



July 2014

FOUNDATION INVESTIGATION AND DESIGN REPORT

Deep Cuts

Reconstruction and Widening of Highway 401

From 0.5 KM West of Regional Road 8/King Street Easterly
to 0.5 KM East of Regional Road 24/Hespeler Road - 5.5 KM

GWP 4-00-00

Ministry of Transportation, Ontario - West Region

Submitted to:

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REPORT



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LIST OF ABBREVIATIONS

LIST OF SYMBOLS

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PART A

FOUNDATION INVESTIGATION REPORT

DEEP CUTS

RECONSTRUCTION AND WIDENING OF HIGHWAY 401

FROM 0.5 KM WEST OF REGIONAL ROAD 8/KING STREET EASTERLY TO

0.5 KM EAST OF REGIONAL ROAD 24/HESPELER ROAD – 5.5 KM

GWP 4-00-00

MINISTRY OF TRANSPORTATION - WEST REGION



1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Delcan Corporation (a Parsons Company) (Delcan) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detail design work for GWP 4-00-00. The project involves the detail design for the reconstruction and widening of Highway 401 from 0.5 kilometres west of King Street (Waterloo Regional Road 8) easterly to 0.5 kilometres east of Hespeler Road (Waterloo Regional Road 24).

This report addresses deep cuts associated with the reconstruction and widening of Highway 401. Deep cuts in excess of 4.5 metres will be required between approximate Stations 15+995 to 16+010, 16+065 to 16+220, and 16+365 to 16+625 on the north side and Stations 15+970 to 16+270 on the south side. For the purposes of this report, Highway 401 is assumed to be oriented in an east-west direction.

The purpose of the foundation investigation is to explore the subsurface conditions at the proposed deep cut locations by drilling boreholes and carrying out in situ testing and laboratory testing on selected samples of the subsurface materials. The terms of reference for the scope of work are outlined in the MTO's Request for Proposals and in Golder Associates' proposal P0-1132-0056 dated July 23, 2010 and the revised scope letter 10-1132-0056-2000-L02 dated May 28, 2012. The work was carried out in accordance with our Quality Control Plan for Foundations Engineering dated September 2010.

Delcan provided Golder Associates with drawings for this project in digital format.



2.0 SITE DESCRIPTION

2.1 General

The reconstruction and widening of Highway 401 to be undertaken as GWP 4-00-00 extends from west of King Street Easterly (Regional Road 8) to east of Hespeler Road (Regional Road 24) in the City of Cambridge, Region of Waterloo. For the purposes of this report Highway 401 is assumed to be oriented in an east-west direction. This section of Highway 401 is currently a six lane divided highway with a median wall. Two underpass structures for Fountain Street North and Speedsville Road, two bridges for the east and west channels of the Speed River, as well as two overhead structures for the Grand River Electric Railway (GRER) tracks and the Canadian National Railway tracks are situated within the project limits.

The deep cuts are located at various intervals between the Highway 401 GRER overhead structure and about 450 metres east, as shown in the Key Plan, Figure 1. There is a total length of 750 metres, split into five segments. On the north side there are three segments: Stations 15+995 to 16+010 Left (Lt), 16+065 to 16+220 Lt and 16+365 to 16+625 Lt. On the south side there are two segments Stations 15+970 to 16+055 Right (Rt) and 16+110 to 16+270 Rt. Left (Lt) and Right (Rt) are defined by an observer facing the direction of increasing chainage. The following table summarizes the locations and lengths of the deep cuts.

Side of Highway	Stations		Length (m)	Boreholes
	From	To		
Lt (North)	15+995	16+010	15	704
Lt (North)	16+065	16+220	155	708 to 710
Lt (North)	16+365	16+625	260	2 (40P8-226) 711 to 714
Rt (South)	15+970	16+055	85	701 and 707
Rt (South)	16+110	16+270	160	702, 705 and 706

The lands in the vicinity of the deep cuts are primarily undeveloped and/or used for agricultural purposes. However residential lands are found on the north side of the highway between Stations 16+365 to 16+635.



2.2 Site Geology

This project lies within the physiographic region of southwestern Ontario known as the Waterloo Hills which primarily comprises sandy glacial till ridges or glacial kame moraines with outwash sands in the lower areas. The physiographic mapping indicates that the deep cuts are situated in a former glaciofluvial spillway area.¹

The surficial materials encountered at the deep cuts will vary because the sites are at different locations along the Highway 401. The quaternary geology mapping indicates that surficial materials may consist of: Port Stanley Till containing silt and sandy silt glacial till, Maryhill Till containing clayey silt glacial till, and ice-contact gravel made up of kames and eskers.² The approximate underlying bedrock surface for the deep cuts is typically found between elevations of 261 to 278 metres increasing from west to east based on geologic mapping.³ The rock formation is mapped and described as cream and brown, fine to medium crystalline dolomite of the Guelph Formation.⁴

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

² Karrow, P.F., 1987: Quaternary Geology of the Cambridge Area, Southern Ontario. Ontario Geological Survey, Map 2508, scale 1:50,000.

³ Ontario Department of Mines, 1960: Bedrock Topography, Galt Area, Southern Ontario. Map 2030, scale 1:50,000

⁴ Sanford, B.V., 1969: Geology, Toronto-Windsor Area, Ontario. Geological Survey of Canada, Map 1263A, scale 1:250,000.



3.0 INVESTIGATION PROCEDURES

The field work for the investigation was carried out between May 30 and November 27, 2012 during which time 13 boreholes, boreholes 701, 702 and 704 to 714 were drilled at the locations shown on the Borehole Location Plan, Drawing 1. These boreholes were supplemented with borehole 2 which was originally advanced for the overhead signs component of this project (Geocres No. 40P8-226). Borehole 703 was drilled for the high fill component of this project. The table below summarizes the locations, ground surface elevations and depths of the current boreholes:

Borehole	Location (m)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting		
2 (40P8-226)	4808290	235084	297.97	15.70
701	4807930	234770	299.59	7.47
702	4808074	234951	298.96	9.60
704	4807968	234702	296.89	3.51
705	4808034	234907	301.27	7.47
706	4808005	234869	303.31	9.60
707	4807900	234738	303.14	10.97
708	4808103	234852	298.75	8.08
709	4808040	234772	304.37	15.51
710	4808071	234813	301.72	11.73
711	4808217	235006	296.40	10.21
712	4808259	235046	297.28	13.35
713	4808322	235123	298.05	13.87
714	4808350	235159	296.21	13.14

The investigation was carried out using track mounted drilling equipment supplied and operated by a specialist drilling contractor. In the boreholes, samples of the overburden were obtained at generally 0.75 metre intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures of ASTM D 1586. According to ASTM D1586, the SPT resistance or N value is defined as the number of blows required by a 63.5 kilogram hammer dropped from a height of 760 millimetres to drive a split spoon a distance of 300 millimetres after a seating drive of 150 millimetres. In cases where it was not possible to achieve a full 450 millimetres of drive, a penetration resistance representing the number of blows required to drive the sampler is recorded on the Record of Borehole. The penetration resistance obtained in the first 150 millimetres is normally neglected unless the sampler could only be driven 150 millimetres or less. The boreholes were terminated between 3.5 and 15.7 metres below the existing pavement or ground surface. Groundwater conditions in the boreholes were observed throughout the drilling operations. The boreholes were



FOUNDATION INVESTIGATION AND DESIGN REPORT DEEP CUTS

backfilled in accordance with current MTO procedures and Ontario Regulation 903 (as amended). Piezometers were installed in boreholes 2 (40P8-226), 702, 706, 707, 710 and 714 in order to monitor the groundwater conditions in the deep cut areas.

The field work was monitored on a full-time basis by experienced Golder staff members who also located the boreholes in the field, monitored 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 testing. Index and classification tests, consisting of water content determinations, grain size distribution analyses and Atterberg Limits 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 Drawings 1 to 4, attached.



4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the in situ testing and the laboratory testing carried out on selected samples, are provided on the attached Record of Borehole sheets following the text of this report and in Appendix A. The results of the SPT N-values or penetration resistance are unmodified (not standardized for hammer efficiency, borehole diameter, rod length etc.) and therefore represent field values. 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 and rock 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 underlain by variable amounts of fill underlain by predominantly granular deposits comprised of silty sand, sandy silt, sand, silt and sand and gravel. Clayey silt and silty clay were encountered near the ground surface between Stations 16+365 to 16+625 Lt. Sandy silt till and clayey silt till were generally found at depth but were also present above the granular deposits at the east end of the cut area. The locations and elevations of the boreholes, together with the interpreted stratigraphic profiles, are shown on Drawings 1 to 4. Detailed description of the subsurface conditions encountered in the boreholes are provided on the Record of Borehole sheets and are summarized in the following sections.

4.1.1 Topsoil

Topsoil layers 60 to 460 millimetres thick were encountered at the ground surface of all boreholes. Materials designated as topsoil in this report were classified solely based on visual and textural evidence. Testing of organic content or for other nutrients was not carried out. Therefore, the use of materials classified as topsoil cannot be relied upon for support and growth of landscaping vegetation.

4.1.2 Fill

Fill was encountered beneath the topsoil in boreholes 701, 702 and 713 at elevations 297.6 to 299.4 metres. The fill thickness ranged from 0.3 to 1.3 metres. The fill consisted of sand and silty sand. The fill was very loose to compact with recorded SPT N values of 3 to 18 blows per 0.3 metres and contained some topsoil in borehole 713.

4.1.3 Silty Sand

Layers of silty sand were encountered beneath the topsoil in boreholes 704 and 705 at elevations 296.8 and 301.1 metres, respectively, below the sand in boreholes 707, 708, 712 and 713 from elevations 298.1 to 284.5 metres, below the sand and gravel in boreholes 710 and 712 at elevations 294.3, 292.1 and 288.4 metres, below the sandy silt till in boreholes 2 (40P8-226) and 711 at elevations 293.4 and 294.4 metres, respectively, and



below the clayey silt till in borehole 713 at elevation 292.4 metres. Borehole 712 was terminated in the silty sand after exploring the layer for 0.6 metres. Where fully penetrated, the silty sand layer was 0.4 to 8.4 metres thick.

The silty sand is compact to very dense based on measured N values of 14 to greater than 100 blows per 0.3 metres. The water contents of samples of silty sand ranged from 3 to 16 per cent. The grain size distribution curves for samples of the silty sand are presented on Figure A-1.

4.1.4 Sandy Silt

Layers of sandy silt, 0.3 to 6.4 metres thick, were encountered beneath the topsoil in boreholes 2 (40P8-226), 707, 709, 712 and 714 at elevations 296.1 to 304.1 metres, below the sand in borehole 709 at elevation 297.3 metres and below the clayey silt at elevation 294.4 metres.

The sandy silt is loose to very dense based on measured N values of 7 to greater than 100 blows per 0.3 metres. The water contents of samples of sandy silt ranged from 7 to 19 per cent. The gradation of a sample of the sandy silt is presented on Figure A-2.

4.1.5 Sand

Layers of very loose to very dense sand were encountered beneath the topsoil in boreholes 708 and 710 at elevations 298.5 and 301.5 metres, respectively, beneath the fill in borehole 701 at elevation 299.2 metres, beneath the silty sand in boreholes 704, 705, 707 and 711 to 713 at elevations 286.0 to 300.7 metres, beneath the sandy silt in borehole 707 at elevation 302.7 metres, beneath the sandy silt till in boreholes 701, 702 and 705 at elevations 289.5 to 295.3 metres, beneath the silt in borehole 709 at elevation 297.9 metres, beneath the sand and gravel in boreholes 708 and 714 at elevations 293.6 and 283.4 metres, respectively, beneath the clayey silt in borehole 712 at elevation 296.2 metres and beneath the clayey silt till in borehole 2 (40P8-226) at elevation 295.1 metres. Where fully penetrated, the sand layers were about 0.3 to 7.0 metres thick. Boreholes 701, 702 and 714 were terminated in the sand after drilling through 0.1 to 0.3 metres of the layer.

The sand had a measured N value of 3 to greater than 100 blows per 0.3 metres. Very loose sand was only found in boreholes 705 and 710 near ground surface. Water contents above the groundwater level of 3 to 9 per cent were measured in selected samples with an average water content of about 5 per cent. Grain size distribution curves for samples of the sand recovered from the standard penetration testing are provided on Figure A-3.

4.1.6 Clayey Silt

Layers of clayey silt were encountered in borehole 712 beneath the sandy silt at elevation 296.6 metres and beneath the sand at elevation 295.2 metres. The clayey silt layers were 0.4 and 0.8 metres thick.

The clayey silt was stiff to very stiff with measured N values of 9 to 18 blows per 0.3 metres. Water contents of 11 and 14 per cent were measured in selected samples of clayey silt. The clayey silt is of low plasticity based on a plastic limit of 13 per cent, a liquid limit of 21 per cent and a plasticity index of 8 per cent. The results of the



Atterberg limits determination are shown on Figure A-12. The grain size distribution of a single sample of clayey silt is presented on Figure A-4.

4.1.7 Silty Clay

A 3.2 metre thick layer of very stiff silty clay was found at elevation 296.4 metres beneath the fill in borehole 713. Within this layer, N values of 19 to 29 blows per 0.3 metres were measured. A representative silty clay sample had a water content of 20 per cent.

The silty clay is of intermediate plasticity based on a plastic limit of 20 per cent, a liquid limit of 37 per cent and a plasticity index of 17 per cent. The results of the Atterberg limits determination are shown on Figure A-12. The grain size distribution of this sample is shown on Figure A-5.

4.1.8 Silt

Layers of silt were found beneath the silty sand in borehole 707 at elevation 294.2 metres and beneath the silty clay in borehole 713 at elevation 293.2 metres. A layer of silt with gravel was encountered below the sand and gravel in borehole 709 at elevation 298.6 metres. The silt layers were 0.3 to 0.8 metres thick. N values of 43 to 70 blows per 0.3 metres were measured in the dense to very dense silt. The silt samples had water contents of 14 and 20 per cent. Grain size distribution curves of samples of the silt are shown on Figure A-6.

4.1.9 Gravel

The sand and gravel in borehole 709 contained a 0.8 metre thick layer of gravel at elevation 292.3 metres. Clayey silt layers and cobbles were observed in the gravel layer. The gravel was very dense and had a measured N value of 61 blows per 0.3 metres. The measured water content was 10 per cent. The gradation of the gravel is presented on Figure A-7.

4.1.10 Sand and Gravel to Silty Sand and Gravel

Layers of sand and gravel were encountered beneath the topsoil in borehole 706 at elevation 303.0 metres, beneath the sand in boreholes 701, 704, 705 and 710 at elevations 293.7 to 300.4 metres, beneath the silty sand in boreholes 708 and 712 at elevations 295.3 and 291.7 metres, respectively, beneath the sandy silt in boreholes 709, 712 and 714 at elevations 289.7 to 303.0 metres, beneath the gravel in borehole 709 at elevation 291.6 metres and beneath the sandy silt till in boreholes 2, 702 and 710 at elevations 283.6 to 296.8 metres. Boreholes 704 to 706, 709 and 710 were terminated in sand and gravel layers after exploring for some 1.2 to 9.3 metres. Where fully penetrated, the layers were 0.4 to 6.3 metres thick. The sand and gravel deposits contained silty layers 0.8 to 5.6 metres thick in boreholes 2, 702, 705, 706, 709, 710 and 714. Cobbles and/or boulders were encountered in the sand and gravel layers in boreholes 702, 705, 706, 708 and 710.



The sand and gravel is compact to very dense based on measured N values of 11 to greater than 100 blows per 0.3 metres. Water contents of 2 to 10 per cent were measured in select samples of sand and gravel. The results of grain size analyses carried out on representative samples of sand and gravel are shown on Figure A-8 with gradations of silty sand and gravel sample presented on Figure A-9.

4.1.11 Sandy Silt Till

Sandy silt glacial till was encountered between elevation 285.2 and 297.6 metres beneath the topsoil in borehole 711, the fill in borehole 702, the sand and gravel in boreholes 701, 702 and 705, the silty sand in boreholes 2 and 710, the silt in borehole 707 and the sand in boreholes 2, 708 and 711. Where fully penetrated, the sandy silt till was found to be 0.6 to 2.7 metres thick. Boreholes 707, 708 and 711 were terminated in the sandy silt till deposit after exploring some 1.2 to 2.3 metres. Cobbles were encountered in the sandy silt till layers in boreholes 705 and 707. Although boulders were not inferred in the sandy silt till, the presence of both cobbles and boulders should be expected within the glacial till deposits.

Standard penetration test N values of 11 to over 100 blows per 0.3 metres were obtained in the compact to very dense sandy silt till. Water contents of the sandy silt till samples varied from 6 to 18 per cent. The results of the grain size analyses are presented on A-10.

4.1.12 Clayey Silt Till

Clayey silt glacial till was found in borehole 713 beneath the silt and silty sand layers at elevations 292.9 and 284.9 metres, respectively; and beneath the sandy silt in borehole 2 at elevation 296.4 metres. Borehole 713 was terminated in the clayey silt till after exploring it for some 0.7 metres. Where fully penetrated, the clayey silt till was found to be 0.5 and 1.3 metres thick. The clayey silt till was very stiff to hard based on recorded N values of 19 to 87 blows per 0.3 metres. Water contents of 12 and 13 per cent were measured in two samples. The clayey silt till is of low plasticity based on plastic limits of 19 and 17 per cent, liquid limits of 34 and 30 per cent and plasticity indices of 15 and 13 per cent. The results of the Atterberg limits determinations and grain size analyses are presented on Figures A-11 and A-12. Although cobbles and boulders were not encountered in the clayey silt till, the presence of both cobbles and boulders should be expected within the glacial till deposits.

4.1.13 Bedrock

Bedrock was encountered in borehole 2 (40P8-226) beneath the sand and gravel at elevation 282.7 metres. Borehole 2 (40P8-226) was terminated due to auger refusal in the bedrock after drilling in the layer for some 0.5 metres. The bedrock had a measured N value of greater than 100 blows per 0.3 metres.



4.2 Groundwater Conditions

Groundwater conditions were observed during and on completion of drilling and sampling. Groundwater was encountered in boreholes 2 (40P8-226), 702 and 710 to 712 at the depths and elevations noted in the following table.

Borehole	Ground Surface Elevation (m)	Encountered Groundwater Level	
		Depth (m)	Elevation (m)
2 (40P8-226)	297.97	12.8	285.2
701	299.59	*	*
702	298.96	5.2 and 9.5	293.8 and 289.5
704	296.89	*	*
705	301.27	*	*
706	303.31	*	*
707	303.14	*	*
708	298.75	*	*
709	304.37	*	*
710	301.72	8.2	293.5
711	296.40	9.4	287.0
712	297.28	12.6	284.7
713	298.05	*	*
714	296.21	*	*

*Groundwater level not established.

The above-noted encountered water levels are not considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken only during the relatively short duration of drilling. Piezometers were installed in boreholes 2 (40P8-226), 702, 706, 707, 710 and 714. The most recent readings were obtained on June 9, 2014 and are summarized in the following table.

Borehole	Ground Surface Elevation (m)	Measured Groundwater Level					
		January 24, 2013		November 20, 2013		June 9, 2014	
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
2 (40P8-226)	297.97	Dry	Dry to 282.43	Dry	Dry to 282.27	Dry	Dry to 282.43
702	298.96	7.39	291.57	7.24	291.72	6.83	292.13
706	303.31	9.14	Dry to 294.17	Dry	Dry to 294.17	Dry	Dry to 294.17
707	303.14	Dry	Dry to 292.17	9.98	293.16	9.75	293.39
710	301.72	6.25	295.47	7.06	294.66	7.06	294.66
714	296.21	12.73	283.48	12.65	283.56	12.70	283.51



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Information from adjacent boreholes advanced for other components of this project were examined in order to better understand groundwater conditions at the site. Borehole 202 (Geocres No. 40P8-210) was drilled approximately 6 metres south of borehole 704. Grey soils were encountered in the sandy silt till in borehole 202 at elevation 286.4 metres. Groundwater was encountered at elevation 287.8 metres in borehole 6 (Geocres No. 40P8-093) which is about 50 metres northwest of borehole 707. On June 9, 2014, the groundwater level was measured in borehole 601 (Geocres No. 40P8-218) at elevation 277.73 metres. This borehole was advanced approximately 25 metres northeast of borehole 711.

Based on the measured and encountered groundwater levels and considering the general absence of grey soils, groundwater levels for each section of deep cut have been inferred as follows:

- 15+995 to 16+010 Lt – Elevation 286.5 metres;
- 16+065 to 16+220 Lt – Elevation 295.5 metres;
- 16+365 to 16+625 Lt – Varies from elevation 287.0 metres at Station 16+365 Lt to elevation 285.0 metres at Station 16+500 Lt to elevation 283.5 metres at Station 16+600 Lt;
- 15+970 to 16+055 Rt – Elevation 293.0 metres;
- 16+110 to 16+270 Rt – Varies from elevation 294.0 metres at Station 16+100 Rt to elevation 292.0 metres at Station 16+270 Rt.

Groundwater levels are expected to fluctuate seasonally and are expected to be higher during periods of sustained precipitation or during spring melt conditions.



5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Aardvark Drilling Inc., an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Michael Arthur under the direction of the Site Investigation Manager, 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 Mr. Brett Thorner, E.I.T. under the direction of the Project Engineer, Ms. Dirka U. Prout, P.Eng. The report was reviewed by Mr. Azmi M. Hammoud, P. Eng. An independent quality control review was carried out 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

DEEP CUTS

RECONSTRUCTION AND WIDENING OF HIGHWAY 401

FROM 0.5 KM WEST OF REGIONAL ROAD 8/KING STREET EASTERLY TO

0.5 KM EAST OF REGIONAL ROAD 24/HESPELER ROAD – 5.5 KM

GWP 4-00-00

MINISTRY OF TRANSPORTATION - 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 deep cuts. 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.

The future widening of Highway 401 will require deep cuts along the north and south sides of the highway at five locations. The proposed deep cuts are between Stations 15+995 and 16+010Lt, 16+065 and 16+220Lt and 16+365 and 16+625Lt on the north side of the highway and between Stations 15+970 and 16+055Rt and Stations 16+110 and 16+270Rt on the south side of Highway 401.

Geotechnical design assumptions were based on the preliminary cross-sections provided by Delcan. The preliminary layout for the proposed retaining wall along Rogers Road (Site 33-499-R) suggests that there may be an overlapping section of retaining wall and cut slope between station 16+225 and 16+270Rt. Recommendations given in this report for this section are general in nature and considered preliminary until the design of the Rogers Road Retaining Wall is refined.

6.2 Deep Cuts – North

The three segments with deep cuts on the north side of Highway 401 are located between approximately Stations 15+995 and 16+010Lt, 16+065 and 16+220Lt and 16+365 and 16+625Lt. Although the width of the highway platform will increase, there will be no changes to the grade of the travelled portion of Highway 401.

6.2.1 Stations 15+995 to 16+010Lt

This segment of roadway features a hillock which extends about 3 metres above the Highway 401 road surface. The hill slopes were too steep to allow drill access. The hillock will be removed to permit construction of the widened Highway 401 main lanes and new ditch. The existing centreline profile of Highway 401 varies from elevation 299.0 metres at Station 15+993 to elevation 298.5 metres at Station 16+010.

Borehole 704 was drilled in this cut area. The subsurface conditions encountered at the borehole location consisted of surficial topsoil underlain by silty sand and compact sand to elevation 295.4 metres with compact to very dense sand and gravel below the sands. The groundwater level is inferred to be near elevation 286.5 metres in this area.

The proposed design requires grades to be lowered about 4 metres for the ditch to the north of the roadway. Cuts of approximately 4.5 to 6.0 metres will be required along the north ditch. Standard cut slopes of 2 horizontal to 1 vertical are proposed. The proposed cuts will be above the groundwater level.



6.2.2 Stations 16+065 to 16+220Lt

This segment of roadway was originally constructed in a cut up to 8 metres deep. The existing centreline profile of Highway 401 varies from elevation 297.5 metres at Station 16+060 to elevation 296.0 metres at Station 16+220.

Boreholes 708 to 710 were drilled in this cut area. The subsurface conditions encountered at the borehole locations consisted of surficial topsoil underlain by very dense silty sand and gravel to sand and gravel with layers of compact to dense sandy silt, silt, silty sand to sand and sandy silt till. Cobbles were noted to be present in the silty sand and gravel to sand and gravel layer. Cobbles and boulders should be expected within the sandy silt till. The groundwater level is inferred to be at approximate elevation 295.5 metres in this area.

The proposed design requires grades to be lowered about 3 metres for the ditch to the north of the roadway. Cuts of approximately 4.5 to 10.5 metres will be required along the north ditch. Standard cut slopes of 2 horizontal to 1 vertical are proposed with a 2 metres bench required for slopes over 6 metres in height. The groundwater level will daylight at or up to 2 metres above the elevation of the ditch invert.

6.2.3 Stations 16+365 to 16+625Lt

West of Station 16+385, the north side of Highway 401 was constructed at grade with minor cuts for the north ditch. East of this point, the highway was constructed in a side hill cut with slopes up to 12 metres in height between the current north ditch and the north limit of right-of-way. The existing centreline profile of Highway 401 varies from elevation 293.0 metres at Station 16+370 to elevation 286.0 metres at Station 16+620.

Boreholes 711 to 714 and borehole 2 (40P8-226) indicated a highly variable stratigraphy in this cut area. The subsurface conditions encountered at the borehole locations consisted of varying amounts of surficial topsoil and granular fill underlain by primarily cohesionless deposits with discontinuous layers of cohesive materials. The cohesionless deposits were typically dense to very dense and comprised silty sand and gravel, silty sand, sandy silt, silt and sandy silt till. The clayey silt, silty clay and clayey silt till were generally very stiff to hard. Bedrock was encountered in borehole 2 (40P8-226) at elevation 282.7 metres. The groundwater level is inferred to vary from elevation 287.0 metres at Station 16+365Lt to elevation 283.5 metres at Station 16+600Lt.

The proposed design requires grades to be lowered about 3 to 5 metres for the ditch to the north of the roadway. Cuts of approximately 4.5 to 11.0 metres will be required along the north ditch. Standard cut slopes of 2 horizontal to 1 vertical are proposed with a 2 metre bench required for slopes over 6 metres in height. The proposed cuts will be above the groundwater level.

6.3 Deep Cuts – South

The two segments with deep cuts on the south side of Highway 401 are located at approximately Stations 15+970 to 16+055Rt and Stations 16+110 to 16+270Rt. Although the width of the Highway platform will increase, there will be no changes in the grade of the travelled portion of Highway 401.



6.3.1 Stations 15+970 to 16+055Rt

This segment of roadway was originally constructed with 5 to 8 metres deep cuts. The existing centreline profile of Highway 401 varies from elevation 299.0 metres at Station 15+970 to elevation 298.0 metres at Station 16+055.

Boreholes 701 and 707 were drilled in this cut area. The subsurface conditions encountered at the borehole locations generally consisted of varying amounts of surficial topsoil and granular fill underlain by compact to very dense sand to elevation 293.0 metres. At the base of the sand layer, the lower 0.4 metres on the west end and 2.4 metres on the east end contained compact sand and gravel or dense to very dense silt and silty sand layers. Compact to very dense sandy silt till was encountered at elevation 293.0 metres. Cobbles and boulders were noted to be present in the sand and gravel to silty sand layer. The groundwater level is inferred to be at approximately elevation 293.0 metres in this area.

The proposed design requires grades to be lowered about 3 metres for the ditch to the south of the roadway. Cuts of approximately 4.5 to 8.0 metres will be required along the south ditch. Standard cut slopes of 2 horizontal to 1 vertical are proposed with a 2 metres bench required for slopes over 6 metres in height. The proposed cut will be above the groundwater level.

6.3.2 Stations 16+110 to 16+270Rt

This segment of roadway was originally constructed with 4.5 to 7.0 metres deep cuts. The existing centreline profile of Highway 401 varies from elevation 297.0 metres at Station 16+110 to elevation 295.5 metres at Station 16+270.

Boreholes 702, 705 and 706 were drilled in this cut area. The subsurface conditions encountered at the borehole locations generally consisted of varying amounts of surficial topsoil and granular fill underlain by compact to very dense sand and gravel to elevation 293.5 metres. Compact to very dense sandy silt till was encountered at the east end from elevation 298.5 to 295.0 metres and below 293.5 metres. Cobbles and boulders were noted in the sand and gravel and sandy silt till layers. The groundwater level is inferred to be at approximately elevation 292.0 metres in this area.

The proposed design requires grades to be lowered about 3 metres for the ditch to the south of the roadway. Cuts of approximately 5 to 10 metres will be required along the south ditch. Standard cut slopes of 2 horizontal to 1 vertical are proposed with a 2 metres bench required for slopes over 6 metres in height. The majority of the proposed cuts will be above the groundwater level.

6.4 Stability Analyses

The drawings provided by Delcan show side slope inclinations of approximately 2 horizontal to 1 vertical along the majority of existing roadway cut areas where slopes are 8 metres in height or greater, mid-slope benches have been proposed. Five critical sections, one from each deep cut area, were selected for slope stability analyses using SLOPE/W, a commercially available software package for limit equilibrium stability analyses.



The critical sections selected were Stations 16+000Lt, 16+090Lt and 16+490Lt on the north side of Highway 401 and Stations 15+990 and 16+130Rt on the south side of Highway 401.

A factor of safety against instability of at least 1.3 is achievable for the proposed deep cut slopes between Stations 15+995 and 16+010Lt on the north side of Highway 401 provided that the slopes are cut to 2 horizontal to 1 vertical and overland flows are directed away from the slope face. The results of the stability analyses conducted for the critical section at Station 16+000Lt are presented on Figure B-1 in Appendix B.

A factor of safety against instability of at least 1.3 is achievable for the proposed deep cut slopes between Stations 16+065 and 16+220Lt on the north side of Highway 401 provided that the slopes are cut to 2 horizontal to 1 vertical including a 2 metre mid-slope bench, and overland flows are directed away from the slope face. The results of the stability analyses conducted for the critical section at Station 16+090Lt are presented on Figure B-2 in Appendix B.

A factor of safety against instability of at least 1.3 is achievable for the proposed deep cut slopes between Stations 16+365 and 16+625Lt on the north side of Highway 401. The slopes should be cut to 2 horizontal to 1 vertical including a 2 metre mid-slope bench, and overland flows should be directed away from the slope face. The results of the stability analyses conducted for the critical section at Station 16+490Lt are presented on Figure B-3 in Appendix B.

A factor of safety against instability of at least 1.3 is achievable for the proposed deep cut slopes between Stations 15+970 and 16+055Rt on the south side of Highway 401 provided that the slopes are cut to 2 horizontal to 1 vertical including a 2 metre mid-slope bench, and overland flows are directed away from the slope face. The results of the stability analyses conducted for the critical section at Station 16+020Rt are presented on Figure B-4 in Appendix B.

A factor of safety against instability of at least 1.3 is achievable for the proposed deep cut slopes between Stations 16+110 and 16+270Rt on the south side of Highway 401 provided that the slopes are cut to 2 horizontal to 1 vertical including a 2 metre mid-slope bench, and overland flows are directed away from the slope face. The results of the stability analyses conducted for the critical section at Station 16+130Rt are presented on Figure B-5 in Appendix B.

6.5 Excavations and Temporary Dewatering

Excavations for cut slopes in the deep cut areas will encounter surficial topsoil and fill and extensive deposits of loose to very dense predominately sands and sand and gravel deposits with occasional layers of sandy silt, silt, clayey silt, clayey silt till, silty clay and sandy silt till. Excavations below approximately elevation 295.5 metres between approximate Stations 16+065 and 16+225Lt on the north side of Highway 401 will extend below the groundwater level for the deep cuts. Also, the groundwater level will be near the toe of the slope or ditch invert level for deep cut excavations between approximate Stations 16+110 and 16+270Rt on the south side of Highway 401. The excavations for the remaining cut sections are not expected to intercept the groundwater table.

Silty sand to sand and gravel deposits are present near the toe of slope in the two areas where seepage is expected to emanate from the slope. These materials are expected to be relatively non-erodible based on the



overall medium to coarse gradation and high permeability. Therefore, additional erosion protection beyond that required for ditch slopes is not necessary. It is recommended that cut slopes, particularly those where groundwater is present at the toe, be constructed during dry summer periods. Provided that the cut slopes are constructed as outlined above and in Section 6.6, it is anticipated that the encountered groundwater can be adequately controlled using properly filtered sumps, drainage ditches and gravel blankets. Following periods of sustained heavy rainfall or during the spring melt, saturated soils may be present near the surface of the cuts. More aggressive dewatering will be required if coarser sand or gravel seams are encountered. All dewatering is to be carried out in accordance with Ontario Provincial Standard Specifications (OPSS) 518. The appropriate NSSP should be included in the contract documents.

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 and cohesionless materials below the groundwater level and any loose granular above the groundwater level would be classified as Type 3 soils. The native clayey materials and properly dewatered cohesionless materials would be classified as Type 2 soils.

6.6 Erosion Protection

Temporary erosion and sediment control measures should be implemented during construction in accordance with OPSS 805. Mid-height or intermediate height benches a minimum of 2 metres wide will be required in deep cut areas where the overall slope height is greater than 6 metres. The benches should be sloped away from the face and drain to a positive outlet. Careful ditching and drainage works should be provided behind the cut and at the mid-height or intermediate height benches to control surface flows and minimize erosion. All ditches should flow to a properly designed outlet. The completed slope should be topsoiled and provided with an erosion control blanket and seeded or sodded, as applicable, immediately after construction. If permanent erosion protection measures will be delayed significantly after final grading, the surface should be roughened or provided with a temporary erosion protection blanket.

The proposed works will result in significant areas of exposed cut slopes in predominantly granular soil prone to ravelling and running above and below the groundwater level, respectively. It will be prudent to implement erosion protection measures, including sodding, seeding and erosion control blankets immediately after construction of the cut slopes. This project includes a significant extent of deep cut slopes. As such, the contract documents should highlight the significance of temporary and permanent erosion and sediment control measures.



7.0 MISCELLANEOUS

This report was prepared by Mr. Brett Thorner, E.I.T. under the direction of the Project Engineer, Ms. Dirka U. Prout, P.Eng. Report review was carried out by Mr. Azmi M. Hammoud, P. Eng. An independent quality control review was conducted 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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Consistency

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

(b) Cohesive Soils

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

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

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

LIST OF SYMBOLS

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

I. General

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

- Notes:** 1 $\tau = c' + \sigma' \tan \phi'$
 2 shear strength = (compressive strength)/2
 * density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

RECORD OF BOREHOLE No 701

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4807930.3 , E 234769.9 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE May 30, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
299.59	GROUND SURFACE						20	40	60	80	100						
0.00	TOPSOIL, sandy Brown																
0.15																	
0.40	FILL, sand, some silt, trace topsoil SAND, fine to medium, trace gravel, trace silt, trace clay Compact Brown																
			1	SS	13												
			2	SS	14												
			3	SS	10												
			4	SS	12												
			5	SS	11												
			6	SS	12												
			7	SS	11												
293.65																	
5.94	SAND AND GRAVEL, trace silt Compact Brown		8	SS	11											8 83 1 8	
293.25																	
6.34	SANDY SILT TILL, trace to some clay, trace gravel Compact to dense Brown		9	SS	37											10 36 37 17	
292.18																	
7.47	SAND, fine, trace to some silt Dense Brown END OF BOREHOLE Groundwater not established during drilling on May 30, 2012.																

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

RECORD OF BOREHOLE No 702

1 OF 1





METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808073.9 , E 234950.7 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE June 4, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+	FIELD VANE								
						● QUICK TRIAXIAL	×	LAB VANE										
298.96	GROUND SURFACE							20	40	60	80	100						
0.00	TOPSOIL, sandy						Concrete											
0.12	Brown																	
	FILL, sand, some silt																	
	Very loose																	
	Brown		1	SS	3		298											
297.59																		
1.37	SANDY SILT TILL, trace to some																	
	clay, some gravel		2	SS	20						○				22	25	38	15
296.83	Compact																	
	Brown																	
2.13	SAND AND GRAVEL, trace to some																	
	silt, trace clay, with cobbles and		3	SS	35													
	boulders																	
	Dense to very dense																	
	Brown		4	SS	77/ 75mm													
	150mm boulder at about elev.																	
	295.7m		5	SS	45													
			6	SS	49		Bentonite											

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/07/14

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 704		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4807967.7 , E 234701.9</u>	ORIGINATED BY <u>MA</u>			
DIST <u> </u> HWY <u>401</u>	BOREHOLE TYPE <u>POWER AUGER, HOLLOW STEM</u>	COMPILED BY <u>LMK</u>			
DATUM <u>GEODETIC</u>	DATE <u>July 3, 2012</u>	CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL
					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)										
296.89	GROUND SURFACE							20	40	60	80	100								
0.09	TOPSOIL, sandy Brown						296													
296.34	SILTY SAND, some gravel Brown																			
0.55	SAND, fine to medium, trace silt Compact Brown		1	SS	11															
295.43							295													
1.46	SAND AND GRAVEL, some silt Compact to very dense Brown		2	SS	21															
			3	SS	60		294								o				56 31 (13)	
293.38			4	SS	56															
3.51	END OF BOREHOLE																			
	Groundwater not established during drilling on July 3, 2012.																			

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/07/14

RECORD OF BOREHOLE No 705

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808034.4, E 234906.7 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 18, 2012 - July 19, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED	+	FIELD VANE	×						LAB VANE	
301.27	GROUND SURFACE						20	40	60	80	100							
0.00	TOPSOIL, sandy																	
0.13	Brown																	
300.72	SILTY SAND, trace roots																	
0.55	Brown																	
	SAND, fine to medium, trace to some silt, trace topsoil		1	SS	3													
	Very loose																	
299.90	Brown																	
1.37	SAND, fine to medium, trace gravel, trace silt		2	SS	4													
	Very loose																	
299.14	Brown																	
2.13	SILTY SAND AND GRAVEL, trace clay, with cobbles		3	SS	74													
	Very dense																	
	Brown																	
			4	SS	92													
297.61																		
3.66	SANDY SILT TILL, some gravel, trace to some clay, with cobbles		5	SS	50/ 150mm													
	Very dense																	
	Brown		6	SS	106													
			7	SS	69													
295.33																		
5.94	SAND, fine to medium, some gravel, some silt		8	SS	54													
294.99	Very dense																	
6.28	Brown																	
	SILTY SAND AND GRAVEL, some clayey silt seams and layers		9	SS	64													
	Very dense																	
	Brown																	
293.80																		
7.47	END OF BOREHOLE																	
	Groundwater not established during drilling on July 18 & 19, 2012.																	

RECORD OF BOREHOLE No 706

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808004.5 , E 234869.2 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 19, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE														
303.31	GROUND SURFACE							20	40	60	80	100										
0.00	TOPSOIL, sandy Brown																					
0.27	SILTY SAND AND GRAVEL Brown																					
302.70																						
0.61	SAND AND GRAVEL, trace silt, trace clay, with cobbles Compact to very dense Brown		1	SS	11																	
			2	SS	12																	
			3	SS	26									○			55 35 7 3					
			4	SS	26																	
			5	SS	100/ 200mm									○			53 39 4 4					
			6	SS	54																	
			7	SS	46									○			42 49 6 3					
			8	SS	36																	
			9	SS	29									○			47 41 8 4					
			10	SS	37																	
			11	SS	39																	
										</												

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

RECORD OF BOREHOLE No 707

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4807900.1, E 234738.1 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 19, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
303.14	GROUND SURFACE														
0.00	TOPSOIL, sandy Brown					Concrete									
0.15															
0.40	SANDY SILT, trace gravel, trace topsoil Brown														
	SAND, fine to medium, trace gravel, trace silt, trace clay Compact to very dense Brown		1	SS	16										
			2	SS	20										
			3	SS	19						○				1 89 3 7
			4	SS	16										
			5	SS	18										
			6	SS	22						○				
			7	SS	24										
			8	SS	30										
			9	SS	72										
295.73															
7.41	SILTY SAND, trace gravel, trace clay Very dense Brown		10	SS	72						○				7 61 24 8
294.91															
8.23	SAND, fine to medium, some gravel, trace silt														
294.52	Dense Brown		11	SS	47										
8.62															
294.15	SILTY SAND, Dense Brown														
8.99			12	SS	43						○				1 10 84 5
293.39	SILT, some sand, trace clay, trace gravel Dense Brown		13	SS	100/ 150mm										
9.75															
	SANDY SILT TILL, trace to some gravel, trace clay, with cobbles Very dense Brown		14	SS	110/ 150mm										
292.17															
10.97	END OF BOREHOLE														
	Groundwater not established during drilling on July 19, 2012.														
	Piezometer dry on January 24, 2013.														
	Water level measured in piezometer at elev. 293.16m on November 20, 2013.														
	Water level measured in piezometer at elev. 293.39m on June 9, 2014.														

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO_GDT 06/07/14

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 708		1 OF 1	METRIC
W.P. <u>4-00-00</u>		LOCATION <u>N 4808102.6 , E 234852.2</u>		ORIGINATED BY <u>MA</u>	
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>POWER AUGER, HOLLOW STEM</u>		COMPILED BY <u>WDF</u>	
DATUM <u>GEODETIC</u>		DATE <u>November 16, 2012</u>		CHECKED BY <u> </u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	w _p	w	w _L					
298.75	GROUND SURFACE																			
0.00	TOPSOIL, sandy Brown																			
0.30	SAND, fine to medium, trace silt Brown SILTY SAND, some gravel, trace clay Compact to very dense Brown																			
298.14																				
0.61			1	SS	14		298													
			2	SS	83		297													
			3	SS	87		296						o				26	40	27	7
			4	SS	58/ 50mm															
295.25	SAND AND GRAVEL, trace to some silt, trace clay, with cobbles Very dense Brown						295													
3.50			5	SS	80/ 125mm		294						o				60	30	8	2
			6	SS	75		293						o				16	70	11	3
293.57	SAND, trace to some gravel, trace silt, trace clay Very dense Brown																			
5.18			7	SS	53		292													
292.81	SANDY SILT TILL, trace to some gravel, trace to some clay Dense Brown becoming grey below about elev. 292.0m																			
5.94			8	SS	41		291													
			9	SS	48															
			10	SS	44															
290.67	END OF BOREHOLE																			
8.08	Groundwater not established during drilling on November 16, 2012.																			

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/07/14

RECORD OF BOREHOLE No 709

1 OF 2

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808040.0 , E 234772.2 ORIGINATED BY DH
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE November 19, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE	20	40	60					
304.37	GROUND SURFACE																
0.00	TOPSOIL, sandy Brown																
0.30	SANDY SILT, trace gravel, trace clay, trace topsoil, trace roots																
303.46	Compact Brown		1	SS	14												
0.91	SILTY SAND AND GRAVEL, trace clay Very dense Brown		2	SS	77												
			3	SS	71												
301.47			4	SS	61												
2.90	SAND AND GRAVEL, trace to some silt Very dense Brown		5	SS	59												
			6	SS	100												
			7	SS	63/ 100mm												
298.55			8	SS	70												
5.82	SILT, with gravel, some sand, trace clay Very dense Brown		9	SS	38												
297.91	SAND, fine, trace to some gravel, some silt Dense to very dense Brown		10	SS	76/ 150mm												
6.46			11	SS	63/ 75mm												
297.33			12	SS	92												
7.04			13	SS	100/ 275mm												
296.90			14	SS	100/ 225mm												
7.47			15	SS	64												
292.33			16	SS	61												
12.04	GRAVEL, some sand, some silt, with clayey silt layers, with cobbles Very dense Brown		17	SS	48												
291.57			18	SS	34/ 50mm												
12.80	SAND AND GRAVEL, trace to some silt, with cobbles Dense to very dense Brown		19	SS	56												

Continued Next Page

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

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/07/14

RECORD OF BOREHOLE No 710

1 OF 1

METRIC

PROJECT 10-1132-0056

W.P. 4-00-00

LOCATION N 4808070.6 , E 234813.1

ORIGINATED BY DH

DIST HWY 401

BOREHOLE TYPE POWER AUGER, HOLLOW STEM

COMPILED BY WDF

DATUM GEODETIC

DATE November 20, 2012

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
								○ UNCONFINED + FIELD VANE												
								● QUICK TRIAXIAL × LAB VANE												
								WATER CONTENT (%)												
301.72	GROUND SURFACE																			
0.00	TOPSOIL, sandy Brown						Concrete													
0.24	SAND, fine, trace to some silt Loose Brown						Backfill													
300.35			1	SS	6															
1.37	SAND AND GRAVEL, trace to some silt Dense Brown		2	SS	31															
299.59																				
2.13	SILTY SAND AND GRAVEL, trace clay, with cobbles Very dense Brown		3	SS	87						○					38 32 23 7				
			4	SS	92															
			5	SS	100															
			6	SS	109															
			7	SS	69															
			8	SS	79															
295.01																				
6.71	SAND AND GRAVEL, trace to some silt Very dense Brown		9	SS	82															
294.25																				
7.47	SILTY SAND, trace gravel, trace clay Dense to very dense Brown		10	SS	62						○					7 49 36 8				
			11	SS	47						○					5 71 20 4				
292.73																				
8.99	SANDY SILT TILL, some gravel, trace clay Very dense Brown		12	SS	100/ 275mm															
291.97																				
9.75	SAND AND GRAVEL, some silt, trace clay Very dense Brown		13	SS	92															
			14	SS	100/ 75mm															

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

RECORD OF BOREHOLE No 711

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808216.6 , E 235005.6 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE November 21, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p W W _L				GR	SA	SI	CL
								20	40	60	80	100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL					
296.40	GROUND SURFACE																			
0.00	TOPSOIL, silty, trace sand Brown																			
0.24	SANDY SILT TILL, some clay, trace gravel Compact to dense Brown		1	SS	17								○				6	37	44	13
			2	SS	42															
294.42																				
1.98	SILTY SAND, some gravel, trace clay Very dense Brown		3	SS	61															
			4	SS	69															
			5	SS	73															
			6	SS	100/ 250mm															
			7	SS	118															
			8	SS	60/ 150mm								○				18	50	28	4
290.00																				
6.40	SAND, some silt, trace gravel Very dense Brown		9	SS	85															
			10	SS	76/ 150mm															
288.48																				
7.92	SANDY SILT TILL, trace to some gravel, trace clay Very dense Brown		11	SS	72															
			12	SS	70								○							
													○							
286.19			13	SS	73								○				2	44	48	6
10.21	END OF BOREHOLE																			
	Groundwater encountered at about elev. 287.0m during drilling on November 21, 2012.																			

RECORD OF BOREHOLE No 712

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808258.7 , E 235046.2 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE November 21, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
							WATER CONTENT (%)										
297.28	GROUND SURFACE						20	40	60	80	100	10	20	30			
0.06	TOPSOIL, silty Brown																
296.58	SANDY SILT, trace topsoil, trace clay																
0.70	Brown																
296.15	CLAYEY SILT, some sand, trace topsoil		1	SS	9							○	○				
1.13	Stiff Brown																
	SAND, some gravel, trace to some silt		2	SS	53												
295.15	Loose to very dense Brown																
2.13	CLAYEY SILT, some sand, trace gravel		3	SS	18							○	○	—		5 27 41 27	
294.39	Very stiff Brown																
2.89	SANDY SILT, some clayey silt seams, trace gravel		4	SS	48												
293.62	Dense Brown																
3.66	SAND AND GRAVEL, trace to some silt		5	SS	71												
	Very dense Brown																
			6	SS	65												
292.10																	
5.18	SILTY SAND, trace clay																
291.65	Very dense Brown		7	SS	100							○	○			0 58 34 8	
5.63	SAND AND GRAVEL, trace to some silt		8	SS	100/ 150mm												
	Very dense Brown		9	SS	100/ 150mm												
			10	SS	100/ 125mm												
			11	SS	100/ 150mm												
288.44																	
8.84	SILTY SAND, trace to some gravel, with clayey silt seams		12	SS	63/ 150mm												
	Very dense Brown		13	SS	86												
			14	SS	100							○				9 58 26 7	
286.00																	
11.28	SAND, fine to medium, trace to some silt		15	SS	75												
	Very dense Brown		16	SS	81												
284.48																	
12.80	SILTY SAND, some clay, trace gravel, with silt seams		17	SS	100/ 250mm							○				6 49 30 15	
283.93	Very dense Brown																
13.35	END OF BOREHOLE																
	Groundwater encountered at about elev. 284.7m during drilling on November 21, 2012.																

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/07/14

RECORD OF BOREHOLE No 713

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808321.9 , E 235122.5 ORIGINATED BY DH
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE November 22, 2012 - November 23, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
298.05	GROUND SURFACE						298	20	40	60	80	100					
0.00	TOPSOIL, silty Brown																
297.59																	
0.46	FILL, silty sand, some clay, some topsoil, trace gravel, trace roots Compact Brown		1	SS	13												
			2	SS	18												
296.37																	
1.68	SILTY CLAY, trace sand Very stiff Brown		3	SS	19												
			4	SS	20												
			5	SS	27												
			6	SS	29												
293.17																	
4.88	SILT, trace to some sand Very dense Brown		7	SS	58												
5.18																	
292.42	CLAYEY SILT TILL, trace sand, trace gravel Hard Brown		8	SS	100/ 200mm												
5.63																	
	SILTY SAND, trace to some gravel, trace clay Very dense Brown		9	SS	34/ 75mm												
			10	SS	50/ 125mm												
			11	SS	46/ 125mm												
			12	SS	44/ 50mm												
			13	SS	100/ 100mm												
			14	SS	100/ 100mm												
287.26																	
10.79	SAND, some silt, trace gravel Dense to very dense Brown		15	SS	58												
			16	SS	49												
285.55																	
12.50	SILTY SAND, some gravel Very dense Brown		17	SS	65/ 100mm												
284.90																	
13.15	CLAYEY SILT TILL, some sand, some gravel Hard Brown		18	SS	87												
284.18																	
13.87	END OF BOREHOLE																
	Groundwater not established during drilling on November 22 & 23, 2012.																

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/07/14

RECORD OF BOREHOLE No 714

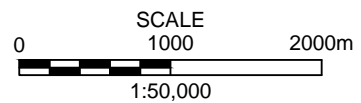
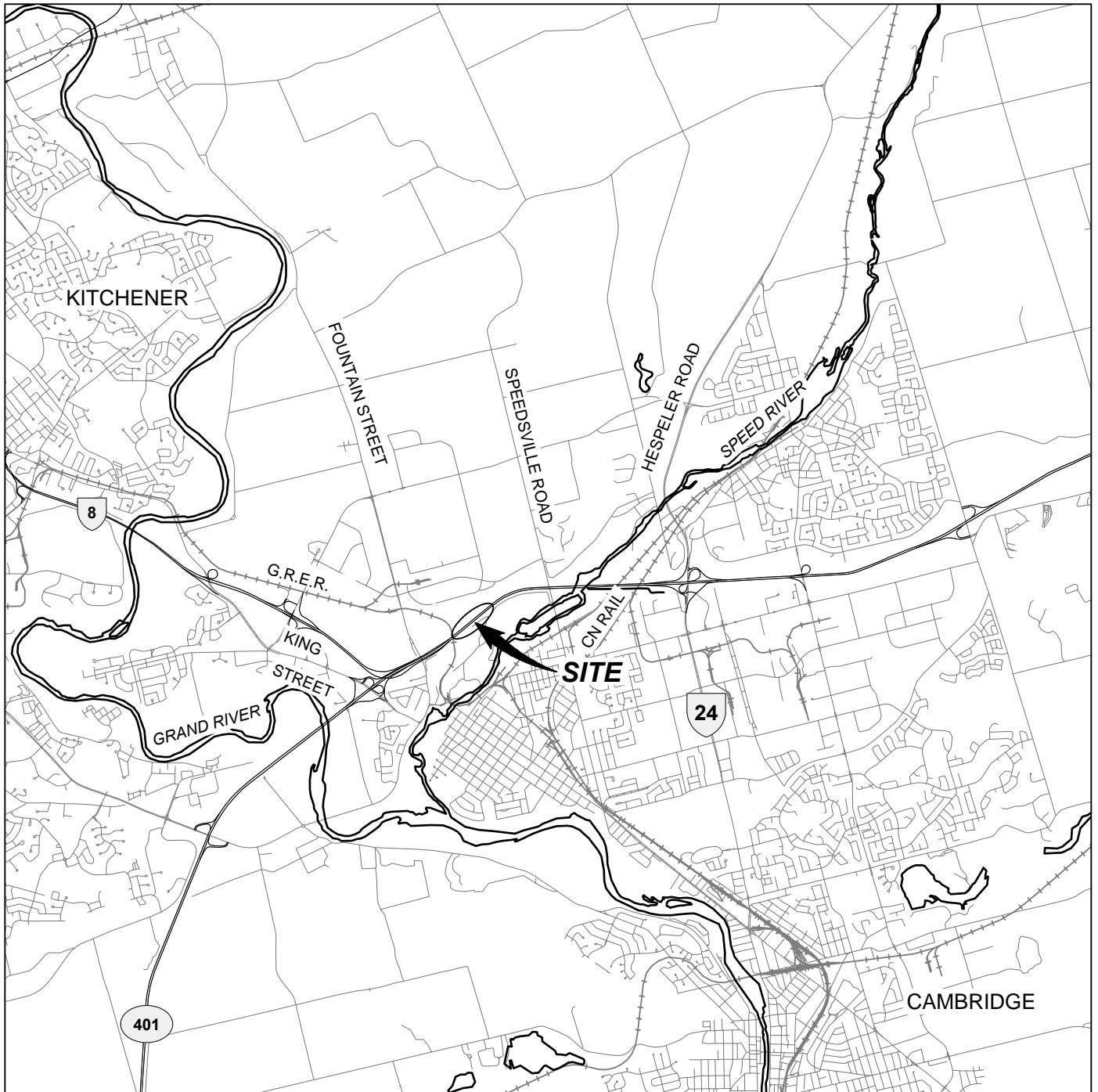
1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808349.9 , E 235158.8 ORIGINATED BY DH
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE November 26, 2012 - November 27, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P	W	W _L			WATER CONTENT (%)	GR
296.21	GROUND SURFACE						Concrete	20	40	60	80	100				
0.00	TOPSOIL, silty Brown							○ UNCONFINED	+	FIELD VANE						
0.12	SANDY SILT, trace to some gravel, trace to some clay Compact to very dense Brown		1	SS	13			● QUICK TRIAXIAL	×	LAB VANE						
			2	SS	30		Backfill	20	40	60	80	100				
			3	SS	69											
			4	SS	69											
			5	SS	44											
			6	SS	70/ 150mm											
			7	SS	15/ 25mm											
			8	SS	50/ 100mm		Grout									
289.66	SAND AND GRAVEL, some silt Very dense Brown		9	SS	100/ 125mm											
			10	SS	50/ 75mm											
			11	SS	100/ 150mm											
287.38	SILTY SAND AND GRAVEL, trace clay Very dense Brown		12	SS	100/ 225mm		Backfill									
			13	SS	57/ 75mm											
			14	SS	100/ 100mm											
285.08	SAND AND GRAVEL, some silt, trace clay Very dense Brown		15	SS	100/ 100mm											
			16	SS	42/ 100mm		Bentonite									
283.41	SAND, some silt, trace gravel Very dense Brown		17	SS	24/ 25mm		Sand Piezometer									
12.80	END OF BOREHOLE															
283.07	Groundwater not established during drilling on November 26 & 27, 2012.															
13.14	Water level measured in piezometer at elev. 283.48m on January 24, 2013.															
	Water level measured in piezometer at elev. 293.51m on June 9, 2014.															

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO_GDT 06/07/14



REFERENCE

PLAN BASED ON CANMAP STREETFILES V.2008.5.

NOTE

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

PROJECT

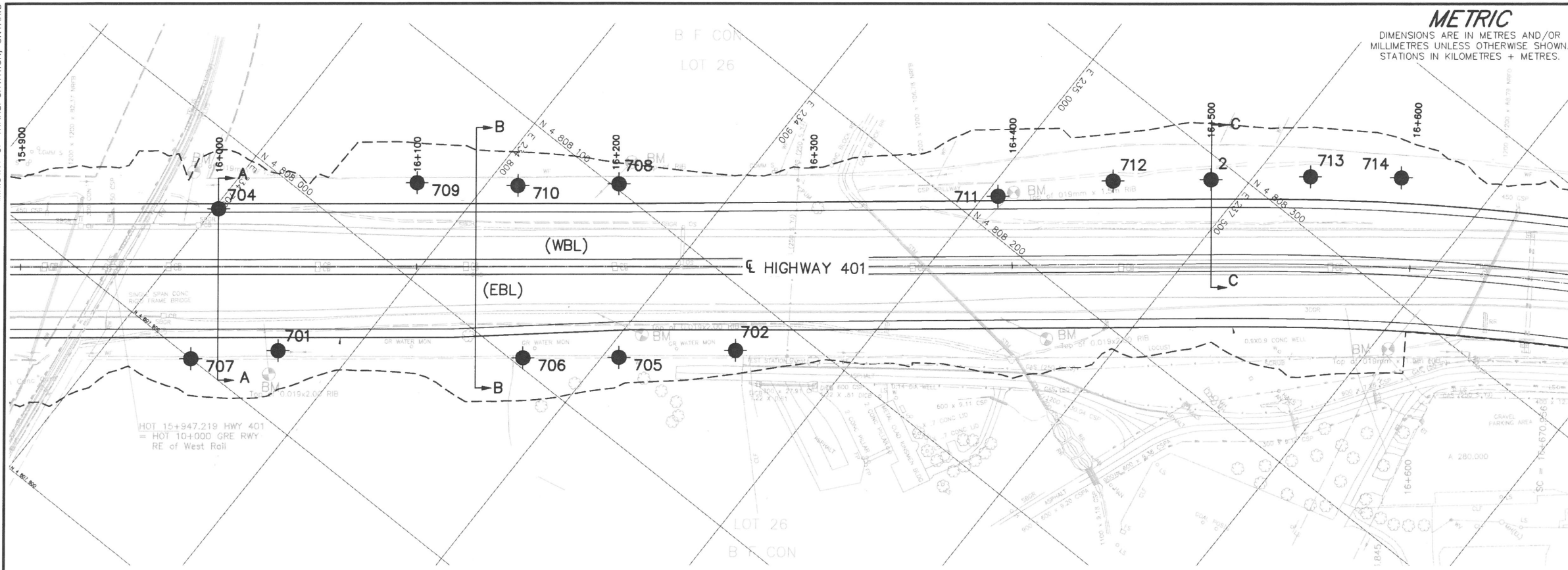
DEEP CUTS
HIGHWAY 401 IMPROVEMENTS
GWP 4-00-00

TITLE

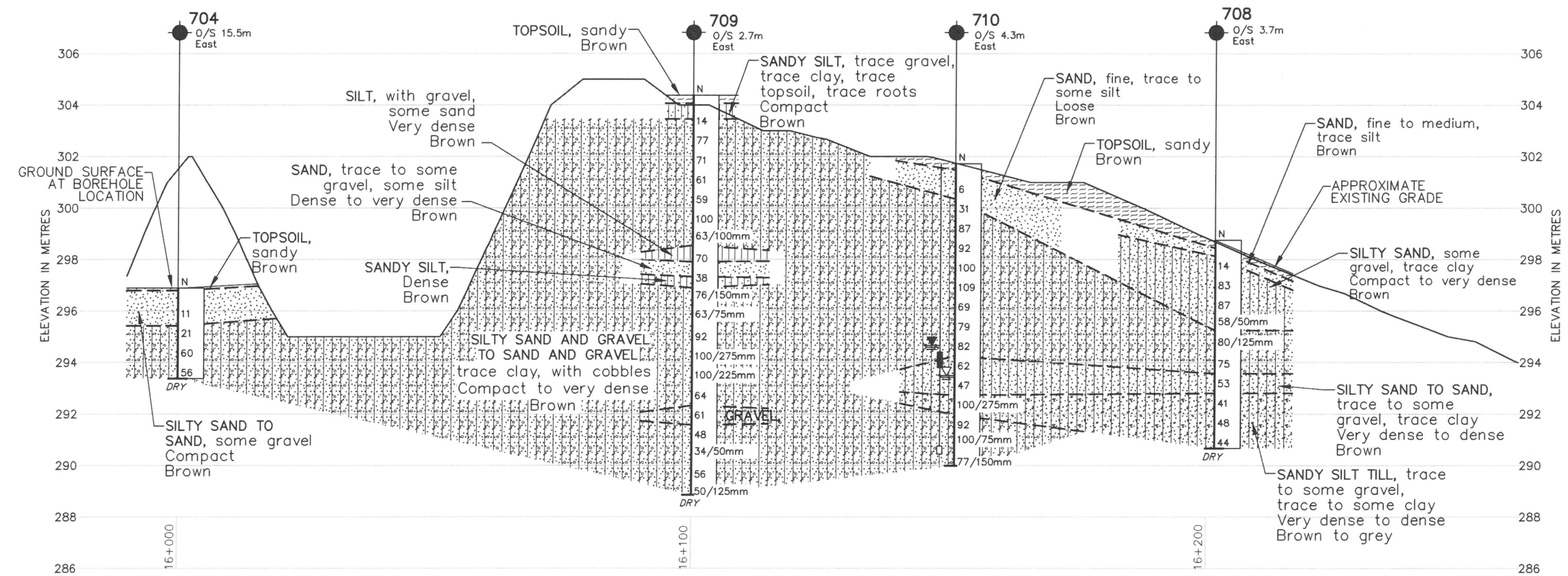
KEY PLAN



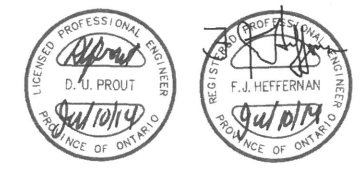
PROJECT No. 10-1132-0056			FILE No. 1011320056-2000-F09A001		
CADD	LMK	Aug. 6/13	SCALE	AS SHOWN	REV. 0
CHECK			FIGURE 1		



PLAN
SCALE
25 0 25 m



PROFILE FROM STA. 15+995 to STA. 16+220 (LEFT SIDE ROW)



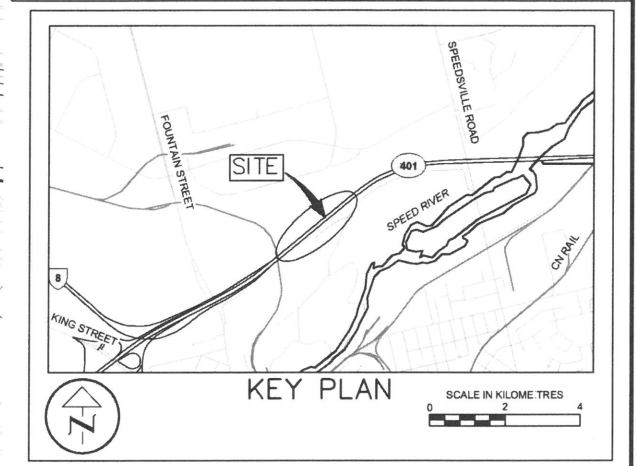
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 4-00-00

DEEP CUTS

HIGHWAY 401 IMPROVEMENTS
BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



LEGEND

- Borehole - Current Investigation
- Seal
- Standpipe
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in standpipe, measured on June 9, 2014.
- WL encountered during drilling
- DRY WL not established

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
701	299.59	4 807 930.3	234 769.9
702	298.96	4 808 073.9	234 950.7
704	296.89	4 807 967.7	234 701.9
705	301.27	4 808 034.4	234 906.7
706	303.31	4 808 004.5	234 869.2
707	303.14	4 807 900.1	234 738.1
708	298.75	4 808 102.6	234 852.2
709	304.37	4 808 040.0	234 772.2
710	301.72	4 808 070.6	234 813.1
711	296.40	4 808 216.6	235 005.6
712	297.28	4 808 258.7	235 046.2
713	298.05	4 808 321.9	235 122.5
714	296.21	4 808 349.9	235 158.8
(Geocres No. 40P8-226)			
2	297.97	4 808 289.7	235 084.3

NOTES

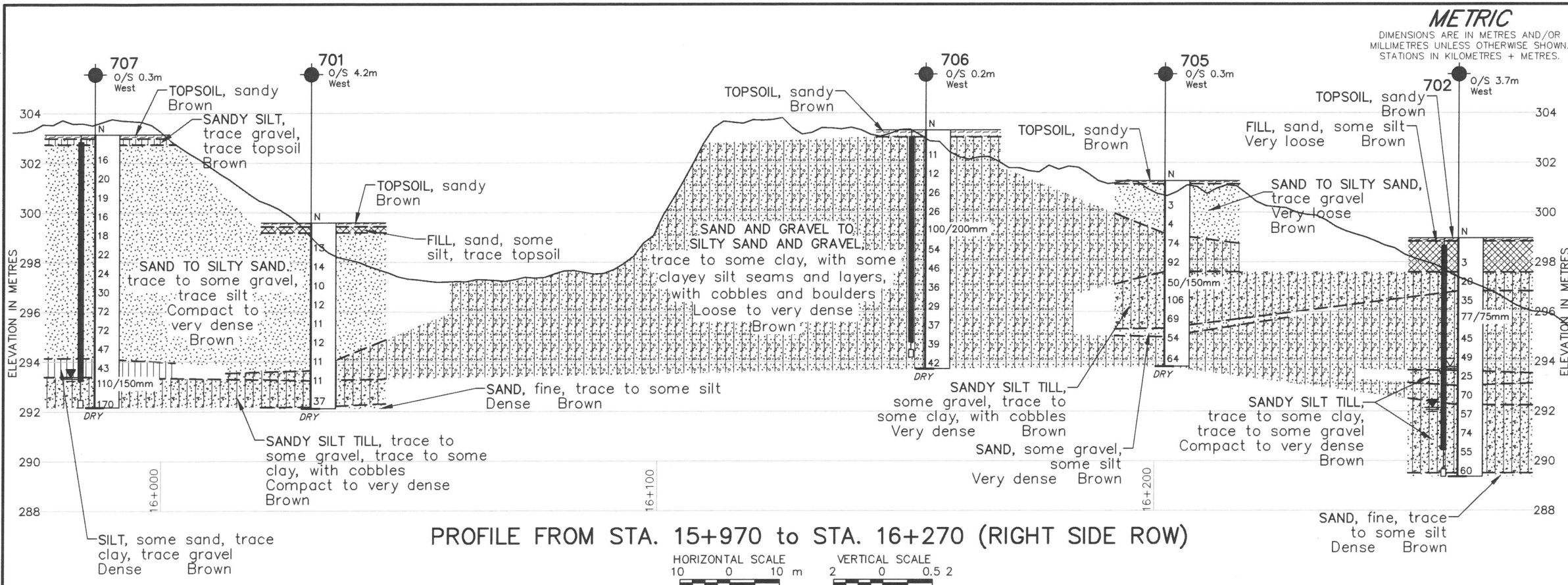
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

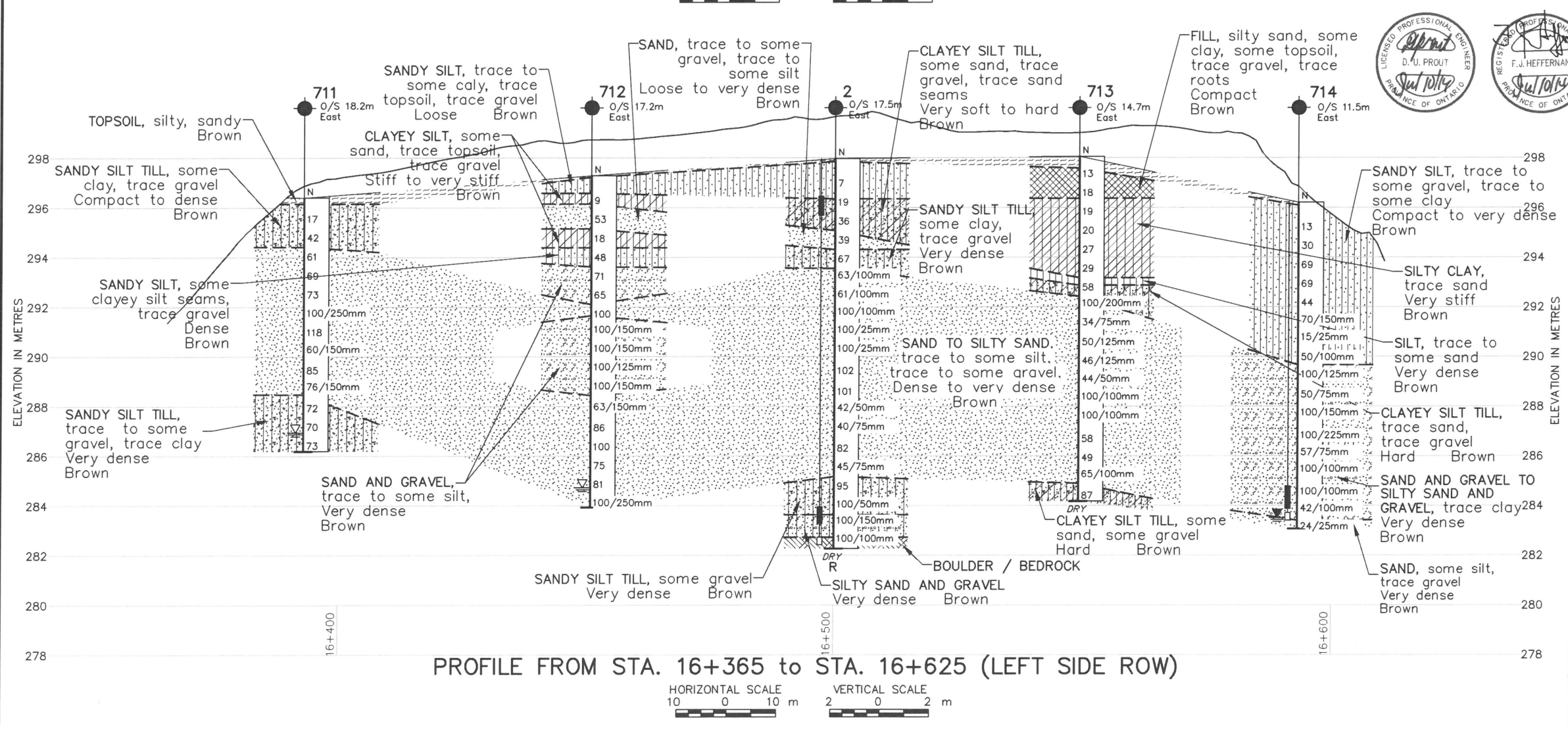
REFERENCE

Base plans provided in digital format by Delcan.

NO.	DATE	BY	REVISION
Geocres No. 40P8-217			
HWY.	401	PROJECT NO.	10-1132-0056
SUBM'D.	NAG	CHKD.	DUP
DRAWN:	LMK	CHKD.	AMH
DATE:	Nov. 28/13	DATE:	Nov. 28/13
APPD.	FJH	APPD.	FJH
SITE:		SITE:	
DWG.	1	DWG.	1



PROFILE FROM STA. 15+970 to STA. 16+270 (RIGHT SIDE ROW)



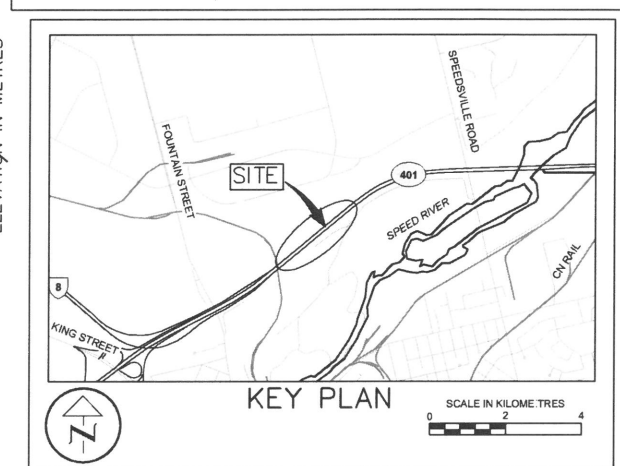
PROFILE FROM STA. 16+365 to STA. 16+625 (LEFT SIDE ROW)

CONT No. WP No. 4-00-00

DEEP CUTS

HIGHWAY 401 IMPROVEMENTS
SOIL STRATA

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



LEGEND

- Borehole - Current Investigation
- Seal
- Standpipe
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in standpipe, measured on June 9, 2014.
- WL encountered during drilling
- DRY WL not established
- R Split-spoon / Auger refusal on inferred bedrock

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
701	299.59	4 807 930.3	234 769.9
702	298.96	4 808 073.9	234 950.7
705	301.27	4 808 034.4	234 906.7
706	303.31	4 808 004.5	234 869.2
707	303.14	4 807 900.1	234 738.1
711	296.40	4 808 216.6	235 005.6
712	297.28	4 808 258.7	235 046.2
713	298.05	4 808 321.9	235 122.5
714	296.21	4 808 349.9	235 158.8
(Geocres No. 40P8-226)			
2	297.97	4 808 289.7	235 084.3

NOTES

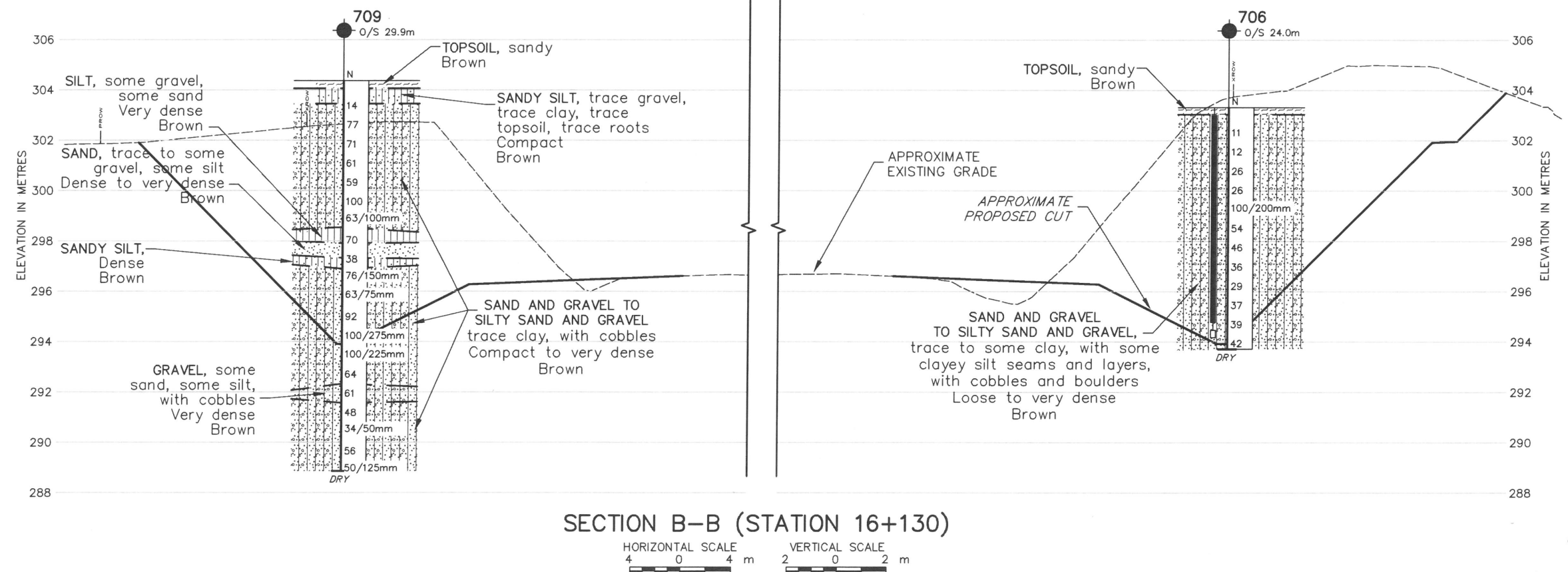
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

REFERENCE

Base plans provided in digital format by Delcan.

NO.	DATE	BY	REVISION
Geocres No. 40P8-217			
HWY.	401	PROJECT NO.	10-1132-0056
SUBM'D.	NAG	CHKD.	DUP
DRAWN:	LMK	CHKD.	AMH
DATE:	Nov. 28/13	DATE:	Nov. 28/13
SITE:		SITE:	
DWG.	2	DWG.	2



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

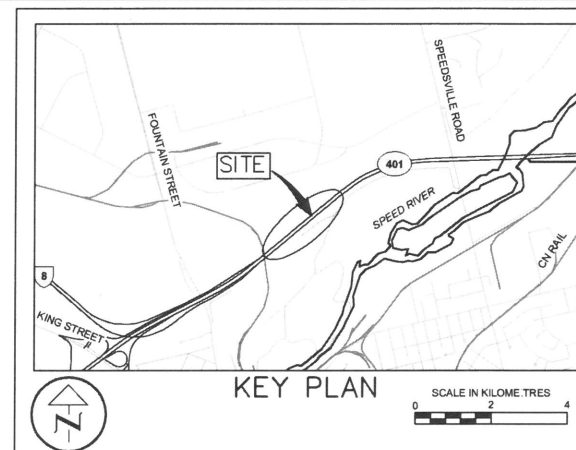
CONT No.
WP No. 4-00-00

DEEP CUTS





SHEET

HIGHWAY 401 IMPROVEMENTS
SOIL STRATA

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



LEGEND

- | | |
|---|--|
|  | Borehole - Current Investigation |
|  | Seal |
|  | Standpipe |
| N | Standard Penetration Test Value |
| 16 | Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow) |
|  | WL in standpipe, measured on June 9, 2014. |
| DRY | WL not established |

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
704	296.89	4 807 967.7	234 701.9
706	303.31	4 808 004.5	234 869.1
707	303.14	4 807 900.1	234 738.1
709	304.37	4 808 040.0	234 772.1

NOTES

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

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

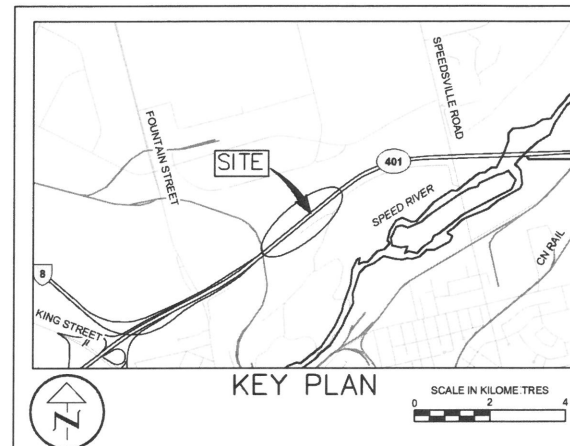
REFERENCE

Base plans provided in digital format by Delcan.





NO.			DATE		
BY			REVISION		
Geocres No. 40P8-217					
HWY. 401		PROJECT NO. 10-1132-0056			DIST.
SUBM'D. NAG		CHKD. DUP	DATE: Nov. 28/13		SITE:
DRAWN: I MK		CHKD. AMH	APPD. FJH		DWG. 3

CONT No.
WP No. 4-00-00

SHEET

HIGHWAY 401 IMPROVEMENTS
SOIL STRATA

LEGEND

- | | |
|---|--|
|  | Borehole — Current Investigation |
|  | Seal |
|  | Standpipe |
| N | Standard Penetration Test Value |
| 16 | Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow) |
|  | WL encountered during drilling |
| DRY | WL not established |
| R | Split-spoon / Auger refusal on inferred bedrock |

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
(Geocres No. 40P8-226)			
2	297.97	4 808 289.7	235 084.3

NOTES

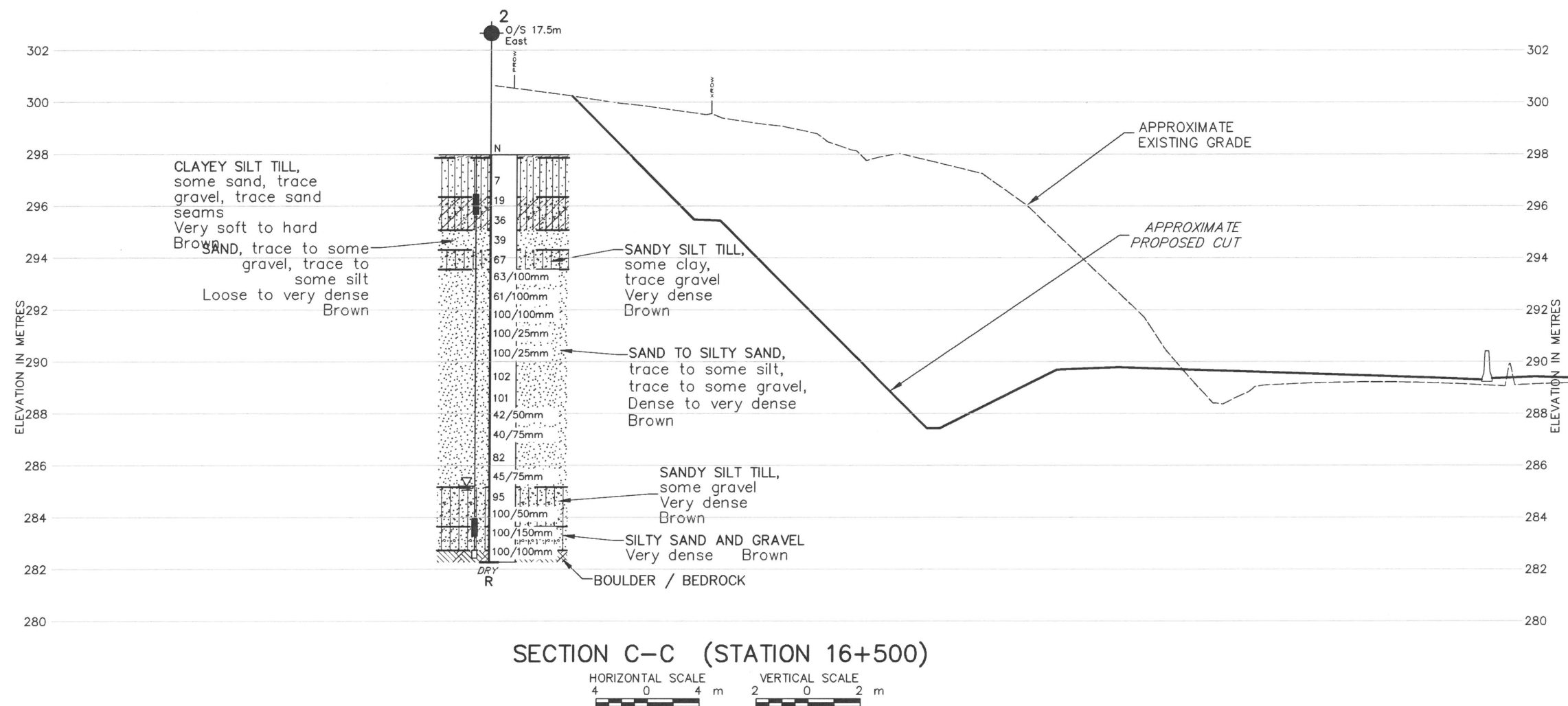
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

REFERENCE

Base plans provided in digital format by Delcan.

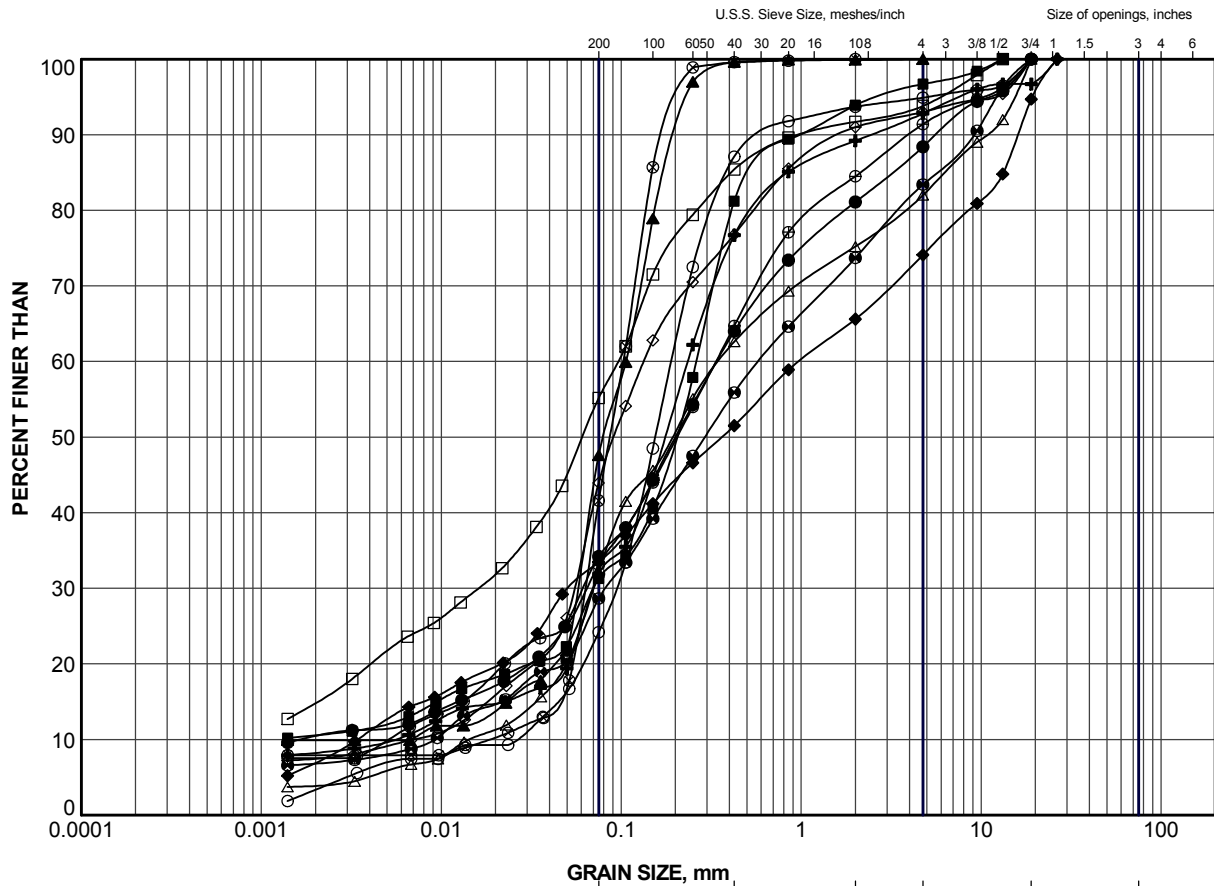
NO.	DATE	BY	REVISION		
Geocres No. 40P8-217					
HWY. 401		PROJECT NO. 10-1132-0056		DIST.	
SUBM'D. NAG	CHKD. DUP		DATE: Nov. 28/13		SITE:
DRAWN: LMK	CHKD. AMH		APPD. FUJ		DWG. 4





APPENDIX A

Laboratory Test Data



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	2	7	292.5
■	2	11	289.4
▲	2	16	285.6
+	707	10	295.3
◆	708	3	296.2
◇	710	10	293.9
○	710	11	292.4
△	711	7	291.0
⊗	712	7	291.9
⊕	712	14	286.4
□	712	17	284.1
⊙	713	10	290.6

PROJECT

DEEP CUTS
HIGHWAY 401 IMPROVEMENTS
GWP 4-00-00

TITLE

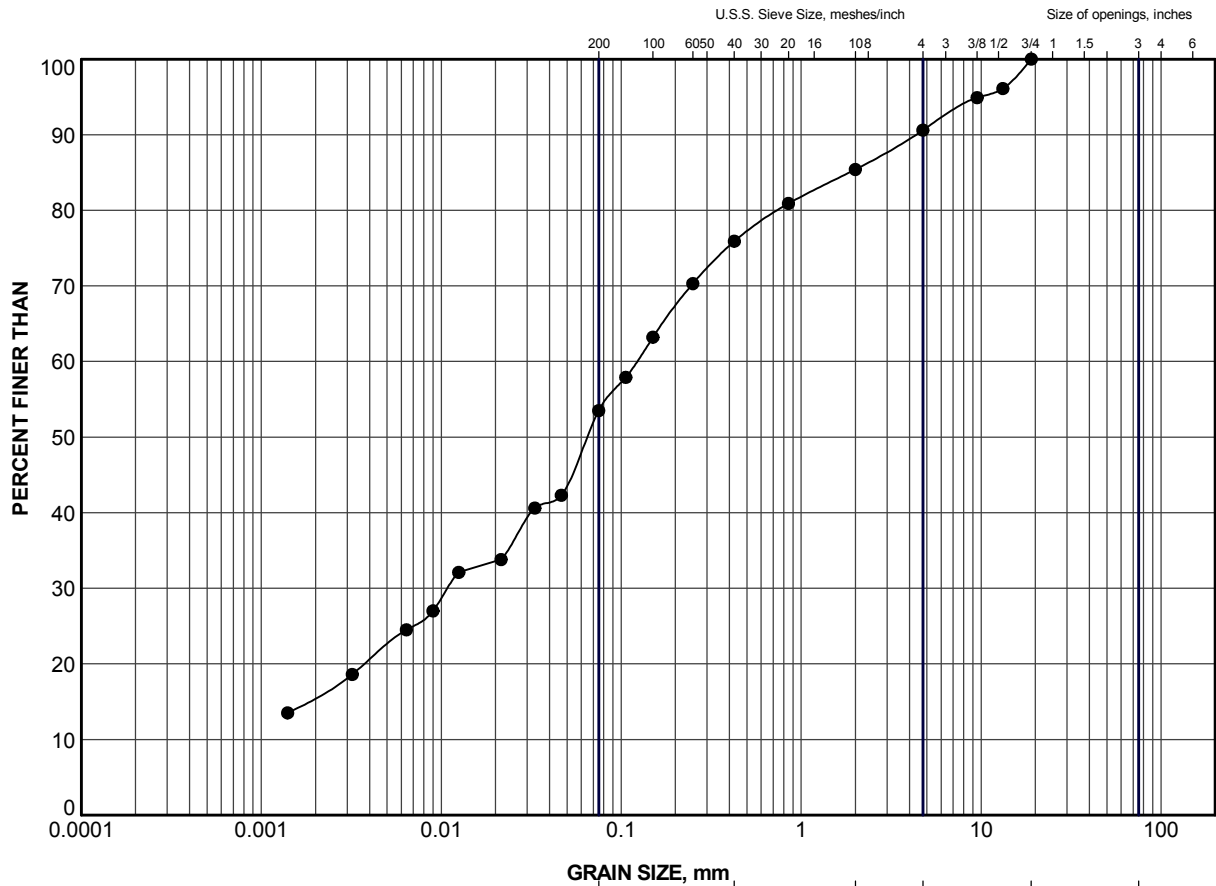
GRAIN SIZE DISTRIBUTION
SILTY SAND



Golder Associates
LONDON, ONTARIO

PROJECT No.	10-1132-0056	FILE N4011320056-2000-F09A0A1
SCALE	N/A	REV.
DRAWN	LMKWDF	Nov. 26/13
CHECK		


FIGURE A-1

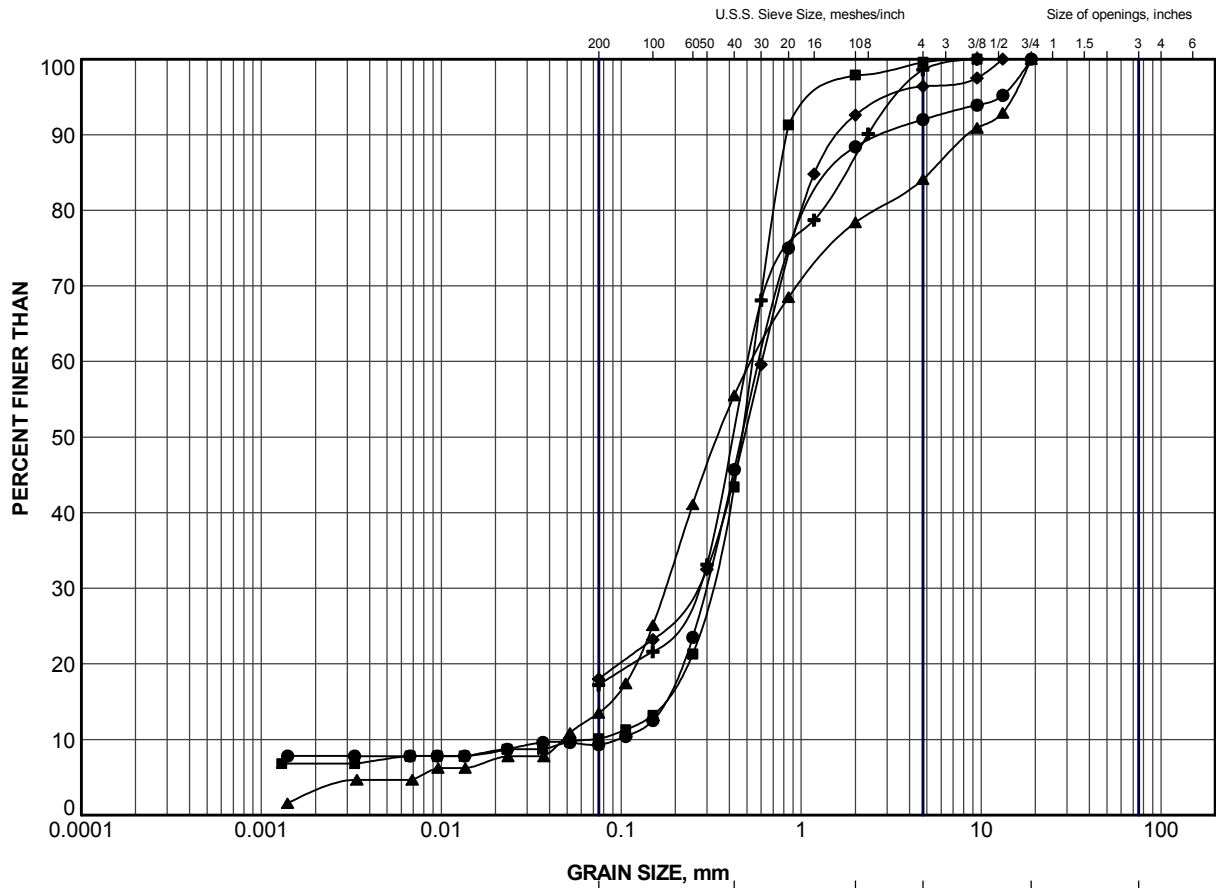


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	714	4	292.9

PROJECT	DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00		
TITLE	GRAIN SIZE DISTRIBUTION SANDY SILT		
 Golder Associates LONDON, ONTARIO	PROJECT No.	10-1132-0056	FILE No. 1011320056-2000-F090A2
	DRAWN	LMKWDF	Nov. 26/13
	CHECK		
	SCALE	N/A	REV.
			FIGURE A-2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	701	5	295.6
■	707	3	300.6
▲	708	7	293.2
+	713	15	286.7
◆	714	17	283.2

PROJECT

DEEP CUTS
HIGHWAY 401 IMPROVEMENTS
GWP 4-00-00

TITLE

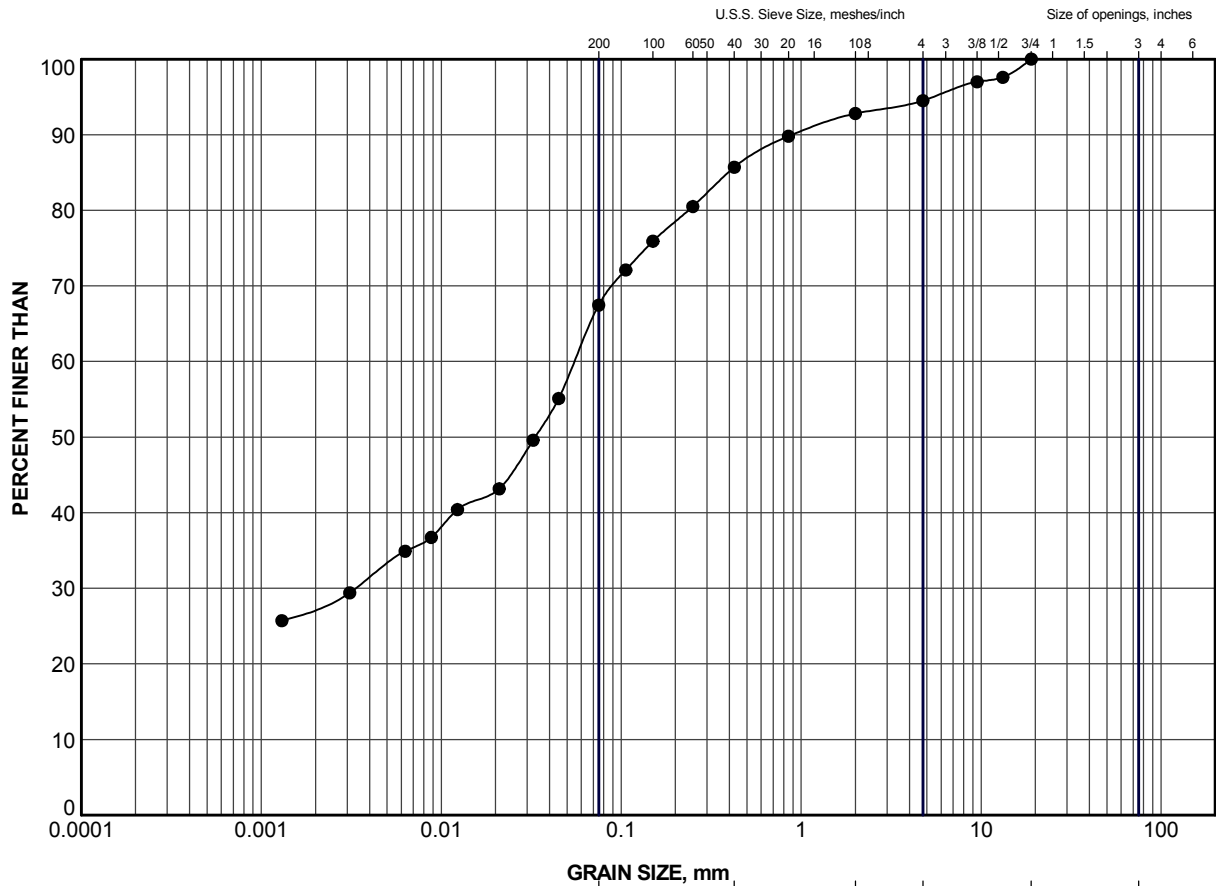
GRAIN SIZE DISTRIBUTION
SAND



**Golder
Associates**
LONDON, ONTARIO

PROJECT No.	10-1132-0056	FILE N4011320056-2000-F09A0A3
DRAWN	LMKWDF	Nov. 26/13
CHECK		
SCALE	N/A	REV.

FIGURE A-3



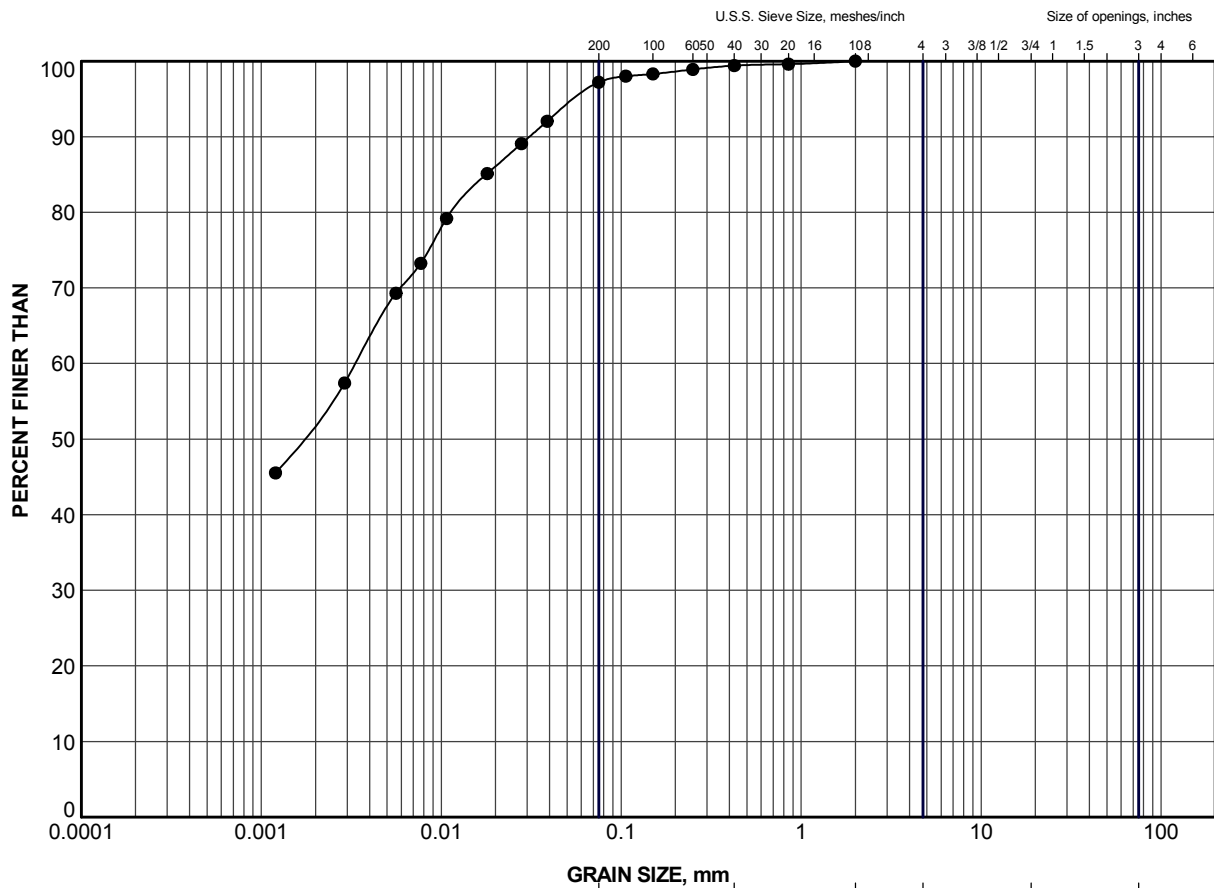
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	712	3	294.8

PROJECT				DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION CLAYEY SILT			
PROJECT No.		10-1132-0056		FILE No.		1011320056-2000-F090A4	
DRAWN		LMKWDF		Nov. 26/13		SCALE N/A REV.	
CHECK						FIGURE A-4	



LDN_MTO_GSD_GLDR_LDN.GDT



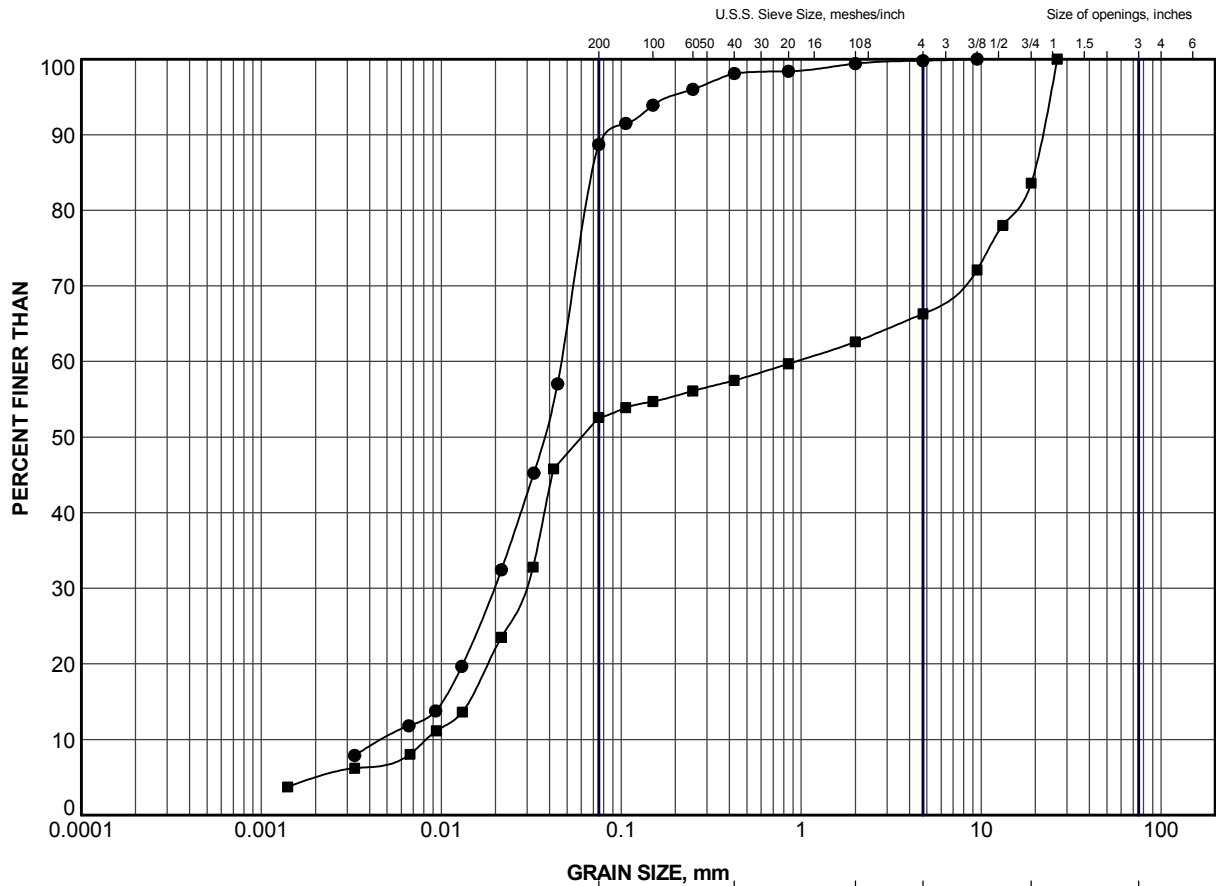
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	713	4	295.1

PROJECT				DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION SILTY CLAY			
PROJECT No.		10-1132-0056		FILE N4011320056-2000-F09A0A5			
DRAWN		LMKWDF		Nov. 26/13		SCALE N/A REV.	
CHECK						FIGURE A-5	



LDN_MTO_GSD_GLDR_LDN.GDT



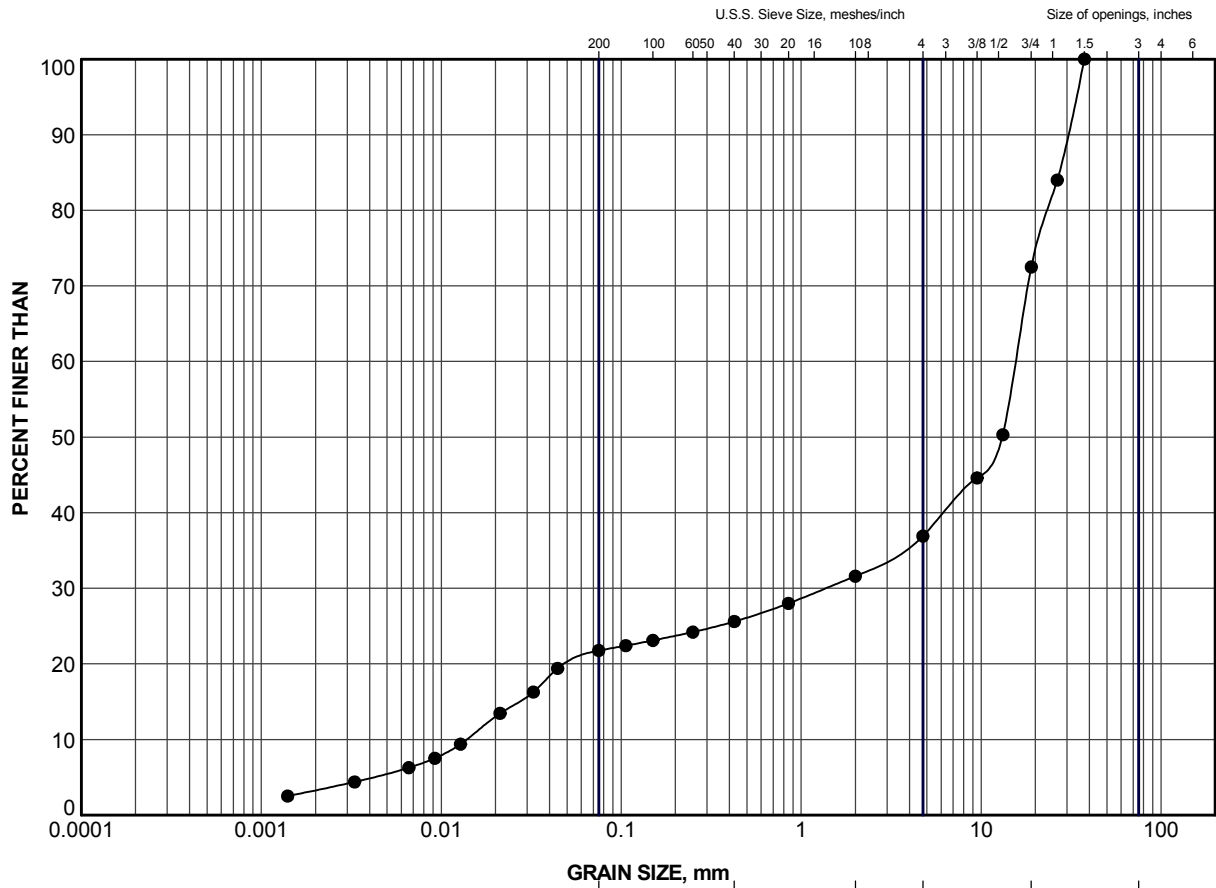
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	707	12	293.8
■	709	8	298.1

PROJECT				DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION SILT to SILT WITH GRAVEL			
PROJECT No.		10-1132-0056		FILE N4011320056-2000-F09A0A6			
DRAWN		LMKWDF		Nov. 26/13		SCALE N/A REV.	
CHECK						FIGURE A-6	




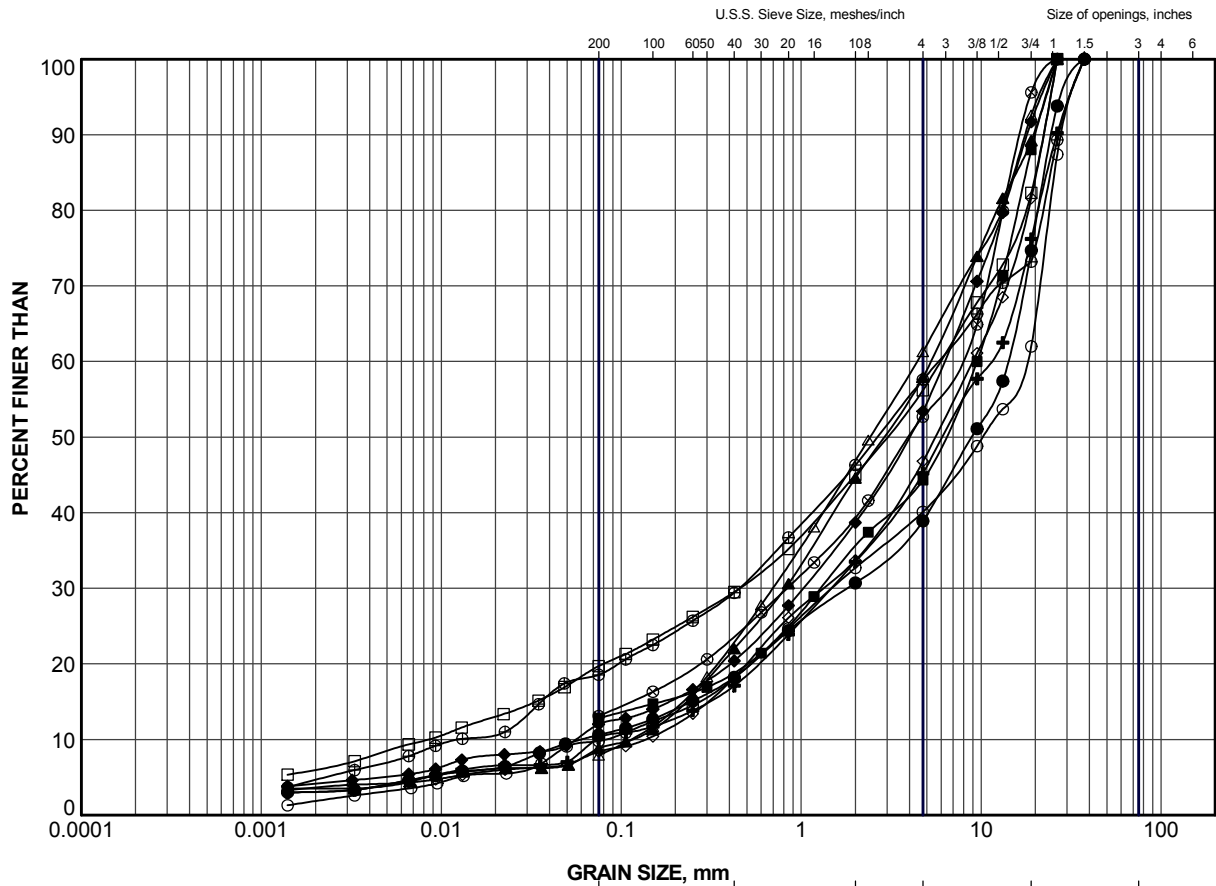
LDN_MTO_GSD_GLDR_LDN.GDT



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

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	709	16	292.0

PROJECT			
DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE			
GRAIN SIZE DISTRIBUTION GRAVEL			
 Golder Associates LONDON, ONTARIO	PROJECT No. 10-1132-0056		FILE N4.011320056-2000-F09A0A7
	DRAWN	LMKWDF	Nov 26/13
	CHECK		
			SCALE N/A REV.
			FIGURE A-7



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	702	6	294.2
■	704	3	294.4
▲	706	3	300.8
+	706	5	299.3
◆	706	7	297.8
◇	706	9	296.2
○	708	6	294.0
△	709	13	294.2
⊗	709	19	289.7
⊕	710	15	290.1
□	714	15	284.6

PROJECT

DEEP CUTS
HIGHWAY 401 IMPROVEMENTS
GWP 4-00-00

TITLE

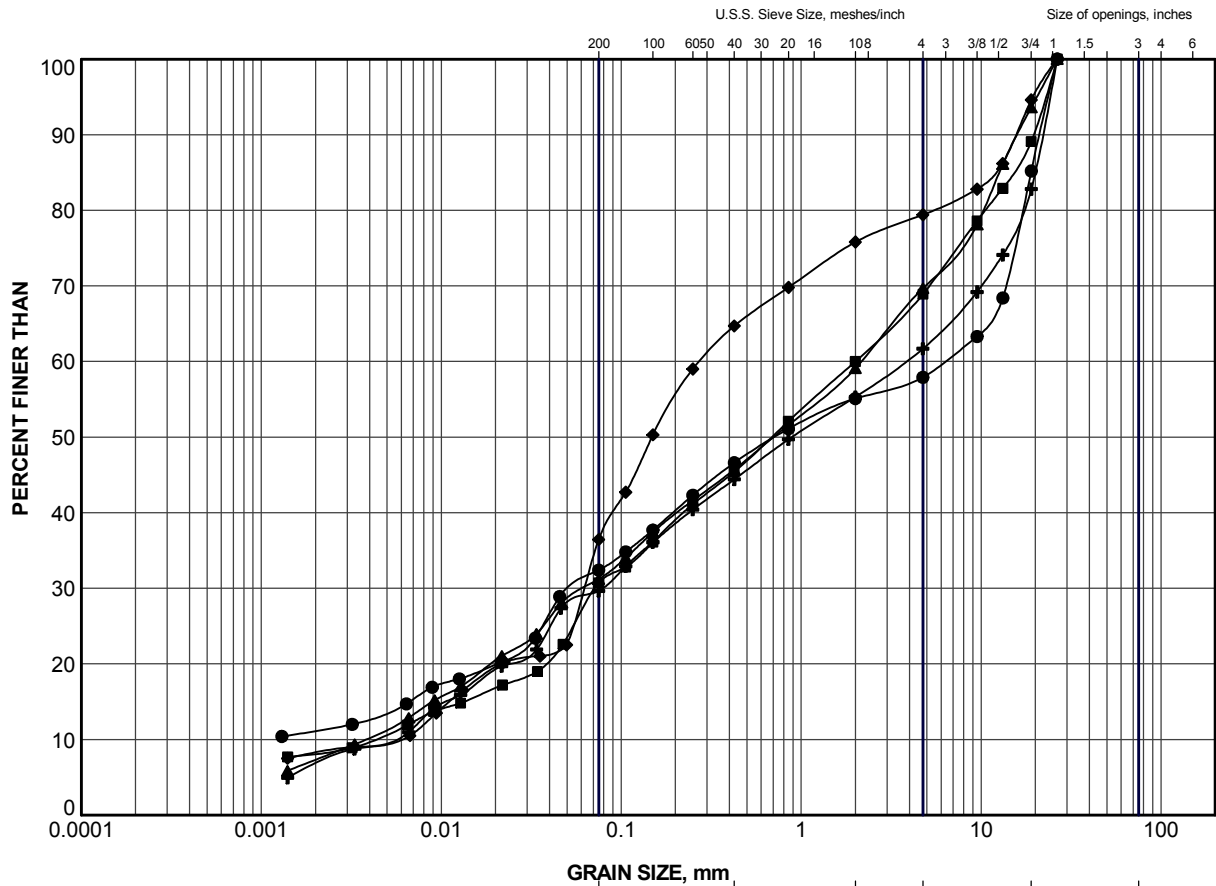
GRAIN SIZE DISTRIBUTION SAND AND GRAVEL



**Golder
Associates**
LONDON, ONTARIO

PROJECT No.	10-1132-0056	FILE N4011320056-2000-F09A0A8
DRAWN	LMKWDF	Nov 26/13
CHECK		
SCALE	N/A	REV.


FIGURE A-8

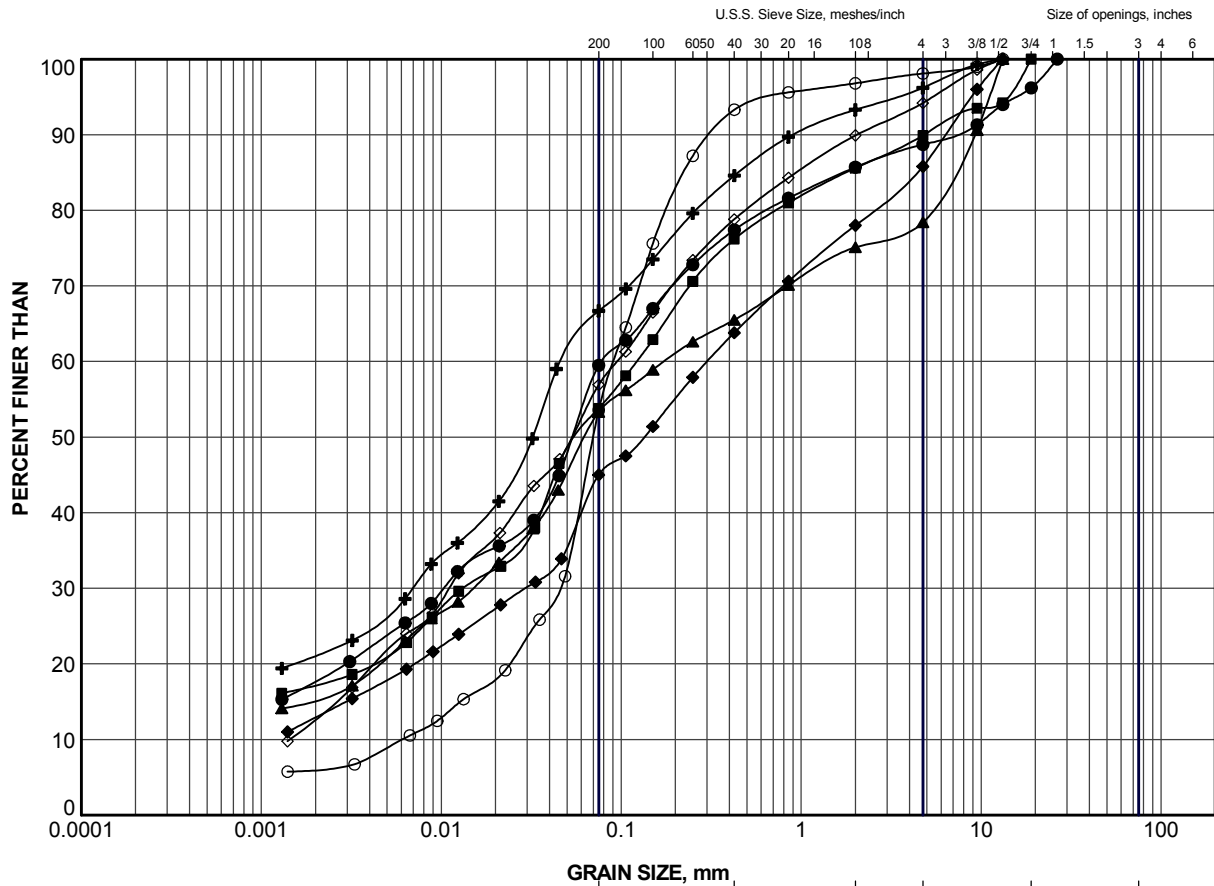


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	702	8	292.6
■	705	4	298.0
▲	709	2	302.6
+	710	3	299.2
◆	714	12	286.8

PROJECT				DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION SILTY SAND AND GRAVEL			
PROJECT No.		10-1132-0056		FILE N4011320056-2000-F09A0A9			
DRAWN		LMKWDF		Nov 26/13		SCALE N/A REV.	
CHECK						FIGURE A-9	
 Golder Associates LONDON, ONTARIO							



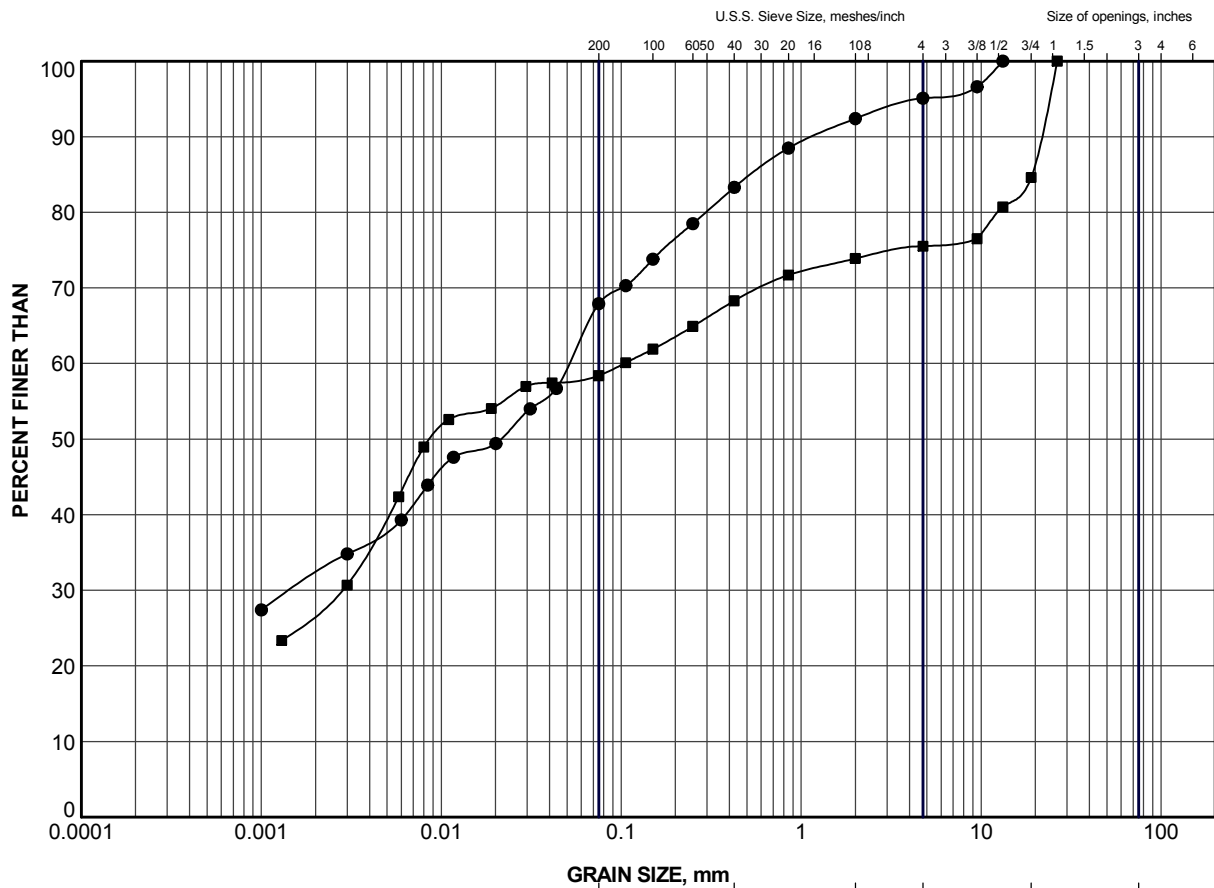
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	2	5	293.9
■	701	9	292.5
▲	702	2	297.2
+	702	9	291.9
◆	705	7	295.7
◇	711	1	295.6
○	711	13	286.4

PROJECT				DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION SANDY SILT TILL			
PROJECT No.		10-1132-0056		FILE No		1011320056-2000-F09AQA10	
DRAWN		LMKWDF		Nov. 26/13		SCALE N/A REV.	
CHECK						FIGURE A-10	




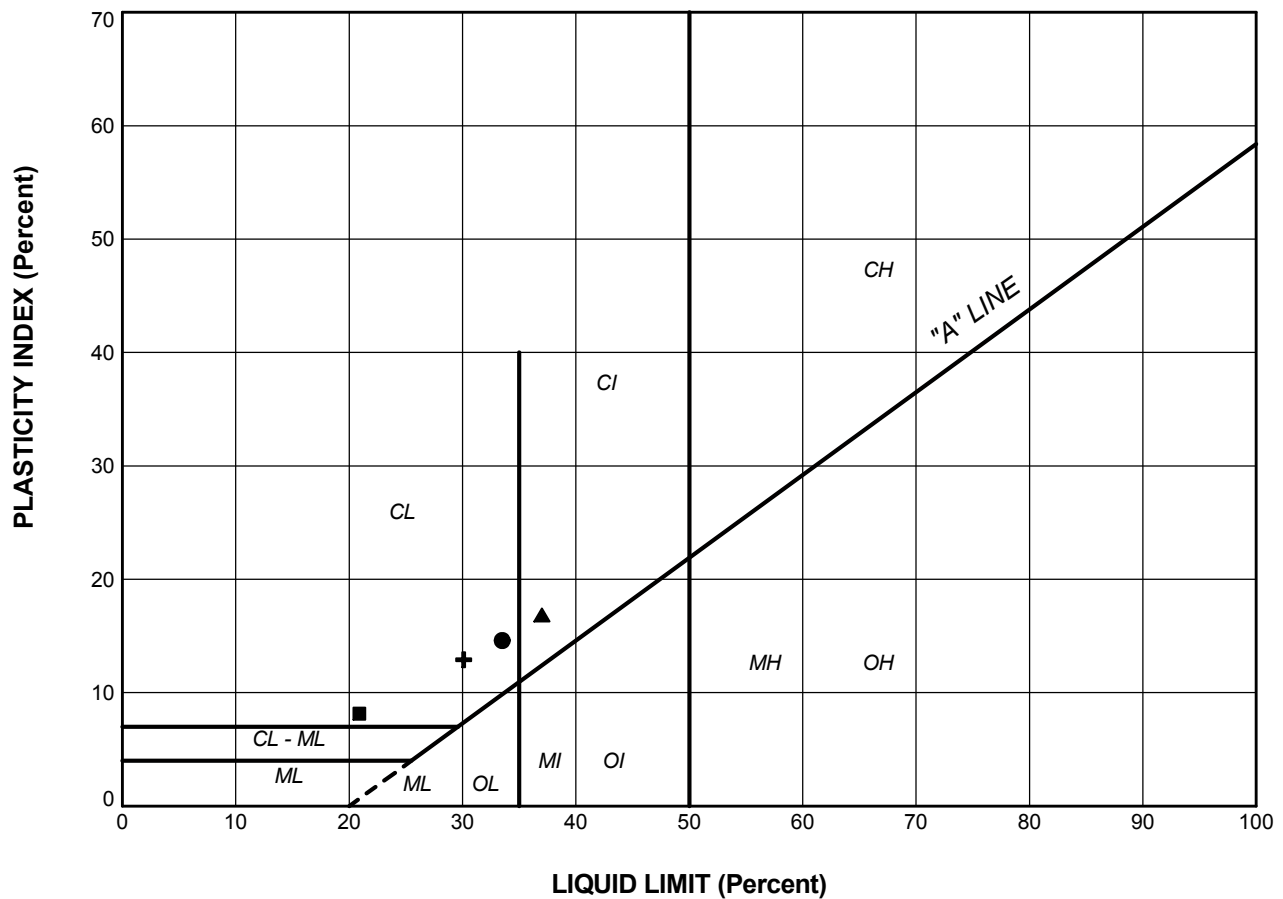


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	2	2	296.2
■	713	18	284.4

PROJECT				DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL			
PROJECT No.		10-1132-0056		FILE No		1011320056-2000-F09A0A11	
DRAWN		LMKWDF		Nov. 26/13		SCALE N/A REV.	
CHECK						FIGURE A-11	
 Golder Associates LONDON, ONTARIO							



LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
CLAYEY SILT					
■	712	3	20.9	12.8	8.2
SILTY CLAY					
▲	713	4	37.0	20.2	16.9
CLAYEY SILT TILL					
●	2	2	33.5	18.9	14.6
+	713	18	30.1	17.2	12.9

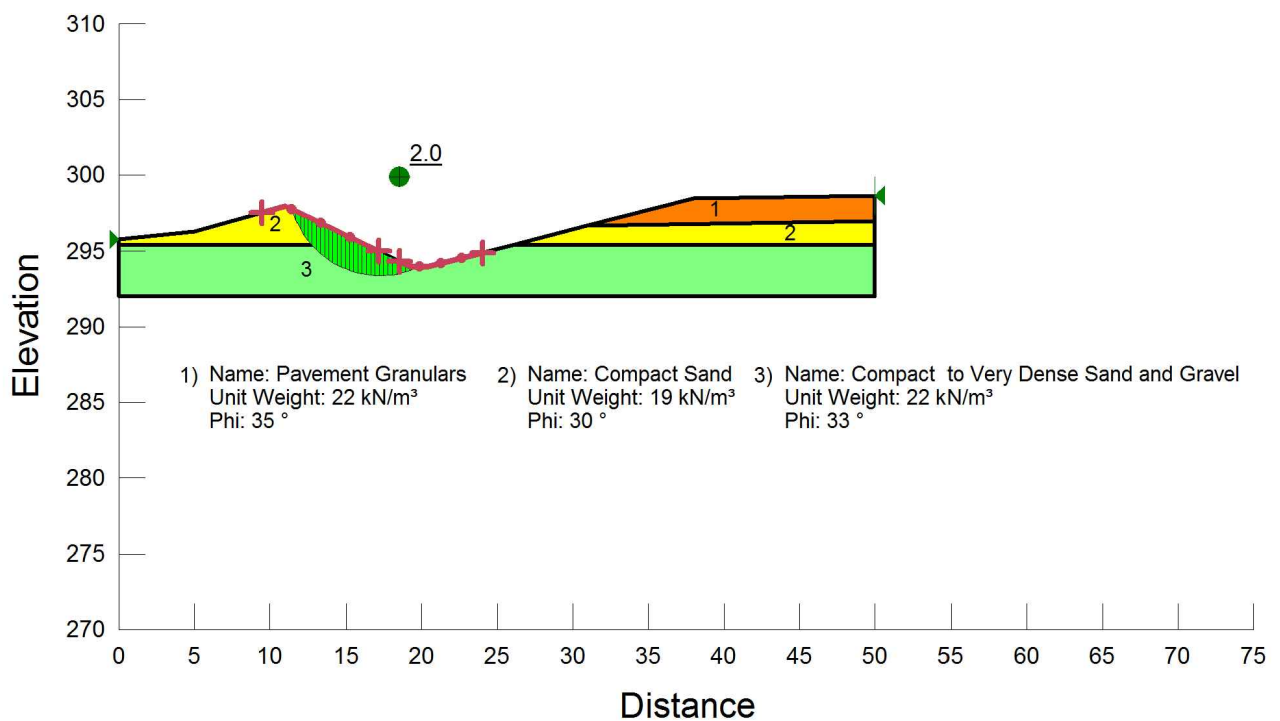
PROJECT		DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		PLASTICITY CHART	
PROJECT No. 10-1132-0056		FILE No1011320056-2000-F09A0A12	
DRAWN	LMKIWDF	Nov. 26/13	SCALE N/A REV.
CHECK			FIGURE A-12






APPENDIX B

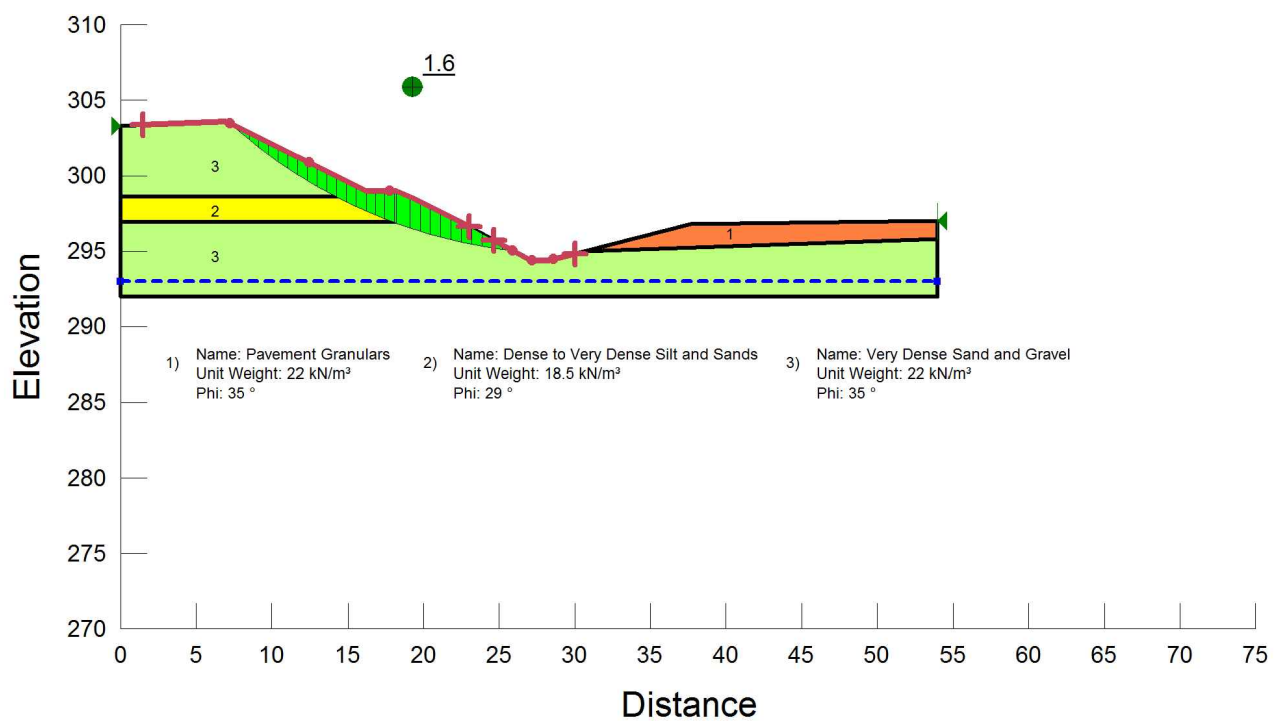
Results of Stability Analyses



NOTE

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

PROJECT		DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		RESULTS OF SLOPE STABILITY ANALYSIS STATION 16+000 LT	
 Golder Associates LONDON, ONTARIO		PROJECT No.	10-1132-0056
		FILE No.	1011320056-2000-F09A0B1
		SCALE	AS SHOWN
CADD		LMKWDF	Nov. 26/13
CHECK			
		REV.	0
FIGURE B-1			

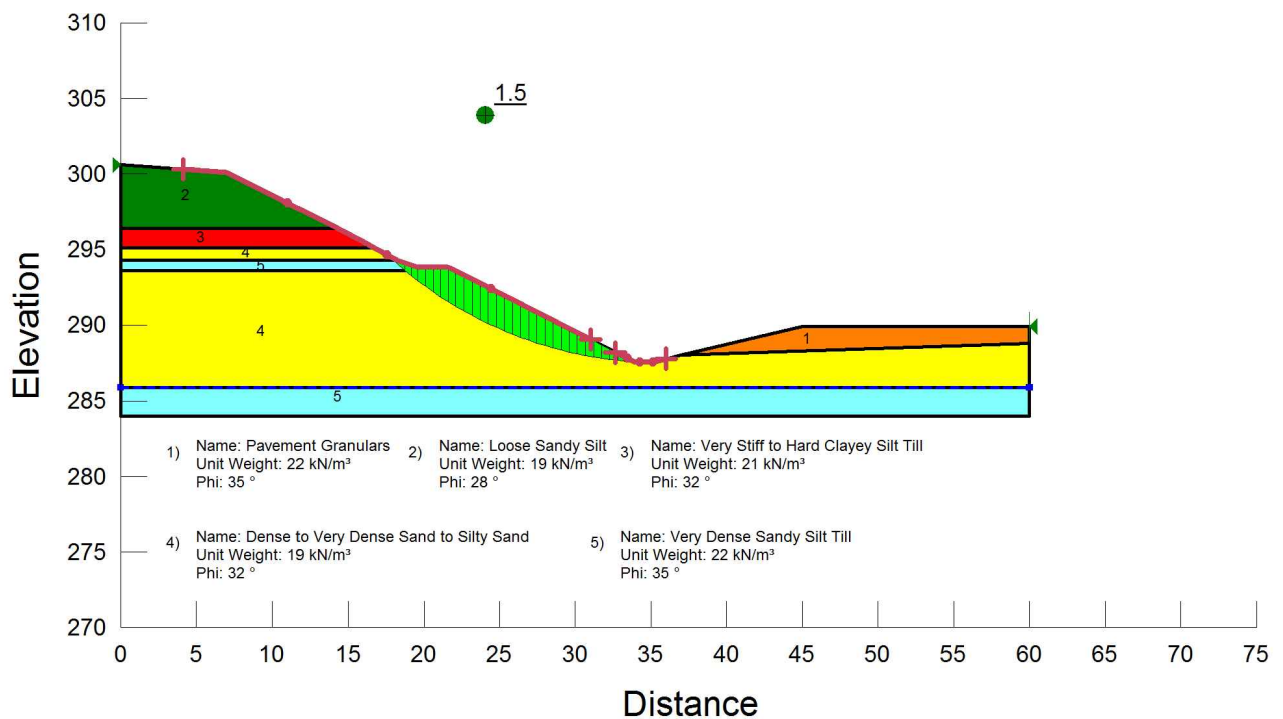


NOTE

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


PROJECT		DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		RESULTS OF SLOPE STABILITY ANALYSIS STATION 16+090 LT	
PROJECT No. 10-1132-0056		FILE No. 1011320056-2000-F09A0B1	
CADD	LMKWDF	Nov. 26/13	SCALE AS SHOWN REV. 0
CHECK			FIGURE B-2

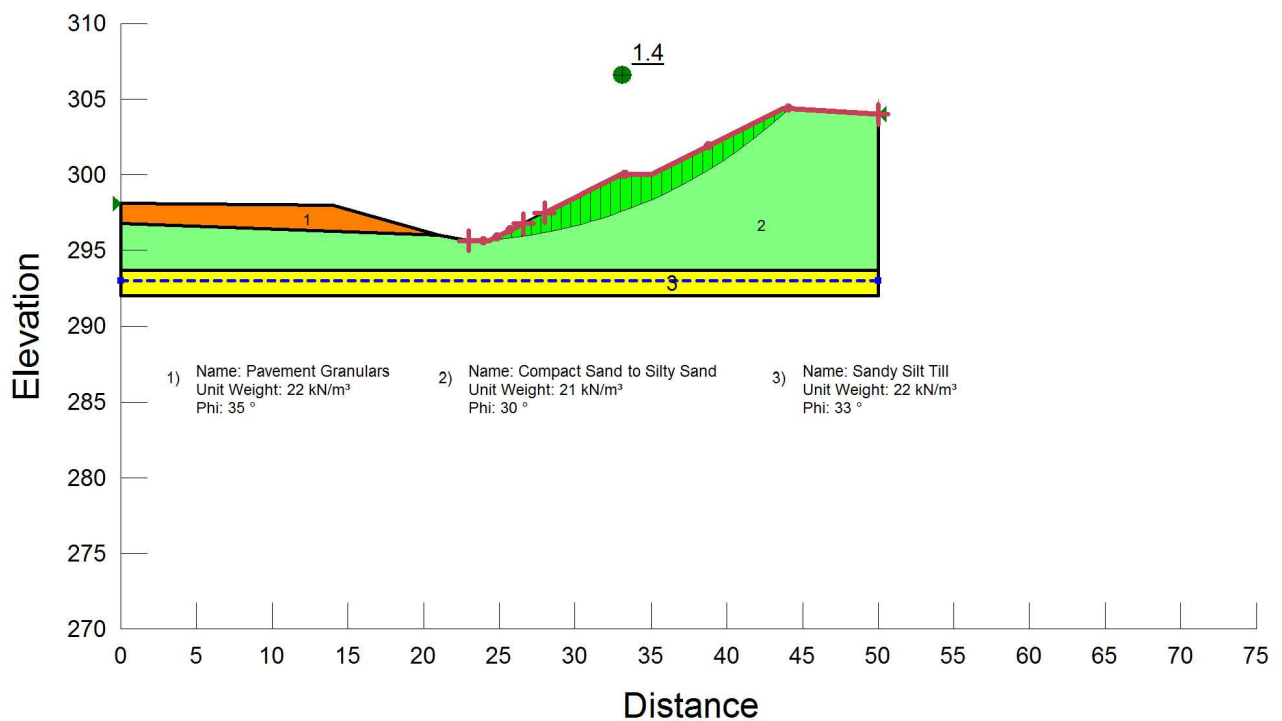




NOTE

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

PROJECT		DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		RESULTS OF SLOPE STABILITY ANALYSIS STATION 16+490 LT	
 Golder Associates LONDON, ONTARIO		PROJECT No.	10-1132-0056
		CADD	LMKWDF Nov. 26/13
		CHECK	
		FILE No.	1011320056-2000-F09A0B1
		SCALE	AS SHOWN
		REV.	0
		FIGURE B-3	

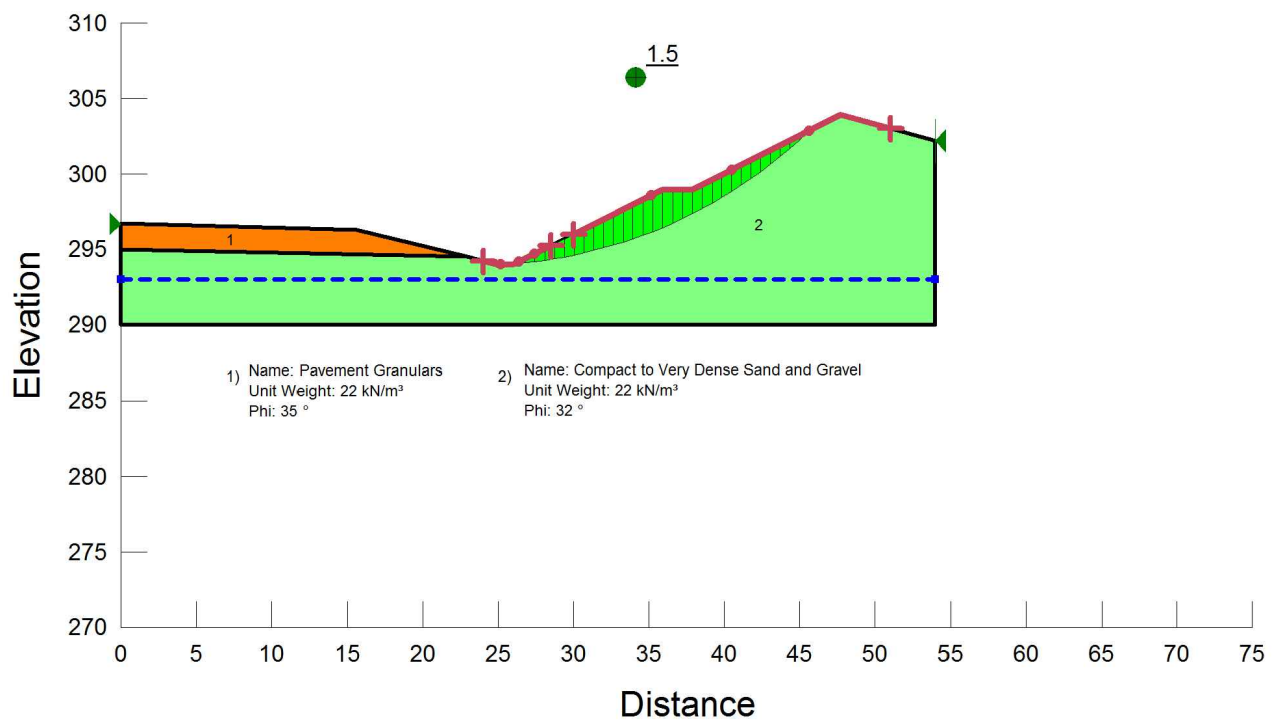


NOTE

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


PROJECT		DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		RESULTS OF SLOPE STABILITY ANALYSIS STATION 16+020 RT	
PROJECT No. 10-1132-0056		FILE No. 1011320056-2000-F09A0B1	
CADD	LMKWDF	Nov. 26/13	SCALE AS SHOWN REV. 0
CHECK			FIGURE B-4





NOTE

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

PROJECT		DEEP CUTS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		RESULTS OF SLOPE STABILITY ANALYSIS STATION 16+130 RT	
 Golder Associates LONDON, ONTARIO		PROJECT No.	10-1132-0056
		CADD	LMKWDF Nov. 26/13
		CHECK	
		FILE No.	1011320056-2000-F09A0B1
		SCALE	AS SHOWN
		REV.	0
		FIGURE B-5	



APPENDIX C

Records of Previous Boreholes (Geocres Report No. 40P8-226)

RECORD OF BOREHOLE No 2

1 OF 2

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808289.7, E 235084.3 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE June 26, 2012 - June 27, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
297.97	GROUND SURFACE							20 40 60 80 100						
0.00	TOPSOIL, sandy Brown							○ UNCONFINED + FIELD VANE						
0.12	SANDY SILT, trace to some clay, trace gravel Loose Brown		1	SS	7			● QUICK TRIAXIAL × LAB VANE						
296.35								20 40 60 80 100						
1.62	CLAYEY SILT TILL, some sand, trace gravel, trace sand seams Very stiff to hard Brown		2	SS	19									5 27 37 31
295.07			3	SS	36									
2.90	SAND, fine, some silt, trace gravel Dense Brown		4	SS	39									
294.31														
3.66	SANDY SILT TILL, some clay, trace to some gravel Very dense Brown		5	SS	67									11 29 42 18
293.55														
4.42	SILTY SAND, trace to some gravel, trace clay Very dense Brown		6	SS	63/ 100mm									
			7	SS	61/ 100mm									4 62 24 10
			8	SS	100/ 100mm									
			9	SS	100/ 25mm									
			10	SS	100/ 25mm									
289.89														
8.08	SILTY SAND, fine to medium, trace to some gravel, some clay Very dense Brown		11	SS	102									3 65 21 11
			12	SS	101									
			13	SS	42/ 50mm									
			14	SS	40/ 75mm									
			15	SS	82									
285.93														
12.04	SILTY SAND, with clayey silt seams Very dense Brown		16	SS	100/ 250mm									0 52 38 10
285.17														
12.80	SANDY SILT TILL, some gravel Very dense Brown		17	SS	95									
			18	SS	45/ 75mm									
283.64														
14.33	SILTY SAND AND GRAVEL Very dense Brown		19	SS	100/ 150mm									

Continued Next Page

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




LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/07/14

RECORD OF BOREHOLE No 2

2 OF 2

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808289.7 , E 235084.3 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE June 26, 2012 - June 27, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
282.73							Sand Piezometer												
15.24	Inferred BEDROCK		20	SS	100/ 100mm														
282.27																			
15.70	END OF BOREHOLE																		
	Auger refusal at about elev. 282.3m																		
	Groundwater encountered at about elev. 285.2m during drilling on June 26, 2012.																		
	Groundwater not established during drilling on June 27, 2012.																		
	Piezometer dry on January 24, 2013.																		
	Piezometer dry on November 20, 2013.																		
	Piezometer dry on June 9, 2014.																		

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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