March 2013

FOUNDATION INVESTIGATION AND DESIGN REPORT

Stormwater Management (SWM) Ponds
Highway 410 Widening
From South of Highway 401 to Queen Street
Regional Municipality of Peel
G.W.P. 2144-07-00(h)

Submitted to:
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REPORT

GEOCRES No. 30M12-360

Report Number: 11-1111-0083-7

Distribution:

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Golder Associates

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PART A

FOUNDATION INVESTIGATION REPORT
STORMWATER MANAGEMENT (SWM) PONDS
HIGHWAY 410 WIDENING FROM SOUTH OF HIGHWAY 401 TO QUEEN STREET, REGIONAL MUNICIPALITY OF PEEL
G.W.P. 2144-07-00(h)

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Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of the detail design for the widening of Highway 410 from south of Highway 401 to Queen Street the Cities of Mississauga and Brampton, in the Regional Municipality of Peel, Ontario.

This report addresses the results of the geotechnical investigation carried out at the locations of six proposed stormwater management (SWM) ponds located along Highway 410.

The terms of reference and scope of work for the foundation investigation are outlined in MTO's Request for Proposal (RFP) dated November 2010, and in Section 6.8 of URS's *Technical Proposal* for this assignment.

2.0 SITE DESCRIPTION

The six proposed SWM pond sites addressed in this report are located along Highway 410 between Highway 401 and Steeles Avenue in the Cities of Mississauga and Brampton, Ontario. In general, the surface topography along this section of Highway 410 is flat-lying to gently sloping. The natural ground surface varies from approximately Elevation 180 m near the Highway 401-Highway 410 interchange, to approximately Elevation 196 m near the Highway 410-Steeles Avenue interchange.

3.0 INVESTIGATION PROCEDURES

The field work for this subsurface investigation was carried out in August 2012, during which time a total of eighteen boreholes (three boreholes per pond, designated as Boreholes P1-1 to P1-3, P2-1 to P2-3, P3-1 to P3-3, P4-1 to P4-3, P5-1 to P5-3, and P6-1 to P6-3) were advanced using a CME-55 track-mounted drill rig, supplied and operated by Geo-Environmental Drilling Inc. of Milton, Ontario, or a Diedrich D-50 track-mounted drill rig, supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced to depths ranging from 1.5 m to 10.8 m, including bedrock coring. The boreholes were drilled through the overburden and into weathered shale bedrock (where present) using 108 mm inside diameter hollow stem augers or 152 mm outside diameter solid stem augers. Samples were obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586-08a – Standard Test Method for Standard Penetration Test). Approximately 8.1 m of bedrock coring was completed in Borehole P4-2, using standard NQ-sized diamond drill coring equipment.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations, and a standpipe piezometer was installed in one borehole at each of the six proposed pond sites (Boreholes P1-2, P2-2, P3-2, P4-1, P5-3, and P6-2) to permit monitoring of the groundwater level at each of the pond locations. The standpipe piezometers consist of 50 mm diameter PVC pipe, with a slotted screen sealed within a sand filter pack at a selected depth interval within the boreholes. Above the sand filter pack and piezometer screen, the annulus surrounding the piezometer pipes was backfilled to the ground surface with bentonite pellets. The piezometer installation details and water level readings are shown on the borehole

records contained in Appendix A. All remaining boreholes were backfilled with bentonite upon completion, in accordance with Ontario Regulation 903 (as amended).

The field work was supervised on a full-time basis by members of Golder's engineering staff who located the boreholes in the field, directed the drilling, sampling, and in situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further examination and laboratory testing. Index and classification tests consisting of water content determinations, Atterberg limits testing, and grain size distribution analyses were carried out on selected soil samples.

The borehole locations were established in the field by Golder personnel relative to site features. The ground surface elevation at each borehole was estimated from the digital terrain model for the site as provided by URS. The borehole locations (referenced to the MTM NAD83 co-ordinate system) and ground surface elevations (referenced to geodetic datum) are summarized in the following table and are shown on Drawings 1 to 6.

Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
P1-1	4,833,897.9	291,310.4	179.5	7.0
P1-2	4,833,931.4	291,281.0	179.8	7.2
P1-3	4,833,960.1	291,245.5	180.2	7.9
P2-1	4,835,088.4	290,143.5	184.0	9.8
P2-2	4,835,120.9	290,119.1	184.6	9.2
P2-3	4,835,149.4	290,089.6	184.0	9.8
P3-1	4,835,894.7	289,367.8	186.3	9.5
P3-2	4,835,948.0	289,320.8	187.5	9.5
P3-3	4,835,999.4	289,275.7	187.5	7.3
P4-1	4,836,957.9	288,322.7	192.3	1.5
P4-2	4,836,919.7	288,337.0	192.1	9.6
P4-3	4,836,878.4	288,351.3	191.6	3.1
P5-1	4,837,409.1	288,320.9	191.7	7.9
P5-2	4,837,502.0	288,275.5	191.8	6.6
P5-3	4,837,528.2	288,319.0	190.6	6.7
P6-1	4,838,326.0	287,902.3	197.7	10.8
P6-2	4,838,372.4	287,879.1	199.9	10.8
P6-3	4,838,418.2	287,893.0	197.5	10.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 410 is located within the western portion of the Peel Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984).

The Peel Plain physiographic region covers the central portions of the Regional Municipalities of York, Peel and Halton. The general topography of this region consists of level to gently rolling terrain, sloping gradually southward toward Lake Ontario. A surficial till sheet, which generally follows the surface topography, is present throughout much of this area. The till, which is mapped in this area as the Halton Till, typically consists of clayey silt to silty clay, with occasional sand to silt zones. Shallow, localized deposits of loose sand and silt and/or soft clay can overlie this uppermost till sheet, and these represent relatively recent deposits, formed in small glacial meltwater ponds scattered throughout the Peel Plain and concentrated near river valleys. The recent sand, silt and clay and uppermost till deposits in this area overlie and are interbedded with stratified deposits of sand, silt and clay. The study area is underlain by grey shale of the Georgian Bay Formation.

4.2 Overview of Subsurface Conditions

As part of the subsurface investigation, three boreholes were advanced in the vicinity of each of the six proposed SWM pond locations. The borehole locations and ground surface elevations at each of the six proposed SWM pond locations are shown on Drawings 1 to 6.

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and geotechnical laboratory testing are given on the borehole records contained in Appendix A. The results of geotechnical laboratory testing are also presented on Figures B1 to B20 contained in Appendix B. The stratigraphic boundaries shown on the borehole records are inferred from observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the soils encountered at the proposed SWM pond sites consist of topsoil, fill or relatively thin surficial deposits of firm to very stiff clayey silt or loose to compact silty sand, overlying a till deposit that varies in composition from stiff to hard clayey silt till, to dense to very dense sand and silt to silty sand and gravel till; cobbles and/or boulders were observed or inferred in the till deposit in many of the boreholes advanced as part of this investigation. The till deposit is underlain by shale bedrock. A more detailed description of the soil deposits and bedrock encountered in the boreholes is provided in the following sections.

4.3 SWM Pond 1 (Station 5+240 to 5+320, 60 m Rt of Highway 410 CL)

4.3.1 Topsoil

Approximately 50 to 80 mm of topsoil was encountered immediately below the existing ground surface in Boreholes P1-1 and P1-2.

4.3.2 Surficial Clayey Silt

A surficial deposit of clayey silt, containing some sand, was encountered at Elevation 180.2 m, immediately below the ground surface in Borehole P1-3. The deposit is approximately 0.7 m thick at this location, with the base of the deposit encountered at approximately Elevation 179.5 m.

One Standard Penetration Test (SPT) "N" value of 17 blows per 0.3 m of penetration was measured within this deposit, suggesting a very stiff consistency.

4.3.3 Clayey Silt Till

A deposit of clayey silt till was encountered below the topsoil or surficial clayey silt in Boreholes P1-1 to P1-3. The surface of the till deposit was encountered between approximately Elevation 179.4 m and 179.7 m. The clayey silt till deposit varies in thickness from about 5.4 m to 6.0 m, with the base of the deposit encountered between approximately Elevation 173.4 m and 174.1 m.

This glacial till deposit consists of clayey silt with sand containing trace to some gravel. The presence of cobbles and boulders within this till deposit was inferred in all boreholes, as noted on the borehole records, based on observations of cobbles, auger grinding and difficult drilling conditions. The results of grain size distribution tests completed on six selected sampled of the clayey silt till are shown on Figure B1 in Appendix B.

Atterberg limits testing was conducted on six selected samples of the clayey silt till and measured plastic limits ranging from 14 to 18 per cent, liquid limits ranging from 19 to 26 per cent, and plasticity indices ranging from 5 to 9 per cent. These test results, which are plotted on a plasticity chart on Figure B2 in Appendix B, confirm that the deposit consists of clayey silt of low plasticity.

The measured SPT "N" values within this deposit range from 16 to 53 blows per 0.3 m of penetration, suggesting a very stiff to hard consistency. Higher SPT "N" values of 106 blows per 0.3 m of penetration, and 80 blows and 114 blows per 0.2 m of penetration, were measured within the deposit and these are considered to be representative of the presence of cobbles and/or boulders within the till deposit.

4.3.4 Shale Bedrock

Shale bedrock was encountered underlying the till deposit in all boreholes advanced at the proposed SWM Pond 1 site, with the bedrock surface between approximately Elevation 173.4 m and 174.1 m. The shale at this site is a member of the Georgian Bay Formation, which is typically weak to medium strong and which is known to contain stronger interlayers of limestone.

The shale bedrock was penetrated for approximately 0.9 m to 1.8 m by augering and split-spoon sampling before auger refusal was reached. Based on the ability to penetrate the shale, this upper portion of the bedrock is considered to be weathered.

4.4 SWM Pond 2 (Station 6+875 to 6+970, 60 m Rt of Highway 410 CL)

4.4.1 Topsoil

Approximately 150 mm to 200 mm of topsoil was encountered immediately below the existing ground surface in all boreholes (Boreholes P2-1 to P2-3) advanced at this site.

4.4.2 Surficial Clayey Silt

A surficial deposit of clayey silt (containing some sand as well as organic matter and rootlets) was encountered immediately below the topsoil in Boreholes P2-1 to P2-3. The surface of this surficial clayey silt deposit was encountered between approximately Elevation 183.8 m and 184.4 m. The clayey silt deposit varies in thickness from about 0.5 m to 1.1 m, with the base of the deposit encountered between approximately Elevation 182.7 m and 183.5 m.

The measured SPT "N" values within the surficial clayey silt deposit range from 8 to 19 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency.

4.4.3 Surficial Silty Sand

An approximately 0.4 m thick surficial layer of silty sand was encountered below the surficial clayey silt in Borehole P2-2, at a depth of about 1.1 m (approximately Elevation 183.5 m). The deposit consists of silty sand containing trace clay as well as clayey silt seams.

One SPT "N" value of 13 blows per 0.3 m of penetration was measured in this layer, indicating a compact relative density.

4.4.4 Sand and Silt Till

A deposit of sand and silt till was encountered below the surficial clayey silt and silty sand deposits in Boreholes P2-1 to P2-3, with the deposit surface between about Elevation 182.7 m and 183.3 m. The boreholes were terminated within this deposit after penetrating it for thicknesses of approximately 7.7 m to 9.1 m

This till deposit consists of sand and silt containing trace to some gravel and trace to some clay. Seams of silty sand were observed within the deposit in Borehole P2-2, and an approximately 0.3 m thick interlayer of silt was encountered within the deposit in Borehole P2-3 (at approximately Elevation 180.6 m). A layer of sand and gravel containing shale fragments was encountered at the base of Borehole P2-1 (at approximately Elevation 174.4 m). The presence of cobbles and boulders within the till deposit was inferred in all boreholes, as noted on the borehole records, based on observations of cobbles, auger grinding and difficult drilling conditions. The results of grain size distribution tests completed on eight selected samples of the sand and silt till are shown on Figures B3-1 and B3-2 in Appendix B.

Atterberg limits testing was conducted on six selected samples of the sand and silt till and measured plastic limits ranging from 10 to 14 per cent, liquid limits ranging from 11 to 15 per cent, and plasticity indices ranging

from 1 to 2 per cent. These test results, which are plotted on a plasticity chart on Figure B4 in Appendix B, confirm that the deposit consists of non-plastic to slightly plastic sand and silt.

The measured SPT "N" values within this deposit range from 16 to 93 blows per 0.3 m of penetration, indicating a compact to very dense relative density. Higher SPT "N" values, equivalent to over 100 blows per 0.3 m of penetration, were measured within the deposit and these are considered to be representative of the presence of cobbles and/or boulders within the till deposit.

4.5 SWM Pond 3 (Station 8+025 to 8+150, 60 m Rt of Highway 410 CL)

4.5.1 Topsoil

Approximately 150 mm to 200 mm of topsoil was encountered immediately below the existing ground surface in all boreholes (Boreholes P3-1 to P3-3) advanced at this site.

4.5.2 Fill

Fill, associated with the existing Highway 410 northbound and Highway 407 ramp embankments, was encountered below the topsoil in Boreholes P3-1 to P3-3 advanced at the proposed SWM Pond 3 site. The thickness of the fill ranged from about 1.2 m to 2.0 m, with the base of the fill layer encountered between approximately Elevation 184.1 m and Elevation 186.0 m.

Both cohesive and cohesionless fill soils were encountered in the boreholes. The cohesive portion of the fill consists of clayey silt with sand to some sand, containing trace gravel as well as organic matter and rootlets. The cohesionless portion of the fill consists of silty sand containing some gravel and trace clay, as well as organic material and rootlets. The results of grain size distribution tests completed on two selected samples of the cohesive portion of the fill are shown on Figure B5 in Appendix B.

Atterberg limits testing was conducted on two selected samples of the cohesive portion of the fill and measured plastic limits of 16 and 18 per cent, liquid limits of 24 and 28 per cent, and plasticity indices of 8 and 10 per cent. These test results, which are plotted on a plasticity chart on Figure B6 in Appendix B, confirm that the cohesive fill consists of clayey silt of low plasticity.

The measured SPT "N" values within the cohesive portions of the fill range from 6 to 12 blows per 0.3 m of penetration, suggesting a firm to stiff consistency, while the SPT "N" values measured in the cohesionless portions of the fill range from 8 to 12 blows per 0.3 m of penetration, indicating a loose to compact relative density. One higher SPT "N" value of 64 blows per 0.3 m of penetration was measured in the cohesive fill in Borehole P3-1, but this is considered to represent the presence of gravel within the fill layer.

4.5.3 Surficial Clayey Silt

An approximately 0.3 m thick surficial layer of clayey silt (containing some sand and trace gravel, as well as organic matter and rootlets) was encountered below the fill in Borehole P3-3. The surface of this layer is at approximately Elevation 186.0 m, and its base is at approximately Elevation 185.7 m.

One SPT "N" value of 6 blows per 0.3 m of penetration was measured within this layer, suggesting a firm consistency.

4.5.4 Clayey Silt Till

A deposit of clayey silt till was encountered below the fill in Boreholes P3-1 and P3-2, and below the surficial clayey silt layer in Borehole P3-3 at the SWM Pond 3 site, with the till surface between approximately Elevation 184.1 m and 186.1 m. The clayey silt till deposit varies in thickness from about 3.7 m to 6.3 m as encountered in these boreholes, with the base of the deposit between approximately Elevation 177.8 m and 182.0 m.

This glacial till deposit consists of clayey silt with sand, containing trace to some gravel. The presence of cobbles and boulders within the till deposit was inferred, as noted on the borehole records, based on observations of cobbles, auger grinding and difficult drilling conditions. The results of grain size distribution tests completed on three selected samples of the clayey silt till are shown on Figure B7 in Appendix B.

Atterberg limits testing was conducted on three selected samples of the clayey silt till and measured plastic limits of 15 to 17 per cent, liquid limits of 25 to 27 per cent, and plasticity indices of 8 to 12 per cent. These test results, which are plotted on a plasticity chart on Figure B8 in Appendix B, confirm that the till deposit consists of clayey silt of low plasticity.

The measured SPT "N" values within this deposit range from 17 blows to 108 blows per 0.3 m of penetration, suggesting a very stiff to hard consistency. Higher SPT "N" values of up to 60 blows per 0.1 m of penetration were measured and these are considered to be representative of the presence of cobbles and/or boulders within the till deposit.

4.5.5 Sand and Silt Till

A deposit of sand and silt till was encountered below the clayey silt till in Boreholes P3-1 to P3-3, with the deposit surface between approximately Elevation 177.8 m and 182.0 m. Borehole P3-1 was terminated in this deposit after penetrating it for a thickness of 1.0 m; the deposit is approximately 1.5 m to 1.8 m thick as encountered in Boreholes P3-2 and P3-3, respectively.

This till deposit consists of sand and silt containing trace to some gravel and trace to some clay. The presence of cobbles and boulders was inferred in Borehole P3-3 based on observations of cobbles, auger grinding and difficult drilling conditions. The results of grain size distribution tests completed on three selected samples of the sand and silt till are shown on Figure B9 in Appendix B.

Atterberg limits testing was conducted on one selected sample of the sand and silt till and measured a plastic limit of 11 per cent, a liquid limit of 12 per cent, and a plasticity index of 1 per cent. This test result, which is plotted on a plasticity chart on Figure B10 in Appendix B, confirms that the deposit consists of non-plastic to slightly plastic sand and silt.

The measured SPT "N" values within this deposit range from 109 blows per 0.23 m of penetration to 132 blows per 0.2 m of penetration, suggesting a very dense relative density.

4.5.6 Shale Bedrock

Shale bedrock was encountered in Borehole P3-2 underlying the sand and silt till, at approximately Elevation 179.0 m. The bedrock surface was also inferred below the sand and silt till in Borehole P3-3, based on auger refusal at approximately Elevation 180.2 m. The shale at this site is a member of the Georgian Bay Formation, which is typically weak to medium strong and which is known to contain stronger interlayers of limestone.

The shale bedrock was penetrated for approximately 1.0 m in Borehole P3-2 by augering and split-spoon sampling; based on the ability to penetrate the shale, the upper portion of the bedrock as encountered in this borehole is considered to be weathered.

4.6 SWM Pond 4 (Station 9+380 to 9+480, 100 m Lt of Highway 410 CL)

4.6.1 Clayey Silt to Silty Clay

A 0.1 m to 0.5 m thick layer of clayey silt to silty clay was encountered immediately below the ground surface in Boreholes P4-1 to P4-3 at the SWM Pond 4 site. The base of the deposit was encountered between approximately Elevation 191.5 m and 191.8 m in these boreholes.

The deposit consists of clayey silt to silty clay containing some sand and trace to some gravel. The results of grain size distribution tests completed on two selected sample of the deposit are shown on Figure B11 in Appendix B.

Atterberg limits testing was conducted on three selected samples of the deposit and measured plastic limits of 21 to 23 per cent, liquid limits of about 35 to 38 per cent, and plasticity indices of 14 to 16 per cent. These test results, which are plotted on a plasticity chart on Figure B12 in Appendix B, confirm that the deposit consists of clayey silt to silty clay of low to intermediate plasticity.

The measured SPT “N” values within this deposit range from 12 to 19 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency.

4.6.2 Shale Bedrock

Shale bedrock was encountered below the surficial silty clay layer in all boreholes (Boreholes P4-1 to P4-3) advanced at the SWM Pond 4 site, with the bedrock surface encountered between approximately Elevation 191.5 m and 191.8 m. The weathered upper 1.0 m to 3.0 m of the bedrock was penetrated by augering and split-spoon sampling in all boreholes, and the bedrock was cored for 7.9 m using NQ-sized coring equipment in Borehole P4-2.

The recovered bedrock core consists of slightly weathered to fresh, laminated, grey, weak to medium strong shale of the Georgian Bay Formation, which contains interbeds of strong fossiliferous limestone. The Rock Quality Designation (RQD) values measured on the core samples are between about 0 and 90 per cent, but are generally over about 69 per cent, indicating a rock mass of fair to good quality. The Total Core Recovery (TCR) ranged from approximately 93 to 100 per cent and the Solid Core Recovery (SCR) ranged from approximately 49 to 91 per cent, but was generally greater than 75 per cent.

4.7 SWM Pond 5 (Station 9+875 to 10+000, 60 m Rt of Highway 410 CL)

4.7.1 Topsoil

Approximately 75 mm to 100 mm of topsoil was encountered immediately below the existing ground surface in Boreholes P5-1 to P5-3 advanced at the site of SWM Pond 5.

4.7.2 Clayey Silt Till

A deposit of clayey silt till was encountered below the topsoil in Boreholes P5-1 to P5-3. The clayey silt till deposit varies in thickness from about 4.2 m to 6.5 m, with the base of the deposit encountered at approximately Elevation 187.4 m in Borehole P5-1. Boreholes P5-2 and P5-3 were terminated upon auger refusal after penetrating to depths of approximately 6.6 m and 6.7 m (Elevation 185.2 m and 183.9 m, respectively). In Boreholes P5-2 and P5-3, the clayey silt till is interlayered with a cohesionless till deposit that is described further in Section 4.7.3.

This cohesive glacial till deposit consists of clayey silt with sand to some sand, containing trace to some gravel. The presence of cobbles and boulders was inferred within this till deposit in all three boreholes based on observations of cobbles, auger grinding and difficult drilling conditions. The results of grain size distribution tests completed on three selected samples of the clayey silt till from this site are shown on Figure B13 in Appendix B.

Atterberg limits testing was conducted on three selected samples of the clayey silt till and measured plastic limits of 14 to 17 per cent, liquid limits of 20 to 25 per cent, and plasticity indices of 6 to 8 per cent. These test results, which are plotted on a plasticity chart on Figure B14 in Appendix B, confirm that the cohesive portion of the till deposit consists of clayey silt of low plasticity.

The measured SPT “N” values within this deposit generally range from 34 blows to 105 blows per 0.3 m of penetration, indicating that the deposit typically has a hard consistency. Two SPT “N” values of 12 and 14 blows were measured immediately below the ground surface in Boreholes P5-2 and P5-3, suggesting that the upper portion of the till at this location has a stiff consistency. Higher SPT “N” values of up to 60 blows per 0.05 m of penetration were also measured in this deposit, and these are considered to be representative of the presence of cobbles and/or boulders within the till deposit.

4.7.3 Gravelly Sand and Silt to Silty Sand and Gravel Till

A deposit or interlayer of cohesionless till was encountered below the clayey silt till in Borehole P5-1, and interlayered within the clayey silt till in Boreholes P5-2 and P5-3. The surface of the cohesionless till deposit/interlayers was encountered between approximately Elevation 186.9 m and 187.8 m. The cohesionless till deposit/interlayers vary in thickness from about 0.5 m to 2.7 m, with the base of the deposit/interlayers encountered between approximately Elevation 184.7 m and 187.3.

The cohesionless till consists of gravelly sand and silt containing trace to some clay, to silty sand and gravel containing trace clay. The presence of cobbles and boulders within the till deposit/interlayers was inferred based on observation of cobbles, auger grinding and difficult drilling. The results of grain size distribution tests completed on three selected samples of the gravelly sand and silt to silty sand and gravel till are shown on Figure B15 in Appendix B.

Atterberg limits testing was conducted on one selected sample of the gravelly sand and silt till and measured a plastic limit of 12 per cent, a liquid limit of 14 per cent, and a plasticity index of 2 per cent. This test result, which is plotted on a plasticity chart on Figure B16 in Appendix B, confirms that this till deposit/interlayer is non-plastic to slightly plastic.

The measured SPT "N" values within the cohesionless till deposit/interlayer range from 45 to 85 blows per 0.3 m of penetration, indicating a dense to very dense relative density. Higher SPT "N" values of up to 60 blows per 0.10 m of penetration were also measured within the deposit, and these are considered to be representative of the presence of cobbles and/or boulders within the till deposit.

4.8 SWM Pond 6 (Station 10+900 to 10+980, 60 m Rt of Highway 410 CL)

4.8.1 Fill

Fill associated with the existing Highway 410 and Steeles Avenue ramp embankments was encountered immediately below the existing ground surface in all three boreholes (Boreholes P6-1 to P6-3) advanced at the proposed SWM Pond 6 site. The thickness of the fill ranged from about 3.0 m to 3.7 m, with the base of the fill layer encountered between Elevation 193.8 m and Elevation 196.2 m.

The fill contains both cohesive and cohesionless soils. The cohesive portion of the fill consists of clayey silt to silty clay with sand to trace sand, containing trace to some gravel. The cohesionless portion of the fill consists of silty sand to sand containing trace to some gravel and trace clay. The results of grain size distribution tests completed on three selected samples of the cohesive portion of the fill are shown on Figure B17 in Appendix B.

Atterberg limits testing was conducted on three selected samples of the cohesive portion of the fill and measured plastic limits of 16 to 22 per cent, liquid limits of 25 to 37 per cent, and plasticity indices of about 9 to 15 per cent. These test results, which are plotted on a plasticity chart on Figure B18 in Appendix B, confirm that the cohesive portion of the fill consists of clayey silt of low plasticity to silty clay of intermediate plasticity.

The measured SPT "N" values within the cohesive portions of the fill range from 6 to 24 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency. SPT "N" values of 13 blows and 14 blows per 0.3 m of penetration were measured within the cohesionless fill, indicating a compact relative density.

4.8.2 Clayey Silt Till

A deposit of clayey silt till was encountered below the fill in Borehole P6-1 to P6-3 advanced at the proposed SWM Pond 6 site. The surface of the till deposit was encountered between approximately Elevation 193.8 m and 196.2 m. All three boreholes were terminated within this deposit after penetrating it for thicknesses of 7.1 m to 7.8 m; Borehole P6-2 was terminated on auger refusal at approximately Elevation 189.1 m.

This till deposit consists of clayey silt with sand to some sand, containing trace to some gravel. The presence of cobbles and boulders was inferred within the till deposit in all three boreholes based on observations of cobbles, auger grinding and difficult drilling conditions. The results of grain size distribution tests completed on six selected samples of the clayey silt till are shown on Figure B19 in Appendix B.

Atterberg limits testing was conducted on six selected samples of the clayey silt till and measured plastic limits of 13 to 16 per cent, liquid limits of 17 to 26 per cent, and plasticity indices of 4 to 10 per cent. These test results, which are plotted on a plasticity chart on Figure B20 in Appendix B, confirm that the deposit consists of clayey silt of low plasticity.

The measured SPT "N" values within this deposit range from 23 to 91 blows per 0.3 m of penetration, suggesting a very stiff to hard consistency. Higher SPT "N" values of up to 100 blows per 0.13 m of penetration were also measured in this deposit, and these are considered to be representative of the presence of cobbles and/or boulders within the till deposit.

4.9 Groundwater Conditions

The water levels were observed in the open boreholes immediately following completion of drilling, and these observations are recorded on the borehole records contained in Appendix A; however, these measured levels are not considered to be representative of the stabilized groundwater levels at the SWM pond sites.

A standpipe piezometer was installed in one borehole at each of the proposed SWM pond sites, and the water levels measured in the piezometers on September 24, 2012 (approximately three to four weeks after installation) are shown on the borehole records in Appendix A and summarized as follows:

SWM Pond	Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date
SWM Pond 1	P1-2	179.8	1.5	178.3	Sep. 24, 2012
SWM Pond 2	P2-2	184.6	2.4	182.2	Sep. 24, 2012
SWM Pond 3	P3-2	187.5	1.0	186.5	Sep. 24, 2012
SWM Pond 4	P4-1	192.3	1.5	190.8	Sep. 24, 2012
SWM Pond 5	P5-3	190.6	2.1	188.5	Sep. 24, 2012
SWM Pond 6	P6-2	199.9	4.3	195.6	Sep. 24, 2012

The measurements summarized above are considered to represent the "stabilized" groundwater level at the SWM pond sites in late summer/fall conditions. However, the water level is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring and following periods of precipitation.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Matt Soderman, E.I.T., and reviewed by Ms. Lisa Coyne, P.Eng., a geotechnical engineer and Principal with Golder. Mr. Fin Heffernan, P.Eng., a Designated MTO Foundations Contact for Golder, conducted an independent review of this report.

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PART B

FOUNDATION DESIGN REPORT
STORMWATER MANAGEMENT (SWM) PONDS
HIGHWAY 410 WIDENING FROM SOUTH OF HIGHWAY 401 TO QUEEN STREET, REGIONAL MUNICIPALITY OF PEEL
G.W.P. 2144-07-00(h)

March 2013
Report No. 11-1111-0083-7

Golder Associates

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides geotechnical recommendations for the design of the six proposed stormwater management (SWM) ponds along Highway 410 between Highway 401 and Steeles Avenue, designated as SWM Pond 1 to SWM Pond 6. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the current subsurface investigation at the proposed SWM pond locations. The interpretation and recommendations contained in this report are intended to provide the designers with sufficient information to complete the detail design of the proposed SWM ponds.

Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions may be required in the Contract Documents. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

The following table summarizes the design pond base elevation and approximate maximum cut depth for each of the proposed SWM ponds.

SWM Pond	Design Pond Base Elevation (m)	Subsurface Conditions at Pond Base	Approximate Maximum Cut Depth (m)
SWM Pond 1	176.2	Clayey silt till, approximately 2 m to 3 m above shale bedrock interface	4.0
SWM Pond 2	180.0	Sand and silt to silty sand till	4.6
SWM Pond 3	182.8	Clayey silt till, approximately 2 m to 2.5 m above shale bedrock interface	4.7
SWM Pond 4	187.5	Shale bedrock	4.8
SWM Pond 5	189.0	Clayey silt till, above sand and silt till and approximately 4 m to 5 m above shale bedrock interface	2.8
SWM Pond 6	190.5	Clayey silt till, approximately 1.5 m to 3.8 m above shale bedrock	7.0 (Average) 9.4 (Maximum)

6.2 Pond Base Stability – Construction and Maintenance Conditions

The following groundwater levels have been considered in developing the design recommendations for the proposed SWM ponds, based on the water levels measured in the piezometers on September 24, 2012 and the potential for higher water levels in spring conditions:

SWM Pond	Pond Base Elevation (m)	Groundwater Elevation (m)	Groundwater Level Relative to Pond Base	Potential for Basal Instability
SWM Pond 1	176.2	178.5	2.3 m above	No
SWM Pond 2	180.0	182.5	2.5 m above	No
SWM Pond 3	182.8	187.0	4.2 m above	No
SWM Pond 4	187.5	191.0	3.5 m above	Yes
SWM Pond 5	189.0	189.0	At/near pond base	No
SWM Pond 6	190.5	196.0	5.5 m above	Yes

At the locations of SWM Ponds 1 to 4 and SWM Pond 6, the groundwater level is approximately 2.3 m to 5.5 m above the design pond base elevation. Relatively minor groundwater seepage is anticipated from the clayey silt till deposit, and slightly greater (though still relatively minor) seepage is anticipated from the sand and silt to silty sand till deposit. Greater seepage is anticipated from lenses or interlayers of water-bearing cohesionless (gravel to silt) soils within or perched on top of the till deposits, although such seepage is anticipated to be of relatively limited duration. More significant groundwater inflows are anticipated from discontinuities and fracture zones within the shale bedrock, as is anticipated at the location of SWM Pond 4.

As noted in the above table, due to a combination of the groundwater level and the subsurface conditions below the base of the proposed SWM ponds, there is potential for basal instability at SWM Ponds 4 and 6. At these locations, dewatering of the shale bedrock below the pond base will be necessary to mitigate the potential for base instability during construction, and further discussion is provided in Section 6.6. These wells should be operated throughout the pond excavation/construction period. The wells do not need to be maintained operational following completion of construction, during normal operating water conditions for the SWM ponds. However, it is anticipated that SWM Ponds 4 and 6 may need to be fully drained in the future for maintenance purposes. Therefore, it is recommended that the construction dewatering well system be maintained at SWM Ponds 4 and 6 following construction, so that the pumps can be activated in advance of future maintenance works, to mitigate against basal instability at these pond locations under fully drained pond conditions.

6.3 Permanent Pool Design and Pond Liner Considerations

If site grading and stormwater storage requirements permit, it is recommended that the permanent pool level (i.e., minimum operating water level in each SWM pond) be designed to be close to the groundwater level at each pond location, as given in Section 6.2, to minimize inflow/outflow of groundwater. However, it is understood that this will not be possible for the proposed SWM ponds on this project.

Where the operating water level in a pond is below the groundwater level, there will be some net groundwater inflow to the SWM pond, resulting in some drawdown of the groundwater table in the immediate vicinity of the pond; however, this drawdown will be localized and is not expected to impact the performance of adjacent green space, roadways or utilities. A pond liner (geosynthetic or compacted clay) is not recommended where the groundwater level is higher than the operating water level in the pond, as such liners can handle only small

differences between the groundwater level and the pond level without requiring pumping from a system of subdrains to lower the groundwater level.

A pond liner is also not required at where the operating pond level is higher than the groundwater level, such as at SWM Pond 5, as the pond bases will be formed in clayey silt till or sand and silt to silty sand till. These till deposits are relatively impermeable and are expected to limit surface water infiltration to allow the SWM Ponds to be maintained as "wet" ponds.

6.4 Global Stability of Pond Cut Slopes

The SWM pond perimeter slopes are proposed to be constructed in cut with a 3 horizontal to 1 vertical (3H:1V) orientation. Slope stability analyses have been performed using the commercially available program *SLIDE*, developed by Rocscience Inc., at critical sections for the pond locations to verify that the cut slopes have a global factor of safety under static conditions equal to or greater than 1.3. This minimum factor of safety is considered appropriate for the proposed SWM pond side slopes on this project, considering the design requirements and the available field and laboratory testing data.

The following parameters have been used in the static global stability analyses, based on field and laboratory test data as well as accepted correlations (CHBDC, 2006; Bowles, 1984; and Kulhawy and Mayne, 1990):

Soil Deposit	Bulk Unit Weight (kN/m^3)	Effective Friction Angle	Undrained Shear Strength (kPa)
Embankment fill	21	32-35°	-
Surficial clayey silt and silty sand layers	18	28°	50
Very stiff to hard clayey silt till	21	32-35°	-
Compact to very dense sand and silt to silty sand till	21	32-35°	-
Shale bedrock	23	40°	-

The piezometric conditions used in the stability analyses are based on a design groundwater level that has been assumed to be slightly higher than the "stabilized" groundwater levels measured on September 24, 2012 in the standpipe piezometer at each pond location, to account for potentially higher water levels in spring conditions. In the stability analyses, the groundwater level has been assumed to be depressed to the base of the pond for unwatered (dry) pond conditions.

The results of the static global stability analyses indicate that a factor of safety of 1.3 or greater is achieved for the global stability of permanent cut slopes oriented at 3H:1V at all SWM pond locations, both under operating conditions and drained conditions (assuming the ponds may be fully unwatered for maintenance purposes). The 3H:1V cut slope configuration is considered appropriate even at SWM Pond 4, where the pond will be excavated into shale bedrock, due to the potential for weathering of the shale bedrock over time. Examples of the global static stability analyses are included on Figures 1 to 4 for selected critical pond locations.

A maximum (steepest) cut slope orientation of 3H:1V is also recommended to promote surficial stability of the cut slopes under changes in the operating water level. Recommendations for protection and enhancement of the surficial stability of the pond side slopes are provided in Section 6.5 (Surficial Stability and Erosion Protection).

6.5 Surficial Stability and Erosion Protection

The requirements for design of erosion protection measures for the inlet and outlet storm sewer pipes should be assessed by the hydraulic design engineer. As a minimum, rip-rap treatment for the inlet and outlet of the storm sewer pipes should be consistent with the standard presented in OPSD 810.010 (Rip-Rap Treatment for Sewer and Culvert Outlets) Rip-Rap Treatment Type A, with the rip-rap placed to above the pipe obvert, in combination with cut-off headwalls if these are adopted. Rip-rap should be provided over the full extent of the side slopes and base grade below and adjacent to the sewer inlet / outlet locations.

The pond slopes above the operating water level should be vegetated as soon as practicable after construction to minimize the potential for erosion due to surface water run-off, either by placement of topsoil and seeding or pegged sod in accordance with OPSS 572 *(Seed and Cover).* Consideration could also be given to protecting the active water line zone (i.e., from the low water level to the high water level) with a minimum 150 mm thick layer of rip-rap meeting Classification R-10 according to OPSS 1004 *(Aggregates)*; however, this may not be necessary if appropriate vegetation can be established in this zone.

In addition, a granular drainage blanket may be required to control surficial sloughing of cut slopes through saturated cohesionless soil (sand to silt) zones or layers, where these are encountered within the till deposit or perched above the till deposit. Determination of the frequency, extent and exact locations of such seepage zones from the limited borehole data is not possible. Therefore, an observational approach is recommended involving examination of the cut slopes during and following construction to identify any areas of water-bearing cohesionless soils, with a granular drainage blanket placed on the pond cut slopes where lenses or layers or water-bearing cohesionless soils are observed to minimize surficial sloughing and/or erosion. This is discussed further in Section 6.6 (Construction Considerations).

6.6 Construction Considerations

6.6.1 Excavations for Pond Construction

The proposed SWM ponds will require excavation to maximum depths that typically range from about 2.8 m to 7.0 m below the present ground surface, although a maximum cut depth of approximately 9.4 m will be required near the central portion of SWM Pond 6. Permanent and temporary excavations for the ponds and any associated drainage structures, if required, will be made through topsoil, existing fill materials, surficial clayey silt or sand/silt deposits, and into clayey silt till to sand and silt till; cobbles and boulders were encountered or inferred at various depths within the till deposits in most of the boreholes. Conventional excavation equipment is expected to be suitable for construction of the ponds.

At SWM Pond 4, up to approximately 4.5 m of excavation into shale bedrock will be required. The shale bedrock is weak to medium strong, and contains interlayers of strong limestone. Hoe-ramming techniques are expected

to be required to penetrate into the bedrock to reach the design base elevation. It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn

If temporary excavations are required within or adjacent to the proposed SWM ponds for drainage structures (e.g. for drainage pipes, drainage structures or headwalls), the existing fill, surficial soils and water-bearing cohesionless soil layers are considered to be Type 3 soils and the till material is considered to be Type 2 soil according to the Occupational Health & Safety Act & Regulation (OHSA) for Construction Projects. As such, temporary open-cut excavations should be completed with side slopes no steeper than 1H:1V. All excavations must be carried out in accordance with the latest edition of the OHSA.

6.6.2 Groundwater Control During and Following Construction

As discussed in Section 6.2, at the locations of SWM Ponds 1 to 4 and SWM Pond 6, the groundwater level is approximately 2.3 m to 5.5 m above the design pond base elevation. Relatively minor groundwater seepage is anticipated from the relatively impermeable clayey silt till deposit, and slightly greater (though still relatively minor) seepage is anticipated from the sand and silt till deposit. Greater seepage is anticipated from lenses or interlayers of water-bearing cohesionless (gravel to silt) soils within or perched on top of the till deposit, although such seepage is anticipated to be of relatively limited duration. More significant groundwater inflows are anticipated from discontinuities and fracture zones within the shale bedrock at the location of SWM Pond 4.

It is recommended that the ponds be excavated and ditches or sub-drains/trenches installed to allow for gravity drainage in advance of reaching the final base grades and side slope orientations, to allow the groundwater to drain and thereby reduce the risk of surficial instability on the side slopes and/or disturbance/softening at the pond base. Consideration could be given to sequencing the excavation to allow construction of the drainage outlet pipes first to provide a passive drainage system for groundwater control during the pond excavation works.

In addition, due to the subsurface and groundwater conditions relative to the proposed pond geometry, there is potential for basal instability at SWM Ponds 4 and 6. At these locations, dewatering of the shale bedrock below the pond base will be necessary to mitigate the potential for base instability during construction. It is anticipated that such dewatering could consist of a set of gravity wells installed around the pond perimeter, and screened in the upper fractured/weathered portion of the bedrock or, in the case of SWM Pond 4, at an appropriate depth below the pond base. These wells should be operated throughout the pond excavation/construction period. It is recommended that a Permit to Take Water be obtained for SWM Ponds 4 and 6, as the dewatering volume is expected to approach or exceed 50,000 L/day at these locations, particularly during initial pumping or wet periods of the year.

Further, if SWM Ponds 4 and 6 are drained in the future for maintenance purposes, it is recommended that these construction dewatering well systems be maintained, so that the pumps can be activated in advance of future maintenance work to mitigate against basal instability at these locations under drained pond conditions.

The following table summarizes the anticipated groundwater control requirements for each of the proposed SWM ponds during initial construction, and in future periods where the pond is fully drained for maintenance purposes.

SWM Pond	Groundwater Control During Construction	Groundwater Control During Future Maintenance
SWM Pond 1	Excavation in clayey silt till – pumping from properly filtered sumps within excavation	Not required
SWM Pond 2	Excavation in sand and silt to silty sand till – pumping from properly filtered sumps within excavation	Not required
SWM Pond 3	Excavation in clayey silt till – pumping from properly filtered sumps within excavation	Not required
SWM Pond 4	Active dewatering of the bedrock below the pond base, plus pumping from properly filtered sumps within the pond excavation	Pumping from perimeter wells recommended to maintain basal stability and prevent softening of pond base
SWM Pond 5	Excavation in clayey silt till, with groundwater level near pond base – pumping from properly filtered sumps within the pond excavation	Not required
SWM Pond 6	Active dewatering of the bedrock below the pond base, plus pumping from properly filtered sumps within the pond excavation	Pumping from perimeter wells recommended to maintain basal stability and prevent softening of pond base

A Non-Standard Special Provision (NSSP), provided in Appendix C, should be included in the Contract Documents to address the groundwater control requirements during construction and the requirement to maintain the groundwater control system at SWM Ponds 4 and 6 following completion of construction. In addition, it is recommended that a Permit to Take Water be obtained for SWM Ponds 4 and 6, as the dewatering volume is expected to approach or exceed 50,000 L/day at these locations, particularly during initial pumping or wet periods of the year.

6.6.3 Granular Drainage Blankets on Pond Cut Slopes

A granular drainage blanket may be required to control surficial sloughing of cut slopes through saturated cohesionless soil (sand to silt) zones or layers, where these are encountered within the till deposit or perched above the till deposit. Determination of the frequency, extent and exact locations of such seepage zones from the limited borehole data obtained as part of this investigation is not possible. Therefore, an observational approach is recommended involving examination of the cut slopes during and following construction to identify any areas of water-bearing cohesionless soils, with a granular drainage blanket placed on the pond cut slopes where lenses or layers or water-bearing cohesionless soils are observed to minimize surficial sloughing and/or erosion.

7.0 CLOSURE

This Foundation Design Report was prepared by Mr. Matt Soderman, E.I.T., and reviewed by Ms. Lisa Coyne, P.Eng., a geotechnical engineer and Principal with Golder, with technical input provided by Mr. Frank Barone, P.Eng., a senior geotechnical and geo-environmental engineer with Golder. Mr. Fin Heffernan, P.Eng., a Designated MTO Foundations Contact for Golder, conducted an independent review of this report.

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Designated MTO Foundations Contact

MAS/LCC/FJH/sm

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Ontario Provincial Standard Specifications (OPSS)

OPSS 572 Construction Specification for Seed and Cover

OPSS 1004 Material Specification for Aggregates – Miscellaneous

OPSS 1010 Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material

Ontario Provincial Standard Drawings (OPSD)

OPSD 810.010 Rip-Rap Treatment for Sewer and Culvert Outlets

MINISTRY OF TRANSPORTATION, ONTARIO

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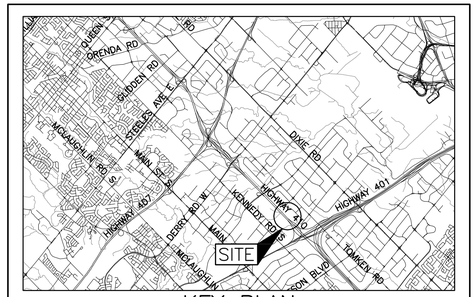
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2144-07-00

SHEET

STORMWATER POND #1
HIGHWAY 410 WIDENING
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



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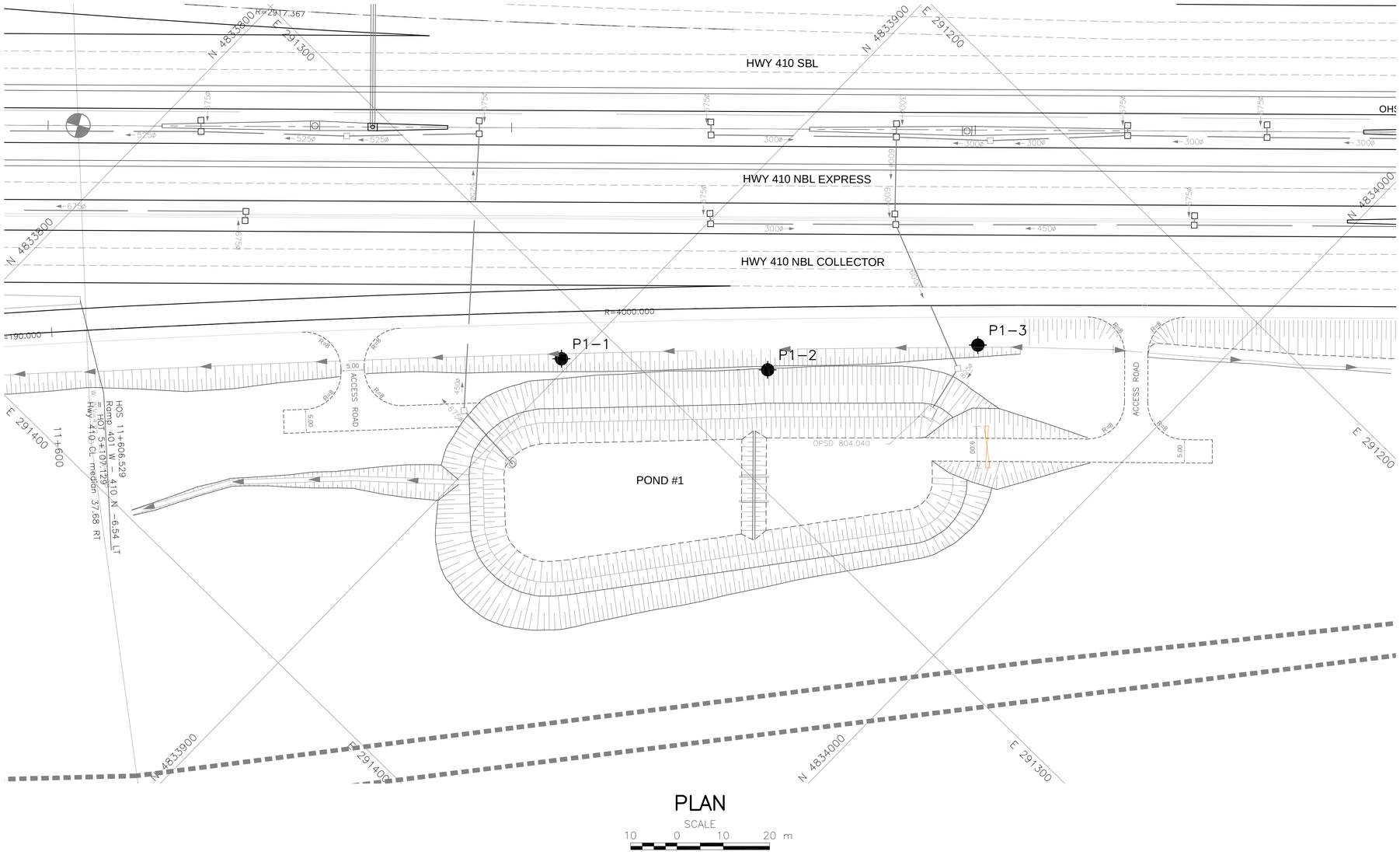


PLAN
SCALE
10 0 10 20 m

LEGEND

Borehole – Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
P1-1	179.5	4833897.9	291310.4
P1-2	179.8	4833931.4	291281.0
P1-3	180.2	4833960.1	291245.5

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by URS Canada Inc., (Drawing File "Hwy410_Utilities.dwg", received Sept. 19, 2012 and "2013 02 07 – Hwy410_Plan.dwg", received Feb. 07, 2013).

LICENSED PROFESSIONAL ENGINEER L.L.C. COYNE Mar. 18, 2013 PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER F. J. HEFFERNAN Mar. 18, 2013 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 30M12-360

HWY. 410	PROJECT NO. 11-1111-0083		DIST. CENTRAL
SUBM'D. MAS	CHKD. LCC	DATE: Feb.15, 2013	SITE:
DRAWN: JFC	CHKD. MAS	APPD. LCC	DWG. 1

PLOT DATE: March 18, 2013
FILENAME: I:\Projects\2011\1-1111-0083 (URS, Peel Region)\-JB- SW Ponds\11111100831B001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

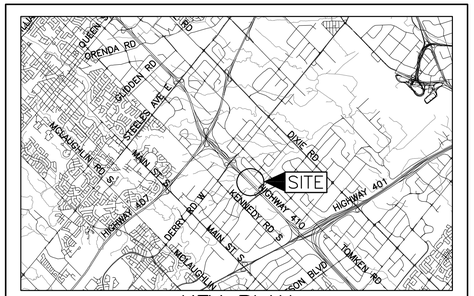
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2144-07-00

SHEET

STORMWATER POND #2
HIGHWAY 410 WIDENING
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
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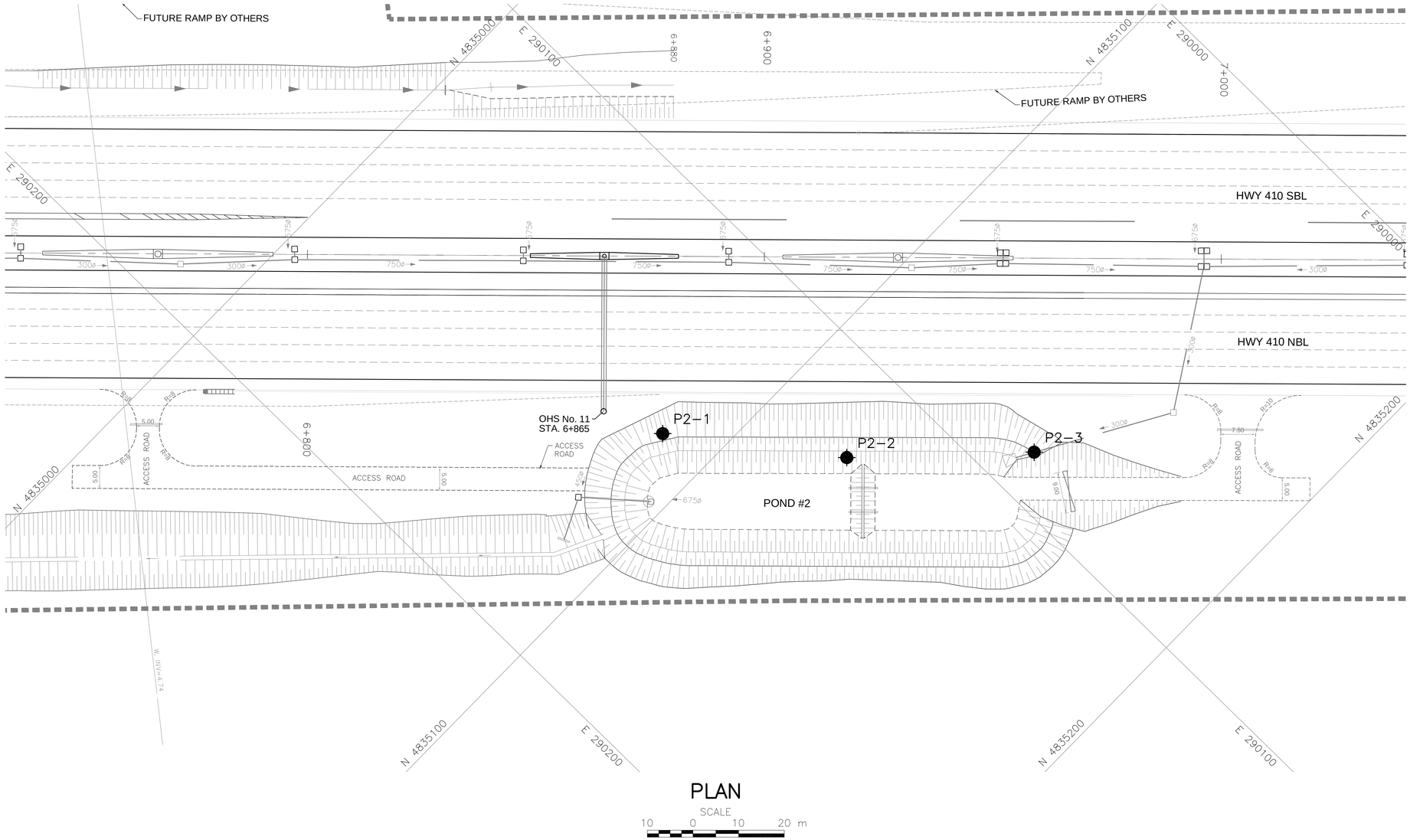

PLAN
SCALE
10 0 10 20 m

LEGEND

Borehole – Current Investigation

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
P2-1	184.0	4835088.4	290143.5
P2-2	184.6	4835120.9	290119.1
P2-3	184.0	4835149.4	290089.6

NOTES

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LICENSED PROFESSIONAL ENGINEER
L.C. COYNER
Mar. 18, 2013
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
F. J. HEFFERNAN
Mar. 18, 2013
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 30M12-360

HWY. 410	PROJECT NO. 11-1111-0083		DIST. CENTRAL
SUBM'D. MAS	CHKD. LCC	DATE: Feb.15, 2013	SITE:
DRAWN: JFC	CHKD. MAS	APPD. LCC	DWG. 2

PLOT DATE: March 18, 2013
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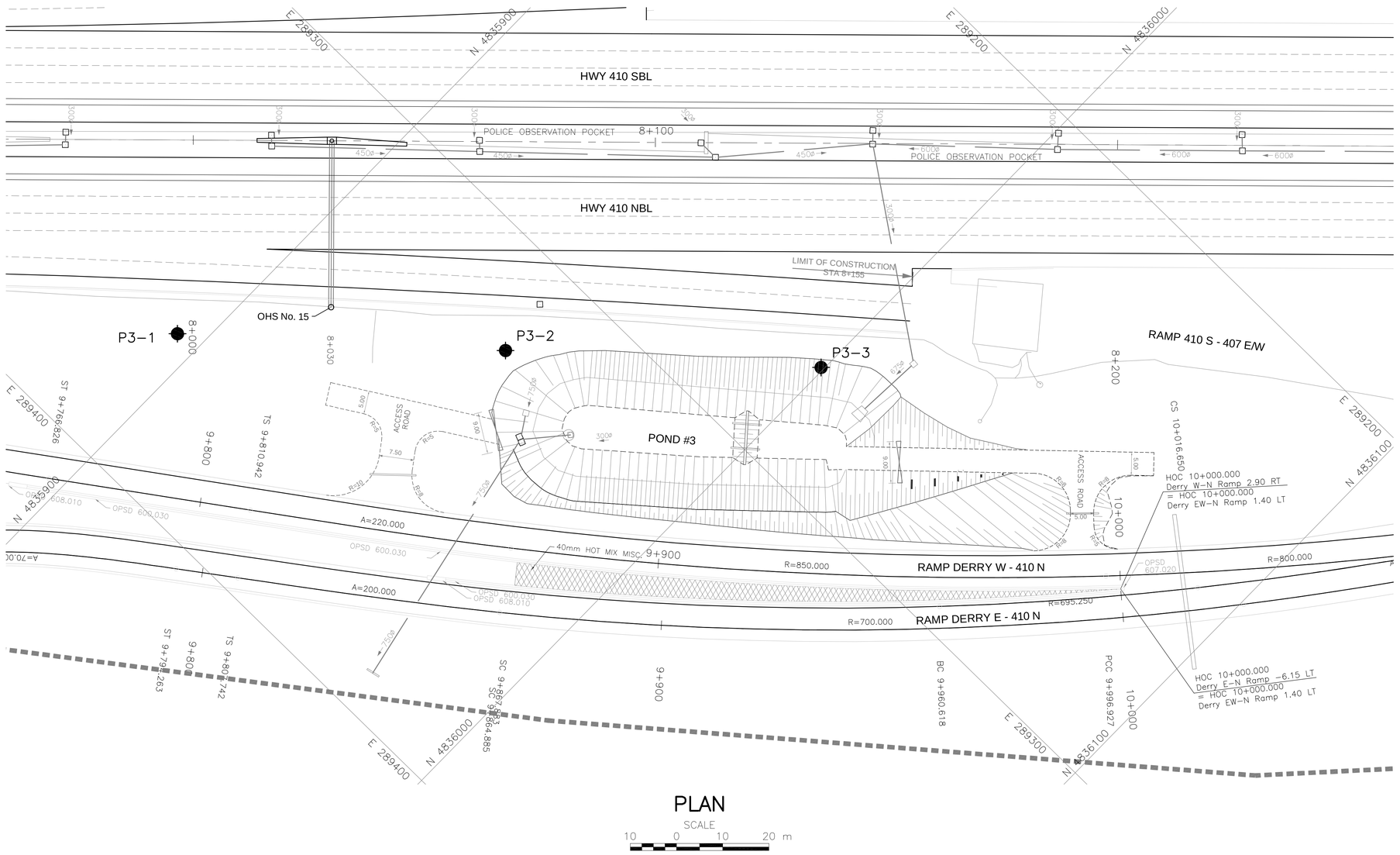
STATIONS IN KILOMETRES + METRES.



PLAN
SCALE
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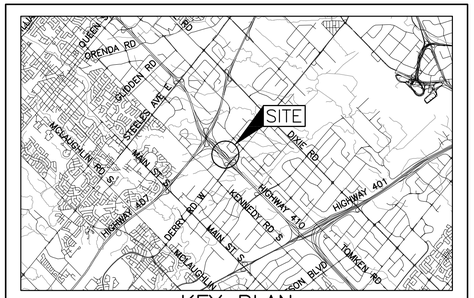
CONT No.
GWP No. 2144-07-00

SHEET

STORMWATER POND #3
HIGHWAY 410 WIDENING
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
2 0 2 4 km

LEGEND
Borehole – Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
P3-1	186.3	4835894.7	289367.8
P3-2	187.5	4835948.0	289320.8
P3-3	187.5	4835999.4	289275.7

NOTES
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Mar. 18, 2013
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
F. J. HEFFERNAN
Mar. 18, 2013
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 30M12-360

HWY. 410	PROJECT NO. 11-1111-0083		DIST. CENTRAL
SUBM'D. MAS	CHKD. LCC	DATE: Feb.15, 2013	SITE:
DRAWN: JFC	CHKD. MAS	APPD. LCC	DWG. 3

PLOT DATE: March 18, 2013
FILENAME: T:\Projects\2011\11-1111-0083 (URS, Peel Region)\--JB-- SW Ponds\11111110083JB003.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

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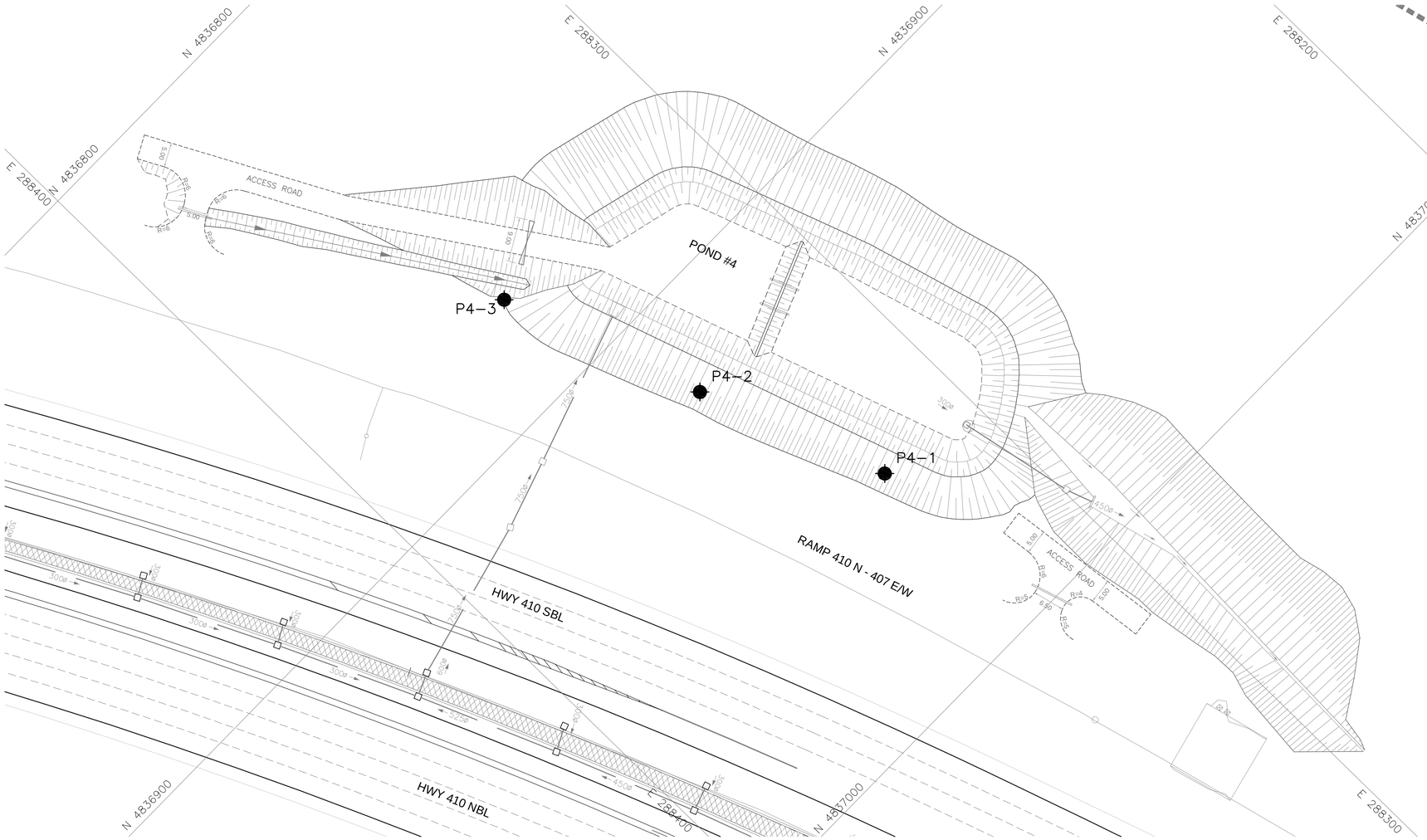
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2144-07-00

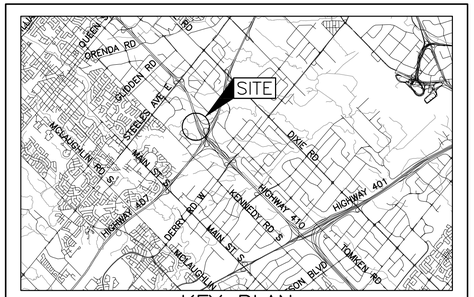
SHEET

STORMWATER POND #4
HIGHWAY 410 WIDENING
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



PLAN
SCALE
10 0 10 20 m



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

Borehole – Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
P4-1	192.3	4836957.9	288322.7
P4-2	192.1	4836919.7	288337.0
P4-3	191.6	4836878.4	288351.3

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by URS Canada Inc., (Drawing File "Hwy410_Utilities.dwg", received Sept. 19, 2012 and "2013 02 07 – Hwy410_Plan.dwg", received Feb. 07, 2013).

LICENSED PROFESSIONAL ENGINEER
L.L.C. COYNE
Mar. 18, 2013
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
C. J. HEFFERNAN
Mar. 18, 2013
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 30M12-360

HWY. 410	PROJECT NO. 11-1111-0083		DIST. CENTRAL
SUBM'D. MAS	CHKD. LCC	DATE: Feb.15, 2013	SITE:
DRAWN: JFC	CHKD. MAS	APPD. LCC	DWG. 4

PLOT DATE: March. 18, 2013
FILENAME: T:\Projects\2011\11-1111-0083 (URS, Peel Region)\-JB- SW Ponds\11111110083JB004.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

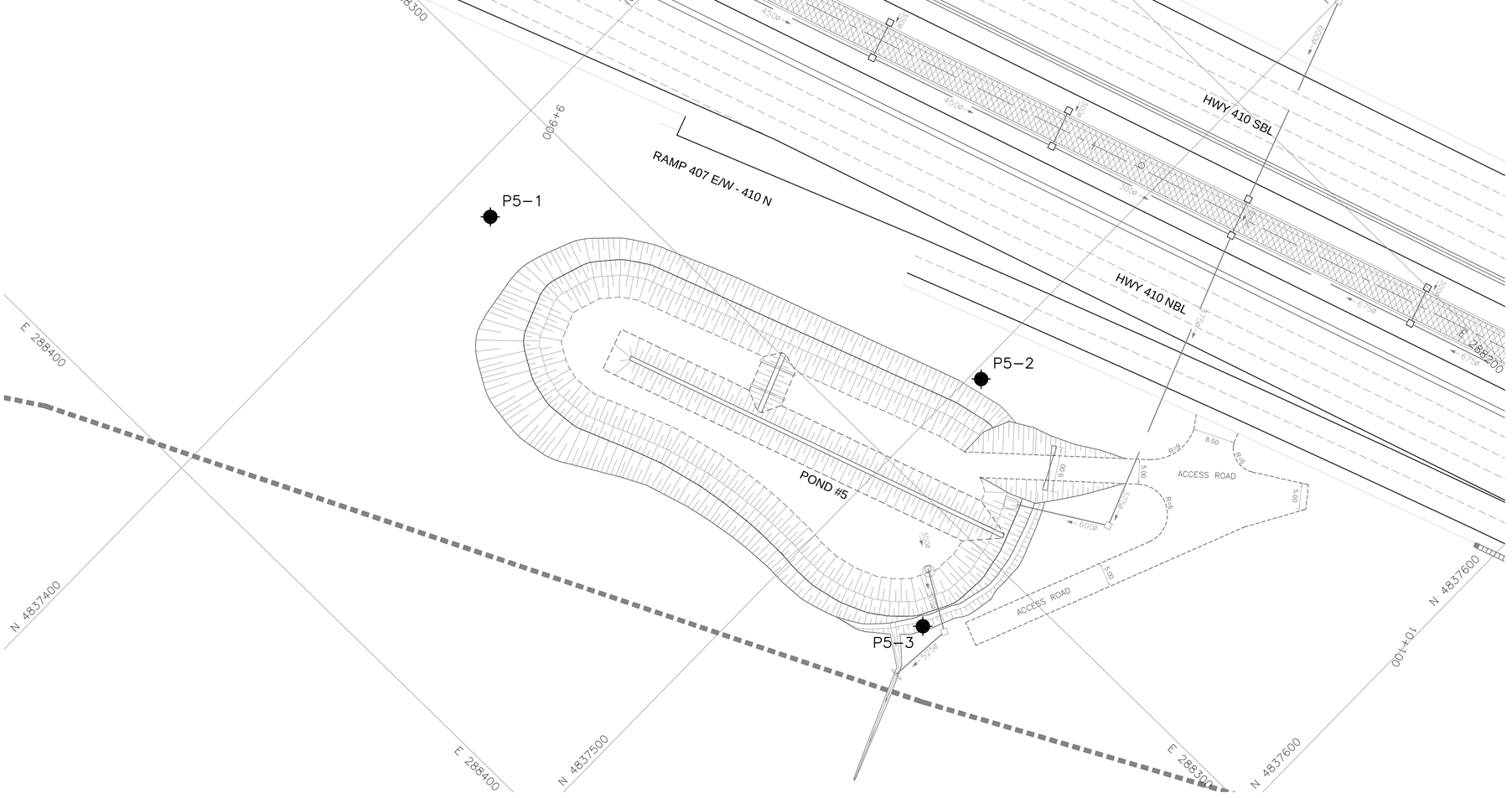
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2144-07-00

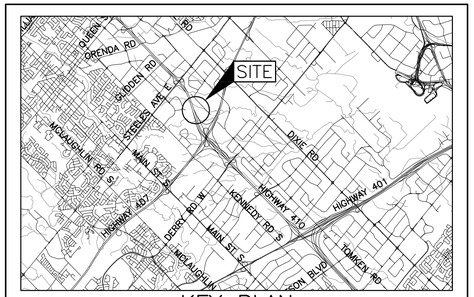
SHEET

STORMWATER POND #5
HIGHWAY 410 WIDENING
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



PLAN
SCALE
10 0 10 20 m



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

Borehole – Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
P5-1	191.7	4837409.1	288320.9
P5-2	191.8	4837502.0	288275.5
P5-3	190.6	4837528.2	288319.0

NOTES

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REFERENCE

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LICENSED PROFESSIONAL ENGINEER L.L.C. COYNE Mar. 18, 2013 PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER F. J. HEFFERNAN Mar. 18, 2013 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 30M12-360

HWY. 410	PROJECT NO. 11-1111-0083		DIST. CENTRAL
SUBM'D. MAS	CHKD. LCC	DATE: Feb.15, 2013	SITE:
DRAWN: JFC	CHKD. MAS	APPD. LCC	DWG. 5

PLOT DATE: March 18, 2013
FILENAME: I:\Projects\2011\11-1111-0083 (URS, Peel Region)\-JB- SW Ponds\11111100832B005.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

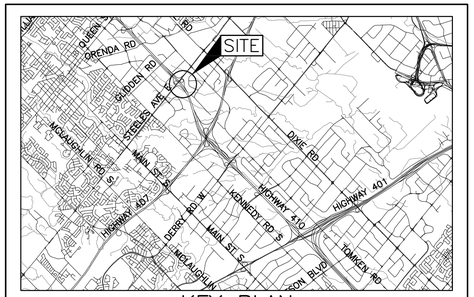
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2144-07-00

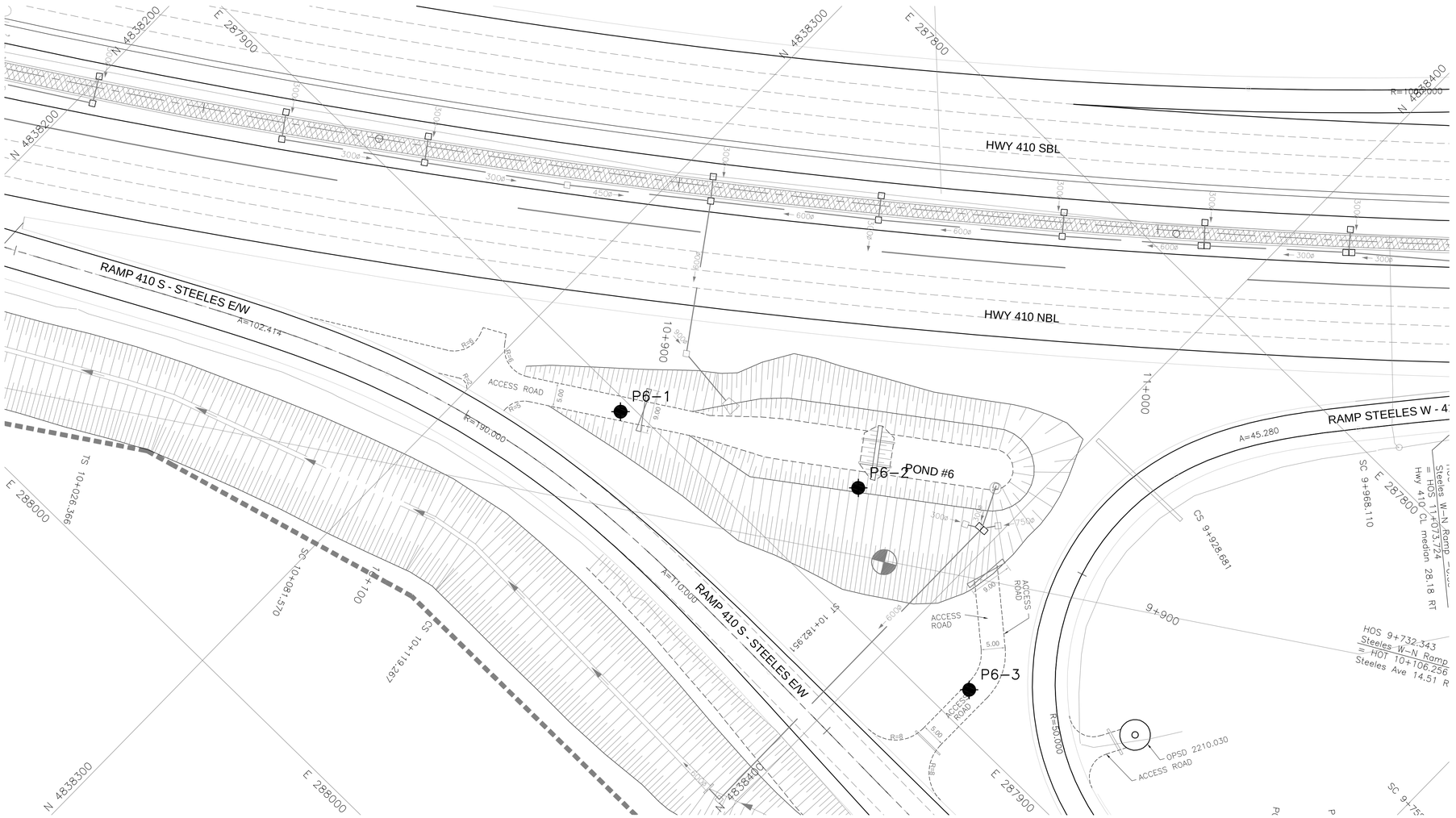
SHEET

STORMWATER POND #6
HIGHWAY 410 WIDENING
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
2 0 2 4 km



PLAN
SCALE
10 0 10 20 m

LEGEND

Borehole – Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
P6-1	197.7	4838326.0	287902.3
P6-2	199.9	4838372.4	287879.1
P6-3	197.5	4838418.2	287893.0

NOTES

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REFERENCE

Base plans provided in digital format by URS Canada Inc., (Drawing File "Hwy410_Utilities.dwg", received Sept. 19, 2012 and "2013 02 07 – Hwy410_Plan.dwg", received Feb. 07, 2013).

LICENSED PROFESSIONAL ENGINEER
L.C. COYNE
Mar. 18, 2013
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
F. J. HEFFERNAN
Mar. 18, 2013
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

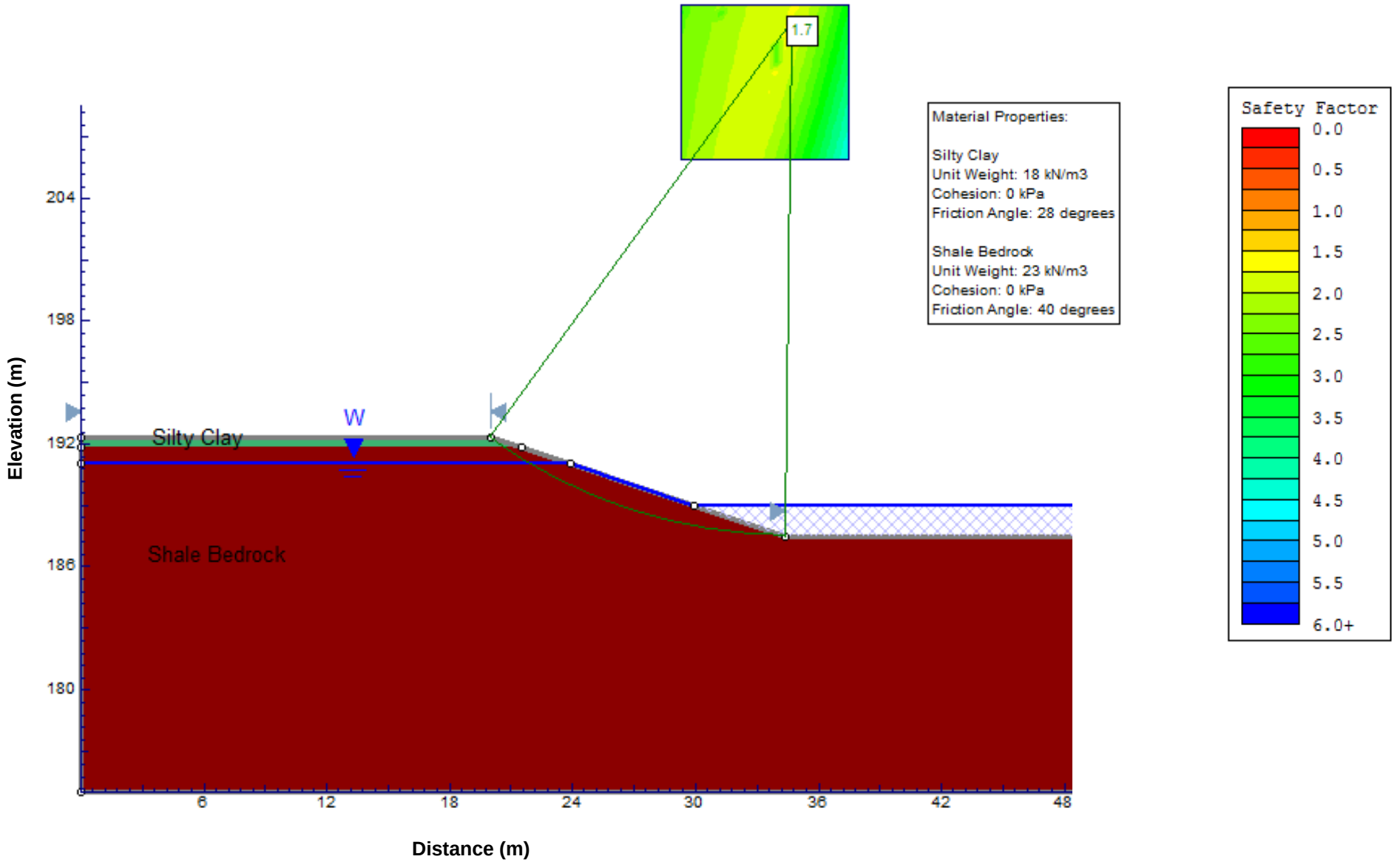
Geocres No. 30M12-360

HWY. 410	PROJECT NO. 11-1111-0083		DIST. CENTRAL
SUBM'D. MAS	CHKD. LCC	DATE: Feb.15, 2013	SITE:
DRAWN: JFC	CHKD. MAS	APPD. LCC	DWG. 6

PLOT DATE: March 18, 2013
FILENAME: T:\Projects\2011\11-1111-0083 (URS, Pearl Region)\~dB~ SW Ponds\11111110083dB006.dwg

Static Slope Stability Analysis
SWM Pond 4 – Operating Conditions

Figure 1



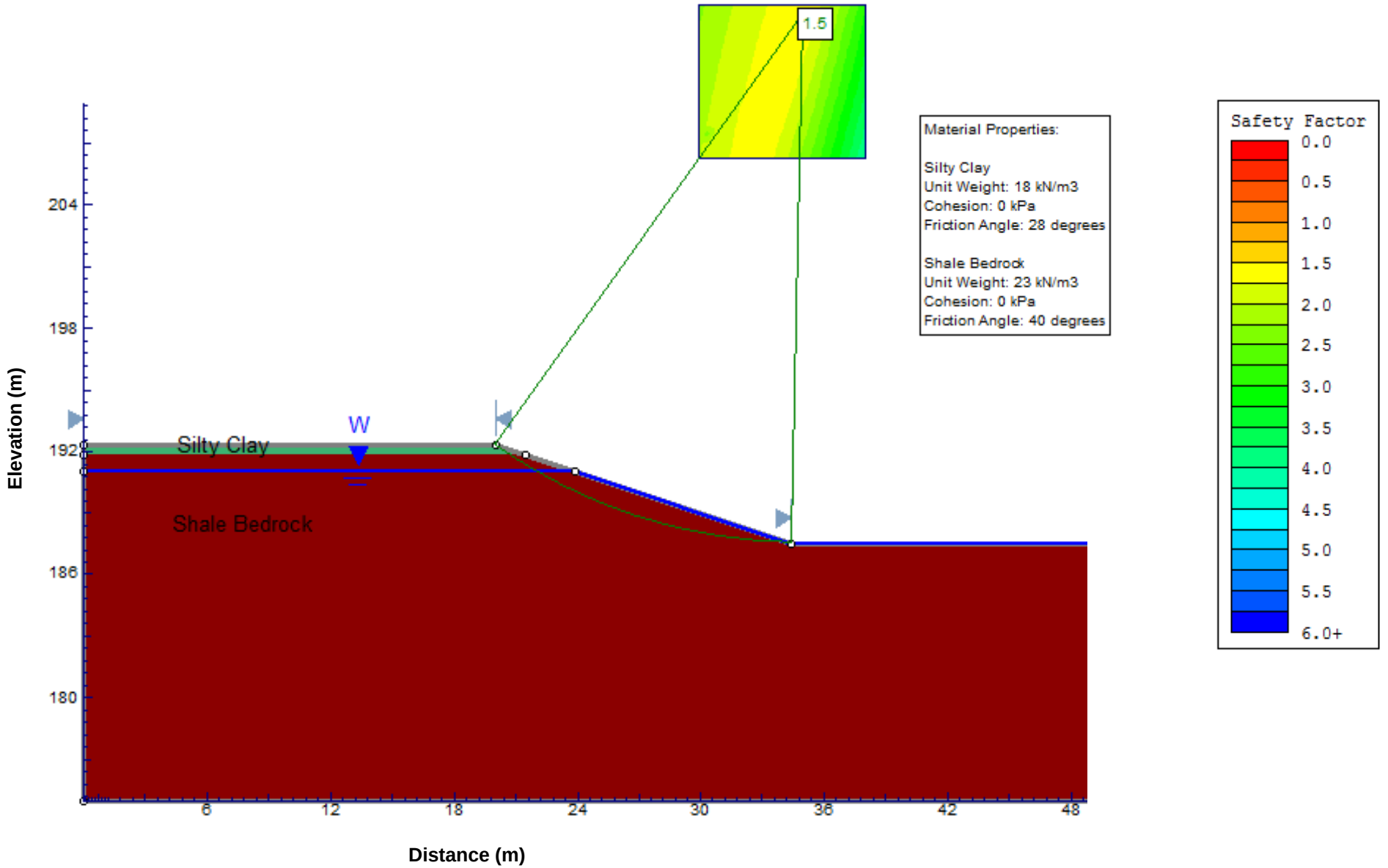
Date: February, 2013
Project No: 11-1111-0083

Analysis By: MAS **Reviewed By:** LCC

Golder Associates

Static Slope Stability Analysis
SWM Pond 4 – Dewatered Condition for Maintenance

Figure 2



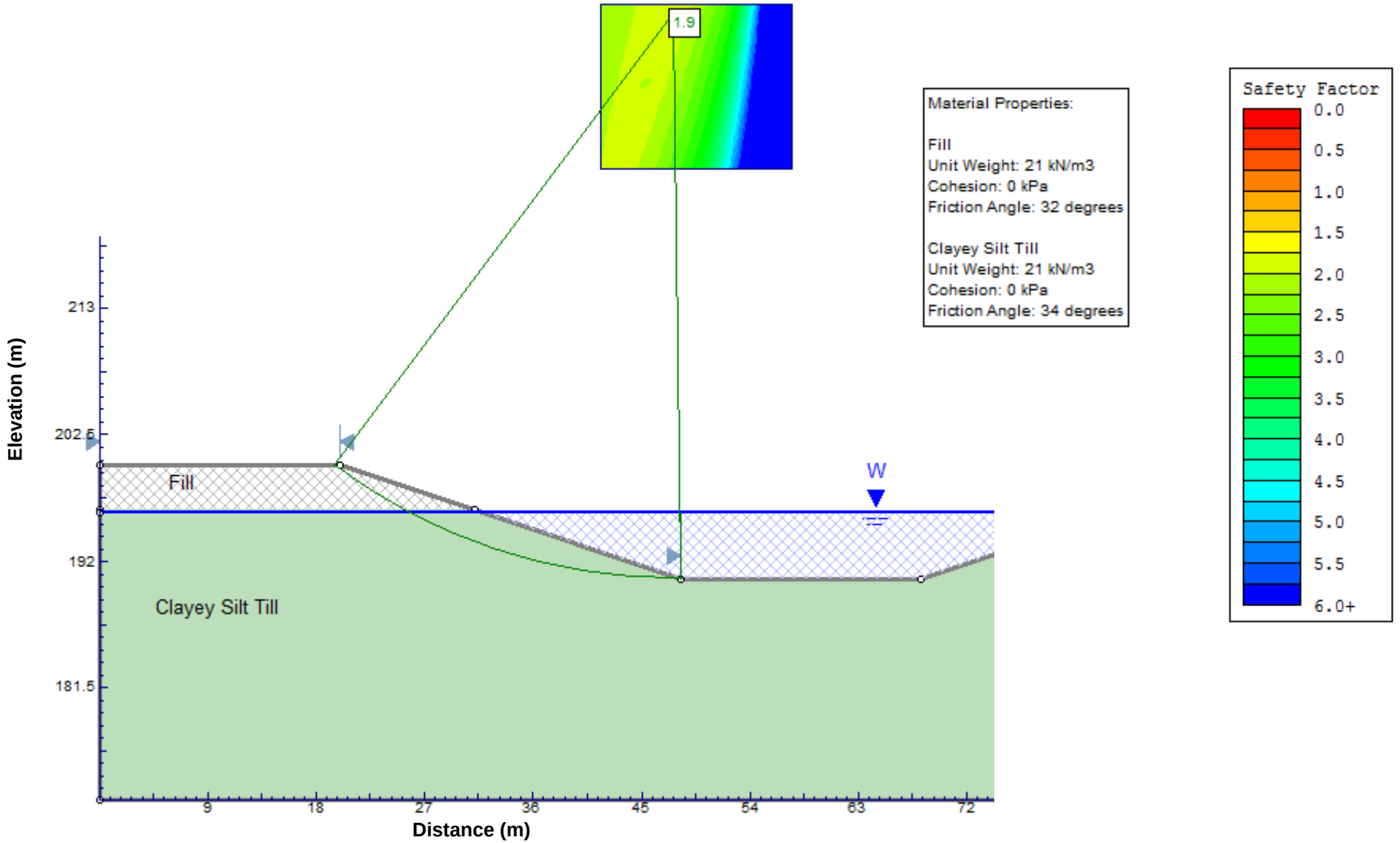
Date: February, 2013
Project No: 11-1111-0083

Analysis By: MAS **Reviewed By:** LCC

Golder Associates

Static Slope Stability Analysis
SWM Pond 6 – Operating Conditions

Figure 3



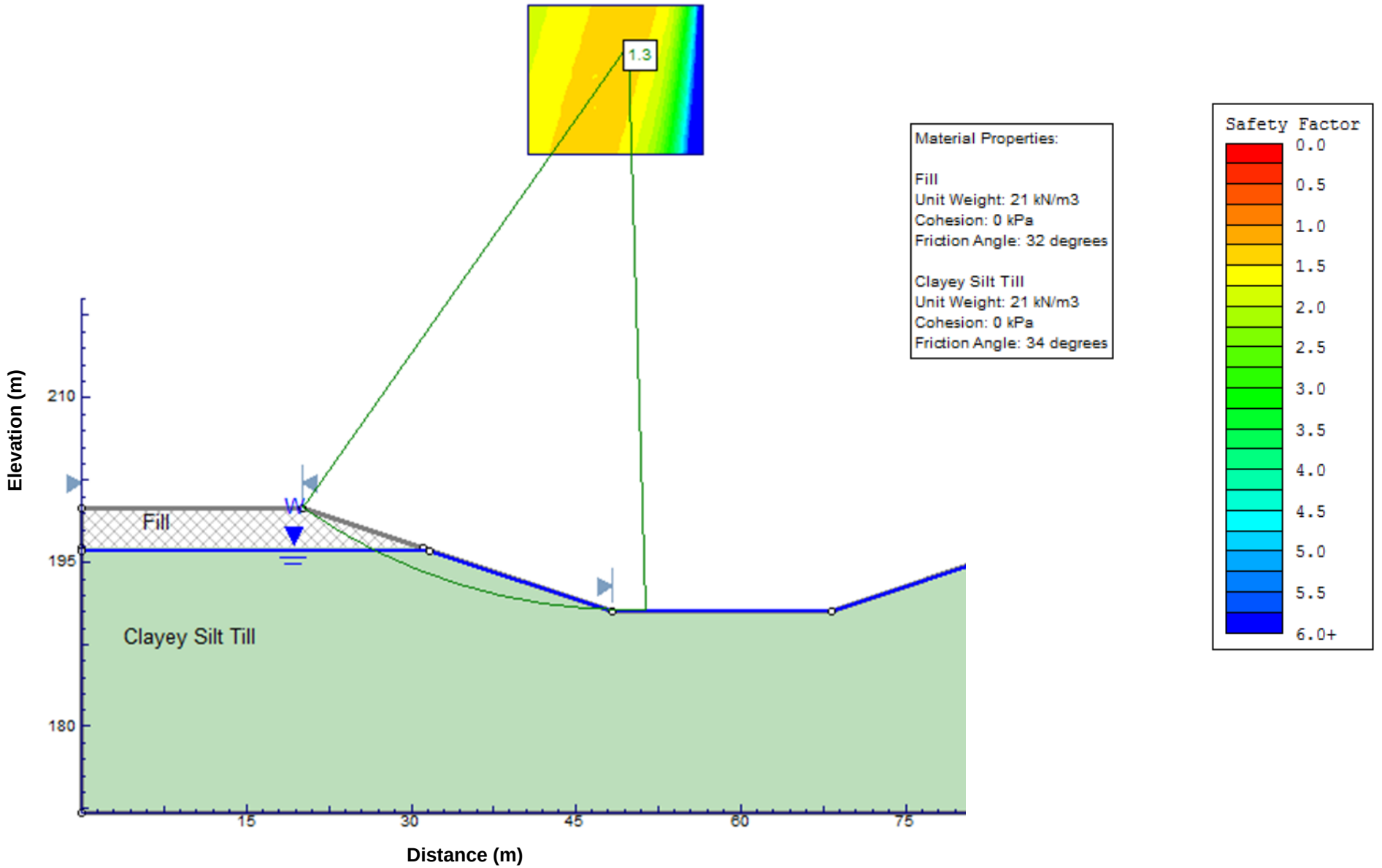
Date: February, 2013
Project No: 11-1111-0083

Analysis By: MAS **Reviewed By:** LCC

Golder Associates

Static Slope Stability Analysis
SWM Pond 6 – Dewatered Condition for Maintenance

Figure 4



Date: February, 2013
Project No: 11-1111-0083

Analysis By: MAS **Reviewed By:** LCC

Golder Associates

APPENDIX A

Borehole Records

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

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

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

Consistency	c_u, s_u kPa	c_u, s_u psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

Percent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (cohesionless) or With (cohesive)	Sand and Gravel / Silty Clay with sand / Clayey Silt with sand

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

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
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_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

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	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_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

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

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index
A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

Golder Associates

RECORD OF BOREHOLE No P1-1

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4833897.9 ;E 291310.4 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE CME-55 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 27, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.5	GROUND SURFACE										
0.0	TOPSOIL										
0.1	CLAYEY SILT, with sand, trace to some gravel, containing rootlets to 0.6 m, containing cobbles and boulders below 3.0 m (TILL) Very stiff to hard Brown becoming grey below a depth of 3.0 m Moist		1	SS	22		179		○		
			2	SS	30						
			3	SS	26		178		○ —		11 24 42 23
			4	SS	33		177				
			5	SS	44				○		
			6	SS	106		176				
			7	SS	31		175		○ —		18 22 41 19
173.4						▽	174				
6.1	SHALE (BEDROCK) Weathered Grey		8	SS	60/0.10		173				
172.5											
7.0	END OF BOREHOLE AUGER REFUSAL NOTE: 1. Water level in open borehole at a depth of 6.1 m (Elev. 173.4 m) on completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No P1-2

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4833931.4 ;E 291281.0 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE CME-55 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 27, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.8	GROUND SURFACE										
0.0	TOPSOIL										
0.1	CLAYEY SILT with sand, trace gravel, containing rootlets to 0.6 m, containing cobbles and boulders below 3.2 m (TILL) Very stiff to hard Brown, becoming grey below a depth of 3.7 m Moist		1	SS	16		179				
			2	SS	32	▼			w		4 21 47 28
			3	SS	23		178				
			4	SS	27		177		w		
			5	SS	60						
			6	SS	39		176		w		4 37 43 16
	Augers griniding heavily between 4.7 m and 6.1 m		7	SS	114/0.20		175		w		
173.7							174				
6.1	SHALE (BEDROCK) Weathered Grey		8	SS	60/0.10		173				
172.6											
7.2	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 6.8 m (Elev. 173.0 m) on completion of drilling.

2. Water level measured in piezometer as follows:

Date	Depth	Elev.
Aug. 27/12	6.8 m	173.0 m
Sep. 24/12	1.5 m	178.3 m

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P1-3

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4833960.1 ;E 291245.5 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE CME-55 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 23, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.2	GROUND SURFACE										
0.0 / 179.5	CLAYEY SILT, some sand Very stiff Brown Moist		1	SS	17		180		○		
0.7	CLAYEY SILT with sand, trace to some gravel, containing cobbles and boulders below 3.0 m (TILL) Very stiff to hard Brown becoming grey below a depth of 3.7 m Moist		2	SS	28		179				
			3	SS	25				○ ⊢⊣		7 24 45 24
			4	SS	42		178				
			5	SS	80/0.20		177		○		
			6	SS	49		176				
			7	SS	53				○ ⊢⊣		40 25 27 8
174.1						▽	175				
6.1 / 173.0	SHALE (BEDROCK / RESIDUAL SOIL) Highly weathered Grey		8	SS	87/0.20		174				
7.2 / 172.3	SHALE (BEDROCK) Weathered Grey		9	SS	60/0.05		173		○		
7.9	END OF BOREHOLE AUGER REFUSAL NOTE: 1. Water level in open borehole at a depth of 5.9 m (Elev. 174.3 m) on completion of drilling.										

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P2-1

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4835088.4 ;E 290143.5 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 108 mm Inner Diameter Hollow Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 8, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.0	GROUND SURFACE										
0.0	TOPSOIL										
0.2 / 183.3	CLAYEY SILT, some sand, containing rootlets to a depth of 0.5 m		1	SS	8						
0.7	Stiff, Brown, Moist		2	SS	30		183				
	SAND and SILT to Silty SAND, trace to some clay, trace to some gravel, containing rootlets to 0.5 m, containing cobbles and boulders below 2.3 m (TILL) Dense to very dense, Brown, Moist		3	SS	38		182				
			4	SS	54				H		8 32 47 13
			5	SS	50		181				
			6	SS	108/0.25	▽	180				
	Becoming grey and wet below a depth of approximately 4.3 m		7	SS	43		179				19 43 27 11
			8	SS	33		178				
			9	SS	89		177				2 57 33 8
			10	SS	79		176				
174.4	SAND and GRAVEL, trace silt, trace clay, containing shale fragments, Very dense, Grey, Wet						175				
9.8	END OF BOREHOLE										

NOTE:

1. Water level in open borehole at a depth of 4.3 m (Elev. 179.7 m) on completion of drilling.

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P2-2

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4835120.9 ;E 290119.1 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 108 mm Inner Diameter Hollow Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 13, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.6	GROUND SURFACE						
0.0	TOPSOIL						
0.2	CLAYEY SILT, some sand, containing organic matter and rootlets Stiff Brown Moist	1	SS	8	184		
183.5		2	SS	13			
183.1	Silty SAND, trace clay, containing clayey silt seams Compact Brown Moist	3	SS	16	183		
1.5	SAND and SILT, trace to some clay, trace to some gravel, containing wet silty sand layers, containing cobbles and boulders below 5.5 m (TILL) Compact to very dense Brown becoming grey below a depth of 3.1 m Moist	4	SS	40	182		3 22 53 12
		5	SS	30			
		6	SS	59	181		
		7	SS	108/0.25	180		
		8	SS	84	179		15 35 42 8
		9	SS	60/0.08	178		
175.4		10	SS	60/0.10	177		
9.2	END OF BOREHOLE				176		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

NOTES:

1. Water level in open borehole at a depth of 5.6 m (Elev. 179 m) on completion of drilling.

2. Water level measured in piezometer as follows:

Date	Depth	Elev.
Aug. 27/12	2.6 m	182.0 m
Sep. 24/12	2.4 m	182.2 m

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P2-3

SHEET 1 OF 1

METRIC

PROJECT 11-1111-0083

G.W.P. 2144-07-00 LOCATION N 4835149.4 ;E 290089.6 ORIGINATED BY TWB

DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 108 mm Inner Diameter Hollow Stem Augers COMPILED BY MAS

DATUM Geodetic DATE August 9, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.0	GROUND SURFACE										
0.0	TOPSOIL										
0.2	CLAYEY SILT, some sand, containing rootlets to 0.5 m Stiff to very stiff Brown Moist		1	SS	10						
			2	SS	19		183				
182.7											
1.3	SAND and SILT, trace to some gravel, trace to some clay (TILL) Dense to very dense Brown Moist		3	SS	32		182				
			4	SS	54				o H		10 31 47 12
180.6			5	SS	35		181		o		
180.3	SILT, trace clay, trace sand Dense										
3.7	Grey Wet		6	SS	28	▽	180				
	SAND and SILT, trace to some gravel, trace to some clay, containing cobbles and boulders (TILL) Compact to very dense Grey Moist		7	SS	43		179		o H		3 37 49 11
			8	SS	63		178				
			9	SS	60/0.08		177		o ‖		4 39 49 8
							176				
			10	SS	93		175				
174.2											
9.8	END OF BOREHOLE										

NOTE:

1. Water level in open borehole at a depth of 4.2 m (Elev. 179.8 m) on completion of drilling.

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

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

Golder Associates

RECORD OF BOREHOLE No P3-1

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4835894.7 ;E 289367.8 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE CME-55 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 20, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.3	GROUND SURFACE										
0.0	TOPSOIL										
0.2	Clayey silt, some sand, trace gravel, containing organic matter and rootlets (FILL) Stiff to hard Brown to grey Moist		1	SS	64		186				
185.1			2	SS	12						
1.4	Silty sand, some gravel, trace clay (FILL) Compact Grey Moist		3	SS	7		185				7 27 40 26
184.1											
2.2	Clayey silt with sand, trace gravel, containing organic matter and rootlets (FILL) Firm Brown to grey Moist		4	SS	24		184				
	CLAYEY SILT with sand, trace to some gravel, containing cobbles and boulders below 5.3 m (TILL) Very stiff to hard Brown becoming grey below a depth of 3.9 m Moist		5	SS	49		183				
			6	SS	87		182				7 26 41 26
			7	SS	78		181				
			8	SS	74		180				
			9	SS	60/0.10		179				
177.8							178				
8.5	SAND and SILT, trace gravel, trace to some clay (TILL) Very dense Grey Moist		10	SS	132/0.20	▽	177				4 40 45 11
176.8											
9.5	END OF BOREHOLE										

NOTE:

1. Water level in open borehole at a depth of 8.6 m (Elev. 177.7 m) on completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No P3-2

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4835948.0 ;E 289320.8 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE CME-55 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 21, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.5	GROUND SURFACE										
0.0	TOPSOIL										
0.2	Clayey silt, some sand, trace gravel, containing organics and rootlets (FILL) Firm Brown and grey Moist		1	SS	8		187				
186.1			2	SS	6	▼			○		3 19 46 32
1.4	CLAYEY SILT with sand, trace to some gravel, containing cobbles and boulders below 5.2 m (TILL) Very stiff to hard Brown becoming grey below a depth of 4.5 m Moist		3	SS	25		186				
			4	SS	48		185				
			5	SS	66		184		○		4 29 44 23
			6	SS	108						
			7	SS	48		183		○		
			8	SS	107		182		○		
180.5							181				
7.0	SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Moist		9	SS	109/0.23		180		○		20 45 29 6
179.0											
8.5	SHALE (BEDROCK) Weathered Grey						179				
178.0			10	SS	126/0.25		178				
9.5	END OF BOREHOLE										

NOTE:

1. Water level in piezometer at a depth of 1.8 m (Elev. 185.7 m) on August 21, 2012.

2. Water level measured in piezometer as follows:

Date	Depth	Elev.
Aug. 27/12	1.1 m	186.4 m
Sep. 24/12	1.0 m	186.5 m

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

Golder Associates

RECORD OF BOREHOLE No P3-3

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4835999.4 ;E 289275.7 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE CME-55 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 21, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.5	GROUND SURFACE										
0.0	TOPSOIL										
0.3	Clayey silt, some sand, trace gravel (FILL) Stiff Brown Moist		1	SS	12		187		○		
			2	SS	8						
186.0	Silty SAND, trace clay, containing organic matter and rootlets (FILL) Loose to compact Brown Moist		3	SS	6		186		○		
185.7 1.8	CLAYEY SILT, some sand, trace gravel, containing rootlets Firm Dark brown Moist		4	SS	17		185				
	CLAYEY SILT with sand, trace to some gravel, containing cobbles and boulders below 3.8 m (TILL) Firm to hard Brown becoming grey below a depth of 3.7 m Moist		5	SS	35		184		○ ⊢		7 21 46 26
			6	SS	65						
			7	SS	60/0.13		183				
182.0 5.5	SAND and SILT, trace to some clay, trace gravel, containing cobbles and boulders (TILL) Very dense Grey Moist		8	SS	103/0.20		182		○		1 37 48 14
180.2 7.3	END OF BOREHOLE AUGER REFUSAL						181				

NOTE:

1. Open borehole dry upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No P4-1

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4836957.9 ;E 288322.7 ORIGINATED BY CS
DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 28, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.3	GROUND SURFACE										
0.0 / 191.8	SILTY CLAY, some sand, trace gravel, containing rootlets Stiff Brown Moist		1	SS	12		192				
0.5	SHALE (BEDROCK) Weathered Grey		2	SS	50/0.10		191				
190.8			3	SS	50/0.01						
1.5	END OF BOREHOLE										

NOTES:

1. Water level in open borehole at a depth of 1.2 m (Elev. 191.1 m) on completion of drilling.

2. Water level measured in piezometer as follows:

Date	Depth	Elev.
Aug. 28/12	1.1 m	191.2 m
Sep. 24/12	1.5 m	190.8 m

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P4-2

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4836919.7 ;E 288337.0 ORIGINATED BY CS
DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 28 and 30, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.1	GROUND SURFACE										
0.0 / 191.8	SILTY CLAY, some sand, trace gravel, containing rootlets		1	SS	19		192		○		7 16 47 30
0.3	Very stiff Brown Moist		2	SS	50/0.07	▽					
	SHALE (BEDROCK) Weathered Grey						191				
190.4			3	SS	50/0.13						
1.7	SHALE (BEDROCK) containing limestone interbeds Bedrock cored from 1.5 m to 9.6 m. Refer to Record of Drillhole P4-2 for rock coring details.		1	RC	REC 100%						RQD = 0%
			2	RC	REC 93%		190				RQD = 43%
			3	RC	REC 99%		189				RQD = 69%
			4	RC	REC 100%		188				RQD = 81%
			5	RC	REC 100%		187				RQD = 90%
			6	RC	REC 100%		186				RQD = 84%
182.5							185				
9.6	END OF BOREHOLE						184				
	NOTES: 1. Water level in open borehole at a depth of 1.1 m below ground surface (Elev. 191.0 m) on completion of overburden drilling. 2. Drillhole P4-2 was advanced adjacent to Borehole P4-2 on August 30, 2012; the depth to bedrock and bedrock surface elevation vary between the borehole and drillhole. 3. Driller noted water return losses during coring.						183				

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

PROJECT:

RECORD OF DRILLHOLE: P4-2

SHEET 1 OF 1

LOCATION: N 4836919.7 ;E 288337.0

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D-50 Track-Mount

DRILLING CONTRACTOR: Walker Drilling

JN - Joint, FLT - Fault, SH - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, RO - Rough, VR - Very Rough
MB - Mechanical Break, BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		SEE RECORD OF BOREHOLE P4-2		190.58																
2		SHALE BEDROCK containing LIMESTONE interbeds (GEORGIAN BAY FORMATION) Slightly weathered to fresh Dark grey Thinly laminated Weak to medium strong		1.52	1								BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													JN,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													JN,UN,SM							
													BD,PL,SM							
					2								BD,PL,SM							
3				189.17									BD,PL,SM							
		END OF DRILLHOLE:		2.93									JN,UN,SM							
													BD,PL,SM							
		NOTES:											BD,PL,SM							
		1. Driller noted water return losses during coring.											BD,PL,SM							
4													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													JN,PL,SM							
					3								BD,PL,SM							
													BD,PL,SM							
													JN,PL,SM							
													JN,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
5													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
					4								BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
6													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
					5								JN,ST,RO							
7													BD,PL,SM							
													BD,PL,SM							
													JN,VN,SM							
													BD,PL,SM							
8													BD,,							
													BD,,							
													BB,,							
													BD,PL,SM							
													BD,PL,SM							
													BD,PL,SM							
					6								BD,PL,SM							
9													BD,PL,SM							
													BD,PL,SM							
10																				
11																				

DEPTH SCALE

1 : 50

LOGGED: CS

CHECKED: LCC

Golder Associates

GTA-RCK 041 1111110083.GPJ GAL-MISS.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P4-3

SHEET 1 OF 1

METRIC

PROJECT 11-1111-0083

G.W.P. 2144-07-00 LOCATION N 4836878.4 ;E 288351.3 ORIGINATED BY CS

DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS

DATUM Geodetic DATE August 28, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
191.6	GROUND SURFACE										
0.0 / 0.1	SILTY CLAY, some sand, trace gravel, containing rootlets Firm Brown Moist		1	SS	85/0.20				○		1 14 50 35
	SHALE (BEDROCK) Weathered Grey		2	SS	50/0.15		191				
			3	SS	50/0.05		190				
188.5							189				
3.1	END OF BOREHOLE SPLIT-SPOON BOUNCING NOTE: 1. Open borehole dry upon completion of drilling.										

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P5-1

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4837409.1 ;E 288320.9 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 26, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
191.7	GROUND SURFACE										
0.0	TOPSOIL										
0.1	CLAYEY SILT with sand, trace to some gravel, containing cobbles and boulders, containing rootlets to 0.8 m (TILL) Hard Brown becoming grey below a depth of 2.7 m Moist		1	SS	34		191				
			2	SS	39				○		
			3	SS	60		190				
			4	SS	68		189		○ H		8 27 44 21
			5	SS	58						
187.4			6	SS	87		188		○		
4.3	Gravelly SAND and SILT, trace to some clay, containing cobbles and boulders (TILL) Very dense Grey Moist		7	SS	60/0.10	▽	187		○		
			8	SS	97/0.23		186		○ H		22 27 41 10
184.7							185				
7.0	SHALE (BEDROCK) Weathered Grey		9	SS	86/0.23		184				
183.8											
7.9	END OF BOREHOLE AUGER REFUSAL										

NOTE:

1. Water level in open borehole at a depth of 4.4 m (Elev. 187.3 m) on completion of drilling.

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P5-2

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4837502.0 ;E 288275.5 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE CME-55 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 26, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
191.8	GROUND SURFACE										
0.0	TOPSOIL										
0.1	CLAYEY SILT with sand, some gravel, containing rootlets to 0.8 m (TILL) Stiff to hard Brown becoming grey below a depth of 2.6 m Moist		1	SS	14		191				
			2	SS	35				○		
			3	SS	57		190				
			4	SS	67		189		○ —		16 26 40 18
			5	SS	40						
187.8							188				
4.0	Gravelly SAND and SILT, trace clay, containing cobbles and boulders (TILL) Very dense Grey Moist		6	SS	85				○		22 22 50 6
187.3											
4.5	CLAYEY SILT, some sand, trace gravel, containing cobbles and boulders (TILL) Hard Grey Moist		7	SS	105		187				
						▽	186				
			8	SS	60/0.05						
185.2											
6.6	END OF BOREHOLE AUGER REFUSAL NOTE: 1. Water level in open borehole at a depth of 6.0 m (Elev. 185.8 m) on completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No P5-3

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4837528.2 ;E 288319.0 ORIGINATED BY TWB
DIST Central HWY 410 BOREHOLE TYPE CME-55 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 27, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.6	GROUND SURFACE										
0.0	TOPSOIL										
0.1	CLAYEY SILT with sand to some sand, trace to some gravel, containing rootlets to 0.8 m, containing cobbles and boulders below 2.7 m (TILL) Stiff to hard Brown becoming grey below a depth of 2.7 m Moist		1	SS	12		190		○		
			2	SS	35						
			3	SS	35		189		○ —		6 31 43 20
			4	SS	39		188				
			5	SS	43						
186.9							187				
3.7	Silty SAND and GRAVEL, trace clay, containing cobbles and boulders (TILL) Very dense to dense Grey Moist becoming wet below a depth of 4.6 m		6	SS	73				○		35 32 28 5
185.6			7	SS	45		186				
5.0	CLAYEY SILT, some sand, some gravel, containing shale fragments below a depth of 5.6 m (TILL) Hard Grey Moist						185				
			8	SS	92/0.20				○		
183.9							184				
6.7	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 3.8 m (Elev. 186.8 m) on completion of drilling.

2. Water level measured in piezometer as follows:

Date	Depth	Elev.
Aug. 27/12	1.9 m	188.7 m
Sep. 24/12	2.1 m	188.5 m

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

Golder Associates

RECORD OF BOREHOLE No P6-1

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4838326.0 ;E 287902.3 ORIGINATED BY CS
DIST Central HWY 410 BOREHOLE TYPE D-25 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 26, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.7	GROUND SURFACE								
0.0	Silty sand, some gravel, trace clay, containing rootlets (FILL) Compact Brown		1	SS	14				
197.0	Moist						197		
0.7	Clayey silt to silty clay, trace to some sand (FILL) Stiff to very stiff Brown and grey Moist		2	SS	18				
			3	SS	12		196		0 10 57 33
			4	SS	20				
194.7							195		
3.0	CLAYEY SILT with sand, trace to some gravel, containing cobbles and boulders below 4.6 m (TILL) Very stiff to hard Brown becoming grey below a depth of 4.6 m Moist		5	SS	29				
			6	SS	50/0.08		194		
			7	SS	85/0.28		193		6 25 46 23
			8	SS	91		192		
			9	SS	63/0.15		191		
			10	SS	99/0.28		190		
							189		16 35 36 13
							188		
186.9			11	SS	74/0.15		187		
10.8	END OF BOREHOLE								

NOTE:

1. Open borehole dry upon completion of drilling.

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P6-2

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4838372.4 ;E 287879.1 ORIGINATED BY CS
DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 26 and 27, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
199.9	GROUND SURFACE										
0.0	Clayey silt with sand, some gravel, containing rootlets (FILL) Very stiff to stiff Brown becoming grey below 3.2 m Moist		1	SS	20		199		○		
			2	SS	17						
			3	SS	9		198		○ ⊢⊣		16 40 27 17
			4	SS	10		197				
196.2			5	SS	18				○		
3.7	CLAYEY SILT with sand, trace to some gravel, containing cobbles and boulders below 8.2 m (TILL) Hard Grey Moist		6	SS	39	▼	196				
			7	SS	50		195				
							194				
			8	SS	61				○ ⊢⊣		3 26 49 22
							193				
			9	SS	73		192				
							191				
			10	SS	48				○ ⊢⊣		15 23 49 13
189.1							190				
10.8	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Open borehole dry upon completion of drilling.

2. Water level measured in piezometer as follows:

Date	Depth	Elev.
Aug. 27/12	Dry	N/A
Sep. 24/12	4.3 m	195.6 m

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

GTA-MTO 001 1111110083.GPJ GAL-GTA.GDT 2/19/13

Golder Associates

RECORD OF BOREHOLE No P6-3

SHEET 1 OF 1 **METRIC**

PROJECT 11-1111-0083
G.W.P. 2144-07-00 LOCATION N 4838418.2 ;E 287893.0 ORIGINATED BY CS
DIST Central HWY 410 BOREHOLE TYPE D-50 Track-mount, 152 mm Solid Stem Augers COMPILED BY MAS
DATUM Geodetic DATE August 27, 2012 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.5	GROUND SURFACE										
0.0	Clayey silt, trace gravel and sand, containing rootlets (FILL) Very stiff Brown Moist		1	SS	24		197		○		
196.8 / 0.7	Sand, trace gravel, trace silt, trace clay (FILL) Compact Brown Moist		2	SS	13						
196.1 / 1.5	Clayey silt, with to some sand, trace to some gravel (FILL) Firm to very stiff Brown to grey Moist		3	SS	10		196		○ ⊢		11 20 40 29
			4	SS	15		195				
193.8 / 3.7	CLAYEY SILT with to some sand, trace to some gravel (TILL) Very stiff to hard Grey Moist		5	SS	6		194		○		
			6	SS	23						
			7	SS	34		193		○ ⊢		5 15 52 28
			8	SS	61		192				
	Containing cobbles and boulders below 7.6 m		9	SS	62		191		○ ⊢		8 33 42 17
			10	SS	62/0.15		190				
186.7 / 10.8	END OF BOREHOLE		11	SS	100/0.13		189				
	NOTE: 1. Open borehole dry upon completion of drilling.						188				
							187				

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

APPENDIX B

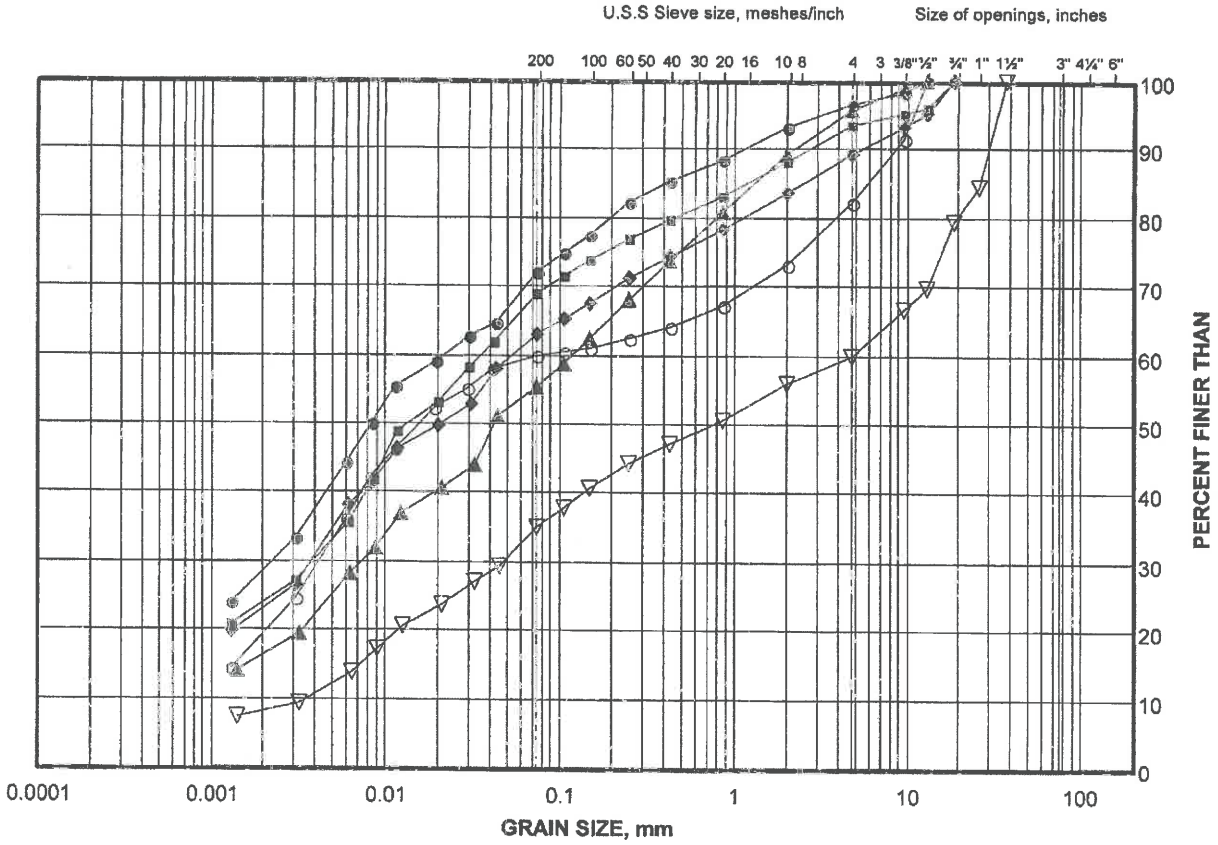
Laboratory Test Results

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 1

Clayey Silt Till

FIGURE B1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P1-2	2	178.7
■	P1-3	3	178.4
◆	P1-1	3	177.7
▲	P1-2	6	175.7
▽	P1-3	7	175.3
○	P1-1	7	174.6

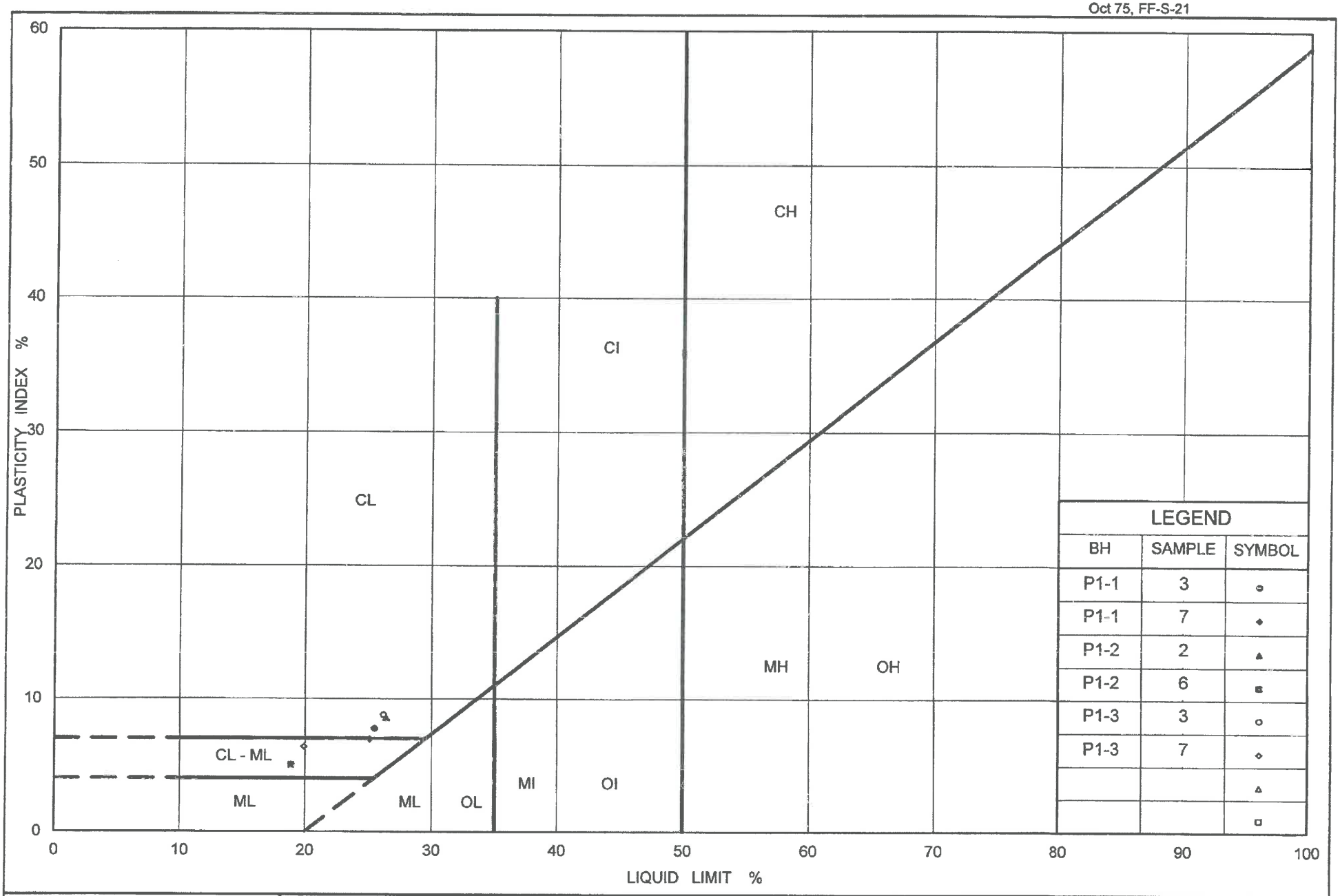
Project Number: 11-1111-0083

Checked By: _____

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART
Pond 1 - Clayey Silt Till

Figure No. B2

Project No. 11-1111-0083

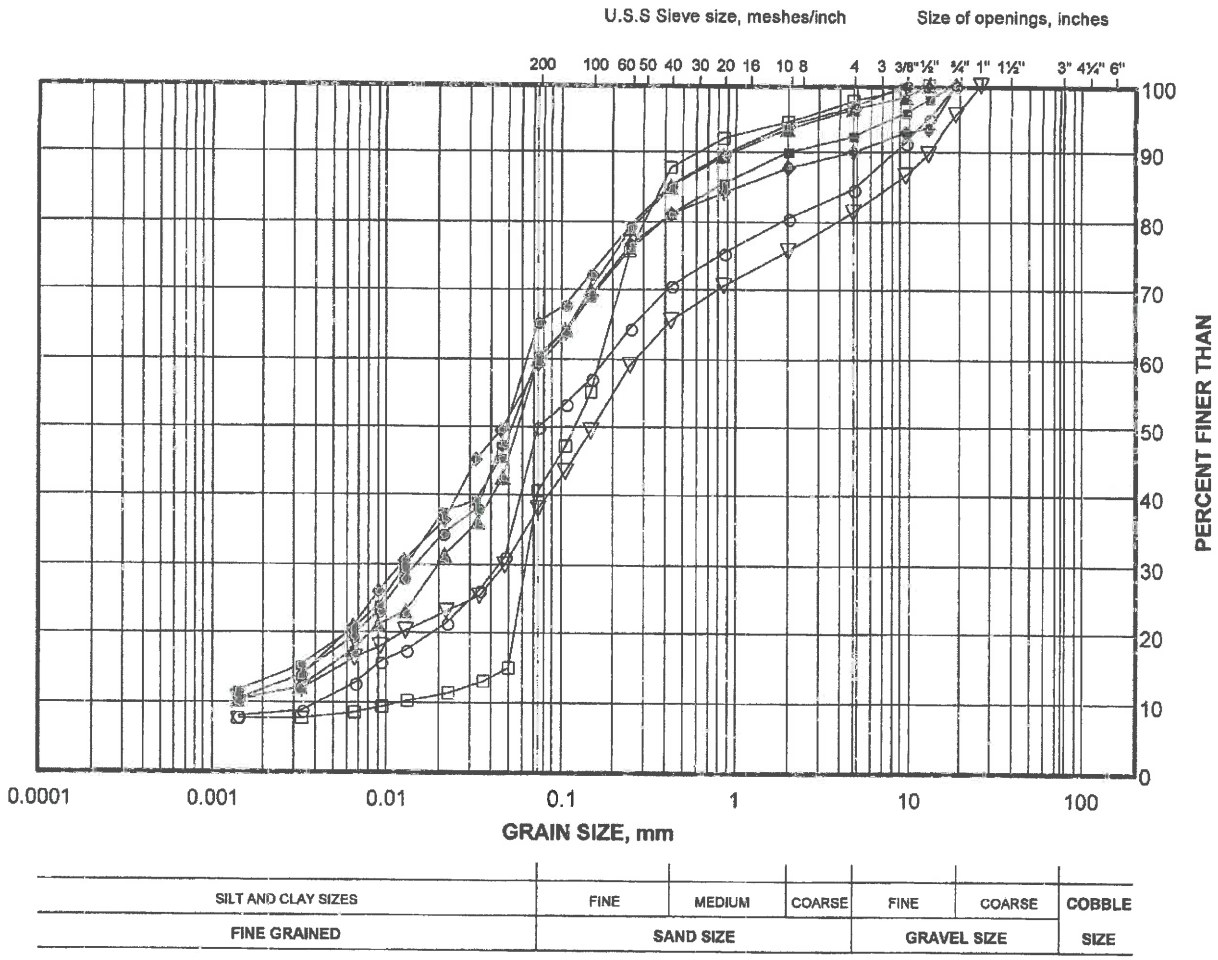
Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 2

Sand and Silt Till

FIGURE B3-1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P2-2	4	182
■	P2-1	4	181.4
◆	P2-3	4	181.4
▲	P2-3	7	179.1
▽	P2-1	7	179.1
○	P2-2	8	178.2
□	P2-1	9	176.1

Project Number: 11-1111-0083

Checked By: Matt Lee

Golder Associates

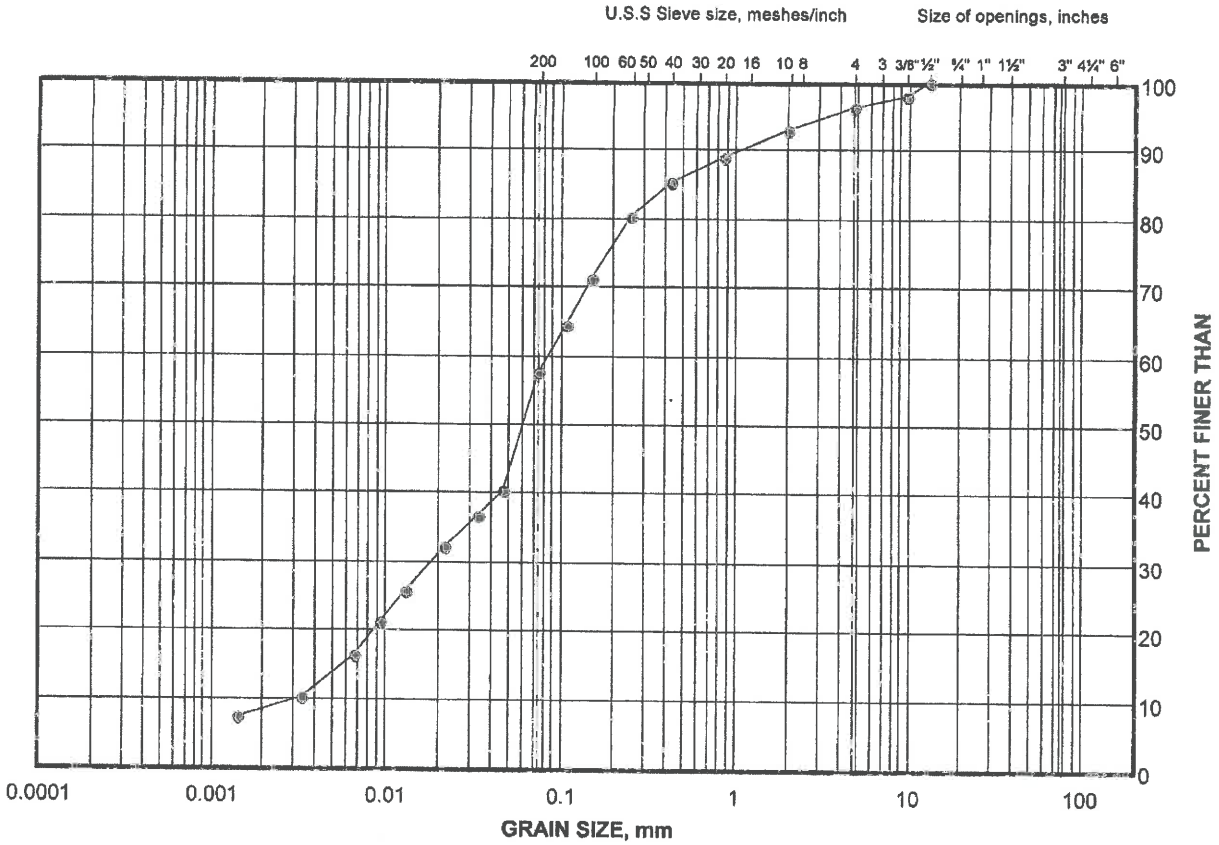
Date: 19-Feb-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 2

Sand and Silt Till

FIGURE B3-2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P2-3	9	176.2

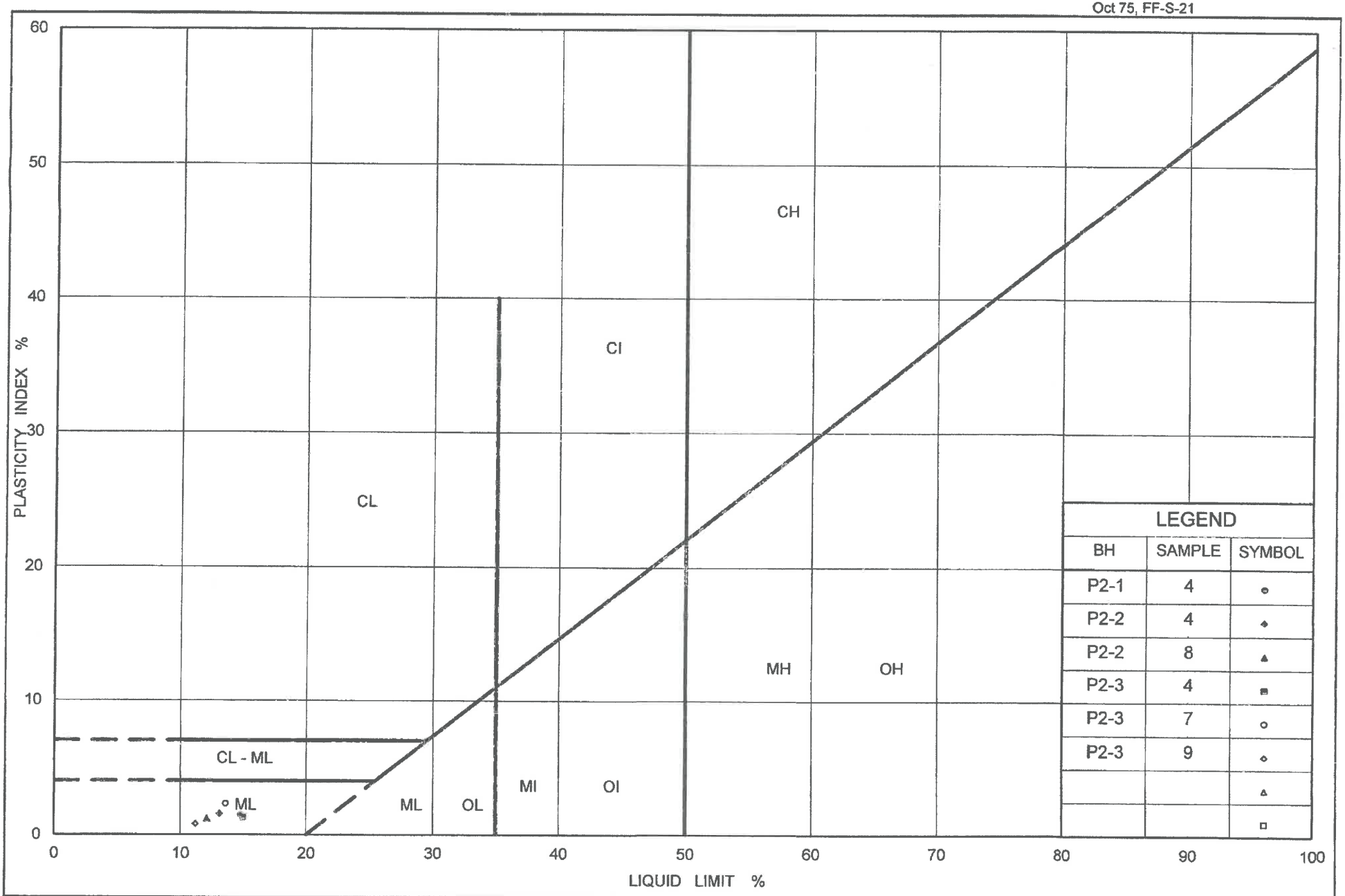
Project Number: 11-1111-0083

Checked By: MH

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART
Pond 2 - Sand and Silt Till

Figure No. B4

Project No. 11-1111-0083

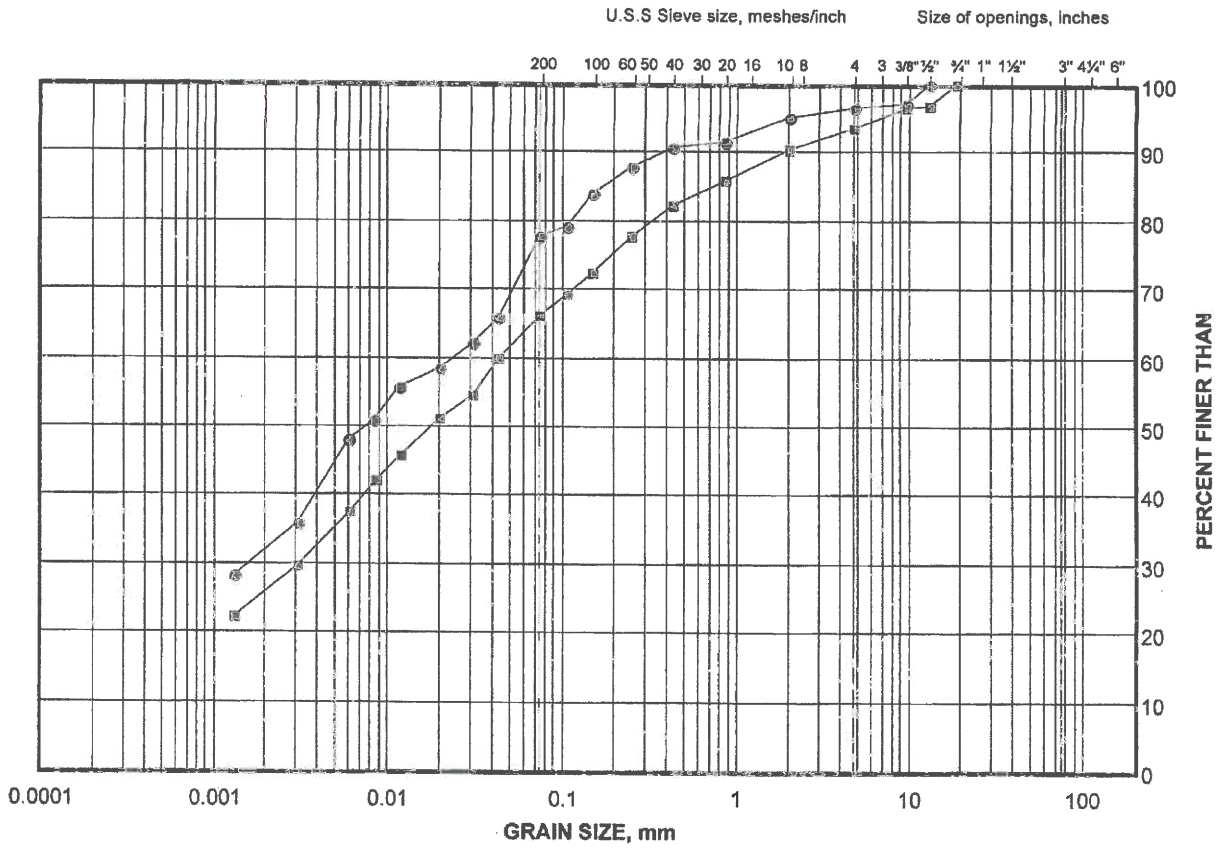
Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 3

Cohesive Fill

FIGURE B5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P3-2	2	186.4
■	P3-1	3	184.5

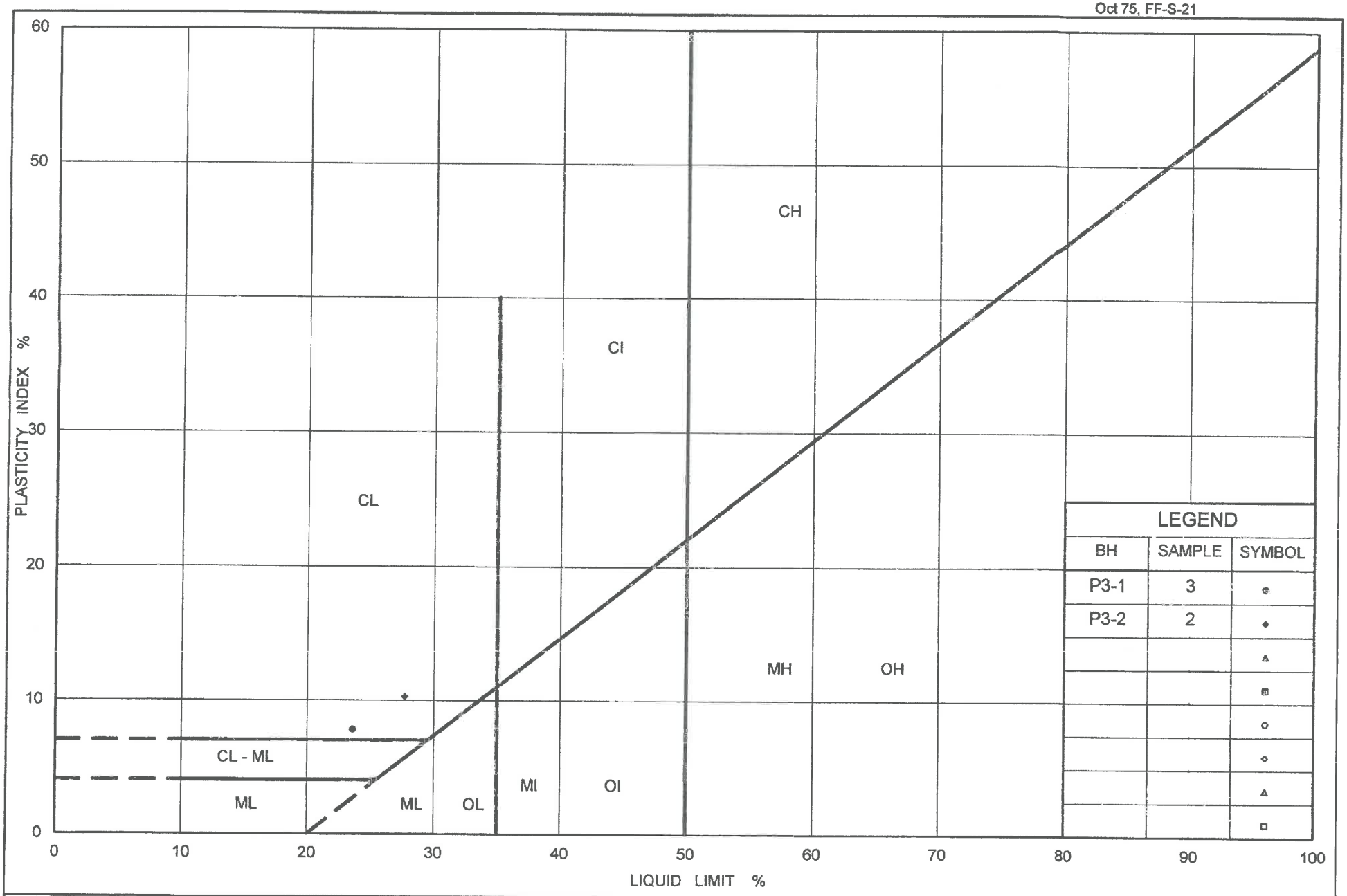
Project Number: 11-1111-0083

Checked By: Matt Lodge

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART
Pond 3 - Cohesive Fill

Figure No. B6

Project No. 11-1111-0083

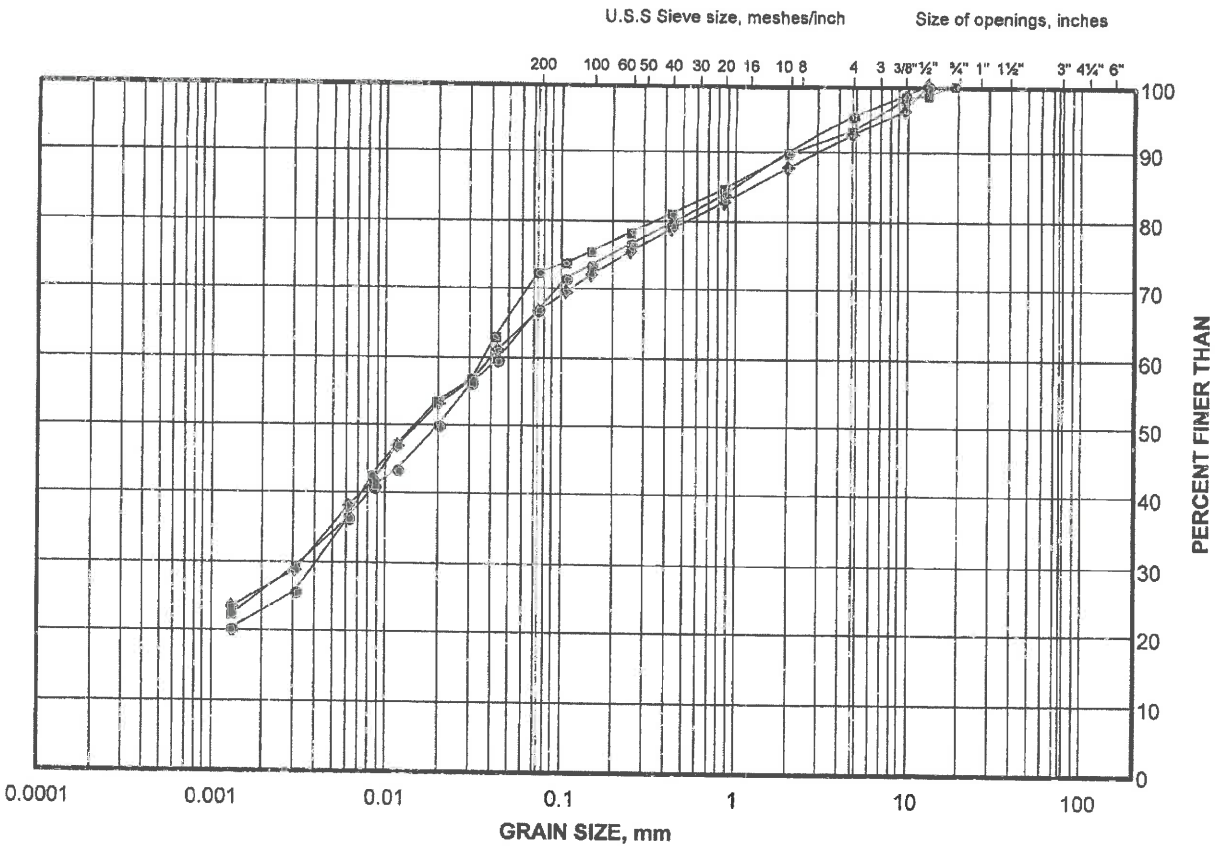
Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 3

Clayey Silt Till

FIGURE B7



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P3-2	5	184.1
■	P3-3	5	184.1
◆	P3-1	6	182.2

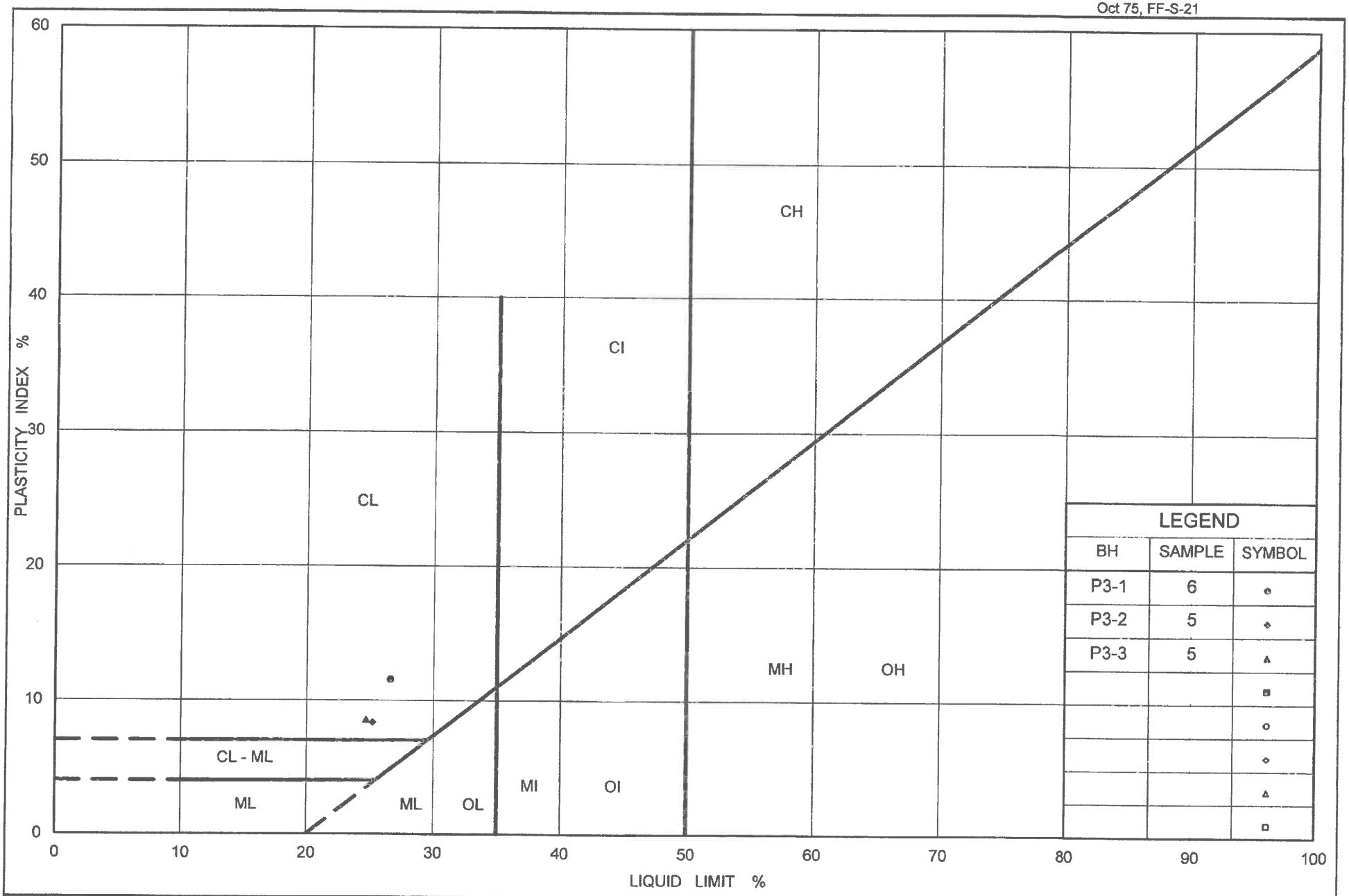
Project Number: 11-1111-0083

Checked By: Matt Ford

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART
Pond 3 - Clayey Silt Till

Figure No. B8

Project No. 11-1111-0083

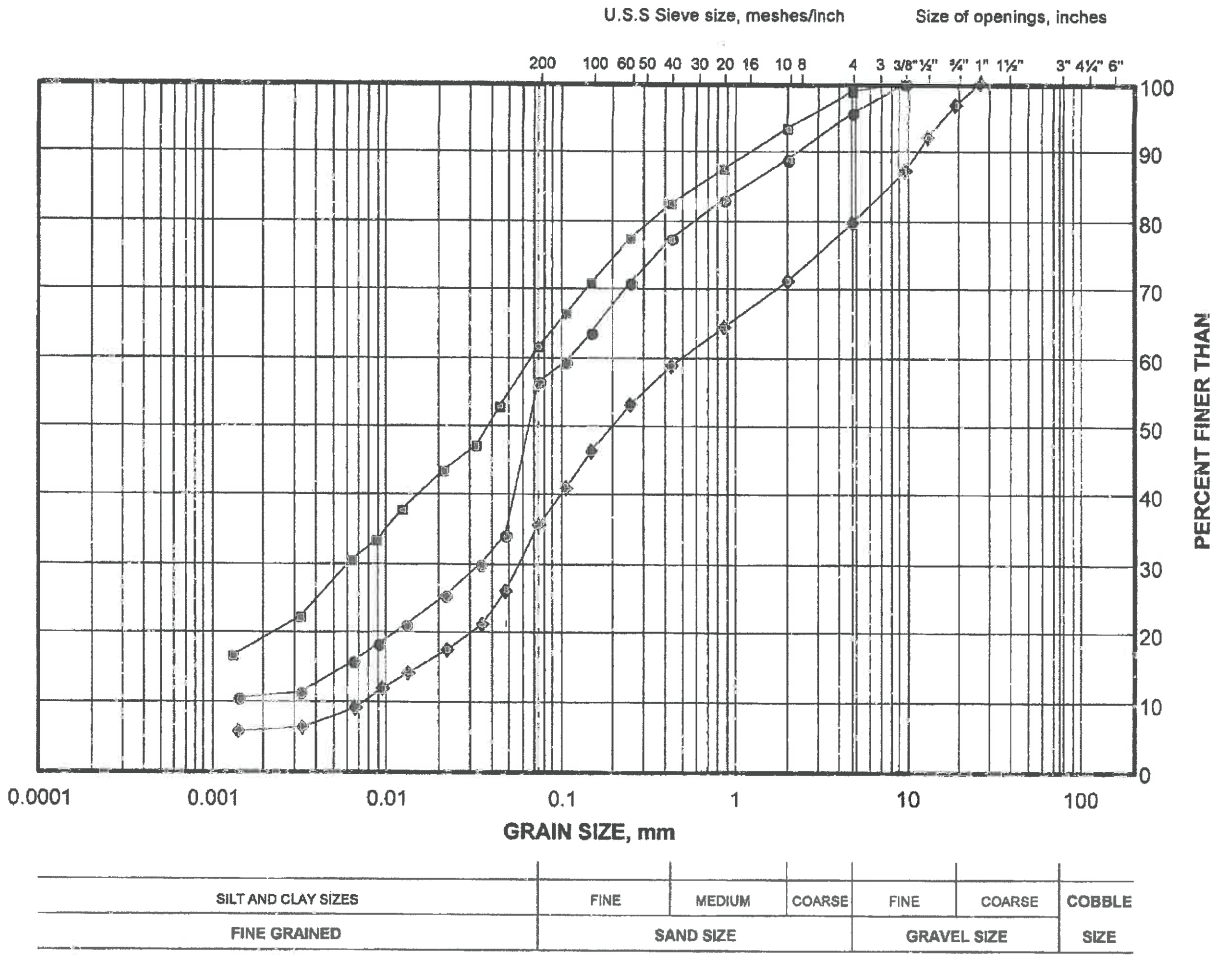
Checked By: Matt Loo

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 3

Sand and Silt Till

FIGURE B9



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P3-1	10	177
■	P3-3	8	181.3
◆	P3-2	9	179.7

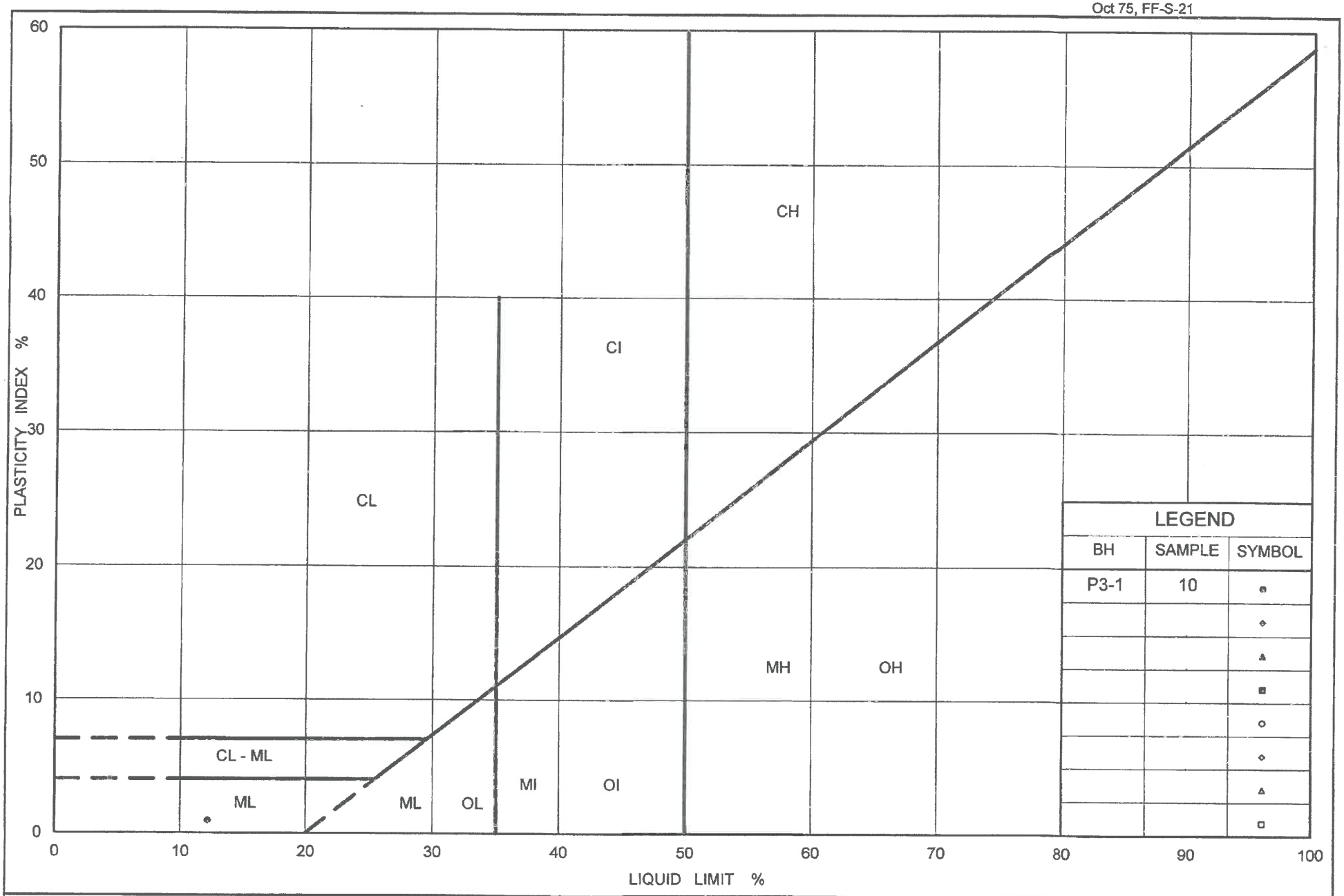
Project Number: 11-1111-0083

Checked By: Matt Good

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART
Pond 3 - Sand and Silt Till

Figure No. B10

Project No. 11-1111-0083

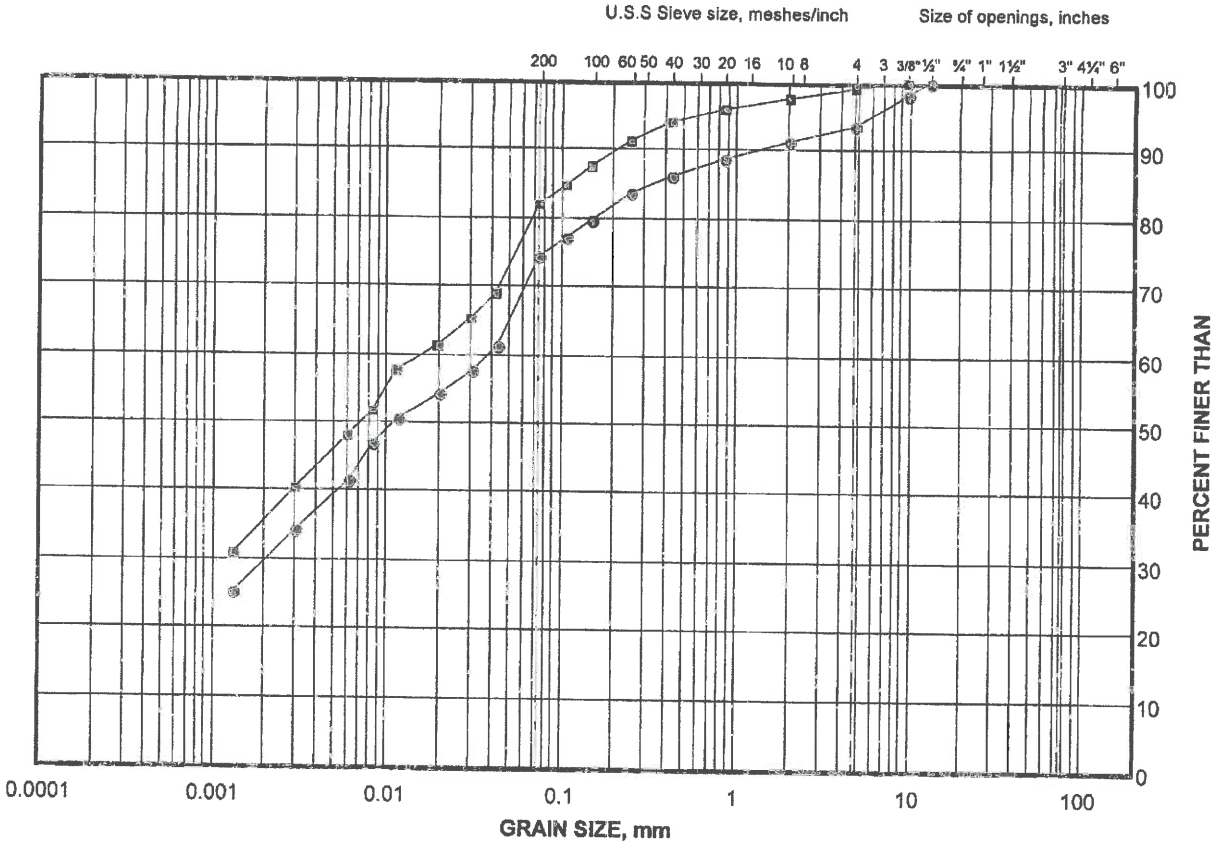
Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 4

Clayey Silt to Silty Clay

FIGURE B11



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P4-2	1a	191.9
■	P4-3	1a	191.5

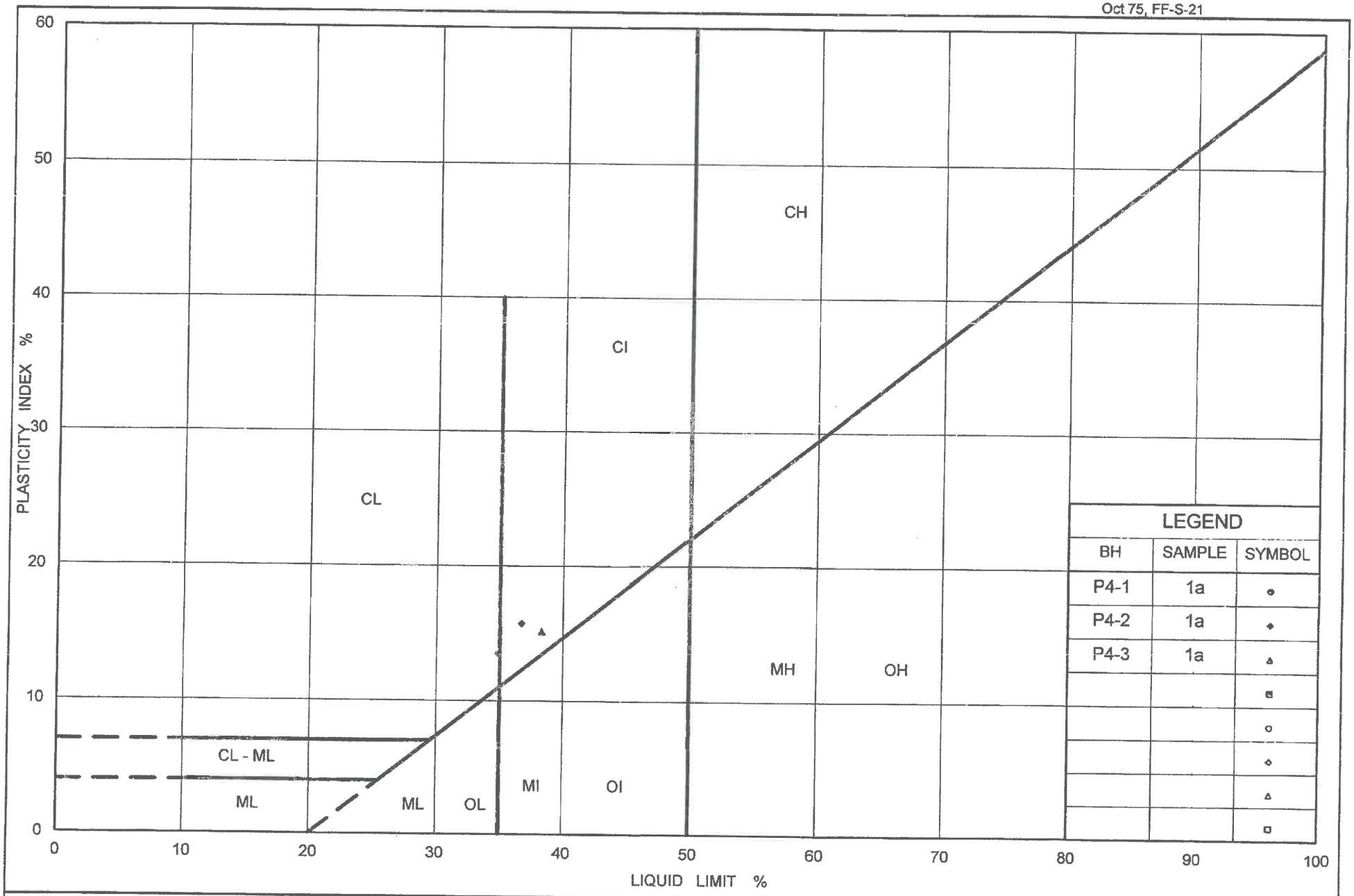
Project Number: 11-1111-0083

Checked By: Matt Ford

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART
Pond 4 - Clayey Silt to Silty Clay

Figure No. B12

Project No. 11-1111-0083

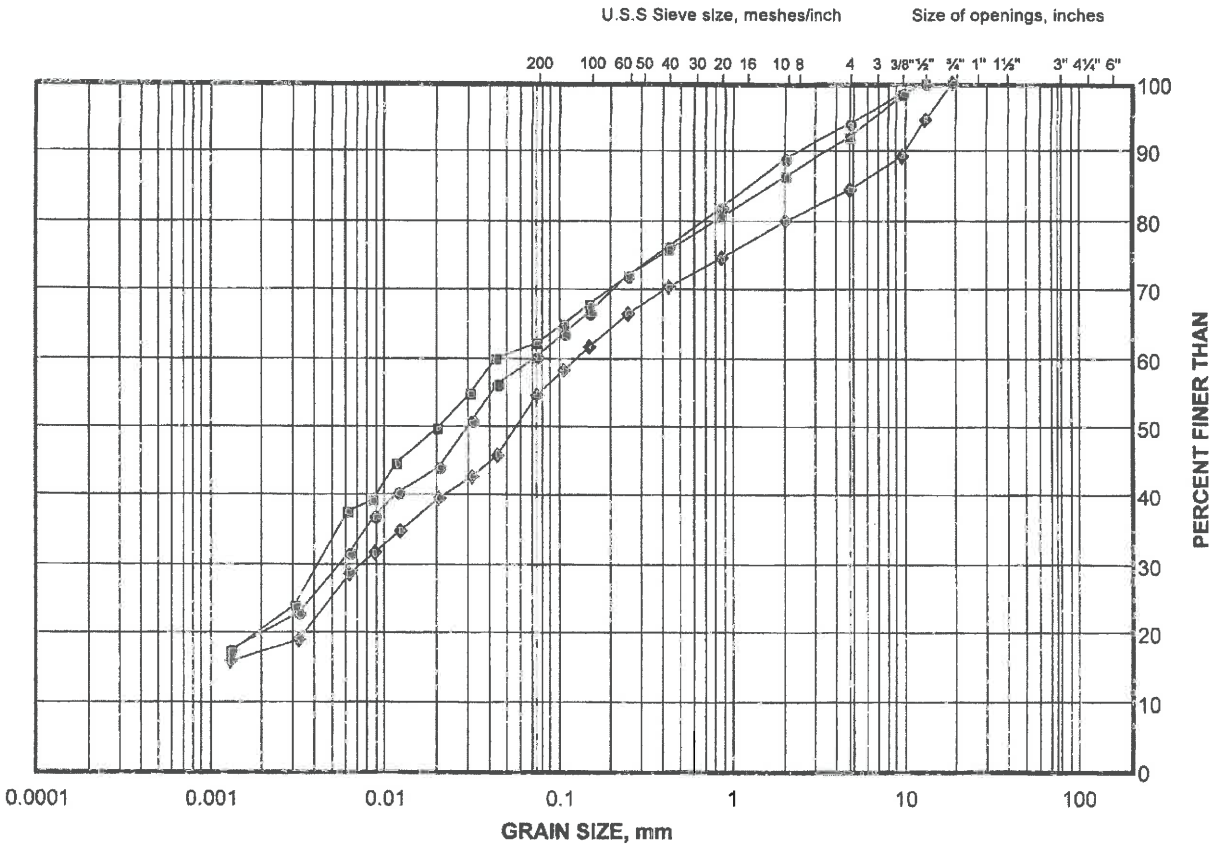
Checked By: MK Soo

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 5

Clayey Silt Till

FIGURE B13



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P5-3	3	188.8
■	P5-1	4	189.1
◆	P5-2	4	189.2

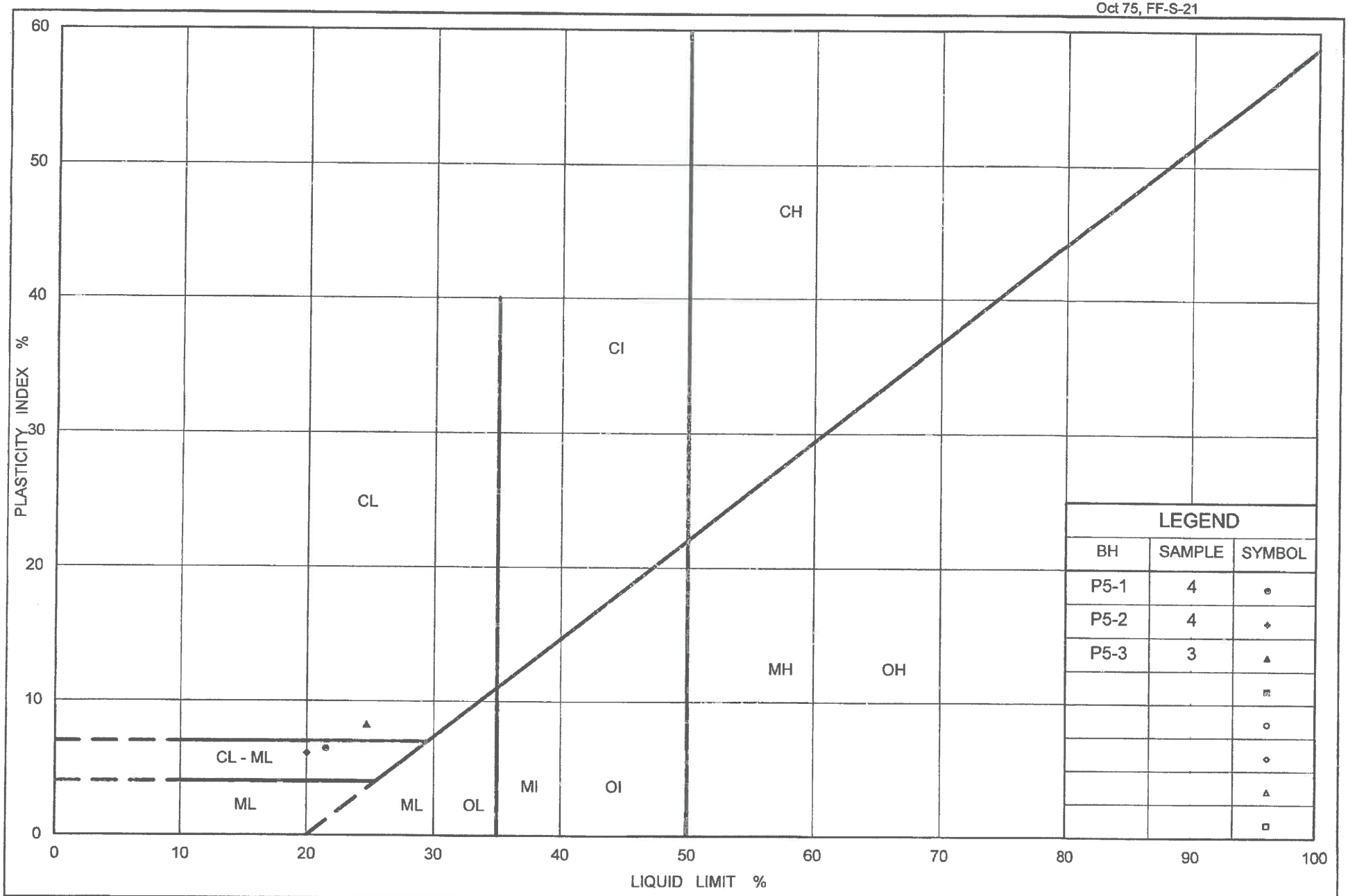
Project Number: 11-1111-0083

Checked By: Matt Ross

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART
Pond 5 - Clayey Silt Till

Figure No. B14

Project No. 11-1111-0083

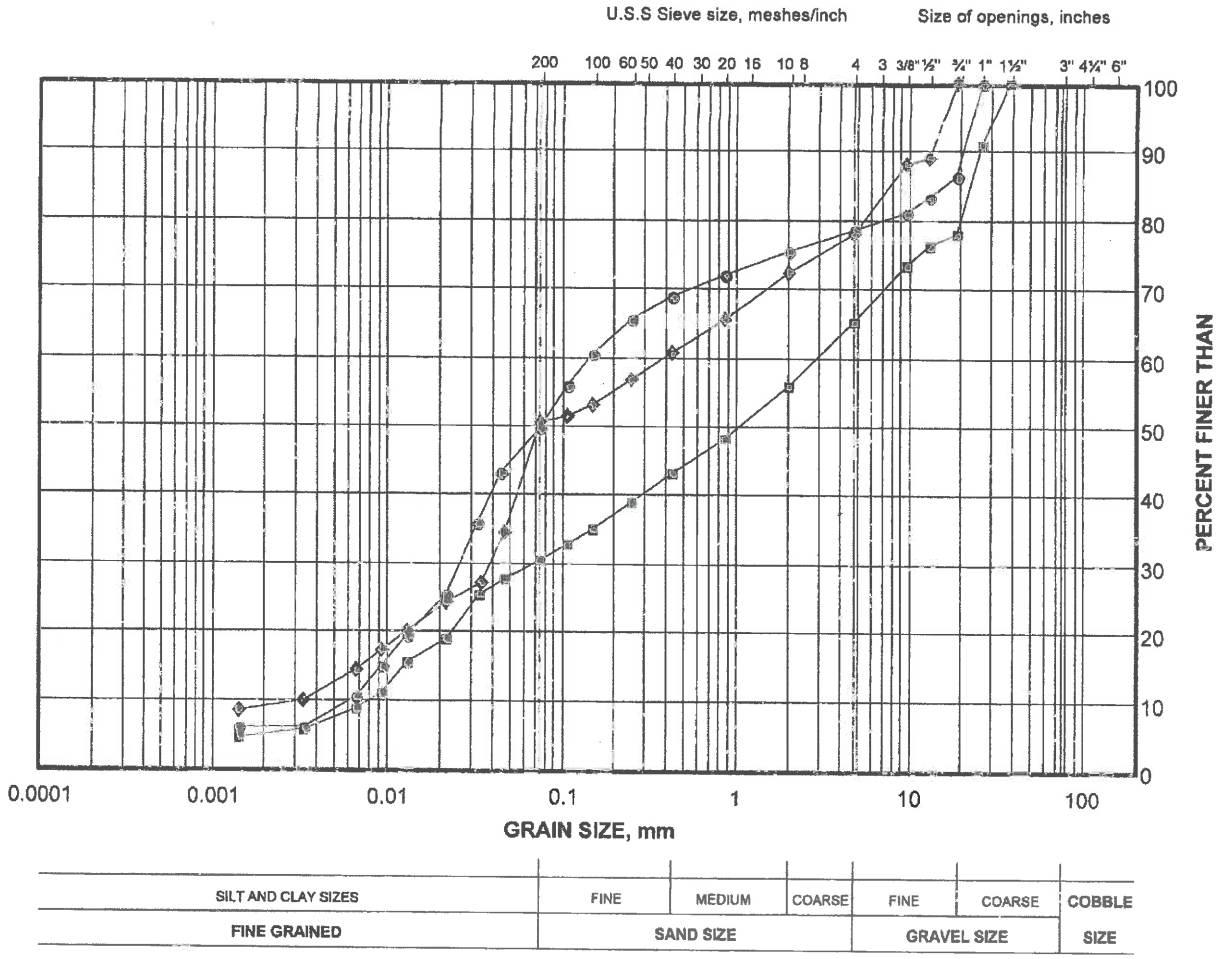
Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 5

Sand and Silt to Silty Sand and Gravel Till

FIGURE B15



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P5-2	6	187.7
■	P5-3	6	186.5
◆	P5-1	8	185.5

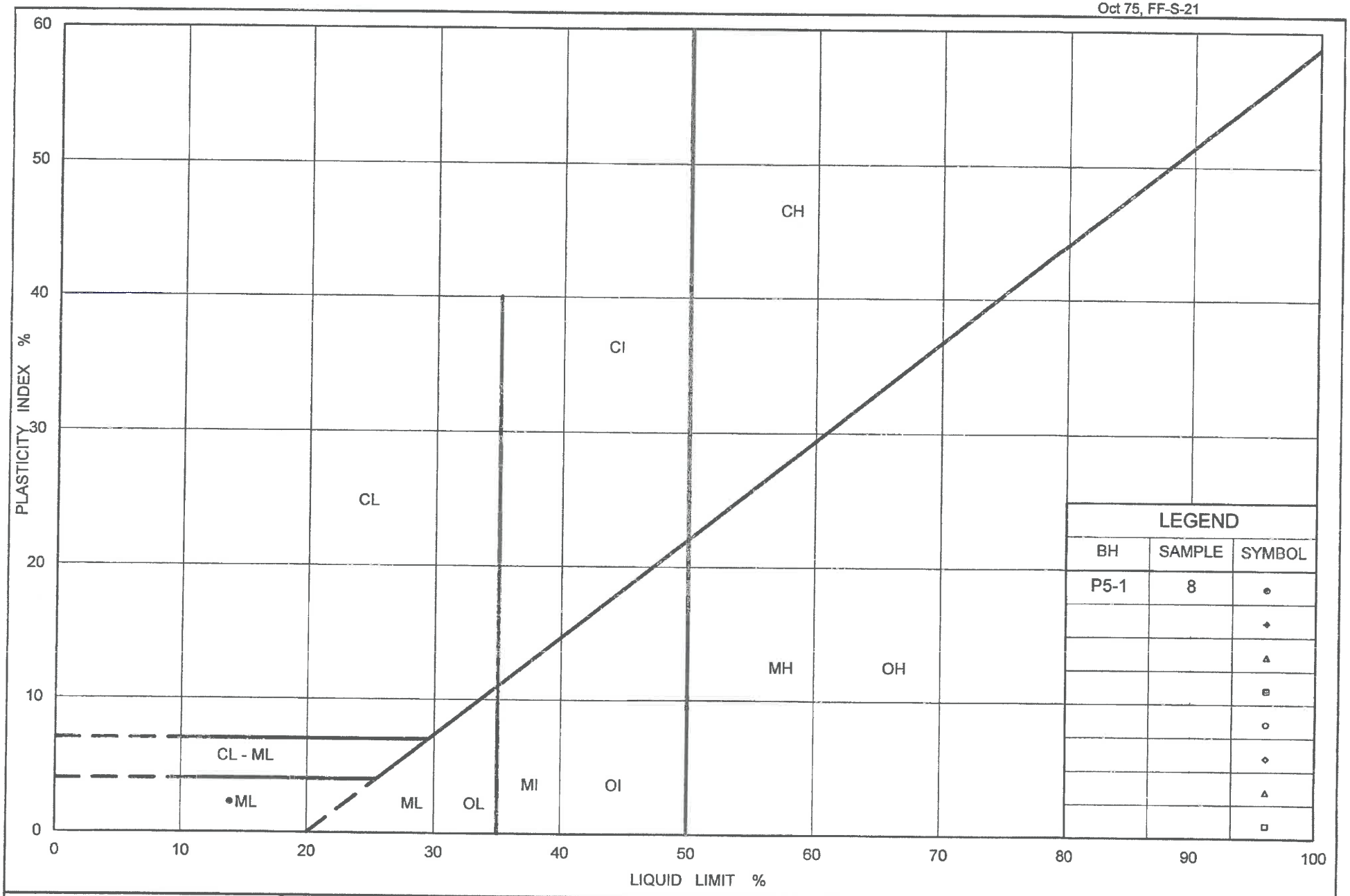
Project Number: 11-1111-0083

Checked By: _____

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART

Pond 5 - Sand and Silt to Silty Sand and Gravel Till

Figure No. B16

Project No. 11-1111-0083

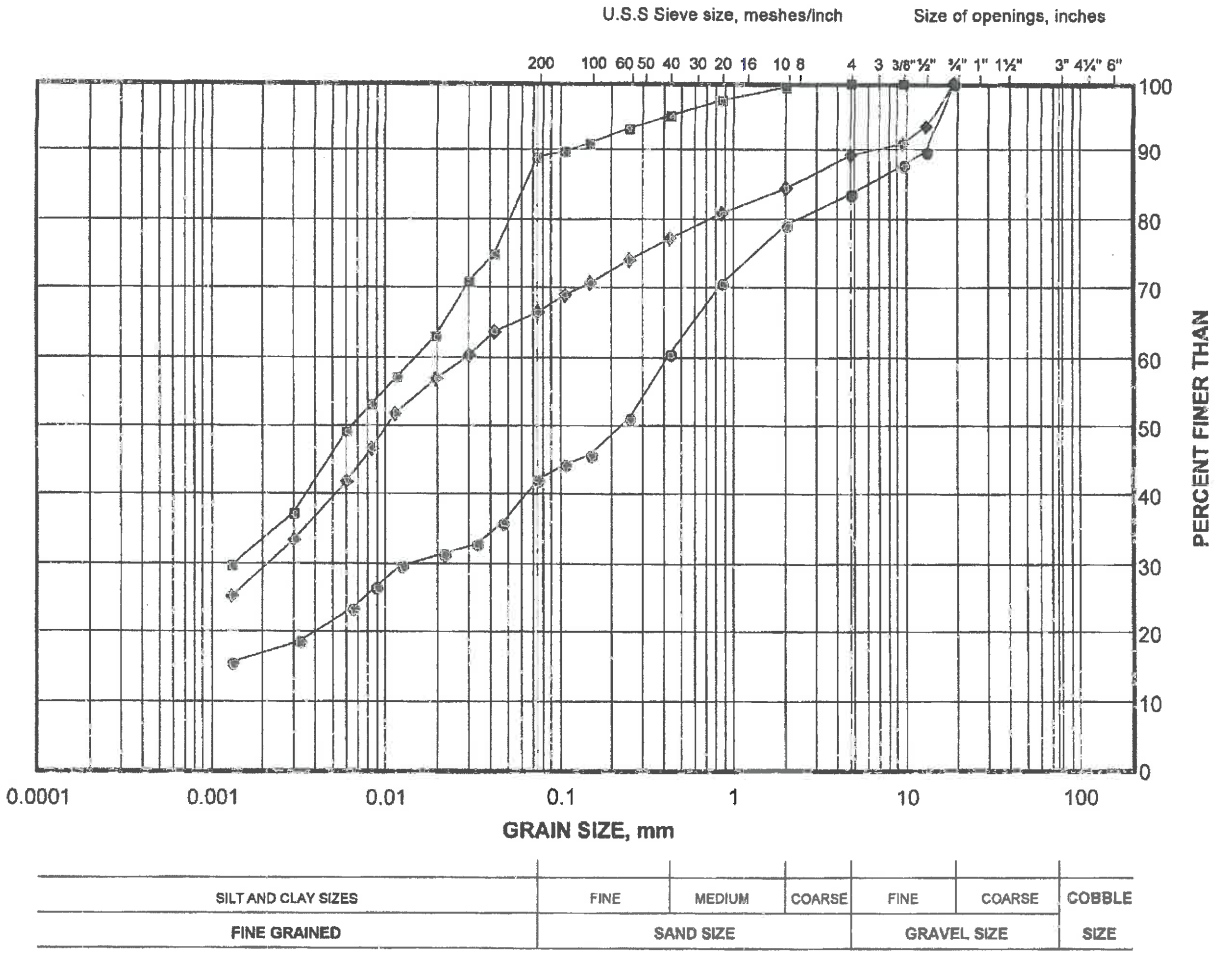
Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 6

Cohesive Fill

FIGURE B17



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P6-2	3	198.1
■	P6-1	3	195.9
◆	P6-3	3	195.7

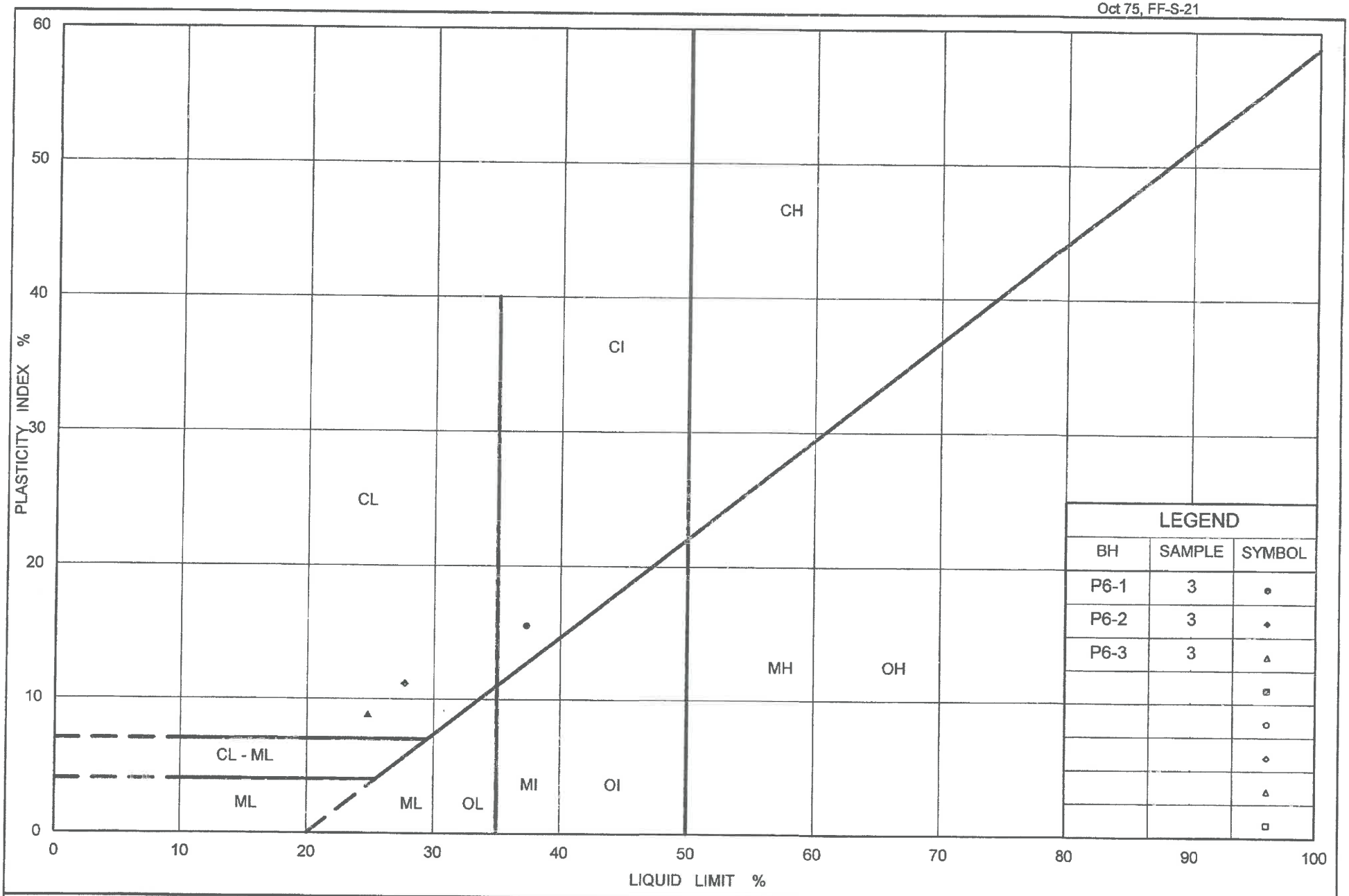
Project Number: 11-1111-0083

Checked By: MH

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



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PLASTICITY CHART
Pond 6 - Cohesive Fill

Figure No. B18

Project No. 11-1111-0083

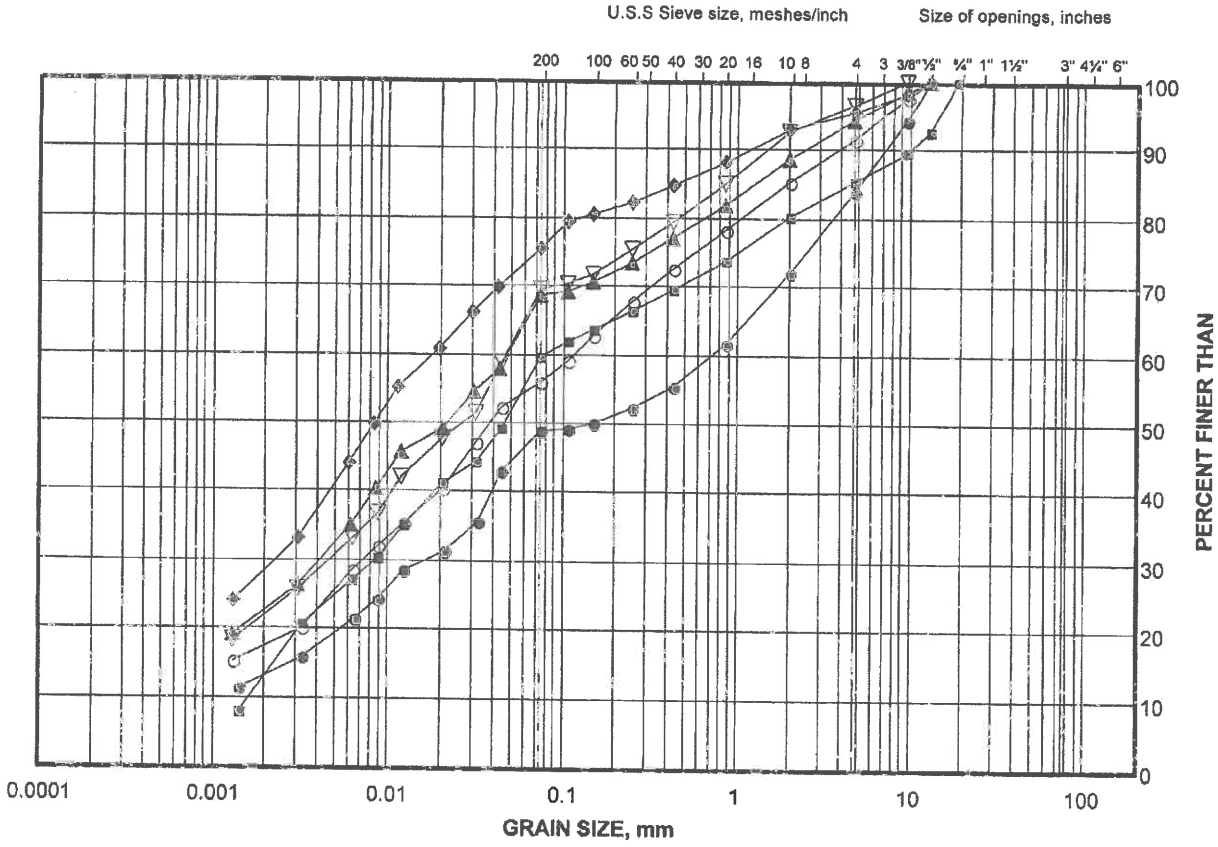
Checked By: Matt Lodge

GRAIN SIZE DISTRIBUTION TEST RESULTS

Pond 6

Clayey Silt Till

FIGURE B19



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	P6-1	10	188.3
■	P6-2	10	190.5
◆	P6-3	7	192.6
▲	P6-1	7	192.9
▽	P6-2	8	193.5
○	P6-3	9	189.6

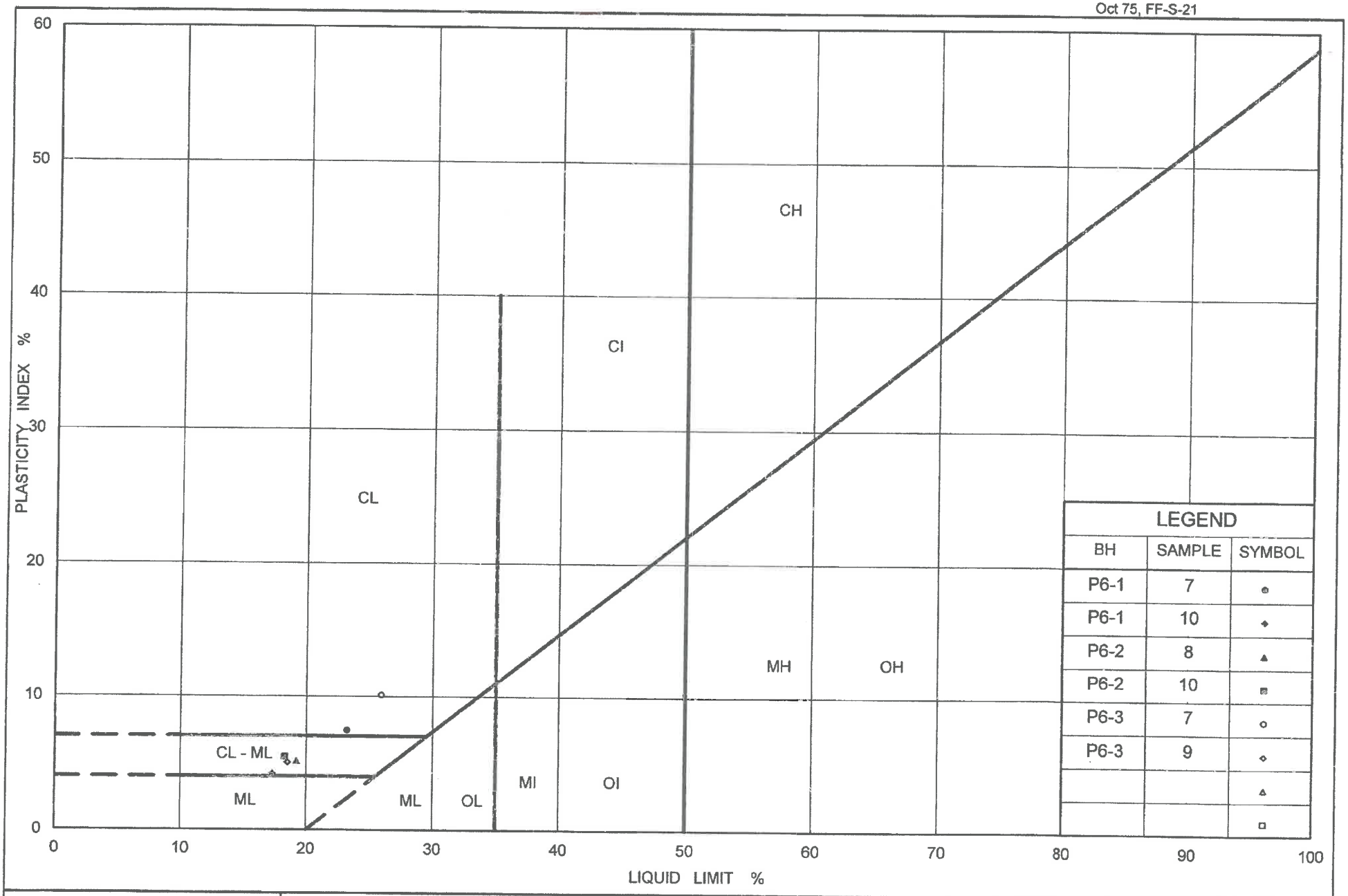
Project Number: 11-1111-0083

Checked By: Matt Foo

Golder Associates

Date: 19-Feb-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Pond 6 - Clayey Silt Till

Figure No. B20

Project No. 11-1111-0083

Checked By:

APPENDIX C

Non-Standard Special Provisions

BEDROCK EXCAVATION – Item No.

Special Provision

The shale bedrock at the site of Stormwater Management (SWM) Pond 4 is weak to medium strong, and contains interbeds of strong limestone. Appropriate construction equipment and procedures will be required for excavation into the bedrock. Bedrock excavation shall not disturb the adjacent highway facilities or utilities.

BASIS OF PAYMENT

Payment at the Contract price for the above tender item shall be full compensation for all labour, equipment and material to do the work.

END OF SECTION

DEWATERING – Item No.

Special Provision

SCOPE

The work under this item includes the design, installation, operation, maintenance and post-construction handover of dewatering systems to facilitate the construction and long-term maintenance of Stormwater Management (SWM) Ponds 4 and 6. Excavations for SWM Ponds 4 and 6 will extend below the groundwater level at these sites, and there is a risk of excavation base instability during initial construction, as well as during future maintenance in the event that the pond is fully drained.

REFERENCES

OPSS 518 Construction Specification for Control of Water from Dewatering Operations

SUBMISSION AND DESIGN REQUIREMENTS

Written details for the proposed dewatering system shall be submitted to the Contract Administrator for information purposes a minimum of ten business days prior to commencing dewatering operations. The Contractor shall reference borehole records included in the Contract Documents as a guide in determining requirements.

CONSTRUCTION

Dewatering System

The Contractor is responsible for the design, installation, operation and maintenance of an adequate dewatering system in the shale bedrock and/or soils below the base at SWM Ponds 4 and 6, to lower the groundwater level to achieve an adequate factor of safety against excavation base instability.

Operation

A continuous dewatering operation shall be provided to maintain an adequate factor of safety against excavation base instability at all times during the work. All components of the dewatering system shall be maintained in an effective, functioning and stable condition at all times during the work. Notwithstanding the above, the work shall be completed in accordance with the environmental and operational constraints specified elsewhere in the contract.

Handover

The dewatering system shall be maintained in place at SWM Ponds 4 and 6 following completion of construction, to allow for recommissioning if the ponds are required to be drained for future maintenance purposes.

BASIS OF PAYMENT

Payment at the contract price for the above tender item shall be full compensation for all labour, equipment and material to do the work.

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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