



February 2011

FOUNDATION INVESTIGATION AND DESIGN REPORT

Proposed Noise Barrier Wall 7

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 AND DESIGN REPORT
PROPOSED NOISE BARRIER WALL 7**

PART A

FOUNDATION INVESTIGATION REPORT

PROPOSED NOISE BARRIER WALL 7

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



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 the proposed noise barrier wall 7 which will be located south of Kehl Street at the Homer Watson Boulevard Interchange between Station 10+467 Rt Homer Watson Boulevard E-N/S Ramp and Station 16+240 Lt Highway 7/8.

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 Foundation Engineering dated July 4, 2008.

Dillon provided Golder Associates with preliminary drawings showing the location of the proposed noise barrier wall.



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, and the proposed noise barrier wall 7 is shown on Noise Wall Location Plan, Figure 2.

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.

The proposed noise barrier wall 7 will be constructed in conjunction with the widening of Highway 7/8 and it will be located south of Kehl Street in the northeast quadrant of the Homer Watson Boulevard Interchange. The noise barrier wall will extend between Station 10+467 Rt Homer Watson Boulevard E-N/S Ramp and Station 16+240 Lt Highway 7/8. The Homer Watson Boulevard E-N/S Ramp stationing starts at 10+000 which is equivalent to Station 16+226 Highway 7/8 chainage. Mostly residential and commercial developments are located within the immediate vicinity of the site. The topography adjacent to the proposed noise barrier wall 7 varies from elevation 332 metres east of the north end of the wall to elevation 328 metres near the east end of the wall.

2.2 Site Geology

This project lies within the physiographic region of southwestern Ontario known as the Waterloo Hills¹. The soils generally consist of sandy hills. Some consist 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 ice contact sands. Adjacent to the site, the Maryhill clayey till is indicated.

The Geologic Survey of Canada Map 1263A entitled "Geology, Toronto-Windsor Area, Ontario" indicates that the subcropping bedrock in the area of 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.



FOUNDATION INVESTIGATION AND DESIGN REPORT PROPOSED NOISE BARRIER WALL 7

Based on the Ontario Department of Mines Preliminary Map No. P168 "Bedrock Topography Series, Stratford Sheet", the bedrock at the site is at about elevation 265 metres or some 67 metres below the Highway 7/8 surface.



3.0 INVESTIGATION PROCEDURES

The foundation investigation for the proposed noise barrier wall 7 carried out on November 18, 2010 at which time three boreholes were drilled along Highway 7/8 at the Homer Watson Boulevard E-N/S Ramp between Stations 10+000 and 10+200. The borehole locations are shown on the Borehole Location Plan, Drawing 1.

The boreholes (numbered 88 through 90, inclusive) were advanced to a depth of 5.2 metres. This information was supplemented at the remaining locations along the proposed noise barrier wall alignment with boreholes advanced for other components of this project as follows:

- Boreholes 102 and 104 (Geocres No. 40P8-173)
- Boreholes 905, 906 and 907 (Geocres No. 40P8-191)

The table below summarises 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)
88	4 810 315	225 257	331.07	5.18
89	4 810 321	225 186	328.89	5.18
90	4 810 354	225 119	327.18	5.18
102	4 810 338	225 388	331.01	11.13
104	4 810 332	225 336	325.93	11.07
905	4 810 357	225 450	330.61	9.60
906	4 810 372	225 512	330.22	9.60
907	4 810 390	225 585	329.61	9.14

The drilling was carried out using a truck mounted CME 45 power auger 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.

The groundwater conditions were observed throughout the drilling operations. A standpipe was installed in borehole 907 to monitor groundwater conditions in this area. The boreholes were backfilled in accordance with current Ontario Ministry of Transportation (MTO) requirements and Ontario Regulation 372/07.



FOUNDATION INVESTIGATION AND DESIGN REPORT PROPOSED NOISE BARRIER WALL 7

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 at the site generally encountered highly complex and variable soil conditions consisting of the existing pavement and/or topsoil and/or layers of granular and cohesive fill underlain by sand, silty sand, sandy silt, silt, clayey silt till, sandy silt till, clayey silt and silty clay.

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 Pavements

Asphaltic concrete was encountered at the ground surface in boreholes 88, 89, 90 and 102. The thickness of the asphalt layers ranged from 100 to 125 millimetres.

Granular base and subbase materials were found underlying the asphaltic concrete in boreholes 88, 89, 90 and 102. The granular base and subbase were 320 to 665 millimetres in combined thickness. Cobbles were found in the granular subbase layers in boreholes 88 and 89.

4.1.2 Topsoil

Topsoil was found at the ground surface in boreholes 104, 905, 906 and 907. In borehole 89, a layer of topsoil was found underlying fill. The thickness of the topsoil varied from 90 to 300 millimetres. 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.



4.1.3 Fill

Fill was encountered underlying the granular base and subbase in boreholes 88, 89 and 102 from elevations 328.1 to 330.4 metres and below the topsoil in boreholes 905, 906 and 907 from elevations 329.6 to 330.5 metres. The fill typically comprises layers of granular fill. In borehole 102, a 0.3 metre thick layer of cohesive fill was found beneath the granular fill layers. The total thickness of the fill layers ranged from 0.7 to 3.6 metres. Trace amounts of topsoil were found in the granular fill layers in borehole 907.

The gradation of the granular fill is highly variable and ranges from sand and gravel to silty sand, sandy silt and sand. The very loose to compact granular fill had N values ranging from 2 to 20 blows per 0.3 metres with water contents of 3 to 29 per cent.

The stiff cohesive fill generally consists of clayey silt and had an N value of 12 blows per 0.3 metres.

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

4.1.4 Sand

Sand layers were encountered in boreholes 90, 102, 104, 905, 906 and 907 from elevations 320.8 to 328.3 metres. The sand layers were found underlying fill, clayey silt, silty sand, clayey silt till and silty clay. Where fully penetrated, the sand layers ranged from 0.8 to 3.4 metres in thickness. Boreholes 102, 906 and 907 were terminated in sand deposits after exploring the layers for 6.7, 1.1 and 4.0 metres, respectively. Coarse sand layers were found in the sand in borehole 104.

The compact to very dense sand had N values of 17 to over 100 blows per 0.3 metres. The water contents were 3 to 25 per cent. Grain size distribution curves for samples of the sand obtained during the standard penetration testing are presented on Figure A-2.

4.1.5 Silty Sand

Layers of silty sand to silty fine sand were encountered in boreholes 88, 102, 104 and 905 between elevations 317.4 and 329.7 metres. The silty sand layers were found underlying granular fill, topsoil, sand and silt. In borehole 104, the silty fine sand was interlayered with sandy silt and sand layers. Where fully penetrated, the silty sand layers were 0.8 to 2.6 metres in thickness. Boreholes 104 and 905 were terminated in the silty sand (lower layers) after exploring the layers for 2.5 and 0.6 metres, respectively.

The compact to very dense silty sand had N values of 18 to over 100 blows per 0.3 metres with water contents of 7 to 11 per cent. The results of grain size testing conducted on samples of the silty fine sand obtained during standard penetration testing are presented on Figure A-3.



4.1.6 Sandy Silt

Compact to dense layers of sandy silt were encountered in boreholes 88 and 90 at elevations 328.2 and 323.5 metres, respectively. In borehole 88, the sandy silt is interlayered with silty fine sand. The thickness of the upper layer of sandy silt in borehole 88 was 0.8 metres. Boreholes 88 and 90 were terminated in the sandy silt after exploring the lower layers for 0.8 and 1.5 metres, respectively.

The sandy silt had N values of 11 to 50 blows per 0.3 metres with water contents of 9 and 10 cent. The results of grain size analyses conducted on samples of the sandy silt obtained during standard penetration testing are presented on Figure A-4.

4.1.7 Silt

Layers of silt were found in boreholes 89, 104 and 905 from elevations 322.4 to 324.3 metres. The silt layers were encountered underlying topsoil, sand and between silty fine sand layers. The thickness of the silt layers was 0.8 metres in borehole 104 and 905. Borehole 89 was terminated in the silt after exploring the layer for 0.6 metres.

The silt is compact to very dense and had N values of 10 to 79 blows per 0.3 metres with a water content of 14 per cent.

4.1.8 Clayey Silt Till

Clayey silt till was encountered underlying sand in boreholes 90 and 906 at elevations 325.1 and 325.5 metres, respectively. The clayey silt till is interlayered with sandy silt till layers in borehole 90. The thickness of the clayey silt till ranged from 0.4 to 1.2 metres.

The very stiff to hard clayey silt till had N values of 17 to 40 blows per 0.3 metres with water contents varying from 11 to 16 per cent. The Atterberg limits tests indicate that the clayey silt till is of low plasticity. The plastic limit, liquid limit and plasticity index for a sample of the clayey silt till is 12, 20 and 8 per cent, respectively. The Atterberg limits results for the test performed on a sample of the clayey silt till are shown on Figure A-8.

The results of the grain size testing conducted on a sample of the clayey silt till obtained during standard penetration testing are presented on Figure A-5. 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.



4.1.9 Sandy Silt Till

A 0.4 metre thick layer of sandy silt till was found between clayey silt till layers in borehole 90 at elevation 324.3 metres.

The compact sandy silt till had an N value of 17 blows per 0.3 metres with a water content of 10 per cent. Although not specifically encountered in borehole 90, cobbles and boulders should be anticipated in the sandy silt till due to the depositional history of this material.

4.1.10 Clayey Silt

Layers of clayey silt were encountered in boreholes 90, 905 and 906 from elevations 323.5 to 326.6 metres. The clayey silt was found underlying fill and sand. In borehole 906, the clayey silt layer was found between sand layers. The thicknesses of the clayey silt layers were 0.4 to 2.0 metres. Sand and sandy silt layers were found in the clayey silt.

The very stiff to hard clayey silt layers had N values of 17 to 45 blows per 0.3 metres with water contents of 15 and 18 per cent. The clayey silt is of low plasticity based on plastic limits of 16 and 18 per cent, liquid limits of 33 and 35 per cent, and plasticity indices of 15 and 19 per cent as determined during the Atterberg limits testing on two samples of the clayey silt. The Atterberg limits results for test performed on the clayey silt are shown on Figure A-8.

The results of the grain size testing conducted on two samples of the clayey silt obtained during standard penetration testing are presented on Figure A-6.

4.1.11 Silty Clay

A 2.1 metre thick layer of silty clay with sandy silt layers was found underlying fill in borehole 907 at elevation 326.6 metres.

The very stiff to hard silty clay had N values of 23 to 35 blows per 0.3 metres with a water content of 18 per cent. The silty clay is of intermediate plasticity based on a plastic limit, a liquid limit and a plasticity index of 20, 39 and 19 per cent, respectively. The results of the Atterberg limits tests are presented on Figure A-8.

A grain size distribution curve for a sample of the silty clay is shown on Figure A-7.



4.2 Groundwater Conditions

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

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
88	331.07	Dry	Below 325.9
89	328.89	Dry	Below 323.7
90	327.18	Dry	Below 322.0
102	331.01	Dry	Below 319.9
104	325.93	6.1	319.8
905	330.61	Dry	Below 321.0
906	330.22	Dry	Below 320.6
907	329.61	6.1	323.5

During the field work, groundwater was encountered at elevations 319.8 and 323.5 metres in boreholes 104 and 907, respectively. The remaining boreholes were dry and were advanced to depths of 5 to 11 metres and terminated in the sands or silts. With the exception of boreholes 89, 90 and 104, grey soils were not encountered in any of the boreholes which were dry upon completion. As a result, the groundwater level is inferred to be below the bottom of any borehole that was dry and did not intercept grey soils.

A 12.5 millimetre diameter standpipe was installed in borehole 907. The measurements obtained during post-field work groundwater monitoring for borehole 907 are presented below.

Borehole	Ground Surface Elevation (m)	Installation	Measured Groundwater Elevation (m)			
			Upon Installation	Jun 02, 2010	Jun 30, 2010	Nov 25, 2010
907	329.61	Standpipe	322.42	323.69	323.54	323.01

The above noted measured water level is considered to be representative of the long-term, stabilized groundwater condition.

The groundwater level is inferred to be near elevation 322.0 metres at Station 10+200 Rt Homer Watson Boulevard E-N/S Ramp and at approximately 323.5 metres at Station 16+250 Lt Highway 7/8. It should be noted that 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 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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**FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED NOISE BARRIER WALL 7**

PART B

FOUNDATION DESIGN REPORT

PROPOSED NOISE BARRIER WALL 7

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 the proposed noise barrier wall 7 south of Kehl Street in the northeast quadrant of the Homer Watson Boulevard Interchange. Two overlapping segments of noise barrier wall will be constructed between Station 10+467 Rt Homer Watson Boulevard E-N/S Ramp and Station 16+240 Lt Highway 7/8. The proposed noise barrier wall is to be shoulder mounted and 5.0 metres high.

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. Foundation 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.

The passive resistance in the upper 1.4 metres below the ground should be neglected to account for frost action. In addition, for foundation design, full passive resistance will be mobilized only where the ground surface in front and behind the caisson is level. Where sloping ground is present adjacent to the noise barrier wall, the K_p values used in the calculation should be adjusted to account for the presence of the sloping ground.

The ground behind the proposed noise barrier wall adjacent to the northwest slope of the Ottawa Street South overpass approach embankment slopes downwards at a maximum slope of 2 horizontal to 1 vertical between Stations 10+200 RT Homer Watson Boulevard E-N/S Ramps and 15+975 LT Highway 7/8. Adjusted K_p values are provided in Table I for these areas. The adjusted K_p value is to be applied to that portion of the caisson that is above the elevation of the ground surface at the toe of the slope; below this elevation, the full K_p value is to be applied.



FOUNDATION INVESTIGATION AND DESIGN REPORT PROPOSED NOISE BARRIER WALL 7

It may be necessary to use deeper or larger diameter caissons at locations with deep fills containing zones of loose granular fill. These locations are in the vicinity of:

- Borehole 89 – Station 10+100 Rt Homer Watson Boulevard E-N/S Ramp. Based on borehole 89, generally loose fill underlain by buried topsoil extends to elevation 324.3 metres or a depth of about 4.6 metres.
- Boreholes 905, 906 and 907 – Stations 16+105 to 16+250 Lt Highway 7/8. Based on boreholes 905, 906 and 907, the fill extends to elevations 326.6 to 328.3 metres or depths of 2.3 to 3.1 metres. The very loose fill in borehole 906 should not be relied upon to provide lateral support of the augered caissons.

The existing Ottawa Street South overpass is located between approximately Stations 15+975 and 16+025 Lt. Due to right-of-way restrictions, it has also been proposed to install a retained soil system (RSS) wall between the Ottawa Street South structure and the CNR overhead structure to the west. In this area, placement of noise wall foundations will need to be coordinated with the design of the RSS walls.

6.3 Construction Considerations

Excavation for the construction of the noise barrier wall foundations will penetrate the surficial fill and topsoil and will extend through deposits of sand, silty sand, sandy silt, silt, clayey silt till, sandy silt till, clayey silt and silty clay. The sands and sandy silt tills are predominantly fine grained and uniform in composition. The silts, clayey silts, clayey silt tills and silty clays at the site are susceptible to disturbance during caisson excavation and construction. A non-Standard Special Provision (NSSP) should be included in the contract documents to alert the Contractor about the requirements for support of augered excavations. The NSSP should also state that measures and equipment are required to deal with cobbles which were encountered in the fill in boreholes 88 and 89 and cobbles and boulders which can be expected in the clayey silt till and sandy silt till.

The caissons should be constructed and inspected in accordance with Ontario Provisional Standard Specification 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 7**

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^2 Level Ground/ 2H:1V	Coefficient of Active Pressure, K_a Level Ground	Unit Weight ³ (kNm ⁻³)	
								Bulk γ	Effective, γ'
Homer Watson Boulevard E-N/S Ramp 10+435 to 10+467 Borehole 90	Compact sand	325.8 to 325.0	322.0	-	30	3.0/1.1	0.33	19.0	9.0
	Very stiff clayey silt till	325.0 to 323.5		150	30	3.0/1.1	0.33	21.0	11.0
	Dense sandy silt	Below 323.5		-	33	3.4/1.3	0.30	19.0	9.0
Homer Watson Boulevard E-N/S Ramp 10+360 to 10+435 Borehole 89	Loose to compact granular fill	327.6 to 324.0	324.0	-	29	2.9/1.1	0.35	18.5	8.5
	Compact silt	Below 324.0		-	30	3.0/1.1	0.33	18.5	8.5
Homer Watson Boulevard E-N/S Ramp 10+360 to Highway 7/8 15+950 Borehole 88	Compact silty sand to sandy silt	Below 329.7	Below 326.0	-	32	3.3/1.2	0.31	19.0	9.0

**FOUNDATION DESIGN PARAMETERS
PROPOSED NOISE BARRIER WALL 7**

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^2 Level Ground/ 2H:1V	Coefficient of Active Pressure, K_a Level Ground	Unit Weight ³ (kNm ⁻³)	
								Bulk γ	Effective, γ'
Highway 7/8 15+930 to 16+015 Borehole 104	Compact to very dense silty fine sand	324.5 to 320.8	320	-	32	3.3/1.2	0.31	19.0	9.0
	Very dense sand	Below 320.8			35	3.7/1.4	0.27	19.0	9.0
Highway 7/8 16+015 to 16+070 Borehole 102	Stiff cohesive fill	329.5 to 329.0	Below 320.0	-	29	2.9/N/A	0.35	19.0	9.0
	Compact to dense silty sand	329.0 to 326.5		-	33	3.4/N/A	0.30	19.5	9.5
	Dense to very dense sand	Below 326.5		-	35	3.7/N/A	0.27	19.5	9.5
Highway 7/8 16+070 to 16+135 Borehole 905	Loose granular fill	329.2 to 328.5	Below 321.0	-	29	2.9/N/A	0.35	19.0	9.0
	Compact to dense sand	328.5 to 325.0		-	32	3.3/N/A	0.31	19.0	9.0
	Very stiff to hard clayey silt	325.0 to 323.0		160	29	2.9/N/A	0.35	20.5	10.5
Highway 7/8 16+135 to 16+200 Borehole 906	Very loose to loose granular fill	328.8 to 327.3	Below 320.5	-	-	-	-	18.0	8.0
	Compact to dense sand	327.3 to 325.5		-	32	3.3/N/A	0.31	19.5	9.5
	Hard clayey silt till	325.5 to 324.3		200	30	3.0/N/A	0.33	21.0	11.0
Highway 7/8 16+200 to 16+240 Borehole 907	Loose granular fill	328.2 to 326.5	323.5	-	28	2.8/N/A	0.36	19.0	9.0
	Very stiff to hard silty clay	326.5 to 324.4		190	28	2.8/N/A	0.36	20.0	10.0
	Compact to dense sand	Below 324.4		-	34	3.5/N/A	0.28	19.5	9.5

**FOUNDATION DESIGN PARAMETERS
PROPOSED NOISE BARRIER WALL 7**

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. Passive earth pressure coefficient (K_p) values are provided for level ground. Where sloping ground is present, adjacent to the noise barrier wall, adjusted K_p values must be used in the foundation design. The ground behind the proposed noise barrier wall will slope downwards at a maximum slope of 2 horizontal to 1 vertical between Stations 10+200 RT Homer Watson Boulevard E-N/S Ramp and Station 15+975 Lt Highway 7/8.
3. Below the groundwater level, the effective unit weight of the soil (γ') should be used.
4. The very loose granular fill in borehole 906 should not be relied upon for lateral support of the augered caissons.
5. 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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Consistency

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

(b) Cohesive Soils

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

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

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

LIST OF SYMBOLS

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

I. General

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

- Notes:**
- 1 $\tau = c' + \sigma' \tan \phi'$
 - 2 shear strength = (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)

RECORD OF BOREHOLE No 88

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4810314.8 ; E 225257.3 ORIGINATED BY MA
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE November 18, 2010 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													
331.07	ROAD SURFACE																				
	ASPHALT (100mm)																				
0.20	FILL, sand and gravel, crushed																				
330.37	FILL, sand and gravel, with cobbles																				
0.70	FILL, silty fine sand																				
329.70	Compact Brown		1	SS	15																
1.37	SILTY FINE SAND, some clay, trace gravel																				
328.18	Compact Brown		2	SS	28																
2.89	SANDY SILT, trace clay, trace gravel																				
327.41	Compact Brown		3	SS	29																
3.66	SILTY FINE SAND, trace gravel																				
326.65	Dense Brown		4	SS	26																
4.42	SANDY SILT, trace clay																				
325.89	Compact Brown		5	SS	34																
5.18	END OF BOREHOLE																				
	Borehole dry during drilling on November 18, 2010.																				

RECORD OF BOREHOLE No 89

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4810321.4 ; E 225185.6 ORIGINATED BY MA
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE November 18, 2010 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									
								20 40 60 80 100									
328.89	ROAD SURFACE																
0.00	ASPHALT (125mm)																
0.12	FILL, sand and gravel, crushed																
0.36	FILL, sand and gravel, with cobbles																
328.10	Brown																
0.79	FILL, sandy silt, some clay, trace gravel		1	SS	10		328										
327.52	Compact Grey																
1.37	FILL, silt, some sand, some clay, trace gravel, layered		2	SS	10		327										
	Loose to Compact Brown																
			3	SS	6		326									4 15 63 18	
			4	SS	6												
325.23	FILL, silty fine sand, trace gravel						325										
3.66	Compact Brown		5	SS	20												
324.47	TOPSOIL, silty Black																
4.42	SILT, some sand, trace gravel						324										
4.57	Compact Grey		6	SS	10												
323.71	END OF BOREHOLE																
5.18	Borehole dry during drilling on November 18, 2010.																

RECORD OF BOREHOLE No 90

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4810353.8 ; E 225118.6 ORIGINATED BY MA
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE November 18, 2010 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										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
327.18	GROUND SURFACE						20	40	60	80	100									
0.40	ASPHALT (100mm)																			
0.24	FILL, sand and gravel, crushed																			
326.63	FILL, sand, trace gravel																			
0.55	Brown																			
326.27	CLAYEY SILT, trace sand, trace gravel		1	SS	17															
0.91	Very stiff Brown																			
	SAND, fine to medium, trace silt, trace gravel		2	SS	29															
325.05	Compact Brown																			
2.13	CLAYEY SILT TILL, some sand, trace gravel		3	SS	20															
324.28	Very stiff Brown																			
2.90	SANDY SILT TILL, Compact		4	SS	17															
323.89	Grey																			
3.29	CLAYEY SILT TILL, Very stiff																			
323.52	Brown		5	SS	44															
3.66	SANDY SILT, some clay, trace gravel																			
	Dense Grey		6	SS	50															
322.00																				
5.18	END OF BOREHOLE																			
	Borehole dry during drilling on November 18, 2010.																			

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

PROJECT 08-1132-084-1

W.P. 131-98-00

LOCATION N 4810337.9 ; E 225388.1

ORIGINATED BY MA

DIST HWY 7/8

BOREHOLE TYPE POWER AUGER

COMPILED BY LMK/SL

DATUM GEODETIC

DATE October 24, 2008

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											
331.01	PAVEMENT SURFACE						20	40	60	80	100										
0.11	ASPHALT																				
330.58	FILL, sand and gravel, crushed, trace silt																				
0.43	Brown																				
	FILL, fine sand, some silt, trace gravel		1	SS	19																
	Compact																				
	Brown																				
329.45			2	SS	12																
1.56	FILL, clayey silt, some sand, trace gravel																				
1.86	Stiff																				
	Brown																				
	SILTY SAND, trace gravel, trace clay		3	SS	18											3	56 31 10				
	Compact to dense																				
	Brown																				
			4	SS	30																
			5	SS	42																
326.59																					
4.42	SAND, fine, trace silt		6	SS	35																
	Dense																				
	Brown																				
325.83																					
5.18	SAND, fine to medium, trace silt, some gravel, trace clay		7	SS	69											18	71 8 3				
	Very dense																				
	Brown																				
324.61			8	SS	61																
6.40	SAND, fine, some silt																				
	Very dense																				
	Brown																				
			9	SS	52																
			10	SS	55																
			11	SS	54																

RECORD OF BOREHOLE No 104

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4810331.7 ; E 225335.9 ORIGINATED BY JB
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER COMPILED BY LMK/SL
DATUM GEODETIC DATE October 27, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)				
								○ UNCONFINED		+ FIELD VANE												
								● QUICK TRIAXIAL		× LAB VANE												
325.93	GROUND SURFACE						20	40	60	80	100						GR SA SI CL					
0.00	TOPSOIL																					
0.30	SILTY FINE SAND Compact to dense Brown		1	SS	21																	
			2	SS	40																	
323.64																						
2.29	SILT, trace clay, trace sand Very dense Brown		3	SS	79																	
322.88																						
3.05	SILTY FINE SAND, trace clay Very dense Brown		4	SS	106								○				0 72 23 5					
			5	SS	120																	
			6	SS	102																	
320.75																						
5.18	SAND, fine, with coarse sand layers, trace gravel Very dense Brown		7	SS	92																	
319.83																						
6.10	SAND, fine, some silt, trace clay Very dense Brown		8	SS	51																	
			9	SS	107/ 200mm								○				0 86 11 3					
317.40																						
8.53	SILTY FINE SAND Very dense Grey		10	SS	124																	
314.86			11	SS	110/ 250mm																	
11.07	END OF BOREHOLE																					
	Groundwater encountered at about elev. 319.8m during drilling on October 27, 2008.																					

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 23/12/10

PROJECT <u>08-1132-084-1</u>		RECORD OF BOREHOLE No 905		1 OF 1 METRIC	
W.P. <u>131-98-00</u>		LOCATION <u>N 4810356.5 ; E 225449.8</u>		ORIGINATED BY <u>MR</u>	
DIST <u> </u> HWY <u>7/8</u>		BOREHOLE TYPE <u>POWER AUGER / HOLLOW STEM</u>		COMPILED BY <u>WDF</u>	
DATUM <u>GEODETIC</u>		DATE <u>May 21, 2010</u>		CHECKED BY <u> </u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								20	40	60	80	100	W _p	W	W _L						
330.61	GROUND SURFACE																				
0.09	TOPSOIL, silty Dark brown																				
330.15	FILL, sand and gravel, trace silt Brown																				
0.46	FILL, silty sand, with silt layers Compact Brown		1	SS	16																
329.24	FILL, sand, fine to medium, some silt Loose Brown		2	SS	6																
1.37																					
328.32																					
2.29	SAND, fine to medium, trace silt, trace clay Compact to dense Brown		3	SS	26																
			4	SS	29																
			5	SS	36																
			6	SS	27																
325.12																					
5.49	CLAYEY SILT, some sand, trace gravel, trace sandy silt layers Very stiff to hard Brown		7	SS	17																
			8	SS	22																
			9	SS	35																
323.14																					
7.47	SAND, fine to coarse, some gravel Very dense Brown		10	SS	69																
322.38																					
8.23	SILT, some sand Dense Brown		11	SS	37																
321.62																					
8.99	SILTY FINE SAND Dense Brown		12	SS	40																
321.01																					
9.60	END OF BOREHOLE																				
	Borehole dry during drilling on May 21, 2010.																				

LDN_MTO_06_08-1132-084-1.GPJ LDN_MTO.GDT 23/12/10

PROJECT 08-1132-084-1		RECORD OF BOREHOLE No 906		1 OF 1	METRIC
W.P. 131-98-00	LOCATION N 4810372.4 ; E 225511.5	ORIGINATED BY MR			
DIST HWY 7/8	BOREHOLE TYPE POWER AUGER / HOLLOW STEM	COMPILED BY WDF			
DATUM GEODETIC	DATE May 21, 2010	CHECKED BY			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100	20 40 60 80 100	W _P W W _L							
330.22	GROUND SURFACE																
0.00	TOPSOIL, silty Dark brown																
0.21	FILL, sand and gravel, trace silt Brown																
329.46																	
0.76	FILL, sand, fine to medium Very loose to compact Brown		1	SS	15							○					
			2	SS	4							○					
			3	SS	2							○					
327.32																	
2.90	SAND, fine to medium, trace to some silt, trace clay Compact to dense Brown		4	SS	21												
			5	SS	35							○				0 87 10 3	
325.50																	
4.72	CLAYEY SILT TILL, trace sand, trace gravel Hard Brown		6	SS	37												
			7	SS	40							○					
324.28																	
5.94	SAND, fine to medium, trace silt, trace gravel Very dense Brown		8	SS	65												
323.51																	
6.71	CLAYEY SILT, some sand, with sand layers Hard Brown		9	SS	45												
			10	SS	44							○	—————			0 25 32 43	
321.69																	
8.53	SAND, fine to medium, trace gravel Dense Brown		11	SS	40												
			12	SS	31												
320.62																	
9.60	END OF BOREHOLE																
	Borehole dry during drilling on May 21, 2010.																

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 23/12/10

RECORD OF BOREHOLE No 907

1 OF 1

METRIC

PROJECT 08-1132-084-1

W.P. 131-98-00

LOCATION N 4810390.0 ; E 225585.0

ORIGINATED BY MR

DIST HWY 7/8

BOREHOLE TYPE POWER AUGER / HOLLOW STEM

COMPILED BY WDF

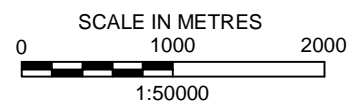
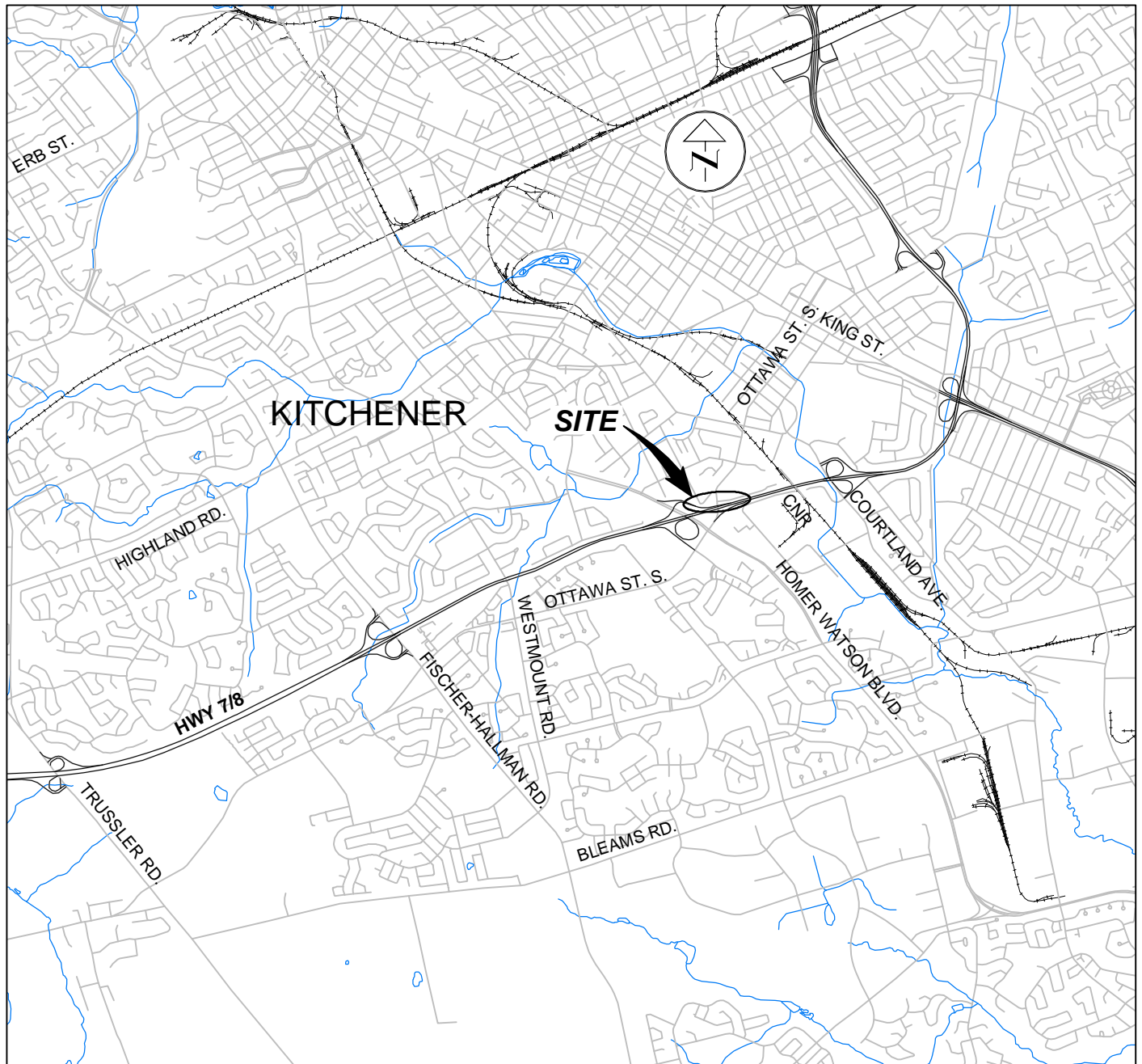
DATUM GEODETIC

DATE May 25, 2010

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										WATER CONTENT (%)	
								20	40	60	80	100						20	40
329.61	GROUND SURFACE																		
0.00	TOPSOIL, silty Dark brown																		
0.24	FILL, sand and gravel Brown																		
0.46	FILL, silty sand, trace topsoil, trace clay, trace gravel Loose to compact Brown		1	SS	15														
			2	SS	8														
			3	SS	7														
326.56																			
3.05	SILTY CLAY, trace to some sand, with sandy silt layers Very stiff to hard Brown		4	SS	23														
			5	SS	26														
			6	SS	35														
324.43																			
5.18	SAND, fine to medium, trace silt, trace clay Compact to dense Brown		7	SS	43														
			8	SS	34														
			9	SS	40														
			10	SS	25														
			11	SS	23														
320.47																			
9.14	END OF BOREHOLE																		
	Augers advanced to 9.14m but sampler impeded by blowback below elev. 320.8m																		
	Groundwater encountered at about elev. 323.5m during drilling on May 25, 2010.																		
	Water level measured in standpipe at elev. 322.42m following installation on May 25, 2010.																		
	Water level measured in standpipe at elev. 323.69m on June 2, 2010.																		
	Water level measured in standpipe at elev. 323.54m on June 30, 2010.																		
	Water level measured in standpipe at elev. 323.01m on Nov. 25, 2010.																		

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



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 7
WIDENING OF HIGHWAY 7/8
GWP 131-98-00**

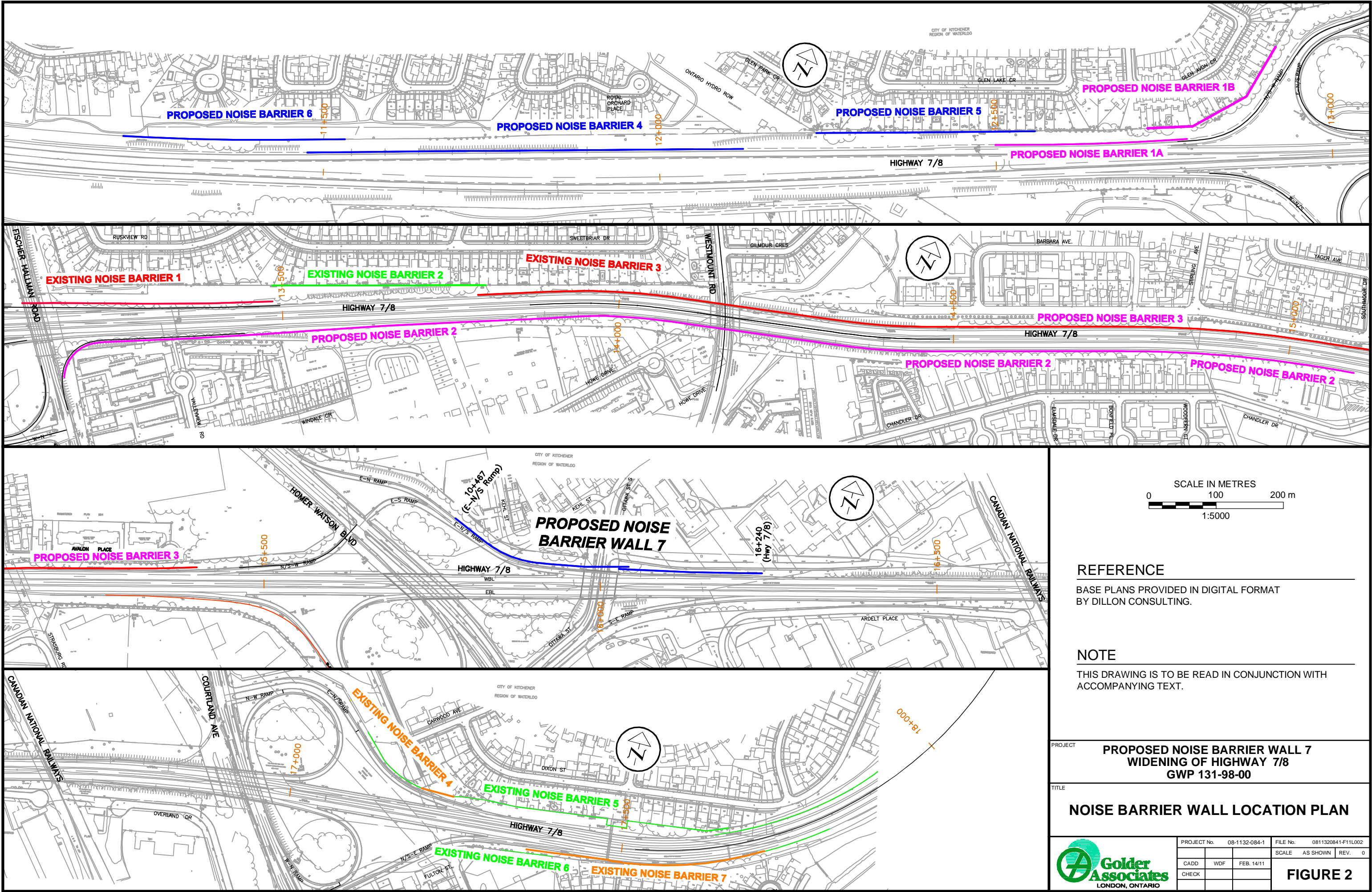
TITLE

KEY PLAN



PROJECT No. 08-1132-084-1			FILE No. 0811320841-F11L001		
CADD WF/LK/AG FEB. 11/11			SCALE	AS SHOWN	REV.
CHECK			FIGURE 1		

Drawing file: 0811320841-F11L002.dwg Feb 17, 2011 - 11:16am



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

CONT No.
WP No. 131-98-00

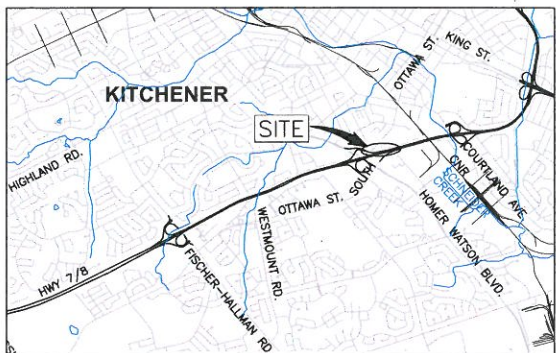


PROPOSED NOISE
BARRIER WALL 7
WIDENING OF HIGHWAY 7/8
BOREHOLE LOCATIONS

SHEET



Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN

LEGEND

● Borehole - Current Investigation

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
88	331.07	4 810 314.8	225 257.3
89	328.89	4 810 321.4	225 185.6
90	327.18	4 810 353.8	225 118.6
102	331.01	4 810 337.9	225 388.1
104	325.93	4 810 331.7	225 335.9
905	330.61	4 810 356.5	225 449.8
906	330.22	4 810 372.4	225 511.5
907	329.61	4 810 390.0	225 585.0

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. 40P8-195			
HWY.	7/8	PROJECT NO. 08-1132-084-1	DIST.
SUBM'D.	DUP	CHKD.	DATE: FEB. 11/11
DRAWN:	WF/LK/AG	CHKD.	APPD.
			DWG. 1



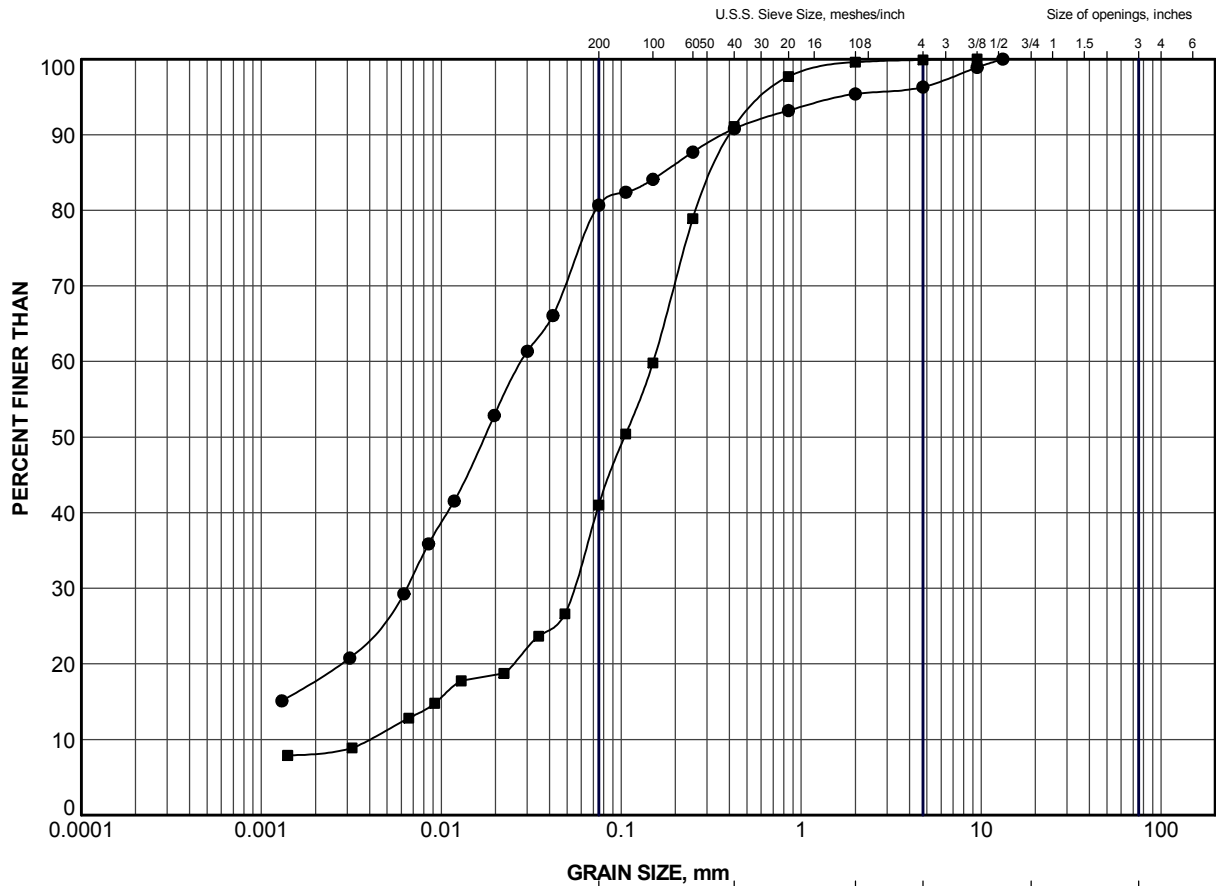
PLAN

SCALE
30 0 30 m



APPENDIX A

Laboratory Test Data



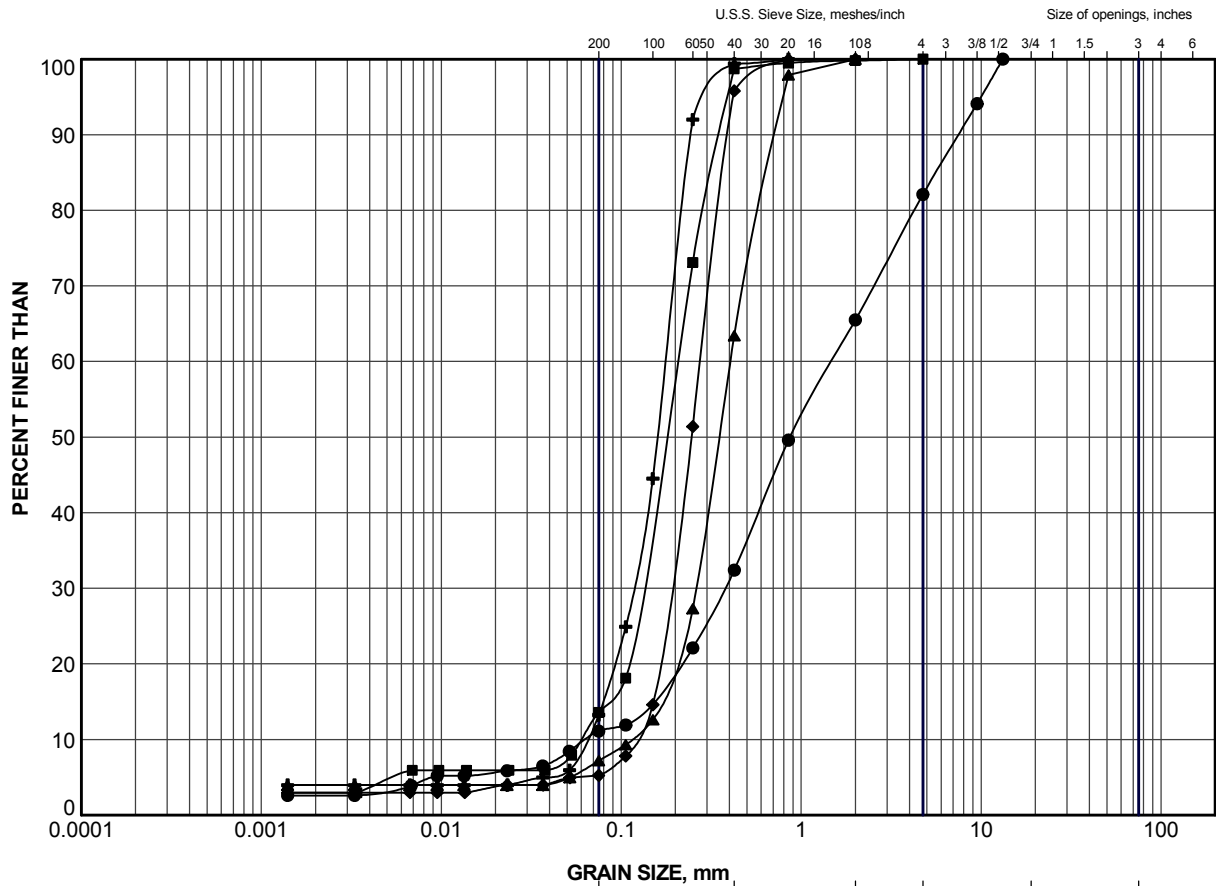
GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	89	3	326.4
■	907	3	327.1

PROJECT				PROPOSED NOISE BARRIER WALL 7 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION FILL			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-F11L0A1	
DRAWN		WDF/AMG		FEB. 11/11		SCALE N/A REV.	
CHECK						FIGURE A-1	





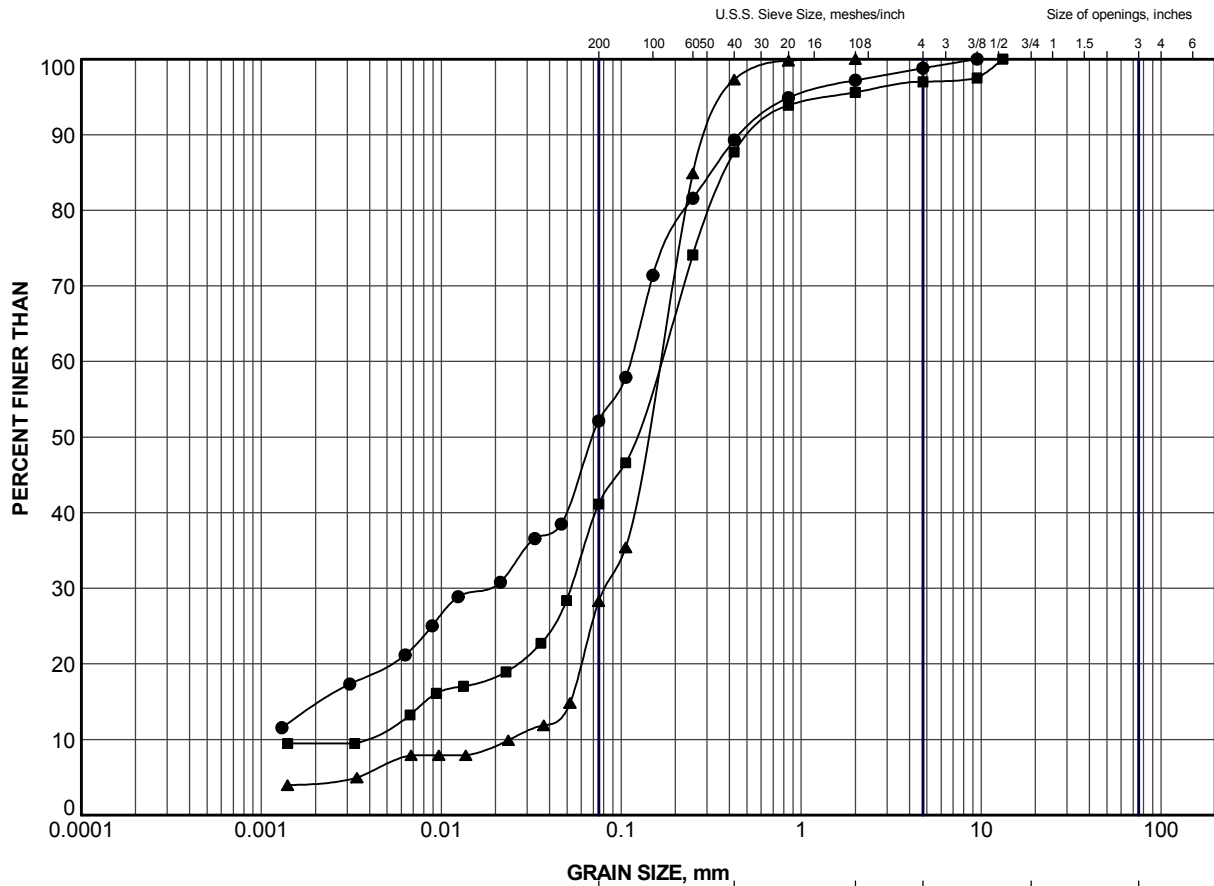
CLAY AND SILT		GRAVEL SIZE, mm					Cobble Size
		fine	medium	coarse	fine	coarse	
		SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	102	7	325.5
■	104	9	318.1
▲	905	3	328.1
+	906	5	326.2
◆	907	10	321.8

PROJECT				PROPOSED NOISE BARRIER WALL 7 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION SAND			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-F11L0A2	
DRAWN		WDF/AMG		FEB. 11/11		SCALE N/A REV.	
CHECK						FIGURE A-2	





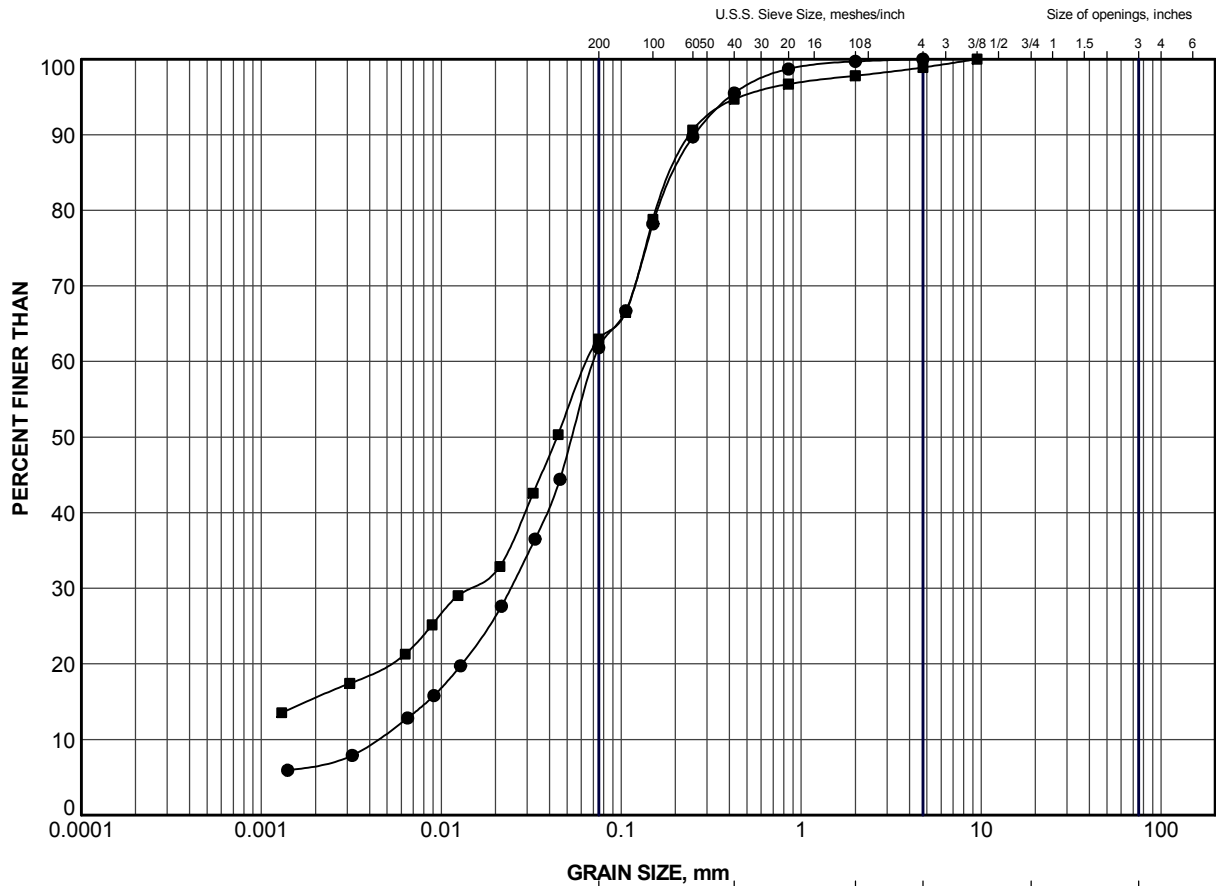
CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	88	3	328.6
■	102	3	328.5
▲	104	4	322.7

PROJECT				PROPOSED NOISE BARRIER WALL 7 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION SILTY SAND			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-F11L0A3	
DRAWN		WDF/AMG		SCALE		N/A	
CHECK				REV.			
		FEB. 11/11		FIGURE A-3			

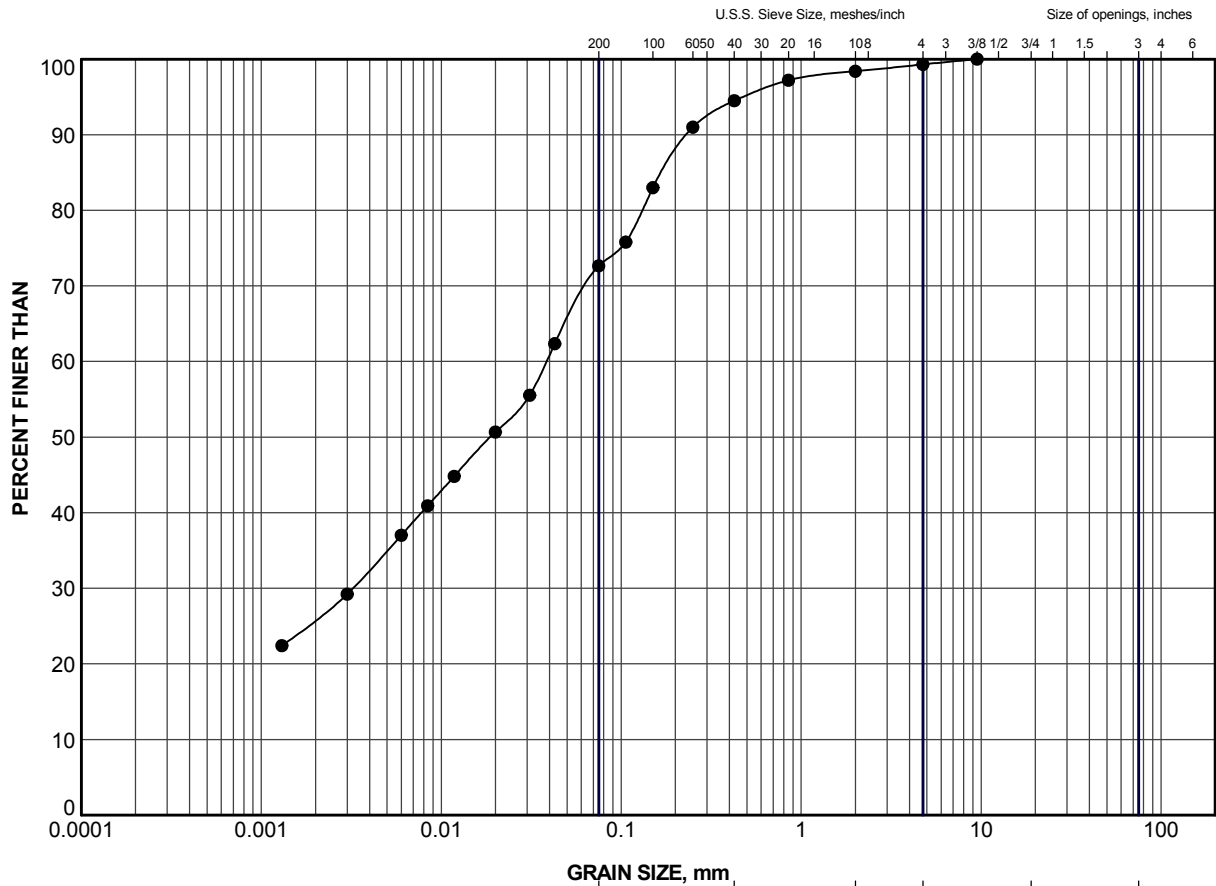




LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	88	6	326.3
■	90	6	322.3

PROJECT		PROPOSED NOISE BARRIER WALL 7 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE		GRAIN SIZE DISTRIBUTION SANDY SILT			
PROJECT No.		08-1132-084-1		FILE No. 0811320841-F11L0A4	
DRAWN		WDF/AMG		FEB. 11/11	
CHECK					
Golder Associates LONDON, ONTARIO		SCALE		N/A REV.	
				FIGURE A-4	

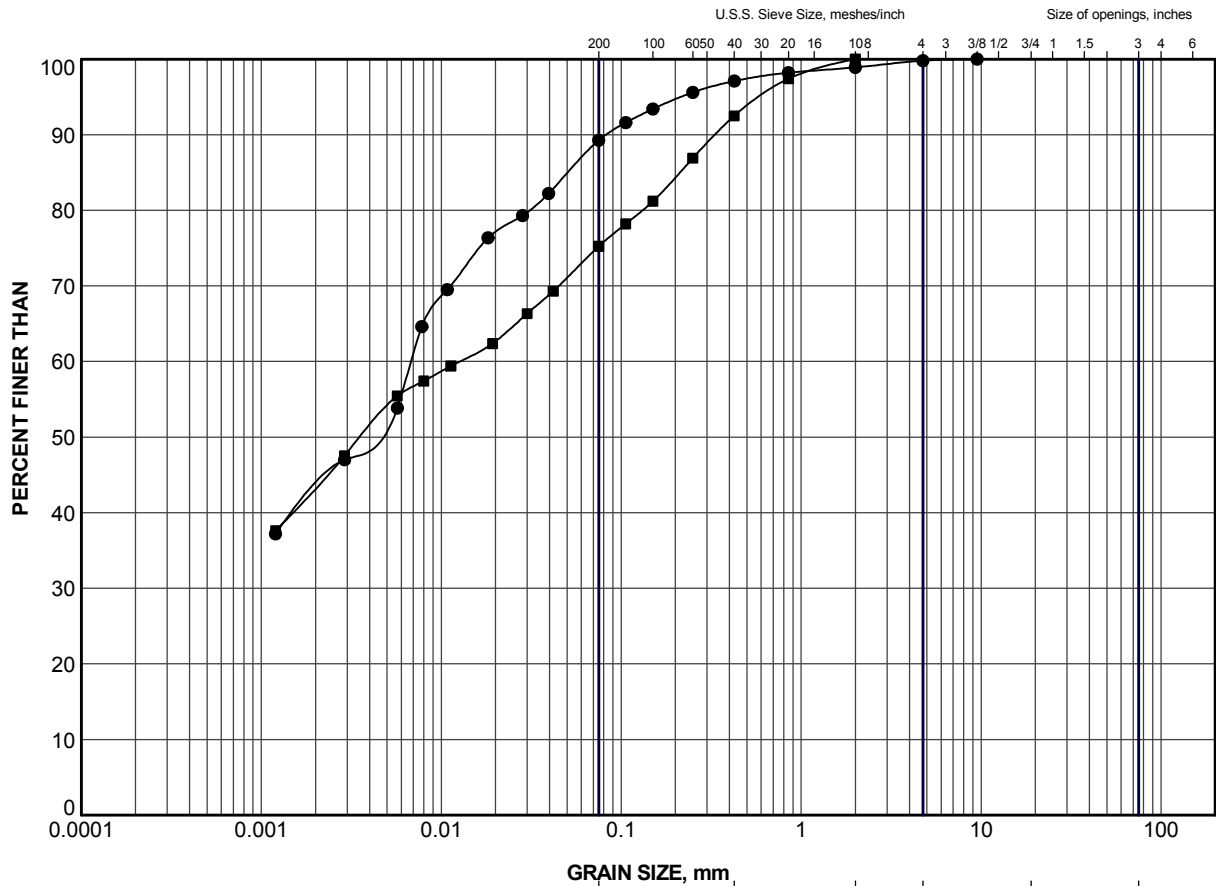


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	90	3	324.7


PROJECT				PROPOSED NOISE BARRIER WALL 7 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-F11L0A5	
DRAWN		WDF/AMG		SCALE		N/A	
CHECK				REV.			
		FEB. 11/11		FIGURE A-5			



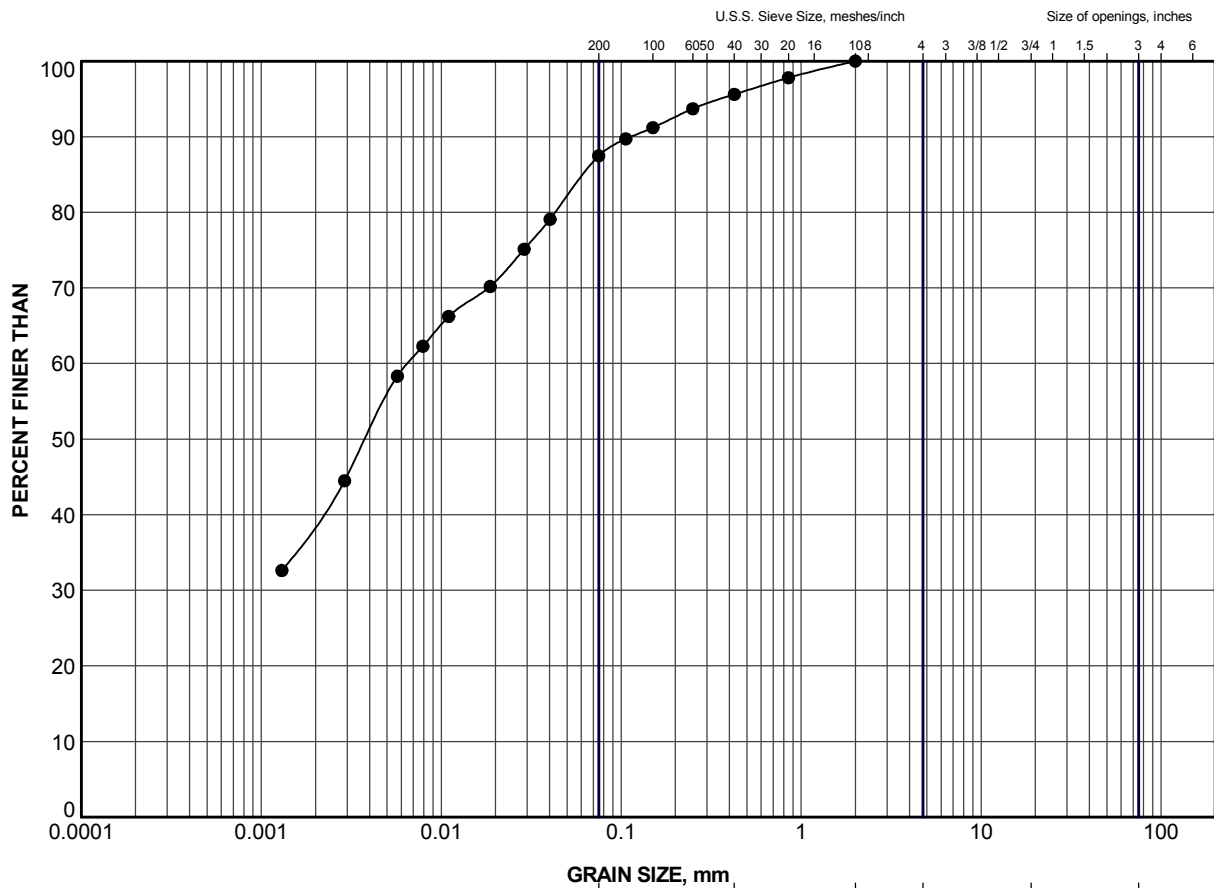


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	905	8	324.3
■	906	10	322.4

PROJECT				PROPOSED NOISE BARRIER WALL 7 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION CLAYEY SILT			
 Golder Associates LONDON, ONTARIO		PROJECT No. 08-1132-084-1		FILE No. 0811320841-F11L0A6			
		DRAWN WDF/AMG	FEB. 11/11	SCALE N/A	REV.		
		CHECK					
FIGURE A-6							


LDN_MTO_NEW_GLDR_LDN.GDT

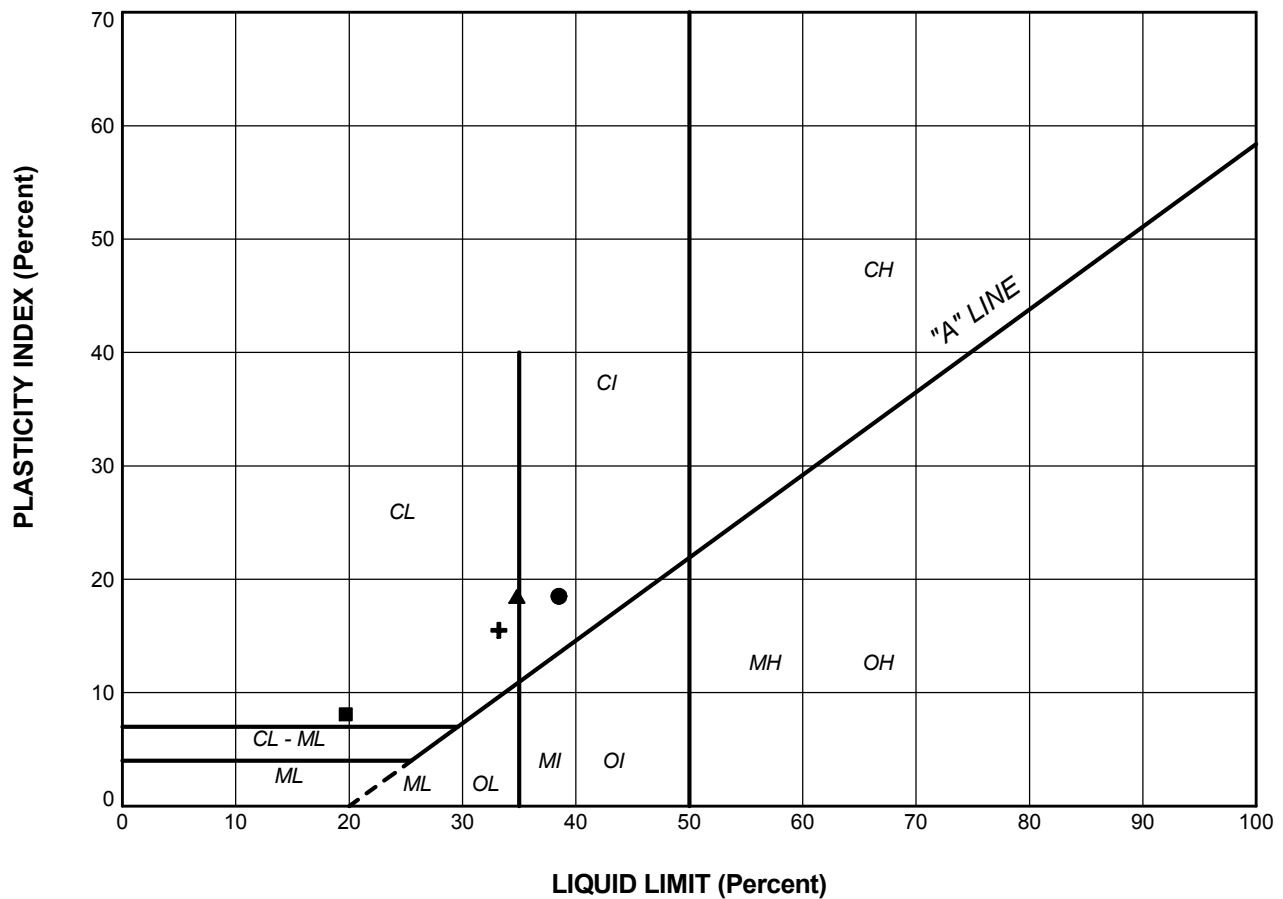


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	907	5	325.6

PROJECT				PROPOSED NOISE BARRIER WALL 7 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION SILTY CLAY			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-F11L0A7	
DRAWN		WDF/AMG		SCALE		N/A	
CHECK				REV.			
		FEB. 11/11					
 Golder Associates LONDON, ONTARIO				FIGURE A-7			



LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
CLAYEY SILT TILL					
■	90	3	19.7	11.6	8.1
CLAYEY SILT					
▲	905	8	34.8	16.3	18.5
+	906	10	33.2	17.7	15.5
SILTY CLAY					
●	907	5	38.5	20.0	18.5

PROJECT				PROPOSED NOISE BARRIER WALL 7 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				PLASTICITY CHART			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-F11L0A8	
DRAWN	WDF/AMG	FEB. 11/11		SCALE	N/A	REV.	
CHECK				FIGURE A-8			



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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