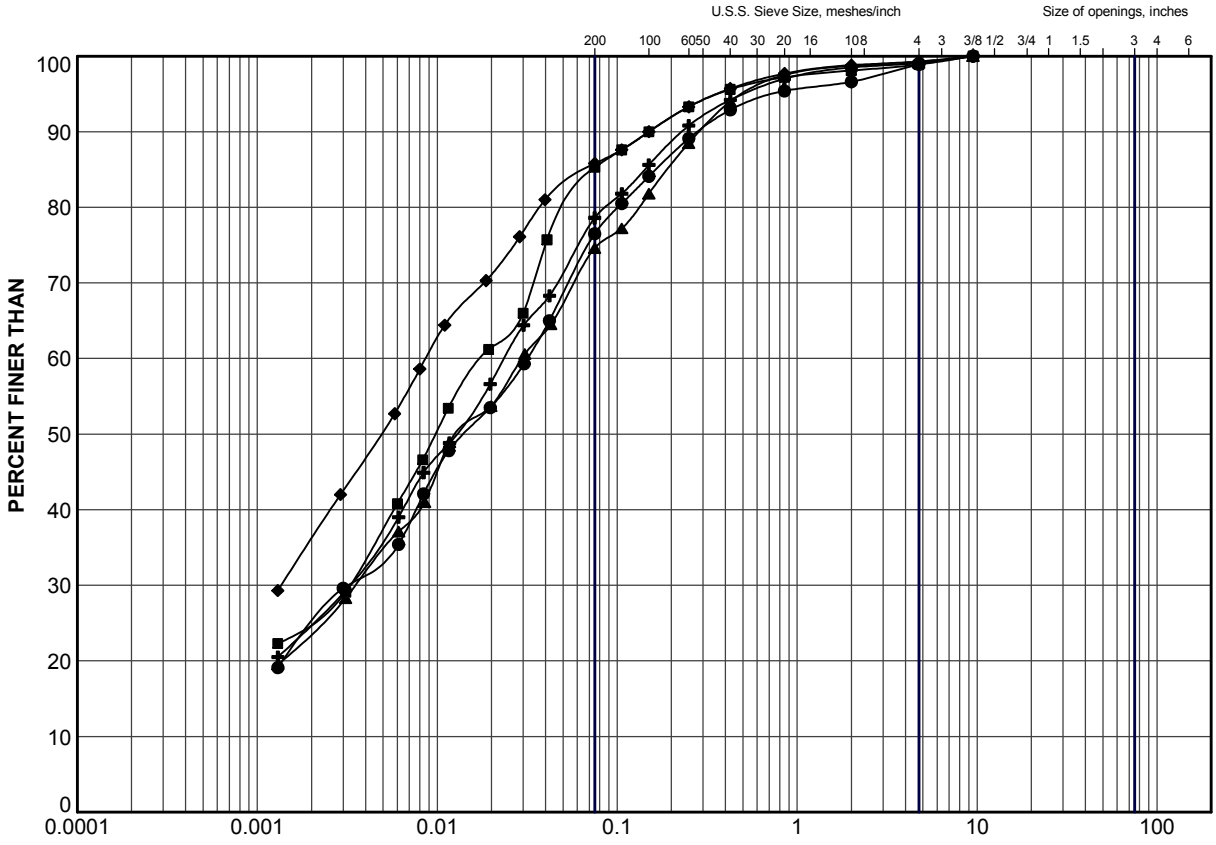
GRAIN SIZE DISTRIBUTION

SILTY SAND

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1		FILE No.	0811320841-F11K0A2
			SCALE	N/A REV.
DRAWN	WDF	Feb. 24/11		
CHECK			**FIGURE A-2**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	24	3	345.4
■	84	2	344.6
▲	85	5	339.7
✚	86	4	339.7
◆	87	6	337.9

PROJECT

PROPOSED NOISE BARRIER WALL 1B
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

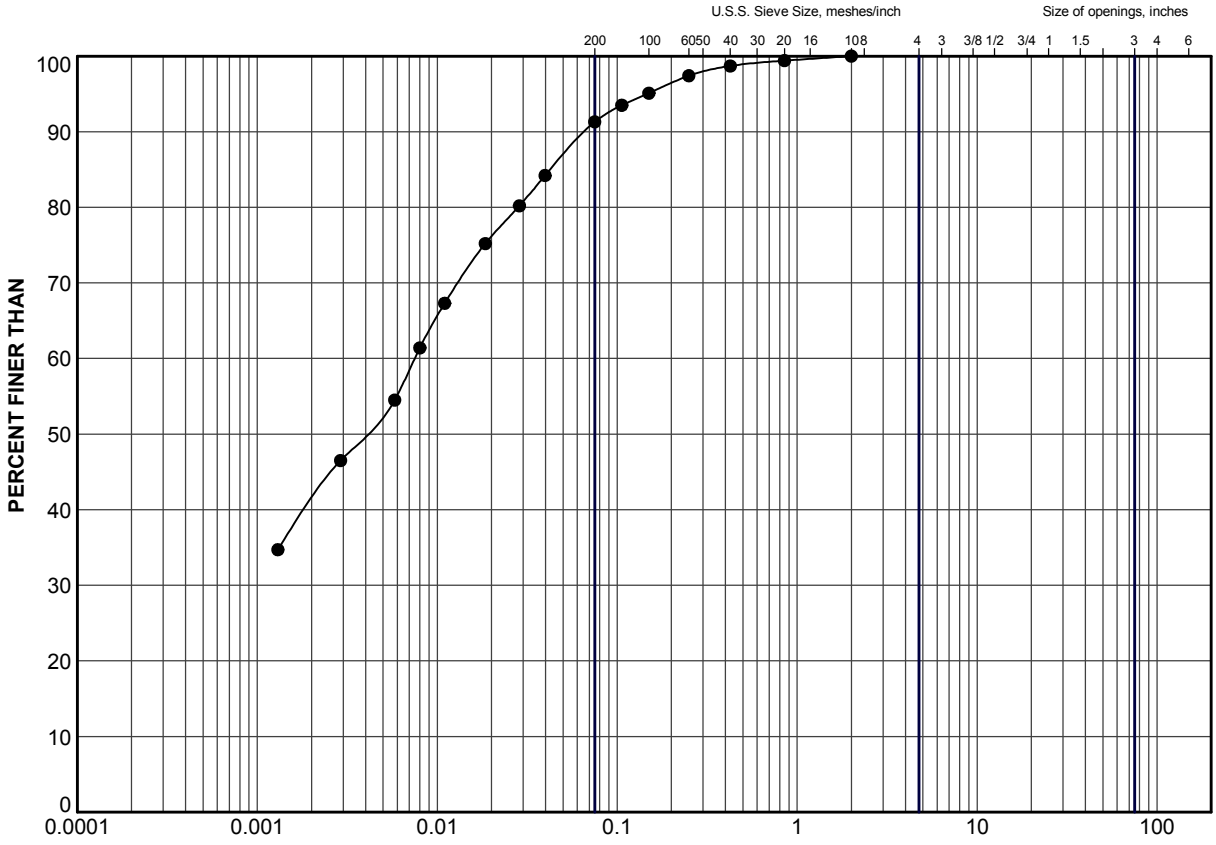
GRAIN SIZE DISTRIBUTION

CLAYEY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.			08-1132-084-1	FILE No.	0811320841-F11K0A3
				SCALE	N/A	REV.
DRAWN	WDF	Feb. 24/11			
CHECK				**FIGURE A-3**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	21	5	340.7

PROJECT

PROPOSED NOISE BARRIER WALL 1B
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

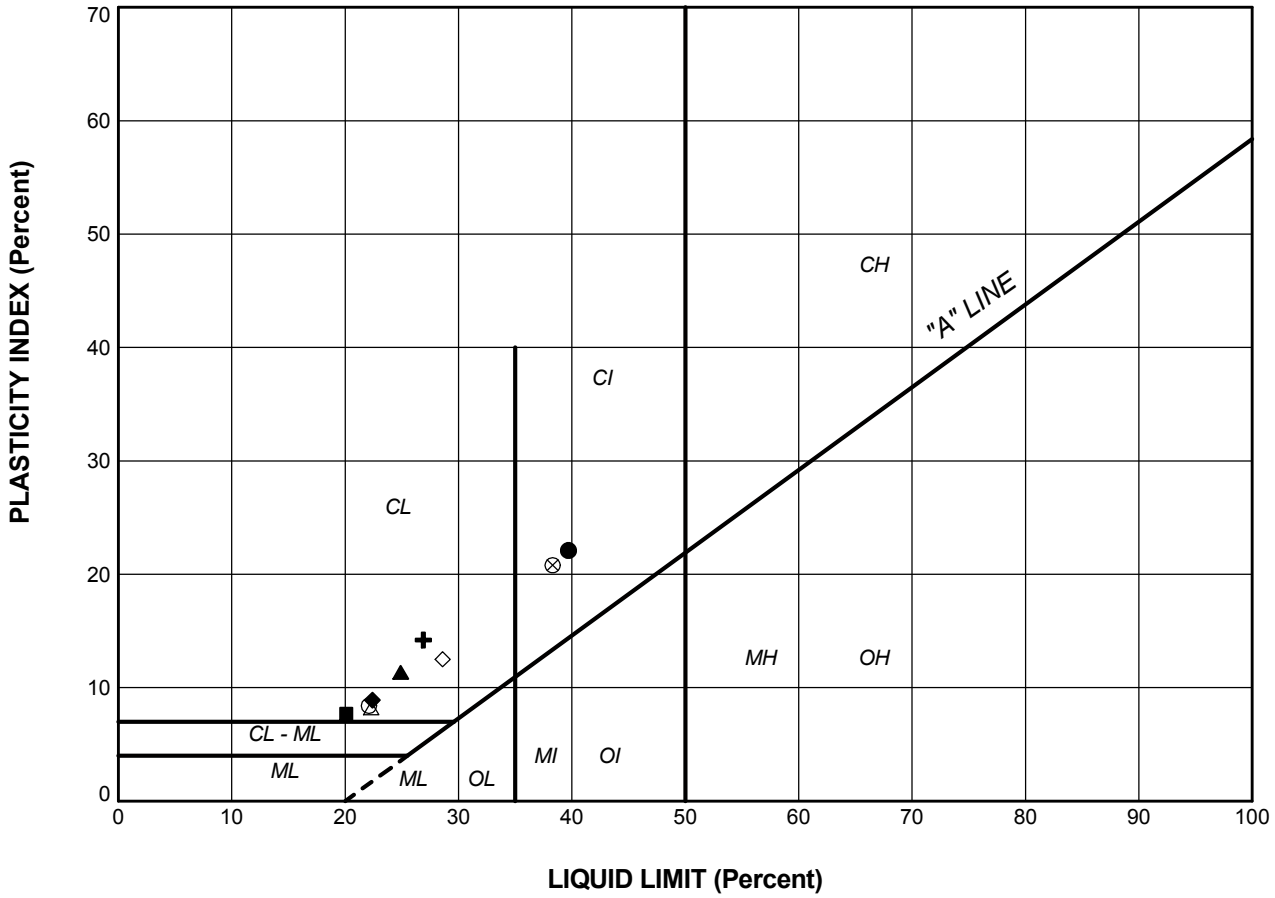
GRAIN SIZE DISTRIBUTION

SILTY CLAY

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1		FILE No.	0811320841-F11K0A4
			SCALE	N/A REV.
DRAWN	WDF	Feb. 24/11		
CHECK			**FIGURE**	**A-4**

LDN_MTO_NEW GLDR_LDN.GDT



SOIL TYPE	PLASTICITY
C = Clay	L = Low
M = Silt	I = Intermediate
O = Organic	H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
FILL - COHESIVE					
●	22	3	39.7	17.6	22.1
■	23	1	20.1	12.4	7.7
▲	23	4	24.9	13.6	11.4
CLAYEY SILT TILL					
✚	24	3	26.9	12.7	14.2
◆	84	2	22.4	13.5	8.9
○	85	5	22.1	13.7	8.4
△	86	4	22.3	14.1	8.2
◇	87	6	28.6	16.1	12.5
SILTY CLAY					
⊗	21	5	38.3	17.5	20.8

PROJECT

PROPOSED NOISE BARRIER WALL 1B
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

PLASTICITY CHART

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1		FILE No.	0811320841-F11K0A5	
			SCALE	N/A	REV.
DRAWN	WDF	Feb. 24/11			
CHECK			FIGURE	A-5	

MTO_PI GLDR_LDN.GDT

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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