GEMTEC
www.gemtec.ca

Geotechnical and Hydrogeological Investigation
Proposed Residential Development
Creekside 2 - Village of Richmond
2770 Eagleson Road
Ottawa, Ontario

GEMTEC
www.gemtec.ca

Submitted to:

1470424 Ontario Inc.
301 Moodie Drive, Suite 100
Ottawa, Ontario
K2H 9C4

Geotechnical and Hydrogeological Investigation
Proposed Residential Development
Creekside 2 - Village of Richmond
2770 Eagleson Road
Ottawa, Ontario

February 1, 2022
Project: 61899.04

GEMTEC Consulting Engineers and Scientists Limited
32 Steacie Drive
Ottawa, ON, Canada
K2K 2A9

February 1, 2022 File: 61899.04

1470424 Ontario Inc.
301 Moodie Drive, Suite 100
Ottawa, Ontario
K2H 9C4

Attention: Chris Collins, Senior Land Development Manager

Re: Geotechnical and Hydrogeological Investigation
Proposed Residential Development
Creekside 2 – Village of Richmond
2770 Eagleson
Clarence-Rockland, Ontario

Please find enclosed our geotechnical and hydrogeological investigation report for the above noted project based on the scope of work provided in our proposal dated February 21, 2020. This report was prepared by Mr. Alex Meacoe, P.Eng., and reviewed by Mr. Brent Wiebe, P.Eng.

Do not hesitate to contact the undersigned if you have any questions or require additional information.

Alex Meacoe, P.Eng. Brent Wiebe, P.Eng.

WAM/BW

Enclosures
N:\Projects\61800\61899.04\04_Deliverables\Development\61899.04_RPT.01_GEOT_V02_2022-02-01.docx

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical and hydrogeological investigation carried out for the proposed residential development of Creekside 2 located in the Village of Richmond in Ottawa, Ontario. The purpose of the investigation was to identify the general subsurface conditions at the site by means of a limited number of boreholes and, based on the factual information obtained, to provide engineering guidelines on the geotechnical design aspects of the project, including construction considerations that could influence design decisions.

A preliminary geotechnical investigation was completed at the site by SPL Consultants Limited (SPL), and the results of that investigation are provided in the following report:

- Report to Cardel Homes, titled "Preliminary Geotechnical Investigation, Proposed Subdivision At 5831 to 5837 Perth Street and 2770 Eagleson Road, Ottawa, Ontario" dated February 2014 (Report No. 1776-710)

2.0 BACKGROUND

2.1 Project Description

Plans are being prepared for a residential development of Creekside 2 located in the Village of Richmond in Ottawa, Ontario. Based on the conceptual plan provided, the overall site is irregular in shape with plan dimensions of about 1,200 metres from north to south and ranges from about 750 metres to 1,000 metres from east to west (about 105 hectares). The site is currently agricultural lands with the Creekside residential development on the west side (adjacent to Shea Road). The proposed development will include 263 single family houses and 159 townhouse units (for a total of 422 units).

2.2 Site Geology

Based on our review of available borehole data in the Richmond area, Ministry of the Environment, Conservation and Parks (MECP) water well records, and published geological mapping of the Ottawa area, it is expected that the site is underlain by silty clay over glacial till. Drift thickness mapping indicates that the bedrock surface is expected at depths of about 5 to 25 metres, sloping down to the north. Fill material associated with previous development may also be present at the south and west portions of the site. The overburden is underlain by limestone/dolostone bedrock of the Oxford formation.

3.0 SUBSURFACE INVESTIGATION

3.1 Geotechnical Investigation

The fieldwork for this investigation of the entire site was carried out between July 3 and 20, 2020. During that time, a total of 26 boreholes were advanced using a track mounted hollow stem auger

drill rig supplied and operated by CCC Geotechnical and Environmental Drilling of Ottawa, Ontario.

Details for the boreholes advanced for the detailed design of the residential development are provided below:

- 21 boreholes, numbered 20-01A, 20-02 to 20-04, 20-05A, 20-06, 20-07A, 20-08, 20-09, 20-10A, 20-11 to 20-15, 20-16A, 20-17, 20-18A, 20-19, 20-20, 20-21, and 20-25 were advanced to depths ranging from about 6.1 to 10.4 metres below ground surface.
- 6 boreholes, numbered 20-01B, 20-05B, 20-07B, 20-10B, 20-16B, and 20-18B were advanced adjacent to boreholes 20-01A, 20-05A, 20-07A, 20-10A, 20-16A, and 20-18A, respectively, for the installation of shallow monitoring wells and/or obtaining relatively undisturbed Shelby tube samples.

Standard penetration tests were carried out in the boreholes and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler. In situ vane shear testing was carried out, where possible, in the boreholes to measure the undrained shear strength of the silty clay. Five relatively undisturbed samples of the silty clay deposit were obtained from boreholes for oedometer consolidation testing.

Well screens were sealed in the overburden at all borehole locations, except borehole 20-05B, to measure the groundwater levels and for hydraulic conductivity testing.

The fieldwork was supervised throughout by a member of our engineering staff who directed the drilling operations, logged the samples and carried out the in-situ testing. Following the fieldwork, the soil samples were returned to our laboratory for examination by a geotechnical engineer. Selected samples of the soil were tested for water content, Atterberg limits, shrinkage limits, and grain size distribution testing. Oedometer consolidation testing was carried out on the relatively undisturbed Shelby tube samples collected at boreholes 20-16 and 20-18B. Samples of the soil recovered from boreholes 20-06 and 20-16 were sent to an accredited laboratory for basic chemical testing relating to corrosion of buried concrete and steel.

The borehole locations were positioned in the field by GEMTEC personnel using our Trimble R10 GPS survey instrument. The ground elevations at the boreholes were also determined using our Trimble R10 GPS survey instrument. The elevations are referenced to geodetic datum.

Descriptions of the subsurface conditions logged in the boreholes are provided on the Record of Borehole sheets in Appendix A. The results of the laboratory tests are provided on the borehole logs and in Appendix B. The record of borehole logs from previous investigations are provided in Appendix C. The results of chemical testing completed on two soil samples are provided in Appendix D. The approximate locations of the test holes are shown on the Site Plan, Figure 1.

3.2 Multi-Channel Analysis of Surface Waves Testing

The average shear wave velocity within the upper 30 metres was measured at the site using the Multi-channel Analysis of Surface Waves (MASW) methodology. MASW is a geophysical surveying method that uses the dispersive characteristics of surface waves to measure shear velocity variations with depth. The surveying was carried out on October 5, 2020 by GEMTEC. The approximate location of the MASW survey is provided on the Borehole Location Plan, Figure 1. The results of the survey are provided in Appendix E.

4.0 SUBSURFACE CONDITIONS

4.1 General

As previously indicated, the soil and groundwater conditions identified in the boreholes are given on the Record of Borehole sheets in Appendix A. The borehole logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the method of drilling, the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at other than the test locations may vary from the conditions encountered in the boreholes. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties.

The groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities in the area.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and GEMTEC does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The following presents an overview of the subsurface conditions encountered in the boreholes advanced during this investigation.

4.2 Topsoil

A layer of topsoil was encountered at the ground surface at the borehole locations with a thickness ranging from about 50 to 200 millimetres.

4.3 Silty Clay

Native deposits of silty clay were encountered in all of the boreholes. Where fully penetrated, the silty clay extends to depths ranging from about 2.6 to 8.4 metres below ground surface.

The full depth of the silty clay in boreholes 20-07, 20-12, 20-15, and 20-19 and the upper part of the silty clay in the remaining boreholes is weathered to a grey brown crust. The weathered silty clay crust has a thickness ranging from about 2.5 to 4.4 metres and extends to depths ranging from about 2.6 to 4.6 metres below the existing ground surface (elevation ranging from about 89.2 to 91.6 metres). At boreholes 20-01 to 20-06, 20-07, 20-16, 20-18, 20-19, and 20-21 the weathered silty clay contains silty sand seams.

Standard penetration tests carried out in the weathered silty clay crust gave N values ranging from 2 to 18 blows per 0.3 metres of penetration. In situ vane shear strength tests carried out in the weathered silty clay crust gave undrained shear strengths ranging from about 80 to greater than 96 kilopascals. The results of the in situ testing reflects a stiff to very stiff consistency.

Grain size distribution tests were undertaken on four selected samples of the weathered silty clay crust from boreholes 20-06, 20-13, 20-14, and 20-20. The results are provided in Appendix B and are summarized in Table 4.1.

Table 4.1 – Summary of Grain Size Distribution Test (Weathered Crust)

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
20-06	2	08 – 1.4	0	2	45	53
20-13	3	1.5 – 2.1	0	1	38	61
20-14	3	1.5 – 2.1	0	2	41	57
20-20	3	1.5 – 2.1	0	2	37	61

The results of the Atterberg limit tests carried out on samples of the weathered silty clay crust are provided in Appendix B. The results are summarized in Table 4.2.

Table 4.2 – Summary of Atterberg Limit Test Results (Weathered Crust)

Borehole / Sample No.	Water Content (%)	Liquid Limits (%)	Plastic Limits (%)	Plasticity Index
20-01 / 3	40	41	21	20
20-02 / 2	31	42	22	20
20-03 / 3	43	43	17	26
20-04 / 3	49	41	13	28
20-05 / 3	37	46	21	25

Borehole / Sample No.	Water Content (%)	Liquid Limits (%)	Plastic Limits (%)	Plasticity Index
20-06 / 2	23	41	22	19
20-07 / 3	46	46	21	25
20-08 / 2	42	41	21	20
20-09 / 2	33	41	19	22
20-10 / 3	47	47	24	23
20-11 / 2	15	39	20	19
20-12 / 3	47	44	26	18
20-13 / 3	28	38	19	19
20-14 / 3	45	44	18	26
20-15 / 3	39	37	20	17
20-16 / 2	28	41	21	20
20-17 / 2	37	40	20	20
20-18A / 3	39	48	24	24
20-19 / 3	51	45	24	21
20-20 / 3	41	40	20	20
20-21 / 3	41	48	22	26
20-25 / 3	43	46	21	25

This testing indicates that the samples of weathered silty clay tested from the boreholes has a medium plasticity.

The water content of the weathered silty clay ranges from about 15 to 60 percent.

Below the weathered zone in boreholes 20-01 to 20-06, 20-08 to 20-11, 20-13, 20-14, 20-16, 20-17, 20-18, 20-20, 20-21, and 20-25, the silty clay is grey in colour. The silty clay was not fully penetrated in all the boreholes, but was proven to depths ranging from about 4.5 to 9.9 metres below ground surface (elevation ranging from about 83.9 to 89.3 metres).

Standard penetration tests carried out in the grey silty clay gave N values of Static Weight of Hammer “WH” to 4 blows per 0.3 metres of penetration. In situ vane shear strength tests carried out in the grey silty clay gave undrained shear strengths ranging from about 25 to greater than 96 kilopascals, which indicate a firm to very stiff consistency, generally increasing with depth.

The results of the Atterberg limit tests carried out on one sample of the silty clay are provided in Appendix B. The results are summarized in Table 4.3.

Table 4.3 – Summary of Atterberg Limit Test Results (Grey Silty Clay)

Borehole / Sample No.	Water Content (%)	Liquid Limits (%)	Plastic Limits (%)	Plasticity Index
20-18 / 5	47	44	18	26

This testing indicates that the sample of silty clay tested has a medium plasticity.

The water content of the grey silty clay ranges from about 30 to 74 percent.

Two laboratory oedometer consolidation tests were carried out on Shelby tube samples from boreholes 20-16 and 20-18B from the current investigation. The results are summarized in Table 4.4.

Table 4.4 – Summary of Oedometer Testing

Test Hole	Sample Depth (metres)	Estimated Apparent Past Preconsolidation Pressure, P_c', (kilopascals)	Calculated Existing Vertical Effective Stress, P_o' (kilopascals)	Initial Void Ratio, e_o	Recompression Index, C_r	Compression Index, C_c
20-16	4.9	175	58	1.80	0.04	1.74
20-18B	4.9	150	49	1.93	0.04	2.05

Plots of the variation in void ratio with applied stress from the consolidation tests from the current investigation are presented in Appendix B.

4.4 Clayey Silt

A deposit of clayey silt with some sand and trace gravel was encountered below the silty clay in borehole 20-11. The clayey silt deposit has a thickness of about 1.0 metres and extends to a depth of about 5.5 metres below ground surface (elevation of about 88.3 metres).

One standard penetration test carried out in the clayey silt deposit gave an N value of 4 blows per 0.3 metres of penetration, which indicates a very loose relative density.

One grain size distribution test was undertaken on a sample of the clayey silt from borehole 20-11. The results are provided in Appendix B and are summarized in Table 4.5.

Table 4.5 – Summary of Grain Size Distribution Test (Clayey Silt)

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
20-11	7	4.6 – 5.2	1	13	52	34

The water content of one sample of the clayey silt is about 40 percent.

4.5 Glacial Till

A deposit of glacial till was encountered below the silty clay and clayey silt in boreholes 20-01, 20-02, 20-04, 20-07 to 20-12, 20-15, 20-17 to 20-19, and 20-25. The glacial till was not fully penetrated in the boreholes but was proven to depths ranging from about 5.3 to 10.4 metres below ground surface (elevation ranging from about 83.3 to 88.8 metres).

The glacial till is a heterogeneous mixture of all grain sizes, which at this site, can be described as grey silty sand with trace to some gravel and clay to gravelly silty sand with some clay. Although not encountered in the borehole locations directly, the glacial till deposits in this area are known to contain cobbles and boulders.

Standard penetration tests carried out in the glacial till deposit gave N values ranging from 1 to 109 blows per 0.3 metres of penetration, which indicates a very loose to very dense relative density.

Two grain size distribution test were undertaken on select samples of the glacial till from boreholes 20-15 and 20-19. The results are provided in Appendix B and are summarized in Table 4.6.

Table 4.6 – Summary of Grain Size Distribution Test (Glacial Till)

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
20-15	5	3.1 – 3.7	21	43	25	11
20-19	5	3.1 – 3.7	9	45	27	19

The water content of the glacial till ranges from about 10 to 22 percent.

4.6 Sand

A deposit of sand with trace to some gravel was encountered below the glacial till in boreholes 20-12 and 20-15. The sand deposit was not fully penetrated by the boreholes but was proven to

depths of about 6.7 and 6.1 in boreholes 20-12 and 20-15, respectively (elevations of about 87.2 and 88.0 metres, respectively).

Standard penetration tests carried out in the sand deposit gave N values ranging from 6 to 28 blows per 0.3 metres of penetration, which indicates a loose to compact relative density.

One grain size distribution test was undertaken on a sample of the sand from borehole 20-15. The results are provided in Appendix B and are summarized in Table 4.7.

Table 4.7 – Summary of Grain Size Distribution Test (Sand)

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
20-15	8	5.5 – 5.9	1	92	2	5

The water content of one sample of the sand is about 19 percent.

4.7 Auger Refusal

Auger refusal was encountered in borehole 20-07 at a depth of about 6.5 metres below ground surface (elevation of about 87.3 metres).

4.8 Groundwater Levels

Well screens were installed in the overburden at all the borehole locations, with the exception of 20-05B. The groundwater levels measured in the well screens on September 30, 2020 are summarized in Table 4.8.

Table 4.8 – Groundwater Depth and Elevation

Borehole No.	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)	Date of Reading
20-01A	2.4	91.5	September 30, 2020
20-01B	2.2	91.7	September 30, 2020
20-02	1.7	91.9	September 30, 2020
20-03	0.3	93.1	September 30, 2020
20-04	1.7	92.1	September 30, 2020
20-05A	2.1	91.5	September 30, 2020

Borehole No.	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)	Date of Reading
20-06	2.0	91.7	September 30, 2020
20-07A	2.1	91.7	September 30, 2020
20-07B	2.4	91.4	September 30, 2020
20-08	1.8	91.9	September 30, 2020
20-09	2.2	91.6	September 30, 2020
20-10A	-[1]	-	September 30, 2020
20-10B	2.1	91.6	September 30, 2020
20-11	2.3	91.5	September 30, 2020
20-12	2.6	91.3	September 30, 2020
20-13	1.8	92.1	September 30, 2020
20-14	2.2	91.7	September 30, 2020
20-15	2.4	91.6	September 30, 2020
20-16A	2.6	91.1	September 30, 2020
20-16B	1.5	92.3	September 30, 2020
20-17	1.3	92.5	September 30, 2020
20-18A	-[1]	-	September 30, 2020
20-18B	2.1	91.9	September 30, 2020
20-19	2.5	91.7	September 30, 2020
20-20	1.2	92.6	September 30, 2020
20-21	0.9	92.9	September 30, 2020
20-25	1.5	91.4	September 30, 2020

Notes: Monitoring well 20-10A and 20-18A compromised; blockages identified.

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.9 Hydraulic Test Results

The results of the hydraulic testing carried out in select monitoring wells are provided in Appendix F. A summary of the recovery measurements made during the hydraulic testing carried out by introducing/removing a slug into the well screens is provided in Table 4.9.

Table 4.9 – Summary of Falling Head and Rising Head Test Results

Borehole	Geological Material Tested	Static Groundwater Depth (metres bgs)	Recovery Falling Head Test[1] (min / %)	Recovery Rising Head Test[2] (min / %)	Calculated *k* Falling Head (m/s)[3]	Calculated *k* Rising Head (m/s)[3]
20-01A	Glacial Till	2.14	24.5 / 86	-	7×10^{-7}	-
20-01B	Silty Clay	2.41	28 / 90	-	2×10^{-6}	-
20-03	Silty Clay	0.83	33 / 67	-	3×10^{-7}	-
20-07A	Glacial Till	2.52	36 / 43	-	1×10^{-7}	-
20-07B	Silty Clay / Glacial Till	2.44	23.5 / 78	-	4×10^{-7}	-
20-11	Silty Clay	2.36	20 / 88	14 / 85	1×10^{-5}	1×10^{-5}
20-14	Silty Clay	2.23	23.5 / 97	-	2×10^{-6}	-
20-16A	Silty Clay	2.59	20 / 97	22 / 90	2×10^{-6}	1×10^{-6}
20-16B	Silty Clay	1.36	7 / 95	6 / 95	7×10^{-6}	7×10^{-6}
20-19	Silty Clay / Glacial Till	2.53	9.5 / 88	-	2×10^{-5}	-

Notes:
1. Falling head test were completed by inserting a slug with a known displacement (0.45 or 0.60 metre). The water level was monitored manually using a water level meter and electronically using a VanEssen Diver Datalogger, recording at 0.5 minute intervals.
2. Rising head tests were completed by removing a slug with a known displacement (0.45 or 0.60 metre), after completion of the falling head test. The water level was monitored manually using a water level meter and electronically using a VanEssen Diver Datalogger, recording at 0.5 minute intervals
3. The hydraulic conductivities were calculated using the Hvorslev solution in an unconfined aquifer.

The falling head tests (i.e. inserting a slug) recorded minimal water level recovery in most boreholes, with less than 90 percent recovery after 20 to 35 minutes. As a result, rising head testing (i.e. removing the slug) could not be completed. Hydraulic conductivity estimates calculated for silty clay and glacial till at the site range from 1 x 10^{-7} to 2 x 10^{-5} metres per second. Literature values of hydraulic conductivity for silty clay and glacial till (Freeze and Cherry, 1979) range from approximately 1 x 10^{-12} to 1 x 10^{-6} metres per second.

The majority of calculated hydraulic conductivities are considered representative of literature values for silty clay and glacial till, with the exception of boreholes 20-11 and 20-19 which had slightly higher calculated hydraulic conductivities compared to literature values. The higher hydraulic conductivity may be attributed to the variability of the fine-textured glaciomarine soils (e.g. glacial till) encountered on-site.

Given the range of calculated hydraulic conductivities and the presence of higher permeability soils on-site, as indicated on borehole logs (e.g. clayey silt and sand layers at depths ranging from 4.5 to 5.3 metres below ground surface in boreholes 20-11, 20-12 and 20-15), the hydraulic conductivity of the overburden soils is expected to be variable across the site.

4.10 Soil Chemistry Relating to Corrosion

The results of chemical testing on soil samples recovered from boreholes 20-06 and 20-16 are provided in Appendix D and are summarized in Table 4.10.

Table 4.10 – Summary of Corrosion Testing

Parameter	Borehole 20-06 Sample No. 3 Depth: 1.5 to 2.1 m	Borehole 20-16 Sample No. 3 Depth 1.5 to 2.1
Chloride Content (ug/g)	14	12
Resistivity (Ohm.m)	67.9	75.7
pH	7.7	7.7
Sulphate Content (ug/g)	8	< 5

4.11 Subsurface Investigation by SPL

Based on the results of the boreholes advanced during the previous investigation by SPL, the subsurface conditions generally consist of silty clay over glacial till.

The silty clay generally extends to depths ranging from about 3.6 to 11.6 metres below surface grade. Three laboratory oedometer consolidation tests were carried out on samples collected from boreholes 13-4, 13-5, and 13-8 and gave preconsolidation pressures ranging from about

100 to 290 kilopascals. However, based on a review of the results from borehole 13-8, it is considered possible that the sample was disturbed prior to testing and the results may not be representative of the actual preconsolidation pressure of the sample. The results of the laboratory consolidation testing by SPL are provided in Appendix C.

A deposit of silty sand was encountered below the silty clay in borehole 13-4. The silty sand layer extends to a depth of about 9.1 metres below surface grade.

Deposits of glacial till exist below the silty clay. The glacial till generally consists of gravelly silty sand to silty sand and was proven to depth ranging from about 8.2 to 13.6 metres below surface grade.

Refusal to dynamic cone penetration testing was encountered in borehole 13-2 at a depth of about 11.8 metres below ground surface. The limestone bedrock was encountered in boreholes 13-4 and 13-8 at depths of about 12.3 and 13.6 metres below ground surface.

Well screens were installed in the overburden at select borehole locations. The groundwater levels measured in the well screens on August 28, 2013 and January 27, 2014, and are summarized in the table below.

Table 4.11 – Groundwater Depth and Elevation from SPL

Borehole No.	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)	Date of Reading
13-2	1.3	92.7	August 28, 2013
	0.6	93.4	January 17, 2014
13-4	1.6	92.0	August 28, 2013
	0.9	92.7	January 17, 2014
13-6	1.6	92.1	August 28, 2013
	1.1	92.6	January 17, 2014
13-8	1.3	-	January 17, 2014
13-9	0.9	-	January 17, 2014

5.0 GEOTECHNICAL GUIDELINES

5.1 General

The information in the following sections is provided for the guidance of the design engineers and is intended for the design of this project only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services retained for this project include only the geotechnical aspects of the subsurface conditions. The implications of possible surface and/or subsurface contamination resulting from previous uses or activities of this site or adjacent properties, and/or resulting from the introduction onto the site from materials from offsite sources are outside the terms of reference for this report and have not been addressed.

5.2 Site Grade Raise Restrictions

The development is underlain by deposits of sensitive silty clay, which has a limited capacity to support loads imposed by grade raise fill material, pavement structures and foundations for the houses. The placement of fill material on this site must therefore be carefully planned and controlled so that the stress imposed by the fill material does not result in excessive consolidation of the silty clay deposit. Concrete slabs, granular base materials, overall grade raise and pavement structures are considered grade raise filling. Groundwater lowering also results in a stress increase on the underlying sensitive silty clay deposit.

Based on the results of the subsurface investigation in conjunction with the oedometer consolidation test results, the maximum thickness of any grade raise filling should be limited to the following within the assessment areas as shown in the table below:

Table 5.1: Maximum Permissible Grade Raise

Assessment Area	Maximum Permissible Grade Raise (metres)
A	2.7
B	1.7
C	1.9

The grade raise restriction for the residential development has been calculated in order to limit the total settlement of the ground to about 25 millimetres in the long term. For design purposes, we have made the following assumptions:

- The groundwater lowering due to the development at this site will be at most 0.5 metres below the underside of footing elevation;
- The unit weight of the grade raise material used in the vicinity of the structures is not greater than 20.0 kilonewtons per cubic metre; and,
- The grade raise fill material used below the structures, where required, will be composed of compacted granular material having a unit weight of 21.5 kilonewtons per cubic metre.

If heavier grade raise fill material is used, the maximum grade raise will have to be reduced accordingly.

As previously indicated, the proposed grades within the development are generally up to about 3.0 metres above original grade. Based on our review of the proposed grades, it is anticipated that the use of expanded polystyrene (EPS) blocks or surcharge preloading will be required in Areas B and C. As a preliminary assessment, the EPS should extend at least 2.4 metres beyond the entire perimeter of the foundations and within the garages and porches, where necessary. EPS blocks could also by used below the roadways. Additional information regarding the use of EPS blocks or surcharging could be provided as the design progresses.

Given the thickness of grade raise filling, we suggest that the placement of the grade raise fill material be carried out well in advance of construction (i.e., 6 months or more), where possible, in order to minimize the amount of post construction settlement.

5.3 Proposed Buildings

5.3.1 Excavation

The excavations for the foundations should be taken through topsoil to expose undisturbed native silty clay, and possibly into the glacial till. The sides of the excavations should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the shallow native overburden deposits can be classified as Type 3 and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical extending upwards from the base of the excavation.

Based on our previous experience, groundwater inflow from the silty clay deposits into the excavations should be relatively small and controlled by pumping from filtered sumps within the excavations. It is not expected that short term pumping during excavation will have any significant effect on nearby structures and services.

5.3.2 Foundation Design

The native silty clay deposits are considered suitable for the support of residential structures founded on conventional spread footing foundations.

In areas where proposed founding level is above the level of the native soil, or where subexcavation of disturbed material is required below proposed founding level, imported granular material (engineered fill) should be used. The engineered fill should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type II and should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. In areas where groundwater inflow is encountered, pumping should be carried out from sumps in the excavation during placement of the engineered fill. To allow spread of load beneath the footings, the engineered fill should extend horizontally at least 0.3 metres beyond the footings and then down and out from this point at 1 horizontal to 1 vertical, or flatter. The excavations for the residential dwellings should be sized to accommodate this fill placement. The engineered fill should be placed in accordance with the site grade raise restrictions.

Spread footings founded on or within native undisturbed silty clay deposits, or on a pad of compacted granular material above native, undisturbed soil should be sized using an allowable bearing pressure of 75 kilopascals. Provided that any loose or disturbed soil is removed from the bearing surfaces, and the grade raise restrictions provided above are adhered to, the settlement of the footings should be less than 25 millimetres.

5.3.3 Seismic Site Class

Based on the results of the investigation, it is anticipated that the proposed foundations will be supported on a deposit of stiff to very stiff weathered silty clay crust or glacial till or a pad of engineered fill constructed on the weathered crust or glacial till.

The seismic design provisions of the 2012 Ontario Building Code (OBC) depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or rock below founding level. The results of the MASW testing indicate an average shear wave velocity (V_s30) at the site of about 479 and 442 metres per second for survey lines 1 and 2, respectively. Based on these values, this site can be assigned a Site Class of C for seismic design purposes.

There is no potential for liquefaction of the overburden deposits at this site.

5.3.4 Frost Protection of Foundations

All exterior footings should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated (unheated) footings that are located in areas that are to be cleared of snow should be provided with at least 1.8 metres of earth cover for frost protection purposes. Alternatively, the required frost protection could be provided by means of a combination of earth

cover and extruded polystyrene insulation. Further details regarding the insulation of foundations could be provided, if necessary.

5.3.5 Backfill and Drainage

5.3.5.1 Basement Foundation Walls

In accordance with the Ontario Building Code, the following alternatives could be considered for drainage of the basement foundation walls:

- Damp proof the exterior of the foundation walls and backfill the walls with free draining, non-frost susceptible sand or sand and gravel such as that meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type I or II. OR
- Damp proof the exterior of the foundation walls, install an approved proprietary drainage material on the exterior of the foundation walls and backfill the walls with native material or imported soil.

Where the backfill will ultimately support areas of hard surfacing (pavement, sidewalks or other similar surfaces), the backfill should be placed in maximum 200 millimetre thick lifts and should be compacted to at least 95 percent of the standard Proctor maximum dry density value using suitable compaction equipment. Where future landscaped areas will exist next to the proposed structure and if some settlement of the backfill is acceptable, the backfill could be compacted to at least 90 percent of the standard Proctor maximum dry density value.

A perforated drain should be installed around the basement area at the level of the bottom of the footings. The drain should outlet by gravity to a storm sewer or to a sump pit from which the water is pumped.

5.3.5.2 Garage Foundation Walls and Isolated Piers

To avoid adfreeze and possible jacking (heaving) of the foundation walls, the interior and exterior of the garage foundation walls should be backfilled with free draining, non-frost susceptible sand or sand and gravel such as that meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type I or II. The backfill within the garage should be compacted in maximum 300 millimetres thick lifts to at least 95 percent of the standard Proctor dry density value using suitable vibratory compaction equipment.

The backfill against isolated (unheated) walls or piers should consist of free draining, non-frost susceptible material, such as sand or sand and gravel meeting OPSS Granular B Type I or II requirements. Other measures to prevent frost jacking of these foundation elements could be provided, if required.

5.3.6 Lateral Earth Pressures

Foundation walls that are backfilled with granular material such as that meeting OPSS Granular B Type I or II requirements should be designed to resist "at rest" earth pressures calculated using the following formula:

$P_o = 0.5\ K_o\ \gamma\ H^2$

where;

- P_o: Static "At Rest" thrust (kilonewtons per metre);
- γ: Moist material unit weight (kilonewtons per cubic metre);
- K_o: "At Rest" earth pressure coefficient;
- H: Wall height (metre).

Seismic shaking can increase the forces on the retaining wall. The total "At Rest" thrust acting on the walls (P_{oe}) during a seismic event is composed of a static component (P_o) and a dynamic component (P_e), that is:

$P_{oe} = P_o + P_e$

The dynamic at rest thrust component (P_e), which acts only during seismic loading conditions, should be calculated using the following formula:

$P_e = 0.5\ (K_{oe} - K_o)\ \gamma\ H^2$

where;

- P_e: Total "At Rest" thrust (kilonewtons per metre);
- γ: Moist material unit weight (kilonewtons per cubic metre);
- K_o "At Rest" earth pressure coefficient
- K_{oe}: Dynamic "At Rest" earth pressure coefficient;
- H: Wall height (metre).

The static thrust component (P_o) acts at a point located H/3 above the base of the wall. During seismic shaking, the dynamic at rest thrust component (P_o) acts at a point located about 0.6H above the base of the wall.

For design purposes, the parameters provided in Table 5.2 can be used to calculate the thrust acting on the walls during static and seismic loading conditions.

Table 5.2 – Summary of Design Parameters (Building Foundation Walls)

Parameter	OPSS Granular B Type I	OPSS Granular B Type II
Material Unit Weight, γ (kilonewtons per cubic metre)	22	22
Estimated Friction Angle (degrees)	34	38
"At Rest" Earth Pressure Coefficient, K_o, assuming horizontal backfill behind the structure	0.44	0.38
Dynamic "At Rest" Earth Pressure Coefficient, K_{oe}, assuming horizontal backfill behind the structure	0.46[1]	0.40[1]

Notes:

1) According to the 2015 National Building Code of Canada, the peak ground acceleration (PGA) for this site is 0.26 for Site Class C. The dynamic at rest earth pressure coefficient was calculated using the method suggested by Mononobe and Okabe, assuming a horizontal seismic coefficient, kh, of 0.13 and assuming that the vertical seismic coefficient, kv, is zero.

Heavy construction traffic should not be allowed to operate adjacent to foundation walls for the proposed building (within about 2 metres horizontal) during construction, without the approval of the designers.

5.3.7 Basement Floor Slabs

To provide predictable settlement performance of basement slabs, all topsoil, loose soil, or debris should be removed from the slab area. The base of the floor slab should consist of at least 200 millimetres of 19 millimetre clear crushed stone. Any necessary grade raise fill should consist of either 19 millimetre clear crushed stone or OPSS Granular B Type II. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular B Type II material. Since the source of recycled material cannot be determined or controlled, it is suggested that any imported Granular B Type II materials be composed of 100 percent crushed rock only.

The clear crushed stone should be nominally compacted in maximum 300 millimetre thick lifts with at least 2 passes of a diesel plate compactor. The Granular B Type II should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment.

The ACI 302.1R-04 "Guide for Concrete Floor and Slab Construction" should be referenced for design purposes.

A polyethylene vapour retarder is recommended below the floor slabs.

5.3.8 Effects of Agricultural Tile Drains

It is likely that some of the agricultural fields within the subject site are tile drained. Any agricultural tile drains encountered within the house excavations could be a source of significant volumes of water, which could impact on the basements of the houses. It is suggested that any drainage tiles that are within about 2 metres horizontal distance to the dwellings be removed and the excavation for the tiles backfilled with compacted silty clay to prevent any water flow through the tiles or trench. The silty clay could be compacted with the bucket of the excavator. Any drainage tiles that are below proposed footings should be removed. The ends of the drains should be severed at least 2 metres outside of the proposed basement foundations to reduce the potential for post construction groundwater inflow into the basements. The excavation for the tiles should be backfilled with compacted silty clay as described above.

5.3.9 Corrosion of Buried Concrete and Steel

According to Canadian Standards Association (CSA) "Concrete Materials and Methods of Concrete Construction", the concentration of sulphate in the soil samples recovered from borehole 20-303 can be classified as low. For low exposure conditions, any concrete that will be in contact with the native soil or groundwater could be batched with General Use (GU) type cement. The effects of freeze thaw in the presence of de-icing chemical (sodium chloride) near the building should be considered in selecting the air entrainment and the concrete mix proportions for any exposed concrete.

Based on the resistivity and pH of the soil samples tested the soil can be generally classified as non aggressive toward unprotected steel. It is noted that the corrosivity of the soil could vary throughout the year due to the application sodium chloride for de-icing.

5.4 Site Services

5.4.1 Excavation

The overburden excavations for the site services will be carried out through topsoil, weathered silty clay crust, and into the grey silty clay, and possibly the glacial till.

In the overburden, the excavation for flexible service pipes should be in accordance with Ontario Provincial Standard Drawing (OPSD) 802.010 for Type 3 soil. The excavation for rigid service pipes should be in accordance with OPSD 802.031 for Type 3 soil.

The sides of the excavations within overburden soils should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, most of the soils at this site can be classified as Type 3 soils. Therefore, for design purposes, allowance should be made for 1 horizontal to 1 vertical, or flatter, excavation slopes. For excavations below the groundwater, an allowance should be made for 3 horizontal to 1 vertical, or flatter, excavation slope.

As an alternative or where space constraints dictate, the service installations could be carried out within a tightly fitting, braced steel trench box, which is specifically designed for this purpose.

Based on our observations on site, groundwater inflow from the overburden deposits into the excavations should be controlled by pumping from filtered sumps within the excavations. It is not expected that short term pumping during excavation will have any significant affect on nearby structures and services.

5.4.2 Groundwater Pumping

Based on the results of the investigation, it is anticipated that the groundwater inflow into excavations for site services could be handled by pumping from within the excavations. It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services. Suitable detention and filtration will be required before discharging water. The contractor should be required to submit an excavation and groundwater management plan for review.

It is anticipated that the water takings for this project will be less than 400,000 litres per day, assuming a single open excavation with approximate dimensions of 30 metres length by 4.5 metres width and up to 5 metres below ground surface. The rate of groundwater inflow will generally be limited by the low permeability soils; however, higher permeability soils were encountered at depths of approximately 5 metres below ground surface (i.e. clayey silt and sand layers) which can result in increased groundwater inflows. Depending on the time of year the work is carried out, and given the likelihood of carrying out multiple, consecutive open excavations, a Category 3 Permit to Take Water (PTTW) is recommended. For completion of a Category 3 PTTW, an additional hydrogeological investigation report will be required to support the PTTW application. The application may take up to three months to be reviewed by the Ministry of Environment, Conservation and Parks (MECP).

5.4.3 Bedding and Cover

The bedding and cover for the proposed utilities should consist of least 150 millimetres of OPSS Granular A backfill placed in accordance with the applicable Ontario Standard Drawings (OPSD) for the type of underground utility installed. The use of 19 millimetre clear stone is not recommended as bedding or cover.

The native silty clay deposits below the groundwater level are sensitive to disturbance. An allowance should be made for a subbedding composed of at least 300 millimetres of OPSS Granular B Type II where these materials are encountered at subgrade level below the pipe.

Bedding, subbedding and cover materials should be placed in lifts not exceeding 200 millimetres thick and compacted to at least 98 percent of standard Proctor density (ASTM D698).

5.4.4 Trench Backfill

In areas where the service trench will be located below or in close proximity to existing or future areas of hard surfacing (i.e., access roadways and parking), acceptable native materials should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetration in order to reduce the potential for differential frost heaving between the area over the trench and the adjacent hard surfaced area. The depth of frost penetration in exposed areas can normally be taken as 1.8 metres below finished grade. Where native backfill is used, it should match the native materials exposed on the trench walls. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming to OPSS Granular B Type I.

It is anticipated that most of the inorganic overburden materials encountered during the subsurface investigation will be acceptable for reuse as trench backfill. Topsoil or other organic material should be wasted from the trench.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadways, curbs, driveways, etc., the trench backfill should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. The specified density for compaction of the backfill materials may be reduced where the trench backfill is not located below or in close proximity to existing or future areas of hard surfacing and/or structures, provided that some settlement above the trench is acceptable.

The unweathered grey silty clay deposits have water contents that are too high for adequate compaction. Furthermore, depending on the weather conditions at the time of construction, some wetting of materials could occur. As such, the specified densities may not be possible to achieve and, as a consequence, some settlement of these backfill materials should be expected. Consideration could be given to implementing one or a combination of the following measures to reduce post construction settlement above the trenches, depending on the weather conditions encountered during the construction:

- Allow the overburden materials to dry prior to compaction;
- Reuse any wet materials in the lower part of the trenches and make provision to defer final paving of surface course (i.e., the Superpave 12.5 asphaltic concrete) in the roadway for 3 months, or longer, to allow the trench backfill settlement to occur and thereby improve the final roadway appearance.

5.4.5 Seepage Barriers

The granular bedding in the service trench could act as a “French Drain”, which could promote groundwater lowering. As such, we suggest that seepage barriers be installed along the service trenches at strategic locations at a horizontal spacing of about 100 metres. The seepage barriers should begin at subgrade level and extend vertically through the granular pipe bedding and

granular surround to within the native backfill materials, and horizontally across the full width of the service trench excavation. The seepage barriers could consist of 1.5 metre wide dykes of compacted weathered silty clay. The weathered silty clay should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. The locations of the seepage barriers could be provided as the design progresses.

5.4.6 Post-Construction Settlement

Along the proposed roadway within the development, the proposed grades range from about 2 to 3 metres above original surface grade. The design of the services should consider some differential settlement between these areas (i.e., sagging of the pipes should be anticipated within the heavily filled areas). The amount of differential settlement is expected to be less than 25 millimetres. We suggest that the placement of the grade raise fill material be carried out well in advance of construction (i.e., 6 months or more), where possible, in order to minimize the amount of post construction settlement.

5.5 Roadway Construction

5.5.1 Subgrade Preparation

In preparation for roadway construction at this site, all surficial topsoil and any soft, wet or deleterious materials should be removed from the proposed roadways. Any subexcavated areas could be filled with compacted earth borrow. Similarly, should it be necessary to raise the roadway grades at this site, material which meets OPSS specifications for Select Subgrade Material or Earth Borrow could be used. The Select Subgrade Material or Earth Borrow should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using vibratory compaction equipment. Prior to placing granular material for the roadway, the exposed subgrade should be heavily proof rolled and inspected and approved by geotechnical personnel. Any soft areas evident from the proof rolling should be subexcavated and replaced with suitable earth borrow approved by the geotechnical engineer.

The roadway subgrade surfaces should be made smooth and crowned or sloped prior to placing the granular materials to promote drainage of the roadway base and subbase materials.

5.5.2 Pavement Design

The following minimum pavement structure is suggested for local roadways at this site, assuming that the roadways will not be used as collector roads or bus routes:

- 90 millimetre thick layer of asphaltic concrete (40 millimetres of Superpave 12.5 Traffic Level B over 50 millimetres of Superpave 12.5 Traffic Level B); over
- 150 millimetre thick layer of base (OPSS Granular A); over
- 400 millimetre thick layer of subbase (OPSS Granular B Type II);

In the absence of detailed traffic data, the thickness of asphaltic concrete and OPSS Granular B Type II subbase should be increased for collector/arterial roadways and bus routes, as follows:

- 120 millimetre thick layer of asphaltic concrete (50 millimetres of Superpave 12.5 Traffic Level D over 70 millimetres of Superpave 19.0 Traffic Level D); over
- 150 millimetre thick layer of base (OPSS Granular A); over
- 600 millimetre thick layer of subbase (OPSS Granular B Type II);

5.5.3 Effects of Subgrade Disturbance

If the roadway subgrade surface becomes disturbed or wetted due to construction operations or precipitation, or the granular pavement materials are to be used by construction traffic (i.e., if the granular pavement materials are placed during installation of the sewers, watermains, and laterals), the Granular B Type II thicknesses provided above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase. The contractor should be responsible for providing suitable access for construction equipment.

The required thickness of the subbase materials will depend on a number of factors, including contractor workmanship and schedule, contractor methodology, soil types and weather conditions, and should be assessed by geotechnical personnel at the time of construction. In our opinion, the preferred approach from a geotechnical point of view is to:

- Proof roll the subgrade conditions at the time of construction under the supervision of experienced geotechnical personnel.
- Adjust the thickness of the subbase material and include a woven geotextile separator, as required. Unit rate allowances should be made in the contract for subexcavation and replacement with OPSS Granular B Type II.

5.5.4 Granular Material Placement

The pavement granular materials should be compacted in maximum 300 millimetre thick lifts to at least 99 percent of standard Proctor maximum dry density using suitable vibratory compaction equipment.

5.5.5 Asphaltic Cement

Performance graded PG 58-34 asphaltic cement is recommended for local roadways while performance graded PG 64-34 asphalt is recommended for collector/arterial roadways and bus routes.

5.5.6 Transition Treatments

In areas where the new pavement structure will abut existing pavements (e.g., Eagleson Road), the depths of the granular materials should taper up or down at 5 horizontal to 1 vertical, or flatter, to match the depths of the granular material(s) exposed in the existing pavement.

5.5.7 Pavement Drainage

In order to provide drainage of the granular subbase, it is suggested that catch basins be provided with perforated stub drains extending about 3 metres out from the catch basins in two directions parallel to the roadway. These drains should be installed at the bottom of the subbase layer.

In cut sections of the roadway, we recommend that longitudinal subdrains be installed along both sides of the roadway at subgrade level. The subdrains should outlet by gravity to a nearby catch basin.

5.6 Sensitive Marine Clay – Effects of Trees

The site is underlain by silty clay, a material which is known to be susceptible to shrinkage with a change/reduction in moisture content. Research by the Institute for Research in Construction (formerly the Division of Building Research) of the National Research Council of Canada has shown that trees can cause a reduction of moisture content in the silty clays in the Ottawa area, which can result in significant settlement/damage to nearby buildings supported on shallow foundations, or hard surfaced areas. Therefore, deciduous tree planting should be carried in accordance with the guidelines identified in the City of Ottawa document titled: "Tree Planting in Sensitive Marine Clay Soils – 2017 Guidelines".

The City of Ottawa Tree Planting Guidelines indicates that sensitive marine clay soils with a modified plasticity index of less than 40 percent are considered to have a low/medium potential for soil volume change. Clay soils with a modified plasticity index that exceeds 40 percent are considered to have a high potential for soil volume change.

As part of the geotechnical investigation, a soil sample at 150 metre spacing was tested in our laboratory to determine the Atterberg limits for the sensitive marine clay. A summary of the test results is provided in Table 5.3.

Table 5.3 – Summary of Modified Plasticity Index

Borehole / Sample No.	Shrinkage Limit[3] (%)	Plastic Limit[1] (%)	Liquid Limit[1] (%)	Plasticity Index[1] (%)	Modified Plasticity Index[2] (%)
20-01 / 3	-	21	41	20	20
20-02 / 2	-	22	42	20	20
20-03 / 3	-	17	43	26	25

Borehole / Sample No.	Shrinkage Limit[3] (%)	Plastic Limit[1] (%)	Liquid Limit[1] (%)	Plasticity Index[1] (%)	Modified Plasticity Index[2] (%)
20-04 / 3	14	13	41	28	27
20-05 / 3	-	21	46	25	25
20-06 / 2	-	22	41	19	19
20-07 / 3	-	21	46	25	25
20-08 / 2	-	21	41	20	20
20-09 / 2	-	19	41	22	22
20-10 / 3	-	24	47	23	23
20-11 / 2	-	20	39	19	19
20-12 / 3	-	26	44	18	18
20-13 / 3	-	19	38	19	19
20-14 / 3	-	18	44	26	25
20-15 / 3	-	20	37	17	17
20-16 / 2	-	21	41	20	20
20-17 / 2	-	20	40	20	20
20-18A / 3	17	24	48	24	24
20-19 / 3	-	24	45	21	21
20-20 / 3	-	20	40	20	20
20-21 / 3	-	22	48	26	25

1. Calculated in accordance with ASTM D4318.
2. The modified plasticity index (PI_m) was calculated using the following formula, where PI is the plasticity index determined in accordance with ASTM D4318: PI_m = PI x (% passing the 425 micrometre sieve / 100).
3. Calculated in accordance with ASTM D4943, which was discontinued in 2017 by the ASTM Sponsoring Committee responsible for the standard.

The modified plasticity index of the samples tested ranges from about 17 to 27 percent. As such, the potential for soil volume change, as defined by the City of Ottawa, is low/medium. For this site, the low/medium potential clay soils encompass the entire site.

In accordance with the City of Ottawa Tree Planting Guidelines, tree planting restrictions apply where clay soils with low/medium potential for volume change are present between the underside

of footing and a depth of 3.5 metres below finished grade (refer to the City of Ottawa document titled: “Tree Planting in Sensitive Marine Soils - 2017 Guidelines”).

According to the City of Ottawa 2017 Tree Planting Guidelines, the tree to foundation setbacks within the development can be reduced to 4.5 metres for small to medium sized trees (i.e., trees with a mature height of less than 14 metres), provided that all the following conditions are met:

- For footings within 10 metres of the proposed tree, the underside of footing must be 2.1 metres or greater below finished grade;
- The foundations are reinforced with a minimum of two upper and two lower 15M bars in the foundation wall;
- Grading surrounding the tree must promote draining to the tree root zone; and,
- A small size tree (i.e., a tree with a mature height of less than 7.5 metres) must be provided with a minimum of 25 cubic metres of available soil volume. For medium size trees (i.e., trees with a mature height of between 7.5 and 14 metres), a minimum soil volume of 30 cubic metres must be provided.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Effects of Construction Induced Vibration

Some of the construction operations (such as granular material compaction, excavation, etc.) will cause ground vibration on and off of the site. The vibrations will attenuate with distance from the source, but may be felt at nearby structures. The magnitude of the vibrations will be much less than that required to cause damage to the nearby structures or services in good condition.

6.2 Monitoring Well Abandonment

All monitoring wells installed as part of this investigation should be decommissioned by a licensed well technician. The well abandonment could be carried out in advance of or during construction.

6.3 Disposal of Excess Soil

It is noted that the professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination, including naturally occurring source of contamination, are outside the terms of reference for this report. This report does not constitute a Phase II Environmental Site Assessment (ESA) nor does it constitute a contaminated material management plan.

6.4 Design Review and Construction Observation

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed excavations do

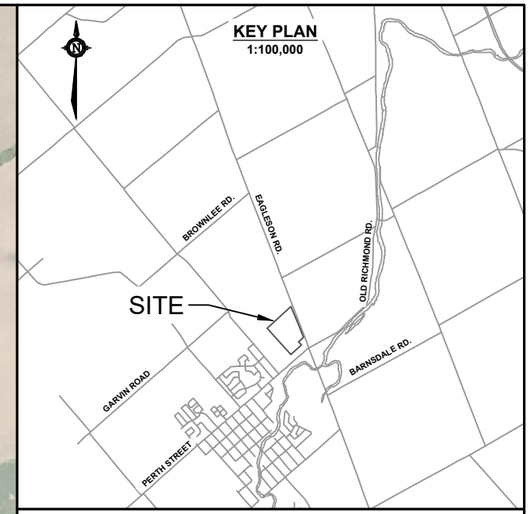
not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. The subgrade surfaces for the houses, services, and roadways should be inspected by experienced geotechnical personnel to ensure that suitable materials have been reached and properly prepared. The placing and compaction of earth fill and imported granular materials should be inspected to ensure that the materials used conform to the grading and compaction specifications.

7.0 CLOSURE

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

Alex Meacoe, P.Eng.
Geotechnical Engineer

Brent Wiebe, P.Eng.
VP Operations - Ontario



LEGEND

- **BOREHOLE LOCATION IN PLAN** (current investigation by GEMTEC)
- **BOREHOLE LOCATION IN PLAN** (previous investigation by SPL CONSULTANTS LTD, (February 2014))
- **BOREHOLE LOCATION IN PLAN** (previous investigation by GOLDER ASSOCIATES, (August 2015))

BH/TP # ← BH/TP ID

XX.XX ← GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

APPROXIMATE LOCATION OF RESIDENTIAL DEVELOPMENT SITE BOUNDARY

MASW TEST LOCATION

Scale 1:7500

0 150 300 450m

GEMTEC
Consulting Engineers and Scientists
32 Steacie Drive
Ottawa, ON K2K 2A9
Tel: (613) 836-1422
www.gemtec.ca
ottawa@gemtec.ca

Client	Project
CARDEL HOMES	61899.04

Location: CREEKSIDE DEVELOPMENT 2, EAGLESON ROAD, OTTAWA, ON

Drwn by	Chkd by	
A.N.	W.A.M.	SITE PLAN

Date	Rev.	
DECEMBER 2020	0	**FIGURE 1**

APPENDIX A

Record of Borehole Sheets – Current Investigation
List of Abbreviations and Symbols

RECORD OF BOREHOLE 20-01A

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 16 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED); WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Hollow Stem Auger (210mm OD)	Ground Surface		93.88							
		TOPSOIL		93.68							
		Stiff to very stiff, grey brown SILTY CLAY, with sand seams (WEATHERED CRUST)		0.20	1	SS	205	12			Above Ground Protector & Bentonite
1					2	SS	100	7			
2					3	SS	455	5			Soil Cuttings
					4	SS	610	9			
3					5	SS	610	4			
				90.07							
4		Stiff, grey SILTY CLAY		3.81	6	SS	610	2			
					7	SS	610	WH			Bentonite
5											
				88.09							
6		Very loose to compact, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		5.79	8	SS	610	7			
7					9	SS	50	1			Filter Sand
					10	SS	610	3			50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
8					11	SS	455	3			Cave
9					12	SS	310	15			Cave
				84.13							
10		End of borehole		9.75							
11											
12											

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL, ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.4 ▽	91.5

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-01B

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 16 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		93.88							
		TOPSOIL		93.68							
	Power Auger Hollow Stem Auger (210mm OD)	Stiff to very stiff, grey brown SILTY CLAY, with sand seams (WEATHERED CRUST)		0.20							Bentonite; Soil Cuttings; Bentonite; Filter Sand; 50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
4		End of borehole Soil stratigraphy inferred from BH 20-1A		90.04 3.84							

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.2 ▽	91.7

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-02

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

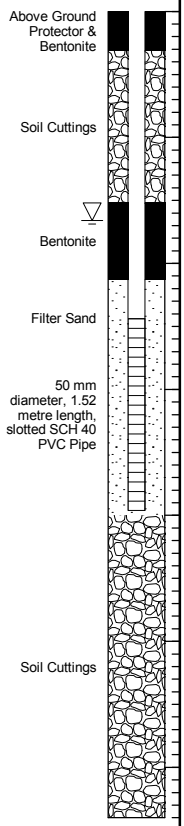
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 16 2020

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
		Ground Surface		93.59				
0	Power Auger Hollow Stem Auger (210mm OD)	TOPSOIL		93.39 0.20	1	SS	205	9
		Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)			2	SS	455	7
1					3	SS	610	7
2					4	SS	610	6
3					5	SS	610	4
				89.78 3.81				
4		Stiff, grey SILTY CLAY			6	SS	610	4
5				88.41 5.18				
		Loose to compact grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			7	SS	310	9
6					8	SS	310	25
				87.19 6.40				
		End of borehole						
7								
8								
9								
10								
11								
12								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.7 ▽	91.9

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

RECORD OF BOREHOLE 20-03

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 17 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		93.44					MH	Above Ground Protector & Bentonite
		TOPSOIL		93.29 / 0.15	1	SS	150	6		
1		Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)			2	SS	405	6		Soil Cuttings
2					3	SS	510	3		Bentonite
					4	SS	610	5		Filter Sand
3					5	SS	610	6		50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
				89.63 / 3.81						
4		Stiff, grey SILTY CLAY			6	SS	610	WH		
5					7	SS	610	WH		Soil Cuttings
					8	SS	610	WH		
6				86.89 / 6.55						
		End of borehole								
7										
8										
9										
10										
11										
12										

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL, ⊕ REMOULDED
WATER CONTENT, % — W_P — W — W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	0.3 ▽	93.1

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-04

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 3 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Hollow Stem Auger (210mm OD)	Ground Surface		93.73							
		TOPSOIL		0.08							
		Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)			1	SS	405	8			
1					2	SS	460	10			
2					3	SS	405	6			
					4	SS	610	5			
3					5	SS	610	4			
				90.07							
		Stiff to very stiff, grey SILTY CLAY		3.66	6	SS	310	1			
4											
5				88.40							
		Very loose to loose, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		5.33	7	SS	405	2			
6					8	SS	355	5			
				87.02							
		End of borehole		6.71							
7											
8											
9											
10											
11											
12											

PIEZOMETER OR STANDPIPE INSTALLATION:
- Above Ground Protector & Bentonite
- Soil Cuttings
- Bentonite
- Filter Sand
- 50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.7	92.1

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-05A

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 15 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		93.58							
		TOPSOIL		93.45 / 0.13	1	SS	205	18			Above Ground Protector & Bentonite
		Stiff to very stiff, grey brown SILTY CLAY, trace sand (WEATHERED CRUST)			2	SS	100	9			Soil Cuttings
1											
2	Power Auger / Hollow Stem Auger (210mm OD)				3	SS	455	5			Bentonite
					4	SS	610	4			Filter Sand
3											50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
					5	SS	610	2			
4		Firm to stiff, grey SILTY CLAY		89.92 / 3.66							
					6	SS	610	WH			Soil Cuttings
5											
6		End of borehole		87.48 / 6.10							
7											
8											
9											
10											
11											
12											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.1 ▽	91.5

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-05B

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 16 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Hollow Stem Auger (210mm OD)	Ground Surface		93.58							
		TOPSOIL		93.45 / 0.13							
1		Stiff to very stiff, grey brown SILTY CLAY, trace sand (WEATHERED CRUST)									
2											
3											Soil Cuttings
				89.92 / 3.66							
4		Firm to stiff, grey SILTY CLAY			1	TP	610	PM			
5											
				88.22 / 5.36							
6		End of borehole Soil stratigraphy inferred from BH 20-5A									
7											
8											
9											
10											
11											
12											

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

RECORD OF BOREHOLE 20-06

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 14 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (260mm OD)	Ground Surface		93.72							
		TOPSOIL		93.52 / 0.20	1	SS	180	14		MH	Above Ground Protector & Bentonite
1		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			2	SS	355	5			Soil Cuttings
2					3	SS	610	5			Bentonite
3					4	SS	610	5			Filter Sand
					5	SS	610	5			50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
4				89.91 / 3.81	6	SS	610	WH			
		Stiff, grey SILTY CLAY									
5					7	SS	610	WH			Soil Cuttings
6					8	SS	610	WH			
				87.17 / 6.55							
7		End of borehole									
8											
9											
10											
11											
12											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.0 ▽	91.7

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-07A

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 20 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED); WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		93.80							
		TOPSOIL		93.65 / 0.15	1	SS	205	10			Above Ground Protector & Bentonite
1		Stiff to very stiff, grey brown SILTY CLAY, with sand seams (WEATHERED CRUST)			2	SS	405	6			
2					3	SS	610	5			Soil Cuttings
					4	SS	610	4			
3				90.45 / 3.35	5	SS	610	6			
4		Very loose to compact, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			6	SS	205	9			Bentonite
5					7	SS	205	3			Filter Sand
					8	SS	25	9			50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
6					9	SS	100	26			
		Auger refusal		87.27 / 6.53							
7		End of borehole									
8											
9											
10											
11											
12											

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL, ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.6 ▽	91.3

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

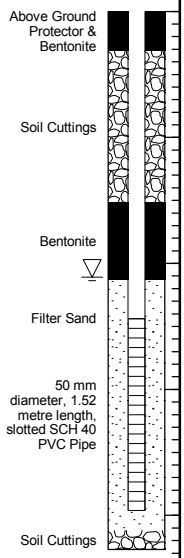
RECORD OF BOREHOLE 20-07B

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 17 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		93.80							
		TOPSOIL		93.65 / 0.15							
1		Stiff to very stiff, grey brown SILTY CLAY, with sand seams (WEATHERED CRUST)									
2											
3				90.45 / 3.35							
4		Very loose to compact, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)									
		End of borehole Soil stratigraphy inferred from BH 20-7A		89.53 / 4.27							
5											
6											
7											
8											
9											
10											
11											
12											

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL, ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.1 ▽	91.7

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

RECORD OF BOREHOLE 20-08

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

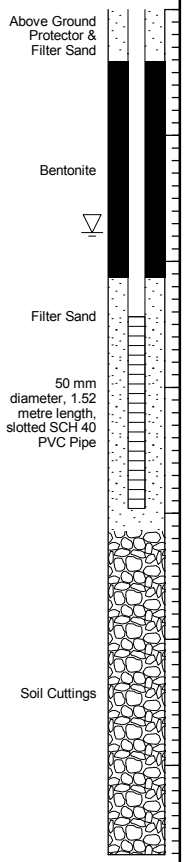
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 6 2020

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger Hollow Stem Auger (210mm OD)	Ground Surface		93.70				
		TOPSOIL		0.10	1	SS	355	9
		Stiff to very stiff, grey brown SILTY CLAY, trace sand (WEATHERED CRUST)			2	SS	405	5
					3	SS	610	5
					4	SS	610	5
				90.04 3.66				
		Firm, grey SILTY CLAY			5	SS	610	WH
					6	TP	610	PM
				88.06 5.64				
		Very loose grey SILTY SAND, some gravel, with cobbles (GLACIAL TILL)			7	SS	150	2
				86.99 6.71				
		End of borehole						

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: NATURAL, REMOULDED
WATER CONTENT, % (W_P, W, W_L)
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.8 ▽	91.9

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-09

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 17 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Hollow Stem Auger (210mm OD)	Ground Surface		93.81					10 20 30 40 50 60 70 80 90		
		TOPSOIL		0.05							
		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			1	SS	205	8			Above Ground Protector & Bentonite
1					2	SS	610	9			Soil Cuttings
2					3	SS	610	7			Bentonite
					4	SS	535	4			Filter Sand
3					5	SS	610	3			50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
4		Stiff, grey SILTY CLAY		89.85 3.96							
					6	SS	610	1			
5											
		Compact, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		88.09 5.72	7	SS	355	15			
6		End of borehole		87.10 6.71							
7											
8											
9											
10											
11											
12											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.2 ▽	91.6

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-10A

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 13 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		93.68							
		TOPSOIL		93.48 / 0.20							
		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			1	SS	100	11			Above Ground Protector & Bentonite
1					2	SS	75	9			
2					3	SS	405	5			
					4	SS	610	4			
3					5	SS	610	4			Soil Cuttings
				89.87 / 3.81							
4		Firm to stiff, grey SILTY CLAY			6	SS	610	1			
5					7	SS	610	WH			
6											
7					8	SS	610	1			Bentonite
				86.36 / 7.32							
		Loose, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			9	SS	405	3			Filter Sand
8					10	SS	610	4			50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
9				84.54 / 9.14							
		Compact, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			11	SS	455	28			
10					12	SS	610	27			Soil Cuttings
		End of borehole		83.32 / 10.36							Notes: Monitoring well blocked at 2.1m depth
11											
12											

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

RECORD OF BOREHOLE 20-10B

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 14 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED); WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Hollow Stem Auger (210mm OD)	Ground Surface		93.68							
		TOPSOIL		93.48 / 0.20							
1		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)									
2											
3				89.87 / 3.81							
4		Firm to stiff, grey SILTY CLAY									
5				88.50 / 5.18							
		End of borehole Soil stratigraphy inferred from BH 20-10A									
6											
7											
8											
9											
10											
11											
12											

10 20 30 40 50 60 70 80 90

Above Ground Protector & Bentonite
Soil Cuttings
Bentonite
Filter Sand
50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
Soil Cuttings

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.1 ▽	91.6

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-11

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 10 2020

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		93.77						
0	Power Auger Hollow Stem Auger (210mm OD)	TOPSOIL		93.57 / 0.20	1	SS	125	9		Above Ground Protector & Bentonite
1		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			2	SS	230	6		Soil Cuttings
2					3	SS	610	5		Bentonite
					4	SS	610	4		Filter Sand
3					5	SS	610	3		50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
				90.11 / 3.66						
4		Firm, grey SILTY CLAY			6	SS	610	WH		
				89.30 / 4.47						
5		Very loose to loose grey CLAYEY SILT, some sand, trace gravel			7	SS	405	4	MH	
				88.28 / 5.49						Soil Cuttings
6		Loose to compact, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			8	SS	205	23		
					9	SS	455	10		
				87.06 / 6.71						
7		End of borehole								
8										
9										
10										
11										
12										

SOIL PROFILE / SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.3 ▽	91.5

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-12

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

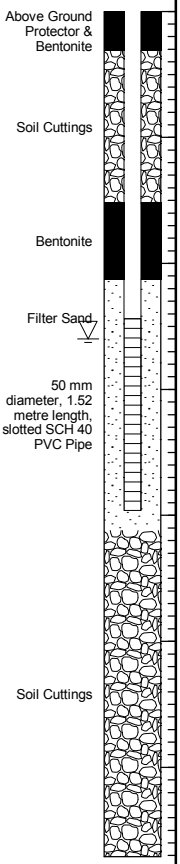
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 17 2020

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
		Ground Surface		93.94				
0	Power Auger Hollow Stem Auger (210mm OD)	TOPSOIL		0.10				
		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			1	SS	100	12
1					2	SS	355	9
2					3	SS	610	5
					4	SS	610	4
3				90.49	5	SS	610	4
		Very loose to loose, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		3.45				
4					6	SS	255	4
5				88.61	7	SS	255	5
		Compact, grey SAND, some gravel		5.33	8	SS	355	28
6					9	SS	455	24
				87.23				
7		End of borehole		6.71				
8								
9								
10								
11								
12								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.6 ▽	91.3

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

RECORD OF BOREHOLE 20-13

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 6 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Hollow Stem Auger (210mm OD)	Ground Surface		93.97						
		TOPSOIL		0.08	1	SS	355	11		Above Ground Protector & Filter Sand
		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			2	SS	510	9		Bentonite
1										Soil Cuttings
					3	SS	610	8	MH	Bentonite
2										Filter Sand
					4	SS	610	3		
3										50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
					5	SS	610	2		
		Firm to stiff, grey SILTY CLAY		90.46 3.51						
4										
					6	SS	610	WH		
5										
					7	SS	610	1		Soil Cuttings
6										
		End of borehole		87.26 6.71						
7										
8										
9										
10										
11										
12										

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: NATURAL, REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.8	92.2

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-14

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 9 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		93.91						
0	Power Auger; Hollow Stem Auger (210mm OD)	TOPSOIL		93.71 / 0.20	1	SS	50	11		Above Ground Protector & Bentonite
		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			2	SS	50	4		Soil Cuttings
1										
2					3	SS	455	3	MH	Bentonite
					4	SS	610	3		Filter Sand
3										50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
					5	SS	610	2		
				90.25 / 3.66						
4		Firm to stiff, grey SILTY CLAY								
					6	SS	610	WH		Soil Cuttings
5										
6				87.81						
		End of borehole		6.10						
7										
8										
9										
10										
11										
12										

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: NATURAL, REMOULDED
WATER CONTENT, % (W_P, W, W_L)
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.2 ▽	91.7

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-15

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

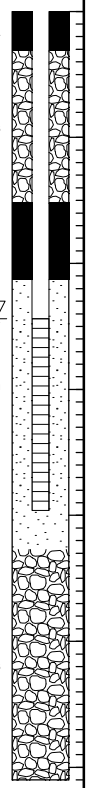
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 10 2020

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING
		Ground Surface		94.09					
0	Power Auger Hollow Stem Auger (260mm OD)	TOPSOIL		93.89					
		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)		0.20	1	SS	355	8	
1					2	SS	0	9	
2					3	SS	405	7	
					4	SS	610	6	
3				91.04					
		Very loose to compact, grey gravelly SILTY SAND, some clay, with cobbles and boulders (GLACIAL TILL)		3.05	5	SS	355	6	MH
4					6	SS	200	1	
5					7	SS	200	26	
				88.76					
		Loose, grey SAND		5.33	8	SS	355	6	MH
6				87.99					
		End of borehole		6.10					
7									
8									
9									
10									
11									
12									

SAMPLES

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA
+ NATURAL ⊕ REMOULDED
WATER CONTENT, %
W_P W W_L
10 20 30 40 50 60 70 80 90

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.4 ▽	91.7

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-16A

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

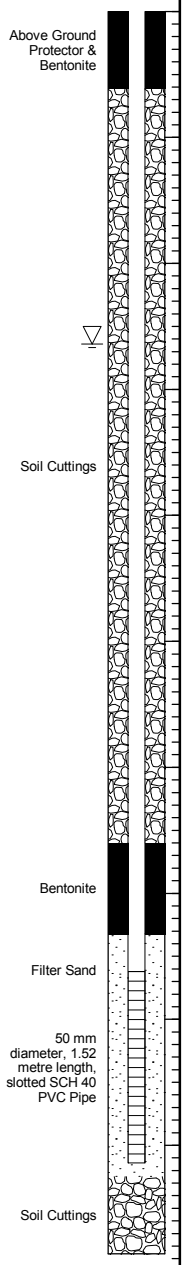
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 7 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		93.77				
		TOPSOIL		0.10	1	SS	310	9
		Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)			2	SS	610	8
1					3	SS	610	5
2					4	SS	610	4
3				90.72				
		Firm to stiff, grey SILTY CLAY, trace sand seams		3.05	5	SS	610	1
4								
					6	TP	610	PM
5								
6					7	SS	610	WH
7								
					8	SS	610	WH
8								
9					9	SS	310	2
		End of borehole		83.91 / 9.86				
10								
11								
12								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, % — W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.6 ▽	91.1

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

RECORD OF BOREHOLE 20-16B

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 7 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Hollow Stem Auger (210mm OD)	Ground Surface		93.77					10 20 30 40 50 60 70 80 90		Above Ground Protector & Bentonite
		TOPSOIL		0.10							
1		Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)									Soil Cuttings
2											Bentonite
3				90.72							Filter Sand
		Firm to stiff, grey SILTY CLAY, trace sand seams		3.05							50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
4				89.50							
		End of borehole Soil stratigraphy inferred from BH 20-16A		4.27							
5											
6											
7											
8											
9											
10											
11											
12											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.5 ▽	92.3

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-17

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

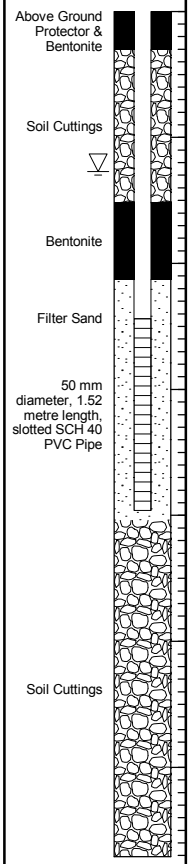
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 6 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		93.79				
		TOPSOIL		93.66 / 0.13	1	SS	280	9
		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			2	SS	460	6
1								
					3	SS	610	7
2								
					4	SS	610	4
3								
				89.22 / 4.57				
4		Stiff, grey SILTY CLAY			5	SS	610	WH
				88.07 / 5.72				
5		Very dense, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			6	SS	310	109
				87.08 / 6.71				
6		End of borehole						
7								
8								
9								
10								
11								
12								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: NATURAL, REMOULDED
WATER CONTENT, % W_P W W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.3	92.5

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-18A

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

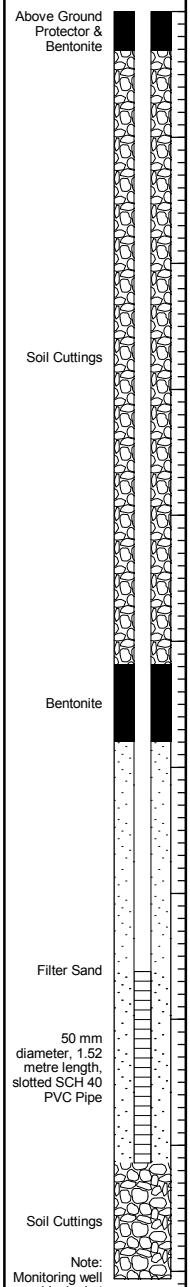
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 9 2020

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0		Ground Surface		93.94				
		TOPSOIL		93.79 / 0.15				
	Power Auger / Hollow Stem Auger (210mm OD)	Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)			1	SS	50	9
1					2	SS	50	6
2					3	SS	355	6
					4	SS	610	5
3				90.89 / 3.05				
		Firm to stiff, grey SILTY CLAY			5	SS	610	3
4								
5					6	SS	610	WH
6					7	SS	610	WH
7								
8					8	SS	610	3
				85.56 / 8.38				
9		Compact, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			9	SS	405	20
10					10	SS	460	16
		End of borehole						
11								
12								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: NATURAL, REMOULDED
WATER CONTENT, % (W_P, W, W_L)
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

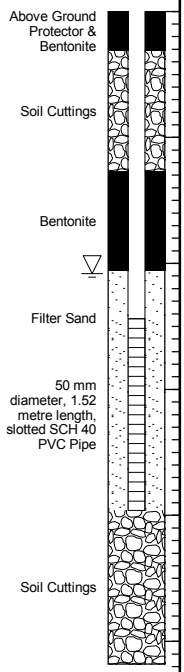
RECORD OF BOREHOLE 20-18B

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 9 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger / Hollow Stem Auger (210mm OD)	Ground Surface		93.94							
		TOPSOIL		93.79 / 0.15							
1		Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)									
2											
3				90.89 / 3.05							
		Firm to stiff, grey SILTY CLAY									
4					1	TP	610	PM			
5				88.76 / 5.18							
		End of borehole Soil stratigraphy inferred from BH 20-18A									
6											
7											
8											
9											
10											
11											
12											

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL, ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.1 ▽	91.9

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-19

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 8 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Hollow Stem Auger (210mm OD)	Ground Surface		94.20							
		TOPSOIL		0.08							
		Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)			1	SS	75	11			
1					2	SS	510	5			
2					3	SS	610	4			
				91.61	4	SS	610	8			
		Loose to compact, grey brown SILTY SAND, trace gravel, with cobbles and boulders (GLACIAL TILL)		2.59							
3					5	SS	455	20		MH	
				90.54							
		Loose to compact, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		3.66							
4					6	SS	125	11			
5					7	SS	100	10			
					8	SS	255	16			
6				88.10							
		End of borehole		6.10							
7											
8											
9											
10											
11											
12											

PIEZOMETER OR STANDPIPE INSTALLATION:
- Above Ground Protector & Bentonite
- Soil Cuttings
- Bentonite
- Filter Sand
- 50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
- Soil Cuttings

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	2.5	91.7

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-20

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

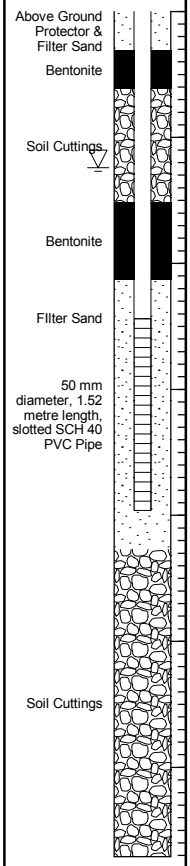
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 8 2020

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		93.87				
		TOPSOIL		0.08	1	SS	100	9
1		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			2	SS	205	7
2					3	SS	610	4
					4	SS	610	2
				90.97				
3		Firm, grey SILTY CLAY		2.90	5	SS	610	1
4								
5					6	SS	610	WH
6					7	SS	610	WH
				87.16				
7		End of borehole		6.71				
8								
9								
10								
11								
12								

PENETRATION RESISTANCE (N), BLOWS/0.3m
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA: + NATURAL ⊕ REMOULDED
WATER CONTENT, %: W_P — W — W_L
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING: MH

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.2 ▽	92.6

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

RECORD OF BOREHOLE 20-21

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 7 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		93.88						Above Ground Protector & Bentonite
		TOPSOIL		0.10	1	SS	310	9		
1		Stiff to very stiff, grey brown SILTY CLAY, trace sand seams (WEATHERED CRUST)			2	SS	610	5		Soil Cuttings
2					3	SS	610	4		Bentonite
					4	SS	610	3		FIlter Sand
3				90.83						
		Firm to stiff, grey SILTY CLAY		3.05	5	SS	610	1		50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
4										
5					6	SS	610	WH		
										Soil Cuttings
6					7	SS	610	WH		
				87.17						
7		End of borehole		6.71						
8										
9										
10										
11										
12										

SHEAR STRENGTH (Cu), kPA
PENETRATION RESISTANCE (N), BLOWS/0.3m — NATURAL ⊕ REMOULDED
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
WATER CONTENT, %
W_P — W — W_L
10 20 30 40 50 60 70 80 90

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	0.9 ▽	93.0

GEMTEC
Consulting Engineers and Scientists

LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

RECORD OF BOREHOLE 20-25

CLIENT: Cardel Homes
PROJECT: Geotechnical & Hydrogeological Investigation
JOB#: 61899.04
LOCATION: See Site Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 14 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PENETRATION RESISTANCE (N), BLOWS/0.3m / DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA (NATURAL, REMOULDED) / WATER CONTENT, % (W_P, W, W_L)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, Hollow Stem Auger (210mm OD)	Ground Surface		92.97							
		TOPSOIL		92.77 / 0.20	1	SS	205	18			Above Ground Protector & Bentonite
		Stiff to very stiff, grey brown SILTY CLAY (WEATHERED CRUST)			2	SS	150	8			Soil Cuttings
1											
					3	SS	510	5			Bentonite
2											
					4	SS	610	4			Filter Sand
3				89.92 / 3.05							
		Soft to firm, grey SILTY CLAY			5	SS	610	1			50 mm diameter, 1.52 metre length, slotted SCH 40 PVC Pipe
4											
					6	TP	610	PM			
5											Soil Cuttings
6				86.87 / 6.10							
		Very loose to loose, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)			7	SS	455	4			
				86.26 / 6.71							
		End of borehole									
7											
8											
9											
10											
11											
12											

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-09-30	1.6 ▽	91.4

GEMTEC
Consulting Engineers and Scientists

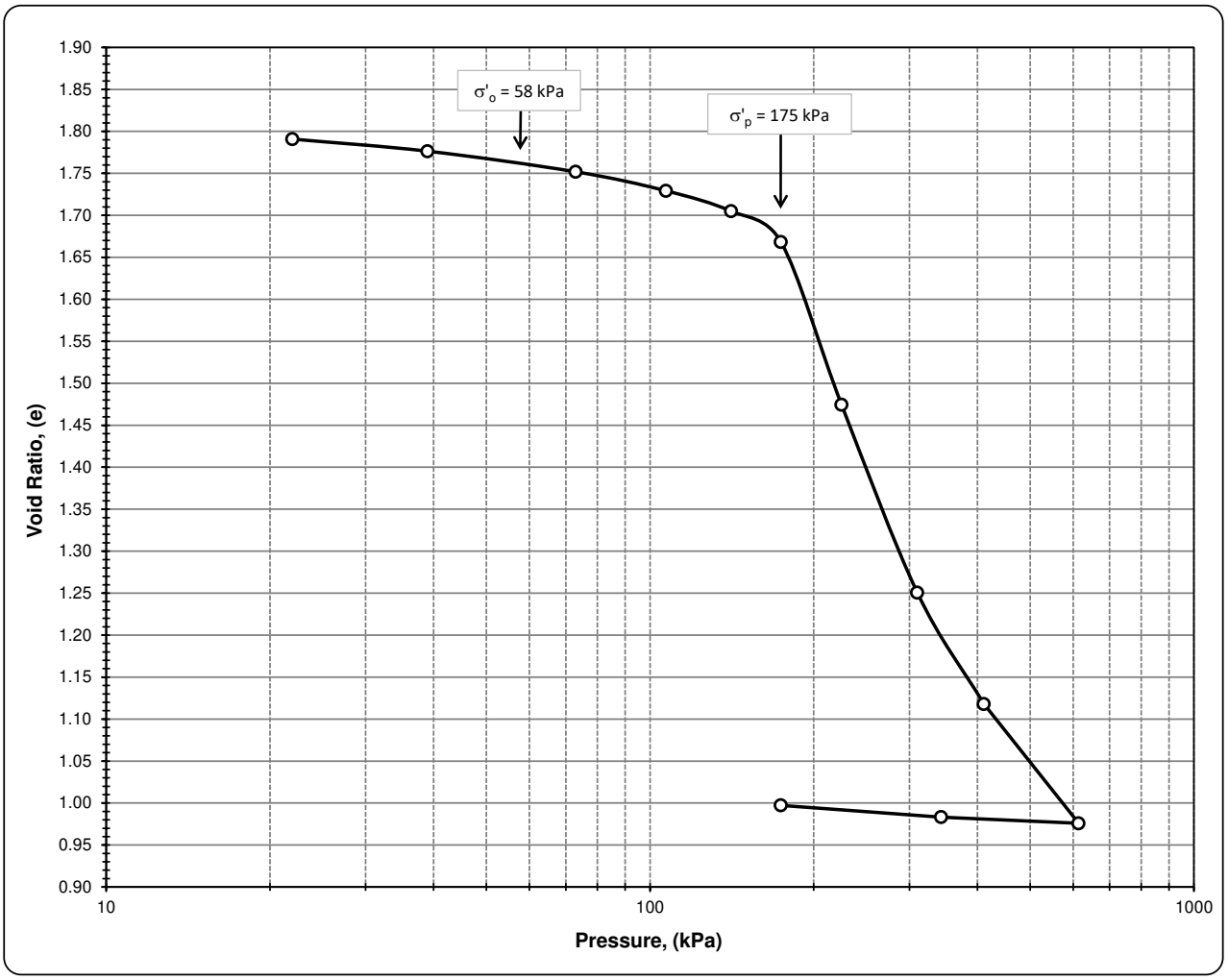
LOGGED: ML
CHECKED: WAM

GEO - BOREHOLE LOG 61899.04_BOREHOLE LOGS_R0_2020-07-17.GPJ GEMTEC 2018.GDT 11-30-20

APPENDIX B

Laboratory Test Results

CONSOLIDATION ANALYSIS



Borehole	Sample	Depth (m)
20-16	SA 6	4.6 to 5.2

Determined Properties:

W	70	percent
e_o	1.80	

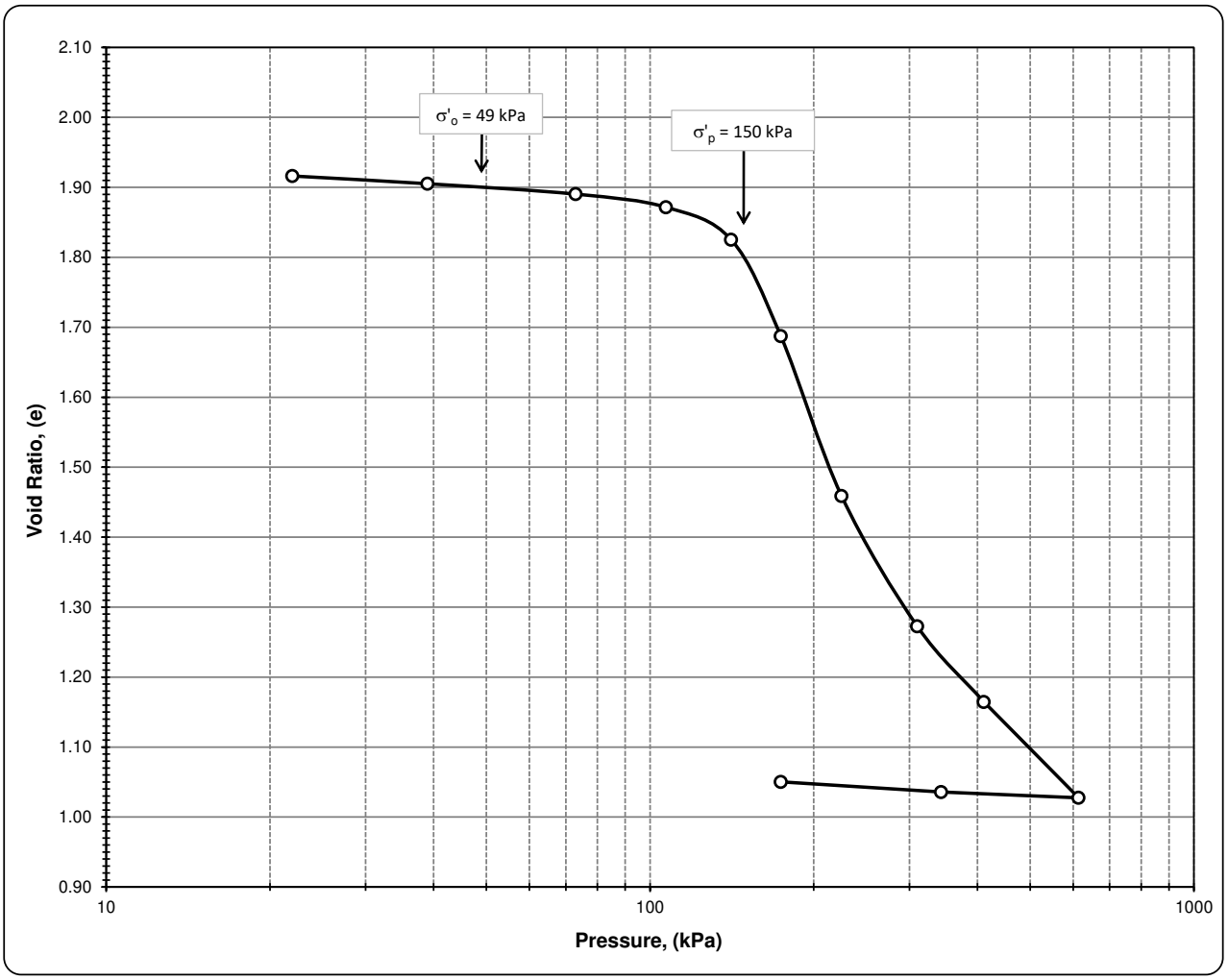
Test Results:

C_r	0.04	
C_c	1.74	
σ'_p	175	kPa

GEMTEC
Consulting Engineers and Scientists

Date: Sep 2020
Project: 61899.04

CONSOLIDATION ANALYSIS



Borehole	Sample	Depth (m)
20-18B	SA 1	4.6 to 5.2

Determined Properties:

W	73	percent
e_o	1.93	

Test Results:

C_r	0.04	
C_c	2.05	
σ'_p	150	kPa

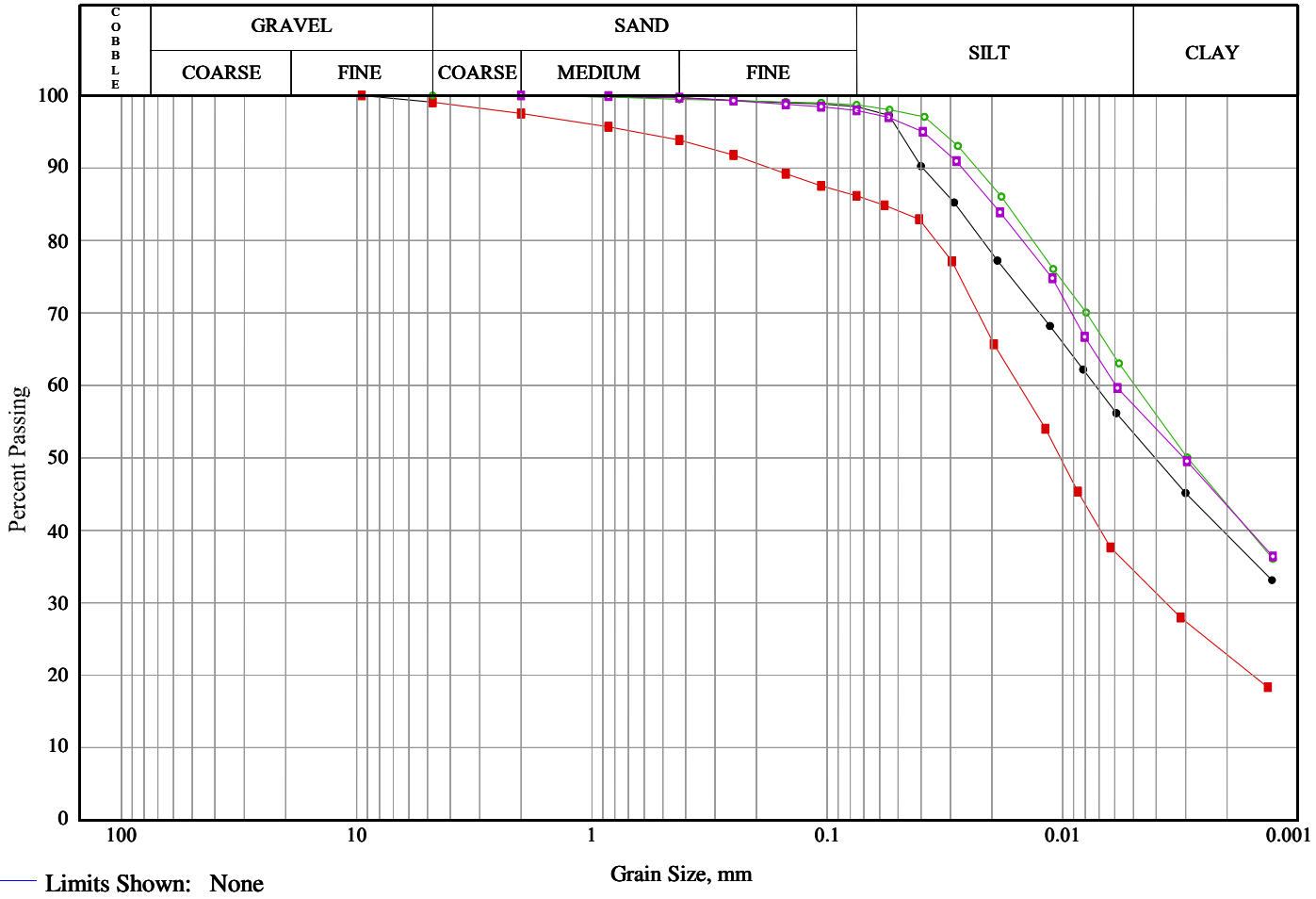
GEMTEC
Consulting Engineers and Scientists

Date: Sep 2020
Project: 61899.04

GEMTEC
Consulting Engineers and Scientists

Client:	Cardel Homes
Project:	Geotechnical Investigation, Proposed Residential Develo
Project #:	6189904

Soils Grading Chart



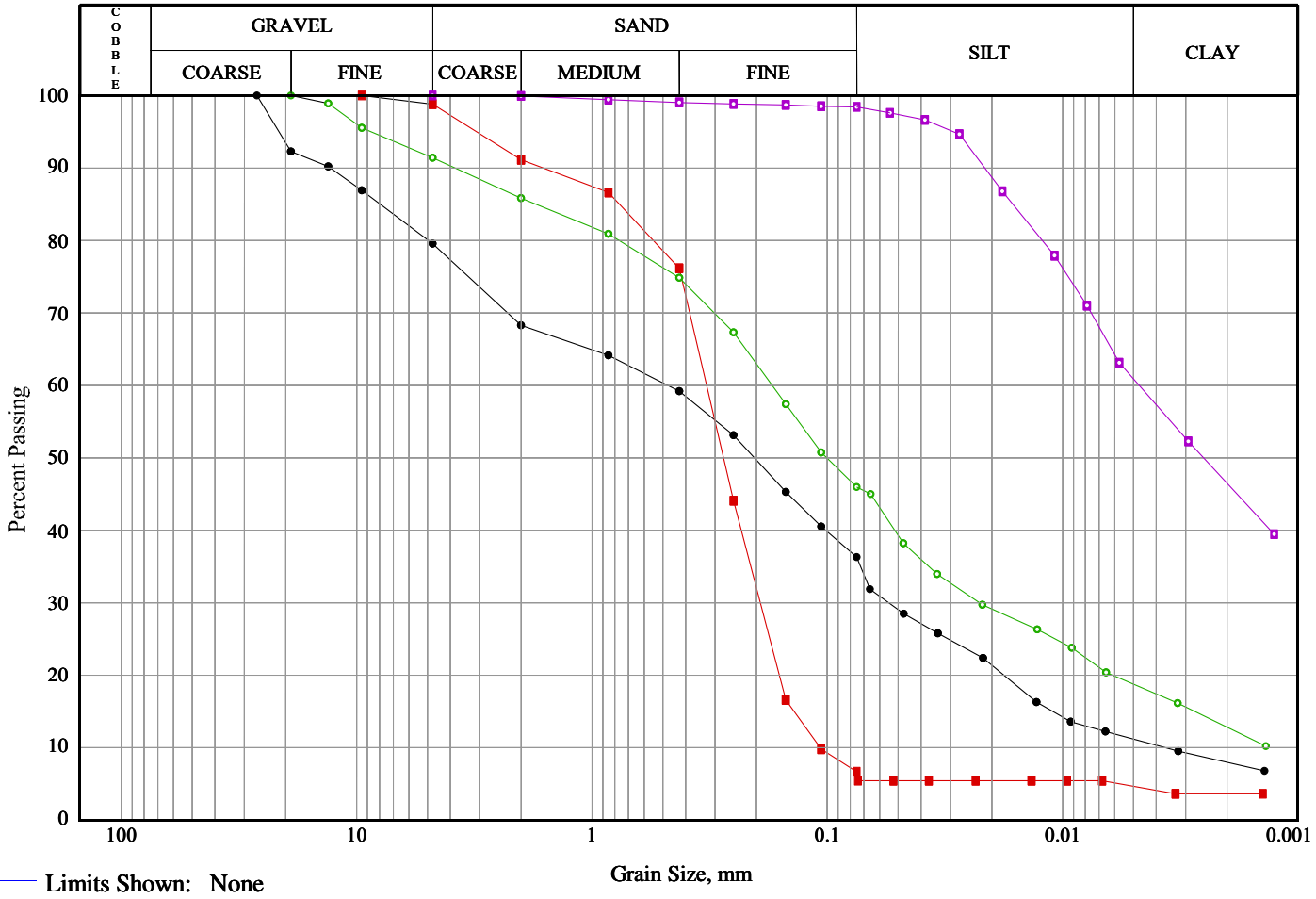
Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
●	Weathered Silty Clay Crust	20-06	SA 2	0.76-1.37	0.0	1.5	45.0	53.4
■	Clayey Silt	20-11	SA 7	4.57-5.18	0.9	12.9	51.7	34.5
○	Weathered Silty Clay Crust	20-13	SA 3	1.52-2.13	0.0	1.3	38.4	60.3
□	Weathered Silty Clay Crust	20-14	SA 3	1.52-2.13	0.0	2.1	40.6	57.3

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
●	Clay and silt , trace sand	CL	---	---	---	0.00	0.01	0.03	45.0
■	Clayey silt , some sand , trace gravel	N/A	---	---	0.00	0.01	0.02	0.06	51.7
○	Clay and silt , trace sand	CL	---	---	---	0.00	0.00	0.02	38.4
□	Clay and silt , trace sand	CL	---	---	---	0.00	0.01	0.02	40.6

GEMTEC
Consulting Engineers and Scientists

Client:	Cardel Homes
Project:	Geotechnical Investigation, Proposed Residential Develo
Project #:	6189904

Soils Grading Chart



Limits Shown: None

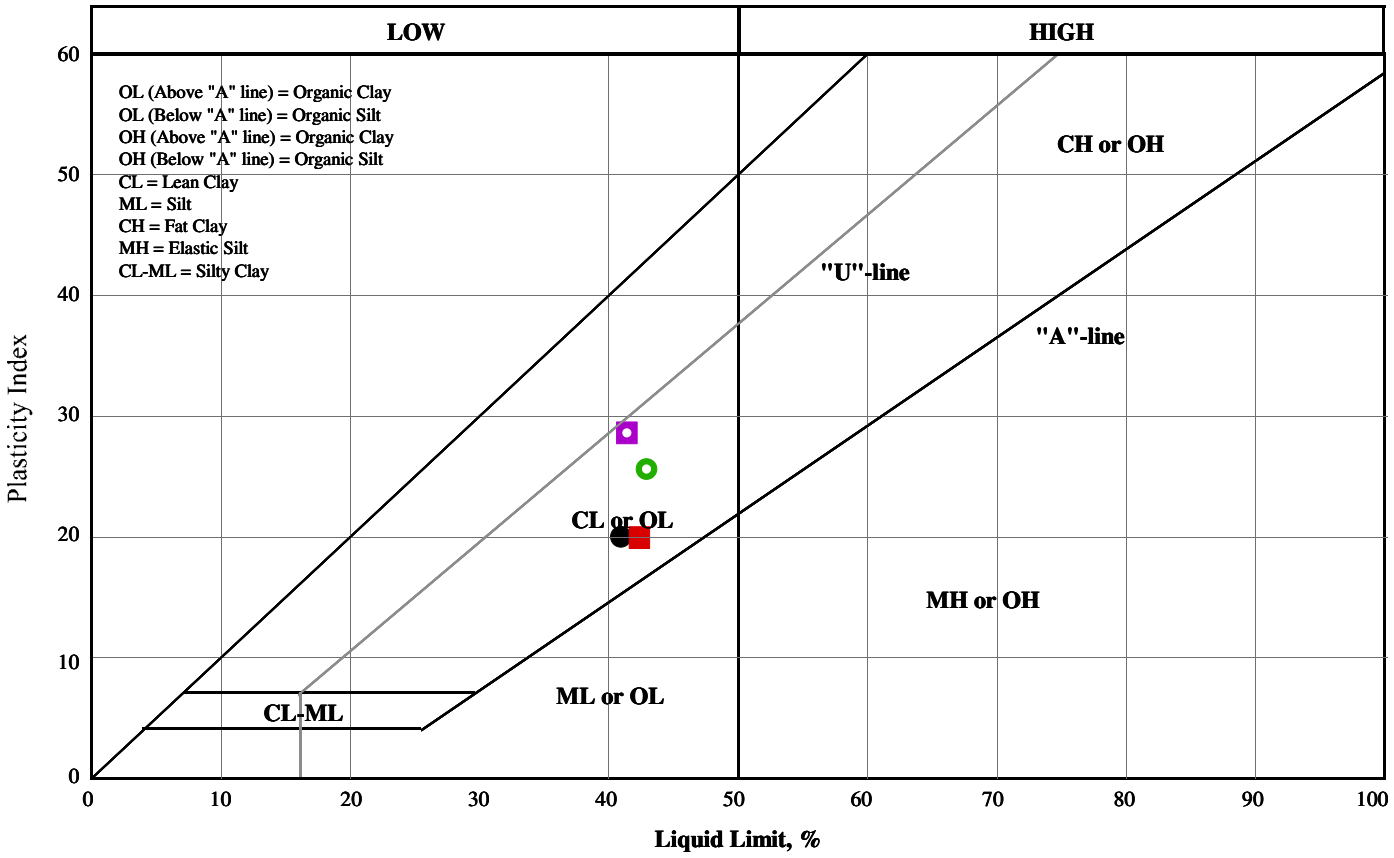
Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
	Glacial Till	20-15	SA 5	3.05-3.66	20.4	43.3	25.1	11.2
	Sand	20-15	SA 8	5.45-5.94	1.2	92.2	2.0	4.7
	Glacial Till	20-19	SA 5	3.05-3.66	8.6	45.5	27.2	18.7
	Weathered Silty Clay Crust	20-20	SA 3	1.52-2.13	0.0	1.6	37.5	60.9

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
	Gravelly silty sand , some clay	N/A	0.00	0.01	0.05	0.20	0.48	7.94	25.1
	Sand , trace gravel, trace silt, trace clay	N/A	0.11	0.14	0.19	0.28	0.33	0.76	2.0
	Silty sand , some clay , trace gravel	N/A	---	0.00	0.02	0.10	0.17	1.73	27.2
	Clay and silt , trace sand	CL	---	---	---	0.00	0.00	0.02	37.5

GEMTEC
Consulting Engineers and Scientists

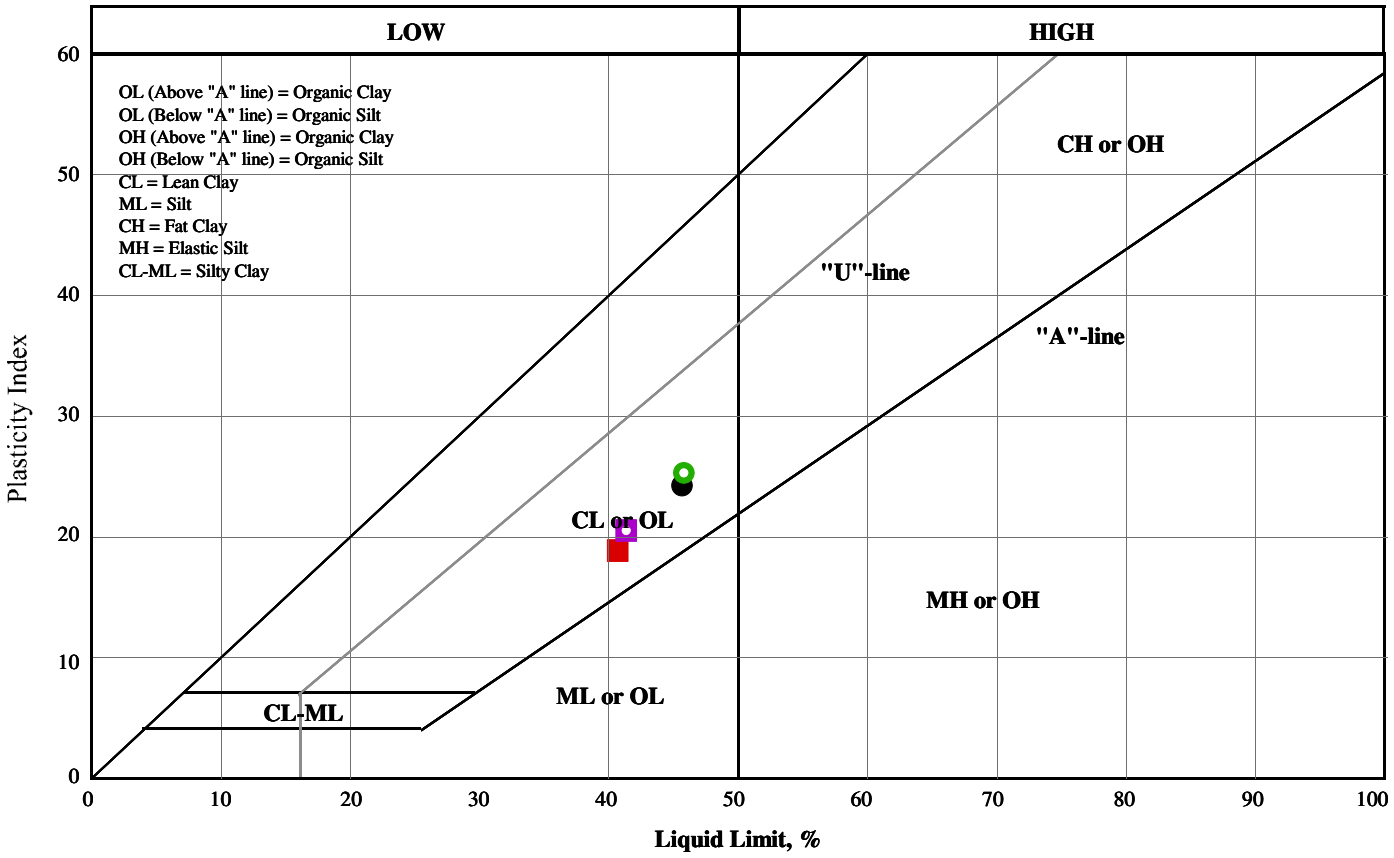
Client:	Cardel Homes
Project:	Geotechnical Investigation, Proposed Residential Develo
Project #:	6189904

Plasticity Chart



Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	20-01	SA 3	1.52-2.13	40.9	20.9	20.0	☐	40.15
■	20-02	SA 2	0.76-1.37	42.4	22.4	19.9	☐	31.04
○	20-03	SA 3	1.52-2.13	42.9	17.3	25.6	☐	43.30
◘	20-04	SA 3	1.52-2.13	41.4	12.8	28.6	☐	49.00

GEMTEC Consulting Engineers and Scientists	Client: Cardel Homes	Plasticity Chart
	Project: Geotechnical Investigation, Proposed Residential Develo	
	Project #: 6189904	

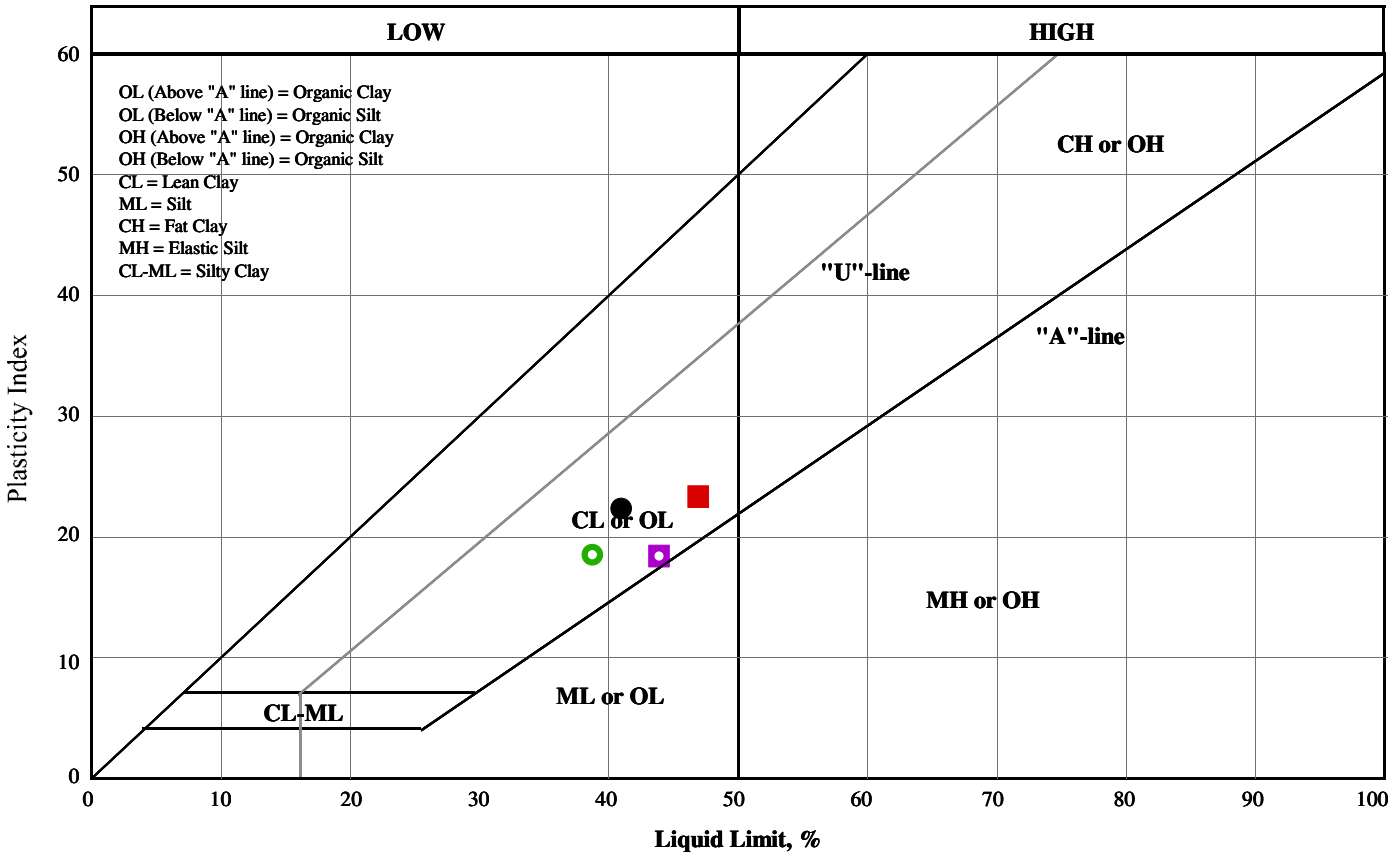


Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	20-05	SA 3	1.52-2.13	45.6	21.4	24.2	☐	36.65
■	20-06	SA 2	0.76-1.37	40.7	21.8	18.9	☐	23.24
○	20-07	SA 3	1.52-2.13	45.8	20.5	25.3	☐	46.03
◘	20-08	SA 2	0.76-1.37	41.3	20.8	20.5	☐	41.72

GEMTEC
Consulting Engineers and Scientists

Client:	Cardel Homes
Project:	Geotechnical Investigation, Proposed Residential Develo
Project #:	6189904

Plasticity Chart

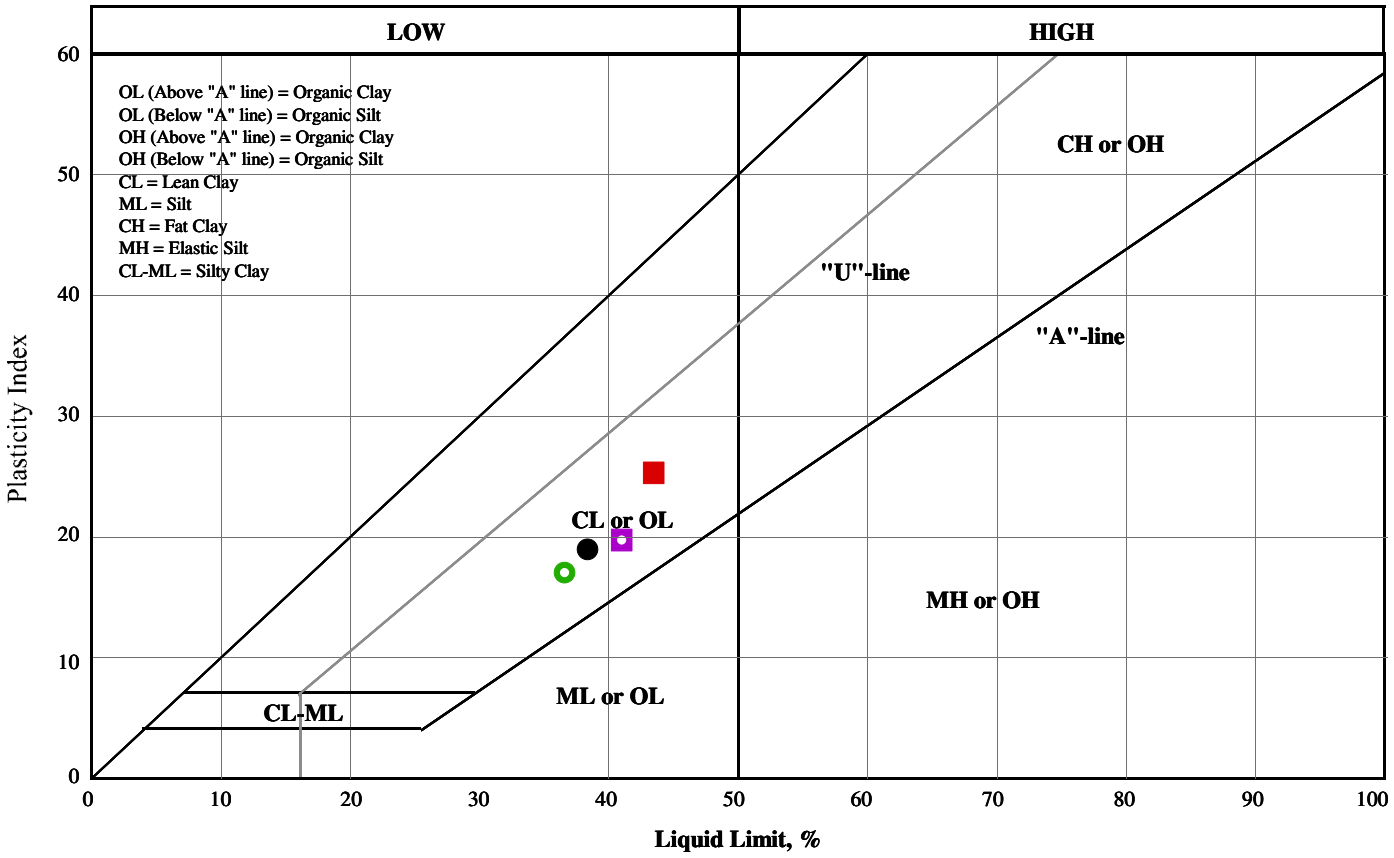


Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	20-09	SA 2	0.76-1.37	41.0	18.6	22.3	☐	33.34
■	20-10	SA 3	1.52-2.13	46.9	23.6	23.3	☐	47.48
○	20-11	SA 2	0.76-1.37	38.7	20.2	18.5	☐	15.43
▣	20-12	SA 3	1.52-2.13	43.9	25.5	18.4	☐	47.30

GEMTEC
Consulting Engineers and Scientists

Client:	Cardel Homes
Project:	Geotechnical Investigation, Proposed Residential Develo
Project #:	6189904

Plasticity Chart

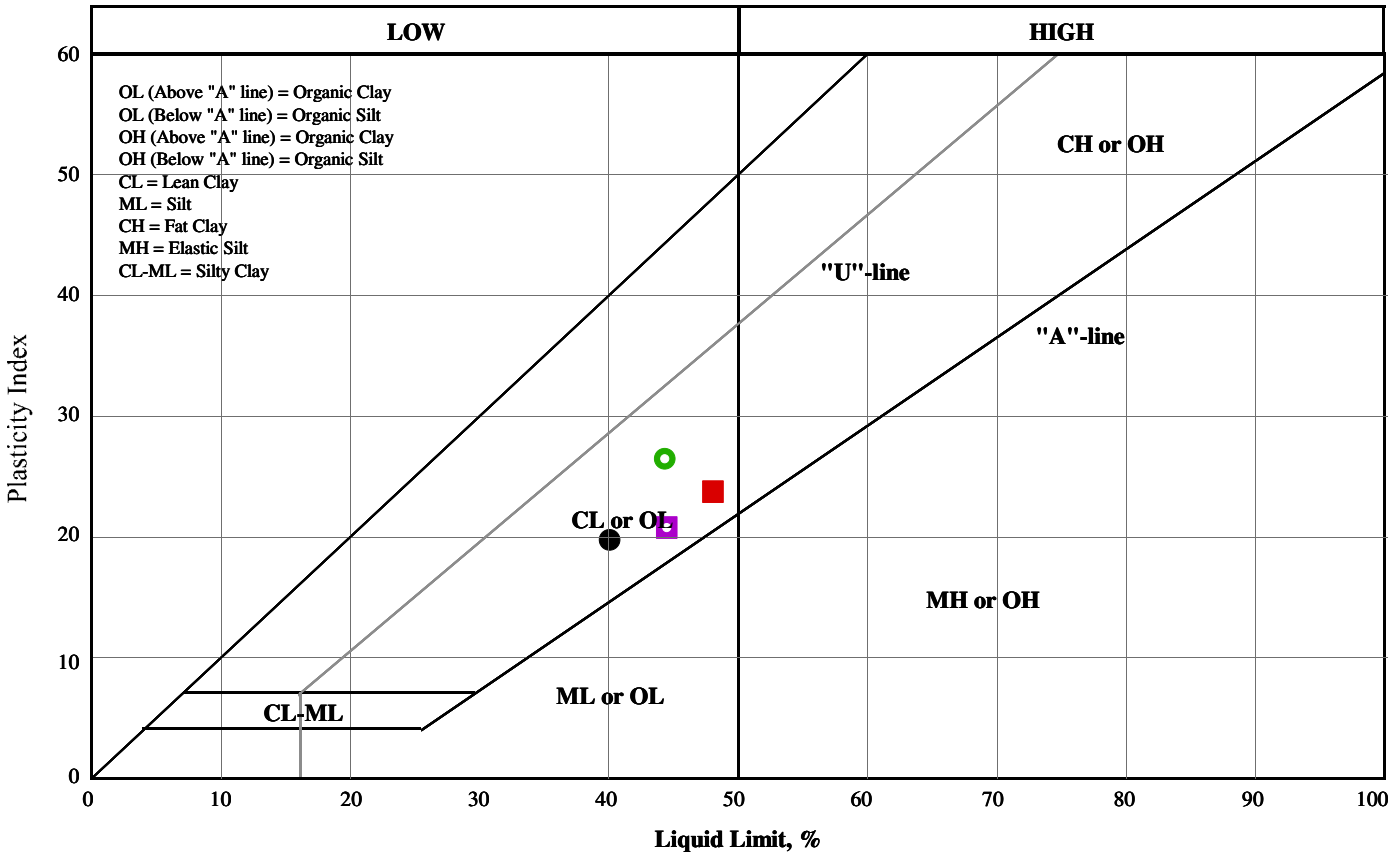


Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	20-13	SA 3	1.52-2.13	38.3	19.4	19.0	☐	28.37
■	20-14	SA 3	1.52-2.13	43.5	18.2	25.3	☐	45.20
○	20-15	SA 3	1.52-2.13	36.6	19.5	17.0	☐	38.80
▣	20-16	SA 2	0.76-1.37	41.0	21.3	19.7	☐	27.78

GEMTEC
Consulting Engineers and Scientists

Client:	Cardel Homes
Project:	Geotechnical Investigation, Proposed Residential Develo
Project #:	6189904

Plasticity Chart

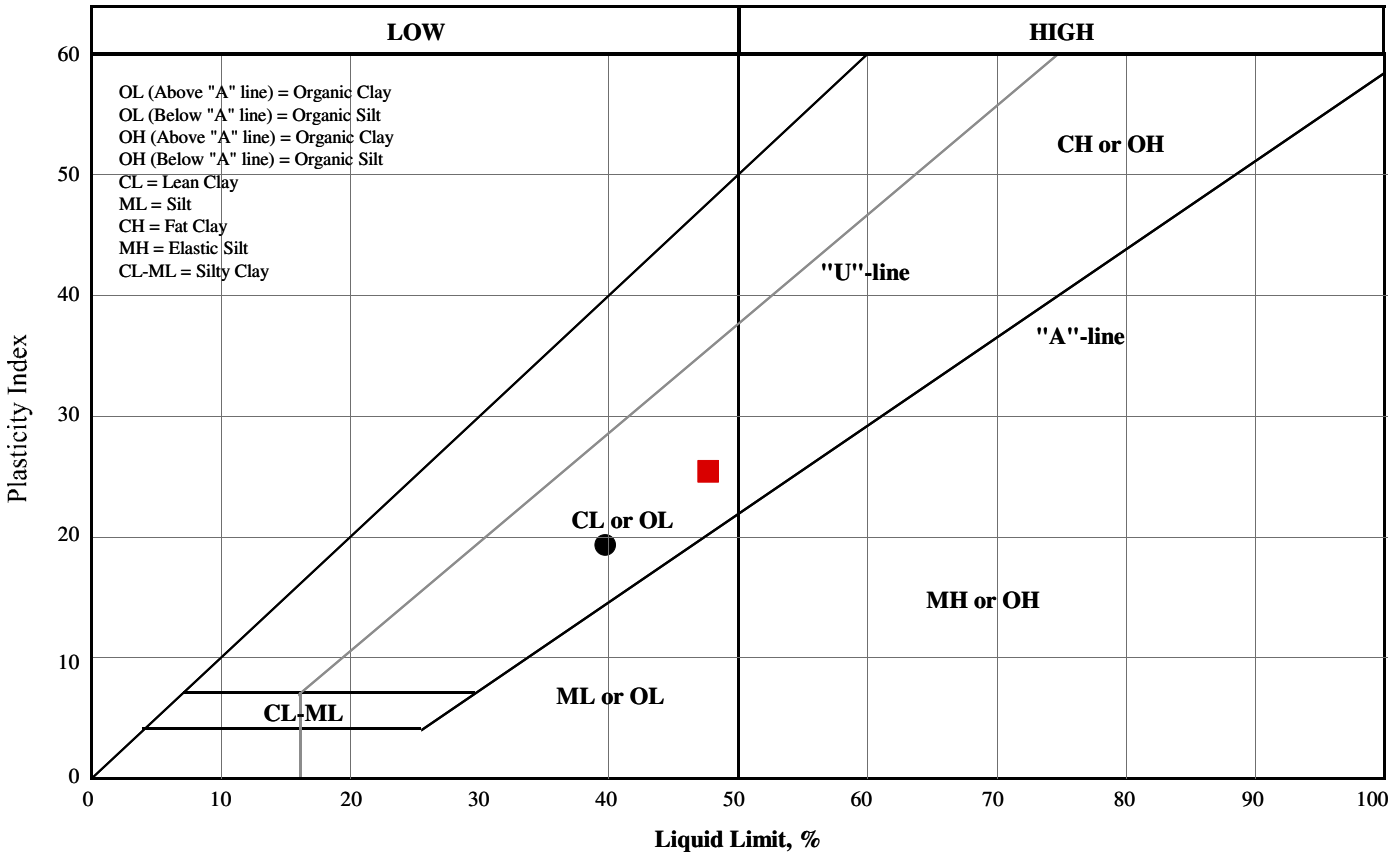


Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	20-17	SA 2	0.76-1.37	40.0	20.3	19.7	☐	37.39
■	20-18A	SA 3	1.52-2.13	48.1	24.3	23.7	☐	38.59
○	20-18A	SA 5	3.05-3.66	44.3	17.9	26.5	☐	47.30
◘	20-19	SA 3	1.52-2.13	44.5	23.7	20.8	☐	51.49

GEMTEC
Consulting Engineers and Scientists

Client:	Cardel Homes
Project:	Geotechnical Investigation, Proposed Residential Develo
Project #:	6189904

Plasticity Chart



Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	20-20	SA 3	1.52-2.13	39.7	20.4	19.3	☐	41.05
■	20-21	SA3	1.52-2.13	47.7	22.3	25.4	☐	41.09

APPENDIX C

Record of Test Holes – Previous Investigation

LOG OF BOREHOLE BH13-1

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd.
CLIENT: Cardel Homes
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 5006187 E 435121

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203mm
Date: Aug/02/2013
REF. NO.: 1776-710
ENCL NO.:

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.7										
93.6	**Topsoil**									
0.2	**Silty Clay** brown, moist, stiff, (weathered crust)		1	SS	7		93			
			2	SS	4					
			3	SS	6		92			
			4	SS	5		91		17.0	
90.7										
3.1	**Silty Clay** grey, moist, firm to stiff		5	SS	3		90			
				VANE						
				VANE						
88.8			6A	SS	1		89			
4.9	**Silty Clay** mixed with silty sand and some gravel		6B	SS	1					
88.5										
5.3	**Gravelly Silty Sand** grey, wet, compact (Till)						88			
			7	SS	9		87			29 39 (32)
			8	SS	6		86			
85.5										
8.2	**END OF BOREHOLE**									

Notes:
1) Upon completion, standing water in borehole at 4.2 m depth

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa) (25 50 75 100 125)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (25 50 75)

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 23/1/14

LOG OF BOREHOLE BH13-2

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd. **DRILLING DATA**
CLIENT: Cardel Homes — Method: Hollow Stem Augers
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa — Diameter: 203mm — REF. NO.: 1776-710
DATUM: Geodetic — Date: Aug/02/2013 — ENCL NO.:
BH LOCATION: See Borehole Location Plan N 5006406 E 434911

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"
94.0				
93.8	**Topsoil** 200 mm			
0.2	**Silty Clay** brown, moist, firm to stiff, (weathered crust)	1	SS	5
		2	SS	2
		3	SS	4
		4	SS	3
91.0				
3.1	**Silty Clay** grey, wet, firm	5A	SS	2
90.4		5B	SS	2
3.6	**Gravelly Silty Sand** grey, wet, compact (Till)			
	- Possible cobble/boulder	6A	SS	50/ 4"
		6B	SS	
		7	SS	16
	- Auger refusal at 7.4 m. No SPT refusal. Possible cobble/boulder at 7.4 m.	8	SS	34
	- Drilling ended at 8.2 m. Gravelly Silty Sand (Infered based on DCPT results)			
82.2				
11.8	**END OF BOREHOLE**			

Notes:
1) Upon completion, standing water in borehole at 4.2 m depth
2) DCPT refusal at 11.8 m
3) 19mm dia. piezometer was installed in the borehole upon completion
4) Date / Depth
28/08/2013 1.3 m
17/01/2014 0.6 m

W. L. 93.4 m Jan 17, 2014
W. L. 92.7 m Aug 28, 2013
Bentonite
Cave in around pipe
Screen

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa) (25 50 75 100 125)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (25 50 75)

NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
17.0	
18.3	
	29 39 (31)

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 23/1/14

LOG OF BOREHOLE BH13-3

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd. **DRILLING DATA**
CLIENT: Cardel Homes — Method: Hollow Stem Augers
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa — Diameter: 65mm — REF. NO.: 1776-710
DATUM: Geodetic — Date: Aug/02/2013 — ENCL NO.:
BH LOCATION: See Borehole Location Plan N 5006312 E 434755

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (25 50 75 100 125)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.8												
93.6	**Topsoil** 200 mm											
0.2	**Silty Clay** brown, moist, firm to stiff, (weathered crust)		1	SS	5		93					
			2	SS	3						17.6	
			3	SS	5		92					
			4	SS	4						18.2	
90.8							91					
3.1	**Silty Clay** grey, wet, firm		5	SS	WH						16.4	
				VANE			90	7				
				VANE				5				
			6	SS	WH		89					
				VANE				4				
				VANE			88	7				
			7	SS	3							
86.8				VANE			87	4				
7.0	**Silty Sand** some gravel, grey, wet compact (Till)											
			8	SS	27		86					17 52 (31)
85.6												
8.2	**END OF BOREHOLE**											

Notes:
1) Upon completion, standing water in borehole at 1.5 m depth

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES: + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 23/1/14

LOG OF BOREHOLE BH13-4

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd. **DRILLING DATA**
CLIENT: Cardel Homes — Method: Hollow Stem Augers
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa — Diameter: 203mm — REF. NO.: 1776-710
DATUM: Geodetic — Date: Aug/01/2013 — ENCL NO.:
BH LOCATION: See Borehole Location Plan N 5006087 E 434954

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
93.6							
93.4 0.0	**Topsoil** 175mm		1A	SS	9		
0.2	**Silty Clay** brown, moist, stiff, (weathered crust)		1B	SS	9		93
			2	SS	5	W. L. 92.7 m Jan 17, 2014	
			3	SS	4	Hole Plug W. L. 92.0 m Aug 28, 2013	
			4	SS	4		91
90.5							
3.1	**Silty Clay** grey, wet, firm		5	TW			
				VANE			90
				VANE			
			6	SS			89
				VANE			
				VANE			88
87.0			7A	SS	1		
6.6	**Silty Sand** some gravel, trace clay, grey, wet, very loose		7B	SS	1		87
						Cuttings	
			8	SS	1		
84.5							85
9.1	**Silty Sand** trace gravel, grey, wet, compact (Till)		9	SS	14		84
	- Heaving noted at 10.6 m		10	SS	24		83
							82
81.3	- Auger refusal at 12.3 m, switch to coring		11	SS	50/ 75 mm		
12.3	**Limestone** with shale partings, fresh to slightly weathered, grey TCR = 95% SCR = 95% RQD = 95%		1	RC		Hole Plug	81
79.6							80
14.0	**Limestone** with shale partings, fresh to slightly weathered, grey TCR = 100% SCR = 100% RQD = 93%		2	RC			79

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa) (25 50 75 100 125)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (25 50 75)

POCKET PEN. (Cu) (kPa) — NATURAL UNIT WT (KN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	0	1	56	43
	16	47	31	7
	6	44	43	7

Continued Next Page

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES: + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 27/1/14

LOG OF BOREHOLE BH13-4

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd. **DRILLING DATA**
CLIENT: Cardel Homes — Method: Hollow Stem Augers
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa — Diameter: 203mm — REF. NO.: 1776-710
DATUM: Geodetic — Date: Aug/01/2013 — ENCL NO.:
BH LOCATION: See Borehole Location Plan N 5006087 E 434954

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (25 50 75 100 125)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.2												
15.4	**Limestone** with shale partings, fresh to slightly weathered, grey TCR = 83% SCR = 81% RQD = 81%		3	RC			Sand; Screen					
76.8							77					
16.8	**Limestone** with shale partings, fresh to slightly weathered, grey TCR = 97% SCR = 90% RQD = 90%		4	RC								
76.0												
17.6	**END OF BOREHOLE** Notes: 1) 50 mm dia. monitoring well installed in the borehole upon completion 2) Depth of Water 3) Date — Depth 28/08/2013 — 1.6 m 17/01/2014 — 0.9 m											

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 27/1/14

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES: $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

LOG OF BOREHOLE BH13-7

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd.
CLIENT: Cardel Homes
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203mm
Date: Dec/19/2013
REF. NO.: 1776-710
ENCL NO.:

SOIL PROFILE (m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 25 50 75 100 125	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 25 50 75	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**Topsoil - 200 mm**										
0.2	**Silty Clay** brown, moist, stiff		1	SS	18						
			2	SS	12					19.4	
			3	SS	12					17.2	
			4	SS	5					17.0	
			5	SS	2					17.2	
				VANE				+ 10			
4.6	**Silty Sand and Gravel** trace clay, grey, wet, loose (TILL)		6	SS	7						20 52 (28)
			7	SS	10						
	- Compact below 7.6 m		8	SS	17						
8.2	**END OF BOREHOLE**										

Notes:
1) Upon completion, standing water in borehole at 7.3 m B.S.L

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 23/1/14

LOG OF BOREHOLE BH13-8

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd. **DRILLING DATA**
CLIENT: Cardel Homes — Method: Hollow Stem Augers
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa — Diameter: 203mm — REF. NO.: 1776-710
DATUM: N/A — Date: Dec/20/2013 — ENCL NO.:
BH LOCATION: See Borehole Location Plan

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (25 50 75 100 125)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**Topsoil - 225 mm**											
0.3	**Silty Clay** brown, moist, firm		1	SS	5							
			2	SS	7						18.2	
							W. L. 1.3 mBSL Jan 17, 2014					
			3	SS	8						18.7	
			4	SS	4						18.0	
			5	SS	2						17.4	
3.7	**Silty Clay** grey, wet, firm to stiff			VANE				6, 6				
				VANE								
			6	SS	WH						15.5	
				VANE				7, 8				
				VANE								
			7	TW			Cuttings and Bentonite					0 1 44 56
				VANE				7, 5				
				VANE								
			8	SS	WH							
				VANE				4				
8.7	**Silty Sand and Gravel** grey, wet, compact (TILL)		9	SS	11							
	- very dense below 12.8 m		10	SS	50/ 125 mm							18 52 (30)
			11	SS	50/ 100 mm							
13.6	**BEDROCK:** Limestone with shale partings, weathered, very intensely fractured, grey						Bentonite					

Continued Next Page

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 24/1/14

LOG OF BOREHOLE BH13-8

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd. **DRILLING DATA**
CLIENT: Cardel Homes — Method: Hollow Stem Augers
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa — Diameter: 203mm — REF. NO.: 1776-710
DATUM: N/A — Date: Dec/20/2013 — ENCL NO.:
BH LOCATION: See Borehole Location Plan

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION
14.9	**BEDROCK:** Limestone with closely spaced shale partings, intensely fractured, grey to dark grey TCR =50% SRC = 32% RQD = 22%(Continued)						
17.1	**BEDROCK:** Limestone with closely spaced shale partings and calcite filled discontinuities, fresh, grey TCR = 93% SRC = 86% RQD = 73%					Sand Screen	
18.2	**BEDROCK:** Limestone with closely spaced shale partings, fresh, grey TCR = 100% SRC = 95% RQD = 86%						
19.2	**END OF BOREHOLE** Notes: 1) Auger refusal at 13.6 m. Drilling ends, switch to rock coring. 2) Rock corings ends at 19.2 m. 3) 50mm dia. well installed at 19.2 m. 4) Date Depth 17/01/2014 1.3 m						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE — 25 50 75 100 125
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%): 25 50 75
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (KN/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%) — GR SA SI CL

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 24/1/14

LOG OF BOREHOLE BH13-9

PROJECT: Geotechnical Investigation - 5831/5873 Perth St. & 2770 Eagleson Rd. **DRILLING DATA**
CLIENT: Cardel Homes — Method: Hollow Stem Augers
PROJECT LOCATION: 5831/ 5873 Perth St. and 2770 Eagleson Rd., Ottawa — Diameter: 203mm — REF. NO.: 1776-710
DATUM: N/A — Date: Dec/19/2013 — ENCL NO.:
BH LOCATION: See Borehole Location Plan

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
0.0	**Topsoil - 225 mm**		1	SS	10		
0.3	**Silty Clay** brown, moist, stiff		2	SS	8	W. L. 0.9 mBSL Jan 17, 2014	
			3	SS	5	Cuttings	
			4	SS	2		
3.1	**Silty Clay** grey, wet, firm		5	SS	WH		
				VANE			
				VANE		Bentonite	
			6	TW			
				VANE			
				VANE			
			7	SS	WH	Sand	
				VANE		Screen	
				VANE			
			8	SS	WH		
				VANE			
				VANE			
11.0	**Glacial Till (Inferred based on DCPT test results)**						
11.8	**END OF BOREHOLE**						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE: 25 50 75 100 125
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%): 25 50 75
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (KN/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%) — GR SA SI CL

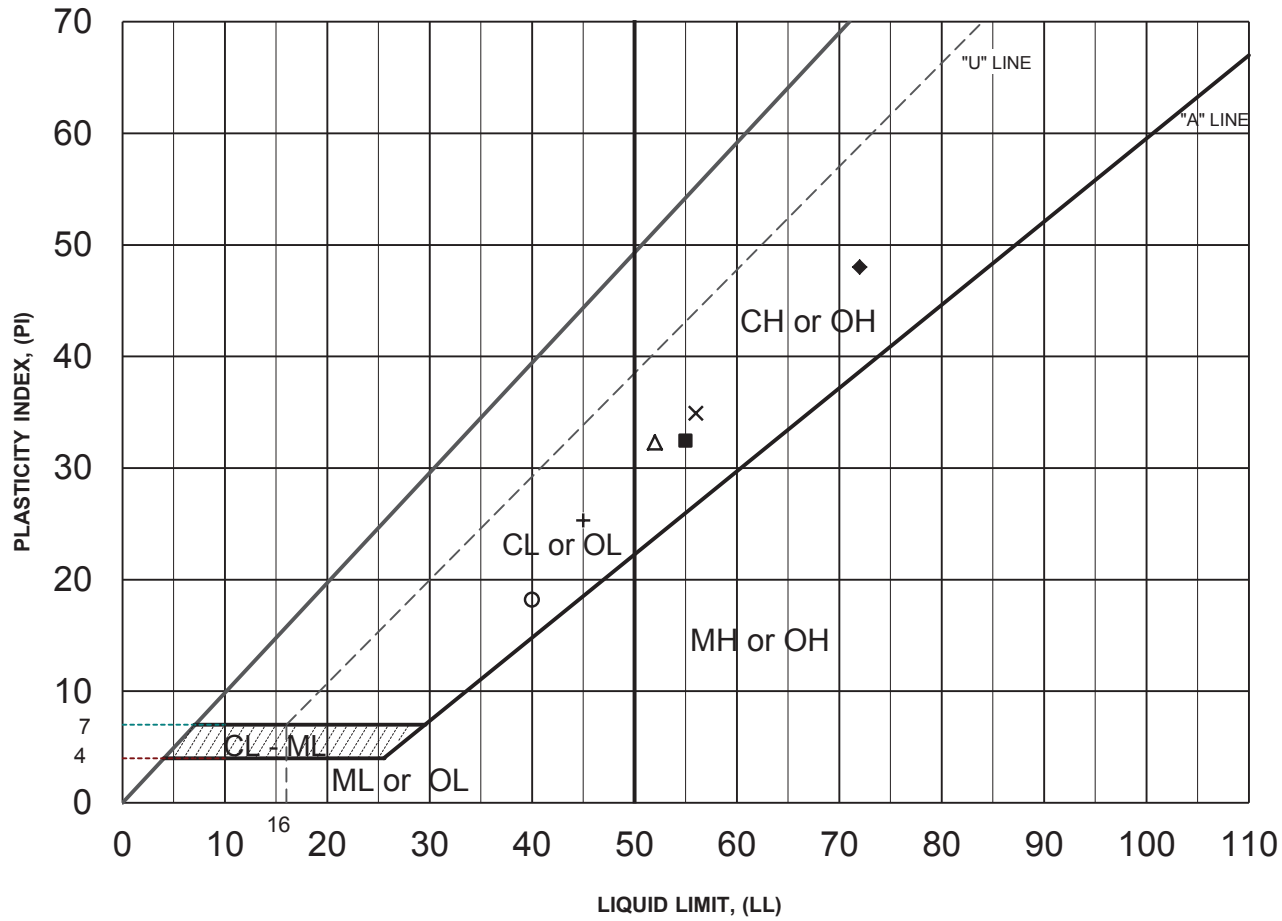
Notes:
1) Drilling ends at 8.8 m. Borehole continued with DCPT.
2) DCPT refusal at 11.8 m.
3) 19mm dia. piezometer was installed in the borehole upon completion
4) Date — Depth
17/01/2014 — 0.9 m

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES: + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

SPL SOIL LOG-OTTAWA 1776-710.GPJ SPL.GDT 23/1/14

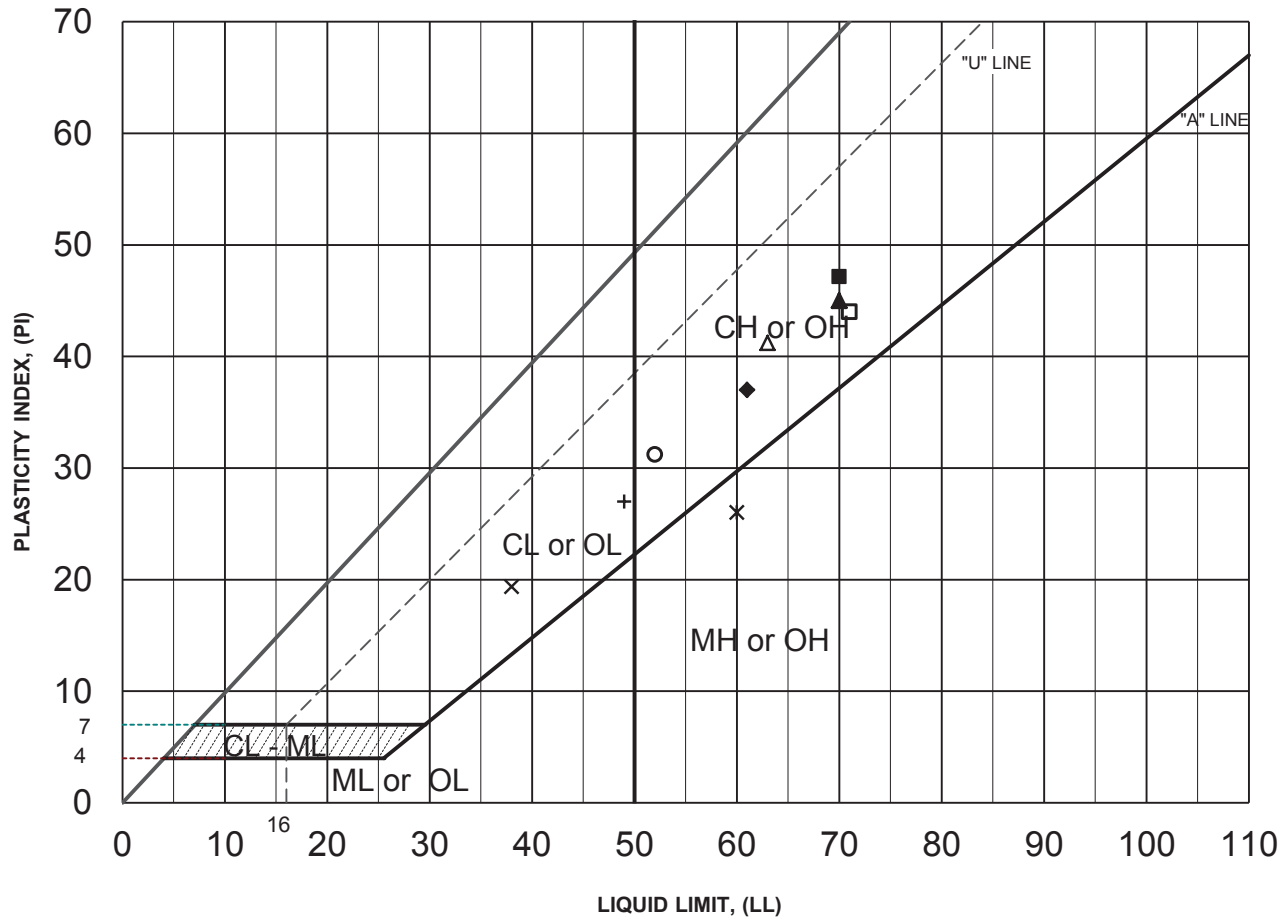
PLASTICITY CHART
(Brown Silty Clay)



Bore Hole:	Sample	Depth (m)	Legend
1	2	0.76 - 1.37	△
2	3	1.52 - 2.13	■
3	2	0.76 - 1.37	○
4	3	1.52 - 2.13	+
6	2	0.76 - 1.37	x
7	4	2.29 - 2.90	♦

PLASTICITY CHART

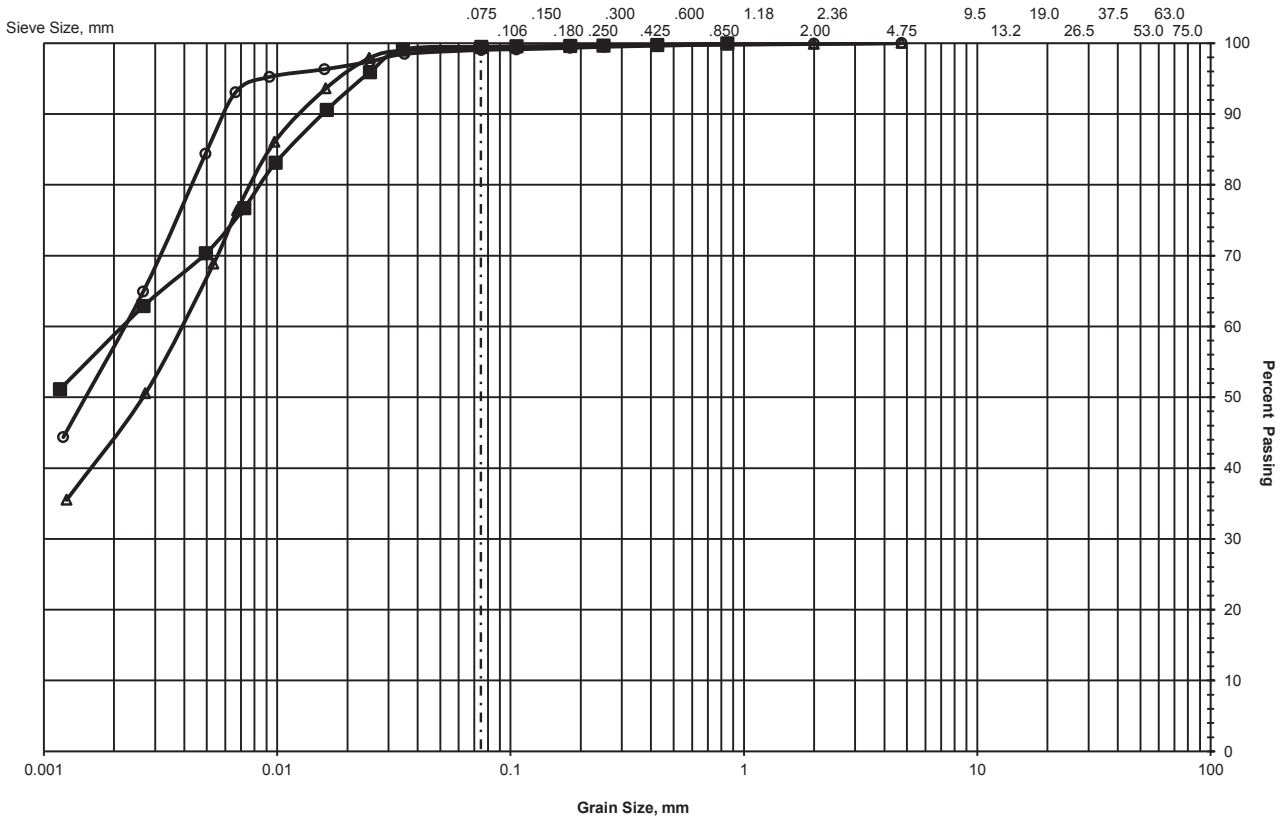
(Grey Silty Clay)



Bore Hole:	Sample	Depth (m)	Legend
1	5	3.05 - 3.66	△
4	5	3.05 - 3.66	■
4	6	4.57 - 5.18	○
5	5	3.05 - 3.66	+
5	6	4.57 - 5.18	x
6	5	3.05 - 3.66	♦
8	6	4.57 - 5.18	✶
8	7	6.10 - 6.71	▲
9	8	7.62 - 8.23	□

GRAIN SIZE DISTRIBUTION

(Grey Silty Clay)

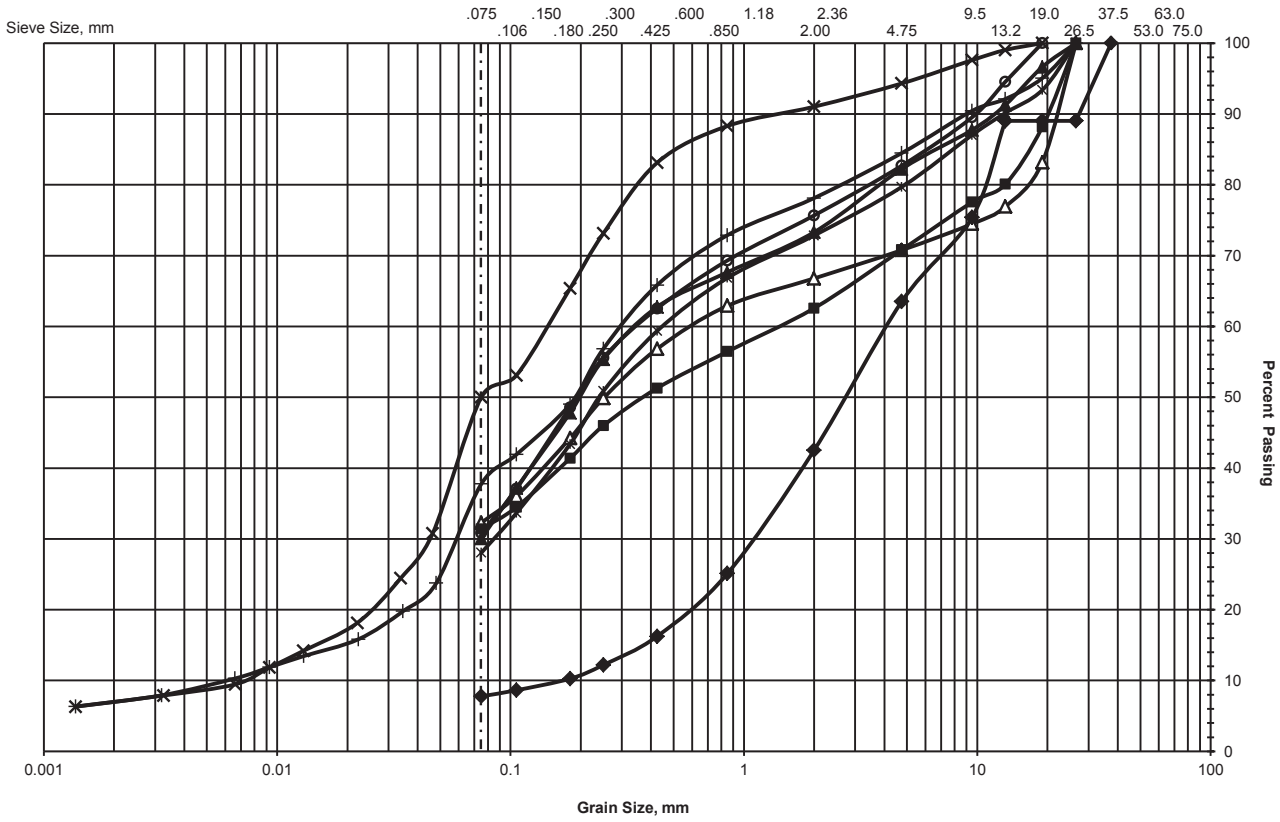


CLAY and SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	
UNIFIED SOIL CLASSIFICATION SYSTEM					

Bore Hole	Sample	Depth (m)	Legend
4	6	4.57 - 5.18	△
5	5	3.05 - 3.66	■
8	7	6.10 - 6.71	○

GRAIN SIZE DISTRIBUTION

(Till)



CLAY and SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	
UNIFIED SOIL CLASSIFICATION SYSTEM					

Bore Hole	Sample	Depth (m)	Legend
1	7	6.10 - 6.71	△
2	8	7.47 - 8.08	■
3	8	7.62 - 8.23	○
4	8	7.62 - 8.23	+
4	9	9.14 - 9.75	x
6	8	7.62 - 8.23	♦
7	7	6.10 - 6.71	✶
8	10	10.67 - 11.28	▲

CONSOLIDATION TEST SUMMARY

FIGURE

SAMPLE IDENTIFICATION

Project Number	13-1183-0092	Sample Number	5
Borehole Number	4	Sample Depth, m	3.0-3.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	10		
Date Started	8/12/2012		
Date Completed	8/28/2013		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.53	Unit Weight, kN/m^3	16.46
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	10.46
Area, cm^2	31.67	Specific Gravity, measured	2.76
Volume, cm^3	80.25	Solids Height, cm	0.980
Water Content, %	57.34	Volume of Solids, cm^3	31.03
Wet Mass, g	134.73	Volume of Voids, cm^3	49.22
Dry Mass, g	85.63	Degree of Saturation, %	99.7

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	2.534	1.587	2.534				
10.67	2.532	1.585	2.533	1	1.36E+00	6.66E-05	8.87E-06
20.38	2.529	1.581	2.530	36	3.77E-02	1.42E-04	5.26E-07
39.75	2.523	1.575	2.526	79	1.71E-02	1.24E-04	2.08E-07
78.54	2.506	1.558	2.514	60	2.23E-02	1.71E-04	3.74E-07
39.75	2.510	1.562	2.508				
10.65	2.517	1.569	2.514				
39.75	2.512	1.564	2.514	29	4.62E-02	6.92E-05	3.13E-07
78.51	2.505	1.557	2.508	31	4.30E-02	6.92E-05	2.92E-07
117.14	2.493	1.545	2.499	118	1.12E-02	1.17E-04	1.29E-07
155.75	2.478	1.529	2.486	240	5.46E-03	1.58E-04	8.47E-08
233.17	2.447	1.498	2.462	360	3.57E-03	1.58E-04	5.53E-08
310.39	2.373	1.422	2.410	1750	7.04E-04	3.78E-04	2.60E-08
619.57	2.019	1.061	2.196	1245	8.21E-04	4.51E-04	3.63E-08
155.75	2.046	1.088	2.033				
39.75	2.097	1.141	2.072				
10.67	2.128	1.172	2.113				

Note:
Consolidation loading and unloading schedule assigned by the client.
Specimen taken 7 to 14cm from bottom of the tube
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

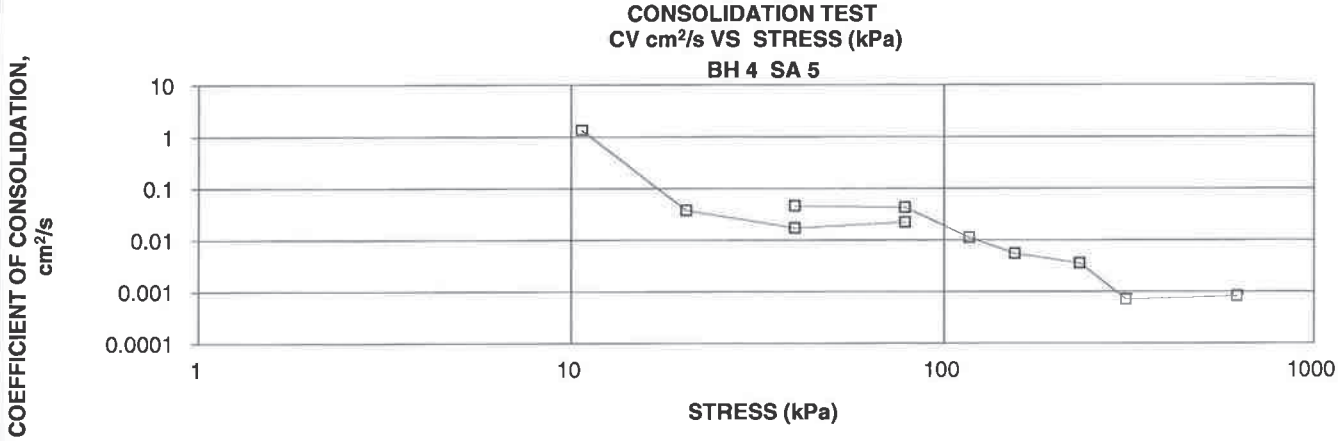
Sample Height, cm	2.13	Unit Weight, kN/m^3	17.95
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	12.46
Area, cm^2	31.67	Specific Gravity, measured	2.76
Volume, cm^3	67.38	Solids Height, cm	0.980
Water Content, %	44.06	Volume of Solids, cm^3	31.03
Wet Mass, g	123.36	Volume of Voids, cm^3	36.36
Dry Mass, g	85.63		

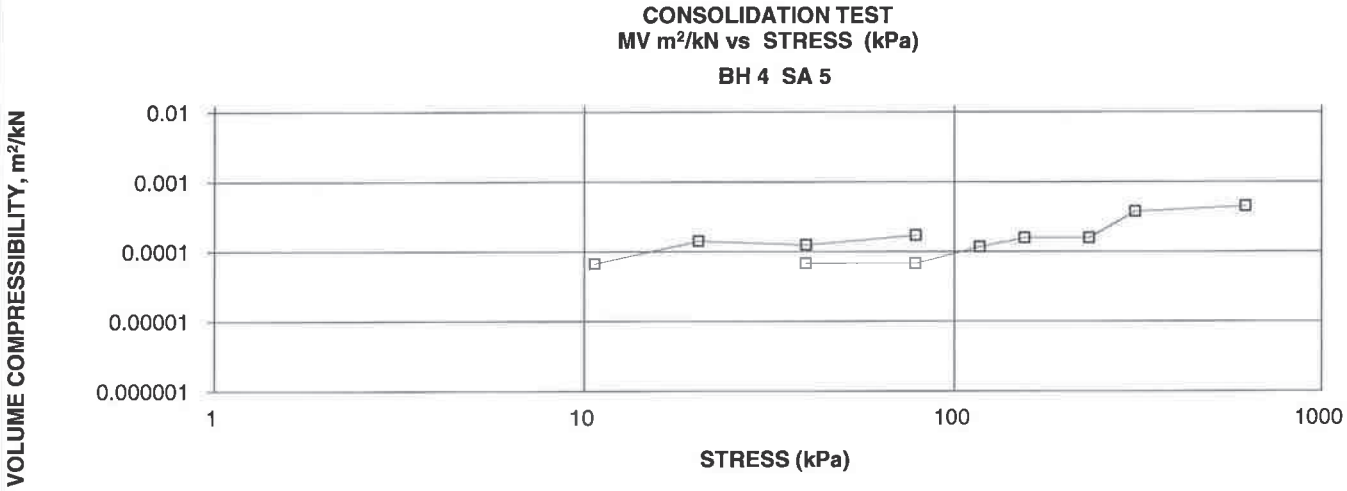
Prepared By: LG

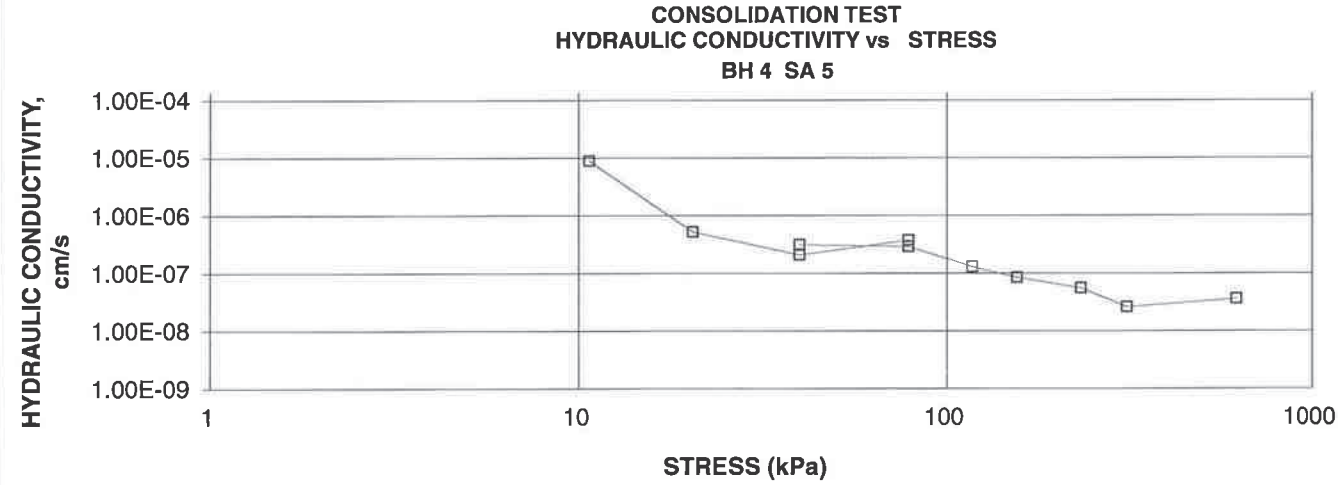
Golder Associates

Checked By:

CONSOLIDATION TEST SUMMARY	FIGURE





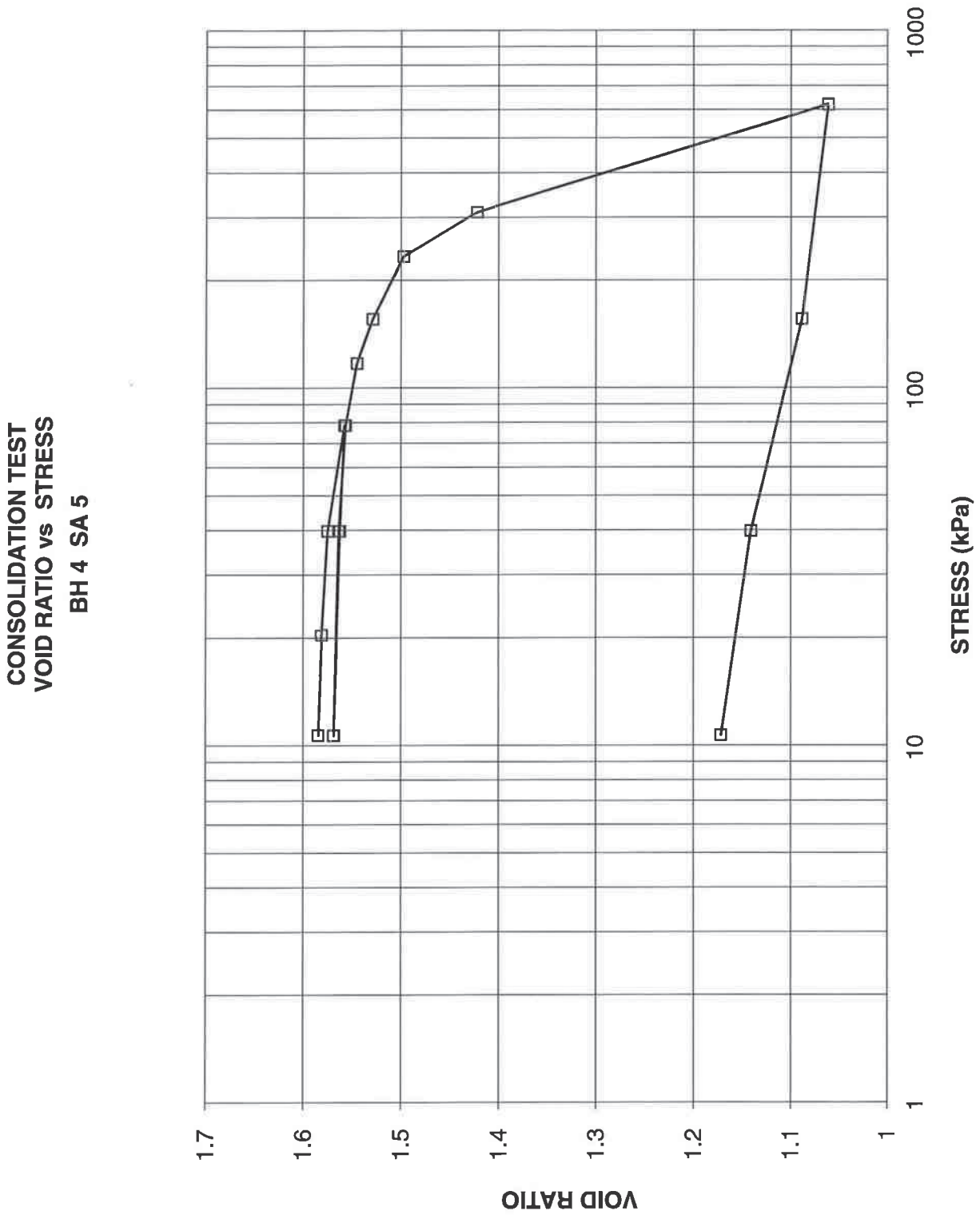


Project No. 13-1183-0092
Prepared By: LG

Golder Associates

Checked By:

CONSOLIDATION TEST VOID RATIO VS LOG STRESS	FIGURE



Project No. 13-1183-0092

Prepared By: LG

Golder Associates

Checked By:

SPECIFIC GRAVITY TEST RESULTS

ASTM D 854-06 TEST METHOD A

PROJECT NUMBER	13-1183-0092
PROJECT NAME	SPL / Lab Testing / 1776-710
DATE TESTED	August, 2013

Borehole No.	Sample No.	Specific Gravity
4	5	2.76
5	6	2.73

Note: Test carried out on soil particles <2.00mm using distilled water.

Checked By: MM

Golder Associates

CONSOLIDATION TEST SUMMARY

FIGURE

SAMPLE IDENTIFICATION

Project Number	14-1183-0001	Sample Number	TW7
Borehole Number	13-8	Sample Depth, m	6.1-6.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	1		
Date Started	1/09/2014		
Date Completed	1/26/2014		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.56	Unit Weight, kN/m^3	17.01
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	11.81
Area, cm^2	31.54	Specific Gravity, measured	2.77
Volume, cm^3	80.58	Solids Height, cm	1.110
Water Content, %	44.09	Volume of Solids, cm^3	35.02
Wet Mass, g	139.78	Volume of Voids, cm^3	45.56
Dry Mass, g	97.01	Degree of Saturation, %	93.9

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv, cm^2/s	mv m^2/kN	k cm/s
0.00	2.555	1.301	2.555				
10.91	2.515	1.265	2.535	194	7.02E-03	1.42E-03	9.78E-07
20.75	2.491	1.243	2.503	1636	8.12E-04	9.90E-04	7.88E-08
40.26	2.451	1.208	2.471	747	1.73E-03	7.84E-04	1.33E-07
79.11	2.396	1.158	2.424	667	1.87E-03	5.61E-04	1.03E-07
20.75	2.406	1.167	2.401				
79.23	2.390	1.152	2.398	167	7.30E-03	1.12E-04	8.00E-08
118.26	2.356	1.122	2.373	5165	2.31E-04	3.34E-04	7.56E-09
156.80	2.314	1.084	2.335	1500	7.71E-04	4.34E-04	3.27E-08
195.83	2.288	1.060	2.301	2323	4.83E-04	2.60E-04	1.23E-08
311.88	2.208	0.988	2.248	1873	5.72E-04	2.69E-04	1.51E-08
622.33	2.088	0.880	2.148	452	2.16E-03	1.52E-04	3.22E-08
1243.05	1.979	0.782	2.033	171	5.12E-03	6.86E-05	3.45E-08
311.88	2.001	0.802	1.990				
156.80	2.012	0.812	2.007				
40.26	2.042	0.839	2.027				
10.91	2.066	0.861	2.054				

Note:
Consolidation loading and unloading schedule assigned by the client.
Specimen taken 6 to 10cm from bottom of the tube
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

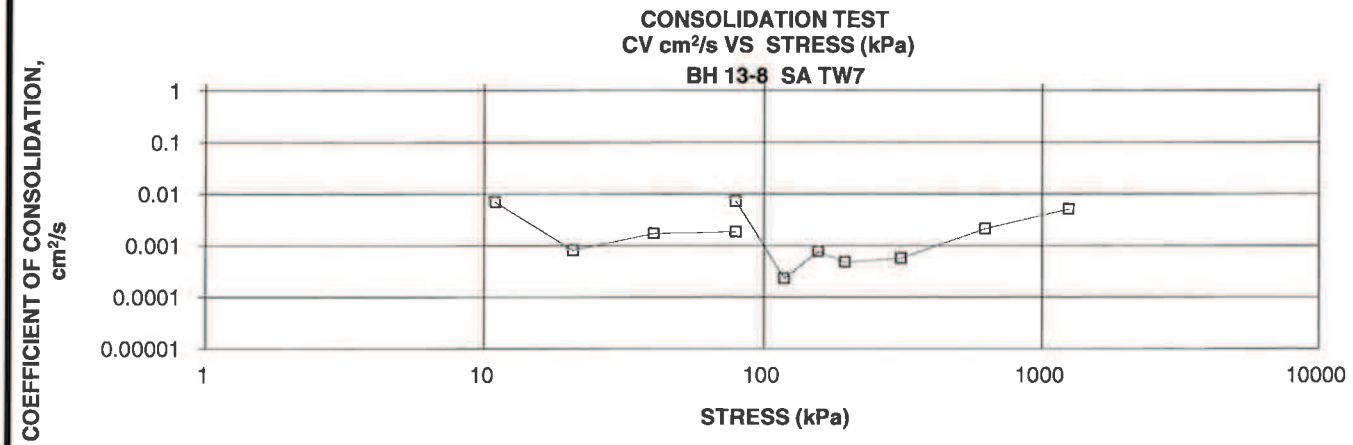
Sample Height, cm	2.07	Unit Weight, kN/m^3	19.00
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	14.60
Area, cm^2	31.54	Specific Gravity, measured	2.77
Volume, cm^3	65.16	Solids Height, cm	1.110
Water Content, %	30.13	Volume of Solids, cm^3	35.02
Wet Mass, g	126.24	Volume of Voids, cm^3	30.14
Dry Mass, g	97.01		

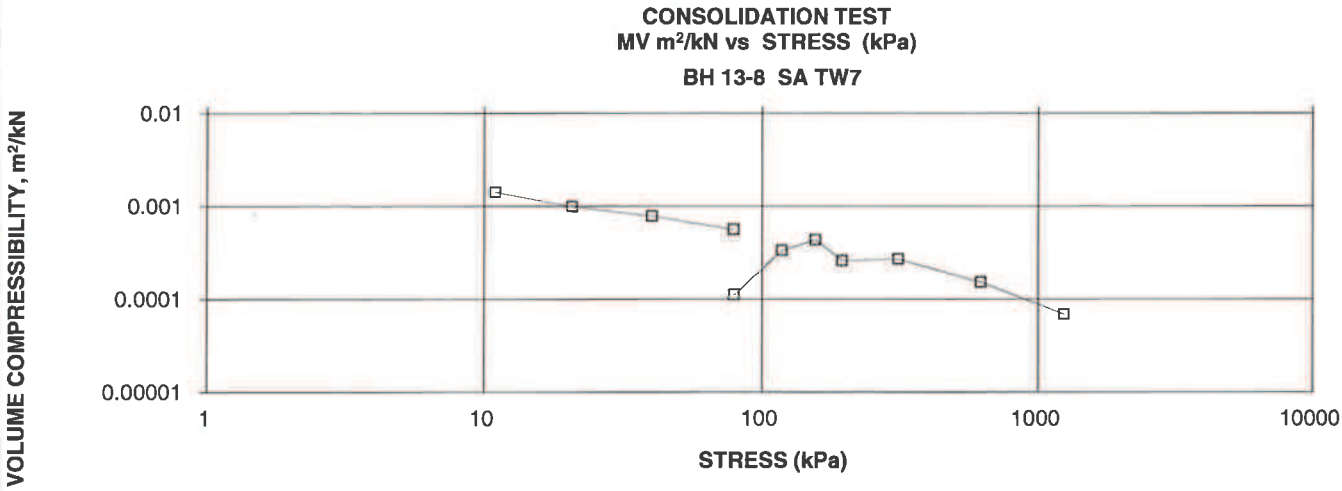
Prepared By: LG

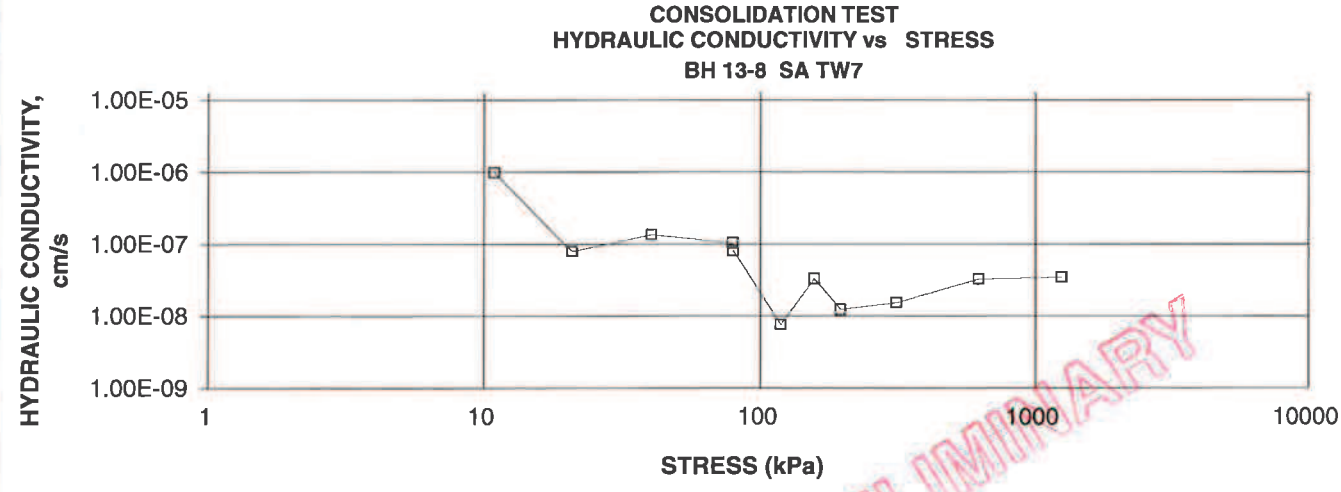
Golder Associates

Checked By:

CONSOLIDATION TEST SUMMARY	FIGURE





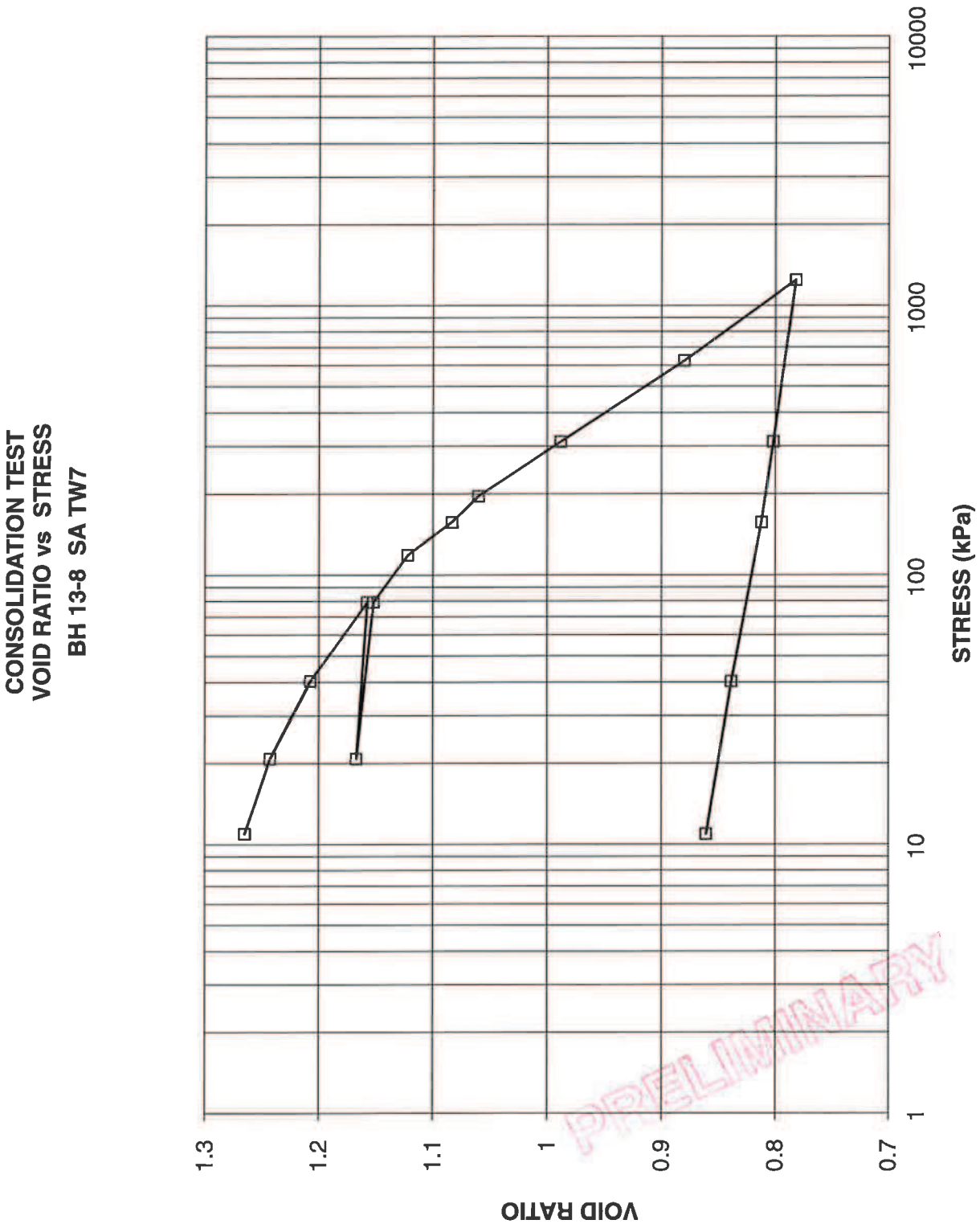


Project No. 14-1183-0001
Prepared By: LG

Golder Associates

Checked By:

CONSOLIDATION TEST VOID RATIO VS LOG STRESS	FIGURE



Project No. 14-1183-0001

Prepared By: LG

Golder Associates

Checked By:

Certificate of Analysis

Client: SPL Consultants Ltd.
146 Colonnade Rd., Unit 17
Ottawa, ON
K2E 7Y1
Attention: Mr. Omer Eissa
PO#: VISA
Invoice to: SPL Consultants Ltd.

Report Number: 1317978
Date Submitted: 2013-08-20
Date Reported: 2013-08-23
Project: 1776-710
COC #: 166358

Group	Analyte	MRL	Units	Guideline	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1051567 Soil 2013-08-06 TH6-SS2	1051568 Soil 2013-08-02 TH3 - SS3
Agri. - Soil	Electrical Conductivity	0.05	mS/cm			0.13	0.20
	pH	2.0				7.2	7.9
General Chemistry	Cl	0.002	%			0.004	0.003
	Resistivity	1	ohm-cm			7690	5000
	SO4	0.01	%			<0.01	<0.01

Guideline = *** = Guideline Exceedence**
** = Analysis completed at Mississauga, Ontario.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX D

Chemical Analysis of Soil Samples
Samples Relating to Corrosion
(Paracel Laboratories Ltd. Order No. 2024534)

Certificate of Analysis

Report Date: 28-Jul-2020

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 22-Jul-2020

Client PO:

Project Description: 61899.04

	Client ID:	20-06 SA3	20-16 SA3	-	-
	Sample Date:	14-Jul-20 09:00	07-Jul-20 09:00	-	-
	Sample ID:	2030291-01	2030291-02	-	-
	MDL/Units	Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	74.8	74.7	-	-
General Inorganics					
Conductivity	5 uS/cm	147	132	-	-
pH	0.05 pH Units	7.72	7.72	-	-
Resistivity	0.10 Ohm.m	67.9	75.7	-	-
Anions					
Chloride	5 ug/g dry	14	12	-	-
Sulphate	5 ug/g dry	8	<5	-	-

APPENDIX E

MASW Testing

GEMTEC
Consulting Engineers and Scientists

GEMTEC Consulting Engineers and Scientists Limited
300 Horseshoe Lake Drive, Suite 303
Halifax, NS, Canada
B3S 0B7

tel: 902.832.5999
fax: 902.832.5929
halifax@gemtec.ca
www.gemtec.ca

October 15, 2020 File: 61899.04

Cardel Homes
300 Moodie Drive, Suite 100
Ottawa, Ontario
K2H 9C4

Attention: Chris Collins

Re: MASW Surveys - Proposed Residential Development, Creekside 2, Village of Richmond, 2770 Eagleson Road, Ottawa, ON

SITE CLASSIFICATION FOR SEISMIC SITE RESPONSE

Introduction

This letter provides the results of the Multichannel Analysis of Surface Waves (MASW) investigation that was completed as part of an overall geotechnical investigation for the proposed residential development, Creekside 2, Village of Richmond, 2770 Eagleson Road, Ottawa, Ontario. The MASW surveys provide Seismic Site Class information using V_s30 values in conjunction with Table 4.1.8.4.A of the 2012 Ontario Building Code (OBC).

Survey Procedures

The field work for this investigation was completed on October 5, 2020 and consisted of two (2) MASW survey lines as shown on Figure 1. Survey line 1 was completed within the eastern portion of the proposed development and survey line 2 was completed within the western portion of the proposed development.. The survey lines were made up of linearly placed geophones that were firmly coupled to the ground surface using soil penetrating spikes. The survey equipment used during the investigation included twelve 4.5 Hertz geophones, a 12-channel geophone cable, one 24-channel geometrics geode, a high impact polyethylene plate, and a 9 kilogram sledgehammer that functioned as the main seismic source (during active surveying). The Geophones were positioned at 3 metre intervals, resulting in a 33 metre spread length. Six shot locations were used during the active surveying and included both forward and reverse shot locations at distances of 3, 8, and 12 metres from the end geophones.

Passive data records were also acquired during the investigation in an effort to improve sampling at lower frequencies. A total of twenty (20) passive data records were recorded for each survey location, which utilizes the low frequency induced seismicity from ambient seismic sources (i.e., traffic). Both passive and active data records were processed individually and then combined into composite data records to generate final V_s30 results.

Tables 1 and 2 below, outline the survey parameters used during both active and passive surveying for this investigation.

Table 1 – Acquisition Parameters for Active Surveying

Acquisition Parameters	Description
Geophones	4.5 Hertz geophones (12 total)
Geophone Intervals	3 metres
Survey Line Length	33 metres
Shot Records	6 shot records 3, 8, and 12 m from the end geophones
Source	9 kg sledgehammer and 30 cm x 30 cm x 7.5 cm impact plate
Sample Interval	0.25 milliseconds
Record Length	2 seconds
Stacking	Up to 10 stacks per shot location

Table 2 – Acquisition Parameters for Passive Surveying

Acquisition Parameters	Description
Geophones	4.5 Hertz geophones (12 total)
Geophone Intervals	3 metres
Survey Line Length	33 metres
Shot Records	20 shot records (no stacking)
Source	Induced seismicity (e.g. traffic)
Sample Interval	2 milliseconds
Record Length	32 seconds

Data Processing

The shot records were initially inspected for data quality in the SeisimagerSW™ software package and inspections were used to identify and discard low quality data prior to processing. Records passing inspection were converted from the time domain to the frequency domain using a Fast

Fourier Transform (FFT). The converted data records were then plotted as phase velocity vs. frequency plots to display fundamental mode dispersion curves. The dispersion curves were then picked for each of the active shot locations, and for the combined passive records. The seven (7) dispersion curves were compiled into a composite record for input into an inversion routine. Using a least squares method (LSM), the inversion routine executed a fit of the composite data records to a model simulating site parameters (from borehole information) in order to generate 1D shear wave velocity profiles and time-averaged V_s30 values. The results from the MASW surveys can be viewed on Figure D1.

RESULTS

The MASW surveys completed for the proposed residential development resulted in V_s30 values of 479 m/s and 442 m/s for MASW survey lines 1 (east) and 2 (west), respectively.

CLOSURE

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

Mike West, M.Sc., P.Geo., P.Eng

Greg Davidson, P.Eng.
Geotechnical Engineer

MW/GD

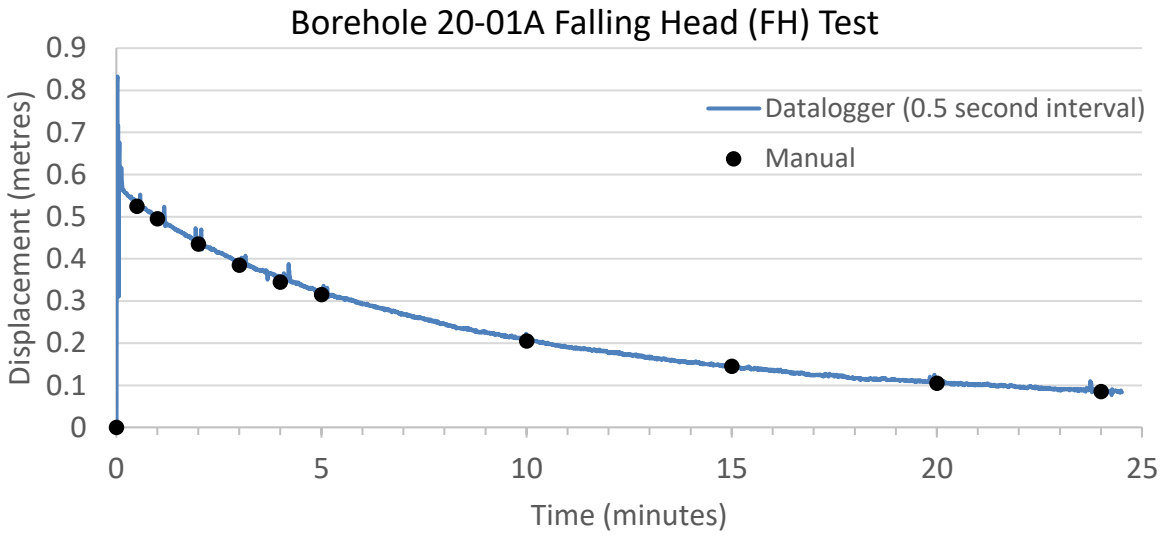
Enclosures
N:\files\61800\61899.04\04_Deliverables\MASW\61899.04 MASW Surveys - Cardel Geotech.docx

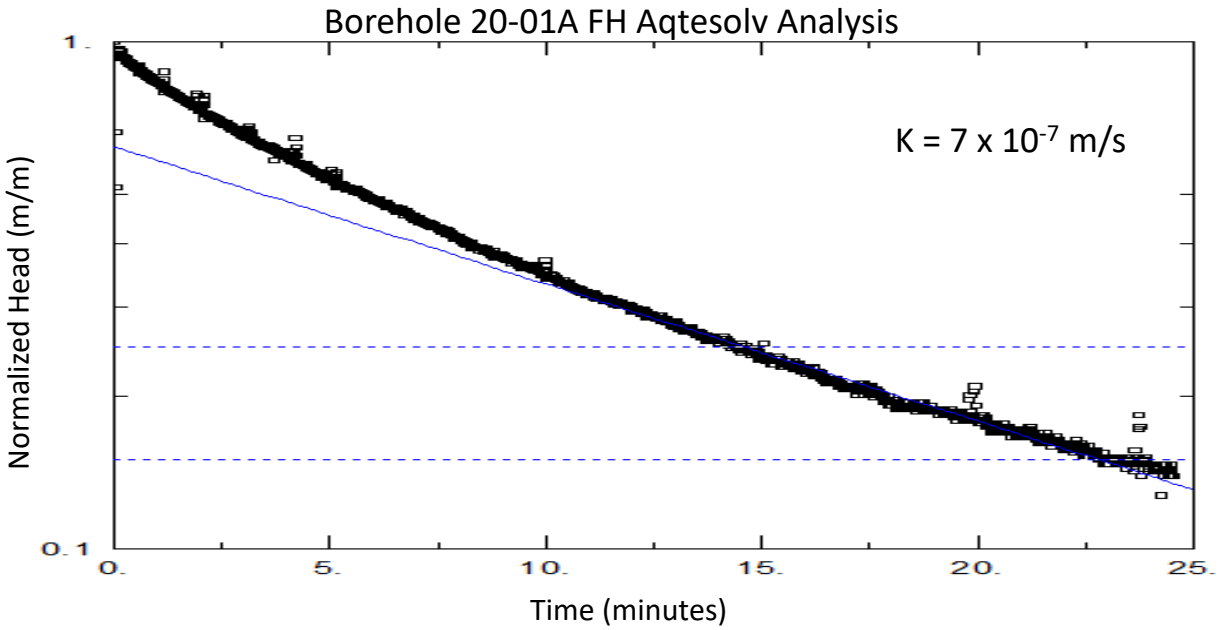
APPENDIX F

Hydraulic Conductivity Test Results
Figures 1 to 13

Hydraulic Testing

FIGURE 1





<u>Well Data:</u>
Slug Displacement: 0.60 metres
Well Depth: 9.14 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

<u>Aquifer Data</u>
Saturated Thickness: 7.0 metres
Static Water Level: 2.14 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

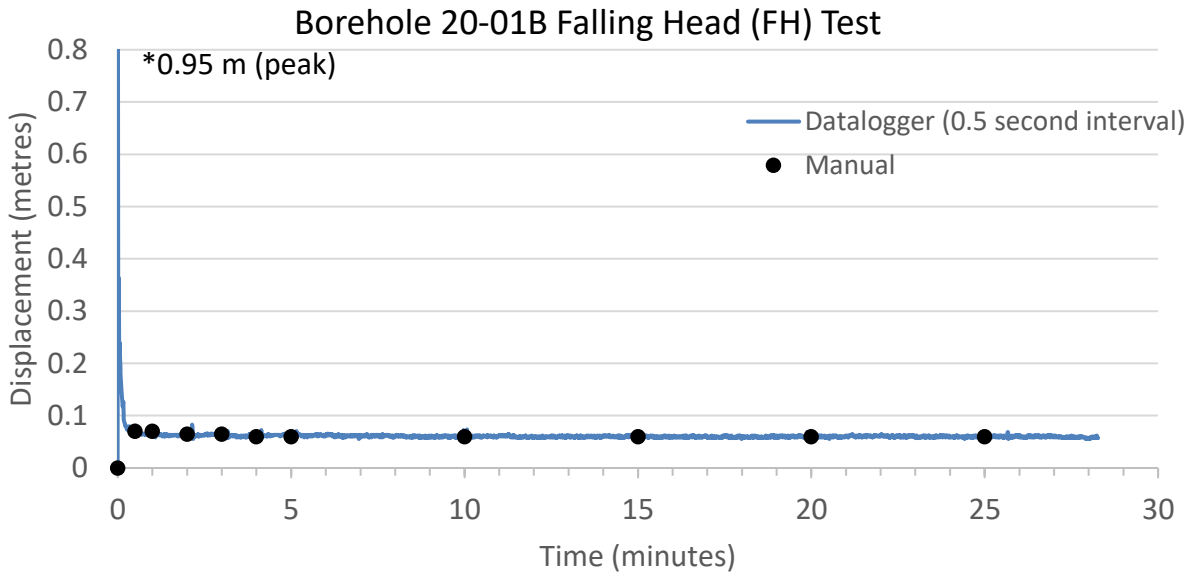
GEMTEC
Consulting Engineers and Scientists

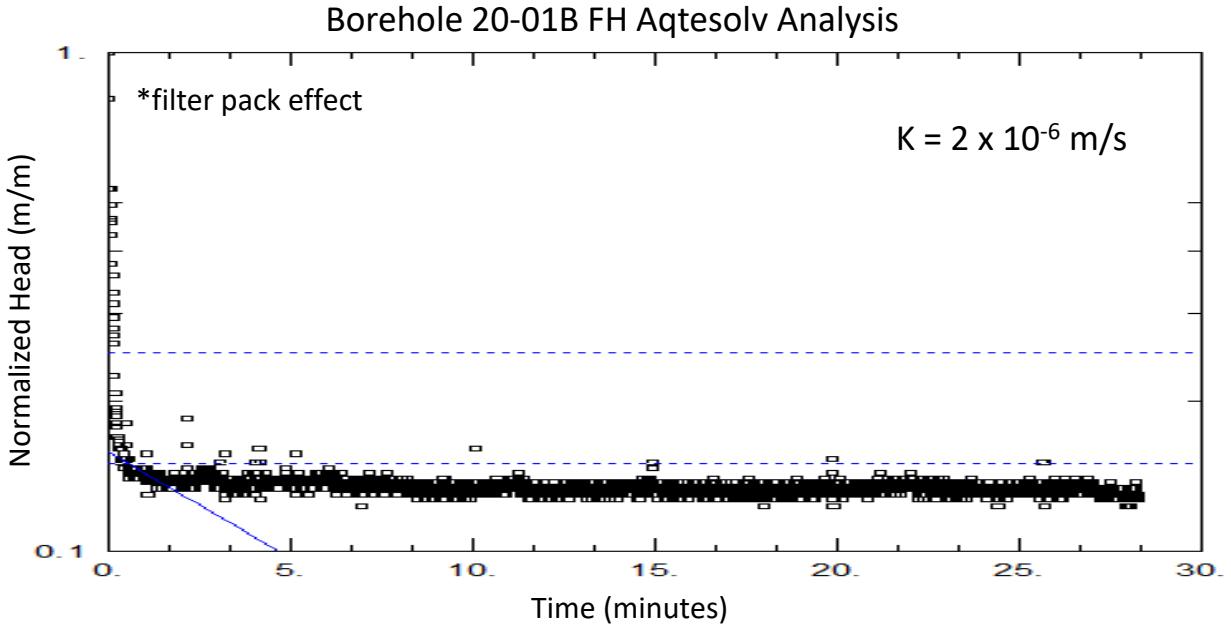
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 2





Well Data:
Slug Displacement: 0.45 metres
Well Depth: 3.83 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

Aquifer Data
Saturated Thickness: 1.42 metres
Static Water Level: 2.41 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

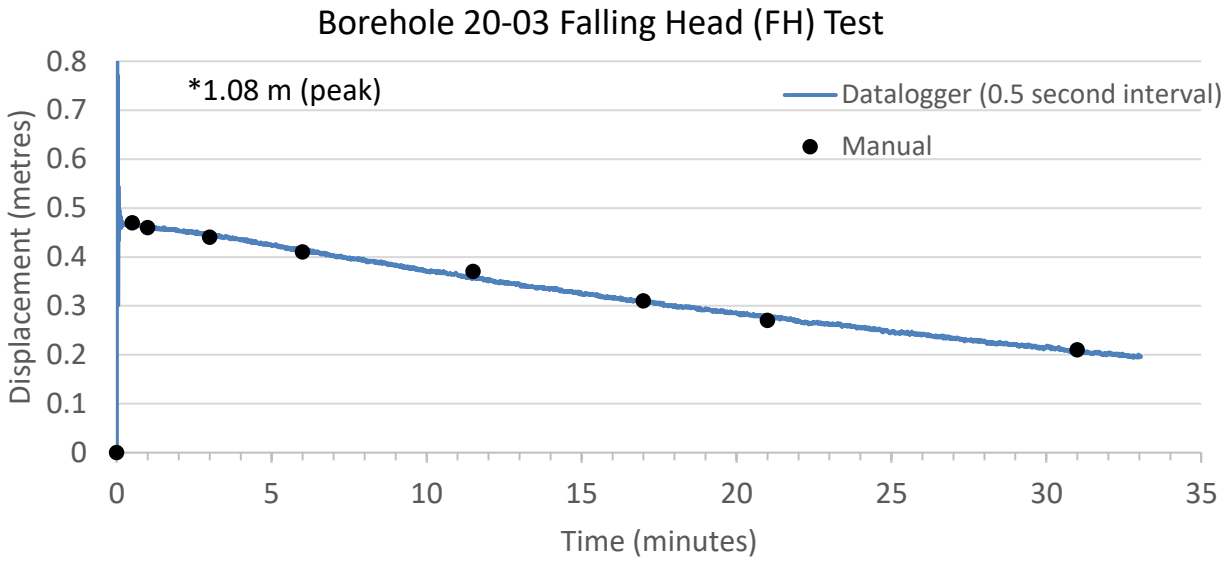
GEMTEC
Consulting Engineers and Scientists

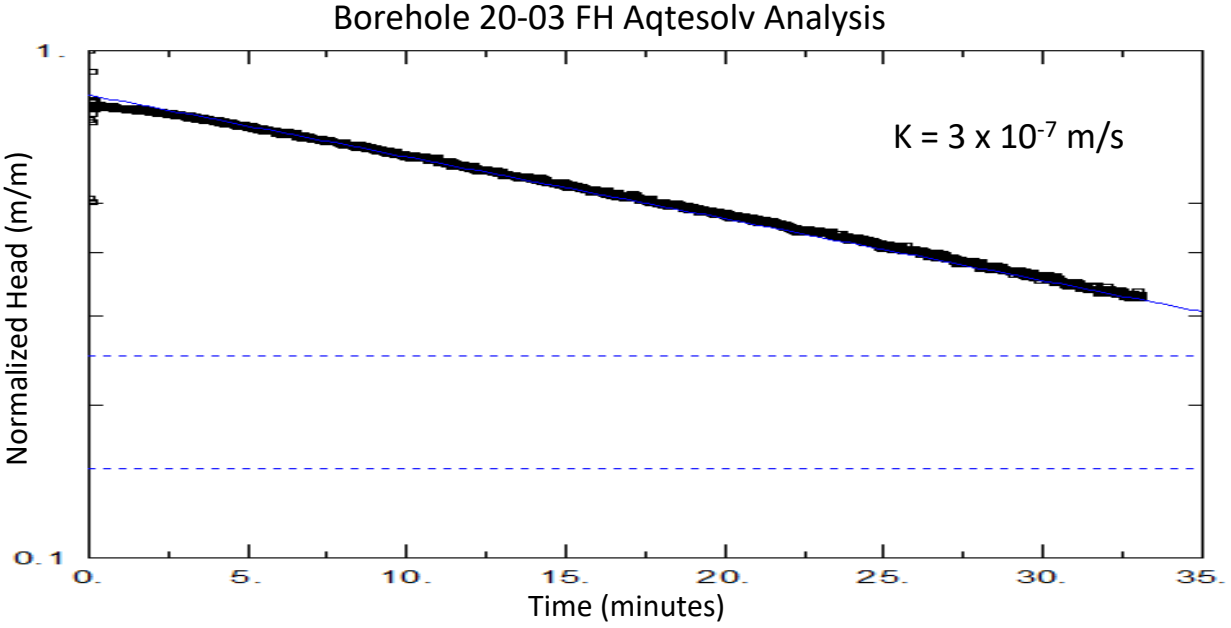
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 3





<u>Well Data:</u>
Slug Displacement: 0.60 metres
Well Depth: 3.96 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

<u>Aquifer Data</u>
Saturated Thickness: 3.13 metres
Static Water Level: 0.83 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

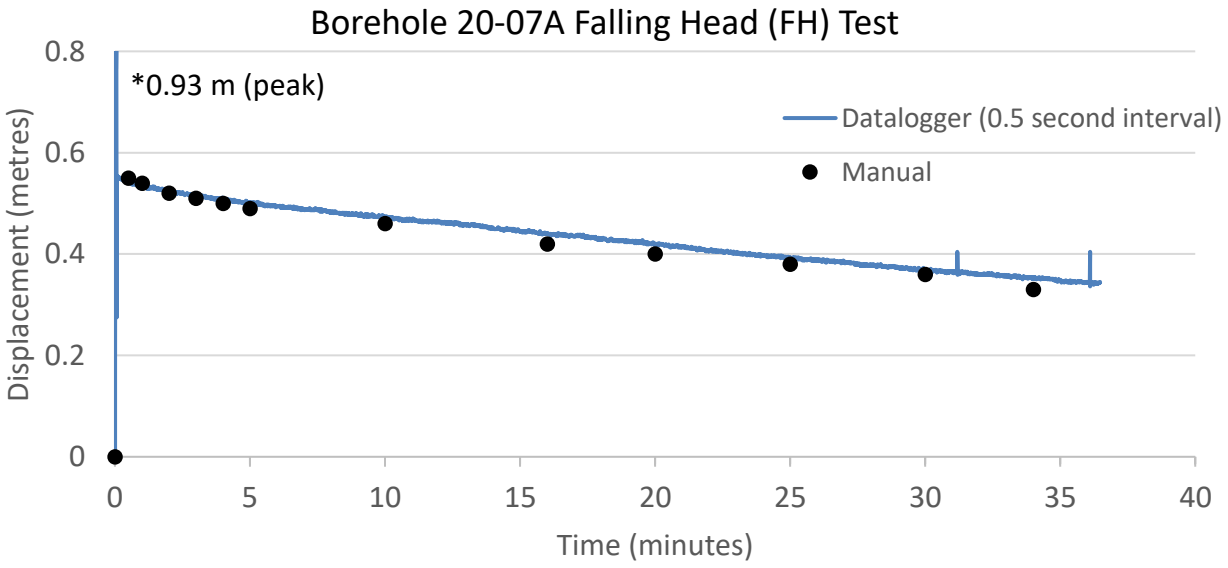
GEMTEC
Consulting Engineers and Scientists

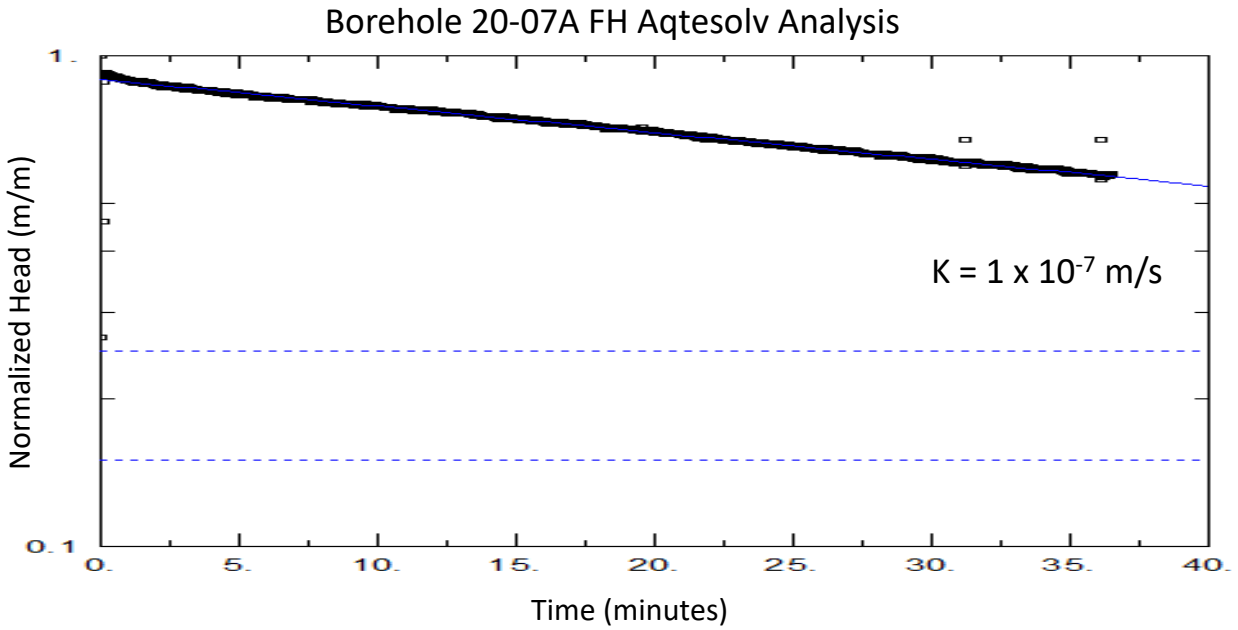
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 4





Well Data:
Slug Displacement: 0.60 metres
Well Depth: 6.55 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

Aquifer Data
Saturated Thickness: 4.03 metres
Static Water Level: 2.52 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

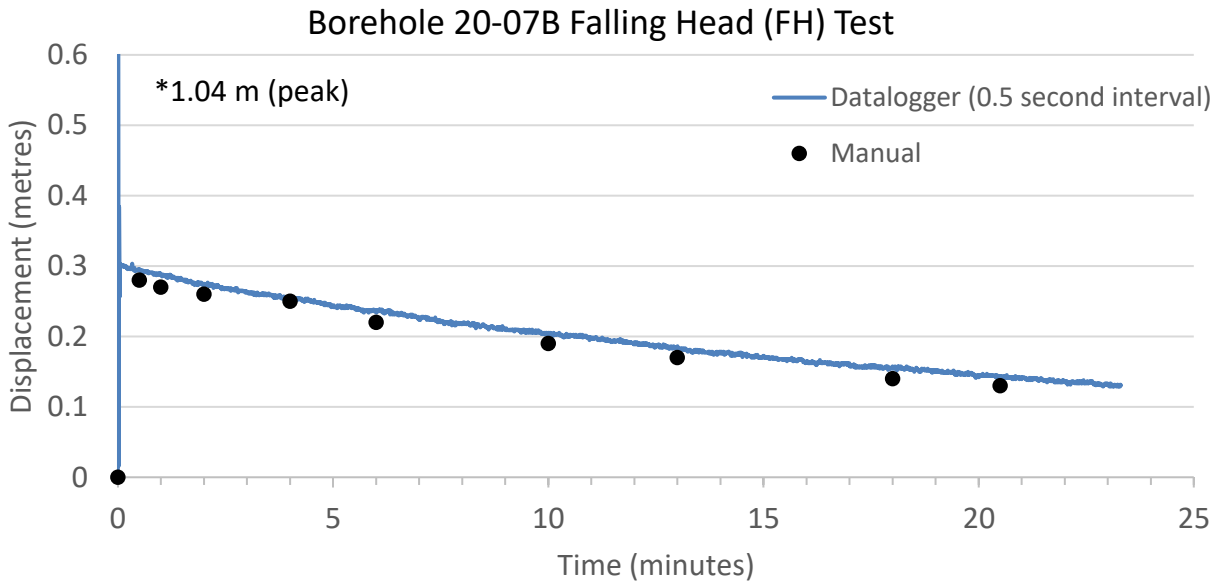
GEMTEC
Consulting Engineers and Scientists

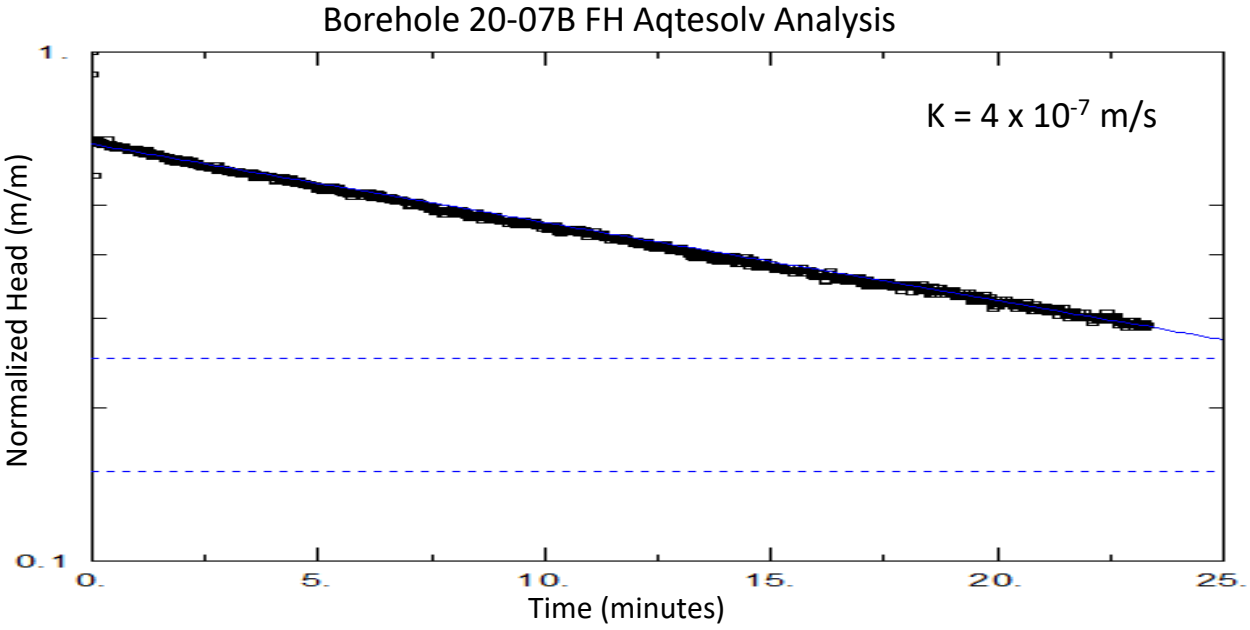
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 5





Well Data:
Slug Displacement: 0.45 metres
Well Depth: 3.96 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

Aquifer Data
Saturated Thickness: 1.52 metres
Static Water Level: 2.44 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

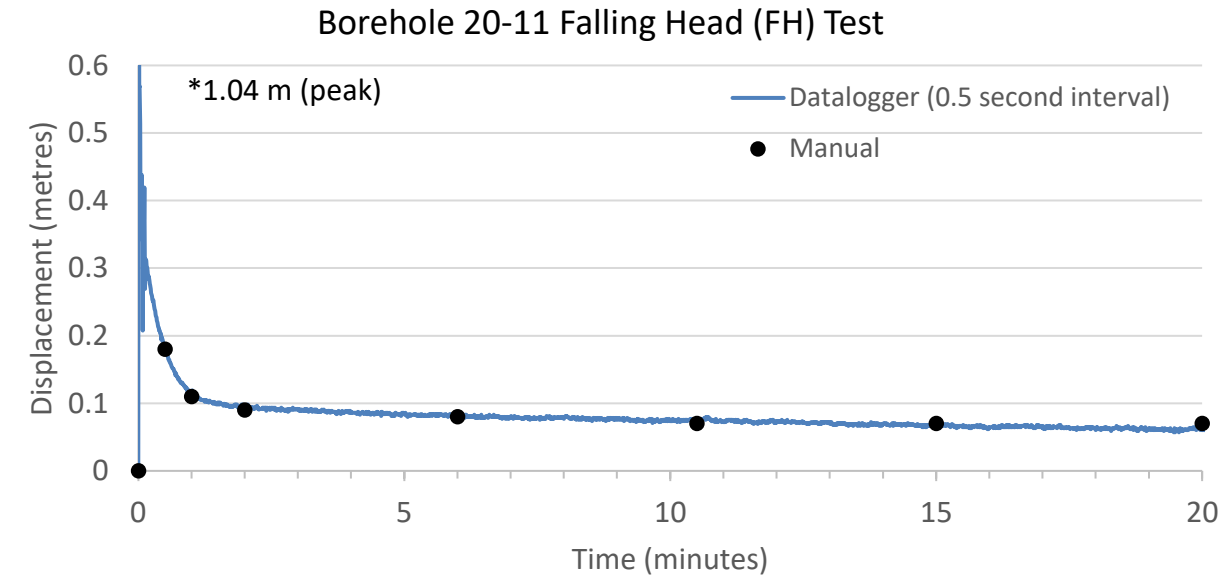
GEMTEC
Consulting Engineers and Scientists

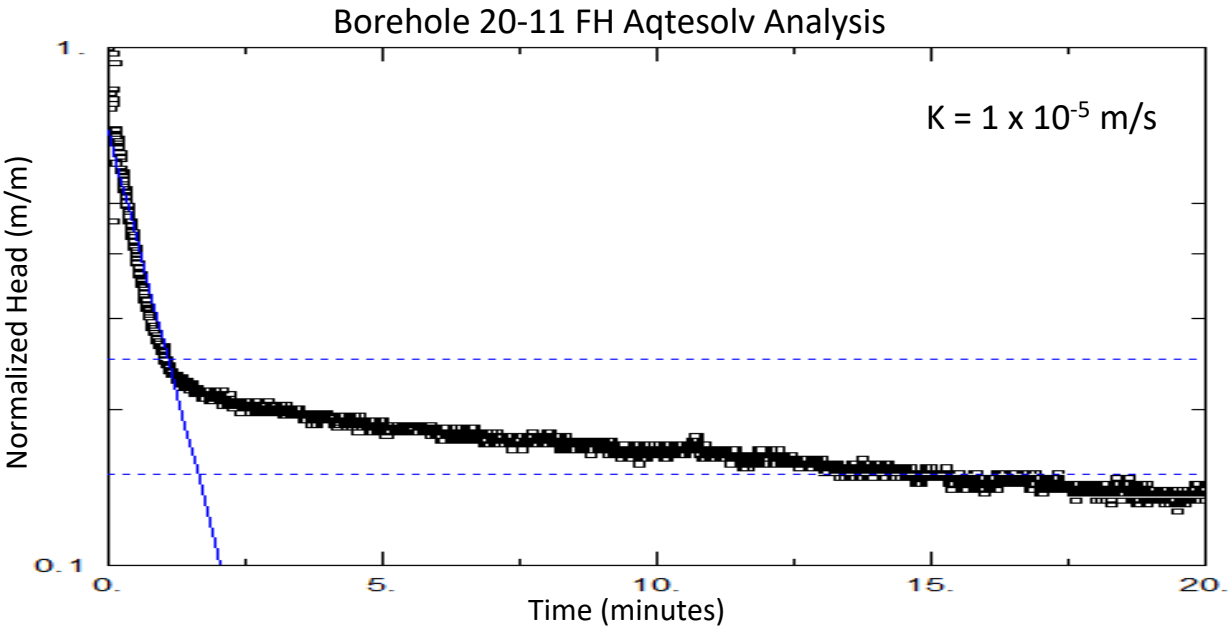
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 6





Well Data:
Slug Displacement: 0.45 metres
Well Depth: 3.96 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

Aquifer Data
Saturated Thickness: 1.60 metres
Static Water Level: 2.36 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

GEMTEC
Consulting Engineers and Scientists

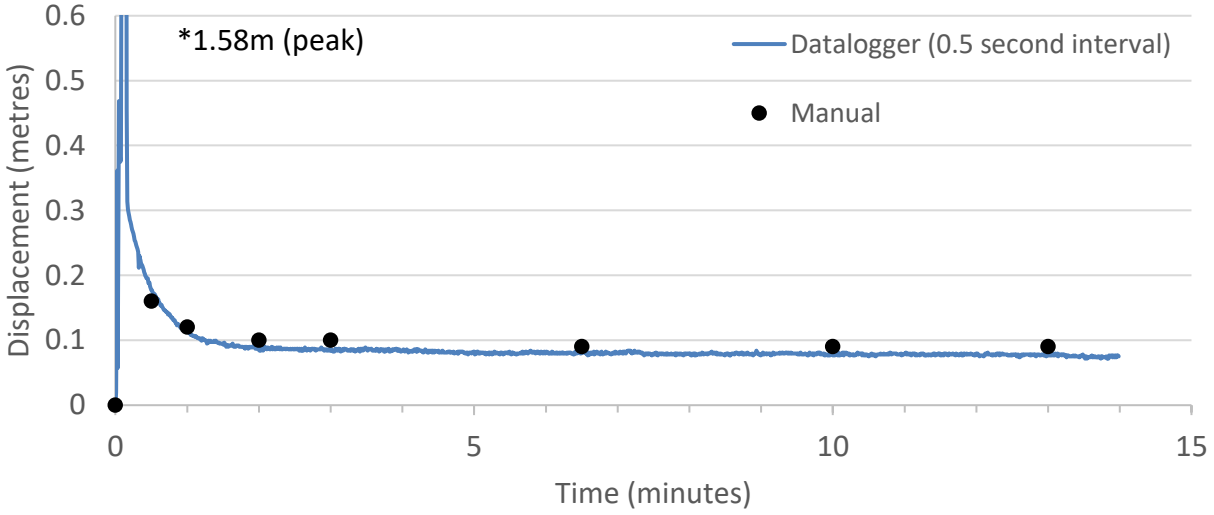
Date: November 2020

Project: 61899.04

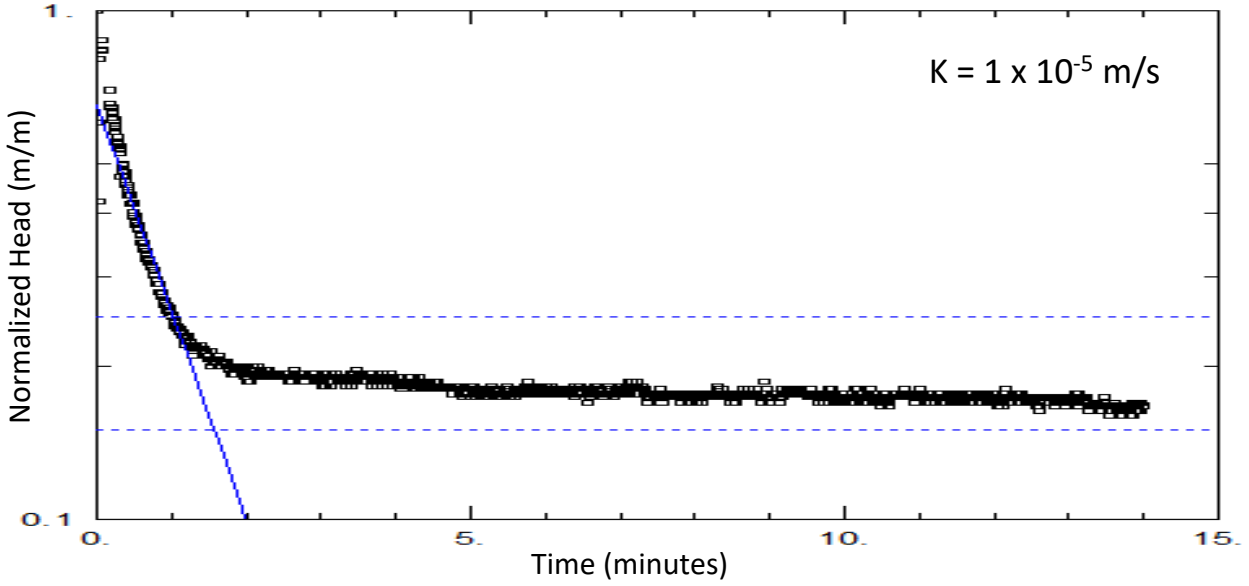
Hydraulic Testing

FIGURE 7

Borehole 20-11 Rising Head (RH) Test



Borehole 20-11 RH Aqtesolv Analysis



<u>Well Data:</u>
Slug Displacement: 0.45 metres
Well Depth: 3.96 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

<u>Aquifer Data</u>
Saturated Thickness: 1.60 metres
Static Water Level: 2.36 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

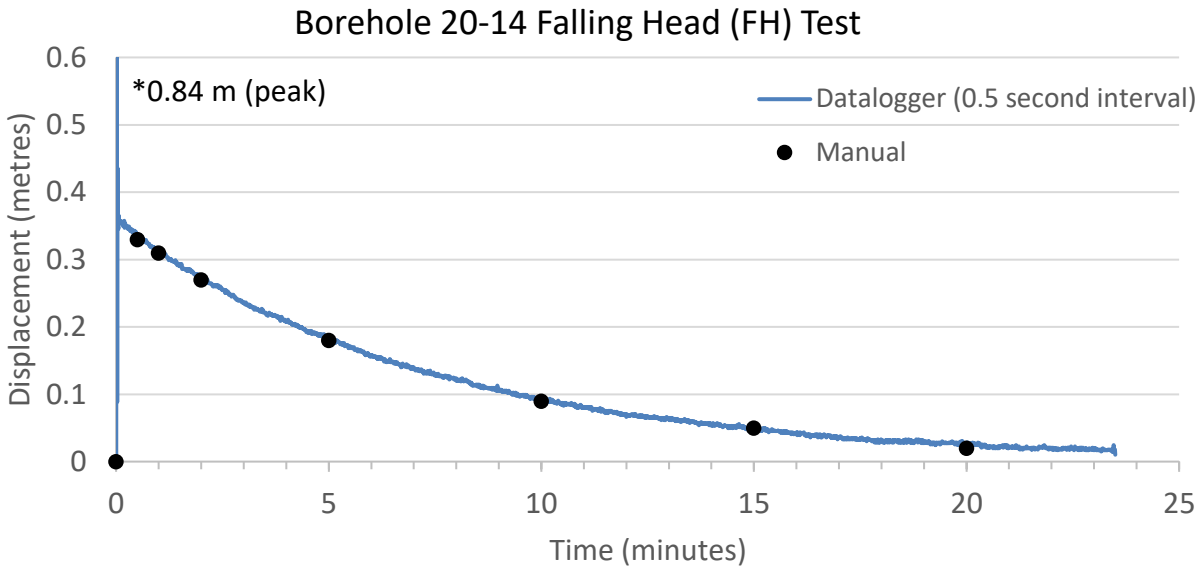
GEMTEC
Consulting Engineers and Scientists

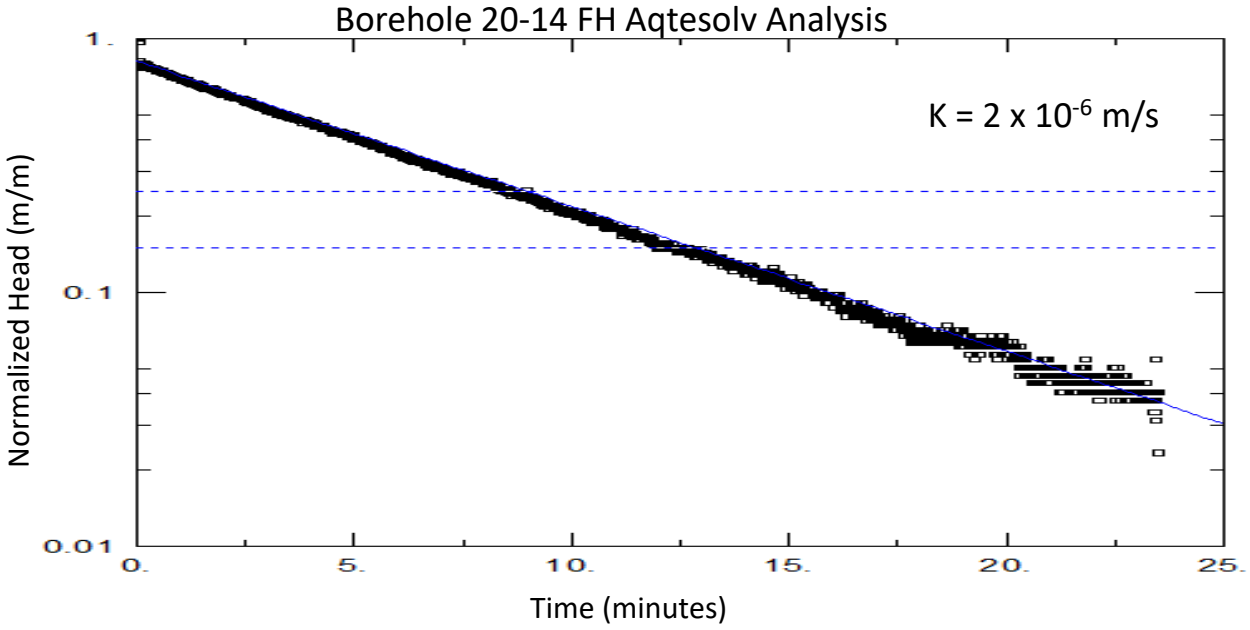
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 8





<u>Well Data:</u>
Slug Displacement: 0.45 metres
Well Depth: 3.96 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

<u>Aquifer Data</u>
Saturated Thickness: 1.73 metres
Static Water Level: 2.23 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

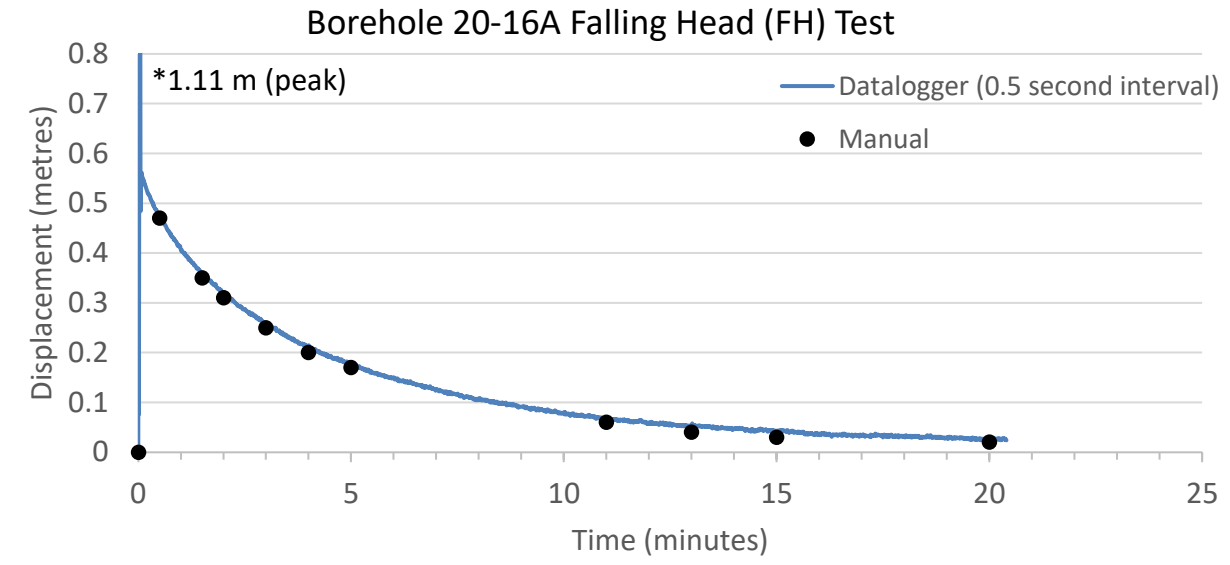
GEMTEC
Consulting Engineers and Scientists

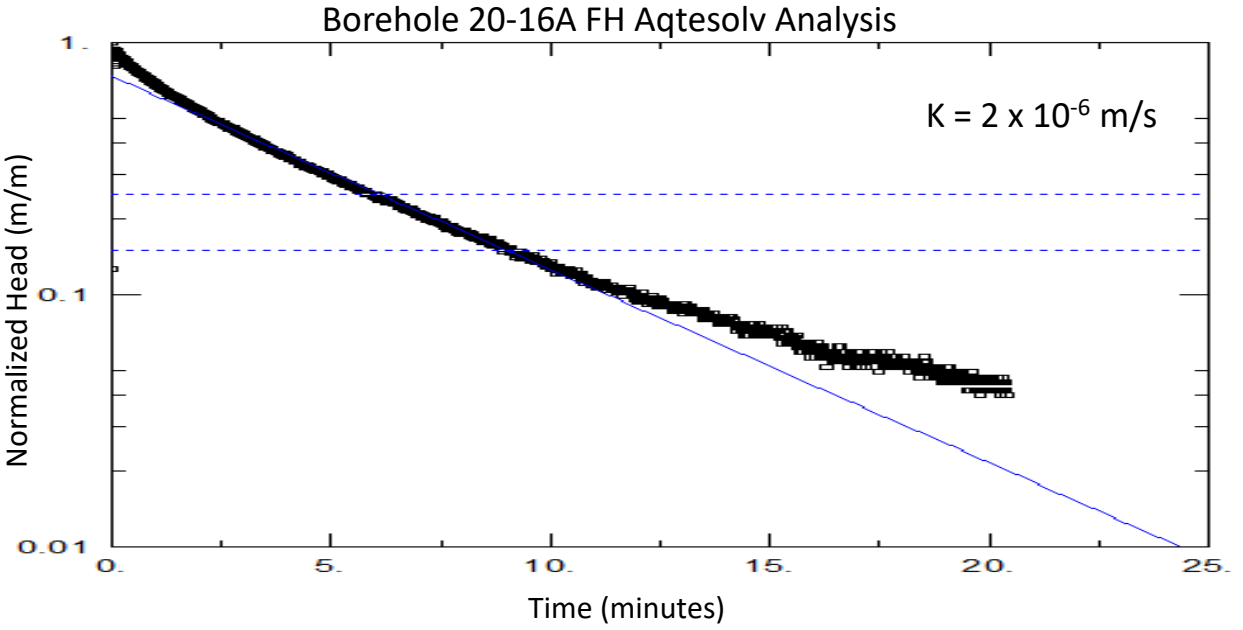
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 9





Well Data:
Slug Displacement: 0.60 metres
Well Depth: 9.14 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

Aquifer Data
Saturated Thickness: 6.55 metres
Static Water Level: 2.59 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

GEMTEC
Consulting Engineers and Scientists

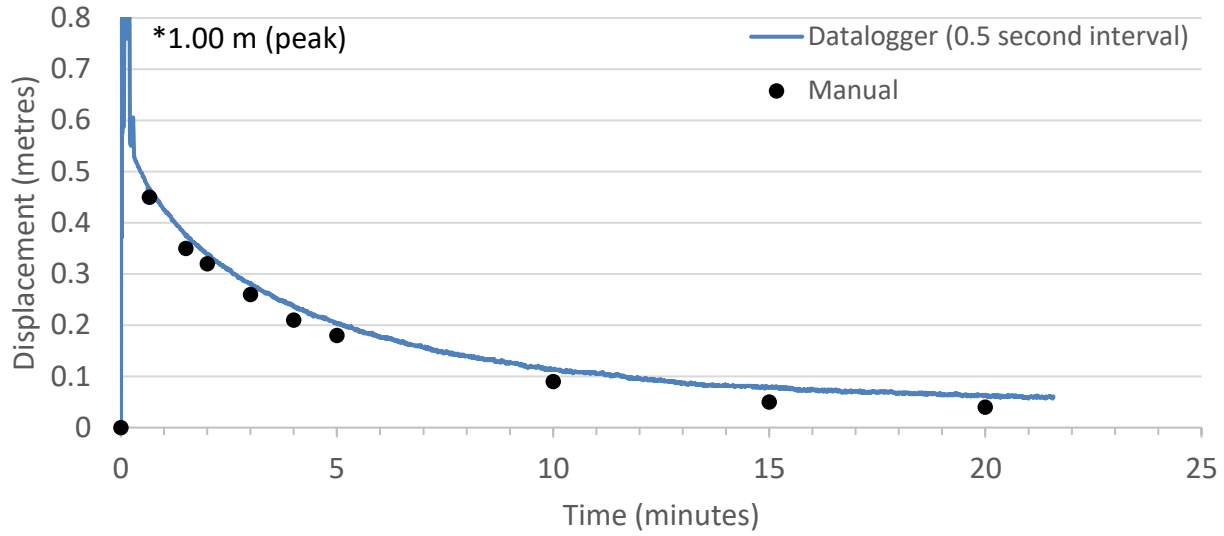
Date: November 2020

Project: 61899.04

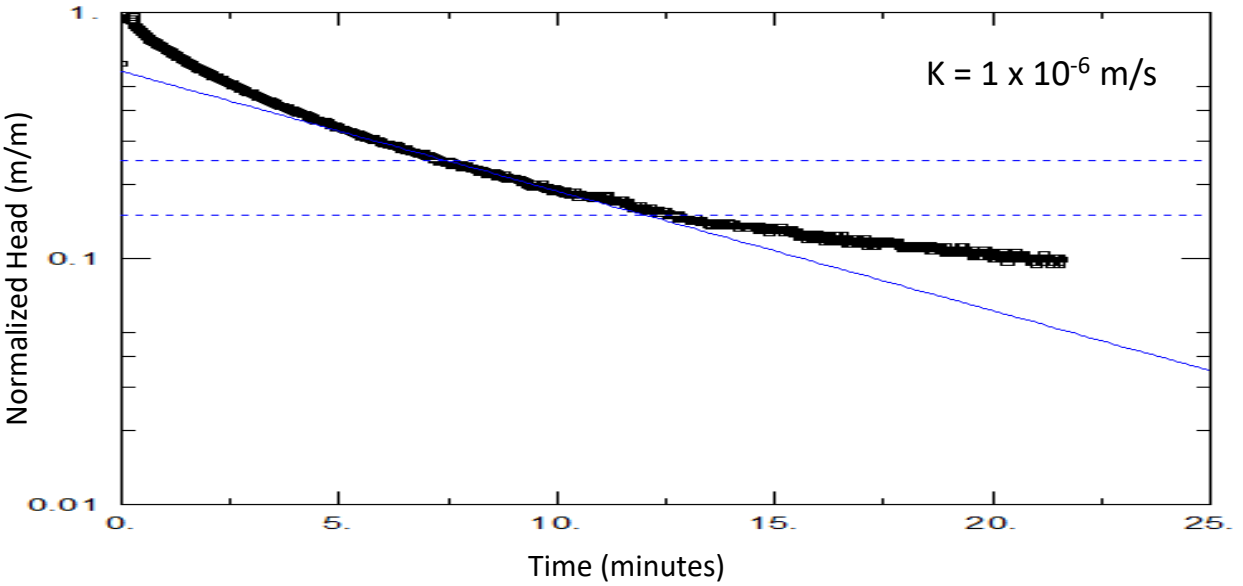
Hydraulic Testing

FIGURE 10

Borehole 20-16A Rising Head (RH) Test



Borehole 20-16A RH Aqtesolv Analysis



Well Data:
Slug Displacement: 0.60 metres
Well Depth: 9.14 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

Aquifer Data
Saturated Thickness: 6.55 metres
Static Water Level: 2.59 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

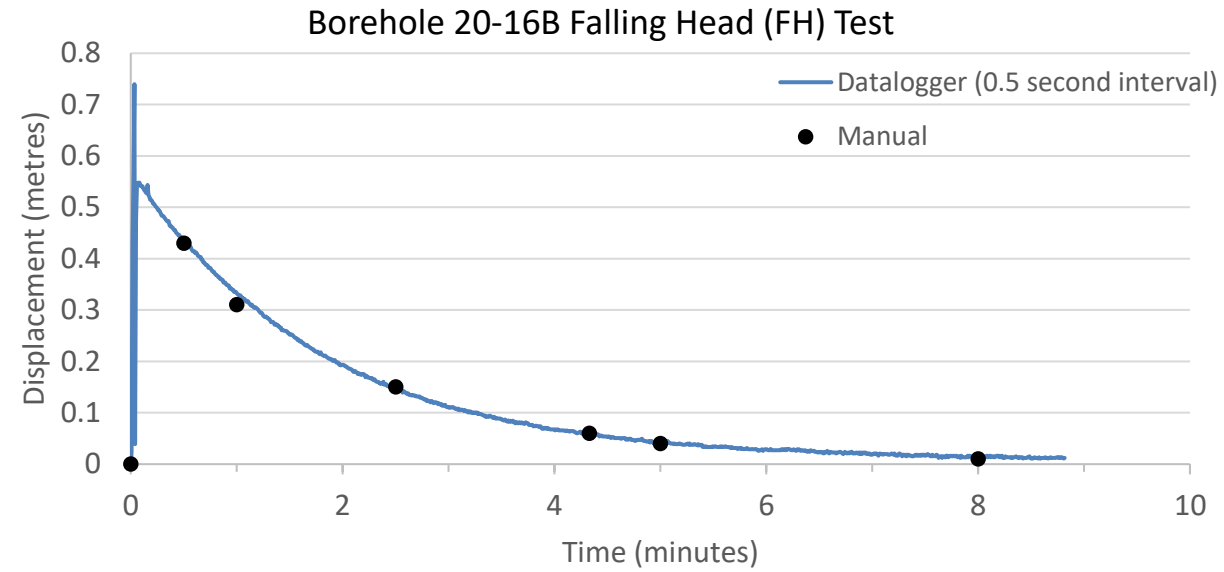
GEMTEC
Consulting Engineers and Scientists

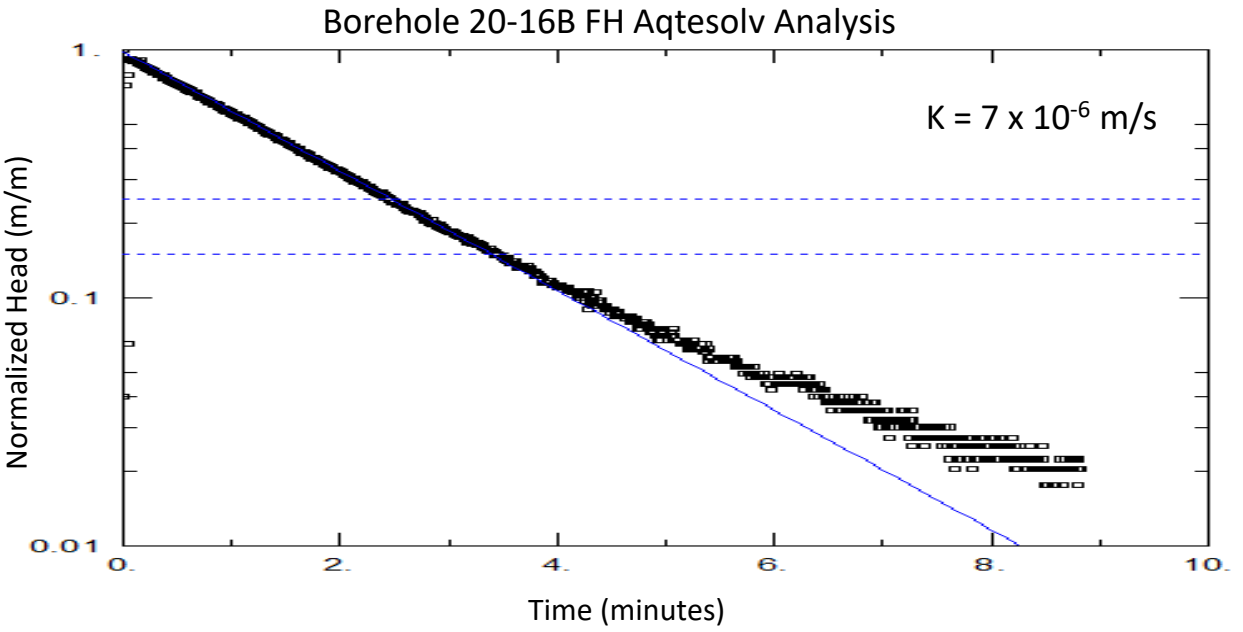
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 11





Well Data:
Slug Displacement: 0.60 metres
Well Depth: 3.96 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

Aquifer Data
Saturated Thickness: 1.87 metres
Static Water Level: 2.09 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

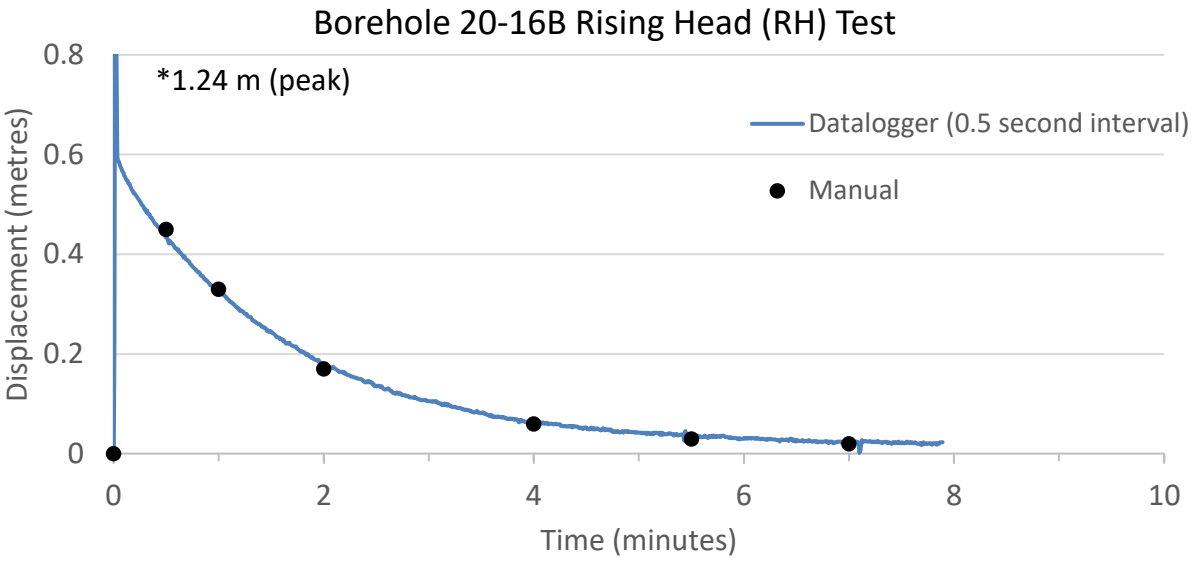
GEMTEC
Consulting Engineers and Scientists

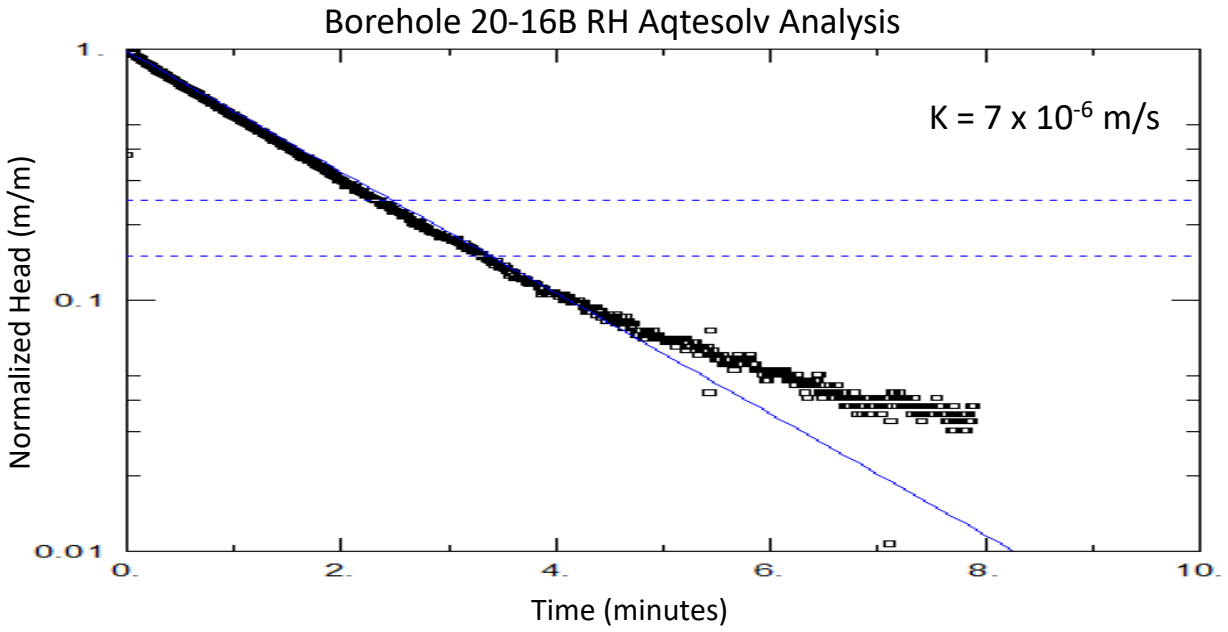
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 12





<u>Well Data:</u>
Slug Displacement: 0.60 metres
Well Depth: 3.96 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

<u>Aquifer Data</u>
Saturated Thickness: 1.87 metres
Static Water Level: 2.09 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

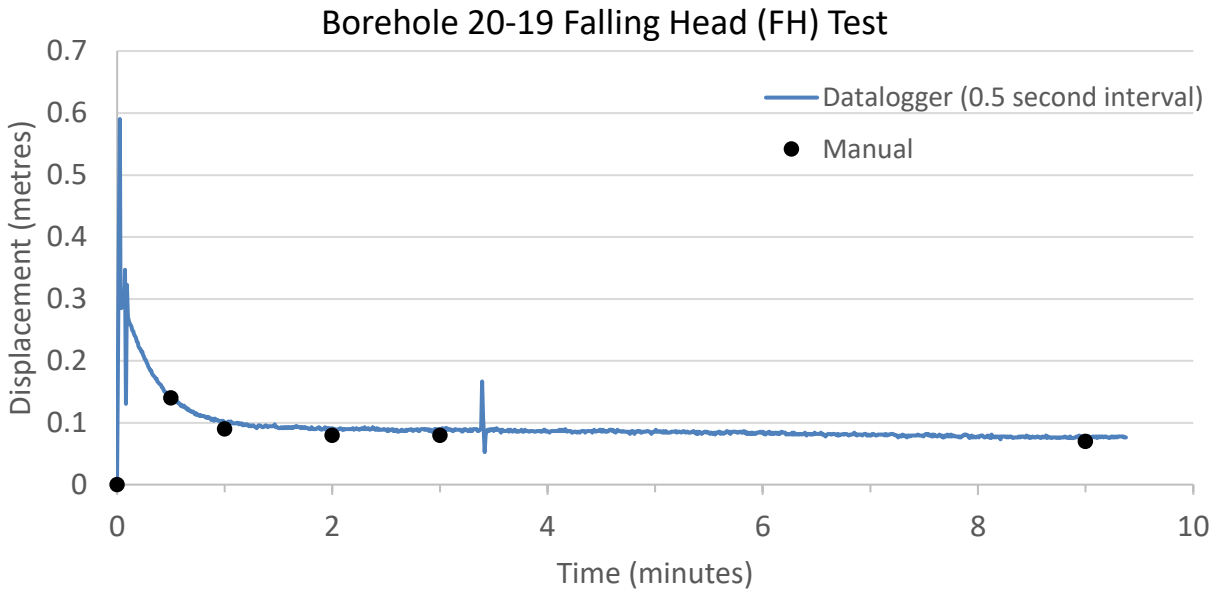
GEMTEC
Consulting Engineers and Scientists

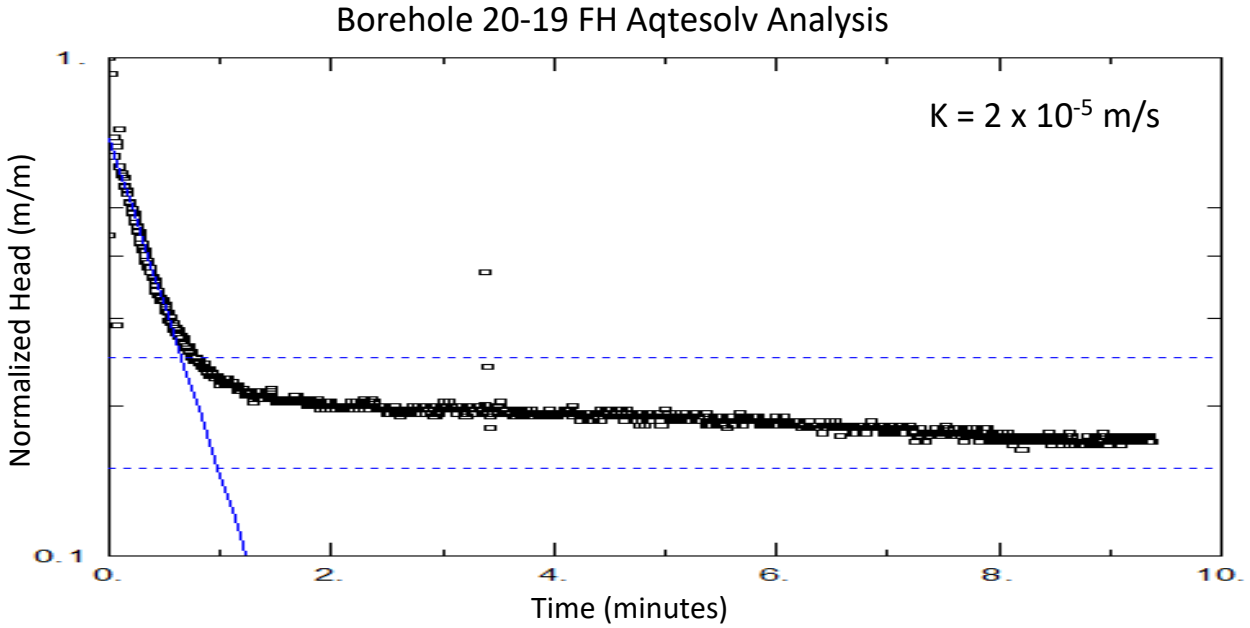
Date: November 2020

Project: 61899.04

Hydraulic Testing

FIGURE 13





Well Data:
Slug Displacement: 0.45 metres
Well Depth: 4.08 metres
Screen Length: 1.52 metres
Well Radius: 0.085 metres

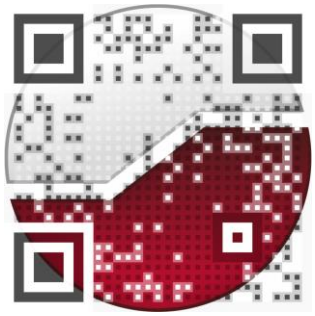
Aquifer Data
Saturated Thickness: 1.55 metres
Static Water Level: 2.53 metres bgs
Anisotropy Ratio (Kz/Kr): 1
Aquifer Model: Unconfined, Hvorslev

GEMTEC
Consulting Engineers and Scientists

Date: November 2020

Project: 61899.04

experience • knowledge • integrity



civil	civil
geotechnical	géotechnique
environmental	environnementale
field services	surveillance de chantier
materials testing	service de laboratoire des matériaux

expérience • connaissance • intégrité