April 2010

FOUNDATION INVESTIGATION AND DESIGN REPORT

High Fills for CNR Overhead
Rehabilitation of Highway 7
From 0.4 km West of Middlesex Road 50 to 0.85 km East of Perth County Line (18 km)
GWP 361-98-00, Agreement No. 3006-E-0092
Ministry of Transportation, Ontario - West Region

Submitted to:
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REPORT

Report Number: 08-1132-159-0-2000-R03
Geocres No. 40P3-50
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PART A

FOUNDATION INVESTIGATION REPORT

HIGH FILLS FOR CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
FROM 0.4 KM WEST OF MIDDLESEX ROAD 50 TO 0.85 KM
EAST OF PERTH COUNTY LINE (18 KM)
GWP 361-98-00, AGREEMENT NO. 3006-E-0092
MINISTRY OF TRANSPORTATION, ONTARIO - WEST REGION

1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Delcan Corporation (Delcan) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detailed design work for GWP 361-98-00. The project involves the detailed design for the rehabilitation of Highway 7 from 0.4 kilometres west of Middlesex Road 50 to 0.85 kilometres east of Perth Line for a distance of 18 kilometres and includes lane and shoulder widening.

This report addresses the high fills associated with the approaches for the Canadian National Railway (CNR) Overhead structure (Site No. 19-454) located approximately 450 metres west of the intersection of Highway 7 with Cobble Hills Road and James Street. High fills, in excess of 4.5 metres, will be required along Highway 7 between approximately Stations 19+050 and 19+650 to widen the existing embankments. The high fills will result in slopes up to approximately 10.5 metres in height.

The purpose of the detailed 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 and Golder Associates' proposal P71-3160-P03 dated August 7, 2008. The work was carried out in accordance with our Quality Control Plan for Foundation Engineering dated December 15, 2008.

Delcan provided Golder Associates with preliminary drawings for this project in digital format. At the time of the writing of this report, the detail design for the rehabilitation of Highway 7 was proceeding but the high fills at the CNR Overhead had been deferred for a future project.

2.0 SITE DESCRIPTION

The rehabilitation of Highway 7 to be undertaken as GWP 361-98-00 extends from 0.4 kilometres west of Middlesex Road 50 to 0.85 kilometres east of Perth Line. The study area covered by this report includes the CNR Overhead high fill embankment and extends from Station 19+000 (east of Cherry Hill Road) to Station 19+700 (west of the intersection of Cobbles Hill Road) along Highway 7. The Town of St. Marys is situated north of intersection of Cobble Hills Road and Highway 7. Highway 7 in this area is the boundary between the County of Middlesex to the south and the County of Perth to the north. The site location is shown on the Key Plan on Figure 1 and on Drawing 1. Site photographs are presented in Appendix C.

High embankment fills exist at the CNR Overhead approaches and are to be widened along the highway alignment. Based on the existing Highway 7 plan, profile and cross-sections, the high fills extend from approximately Stations 19+050 to 19+650.

Highway 7 at the CNR Overhead currently consists of a secondary two-lane highway. The subject section of roadway is constructed on embankments 2 to 11 metres high between approximately Stations 18+940 and 19+720. At the centreline of the CNR tracks, the elevation of the base of the rails is elevation 328.46 metres and 336.90 metres at the surface of Highway 7. A decommissioned roadbed for the detour used during construction of the CNR/Highway 7 grade separation is north of Highway 7. The site is located in an area where the land use is primarily rural residential and agricultural.

The topography of the lands adjacent to Highway 7 in the subject area can be described as undulating from elevation 326 to 331 metres. Two areas, likely former aggregate extraction areas for the St. Marys cement plant to the north, are located east and west of the CNR railway directly north of the Highway 7 CNR Overhead structure.

Evidence of surficial failures or movement of the northern embankment slope was observed east of the CNR Overhead structure during the initial site reconnaissance for this project. The slopes were noted to be locally steeper than 2 horizontal to 1 vertical. Evidence of localized surficial failures/movement was also noted on the northern slope west of the rail line and on the southern embankment slopes on each side of the railway.

2.1 Site Geology

The area of the proposed Highway 7 rehabilitation lies in the physiographic region of southern Ontario known as the Stratford Till Plain[1]. The Stratford Till Plain is roughly wedge shaped and extends from London to Blyth with a narrow projection towards Arthur. Its relatively uniform silty clays were deposited as a product of the Huron ice lobe largely derived from the Lake Huron basin.

Based on the Ontario Department of Mines and Northern Affairs Map 1048 entitled “Pleistocene Geology of the Lucan Area” as well as Map 918 entitled “Quaternary Geology of the St. Marys Area”, the majority of the section of Highway 7 is underlain by sandy silt to silty sand till. The till is truncated by a narrow band of outwash

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

material (alluvium) along the banks of the North Branch of the Thames River and immediately north of Wildwood Lake. East of the river, there is a substantial deposit of stratified drift largely consisting of sand and gravel. Smaller, localized pockets of clayey silt till are mapped throughout the study area. A deposit of lacustrine silt and clay is located at the most eastern extent of the site.

The bedrock is reported to be microcrystalline limestone belonging to the Dundee and Lucas formation of Upper Silurian Age (Geological Survey of Canada, Map 1263A entitled “Geology, Toronto-Windsor Area”, dated 1969). The bedrock surface is at approximately elevation 310 metres in the region of the Highway 7 CNR overhead according to Ontario Department of Mines Maps 291.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on June 9 through 12, 16, 18 and 22, 2009 at which time fourteen boreholes, numbered 301 through 314, were drilled to depths of 5.2 to 16.3 metres.

The investigation was carried out using an all-terrain vehicle mounted CME 55 power auger as well as truck mounted B57 and CME 45 power augers supplied and operated by specialist drilling contractors. Samples of the overburden were obtained at 0.75 and 1.5 metre intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. The samplers used in the investigations limit the maximum particle size that can be sampled and tested to about 40 millimetres. Therefore, particles or objects that may exist within the soils that are larger than this dimension will not be sampled or represented in the grain size distributions. Larger particle sizes, including cobbles and boulders, are known to be present in the glacial till deposits as discussed in the text of this report. In situ field vane shear testing was conducted in boreholes 301, 303, 307, 311 and 312 to provide additional strength data for the cohesive soils and fills.

Groundwater conditions in the boreholes were observed throughout the drilling operations. Standpipes were installed in boreholes 308 and 311 to monitor the groundwater conditions. The boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 372/07.

The field work was supervised on a full-time basis by an experienced member of our engineering staff who located the boreholes in the field, directed the drilling, sampling and in situ testing operations and logged the boreholes. The samples were identified in the field, placed in labelled containers and transported to our London laboratory for further examination and routine classification testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg limits determinations were carried out on selected samples. The results of the testing are shown on the Record of Borehole sheets and in Appendix A.

The locations of the boreholes are shown on the Record of Borehole sheets and on Drawing 1. The table below summarizes the borehole locations, ground surface elevations at the borehole locations and borehole depths.

Borehole	Location (m)		Ground Surface Elevation (m)	Depth (m)
	Northing	Easting		
301	4 788 701	415 546	336.81	15.09
302	4 788 806	415 681	327.80	9.54
303	4 788 734	415 594	336.78	13.87
304	4 788 837	415 775	327.02	6.49
305	4 788 647	415 396	334.54	16.25
306	4 788 859	415 881	331.06	8.84
307	4 788 758	415 676	336.04	15.94
308	4 788 786	415 741	334.73	14.63
309	4 788 620	415 299	327.65	5.18

Borehole	Location (m)		Ground Surface Elevation (m)	Depth (m)
	Northing	Easting		
310	4 788 717	415 483	327.82	9.54
311	4 788 603	415 361	327.48	6.77
312	4 788 639	415 457	327.48	9.45
313	4 788 816	415 842	326.12	6.55
314	4 788 716	415 653	326.36	11.13

Borehole data from the current investigation was supplemented with information from boreholes 1 through 4, inclusive, from Geocres Report No. 40P3-028 entitled "W.P. 20-60, Report to Department of Highways, Ontario on Soil Conditions and Foundation, Proposed Canadian National Railway Crossing, Proposed Highway No. 7 - Line 'A', St. Mary's, Ontario", dated September 30, 1966. The Records of Boreholes 1 to 4 (40P03-028) and the results of the related laboratory testing are presented in Appendix B. The locations of the boreholes are shown on Drawing 1. The following table summarizes the borehole locations, ground surface elevations at the boreholes and boreholes depths:

Borehole	Location (m)		Ground Surface	Depth
	Northing	Easting	Elevation	
			(m)	(m)
1	4 788 737	415 594	325.77	10.36
2	4 788 712	415 587	326.01	6.55
3	4 788 704	415 560	326.68	6.10
4	4 788 726	415 568	326.50	4.88

The locations of the previous boreholes should be considered somewhat approximate since the locations were originally referenced to imperial chainages and offsets rather than current metric MTM coordinates.

4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

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

The boreholes drilled at the site generally encountered surficial topsoil or fill over thin surficial layers of clayey silt, silty clay, silty sand and/or sand which are underlain by strata of glacial tills consisting of predominately clayey silt. The till at depth is underlain by silt and/or sand and gravel in some areas. The glacial till is interlayered with silt, sand and clayey silt.

The locations and elevations of the boreholes, together with the interpreted stratigraphic profiles, are shown on the attached Drawing 1 through 3. A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and is summarized in the following sections.

4.1.1 Pavement Structure

Layers of asphalt underlain by concrete were encountered from surface in boreholes 301 and 303 on the roadway. The asphalt was 300 and 340 millimetres thick and the concrete was 150 to 250 millimetres thick in boreholes 301 and 303, respectively.

The asphalt and concrete layers in boreholes 301 and 303 were underlain by sand and gravel (pavement granulars) from elevation 336.3 metres. Pavement granular materials were also encountered at ground surface in boreholes 305 through 308 which were advanced through the shoulders. The pavement base (crushed sand and gravel) was 120 to 370 millimetres at the borehole locations. The granular subbase (sand and gravel with cobbles) was 150 to 730 millimetres thick. The sand and gravel fill in borehole 303 was compact with an N value of 12 blows per 0.3 metres.

4.1.2 Topsoil

Layers of topsoil from 90 to 270 millimetres thick were encountered from ground surface in boreholes 302, 304 and 309 through 314. Layers of buried topsoil 130 to 300 millimetres thick were encountered from elevation 325.5 to 326.4 metres in boreholes 307, 308 and 1 to 4 (40P03-028). This is near the original ground surface

elevation of 326 metres before the grade separation was constructed. The topsoil was very stiff with an N value of 17 blows per 0.3 metres and water contents of 20 to 21 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.

4.1.3 Fill

Fill materials consisting of sand and gravel or silt was found at the surface of boreholes 1 to 4 (40P03-028). Fill materials were encountered beneath the pavement granulars in boreholes 301, 303 and 305 through 308 from elevation 330.5 to 336.1 metres and under topsoil in boreholes 302, 304, 310, 312 and 314 from elevation 326.1 to 327.7 metres. The fill ranged from 0.2 to 9.5 metres in thickness. The fill primarily consisted of clayey silt with seams or layers of silt, topsoil, silty sand and sand.

The clayey silt fill was soft to hard based on N values of 3 to 64 blows per 0.3 metres and the silt fill was compact based on a single N value of 12 blows per 0.3 metres. In situ shear vane tests conducted within the softer zone in the clayey silt fill resulted in undisturbed shear strength values ranging from 93 to greater than 144 kilopascals indicating a stiff to very stiff consistency. The sensitivity ranged from 1.7 to 3.7. The clayey silt fill had water contents of 8 to 24 per cent and is of low plasticity based on plastic limits of 12 to 17 per cent, liquid limits of 23 to 30 per cent and plasticity indices of 11 to 14 per cent.

The results of the Atterberg limits determinations of fill material are shown on the Plasticity Chart, Figure A-9 and grain size distribution curves for samples of clayey silt fill recovered from the standard penetration testing are shown on Figures A-1 and A-2 of Appendix A.

The water content of the fill ranges from 8 to 24 per cent. A water content of 24 per cent was obtained on a sample from borehole 302 that contained topsoil.

4.1.4 Clayey Silt

Layers of clayey silt were encountered in boreholes 301, 302, 305 and 310 underlying layers of fill from elevation 324.8 to 326.9 metres and in borehole 308 underlying topsoil from elevation 325.4 metres. In boreholes 311, 313 and 2 (40P03-028), the clayey silt till from elevation 324.9 and 320.9 metres was underlain by clayey silt with silt or silty sand seams. The clayey silt layers ranged from 0.2 to 2.3 metres thick.

The clayey silt near elevation 325 metres was stiff to very stiff based on N values of 10 to 23 blows per 0.3 metres. The clayey silt below elevation 321 metres in boreholes 313 and 2 (40P03-028) was hard with N values of 62 to 80 blows per 0.3 metres. Based on in situ vane testing conducted in softer zones, the undisturbed shear strength values ranged from 95 to 102 kilopascals indicating stiff to very stiff consistency with a sensitivity of 1.5 and 1.9. The water content of the clayey silt varied between 12 and 22 per cent. The clayey silt was of low

plasticity based on plastic limits of 13 to 14 per cent, liquid limits of 22 to 31 per cent and plasticity indices of 9 to 15 per cent.

The results of the Atterberg limits determinations and grain size analyses conducted on samples of clayey silt are presented on Figure A-10 and Figure A-3, respectively.

4.1.5 Silt

A 0.7 metre thick layer of upper silt was encountered below the topsoil in borehole 309 from elevation 327.4 metres. The upper silt was compact with an N value of 11 blows per 0.3 metres and a water content of 17 per cent.

The lower silt was encountered in boreholes 304, 307, 310, 311, 314 and 1 (40P03-028) below the upper clayey silt till from elevation 320.4 to 322.9 metres and in borehole 308 beneath a layer of sand and gravel at elevation 320.4 metres. The lower silt was interlayered with clayey silt till in borehole 311 at elevation 325.7 metres. In borehole 2 (40P03-028), the lower silt was encountered beneath clayey silt at elevation 320.4 metres.

The lower silt was very dense based on N values of 96 to greater than 100 blows per 0.3 metres. The water content of the silt varied from 7 to 16 per cent.

The grain size distribution curve for a single silt sample is shown on Figure A-4.

4.1.6 Silty Clay

A silty clay deposit 1.7 metres thick was encountered below the fill at borehole 303 from elevation 325.8 metres. Based on the standard penetration test, N values of 11 and 29 blows per 0.3 metres, the silty clay is stiff to very stiff.

The water content of a single sample of silty clay was 23 per cent. The silty clay is of intermediate plasticity with a plastic limit of 17 per cent, a liquid limit of 43 per cent and a plasticity index was 26 per cent.

The Atterberg limits test results for the silty clay are shown on the Plasticity Chart, Figure A-10 and a grain size distribution curve for the silty clay is shown on Figure A-5.

4.1.7 Silty Sand

Layers of silty sand were encountered in borehole 304 beneath the fill from elevation 326.0 metres and in boreholes 301 and 302 beneath clayey silt layers from elevation 325.1 and 324.5 metres, respectively. The 0.3 to 0.4 metre thick silty sand layers were loose to compact based on N values of 6 to 20 blows per 0.3 metres. The water content of a sample of silty sand was about 24 per cent.

Previous borehole 1 (40P03-028) was terminated in very dense silty sand after exploring it for some 0.6 metres from elevation 316.0 metres. The silty sand had an N value of over 100 blows per 0.3 metres and a water content of 13 per cent.

4.1.8 Clayey Silt Till

A stratum of clayey silt till was encountered in all of the boreholes advanced for the current investigation. Materials described as silt till in boreholes 1 to 4, inclusive, of Geocres No. 40P03-028 were interpreted to be clayey silt till on the basis of the results of the Atterberg limits determinations and grain size analyses. Although not specifically encountered in all of the boreholes, cobbles and boulders should be expected throughout the clayey silt till.

The clayey silt till was encountered between elevations 324.1 and 327.4 metres beneath the topsoil, fill and/or surficial deposits of silty fine sand, silty sand, silty clay, clayey silt and silt in boreholes 301 to 314, inclusive. In boreholes 1 to 4 (40P03-028), the clayey silt till was encountered beneath a layer of silty clay till from elevation 323.6 to 324.0 metres. The upper clayey silt till layers were 0.3 to 5.8 metres thick where fully penetrated. Boreholes 302, 303, 305, 306, 309, 312 and 314 were terminated in the clayey silt till after exploring it for 1.2 to 8.9 metres. Borehole 303 was terminated at elevation 323.7 metres due to auger refusal, probably on a boulder.

The upper clayey silt till was stiff to hard with N values ranging from 9 to over 100 blows per 0.3 metres. A shear strength of greater than 144 kilopascals was measured in a softer clayey silt till zone in borehole 312. Water contents in the upper clayey silt till ranged from 9 to 24 per cent. The upper clayey silt till is of low plasticity based on plastic limits of 12 to 16 per cent, liquid limits of 20 to 34 per cent and plasticity indices of 7 to 17 per cent.

Lower layers of clayey silt till were encountered between elevations 319.4 and 320.4 metres beneath the silt in boreholes 314 and 1 (40P03-028) and below the clayey silt in borehole 2 (40P03-028). Boreholes 314 and 1 (40P03-028) were terminated in the lower clayey silt till after exploring for 0.9 to 4.1 metres.

The lower clayey silt till was hard with N values ranging from 74 to over 100 blows per 0.3 metres. Water contents in the lower clayey silt till ranged from 9 to 12 per cent. The lower clayey silt till is of low plasticity based on plastic limits of 11 and 13 per cent, liquid limits of 24 and 25 per cent and plasticity indices of 12 and14 per cent.

The results of the Atterberg limits testing carried out on samples of the clayey silt till are shown on Figure A-10 and grain size distribution curves for samples of clayey silt till recovered from the standard penetration testing are shown on Figures A-6 and A-7 and Figure 3 in Appendix B.

4.1.9 Silty Clay Till

The buried topsoil in boreholes 1 to 4 (40P03-028) was underlain by silty clay till from elevation 325.1 to 326.1 metres. The silty clay till layer was 1.5 to 2.1 metres thick.

The silty clay till was firm to hard with N values ranging from 6 to 37 blows per 0.3 metres. Water contents in the silty clay till varied from 19 to 22 per cent. A single sample of silty clay till had a plastic limit of 11 per cent, a liquid limit of 23 per cent and plasticity index of 12 per cent.

Although not specifically encountered in the boreholes, the presence of cobbles and boulders in the silty clay till should be anticipated.

4.1.10 Sandy Silt Till

An apparently localized layer of sandy silt till was encountered in borehole 301 from elevation 324.2 metres below a layer of clayey silt till. Borehole 301 was terminated due to auger refusal on a possible boulder in sandy silt till after exploring the layer for 2.4 metres. As such, cobbles and boulders should be expected in the sandy silt till. The sandy silt till was very dense based on N values of greater than 100 blows per 0.3 metres.

4.1.11 Sand

A layer of sand 0.5 metres thick was encountered beneath clayey silt in borehole 311 from elevation 322.6 metres. The sand was compact based on a single N value of 16 blows per 0.3 metres. The results of grain size testing on the sample of sand is shown on Figure A-8.

4.1.12 Sand and Gravel

A 1.2 metre thick layer of sand and gravel was encountered in borehole 308 from elevation 321.6 metres below the upper clayey silt till. The sand and gravel was very dense based on a single N value of greater than 100 blows per 0.3 metres. The water content of the single sample of sand and gravel was about 10 per cent.

4.2 Groundwater Conditions

Groundwater conditions were observed during and upon completion of drilling. The observed groundwater conditions are noted on the Record of Borehole sheets, on the profiles and sections on Drawings 1 to 3 and are summarized in the following text and table.

Borehole	Ground Surface Elevation	Encountered Groundwater Level		Measured Groundwater Level							
		Depth	Elevation	Sept. 28, 1966		Jun. 16, 2009		Aug. 12, 2009		Sept. 28, 2009	
				Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
301	336.81	11.7	325.1	-	-	-	-	-	-	-	-
302	327.80	Dry	Dry	-	-	-	-	-	-	-	-

Borehole	Ground Surface Elevation	Encountered Groundwater Level		Measured Groundwater Level							
		Depth	Elevation	Sept. 28, 1966		Jun. 16, 2009		Aug. 12, 2009		Sept. 28, 2009	
				Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
303	336.78	Dry	Dry	-	-	-	-	-	-	-	-
304	327.02	5.3	321.7	-	-	-	-	-	-	-	-
305	334.54	Dry	Dry	-	-	-	-	-	-	-	-
306	331.06	4.4	326.6	-	-	-	-	-	-	-	-
307	336.04	Dry	Dry	-	-	-	-	-	-	-	-
308	334.73	11.0	323.8	-	-	14.45	320.28	10.29	324.44	14.45	324.15
309	327.65	Dry	Dry	-	-	-		-	-	-	-
310	327.82	Dry	Dry	-	-	-		-	-	-	-
311	327.48	4.9	322.6	-	-	6.77	320.71	0.74	326.73	1.12	326.36
312	327.48	Dry	Dry	-	-	-	-	-	-	-	-
313	326.12	Dry	Dry	-	-	-	-	-	-	-	-
314	326.36	Dry	Dry	-	-	-	-	-	-	-	-
1 (40P03-028)	325.77	-	-	Piezometer 1.58 Standpipe 0.40	324.19 325.37	-	-	-	-	-	-
2 (40P03-028)	326.01	-	-	0.24	325.77	-	-	-	-	-	-
3 (40P03-028)	326.68	-	-	0.73	325.95	-	-	-	-	-	-
4 (40P03-028)	326.50	-	-	0.43	326.08	-	-	-	-	-	-

Groundwater was not encountered during drilling in boreholes 302, 303, 305, 307, 309, 310 and 312 through 314. Standpipes were installed in boreholes 308 and 311. The most recent water level readings obtained on September 28, 2009, indicated water levels of 324.2 and 326.4 metres at boreholes 308 and 311, respectively. This is comparable with historic water levels measured in boreholes 1 to 4 (40P03-028) on September 28, 1966 which ranged from 324.2 to 326.1 metres. Based on colour changes in the native soils and the encountered water levels, the groundwater level has been inferred to be between approximately elevation 325 metres east of the CNR Overhead structure and elevation 327 metres to the west.

Groundwater levels are expected to fluctuate with seasonal and climatic variation.

5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Bud Environmental Inc. and Aardvark Drilling Inc., who are Ontario Ministry of Environment licensed well contractors. 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, Dirka U. Prout, P.Eng., and 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

HIGH FILLS FOR CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
FROM 0.4 KM WEST OF MIDDLESEX ROAD 50 TO 0.85 KM
EAST OF PERTH COUNTY LINE (18 KM)
GWP 361-98-00, AGREEMENT NO. 3006-E-0092
MINISTRY OF TRANSPORTATION, ONTARIO - WEST REGION

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides our recommendations on the foundation aspects of the design of the high fills associated with the widening of Highway 7 for the CNR Overhead approaches. The recommendations are based on our interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

6.2 Proposed High Fills

High fill embankment widenings are to be constructed between approximately Stations 19+050 and 19+650. The widenings will match the existing profile resulting in fill heights up to 11 metres.

6.2.1 West Approach Fill

This portion of Highway 7 was built on a fill embankment about 2 to 11 metres high. The existing centreline profile of the highway in this section ranges from elevation 330.4 metres at Station 18+940 to elevation 336.8 metres at Station 19+300.

Boreholes 301, 305 and 309 through 312 were drilled along the west approach embankment. Boreholes 3 and 4 (40P03-028) were advanced previously in the vicinity of the west abutment and pier of the structure, respectively. The existing fill along this section of Highway 7 is predominantly cohesive in nature with the majority of the fill consisting of firm to very stiff clayey silt with discrete layers of silt. The embankment fills and surficial topsoil overlie firm to very stiff clayey silt, compact silty sand and/or compact silt to elevation 324 to 327 metres. These deposits are underlain by extensive deposits of stiff to hard clayey silt till to silty clay till. In the vicinity of borehole 311, the clayey silt till was interlayered with firm to very stiff clayey silt, compact silt and compact sand. Layers of very dense silt were encountered in several boreholes below the clayey silt till from about elevation 321 metres to the extent of the explorations. In borehole 301, the clayey silt till was underlain by very dense sandy silt till for at least 2.4 metres. The groundwater level is inferred to be at approximately elevation 327 metres.

6.2.2 East Approach Fill

The portion of the highway constructed in this area was built on a fill embankment ranging from 2 to 11 metres high. The existing centreline profile of Highway 7 varies from elevation 336.8 metres at Station 19+360 to elevation 329.9 metres at Station 19+720.

Boreholes 302 through 304, 306 through 308, 313 and 314 were drilled along this section of Highway 7. Previously, boreholes 1 and 2 (40P08-028) were drilled at the east abutment and east pier of the overhead structure, respectively. The embankment fill generally consists of firm to hard clayey silt 0.3 to 9.2 metres thick with thin seams and layers of silt, sand and silty sand. The native subsurface conditions encountered at the east approach consist of surficial topsoil overlying stiff to very stiff clayey silt to silty clay and/or loose to compact silty sand and compact silt to elevation 324 to 327 metres. In boreholes 313 and 307, the surficial topsoil was underlain by clayey silt till. Stiff to hard clayey silt to silty clay till was encountered beneath the layers of topsoil, fill, clayey silt, silty clay and/or silty sand. The clayey silt till is interlayered with a silt layer from elevation 320 metres to 323 metres that is 0.3 to 2.8 metres thick. In borehole 308, the clayey silt till was underlain by a very dense layer of sand and gravel 1.2 metres thick followed by a layer of very dense silt. The groundwater level is inferred to be at approximately elevation 325 metres.

6.3 Subgrade Preparation and Embankment Construction

All surficial topsoil, organic, loose, soft and/or otherwise deleterious materials should be stripped from areas of proposed high fill construction. The exposed subgrade should be proofrolled prior to fill placement under the direction of qualified geotechnical personnel. In addition, all surficial topsoil, organic, loose, soft and deleterious materials should be removed from the existing road cross-section. It is not considered necessary to remove topsoil buried under the existing roadway fills. Grading and fill construction should be conducted in accordance with MTO Special Provision 206S03.

The roadway fill should consist of an approved earth borrow, an approved granular borrow such as Select Subgrade Material (SSM) or Granular B, Type I. The existing embankment consists mainly of clayey silt with occasional granular layers. Due to the previous problematic performance of the embankment as noted in Section 6.5, inspections by qualified geotechnical personnel during construction will be required to ensure that the placement of any clayey embankment fill does not result in adverse impacts on the drainage of the existing fill materials. Should this occur, elevated porewater pressures could develop and adversely affect the stability of the embankment side slopes. In areas where it is necessary to maintain the existing drainage of the cohesive fill materials, Granular B, Type I material should be placed or french drains installed into the existing embankment side slopes prior to placing any additional fill. In all areas where it is proposed to use cohesive fill material, positive drainage should be provided beneath the embankment by means of a 0.5 metre thick layer of Granular B Type III to prevent the development of excess porewater pressures. Construction of the embankment widening using cohesive fill should proceed during dry summer weather periods using material placed near the optimum moisture content.

Embankment fill materials should be placed in maximum 300 millimetre thick loose lifts and properly benched into the existing embankments in accordance with Ontario Provincial Standard Drawing (OPSD) 208.010 and compacted. If the embankment widenings are constructed using granular fills, the benches within the existing clayey fill should be sloped away from the existing embankment to promote drainage. In order to enhance stability, areas with oversteepened slopes should be flattened to 2 horizontal to 1 vertical prior to placement of the granular fill.

Following final grading, the embankment side slopes should be sodded and seeded in accordance with Ontario Provincial Standard Specifications (OPSS) 572 and current MTO procedures.

6.4 Settlement

6.4.1 Analyses

Settlements resulting from the new embankment construction were estimated through settlement analyses which utilized information from the existing boreholes and the design information provided to date. The fill embankments were modelled as separate approaches using the existing dimensions of the Highway 7 road cross-sections at the stations noted and extended to accommodate a 4 metre road widening in each direction. Each overhead approach was modelled as a 400 metre long section having the dimensions of the proposed widened embankment. The magnitude of the imposed load was based on our estimate of the amount of fill required for the proposed widening. The calculated load was then applied directly to the native soils beneath the existing embankments at the specified locations for the purposes of modelling.

The consolidation properties of the soils were inferred from index soil parameters using standard geotechnical correlations.

The following table shows the estimated total settlements below the embankment at selected stations.

Station	Settlement (mm)
West Approach 19+300	45
East Approach 19+400	40

Settlement due to compression of the existing and new embankment materials would be additional to the above values. It is anticipated that, due to overconsolidation of the underlying native soils, approximately 60 per cent of the settlement will occur during construction. The magnitude of post-construction settlements of both approach embankments are expected to be within MTO guidelines. According to the Foundation Layout Drawing, Department of Highways Ontario (DHO) Drawing No. D-6071-3 dated March 1967, each abutment of the CNR Overhead structure was to be founded on two rows of 5 piles spaced 3.56 metres apart. The second and fourth piles in each row were battered at 1 horizontal to 3 vertical and the remaining piles were installed vertically. The abutment piles were nominal 324 millimetres outer diameter steel tube piles with a wall thickness of 6.3 millimetres. The reported design load and length per pile is 622 kilonewtons (70 tons) and 14.63 metres (48

feet), respectively. Based on cut off elevation of 333.30 metres, the piles were founded at elevation 318.67 metres in hard clayey silt till.

Downdrag loads on the existing piles are expected to be less than 100 kilonewtons per pile. It is considered that the existing piles have sufficient capacity to accommodate the additional downdrag generated by placement of additional fill for the embankment widening; therefore, settlement of the existing CNR Overhead piled foundations in the abutment areas is expected to be minimal.

6.5 Stability

6.5.1 Existing Embankments

Previous and Existing Slope Failures

The existing CNR Overhead structure and associated embankments were constructed in 1968. Areas of distressed and/or locally oversteepened side slopes were noted along the high fills adjacent to the CNR Overhead structure during the initial site reconnaissance for this project. Differential movements were noted in the pavement surfaces in the vicinity of the abutments. On June 23, 2009, senior personnel from our office visited the site and observed that old guiderail beams had been displaced to near the midpoint of the northern side slope approximately 150 metres east of the structure (See Photograph 2). Surficial failures/slope movements were noted within 30 metres east and west of the culvert at Station 19+472. The sideslopes in this area were found to be locally inclined at 30 to 34 degrees. In the northwest quadrant, the sideslopes were inclined at 26 to 28 degrees and exhibited localized surficial failures. Evidence of local surficial movements were noted on the southern side slopes on both sides of the structure. The southern side slopes were inclined at 26 to 30 degrees. Distressed areas were observed on the western and eastern foreslopes during the bridge inspection conducted for this structure as part of GWP 361-98-00 and reported under separate cover. Loose, unvegetated granular soils were noted on both foreslopes and the top of the pile cap was exposed at the west abutment. Photographs of these areas are presented in Appendix C, Photographs 3 to 6.

Information obtained from the Geocres files describe severe post construction settlement problems with the high fills adjacent to the abutments, apparently as a result of an upper zone of inadequately compacted fill. An inspection conducted by the MTO in May 1969 reported that settlement of the approach fills had created an approximately 65 millimetre void below the approach slabs. The Principal Foundation Engineer at the time concludes that water contents were elevated presumably associated with the placement of frozen fill materials. The curb was noted to be pulling away from the slab. Tension cracks were noted at the end of the approach slab. Boreholes advanced in the areas where the distresses occurred encountered 0.8 metres of granular material underlain by 0.9 to 2.1 metres of soft clay fill with a plastic limit of 14 per cent, a liquid limit of 31 per cent, a plasticity index of 16 per cent and a water content of 16 per cent. The reported water content and Atterberg limits are within the ranges obtained from samples obtained from the current investigation. The fill below this depth was described as firm to hard clayey silt.

A memorandum from the MTO Bridge Section dated May 13, 1970 also documented the presence of settlement related voids beneath both approach slabs. At that time, a longitudinal fissure up to 0.5 metres wide and 6.1 metres long in the westbound lane was patched. A recommendation was made an April 1970 inspection report to pressure grout under the approach slabs. No Geocres information pertaining to remediation of the observed distresses has been provided.

Subsurface Conditions In Approach Slab Areas

Boreholes 301 and 303 were advanced in the vicinity of the west and east approach slabs. At the west approach, a 0.2 metre thick granular layer was encountered beneath the asphalt and concrete pavement, respectively. The granular fill was underlain by firm to very stiff clayey silt fill with N values of 6 to 9 blows per 0.3 metres to approximately elevation 331 metres and N values of 16 to 29 blows per 0.3 metres from elevation 331 to 327 metres. Above elevation 331 metres, the clayey silt fill had in situ shear strengths of 106 and 121 kilopascals. The fill was underlain by stiff to very stiff clayey silt to elevation 325 metres, very stiff clayey silt till to elevation 324 metres and very dense sandy silt till below elevation 324 metres. No voids were noted at borehole 301.

At the east approach, the asphalt and concrete pavement was underlain by 1.0 metre of granular fill to elevation 336 metres. The granular fill was underlain by firm to hard clayey silt fill with N values of 4 blows per 0.3 metres to approximately elevation 334 metres and N values of 13 to 38 blows per 0.3 metres from elevation 334 to 327 metres. Above elevation 331 metres, the clayey silt fill had in situ shear strengths of 93 and 109 kilopascals. The clayey silt fill was underlain 0.5 metres of compact silt to elevation 326 metres, then stiff to very stiff silty clay to elevation 325 metres. The silty clay was underlain by hard clayey silt till. No voids were noted at borehole 303.

6.5.2 Proposed Widened Embankments

The drawings provided by Delcan show existing embankment side slope inclinations of approximately 2 horizontal to 1 vertical along the majority of existing roadway embankments for the overhead approaches. In order to model the proposed Highway 7 improvements, the existing road cross sections were widened by 4 metres in both directions.

Based on the stability analyses, a factor of safety against instability of 1.3 is achievable for the proposed widened embankment slopes between approximately Stations 18+940 and 19+300 (along the west approach) as well as between Stations 19+360 and 19+720 (along the east approach).

In addition to the recommendations in Section 6.3, any loosened or disturbed materials should be removed and recompacted within the areas where distresses have occurred or replaced with compacted granular fill. A 2 metre wide bench should be added at mid-height for slopes more than 8 metres in height.

Any loose granular material at the abutment foreslopes should be subexcavated along with the existing cohesive embankment fill to the frost depth of 1.2 metres and replaced with granular fill placed at 2 horizontal to 1 vertical. Care must be taken not to undermine the existing abutment foundations. The granular fill should be keyed into the existing embankment fill in accordance with OPSD 208.010. Granular A or Granular B Type I containing a

maximum of 5 per cent passing the 75 micron sieve may be used for construction. The abutment foreslopes should be provided with erosion protection in accordance with current MTO standards and practices.

It is our understanding that the proposed improvements to Highway 7 have been deferred. As a result, the recommendations provided in this report should be revisited when the project proceeds to detail design. In the absence of rehabilitation to the areas of concern, continued slope instability should be expected (especially during prolonged wet periods). As a result, a slope monitoring program may be considered to be warranted for these areas. As a minimum, the slope monitoring program should include visual inspection on a regular basis.

6.6 Excavations and Temporary Cut Slopes

All excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Ontario Occupational Health and Safety Act and Regulations For Construction Projects. The fill materials at this site would be classified as Type 3 soils as would any cohesionless materials below the groundwater level. The native clayey materials, properly dewatered cohesionless materials and tills would be classified as Type 2 soils. Excavations are not expected to extend below the groundwater table.

7.0 CLOSURE

This report was prepared by the Project Engineer, Dirka U. Prout, P.Eng., and 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.

GOLDER ASSOCIATES LTD.

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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 301

1 OF 2

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
LOCATION N 4788701.3 ;E 415545.5
ORIGINATED BY MR
DIST HWY 7
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
COMPILED BY LMK
DATUM GEODETIC
DATE June 9, 2009
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
336.81	PAVEMENT SURFACE										
0.00	ASPHALT										
0.30	CONCRETE										
0.55	FILL, sand and gravel, crushed, trace silt, Brown		1	SS	7		336				
0.76	FILL, clayey silt, some sand, trace gravel, trace topsoil, Firm to very stiff, Brown to grey		2	SS	6		335				
			3	SS	9		334	+ 3.7, 120.7	3.2		3 22 45 30
			4	SS	7		333	>144			
			5	SS	16		332	>144			
			6	SS	13		331				
			7	SS	16		330				5 29 44 22
			8	SS	29		329				
			9	SS	29		328				
326.90							327				
9.91	CLAYEY SILT, trace to some sand, trace gravel, Stiff to very stiff, Brown and grey		10	SS	12		326				1 8 58 33
			11	SS	23		325				
325.08			12	SS	20	▽	324				
11.73 / 324.77	SILTY FINE SAND, Compact, Brown						323				
12.04 / 324.16	CLAYEY SILT TILL, some sand, trace gravel, Very stiff, Grey		13	SS	17		322				
12.65	SANDY SILT TILL, some gravel, trace clay, with boulders, Very dense, Grey		14	SS	110/250mm						

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 301

2 OF 2

METRIC

PROJECT 08-1132-159-0 | W.P. 361-98-00 | DIST _____ HWY 7 | DATUM GEODETIC

LOCATION N 4788701.3 ;E 415545.5 | BOREHOLE TYPE POWER AUGER, HOLLOW STEM | DATE June 9, 2009

ORIGINATED BY MR | COMPILED BY LMK | CHECKED BY _____

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
321.72 15.09	END OF BOREHOLE Auger refusal at about elev. 321.7m on possible boulder. Groundwater encountered at about elev. 325.1m during drilling on June 9, 2009.		15	SS	50/ 0mm		321				

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

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RECORD OF BOREHOLE No 302

1 OF 1

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
DIST _____ HWY 7
DATUM GEODETIC

LOCATION N 4788805.7 ;E 415680.7
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE June 9, 2009

ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.80	GROUND SURFACE										
0.00	TOPSOIL, silty										
0.18	Brown FILL, clayey silt, some sand, some gravel Very stiff to hard Brown and grey		1	SS	28		327				
			2	SS	32		326				
325.67											
2.13	FILL, silty topsoil, trace sand										
325.30	Compact		3	SS	10						
2.50	Grey FILL, clayey silt, some sand						325				
324.75	Stiff										
3.05	Grey		4	SS	10						
3.26	CLAYEY SILT, some sand, trace gravel										
324.14	Stiff										
3.66	Brown and grey mottled SILTY SAND, with clayey silt layers		5	SS	100/200mm		324				5 30 40 25
	Compact Brown CLAYEY SILT TILL, some sand, trace to some gravel, with cobbles		6	SS	43		323				
	Hard Brown to grey at about elev. 323.5m		7	SS	71						6 21 50 22
			8	SS	85		322				
							321				
			9	SS	70		320				
							319				
318.26			10	SS	100/250mm						
9.54	END OF BOREHOLE Borehole dry during drilling on June 9, 2009.										

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

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

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London, Ontario

RECORD OF BOREHOLE No 303

1 OF 2

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
DIST _____ HWY 7
DATUM GEODETIC

LOCATION N 4788733.6 ;E 415594.0
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
DATE June 10, 2009

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
336.78	PAVEMENT SURFACE										
0.00 / 336.44	ASPHALT										
0.34	CONCRETE										
0.49	FILL, sand and gravel, crushed, trace silt, Brown		1	SS	12		336				
0.64 / 335.41	FILL, sand and gravel, trace silt, cobbles, Compact, Brown		2	SS	4		335				0 20 48 32
1.37	FILL, clayey silt, some sand, trace gravel, Firm to hard, Brown and grey							+ 1.9			
							334	+ 1.7			
			3	SS	4						
			4	SS	13		333				
			5	SS	14		332				7 24 41 28
			6	SS	16						
			7	SS	19		331				
			8	SS	15		330				
			9	SS	38		329				
			10	SS	18		328				
			11	SS	16						
			12	SS	15		327				
326.26											
10.52 / 325.81	FILL, silt, trace sand, trace gravel, trace clay, Compact, Grey		13	SS	12		326				
10.97	SILTY CLAY, some sand, with silty sand layers, trace roots, Stiff to very stiff, Brown and grey mottled		14	SS	11		325			43	0 11 48 41
324.13			15	SS	29						
12.65	CLAYEY SILT TILL, trace sand, trace gravel, Hard, Brown						324				
322.91			16	SS	100/ 0mm		323				
13.87	END OF BOREHOLE Auger refusal at about elev. 322.9m on possible boulder. Borehole dry during drilling on										

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 303

2 OF 2

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
LOCATION N 4788733.6 ;E 415594.0
ORIGINATED BY MA
DIST HWY 7
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
COMPILED BY LMK
DATUM GEODETIC
DATE June 10, 2009
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	June 10, 2009.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 304

1 OF 1

METRIC

PROJECT 08-1132-159-0 | W.P. 361-98-00 | DIST _____ HWY 7 | DATUM GEODETIC

LOCATION N 4788837.0 ;E 415775.1 | BOREHOLE TYPE POWER AUGER, SOLID STEM | DATE June 10, 2009

ORIGINATED BY MA | COMPILED BY LMK | CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.02	GROUND SURFACE										
0.00	TOPSOIL, silty										
0.12	Brown FILL, clayey silt, some sand, trace gravel, trace topsoil Firm										
325.95	Brown		1	SS	6		326				
1.07	SILTY SAND, with clayey silt layers										
1.37	Loose Brown CLAYEY SILT TILL, some sand, trace to some gravel, with silt partings Stiff to hard Brown to grey at about elev. 323.4m		2	SS	10		325				
			3	SS	23						4 38 39 19
			4	SS	29		324				
			5	SS	68		323				
321.99			6	SS	77		322				
5.03	SILT, some sand, trace gravel, with silty sand, sandy silt and sand layers Very dense Grey		7	SS	100/ 300mm	▽					4 15 71 10
320.53			8	SS	100/ 250mm		321				
6.49	END OF BOREHOLE Groundwater encountered at about elev. 321.7m during drilling on June 10, 2009.										

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 305

1 OF 2

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
LOCATION N 4788646.7 ;E 415396.3
ORIGINATED BY MA
DIST HWY 7
BOREHOLE TYPE POWER AUGER, SOLID STEM
COMPILED BY LMK
DATUM GEODETIC
DATE June 11, 2009
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
334.54	GROUND SURFACE										
0.00	FILL, sand and gravel, trace silt, crushed										
0.30	Brown										
0.55	FILL, sand and gravel, trace silt, cobbles Brown		1	AS	9		334				
	FILL, clayey silt, some sand, trace gravel, with silt layers Stiff to very stiff Brown and grey		2	SS	12		333				
			3	SS	15		332				
			4	SS	16		331				
			5	SS	13						9 27 40 24
			6	SS	13		330				
			7	SS	18		329				
			8	SS	12						12 24 38 26
327.83							328				
6.71	FILL, clayey silt, trace to some sand, trace gravel, trace topsoil Firm to very stiff Brown and grey		9	SS	17		327				
			10	SS	5						
326.31							326				
8.23	CLAYEY SILT, rootlets Stiff Brown and grey mottled		11	SS	10						
325.55							325				
8.99	CLAYEY SILT TILL, some sand, trace gravel Stiff to hard Brown to grey at about elev. 324.5m		12	SS	21						3 25 42 30
			13	SS	11		324				
			14	SS	13		323				
			15	SS	100/150mm		322				
							321				
							320				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 305

2 OF 2

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
LOCATION N 4788646.7 ;E 415396.3
ORIGINATED BY MA
DIST HWY 7
BOREHOLE TYPE POWER AUGER, SOLID STEM
COMPILED BY LMK
DATUM GEODETIC
DATE June 11, 2009
CHECKED BY

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	CLAYEY SILT TILL, some sand, trace gravel Stiff to hard Brown to grey at about elev. 324.5m						319				
318.29			16	SS	106/ 250mm				○		
16.25	END OF BOREHOLE Borehole dry during drilling on June 11, 2009.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 306

1 OF 1

METRIC

PROJECT 08-1132-159-0 | W.P. 361-98-00 | DIST _____ HWY 7 | DATUM GEODETIC

LOCATION N 4788859.1 ;E 415880.7 | BOREHOLE TYPE POWER AUGER, SOLID STEM | DATE June 11, 2009

ORIGINATED BY MA | COMPILED BY LMK | CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
331.06	GROUND SURFACE										
0.00 / 330.69	FILL, sand and gravel, trace silt, crushed Brown										
0.37 / 0.52	FILL, sand and gravel, trace silt, cobbles Brown		1	SS	7		330		○		
	FILL, clayey silt, some sand, trace gravel, with silt and silty sand seams Soft to stiff Brown and grey		2	SS	3						
			3	SS	10		329		○		2 17 49 32
			4	SS	14		328		○		
327.04			5	SS	8		327		○		
4.02 / 326.64	FILL, clayey silt, some sand, trace gravel, with topsoil and rootlets Stiff Grey					▽					
4.42	CLAYEY SILT TILL, some sand, trace gravel Stiff to hard Brown to grey at about elev. 324.1m		6	SS	11		326		○		
			7	SS	30		325		○		5 35 38 22
			8	SS	100/ 250mm		324				
			9	SS	68		323				
322.22											
8.84	END OF BOREHOLE Groundwater encountered at about elev. 326.6m during drilling on June 11, 2009.										

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

LDN_MTO_01 08-1132-159-0.GPJ LDN_MTO.GDT 12/17/09

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 307

1 OF 2

METRIC

PROJECT 08-1132-159-0 | W.P. 361-98-00 | DIST _____ HWY 7 | DATUM GEODETIC

LOCATION N 4788758.1 ;E 415676.3 | BOREHOLE TYPE POWER AUGER, SOLID STEM | DATE June 12, 2009

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)	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
336.04	GROUND SURFACE										
0.00 / 0.12	FILL, sand and gravel, trace silt, Brown										
335.43 / 0.61	FILL, coarse sand and fine gravel, trace silt, Brown										
	FILL, clayey silt, some sand, trace gravel, with silt, silty sand and sand seams and layers, Stiff to hard, Brown to grey		1	SS	11		335				
			2	SS	10		334				
			3	SS	17		333				
			4	SS	17		332				
			5	SS	8			>144			4 21 49 28
			6	SS	42		331				
			7	SS	23		330				
			8	SS	12		329				
			9	SS	17		328				1 19 48 32
			10	SS	12		327				
326.29 / 9.75	FILL, clayey silt, some sand, trace gravel, trace topsoil		11	SS	17						
325.95 / 10.09	Very stiff, Grey		12	SS	17		326				
10.36	TOPSOIL, silty, trace sand, Very stiff, Grey		13	SS	21		325				7 23 45 25
	CLAYEY SILT TILL, some sand, trace gravel, Very stiff to hard, Brown		14	SS	52		324				
322.93 / 13.11	SILT, trace sand, trace gravel, trace clay, Very dense, Grey		15	SS	100/175mm		323				
							322				

Continued Next Page

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 307

2 OF 2

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
LOCATION N 4788758.1 ;E 415676.3
ORIGINATED BY MA
DIST HWY 7
BOREHOLE TYPE POWER AUGER, SOLID STEM
COMPILED BY LMK
DATUM GEODETIC
DATE June 12, 2009
CHECKED BY

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	SILT, trace sand, trace gravel, trace clay Very dense Grey										
320.10			16	SS	100/ 200mm						
15.94	END OF BOREHOLE Borehole dry during drilling on June 12, 2009.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 308

1 OF 2

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
DIST _____ HWY 7
DATUM GEODETIC
LOCATION N 4788786.4 ;E 415741.3
BOREHOLE TYPE POWER AUGER, SOLID STEM
DATE June 16, 2009
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
334.73	GROUND SURFACE										
0.00	FILL, sand and gravel, trace silt, crushed										
0.21 / 334.21	Brown										
0.52	FILL, sand and gravel, trace silt										
	Brown										
	FILL, clayey silt, some sand, trace gravel		1	SS	12		334				
	Stiff to hard										
	Brown to grey		2	SS	64		333				
			3	SS	18		332				
			4	SS	20						1 12 52 35
331.07											
3.66	FILL, clayey silt, some sand, trace gravel, with silt and silty sand seams and layers		5	SS	20		331				
	Stiff to very stiff										
	Brown and grey		6	SS	22		330				
			7	SS	23		329				
			8	SS	10						2 30 45 23
							328				
			9	SS	26						
			10	SS	21		327				
			11	SS	20		326				
325.59											
9.14	TOPSOIL, silty, trace sand										
9.27	Very stiff		12	SS	15						
	Brown						325				
	CLAYEY SILT, some sand, trace gravel										
324.67											
10.06	Very stiff										
	Brown										
	CLAYEY SILT TILL, some sand, trace gravel		13	SS	31		324				
	Hard										
	Brown to grey at about elev. 323.3m										
							323				
			14	SS	59						3 20 51 26
321.62							322				
13.11	SAND AND GRAVEL, some silt										
	Very dense										
	Grey		15	SS	100/175mm		321				
320.40											
14.33	SILT, trace sand, trace gravel										
320.10	Very dense		16	SS	100/150mm						
14.63	Grey										

Continued Next Page

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 308

2 OF 2

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
LOCATION N 4788786.4 ;E 415741.3
ORIGINATED BY MA
DIST HWY 7
BOREHOLE TYPE POWER AUGER, SOLID STEM
COMPILED BY LMK
DATUM GEODETIC
DATE June 16, 2009
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	END OF BOREHOLE Groundwater encountered at about elev. 323.8m during drilling on June 16, 2009. Water level measured in standpipe at elev. 320.28m on June 16, 2009. Water level measured in standpipe at elev. 324.44m on August 12, 2009. Water level measured in standpipe at elev. 324.15m on September 28, 2009.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 309

1 OF 1

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
DIST _____ HWY 7
DATUM GEODETIC
LOCATION N 4788619.5 ;E 415299.3
BOREHOLE TYPE POWER AUGER, SOLID STEM
DATE June 16, 2009
ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.65	GROUND SURFACE										
0.00	TOPSOIL, sitly Brown										
0.27	SILT, trace sand, trace clay Compact Brown						327				
326.65			1	SS	11				○ ○		
1.00	CLAYEY SILT TILL, some sand, trace gravel, with silt, silty sand and sand seams and layers Stiff to very stiff Brown to grey at about elev. 325.2m		2	SS	15		326				
			3	SS	15		325		○ — ○		2 14 35 49
			4	SS	11						
			5	SS	14		324		○		
			6	SS	15		323				
322.47											
5.18	END OF BOREHOLE Borehole dry during drilling on June 16, 2009.										

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 310

1 OF 1

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
LOCATION N 4788716.7 ;E 415483.3
ORIGINATED BY MA
DIST HWY 7
BOREHOLE TYPE POWER AUGER, SOLID STEM
COMPILED BY LMK
DATUM GEODETIC
DATE June 18, 2009
CHECKED BY

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
327.82	GROUND SURFACE							
0.09	TOPSOIL, silty Brown FILL, clayey silt, some sand, trace gravel Stiff							
326.75	Brown	1	SS	10				
1.07	CLAYEY SILT, some topsoil Stiff							
1.37	Brown CLAYEY SILT TILL, trace to some sand and gravel Very stiff to hard Brown to grey at about elev. 322.8m	2	SS	19				
		3	SS	26	0	7	53	40
		4	SS	30				
		5	SS	18				
		6	SS	19				
		7	SS	81	12	21	46	21
		8	SS	84				
320.66								
7.16	SILT, trace sand, trace gravel Very dense Grey	9	SS	96				
318.28		10	SS	100/250mm				
9.54	END OF BOREHOLE Borehole dry during drilling on June 18, 2009.							

ELEVATION SCALE: 327, 326, 325, 324, 323, 322, 321, 320, 319

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × 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/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GROUND WATER CONDITIONS

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

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

LDN_MTO_01 08-1132-159-0.GPJ LDN_MTO.GDT 12/17/09

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 311

1 OF 1

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
LOCATION N 4788603.0 ;E 415361.2
ORIGINATED BY MA
DIST HWY 7
BOREHOLE TYPE POWER AUGER, SOLID STEM
COMPILED BY LMK
DATUM GEODETIC
DATE June 18, 2009
CHECKED BY

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.48	GROUND SURFACE						
0.09	TOPSOIL, silty, Brown						
	CLAYEY SILT TILL, trace to some sand, trace gravel with silt seams, Stiff to very stiff, Brown	1	SS	20	327		
		2	SS	14	326		
325.65							
1.83	SILT, some sand, with clayey silt seams and layers, Compact, Brown	3	SS	12			
325.19					325		
2.29	CLAYEY SILT TILL, trace to some sand, trace gravel, Stiff, Brown	4	SS	7			0 1 57 42
2.59	CLAYEY SILT, trace sand, with silty sand seams, Firm, Grey	5	SS	4	324		
322.60					323		
4.88	SAND, fine to medium, trace silt, Compact, Grey	6	SS	16			0 88 6 6
322.09					322		
5.39	CLAYEY SILT TILL, trace sand, trace gravel, Hard, Grey	7	SS	60			
321.08							
6.40	SILT, with sand, trace gravel, trace clay, Very dense, Grey	8	SS	100/200mm	321		
320.71							
6.77	END OF BOREHOLE						

Groundwater encountered at about elev. 322.6m during drilling on June 18, 2009.

Water level measured in standpipe at elev. 320.71m on June 18, 2009.

Water level measured in standpipe at elev. 326.73m on August 12, 2009.

Water level measured in standpipe at elev. 326.36m on September 28, 2009.

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

+1.5
+1.9

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

LDN_MTO_01 08-1132-159-0.GPJ LDN_MTO.GDT 12/17/09

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 312

1 OF 1

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
DIST _____ HWY 7
DATUM GEODETIC

LOCATION N 4788639.0 ;E 415456.8
BOREHOLE TYPE POWER AUGER, SOLID STEM
DATE June 18, 2009

ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.48	GROUND SURFACE										
0.00	TOPSOIL, silty Brown										
0.27	FILL, clayey silt, trace sand, trace gravel, trace topsoil Brown										
0.52	CLAYEY SILT TILL, trace to some sand, trace gravel, with silt seams Stiff to hard Brown to grey at about elev. 323.8m		1	SS	17		327				
			2	SS	24		326		○		
			3	SS	24		325				
			4	SS	10				○ —		0 7 58 35
			5	SS	9		324				
							323	>144			
			6	SS	80		322		○		
			7	SS	100/200mm		321				
			8	SS	100/250mm		320		○ —		6 26 44 24
							319				
318.03			9	SS	66						
9.45	END OF BOREHOLE Borehole dry during drilling on June 18, 2009.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 313

1 OF 1

METRIC

PROJECT 08-1132-159-0
W.P. 361-98-00
DIST _____ HWY 7
DATUM GEODETIC
LOCATION N 4788816.4 ;E 415842.0
BOREHOLE TYPE POWER AUGER, SOLID STEM
DATE June 22, 2009
ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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
326.12	GROUND SURFACE										
0.00	TOPSOIL, silty, trace sand Brown						326				
0.24	CLAYEY SILT TILL, some sand, trace to some gravel, with silt partings Very stiff to hard Brown to grey at about elev. 323.2m		1	SS	24		325		o		
			2	SS	18						
			3	SS	30		324		o		
			4	SS	73		323				
			5	SS	35		322		o		
			6	SS	69						
320.94							321				
5.18	CLAYEY SILT, some sand, trace gravel, with silt layers Hard Grey		7	SS	62				o——		2 17 57 24
319.57			8	SS	80		320				
6.55	END OF BOREHOLE Borehole dry during drilling on June 22, 2009.										

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 314

1 OF 1

METRIC

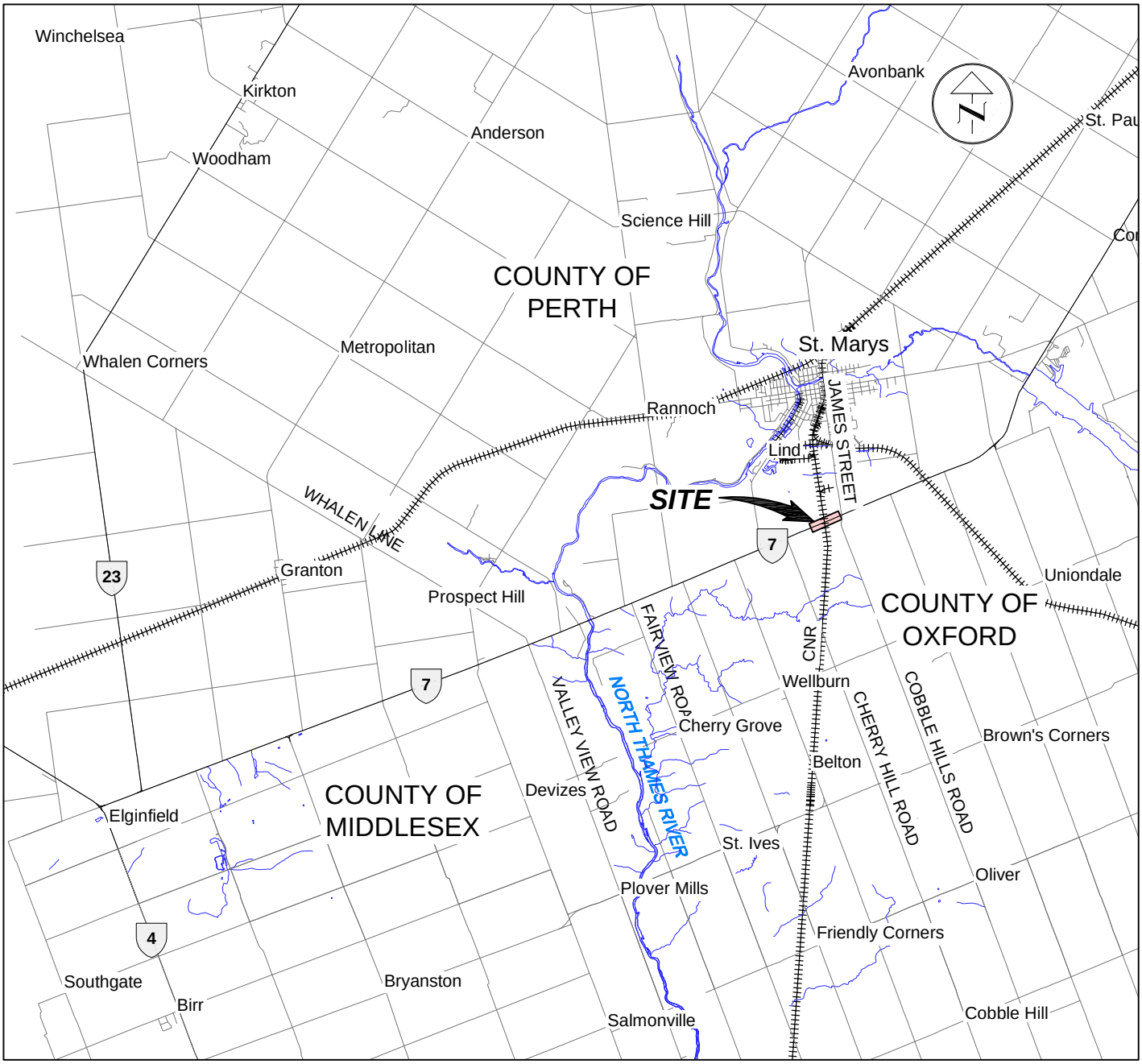
PROJECT 08-1132-159-0
W.P. 361-98-00
DIST _____ HWY 7
DATUM GEODETIC
LOCATION N 4788716.4 ;E 415653.3
BOREHOLE TYPE POWER AUGER, SOLID STEM
DATE June 22, 2009
ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.36	GROUND SURFACE						326				
0.00	TOPSOIL, silty Brown										
0.24 325.81	FILL, clayey silt, with topsoil										
0.55	Brown CLAYEY SILT TILL, some sand, trace gravel, with silt and silty sand seams and layers Stiff to hard Brown to grey at about elev. 323.5m		1	SS	12		325				
			2	SS	17						
			3	SS	26		324				
			4	SS	31		323				
			5	SS	36						5 23 46 26
			6	SS	68		322				
			7	SS	28		321				
320.42											
5.94	SILT, trace sand, with clayey silt layers Very dense Grey		8	SS	100		320				
319.35											
7.01	CLAYEY SILT TILL, some sand, trace gravel Hard Grey		9	SS	100		319				4 27 44 25
			10	SS	74		318				
			11	SS	101		317				
315.23							316				
11.13	END OF BOREHOLE Borehole dry during drilling on June 22, 2009.										

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

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

LDN_MTO_01 08-1132-159-0.GPJ LDN_MTO.GDT 12/17/09



SCALE IN METRES

0 3000 6000

1:150000

REFERENCE

DRAWING BASED ON CANMAP STREETFILES V2005.4.

NOTE

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

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

HIGH FILLS - CNR OVERHEAD REHABILITATION OF HIGHWAY 7 GWP 361-98-00

TITLE

KEY PLAN

Golder Associates LONDON, ONTARIO

PROJECT No.	08-1132-159-0		FILE No.	0811321590-2000-F03001
			SCALE	AS SHOWN REV. 0
CADD	DMB/LMK	Dec. 8/09		
CHECK				

FIGURE 1

Drawing file: 0811321590-2000-F03001.dwg Feb 11, 2010 - 9:40am

MINISTRY OF TRANSPORTATION, ONTARIO

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

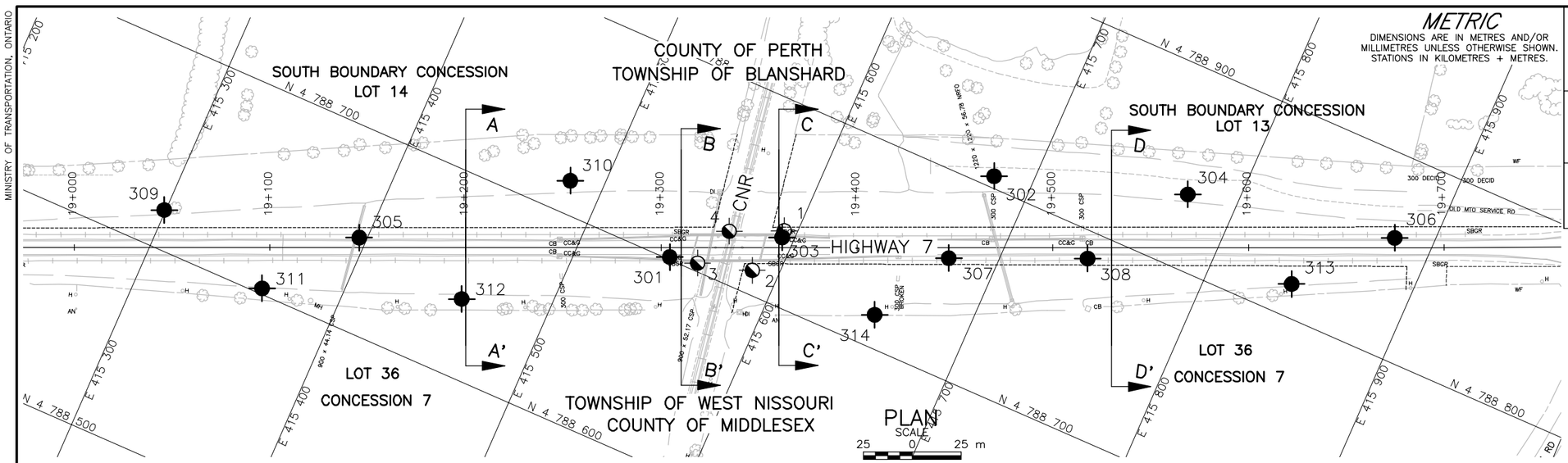
CONT No.
WP No. 361-98-00

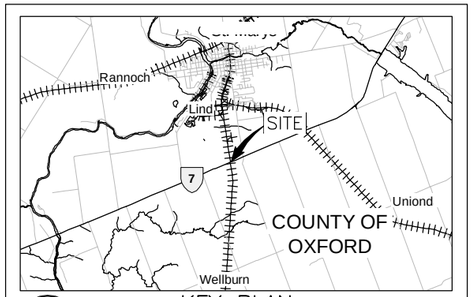
SHEET

HIGH FILLS – CNR OVERHEAD

REHABILITATION OF HIGHWAY 7
BOREHOLE LOCATIONS & SOIL STRATA

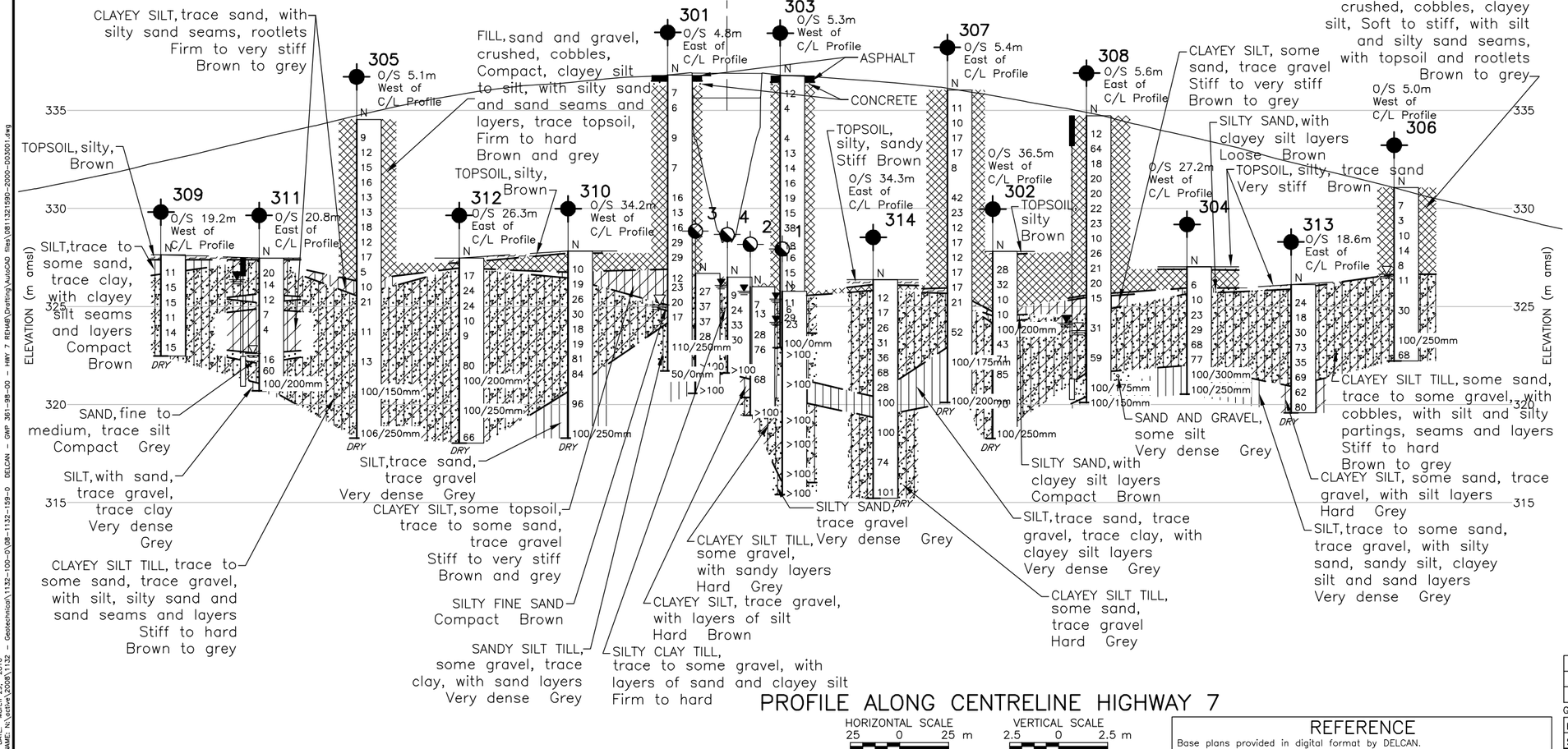
Golder Associates Ltd.
LONDON, ONTARIO, CANADA





LEGEND

- Borehole – Current Investigation
- Borehole (Geocres #40P03-028)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Seal
- Standpipe
- DRY Borehole dry during drilling
- WL encountered during drilling
- Measured WL



PROFILE ALONG CENTRELINE HIGHWAY 7

HORIZONTAL SCALE 25 0 25 m
VERTICAL SCALE 2.5 0 2.5 m

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
301	336.81	4 788 701.3	415 545.5
302	327.80	4 788 805.7	415 680.7
303	336.78	4 788 733.6	415 594.0
304	327.02	4 788 837.0	415 775.1
305	334.54	4 788 646.7	415 396.3
306	331.06	4 788 859.1	415 880.7
307	336.04	4 788 758.1	415 676.3
308	334.73	4 788 786.4	415 741.3
309	327.65	4 788 619.5	415 299.3
310	327.82	4 788 716.7	415 483.3
311	327.48	4 788 603.0	415 361.2
312	327.48	4 788 639.0	415 456.8
313	326.12	4 788 816.4	415 842.0
314	326.36	4 788 716.4	415 653.3
(Geocres	#40P03-028)		
1	325.77	4 788 737.1	415 593.6
2	326.01	4 788 712.0	415 586.8
3	326.68	4 788 704.2	415 559.8
4	326.50	4 788 725.6	415 568.0

NOTES

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

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

Please refer to Record of Boreholes and Sections for further detail.

REFERENCE

Base plans provided in digital format by DELCAN.

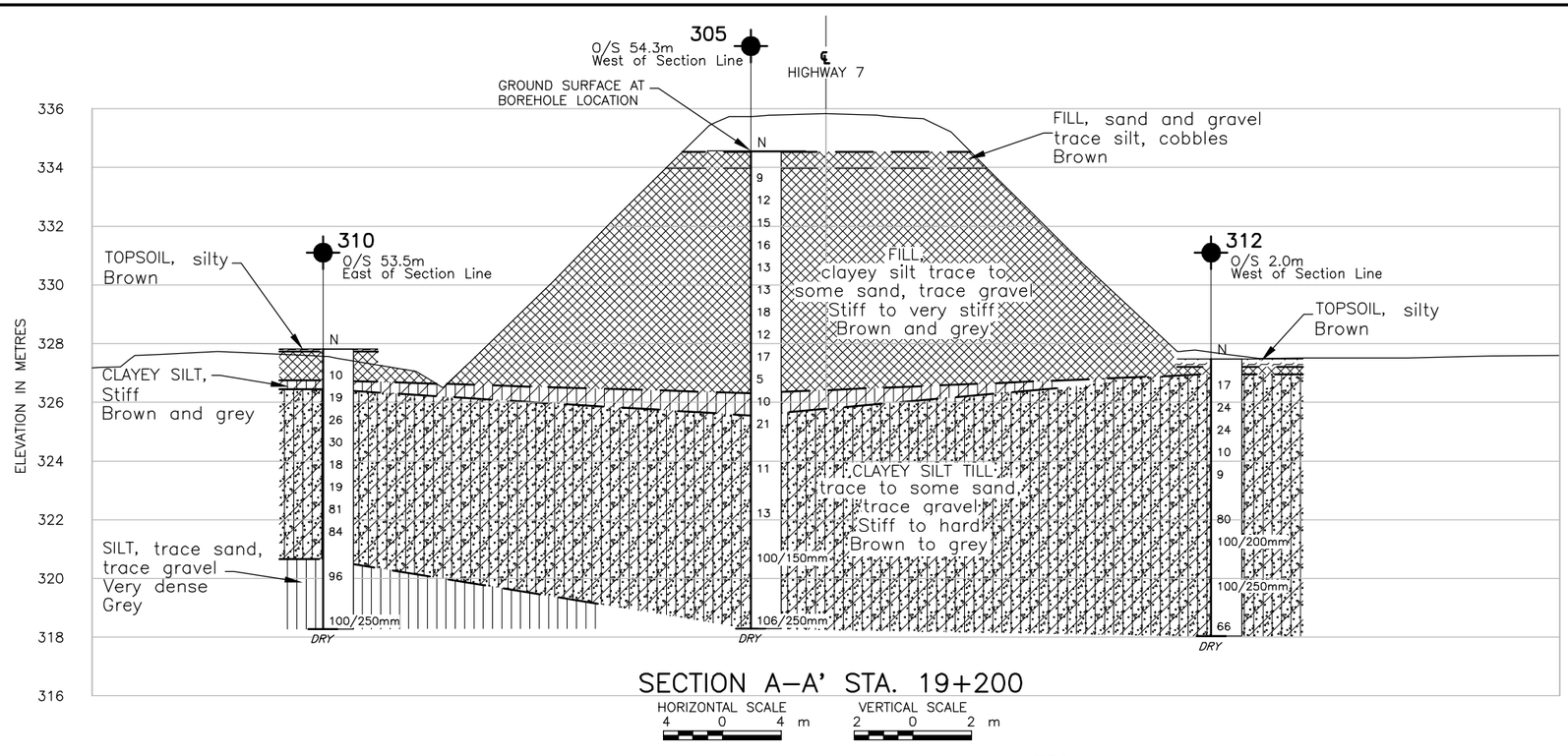
NO.	DATE	BY	REVISION

Geocres No. 40P3-50

HWY. 7		PROJECT NO. 08-1132-159-0		DIST.
SUBM'D. DUP	CHKD.		DATE: Dec. 8/09	SITE:
DRAWN: DMB/LMK	CHKD.		APPD.	DWG. 1

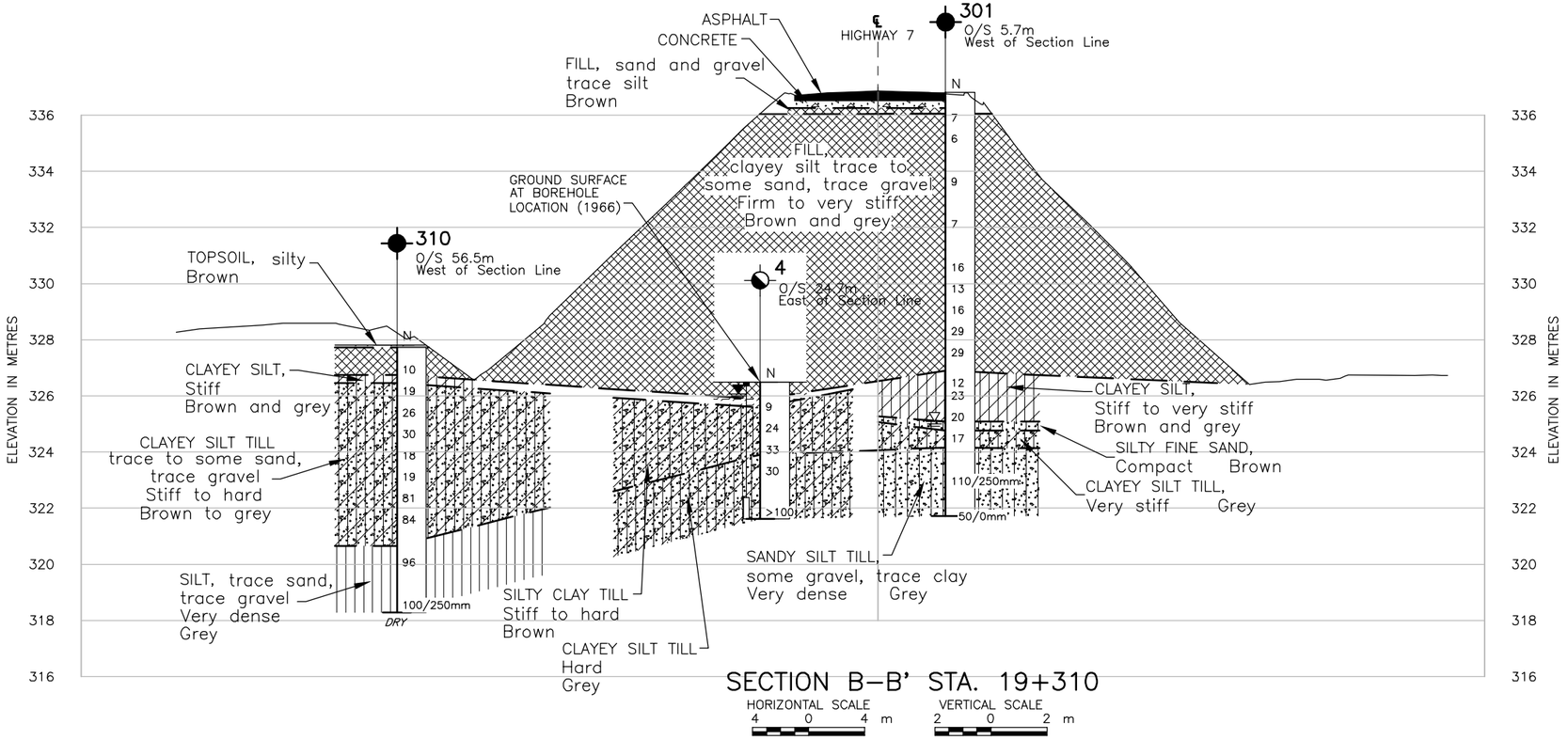
PLOT DATE: March 29, 2010
FILENAME: N:\active\2008\1132 - Geotechnical\1132-100-01\08-1132-159-0 DELCAN - GWP 361-98-00 - HWY 7 REHAB\Drafting\AutoCAD files\08113215900-2000-003001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO



SECTION A–A' STA. 19+200

HORIZONTAL SCALE 4 0 4 m
VERTICAL SCALE 2 0 2 m



SECTION B–B' STA. 19+310

HORIZONTAL SCALE 4 0 4 m
VERTICAL SCALE 2 0 2 m

METRIC

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

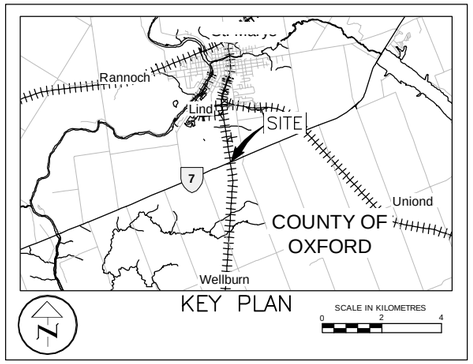
CONT No.
WP No. 361–98–00

HIGH FILLS – CNR OVERHEAD

REHABILITATION OF HIGHWAY 7
SOIL STRATA

SHEET

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN

LEGEND

- Borehole – Current Investigation
- Borehole (Geocres #40P03–028)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Seal
- Standpipe
- DRY Borehole dry during drilling
- WL upon completion of drilling
- Measured WL

No.	ELEVATION	CO–ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
301	336.81	4 788 701.3	415 545.5
305	334.54	4 788 646.7	415 396.3
310	327.82	4 788 716.7	415 483.3
312	327.48	4 788 639.0	415 456.8
(Geocres #40P03–028)			
4	326.50	4 788 725.6	415 568.0

NOTES

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

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

Please refer to Record of Boreholes and Sections for further detail.

REFERENCE

Base plans provided in digital format by DELCAN.

NO.	DATE	BY	REVISION

Geocres No. 40P3–50

HWY. 7	PROJECT NO. 08–1132–159–0		DIST.
SUBM'D. DUP	CHKD.	DATE: Oct. 23/09	SITE:
DRAWN: WDF/LMK	CHKD.	APPD.	DWG. 2

PLOT DATE: March 29, 2010
FILENAME: N:\active\2008\1132 – Geotechnical\1132–100–0\08–1132–159–0 DELCAN – GWP 361–98–00 – HWY 7 REHAB\Drafting\AutoCAD files\081321590–2000–003001.dwg

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

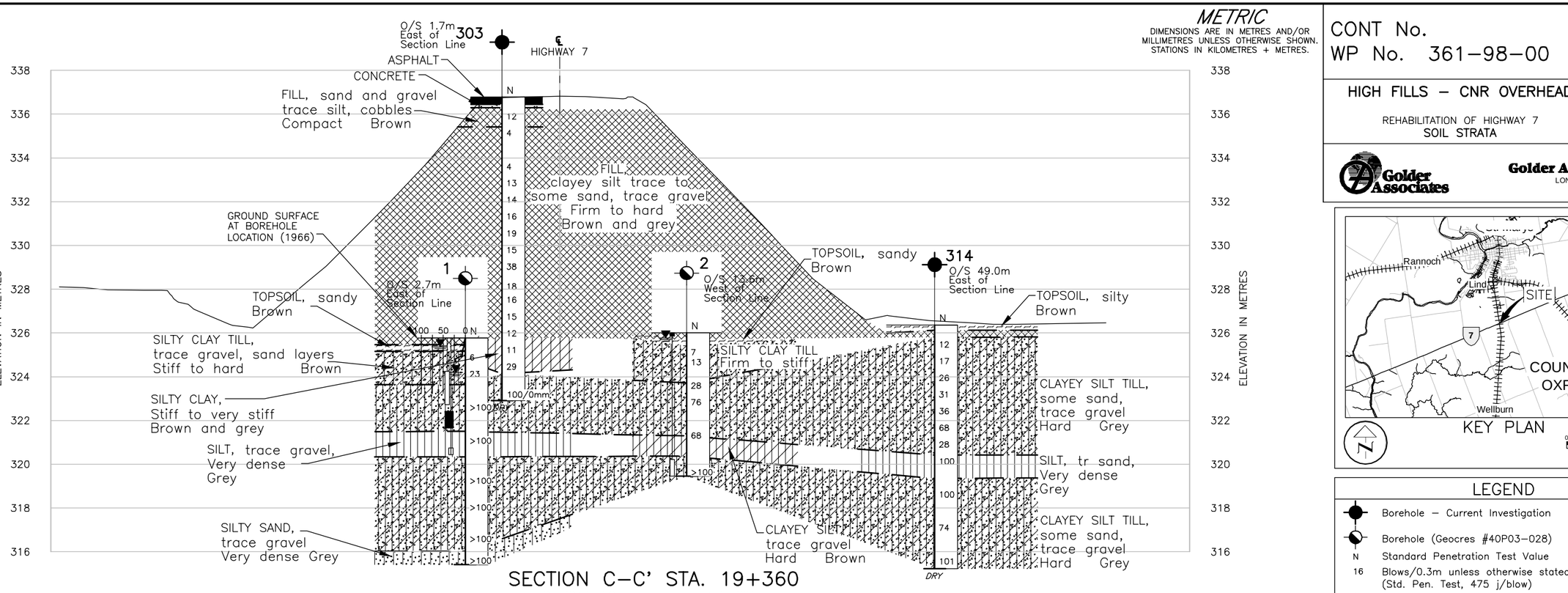
CONT No.
WP No. 361-98-00

HIGH FILLS – CNR OVERHEAD

REHABILITATION OF HIGHWAY 7
SOIL STRATA

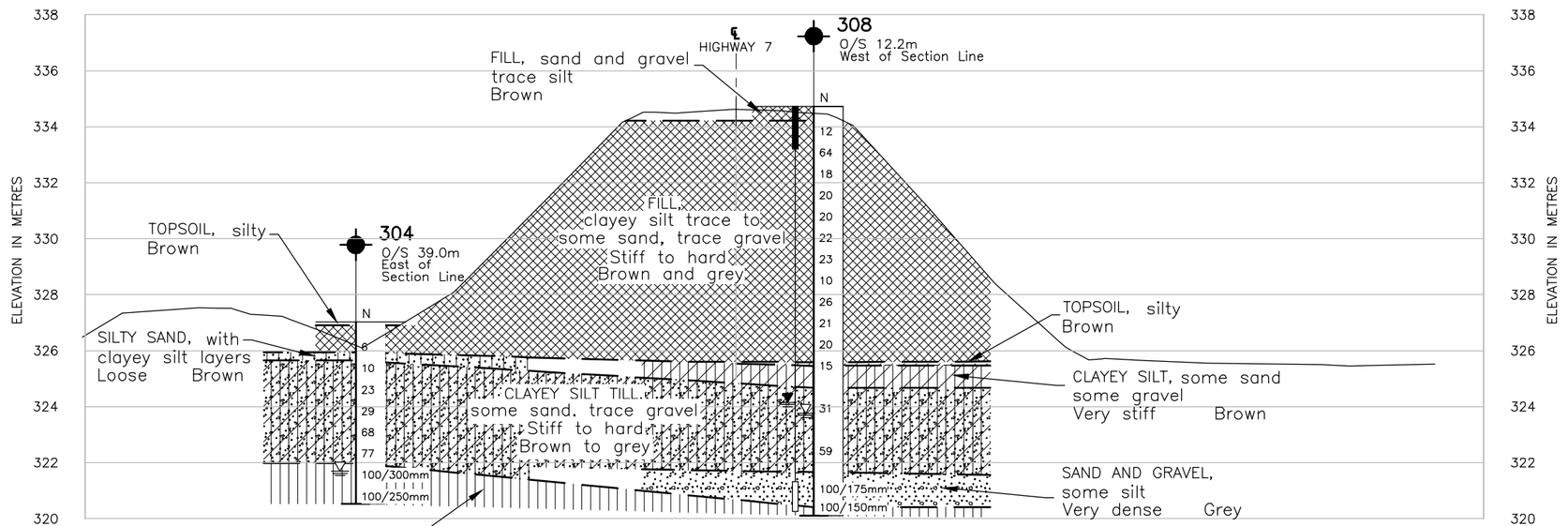
SHEET

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



SECTION C–C' STA. 19+360

HORIZONTAL SCALE 4 0 4 m
VERTICAL SCALE 2 0 2 m



SECTION D–D' STA. 19+530

HORIZONTAL SCALE 4 0 4 m
VERTICAL SCALE 2 0 2 m

LEGEND

- Borehole – Current Investigation
- Borehole (Geocres #40P03–028)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Seal
- Standpipe
- DRY Borehole dry during drilling
- WL encountered during drilling
- Measured WL

No.	ELEVATION	CO–ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
303	336.78	4 788 733.6	415 594.0
304	327.02	4 788 837.0	415 775.1
308	334.73	4 788 786.4	415 741.3
314	326.36	4 788 716.4	415 659.3
(Geocres #40P03–028)			
1	325.77	4 788 737.1	415 593.6
2	326.01	4 788 712.0	415 586.8

NOTES

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

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

Please refer to Record of Boreholes and Sections for further detail.

REFERENCE

Base plans provided in digital format by DELCAN.

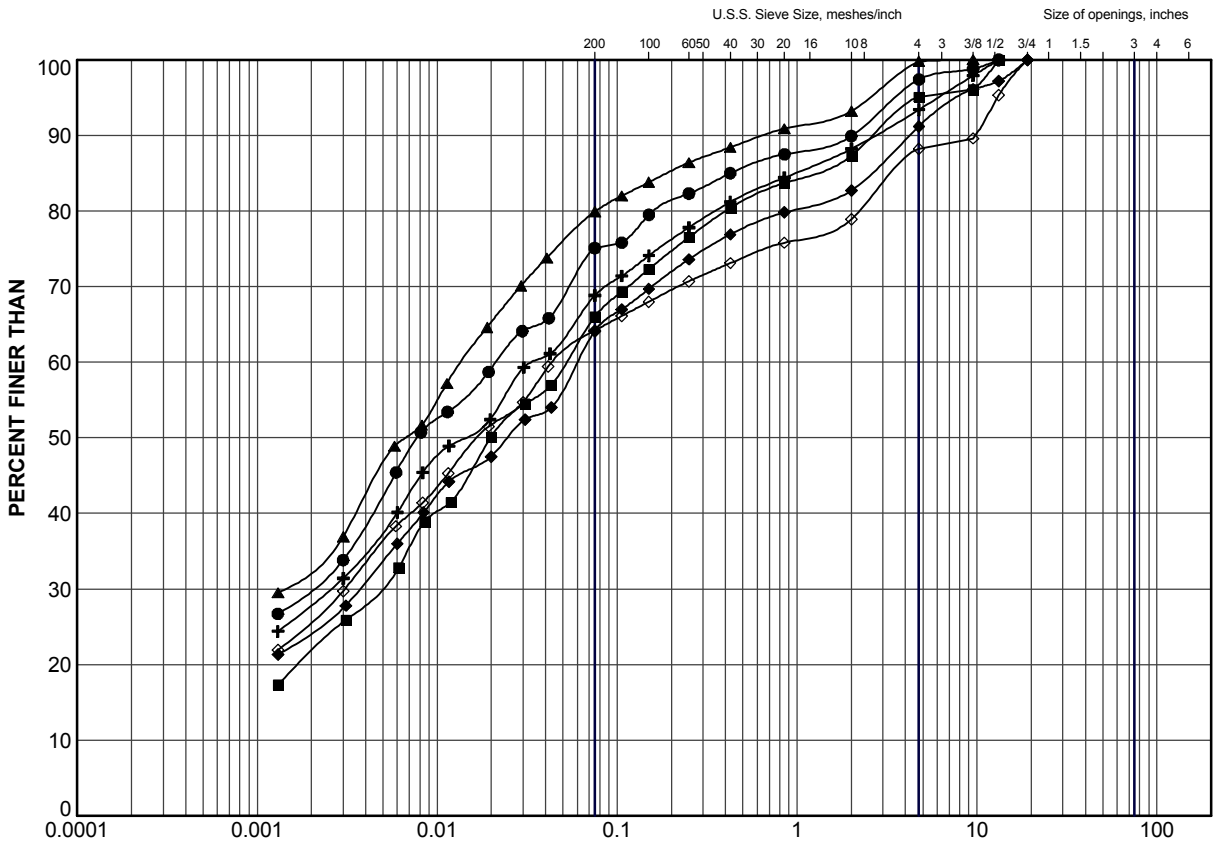
NO.	DATE	BY	REVISION

Geocres No. 40P3–50

HWY. 7		PROJECT NO. 08–1132–159–0	DIST.
SUBM'D. DUP	CHKD.	DATE: Dec. 8/09	SITE:
DRAWN: WDF/LMK	CHKD.	APPD.	DWG. 3

APPENDIX A

Laboratory Test Data (Current Investigation)



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	301	3	333.5
■	301	7	325.0
▲	303	2	335.0
+	303	5	332.0
◆	305	5	330.5
◇	305	8	328.2

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE

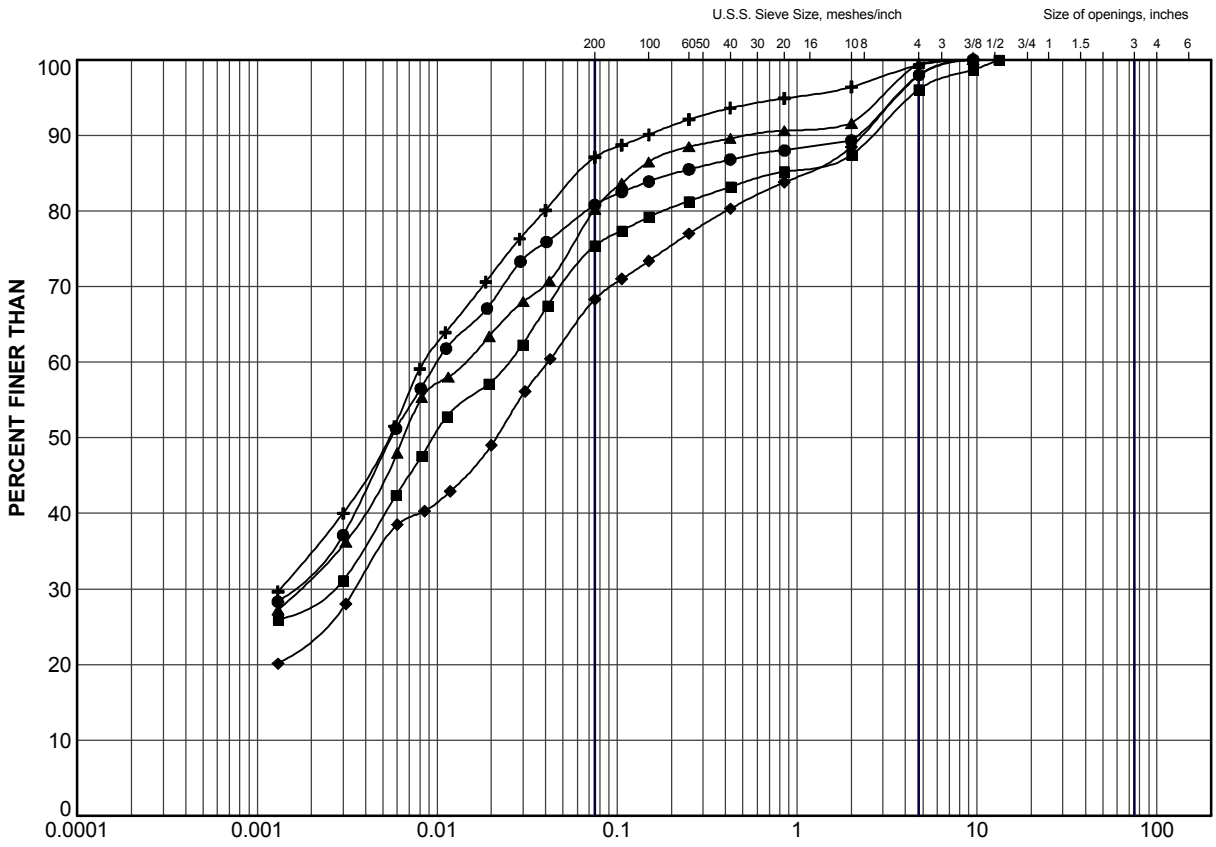
GRAIN SIZE DISTRIBUTION

FILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-159-0	FILE No.	0811321590-2000-R030A1	
			SCALE	N/A	REV.
DRAWN	LMK	Oct 22/09			
CHECK			**FIGURE**	**A-1**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	306	3	328.5
■	307	5	332.0
▲	307	9	328.2
+	308	4	331.5
◆	308	8	328.4

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE

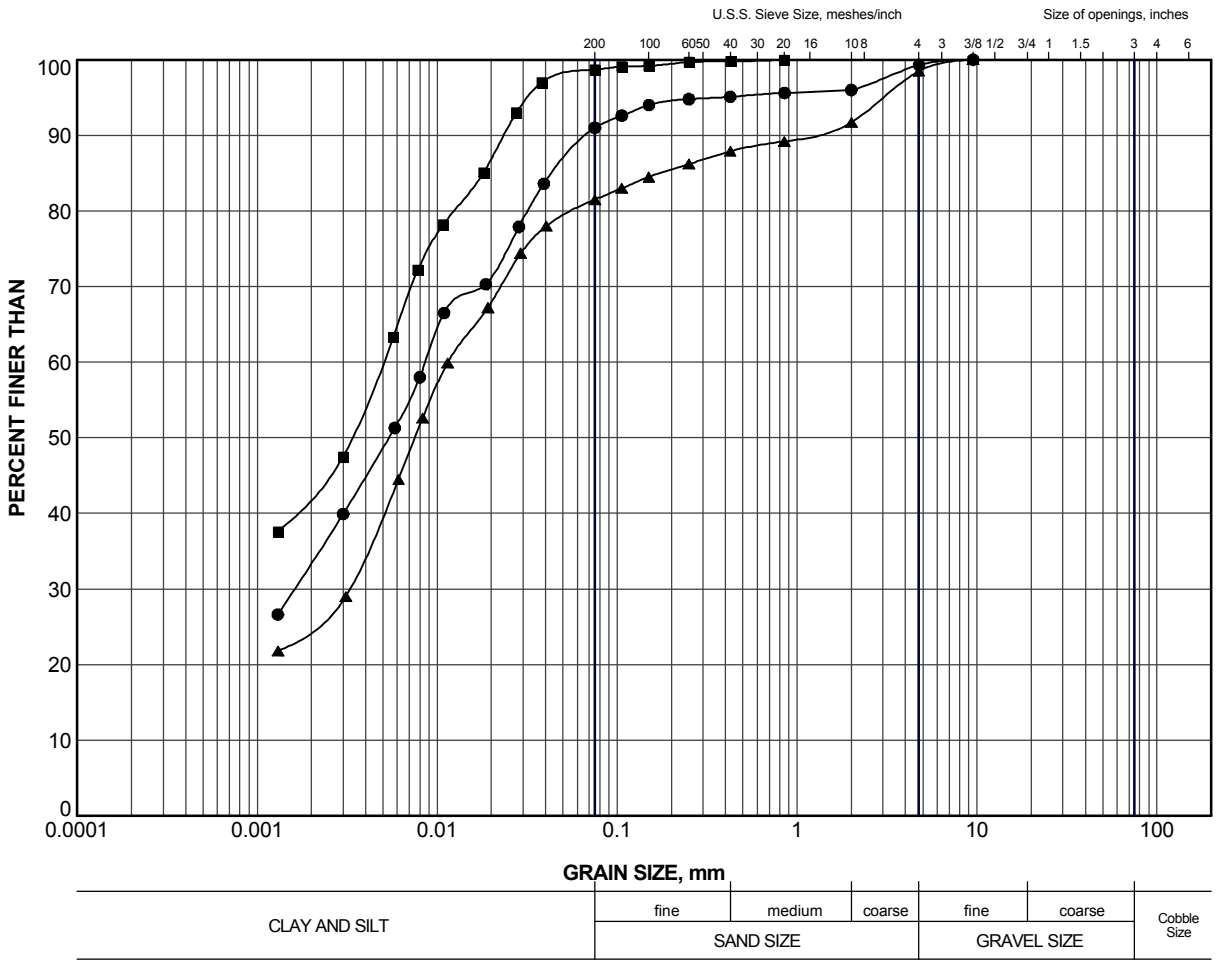
GRAIN SIZE DISTRIBUTION

FILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-159-0	FILE No.	0811321590-2000-R030A2	
			SCALE	N/A	REV.
DRAWN	LMK	Oct 22/09			
CHECK			**FIGURE**		**A-2**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	301	11	325.9
■	311	4	324.5
▲	313	7	320.6

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE

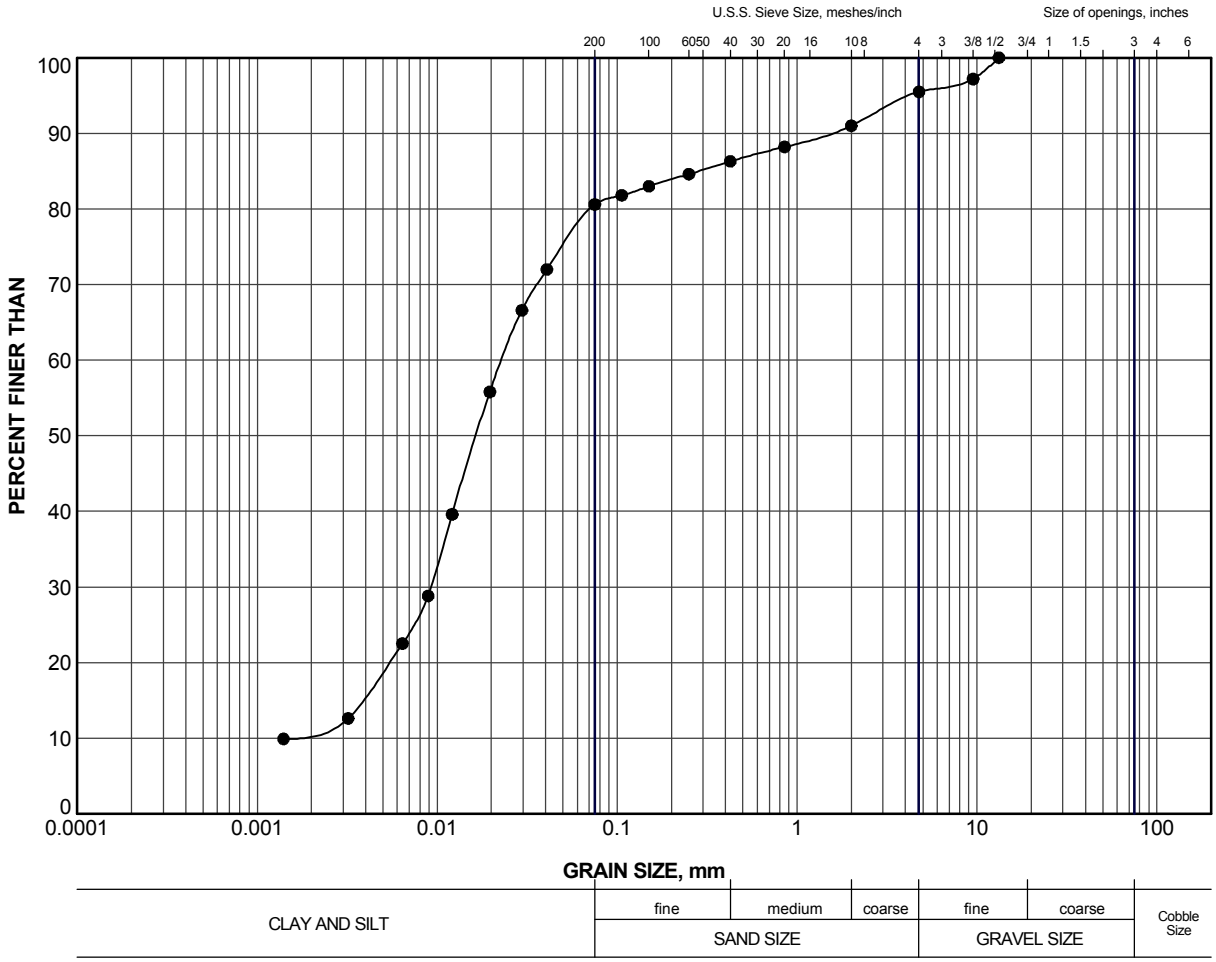
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-159-0		FILE No.	0811321590-2000-R030A3	
			SCALE	N/A	REV.
DRAWN	LMK	Oct 22/09			
CHECK			**FIGURE**	**A-3**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	304	7	321.5

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE

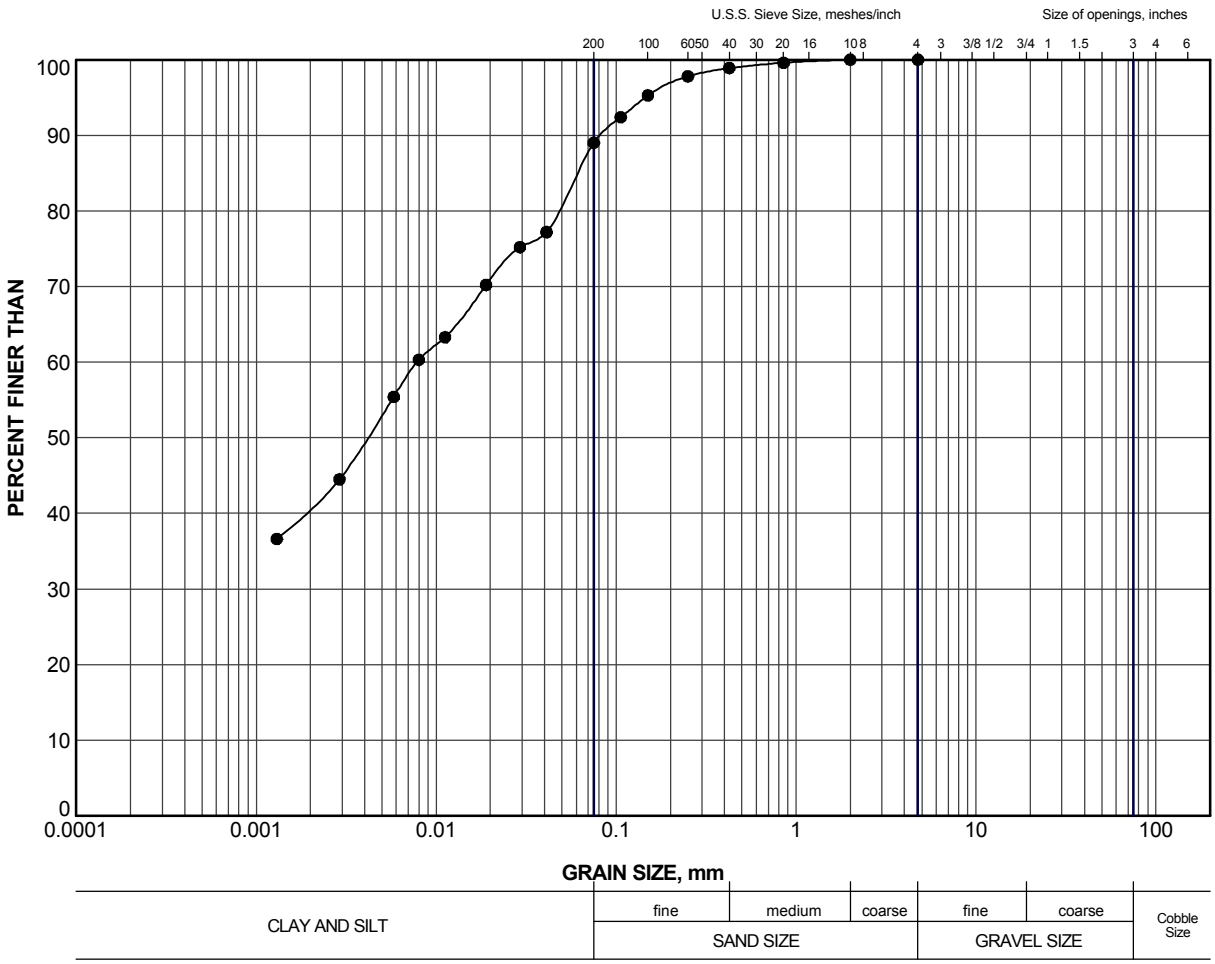
GRAIN SIZE DISTRIBUTION

SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-159-0		FILE No.	0811321590-2000-R030A4	
			SCALE	N/A	REV.
DRAWN	LMK	Oct 22/09			
CHECK			**FIGURE**	**A-4**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	303	14	325.9

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE

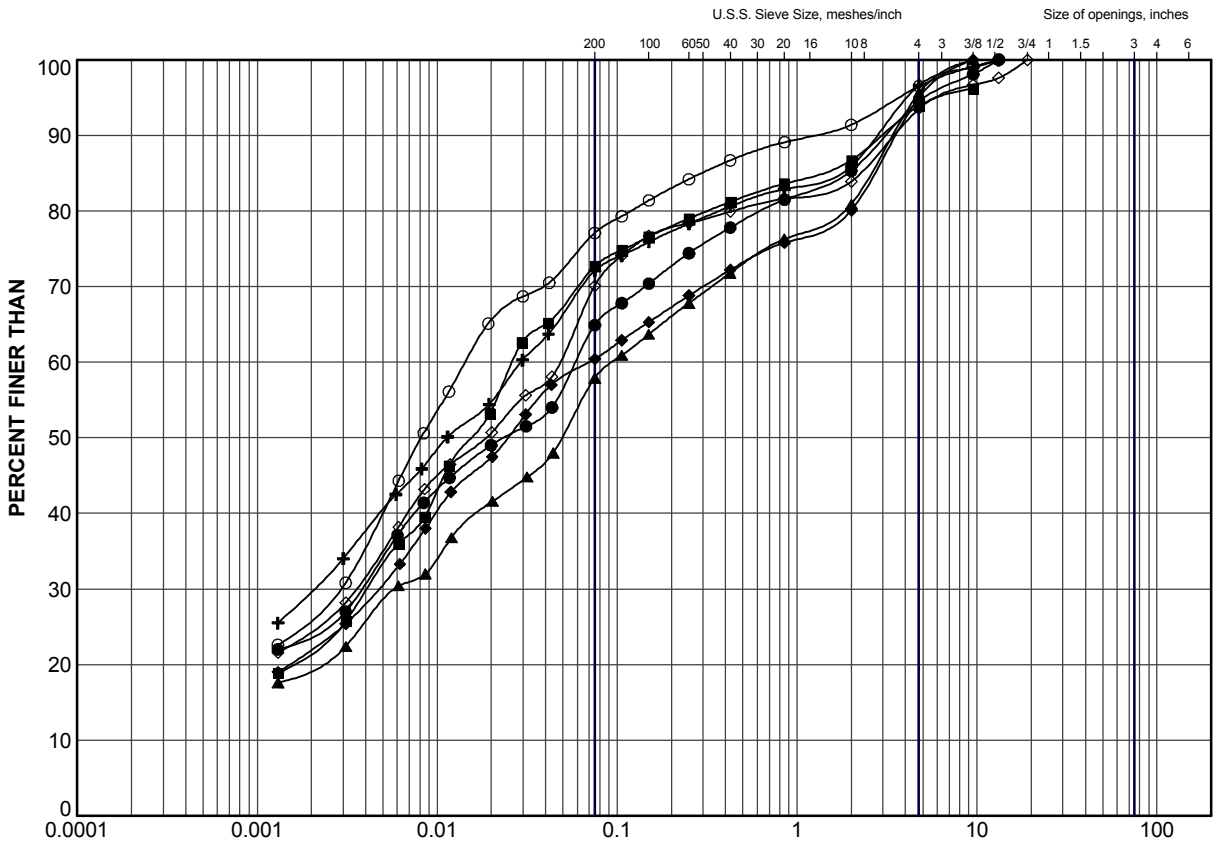
GRAIN SIZE DISTRIBUTION

SILTY CLAY

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-159-0		FILE No.	0811321590-2000-R030A5
			SCALE	N/A REV.
DRAWN	LMK	Oct 01/09		
CHECK			**FIGURE**	**A-5**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	302	5	323.8
■	302	7	322.2
▲	304	3	324.5
+	305	12	325.2
◆	306	7	324.7
◇	307	13	325.1
○	308	14	322.3

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE

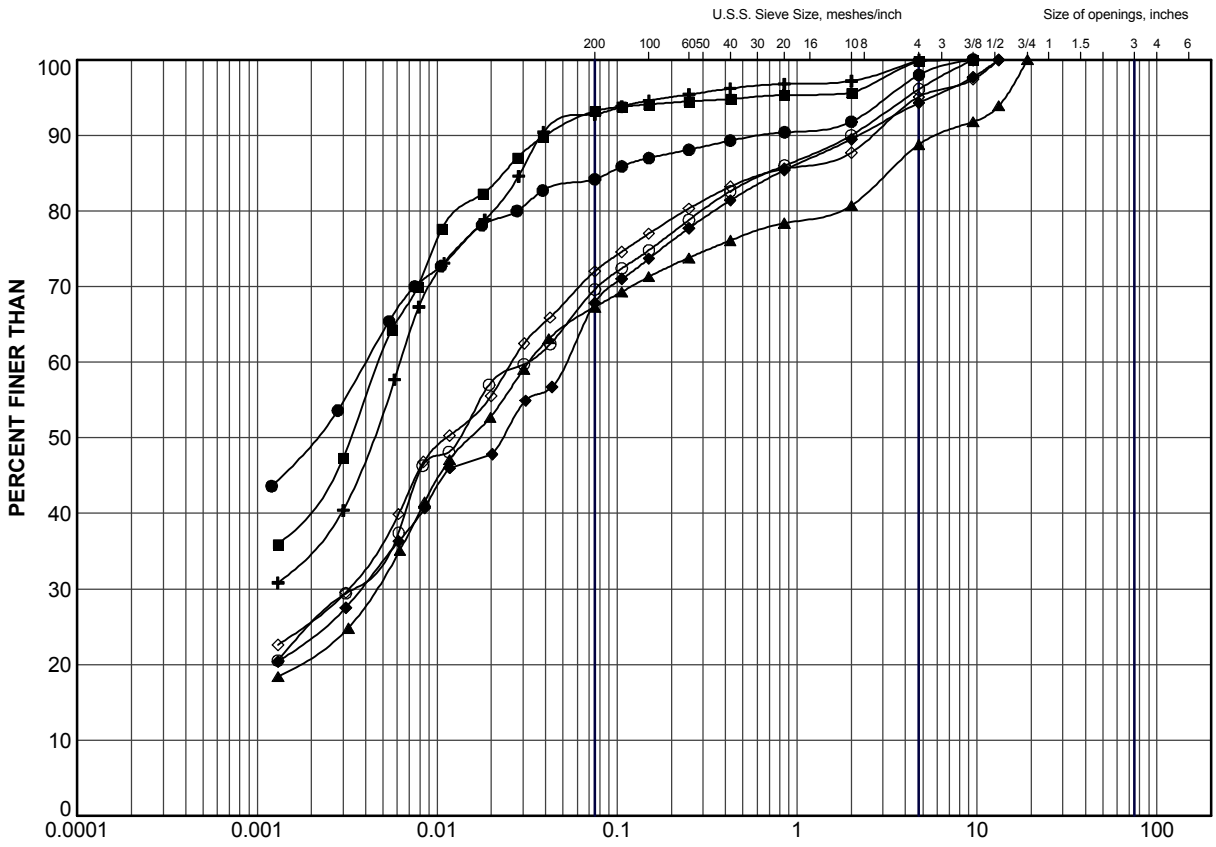
GRAIN SIZE DISTRIBUTION

CLAYEY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-159-0	FILE No.	0811321590-2000-R030A6	
			SCALE	N/A	REV.
DRAWN	LMK	Oct 22/09			
CHECK			**FIGURE**	**A-6**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	309	3	325.1
■	310	3	325.3
▲	310	7	322.3
+	312	4	324.2
◆	312	8	319.7
◇	314	5	322.3
○	314	9	318.5

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE

GRAIN SIZE DISTRIBUTION

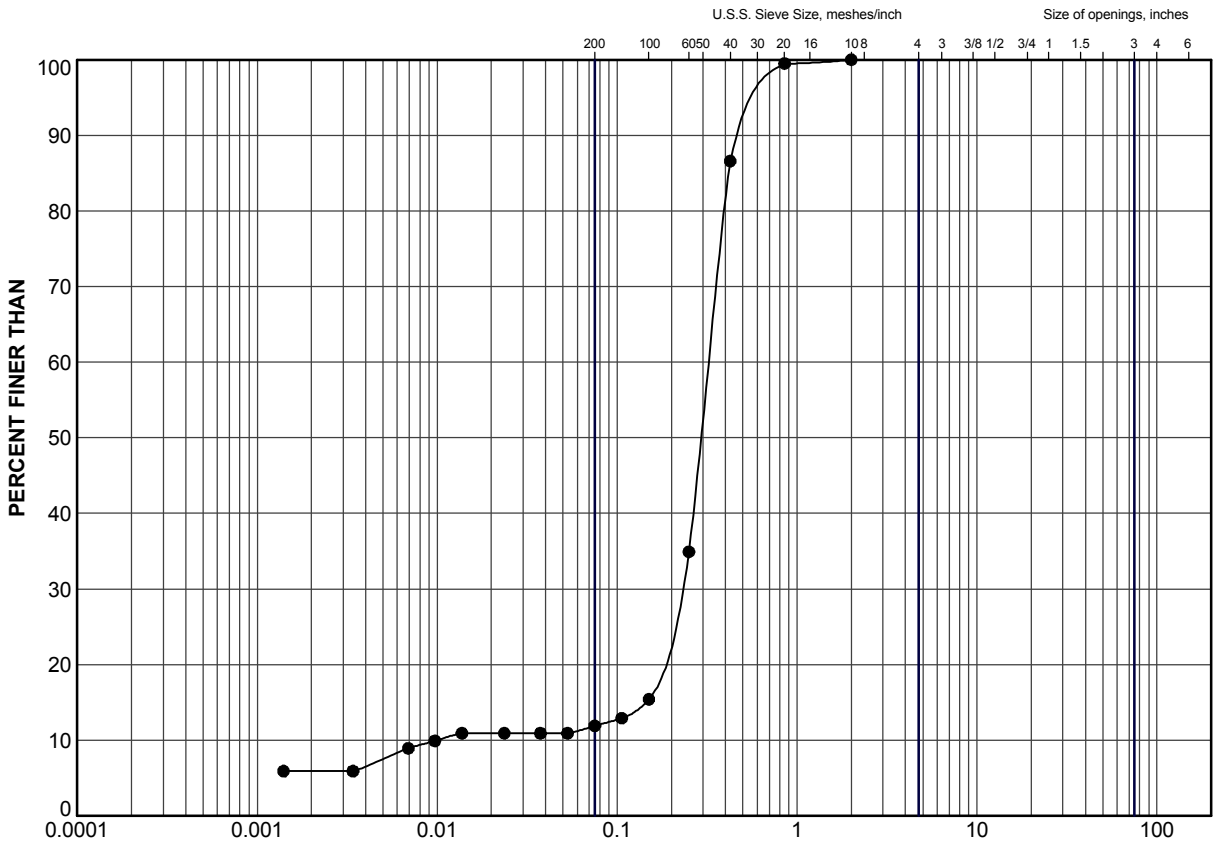
CLAYEY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-159-0		FILE No.	0811321590-2000-R030A7
			SCALE	N/A
DRAWN	LMK	Oct 22/09	REV.	
CHECK				

FIGURE A-7

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	311	6	322.2

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE

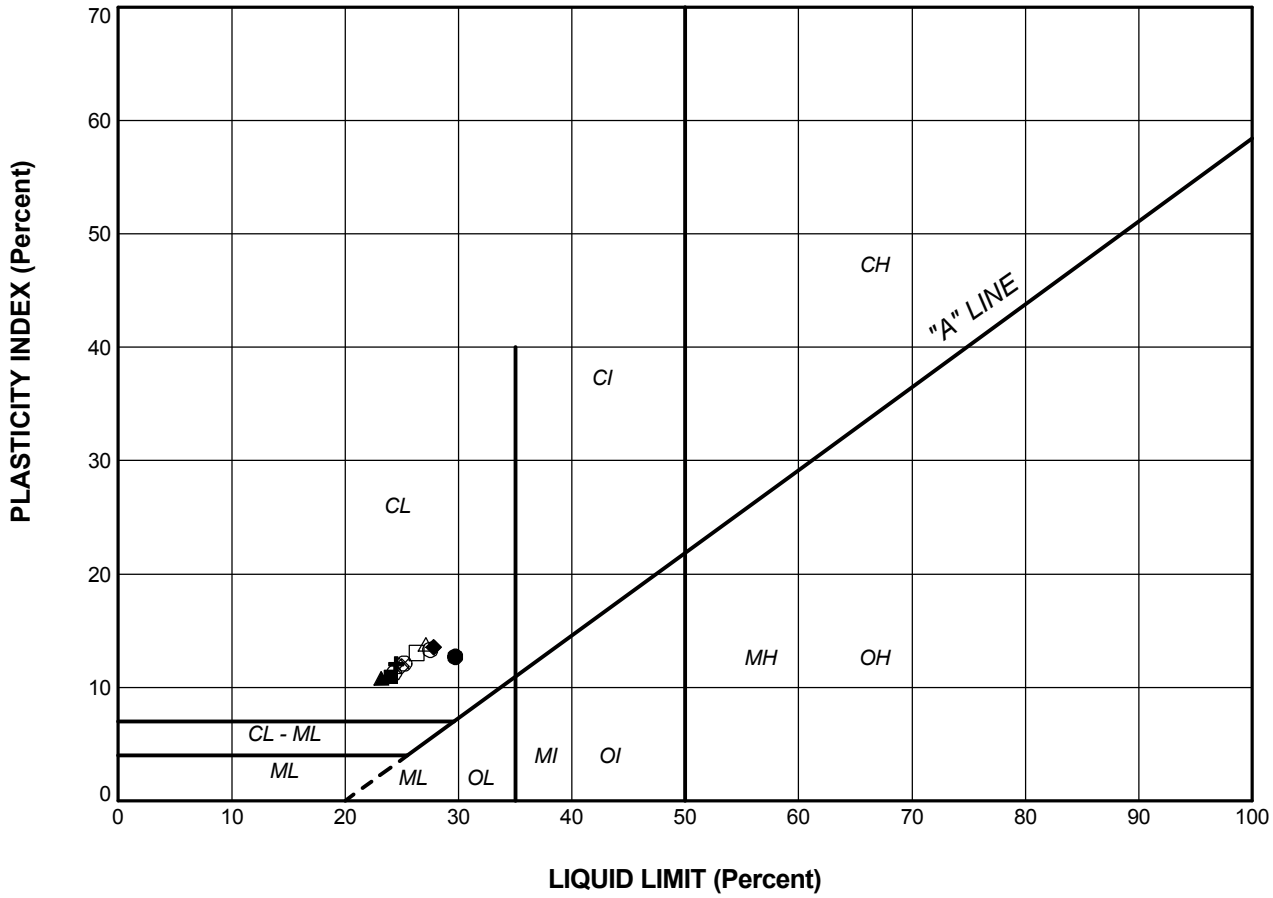
GRAIN SIZE DISTRIBUTION

SAND

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-159-0		FILE No.	0811321590-2000-R030A8	
			SCALE	N/A	REV.
DRAWN	LMK	Sep 28/09			
CHECK			**FIGURE**	**A-8**	

LDN_MTO_NEW GLDR_LDN.GDT



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
FILL					
●	301	3	29.7	17.0	12.7
■	301	7	24.0	13.1	11.0
▲	303	2	23.2	12.4	10.8
✚	303	5	24.5	12.5	12.1
◆	305	5	27.8	14.3	13.6
◇	305	8	25.0	13.2	11.9
○	306	3	27.5	14.2	13.3
△	307	5	27.1	13.3	13.8
⊗	307	9	25.2	13.1	12.1
⊕	308	4	24.3	13.1	11.3
□	308	8	26.3	13.3	13.1

PROJECT

HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

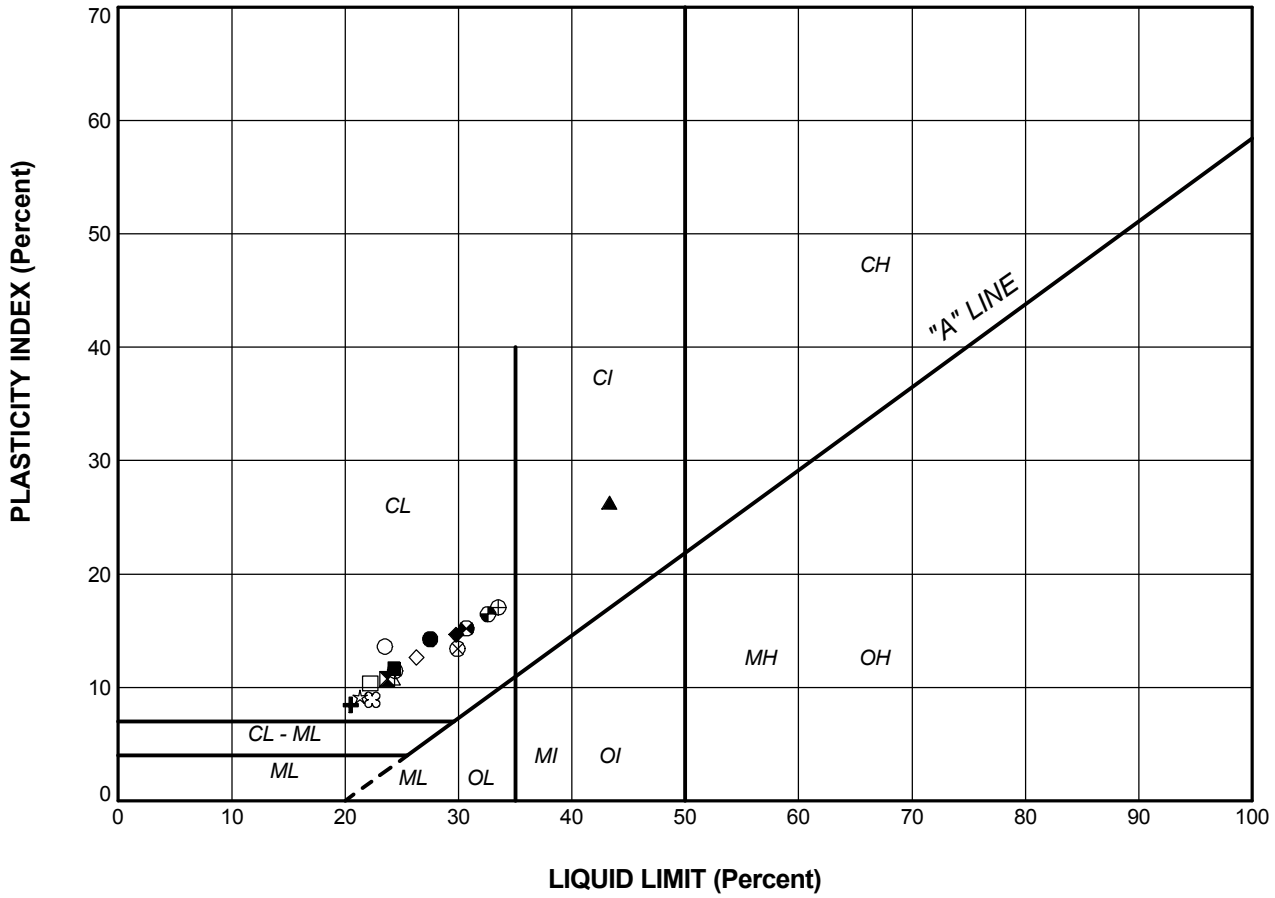
TITLE

PLASTICITY CHART
FILL MATERIALS

Golder Associates
LONDON, ONTARIO

PROJECT No.			08-1132-159-0	FILE No.	0811321590-2000-R030A9
				SCALE	N/A
DRAWN	LMK		Oct 01/09	REV.	
CHECK				FIGURE	A-9

MTO_PI GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
SILTY CLAY					
▲	303	14	43.3	17.0	26.3
CLAYEY SILT					
●	301	11	27.5	13.3	14.3
⊖	311	4	30.7	15.5	15.2
⊠	313	7	22.4	13.5	8.9
CLAYEY SILT TILL					
■	302	5	24.3	12.6	11.7
✚	304	3	20.5	12.1	8.5
◆	305	12	29.8	15.2	14.7
◇	306	7	26.3	13.7	12.7
○	307	13	23.5	9.9	13.6
△	308	14	24.2	13.4	10.8
⊗	309	3	29.9	16.5	13.4
⊕	310	3	33.5	16.5	17.1
□	310	7	22.2	11.9	10.4
◕	312	4	32.6	16.2	16.5
☆	312	8	21.3	12.2	9.2
⊠	314	5	23.7	13.0	10.8
⊙	314	9	24.4	13.0	11.5

PROJECT
HIGH FILLS - CNR OVERHEAD
REHABILITATION OF HIGHWAY 7
GWP 361-98-00

TITLE
PLASTICITY CHART
NATIVE SOILS

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-159-0	FILE No.	0811321590-2000-R030A10	
			SCALE	N/A	REV.
DRAWN	LMK	Dec 08/09			
CHECK			**FIGURE A-10**		

MTO_PI_25 GLDR_LDN.GDT

APPENDIX B

Previous Borehole and Laboratory Data (Geocres No. 40P03-028)

PROJECT No. 66514

RECORD OF BOREHOLE 1

LOCATION See Figure 1 BORING DATE SEPT. 9-12, 1966 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FT.
1068.8 / 0.0	GROUND LEVEL				
1067.8 / 1.0	LOOSE BROWN SAND AND GRAVEL (FILL)				
1066.8 / 2.0	LOOSE DARK BROWN SANDY TOPSOIL				
	STIFF TO HARD LIGHT BROWN SILTY CLAY TRACE SMALL GRAVEL OCCASIONAL LAYERS OF FINE TO MEDIUM SAND AND CLAYEY SILT (TILL)		1	2" DO	6
			2	"	25
1061.8 / 7.0	VERY DENSE GREY SILT, WITH SOME FINE TO COARSE GRAVEL AND TRACE OF CLAY. OCCASIONAL MORE SANDY LAYERS (TILL)		3	"	>100
1054.8 / 14.0	VERY DENSE GREY SILT WITH OCCASIONAL FINE GRAVEL		4	"	>100
1051.0 / 17.8	VERY DENSE GREY SILT, WITH SOME FINE TO COARSE GRAVEL AND TRACE OF CLAY. OCCASIONAL MORE SANDY LAYERS (TILL)		5	AXT RC	—
			6	2" DO	>100
			7	"	>100
			8	"	>100
1036.8 / 32.0	VERY DENSE GREY SILTY SAND TRACE OF GRAVEL		9	"	>100
1034.8 / 34.0	END OF HOLE				

ELEVATION SCALE: 1070, 1065, 1060, 1055, 1050, 1045, 1040, 1035

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. — 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT.

END OF PEN. TEST ELEV. 1061.1
100 BLOWS FOR LAST 9 INCHES

15 10 5 Percent axial strain at failure

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT — W_P W W_L — 10 20 30 40

ADDITIONAL LAB. TESTING: MH, MH, MH, MH, MH

PIEZOMETER OR STANDPIPE INSTALLATION

CAP
GROUND LEVEL
STANDPIPE
BENTONITE SEAL
PIEZOMETER
SAND AND GRAVEL FILL

W.L. IN PIEZOMETER AT ELEV. 1063.6 SEPT. 28, 1966

W.L. IN STANDPIPE AT ELEV. 1067.5 SEPT. 28, 1966

(Golder Report No. 66514)

" Note: This Drawing has been Reduced and is in Imperial Units "

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.W.A.
CHECKED J.J.G.

PROJECT No. 66514

RECORD OF BOREHOLE 2

LOCATION See Figure 1 BORING DATE SEPT. 12, 1966 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FT.
1069.6 / 0.0	GROUND LEVEL				
1068.6 / 1.0	LOOSE BROWN AND GREY SILT (FILL)				
1067.6 / 2.0	LOOSE DARK BROWN SANDY TOPSOIL				
	FIRM TO STIFF LIGHT BROWN SILTY CLAY WITH OCCASIONAL GRAVEL (TILL)		1	2" DO	7
			2	"	13
1062.1 / 7.5			3	"	28
	COMPACT TO VERY DENSE GREY SILT WITH OCCASIONAL FINE TO COARSE GRAVEL AND TRACE OF CLAY (TILL)		4	"	76
1054.1 / 15.5	VERY DENSE LAYERED BROWN CLAYEY SILT AND LIGHT BROWN SILT WITH TRACE OF GRAVEL		5	"	68
1051.1 / 18.5	VERY DENSE GREY SILT WITH OCCASIONAL FINE TO COARSE GRAVEL (TILL)		6	"	>100
1048.1 / 21.5	END OF HOLE				

ELEVATION SCALE: 1070, 1065, 1060, 1055, 1050, 1045

DYNAMIC PENETRATION RESISTANCE BLOWS/FT.

SHEAR STRENGTH C_u, LB./SQ.FT.

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT — W_P, W, W_L — 10 20 30 40

ADDITIONAL LAB. TESTING: MH

PIEZOMETER OR STANDPIPE INSTALLATION: CAP, GROUND LEVEL, CONCRETE, STANDPIPE, SAND AND GRAVEL FILL

W.L. IN STANDPIPE AT ELEV. 1068.9 SEPT. 28, 1966

(Golder Report No. 66514)

" Note: This Drawing has been Reduced and is in Imperial Units "

15 / 10 / 5 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.W.A.
CHECKED J.J.

PROJECT No. 66514

RECORD OF BOREHOLES 3 & 4

LOCATION See Figure 1 BORING DATE SEPT. 13-14, 1966 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

3/

ELEVN. / DEPTH	DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FT.
1071.8 / 0.0	GROUND LEVEL			
1070.8 / 1.0	LOOSE BROWN AND GREY SILT (FILL)			
1069.8 / 2.0	LOOSE DARK BROWN SANDY TOPSOIL			
	STIFF LIGHT BROWN SILTY CLAY WITH OCCASIONAL GRAVEL, OCCASIONAL LAYERS OF FINE TO MEDIUM SAND AND CLAYEY SILT (TILL)	1	2" DO	27
		2	"	37
1063.0 / 8.8		3	"	37
	VERY DENSE GREY SILT WITH OCCASIONAL FINE TO COARSE GRAVEL AND TRACE OF CLAY, OCCASIONAL MORE SANDY LAYERS (TILL)	4	"	28
1054.0 / 17.8		5	"	>100
1051.8 / 20.0	VERY DENSE GREY SILT WITH TRACE OF FINE GRAVEL; END OF HOLE	6	"	>100

ELEVATION SCALE: 1070, 1065, 1060, 1055, 1050

DYNAMIC PENETRATION RESISTANCE BLOWS/FT.

SHEAR STRENGTH C_u, LB./SQ.FT.

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT — W_P W W_L — 10 20 30 40

ADDITIONAL LAB. TESTING: MH; MH

PIEZOMETER OR STANDPIPE INSTALLATION: CAP; GROUND LEVEL; CONCRETE; STANDPIPE; SAND AND GRAVEL FILL

W.L. IN STANDPIPE ELEV. 1069.4 SEPT. 28, 1966

(Golder Report No. 66514)

" Note: This Drawing has been Reduced and is in Imperial Units "

4/

ELEVN. / DEPTH	DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FT.
1071.2 / 0.0	GROUND LEVEL			
1069.2 / 2.0	LOOSE BROWN AND GREY SILT (FILL)			
1068.2 / 3.0	LOOSE DARK BROWN SANDY TOPSOIL			
	STIFF LIGHT BROWN SILTY CLAY WITH TRACE OF GRAVEL, OCCASIONAL LAYERS OF FINE TO MEDIUM SAND AND CLAYEY SILT (TILL)	1	2" DO	9
		2	"	24
1062.7 / 8.5		3	"	33
	VERY DENSE GREY SILT WITH OCCASIONAL FINE TO COARSE GRAVEL AND TRACE OF CLAY, OCCASIONAL MORE SANDY LAYERS (TILL)	4	"	30
1055.2 / 16.0		5	"	>100
	END OF HOLE			

ELEVATION SCALE: 1070, 1065, 1060, 1055

DYNAMIC PENETRATION RESISTANCE BLOWS/FT.

SHEAR STRENGTH C_u, LB./SQ.FT.

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT — W_P W W_L — 10 20 30 40

ADDITIONAL LAB. TESTING: MH

PIEZOMETER OR STANDPIPE INSTALLATION: CAP; GROUND LEVEL; CONCRETE; STANDPIPE; SAND AND GRAVEL FILL

W.L. IN STANDPIPE ELEV. 1069.8 SEPT. 28, 1966

(Golder Report No. 66514)

" Note: This Drawing has been Reduced and is in Imperial Units "

15-○-5 Percent axial strain at failure
10

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.W.A.
CHECKED J.J.N.

PROJECT No. 66514

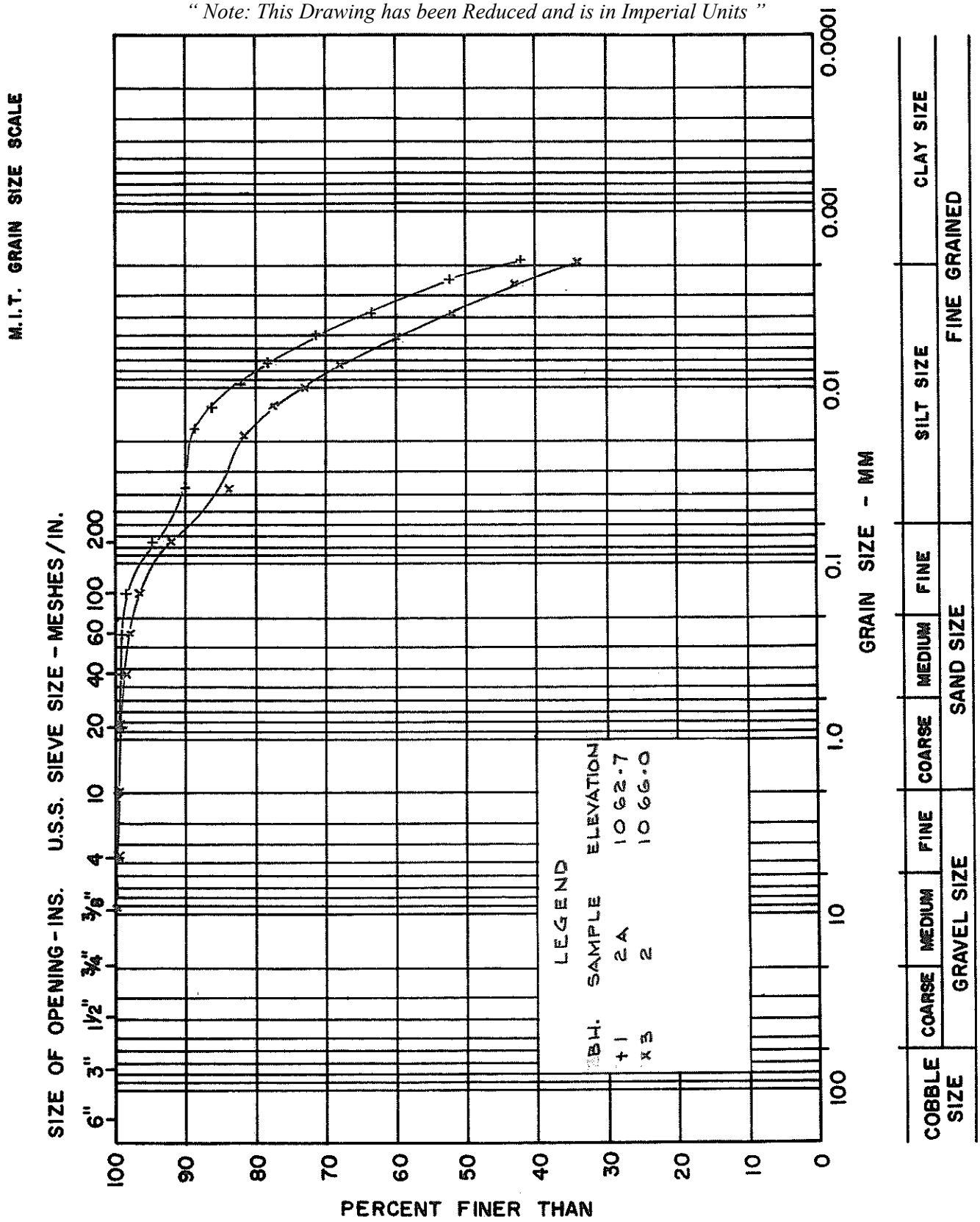
GRAIN SIZE DISTRIBUTION

SILTY CLAY TILL

FIGURE 2

(Golder Report No. 66514)

" Note: This Drawing has been Reduced and is in Imperial Units "



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PROJECT No. 66514

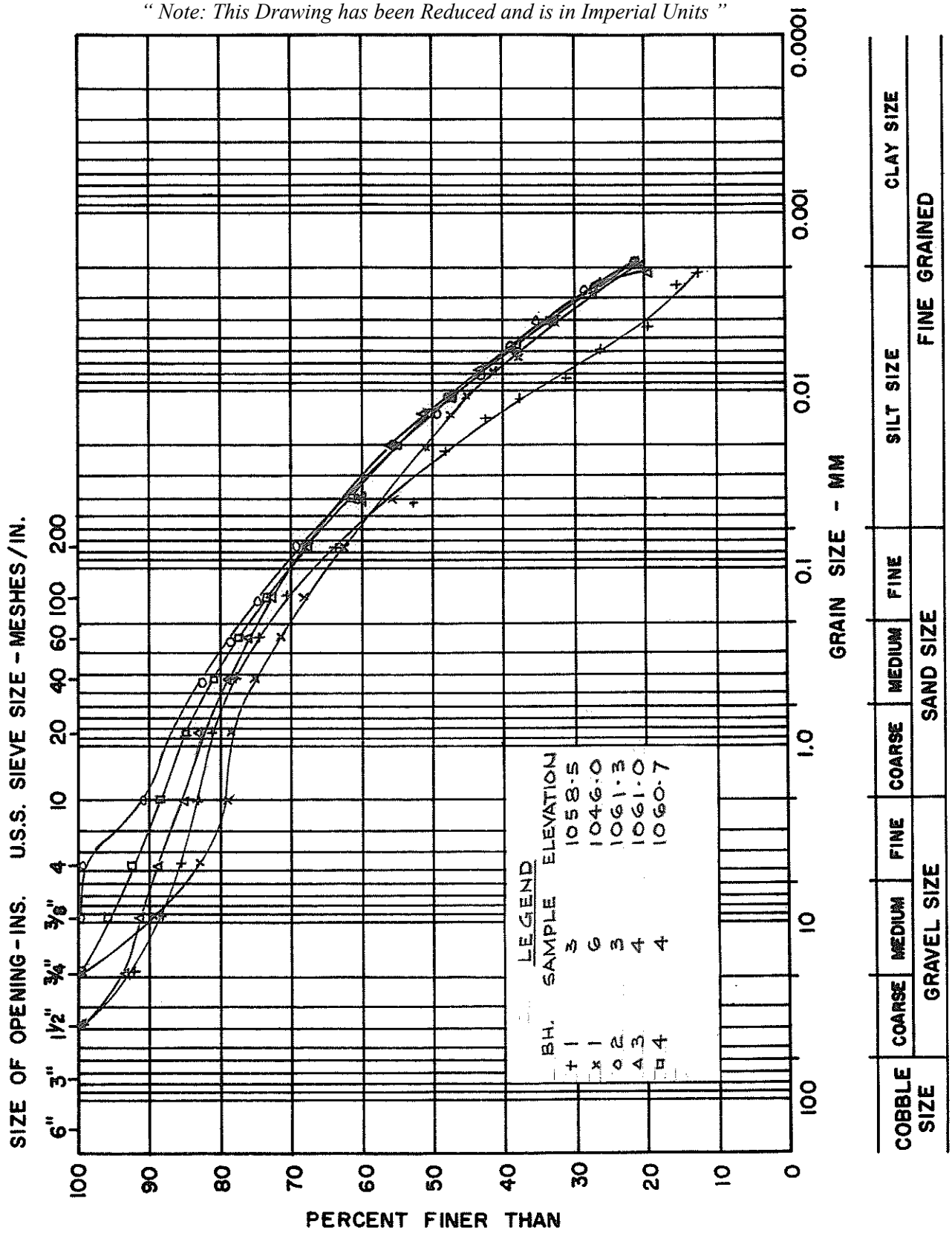
GRAIN SIZE DISTRIBUTION

SILT TILL

FIGURE 3

(Golder Report No. 66514)

" Note: This Drawing has been Reduced and is in Imperial Units "



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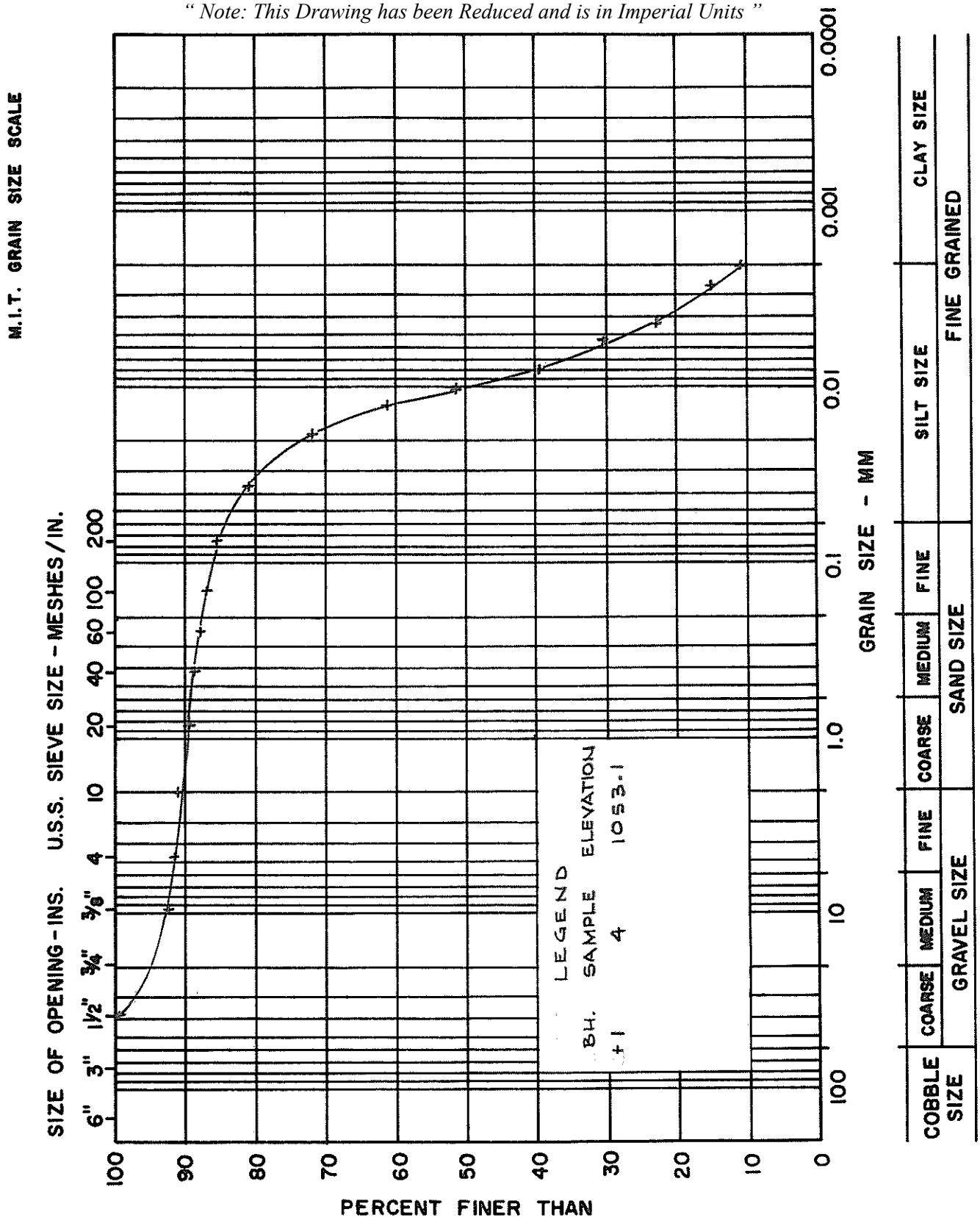
GRAIN SIZE DISTRIBUTION

SILT LAYER

FIGURE 4

(Golder Report No. 66514)

" Note: This Drawing has been Reduced and is in Imperial Units "



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APPENDIX C

Site Photographs

Photograph 1: West approach of CNR Overhead looking east along Highway 7 near Station 19+000.

Photograph 2: Guide-rail approximately at mid-point of north side slope approximately 150 metres east of CNR Overhead.

Photograph 3: Loose fill at foreslope of west abutment.

Photograph 4: Area of loose fill at foreslope of west abutment; view from south elevation.

Photograph 5: East abutment foreslope. Loose granular fill is exposed at surface.

Photograph 6: East abutment. Close up of loose fill on foreslope.

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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