February 2011

FOUNDATION INVESTIGATION AND DESIGN REPORT

Relocation of Existing Noise Barrier Wall 1
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

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REPORT

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Geocres No. 40P7-57

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(Geocres No. 40P8-185)

PART A

FOUNDATION INVESTIGATION REPORT

RELOCATION OF EXISTING NOISE BARRIER WALL 1
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, within the project limits. This report presents the results of the foundation investigation conducted for the relocation of existing noise barrier wall 1 which is located immediately east of the Fischer-Hallman Road Interchange from Station 13+114 to 13+486 Lt along Highway 7/8. The relocated noise barrier wall is to be mounted on the shoulder of the highway.

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, 2010, 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 locations 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 and the wall location is shown on the Noise Barrier 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, as well as an overhead structure for CNR tracks, are situated within the project limits.

Land use adjacent to this site is typically urban residential north of Highway 7/8 with predominantly industrial, commercial and residential areas to the south.

Existing noise barrier wall barrier 1 will be relocated between Station 13+114 and 13+486 Lt along Highway 7/8. The topography along the noise barrier wall is described as hummocky with ground surface elevations ranging between 342 and 344 metres.

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 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 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 site is dolomite and mudstone of the Salina formation of Upper Silurian age. Based on the Ministry of Natural Resources Map P.168 entitled “Bedrock Topography Series, Stratford, Southern Ontario”, the bedrock surface along the proposed noise barrier wall alignment subcrops at about elevations 259 to 265 metres or some 80 to 85 metres below ground surface.

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

3.0 INVESTIGATION PROCEDURES

The foundation investigation fieldwork for the design of the relocation of existing noise barrier wall barrier 1 was carried out on May 6, 7 and 11, 2010 during which time five boreholes were drilled along Highway 7/8 in the vicinity of the existing noise barrier wall 1. The borehole locations are shown on the Borehole Location Plan, Drawing 1.

All of the boreholes (25 to 29) were advanced to a depth of 5.0 metres. This information was supplemented at the existing noise barrier wall location with the following boreholes which were advanced for other components of this project:

- Boreholes 801 and 813 (Geocres No. 40P7-63) were advanced to depths of 25.9 and 3.7 metres, respectively. Borehole 801 was drilled on October 6, 2008 and Borehole 813 was drilled on June 24, 210.
- Borehole 921 (Geocres No.40P8-185) was drilled on May 7, 2010 and advanced to a depth of 6.6 metres.

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)
25	4 809 335	222 687	342.67	5.03
26	4 809 369	222 747	342.58	5.03
27	4 809 428	222 874	343.39	5.03
28	4 809 455	222 923	342.74	5.03
29	4 809 482	222 986	344.24	5.03
801 (40P7-63)	4 809 316	222 655	343.15	25.91
813 (40P7-63)	4 809 323	222 651	344.90	3.68
921 (40P8-185)	4 809 404	222 820	342.93	6.55

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.

The groundwater conditions were observed throughout the drilling operations and upon completion of drilling. No groundwater monitoring devices were installed in any of boreholes 25 to 29. However, a standpipe and a

piezometer were installed in borehole 801 (40P7-63). A summary of the groundwater level observations for all boreholes are presented in Table 1. The boreholes were backfilled in accordance with current Ontario Ministry of Transportation (MTO) procedures and Ontario Regulation 372/07.

The fieldwork 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 Record of Borehole sheets for boreholes 801, 813 (40P7-63) and 921 (40P8-185) are presented in Appendix B.

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 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 variable ground conditions, ranging from surficial topsoil and / or variable layers of fill underlain by sandy silt, silty clay, clayey silt till, silty sand, sand and silt.

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

Topsoil was encountered at the ground surface in all boreholes. The thickness of the topsoil ranged from 120 to 210 millimetres. A layer of buried topsoil was also encountered underlying the granular fill in borehole 27 at elevation 341.9 metres. Borehole 813 (40P7-63) was terminated in a topsoil fill layer which was encountered at elevation 342.1 metres. It should also be noted that traces of topsoil were observed in the granular fill at elevation 341.3, 342.4, and 342.8 metres in boreholes 25, 26 and 921 (40P8-185), respectively and in the cohesive fill from elevation 344.2 metres in borehole 813.

The topsoil layer underlying the granular fill in borehole 27 had a standard penetration test N value of 5 blows per 0.3 metres indicating a loose condition. The compact to very dense topsoil fill layer in borehole 813 had N values of 20 and over 100 blows per 0.3 metres with water contents of 4 to 17 per cent.

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

Fill materials were encountered underlying topsoil in boreholes 25 through 27,801 (40P7-63), 813 (40P7-63) and 921 (40P8-185) from elevations 341.6 to 343.3 metres. The fill is generally granular in nature, comprising sand

and gravel, silty sand, sandy silt and silt. The silty sand and gravel layer at elevation 343.0 metres in borehole 801 contained cobbles.

In borehole 25, a 0.9 metre thick layer of cohesive fill was found in between the topsoil and the granular fill at elevation 342.5 metres. Layers of clayey silt fill were encountered at elevations 344.23 and 342.8 metres in borehole 813. The cohesive fill layers in borehole 813 were 0.6 and 0.8 metres thick. The thickness of the granular fill ranged from 1.4 to 3.3 metres.

The granular fill had N values of 3 to 46 blows per 0.3 metres indicating a very loose to dense relative density. Water contents of 4 to 23 per cent were measured for granular fill samples.

N values of 46 blows per 0.3 metres were obtained for the clayey silt fill encountered in boreholes 25 and 813 (40P7-63) indicating a stiff to hard consistency. The measured water contents for the clayey silt fill samples ranged from 10 to 13 per cent. The cohesive fill is of low plasticity based on a plastic limit of 11 per cent, a liquid limit of 19 per cent and a plasticity index of 8 per cent. The results of the Atterberg Limits testing are shown on Figure A-8.

The results of the grain size analyses conducted on four fill samples recovered from the standard penetrating testing are presented on Figure A-1 in Appendix A.

The original general arrangement drawing and soil strata drawings for the Fischer-Hallman Underpass Structure (Geocres No. 40P07-23) indicated that the original ground in the vicinity of the north foreslope varied between elevations 340 and 343 metres. The original channel of Sandrock Creek flowed across the north foreslope from just inside the west edge of Pier A to approximately mid-way between the east end of the north pier (Pier A) and the east edge of the north abutment at the approximate location shown in Drawing 1. Additional deposits of fill associated with the creek realignment should be expected.

4.1.3 Sandy Silt

With the exception of borehole 25, layers of sandy silt were found in all boreholes which penetrated native materials, from elevations 335.23 to 344.1 metres. The sandy silt was found underlying granular fill in borehole 26, underlying topsoil in boreholes 27 and 29 and at depth underlying silty clay in borehole 28 and silt in borehole 801 (40P7-63). In borehole 801 and 921, the sandy silt is interlayered with clayey silt. The thickness of the sandy silt layers ranged from 0.3 to 1.7 metres.

The very loose to very dense sandy silt layers had N values ranging from 1 to 53 blows per 0.3 metres. Water contents of 11 to 18 per cent were measured on sandy silt samples.

The results of grain size analyses conducted on three sandy silt samples obtained during the standard penetration testing are presented on Figure A-2.

4.1.4 Silty Clay

Stiff to very stiff silty clay was encountered in boreholes 27 and 28 at elevations 340.5 and 342.6 metres, respectively. The silty clay was found between granular layers of silty sand and sand in borehole 27. In borehole 28, the silty clay was found beneath the topsoil. It should be noted that silt seams were observed within the silty clay stratum in borehole 27. The thicknesses of the silty clay layers were 1.5 and 3.5 metres in boreholes 27 and 28, respectively.

The N values in the silty clay ranged from 16 to 21 blows per 0.3 metres. Water contents of 13 to 19 per cent were measured on silty clay samples. The silty clay is of intermediate plasticity, based on two Atterberg limits determinations, with an average plastic limit of 18 per cent, liquid limits of 37 and 42 per cent and plasticity indices of 19 to 24 per cent. The results of the two Atterberg limits tests are presented on Figure A-8.

The grain size distribution curves for two silty clay samples obtained during standard penetration testing are shown on Figure A-3. It should be noted that there was insufficient recovery of sample 4 during standard penetrating testing in borehole 27 at elevation 340.1 metres to undertake a grain size distribution analysis, therefore, only water content and Atterberg limits determinations were carried out. Supplementary water content and grain size distribution analysis were carried out on sample 5 obtained at elevation 339.4 metres to further characterize the silty clay.

4.1.5 Clayey Silt Till

Clayey silt till was encountered beneath the fill in borehole 25 from elevation 339.8 metres and below the upper silt layer in borehole 801 (40P7-63) from elevation 339.0 metres. Borehole 25 was terminated in the clayey silt till after exploring the stratum for 2.1 metres. .

The stiff to hard clayey silt till had N values of 12 to 48 blows per 0.3 metres. The water content of the two clayey silt samples tested averaged 15 per cent. The results of two Atterberg limits determinations indicated that the clayey silt till is of low plasticity. The two samples tested had plasticity limits of 12 and 15 per cent, liquid limits of 21 and 24 per cent and plasticity indices of 9 and 10 per cent. The Atterberg limits results for the clayey silt till are shown on Figure A-8.

The results of the grain size testing conducted on two clayey silt till samples recovered from the standard penetration testing is presented on Figure A-4. 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

4.1.6 Clayey Silt

Layers of clayey silt interlayered with sandy silt were encountered in borehole 921 (40P8-185) at elevations 337.0 and 338.5 metres. The thickness of the upper clayey silt layer was 0.8 metres. Borehole 921 (40P8-185)

was terminated in the lower layer of clayey silt after exploring the layer for 0.6 metres. The clayey silt had N values of 11 blows per 0.3 metres indicating a stiff consistency.

4.1.7 Silty Sand

Deposits of compact silty sand were encountered in boreholes 26 and 27 at elevations 338.2 and 341.3 metres, respectively. The silty sand was found underlying sandy silt in borehole 26 and between sandy silt and silty clay in borehole 27. The silty sand was 0.8 metres thick in borehole 27. Borehole 26 was terminated in the silty sand after exploring the stratum for 0.6 metres. The silty sand had N values of 14 and 27 blows per 0.3 metres with a water content of 11 per cent.

Layers of dense to very dense silty sand were found at depth in boreholes 801 (40P7-63) from elevation 333.9 metres and elevation 320.4 metres. These lower silty sand layers were 0.6 and 2.9 metres thick. N values in the lower silty sand ranged from 48 to 106 blows per 0.3 metres. Water contents of 18 and 20 per cent were measured in samples of the silty sand.

The results of the grain size analysis conducted on two samples of silty sand recovered from the standard penetration testing are presented on Figure A-5.

4.1.8 Sand

Generally compact layers of upper sand were encountered in boreholes 27 and 29 at elevations 339.0 and 342.4 metres. A layer of silt was found between the upper sand layers in borehole 29 at elevation 340.1 metres. The thickness of the sand layer in borehole 29 (uppermost layer) was 2.3 metres. Boreholes 27 and 29 were terminated in the sand after exploring the stratum for 0.6 metres. N values in the sand layers ranged from 12 to 40 blows per 0.3 metres and a water content of 2 per cent was measured in a sample of the upper sand.

Lower layers of sand were found at depth in borehole 801 (40P7-63) from elevations 323.0 and 319.8 metres. Borehole 801 (40P7-63) was terminated in the lower sand after exploring some 3.6 metres. The lower sand was very dense with N values greater than 100 blows per 0.3 metres. The lower sand had a water content of 20 per cent.

The grain size distribution curves for two samples of sand recovered from the standard penetration testing are presented on Figure A-6.

4.1.9 Silt

Silt was encountered between the sand in borehole 29 at elevation 340.1 metres, below the fill in borehole 801 (40P7-63) at elevation 339.6 metres and below the clayey silt till in borehole 801 (40P7-63) from elevation 336.4

metres. The silt layers were 0.3 to 1.2 metres thick. The silt layers were compact to dense based on N values of 27 to 46 blows per 0.3 metres. The silt had a water content of 14 per cent.

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 Table 1.

Table 1: Summary of Encountered Groundwater Levels

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
25	342.67	Dry	Below 337.6
26	342.58	4.4	338.2
27	343.39	Dry	Below 338.4
28	342.74	Dry	Below 337.7
29	344.24	Dry	Below 339.2
801 (40P7-63)	343.15	9.3 16.9	333.9 326.2
813 (40P7-63)	344.90	Dry	Below 341.2
921 (40P8-185)	342.93	5.8	337.1

During the fieldwork period, groundwater was encountered at depth at elevation 326.2 metres in borehole 801 and between elevations 333.9 and 338.2 in boreholes 801 (40P7-63), 26 and 921 (40P8-185). The remaining boreholes were found to be dry during and upon completion of drilling. One 12.5 millimetre diameter, slotted section, groundwater monitoring standpipe and a piezometer were installed in borehole 801. The post field work groundwater monitoring results for borehole 801 are summarized in the following table.

Borehole	Ground Surface Elevation (m)	Installation	Measured Groundwater Elevation (m)			
			October 6, 2008	August 25, 2009	June 30, 2010	October 13, 2010
801 (40P7-63)	343.15	Standpipe	342.26	338.04	338.20	338.12
		Piezometer	333.60	334.06	334.07	333.93

The inferred groundwater level at this site varies as follows:

- Station 13+114 to 13+260 - 338 metres
- Station 13+260 to 13+330 - 337 metres
- Station 13+330 to 13+480 - Below 338 metres

The inferred groundwater levels are based on groundwater levels encountered and the colour change in the soil samples from brown to grey.

The above-noted groundwater levels are not necessarily 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. 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, 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

RELOCATION OF EXISTING NOISE BARRIER WALL 1
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 foundation design parameters and recommendations for the design of the proposed relocation of existing noise barrier wall 1 along the north side of Highway 7/8 between Stations 13+114 Lt and 13+486 Lt. This noise barrier wall is to be shoulder mounted. The currently proposed design includes a combined retaining and noise barrier wall across the north foreslope of the Fischer-Hallman Underpass. The outer facing of the retaining portion of the wall will serve as a traffic barrier. The noise wall and traffic barrier facing/soil retention system is to be designed by a contractor. The foreslope is being modified to accommodate the widening of Highway 7/8 and the realignment of the E-N/S Ramp within the Fischer-Hallman Underpass Interchange. Further details regarding the geotechnical aspects of the modification of the north foreslope can be found in Geocres Report No. 40P7-63.

The design parameters and recommendations have been developed based on interpretation of the factual data obtained from the boreholes advanced at the site. The interpretations 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 foundations should be designed and constructed in accordance with MTO's SP599F01. It is recommended that the noise barrier wall be supported using 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 alignment. The stratigraphy presented in Table I has been simplified for the purposes of the noise barrier wall foundation design.

Where both an undrained shear strength, c_u, and effective friction angle, ϕ', have been given for a specific stratum, the caisson design should be checked for both the drained and the 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 27 near Station 13+359 Lt, and the topsoil/topsoil fill layers found in borehole 813 (40P7-63) near Station 13+115 Lt, should be neglected in the design. The passive resistance in the upper 1.4 metres below

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 of 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 slope of the widened embankment, behind the proposed noise barrier wall, will be 3 horizontal to 1 vertical between Stations 13+141 and 13+455 Lt. 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 embankment or slope; below this elevation, the full K_p is to be applied.

It may be necessary to use deeper caissons in the vicinity of Station 13+300 Lt as borehole 921 (40P8-185) encountered loose granular fill to a depth of 3.2 metres in this area.

The noise barrier wall will be combined with a retaining wall across the toe of the modified north foreslope of the Fischer-Hallman Road. The combined retaining/noise barrier wall will be constructed between Stations 13+114 and 13+154 Lt. The retaining portion of the combined wall will be up to 0.85 metres high and may require the use of deeper caisson foundations.

6.2.1 Lateral Earth Pressures

The lateral pressures acting on the retaining portion of the wall will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the freedom of lateral movement of the structure and on the drainage conditions behind the walls. The following recommendations are made concerning the design of the retaining wall, in accordance with the CHBDC:

- Select, free-draining granular fill meeting the specifications of Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B but with less than 5 per cent passing the 75 micron sieve should be used as backfill behind the walls. This fill should be compacted in loose lifts not greater than 200 millimetres in thickness in accordance with SP105S10. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill.

- The earth pressures from the embankment fill materials and the following parameters (unfactored) may be used:

  Soil unit weight: 20 kN/m³

  Coefficients of lateral earth pressure (backfill at 2H:1V):

  Active, K_a 0.54

  At rest, K_o 0.72

6.3 Construction Considerations

Excavations for construction of the caissons for the noise barrier wall foundations will penetrate the pavement in the shoulder area or topsoil and surficial fill and will extend though deposits of clayey silt till, sandy silt, silty sand, silty clay, sand, silt and clayey silt. The presence of cobbles and/or boulders should be anticipated in the clayey silt till. The sands are predominantly fine grained and uniform in composition. The sands, silts, clayey silt and silty clay at this site are susceptible to disturbance during caisson excavation and construction.

Excavation of granular materials below the groundwater level will be required in the vicinity of Station 13+219. With proactive dewatering, 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 caisson 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 (augering with the hole filled with bentonite slurry) and placement of the concrete by tremie. Surface water runoff 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 the augered excavation and measures to deal with excavation of saturated granular soils below groundwater level. In addition, the NSSP should state that the Contractor's method and equipment should be capable of handling cobbles and/or boulders which were noted in granular fill in borehole 801 and are expected in the clayey silt till. The NSSP should include a note to the designer that near Station 13+300 Lt, use of deeper caissons may be warranted due to the presence of deep loose fills.

The caissons should be constructed and inspected in accordance with Ontario Provincial Standard Specification 903 and SP59F01. Following construction, the Quality Verification Engineer shall submit a Certification 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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Fintan J. Heffernan, P.Eng.
MTO Designated Contact

MSWL/DUP/PRB/FJH/cr/ly

n:\active\2008\1132 - geotechnical\1132-000-0\08-1132-084-1 dillon - gwp 131-98-00 fdns - hwy 7-8\reports\0811320841-r11 - noise walls\r11d - existing noise wall 1\0811320841-r11d feb 22 11 - (final) parts a&b existing nw 1.docx

TABLE I

FOUNDATION DESIGN PARAMETERS
RELOCATION OF NOISE BARRIER WALL 1

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 / 3H:1V Slope	Coefficient of Active Pressure, K_a Level Ground	Unit Weight[3] (kNm^{-3})	
								Bulk γ	Effective, γ'
13+114 to 13+135 Boreholes 801 & 813 (40P7-63)	Compact granular fill	343.5 to 342.5	338.0	-	30	3.0	0.33	18.5	8.5
	Stiff to very stiff cohesive fill	342.5 to 342.0		100	29	2.9	0.35	19.0	9.0
	Topsoil fill and topsoil	342.0 to 341.0		-	-	-	-	18.0	8.0
	Compact granular fill	341.0 to 339.5		-	29	2.9	0.35	18.5	8.5
	Dense silt	339.5 to 339.0		-	31	3.1	0.32	19.0	9.0
	Hard clayey silt till	Below 339.0		260	32	3.3	0.31	21.0	11.0
13+135 to 13+185 Borehole 25	Loose to compact granular fill	Above 340	338	-	28	2.8 / 1.5	0.36	18.5	8.5
	Stiff to very stiff clayey silt till	Below 340		100	30	3.0 / 1.6	0.33	21.0	11.0
13+185 to 13+260 Borehole 26	Loose to compact granular fill	Above 340	338	-	28	2.8 / 1.5	0.36	18.5	8.5
	Compact sandy silt to silty sand	Below 340		-	30	3.0 / 1.6	0.33	19.0	9.0
13+260 to 13+330 Borehole 921 (40P8-185)	Loose granular fill	342 to 340	337	-	27	2.7 / 1.5	0.37	18.5	8.5
	Loose sandy silt	340 to 339		-	28	2.8 / 1.5	0.36	18.5	8.5
	Stiff clayey silt	339 to 338		70	29	2.9 / 1.6	0.35	19.0	9.0
	Compact sandy silt	338 to 337		-	29	2.9 / 1.6	0.35	19.0	9.0
	Stiff clayey silt	Below 337		70	29	2.9 / 1.6	0.35	19.0	9.0

FOUNDATION DESIGN PARAMETERS
RELOCATION OF NOISE BARRIER WALL 1

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 / 3H:1V Slope	Coefficient of Active Pressure, K_a Level Ground	Unit Weight[3] (kNm^{-3})	
								Bulk γ	Effective, γ'
13+330 to 13+390 Borehole 27	Loose to compact sandy silt and silty sand	341.5 to 340.5	Below 338	-	29	2.9 / 1.6	0.35	18.5	8.5
	Very stiff silty clay	340 to 339		125	28	2.8 / 1.5	0.36	19.0	9.0
	Compact sand	Below 339		-	31	3.1 / 1.7	0.32	20.0	10.0
13+390 to 13+450 Borehole 28	Very stiff silty clay	Above 339	Below 338	125	28	2.8 / 1.5	0.36	19.0	9.0
	Compact sandy silt	Below 339		-	29	2.9 / 1.6	0.35	19.0	9.0
13+450 to 13+486 Borehole 29	Compact sandy silt	Above 342	Below 339	-	30	3.0 / 1.6	0.33	20.0	10.0
	Compact Sand	Below 342			31	3.1 / 1.7	0.32	20.0	10.0

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. Between approximately Stations 13+141 and 13+455, the embankment slope behind the proposed noise barrier wall will slope downwards at 3 horizontal to 1 vertical.
3. Below the groundwater level, the effective unit weight of the soil (γ') should be used.
4. This table is to be read in conjunction with the accompanying report.

Prepared By: DB
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 25

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
LOCATION N 4809335.1 ;E 222686.6
ORIGINATED BY MR
DIST HWY 7/8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
COMPILED BY WDF
DATUM GEODETIC
DATE May 11, 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
342.67	GROUND SURFACE										
0.00	TOPSOIL, silty										
0.18	Dark grey										
	FILL, clayey silt, trace sand, trace gravel Hard						342				
341.60	Brown		1	SS	46				○		
1.07	FILL, sand and gravel Dense										
1.37	Brown										
	FILL, sandy silt, some clay, trace gravel, trace topsoil Loose to compact Brown		2	SS	12		341		○		
			3	SS	9				○		
339.77							340				
2.90	CLAYEY SILT TILL, some sand Stiff to very stiff Brown to grey at about elev. 338.3m		4	SS	16				⊢●⊣		0 13 65 22
			5	SS	19		339				
			6	SS	12		338				
337.64											
5.03	END OF BOREHOLE Borehole dry during drilling on May 11, 2010.										

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 16/02/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 26

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
LOCATION N 4809368.7 ;E 222746.9
ORIGINATED BY MR
DIST HWY 7/8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
COMPILED BY WDF
DATUM GEODETIC
DATE May 11, 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
342.58	GROUND SURFACE										
0.00	TOPSOIL, silty										
0.21	Dark brown FILL, sandy silt, some clay, trace topsoil, trace gravel Loose to compact Brown		1	SS	13		342		○		5 26 49 20
			2	SS	10		341		○		
339.68			3	SS	6		340		○		
2.90	SANDY SILT, trace clay, trace gravel Compact Brown		4	SS	13				○		3 28 60 9
			5	SS	14		339				
338.16						▽					
4.42	SILTY SAND, some gravel Compact Brown		6	SS	27		338				
337.55											
5.03	END OF BOREHOLE Groundwater encountered at about elev. 338.2m during drilling on May 11, 2010.										

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

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 16/02/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 27

1 OF 1

METRIC

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

LOCATION N 4809428.0 ;E 222873.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 7, 2010

ORIGINATED BY MR
COMPILED BY WDF
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
343.39	GROUND SURFACE										
0.00 / 0.12	TOPSOIL, silty, Dark grey										
	FILL, silt, some clay, trace sand, Very loose, Brown		1	SS	3		343				
341.87											
1.52 / 341.56	TOPSOIL, silty, Loose		2	SS	5		342				
1.83	Black										
2.13	SANDY SILT, Loose, Brown		3	SS	14		341	○			0 57 38 5
340.49	SILTY SAND, trace clay, Compact, Brown										
2.90	SILTY CLAY, some sand, with silt seams, Very stiff, Brown		4	SS	16		340	○ —			
			5	SS	21			○			0 15 54 31
338.97							339				
4.42	SAND, fine, some silt, Compact, Brown		6	SS	20						
338.36											
5.03	END OF BOREHOLE Borehole dry during drilling on May 7, 2010.										

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 16/02/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 28

1 OF 1

METRIC

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

LOCATION N 4809454.9 ;E 222922.6
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 7, 2010

ORIGINATED BY MR
COMPILED BY WDF
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
342.74	GROUND SURFACE										
0.00	TOPSOIL, clayey										
0.18	Dark brown SILTY CLAY, trace sand, with silt seams Very stiff Brown		1	SS	17		342				
			2	SS	21		341		w_P 18 w_L 42		0 7 48 45
			3	SS	19		340				
339.08			4	SS	16						
3.66	SANDY SILT, trace to some clay Compact Brown		5	SS	11		339		○		0 31 55 14
337.71			6	SS	13		338				
5.03	END OF BOREHOLE Borehole dry during drilling on May 7, 2010.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 29

1 OF 1

METRIC

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

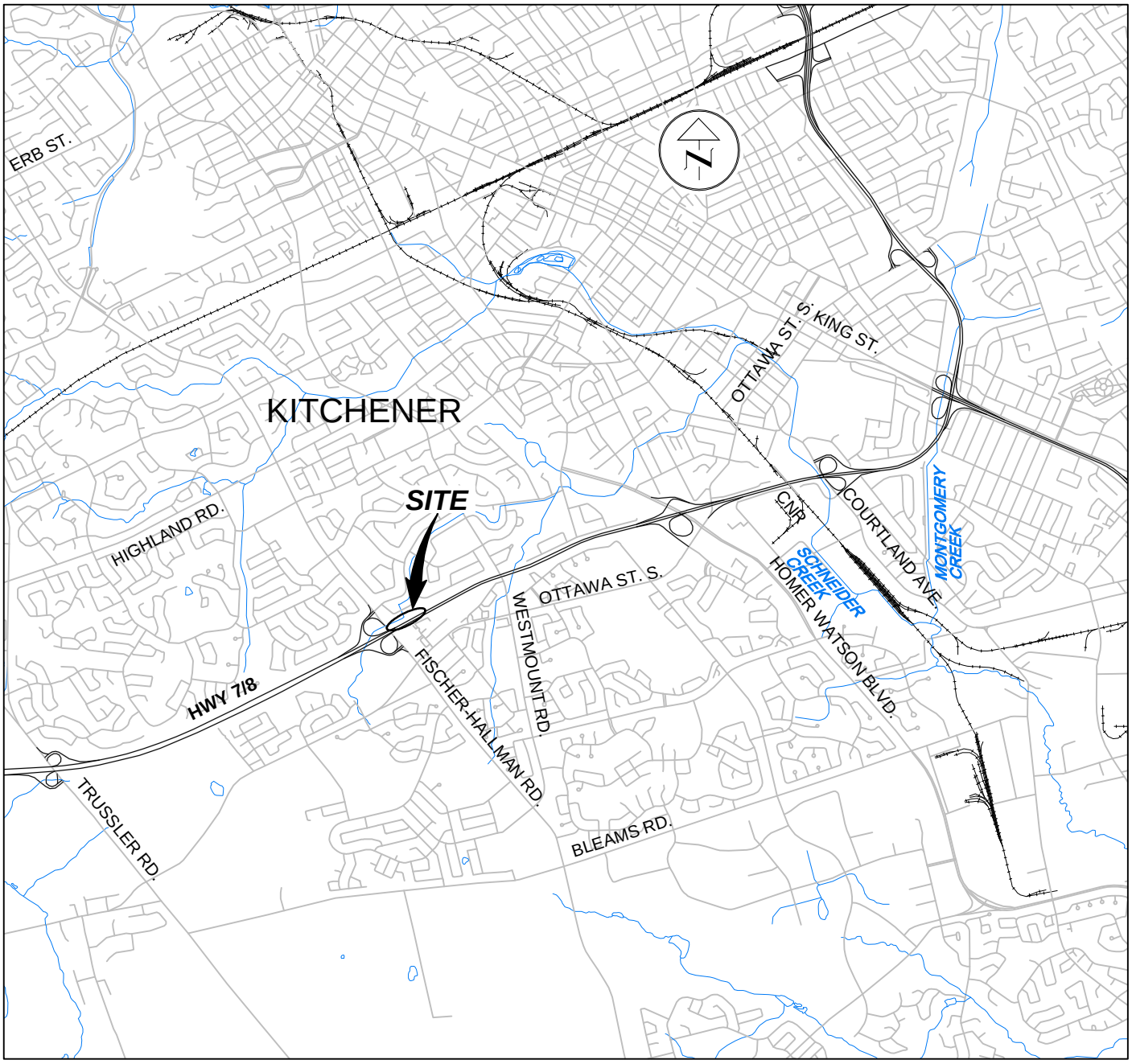
LOCATION N 4809482.4 ;E 222985.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 6, 2010

ORIGINATED BY MR
COMPILED BY WDF
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
344.24	GROUND SURFACE										
0.00	TOPSOIL, silty										
0.18	Dark brown SANDY SILT, trace clay Very loose to compact Brown		1	SS	1		344				
							343				
342.41			2	SS	12						
1.83	SAND, some silt, trace clay Compact Brown		3	SS	25		342		○		0 79 18 3
			4	SS	22		341				
340.13			5	SS	28						
4.11	SILT, some sand						340				
339.82	Compact Brown										
4.42	SAND, some silt, trace clay Dense Brown		6	SS	40						
339.21											
5.03	END OF BOREHOLE Borehole dry during drilling on May 6, 2010.										

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE



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

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

TITLE

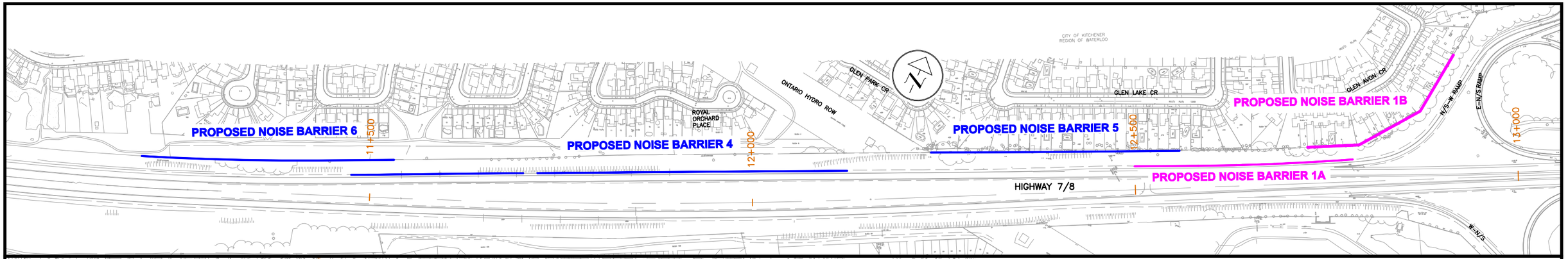
KEY PLAN

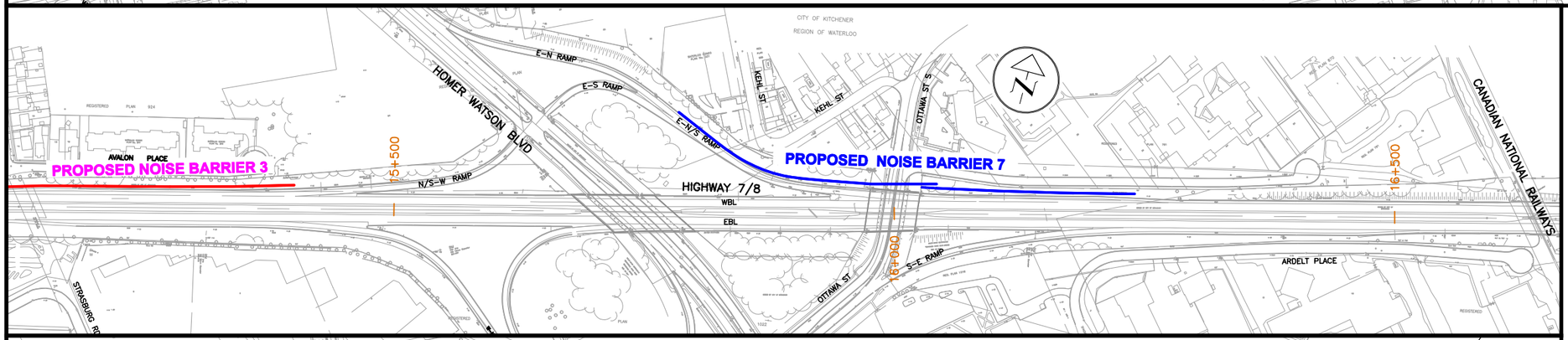
Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1		FILE No.	0811320841-F11D001
			SCALE	AS SHOWN REV.
CADD	WDF	Feb. 16/11		
CHECK				

FIGURE 1

Drawing file: 0811320841-F11D001.DWG Feb 16, 2011 - 3:55pm





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

EXISTING NOISE BARRIER WALL 1
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-F11D002	
			SCALE	AS SHOWN	REV. 0
CADD	WDF	Feb. 16/11			
CHECK					

FIGURE 2

Drawing file: 0811320841-F11D002.dwg Feb 16, 2011 - 4:04pm

MINISTRY OF TRANSPORTATION, ONTARIO

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

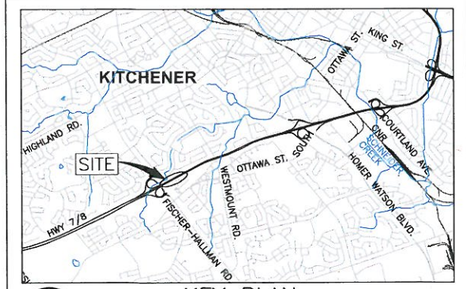
CONT No.
WP No. 131-98-00

SHEET

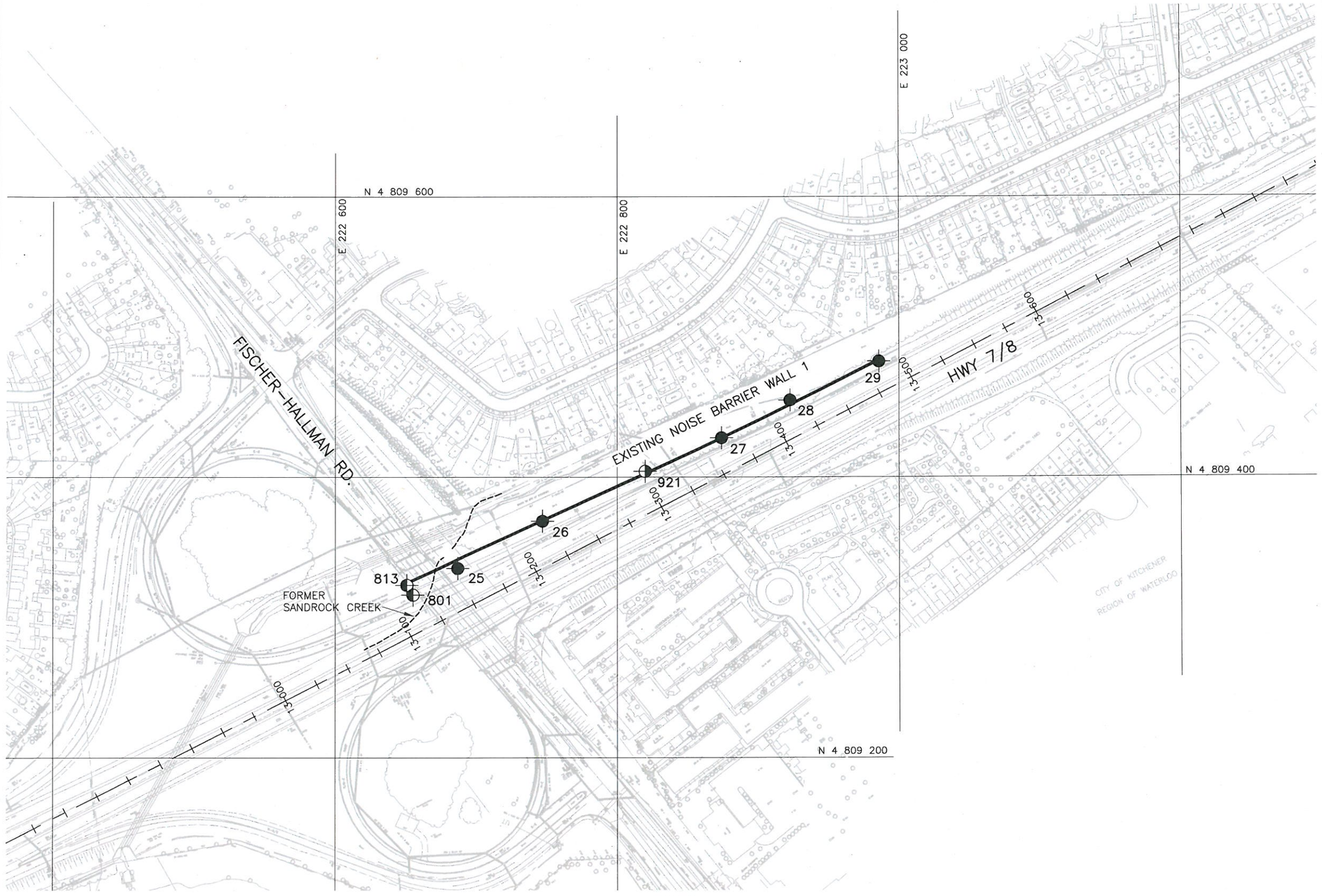
EXISTING NOISE BARRIER WALL 1
WIDENING OF HIGHWAY 7/8
BOREHOLE LOCATIONS

Golder Associates

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN
SCALE IN KILOMETRES 0 1 2



PLAN
SCALE
30 0 30 m

LEGEND

- Borehole – Current Investigation
- Borehole – (Geocres No. 40P7-63)
- Borehole – (Geocres No. 40P8-185)

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10) NORTHING	EASTING
25	342.67	4 809 335.1	222 686.6
26	342.58	4 809 368.7	222 746.9
27	343.39	4 809 428.0	222 873.8
28	342.74	4 809 454.9	222 922.6
29	344.24	4 809 482.4	222 985.8
(Geocres No. 40P7-63)			
801	343.15	4 809 316.0	222 655.0
813	344.90	4 809 323.0	222 650.6
(Geocres No. 40P8-185)			
921	342.93	4 809 404.2	222 819.7

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.

D. U. PROUT — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO — Feb. 23/11

F.J. HEFFERNAN — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO — Feb. 23/11

NO.	DATE	BY	REVISION

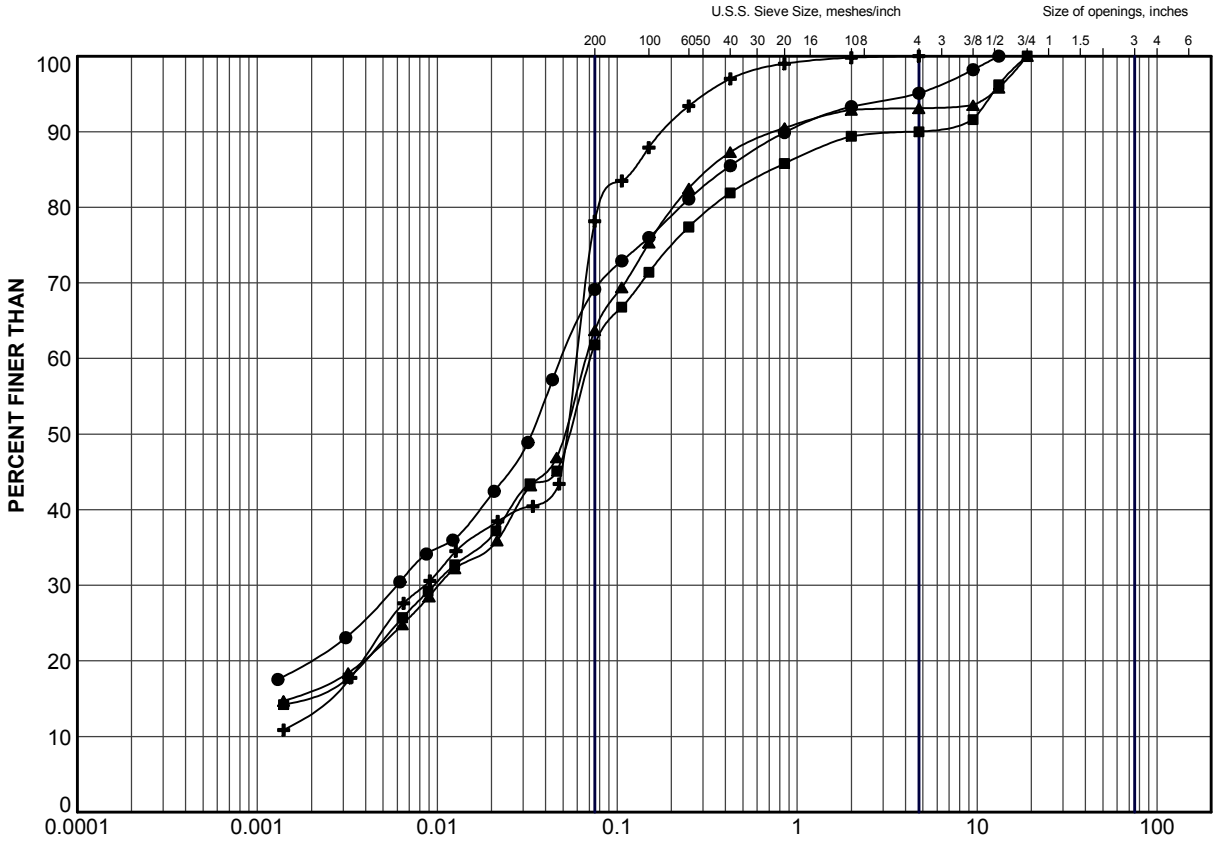
Geocres No. 40P7-57

HWY. 7/8		PROJECT NO. 08-1132-084-1		DIST.
SUBM'D. ML	CHKD.		DATE: Feb. 16/11	SITE:
DRAWN: WDF	CHKD.		APPD.	DWG. 1

PLOT DATE: February 23, 2011
FILENAME: N:\active\2008\1132 - Geotechnical\1132-000-G\08-1132-084-1 DILLON - GWP 131-98-00 FDNS - HWY 7-8\Drafting\AutoCAD files\0811320841-D11D001.dwg

APPENDIX A

Laboratory Test Data



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	26	1	341.6
■	813	2	343.9
▲	813	3	343.3
✚	921	2	341.2

PROJECT

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

TITLE

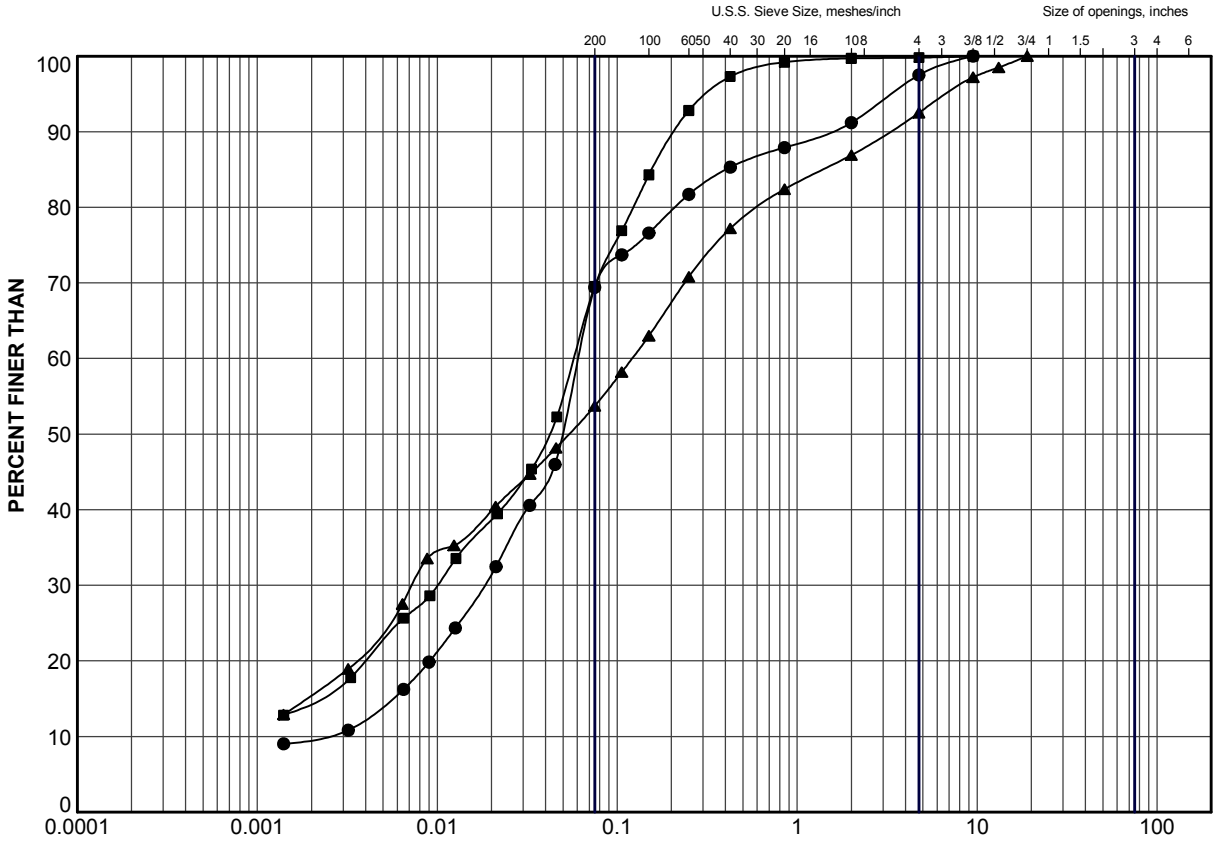
GRAIN SIZE DISTRIBUTION

FILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-F11D0A1
			SCALE	N/A REV.
DRAWN	LMK	Feb. 16/11		
CHECK			**FIGURE**	**A-1**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	26	4	339.3
■	28	5	338.7
▲	921	5	338.9

PROJECT

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

TITLE

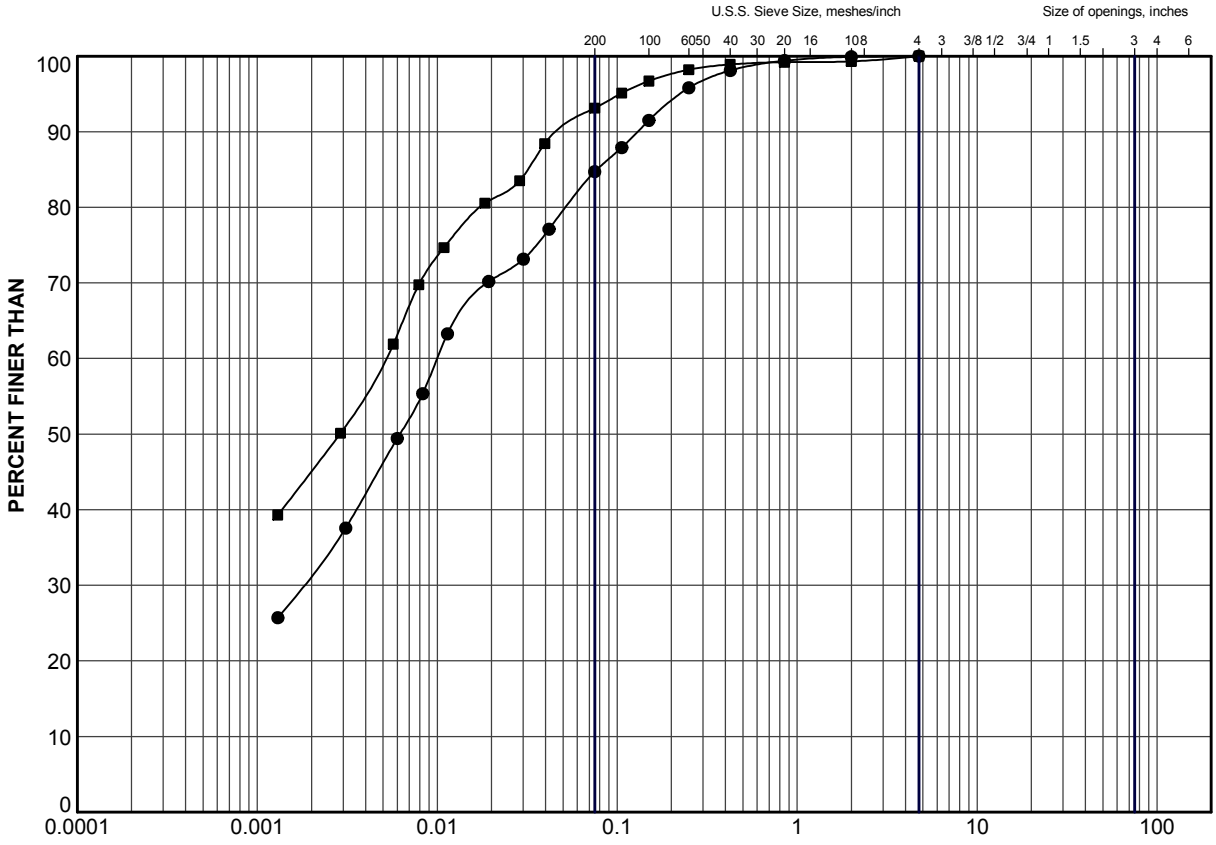
GRAIN SIZE DISTRIBUTION

SANDY SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.			08-1132-084-1	FILE No.	0811320841-F11D0A2
				SCALE	N/A	REV.
DRAWN	LMK	Feb. 16/11			
CHECK				**FIGURE A-2**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	27	5	339.4
■	28	2	341.0

PROJECT

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

TITLE

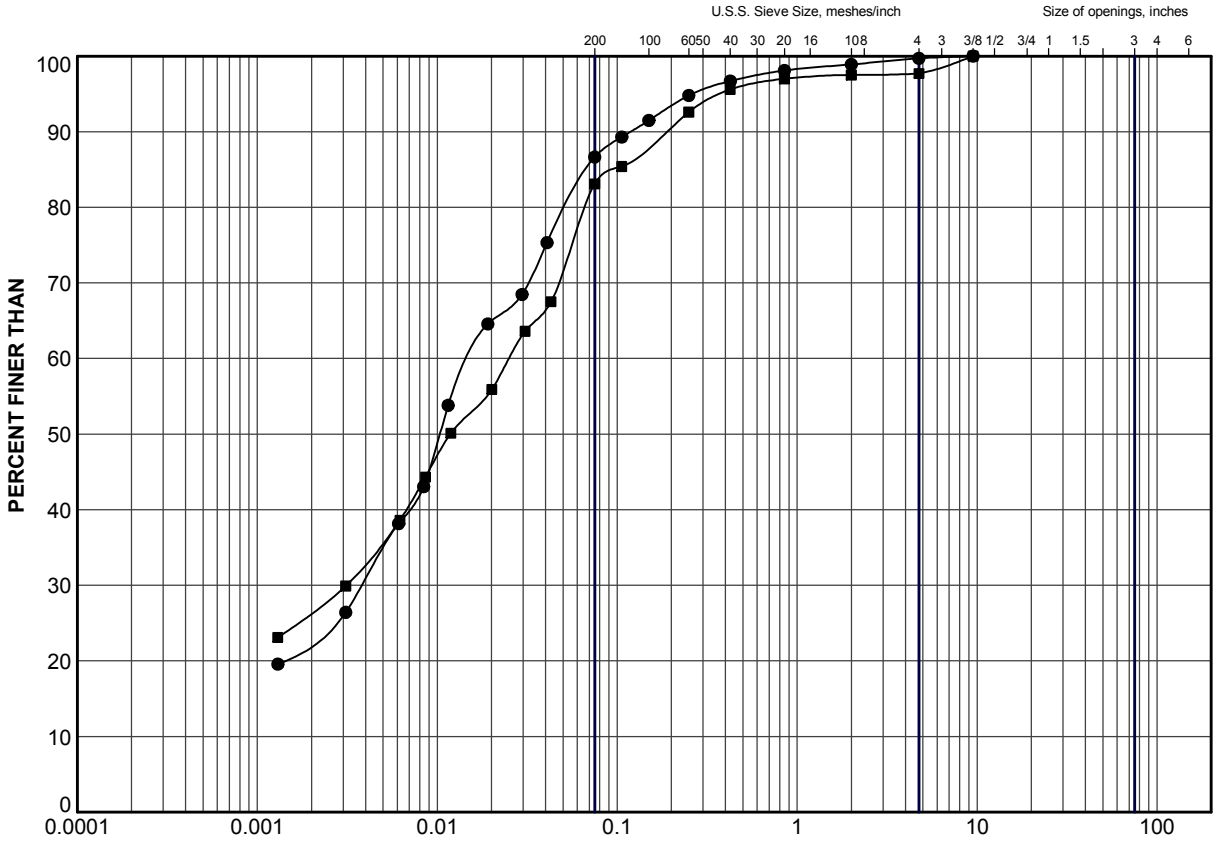
GRAIN SIZE DISTRIBUTION

SILTY CLAY

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-F11D0A3
			SCALE	N/A REV.
DRAWN	LMK	Feb. 16/11		
CHECK			**FIGURE**	**A-3**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	25	4	339.4
■	801	7	337.6

PROJECT

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

TITLE

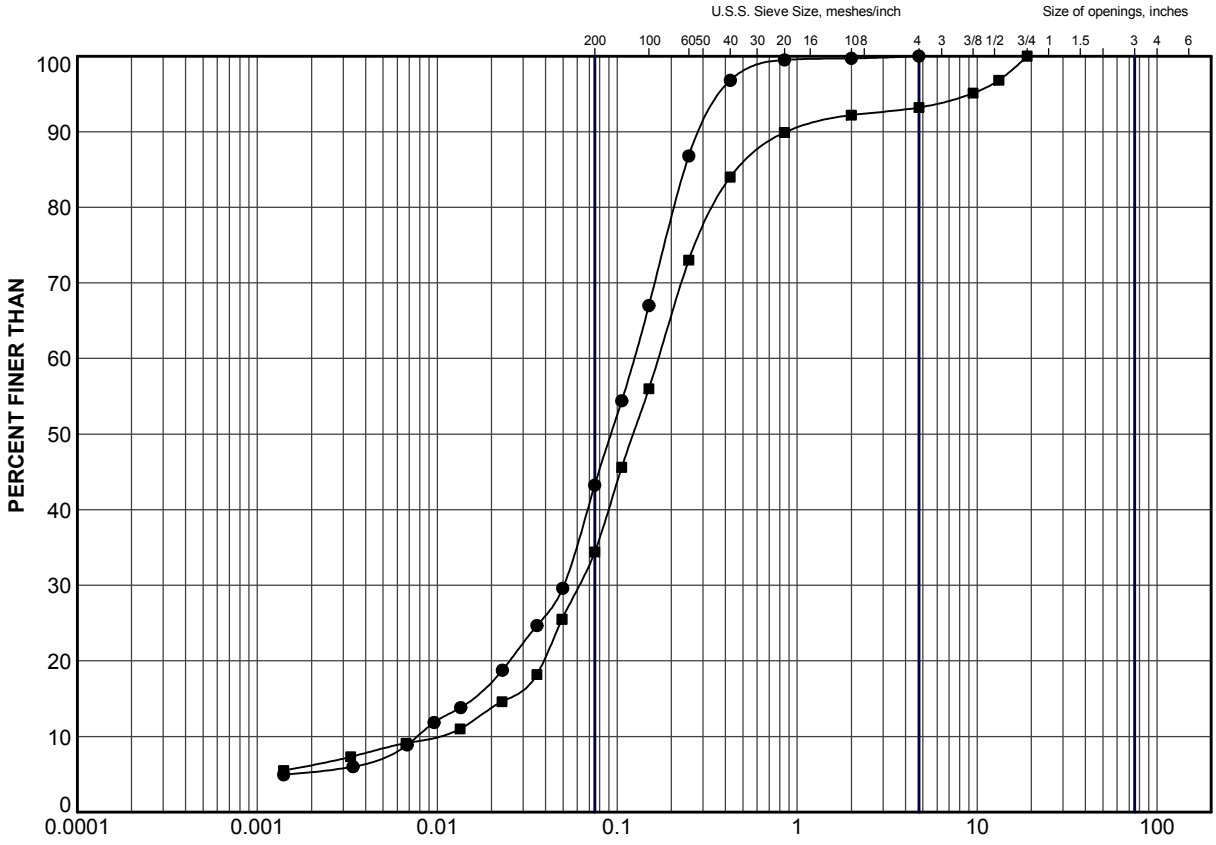
GRAIN SIZE DISTRIBUTION

CLAYEY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-F11D0A4
			SCALE	N/A REV.
DRAWN	LMK	Feb. 16/11		
CHECK			**FIGURE**	**A-4**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	27	3	340.9
■	801	11	333.0

PROJECT

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

TITLE

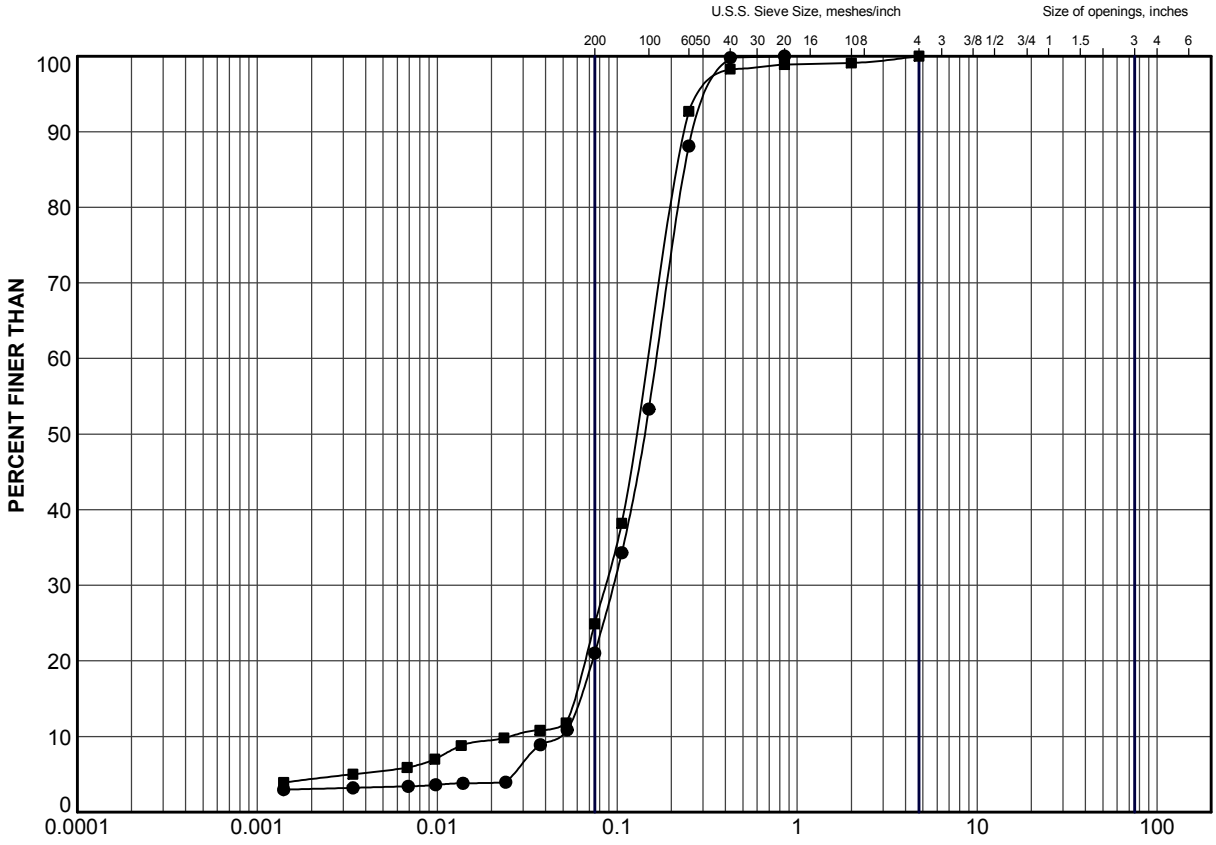
GRAIN SIZE DISTRIBUTION

SILTY SAND

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-F11D0A5
			SCALE	N/A REV.
DRAWN	LMK	Feb. 16/11		
CHECK			**FIGURE**	**A-5**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	29	3	341.7
■	801	18	322.2

PROJECT

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

TITLE

GRAIN SIZE DISTRIBUTION

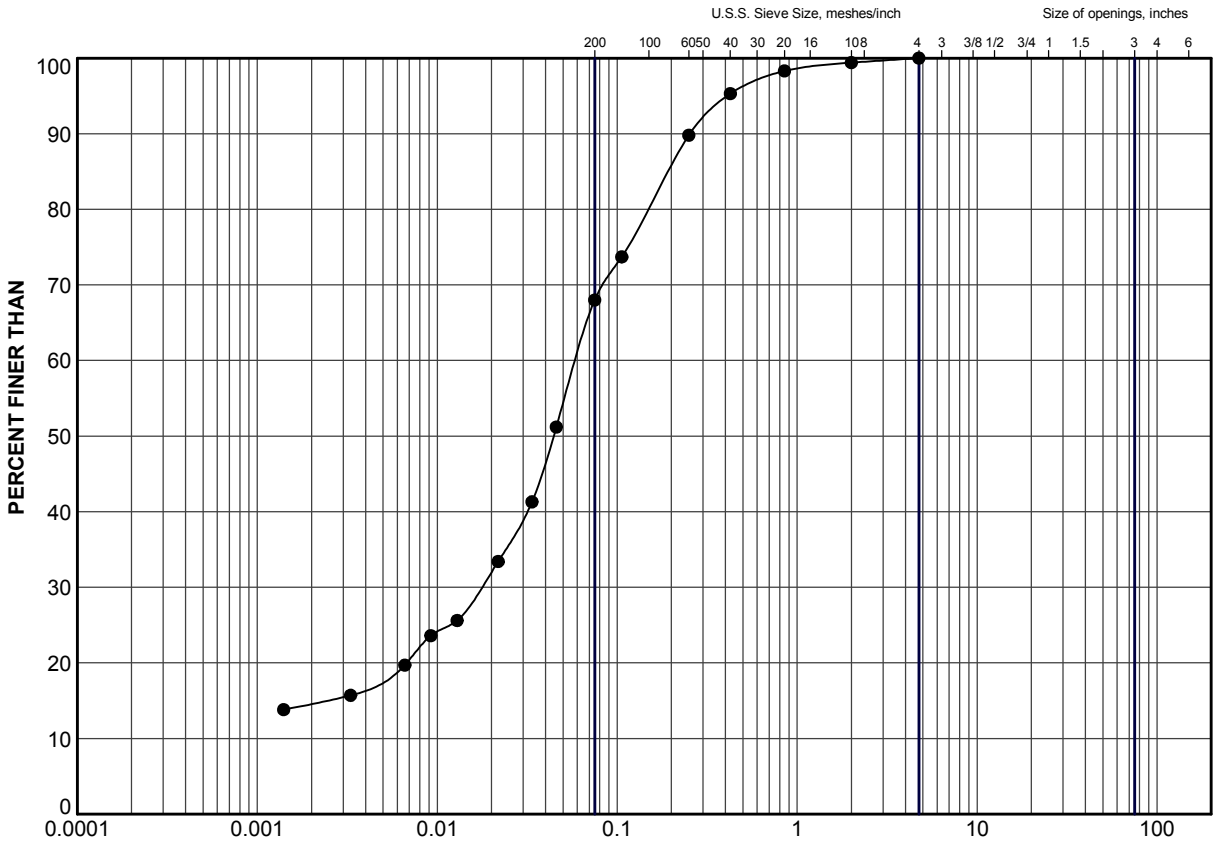
SAND

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-F11D0A6
			SCALE	N/A
DRAWN	LMK	Feb. 16/11	REV.	
CHECK				

FIGURE A-6

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	801	14	328.4

PROJECT

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

TITLE

GRAIN SIZE DISTRIBUTION

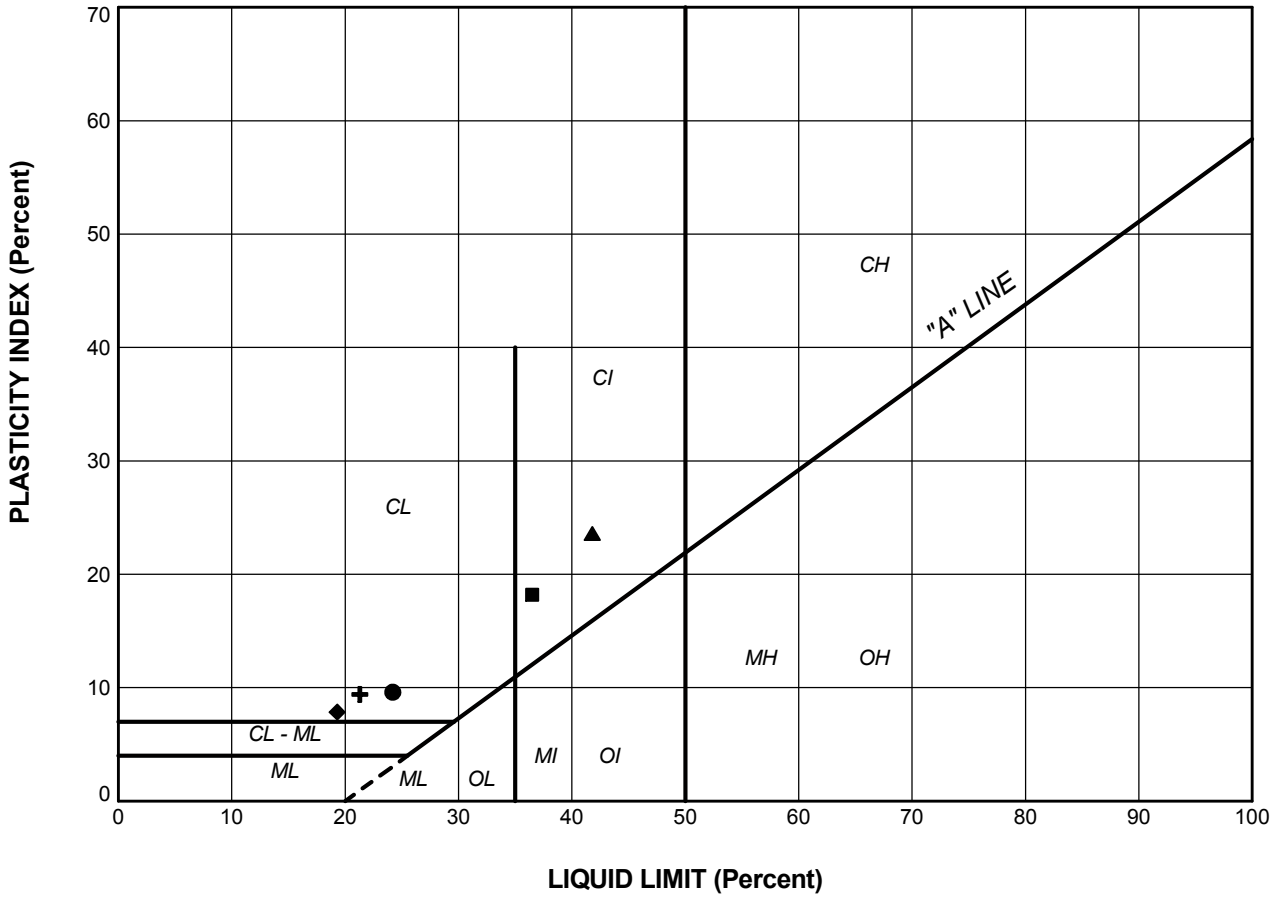
SANDY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-F11D0A7
			SCALE	N/A
DRAWN	WDF	Feb. 16/11	REV.	
CHECK				

FIGURE A-7

LDN_MTO_NEW GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
FILL					
◆	813	2	19.3	11.5	7.9
CLAYEY SILT TILL					
●	25	4	24.2	14.6	9.6
✚	801	7	21.3	11.9	9.4
SILTY CLAY					
■	27	4	36.5	18.3	18.2
▲	28	2	41.8	18.2	23.6

PROJECT

EXISTING NOISE BARRIER WALL 1
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-F11D0A8	
			SCALE	N/A	REV.
DRAWN	LMK	Feb. 16/11			
CHECK			FIGURE	A-8	

MTO_PI GLDR_LDN.GDT

APPENDIX B

Records of Additional Boreholes

APPENDIX B-1

Record of Borehole from GWP 131-98-00 – North Foreslope Modifications, Fischer-Hallman Road Underpass (Site 33-229) (Geocres No. 40P7-63)

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 801

1 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4809316.0 ;E 222655.0
BOREHOLE TYPE POWER AUGER / ROTARY DRILLING / TRICONE
DATE October 6, 2008
ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
343.15	GROUND SURFACE						343				
0.00	TOPSOIL, sandy					Concrete					
0.18	Brown										
342.39	FILL, silty sand and gravel, with cobbles						342				
0.76	Brown		1	SS	13						
	FILL, sandy silt, some clay, trace gravel Compact Grey and brown		2	SS	25	Bentonite					
			3	SS	25		341				
340.56											
2.59	FILL, silt, some sand, some clay Compact Grey		4	SS	11		340				
339.64						Backfill					
3.51	SILT, trace clay, trace sand, trace gravel Dense		5	SS	46						
339.04	Grey						339				
4.11	CLAYEY SILT TILL, trace to some sand, trace gravel with silty sand layers Hard Brown becoming grey at about elev. 338.6m		6	SS	36						
						Standpipe	338				
			7	SS	48	Sand					3 14 57 26
			8	SS	34		337				
336.44											
6.71	SILT, some clay, some sand with silty sand partings Compact Grey		9	SS	27		336				
335.23											
7.92	SANDY SILT, trace clay, trace gravel with clayey silt layers Very dense Grey		10	SS	53		335				
333.85											
9.30	SILTY SAND, fine to medium, trace clay, trace gravel Dense to very dense Grey						334				
			11	SS	55		333				7 59 28 6
						Bentonite					
			12	SS	48		332				
330.96											
12.19	SANDY SILT TILL, some clay, trace gravel with sand and clayey silt layers Compact Grey						331				
			13	SS	18		330				
			14	SS	17		329				0 32 53 15

Continued Next Page

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 801

2 OF 2 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | LOCATION N 4809316.0 ;E 222655.0 | ORIGINATED BY MA
DIST | HWY 7/8 | BOREHOLE TYPE POWER AUGER / ROTARY DRILLING / TRICONE | COMPILED BY LMK
DATUM GEODETIC | DATE October 6, 2008 | CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"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
	SANDY SILT TILL, some clay, trace gravel with sand and clayey silt layers Compact Grey						328				
			15	SS	20		327				
326.23											
16.92	SILTY SAND AND GRAVEL, with cobbles Very dense Grey						326				
			16	SS	66						
							325				
			17	SS	67		324				
323.03											
20.12	SAND, fine to medium, trace to some silt, trace clay Very dense Grey						323				
			18	SS	101		322		○		0 76 20 4
							321				
320.42			19	SS	106						
22.73	SILTY SAND, trace clay Very dense Grey						320				
319.83											
23.32	SAND, fine to medium Very dense Grey										
			20	SS	60/ 50mm		319				
							318				
			21	SS	124						
317.24											
25.91	END OF BOREHOLE										

Groundwater encountered at about elev. 333.9m and elev. 326.2m during drilling on October 6, 2008.
Water level measured in standpipe at elev. 342.26m on October 6, 2008.
Water level measured in piezometer at elev. 333.60m on October 6, 2008.
Water level measured in standpipe at elev. 338.04m on August 25, 2009.
Water level measured in piezometer at elev. 334.06m on August 25, 2009.

Water level measured in standpipe at elev. 338.20m on June 30, 2010.
Water level measured in piezometer at elev. 334.07m on June 30, 2010.
Water level measured in standpipe at elev. 338.12m on October 13, 2010.
Water level measured in piezometer at elev. 333.93m on October 13, 2010.

Bentonite
Piezometer

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 813

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4809323.0 ;E 222650.6
BOREHOLE TYPE MANUAL AUGER / SOLID STEM
DATE June 24, 2010
ORIGINATED BY MA
COMPILED BY WDF/AMG
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
344.90	GROUND SURFACE										
0.00	TOPSOIL, silty, some sand, trace gravel, Brown										
0.15			1	SS	11				○		
344.23	FILL, silty sand and gravel, Compact, Brown						344				
0.67			2	SS	13				○		10 28 47 15
343.62	FILL, clayey silt, some sand, some gravel, trace topsoil, with sandy silt layers, Stiff, Brown										
1.28			3	SS	19				○		7 29 48 16
342.84	FILL, silty fine sand, trace gravel, Compact, Brown		4	SS	11		343		○		
2.06									○		
342.08	FILL, clayey silt, trace sand, trace gravel, Stiff to very stiff, Brown		5	SS	28				○		
2.82			6	SS	20		342		○		
341.22	FILL, silty topsoil, trace sand, trace gravel, Compact to very dense, Dark brown		7	SS	50/50mm				○		
3.68	END OF BOREHOLE										

Borehole dry during drilling on June 24, 2010.

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 16/02/11

APPENDIX B-2

Record of Borehole from GWP 131-98-00 – Overhead Signs (Geocres No. 40P8-185)

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 921

1 OF 1 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | LOCATION N 4809404.2 ;E 222819.7 | ORIGINATED BY MR

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

DATUM GEODETIC | DATE May 7, 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
342.93	GROUND SURFACE									
0.00	TOPSOIL, clayey silt									
0.15	Brown FILL, sandy silt, trace to some clay, trace gravel, trace to some topsoil Loose Brown and grey		1	SS	6		342			
			2	SS	4		341			0 22 65 13
			3	SS	5		340			
339.73										
3.20	SANDY SILT, some clay, trace gravel Loose Brown		4	SS	5					
			5	SS	9		339			7 39 39 15
338.51										
4.42	CLAYEY SILT, trace sand Stiff Grey		6	SS	11		338			
337.75										
5.18	SANDY SILT, Compact Brown		7	SS	13	▽	337			
336.99										
5.94	CLAYEY SILT, trace sand Stiff Grey		8	SS	11					
336.38										
6.55	END OF BOREHOLE Groundwater encountered at about elev. 337.1m during drilling on May 7, 2010.									

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 16/02/11

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