PRELIMINARY GEOTECHNICAL INVESTIGATION
PROPOSED SUBDIVISION AT
5831 to 5837 Perth Street and 2770 Eagleson Road.
OTTAWA, ONTARIO

Prepared for:

CARDEL HOMES

By:

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1. INTRODUCTION

SPL Consultants Limited (SPL) was retained by Cardel Homes (Cardel) to conduct a preliminary geotechnical investigation at 5831 to 5873 Perth Street and 2770 Eagleson Road in Ottawa, ON. The terms of reference for the project are as outlined in our proposal number P-13.06.060 dated June 20th, 2013 as well as subsequent project correspondence.

This report presents the results of the investigation and provides geotechnical recommendations related to the due diligence and preliminary stages of the project. This report does not contain recommendations related to environmental issues (which are outside the scope of this study). A preliminary hydrogeology study was also completed concurrently with the geotechnical investigation. The results of this study have been provided under separate cover.

2. PROJECT AND SITE DESCRIPTION

The project site is two a parcels of land located at 5831 to 5873 Perth Street and 2770 Eagleson Road near the intersection of Perth Street and Eagleson Road, in Ottawa, ON as shown in Drawings No. 1 and No. 2. The site is bounded on the south by Perth Street, to the east by Eagleson Road and to the west by Shea Road. To the north of the site are undeveloped cultivated farms. It is understood that Cardel is considering the land for the development of low-rise residential construction.

The topography in the general area is relatively flat with most of the site being cultivated farm land. A small watercourse bisects the site flowing from approximately north to south meeting the Jock River south of the site. The area along the stream course is vegetated with grass and small brush.

3. INVESTIGATION PROCEDURES

The geotechnical investigation at 5831 to 5873 Perth Street was carried out on August 1st to 6th, 2013 followed by an investigation of 2770 Eagleson Road on December 19th and 20th, 2013. The scope of work included a field investigation, hydrogeological investigation, laboratory testing, analysis and preparation of this report.

A total of nine boreholes (BH13-1 through BH13-9) were advanced at the site as shown in Drawing No. 2. Borehole depths ranged from 7.4 m to 19.2 m below the existing ground surface. The boreholes drilled in August 2013 were advanced using a track-mounted auger drill rig supplied and operated by Ohlmann Geotechnical Services (OGS) Inc. of Almonte, ON. The boreholes drilled in December 2013 were advanced using a track-mounted auger drill rig supplied and operated by George Downing Estate Drilling Ltd. of Hawkesbury, ON. At Boreholes BH13-4 and BH13-8, upon meeting with auger refusal bedrock was cored using “H” size coring equipment. Drilling activities were supervised by a member of SPL’s geotechnical staff.

All soil samples retrieved during drilling were logged and visually classified in the field. In-situ tests including Standard Penetration (SPT) Testing, field shear vane testing and Dynamic Cone Penetration (DCPT) testing were carried out at regular intervals.

Standpipe piezometers and were installed in Boreholes BH13-2, BH13-6 and BH13-9 to allow for subsequent measurement of stabilized groundwater levels at the site. Monitoring wells were installed in Boreholes BH13-4 and BH13-8 to allow for measurement of stabilized groundwater levels as well as in-situ testing of hydraulic conductivity (the results of hydraulic conductivity testing are included in the preliminary hydrogeology study submitted under separate cover). All boreholes were backfilled with bentonite and soil cuttings and were sealed at the ground surface.

Upon completion of the field work soil samples were returned to SPL's laboratory for further examination, classification and testing. A laboratory testing program, including determination of natural water content, grain size distribution and Atterberg limits (plasticity) was carried out. Chemical analyses for soil corrosivity were carried out on four selected soil samples.

Oedometer (consolidation) testing was carried out on three relatively undisturbed samples of silty clay obtained during drilling to determine the load-settlement characteristics of the soil. The results of the oedometer testing are included in Appendix B.

In addition, in 2011, SPL completed a geotechnical investigation on Shea Road northwest of the subject properties. As part of that investigation, two boreholes were advanced on Shea Road. The results of that investigation have also been considered in preparing this report. A single oedometer test was completed as part of the previous investigation. The results of the previous investigation (borehole logs and consolidation test data) are included in Appendix C.

Borehole locations are shown in Drawing No. 2. Borehole coordinates and elevations had been provided to SPL based on a site survey completed subsequent to the field investigation in August 2013. At the time of this report, no survey information has been provided for the second parcel at 2770 Eagleson; borehole locations in this parcel have been determined using a hand-held GPS unit.

4. SUBSURFACE CONDITIONS

The subsurface conditions at the site are discussed in the following sections. Detailed descriptions of the stratigraphy encountered at each of the borehole locations are included in the individual borehole records included in Appendix A.

4.1 Soil Conditions

The following provides a general description of the major soil types and the stratigraphy encountered across the site.

4.1.1 Topsoil

A thin topsoil layer ranging in thickness from 150 mm to 250 mm was encountered in all boreholes.

4.1.2 Silty Clay

Underlying the topsoil is a layer of sensitive silty clay. The deposit generally consists of interlayered clay, silty clay and silt. Sand lenses may also be present within this layer. For simplicity this deposit is referred to as silty clay (as this is the predominant soil type). The silty clay extends to depths ranging from 3.6 m to 11.6 m below the existing ground surface in the various boreholes drilled at the site. In the boreholes drilled on Shea Road in 2011 the silty clay extended to the depth of drilling (8.2 m depth).

Brown Silty Clay (Weathered Crust)

The uppermost portion of the silty clay is generally weathered to form a greyish-brown crust which typically exhibits an apparent over consolidation, generally resulting in improved settlement and strength characteristics as compared with the unweathered clay.

This upper weathered crust was found to extend to a depth of approximately 3.1 m to 4.6 m below the ground surface in the various boreholes drilled at the site, but can vary from location to location.

Atterberg limit testing carried out on selected samples of the silty clay yielded plastic limit values of 20 to 24, with an average value of approximately 21. The liquid limit values ranged from 40 to 72 with an average value 56. These values indicate a silty clay of intermediate to high plasticity. Results of Atterberg limits testing on samples from this layer are plotted on the plasticity chart provided in Figure 3. Individual test results are included on the relevant borehole logs.

Natural water contents within the upper weathered crust were found to be between 22 and 59. The unit weight of the brown silty clay ranged from 17.0 kN/m^3 to 19.4 kN/m^3 with an average value of 17.8 kN/m^3. Individual test results are also presented on the borehole logs.

Grey Silty Clay (Unweathered)

The lower unweathered silty clay is typically grey in colour and is more lightly over-consolidated, sensitive, compressible, and usually has lower undrained shear strength. The lower unweathered grey silty clay was encountered in all of the boreholes advanced on site (with the exception of BH13-7) and extended to depths ranging from 3.6 m in to 11.6 m below the existing ground surface.

Atterberg limit testing carried out on selected samples of the unweathered grey silty clay yielded plastic limit values of 19 to 34, with an average value of approximately 27, and liquid limit values of 38 to 71 with an average value of approximately 58. These values indicate a silty clay of intermediate to high plasticity. The results of Atterberg limit testing for this layer are plotted on a plasticity chart in Figure 4. Individual test results are also included on the relevant borehole logs

Natural water contents within the grey silty clay were found to be between 28 and 75 and are generally close to, or above, the soil's liquid limit. The natural unit weight of the grey silty clay ranged from 15.5 kN/m^3 to 18.3 kN/m^3 with an average value of 16.6 kN/m^3. Individual test results are presented on the borehole logs.

The grain size distributions for selected samples of the grey silty clay are presented in Table 1 below. Grain size distribution curves are provided in Figure 5.

Table 1 – Results of Grain Size Analyses for Grey Silty Clay

Borehole No.	Sample No.	Grain Size Distribution			
		% Gravel	% Sand	% Silt	% Clay
BH13-4	6	0	1	56	43
BH13-5	5	0	0	42	58
BH13-8	7	0	1	44	55

Oedometer testing was carried out on three samples of grey silty clay obtained during the current investigation to determine the consolidation characteristics of the soil. In addition, SPL Consultants carried out a geotechnical investigation on nearby Shea Road northwest of the site in 2011. As part of the 2011 investigation, an oedmoeter test was carried out on a sample of grey silty clay sample similar to that encountered during this investigation. The results of the completed tests are summarized in Table 2 below.

Table 2 – Summary of Consolidation Properties for Grey Silty Clay Layer

Borehole/ Sample No.	Depth	σ_p' (kPa)	σ_{v0}' (kPa)	C_r	C_c	e_0	OCR
BH11-S-1 Sample 7 (Shea Rd.)	6.5 m	125	90	0.02	1.1	1.89	1.4
BH13-4 Sample 5	3.1 m	290	41	0.015	1.2	1.59	7.1
BH13-5 Sample 6	4.6 m	125	67	0.02	1.0	1.56	1.9
BH13-8 Sample 7	6.1 m	100	62	0.015	0.4	1.30	1.6

4.1.3 Silty Sand

A layer of wet, grey silty sand was encountered underlying the silty clay in BH13-4 at a depth of 6.6 m below the existing ground surface and extending to 9.1 m. The consistency of the silty sand would be described as very loose based on SPT values. The grain size distribution for a sample of the silty sand is presented in Table 3 below.

Table 3 – Results of Grain Size Analyses for Silty Sand

Borehole No.	Sample No.	Grain Size Distribution			
		% Gravel	% Sand	% Silt	% Clay
BH13-4	8	16	47	31	7

The moisture content of the sample collected within this layer is 13%. The silty sand layer has some similarities in composition the silty sand till usually encountered in the area, and may form a transition zone into the more competent sandy till below.

4.1.4 Gravelly Silty Sand (Till)

In all boreholes drilled at the site the silty clay layer was underlain by a layer of glacial till. The till is a heterogeneous mixture of gravel, sand, silt and clay but is primarily gravelly to silty sand. The consistency of the till (interpreted based on SPT "N" values) is described as compact to very dense. The majority of the boreholes were terminated within this till layer.

The grain size distributions of selected samples of the till are presented in Figure 6 and summarized in Table 4 below. It should be noted that the grain size distribution tests were carried out on samples obtained through SPT testing, which does not recover coarse gravel, cobble and boulder sized particles. Because of this, the grain size distribution curves shown in Figure 6 and Table 4 may be finer overall than some portions of the materials in the field. Cobbles and boulders were noted within the till and should be anticipated during construction.

Table 4 – Results of Grain Size Analyses for Gravelly Silty Sand Till

Borehole No.	Sample No.	Grain Size Distribution			
		% Gravel	% Sand	% Silt	%Clay
13-1	9	29	39	32	
13-2	8	29	40	31	
13-3	8	17	52	31	
13-4	9	6	44	43	7
13-5	8	37	56	8	
13-7	7	20	52	28	
13-8	10	18	52	30	

4.1.5 Bedrock

Auger refusal was encountered at 12.3 m depth in Borehole BH13-4 and at 13.6 m in Borehole BH13-8. At these locations bedrock was cored using "H" size coring equipment. The bedrock was found to be fresh to slightly weathered limestone with shale partings. In Borehole BH13-4 the Rock Quality Designation (RQD) measurements of the rock range from 81% to 95% indicating good to excellent rock quality. In Borehole BH13-8 the upper portion (approximately 3.5 m) of recovered bedrock has an RQD ranging from 0% to 50% indicating a "poor" to "very poor" designation. The lower portion of the recovered bedrock (approximately 2.1 m) has a RQD ranging from 73% to 86% indicating a "fair" to "good" designation.

4.1.6 Simplified Soil Profiles

The following table provides an overview of the major soil strata encountered at each of the borehole. Detailed descriptions are included on the relevant borehole records included in Appendix A.

Table 5 – Simplified Soil Profiles

Borehole #	Simplified Stratigraphy (m)					Termination
	Topsoil	Brown Silty Clay	Grey Silty Clay	Silty Sand /Till	Bedrock (cored)	
BH13-1	0 - 0.2	0.2 – 3.1	3.1 - 5.3	5.3 - 8.2	--	Borehole terminated at 8.2 m in Till.
BH13-2	0 - 0.2	0.2 – 3.1	3.1 - 3.6	3.6 - 11.8	--	Auger refusal at 7.4 m; DCPT refusal at 11.8 m.
BH13-3	0 - 0.2	0.3 – 3.1	3.1 - 7.0	7.0 - 8.2	--	Borehole terminated at 8.2 m in Till.
BH13-4	0 - 0.2	0.2 – 3.1	3.1 - 6.6	6.6 - 12.3	12.3-17.6	Auger refusal at 12.3 m; rock cored to 17.6 m.
BH13-5	0 - 0.2	0.2 – 3.1	3.1 - 11.6	11.6 – 11.7	-	DCPT refusal at 11.7.
BH13-6	0 - 0.2	0.2 – 3.1	3.1 – 7.1	7.1 - 7.4	-	Auger and DCPT refusal at 7.4 m.
BH13-7	0 - 0.2	0.2 – 4.6	-	4.6 - 8.2	-	Borehole terminated at 8.2 m in Till.
BH13-8	0 - 0.2	0.2 – 3.6	3.6 – 8.7	8.7 – 13.6	13.6 – 19.2	Auger refusal at 13.6 m; rock cored to 19.2 m.
BH13-9	0 - 0.2	0.2 – 3.1	3.1 – 11.0	11.0 – 11.8	-	DCPT refusal at 11.8 m

4.2 Groundwater Conditions

Standpipe piezometers or monitoring wells were installed in Boreholes BH13-2, BH13-4, BH13-6, BH13-8 and BH13-9 to allow for subsequent measurement of stabilized groundwater levels and hydrogeological studies at the site. Groundwater level measurements and dates of readings are provided in the individual borehole logs. The measured stabilized groundwater levels ranged between 0.6 m in BH13-2 (January 2014) to 1.6 m in BH13-4 and BH13-6 (August 2013). These values correspond to elevations of approximately 92 m to 93.4 m.

Table 6 – Groundwater levels

Borehole No.	Groundwater Depth/Elevation		
	Borehole Elevation	August 2013	January 2014
BH13-2	94.0	1.3 m / 92.7 m	0.6 m / 93.4 m
BH13-4	93.6	1.6 m / 92.0 m	0.9 m / 92.7 m
BH13-6	93.7	1.6 m / 92.1 m	1.1 m / 92.6 m
BH13-8	N/A	--	1.3 m / N/A
BH13-9	N/A	--	0.9 m / N/A

It should be recognized that groundwater levels may fluctuate in response to seasonal factors, precipitation events or due to construction activities and future land uses.

5. DISCUSSION AND RECOMMENDATIONS

This section of the report presents preliminary geotechnical recommendations related to the proposed development. The recommendations contained in this report form part of a preliminary geotechnical study intended to allow the designers to begin determining the overall design for the new development. They should be reviewed and if needed revised based on additional site information and proposed construction grades, site plans, foundation types, etc.

The recommendations included in this section are intended to provide the client with the information required to evaluate the suitability of the project site for the intended development. Where comments are made concerning construction considerations they are intended to provide insight into potential geotechnical concerns associated with the various aspects of the project. Those requiring detailed information regarding construction aspects of the project should review the factual information and draw their own conclusions as to how the subsurface conditions may affect their work.

5.1 General

The site is underlain by a layer of silty clay, which includes both an upper stiff "weathered crust" and a lower, more compressible unweathered grey zone. The weathered brown silty clay extends to depths of 3.1 m to 4.6 m below the existing ground surface, with the unweathered grey clay below extending to depths of up to 11.6 m.

Groundwater levels at the site were found to be relatively high, ranging from 0.6 m to 1.6 m below the existing ground surface in August and January, 2014.

5.2 Site Classification for Seismic Site Response

The subsurface conditions at the site include silty clay and sandy till up to 17.6 m in depth, underlain by limestone bedrock. In accordance with Table 4.1.8.4.A of the National Building Code of Canada (2010) the site can be classified as a Site Class "E" (soft soil) for the purposes of site-specific seismic response to earthquakes.

5.3 Frost Protection

Exterior foundations of heated structures should be provided with a minimum of 1.5 m of cover (or the thermal equivalent if insulation is used) for the purposes of protection from frost. Foundations of unheated structures should be provided with a minimum of 1.8 m of earth cover (or equivalent insulation).

5.4 Grade Raise

Detailed building plans are not available at this time, however it is understood the grade on the site may be raised to facilitate construction. Based on borehole elevations provided to SPL, the site appears to be relatively level at approximately 93.5 m to 94.0 m.

The unweathered silty grey clay has the potential to settle under the weight of any new fill placed across the site to raise the grade. The amount by which the overall site can be raised will need to be limited to maintain consolidation settlement within normal limits, and to ensure that sufficient capacity exists to support the proposed foundations.

The final amount by which the grade can be raised will vary across the site (due to the changing sub-surface conditions) and on the proposed construction. For preliminary planning purposes, an assessment of the permissible grade raise has been carried out based on the conditions at the borehole locations. The results of this assessment are presented in Table 7 below. These limits are based on maintaining the grade raise to a level which will not exceed the pre-consolidation pressure of the underlying soil (with a margin of safety) while retaining additional capacity for typical foundation loads.

Table 7 – Preliminary Allowable Grade Raises

Borehole	Preliminary Allowable Grade Raise
BH13-1	2.0 m
BH13-2	2.0 m
BH13-3	1.8 m
BH13-4	1.6 m
BH13-5	0.3 m
BH13-6	1.5 m
BH13-7	2.0 m
BH13-8	0.9 m
BH13-9	0.5 m

The above analysis is based on the use of normal earth or granular backfill with a unit weight of 21.5 kN/m^3. If lighter materials are used it would be possible to increase these values proportionally.

The allowable grade raises presented above are based on the borehole information obtained to date. It is possible that deeper or more compressible zones of unweathered clay could exist between the relatively widely spaced boreholes. Additional investigations during details design may be warranted, particularly in marginal areas such as Boreholes BH13-5 and BH13-9 and in transitions between zones

It should also be noted that these values are based on adding additional fill to the site. Site settlement due to long-term lowering of the groundwater table in the area (if any) due to increased demand from wells has not been included in the above estimates and should be considered in detailed design when additional hydrogeological studies have been completed.

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5.5 Foundations

It is expected that the structures would be primarily low-rise, wood-frame structures founded on shallow foundations with basements.

For shallow foundations founded at a depth of 1.5 m in the (upper) weathered brown silty clay or suitable engineered fill (typically OPSS Granular B) the factored geotechnical resistance at ULS may be assumed to be 100 kPa.

Foundations at a depth of 1.5 m and having a maximum width of 1.5 m (1.2 m around Boreholes BH13-5, BH13-8 and BH13-9) may be designed for an allowable (SLS) bearing pressure of 75 kPa (which would be used in conjunction with dead loads and sustained live loads). Near boreholes BH13-5, BH13-8 and BH13-9 it is not recommended that the footing width be increased beyond 1.2 m without additional detailed geotechnical analysis based on the proposed grade raise, foundation level and loading.

The final foundation bearing capacities will need to be reviewed based on the actual proposed site grades, as well as any additional sub-surface information obtained during detailed design. The final foundation loading should be reviewed as the project progresses and should take into account:

- The thickness of the weathered crust below the foundation level, as well as the total thickness of the unweathered clay;
- The size and depth of the proposed footings;
- The amount of grade raise or other surcharges in the area;
- Any long-term impacts to the groundwater table, such as groundwater lowering which could be caused by this or other construction.

Provided that the foundation subgrade is properly prepared, and not unduly disturbed by construction activities, total and differential settlements associated with the above SLS resistance values are expected to be less than 25 mm and 20 mm, respectively.

All bearing surfaces should be checked, evaluated and approved at the time of construction by a geotechnical engineer who is familiar with the findings of this investigation and the design and construction of similar projects prior to placement of any concrete, bedding, back fill, etc.

5.6 Slabs-on-Grade

Prior to placement of basement and garage floor slabs all loose, wet, disturbed or deleterious material should be removed. Where soft or unsuitable layers are encountered they should be over-excavated and replaced with compacted granular fill.

Basement floor slabs should be supported on a minimum of 200 mm of 19 mm clear crushed stone. Where basement floors could be below the groundwater level positive drainage would be required

either to a sump or sewer. In this case a geotextile filter should also be provided between the clear stone and the subgrade soils to prevent loss of fines into the drainage layer (if not already placed as part of the temporary work – see Section 5.8).

Garage floor slabs should be supported on 150 mm of crushed sand and gravel (OPSS Granular A).

All subgrades should be reviewed by a geotechnical engineer prior to placement of any geotextile, granular base, concrete, etc.

5.7 Lateral Earth Pressures

The lateral earth pressure acting on below-grade walls, retaining walls, etc. may be calculated using the following expression:

$$P = K(\gamma h+q)$$

Where P = lateral earth pressure (kPa) acting at depth h

K = earth pressure coefficient; for unrestrained walls and structures where some movement is acceptable (such as retaining walls) use a coefficient of active earth pressure (K_a) equal to 0.3, for restrained walls (such as basement walls) use the coefficient of earth pressure at rest (K_0) equal to 0.5

γ = the density of the backfill; use 21.5 kN/m^3 for compacted granular backfill

h = the depth to the point of interest (m)

q = the magnitude of any design surcharge at the ground surface;

The above values assume free-draining granular backfill will be used. If this is not the case then the above values may need to be adjusted based on the soil type used, and water pressures should be considered in the calculation of lateral pressures. SPL can provide additional guidance based on actual building plans if required.

Earth pressures will be higher under seismic loading conditions. In order to account for seismic earth pressures the total earth pressure during a seismic event (including both the seismic and static components) may be assumed to be:

$$\sigma_h(z) = K_a \gamma z + (K_{AE} – K_a) \gamma (H-z)$$

Where $\sigma_h(z)$ = the total earth pressure at depth z (kPa);
K_a = the active earth pressure coefficient (0.3);
γ = the unit weight of soil (21.5 kN/m^3 for granular fill or 19 kN/m^3 for native soils);
K_{AE} = the combined active earth pressure and seismic earth pressure coefficient (use 0.8);
H = the total height of the wall (m)

z = the depth below the top of the wall (m)

The above earth pressure values (both static and seismic) are unfactored values.

5.8 Temporary Excavations and Groundwater Control

All temporary excavations should be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). Part III of Ontario Regulation 213/91 deals with excavations. The soils encountered at the site within typical excavation depths (i.e. less than approximately 3 m) include primarily stiff weathered silty clay. For the purposes of preliminary excavation planning the brown silty clay material may be considered as a Type 3 soil. If excavations extend into the soft grey silty clay or the gravelly silty sand till below the water table the soil should be considered as Type 4 soil, and may require significant excavation support or very flat slopes to maintain safe and stable excavations. These classifications should be confirmed by qualified individuals as the site is excavated and if necessary adjusted.

The groundwater level at the site was found to be at approximately 0.6 m to 1.6 m below the existing ground surface (which corresponds to elevations of 92 m to 93.4 m. Groundwater levels could be higher during wetter periods of the year or during large rainfall events. Groundwater flow into basement excavations should be manageable by pumping from properly filtered sumps within the excavations.

The existing silty clay sub-grade is expected to be very sensitive to disturbance and may require protection during construction. This protection would typically be a thin layer of lean concrete (mud slab) or a 150 mm to 200 mm thick layer of granular fill (OPSS Granular A) underlain by a non-woven geotextile.

5.9 Backfilling and Compaction

Backfill for below-grade walls, foundation excavations, etc. should comprise free draining Granular “A” or “B” materials. The existing soils are considered to be frost-susceptible, and should not be used as backfill against basement walls. Backfill should be placed in shallow lifts, not exceeding 200 mm loose thickness, and compacted to 98% SPMDD where it is supporting any structures or services, or 95% in other areas.

The existing site materials do not meet the requirements for Granular “A” or “B” materials. The suitability of imported materials should be confirmed prior to placement from both a geotechnical and environmental perspective.

To avoid damaging or laterally displacing the structures, care should be exercised when compacting fill adjacent to new structures. Heavy equipment should be kept a minimum of 1 m away from structures during backfilling.

5.10 Site Services

Excavations up to approximately 3 m below the existing ground surface would be primarily within the weathered silty clay layer. Excavations deeper than this would extend into the unweathered grey silty clay or gravelly silty sand till.

Details of the proposed site services are not available at this time; however it is assumed that they will include localized trenches throughout the site. Trenches can be temporarily supported using sloped excavations (see Section 5.8) or trench boxes.

Bedding for site services should be in accordance with the relevant OPSD standard drawing and would typically consist of Granular "A" compacted to 95% SPMDD. Where wet or disturbed conditions are encountered in the base of the trench it may be necessary to over-excavate and replace unsuitable soils with compacted granular fill to provide a stable sub-grade for the bedding. The use of clear stone as a bedding and cover material is not recommended as the finer particles of the native soils and backfill may migrate into the voids of the clear stone, resulting in loss of pipe support.

Cover material above the spring line should consist of Granular "A" or Granular "B" material with a maximum particle size of 25 mm. Cover material should be compacted to a minimum of 95% SPMDD.

Backfill may consist of additional granular fill, or the stiff, brown weathered silty clay and should be compacted to 95% SPMDD (98% if below structures). Where backfill is below paved areas (such as parking lots and access roads) and is within the frost depth, the backfill profile (above the minimum cover required) in the trench should be made to match the native soils on either side as much as is practical in order to minimize the potential for differential frost heave. As a result, portions of the brown silty clay above the water table may be retained, moisture conditioned (if necessary) and re-used.

Any service trenches which extend below the water table should have clay cut-offs installed across the trench at regular intervals (typically 100 m) to prevent the trench acting as a drain and lowering the groundwater table in the general area. These cut-offs should extend the full width of the trench and must completely penetrate the bedding, cover and any other granular materials in the trench.

The above are general guidelines for typical site services. All services installations should be completed in accordance with the relevant OPSS's and OPSD's for the particular application and size. SPL can provide additional review during detailed design based on the actual services proposed if required.

The designer of the site services (particularly gravity services) should be aware of the potential for settlement which could arise as a result of the raising of the grade.

5.11 Pavement Structures

Typical pavement structures are provided in Table 8. No detailed traffic information has been provided as part of this study and these structures are based on experience with similar projects using an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples.

A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements but would involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

Table 8: Recommended Pavement Structure Thickness

Pavement Layer	Light Duty Roads (Cars only)	Heavy Duty Parking (Cars plus Buses, Trucks, etc.)
Asphaltic Concrete	40 mm HL 3 or SP 12.5 50 mm HL 8 or SP 19.0	40 mm HL 3 or SP 12.5 50 mm HL 8 or SP 19.0
OPSS Granular A Base	150 mm	150 mm
OPSS Granular B Sub-Base	450 mm	600 mm

The long term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond within or adjacent to paved areas. Subdrains should be installed (as per typical civil design) to intercept excess subsurface moisture and prevent subgrade softening. This is particularly important in heavy-duty pavement areas.

Additional comments on the construction of parking areas and access roadways are as follows:

- As part of the subgrade preparation, proposed parking areas and access roadways should be stripped of topsoil and other obvious objectionable material. Fill required to raise the grades to design elevations should conform to backfill requirements outlined in previous sections of this report. The subgrade should be properly shaped, crowned then proof-rolled in the full time presence of a qualified individual. Soft or spongy subgrade areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98% SPMDD.

- Proper sub-drainage should be included in the overall pavement design to ensure that water which infiltrates through the pavement surface is drained away and does not become trapped at the base of the granular layers. Assuming that satisfactory crossfalls in the order of two percent have been provided, subdrains extending from and between catch basins may be satisfactory. In the event that shallower crossfalls are considered, a more extensive system of sub-drainage may be necessary.

- The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted access lanes, half-loads during paving, etc., may be required, especially if construction is carried out during unfavourable weather.

- It is recommended that SPL Consultants Limited be retained to review the final pavement structure designs and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

5.12 Corrosion and Cement Type

Samples of the existing soils were submitted to Exova for testing related to soil corrosivity and potential exposure of concrete elements to sulphate attack. The results of these tests are included in Appendix D and summarized in Table 9 below.

Table 9 – Results of Soil Corrosivity Testing

Borehole/Testpit Sample No.	Soil Type	Chloride (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (ohm-cm)	Sulphate (%)
BH13-3/SS2	Silty Clay	0.004	0.13	7.2	7690	<0.01
BH13-6/SS3	Silty Clay	0.003	0.20	7.9	5000	<0.01
BH13-7/SS2	Silty Clay	0.004	0.15	6.7	6670	0.02
BH13-9/SS3	Silty Clay	0.003	0.17	7.4	5880	0.03

The soil resistivity values measured in the existing fill suggest a moderately corrosive environment for buried steel elements. The test results indicate low to negligible soluble sulphate content and as such sulphate resistant Portland cement is not required.

6. GENERAL COMMENTS

It is understood that SPL Consultants Limited will provide a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the opportunity to undertake this review, SPL Consultants Limited will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole and laboratory test results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

7. LIMITATIONS OF REPORT

The limitations of this report are included in Appendix E.

8. CLOSURE

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

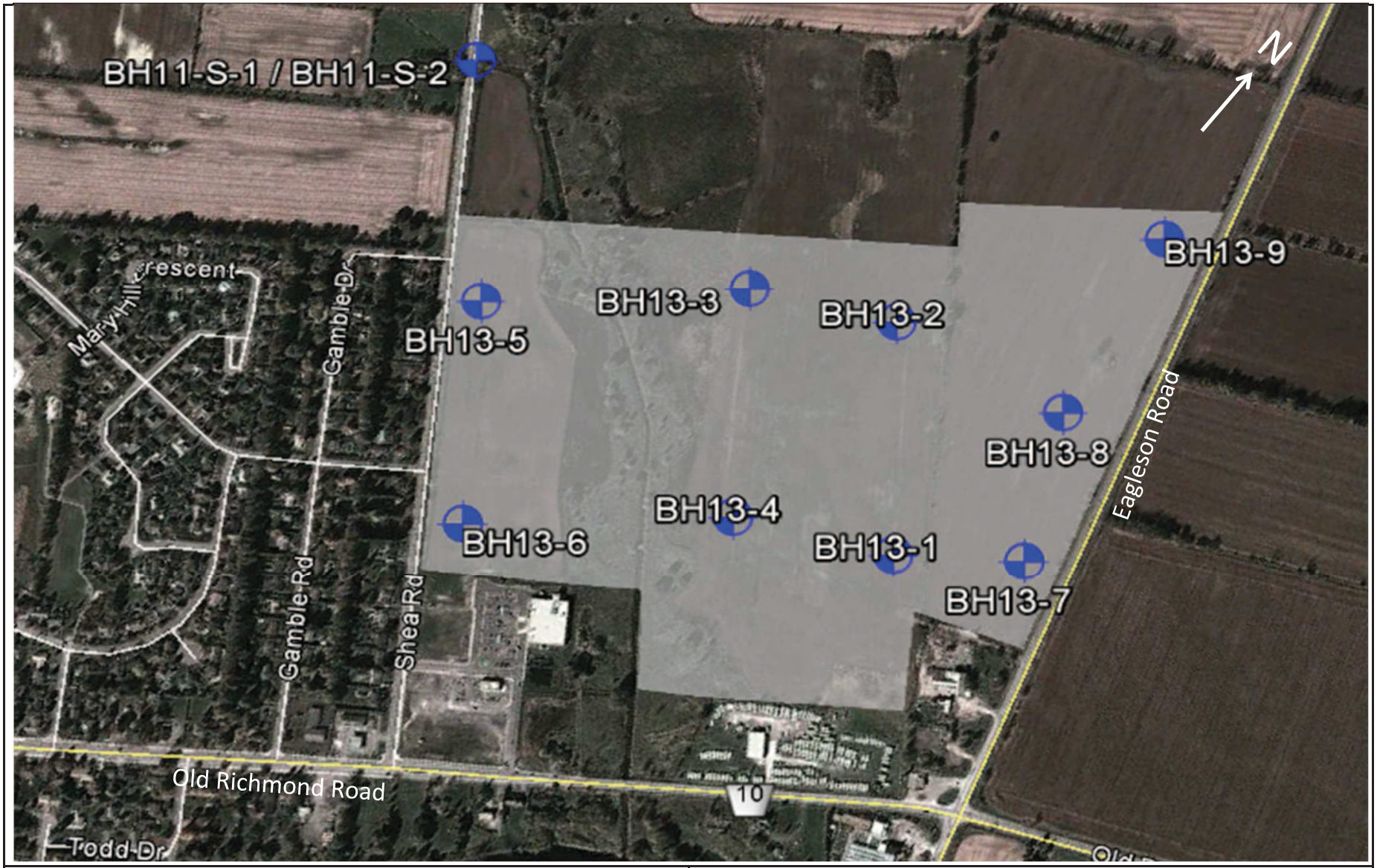
SPL CONSULTANTS LIMITED

Omer Eissa, P.Eng.

Chris Hendry, M.Eng., P.Eng.

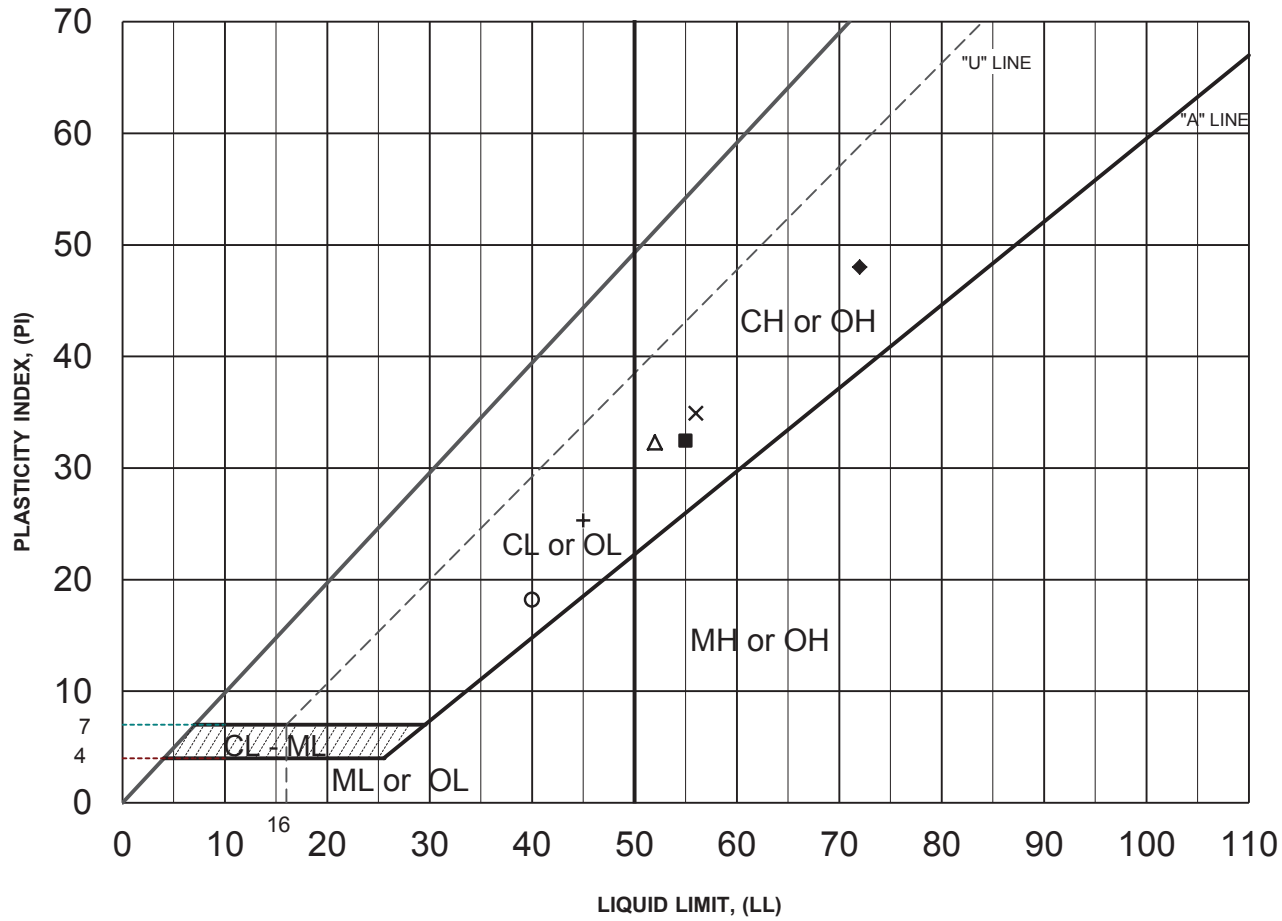
Drawings

Client:	Cardel Homes			Title:	Site Plan
Project#:	1776-710	DWG #:	1	Project:	Preliminary Geotechnical Investigation - Cardel Homes 5831 and 5873 Perth Street and 2770 Eagleson Rd
Drawn:	OE/DW	Approved:	CH		
Date:	Jan 2014	Scale:	N. T. S.		SPL Consultants Limited Geotechnical Environmental Materials Hydrogeology
Size:	Letter	Rev:	0		



Client:	Cardel Homes			Title:	Borehole Location Plan
Project#:	1776-710	DWG #:	2	Project:	Preliminary Geotechnical Investigation - Cardel Homes 5831 and 5873 Perth Street and 2770 Eagleson Rd
Drawn:	DW	Approved:	CH		
Date:	Jan, 2014	Scale:	N. T. S.		SPL Consultants Limited Geotechnical Environmental Materials Hydrogeology
Size:	Letter	Rev:	0		

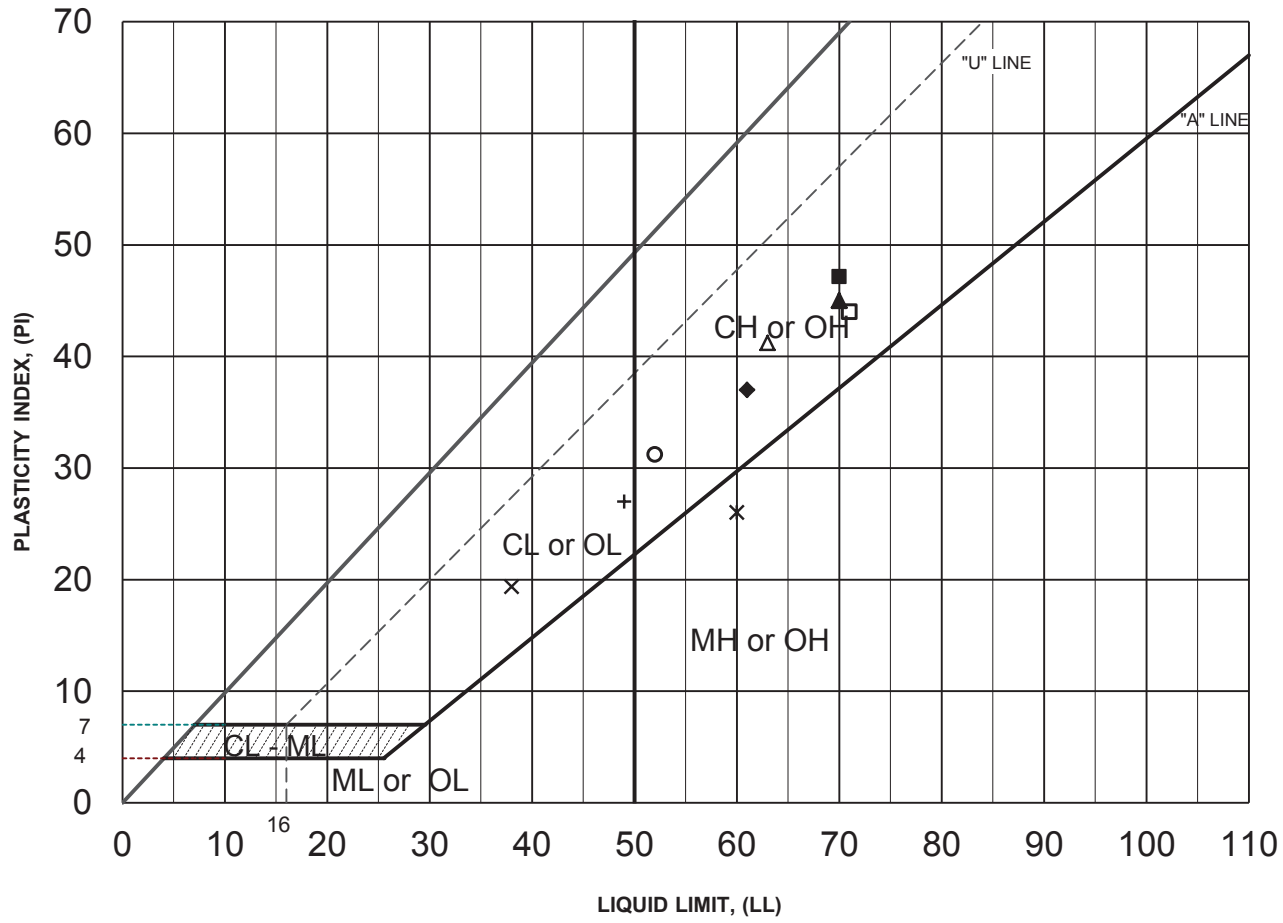
PLASTICITY CHART
(Brown Silty Clay)



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

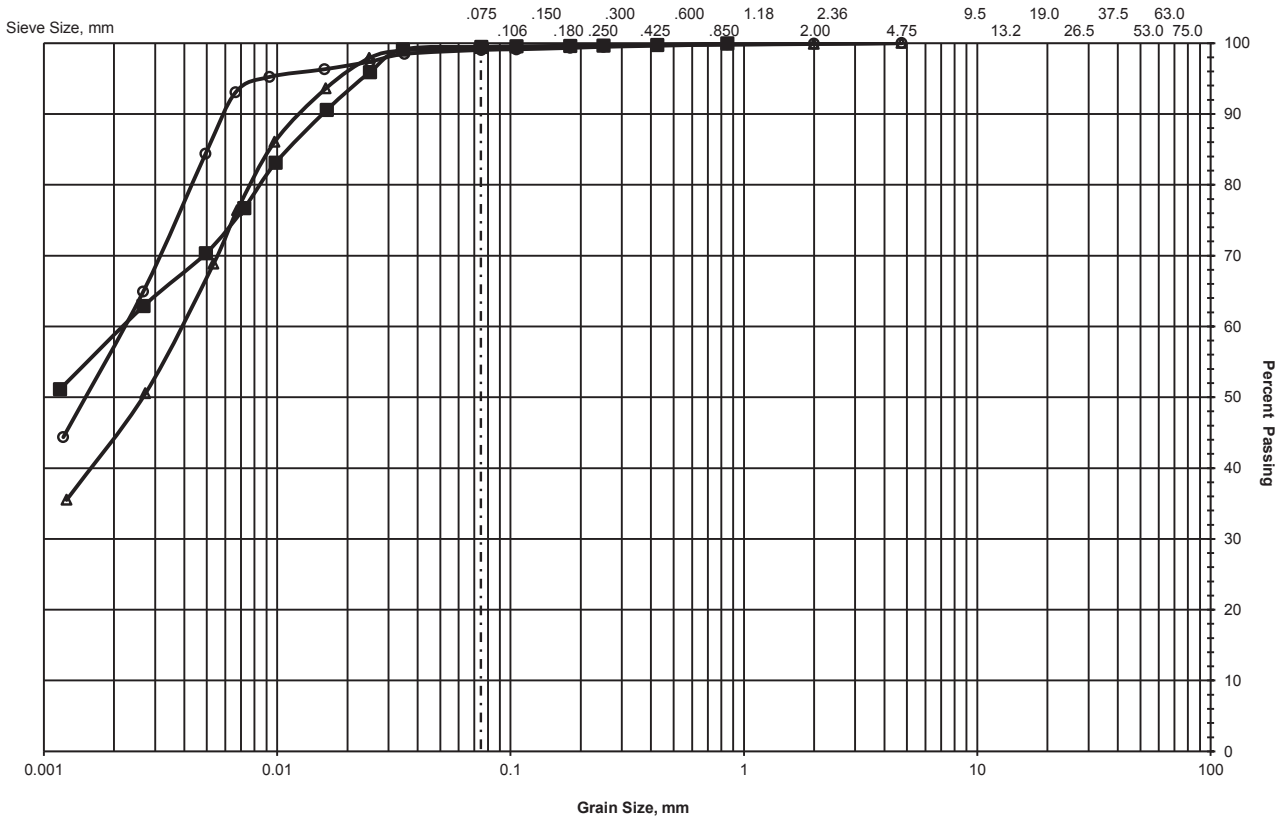
(Grey Silty Clay)



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)

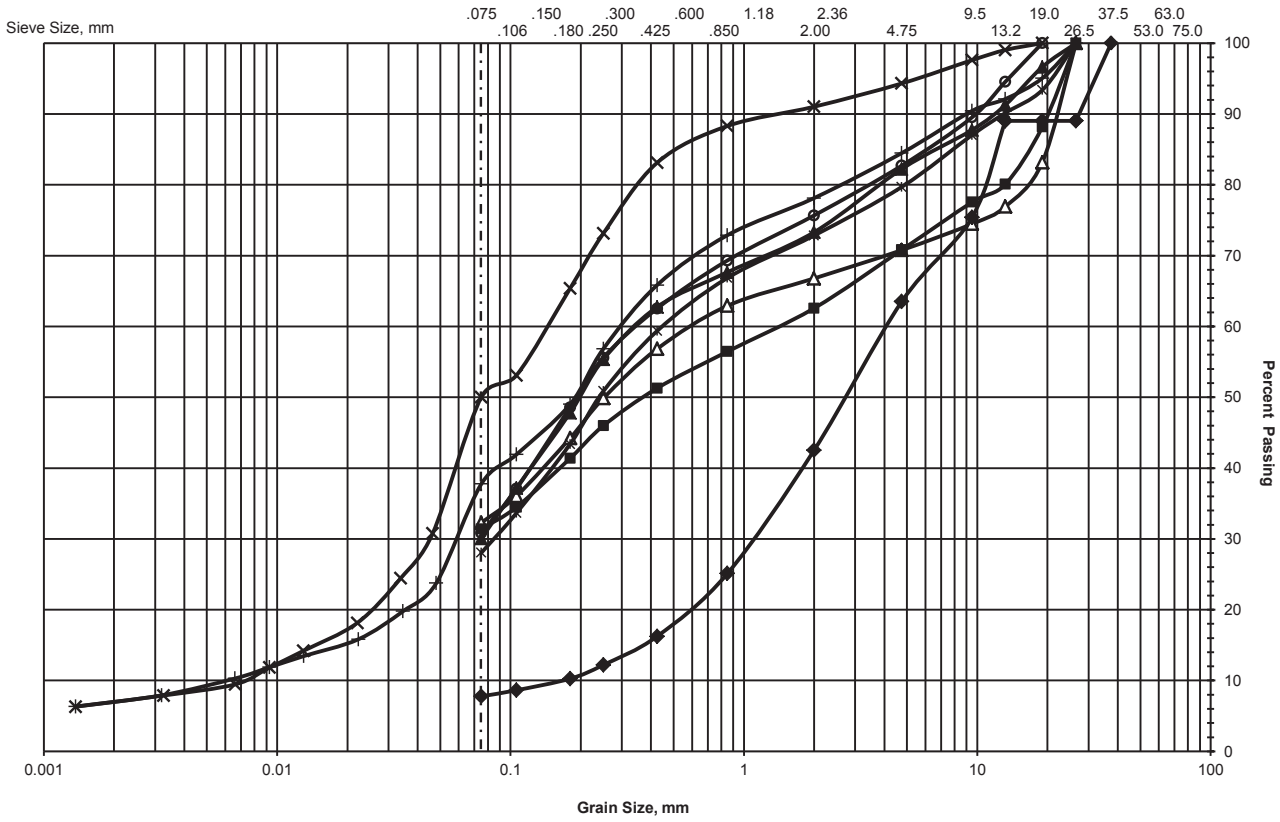


CLAY and SILT	FINE	MEDIUM	COARSE	FINE	COARSE
	SAND			GRAVEL	
UNIFIED SOIL CLASSIFICATION SYSTEM					

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	▲

Appendix A

Borehole Records

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

LOG OF BOREHOLE BH13-5

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 5006070 E 434540

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203mm
Date: Aug/06/2013

REF. NO.: 1776-710
ENCL NO.:

(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
93.5												
93.2 / 0.0	**Topsoil** 225 mm											
0.3	**Silty Clay** brown, moist, firm to stiff, (weathered crust)		1	SS	9		93					
			2	SS	4							
			3	SS	5		92				17.8	
			4	SS	3		91					
90.4												
3.1	**Silty Clay** grey, wet, firm, medium plasticity		5	TW			90	8, 8				0 1 42 58
				VANE								
				VANE								
			6	TW			89					
				VANE				18, 18				
				VANE			88					
			7	SS	WH						16.0	
				VANE			87	6, 11				
				VANE								
			8	SS	WH		86					
				VANE				4, 9				
				VANE			85					
81.9							84					
11.6 / 81.6	**Till** (Infered from DCPT)						83					
11.9	**END OF BOREHOLE**						82					

Notes:
1) Upon completion, standing water 3.0 m BSL
2) DCPT refusal at 11.9 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

LOG OF BOREHOLE BH13-6

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 5005854 E 434736

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203mm
Date: Aug/06/2013

REF. NO.: 1776-710
ENCL NO.:

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
93.7							
93.6	**Topsoil** 200 mm						
0.2	**Silty Clay**, brown, moist, firm to stiff, (weathered crust)		1	SS	9		
			2	SS	5		93
			3	SS	3		
			4	SS	3		91
90.7							
3.1	**Silty Clay** grey, wet, firm		5	TW			
				VANE			90
				VANE			
			6	SS	WH		89
				VANE			
				VANE			88
			7	SS	3		
				VANE			87
86.6							
7.1	**Sand and Gravel** trace silt, grey, wet, very dense		8		50/ 12mm		
86.3							
7.4	**END OF BOREHOLE**						

W. L. 92.6 m Jan 17, 2014
W. L. 92.1 m Aug 28, 2013

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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)
17.9
16.9

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL
37 56 (8)

Notes:
1) Upon completion, standing water level 3.6 m BSL
2) DCPT refusal at 7.4 m
3) Auger refusal at 7.4 m
4) 19mm dia. piezometer was installed in the borehole upon completion
5) Depth of Water

Date	Depth
28/08/2013	1.6 m
17/01/2014	1.1 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

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

Appendix B

Consolidation Test Results

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

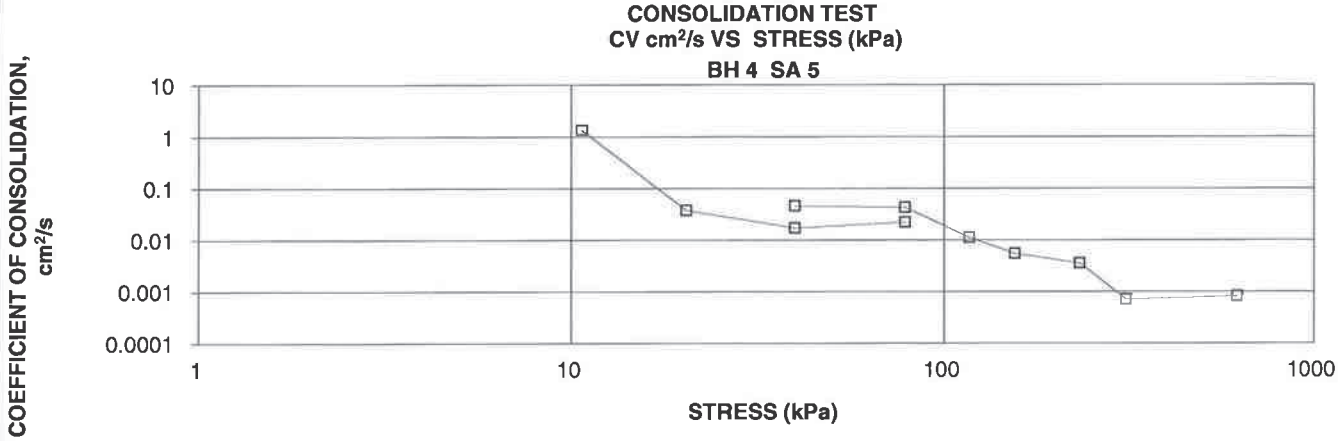
Sample Height, cm	2.13	Unit Weight, kN/m^3	17.95
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	12.46
Area, cm^2	31.67	Specific Gravity, measured	2.76
Volume, cm^3	67.38	Solids Height, cm	0.980
Water Content, %	44.06	Volume of Solids, cm^3	31.03
Wet Mass, g	123.36	Volume of Voids, cm^3	36.36
Dry Mass,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

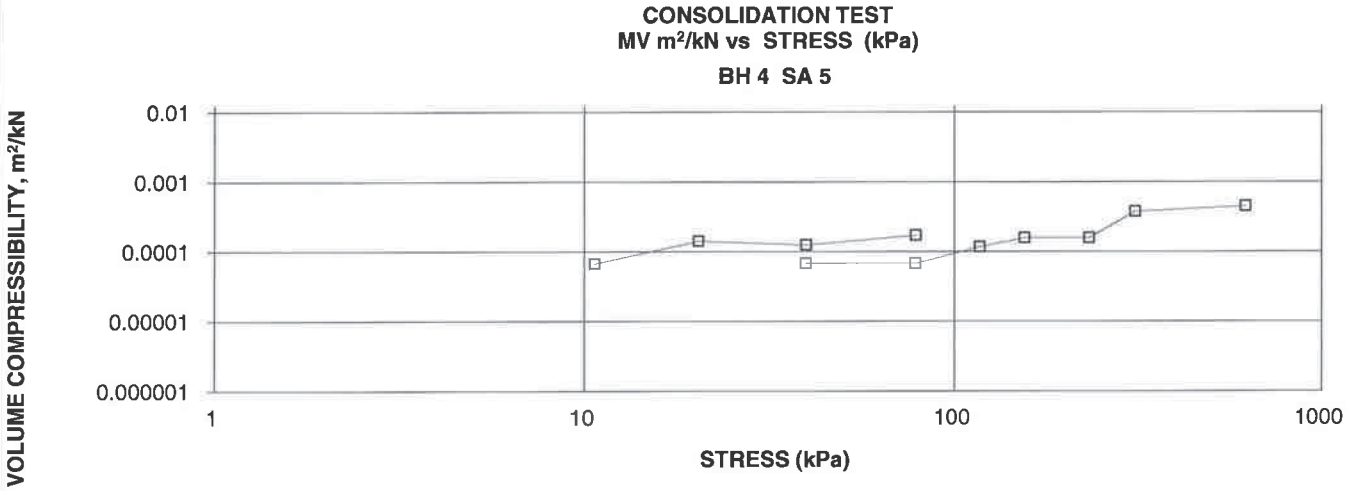
Prepared By: LG

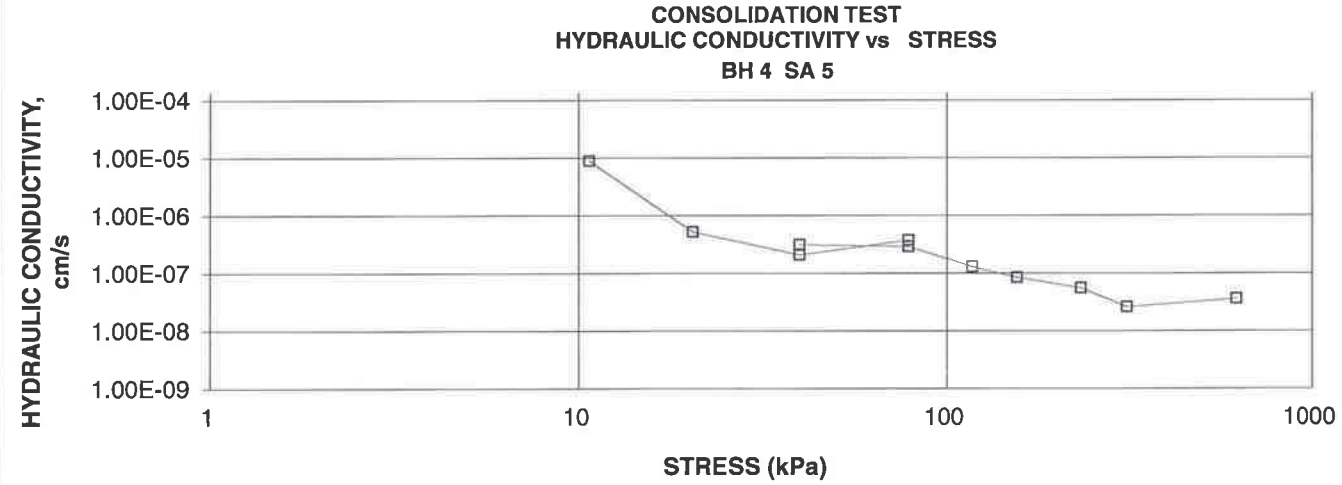
Golder Associates

Checked By:

CONSOLIDATION TEST SUMMARY	FIGURE





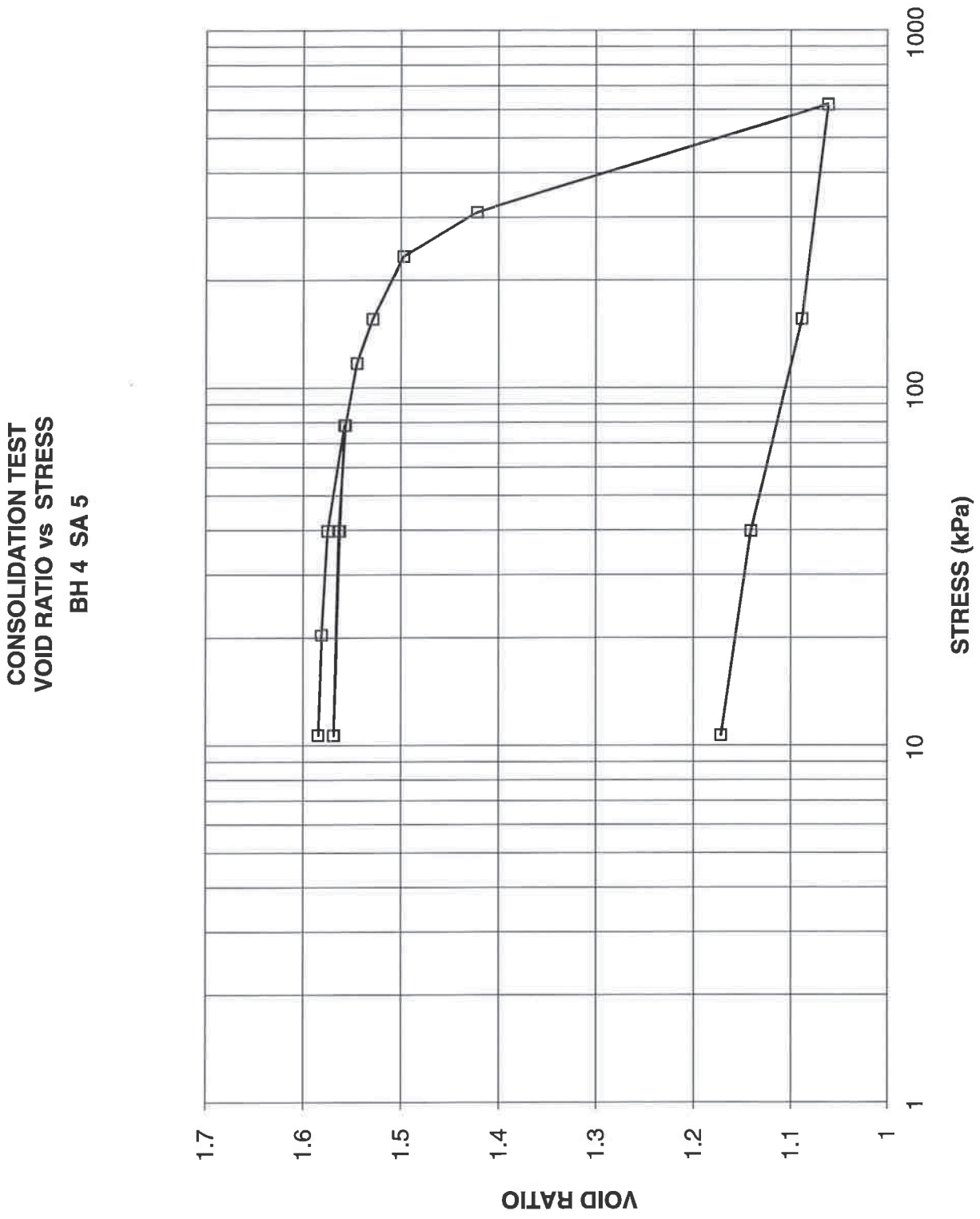


Project No. 13-1183-0092
Prepared By: LG

Golder Associates

Checked By:

CONSOLIDATION TEST VOID RATIO VS LOG STRESS	FIGURE



Project No. 13-1183-0092

Prepared By: LG

Golder Associates

Checked By:

CONSOLIDATION TEST SUMMARY

FIGURE

SAMPLE IDENTIFICATION

Project Number	13-1183-0092	Sample Number	6
Borehole Number	5	Sample Depth, m	4.6-5.2

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	11		
Date Started	8/12/2012		
Date Completed	8/27/2013		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.53	Unit Weight, kN/m^3	16.47
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	10.44
Area, cm^2	31.70	Specific Gravity, measured	2.73
Volume, cm^3	80.23	Solids Height, cm	0.987
Water Content, %	57.73	Volume of Solids, cm^3	31.30
Wet Mass, g	134.78	Volume of Voids, cm^3	48.93
Dry Mass, g	85.45	Degree of Saturation, %	100.8

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	2.531	1.563	2.531				
10.66	2.510	1.541	2.520	1	1.35E+00	7.97E-04	1.05E-04
20.59	2.501	1.533	2.505	60	2.22E-02	3.30E-04	7.18E-07
39.77	2.482	1.514	2.492	109	1.21E-02	3.96E-04	4.68E-07
78.44	2.447	1.478	2.465	135	9.54E-03	3.55E-04	3.31E-07
117.08	2.408	1.439	2.428	844	1.48E-03	3.99E-04	5.79E-08
39.77	2.420	1.450	2.414				
10.65	2.433	1.464	2.426				
39.77	2.425	1.455	2.429	47	2.66E-02	1.21E-04	3.15E-07
78.43	2.414	1.445	2.419	34	3.65E-02	1.04E-04	3.73E-07
117.08	2.398	1.429	2.406	1307	9.39E-04	1.64E-04	1.51E-08
155.66	2.334	1.364	2.366	5227	2.27E-04	6.55E-04	1.46E-08
310.55	2.040	1.066	2.187	1058	9.58E-04	7.52E-04	7.06E-08
618.95	1.854	0.878	1.947	540	1.49E-03	2.38E-04	3.47E-08
155.66	1.877	0.900	1.865				
39.77	1.913	0.937	1.895				
10.66	1.945	0.970	1.929				

Note:
Consolidation loading and unloading schedule assigned by the client.
Specimen taken 6 to 12cm from bottom of the tube
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

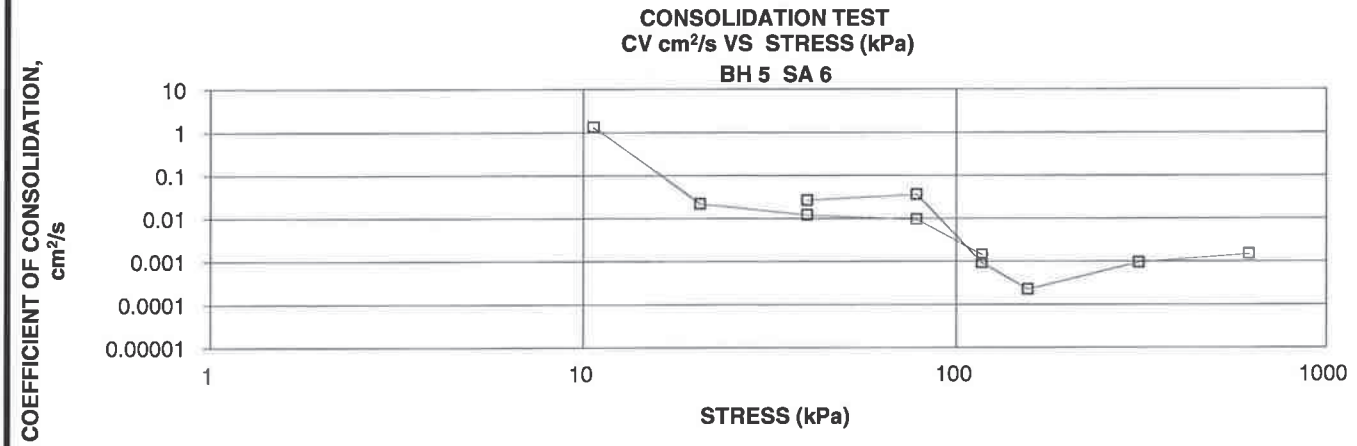
Sample Height, cm	1.95	Unit Weight, kN/m^3	18.72
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	13.59
Area, cm^2	31.70	Specific Gravity, measured	2.73
Volume, cm^3	61.67	Solids Height, cm	0.987
Water Content, %	37.75	Volume of Solids, cm^3	31.30
Wet Mass, g	117.71	Volume of Voids, cm^3	30.37
Dry Mass, g	85.45		

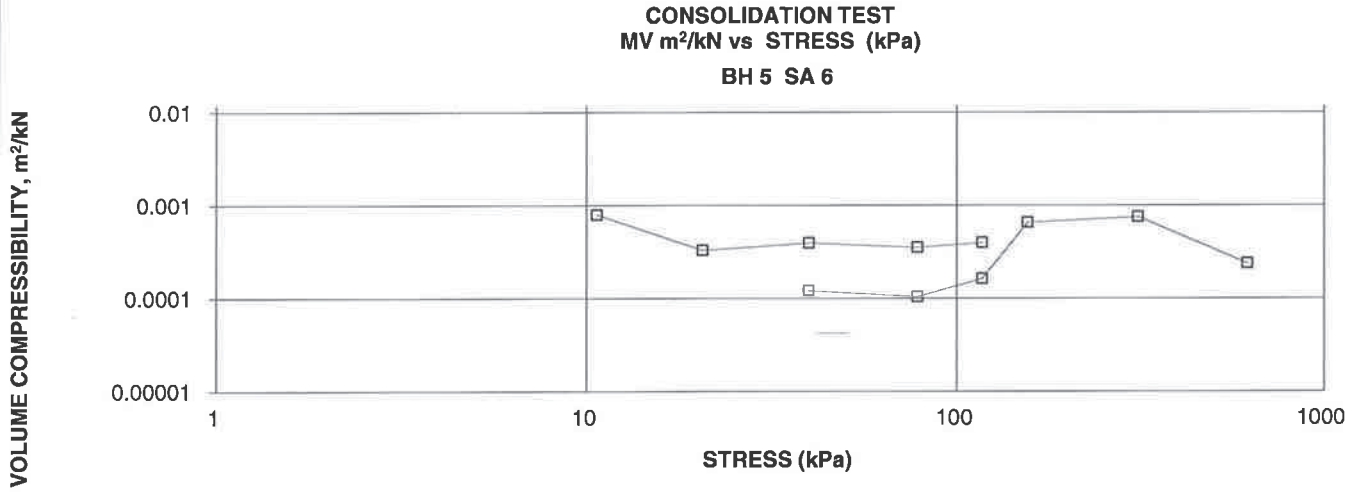
Prepared By: LG

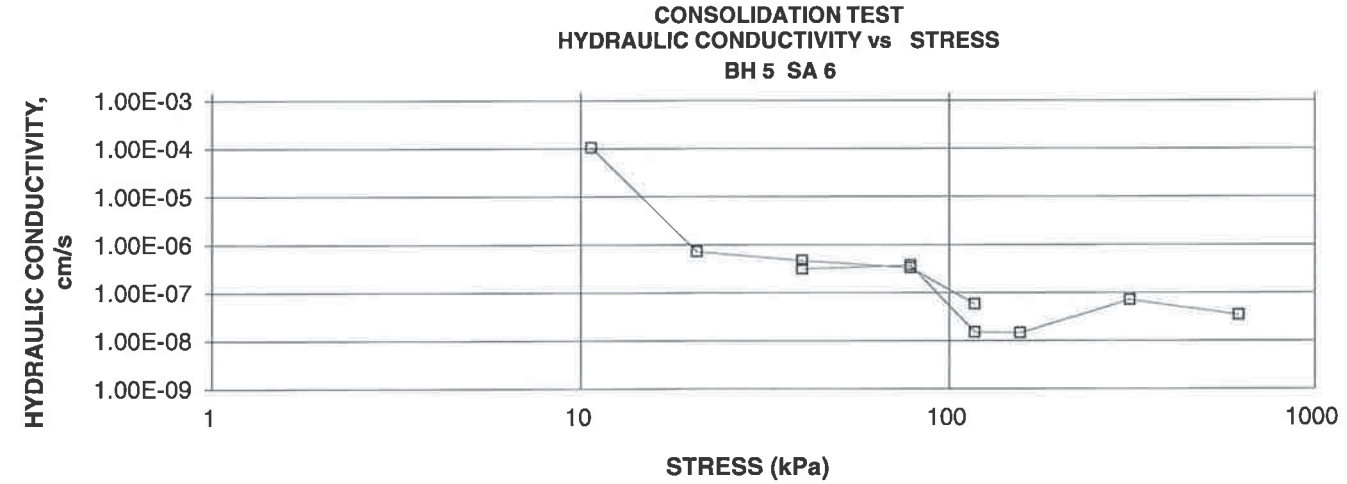
Golder Associates

Checked By:

CONSOLIDATION TEST SUMMARY	FIGURE





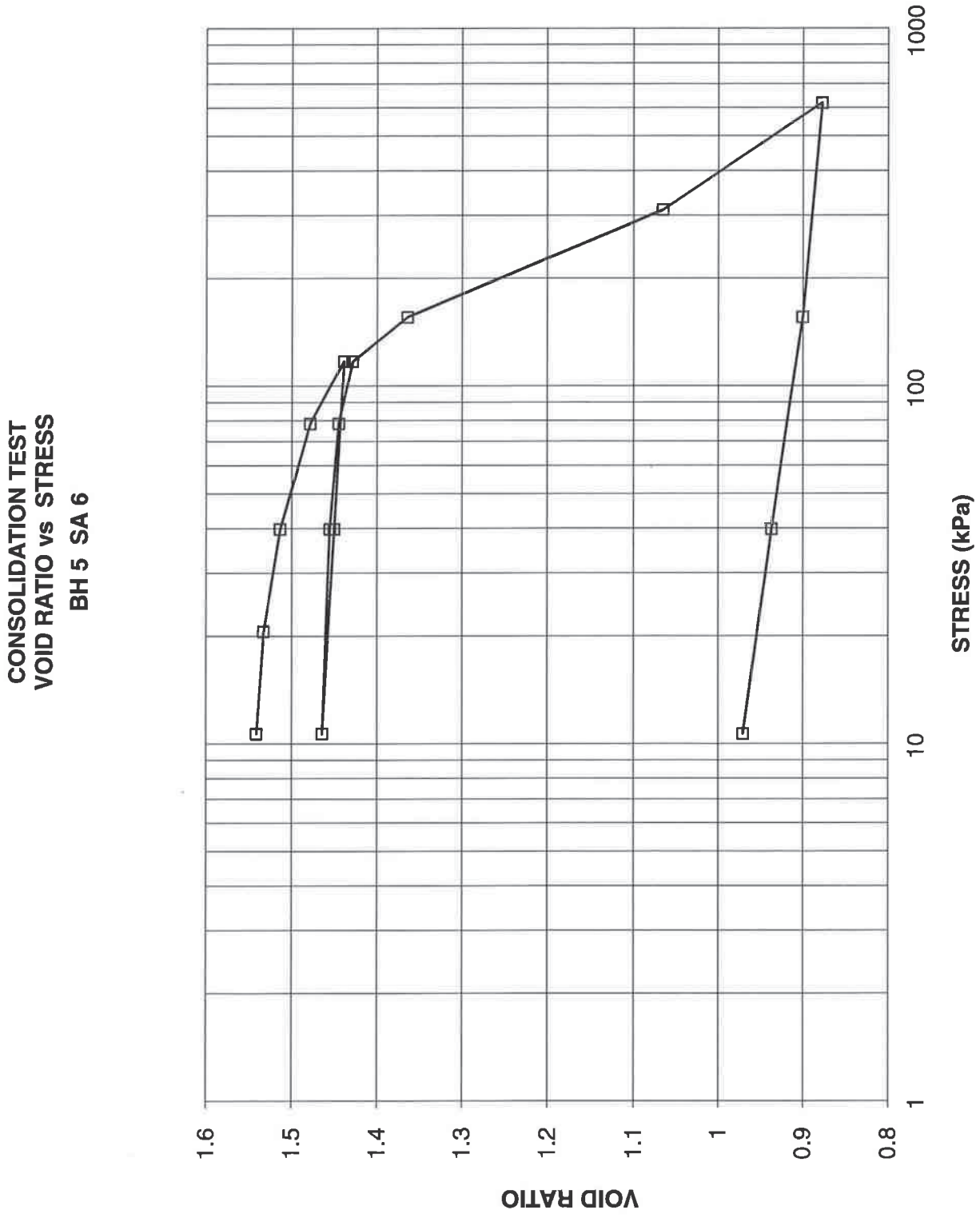


Project No. 13-1183-0092
Prepared By: LG

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

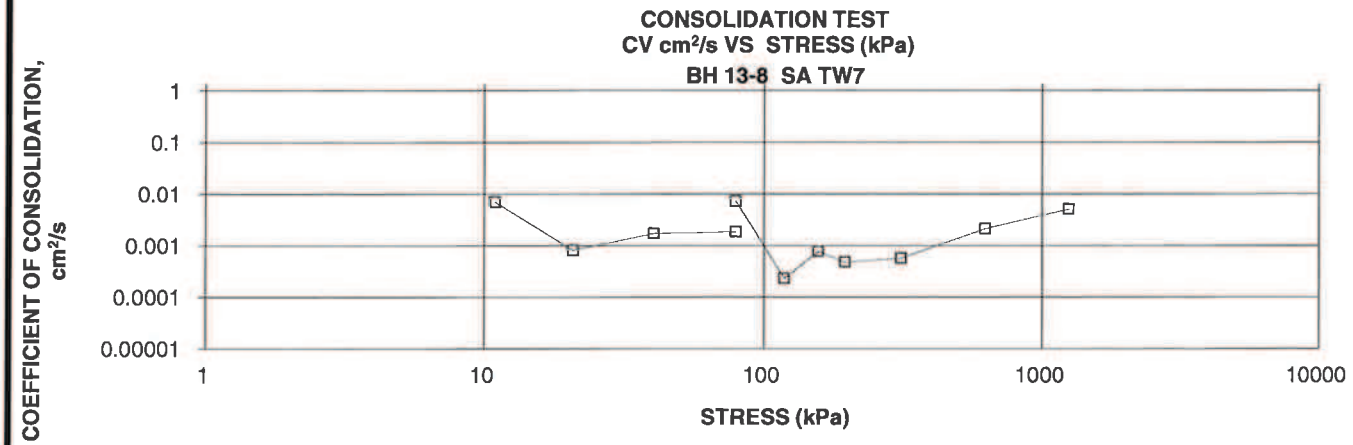
Sample Height, cm	2.07	Unit Weight, kN/m^3	19.00
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	14.60
Area, cm^2	31.54	Specific Gravity, measured	2.77
Volume, cm^3	65.16	Solids Height, cm	1.110
Water Content, %	30.13	Volume of Solids, cm^3	35.02
Wet Mass, g	126.24	Volume of Voids, cm^3	30.14
Dry Mass,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

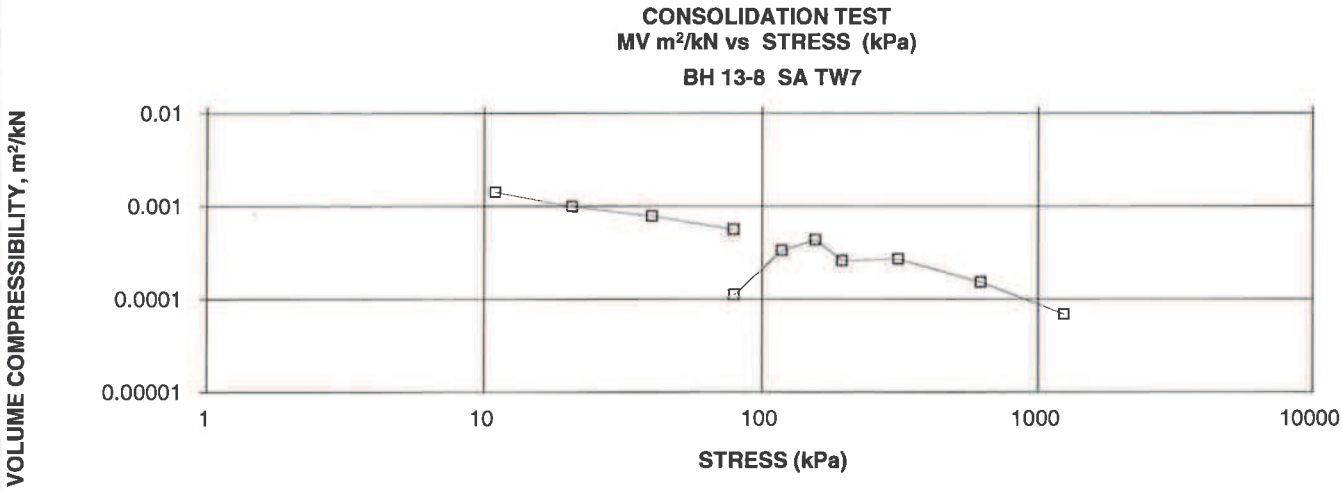
Prepared By: LG

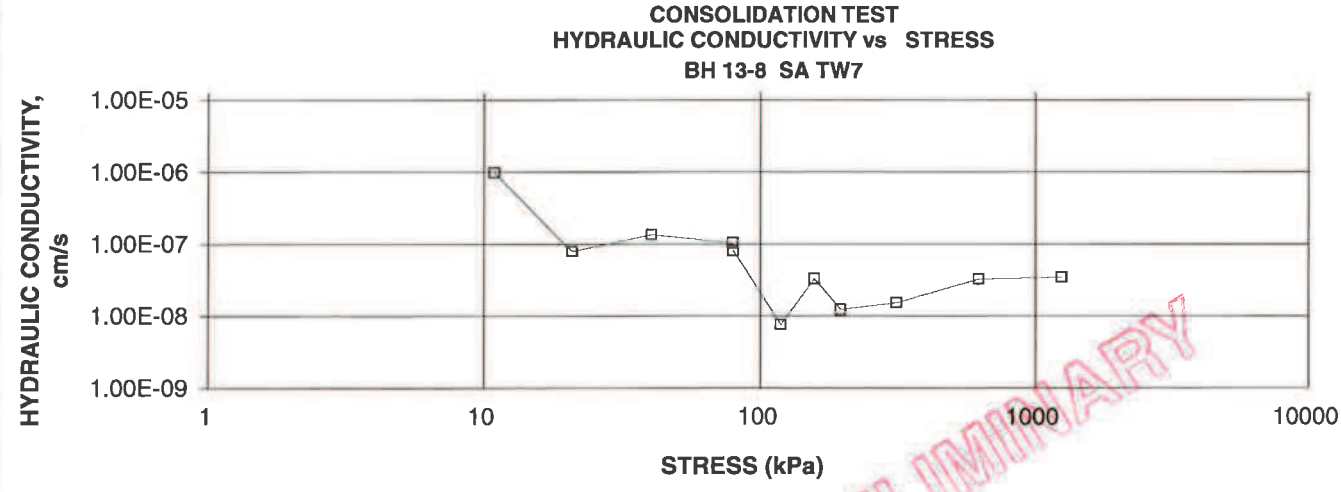
Golder Associates

Checked By:

CONSOLIDATION TEST SUMMARY	FIGURE





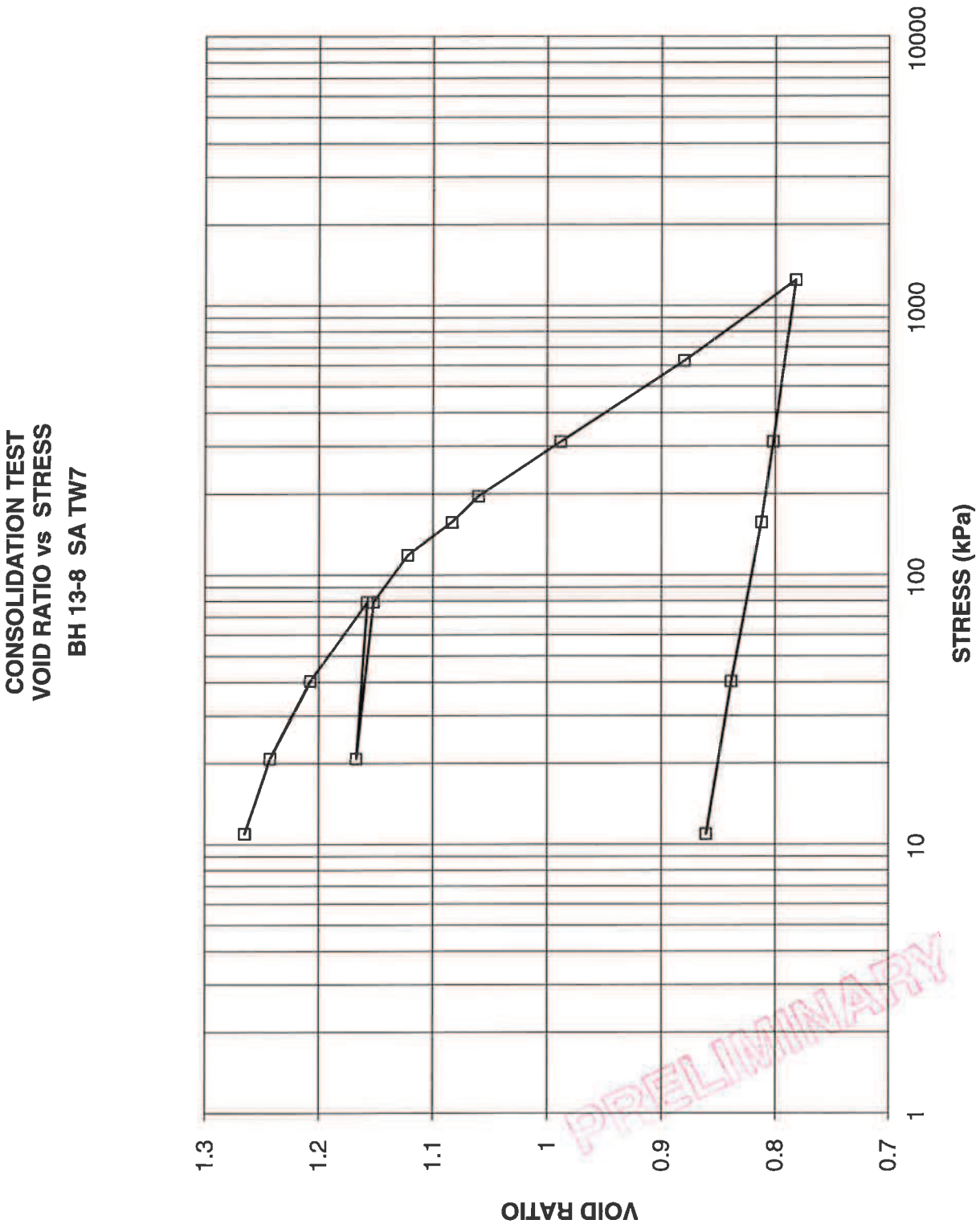


Project No. 14-1183-0001
Prepared By: LG

Golder Associates

Checked By:

CONSOLIDATION TEST VOID RATIO VS LOG STRESS	FIGURE



Project No. 14-1183-0001

Prepared By: LG

Golder Associates

Checked By:

Appendix C

Results of 2011 Investigation at Shea Road (Borehole Logs and Consolidation Test)

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

LOG OF BOREHOLE BH11-S-1

PROJECT: Geotechnical Investigation - Culvert Replacement
CLIENT: R. V. Anderson Associates Limited
PROJECT LOCATION: Shea Road & Ridell Drive, Ottawa, Ontario
DATUM: Geodetic
BH LOCATION: See BH Location Plan

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 203mm
Date: Jul/07/2011

REF. NO.: 877-1101
ENCL NO.:

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (Mg/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.3										
94.2 / 0.1	**ASPHALT:** 75 mm									
	SAND AND GRAVEL: some silt, brown, moist, compact (FILL)		1	SS	25		SAND			42 47 11 0
			2	SS	10		CUTTING			
92.8							BENTONITE			
1.5	**SILTY CLAY:** brown, moist, firm (weathered)		3	SS	10					
			4	SS	6		92		18.3	
91.2										
3.1	**SILTY CLAY:** grey, wet, soft to very soft		5	SS	4		91			
				VANE			CUTTING 2.4			
							W. L. 90.3 m Jul 13, 2011			
			6	SS	2		90			
				VANE			8			
							89			
			7	TW			88		17.8	
				VANE			SAND			
							87			
86.1			8	SS	WH					
8.2	**END OF BOREHOLE**									

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 10 20 30 40 50
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

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

SPL SOIL LOG 877-1101-LOG.GPJ SPL.GDT 29/7/11

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

LOG OF BOREHOLE BH11-S-2

PROJECT: Geotechnical Investigation - Culvert Replacement
CLIENT: R. V. Anderson Associates Limited
PROJECT LOCATION: Shea Road & Ridell Drive, Ottawa, Ontario
DATUM: Geodetic
BH LOCATION: See BH Location Plan

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 203mm
Date: Jul/07/2011

REF. NO.: 877-1101
ENCL NO.:

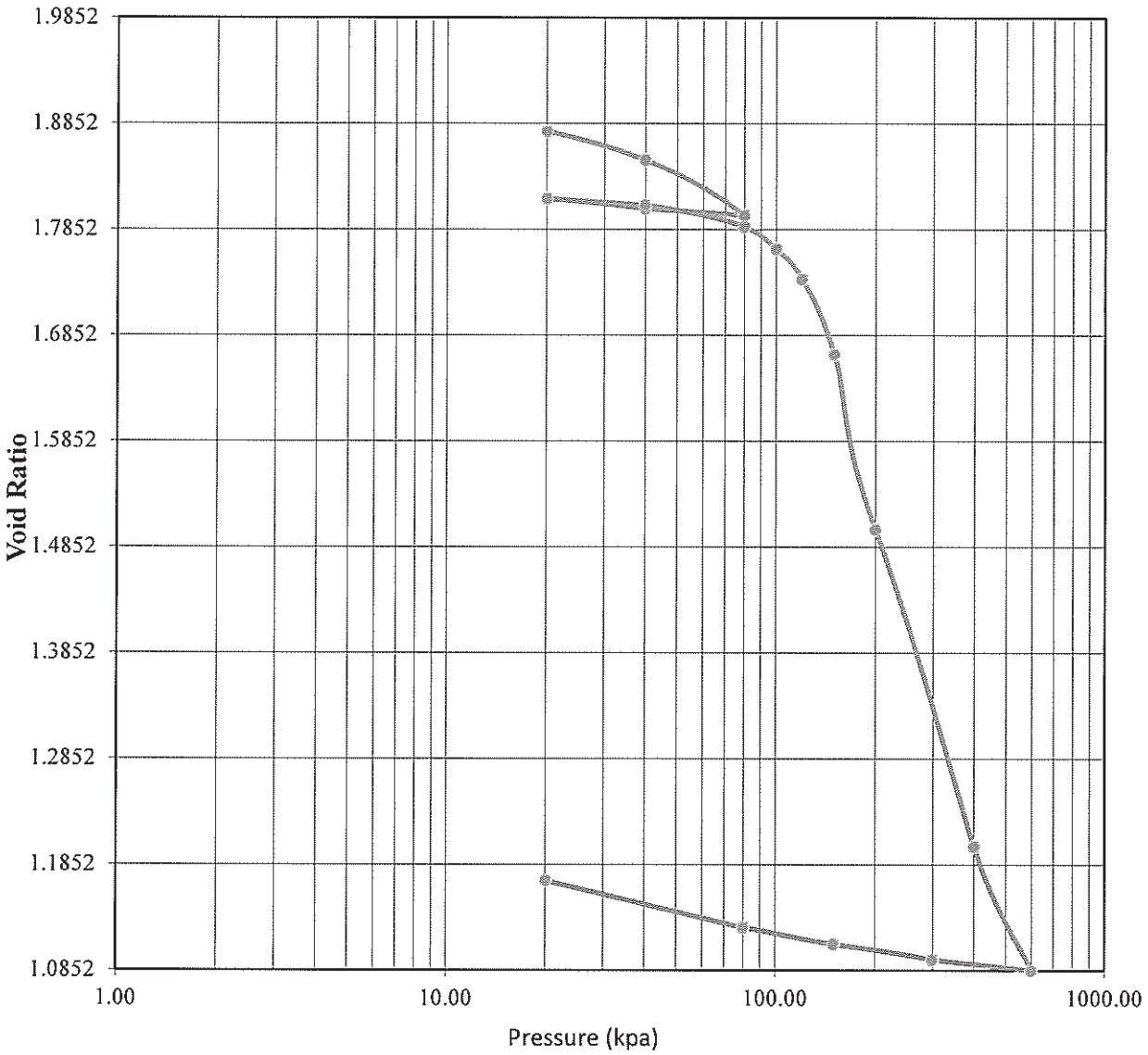
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (Mg/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.4										
94.0 / 0.1	**ASPHALT:** 70 mm									
	SAND AND GRAVEL: some silt, brown, moist, compact (FILL)		1	SS	26		94			
93.0			2	SS	12					
1.4	**SILTY CLAY:** brown, moist, firm (waethered)		3	SS	8		93			
91.7			4	SS	4		92		18.4	
2.7	**SILTY CLAY:** grey, wet, soft to very soft		5	SS	4		91		18.1	
			6	SS	WH		90			
				VANE			89			
			7	SS	WH		88			
				VANE			87			
86.2			8	SS	WH					
8.2	**END OF BOREHOLE**									

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 10 20 30 40 50
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

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

SPL SOIL LOG 877-1101-LOG.GPJ SPL.GDT 29/7/11

Consolidation Test
Test Results



	Before	After				
			Liquid Limits:	44	**Test Date:**	July 14, 2011
Moisture (%):	69.55	44.23	**Plastic Limits:**	25		
Dry Density (g/cm3):	0.95	1.26	**Plasticity Index (%):**	19		
Saturation (%):	100.63	103.38				
Void Ratio:	1.8891	1.1682	**Specific Gravity:**	2.744	Measured	

Soil Description:

Project Number: 11-214 **Depth:** 6.10 - 6.71 **Remarks:**

Sample Number: M1178 **Boring Number:** BH -5-1

Project: Materials Testing

Client: SPL Consultants Ltd.

Location: n/a

Consolidation Test
Consolidation Specimen Information

Project: Materials Testing
Location: n/a
Job Number: 877-1101

Project Number: 11-214
Test Date: July 14, 2011

Sample Number: M1178
Boring Number: BH -5-1
Depth: 6.10 - 6.71
Sample Type: Undisturbed

Sample Description:

Remarks:

Test Number: 1
Liquid Limit: 44
Plastic Limit: 25
Specific Gravity: 2.744 Measured

Initial Void Ratio: 1.889
Plasticity Index (%): 19
Weight of Ring (g): 110.60

Initial Height (mm): 25.40
Initial Diameter (mm): 63.50

Parameters	Initial Specimen	Final Specimen
Moist Weight + Container (g)	239.80	258.60
Dry Soil + Container (g)	186.80	224.90
Weight of Container (g)	110.60	148.70
Moisture Content (%)	69.55	44.23
Void Ratio	1.8891	1.1682
Saturation (%)	100.63	103.38
Dry Density (g/cm3)	0.95	1.26

Tested By:

Checked By:

Consolidation Test Results
Summary

Project: Materials Testing
Location: n/a
Job Number: 877-1101

Project Number: 11-214

Sample Number: M1178
Boring Number: BH -5-1
Depth: 6.10 - 6.71
Sample Type: Undisturbed

Sample Description:

Remarks:

Test Number:
Test Date: July 14, 2011

Index	Load Sequence (kpa)	Cummulative Change in Height (mm)	Specimen Height (mm)	Height of Void (mm)	Vertical Strain (%)	Void Ratio	t90 Fitting Time (min)	t50 Fitting Time (min)	t90 Cv (mm2/sec)	t50 Cv (mm2/sec)
0	0.000	0.0000	25.4000	16.6153	0.00	1.8914	0.000	0.000	0.000	0.000
1	20.000	0.1203	25.2797	16.4950	0.47	1.8777	2.115	* 1.1750	1.068	0.446
2	40.000	0.3576	25.0424	16.2577	1.41	1.8507	2.772	* 1.5399	0.799	0.334
3	80.000	0.8150	24.5850	15.8004	3.21	1.7986	2.684	* 1.4910	0.796	0.333
4	40.000	0.7617	24.6383	15.8537	3.00	1.8047	0.000	0.000	0.000	0.000
5	20.000	0.6792	24.7208	15.9362	2.67	1.8141	0.000	0.000	0.000	0.000
6	40.000	0.7307	24.6693	15.8846	2.88	1.8082	1.482	* 0.8235	1.451	0.607
7	80.000	0.9113	24.4887	15.7041	3.59	1.7877	1.814	* 1.0078	1.168	0.488
8	100.000	1.0953	24.3047	15.5201	4.31	1.7667	1.673	* 0.9297	1.247	0.522
9	120.000	1.3463	24.0537	15.2690	5.30	1.7382	1.483	* 0.8237	1.379	0.577
10	150.000	1.9705	23.4295	14.6449	7.76	1.6671	3.568	* 1.9822	0.544	0.227
11	200.000	3.4234	21.9766	13.1919	13.48	1.5017	190.278	* 105.7099	0.009	0.004
12	400.000	6.0542	19.3458	10.5611	23.84	1.2022	16.070	* 8.9280	0.082	0.034
13	600.000	7.0825	18.3175	9.5329	27.88	1.0852	10.506	* 5.8368	0.113	0.047
14	300.000	6.9913	18.4087	9.6240	27.52	1.0955	0.000	0.000	0.000	0.000
15	150.000	6.8641	18.5359	9.7513	27.02	1.1100	0.000	0.000	0.000	0.000
16	80.000	6.7265	18.6735	9.8888	26.48	1.1257	0.000	0.000	0.000	0.000
17	20.000	6.3379	19.0621	10.2774	24.95	1.1699	0.000	0.000	0.000	0.000

Predicted value indicated with *

Tested By:

Checked By:

Appendix D

Soil Corrosivity Test Results

EXOVA OTTAWA

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

Dear Omer Eissa:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: Digitally signed by Lorna Wilson Date: 2013.08.23 14:09:28 -04'00'

Lorna Wilson
Laboratory Supervisor, Inorganics

Exova (Ottawa) is certified and accredited for specific parameters by:
CALA, Canadian Association for Laboratory Accreditation (to ISO 17025), OMAFRA, Ontario Ministry of Agriculture, Food and Rural Affairs (for farm soils), Licensed by Ontario MOE for specific tests in drinking water.

Exova (Mississauga) is accredited for specific parameters by:
SCC, Standards Council of Canada (to ISO 17025)

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only.

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

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

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 256400 **Analysis Date** 2013-08-22 **Method** Ag Soil			
Electrical Conductivity	<0.05 mS/cm	104	80-120
pH		100	90-110
Resistivity			
SO4	<0.01 %	98	70-130
Run No 256493 **Analysis Date** 2013-08-23 **Method** C CSA A23.2-4B			
Cl		100	90-110

Guideline = *** = Guideline Exceedence**
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EXOVA OTTAWA

Certificate of Analysis

Exova

Client: SPL Consultants Ltd.
146 Colonnade Rd., Unit 17
Ottawa, ON
K2E 7Y1
Attention: Ms. Wendy McLaughlin
PO#:
Invoice to: SPL Consultants Ltd.

Report Number: 1400088
Date Submitted: 2014-01-06
Date Reported: 2014-01-08
Project: 1776-710
COC #: 172935

Dear Wendy McLaughlin:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: Nadine Pinsonneault 2014.01.08 14:15:22 -05'00'

Nadine Pinsonneault
Technician, Inorganics

Exova (Ottawa) is certified and accredited for specific parameters by:
CALA, Canadian Association for Laboratory Accreditation (to ISO 17025), OMAFRA, Ontario Ministry of Agriculture, Food and Rural Affairs (for farm soils), Licensed by Ontario MOE for specific tests in drinking water.

Exova (Mississauga) is accredited for specific parameters by:
SCC, Standards Council of Canada (to ISO 17025)

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only.

Certificate of Analysis

Client: SPL Consultants Ltd.
146 Colonnade Rd., Unit 17
Ottawa, ON
K2E 7Y1
Attention: Ms. Wendy McLaughlin
PO#:
Invoice to: SPL Consultants Ltd.

Report Number: 1400088
Date Submitted: 2014-01-06
Date Reported: 2014-01-08
Project: 1776-710
COC #: 172935

				Lab I.D.	1080989	1080990
				Sample Matrix	Soil	Soil
				Sample Type		
				Sampling Date	2013-12-19	2013-12-19
				Sample I.D.	BH 13-7 SS2	BH 13-9 SS3
Group	**Analyte**	**MRL**	**Units**	**Guideline**		
Agri. - Soil	Electrical Conductivity	0.05	mS/cm		0.15	0.17
	pH	2.0			6.7	7.4
General Chemistry	Cl	0.002	%		0.004	0.003
	Resistivity	1	ohm-cm		6670	5880
	SO4	0.01	%		0.02	0.03

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Client: SPL Consultants Ltd.
146 Colonnade Rd., Unit 17
Ottawa, ON
K2E 7Y1
Attention: Ms. Wendy McLaughlin
PO#:
Invoice to: SPL Consultants Ltd.

Report Number: 1400088
Date Submitted: 2014-01-06
Date Reported: 2014-01-08
Project: 1776-710
COC #: 172935

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 263483 **Analysis Date** 2014-01-07 **Method** Ag Soil			
Electrical Conductivity	<0.05 mS/cm	100	80-120
pH		99	90-110
Resistivity			
SO4	<0.01 %	96	70-130
Run No 263491 **Analysis Date** 2014-01-07 **Method** C CSA A23.2-4B			
Cl	<0.002 %	105	90-110

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 E

Limitations of This Report

LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to SPL Consultants Limited at the time of preparation. Unless otherwise agreed in writing by SPL Consultants Limited, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. SPL Consultants Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.