



July 2014

FOUNDATION INVESTIGATION AND DESIGN REPORT

**High Fill Embankments
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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Report Number: 10-1132-0056-2000-R09B

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PART A

FOUNDATION INVESTIGATION REPORT

HIGH FILL EMBANKMENTS

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). For the purposes of this report Highway 401 is assumed to be oriented in an east-west direction.

This report addresses high fills (for embankment heights of 4.5 metres or greater) associated with the reconstruction and widening of Highway 401 and the new W-N/S ramp at the Hespeler Road Interchange. This report deals with high fills proposed to be placed on the north side of Highway 401 between approximately Stations 18+080 and 18+790 and on the south side between approximately Stations 18+080 and 18+970. There are other areas of high fill placement which are discussed in Foundation Investigation and Design Reports (FIDRs) prepared for other components of this project. The following table contains the summary of those areas and FIDRs to be referenced.

High Fill Section	Component	Geocres Report No.
Station 15+920 to 15+985 Lt	Approaches for Grand River Electric Railway Overhead, Site 33-144	40P8-210
Station 15+850 to 15+950 Rt		
Station 16+310 to 16+335 Lt	Speed River Tributary Culvert, Site 33-500/C &	40P8-218;
Station 16+350 to 16+445 Rt	Rogers Road Retaining Wall, Site 33-499-R	40P8-227
Station 18+030 to 18+035 Lt	Speed River Bridge (East Channel), Site 33+147-W	40P8-220

Additional comments for the high fill approaches at the Canadian National Railway (CNR) Overhead (Site 33-149) are presented in a separate FIDR.

The purpose of the foundation investigation is to explore the subsurface conditions at the proposed high fill embankment 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-L06 dated May 7, 2013. The work was carried out in accordance with our Quality Control Plan for Foundations Engineering dated March 8, 2012.

Preliminary base plans and cross sections of the project area were provided by Delcan 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 (Regional Road 8) easterly to east of Hespeler Road (Regional Road 24) in the City of Cambridge, Region of Waterloo. This section of Highway 401 is currently a six lane divided highway oriented generally east-west. 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 tracks and the Canadian National Railway (CNR) tracks are situated within the project limits.

The high fill embankments are located on the north side of Highway 401 between approximately Stations 18+080 and 18+790 and on the south side between approximately Stations 18+080 and 18+970. The abandoned Grand River Electric Railway (GRER) alignment, at about Station 18+300, and the active CNR overhead structure, at about Station 18+600, cross the highway within the high fill areas.

The high fill area is within the Speed River Wetland Complex and lies between Speed River and Hespeler Road. Figure A.2.2.3 entitled "Provincially and Locally Significant Wetlands, Hespeler West Subwatersheds Study" dated April 2003 prepared by Planning and Engineering Initiatives Ltd. for the City of Cambridge shows the eastern extent of the wetland on the north side of the highway is the CNR and on the south side is the abandoned GRER; the western limit of the Speed River Wetland Complex is Speedsville Road. The wetland complex is a Provincially Significant Wetland (PSW).

The lands surrounding the north high fill area are primarily undeveloped, often used for recreational purposes. Undeveloped lands are also present surrounding the south high fills area between Stations 18+080 and 18+250. Commercial developments are present on the north side of the highway east of about Station 18+800 and on the south side of the highway between about Stations 18+600 to 18+900. The Cambridge Preston Transformer Station is situated at 145 McGovern Drive. Also, a known landfill site is located on the south side of Highway 401 between the abandoned GRER and the CNR overhead structure, between about Stations 18+250 and 18+525. The landfill site, known as the Preston Landfill Site, reportedly accepted urban municipal domestic waste and closed in 1976; the duration of operation is not known. Information regarding the landfill site and the transformer station has been presented under draft Golder Report No. 10-1132-0056-6000-R01 "Preliminary Site Screening" issued in August 2013 for the environmental component of this assignment.

The elevation of the Highway 401 pavement within the high fills area slopes upward from west to east, from elevation 283 metres at Station 18+080 to elevation 295 metres at Station 18+970. The existing off platform ground surface elevation within the north high fills area varies from elevation 278 metres at the west end to elevation 290 metres at the east end. The existing off platform ground surface elevation within the south high fills area varies from elevation 279 metres at the west end to elevation 290 metres at the east end.



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 high fill embankments are situated in a former glaciofluvial spillway.¹

Quaternary geology mapping indicates that a portion of the high fill areas are located within the Speed River Wetland Complex which consists of gravel, sand, silt, and clay stream deposits as well as a shale and dolomite rock outcropping. An eroded scarp of outwash gravel comprises the east end of the high fill areas.²

The underlying bedrock surface in the high fill areas based on geologic mapping is typically found between elevations of 274 to 282 metres increasing from west to east, with outcrop elevations of up to about 290 metres.³ The depth of bedrock ranges from about 0.5 to 7.0 metres from the original ground surface. The rock formation is mapped and described as cream and brown, fine to medium crystalline dolostone 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 on June 13, 2012 and between June 23 and August 28, 2013, during which time 35 boreholes were drilled at the locations shown on the Borehole Location Plan, Drawing 1. The borehole numbers are not consecutive because the boreholes for this investigation were drilled over the course of fourteen months concurrently with boreholes for other investigations associated with this assignment. The boreholes were supplemented with seven boreholes advanced for other components of the project:

- Boreholes 501, 502, 503, and 505 – FIDR for CNR Overhead, Site 33-149;
- Boreholes 724, 725, and 757 – FIDR for Swamp/Soft Ground.

The table below summarizes the locations, ground surface elevations, and depths of the boreholes.

Relevant High Fill Area	Borehole	Location (m)		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing	Easting		
South side of Highway 401	501	4 808 536	267 084	293.28	8.62
	502	4 808 536	237 128	294.14	12.8
	703	4 808 510	236 787	279.91	2.13
	715	4 808 503	237 444	289.82	5.03
	716	4 808 507	237 391	289.64	6.55
	717	4 808 506	237 341	289.67	1.80
	717B	4 808 506	237 334	289.67	1.22
	718	4 808 506	237 290	289.52	6.93
	719	4 808 507	237 240	287.85	3.17
	720	4 808 507	237 215	287.71	6.10
	721	4 808 495	237 138	286.31	4.82
	730	4 808 533	237 411	295.11	12.19
	731	4 808 528	236 690	284.75	6.95
	757	4 808 501	236 641	278.35	0.67
	758	4 808 510	236 674	279.36	1.83
	759	4 808 508	236 721	279.32	2.29
	770	4 808 480	236 894	285.84	6.50
	771	4 808 486	236 986	285.31	5.41
	772	4 808 489	237 015	284.24	3.51
	773	4 808 531	236 834	288.94	9.75



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Relevant High Fill Area	Borehole	Location (m)		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing	Easting		
South side of Highway 401	774	4 808 533	236 938	290.93	11.83
	775	4 808 536	237 266	295.48	9.33
North side of Highway 401	503	4 808 572	237 155	294.40	13.34
	505	4 808 604	237 179	283.41	7.62
	722	4 808 597	237 290	289.85	3.05
	723	4 808 603	237 240	287.72	4.27
	724	4 808 581	236 610	278.42	0.52
	725	4 808 585	236 610	278 .24	0.36
	726	4 808 578	237 264	295.43	10.45
	727	4 808 569	236 972	291.62	11.52
	728	4 808 564	236 810	288.38	12.41
	729	4 808 562	236 660	283.91	6.92
	732	4 808 605	237 095	281.35	0.41
	733	4 808 605	237 042	280.43	0.43
	734	4 808 603	236 990	280.16	2.13
	735	4 808 600	236 945	279.71	0.70
	736	4 808 598	236 892	279.67	1.74
	737	4 808 591	236 840	279.12	0.76
	738	4 808 590	236 790	278.87	1.37
	739	4 808 588	236 740	278.52	0.46
	740	4 808 584	236 690	278.51	0.88
	741	4 808 583	236 650	278.34	1.22

The investigation was carried out using 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 D1586. The recorded SPT N values are noted on the Record of Borehole sheets. 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 sampler a distance of 300 millimetres, after an initial 150 millimetres of penetration. In cases where it was not possible to achieve a full 450 millimetres of drive, a penetration resistance representing the number of blows 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, in which case SPT testing



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was terminated after 100 blows. The results of the SPT testing as presented on the Record of Borehole sheets and in Section 4 are unmodified (not standardized for hammer efficiency, borehole diameter, rod length, etc.).

The samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 40 millimetres. Therefore particles that may exist within the soils that are larger than this dimension have not been sampled or represented in the grain size distributions. Larger particle sizes including cobbles and boulders are known to be present in the fill materials and native soils as discussed in the text of this report.

The boreholes were terminated between 0.4 to 12.4 metres below the existing pavement or ground surface. Groundwater conditions in the boreholes were observed throughout the drilling operations. Groundwater monitoring standpipes were installed in boreholes 703, 715, 718 and 720 as indicated on the corresponding Record of Borehole sheets. The boreholes were backfilled and the standpipes subsequently decommissioned in general accordance with current MTO procedures and Ontario Regulation 903 (as amended).

The field work was monitored on a full-time basis by experienced Golder Associates 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 an Atterberg limits determination were carried out on selected samples. The results of the testing are shown on the Record of Borehole sheets and in Appendix A.

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



4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the in situ 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 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 the existing pavement structure and embankment fill materials, or topsoil and fill materials, overlying native granular soils underlain by bedrock. The locations and elevations of the boreholes, together with the interpreted stratigraphic profiles, are shown on Drawings 1 to 4. Detailed descriptions 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 North of Highway, Station 18+080 to 18+790

Pavement Structure

Boreholes 503, 726, 727, 728 and 729, advanced through the westbound paved shoulder of Highway 401, encountered between 125 and 370 millimetres of asphaltic concrete underlain by 50 to 460 millimetres of granular base materials. The surficial pavement structure in borehole 726 was underlain by an additional 75 millimetre thick layer of asphaltic concrete and 175 millimetres of granular base materials.

Fill Materials

Between 5.5 and 10.8 metres of granular embankment fill material was encountered beneath the pavement structure in boreholes 726, 727, 728 and 729 between elevations 283.5 and 295.0 metres. Also, 1.0 to 1.1 metres of granular fill material was encountered at elevations 283.2 and 287.5 metres beneath surficial topsoil in boreholes 505 and 723, respectively. The granular fill materials generally consisted of sand and sand and gravel. Cobbles were encountered within the fill material in boreholes 727 and 729. Measured N values from standard penetration testing carried out in the fill materials ranged from 5 to greater than 100 blows per 0.3 metres. Water contents of samples of the fill materials ranged from 4 to 15 per cent. The results of grain size distribution analyses carried out on samples of the fill materials are shown on Figures A-1 and A-2.



Topsoil

Topsoil was encountered at the ground surface in boreholes 505, 722 to 724, and 732 to 741 and beneath the fill materials in borehole 728. The topsoil was between 60 and 400 millimetres thick.

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.

Sand and Gravel

Compact to very dense sand and gravel was encountered beneath the topsoil in boreholes 722, 725, 728, and 732 to 740, beneath the fill materials in boreholes 505, 723, 726 and 727, beneath the sandy silt in borehole 723, and beneath silty sand in borehole 741. The sand and gravel was encountered between elevations 277.6 and 289.5 metres and was between 0.2 and 4.5 metres thick. Cobbles were encountered within the sand and gravel in boreholes 728, 737 and 738. Layers of silty sand and gravel were encountered in boreholes 723, 725, 727, 739, 740 and 741.

Measured N values within the sand and gravel ranged from 11 to greater than 100 blows per 0.3 metres. Penetration resistances associated with split-spoon refusal on cobbles, boulders, or bedrock are not necessarily indicative of the overall relative density of the sand and gravel. Water contents of samples of the sand and gravel ranged from 2 to 18 per cent. The results of grain size distribution analyses carried out on samples of the sand and gravel and silty sand and gravel are shown on Figures A-3 and A-4, respectively.

Silty Sand

Approximately 0.2 to 2.3 metres of silty sand was encountered underlying the topsoil at approximate elevation 278.2 metres in boreholes 724 and 741 and below sand and gravel in borehole 503 from elevation 284.7 metres. The silty sand in borehole 503 was compact to dense with measured N values between 11 and 34 blows per 0.3 metres. Two samples from borehole 503 had water contents of 12 and 14 per cent. The results of grain size distribution analyses carried out on samples of the silty sand are presented on Figure A-5.

Sand to Sand and Silt

A 0.8 metre thick layer of compact sand and silt was encountered beneath the fill materials in borehole 729 at elevation 277.8 metres. A single N value of 24 blows per 0.3 metres was measured in the sand and silt. The water content of a single sample of the sand and silt was 14 per cent.

The silty sand in borehole 503 was underlain by a 0.3 metre thick layer of sand. The sand was inferred to be very dense based on the sample N value of 95 blows per 0.3 metres. The sand sample had a water content of 10 per cent.

The grain size distribution curves of samples of sand and sand and silt are shown on Figure A-6.



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Sandy Silt Till

The sand and gravel layer in borehole 723 was interlayered with a 0.8 metre thick layer of sandy silt till from elevation 285.6 to 284.8 metres. The sandy silt till was compact with a measured N value of 17 blows per 0.3 metres. The water content of a sample of the sandy silt till was 8 per cent. Based on one Atterberg limits determination carried out, the sandy silt till had a liquid limit of 26, a plastic limit of 14, and a plasticity index of 12, indicating low plasticity. The Atterberg limits results can be seen on Figure A-8. The results of a grain size analysis carried out on a sample of the sandy silt till are shown on Figure A-7.

Bedrock

Each of the boreholes in the north high fill area, boreholes 503, 505, 722 to 729, 732 to 741 were terminated due to auger and/or split spoon refusal on inferred bedrock. Boreholes 729, 737, and 738 penetrated the bedrock between approximately 60 and 1000 millimetres prior to termination. The bedrock in borehole 505 was cored using NQ size equipment. The core was examined by a geologist from Golder Associates and found to be dolostone of the Guelph Formation. The encountered bedrock elevation varied from 277.1 to 286.8 metres and was found to slope upwards from west to east. The following table summarizes the encountered bedrock depths and elevations.

Borehole	Encountered Bedrock	
	Depth (m)	Elevation (m)
503	13.34	282.06
505	1.28	282.13
722	3.05	286.80
723	4.27	283.45
724	0.52	277.90
725	0.36	277.88
726	10.45	284.98
727	11.52	280.10
728	12.41	275.97
729	6.86	277.05
732	0.41	280.96
733	0.43	280.00
734	2.13	278.03
735	0.70	279.01
736	1.74	277.93
737	0.67	278.45
738	1.28	277.59



FOUNDATION INVESTIGATION AND DESIGN REPORT HIGH FILL EMBANKMENTS

Borehole	Encountered Bedrock	
	Depth (m)	Elevation (m)
739	0.46	278.06
740	0.88	277.63
741	1.22	277.12

4.1.2 South of Highway, Station 18+140 to 18+820

Pavement Structure

Boreholes 501, 502, 730, 731, 773, 774 and 775 were advanced through the eastbound paved shoulder of Highway 401 where the thickness of the asphaltic concrete was between 90 and 370 millimetres. With the exception of borehole 502, where the road base granulars could not be distinguished from the embankment fill, the asphaltic concrete was underlain by 140 to 370 millimetres of granular base materials.

Fill Materials

Between 5.5 and 11.0 metres of granular embankment fill material was encountered beneath the pavement structure in boreholes 501, 502, 730, 731, 773, 774 and 775. It should be noted that borehole 501 was drilled at two locations approximately 3 metres apart and experienced refusal at elevations 285.8 and 284.7 metres on possible concrete or boulders. Between 0.2 and 6.4 metres of granular fill was encountered underlying the topsoil in boreholes 703, 715 to 721, 758, 759, 771, and 772 and from the ground surface in borehole 770. The granular fill materials generally consisted of sand, sandy silt, silty sand, and sand and gravel. Cobbles, occasionally with boulders, were encountered within the fill material in boreholes 501, 716, 718, 720, 721, 730, 731, 773 and 774. Boreholes 717 and 717B were terminated in the fill materials due to auger refusal on assumed boulders.

Boreholes 770 to 772 were advanced within the Preston Landfill since steep embankment and landfill slopes prevented access to the area along the toe of the proposed embankments. The upper approximately 4.2 metres of fill in borehole 771 consisted primarily of wood, plastic, metal and cloth debris. The granular fill in boreholes 770 and 772 also contained varying amounts of debris.

Measured N values from standard penetration testing carried out in the fill materials generally ranged from 4 to greater than 100 blows per 0.3 metres, with SPT N values from 0 blows (sampler advanced under weight of hammer) to 16 blows per 0.3 metres obtained in layers of debris. The embankment fill was found to be generally compact to very dense. Water contents of samples of the fill materials ranged from 2 to 12 per cent. The results of grain size distribution analyses carried out on samples of the fill materials are shown in Figures A-1 and A-2.



Topsoil and Peat

Surficial topsoil was encountered in boreholes 703, 715 to 721, 757, 758, 759, 771 and 772. Buried topsoil was encountered beneath the fill materials in boreholes 502, 717 and 772 at elevations 282.8, 289.3 and 281.5 metres, respectively. The topsoil layers were between 40 and 670 millimetres thick. The water content of a sample of the buried topsoil with peat from borehole 772 was 55 per cent. The buried topsoil in borehole 502 had a water content of 11 per cent. Amorphous peat, 360 millimetres thick, was encountered at elevation 278.3 metres beneath the fill materials in borehole 758.

Sand and Gravel

Compact to very dense sand and gravel was encountered beneath the topsoil in boreholes 717 and 772, beneath the peat in borehole 758, beneath the fill materials in boreholes 703, 715, 716, 717B to 721, 730, 731, 759, and 770 to 774, and beneath sandy silt in borehole 715. The sand and gravel was encountered between elevations 277.9 and 289.3 metres and was between 0.1 and 6.3 metres thick where fully penetrated. Boreholes 715 and 716 were terminated in the sand and gravel after exploring it for some 0.3 and 6.0 metres, respectively. Cobbles and boulders were encountered within the sand and gravel in boreholes 715 to 721 and 730. Boreholes 717, 717B and 719 were terminated in the sand and gravel due to auger refusal on probable boulders. Layers of silty sand and gravel were encountered in boreholes 703, 715, 716, 718, 721, 730, 758, 770, 771 and 774.

Measured N values within the sand and gravel ranged from 11 to greater than 100 blows per 0.3 metres. Penetration resistances associated with split-spoon refusal on cobbles, boulders, or bedrock are not necessarily indicative of the overall relative density of the sand and gravel. Water contents of samples of the sand and gravel ranged from 1 to 15 per cent. The results of grain size distribution analyses carried out on samples of the sand and gravel and silty sand and gravel are shown in Figures A-3 and A-4, respectively.

Sandy Silt

A 0.3 metre thick layer of dense sandy silt was encountered beneath the sand and gravel in borehole 715 at elevation 285.4 metres. A single measured N value from the sandy silt was 33 blows per 0.3 metres.

Bedrock

Boreholes 502, 703, 718, 720, 721, 730, 731, 757, 758, 759, and 770 to 775 were terminated due to auger and/or split spoon refusal on inferred bedrock. Boreholes 502, 703, and 775 penetrated the bedrock approximately 0.2 to 0.8 metres prior to termination. The encountered bedrock elevation varied from 277.0 to 286.3 metres and was found to slope upwards from west to east. The following table summarizes the encountered bedrock depths and elevations.



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Borehole	Encountered Bedrock	
	Depth (m)	Elevation (m)
502	8.62	281.95
703	1.37	278.54
718	6.93	282.59
720	6.10	281.61
721	4.82	281.49
730	12.19	282.92
731	6.95	277.80
757	0.67	277.68
758	1.83	277.53
759	2.29	277.03
770	6.55	279.29
771	5.41	279.90
772	3.51	280.73
773	9.75	279.19
774	11.83	279.10
775	9.14	286.34

4.2 Groundwater Conditions

Groundwater conditions were observed during and on completion of drilling and sampling. Groundwater was encountered in boreholes 703, 715, 716, 718, 720, 721, 727 to 740, 758, 759, 770, 771, 773 and 774. The encountered depths and elevations are summarized in the following table.

Relevant High Fill Area	Borehole	Ground Surface Elevation (m)	Encountered Groundwater	
			Depth (m)	Elevation (m)
South side of Highway 401	501	293.3	7.1	286.2
	502	294.1	10.9	283.2
	703	279.9	1.1	278.8
	715	289.8	3.6	286.2
	716	289.6	4.1	285.5



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Relevant High Fill Area	Borehole	Ground Surface Elevation (m)	Encountered Groundwater	
			Depth (m)	Elevation (m)
South side of Highway 401	717	289.8	*	*
	717B	289.8	*	*
	718	289.5	5.0	284.5
	719	287.9	*	*
	720	287.7	5.5	282.2
	721	286.3	4.3	282.0
	730	295.1	9.7	285.4
	731	284.8	6.1	278.7
	757	278.4	0.4	278.0
	758	279.4	1.4	278.0
	759	279.3	1.8	277.5
	770	285.8	4.8	281.0
	771	285.3	4.1	281.2
	772	284.2	*	*
	773	288.9	9.3	279.6
	774	290.9	9.7	281.2
	775	295.5	*	*
North side of Highway 401	503	294.4	11.6	282.8
	505	283.4	*	*
	722	289.9	*	*
	723	287.7	*	*
	724	278.4	*	*
	725	278.2	*	*
	726	295.4	*	*
	727	291.6	9.5	282.1
	728	288.4	9.5	278.9
	729	283.9	6.1	277.8
	732	281.4	0.1	281.3
	733	280.4	0.1	280.3
	734	280.2	0.1	280.1
	735	279.7	0.1	279.6
	736	279.7	0.0	279.7



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Relevant High Fill Area	Borehole	Ground Surface Elevation (m)	Encountered Groundwater	
			Depth (m)	Elevation (m)
	737	279.1	0.0	279.1
	738	278.9	0.1	278.8
	739	278.5	0.1	278.4
	740	278.5	0.1	278.4
	741	278.3	*	*

* Groundwater level not established.

Groundwater monitoring standpipes were installed in boreholes 703, 715, 718 and 720. The measured groundwater depths and elevations are summarized in the following table.

Borehole	Ground Surface Elevation (m)	Measured Groundwater		
		Date	Depth (m)	Elevation (m)
703	279.91	* June 13, 2012	2.13	277.78
		** Nov. 7, 2012	0.91	279.00
715	289.82	* June 24, 2013	4.37	285.45
		** July 31, 2013	3.75	286.07
718	289.52	* June 23, 2013	6.07	283.45
		** July 31, 2013	4.82	284.70
720	287.71	* June 26, 2013	5.67	282.04
		** July 31, 2013	5.55	282.16

* Following installation.

** Prior to decommissioning.

The above-noted water levels are not considered to be representative of the long-term, stabilized groundwater conditions. Based on the encountered and measured groundwater levels, the inferred groundwater level is expected to generally follow the original ground surface. Groundwater levels are expected to fluctuate seasonally and are expected to be higher during periods of sustained precipitation or spring melt conditions.

The inferred groundwater level in the northern widening area is below elevation 277.9 metres, or the termination depth of boreholes 724 and 725 near Station 18+080 then rises to approximate elevation 279.0 metres just west of the abandoned GRER line. East of this structure, the inferred groundwater level rises from elevation 280.0 metres to elevation 283.0 metres at the CNR overhead structure. The groundwater level east of the CNR structure is below elevations 283.5 to 286.8 metres, or the termination depths of boreholes 722, 723 and 726.



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The inferred groundwater level in the southern widening area varies from elevation 278.0 metres near Station 18+100 to elevation 279.0 metres just west of the abandoned GRER line. East of this structure, the inferred groundwater level rises from elevation 280.0 metres to elevation 283.0 metres at the CNR Overhead structure. Between the CNR and Station 18+710, the groundwater is inferred at elevation 282.0 metres. East of Station 18+710, the groundwater rises to elevation 285.0 metres then to about elevation 286.0 metres near Station 18+900.



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, Mr. Lubo Kosci, P.Eng., and Mr. Dan Babcock, P.Eng. under the direction of the Site Investigation Field 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 Ms. Nicole A. Gould, P.Eng. under the direction of the Project Engineer, Ms. Dirka U. Prout, P.Eng. This report was reviewed by Mr. Azmi M. Hammoud, P.Eng., an Associate and Senior Geotechnical Engineer with Golder Associates. An independent quality review of this report 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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**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH FILL EMBANKMENTS**

PART B

FOUNDATION DESIGN REPORT

HIGH FILL EMBANKMENTS

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

This section of the report provides our recommendations on the foundation aspects of the design of the high fill embankments east of Station 18+080. The recommendations are based on our interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, and scheduling.

6.1 General

This report addresses the construction of high fill embankments associated with the reconstruction and widening of Highway 401 and construction of the new W-N/S ramp in the Hespeler Road Interchange. The high fill embankments are located on the north side of Highway 401 between approximately Stations 18+080 and 18+790 and on the south side between approximately Stations 18+080 and 18+970. High fills placed between Station 18+080 Lt (north side) and the CNR Overhead and between 18+080 Rt (south side) and the abandoned GRER line will lie within the Speed River Wetland Complex. The cross sections provided by Delcan indicate that the highway platform is to be widened within the high fill areas by up to 19 metres on each side, with maximum heights of new fill up to 8.2 metres. Side slopes of the proposed cross sections have inclinations no steeper than two horizontal to one vertical (2H:1V). Based on our review of the proposed embankment cross-sections provided by Delcan, the Highway 401 platform will be widened from the current six-lane to the proposed 10-lane configuration with no grade raise. The Hespeler Road W-N/S ramp will occupy the southern portion of the widened embankment east of the bullnose at Station 18+678.5 Rt (Station 10+000 for the W-N/S Ramp). The ramp fills will be up to 7.5 metres high.

6.2 Embankments

Due to the relatively shallow depths of organic soils and fill materials encountered, the granular nature of the native soils, and the generally shallow depth to bedrock, stability and settlement issues are not anticipated provided any organic materials, soft soils, and otherwise deleterious materials are removed from the embankment widening subgrades as recommended in this report. Critical slope sections were selected for stability and settlement analyses which correspond to the greatest new embankment height and/or the maximum thickness of loose soils.

Embankment fill alternatives include rock fill, granular fill, and expanded polystyrene (EPS) lightweight fill; however, based on the existing embankment fills being granular, local availability of granular fill materials, and the relatively shallow depth to competent founding soils and bedrock, it is anticipated that the widened



embankments will be constructed using granular fill. Detailed recommendations for embankment construction are presented in Section 6.5.

6.2.1 Stability

No stability issues are anticipated for the proposed embankment widenings due to the relatively shallow depth to bedrock and the presence of compact to very dense granular overburden, provided all organic materials and deleterious fills are removed from the embankment widening subgrades. Critical sections from each high fill area were selected for slope stability analyses using SLOPE/W, a commercially available software package for limit equilibrium stability analyses. In the following report sections, critical cross sections selected for slope stability and settlement analyses correspond to the greatest new embankment height and/or the maximum thickness of loose soils. A factor of safety against instability of at least 1.3 was found to be available for the slopes as presented in the cross sections on Figures B-1 to B-3 in Appendix B. For slope stability analyses it has been assumed that removal of organic materials and deleterious fills and subgrade preparation are carried out as described in this report. The results of the stability analyses conducted for the critical sections are discussed in Section 6.3.

6.2.2 Settlement

The depth of the native granular overburden was found to be generally minimal; therefore, it is anticipated that the settlement of the foundation soils will occur over a relatively short time period during construction. As such, settlement will be negligible in most of the high fill areas. Isolated areas of deeper soil deposits and/or loose soils were encountered during the foundation investigation and will be subject to marginally greater settlements. Settlement of the founding soils at critical sections was calculated using the modified Hough's method for calculating immediate settlement of embankments on cohesionless soils, the results of which are discussed in Section 6.3, below. Additional settlement of the embankment fill materials should be anticipated.

Settlement Performance Requirements

According to the MTO Embankment Settlement Criteria for Design (July 2010) the total post-construction settlement of the paved portion of a roadway for embankment widenings on freeways shall not exceed 50 millimetres over a 20 year period. The settlement analyses have indicated that settlement across the areas of high fill embankments will be well within this criteria.



6.3 Site Specific Recommendations

For the purpose of this discussion, five distinct high fill areas were selected:

- North of highway, west of CNR, from Station 18+080 to 18+600;
- North of highway, east of CNR, from Station 18+650 to 18+790;
- South of highway, west of the Preston Landfill Site, Station 18+080 to 18+250;
- South of highway, within the extents of the Preston Landfill Site, Station 18+250 to 18+540; and
- South of highway, east of CNR, Station 18+580 to 18+970.

Each of these areas is described below along with the results of stability and settlement analyses and site specific recommendations.

6.3.1 North of Highway, Station 18+080 to 18+600

The embankment widenings in this area will typically be 8.0 to 14.0 metres wide with a maximum height of new fill up to about 7.5 metres. The subsurface conditions in this area can be seen on Drawing 2, Section A-A. This area is generally flat and low-lying and trees are the predominant vegetation. This entire area is within the Speed River Wetland Complex.

In this high fill area, approximately 0.1 to 0.3 metres of surficial topsoil underlain by 0.2 to 2.0 metres of native granular soils was encountered over the bedrock. The native granular soils in this area generally consisted of compact to very dense sand and gravel which was found to contain cobbles at some locations. The bedrock surface was encountered at between elevations 277.8 and 281.3 metres, or about 0.4 to 2.1 metres below the ground surface. The boreholes drilled through the existing highway platform in this area encountered between 6.1 and 11.3 metres of pavement structure and existing embankment fill materials. The existing embankment fill materials generally consisted of compact to very dense sand and gravel with cobbles. Also, a thin layer of approximately 0.1 metres of topsoil was encountered beneath the fill materials in borehole 728, near Station 18+300. The groundwater level in this area is inferred to be below elevations 277.9 metres, near Station 18+080, rising to elevation 283.0 metres near Station 18+600, or between the ground surface and 0.1 metres below the ground surface.

Subgrade preparation in this area should consist of the removal of surficial topsoil from the embankment widening plan limits. The embankment widening in this area may be founded on the native granular soils or bedrock. It is not considered necessary to remove organic materials that may be present beneath existing embankments as they have been in place for over 50 years under the embankment loading. It is expected that excavations for subgrade preparation in this area will encounter the groundwater level.



Two critical sections for slope stability were selected within this high fill area. At Station 18+270 the maximum height of new fill will be about 7.5 metres with a total embankment height of about 11 metres. The stratigraphy is shown on Section C-C on Drawing 3. The calculated factor of safety for the embankment side slope is 1.6. At Station 18+420 the maximum height of new fill will be about 6.0 metres with a total embankment height of about 12 metres, as shown on Section D-D on Drawing 3. A factor of safety of 1.4 was calculated for the embankment side slope at Station 18+420. The results of the stability analyses carried out at these sections are provided on Figures B-1 and B-2 in Appendix B.

Negligible settlements of the native soils are anticipated except in areas where loose to compact saturated native soils form the subgrade. Settlements of the native soils in the range of 10 millimetres are expected near borehole 734 at Station 18+450, where near-surface compact sand and gravel is present. The groundwater level in this section is at or slightly below the existing ground surface; therefore, trafficability problems may be experienced during stripping of the topsoil layers and placement of the initial lifts of embankment fill. In order to facilitate construction, ditching, placement of a working platform, and/or restrictions on use of heavy equipment as outlined in Section 6.4 may be required.

6.3.2 North of Highway, Station 18+650 to 18+790

Embankment widenings in this high fill area, east of the CNR overhead structure, will be between about 7.0 and 8.0 metres wide with new fill up to about 5.3 metres high. The subsurface conditions in this area are presented in profile on Drawing 2, Section A-A. The topography of this area slopes upwards at a relatively steep grade (about 5 per cent) from west to east. The off-platform elevation increases from about 283.0 metres at Station 18+650 to 289.5 metres at Station 18+790. The adjacent commercial property is partly treed.

The subsurface soils encountered in the boreholes advanced in this high fill area consisted of topsoil and/or fill materials and native granular soils overlying bedrock. Between 0.2 to 0.4 metres of surficial topsoil was encountered in the boreholes. A 1.0 metre thick layer of fill material was encountered beneath the topsoil at about Station 18+700. The borehole drilled on the existing highway platform in this area encountered 5.9 metres of pavement structure and existing embankment fill materials. Between 2.7 and 4.5 metres of native granular soils was encountered which consisted of compact to very dense sand and gravel to silty sand and gravel. The bedrock surface was between elevations 283.5 and 286.8 metres, or about 3.1 to 4.3 metres below the ground surface. The groundwater level was not established in this high fill area though the boreholes were dry during drilling.

It is recommended that the surficial topsoil be sub-excavated and the embankment widening be founded on the compact to very dense native sand and gravel. If inspection of embankment subgrade comprised of fill materials indicates a significant amount of organic material is present, this should be sub-excavated to the native granular soils. It is expected that the groundwater level will not be encountered in this area during excavations for subgrade preparation.

The critical section for slope stability selected within this high fill area is at about Station 18+700, near borehole 723, where the embankment will be widened by about 8.0 metres with the height of new fill about 5.3 metres and a total embankment height of about 8.0 metres. The stratigraphy is shown on Section E-E on Drawing 4. A



factor of safety of 1.6 was calculated for the embankment side slope. The results of the stability analysis carried out at this section are provided on Figure B-3 in Appendix B.

The anticipated maximum magnitude of settlement is 15 millimetres.

6.3.3 South of Highway, Station 18+080 to 18+250

This area is west of the abandoned GRER right-of-way and within the Speed River Wetland Complex. This high fill area will have 10.5 to 11.5 metre embankment widenings with a maximum height of new fill up to about 5.6 metres. The subsurface conditions in this area can be seen on Drawing 2, Section B-B. This area is generally flat and low-lying and trees are the predominant vegetation.

The subsurface soils encountered in this high fill area generally comprised between 0.1 to 0.2 metres of surficial topsoil over fill materials and native granular soils over bedrock. Also, a 0.4 metre thick layer of amorphous peat was encountered below the fill materials in borehole 758 near Station 18+140. The layers of fill materials, 0.4 to 1.0 metres thick, generally consisted of loose to very dense sand to sand and gravel, with cobbles within the existing embankment fills. The borehole drilled on the existing highway platform in this area encountered 5.9 metres of pavement structure and existing embankment fill materials. The 0.4 to 1.7 metres of native granular soils generally consisted of compact to very dense silty sand and sand and gravel which was found to contain cobbles at some locations. The bedrock surface was between elevations 277.0 and 279.2 metres, or about 2.4 to 2.3 metres below the ground surface. The groundwater level in this area is inferred to be between elevations 278.0 metres, near Station 18+080, and 279.0 metres, near Station 18+250, or about 0.4 to 1.8 metres below the ground surface in the widened area.

It is recommended that the surficial topsoil be sub-excavated and the embankment widening be founded on the native compact to very dense silty sand to sand and gravel, or the bedrock. Also, the buried peat in the area of borehole 758 should be fully sub-excavated. It is anticipated that removal of organic materials will require excavation below the groundwater level throughout this high fill area.

Station 18+250, near borehole 703, was selected as the critical section for slope stability within this high fill area. At this location the embankment widening will be 11.5 metres wide with a maximum height of new fill of about 5.6 metres and a total embankment height of about 8 metres. The subgrade conditions are presented on Section C-C on Drawing 3. A factor of safety of 1.5 was calculated for the embankment side slope. The results of the stability analysis carried out at this section are provided on Figure B-1 in Appendix B.

It is anticipated that the groundwater level in this section may be encountered during stripping of the topsoil layers and placement of the initial lifts of embankment fill; therefore, trafficability problems may be experienced. In order to facilitate construction, ditching, placement of a working platform, and/or restrictions on use of heavy equipment as outlined in Section 6.4 may be required.

The expected total settlement is expected to be 10 millimetres or less.



6.3.4 South of Highway, Station 18+250 to 18+540 - Preston Landfill Site

The high fill area within the limits of the Preston Landfill site extends from Station 18+250 to 18+540. The embankment widening in this area will be 10 to 13 metres wide with maximum heights of new fill of 5.8 to 7.9 metres. The subsurface conditions in this area can be seen on Drawing 2, Section B-B. The topography of this area is generally flat with somewhat sparse and variable vegetation. It is understood that this area has been built up as part of the historic landfill operations. The proposed toe of the widened embankment may likely encroach on the current landfill area between Station 18+355 and 18+540. Along this section of the landfill, lands abutting the MTO right-of-way slope down towards the existing Highway 401 embankment and ditch at inclinations of up to 2H:1V to 3H:1V. The landfill slopes are up to 5 metres high.

The subsurface soils encountered in the boreholes advanced in this high fill area generally comprised up to 0.7 metres of surficial topsoil over between about 2.1 to 6.4 metres of fill materials, underlain by 0.1 to 1.4 metres of native granular soils over bedrock. The boreholes drilled on the existing highway platform in this area encountered 8.4 and 10.5 metres of pavement structure and existing embankment fill materials which consisted of compact to very dense sand and sand and gravel with cobbles. The off-platform boreholes were advanced within a portion of the landfill which will be acquired by MTO under MTO Property Request No. 4-00-00 PR3-18. Boreholes 770, 771 and 772 encountered fill materials which generally consisted of very loose to compact sand, silty sand, and sand and gravel with cobbles as well as large pockets and layers of debris including wood, plastic, cloth and metal. A 0.4 metre thick layer of buried topsoil was encountered below the fill materials in borehole 772, near Station 18+490. The native granular soils in this area generally consisted of compact to very dense sand and gravel. The bedrock surface was between elevations 279.1 and 280.7 metres, or about 3.5 to 6.5 metres below the ground surface. The groundwater level in this area is inferred to be between elevations 280.0 metres, near Station 18+300, and 281.0 metres, near station 18+450, or about 0.9 to 1.8 metres below the ground surface.

The off-platform fill materials encountered in this high fill area are not considered suitable to support the widened embankment. The geometry of the site between Stations 18+350 and 18+550 did not permit advancement of boreholes within the footprint of the proposed widening. It should also be noted that a search carried out for the Preliminary Site Screening did not uncover documents that define the limits of the Preston Landfill. Therefore it is possible that some deleterious landfill materials may be within the plan limits of the proposed embankment widenings. It is recommended that any surficial or buried topsoil as well as deleterious fill materials that are encountered during subgrade preparation be removed from within the plan limits of the embankment widening.

If landfill materials are present within the footprint of the widening, their removal will complicate construction in this area. It has been indicated that encroachment onto the Preston Landfill Site may require a Certificate of Approval amendment or a Section 46 Approval under the Environmental Protection Act. Impacts from landfill gas and leachate may need to be addressed as well. Other concerns regarding health and safety and the need to maintain the integrity of the landfill may need to be addressed. The existing landfill materials within the limits of the widening area are outside the zone of influence of the traffic defined by a 1H:1V slope from the proposed edge of the paved roadway. Therefore it is possible to construct the embankment widening on the landfill materials if some minor settlement of the lower embankment sideslopes can be tolerated. MTO policies on construction of embankments on uncontrolled fills and/or MOE policies on landfills will also influence the decision



as to whether this material can remain in place. It is recommended that the design team liaise with the MTO and MOE to select an appropriate course of action. Golder Associates will continue to work with the TPM to provide ongoing input and the recommendations in this report may be updated when the design is finalized.

The embankment widening in this area may be founded on the native granular materials or the bedrock. If debris, soft or loose soils, organic materials, or other deleterious fill materials are observed in the subgrade soils during inspection, sub-excavation should be carried out to the native granular soils. It is not considered necessary to remove fill or organic materials that may be present beneath existing embankments. It is anticipated that subgrade preparation in this area will require excavation to below the groundwater level.

The critical section for slope stability selected within this high fill area is at about Station 18+500, where the embankment will be widened 13.0 metres with a maximum height of new fill of 7.9 metres and a total embankment height of 11.5 metres. A factor of safety of 1.4 was calculated for the embankment side slope. The results of the stability analysis carried out at this section are provided on Figure B-2 in Appendix B.

Provided that any landfill materials are removed from within the footprint of the widening, negligible settlement of the native soils is anticipated in this area.

6.3.5 South of Highway, Station 18+580 to 18+970

This high fill area, which is east of the CNR overhead structure, includes the Highway 401/Hespeler Road W-N/S ramp. The area immediately adjacent to this high fill area is occupied by industrial and commercial structures and is generally flat with groomed grassy areas and planted trees. The subsurface conditions in this area can be seen on Drawings 2 and 4, Sections A-A and E-E.

Based on the base plan and cross sections provided by Delcan it has been inferred that the ramp bullnose (Station 10+000) corresponds to Highway 401 Station 18+678.5 Rt. From Station 18+580 to 18+690 the embankment widening will be between 16.0 and 19.0 metres wide with the height of new fill up to 8.2 metres and total embankment height between 10.0 and 11.0 metres. From Station 18+690 to 19+970 the embankment widenings will be minimal (less than about 4 metres wide and less than about 3.5 metres of new fill placement); however, the corresponding section of the W-N/S ramp, Station 10+000 to 10+280, will have embankment heights between 4.9 and 7.5 metres. Cross sections were not available for the ramp at the time of this report; therefore, the width and overall geometry of the embankment widening in this area is not known and stability analyses could not be carried out. Typical embankment side slopes and the provided ramp profile have been used to estimate settlement of the founding soils along the ramp.

The subsurface soils encountered in this area generally comprised between 0.1 to 0.3 metres of surficial topsoil, and between about 0.2 and 4.3 metres of fill materials underlain by native granular soils over bedrock. Boreholes 775 and 730 were advanced through the existing highway platform and encountered 5.9 and 9.1 metres of pavement structure and existing embankment fill materials. Boreholes 720 and 721, advanced adjacent to the proposed speed change lane for the W-N/S ramp, encountered between 1.5 and 4.3 metres of fill materials. The remaining boreholes in this area were advanced along the alignment of the proposed ramp and encountered between 0.2 and 0.9 metres of fill materials. The fill materials generally consisted of loose to very



dense sand, sandy silt, and sand and gravel with cobbles. The 0.4 to 6.3 metres of native granular soils in this area generally consisted of compact to very dense sand and gravel. The bedrock surface was between elevations 281.5 and 282.9 metres, or about 3.2 to 6.9 metres below the ground surface. The groundwater level in this high fill area is inferred to be between elevations 282.0 metres, at Station 18+600, and 286.0 metres, at Station 18+870 (ramp Station 10+191.5), or about 4.1 to 6.0 metres below ground surface.

It is recommended that the surficial topsoil be removed and the embankment widening be founded on the native compact to very dense silty sand to silty sand and gravel or the bedrock. It is anticipated that the groundwater level will not be encountered during subgrade preparation in this area.

Station 18+690, near borehole 720, was selected as the critical section for slope stability within this high fill area. The cross section at this station indicated that the embankment widening will be 19 metres wide with a maximum height of new fill of 8.2 metres and total embankment height of 11.0 metres. A factor of safety of 1.7 was calculated for the embankment side slope. The results of the stability analysis carried out at this section are provided on Figure B-3 in Appendix B.

The settlement of these founding soils is expected to be 10 millimetres or less.

6.4 Subgrade Preparation

Following clearing and grubbing of the embankment widening areas, all unsuitable foundation materials including topsoil and peat, soft/loose soils, deleterious fill materials, as noted in Section 6.3.4, and any frozen materials should be stripped from the plan limit of the proposed works. Clearing and grubbing should be carried out in accordance with Ontario Provincial standard Specifications (OPSS) 201. It is not considered necessary to remove organic materials that may be present beneath existing embankments.

The exposed soil or rock embankment foundations should be inspected by a geotechnical Quality Verification Engineer (QVE) prior to fill placement. Proof-rolling of the embankment earth foundation material may not be feasible especially where saturated fine, silty sands are present such as in the wetland area west of the abandoned GRER line. The strength of the subgrade may be increased by provision of temporary ditches installed prior to the start of embankment construction. The use of heavy construction equipment in such areas should be limited until a working platform consisting of a minimum thickness of 1.0 metre of Granular B (Type II or coarse Type III) is placed. This working platform can be prepared by end dumping and bulldozing the embankment material with nominal compaction. Any areas of unsuitable subgrade soils identified should be sub-excavated and replaced with Select Subgrade Materials (SSM) only above a minimum distance of 600 millimetres above the groundwater level. Backfill placed on saturated subgrades including over-excavated areas should consist of Granular B Type II, or a robust Granular B Type III.



6.5 Embankment Construction

Except for the top approximately 0.5 metres, where Granular A and B Type III material will be placed for the pavement structure, embankment fills placed 600 millimetres or more above the groundwater level should consist of an approved granular borrow such as SSM. Consideration may be given to using native granular material excavated from cut areas of this project provided it meets the gradation requirements of SSM.

Where embankment construction is to be carried out in wet areas, including up to 600 millimetres above the groundwater level, the embankment fill should consist of Granular B Type II or a coarse granular material such as Granular B Type III. In localized areas embankment construction may not be possible without placement of a working platform as discussed in Section 6.4. Additional short-term settlement and deformation of embankment fill materials placed below the water level should be anticipated.

In areas where fill is placed below the water level, the grading contractor should carry out a program of settlement monitoring to ensure deformations have subsided prior to constructing the overlying pavement structure. It is recommended that the settlement monitoring program consist of an array of settlement pins installed into the top of new fill at approximately 50 metre intervals. Each settlement pin should consist of a steel bolt or rod with a rounded or angled head such that a single survey point can be clearly identified and repeated. The pins should be cast in concrete in holes augered into the top of the new fill at offsets consistent with the maximum height of new fill placement. The pins should be installed and surveyed as soon as possible following embankment fill placement to ensure accurate baseline conditions are recorded. The elevation and location of the pins should be surveyed using instruments, methods, and personnel capable of achieving a repeatable accuracy of plus or minus 2 millimetres or less, and the survey referenced to two independent benchmarks. A Non-Standard Special Provision (NSSP) should be included in the Contract Documents to indicate the need for settlement monitoring.

Embankment fill materials should be placed in maximum 300 millimetre thick loose lifts, properly benched into the existing embankments in accordance with Ontario Provincial Standard Drawing (OPSD) 208.010, and compacted. Upon completion of filling to the pavement subgrade level, the embankment side slopes should be trimmed to a final inclination of two horizontal to one vertical or flatter. Embankments with total height greater than 8 metres should be construction with minimum 2 metre wide mid-height benches. All grading and embankment construction should be conducted in accordance with OPSS 206 (November 2013) and MTO Special Provision 105S10 (amendment to OPSS 501).

6.6 Groundwater Control

Excavations for removal of deleterious materials will extend below the groundwater level in parts of the high fill areas. Groundwater flow into the open excavations should be anticipated. Unwatering of the excavations may be advantageous for the placement of embankment fill material but may be restricted due to environmental regulations concerning construction in a Provincially Significant Wetland. As such, embankment fill materials placed below the groundwater level should consist of a coarse granular material as described above. If allowed,



temporary and/or permanent ditches should be constructed to lower the groundwater levels. In addition, it is preferred that the work be carried out in the summer or early fall during periods of low precipitation. Surface water should be directed away from the excavations at all times.

6.7 Excavations

Excavations for embankment widening subgrade preparation may encounter the existing embankment fill materials, landfill materials, organic materials such as topsoil and peat, native granular soils, and bedrock. Temporary open cut slopes within these soils should be maintained no steeper than 1 horizontal to 1 vertical and localized sloughing and ground movements should be expected. Flatter slopes may be necessary within the area of the Preston Landfill. Where excavations extend below the groundwater level in granular soils, it may be necessary to use flatter slopes or blanketing the slopes with coarse granular materials to maintain the stability of the cut slopes.

All excavations should be carried out in accordance with the latest edition of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. Any existing fill and landfill materials, any organic materials that may be encountered at the site, and the native granular materials below the groundwater table would be classified as Type 3 soils. Properly dewatered native granular materials and native granular materials above the groundwater table may be considered Type 2 soils.

6.8 Erosion Protection

Temporary erosion and sediment control measures should be implemented during construction in accordance with OPSS 805. If slopes are constructed with mid-height benches, they should be sloped away from the slope face and drain to a positive outlet. The completed slopes should be topsoiled 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.



7.0 MISCELLANEOUS

This report was prepared by Ms. Nicole A. Gould, P.Eng. under the direction of the Project Engineer, Ms. Dirka U. Prout, P.Eng. This report was reviewed by Mr. Azmi M. Hammoud, P.Eng., an Associate and Senior Geotechnical Engineer with Golder Associates. An independent quality review of this report 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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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 $= (\text{compressive strength})/2$
 - * density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 501		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808535.9 , E 237084.1</u>	ORIGINATED BY <u>LK</u>			
DIST <u> </u> HWY <u>401</u>	BOREHOLE TYPE <u>POWER AUGER, HOLLOW STEM</u>	COMPILED BY <u>AMG/LMK</u>			
DATUM <u>GEODETIC</u>	DATE <u>September 20, 2012</u>	CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT 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
								20	40	60	80	100								
293.28	PAVEMENT SURFACE					▽	293													
0.00	ASPHALT						292													
292.91							291													
0.37	FILL, sand and gravel, crushed, trace silt Brown		1	SS	49		290													
0.64	FILL, sand and gravel, trace to some silt, trace clay, trace cobbles Compact to very dense Brown		2	SS	19		289													
			3	SS	22		288													
			4	SS	11		287													
			5	SS	15		286													
			6	SS	18		285													
			7	SS	17															
			8	SS	77															
		9	SS	43																
		10	SS	113																
284.66	END OF BOREHOLE	11	SS	100/ 75mm																
8.62	Auger refusal on possible concrete or boulder. Groundwater encountered at about elev. 286.2m during drilling on September 20, 2012.																			

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 502		1 OF 1		METRIC	
W.P. <u>4-00-00</u>		LOCATION <u>N 4808536.0 , E 237128.1</u>		ORIGINATED BY <u>SM</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>POWER AUGER, HOLLOW STEM</u>		COMPILED BY <u>AMG/LMK</u>			
DATUM <u>GEODETIC</u>		DATE <u>September 20, 2012</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	W _p	W	W _L		
294.14	PAVEMENT SURFACE					▽	294									49 45 (6)	
0.00	ASPHALT						293										
293.79							292										
0.35	FILL, sand and gravel, trace to some silt Compact to very dense Brown						291										
							290										
							289										
							288										
							287										
							286										
							285										
							284										
							283										
							282										
282.84															42 44 (14)		
11.30	TOPSOIL, sandy silt																
282.39	Compact Black																
11.75	SILTY SAND, some gravel																
281.95	Compact															32 57 (11)	
12.19	Brown																
	Assumed BEDROCK																
281.34																	
12.80	END OF BOREHOLE																
	Groundwater encountered at about elev. 283.2m during drilling on September 20, 2012.																

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 03/03/14

RECORD OF BOREHOLE No 503

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808572.4 , E 237155.1 ORIGINATED BY SM
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF/LMK
DATUM GEODETIC DATE September 24, 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 (%)		
								20	40	60	80	100						20	40	60
294.40 0.00	PAVEMENT SURFACE ASPHALT																			
0.30 293.64 0.76	FILL, sand and gravel, crushed, trace silt Brown						294													
	FILL, sand and gravel, trace to some silt, trace clay, with cobbles Compact to dense		1	SS	11															
			2	SS	12		293													
			3	SS	38		292													
			4	SS	48		291									58 35 4 3				
			5	SS	22		290													
			6	SS	26															
			7	SS	50		289													
			8	SS	40		288									38 51 6 5				
			9	SS	43		287													
286.93 7.47	FILL, sand and gravel, some silt, some topsoil, with cobbles Very dense		10	SS	51		286													
			11	SS	50															
285.40 9.00	SAND AND GRAVEL, some silt Dense to compact Brown		12	SS	100/ 75mm		285													
284.65 9.75	SILTY SAND, trace to some topsoil, trace to some clay, trace gravel Compact to dense Brown		13	SS	34		284									3 71 21 5				
			14	SS	11															
			15	SS	18		283									0 61 24 15				
282.36 12.04 282.06 12.34	SAND, trace gravel, trace silt, trace clay Very dense Brown		16	SS	95		282									1 81 9 9				
	Weathered DOLOSTONE, assumed bedrock		17	SS	100/ 0mm															
281.06 13.34	END OF BOREHOLE Auger Refusal at elev. 281.1m Groundwater encountered at about elev. 282.8m during drilling on September 24, 2012.																			

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 03/03/14

PROJECT 10-1132-0056		RECORD OF BOREHOLE No 505		1 OF 1	METRIC
W.P. 4-00-00		LOCATION N 4808604.2, E 237178.9		ORIGINATED BY MA	
DIST HWY 401		BOREHOLE TYPE POWER AUGER, HOLLOW STEM / NQ ROCKCORE		COMPILED BY LMK	
DATUM GEODETIC		DATE July 2, 2013 - July 3, 2013		CHECKED BY	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60 80 100	10 20 30						
283.41	GROUND SURFACE															
0.00	TOPSOIL, sandy Brown															
0.21	FILL, sand, fine to coarse, trace gravel, trace silt Brown															
282.65	FILL, sandy silt, trace topsoil, trace clay, trace gravel Very dense Brown		1	SS	100/ 130mm								○			
0.76																
282.13	Weathered tan to blue-grey, thickly bedded (sucrosic) to thinly bedded (crystalline) DOLOSTONE		2	NQ RC			60	0	0							
1.28																
			3	NQ RC			97	80	67							
280.61																
2.80	Fresh tan to blue-grey, thickly bedded (sucrosic) to thinly bedded (crystalline), DOLOSTONE. Thin beds perpendicular to core axis with rare mm scale stylolites parallel to bedding. Common mechanical fractures generally parallel to bedding plane between elev. 281.9m and elev. 278.8m. Common carbonate mineralized vugs and voids and local remnant fossils between elev. 281.6m and end of borehole. little core recovery in last 2 runs. Highly mechanically fractured to rubble. Strength R4		4	NQ RC			98	85	85							
			5	NQ RC												
			6	NQ RC												
275.79	END OF BOREHOLE															
7.62	Borehole dry during drilling on July 2 to 3, 2013.															

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 03/03/14

RECORD OF BOREHOLE No 703

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808510.3 , E 236786.7 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE June 13, 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											
279.91	GROUND SURFACE																					
0.00	TOPSOIL, sandy, some gravel Brown																					
0.24	FILL, sand, some silt, some gravel, trace topsoil Brown																					
279.15																						
0.76	SILTY SAND AND GRAVEL Very dense Brown		1	SS	23/ 50mm																	
278.54																						
1.37	DOLOSTONE, inferred bedrock		2	SS	100/ 0mm																	
277.78																						
2.13	END OF BOREHOLE																					
	Auger refusal at elev. 277.84m																					
	Groundwater encountered at about elev. 278.8m during drilling on June 13, 2012.																					
	Water level in standpipe measured at elev. 277.78m after installation.																					
	Water level in standpipe measured at elev. 279.00m on November 7, 2013.																					

RECORD OF BOREHOLE No 715

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808502.9 , E 237444.0 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE June 24, 2013 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
289.82	GROUND SURFACE																
0.09	TOPSOIL, silty, sandy Brown																
289.21	FILL, sandy silt, trace gravel Brown																
0.61	SAND AND GRAVEL, trace silt, with cobbles Very dense Grey		1	SS	57												
			2	SS	53												
			3	SS	59												
			4	SS	54												
286.16	SAND AND GRAVEL, trace silt, with cobbles Very dense Brown and black		5	SS	83/ 150mm												
285.40	SANDY SILT, Dense Brown		6	SS	33												
4.72	SILTY SAND AND GRAVEL Dense Brown																
284.79	END OF BOREHOLE																
5.03	Groundwater encountered at about elev. 286.2m during drilling on June 24, 2013.																
	Water level measured in standpipe at elev. 285.45m after installation on June 24, 2013.																
	Water level measured in standpipe at elev. 286.07m on July 31, 2013.																
	Standpipe decommissioned on on July 31, 2013.																

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

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 716		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808507.0 , E 237390.9</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>June 24, 2013</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
								○ UNCONFINED + FIELD VANE	20	40	60	80	100	W _p	W		W _L			
289.64	GROUND SURFACE					● QUICK TRIAXIAL × LAB VANE	20	40	60	80	100									
0.09	TOPSOIL, sandy Brown																			
289.12	FILL, sandy silt, some gravel, with cobbles Brown																			
0.52	SAND AND GRAVEL, some silt, with cobbles Very dense Grey		1	SS	60							○								
			2	SS	59															
			3	SS	100/ 130mm															
286.74																				
2.90	SILTY SAND AND GRAVEL Compact to dense Brown		4	SS	34							○						19 52	(29)	
			5	SS	16							○								
			6	SS	22							○						38 46	(16)	
284.46																				
5.18	SILTY SAND AND GRAVEL Dense to very dense Brown		7	SS	46															
283.09			8	SS	107															
6.55	END OF BOREHOLE																			
	Groundwater encountered at about elev. 285.5m during drilling on June 24, 2013.																			

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 717		1 OF 1		METRIC	
W.P. <u>4-00-00</u>		LOCATION <u>N 4808505.7 , E 237340.9</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>June 25, 2013</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL 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					
289.67	GROUND SURFACE																			
0.08	TOPSOIL, sandy Brown																			
0.34	FILL, sandy silt, some gravel, trace topsoil Brown																			
0.52	TOPSOIL, silty, sandy Brown		1	SS	71								○				43	44 (13)		
	SAND AND GRAVEL, some silt, with cobbles and boulders Very dense Grey		2	SS	46/ 130mm								○							
287.87	END OF BOREHOLE																			
1.80	Auger & Split-spoon refusal on inferred boulder. Borehole dry during drilling on June 25, 2013.																			




LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14

RECORD OF BOREHOLE No 717B

1 OF 1

METRIC

PROJECT 10-1132-0056 W.P. 4-00-00 LOCATION N 4808505.5 , E 237333.9 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE June 25, 2013 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									
289.67	GROUND SURFACE						20	40	60	80	100						
0.00	TOPSOIL, silty, sandy Brown																
0.30	FILL, sand, fine to coarse, some gravel, trace topsoil Brown																
0.52	SAND AND GRAVEL, some silt, with cobbles and boulders Dense Grey		1	SS	39												
288.45	END OF BOREHOLE																
1.22	Auger refusal on inferred boulder.																
	Borehole dry during drilling on June 25, 2013.																

RECORD OF BOREHOLE No 718



1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808506.2, E 237290.2 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE June 23, 2013 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 (%)										
289.52	GROUND SURFACE						20	40	60	80	100	10	20	30			
0.00	TOPSOIL, silty, sandy, with rootlets Brown																
0.30	FILL, sand and gravel, with cobbles Dense Brown																
288.30			1	SS	32												
1.22	SAND AND GRAVEL, trace to some silt, with cobbles and boulders Compact to very dense Grey																
			2	SS	71							○				60 33 (7)	
			3	SS	47/ 50mm												
			4	SS	40/ 25mm												
			5	SS	15							○				46 39 (15)	
			6	SS	11							○					
284.34																	
5.18	SILTY SAND AND GRAVEL, trace clay Dense to very dense Brown		7	SS	58							○				23 39 29 9	
			8	SS	44												
			9	SS	100/ 75mm							○					
282.59	END OF BOREHOLE																
6.93	Auger & Split-spoon refusal on inferred bedrock. Groundwater encountered at about elev. 284.5m during drilling on June 23, 2013. Water level measured in standpipe at elev. 283.45m after installation on June 23, 2013. Water level measured in standpipe at elev. 284.70m on July 31, 2013. Standpipe decommissioned on July 31, 2013.																

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 719		1 OF 1		METRIC	
W.P. <u>4-00-00</u>		LOCATION <u>N 4808507.3 , E 237240.2</u>		ORIGINATED BY <u>MA</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>POWER AUGER, HOLLOW STEM</u>		COMPILED BY <u>LMK</u>			
DATUM <u>GEODETIC</u>		DATE <u>June 25, 2013</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					
287.85	GROUND SURFACE																			
0.00	TOPSOIL, silty																			
0.15	Brown FILL, silty sand and gravel Compact Brown		1	SS	27							o					42	41 (17)		
286.42																				
1.43	FILL, silty sand, some gravel, some topsoil Compact Brown		2	SS	70															
1.68	Brown SAND AND GRAVEL, some silt, with cobbles and boulders Very dense Brown		3	SS	92							o								
284.68																				
3.17	END OF BOREHOLE		4	SS	100/ 130mm															
	Auger & Split-spoon refusal on inferred boulder. Borehole dry during drilling on June 25, 2013.																			

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14

RECORD OF BOREHOLE No 720

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808506.8 , E 237215.2 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE June 26, 2013 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									
287.71	GROUND SURFACE																			
0.00	TOPSOIL, sandy, gravelly Brown																			
0.21	FILL, sand and gravel, some silt, with sandy silt layers, with cobbles and boulders Compact to dense Grey		1	SS	28															
			2	SS	28															
			3	SS	31															
			4	SS	29															
			5	SS	35															
283.29	SAND AND GRAVEL, some silt, with cobbles and boulders Compact to very dense Brown		6	SS	18															
4.42			7	SS	55															
281.61	END OF BOREHOLE		8	SS	100/ 0mm															
6.10	Auger & Split-spoon refusal on inferred bedrock. Groundwater encountered at about elev. 282.2m during drilling on June 26, 2013. Water level measured in standpipe at elev. 282.04m after installation on June 26, 2013. Water level measured in standpipe at elev. 282.16m on July 31, 2013.																			

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 721		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808494.7 , E 237138.1</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>June 26, 2013</u>	CHECKED BY <u></u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT 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					WATER CONTENT (%)				GR	SA	SI	CL
													20	40	60					
286.31	GROUND SURFACE																			
0.08	TOPSOIL, sandy, gravelly Brown FILL, sand and gravel, trace silt, with cobbles and boulders Loose to very dense Grey																			
			1	SS	88															
			2	SS	32								o						55 36 (9)	
			3	SS	28															
			4	SS	15															
			5	SS	8								o						60 35 (5)	
281.89																				
4.42	SILTY SAND AND GRAVEL, with cobbles																			
281.49	Very dense Grey		6	SS	93/ 100mm								o						38 36 (26)	
4.82	END OF BOREHOLE																			
	Auger & Split-spoon refusal on inferred bedrock.																			
	Groundwater encountered at about elev. 282.0m during drilling on June 26, 2013.																			

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 722		1 OF 1		METRIC	
W.P. <u>4-00-00</u>		LOCATION <u>N 4808596.7 , E 237290.2</u>		ORIGINATED BY <u>MA</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>POWER AUGER, HOLLOW STEM</u>		COMPILED BY <u>LMK</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 2, 2013</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				WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	LAB VANE	W _p		W	W _L		
289.85	GROUND SURFACE																		
0.00	TOPSOIL, sandy, trace gravel Brown																		
289.45																			
0.40	SAND AND GRAVEL, trace silt Dense to very dense Brown		1	SS	46							○							
			2	SS	47							○							
			3	SS	72							○					56	35 (9)	
286.80																			
3.05	END OF BOREHOLE		4	SS	100/ 0mm														
	Auger & Split-spoon refusal on inferred bedrock.																		
	Borehole dry during drilling on July 2, 2013.																		

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 723		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808602.6 , E 237240.2</u>	ORIGINATED BY <u>MA</u>			
DIST <u> </u> HWY <u>401</u>	BOREHOLE TYPE <u>POWER AUGER, HOLLOW STEM</u>	COMPILED BY <u>LMK</u>			
DATUM <u>GEODETIC</u>	DATE <u>June 27, 2013</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 (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w _p	w	w _L					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
287.72	GROUND SURFACE							20	40	60	80	100								
0.00	TOPSOIL, sandy, some gravel Brown						287													
0.21	FILL, sand, some gravel, some silt, some topsoil, trace gravel, with rootlets Compact Brown		1	SS	22															
286.50	SAND AND GRAVEL, some silt, with cobbles Compact Brown		2	SS	21			286												
285.59																				
2.13	SILTY SAND AND GRAVEL, some clay Compact Brown		3	SS	17									○	├───┤				27 25 33 15	
284.82	SAND AND GRAVEL, some silt Dense to very dense Brown		4	SS	37		285													
2.90													○					48 37 (15)		
							284													
283.45			5	SS	50/ 75mm															
283.45	END OF BOREHOLE																			
4.27	Auger & Split-spoon refusal on inferred bedrock. Borehole dry during drilling on June 27, 2013.																			

RECORD OF BOREHOLE No 724

1 OF 1

METRIC

PROJECT 10-1132-0056 LOCATION N 4808580.9 , E 236609.8 ORIGINATED BY MA
W.P. 4-00-00 DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 11, 2013 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									
278.42	GROUND SURFACE						20	40	60	80	100						
0.00	TOPSOIL, silty, sandy Brown						278										
0.30	SILTY SAND, trace gravel, with cobbles Brown																
0.52	END OF BOREHOLE																
	Auger refusal on inferred bedrock.																
	Borehole dry during drilling on July 11, 2013.																

RECORD OF BOREHOLE No 725

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808584.9 , E 236609.8 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 11, 2013 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
278.24	GROUND SURFACE							20	40	60	80	100					
0.00	TOPSOIL, silty, sandy, with rootlets Brown						278										
0.36	SILTY SAND AND GRAVEL Brown END OF BOREHOLE Auger refusal on inferred bedrock. Borehole dry during drilling on July 11, 2013.																

RECORD OF BOREHOLE No 726

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808577.6 , E 237264.2 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF/AMG
DATUM GEODETIC DATE August 26, 2013 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					
295.43	PAVEMENT SURFACE						20	40	60	80	100					
0.00	ASPHALT															
0.25	FILL, sand and gravel, crushed															
0.43	ASPHALT															
	FILL, sand and gravel, crushed Brown		1	SS	58											
	FILL, sand and gravel, some silt to silty, with sand and topsoil layers Loose to very dense Brown		2	SS	54								○			39 48 (13)
			3	SS	21											
			4	SS	28											
			5	SS	45								○			50 40 (10)
			6	SS	49											
			7	SS	9											
289.49			8	SS	100/ 275mm								○			46 43 (11)
5.94	SAND AND GRAVEL, some silt, with silt layers Very dense Brown		9	SS	100											
			10	SS	65											
			11	SS	100/ 125mm											
			12	SS	80								○			18 42 (34)
			13	SS	100/ 175mm											
284.98			14	SS	100/ 0mm											
10.45	END OF BOREHOLE															
	Auger and Split-spoon refusal on inferred bedrock.															
	Borehole dry during drilling on August 26, 2013.															

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 727		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808569.4 , E 236971.6</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/AMG</u>			
DATUM <u>GEODETIC</u>	DATE <u>August 26, 2013</u>	CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL 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	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20	40	60	80	100	W _p	W		W _L				
291.62	PAVEMENT SURFACE																				
0.00	ASPHALT																				
291.28																					
0.34	FILL, sand and gravel, crushed Brown																				
0.52	FILL, sand and gravel, trace to some silt, with cobbles Very dense Brown		1	SS	100/250mm																
			2	SS	65									○				15	64	15	6
			3	SS	100																
			4	SS	100																
			5	SS	110/225mm																
			6	SS	100/275mm																
			7	SS	93									○				49	40	(11)	
			8	SS	65																
			9	SS	51																
			10	SS	81																
			11	SS	60									○				42	47	(11)	
282.63																					
8.99	FILL, sand, fine to coarse, some gravel Loose Brown	12	SS	5									○				5	81	8	6	
		13	SS	9																	
280.95																					
10.67	FILL, sand and gravel, some topsoil Compact Brown	14	SS	25																	
280.34																					
11.28	SILTY SAND AND GRAVEL Very dense Grey	15	SS	100/75mm																	
11.52	END OF BOREHOLE																				
	Auger and Split-spoon refusal on inferred bedrock.																				
	Groundwater encountered at about elev. 282.1m during drilling on August 26, 2013.																				

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14

RECORD OF BOREHOLE No 728

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808564.2, E 236810.1 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF/AMG
DATUM GEODETIC DATE August 26, 2013 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									
288.38	PAVEMENT SURFACE																			
0.00	ASPHALT																			
288.01																				
0.37	FILL, sand and gravel, crushed Brown																			
0.52	FILL, sand and gravel, trace to some silt Very dense Grey to brown		1	SS	48															
			2	SS	43															
			3	SS	74															
			4	SS	94															
			5	SS	46															
			6	SS	81							○				45 44 (11)				
			7	SS	49															
			8	SS	97															
			9	SS	64															
			10	SS	52															
			11	SS	86															
			12	SS	27							○				47 43 (10)				
			13	SS	10							○				31 64 4 1				
277.71			14	SS	100/ 150mm															
10.73	TOPSOIL, silty, sandy, trace gravel Very dense Black SAND AND GRAVEL, trace silt, with cobbles Very dense Grey		15	SS	100/ 150mm							○				48 40 8 4				
275.97			16	SS	112/ 200mm															
12.41	END OF BOREHOLE																			
	Auger and Split-spoon refusal on inferred bedrock.																			
	Groundwater encountered at about elev. 278.9m during drilling on Aug. 26, 2013.																			

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14

RECORD OF BOREHOLE No 729

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808561.9 , E 236660.2 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF/AMG
DATUM GEODETIC DATE August 27, 2013 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									
283.91	PAVEMENT SURFACE							20	40	60	80	100								
0.00	ASPHALT																			
0.24	FILL, sand and gravel, crushed Brown																			
0.40	FILL, sand and gravel, trace to some silt, with cobbles Dense to very dense Grey to brown		1	SS	87		283													
			2	SS	100/ 225mm		282													
			3	SS	55		281													
			4	SS	59		280						○				46 45 (9)			
			5	SS	112		279													
			6	SS	85		278													
			7	SS	47		277						○				25 63 11 1			
277.81	SAND AND SILT, with topsoil and silty sand layers Compact Brown		8	SS	24		277						○				0 54 38 8			
277.05	DOLOSTONE, inferred bedrock END OF BOREHOLE		9	SS	100/ 50mm															
6.92	Split-spoon refusal on inferred bedrock. Groundwater encountered at about elev. 277.81m during drilling on Aug. 27, 2013.																			

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

RECORD OF BOREHOLE No 730

1 OF 1

METRIC

PROJECT 10-1132-0056

W.P. 4-00-00

LOCATION N 4808532.8 , E 237411.1

ORIGINATED BY MA

DIST HWY 401

BOREHOLE TYPE POWER AUGER, HOLLOW STEM

COMPILED BY WDF/AMG

DATUM GEODETIC

DATE August 27, 2013

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE	20	40	60	80	100			10	20
295.11	PAVEMENT SURFACE					▽	295									GR SA SI CL		
0.09	ASPHALT																	
0.34	FILL, sand and gravel, crushed Brown																	
	FILL, sand and gravel, some silt, with cobbles Dense to very dense Brown		1	SS	41													12 70 13 5
			2	SS	100/150mm													
			3	SS	59													
			4	SS	37													
			5	SS	37													27 55 13 5
			6	SS	94													
			7	SS	27													
289.17			8	SS	75				289									
5.94	SAND AND GRAVEL, trace silt, with cobbles Very dense Brown to grey		9	SS	74				288									
			10	SS	93				287									50 41 (9)
			11	SS	56				286									
			12	SS	100/150mm				285									
284.59			13	SS	28				284									50 35 14 1
10.52	SILTY SAND AND GRAVEL, with cobbles Compact to very dense Grey	14	SS	58														
		15	SS	92														
282.92		16	SS	100/0mm			283											
12.19	END OF BOREHOLE																	
	Auger and Split-spoon refusal on inferred bedrock.																	
	Groundwater encountered at about elev. 285.4m during drilling on Aug. 27, 2013.																	

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

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 731		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808528.4 , E 236690.2</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/AMG</u>			
DATUM <u>GEODETIC</u>	DATE <u>August 27, 2013</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 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					
284.75	PAVEMENT SURFACE																			
0.00	ASPHALT																			
0.15	FILL, sand and gravel, crushed Brown																			
0.43	FILL, sand and gravel, some silt, with cobbles Very dense Brown		1	SS	71															
			2	SS	83															
			3	SS	66															
			4	SS	85															
			5	SS	97															
			6	SS	100/ 225mm															
			7	SS	118															
278.81																				
5.94	SAND AND GRAVEL, some silt Compact to very dense Brown becoming grey at about elev. 278.0m		8	SS	28															
277.80			9	SS	100/ 100mm															
6.95	END OF BOREHOLE																			
	Auger and Split-spoon refusal on inferred bedrock.																			
	Groundwater encountered at about elev. 278.7m during drilling on Aug. 27, 2013.																			

RECORD OF BOREHOLE No 732

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808605.4 , E 237094.6 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 12, 2013 CHECKED BY




SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa													
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	LAB VANE								
281.35	GROUND SURFACE																				
0.00	TOPSOIL, sandy, with rootlets																				
0.15	Brown																				
0.41	SAND AND GRAVEL, trace silt																				
	Brown																				
	END OF BOREHOLE																				
	Auger refusal on inferred bedrock.																				
	Groundwater encountered at about elev. 281.3m during drilling on July 12, 2013.																				

RECORD OF BOREHOLE No 733

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808604.7 , E 237041.5 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 12, 2013 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			
280.43	GROUND SURFACE						280													
0.00	TOPSOIL, sandy, with rootlets Brown																			
0.28	SAND AND GRAVEL, trace silt Brown																			
0.43	END OF BOREHOLE																			
	Auger refusal on inferred bedrock.																			
	Groundwater encountered at about elev. 280.3m during drilling on July 12, 2013.																			

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 734		1 OF 1 METRIC	
W.P. <u>4-00-00</u>		LOCATION <u>N 4808602.6 , E 236989.6</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 12, 2013</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						WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE												
280.16	GROUND SURFACE																				
0.00	TOPSOIL, sandy, with rootlets Brown																				
0.15	SAND AND GRAVEL, some silt Compact Grey		1	SS	11																
			2	SS	23																
278.03	END OF BOREHOLE																				
2.13	Auger refusal on inferred bedrock. Groundwater encountered at about elev. 280.1m during drilling on July 12, 2013.																				

RECORD OF BOREHOLE No 735

1 OF 1

METRIC

PROJECT 10-1132-0056 W.P. 4-00-00 LOCATION N 4808600.1 , E 236944.7 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 12, 2013 CHECKED BY

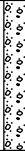
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT							PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE	LAB VANE												
279.71	GROUND SURFACE																								
0.00	TOPSOIL, sandy, with rootlets																								
0.13	Brown																								
279.01	SAND AND GRAVEL, trace silt																								
0.70	Brown																								
	END OF BOREHOLE																								
	Auger refusal on inferred bedrock.																								
	Groundwater encountered at about elev. 279.6m during drilling on July 12, 2013.																								

RECORD OF BOREHOLE No 736

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808598.0 , E 236892.4 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 12, 2013 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 (%)
279.67	GROUND SURFACE					▽	279										
0.00	TOPSOIL, sandy, with rootlets Brown																
0.25	SAND AND GRAVEL, trace silt Dense to very dense Brown		1	SS	50												
277.93	END OF BOREHOLE		2	SS	78/ 50mm		278							○			
1.74	Auger and Split-spoon refusal on inferred bedrock. Groundwater encountered at about elev. 279.7m during drilling on July 12, 2013.																

RECORD OF BOREHOLE No 737

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808591.4 , E 236839.6 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 12, 2013 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							
279.12	GROUND SURFACE					▽		20 40 60 80 100							
0.00	TOPSOIL, sandy, with rootlets Brown					279									
0.28	SAND AND GRAVEL, some silt, with cobbles														
278.45	Brown														
0.76	DOLOSTONE, inferred bedrock END OF BOREHOLE														
	Auger refusal on inferred bedrock.														
	Groundwater encountered at about elev. 279.1m during drilling on July 12, 2013.														

RECORD OF BOREHOLE No 738

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808589.6 , E 236789.7 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 12, 2013 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								
278.87	GROUND SURFACE						20	40	60	80	100									
0.00	TOPSOIL, sandy, with rootlets Brown																			
0.21	SAND AND GRAVEL, some silt, with cobbles Very dense Brown		1	SS	72/ 100mm												53 34 (14)			
277.59	DOLOSTONE, inferred bedrock END OF BOREHOLE																			
1.37	Auger refusal on inferred bedrock. Groundwater encountered at about elev. 278.8m during drilling on July 12, 2013.																			

RECORD OF BOREHOLE No 739

1 OF 1

METRIC

PROJECT 10-1132-0056 W.P. 4-00-00 LOCATION N 4808587.9 , E 236739.7 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 12, 2013 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						
278.52	GROUND SURFACE					▽		20 40 60 80 100						
0.00	TOPSOIL, sandy, with rootlets Brown													
0.25	SILTY SAND AND GRAVEL, Brown		1	SS	100/ 0mm									
0.46	END OF BOREHOLE													
	Auger and Split-spoon refusal on inferred bedrock.													
	Groundwater encountered at about elev. 278.4m during drilling on July 12, 2013.													

RECORD OF BOREHOLE No 740

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808584.3 , E 236689.7 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY LMK
DATUM GEODETIC DATE July 12, 2013 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																				
278.51	GROUND SURFACE						20	40	60	80	100									
0.00	TOPSOIL, silty, sandy, with rootlets Brown																			
0.23	SILTY SAND AND GRAVEL, Very dense Brown																			
277.63	END OF BOREHOLE		1	SS	100/ 75mm															
0.88	Auger and Split-spoon refusal on inferred bedrock. Groundwater encountered at about elev. 278.4m during drilling on July 12, 2013.																			

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 741		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808582.8 , E 236649.7</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 12, 2013</u>	CHECKED BY <u></u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID LIMIT 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
					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)										
278.34	GROUND SURFACE							20	40	60	80	100								
0.00	TOPSOIL, silty, sandy, with rootlets						278													
0.18	Brown																			
277.61	SILTY SAND, trace gravel																			
	Brown																			
0.73	SILTY SAND AND GRAVEL,		1	SS	82									o				40	32 (28)	
277.12	Very dense		2	SS	100/0mm															
1.22	Brown																			
	END OF BOREHOLE																			
	Auger and Split-spoon refusal on inferred bedrock.																			
	Borehole dry during drilling on July 12, 2013.																			

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 757		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808501.4 , E 236640.6</u>	ORIGINATED BY <u>LK</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>July 24, 2013</u>	CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	LAB VANE	w _p	w		w _L			
278.35	GROUND SURFACE						20	40	60	80	100									
0.00	TOPSOIL, silty																			
0.15	Black																			
277.68	SILTY SAND, some gravel, with cobbles and boulders		1	AS																
0.67	Very dense Brown END OF BOREHOLE		2	SS	100/ 25mm															
	Split-spoon refusal on inferred bedrock.																			
	Groundwater encountered at about elev. 278.0m during drilling on July 24, 2013.																			

RECORD OF BOREHOLE No 758






1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808510.1, E 236673.5 ORIGINATED BY LK
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE July 24, 2013 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									
								20 40 60 80 100									
279.36	GROUND SURFACE																
0.00	TOPSOIL, silty, sandy																
0.12	Brown to black																
	FILL, sand and gravel, some topsoil																
	Loose																
	Brown																
278.29			1	SS	7											37 45 (18)	
1.07	PEAT, amorphous, some sand																
277.93	Loose																
1.43	Black																
277.53	SILTY SAND AND GRAVEL,		2	SS	23/ 150mm												
	Very dense																
1.83	Grey																
	END OF BOREHOLE																
	Auger and Split-spoon refusal on inferred bedrock.																
	Groundwater encountered at about elev. 278.0m during drilling on July 24, 2013.																

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 759		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808507.8 , E 236720.8</u>	ORIGINATED BY <u>LK</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>July 24, 2013</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
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20	40	60	80	100	w _p	w		w _L			
279.32	GROUND SURFACE																			
0.00	TOPSOIL, silty, sandy, Brown to black																			
0.18																				
278.71	FILL, sand and gravel, some topsoil Brown																			
0.61	SAND AND GRAVEL, some silt, with cobbles Compact to very dense Grey		1	SS	23							○					63	28	(9)	
			2	SS	26							○					61	28	(11)	
277.03	END OF BOREHOLE		3	SS	100/ 25mm															
2.29	Auger and Split-spoon refusal on inferred bedrock. Groundwater encountered at about elev. 277.5m during drilling on July 24, 2013.																			

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 770		1 OF 1	METRIC
W.P. <u>4-00-00</u>	LOCATION <u>N 4808479.9 , E 236893.9</u>	ORIGINATED BY <u>MA</u>			
DIST <u> </u> HWY <u>401</u>	BOREHOLE TYPE <u>POWER AUGER, HOLLOW STEM</u>	COMPILED BY <u>WDF</u>			
DATUM <u>GEODETIC</u>	DATE <u>August 6, 2013</u>	CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100	W _p	W	W _L						
285.84	GROUND SURFACE																
0.00	FILL, silty sand, some gravel, with cobbles, plastic, wood and cloth debris Compact Brown					▽											
			1	SS	15												
			2	SS	16												
281.57																	
4.27	FILL, sand and gravel, some silt, with pieces of wood Loose Grey		3	SS	7												
			4	SS	6												
279.90																	
5.94	FILL, sand, some silt, with plastic, wood and cloth debris Loose																
279.44	grey		5	SS	98/ 100mm												
6.50	SILTY SAND AND GRAVEL, Very dense Grey END OF BOREHOLE Auger and Split-spoon refusal on inferred bedrock. Groundwater encountered at about elev. 281.0m during drilling on Aug. 6, 2013.																

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 771		1 OF 1	METRIC
W.P. <u>4-00-00</u>		LOCATION <u>N 4808485.7 , E 236986.3</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>August 6, 2013</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						
285.31	GROUND SURFACE																				
0.00	TOPSOIL, sandy Brown																				
0.23	FILL, layers of wood, topsoil and sand and gravel, with plastic and metal debris Loose to compact Brown to black																				
			1	SS	3																
			2	SS	9																
			3	SS	11																
			4	SS	12																
280.89																					
4.42	FILL, silty sand and gravel, with topsoil layers Compact Brown and grey		5	SS	12													44	34		
280.13	SILTY SAND AND GRAVEL																	17	5		
5.18	Very dense Grey		6	SS	100/ 75mm																
5.41	END OF BOREHOLE																				
	Auger and Split-spoon refusal on inferred bedrock.																				
	Groundwater encountered at about elev. 281.2m during drilling on Aug. 6, 2013.																				

RECORD OF BOREHOLE No 772

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808488.6 , E 237015.2 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE August 7, 2013 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE														
284.24	GROUND SURFACE							20	40	60	80	100						GR	SA	SI	CL	
0.00	TOPSOIL, silty, with plastic and metal debris Brown to black						284															
283.57																						
0.67	FILL, sand and gravel, some silt Loose to compact Brown		1	SS	12		283							○				45	43	(12)		
			2	SS	4																	
282.26																						
1.98	FILL, sand, medium to coarse, some gravel, some silt, with plastic and wood debris Very loose Brown		3	SS	WH		282							○								
281.50																						
2.74	TOPSOIL, silty, with peat and rootlets Loose Black		4	SS	26		281								55 ○							
281.10																						
3.14			5	SS	100/0mm																	
280.73	SAND AND GRAVEL, some silt Compact Brown and grey END OF BOREHOLE																					
3.51	Auger and Split-spoon refusal on inferred bedrock. Borehole dry during drilling on Aug. 7, 2013.																					

RECORD OF BOREHOLE No 773

1 OF 1

METRIC

PROJECT 10-1132-0056
W.P. 4-00-00 LOCATION N 4808531.0 , E 236834.1 ORIGINATED BY MA
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF/AMG
DATUM GEODETIC DATE August 27, 2013 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	×					
288.94	PAVEMENT SURFACE						20	40	60	80	100						
0.00	ASPHALT																
0.23	FILL, sand and gravel, crushed Brown																
0.37	FILL, sand and gravel, some silt, trace topsoil, with cobbles Dense to very dense Brown		1	SS	62												
			2	SS	41												
			3	SS	67								○				51 39 (10)
			4	SS	65												
			5	SS	34												
			6	SS	89												
			7	SS	100												
			8	SS	64								○				51 39 (10)
			9	SS	69												
			10	SS	100/ 250mm												
280.59	SAND AND GRAVEL, some silt Dense to very dense Grey		11	SS	110/ 275mm								○				48 43 (9)
8.35			12	SS	36								○				
279.19	END OF BOREHOLE																
9.75	Auger refusal on inferred bedrock. Groundwater encountered at about elev. 279.6m during drilling on Aug. 27, 2013.																

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 774		1 OF 1		METRIC	
W.P. <u>4-00-00</u>		LOCATION <u>N 4808533.0 , E 236938.4</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/AMG</u>			
DATUM <u>GEODETIC</u>		DATE <u>August 27, 2013</u>		CHECKED BY <u> </u>			

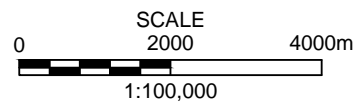
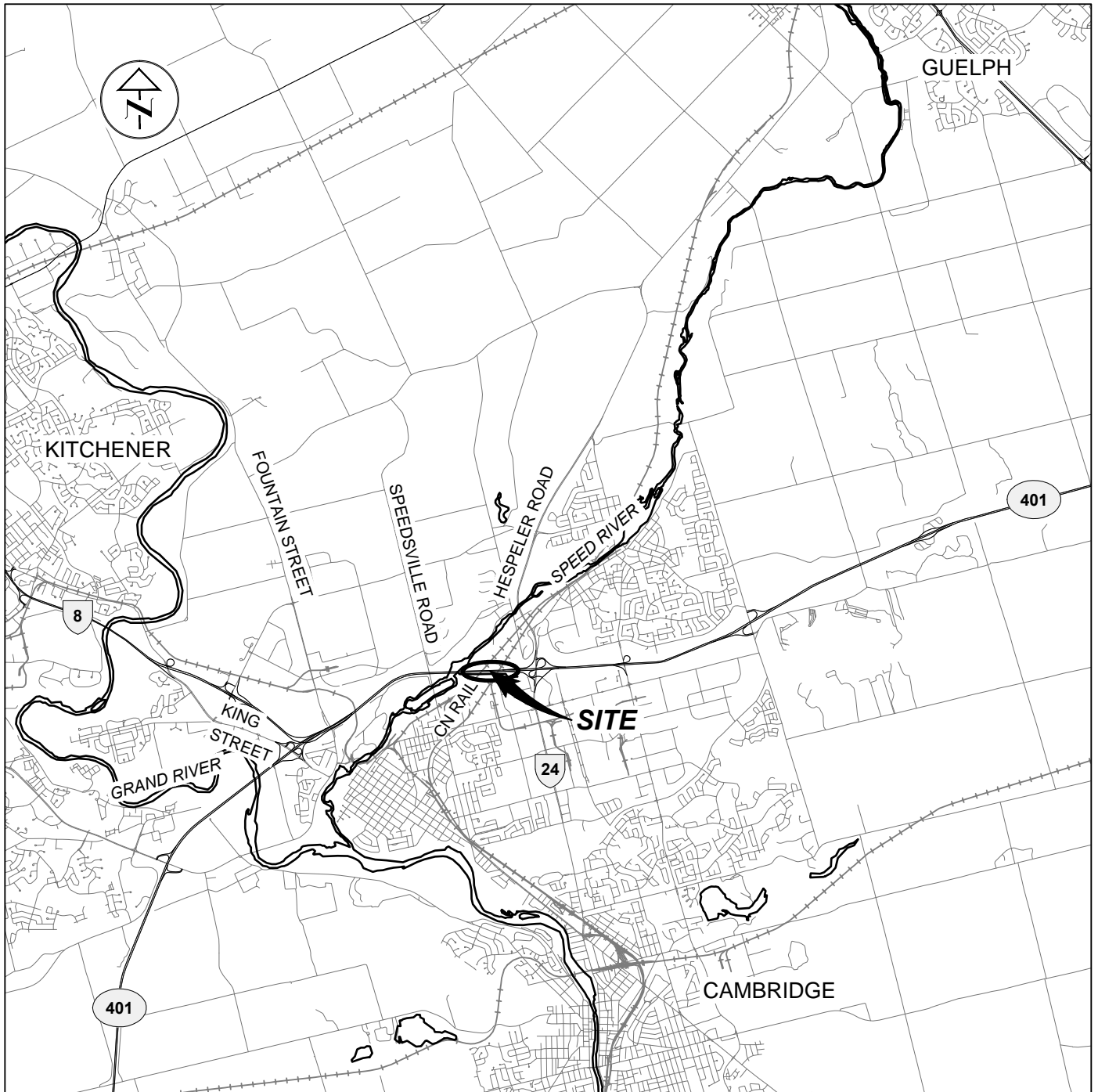
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20	40	60	80	100	W _p	W		W _L			
290.93	PAVEMENT SURFACE																			
0.00	ASPHALT																			
0.18	FILL, sand and gravel, crushed Brown																			
0.46	FILL, sand and gravel, trace to some silt, with cobbles Dense to very dense Brown		1	SS	57															
			2	SS	59															
			3	SS	33															
			4	SS	60															
			5	SS	41															
			6	SS	49								○							
			7	SS	41															
			8	SS	44															
283.92	FILL, sand, fine to coarse, some gravel Compact Brown		9	SS	48													51	40 (9)	
7.01			10	SS	81															
			11	SS	50															
			12	SS	14								○							
			13	SS	22								○					4	83 8 5	
280.41	SAND AND GRAVEL, some silt Dense Brown		14	SS	38								○					16	68 10 6	
10.52			15	SS	119/ 250mm								○					31	36 29 4	
279.65	SILTY SAND AND GRAVEL Very dense Grey																			
279.10	END OF BOREHOLE																			
11.83	Auger and Split-spoon refusal on inferred bedrock. Groundwater encountered at about elev. 281.2m during drilling on Aug. 27, 2013.																			

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO_GDT 06/02/14

PROJECT <u>10-1132-0056</u>		RECORD OF BOREHOLE No 775		1 OF 1 METRIC	
W.P. <u>4-00-00</u>		LOCATION <u>N 4808535.7 , E 237266.4</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/AMG</u>	
DATUM <u>GEODETIC</u>		DATE <u>August 27, 2013</u>		CHECKED BY <u> </u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT 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					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20	40	60	80	100	W _p	W		W _L			
295.48	PAVEMENT SURFACE																			
0.00	ASPHALT																			
0.13	FILL, sand and gravel, crushed Brown																			
295.00	FILL, sand and gravel, some silt, with cobbles																			
0.48	Compact to very dense Brown																			
			1	SS	62															
			2	SS	80/ 200mm															
			3	SS	26															
			4	SS	38															
			5	SS	43															
			6	SS	34															
			7	SS	40															
			8	SS	30															
			9	SS	46															
			10	SS	100															
			11	SS	100/ 200mm															
286.34	DOLOSTONE, inferred bedrock		12	SS	100/ 25mm															
9.14	END OF BOREHOLE																			
9.33	Auger and Split-spoon refusal on inferred boulder. Borehole dry during drilling on Aug. 27, 2013.																			

LDN_MTO_06 10-1132-0056-2000.GPJ LDN_MTO.GDT 06/02/14



REFERENCE

PLAN BASED ON CANMAP STREETFILES V.2008.5.

NOTE

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

PROJECT

HIGH FILLS
HIGHWAY 401 IMPROVEMENTS
GWP 4-00-00

TITLE

KEY PLAN



PROJECT No.		10-1132-0056	FILE No. 1011320056-2000-F09B001	
CADD	LMKWDF	Jan. 07/14	SCALE	AS SHOWN
CHECK			REV.	0
FIGURE 1				

MINISTRY OF TRANSPORTATION, ONTARIO
PLOT DATE: July 11, 2014
FILENAME: M:\Users\j2010\1132 - Geotechnical\1132-0056 - HWY 401 Improvements - Borehole Locations.dwg

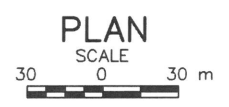
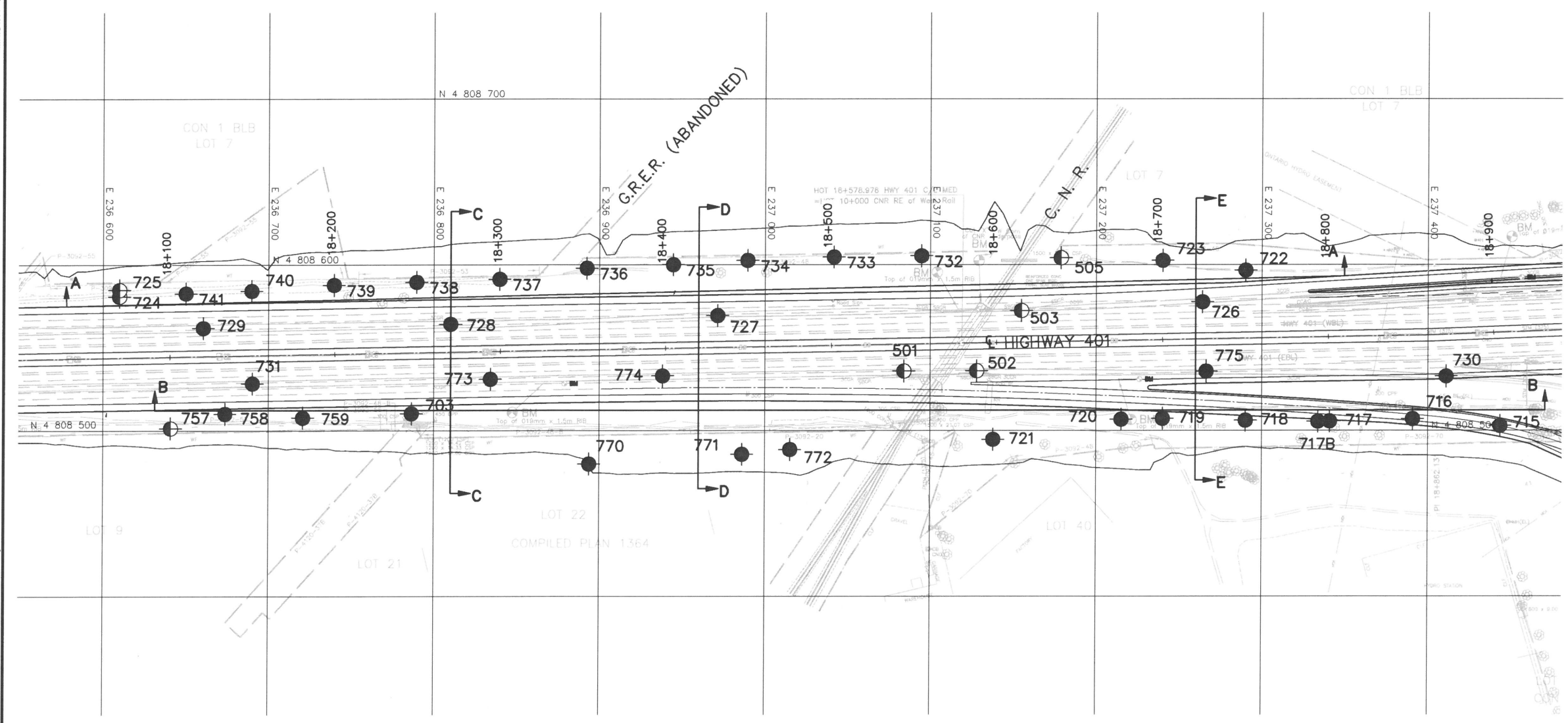
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 4-00-00

HIGH FILLS
HIGHWAY 401 IMPROVEMENTS
BOREHOLE LOCATIONS

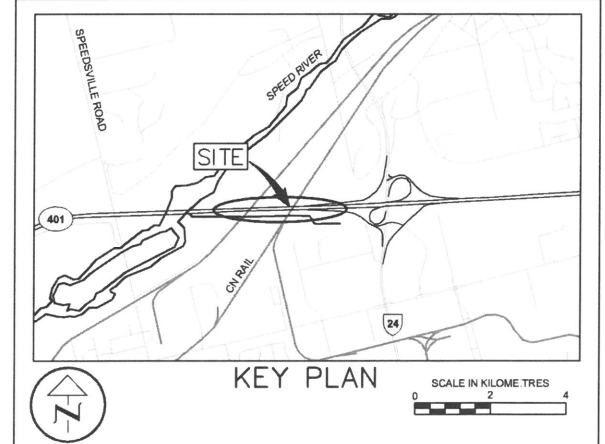
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LONDON, ONTARIO, CANADA




SHEET



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.




LEGEND			
	Borehole - Current Investigation		
	Borehole - Previous Investigations		
No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
703	279.91	4 808 510.3	236 786.7
715	289.82	4 808 502.9	237 444.0
716	289.64	4 808 507.0	237 390.9
717	289.67	4 808 505.7	237 340.9
717B	289.67	4 808 505.5	237 333.9
718	289.52	4 808 506.2	237 290.2
719	287.85	4 808 507.3	237 240.2
720	287.71	4 808 506.8	237 215.2
721	286.31	4 808 494.7	237 138.1
722	289.85	4 808 596.7	237 290.2
723	287.72	4 808 602.6	237 240.2
726	295.43	4 808 577.6	237 264.2
727	291.62	4 808 569.4	236 971.6
728	288.38	4 808 564.2	236 810.1
729	283.91	4 808 561.9	236 660.2
730	295.11	4 808 532.8	237 411.1
731	284.75	4 808 528.4	236 690.2
732	281.35	4 808 605.4	237 094.6
733	280.43	4 808 604.7	237 041.5
734	280.16	4 808 602.6	236 989.6
735	279.71	4 808 600.1	236 944.7
736	279.67	4 808 598.0	236 892.4
737	279.12	4 808 591.4	236 839.6
738	278.87	4 808 589.6	236 789.7
739	278.52	4 808 587.9	236 739.7
740	278.51	4 808 584.3	236 689.7
741	278.34	4 808 582.8	236 649.7
758	279.36	4 808 510.1	236 673.5
759	279.32	4 808 507.8	236 720.8
770	285.84	4 808 479.9	236 893.9
771	285.31	4 808 485.7	236 986.3
772	284.24	4 808 488.6	237 015.2
773	288.94	4 808 531.0	236 834.1
774	290.93	4 808 533.0	236 938.4
775	295.48	4 808 535.7	237 266.4
Borehole - Previous Investigation (Geocres. 40P8-225)			
501	293.28	4 808 535.9	237 084.1
502	294.14	4 808 536.0	237 128.1
503	294.40	4 808 572.4	237 155.1
505	283.41	4 808 604.2	237 178.9
Borehole - Previous Investigation (Geocres. 40P8-222)			
724	278.42	4 808 580.9	236 609.8
725	278.24	4 808 584.9	236 609.8
757	278.35	4 808 501.4	236 640.6

NO.	DATE	BY	REVISION
Geocres No. 40P8-223			
HWY.	401	PROJECT NO.	10-1132-0056
SUBM'D.	NAG	CHKD.	NAG
DATE:	Feb. 21/14	SITE:	
DRAWN:	LMK	CHKD.	DUP
APPD.	FJH	DWG.	1

Base plans provided in digital format by Delcan.

HORIZONTAL SCALE VERTICAL SCALE

30 0 30 m 3 0 3 m




MINISTRY OF TRANSPORTATION, ONTARIO

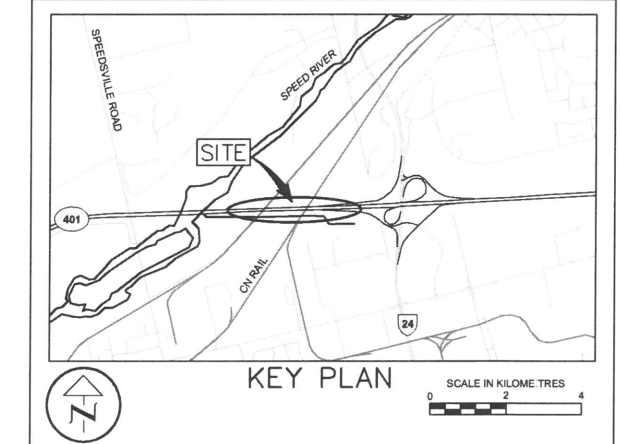
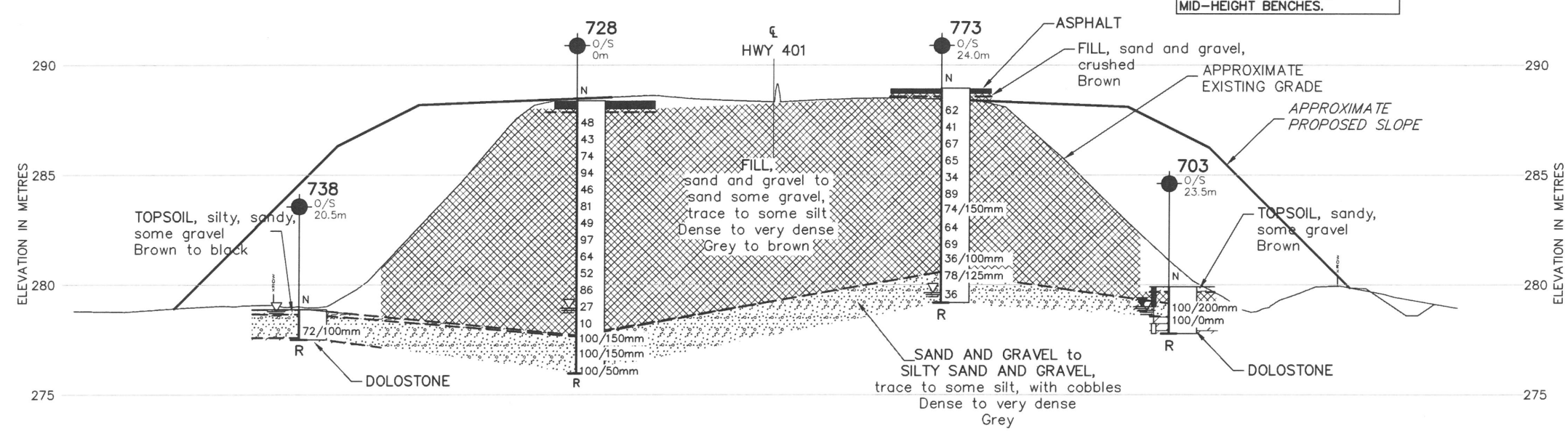
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METRIC
DIMENSIONS ARE IN METRES AND/OR
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STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 4-00-00

HIGH FILLS
HIGHWAY 401 IMPROVEMENTS
SOIL STRATA

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- 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 Nov. 2012.
 - WL encountered during drilling
 - R Split-spoon / Auger refusal on inferred bedrock

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
703	279.91	4 808 510.3	236 786.7
727	291.62	4 808 569.4	236 971.6
728	288.38	4 808 564.2	236 810.1
734	280.16	4 808 602.6	236 989.6
771	285.31	4 808 485.7	236 986.3
773	288.94	4 808 531.0	236 834.1

NOTES

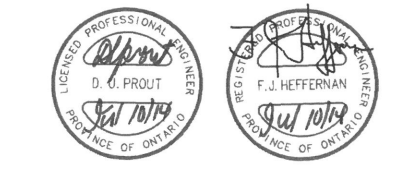
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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.	40P8-223		
HWY.	401	PROJECT NO.	10-1132-0056
SUBM'D.	NAG	CHKD.	NAG
DRAWN:	WDF	CHKD.	DUP
		DATE:	Feb. 21/14
		APPD.	FJH
		DWG.	3



MINISTRY OF TRANSPORTATION, ONTARIO


FILE NAME: N:\Users\j2011\1132 - Geotechnical\1132-00056\10-1132-0056 DELCAN - SWP 4-00-00 - HWY 401\Drawings\AutoCAD files\1011320056-2000-0098003.dwg

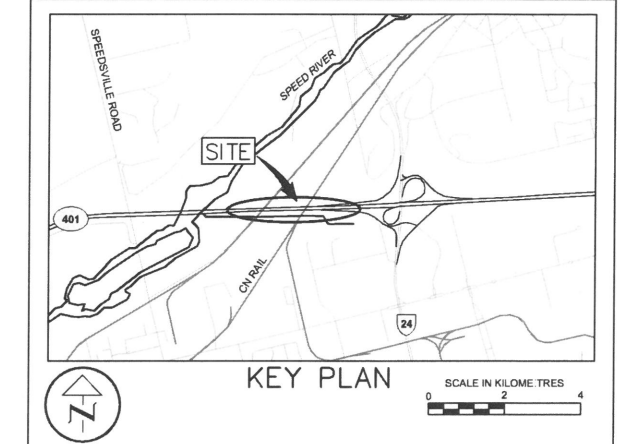
PLOT DATE: July 11, 2014






METRIC
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MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

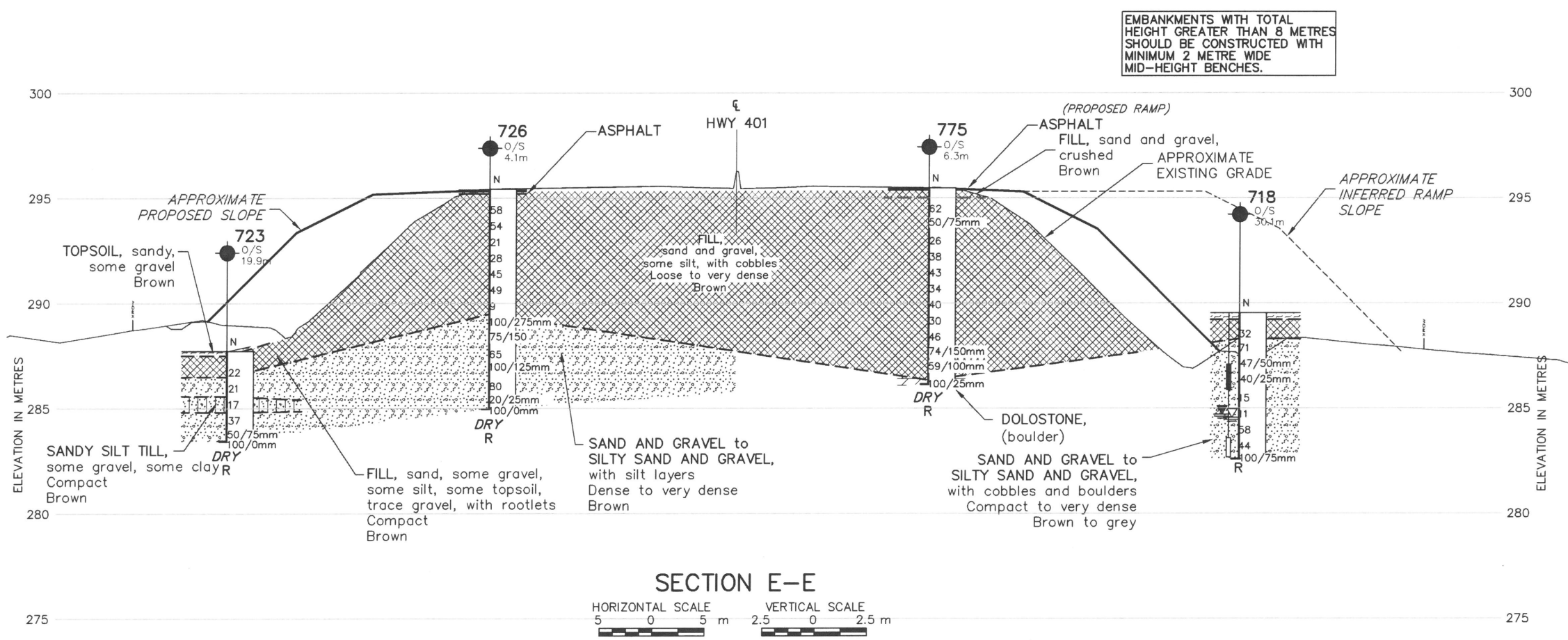
CONT No.
WP No. 4-00-00

HIGH FILLS
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 July 2013.		
	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
718	289.52	4 808 506.2	237 290.2
723	287.72	4 808 602.6	237 240.2
726	295.43	4 808 577.6	237 264.2
775	295.48	4 808 535.7	237 266.4



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.

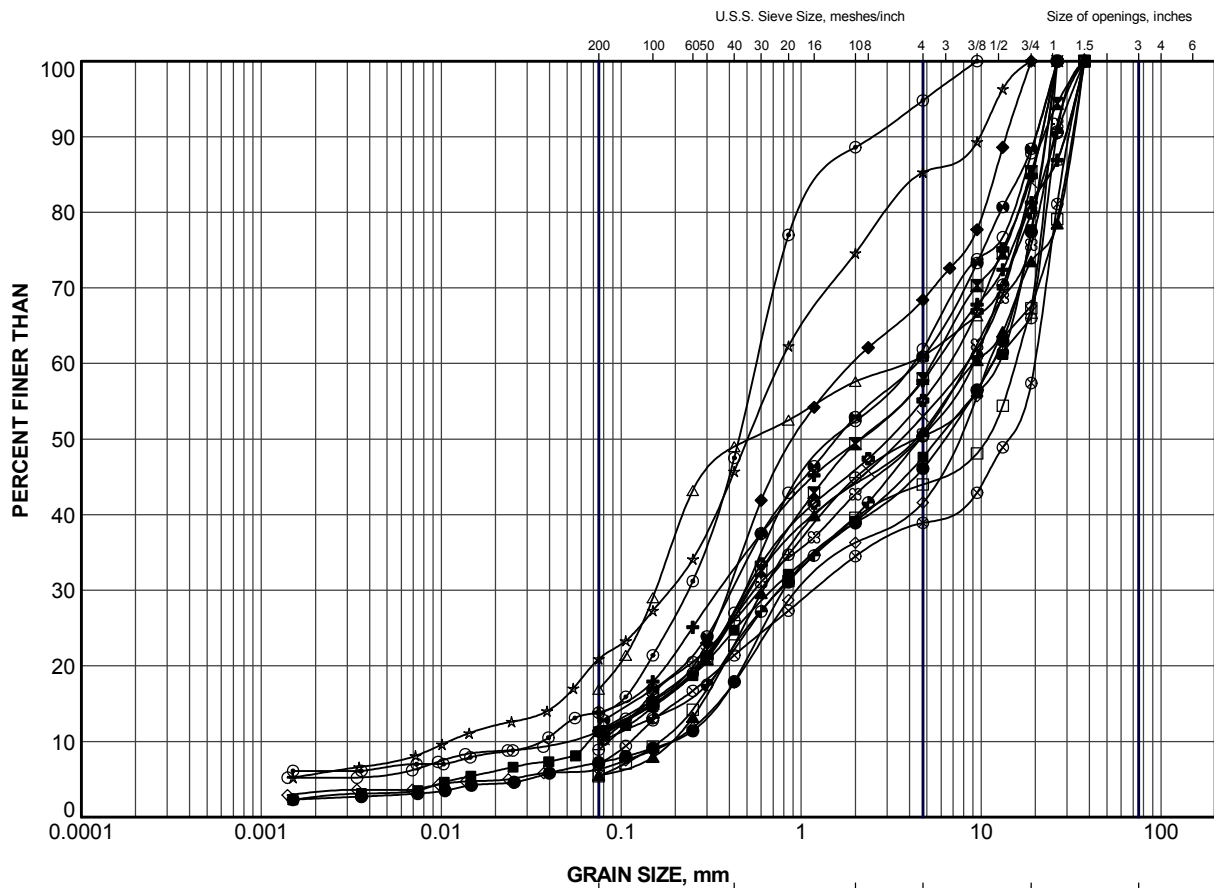


NO.	DATE	BY	REVISION
Geocres No.	40P8-223		
HWY.	401	PROJECT NO.	10-1132-0056
SUBM'D.	NAG	CHKD.	NAG
DRAWN:	WDF	CHKD.	DUP
		APPD.	FJH
		DWG.	4



APPENDIX A


Laboratory Test Data

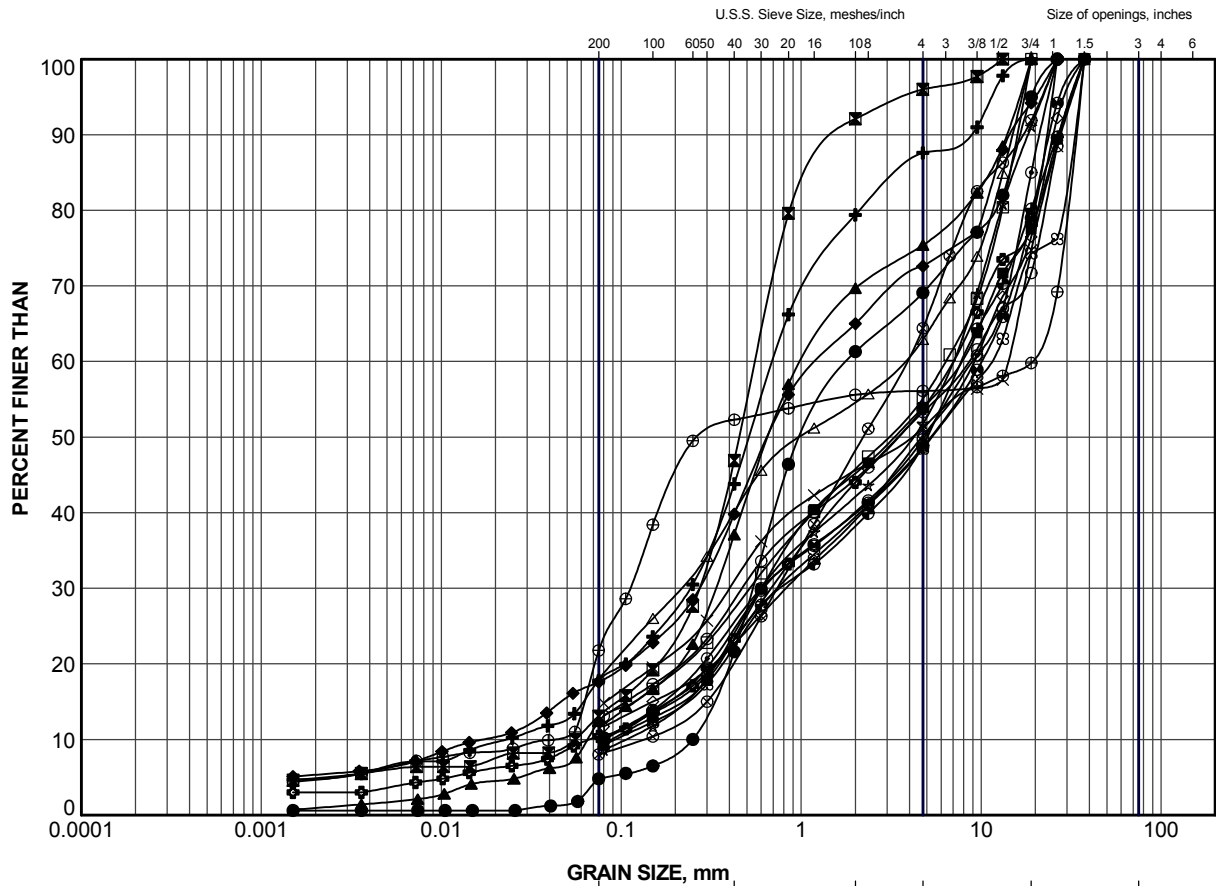


CLAY AND SILT	SAND SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	501	2	291.5
■	501	9	286.2
▲	502	6	289.3
+	502	11	285.5
◆	502	13	284.0
◇	503	4	291.1
○	503	8	288.1
△	719	1	286.9
⊗	720	4	284.4
⊕	721	2	284.6
□	721	4	283.0
⊙	726	2	293.7
⊗	726	5	291.4
★	727	2	289.9
⊗	727	7	286.1
⊗	727	11	283.0
⊙	727	12	282.3
⊕	728	6	283.6
×	728	12	279.0


PROJECT				HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION FILL			
PROJECT No.		10-1132-0056		FILE No.1011320056-2000-F09B0A1			
DRAWN		WDF		Feb 21/14		SCALE N/A REV.	
CHECK						FIGURE A-1	
 Golder Associates LONDON, ONTARIO							

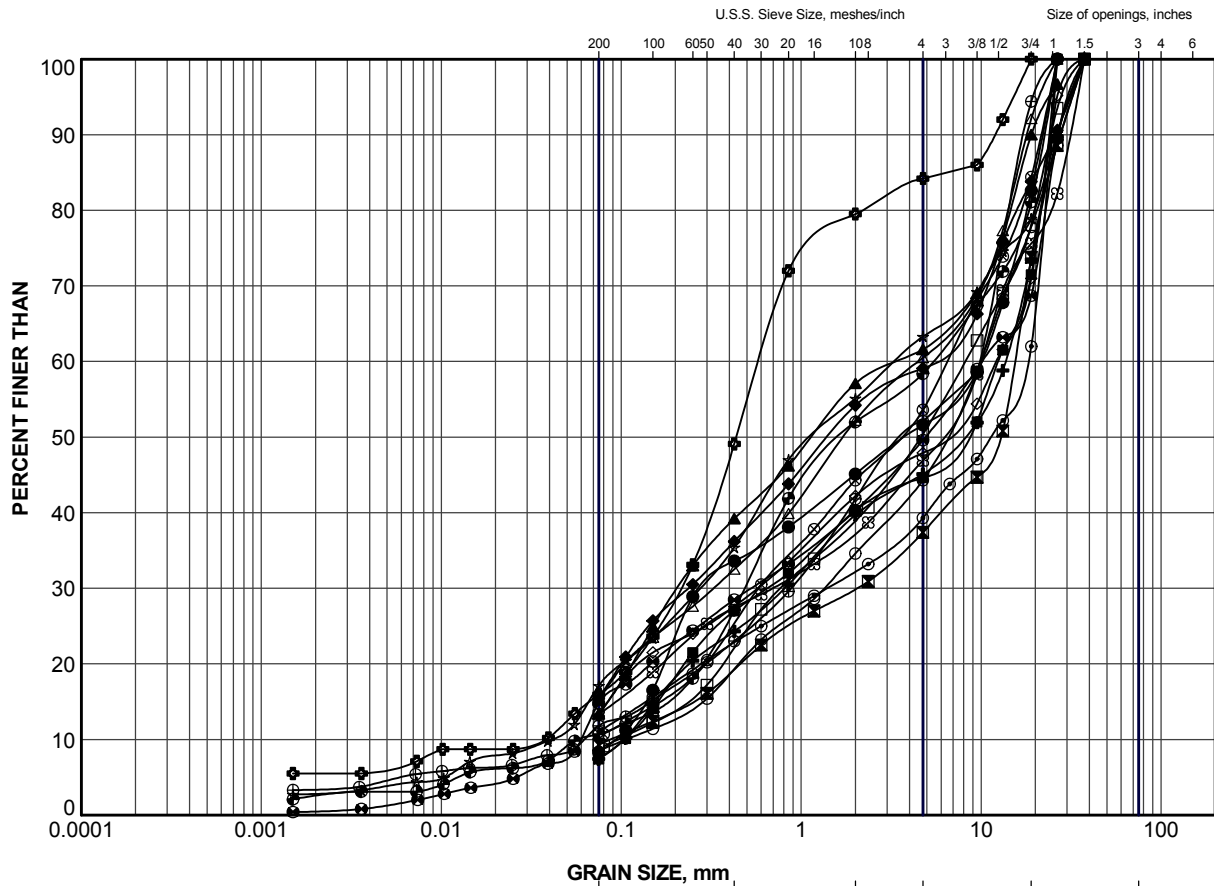


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	728	13	278.2
■	729	4	280.6
▲	729	7	278.4
+	730	1	294.1
◆	730	5	291.1
◇	731	4	281.5
○	731	7	279.2
△	758	1	278.5
⊗	770	4	280.3
⊕	771	5	280.5
□	772	1	283.3
⊙	773	3	286.4
⊗	773	8	282.6
★	773	11	280.4
⊠	774	8	284.6
⊞	774	13	280.8
⊚	775	5	291.4
⊛	775	8	289.2
×	775	10	287.7


PROJECT				HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION FILL			
PROJECT No.		10-1132-0056		FILE No.1011320056-2000-F09B0A2			
DRAWN		WDF		Feb 21/14		SCALE N/A REV.	
CHECK						FIGURE A-2	
 Golder Associates LONDON, ONTARIO							

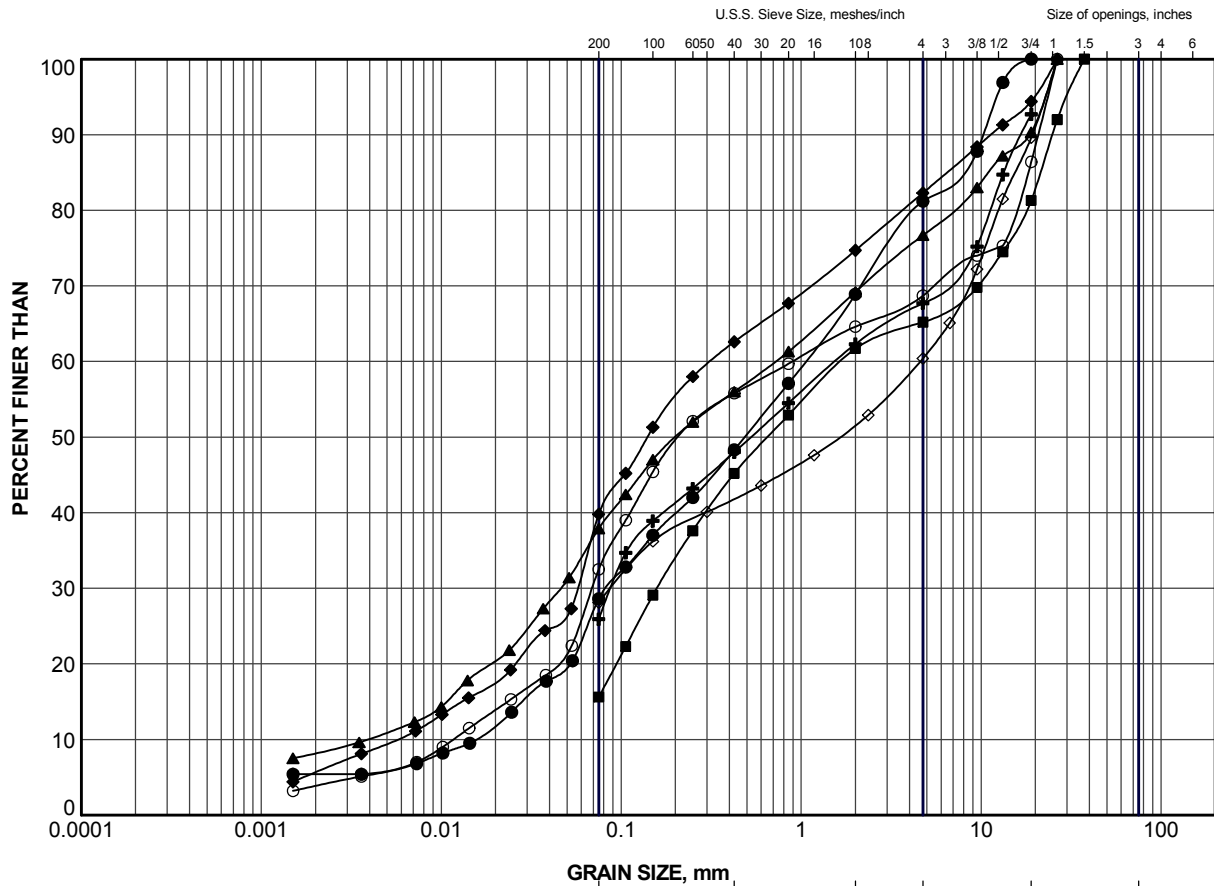


CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	715	2	288.1
■	715	4	286.5
▲	717	1	288.7
+	718	2	287.9
◆	718	5	285.5
◇	720	7	282.2
○	722	3	287.3
△	723	4	284.4
⊗	726	8	289.1
⊕	728	15	276.9
□	730	10	287.3
⊙	730	13	285.0
⊛	731	8	278.4
☆	734	2	278.4
⊠	738	1	277.9
⊞	759	1	278.3
⊚	759	2	277.6
⊛	774	14	280.0


PROJECT				HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION SAND AND GRAVEL			
PROJECT No.		10-1132-0056		FILE No.1011320056-2000-F09B0A3			
DRAWN		WDF		Feb 21/14		SCALE N/A REV.	
CHECK						FIGURE A-3	
 Golder Associates LONDON, ONTARIO							

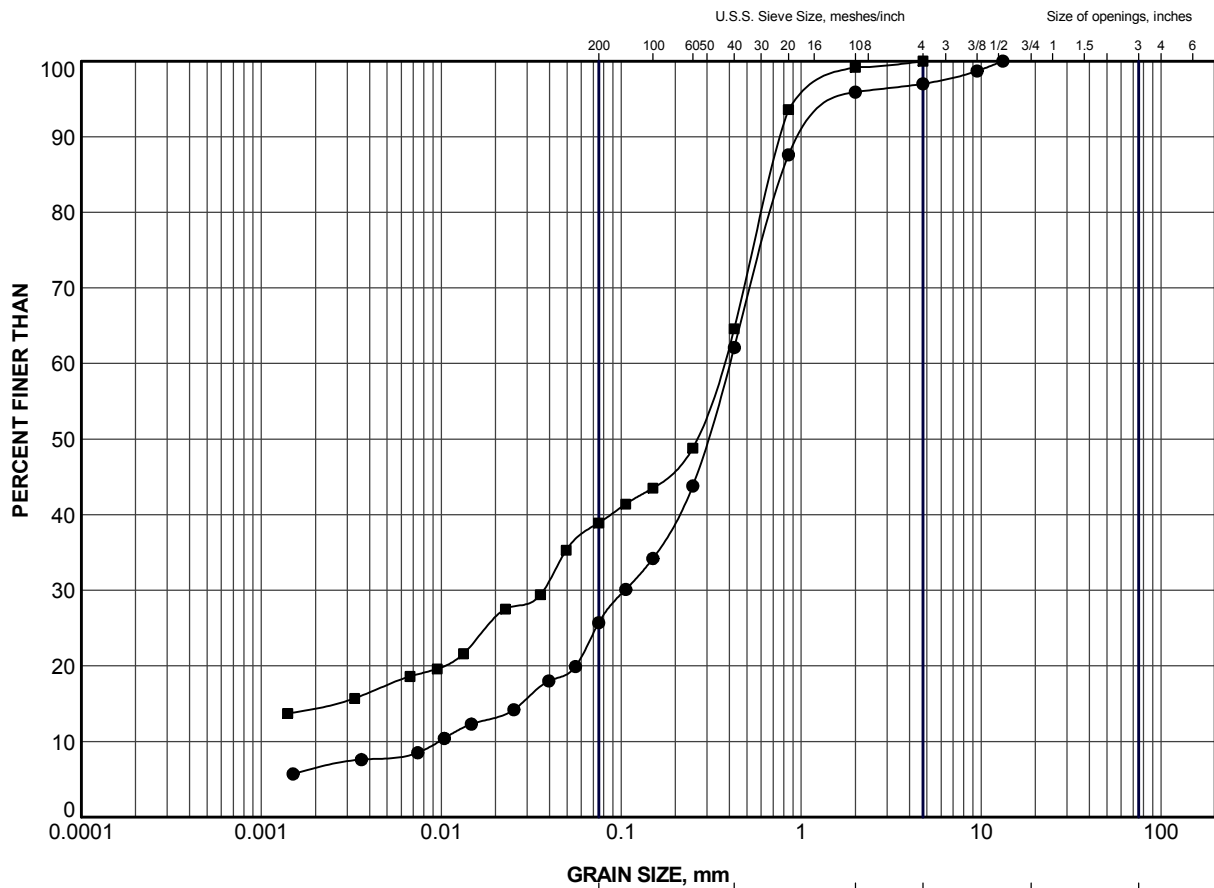


CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	716	4	286.4
■	716	6	284.8
▲	718	7	284.0
+	721	6	281.6
◆	726	12	286.1
◇	741	1	277.4
○	774	15	279.3

PROJECT		HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		GRAIN SIZE DISTRIBUTION SILTY SAND AND GRAVEL	
PROJECT No. 10-1132-0056		FILE No. 1011320056-2000-F09B0A4	
DRAWN	WDF	Feb 21/14	SCALE N/A REV.
CHECK			
 Golder Associates LONDON, ONTARIO		FIGURE A-4	



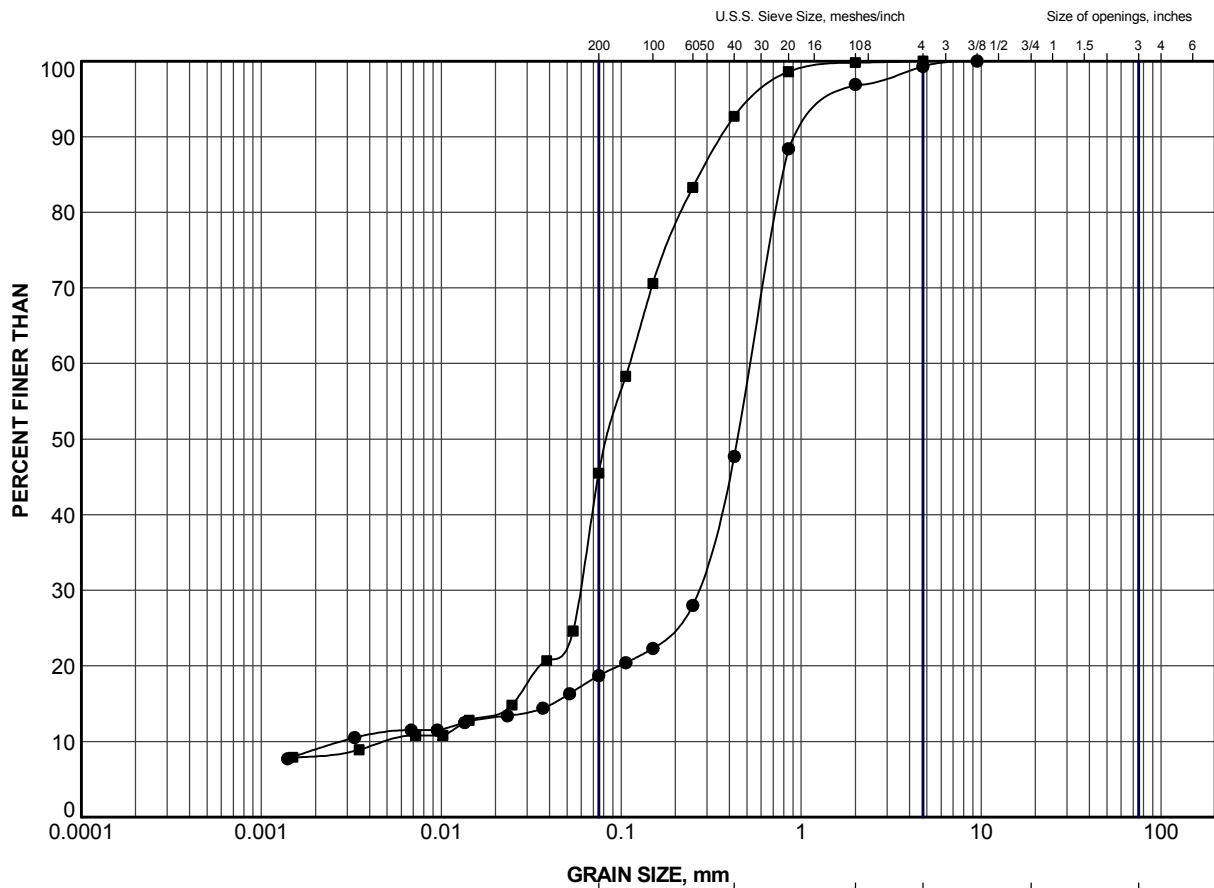
GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	503	13	284.3
■	503	15	282.7

PROJECT				HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION SILTY SAND			
PROJECT No.		10-1132-0056		FILE No.1011320056-2000-F09B0A5			
DRAWN		WDF		Feb 21/14		SCALE N/A REV.	
CHECK						FIGURE A-5	





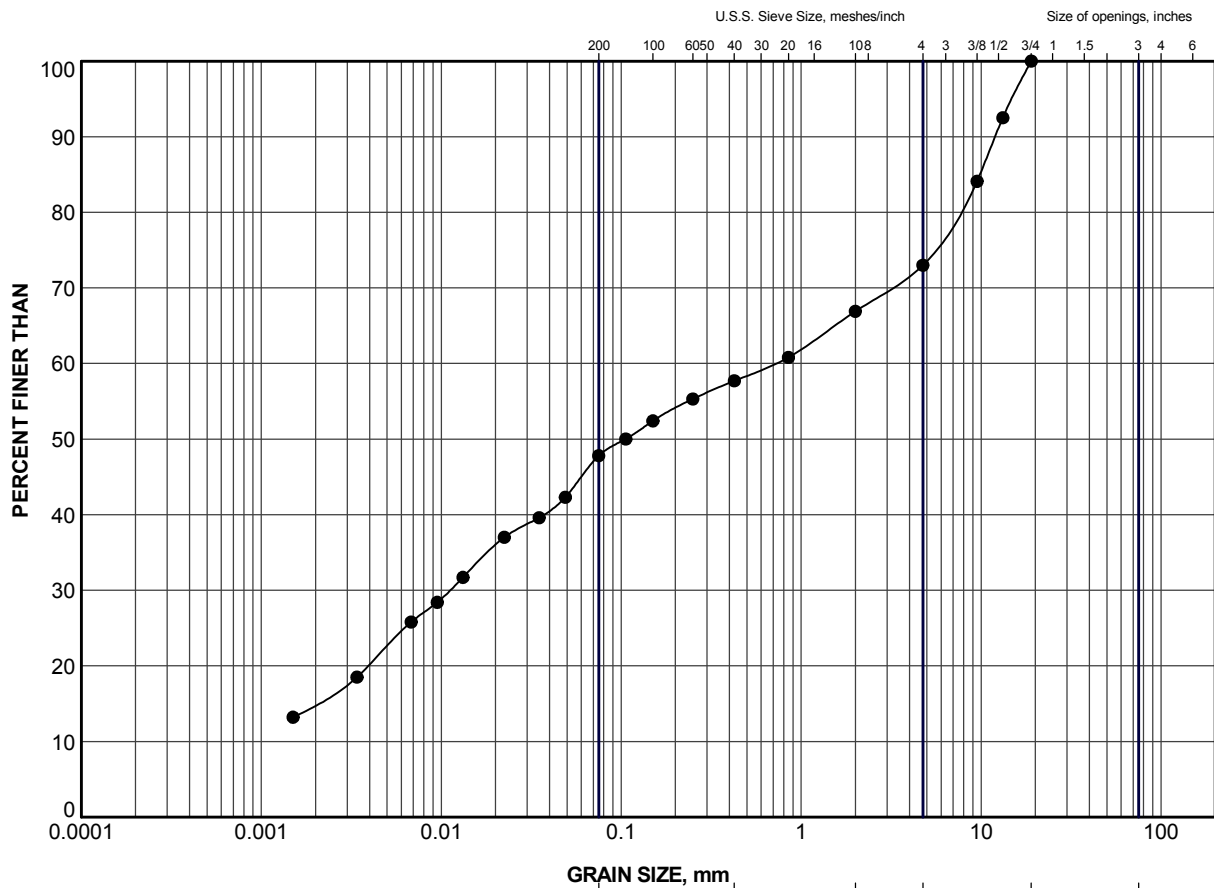
GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	503	16	282.1
■	729	8	277.6

PROJECT				HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION SAND to SAND AND SILT			
PROJECT No.		10-1132-0056		FILE No.1011320056-2000-F09B0A6			
DRAWN		WDF		Feb 21/14		SCALE N/A REV.	
CHECK						FIGURE A-6	






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

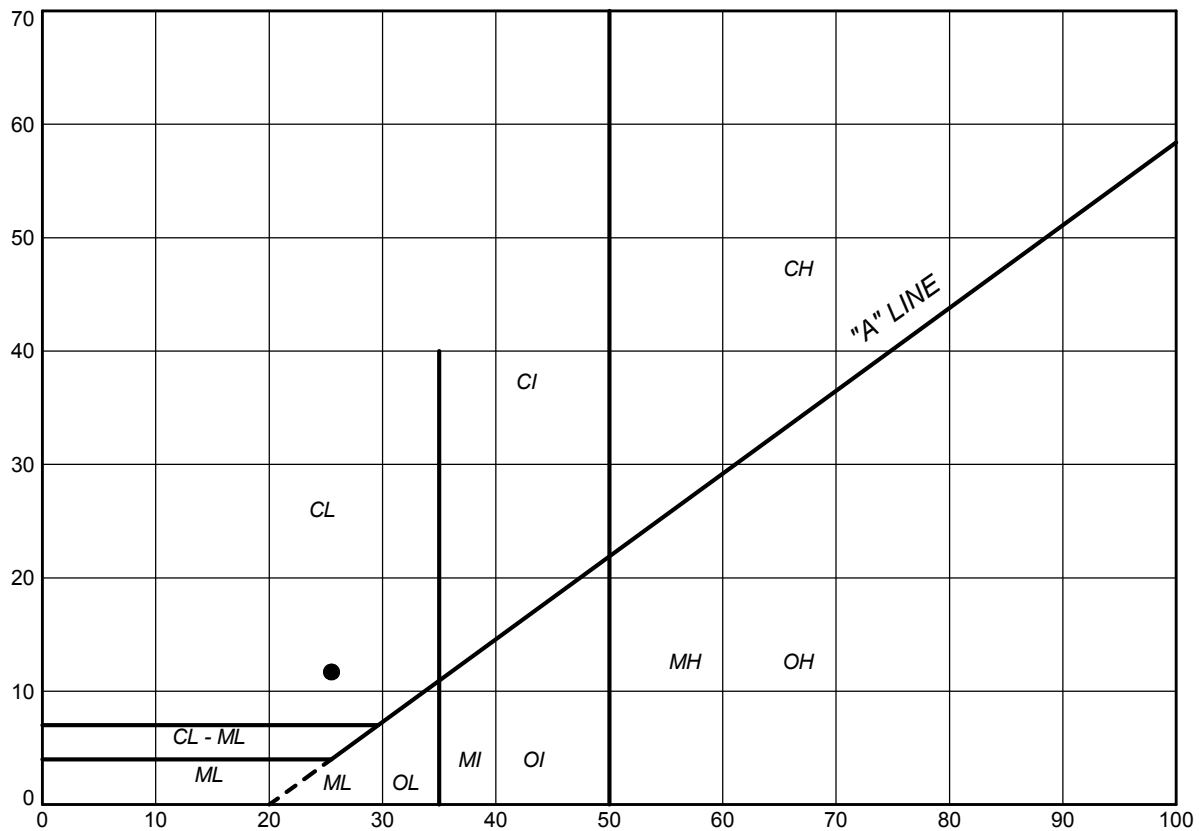
LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	723	3	285.2

PROJECT				HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00			
TITLE				GRAIN SIZE DISTRIBUTION SANDY SILT TILL			
PROJECT No.		10-1132-0056		FILE N4011320056-2000-F09B0A7			
DRAWN		WDF		Feb 21/14		SCALE N/A REV.	
CHECK						FIGURE A-7	


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LDN_MTO_GSD_GLDR_LDN.GDT 07/01/14

PLASTICITY INDEX (Percent)



LIQUID LIMIT (Percent)

SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	723	3	25.5	13.8	11.7

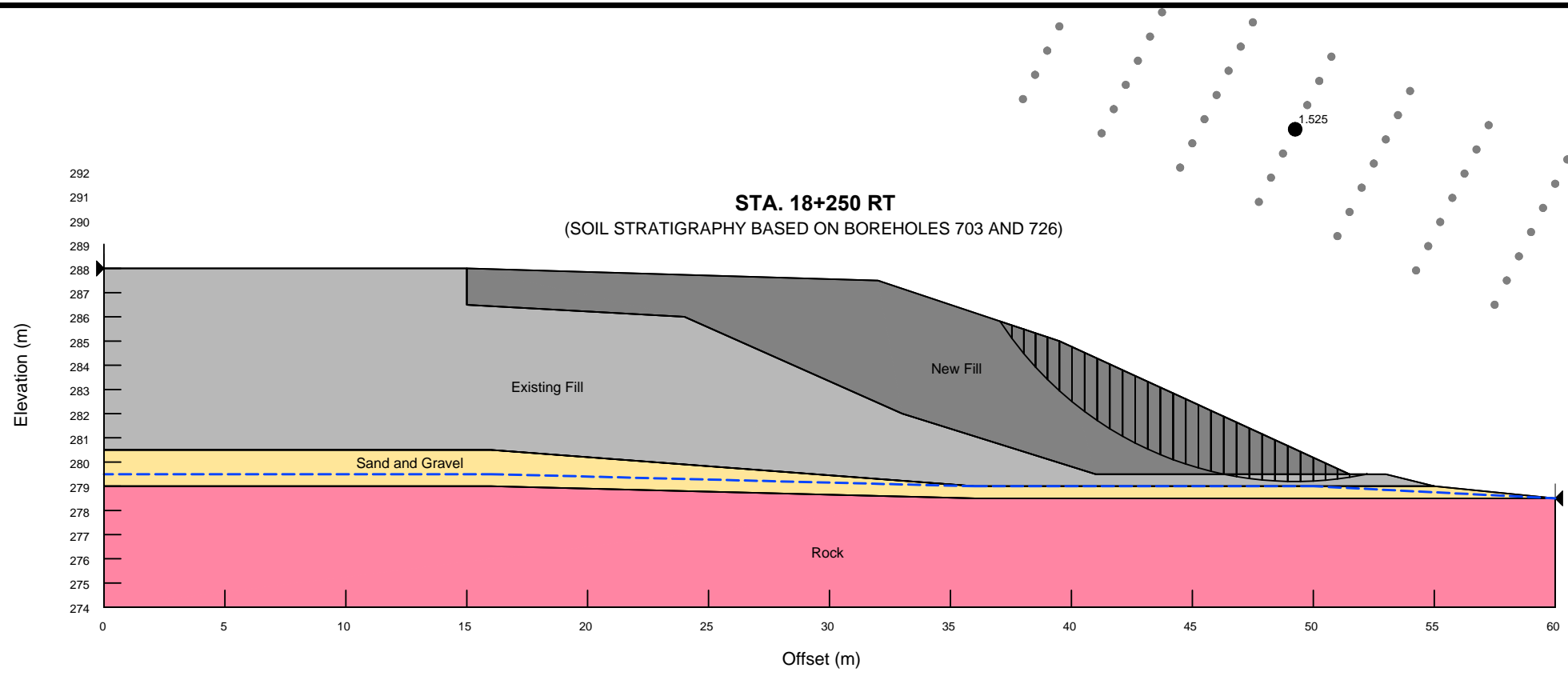
PROJECT		HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		PLASTICITY CHART	
PROJECT No. 10-1132-0056		FILE No.1011320056-2000-F09B0A8	
DRAWN	WDF	Feb 21/14	SCALE N/A REV.
CHECK			FIGURE A-8



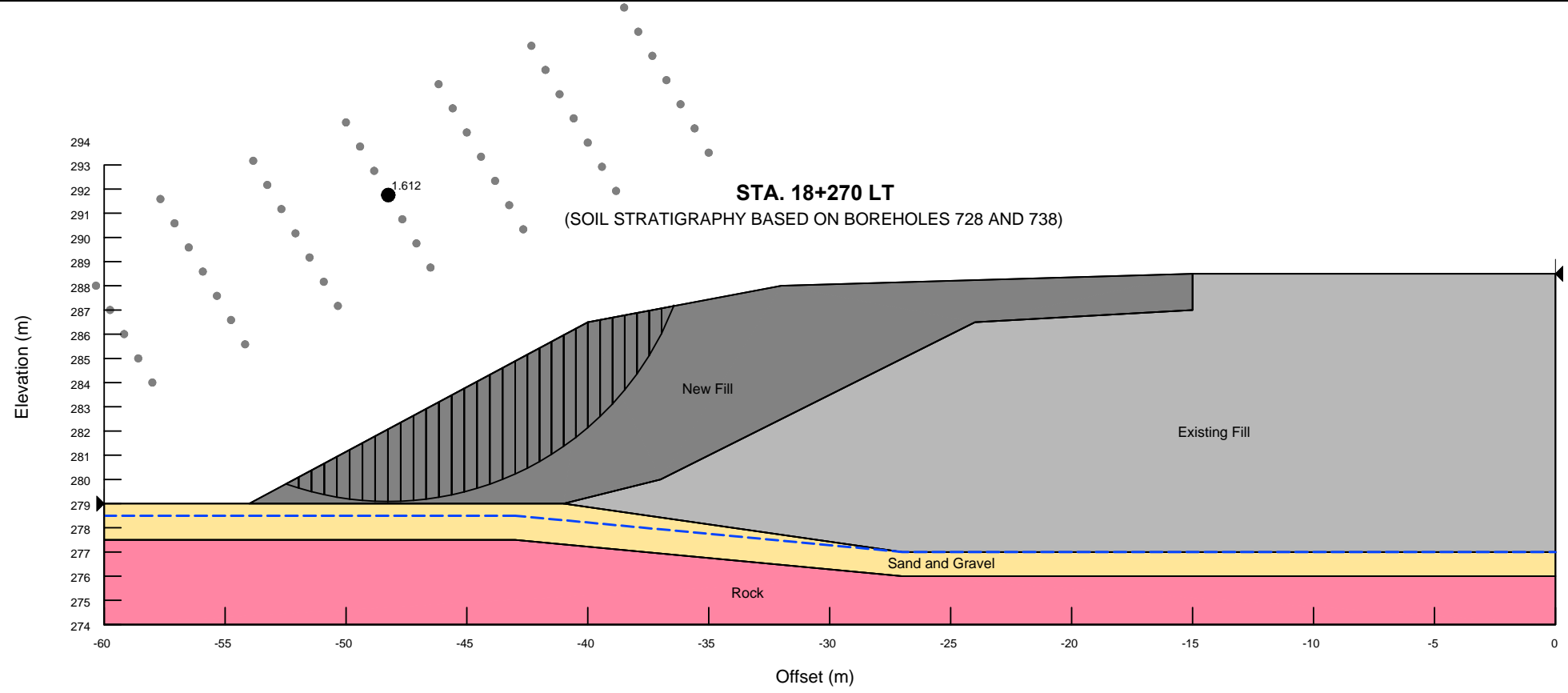


APPENDIX B

Slope Stability Analyses



Soil Properties		
Soil	Angle of Friction ϕ°	Unit Weight, γ (kN/m ³)
New Fill	30	20
Existing Fill	30	20
Existing Fill - Preston Landfill Site	28	18
Sand and Gravel	37	21
Silty Sand and Gravel	35	21




- NOTES**
1. OFFSET = OFFSET FROM HIGHWAY CENTRELINE.
 2. ANALYSES BASED ON CROSS SECTIONS SUPPLIED BY DELCAN.
 3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

PROJECT

HIGH FILLS
HIGHWAY 401 IMPROVEMENTS
GWP 4-00-00

TITLE

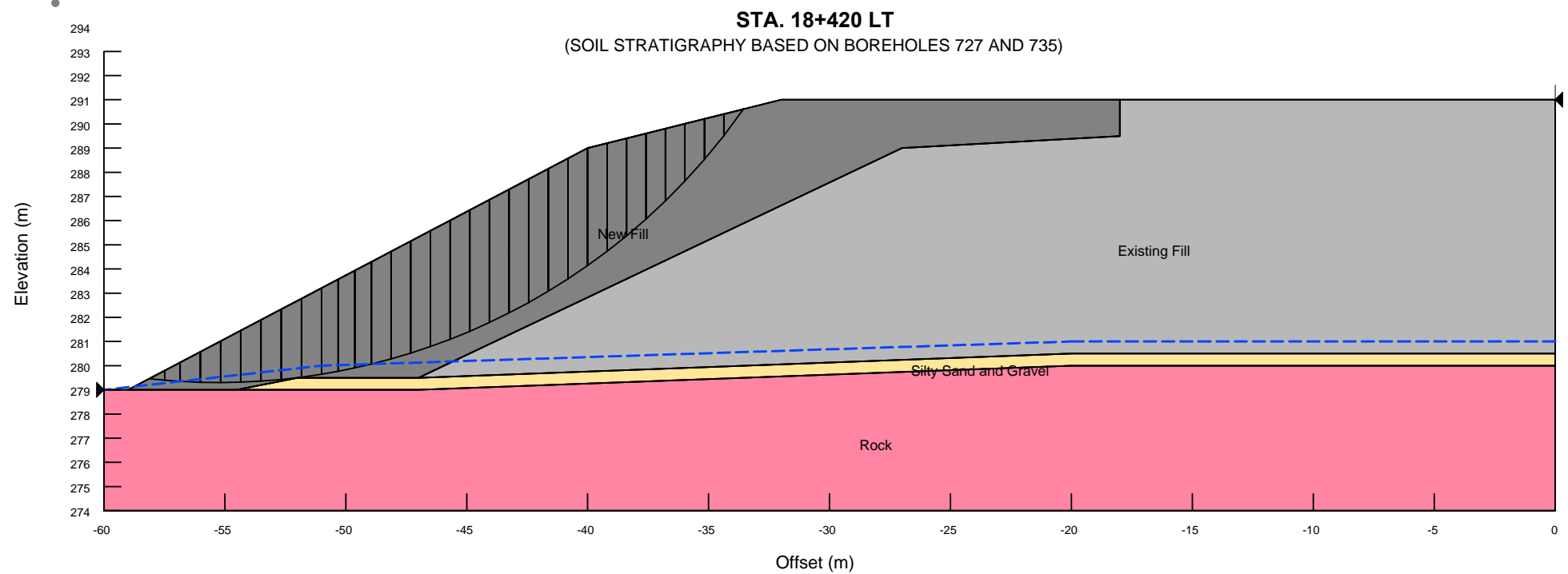
RESULTS OF SLOPE STABILITY ANALYSES

Golder Associates
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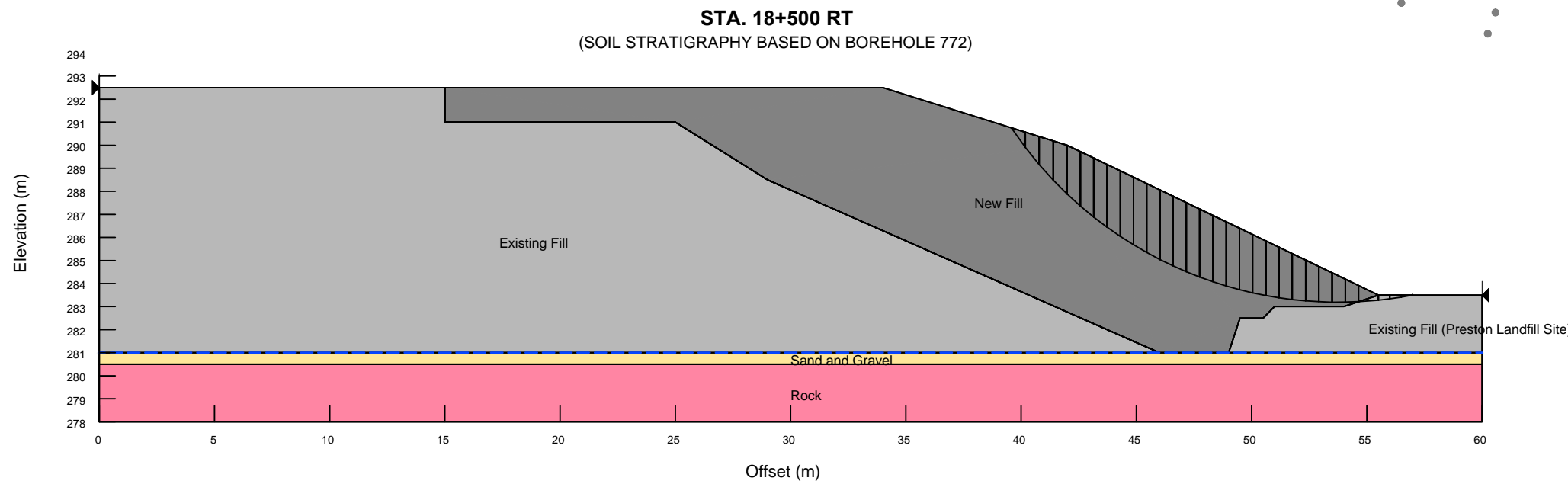
PROJECT No.	10-1132-0056	FILE No. 1011320056-2000-F09B0B1
CADD	WDF	Feb. 06/14
CHECK		

SCALE	AS SHOWN	REV.	0
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FIGURE B-1



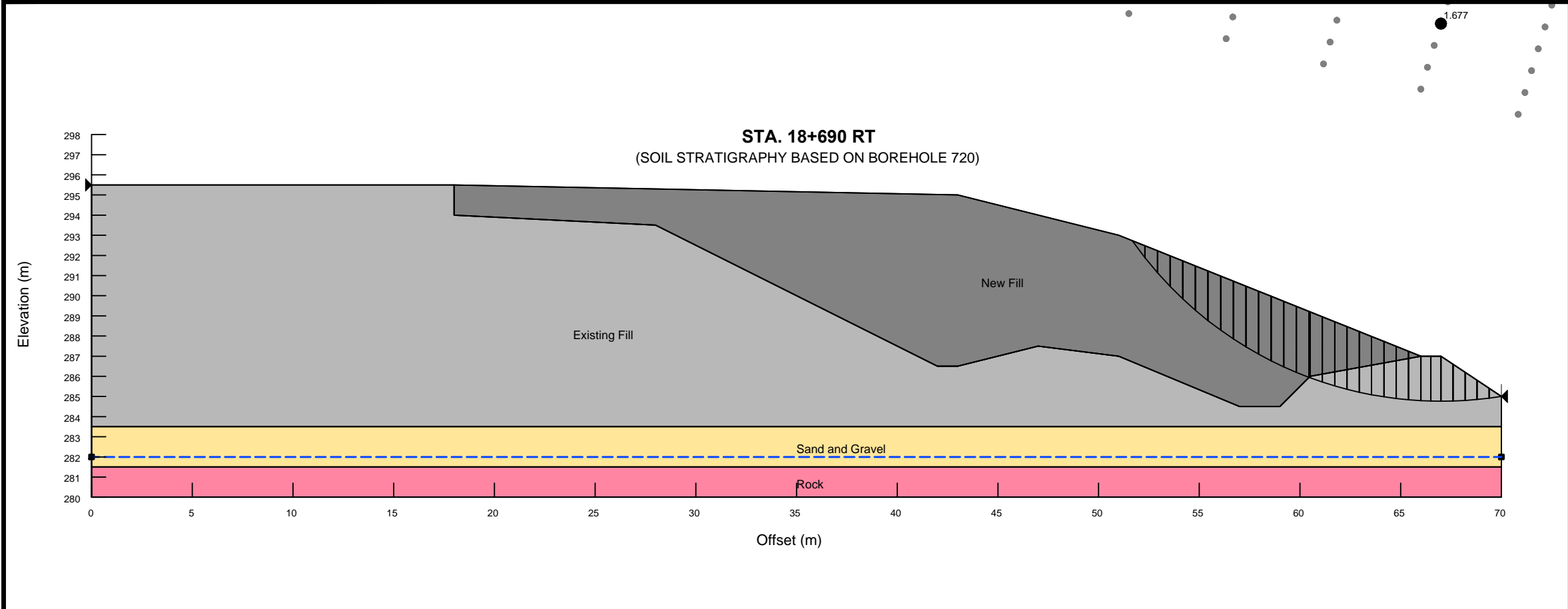
Soil Properties		
Soil	Angle of Friction ϕ°	Unit Weight, γ (kN/m ³)
New Fill	30	20
Existing Fill	30	20
Existing Fill - Preston Landfill Site	28	18
Sand and Gravel	37	21
Silty Sand and Gravel	35	21



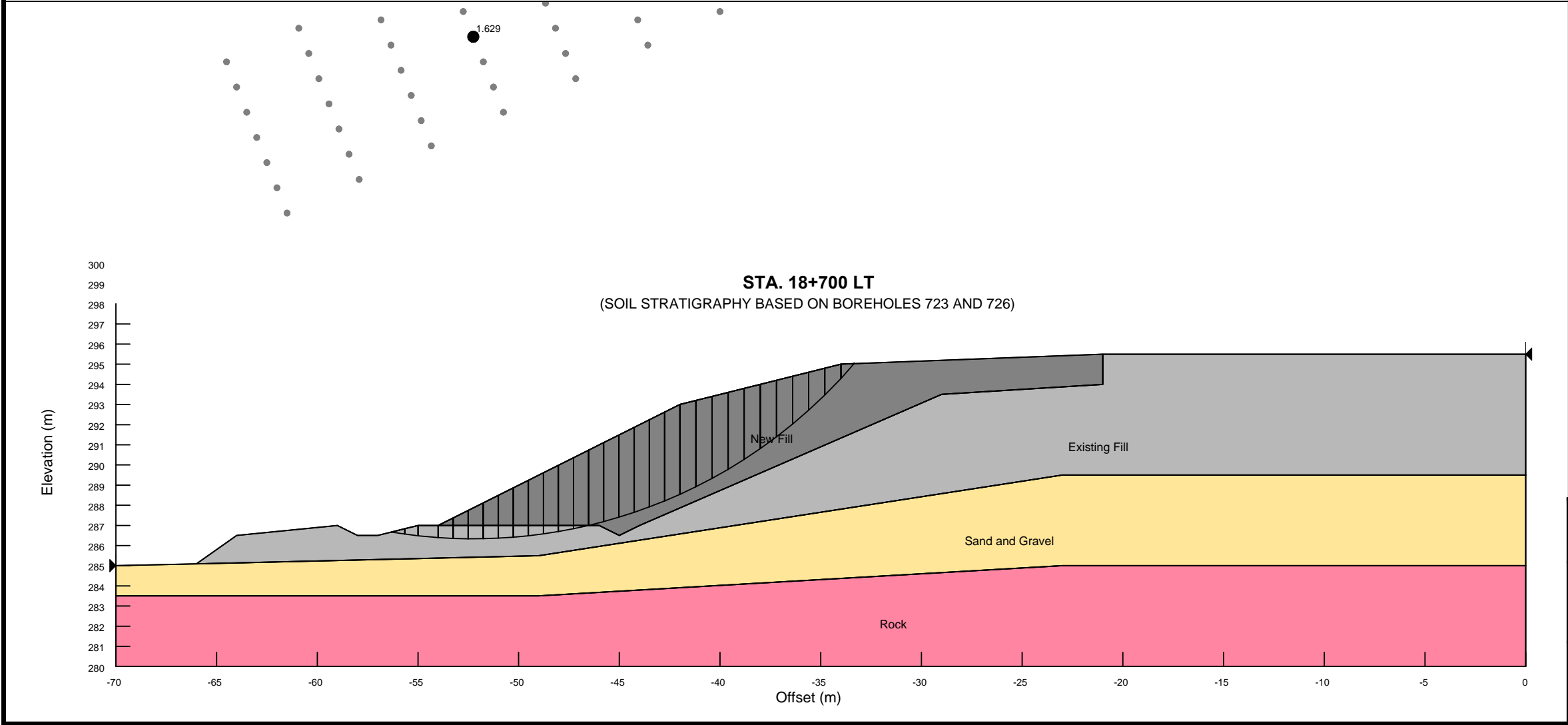
- NOTES**
1. OFFSET = OFFSET FROM HIGHWAY CENTRELINE.
 2. ANALYSES BASED ON CROSS SECTIONS SUPPLIED BY DELCAN.
 3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

PROJECT		HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		RESULTS OF SLOPE STABILITY ANALYSES	
PROJECT No. 10-1132-0056		FILE No. 1011320056-2000-F09B0B1	
CADD	WDF	Feb. 06/14	SCALE AS SHOWN REV. 0
CHECK			FIGURE B-2
 Golder Associates LONDON, ONTARIO			

Drawing file: 1011320056-2000-F09B0B1.DWG Feb 25, 2014 - 12:04pm



Soil Properties		
Soil	Angle of Friction ϕ°	Unit Weight, γ (kN/m ³)
New Fill	30	20
Existing Fill	30	20
Existing Fill - Preston Landfill Site	28	18
Sand and Gravel	37	21
Silty Sand and Gravel	35	21



NOTES

1. OFFSET = OFFSET FROM HIGHWAY CENTRELINE.
2. ANALYSES BASED ON CROSS SECTIONS SUPPLIED BY DELCAN.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

PROJECT		HIGH FILLS HIGHWAY 401 IMPROVEMENTS GWP 4-00-00	
TITLE		RESULTS OF SLOPE STABILITY ANALYSES	
PROJECT No.		10-1132-0056	FILE No. 1011320056-2000-F09B0B1
CADD	WDF	Feb. 06/14	SCALE AS SHOWN REV. 0
CHECK			FIGURE B-3



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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