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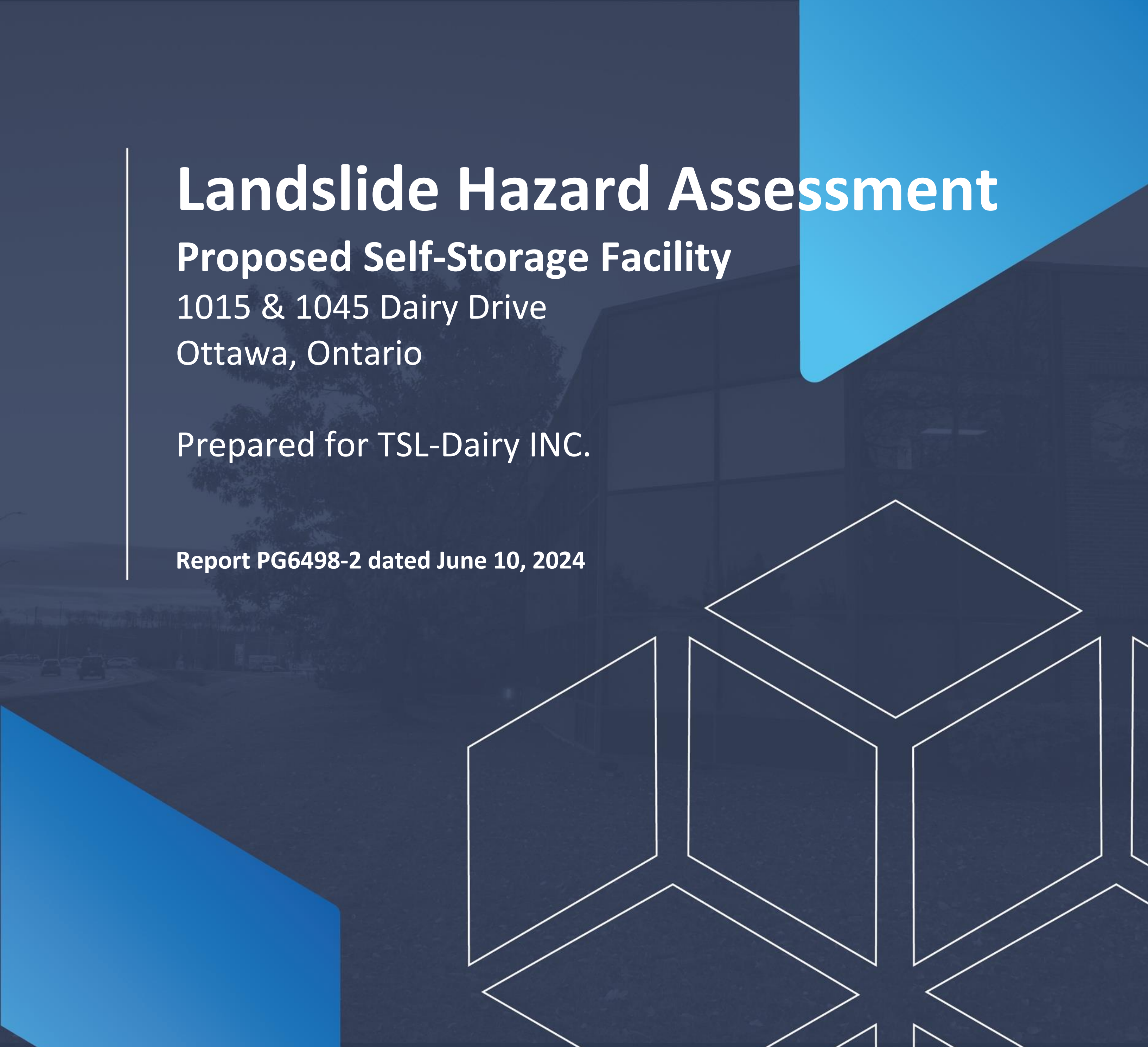

Landslide Hazard Assessment

Proposed Self-Storage Facility

1015 & 1045 Dairy Drive
Ottawa, Ontario

Prepared for TSL-Dairy INC.

Report PG6498-2 dated June 10, 2024

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1.0 Introduction

1.1 Purpose of Study and Scope of Work

Paterson Group (Paterson) was commissioned by TSL-Dairy Inc. to conduct a landslide hazard assessment study for the proposed self-storage facility to be located at 1015 & 1045 Dairy Drive, Ottawa, Ontario (reference should be made to Figure 1 - Key Plan in Appendix 2 of this report). The study has been prepared in response to the requirement by the Rideau Valley Conservation Authority (RVCA) as part of the Site Plan Approval process for the City of Ottawa for the subject site.

The objectives of the hazard assessment were to:

❑ Demonstrate that any landslide on the sloped areas, including a large "catastrophic landslide", has an annual probability less than 1:10,000.

❑ If the landslide hazard cannot be demonstrated to have an annual probability of less than 1:10,000, it must be demonstrated that the individual risk is <1x10^{-5} per year and group risk falls within the "Acceptable" zone on a suitable group risk chart.

❑ If none of these criteria can be satisfied without mitigation measures, then the mitigation actions required must be demonstrated to reduce the risk below 10^{-5} per year and to "as low as reasonably practicable" (ALARP). If mitigation is required, further discussion with the RVCA will be required to determine what will be acceptable.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

1.2 Hazard Assessment Methodology

The methodology of this study was undertaken using a combination of the criteria and requirements set out by the following guidelines:

❑ Fraser Valley Regional District's Hazard Acceptability Thresholds for Development Applications dated October 2020

❑ The Association of Professional Engineers and Geoscientists of British Columbia's (APEGBC) Guidelines for Legislates Landslide Assessments for Proposed Residential Developments in BC, dated May 2010

❑ Geological Survey of Canada's Open File 7312 - Landslide Risk Evaluation Technical Guidelines and Best Practices, dated 2013

The scope of work used in this study included a review of published literature describing local landslides and their associated triggers, geotechnical hazards, inventoried regional landslides and the geological setting of the study area. Desktop review of published topographic mapping, LiDAR imaging, and other geological mapping was also used as part of this assessment.

Field reconnaissance was carried out over geotechnical field programs that have taken place throughout the subject site, including field review and subsurface investigations. Review of publicly available well records located in close proximity to the subject site was also considered as part of our assessment.

1.3 Proposed Development

Based on the available drawings, it is understood that the proposed development will consist of 2 self-storage buildings, Buildings A and B, and 2 sets of industrial condominiums, Buildings C and D.

Buildings A and B will have approximate footprints of 6,400 m^2 and 3,600 m^2, respectively. Each of these buildings will have 2 levels, with the lower level being below-grade at the eastern boundary of the site and daylighting at the western boundary of the site along Dairy Drive.

Buildings C and D will have approximate footprints of 560 m^2 and 910 m^2, respectively, and will consist of single-storey, slab-on-grade structures.

Associated asphalt-paved access lanes and parking areas with landscaped margins will immediately surround the proposed buildings. It is also anticipated that the development will be municipally serviced.

1.4 Review of Previous Geotechnical Investigation

For this assessment, subsurface information was collected from site-specific investigations carried out by Paterson throughout the subject site. The results of the previous investigations are presented in Paterson Group Investigation Report PG6498-1 Revision 4 dated June 10, 2024.

All reviewers of this report should understand that the geotechnical investigation undertaken in support of the proposed development has been undertaken in accordance with the City of Ottawa’s *Geotechnical Investigation and Reporting Guidelines for Development Applications in the City of Ottawa*, that the slope stability fieldwork and analysis had been undertaken in accordance with the City of Ottawa’s *Slope Stability Guidelines for Development Application in the City of Ottawa*, and that laboratory testing was undertaken in accordance with the above-noted guidelines and the *City of Ottawa’s Tree Planting in Marine Clay Soils – 2017 Guidelines*.

2.0 Background of Study Area

2.1 Field Investigation

Geotechnical Investigations

The field program for the current investigation was carried out on December 8 and 9, 2022. At that time, 4 boreholes and 8 test pits were advanced to maximum depths of 7.4 and 2.3 m below the existing ground surface, respectively. A previous investigation was completed by others on February 11, 2019 and consisted of five (5) boreholes advanced to a maximum depth of 6.7 m below ground surface

The test hole locations were placed in a manner to provide general coverage of the subject site taking into consideration site access, features and underground utilities. The borehole locations were determined and surveyed in the field by Paterson personnel. The locations of the boreholes are illustrated on Drawing PG6498-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were completed using a low-clearance drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of personnel from Paterson’s geotechnical division under the direction of a senior engineer. The testing procedure consisted of augering to the required depths and at the selected locations and sampling and testing the overburden soils.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using two different techniques, namely, sampled directly from the auger flights (AU) or collected using a 50 mm diameter split-spoon (SS) sampler. Grab samples were collected from the test pits at selected intervals. All samples were visually inspected and initially classified on site, placed in sealed plastic bags and transported to our laboratory for further examination and classification. The depths at which the auger flights, split spoon samples, and grab samples were recovered from the boreholes are shown as AU, SS, and G respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

A Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split spoon samples. The SPT results are recorded as "N" values on the Soil Profile and Test Data sheets. The "N" value is the number of blows required to drive the split spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Undrained shear strength testing was carried out at regular depth intervals in cohesive soils using a field vane apparatus.

The overburden thickness was evaluated by dynamic cone penetration testing (DCPT) completed at BH 4-22. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1.

Groundwater

All boreholes were fitted with flexible polyethylene standpipes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

The groundwater observations are noted on the Soil Profile and Test Data sheets presented in Appendix 1.

Geotechnical Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging. A total of one (1) shrinkage test, one (1) grain size distribution analysis, and one (1) Atterberg limits test were completed on selected soil samples. The results are presented in Section 2.2 and on the Grain Size Distribution and Hydrometer Testing Results and Atterberg Limit Results sheets presented in Appendix 1.

2.2 Existing Conditions

Surface Conditions

The majority of the subject site currently consists of undeveloped land covered with a grass surface and shrubs. A large 3 to 4 m high fill pile was also observed to be present in the central portion of the site.

The subject site is bordered by an industrial property to the north, undeveloped land and further by Cardinal Creek to the east, Old Montreal Road to the south, and Dairy Drive to the west. The ground surface across the site slopes downward gradually from north to south, from approximate geodetic elevation 63 to 58 m, with the exception of the fill pile which extends up to about geodetic elevation 65.5 m. Further, the ravine around Cardinal Creek, located approximately 13 to 14 m from the eastern site boundary, slopes downward to about geodetic elevation 52 m.

The slopes located along Cardinal Creek and east of the site boundary were reviewed as part of the geotechnical investigation. A slope stability assessment was carried out considering the slope conditions present in the subject site and described above. The results of the slope stability assessment indicated that the existing slopes are stable. The assessment is discussed further in Section 3.0 of this report.

Subsurface Conditions

Generally, the overburden profile consisted of a thin layer of topsoil underlain by a layer of fill material, over a deposit of silty clay.

At the location of the fill pile, the fill material extends to approximate depths ranging between 0.3 to 3.0 m below the existing ground surface and was generally observed to consist of brown to grey silty clay with trace amounts of organics, sand, crushed stone and occasional topsoil.

The deep silty clay deposit consists of a brown, hard to very stiff silty clay crust, becoming stiff and grey at a depth range of approximately 4.5 to 5.3 m below the existing ground surface.

Practical refusal to the DCPT in borehole BH 4-22 was encountered at a depth of 29.0 m below existing ground surface.

Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profiles encountered at each test hole location and Drawing PG6498-1 - Test Hole Location Plan in Appendix 2.

Geotechnical Laboratory Testing

Atterberg Limit Tests

Atterberg limits testing, as well as associated moisture content testing, was completed on a select silty clay sample. The results of the Atterberg limits test are presented in Table 1 and on the Atterberg limits Results sheet in Appendix 1. The results of the moisture content test are presented on the Soil Profile and Test Data Sheet in Appendix 1. The tested silty clay sample classifies as inorganic clay of high plasticity (CH) in accordance with the Unified Soil Classification System.

Table 1 - Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	w (%)	Classification
BH 1-22	2.59	76	24	52	45.26	CH

Note: LL: Liquid Limit; PL: Plastic Limit; PI: Plastic Index; w: water content; CH: Inorganic Clay of High Plasticity

Grain Size Distribution and Hydrometer Testing

Grain size distribution analysis was completed on 1 select recovered silty clay sample. The results of the grain size distribution analysis are presented in Table 2 and on the Grain Size Distribution sheet in Appendix 1.

Table 2 - Grain Size Distribution Results

Sample	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH 2-22	1.83	0.0	0.2	99.8	

Shrinkage Test

Linear shrinkage testing was completed on a sample recovered from 2.59 m depth from borehole BH 2-22 and yielded a shrinkage limit of 20.3 and a shrinkage ratio of 1.69.

Bedrock

Based on available geological mapping, the subject site is located in an area where the bedrock consists of interbedded limestone and dolomite of the Gull River Formation with an overburden drift thickness of 15 to 25 m depth.

Reference should be made to the Soil Profile and Test Data Sheets in Appendix 1 for details of the soil profile encountered at each borehole location.

Groundwater

Groundwater levels were recorded at each piezometer location on December 14, 2022. The measured groundwater level (GWL) readings are presented in Table 3 and in the Soil Profile and Test Data sheets in Appendix 1.

It should be noted that surface water can become trapped within the backfilled borehole column, leading to higher than typical groundwater level observations.

Table 3 - Summary of Groundwater Level Readings

Test Hole Number	Ground Surface Elevation (m)	Measured Groundwater Level		Recording Date
		Depth (m)	Elevation (m)	
BH 1-22	58.74	0.76	57.98	December 14, 2022
BH 2-22	59.42	0.43	58.99	December 14, 2022
BH 3-22	62.41	0.33	62.08	December 14, 2022
BH 4-22	63.66	3.85	59.81	December 14, 2022

Note: The ground surface elevation at each borehole location was surveyed using a handheld GPS using a geodetic datum.

Long-term groundwater level can be estimated based on the observed color, moisture levels and consistency of the recovered soil samples. Based on these observations, the long-term groundwater table can be expected to be approximately **4 to 5 m** below ground surface. Groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could vary at the time of construction.

3.0 Slope Stability Analysis

3.1 Slope Conditions

As part of the geotechnical investigation, Paterson completed a field review of the existing conditions of the slope along the ravine following Cardinal Creek. The field review completed on March 27, 2023 generally consisted of observing surface conditions along the banks of the creek, including identifying the presence of vegetation, erosion and other features associated with slope stability.

A total of two (2) cross-sections were studied as the worst-case scenarios and analyzed as part of the slope stability analysis. Based on the results of our field observations and slope stability analysis, a Limit of Hazard Lands was assigned from the top of slope for the above-noted sections.

The cross-section locations and topographic mapping information are presented on Drawing PG6498-1 - Test Hole Location Plan in Appendix 2.

3.2 Summary of Field Observations

The following section provides a summary of our observations during the time of the field review of the slope located east and beyond the subject site.

The subject site is located west of Cardinal Creek, which meanders in a northwest-southeast direction. The slope profile across the watercourse was generally observed to range between approximate steepness of 2H:1V to 4H:1V. Further, the slopes were observed to be between 6 to 7 m in height. The width of the watercourse was noted to be approximately 6 m wide.

Generally, the slope sections consisted of hard to very stiff brown silty clay overlying a deep deposit of stiff grey silty clay. At the time of our field investigation the slopes were observed to be heavily vegetated with no significant signs of erosion observed throughout the western bank of the ravine. It should be noted that at the time of our visit, the slopes were largely snow covered.

3.3 Slope Stability Analysis

The slope stability analysis was modeled in SLIDE, a computer program which permits a two-dimensional slope stability analysis calculating several methods including the Bishop’s method, which is a widely accepted slope analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to forces favoring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable.

However, due to intrinsic limitations of the calculation methods and the variability of the subsurface soil and groundwater conditions, a factor of safety greater than 1.0 is generally required for the failure risk to be considered acceptable. A minimum factor of safety of 1.5 is generally recommended for conditions where the slope failure would comprise permanent structures. An analysis considering seismic loading was also completed. A horizontal acceleration of 0.16 g was considered for the sections for the seismic loading condition. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

Two (2) slope cross-sections were analyzed based on the existing conditions observed during our site visit, and review of the available topographic mapping. The slope stability analysis was completed at each slope cross-section under worst-case-scenario by assigning cohesive soils under fully saturated conditions. Subsoil conditions at the cross-sections were inferred based on the findings at borehole locations along the top of slope, field observations during site visits and general knowledge of the area’s geology.

The cross-section locations are presented on Drawing PG6498-1 - Test Hole Location Plan in Appendix 2.

The effective strength soil parameters used for static analysis were chosen based on the subsoil information recovered during the geotechnical investigation. The effective strength soil parameters used for static analysis are presented in Table 4.

Table 4 – Effective Stress Soil Parameters (Static Analysis)

Soil Layer	Unit Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
Brown Silty Clay (Crust)	17	33	5
Grey Silty Clay	16	33	10

The total strength parameters for seismic analysis were chosen based on the subsurface conditions observed in the test holes, and our general knowledge of the geology in the area. The strength parameters used for seismic analysis at the slope cross-sections are presented in Table 5.

Table 5 – Total Stress Soil Parameters (Seismic Analysis)

Soil Layer	Unit Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
Brown Silty Clay (Crust)	17	-	90
Grey Silty Clay	16	-	50

3.3.1 Stable Slope Allowance

Static Analysis

The results for the existing slope conditions at Section 1-1’ and Section 2-2’ are shown in Figure 2 and Figure 4 in Appendix 2. The factor of safety for Section 1-1’ was found to be greater than 1.5, and therefore the section is considered stable under static conditions. A factor of safety less than 1.5 was noted for Section 2-2’, which requires a **stable slope allowance of 5 m** from top of slope to obtain a factor of safety greater than 1.5.

It should be noted that the above noted saturated condition for the subject slope is considered to be a worst-case scenario due to the low permeability of the stiff silty clay deposit based on our knowledge of the subsoil conditions within the subject site.

Seismic Loading Analysis

An analysis considering seismic loading was also completed. A horizontal seismic acceleration, K_h, of 0.16g was considered for the analyzed sections.

A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

The results of the analyses including seismic loading are shown in Figure 3 and Figure 5 and attached in Appendix 2 of this report.

The overall slope stability factor of safety at the two slope cross-sections when considering seismic loading was found to be greater than 1.1, which is considered stable under seismic loading. Therefore, setbacks due to slope stability under seismic conditions are not required from a geotechnical perspective at the subject site.

3.3.2 Toe Erosion Allowance

Since the slopes are in direct contact with an active watercourse, erosion of the toe of slope is considered to be a notable factor contributing to the stability of the subject slopes. The toe erosion allowance is based on the nature of the soils, the observed current erosion activities, and the width and location of the current watercourse, and has been determined in accordance with the City of Ottawa’s *Slope Stability Guidelines for Development Application in the City of Ottawa* (2004) and the Ontario Ministry of Natural Resources *Technical Guide - River and Stream System: Erosion Hazard Limit* (2002).

General subsurface conditions at the toe of slope were observed to consist of a layer of brown silty clay underlain by a deep deposit of grey silty clay. Furthermore, the majority of the banks abutting the watercourse were observed to be affected by some form of erosion. Based on this and the consistency of the subsoil materials encountered throughout our field review, a **toe erosion allowance of 2 m** is recommended to be considered for the associated Limit of Hazard Lands designation line for the slopes along Cardinal Creek.

3.3.3 Erosion Access Allowance

Based on our review and current guidelines, a **6 m erosion access allowance** is recommended from the top of stable slope for the slopes to allow future maintenance.

3.3.4 Limit of Hazard Lands

Based on these observations, channel measurements and the results of the slope stability analysis, Paterson suggested a Limit of Hazard Lands setback from the observed top of slope alignment. The Limit of Hazard Lands is a setback formed by a combination of allowances considering stable slope, toe erosion and erosion access. Based on our review, field observations and slope stability analysis, a Limit of Hazard Lands designation line of ranging between 8 to 13 m, and as described in the preceding paragraphs, is considered applicable for the slopes adjacent to the subject site.

Considering the above, the Limit of Hazard Lands setback provided for the subject site is summarized in Drawing PG6498-3 - Slope Setback Plan, attached in Appendix 2. The setbacks are also shown in cross-section A-A’, B-B’ and C-C’ depicted on Drawings PG6498-4, PG6498-5, and PG6498-6, respectively.

It should be noted that the subject site boundary and proposed self-storage facility are located approximately 13.5 m from the top of slope, at its nearest point, the Limit of Hazard Lands does not extend onto the subject site and does not impact the proposed development.

Accordingly, the location of the proposed self-storage facility is considered acceptable from a slope stability and geotechnical perspective. However, it should be noted that additional slope and/or watercourse setbacks may be required from the various regulating authorities, such as the 25 m Top of Valley Slope setback, and which may exceed the Limit of Hazard Lands setback developed based on the slope stability analysis.

It is recommended that the existing vegetation on the slope faces is not removed as it contributes to the stability of the slope and reduces erosion.

3.4 Seismic Design Considerations

Based on the results of the geotechnical investigation, a seismic **Site Class D** is considered applicable for foundation design within the area of the subject site as per Table 4.1.8.4.A of the OBC 2012.

The soils underlying the proposed foundations are not susceptible to liquefaction. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

4.0 Landslide Hazard and Risk Assessment

4.1 General Methodology of Assessment

The methodology for the landside hazard assessment undertaken for this report may be considered as the following:

- ☐ Identify factors that are documented to contribute to the susceptibility for a landslide to occur throughout sloped terrain.
- ☐ Relate the aforementioned factors to the susceptibility for a landslide to occur throughout the subject site.
- ☐ Estimate the probability of a landslide to occur throughout the subject site based on historical regional landslide inventories. A baseline regional probability will be adjusted to a site-specific probability considering the site-specific factors that may promote landslide susceptibility using a Frequency Estimation Method.

If the hazard under consideration cannot be demonstrated to have an annual probability of less than 1:10,000, a group risk assessment estimating the annual probability of loss of lives would be carried out in accordance with the following equation:

$$\text{Risk} = P(H) \times P(S{:}H) \times P(T{:}S) \times V \times E$$

Where R represents the risk or annual probability of loss of life of an individual, P(H) stands for the annual probability that a landslide occurs, P(S:H) indicates the probability of impacting the elements taking into consideration the scale and location of the landslide events, P(T:S) is the temporal spatial probability of the elements being present at the time of a landslide (i.e.- the probability that a person is present at the location at risk), V represents the vulnerability, or likelihood of death or permanent injury of the individual given they are impacted and E represents the number of elements that would be impacted. The variable E can also be considered equal to the number of occupants for grouped areas.

4.2 Factors Affecting Landslide Susceptibility

The following sections discuss factors understood to affect the potential for a landslide to occur. The factors are described briefly and subsequently discussed on their impact to the susceptibility of a landslide throughout the subject site. The study area for the purpose of this discussion is considered as the area bound by the area considered by the Geological Survey of Canada under Open File 5311. The property discussed throughout this report is considered the subject site.

4.2.1 Clay Overburden

Based on the findings of the geotechnical investigation, the slope profiles throughout the subject site consist primarily of a silty clay deposit inferred to be underlain by bedrock. Based on geological mapping undertaken by the Geological Survey of Canada under Open File 5311, the local deposit is considered to be formed by offshore marine sediments in the form of preserved erosional terraces.

The clay deposit encountered throughout the subject site was observed to consist of a hard to very stiff, weathered, brown silty clay crust extending to depths between 4.5 to 5.3 m below the ground surface. The brown silty clay was underlain by a grey silty clay deposit. Sand was not encountered above the clay deposit to form a “sand cap” layer at any borehole.

Review of landslides inventoried under Geological Survey of Canada (GSC) Open Files 5311, 7432 and 8600 document approximately 132 large landslide footprints throughout the Ottawa region. Review of the surficial geology for land adjacent to the landslides inventoried by the above-noted sources indicated approximately 83% (i.e., 109 out of 114 landslides captured by the study area published in OF5311) of these landslides may have originated from marine deposits consisting of clay. The remaining five landslides were considered to have consisted of alluvial sediments and/or organic deposits.

It has also been documented that the retrogression of landslides might be predicted by the undrained shear strength values measured in the silty clay unit. Mitchell & Markell (1974) studied the characteristics of landslides in silty clay soils associated with river valleys. Their study, based on 41 documented landslides located within Eastern and Northern Ontario, indicated that Taylor’s stability number can be used as an indicator to evaluate the susceptibility of landslides to occur. Taylor’s stability number (Ns) is defined as

$$N_s = yH/S_{u,}$$

where y represents the bulk unit weight of soil (kN/m^3), H is the slope height (m), and S_u depicts the peak undrained shear strength of the silty clay (kPa). Mitchell & Markell (1974) determined that N_s should be greater or equal to 6 for the potential of retrogression to occur. However, measurements reviewed further by Demers and others (L’Heureux; Demers, 2014) “determined that large retrogressions have been measured where N_s values were less than 5, and as low as 3.3”. Shear strength at the subject site ranges between 53 to more than 239 kPa for areas where the bank height is observed to be at most 7 m. Based on this, the worse-case scenario **Ns values range between 0.2 and 1.8** and are significantly less than between 3.3 and 6, which would not suggest the potential for retrogression throughout the subject site if a slope failure was triggered.

Mitchell and Markell have also explored the sensitivity of clays as a factor in retrogression, where sensitivity is defined as the ratio of undisturbed to remolded shear strength. In their studies, Mitchell and Markell concluded that the sensitivity of retrogressive clays ranges between 10 to 1,000. Based on our review of clay sensitivity (ratio of in-situ undisturbed to remolded shear strength), the majority of the tested intervals yielded sensitivity ratios to be less than 10. However, at approximate depths ranging between 6.0 to 7.0 m below existing ground surface the clay presented a slightly higher sensitivity (in the range of 6 to 16). Based on this, sensitive clay is considered to be present throughout the overburden profile throughout the subject site.

Based on the above, while the potential for retrogression to occur should a slope failure be triggered does not seem likely, sensitive clay is present throughout the subject site and further inferred to be present along the adjacent Cardinal Creek. Based on this, the baseline probability discussed in Section 4.3 – Hazard Assessment will be multiplied by a factor of 4.0.

4.2.2 Slope Inclination, Bedrock Depth and Surface Relief

Overburden thickness and surface relief are understood to be significant factors contributing to the potential for a landslide. Landslide susceptibility mapping carried out throughout National Topographic System (NTS) area 31H correlated higher values of drift thickness and surface relief to a higher rate of landslide incidence in Champlain Sea clays (Quinn, 2014). The study considered a weight of evidence approach which assigns a positive or negative weight for the ranges in these parameters with respect to the frequency of landslide occurrence.

A similar review was carried out to understand the relationship between overburden thickness and topographic relief for landslides that have occurred throughout the study area (area comprised by OF5311). The results of our interpretation of the available information are summarized in Table 6 and Table 7 below.

Topographic relief was interpreted using DEM provided by Google Earth. Relief was considered as the difference between the lowest and highest elevations and considering distances extending beyond a landslide footprint. Greater distances were considered where a landslide formed into a slope profile. Significantly large landslides could not be reasonably evaluated due to the highly variable topography beyond their footprint. The measure is considered subjective, however, appropriate based on the available topographic information for each of the landslides identified by OF5311, OF7432 and OF8600 and the purpose of this assessment.

Table 6 – Summary of Drift Thickness Throughout Historic Landslide Footprints

Drift Thickness	Number of Incidences	%
0 to 1	0	0.0
1 to 2	0	0.0
2 to 3	0	0.0
3 to 5	0	0.0
5 to 10	8	7.0
10 to 15	7	6.1
15 to 25	34	29.8
25 to 50	49	43.0
50 to 100	16	14.0
Total Landslides Within Study Area	114	94.2
Total Landslides Documented by Open Files	121	

Note: Drift thickness interpreted using Google Earth and is considered subjective, however, appropriate based on the available information for each of the landslides identified by OF5311, OF7432 and OF8600 and the purpose of this assessment.

In summary, incidences of landslides occur more frequently in areas with intermediate overburden thickness ranging between 15 to 40 m, and greater than 10 m of topographic relief throughout the study area. Based on the current test hole coverage and slope stability sections, it is anticipated that up to 25 m of overburden may be present throughout the subject site. Further, up to 9 m of topographic relief may be observed along the slopes located east of the property boundary of the subject site.

Based on the above, the potential for a landslide as based on the above-noted factors is low to moderate throughout the subject site. This is discussed in further detail in *Section 4.3 – Hazard Assessment* of this report.

Slope inclination and shape are also factors associated with assessing landslide susceptibility and overall slope stability. While the majority of the slope analyzed as part of our slope stability assessment yielded factors of safety exceeded local requirements for development purposes, slope geometry throughout the subject site is indicative of terrain that has potential for instability. Based on our review of LiDAR and topographic mapping, slopes are generally rectilinear in shape and reach up to an inclination of approximately 27 degrees. Based on this, it is suggested that the baseline probability discussed in Section 4.3 – Hazard Assessment will be multiplied by a factor of 1.5 to account for slope steepness and shape.

Table 7 – Summary of Topographic Relief Throughout Historic Landslide Footprints

Topographic Relief	Number of Incidences	%
<1	0	0.0
1-2	0	0.0
2-3	1	0.9
3-4	2	1.8
4-5	0	0.0
5-6	2	1.8
6-7	0	0.0
7-8	2	1.8
8-9	3	2.7
9-10	3	2.7
10-12	8	7.1
12-14	11	9.7
14-16	16	14.2
16-18	8	7.1
18-20	5	4.4
20-25	21	18.6
25-30	12	10.6
30-40	13	11.5
>40	6	5.3
Total Landslides Within Study Area Capable of Being Measured	113	93.4
Total Landslides Documented by Open Files	121	

4.2.3 Groundwater and Toe Erosion

Groundwater is understood to be a factor contributing to landslide susceptibility. Landslides throughout the Ottawa Valley have been understood to occur most frequently during the spring thaw, which results in seasonal increases in the depth of the groundwater table and porewater pressure. It has been documented that larger slopes typically fail by a combination of a downward gradient throughout the table lands and an upward gradient (artesian) throughout the bottom of the slope profile and along the channel (Hugenholtz and Lacelle, 2004).

The groundwater regime throughout the subject site is expected to follow general surficial topography such that sheet drainage of surface water across and away from the subject site and towards Cardinal Creek is expected to occur. Due to the parcel located between the subject site and Cardinal Creek being relatively undeveloped, it is expected surface drainage will continue to occur throughout that parcel and the subject slope for the foreseeable future. Fully saturated slope conditions have been considered as part of our slope stability assessment, which are anticipated to govern over the downward gradient conditions as a loading case from a slope stability perspective. Based on the results of the slope stability analysis, factors of safety were either greater than 1.28 or an appropriate stable slope allowance was incorporated as part of the Limit of Hazard lands.

Landslides throughout the Ottawa Valley have also been documented to occur most frequently adjacent to a watercourse. The formation of valley corridors by watercourses results in erosion along the toe of the slope and subsequent downcutting of the bank face by the erosional force of the watercourse. Sufficient downcutting, oversteepening and erosion of the slope can result in the instability of a slope and the potential for a landslide if a slope failure is triggered.

There is a relationship between stream flow (via flow accumulation) and landslide incidence such that larger landslides tend to be associated with larger watercourses (Quinn et al., 2010). In addition, the stream flow of a watercourse can be directly correlated to its stream order. Stream order is the degree of a tributary and branch streams with respect to an artery stream. Larger stream order values indicate the degree of closeness a stream is linked to the principal stream, whereas smaller values indicate the streams are considered to be distant tributaries from an artery stream. In summary, higher values of stream flow are correlated to higher degrees of stream order which are further correlated to older and fully developed watercourses. Smaller values of stream order are correlated to younger and less developed watercourses.

Generally, landslide density throughout the study area undertaken throughout NTS 31H was very low for streams up to order 3 and greater than or equal to order 9 (Quinn, 2009). The findings are similar for flow accumulation such that streams with less flow or smaller stream orders have a negative correlation with landslide incidence (Quinn, 2013). There is some evidence presented by a study area in Norway that younger streams have not fully developed their watercourse morphology and may be more erodible than larger, mature streams. However, the methodology undertaken to assess this for the study area of NTS 31H could not confirm this relationship for local and regional conditions at that time (Quinn, 2013).

Stream sinuosity was also explored as a variable impacting slope stability. Stream sinuosity is defined as the ratio of the total length along a stream segment to the shortest length between its endpoints (Quinn, 2013). Based on the review for the area of NTS 31H, it has been observed that landslides tend to be infrequent along streams with sinuosity lower than 1.338. Furthermore, channels with wider and more tightly spaced meander belts experience higher rates of erosion and are therefore more susceptible to landslides. Preferential occurrence of landslides in slopes situated on the outside of meander belts rather than in streams with low levels of sinuosity was similarly observed by Hugenholtz (2004).

A geomorphic study was undertaken by Geomorphic Solutions in 2007 for the Cardinal Creek watershed. Figure 1 depicts the enumeration of the corresponding reaches of the watershed close to the subject area. The study indicated that Reach C11, which neighbors the subject site, is considered to be a stream order 4, with a sinuosity of 1.39, which would correspond to a low to moderate risk of landslides.

While signs of erosion were not observed during our site visit at the time of conducting the field review in support of the slope stability analysis, the potential for toe erosion remains since the bank will not be provided toe erosion protection. Since toe erosion is a significant trigger for slope failures and the creek geometry is suggestive of a moderate risk of landslide susceptibility, the baseline probability will be multiplied by a factor of 3.0. This is discussed in further detail in *Section 4.3 – Hazard Assessment* of this report.

It should be noted that the toe erosion and erosion access allowances recommended as part of the Limit of Hazard Lands provided in our Geotechnical Report PG6498-1 Revision 4, dated June 10, 2024, are considered an appropriate and sufficient measure to account for the presence of the watercourse at the bottom of the slope from a geotechnical perspective.

Figure 1 - Cardinal Creek Subwatershed (Geomorphic Solutions, 2007)

4.2.4 Proximity to Landslides

Landslide inventory mapping published by GSC indicates the presence of potentially up to 4 landslides in proximity to the subject site. The proximity of land to previous landslides has been documented as a significant factor in assessing the susceptibility of potential for future landslides. It had been assessed that the likelihood of the nearest adjacent landslides being within a specified distance ranging between less than 50 and 2,000 m being between 49.2 and 96.7% (Quinn et al., 2011).

This pattern explains that future landslides are more likely in areas that have experienced previous landslides than in areas where no past landslides exist. This was observed by Hugenholtz (2004) in their review of Green’s Creek and the concentration of landslides to re-occur in concentrated areas along the creek alignment.

It is understood up to potentially four landslides have been documented within 2 km of the subject site and are depicted on Figure 2 for reference. Two of these landslides, Oln17 and Oln18, reported by GSC to have retrogressed into their respective sides of the incised valley of a tributary of Cardinal Creek (GSC OF8600, 2019) and located within 500 m to the southeast of the subject site.

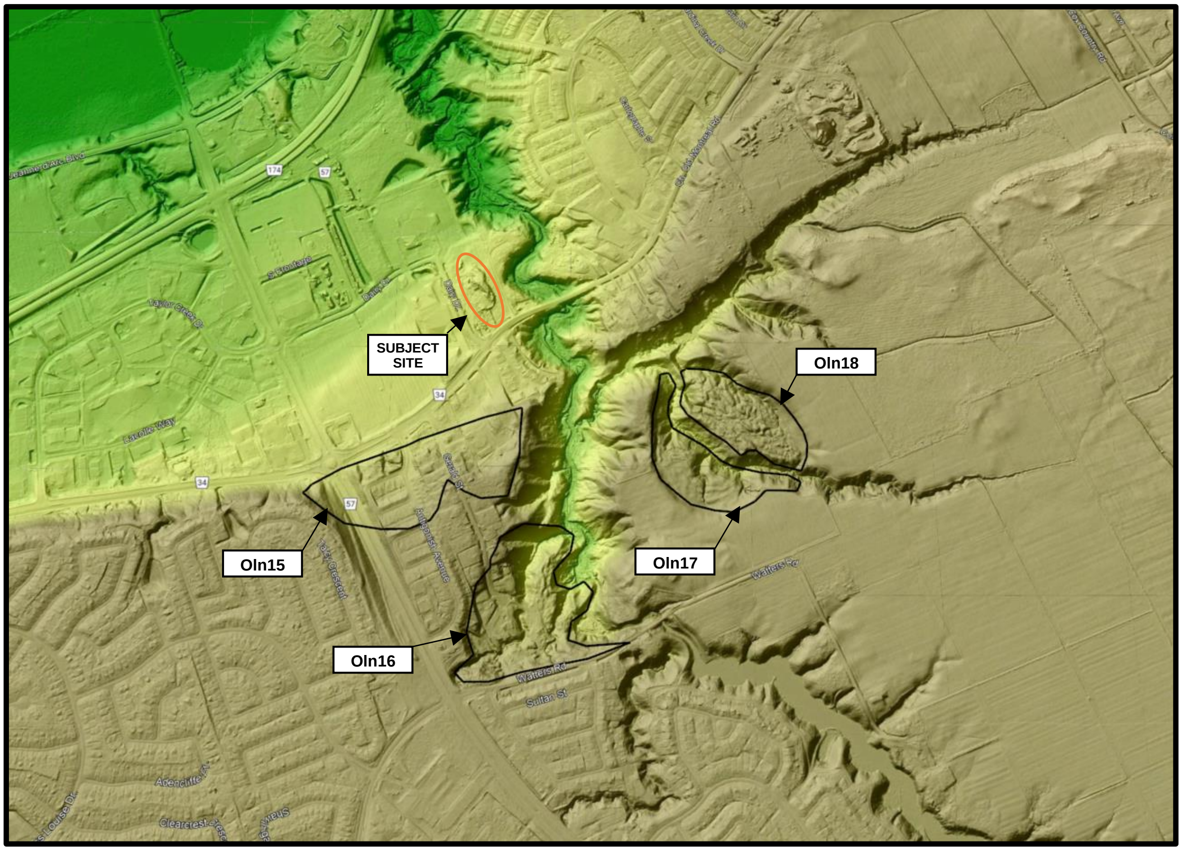

Figure 2 – LiDAR Image of Subject Site and closest landslide and slope failure.

Oln15 and Oln16 are located within 500 m southwest of the subject site. Oln15 is considered a “probable landslide” which may have retrogressed into the scarp slope above a terrace surface of the proto-Ottawa River (OF8600, 2019). The area corresponding to Oln15 experienced approximately 19 m of topographic relief and a relatively steep (i.e., over 20 degrees) slope along their flank. The areas adjacent to Oln17 and Oln18 were measured to experience up to approximately 11 degrees of slope steepness and up to 9 m of relief along their footprints.

Oln16 retrogressed into the western side of the incised valley of Cardinal Creek and has been heavily altered by urban development (OF8600). The area of Oln16 experiences approximately 14 to 16 m of topographic relief and is incised by a creek identified as having a stream order of 4 and sinuosity of 1.39 (Geomorphic Solutions, 2007).

Drift thickness throughout the areas of Oln15 and Oln16 range between 25 to 50 m. Oln17 and Oln18 have been documented by GSC OF5311 as having a drift thickness ranging between 15 to 25 m. However, drift thickness is anticipated to range between 14 to 16 m for Oln18 as based on site-specific test hole coverage.

Comparatively, Oln15 does not share parameters of susceptibility with the subject site and is not considered indicative of a higher probability for a landslide to occur throughout the subject site. However, Oln 16, Oln17 and Oln18 would generally be considered to share similar characteristics to those encountered along the slopes neighboring the subject site.

Based on our knowledge from completing geotechnical investigations for properties within the vicinity of the subject site and along the Cardinal Creek, Paterson understands there are incidents of localized slope failures along the Cardinal Creek which are likely caused by erosion. Since the subject site shares attributes with the aforementioned previous landslides and there are known incidents of slope failures throughout portions of Cardinal Creek, as the subject site would share attributes that may have contributed to the formation of the nearby landslides, it is considered appropriate to increase the baseline probability for landslides to occur throughout the subject site by one order of magnitude (i.e., multiply by a factor of 10) to account for the presence of the aforementioned local previous landslide and slope failure features.

4.2.5 Earthquakes

Earthquakes are understood to be a major contributing factor in triggering some of the largest landslides inventoried throughout Champlain Sea clay deposits. Many large landslides have been estimated to have occurred approximately 4,550 years before present (BP) and another significant cluster approximately 7,060 years BP (GSC OF7432, 2021; Aylsworth and Lawrence, 2003). The lower bound of these paleo-earthquakes have been estimated to have consisted of M5.9 to M6.0 earthquakes. Several landslides were triggered by the 1663 M7 Charlevoix and 2010 Val-des-Bois M6.2 earthquakes.

The behavior of clay slopes during earthquakes is uncertain and is a topic of current research. Current research suggests that large earthquakes can propagate failures along pre-existing or partially developed planes of weakness along the slope footprint. The critical length of the propagation is understood to be influenced by the sensitivity and fracture toughness, or brittleness, of the clay deposit (Quinn et al. 2012).

The slopes and clay deposit throughout the subject site have been subject to large historic earthquakes that may have triggered significantly large historic landslides throughout the Ottawa Valley. Earthquake-induced landslides generally occur where the potential for slope failures already exists and has generally been assessed as part of our slope stability analysis.

Pseudo-static (seismic) loading of the slope profiles considered a PGA of 0.16g and resulted in factors of safety exceeding 1.1 as discussed in Section 3.0 of this report. This PGA is considered equivalent to a 1:878-year earthquake event. It should be noted that the undrained shear strength considered for the grey clay layer within the slope profile is considered conservative given that the in-situ undrained shear strength measured throughout grey clay layer encountered throughout the subject site increases from 50 kPa where this shear strength was encountered. This value is considered suitable for assessing the stability of the subject slopes when subject to loading that may be associated with earthquakes experienced locally and considered slope inclination (i.e., up to 24 degrees for the subject slope).

Further, larger landslides are understood to be associated with clay deposits with remolded shear strength measurements equal to or less than 1 kPa (Quinn et al., 2011). It would be expected that clay deposits with such low values of remolded strength to be conducive to propagating planes of weakness and unable to resist high earthquake loads. Review of our test hole coverage indicated that remolded shear strength values typically exceed 5 kPa within the subject site and are therefore above the threshold associated with landslide susceptibility. Based on this, it is not expected a significant shear band would propagate throughout the slopes located throughout the subject site that would increase landslide susceptibility due to earthquake loading.

This conclusion may be extrapolated further to the potential for sources of subsurface vibrations such as those associated with building construction, compaction equipment, general earthworks equipment, and installation of temporary shoring. These sources of vibrations are not anticipated to exceed or be close to the magnitude of vibrations associated with the assessed earthquake load of 0.16g. Further, local hazard peak-ground acceleration values for the subject site for a 2% exceedance is considered to be 0.316, which is less than the regionally accepted value of 0.32. This suggests that the area of the subject site has a marginally reduced seismicity than would be considered for the Ottawa region in general.

Given the above, earthquake loading is not anticipated to impact landslide susceptibility, and will be considered a slightly notable factor in the calculation of the baseline probability (i.e., multiplied by a factor of 1.5).

4.2.6 Sources of Anthropogenic/Construction Vibrations

It is anticipated that the underlying clay deposit will experience vibrations from several sources during the construction phase of the proposed development. It is anticipated the proposed structures will consist of slab-on-grade construction and be serviced by relatively (i.e., by services with inverts being within 4 m of finished grade throughout the subject site) shallow site services. Further, the presence of a relatively large approximately 4 m high fill pile will be removed from the subject site as part of the earthworks program, which will also provide a notable stress relief to the underlying clay subsoils and associated slope.

Based on the above, earthworks undertaken throughout the subject site are not anticipated to result in vibrations that would be of sufficient magnitude to affect the stability of the subsoils and nearby slope supporting the subject site. General review of the area within the vicinity of the subject site indicates that while some development may have occurred within recent years, nearby parcels are vacant at the time of preparing this report and may become occupied by structures that require the use of heavy-machinery and deep foundations.

These systems could require the use of equipment to drive piles for temporary shoring systems, foundations and/or other systems such as caissons or ground improvement using high-energy compaction equipment. Therefore, while the subject site is not anticipated to undergo works that would impact landslide susceptibility, there is a potential for nearby sites to require those types of works. This would also consider the potential effects of future transit corridors that may be considered in the immediate area of the subject site that may be contemplated by the City of Ottawa.

Based on this, while the construction phase is generally considered negligible from a landslide hazard perspective given the above-noted discussion, the baseline probability will be adjusted by a factor of 3.0 to conservatively consider unknown potential effects the construction programs for sites located beyond the subject site could stress onto the subsoils

4.3 Hazard Assessment

Frequency Estimation Method

Approximately 132 individual landslides have been identified between GSC files OF8600, OF7432 and OF5311. The study area between these files considers an approximate surface area of approximately 11,800 km^2. This surface area may be decreased to approximately 6,845 km^2 when neglecting the area comprised of bedrock.

The study area was reduced accordingly to consider the absence of Champlain Sea marine deposits throughout areas of bedrock outcrops and where overburden is not present. An average landslide density of 1.9×10^{-2} per km^2 may be extrapolated from this information.

Based on the information provided in OF5311, landslides have not been recorded to have originated from areas comprised of till or glaciofluvial deposits. The study area may be therefore reduced further to approximately 5,354 km^2 and consisting of nearshore and offshore marine deposits, alluvial sediments, organic deposits, and sand dunes. The surficial deposits are considered susceptible to a landslide given their vulnerability to failure by the factors discussed in the preceding sections of this report. Based on this, the baseline landslide frequency, and probability, may be considered as 2.5×10^{-2} per km^2 throughout the study area.

The estimated density may vary notably across the study area given that many landslides generally occurred in localized clusters. The distinct clusters of landslides are likely indicative of conditions that are more conducive to landslide hazards in localized zones rather than the entire study area. However, this is considered appropriate as an average density for the purpose of this assessment.

The temporal frequency of landslide occurrence may vary substantially across the study area. OF7432 sought to carbon date 45 separate landslide features throughout the study area. The landslides interpreted by that study documented landslides having occurred potentially between approximately 90 to 7,140 years before present.

The results from the study and approximations provided by OF8600, neglecting the potential deviation and range of uncertainty, are summarized in Figure 3 below.

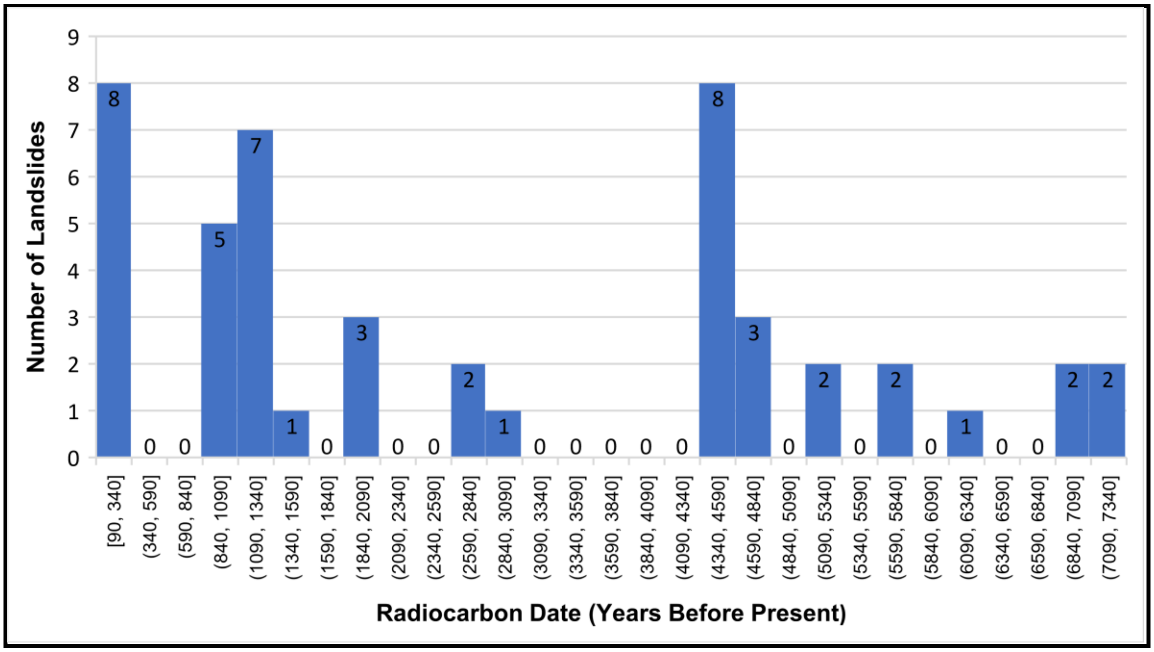

Figure 3 - Summary of Carbon-dated Landslides (GSC OF7432)

Temporal factors such as periods of increased earthquakes and climatic factors affecting these frequencies have been explored by others. Based on the above, more than half of the carbon dated landslides have occurred within the past 3,090 years, and over a quarter within the past 1,090 years.

Quinn et al. (2011) proposed a conservative lower bound of 500 years as a return period for the study area of NTS 31H. This value could be considered appropriate throughout the subject site based on the information presented above. However, the study area of NTS 31H considers a much higher density of landslides (i.e., 1,248 landslides over 75-80,000 km^2) than the study area considered for the subject site.

Based on this, a return period equivalent to the average frequency of landslides (i.e., 132 landslides over 7,140 years) provides a smaller lower bound return period of approximately one large landslide every 54.1 years. An upper bound return period of 878 years was indicated in Subsection 4.2 of this report. Then, a 54.1-year return period is within the previously defined range. With a return period of 54.1 years, a baseline landslide probability of 4.6x10^{-4} landslides per km^2 and annum is calculated over the study area defined by the GSC files. Considering the area of the subject site (approximately 25’000 m^2), this baseline probability may be reduced to a site-specific baseline probability of 1.1x10^{-5} landslide per year. The baseline estimate would be then adjusted based on our assessment of site-specific factors that are known to have resulted in large, catastrophic landslides.

Based on our review, surface relief and drift thickness are considered notable factors affecting landslide susceptibility, as discussed in Subsection 4.2.2 of this report. Hugenholtz (2004) observed in their review of Green's Creek that the concentration of landslides to re-occur throughout concentrated areas along the creek alignment. They had observed as many as 52 landslides of varying sizes and classes over the period of 1928 and 2001 (73 years) using digital photogrammetric techniques. The conditions observed throughout Green's Creek are considered comparable to the area of Cardinal Creek nearby the subject site, and an example of the potential for more frequent smaller-scale landslides beyond the larger-scale retrogressive slides that are more readily identified. Given this, a return period of one tenth of the large landslide return-period (i.e., 5.4-year return period) is considered appropriate for the relief and drift thickness variables throughout the subject site.

Based on our review of site-specific factors identified throughout this report, additional factors have been considered for adjusting the baseline probability to provide a site-specific landslide probability. Table 8 presents a summary of the above-noted Ottawa-wide probability being reduced to a site-specific probability, omitting the factors associated with drift thickness and topographic relief (which are summarized in the preceding paragraphs).

Table 8 – Summary of Site-Specific Baseline Probability Modification Factors

Baseline Probability for Landslide to Occur Throughout Subject Site	1.1×10^{-5}
Section 4.2.1. Factor – Clay Overburden Sensitivity	4.0
Section 4.2.2. Factor – Slope Inclination, Overburden Thickness and Topographic Relied	
Slope Inclination	1.5
Overburden Thickness	Estimated in Subsequent Tables
Topographic Relief	
Section 4.2.3. Factor – Groundwater Conditions and Toe Erosion	4.0
Section 4.2.4. Factor – Proximity to Landslides and Slope Failures	10.0
Section 4.2.5 Factor – Earthquakes	1.5
Section 4.2.6 Factor – Anthropogenic Factors	3.0
Modified Site-Specific Baseline Probability (Not Considering Drift Thickness and Surface Relief Factors)	**1.2×10^{-2}**

The probabilities for landslides to occur throughout the subject site considering drift thickness (Table 9) and surface relief (Table 10) are estimated accordingly in Table 11 and calculated by multiplying the values tabulated in Table 9 and Table 10, and the modified probability presented in Table 8.

Table 9 – Summary of Drift Thickness Throughout Historic Landslide Footprints

Drift Thickness (m)	Number of Incidences	%	Probability (5.4-year return period, cumulative)
0 to 10	8	7.0	0.13
10 to 15	7	6.1	0.024
15 to 25	34	29.8	0.079
25 to 50	49	43.0	0.159

Table 10 – Summary of Surface Relief Throughout Historic Landslide Footprints

Surface Relief (m)	Number of Incidences	%	Probability (5.4-year return period, cumulative)
0 to 4	0	0.0	0.005
4 to 6	0	0.0	0.008
6 to 8	1	0.9	0.011
8 to 10	2	1.8	0.021
10 to 12	0	0.0	0.034
12 to 14	2	1.8	0.053
14 to 16	0	0.0	0.079
16 to 18	2	1.8	0.092
18 to 20	3	2.7	0.100
20 to 25	3	2.7	0.135

Table 11 – Estimate of Site-Specific Landslide Probability

Surface Relief (m)	Drift Thickness (m)
	0 to 50
0 to 4	N/A
4 to 6	N/A
6 to 8	**1:44,503**
8 to 10	**1:23,963**

Note: Bolded text and greyed out cells are considered reflective of site-specific conditions.
The above-noted values are considered in units of landslide per annum.

Based on our assessment, the probability for a landslide to occur throughout the subject site has been estimated to range between **1:44,503 and 1:23,963 per year** (product of baseline probability and probability of landslide occurrence based on cumulative drift thickness up to 50 m and probability based on cumulative surface relief up to 10 m). Based on the above, the annual probability of a large landslide occurring at or directly impacting the subject site is estimated to be less than 1:10,000 per year.

5.0 Conclusion

In summary, 2 self-storage two-storey buildings and 2 sets of industrial condominiums are currently being proposed to occupy the subject site. Several pre-historic landslide events are understood to have taken place in proximity to the subject site.

Field investigations and reconnaissance carried out by Paterson through the ravine located east of the subject site did not indicate significant signs of movement, activity, or cause of concern with respect to landslide susceptibility. The area was also reviewed by means of available published literature of the surrounding inventory, research and studies completed by others specializing in the field of earthquakes, landslides, and geology.

Using a combination of the above and our experience with sites of similar geology throughout the Ottawa region, the annual probability of a large catastrophic landslide occurring at or directly impacting the subject site is estimated to be less than 1:10,000-per year. Based on our interpretation of the information available to carry out this assessment, the subject site is considered safe and suitable for consideration of the proposed development.

6.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project and the applicable guidelines.

A geotechnical investigation of this nature is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations.

The extent of the limited area depends on the soil, bedrock, and groundwater conditions, as well the history of the site reflecting natural, construction, and other activities. Should any conditions at the site be encountered which differ from those at the test locations, we request notification immediately in order to permit reassessment of our recommendations.

The assessments provided in this report are intended for the use of design professionals associated with this project. The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than TSL-Dairy INC. or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Fernanda Carozzi, PhD. Geoph.

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June 10, 2024

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Report Distribution:

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7.0 Literature References

[1] APEGBC, 2010, Guidelines for legislated landslide assessments for proposed residential developments in BC: Technical report, Association of Professional Engineers and Geoscientists of British Columbia.

[2] Aylsworth, J., and D. Lawrence, 2002, Earthquake-induced land sliding east of Ottawa; a contribution to the Ottawa Valley landslide project: Presented at the Geohazards 2003, 3rd Canadian Conference on Geohazards and natural Hazards; Edmonton, Alberta; June 9-10, 2003, Canadian Geotechnical Society.

[3] Bélanger, R., 2008, Urban geology of the National Capital area: Geological Survey of Canada, Open File 5311.

[4] Bobrowsky, P., and R. Couture, 2012, Canadian technical guidelines and best practices related to landslides: a national initiative for loss reduction: Geological Survey of Canada, Open File 7312.

[5] Brooks, G., B. Medioli, J. Aylsworth, and D. Lawrence, 2021, A compilation of radiocarbon dates relating to the age of sensitive clay landslide is in the Ottawa valley, Ontario-Quebec: Geological Survey of Canada, Open File 7432.

[6] Fransham, P., and N. Gadd, 1977, Geological and geomorphological controls of landslides in Ottawa valley, Ontario: Canadian Geotechnical Journal, 14, 531–539.

[7] Hugenholtz, Chris., and Lacelle, Denis, 2004, Geomorphic Controls on Landslide Activity in Champlain Sea Clays along Green’s Creek, Eastern Ontario, Canada: Géographie physique at Quartenaire, 58(1), 9-23.

[8] Mitchell, R., and Markell, A., 1974, Flowsliding in Sensitive Soils: Canadian Geotechnical Journal, 11, 11-31.

[9] Perret, Didier, 2019, Influence of surficial crusts on the development of spreads and flows in Eastern Canadian sensitive clays: Presented at the 72nd Canadian Geotechnical Conference in St-John’s, Newfoundland and Labrador, Canada, Natural Resources Canada, Geological Survey of Canada.

[10] Quinn, Peter Eugene, 2009, Large Landslides in Sensitive Clay in Eastern Canada and the Associated Hazard and Risk to Liner Infrastructure, Queen’s University.

[11] Quinn, P.E., Hutchinson, D.J., Diederichs, M.S., Rowe, R.K., 2010, Regional-scale landslide susceptibility mapping using the weights of evidence method: an example applied to linear infrastructure: Canadian Geotechnical Journal,47, 905-927.

[12] Quinn, P.E., Hutchinson, D.J., Diederichs, M.S., Rowe, R.K., 2011, Characteristics of large landslides in sensitive clay in relation to susceptibility, hazard, and risk: BGC Engineering in Ottawa Ontario and Canadian Geotechnical Journal, 48, 1212-1232.

[13] Quinn, Peter E., 2014, Landslide susceptibility in sensitive clay in eastern Canada: some practical considerations and results in development of an improved model: International Journal of Image and Data Fusion, Volume 5, No 1, 70-96.

[14] L'Heureux, J.-S., Demers, D. 2014, Landslides in Sensitive Clays: From Geosciences to Risk Management, Advances in Natural and technological Hazards Research 36, 77-88.

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

BOREHOLE LOGS BY OTHERS

GRAIN-SIZE DISTRIBUTION TESTING RESULTS

ATTERBERG LIMITS TESTING RESULTS

EARTHQUAKES CANADA SEISMIC HAZARD (NBCC 2015)

TABLE 1 - SUMMARY OF REVIEWED LANDSLIDE INVENTORY DATA

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1045 Dairy Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE December 8, 2022

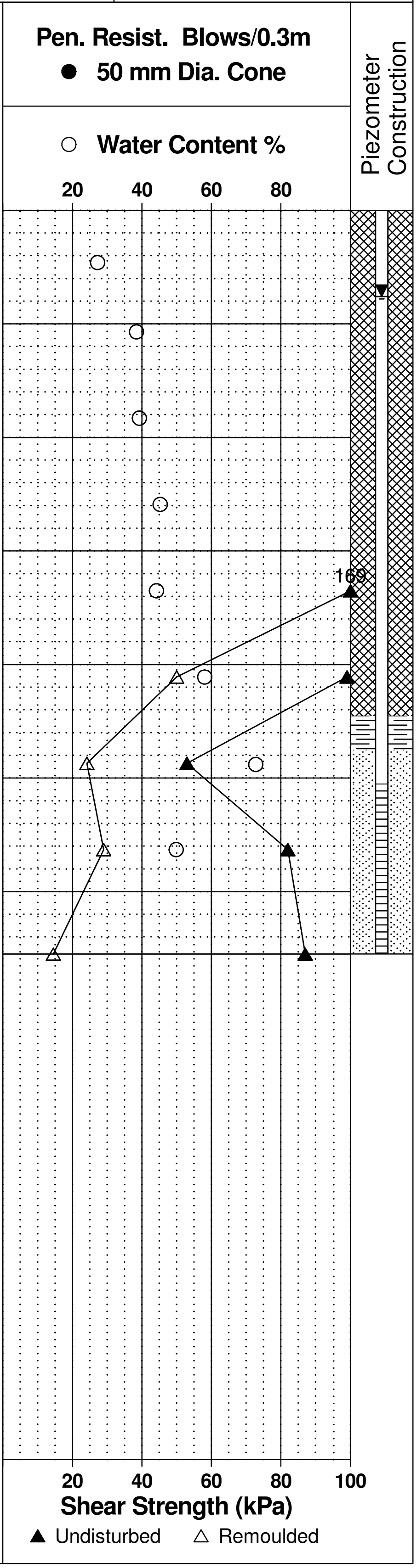
FILE NO. PG6498

HOLE NO. BH 1-22

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
TOPSOIL	0.28
Hard to very stiff, brown **SILTY CLAY** - stiff and grey by 4.5m depth	6.55
End of Borehole (GWL @ 0.76m - Dec. 14, 2022)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	12
SS	3	83	14
SS	4	75	7
SS	5	88	P
SS	6	83	P
SS	7	83	P
G	8		

DEPTH (m)	ELEV. (m)
0	58.74
1	57.74
2	56.74
3	55.74
4	54.74
5	53.74
6	52.74



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1045 Dairy Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

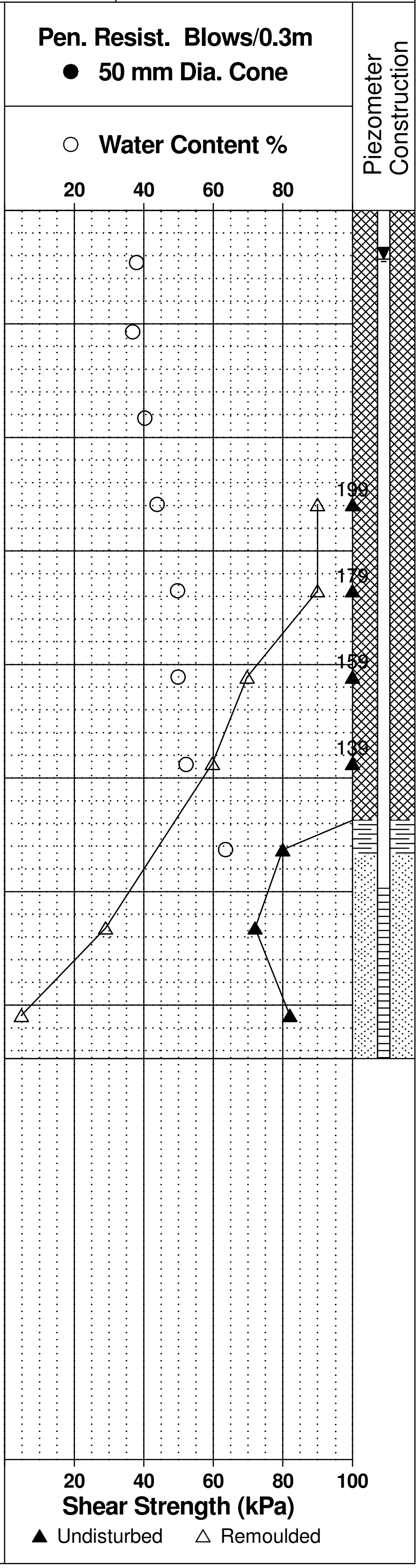
BORINGS BY CME-55 Low Clearance Drill

DATE December 8, 2022

FILE NO. **PG6498**

HOLE NO. **BH 2-22**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	59.42
TOPSOIL 0.30						
	AU	1				
	SS	2	75	12	1	58.42
	SS	3	83	11	2	57.42
	SS	4	67	P	3	56.42
Hard to very stiff, brown **SILTY CLAY**	SS	5	75	P	4	55.42
	SS	6	71	P	5	54.42
	SS	7	79	P		
- stiff and grey by 5.3m depth	G	8			6	53.42
					7	52.42
7.47						
End of Borehole (GWL @ 0.43m - Dec. 14, 2022)						



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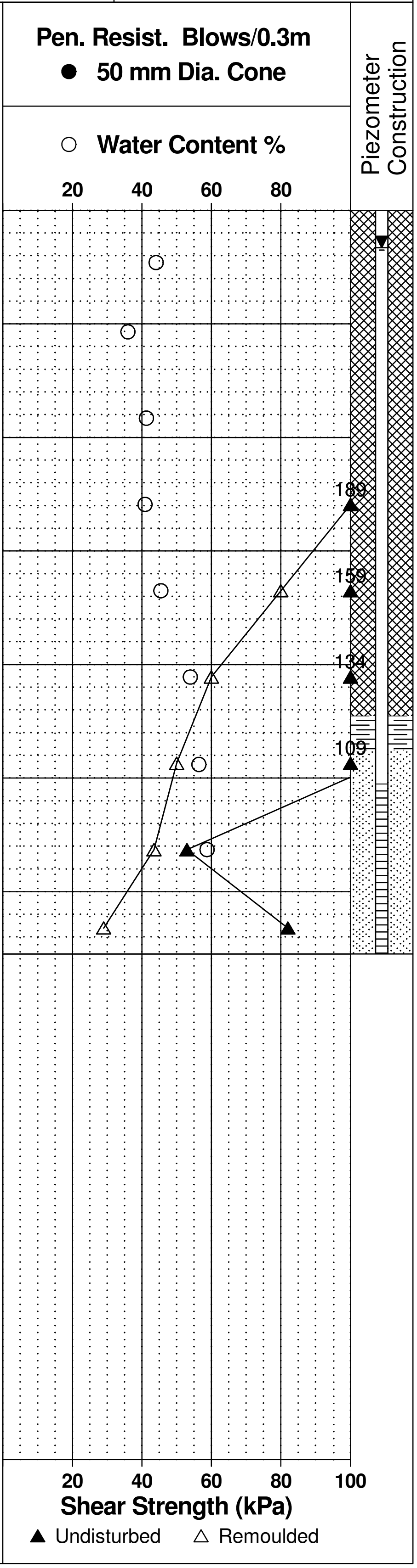
SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1045 Dairy Drive
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY CME-55 Low Clearance Drill
DATE December 8, 2022
FILE NO. **PG6498**
HOLE NO. **BH 3-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	62.41
TOPSOIL 0.25							
		AU	1				
		SS	2	100	13	1	61.41
		SS	3	100	12	2	60.41
Hard to very stiff, brown **SILTY CLAY**		SS	4	100	P		
		SS	5	100	P	3	59.41
		SS	6	100	P	4	58.41
- very stiff to stiff and grey by 4.5m depth		SS	7	100	P	5	57.41
		G	8			6	56.41
6.55							
End of Borehole (GWL @ 0.33m - Dec. 14, 2022)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE December 8, 2022

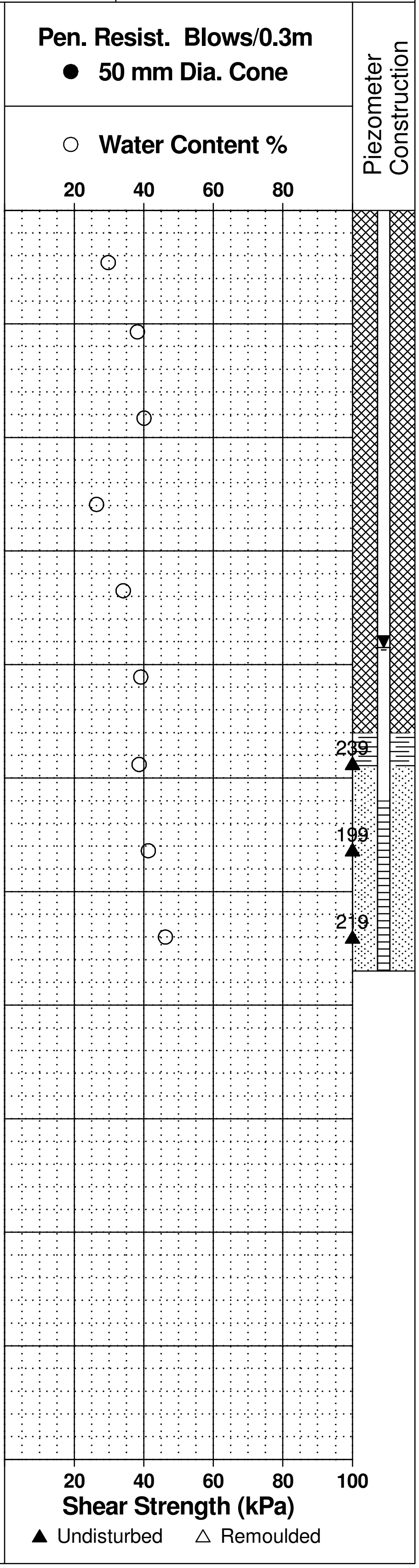
FILE NO. PG6498

HOLE NO. BH 4-22

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.20
FILL: Brown to grey silty clay, some organics, trace sand	2.97
Hard, brown **SILTY CLAY**	6.71
Dynamic Cone Penetration Test commenced at 6.71m depth. Cone pushed to 28.65m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	17	4
SS	3	25	4
SS	4	54	9
SS	5	75	12
SS	6	67	15
SS	7	75	P
SS	8	83	P
SS	9	75	P

DEPTH (m)	ELEV. (m)
0	63.66
1	62.66
2	61.66
3	60.66
4	59.66
5	58.66
6	57.66
7	56.66
8	55.66
9	54.66
10	53.66
11	52.66



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1045 Dairy Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

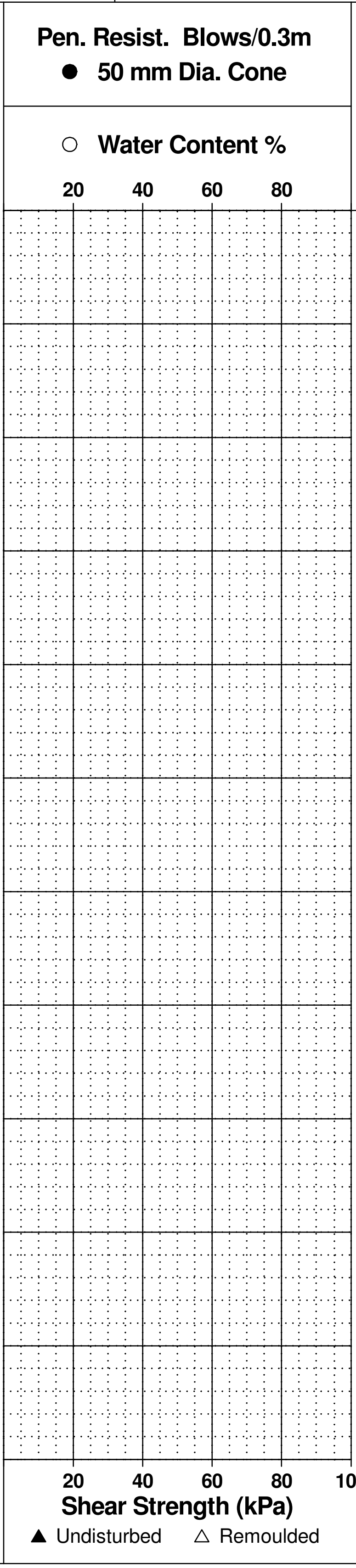
BORINGS BY CME-55 Low Clearance Drill

DATE December 8, 2022

FILE NO. PG6498

HOLE NO. BH 4-22

SOIL DESCRIPTION GROUND SURFACE	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
Dynamic Cone Penetration Test commenced at 6.71m depth. Cone pushed to 28.65m depth.						11	52.66	
						12	51.66	
						13	50.66	
						14	49.66	
						15	48.66	
						16	47.66	
						17	46.66	
						18	45.66	
						19	44.66	
						20	43.66	
						21	42.66	
						22	41.66	



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1045 Dairy Drive
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DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

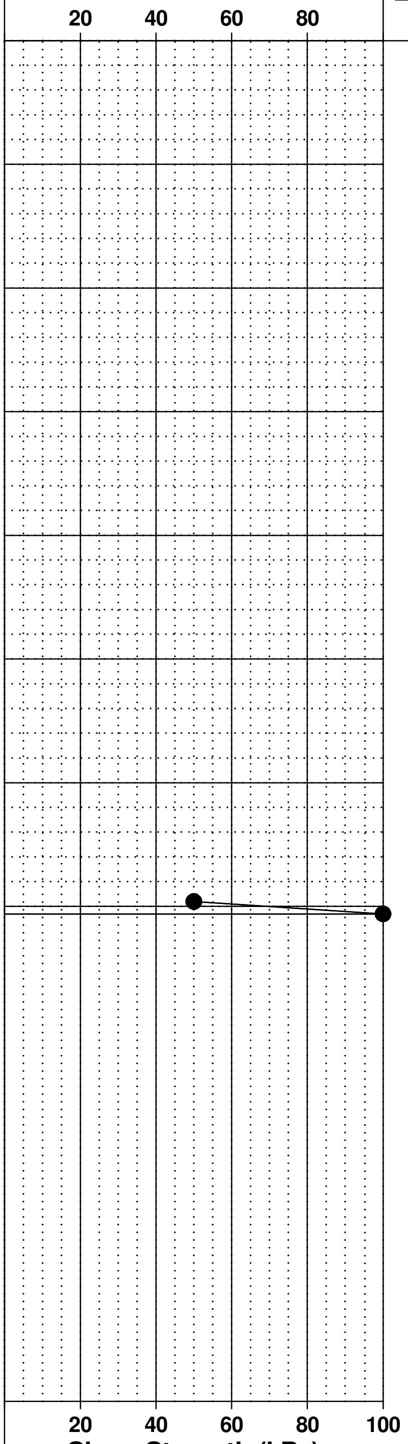
DATE December 8, 2022

FILE NO. PG6498

HOLE NO. BH 4-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 6.71m depth. Cone pushed to 28.65m depth.						22	41.66
						23	40.66
						24	39.66
						25	38.66
						26	37.66
						27	36.66
						28	35.66
29.06						29	34.66
End of Borehole Practical DCPT refusal at 29.06m depth. (GWL @ 3.85m - Dec. 14, 2022)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1015-1045 Dairy Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

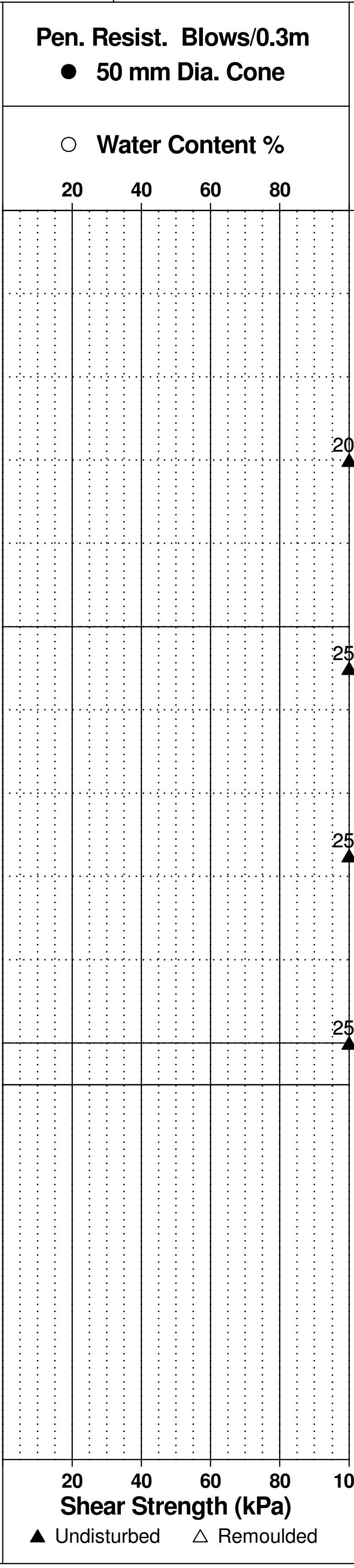
BORINGS BY Backhoe

DATE December 9, 2022

FILE NO. PG6498

HOLE NO. TP 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	59.41
TOPSOIL 0.08	■						
FILL: Brown silty clay, trace to some organics, trace gravel 0.32	▨	G	1				
Hard, brown **SILTY CLAY**	▨	G	2				
		G	3			1	58.41
2.10		G	4			2	57.41
End of Test Pit (Groundwater infiltration at 0.4m depth)							



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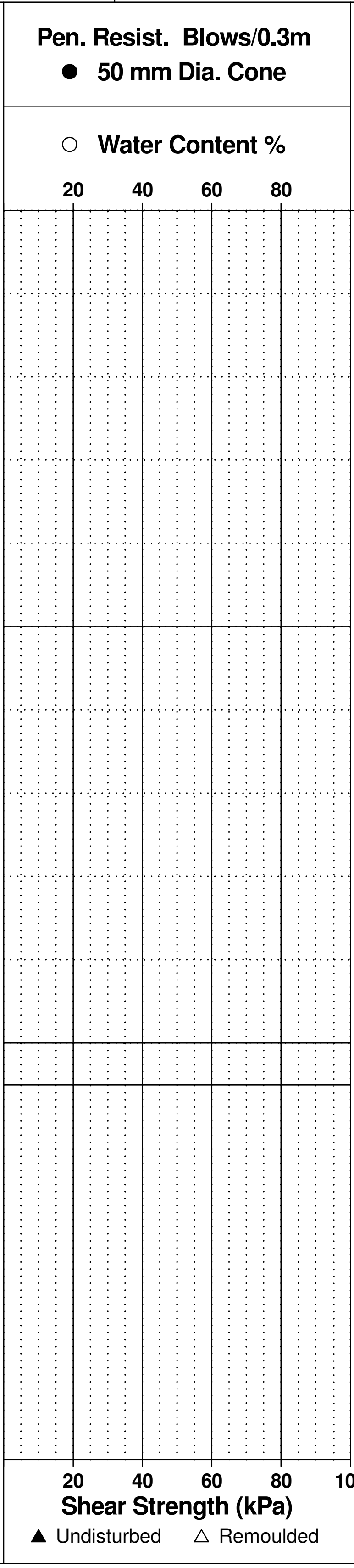
SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1015-1045 Dairy Drive
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY Backhoe
DATE December 9, 2022
FILE NO. PG6498
HOLE NO. TP 2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	61.70	
TOPSOIL 0.10								
FILL: Brown silty clay, trace organics 0.60		G	1					
FILL: Brown silty clay, trace to some organics, trace gravel		G	2			1	60.70	
1.27		G	3					
FILL: Grey silty clay, some topsoil		G	4					
		G	5			2	59.70	
2.10								
End of Test Pit (TP dry upon completion)								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1015-1045 Dairy Drive
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REMARKS

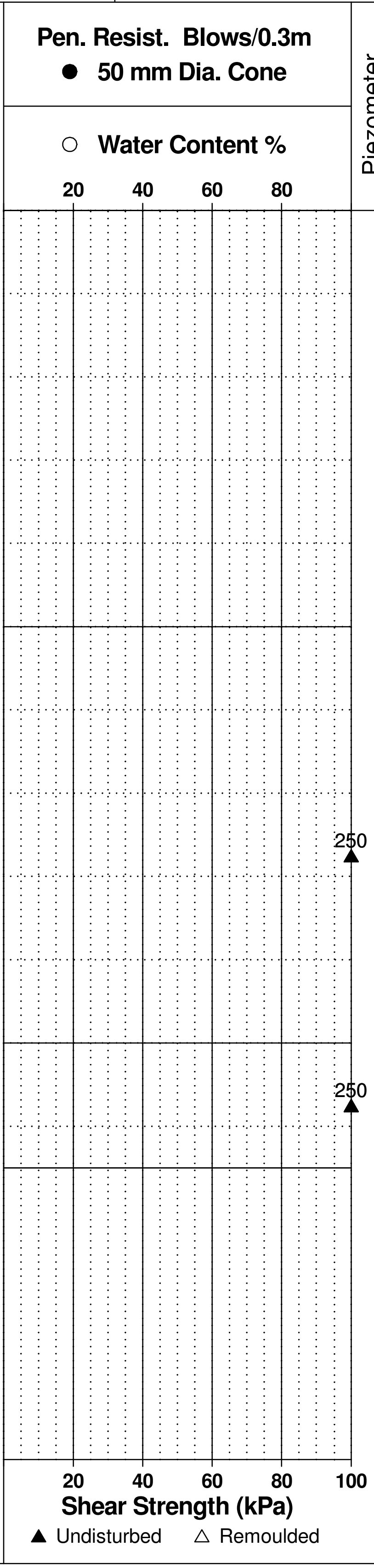
BORINGS BY Backhoe

DATE December 9, 2022

FILE NO. PG6498

HOLE NO. TP 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	61.34
TOPSOIL 0.09							
FILL: Brown silty clay, trace organics 0.40		G	1				
FILL: Grey silty clay with crushed stone, trace topsoil 1.00		G	2			1	60.34
FILL: Brown silty clay, some gravel, trace gravel 1.30		G	3				
Hard, brown **SILTY CLAY** 2.30		G G	4 5			2	59.34
End of Test Pit (Groundwater infiltration at 1.3m depth)							



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1015-1045 Dairy Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

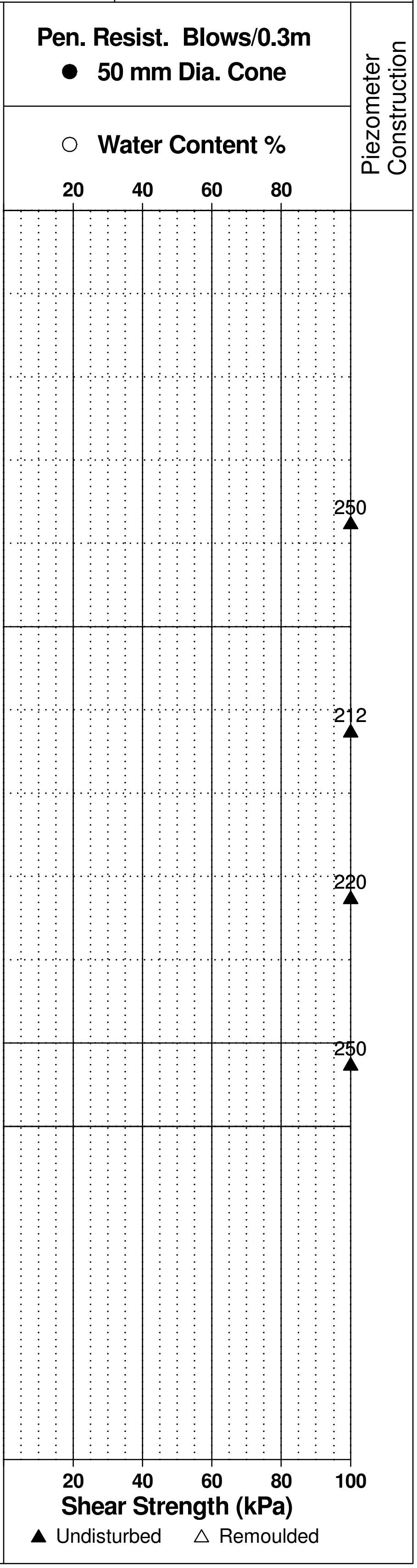
BORINGS BY Backhoe

DATE December 9, 2022

FILE NO. **PG6498**

HOLE NO. **TP 4-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	62.24
TOPSOIL 0.13	■						
FILL: Crushed stone, some organics 0.60	▩	G	1				
Hard, brown **SILTY CLAY,** trace organics 2.20	▨	G G	2 3			1 2	61.24 60.24
End of Test Pit (Groundwater infiltration at 1.5m depth)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1015-1045 Dairy Drive
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DATUM Geodetic

REMARKS

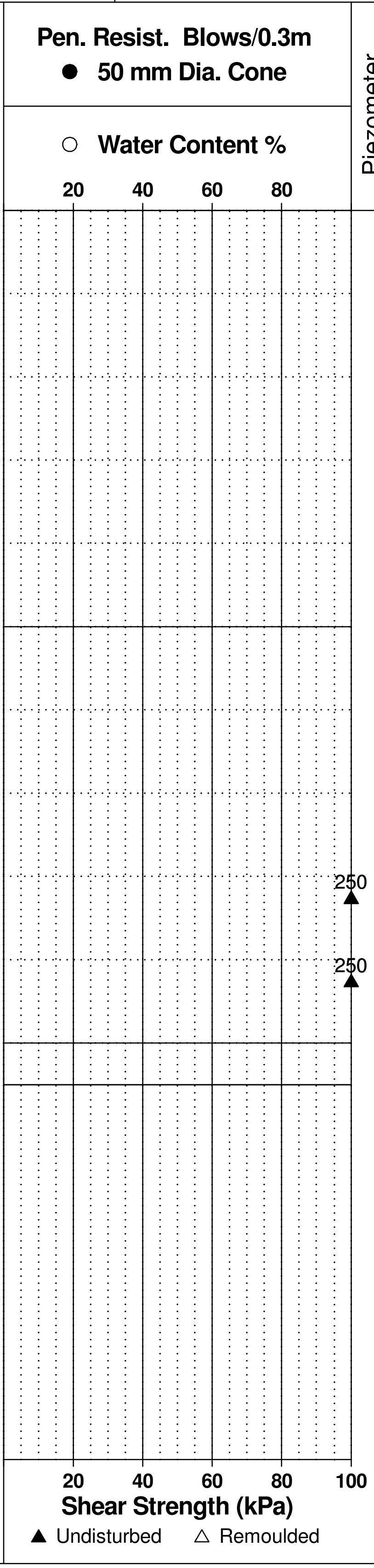
BORINGS BY Backhoe

DATE December 9, 2022

FILE NO. PG6498

HOLE NO. TP 5-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	62.73
TOPSOIL 0.10							
FILL: Brown silty clay, some organics		G	1				
		G	2				
						1	61.73
		G	3				
1.50							
Hard, brown **SILTY CLAY**		G	4				
						2	60.73
2.10							
End of Test Pit (TP dry upon completion)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1015-1045 Dairy Drive
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REMARKS

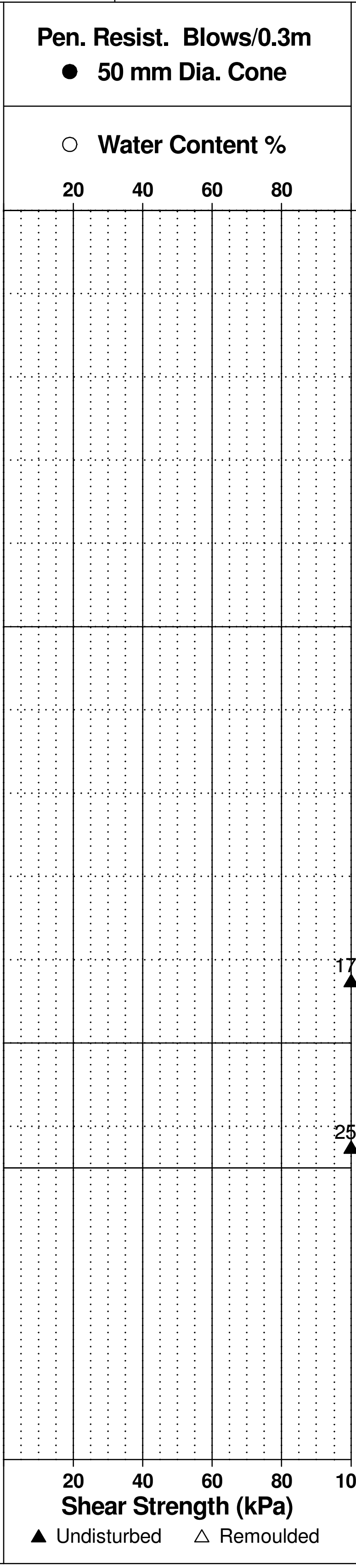
BORINGS BY Backhoe

DATE December 9, 2022

FILE NO. PG6498

HOLE NO. TP 6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	63.30	
TOPSOIL 0.10	■							
	▨	G	1					
	▨	G	2					
FILL: Brown silty clay, trace organics	▨							
	▨					1	62.30	
1.60	▨							
	▨	G	3					
Hard to very stiff, brown **SILTY CLAY**	▨							
	▨					2	61.30	
2.30	▨	G	4					
End of Test Pit (Groundwater infiltration at 1.7m depth)								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1015-1045 Dairy Drive
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REMARKS

BORINGS BY Backhoe

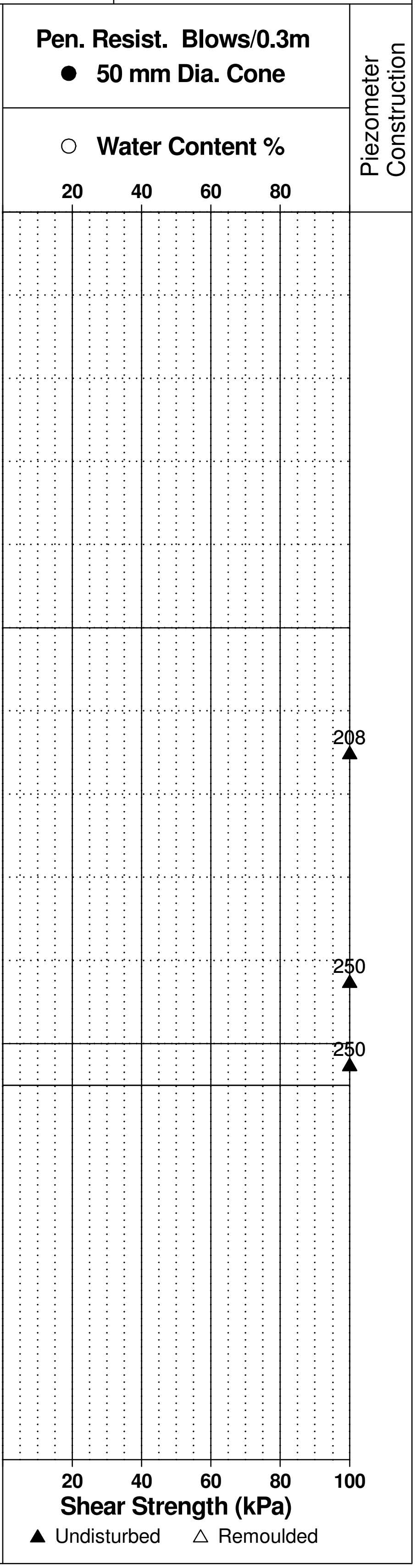
DATE December 9, 2022

FILE NO. PG6498

HOLE NO. TP 7-22

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.09				
FILL: Brown silty clay, trace to some topsoil	0.90	G G	1 2		
Very stiff to hard, brown **SILTY CLAY**	2.10	G G	3 4		
End of Test Pit (TP dry upon completion)					

DEPTH (m)	ELEV. (m)
0	62.88
1	61.88
2	60.88



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Self-Storage Facility - 1015-1045 Dairy Drive
Ottawa, Ontario

DATUM Geodetic

REMARKS

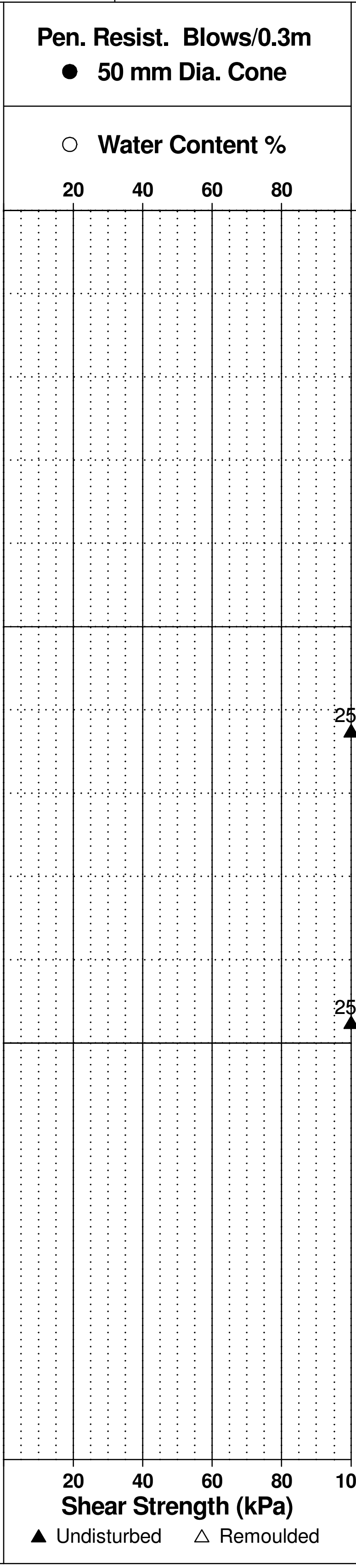
BORINGS BY Backhoe

DATE December 9, 2022

FILE NO. PG6498

HOLE NO. TP 8-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	61.51	
TOPSOIL 0.10								
FILL: Brown to grey silty clay, trace organics		G G G	1 2 3					
1.10						1	60.51	
Hard, brown **SILTY CLAY**		G	4					
2.00						2	59.51	
End of Test Pit (TP dry upon completion)								



SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	‘N’ Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	**ROCK QUALITY**
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic limit, % (water content above which soil behaves plastically)
PI - Plasticity index, % (difference between LL and PL)

Dxx - Grain size which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = $D60 / D10$

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

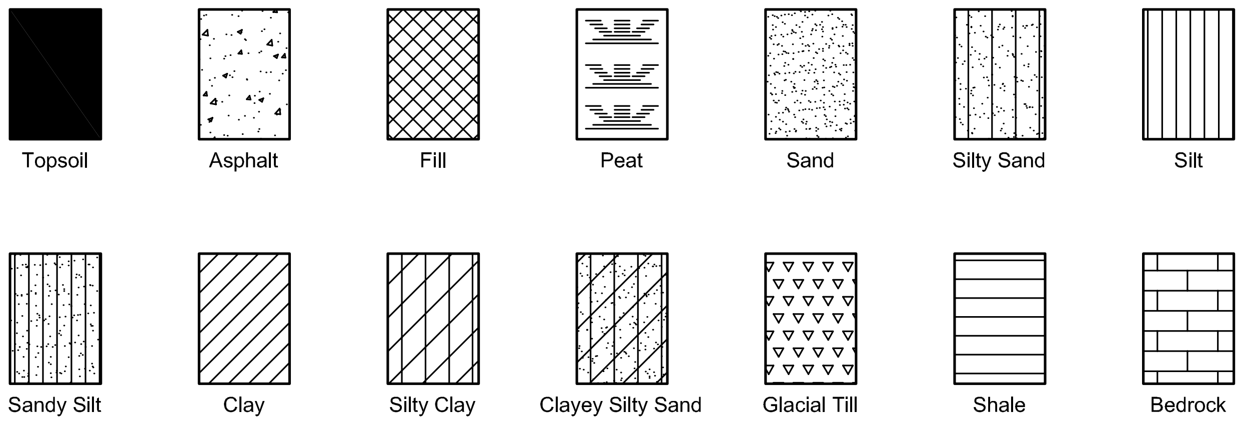
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

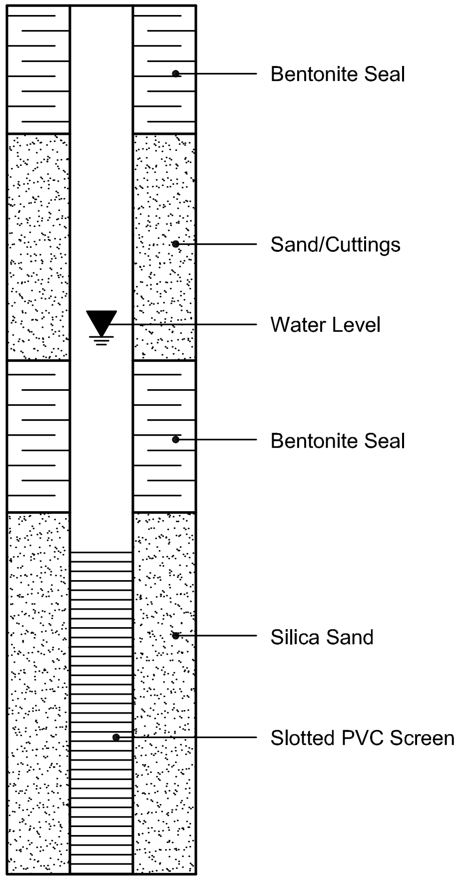
SYMBOLS AND TERMS (continued)

STRATA PLOT

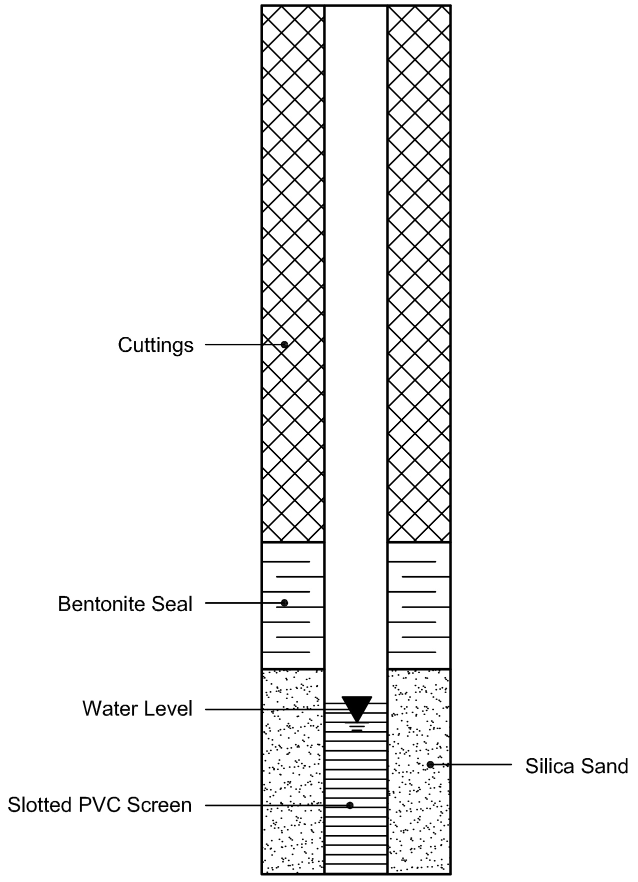


MONITORING WELL AND PIEZOMETER CONSTRUCTION

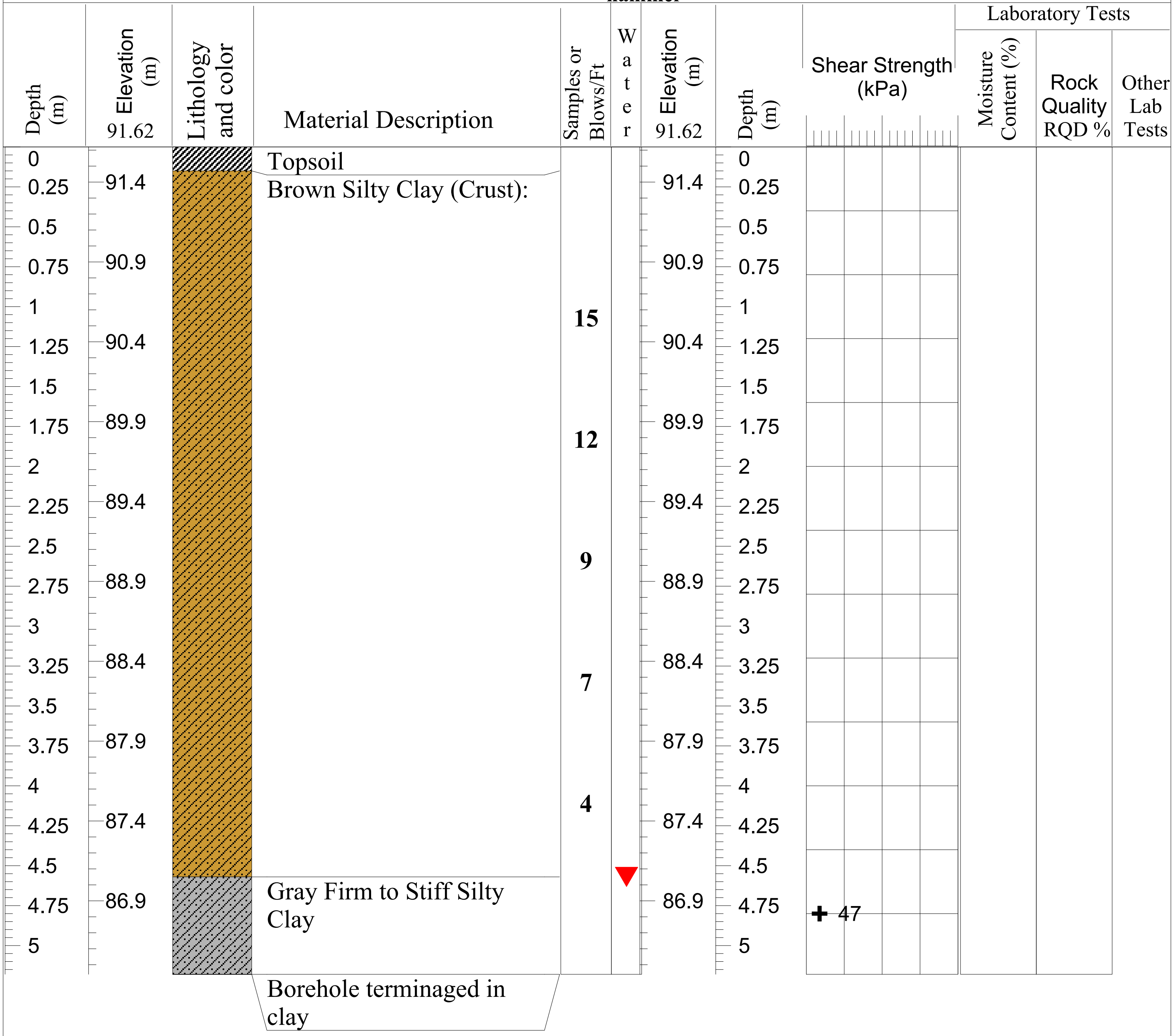
MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Project: **Proposed Industrial Building**		YME Yuri Mendez Engineering.
Location: **1045 Dairy Dr.**	Client: **Versatek Building Inc.**	**Test Hole No.: BH1 of 5**
Job No.: **42-BM**	Test Hole Type: **7" OD Auger.**	Date: **Feb. 11, 2019**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**



Topsoil

Brown Silty Clay (Crust):

Gray Firm to Stiff Silty Clay

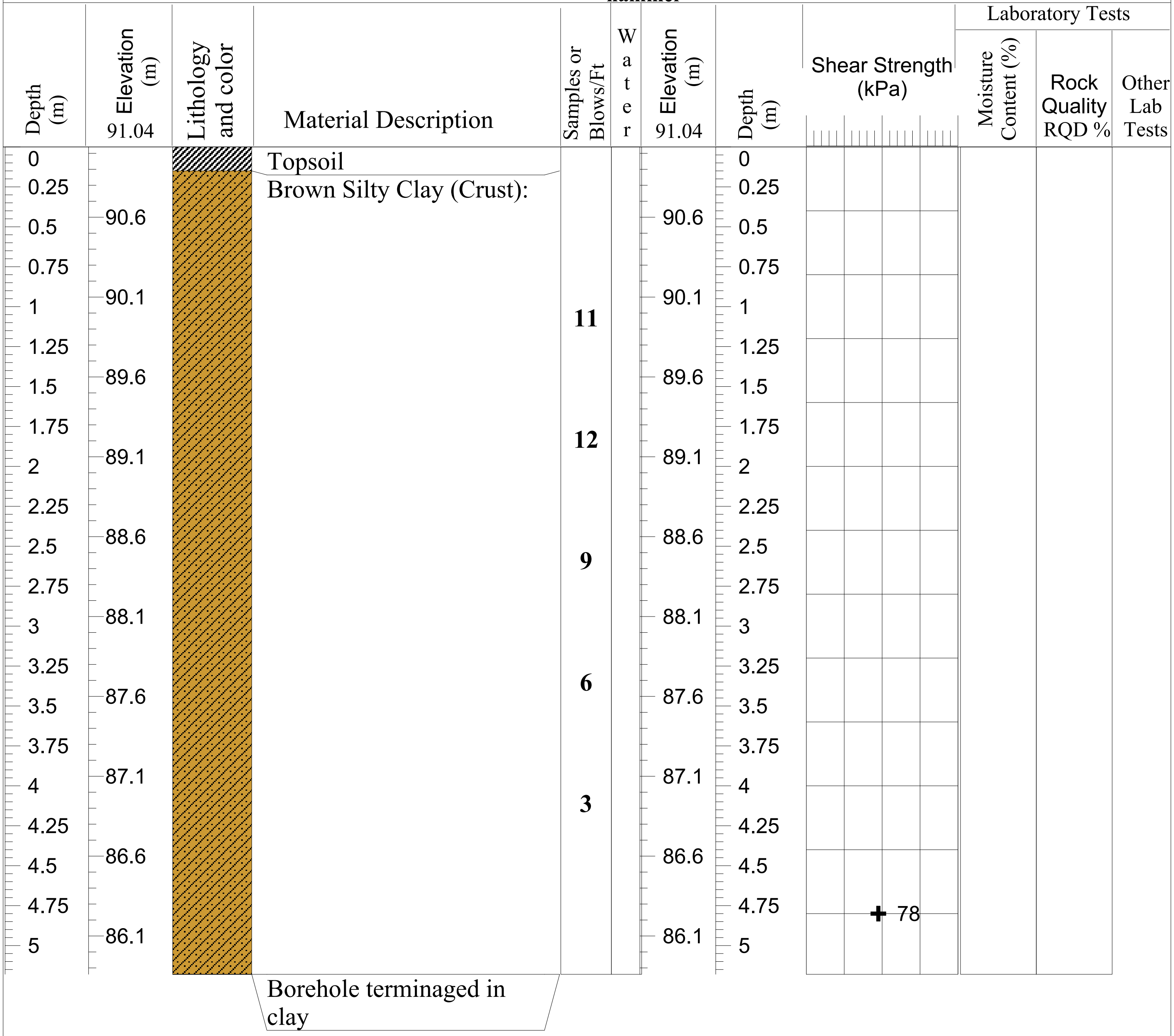
Borehole terminaged in clay

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Industrial Building**		YME Yuri Mendez Engineering.
Location: **1045 Dairy Dr.**	Client: **Versatek Building Inc.**	**Test Hole No.: BH2 of 5**
Job No.: **42-BM**	Test Hole Type: **7" OD Auger.**	Date: **Feb. 11, 2019**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

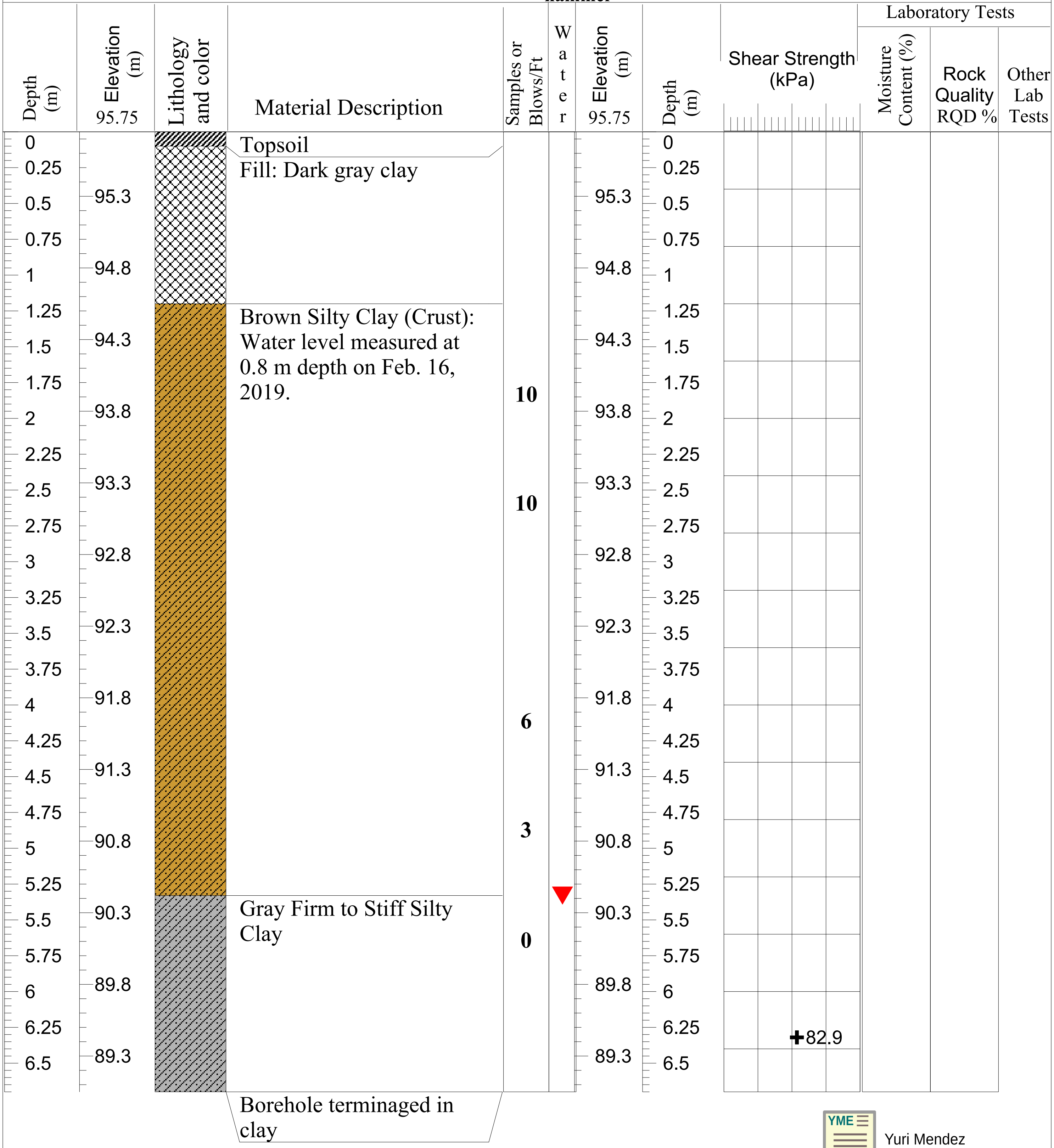


Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project:	**Proposed Industrial Building**	YME Yuri Mendez Engineering.
Location: **1045 Dairy Dr.**	Client: **Versatek Building Inc.**	**Test Hole No.: BH3 of 5**
Job No.: **42-BM**	Test Hole Type: **7" OD Auger.**	Date: **Feb. 11, 2019**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**



Topsoil

Fill: Dark gray clay

Brown Silty Clay (Crust): Water level measured at 0.8 m depth on Feb. 16, 2019.

Gray Firm to Stiff Silty Clay

Borehole terminaged in clay

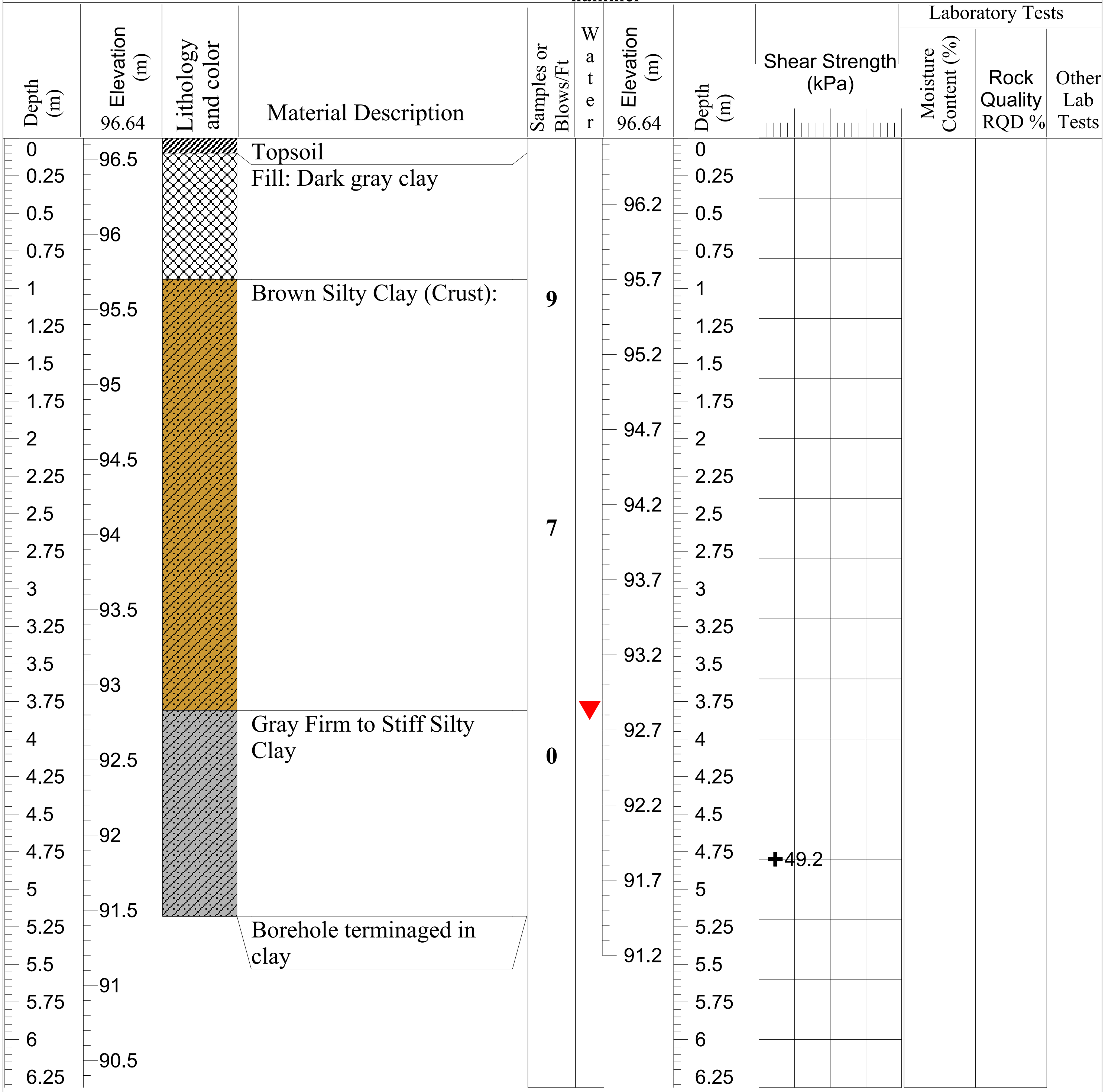
YME

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Industrial Building**		YME Yuri Mendez Engineering.
Location: **1045 Dairy Dr.**	Client: **Versatek Building Inc.**	**Test Hole No.: BH4 of 5**
Job No.: **42-BM**	Test Hole Type: **7" OD Auger.**	Date: **Feb. 11, 2019**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

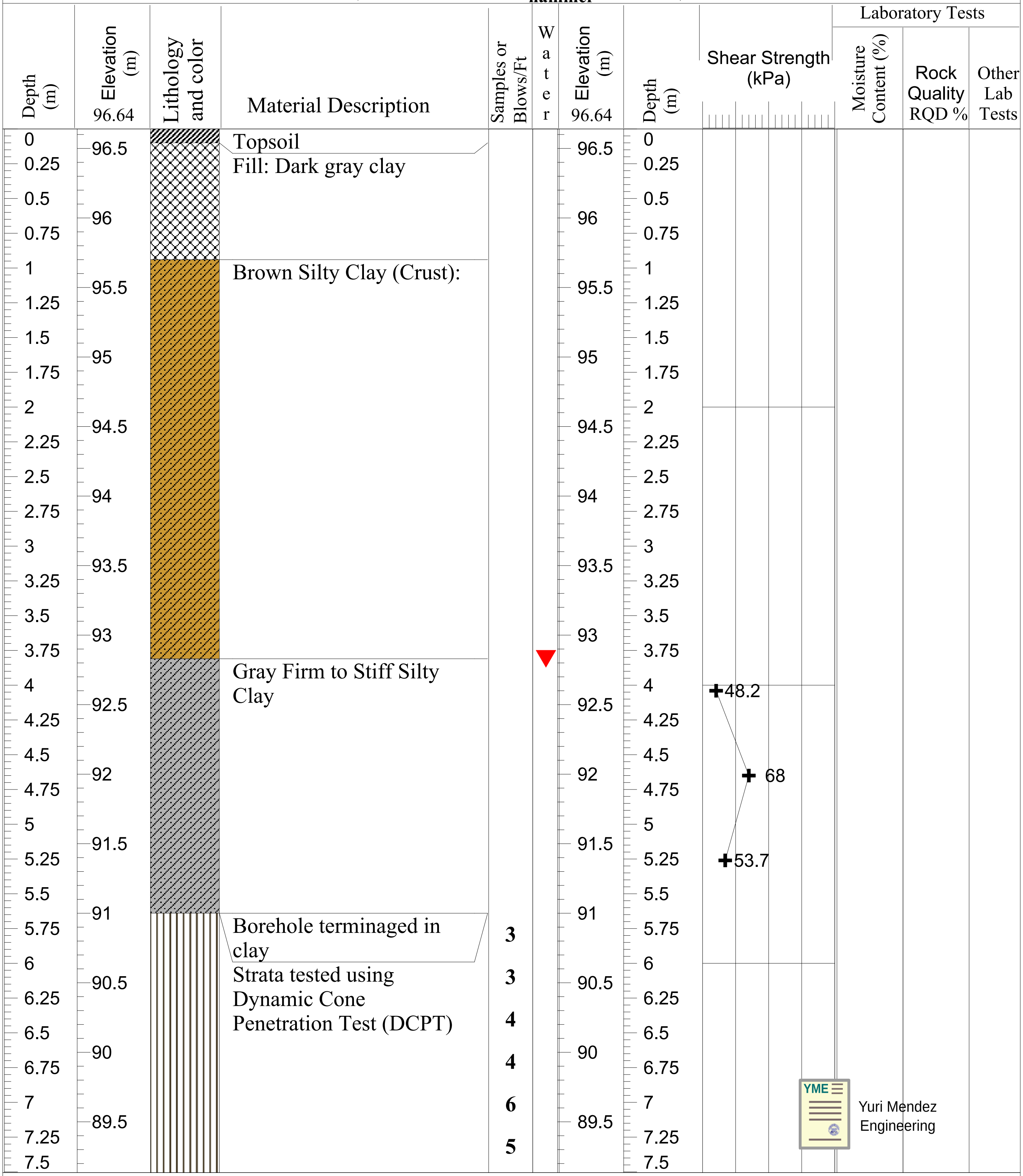


Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Industrial Building**		YME Yuri Mendez Engineering.
Location: **1045 Dairy Dr.**	Client: **Versatek Building Inc.**	**Test Hole No.: BH4-B of 5**
Job No.: **42-BM**	Test Hole Type: **7" OD Auger.**	Date: **Feb. 11, 2019**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**



Topsoil

Fill: Dark gray clay

Brown Silty Clay (Crust):

Gray Firm to Stiff Silty Clay

Borehole terminaged in clay

Strata tested using Dynamic Cone Penetration Test (DCPT)

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Industrial Building**

YME Yuri Mendez Engineering.

Location: **1045 Dairy Dr.**

Client: **Versatek Building Inc.**

Test Hole No.: BH4-B of 5

Job No.: **42-BM**

Test Hole Type: **7" OD Auger.**

Date: **Feb. 11, 2019**

"7" OD Auger."

SPT Hammer Type: **Safety auto hammer**

Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 96.64	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 96.64	Depth (m)	Shear Strength (kPa)	Laboratory Tests Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
7.5 7.75 8 8.25 8.5 8.75 9 9.25 9.5 9.75 10 10.25 10.5 10.75 11 11.25 11.5 11.75 12 12.25 12.5 12.75 13 13.25 13.5 13.75 14 14.25 14.5 14.75 15	89 88.5 88 87.5 87 86.5 86 85.5 85 84.5 84 83.5 83 82.5 82		Strata tested using Dynamic Cone Penetration Test (DCPT)	**6** **6** **6** **9** **8** **13** **8** **7** **12** **12** **11** **12** **12** **16** **13** **14** **13** **13** **17** **16** **13** **15** **13** **18** **17**		89 88.5 88 87.5 87 86.5 86 85.5 85 84.5 84 83.5 83 82.5 82	7.5 7.75 8 8.25 8.5 8.75 9 9.25 9.5 9.75 10 10.25 10.5 10.75 11 11.25 11.5 11.75 12 12.25 12.5 12.75 13 13.25 13.5 13.75 14 14.25 14.5 14.75 15				

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Industrial Building**		YME Yuri Mendez Engineering.
Location: **1045 Dairy Dr.**	Client: **Versatek Building Inc.**	**Test Hole No.: BH4-B of 5**
Job No.: **42-BM**	Test Hole Type: **7" OD Auger.**	Date: **Feb. 11, 2019**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 96.64	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 96.64	Depth (m)	Shear Strength (kPa)	Laboratory Tests		
									Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
15.25 15.5 15.75 16 16.25 16.5 16.75 17 17.25 17.5 17.75 18 18.25 18.5 18.75 19 19.25 19.5 19.75 20 20.25 20.5 20.75 21 21.25 21.5 21.75 22 22.25 22.5	81.5 81 80.5 80 79.5 79 78.5 78 77.5 77 76.5 76 75.5 75 74.5		Strata tested using Dynamic Cone Penetration Test (DCPT)	**16** **15** **16** **19** **18** **18** **19** **18** **31** **28** **28** **25** **27** **29** **29** **30** **27** **27** **31** **30** **29** **29** **28** **32**		81.5 81 80.5 80 79.5 79 78.5 78 77.5 77 76.5 76 75.5 75 74.5	15.25 15.5 15.75 16 16.25 16.5 16.75 17 17.25 17.5 17.75 18 18.25 18.5 18.75 19 19.25 19.5 19.75 20 20.25 20.5 20.75 21 21.25 21.5 21.75 22 22.25 22.5				

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Industrial Building**

YME Yuri Mendez Engineering.

Location: **1045 Dairy Dr.**

Client: **Versatek Building Inc.**

Test Hole No.: BH4-B of 5

Job No.: **42-BM**

Test Hole Type: **7" OD Auger.**

Date: **Feb. 11, 2019**

"7" OD Auger."

SPT Hammer Type: **Safety auto hammer**

Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 96.64	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 96.64	Depth (m)	Shear Strength (kPa)	Laboratory Tests Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
22.75 23 23.25 23.5 23.75 24 24.25 24.5 24.75 25 25.25 25.5 25.75 26 26.25 26.5 26.75 27 27.25 27.5 27.75 28 28.25 28.5 28.75 29 29.25 29.5 29.75 30	74 73.5 73 72.5 72 71.5 71 70.5 70 69.5 69 68.5 68 67.5 67		Strata tested using Dynamic Cone Penetration Test (DCPT)	**31** **30** **29** **30** **33** **32** **31** **32** **32** **41** **39** **39** **37** **37** **41** **37** **38** **37** **39** **44** **43** **42** **45** **42** **67**		74 73.5 73 72.5 72 71.5 71 70.5 70 69.5 69 68.5 68 67.5 67	22.75 23 23.25 23.5 23.75 24 24.25 24.5 24.75 25 25.25 25.5 25.75 26 26.25 26.5 26.75 27 27.25 27.5 27.75 28 28.25 28.5 28.75 29 29.25 29.5 29.75 30				

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Industrial Building**

YME Yuri Mendez Engineering.

Location: **1045 Dairy Dr.**

Client: **Versatek Building Inc.**

Test Hole No.: BH4-B of 5

Job No.: **42-BM**

Test Hole Type: **7" OD Auger.**

Date: **Feb. 11, 2019**

"7" OD Auger."

SPT Hammer Type: **Safety auto hammer**

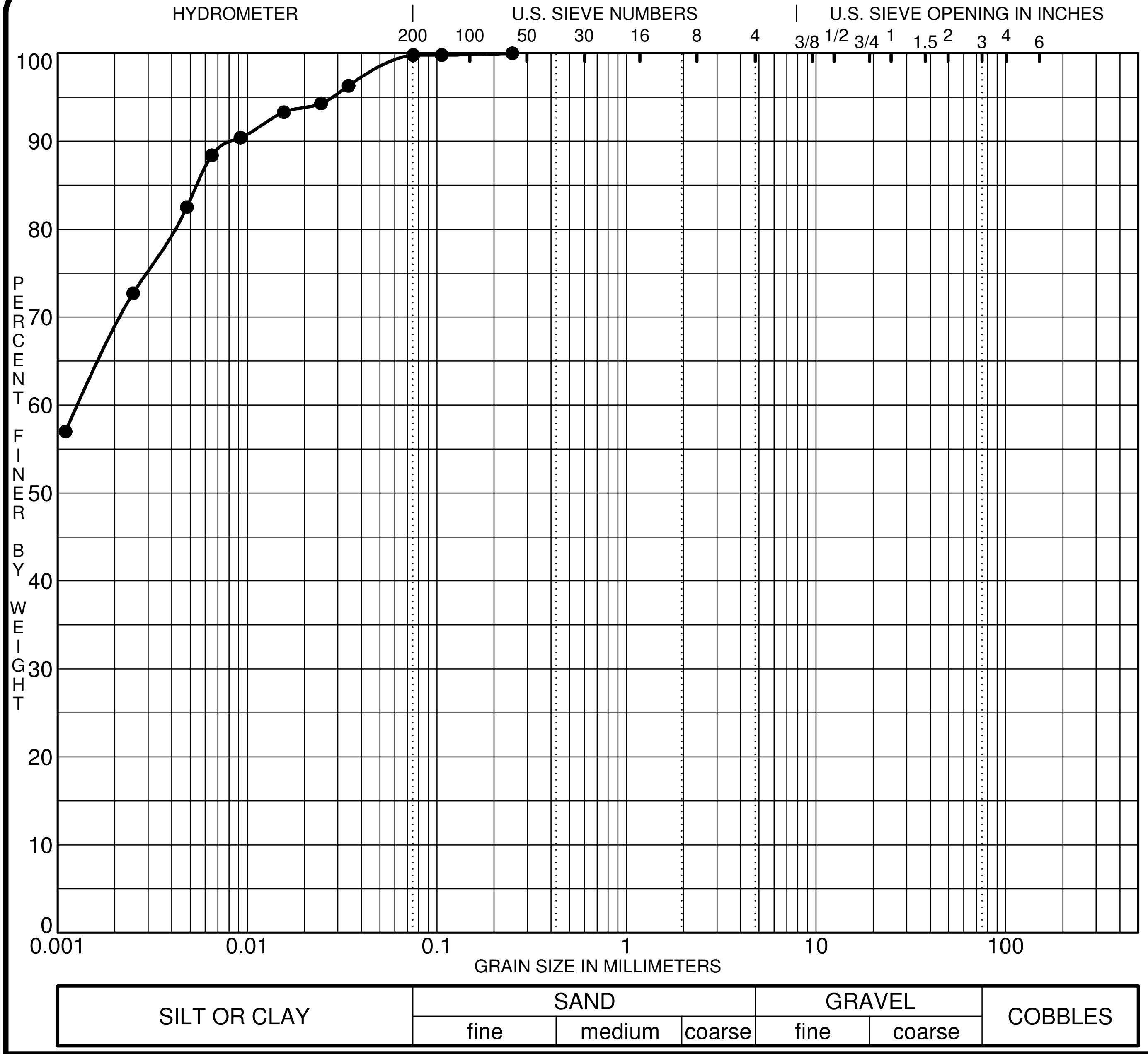
Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 96.64	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 96.64	Depth (m)	Shear Strength (kPa)	Laboratory Tests		
									Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
	66.5	▥		**60**		66.5					
30.25		▥	Strata tested using Dynamic Cone Penetration Test (DCPT)				30.25				
30.5		▥		**57**			30.5				
	66	▥				66					
30.75		▥		**53**			30.75				
31		▥					31				

End of Dynamic Cone Penetration Test at 31.09 m.

S = Sample for lab review and moisture content

▼ Interpreted water level



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH 2-22**	**SS3**							
☒									
▲									
★									

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 2-22**	**SS3**	**0.25**	**0.00**			**0.0**	**0.2**	**99.8**	
☒										
▲										
★										

CLIENT

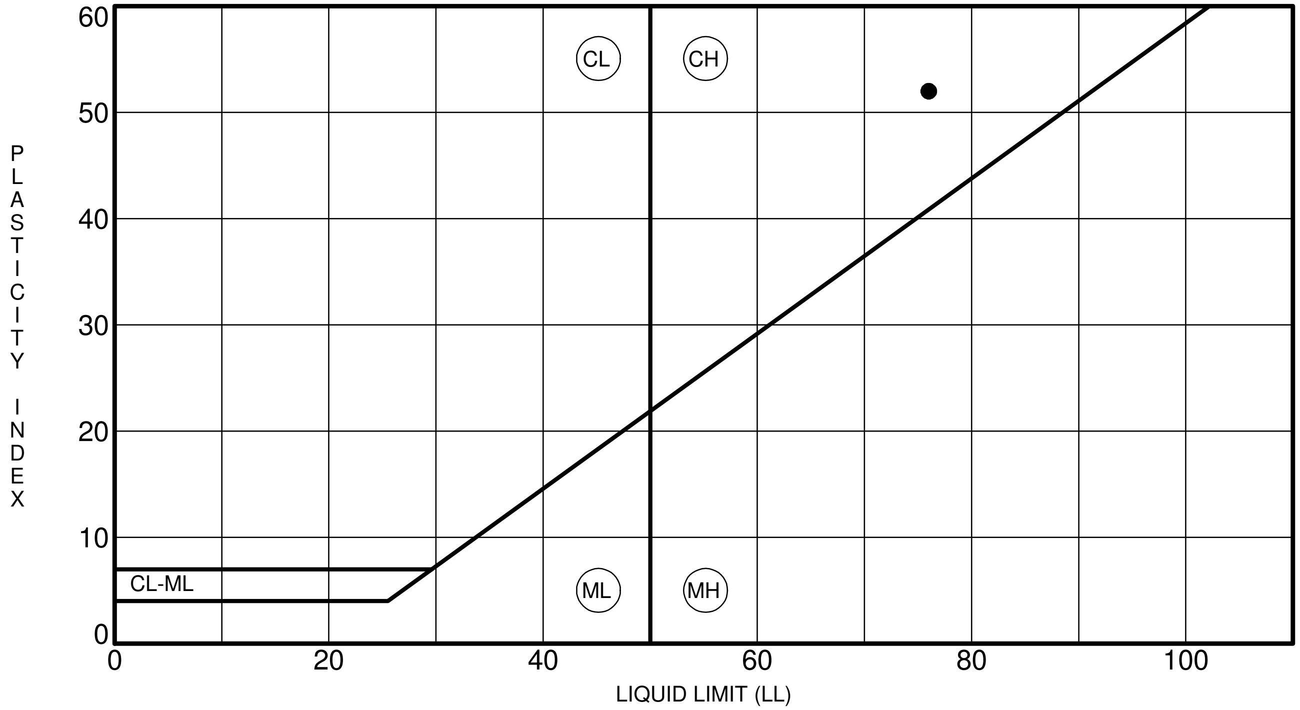
FILE NO. **PG6498**

PROJECT **Geotechnical Investigation - Proposed**
Self-Storage Facility - 1015-1045 Dairy Drive

DATE **8 Dec 22**

patersongroup **Consulting Engineers**
9 Auriga Drive, Ottawa, Ontario K2E 7T9

GRAIN SIZE DISTRIBUTION



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 1-22**	**SS4**	**76**	**24**	**52**		**CH - Inorganic clay of high plasticity**

CLIENT

PROJECT **Geotechnical Investigation - Proposed Self-Storage Facility - 1015-1045 Dairy Drive**

FILE NO. **PG6498**

DATE **8 Dec 22**

patersongroup **Consulting Engineers**

9 Auriga Drive, Ottawa, Ontario K2E 7T9

ATTERBERG LIMITS' RESULTS

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.494N 75.474W **User File Reference:** 1015 & 1045 Dairy Drive 2024-04-19 22:39 UT

Requested by: Paterson Group

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.516	0.284	0.169	0.049
Sa (0.1)	0.597	0.340	0.209	0.067
Sa (0.2)	0.492	0.285	0.178	0.059
Sa (0.3)	0.370	0.215	0.136	0.047
Sa (0.5)	0.259	0.150	0.095	0.033
Sa (1.0)	0.126	0.074	0.047	0.016
Sa (2.0)	0.059	0.034	0.021	0.006
Sa (5.0)	0.016	0.008	0.005	0.001
Sa (10.0)	0.006	0.003	0.002	0.001
PGA (g)	0.316	0.183	0.113	0.036
PGV (m/s)	0.215	0.120	0.073	0.023

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Table 1 - 1015 & 1045 Dairy Drive - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Mississippi River	OF8600	Mss1	45.41279	-76.24891	Landslide	Source area with truncated debris field	0.08	Unknown	15.00	64.59	Marine Deposits	15 to 25	Granite
Mississippi River	OF8600	Mss2	45.41224	-76.25685	Landslide	Source area with debris field	0.03	Unknown	11.00	65.24	Marine Deposits	15 to 25	Granite
Mississippi River	OF8600	Mss3	45.40384	-76.24579	Landslide	Source area with debris field	0.11	Unknown	23.00	64.50	Marine Deposits	15 to 25	Marble
Mississippi River	OF8600	Mss4	45.40073	-76.25147	Landslide	Truncated source area	0.01	Unknown	14.00	65.02	Marine Deposits	15 to 25	Marble
Mississippi River	OF8600	Mss5	45.39957	-76.24593	Landslide	Source area with truncated debris field	0.02	Unknown	20.00	64.60	Erosional Terraces	15 to 25	Marble
Mississippi River	OF8600	Mss6	45.39906	-76.25294	Landslide	Source area with truncated debris field	0.04	Unknown	15.00	65.18	Marine Deposits	15 to 25	Marble
Mississippi River	OF8600	Mss7	45.39121	-76.25506	Landslide	Truncated source area	0.01	Unknown	15.00	65.52	Erosional Terraces	10 to 15	Interbedded Limestone and Shale
Mississippi River	OF8600	Mss8	45.38970	-76.25421	Landslide	Source area with truncated debris field	0.03	Unknown	12.00	65.48	Erosional Terraces	5 to 10	Interbedded Limestone and Shale
Mississippi River	OF8600	Mss9	45.38953	-76.25872	Landslide	Source area with truncated debris field	0.02	Unknown	15.00	65.85	Organic Deposits	5 to 10	Interbedded Limestone and Shale
Mississippi River	OF8600	Mss10	45.38715	-76.25825	Landslide	Source area with truncated debris field	0.01	Unknown	15.00	65.87	Erosional Terraces	5 to 10	Interbedded Limestone and Shale
Mississippi River	OF8600	Mss11	45.37849	-76.26739	Landslide	Truncated source area	0.03	Unknown	13.00	66.81	Erosional Terraces	50 to 100	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss12	45.37130	-76.26864	Landslide	Truncated source area	0.02	Unknown	11.00	67.09	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi Valley	OF8600	Mss13	45.36543	-76.27229	Landslide	Truncated source area	0.02	Unknown	12.00	67.54	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss14	45.36519	-76.27788	Landslide	Source area with truncated debris field	0.02	Unknown	12.00	67.99	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss15	45.36304	-76.27430	Landslide	Source area with truncated debris field	0.03	Unknown	15.00	67.76	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss16	45.36359	-76.26926	Landslide	Truncated source area	0.01	Unknown	17.00	67.34	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss17	45.36075	-76.26736	Landslide	Source area with debris field	0.06	Unknown	20.00	67.27	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss18	45.36124	-76.27193	Landslide	Truncated source area	0.01	Unknown	12.00	67.62	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss19	45.36122	-76.27561	Landslide	Source area with debris field	0.04	Unknown	10.00	67.92	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite

Table 1 - 1015 & 1045 Dairy Drive - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Mississippi River	OF8600	Mss20	45.36267	-76.28135	Landslide	Source area with debris field	0.02	Unknown	10.00	68.34	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss21	45.35604	-76.26640	Landslide	Source area with debris field	0.11	Unknown	15.00	67.33	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss22	45.35416	-76.27441	Landslide	Truncated source area	0.01	Unknown	17.00	68.02	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss23	45.35244	-76.27982	Landslide	Truncated source area	0.01	Unknown	25.00	68.50	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss24	45.35168	-76.28166	Landslide	Truncated source area	0.01	Unknown	25.00	68.67	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss25	45.35103	-76.28318	Landslide	Truncated source area	0.02	Unknown	20.00	68.81	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy1	45.35143	-76.26277	Landslide	Source area with truncated debris field	0.01	Unknown	16.00	67.17	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy2	45.35023	-76.26130	Landslide, possibly	Source area with debris field	0.01	Unknown	***	67.09	***	***	***
Cody Creek	OF8600	Cdy3	45.34522	-76.26452	Landslide	Truncated source area	0.01	Unknown	21.00	67.50	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy4	45.34223	-76.26721	Landslide	Truncated source area	0.02	Unknown	17.00	67.81	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy5	45.33939	-76.25827	Landslide	Source area with truncated debris field	0.07	Unknown	17.00	67.18	Erosional Terraces	15 to 25	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy6	45.33979	-76.24991	Landslide	Source area with truncated debris field	0.06	Unknown	13.00	66.51	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy7	45.34175	-76.24524	Landslide, possibly	Source area with truncated debris field	0.10	Unknown	***	66.07	***	***	***
Cody Creek	OF8600	Cdy8	45.33762	-76.24262	Landslide	Source area with truncated debris field	0.03	Unknown	23.00	66.00	Marine Deposits	10 to 15	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy9	45.33822	-76.23647	Landslide	Source area with truncated debris field	0.01	Unknown	17.00	65.49	Marine Deposits	5 to 10	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy10	45.33477	-76.23220	Landslide	Source area with truncated debris field	0.06	Unknown	12.00	65.27	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy11	45.33386	-76.23415	Landslide, probably	Source area with truncated debris field	0.04	Unknown	**	65.46	**	**	**
Cody Creek	OF8600	Cdy12	45.32989	-76.22645	Landslide, probably	Source area with truncated debris field	0.04	Unknown	**	64.99	**	**	**
Cody Creek	OF8600	Cdy13	45.32654	-76.22004	Landslide, probably	Source area with truncated debris field	0.03	Unknown	**	64.60	**	**	**

Table 1 - 1015 & 1045 Dairy Drive - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Cody Creek	OF8600	Cdy14	45.32031	-76.21358	Landslide	Source area with truncated debris field; isolated areas of debris field	0.05	Unknown	24.00	64.33	Marine Deposits	10 to 15	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy15	45.34728	-76.23587	Landslide, probably	Debris field within a narrow stream valley	0.01	Unknown		65.15			
Madawaska Lake reservoir	OF8600	Mdw1	45.40855	-76.35190	Landslide, former site of	Inundated beneath lake waters	**	Unknown	7.00	73.06	Marine Deposits	10 to 15	Marble
Fitzroy	OF8600	Ftz1	45.50319	-76.22097	Landslide	Truncated source area	0.03	Unknown	10.00	61.55	Alluvial Sediments	5 to 10	Interbedded Limestone and Dolomite
Fitzroy	OF8600	Ftz2	45.50437	-76.21394	Landslide	Truncated source area	0.02	Unknown	16.00	60.97	Alluvial Sediments	5 to 10	Interbedded Limestone and Dolomite
Fitzroy	OF8600	Ftz3	45.49835	-76.15980	Landslide	Source area with truncated debris field	0.16	Unknown	27.00	56.50	Erosional Terraces	10 to 15	Interbedded Limestone and Dolomite
Fitzroy	OF8600	Ftz4	45.50664	-76.13974	Landslide	Truncated source area	0.23	Unknown	11.00	54.87	Erosional Terraces	5 to 10	Interbedded Limestone and Dolomite
Buckhams Bay	OF8600	BkB1	45.48572	-76.10521	Landslide	Source area with truncated debris field	0.49	Unknown	34.00	52.02	Erosional Terraces	15 to 25	Interbedded Limestone and Dolomite
Buckhams Bay	OF8600	BkB2	45.48122	-76.10138	Landslide	Source area with truncated debris field	0.13	Unknown	30.00	51.72	Erosional Terraces	15 to 25	Interbedded Limestone and Dolomite
Buckhams Bay	OF8600	BkB3	45.47977	-76.09564	Landslide	Source area with truncated debris field	0.10	Unknown	30.00	51.25	Erosional Terraces	15 to 25	Interbedded Limestone and Dolomite
Carp Creek	OF8600	Crp1	45.34812	-76.04299	Landslide	Source area with debris field	0.10	Unknown	20.00	49.95	Marine Deposits	25 to 50	Interbedded Limestone and Shale
Rideau River	OF8600	Rid1	45.38818	-75.70428	Landslide	Truncated source area	0.05	Unknown	15.00	22.68	Erosional Terraces	5 to 10	Limestone
Rideau River	OF8600	Rid2	45.32436	-75.69166	Landslide	Source area with debris field	0.06	Unknown	30.00	26.79	Alluvial Sediments	15 to 25	Interbedded Dolomite and Sandstone
Rideau River	OF8600	Rid3	45.28377	-75.69606	Landslide, possibly	Truncated source area?	0.01	Unknown		30.71			
Rockcliffe	OF8600	Rkf1	45.45147	-75.67312	Landslide, probably	Truncated source area	0.02	Unknown		17.16			
Gloucester	OF8600	Glt1	45.44963	-75.59729	Landslide	Source area with debris field	0.12	About 1000 cal yr BP	30.00	11.41	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln1	45.45962	-75.55209	Landslide, possibly	Truncated source area?	0.02	Unknown		7.58			
Orleans	OF8600	Oln2	45.45719	-75.54766	Landslide	Debris field within a narrow stream valley	0.11	Unknown	17.00	7.44	Marine Deposits	25 to 50	Shale
Orleans	OF8600	Oln3	45.46016	-75.54108	Landslide	Debris field within a narrow stream valley	0.05	Unknown	5.00	6.79	Marine Deposits	50 to 100	Shale

Table 1 - 1015 & 1045 Dairy Drive - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Orleans	OF8600	Oln4	45.45726	-75.54049	Landslide	Debris field within a narrow stream valley	0.02	Unknown	5.00	6.96	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln5	45.45487	-75.53897	Landslide	Debris field within a narrow stream valley	0.02	Unknown	9.00	7.03	Marine Deposits	50 to 100	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln6	45.45863	-75.53838	Landslide	Debris field within a narrow stream valley	0.01	Unknown	3.00	6.72	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln7	45.45977	-75.53858	Landslide	Debris field within a narrow stream valley	0.00	Unknown	2.00	6.65	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln8	45.46051	-75.53690	Landslide	Debris field within a narrow stream valley	0.01	Unknown	7.00	6.49	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln9	45.46092	-75.53424	Landslide	Debris field within a narrow stream valley	0.02	Unknown	3.00	6.28	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln10	45.46378	-75.53684	Landslide	Truncated source area	0.07	Unknown	20.00	6.26	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln11	45.46497	-75.53146	Landslide	Truncated source area	0.06	Unknown	18.00	5.82	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln12	45.46706	-75.52809	Landslide	Truncated source area	0.05	Unknown	18.00	5.45	Nearshore Marine	25 to 50	Shale
Orleans	OF8600	Oln13	45.47042	-75.52019	Landslide, probably	Truncated source area	0.07	Unknown		4.69			
Orleans	OF8600	Oln14	45.48981	-75.50782	Landslide	Source area with debris field	0.08	Late Holocene?	18.00	2.85	Alluvial Sediments	15 to 25	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln15	45.48871	-75.47487	Landslide, probably	Truncated source area	0.08	Unknown		0.56			
Orleans	OF8600	Oln16	45.48586	-75.47170	Landslide	Debris field within a narrow stream valley	0.07	Unknown	29.00	0.90	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln17	45.48877	-75.46692	Landslide	Debris field within a narrow stream valley	0.04	Unknown	8.00	0.78	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln18	45.49016	-75.46497	Landslide	Debris field within a narrow stream valley	0.03	Unknown	10.00	0.81	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cumberland	OF8600	Cmb1	45.51313	-75.43362	Landslide	Truncated source area	0.14	Unknown	35.00	4.03	Erosional Terraces	15 to 25	Shale
Cumberland	OF8600	Cmb2	45.51302	-75.40335	Landslide	Source area with debris field	0.04	Unknown	24.00	6.23	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cumberland	OF8600	Cmb3	45.51737	-75.38140	Landslide	Source area with debris field	0.53	relatively young, less than 2000(?)	30.00	8.10	Erosional Terraces	50 to 100	Dolomite
Cumberland	OF8600	Cmb4	45.51651	-75.33631	Landslide	Source area with debris field	0.02	Unknown	49.00	11.63	Nearshore Marine	25 to 50	Interbedded Limestone and Dolomite

Table 1 - 1015 & 1045 Dairy Drive - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Mer Bleue paleochannel	OF8600	MBu1	45.43409	-75.53765	Landslide	Truncated source area	0.02	Unknown	13.00	8.74	Erosional Terraces	25 to 50	Interbedded Limestone and Shale
Mer Bleue paleochannel	OF8600	MBu2	45.43092	-75.51828	Landslide	Source area with debris field	0.12	Unknown	15.00	8.21	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu3	45.42843	-75.51485	Landslide	Source area with debris field	0.01	Unknown	12.00	8.36	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu4	45.42782	-75.51290	Landslide	Truncated source area	0.01	Unknown	**	8.36	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu5	45.42639	-75.50741	Landslide, former site of	Completely altered	N.A.	Unknown	**	8.35	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu6	45.42500	-75.50289	Landslide, former site of	Completely altered	N.A.	Unknown	**	8.39	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu7	45.42364	-75.49702	Landslide, former site of	Completely altered	N.A.	Unknown	**	8.42	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu8	45.42335	-75.49197	Landslide, former site of	Completely altered	N.A.	Unknown	**	8.37	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu9	45.42158	-75.48102	Landslide	Truncated source area	0.03	Unknown	15.00	8.46	Erosional Terraces	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu10	45.42089	-75.47444	Landslide	Truncated source area	0.03	Unknown	15.00	8.52	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu11	45.41891	-75.46077	Landslide	Truncated source area	0.03	Unknown	14.00	8.82	Nearshore Marine	15 to 25	Shale
Mer Bleue paleochannel	OF8600	MBu12	45.41829	-75.45649	Landslide	Truncated source area	0.01	Unknown	15.00	8.94	Nearshore Marine	15 to 25	Shale
Mer Bleue paleochannel	OF8600	MBu13	45.41206	-75.27053	Landslide	Source area with debris field	1.42	about 5200 cal yrBP	19.00	19.28	Nearshore Marine	25 to 50	Interbedded Limestone and Shale
Beta-90881	OF7432	1	45.46110	-75.26110	Landslide	*	*	3050±70	20.00	17.92	Nearshore Marine	15 to 25	Interbedded Limestone and Shale
Beta-122473	OF7432	1	45.44170	-75.22220	Landslide	*	*	4590±40	8.00	21.59	Nearshore Marine	25 to 50	Interbedded Limestone and Shale
Beta-122475	OF7432	1	45.44240	-75.19240	Landslide	*	*	2760±50	20.00	23.94	Erosional Terraces	25 to 50	Interbedded Limestone and Shale
Beta-127281	OF7432	1	45.54160	-75.24160	Landslide	*	*	5130±60	53.00	19.92	Nearshore Marine	10 to 15	Limestone
Beta-127284	OF7432	1	45.52080	-75.26670	Landslide	*	*	4440±80	21.00	17.34	Erosional Terraces	25 to 50	Interbedded Limestone and Shale
Beta-127244	OF7432	1	45.50000	-75.20280	Landslide	*	*	4570±70	30.00	22.32	Erosional Terraces	25 to 50	Interbedded Limestone and Shale

Table 1 - 1015 & 1045 Dairy Drive - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Beta-122472	OF7432	1	45.48330	-75.19170	Landslide	*	*	4520±50	30.00	23.25	Nearshore Marine	15 to 25	Interbedded Limestone and Shale
Beta-127282	OF7432	1	45.47500	-75.12920	Landslide	*	*	4540±90	24.00	28.45	Nearshore Marine	15 to 25	Interbedded Limestone and Shale
Beta-127283	OF7432	1	45.52500	-75.01110	Landslide	*	*	4530±60	12.00	38.26	Erosional Terraces	10 to 15	Interbedded Limestone and Shale
Beta-122478	OF7432	1	45.51390	-75.00280	Landslide	*	*	4700±50	15.00	38.84	Erosional Terraces	15 to 25	Interbedded Limestone and Shale
Beta-122471	OF7432	1	45.51850	-74.95570	Landslide	*	*	1870±40	26.00	42.75	**	**	**
Beta-127242	OF7432	1	45.51380	-74.93750	Landslide	*	*	4820±70	26.00	44.21	**	**	**
Beta-122474	OF7432	1	45.53610	-75.15830	Landslide	*	*	4470±50	**	26.44	Nearshore Marine	25 to 50	Limestone
GSC-1922	OF7432	2	45.54370	-75.40110	Landslide	*	*	4620±80	81.00	8.40	Marine Deposits	15 to 25	Felsic Intrusive Rocks
GSC-2068	OF7432	4	45.52080	-75.49170	Landslide	*	*	6240±70	59.00	3.54	Marine Deposits	25 to 50	Dolomite
UCIAMS-71217	OF7432	6	45.57980	-75.04260	Landslide	*	*	7105±20	35.00	36.89	Erosional Terraces	50 to 100	Shale
UCIAMS-71211	OF7432	7	45.57020	-75.11560	Landslide	*	*	7140±20	31.00	30.82	Marine Deposits	50 to 100	Interbedded Limestone and Dolomite
GSC-1741	OF7432	10	45.46500	-75.75130	Landslide	*	*	120±150	**	23.11	Marine Deposits	25 to 50	Dolomite
UCIAMS-88796	OF7432	11	45.48290	-75.93490	Landslide	*	*	1125±15	29.00	38.01	Marine Deposits	25 to 50	Felsic Intrusive Rocks
UCIAMS-88704	OF7432	11	45.48530	-75.93630	Landslide	*	*	2805±20	29.00	38.11	Marine Deposits	25 to 50	Felsic Intrusive Rocks
GSC-6233	OF7432	11	45.48310	-75.93320	Landslide	*	*	7050±80	25.00	37.87	Marine Deposits	25 to 50	Felsic Intrusive Rocks
UCIAMS-88816	OF7432	11	45.48020	-75.93090	Landslide	*	*	200±15	24.00	37.69	Marine Deposits	15 to 25	Felsic Intrusive Rocks
GSC-6449	OF7432	11	45.47180	-75.91290	Landslide	*	*	1080±70	15.00	36.27	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
UCIAMS-88703	OF7432	11	45.47990	-75.91740	Landslide	*	*	180±20	26.00	36.58	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
GSC-6318	OF7432	11	45.47860	-75.91180	Landslide	*	*	1030±70	24.00	36.13	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite

Table 1 - 1015 & 1045 Dairy Drive - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
UCIAMS-88806	OF7432	11	45.47730	-75.90280	Landslide	*	*	1895±25	12.00	35.40	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
GSC-6482	OF7432	11	45.48120	-75.90670	Landslide	*	*	1210±50	8.00	35.69	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
GSC-6433	OF7432	11	45.48540	-75.89640	Landslide	*	*	1440±50	18.00	34.83	Marine Deposits	15 to 25	Felsic Intrusive Rocks
UCIAMS-88818	OF7432	11	45.48520	-75.90600	Landslide	*	*	2755±20	22.00	35.62	Marine Deposits	25 to 50	Felsic Intrusive Rocks
GSC-6355	OF7432	11	45.48250	-75.91180	Landslide	*	*	1170±50	27.00	36.11	Marine Deposits	25 to 50	Felsic Intrusive Rocks
Beta-139135	OF7432	11	45.49650	-75.92780	Landslide	*	*	310±40	10.00	37.40	Marine Deposits	50 to 100	Felsic Intrusive Rocks
UCIAMS-122468	OF7432	12	45.53530	-76.03060	Landslide	*	*	1095±20	21.00	46.11	Marine Deposits	15 to 25	Felsic Intrusive Rocks
UCIAMS-106656	OF7432	13	45.54090	-76.04890	Landslide	*	*	1150±15	22.00	47.68	Marine Deposits	25 to 50	Felsic Intrusive Rocks
UCIAMS-171460	OF7432	14	45.55390	-76.13020	Landslide	*	*	1305±20	9.00	54.50	Nearshore Marine	50 to 100	Felsic Intrusive Rocks
UCIAMS-171459	OF7432	15	45.55130	-76.14060	Landslide	*	*	185±20	9.00	55.31	Nearshore Marine	50 to 100	Felsic Intrusive Rocks
UCIAMS-106587	OF7432	16	45.55190	-76.28630	Landslide	*	*	1180±20	24.00	67.24	Erosional Terraces	15 to 25	Felsic Intrusive Rocks
UCIAMS-106575	OF7432	17	45.61920	-76.37190	Landslide	*	*	955±15	32.00	75.35	**	**	**
UCIAMS-106650	OF7432	18	45.50140	-76.28260	Landslide	*	*	1145±20	52.00	66.62	Nearshore Marine	15 to 25	Felsic Intrusive Rocks
UCIAMS-106581	OF7432	19	45.51700	-76.27470	Landslide	*	*	5830±20	34.00	66.01	Nearshore Marine	15 to 25	Felsic Intrusive Rocks
UCIAMS-122453	OF7432	20	45.54620	-76.52600	Landslide	*	*	5745±20	**	86.84	**	**	**
UCIAMS-137113	OF7432	21	45.72570	-75.89150	Landslide	*	*	4525±20	52.00	43.86	**	**	**
UCIAMS-137101	OF7432	22	45.69440	-75.89960	Landslide	*	*	90±20	23.00	42.23	**	**	**
UCIAMS-122455	OF7432	23	45.80960	-75.95980	Landslide	*	*	940±15	25.00	54.53	**	**	**

'*' - Indicates information not provided by source (Geological Survey of Canada Open File 7432)

'' Indicates information could not be interpreted from available mapping.**

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 to 5 - SLOPE STABILITY ANALYSIS SECTIONS

DRAWING PG6498-1 - TEST HOLE LOCATION PLAN

DRAWING PG6498-3 - SLOPE SETBACK PLAN

DRAWING PG6498-4 - CROSS-SECTION A-A’

DRAWING PG6498-5 - CROSS-SECTION B-B’

DRAWING PG6498-6 - CROSS-SECTION C-C’

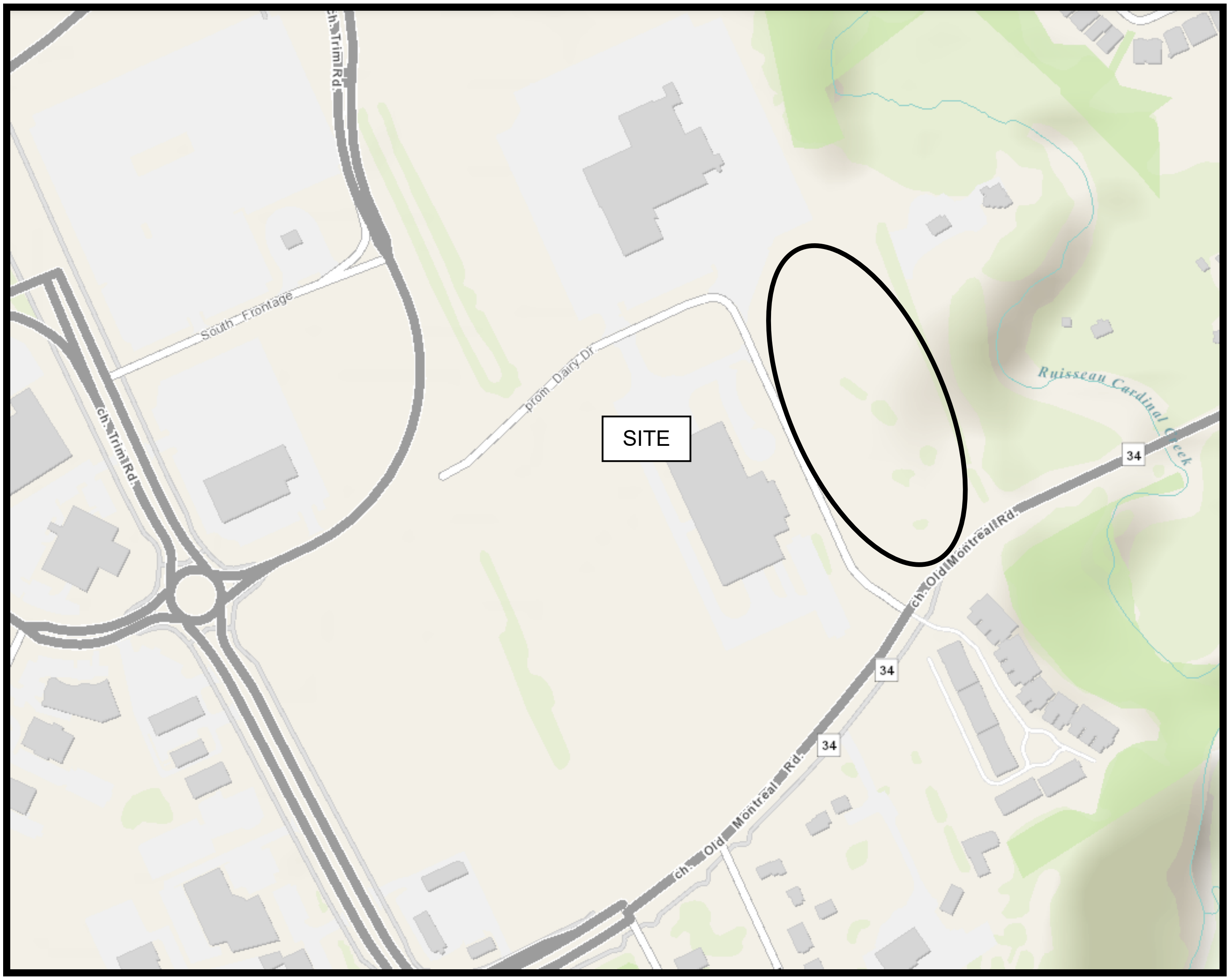


FIGURE 1

KEY PLAN

PATERSON GROUP

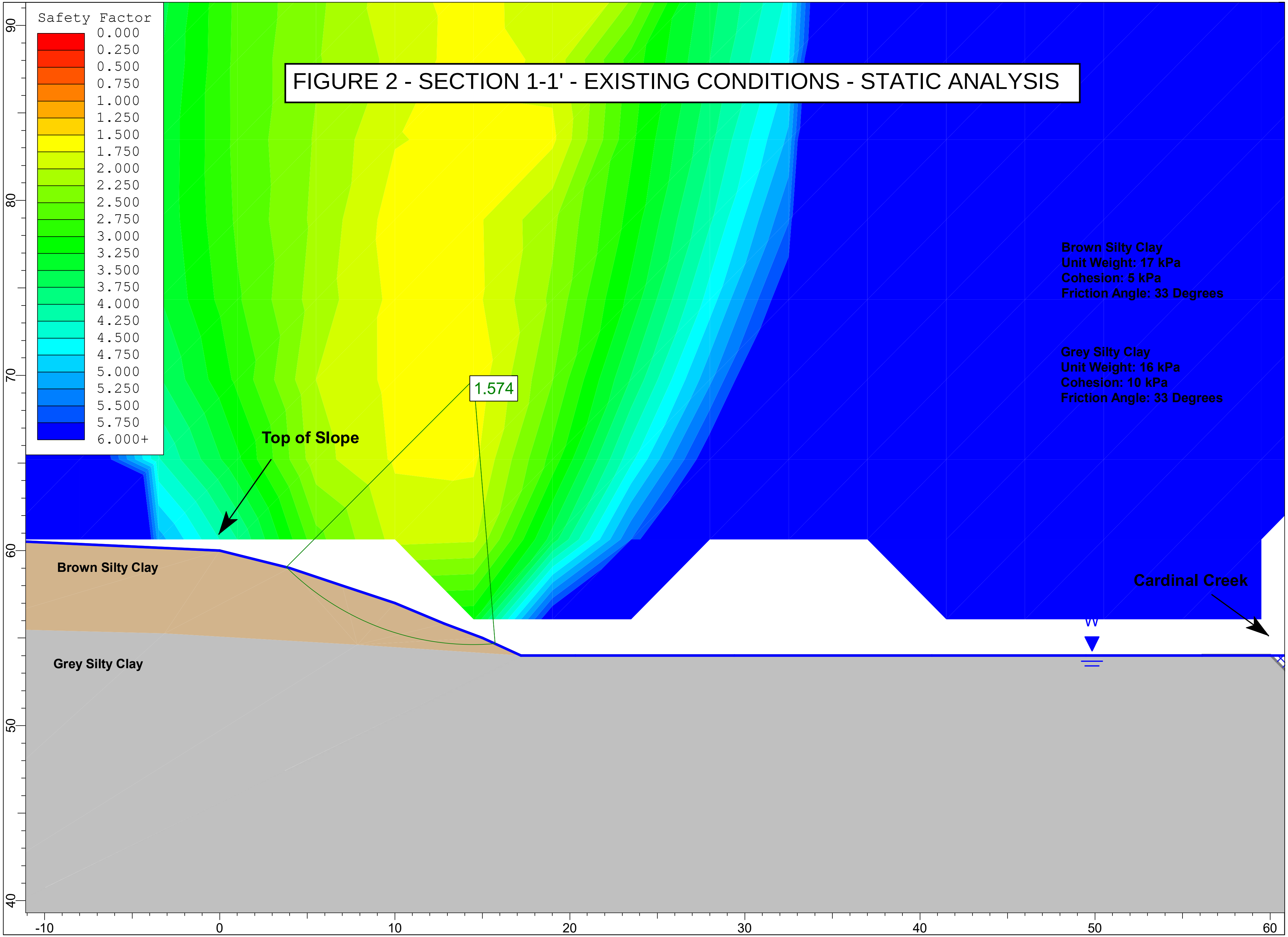
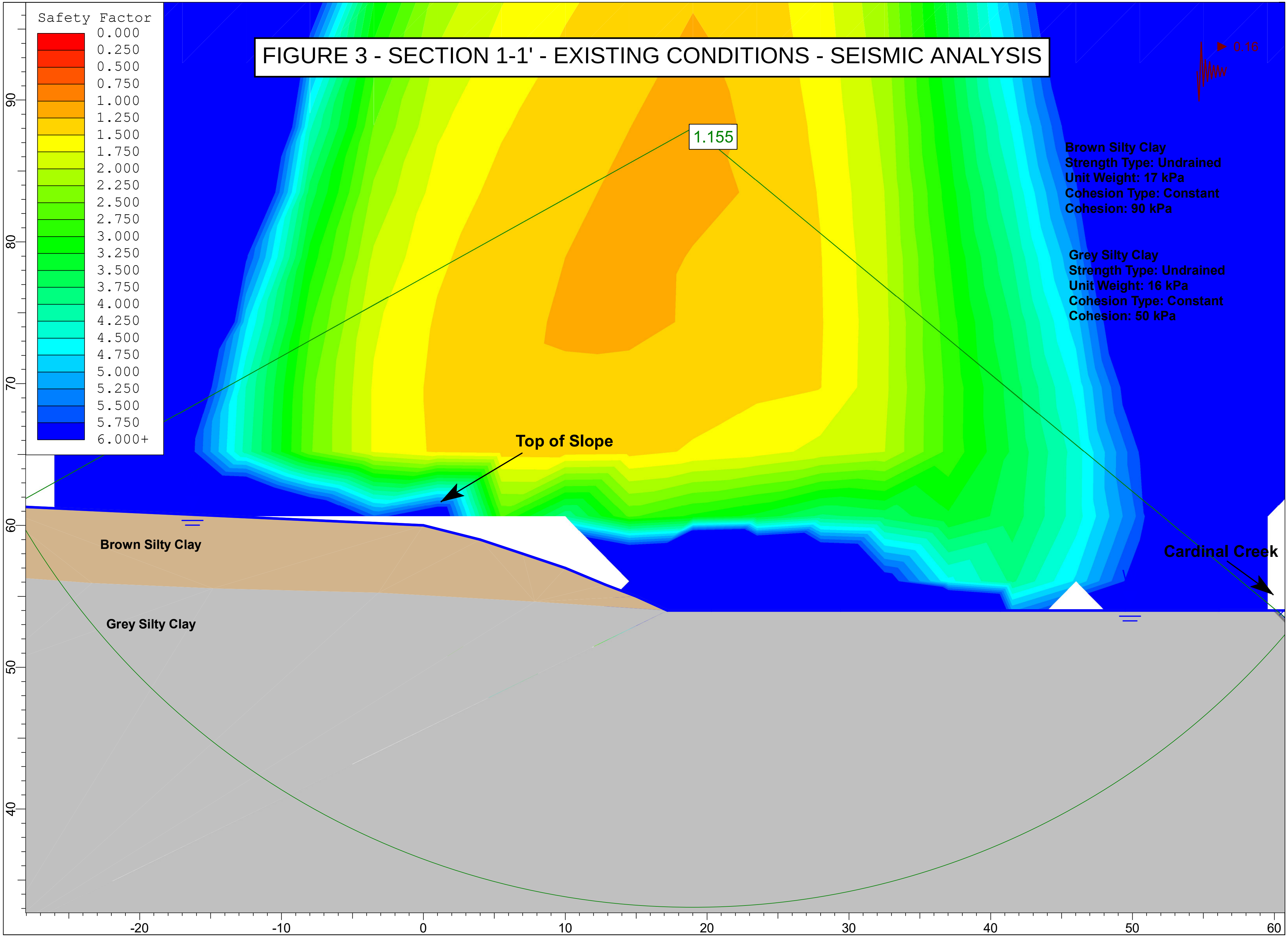


FIGURE 2 - SECTION 1-1' - EXISTING CONDITIONS - STATIC ANALYSIS

FIGURE 3 - SECTION 1-1' - EXISTING CONDITIONS - SEISMIC ANALYSIS



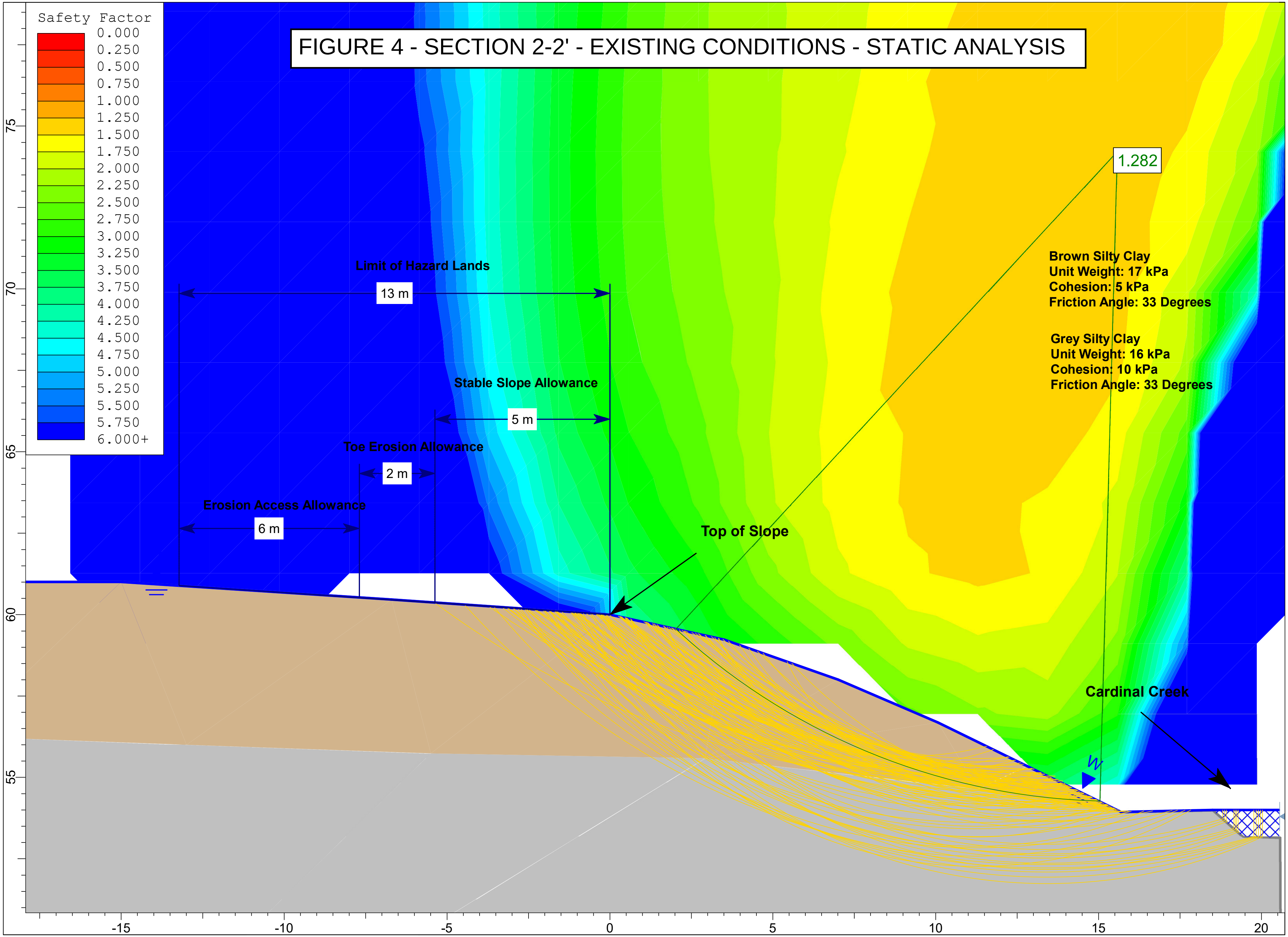


FIGURE 4 - SECTION 2-2' - EXISTING CONDITIONS - STATIC ANALYSIS

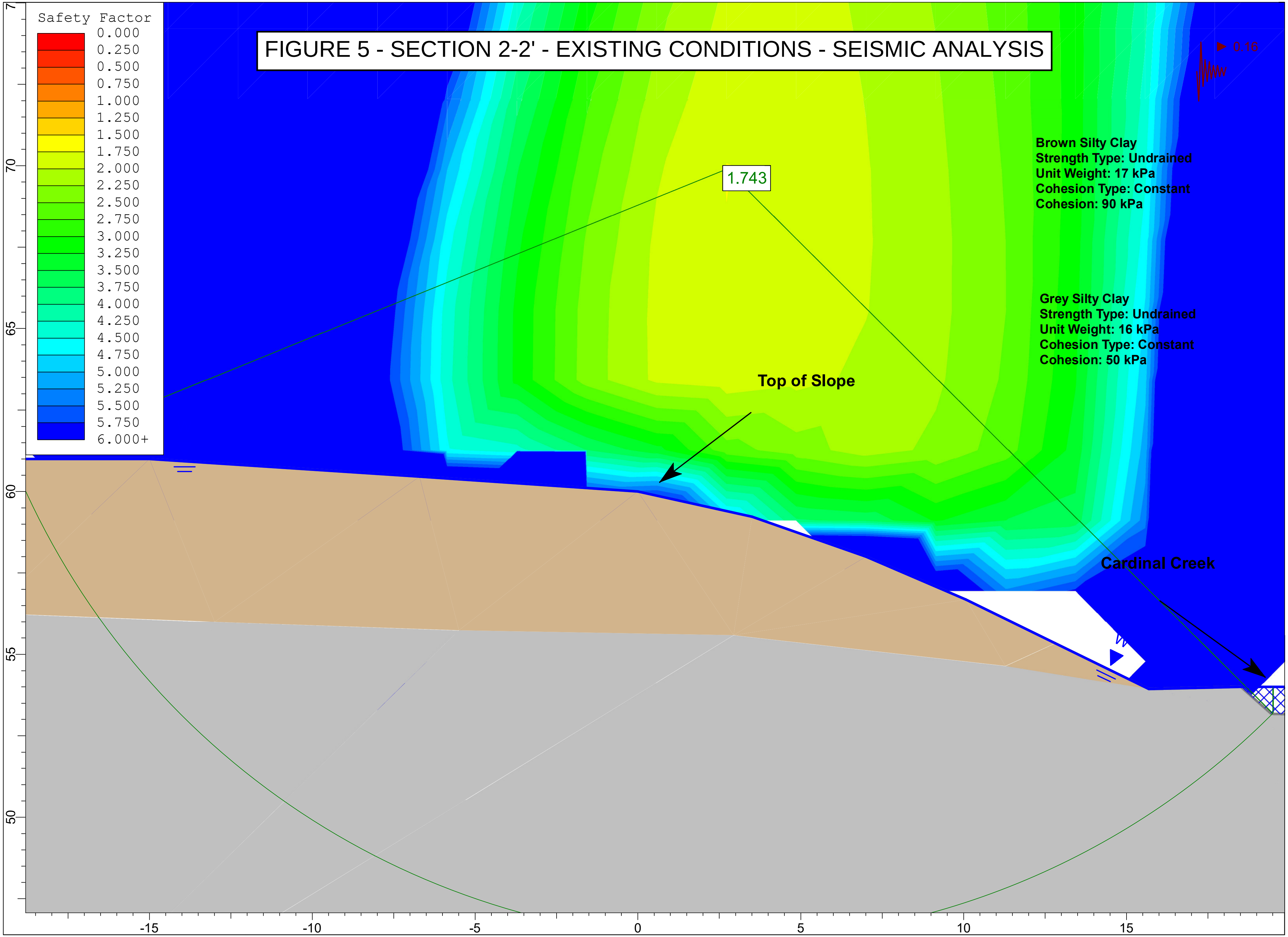
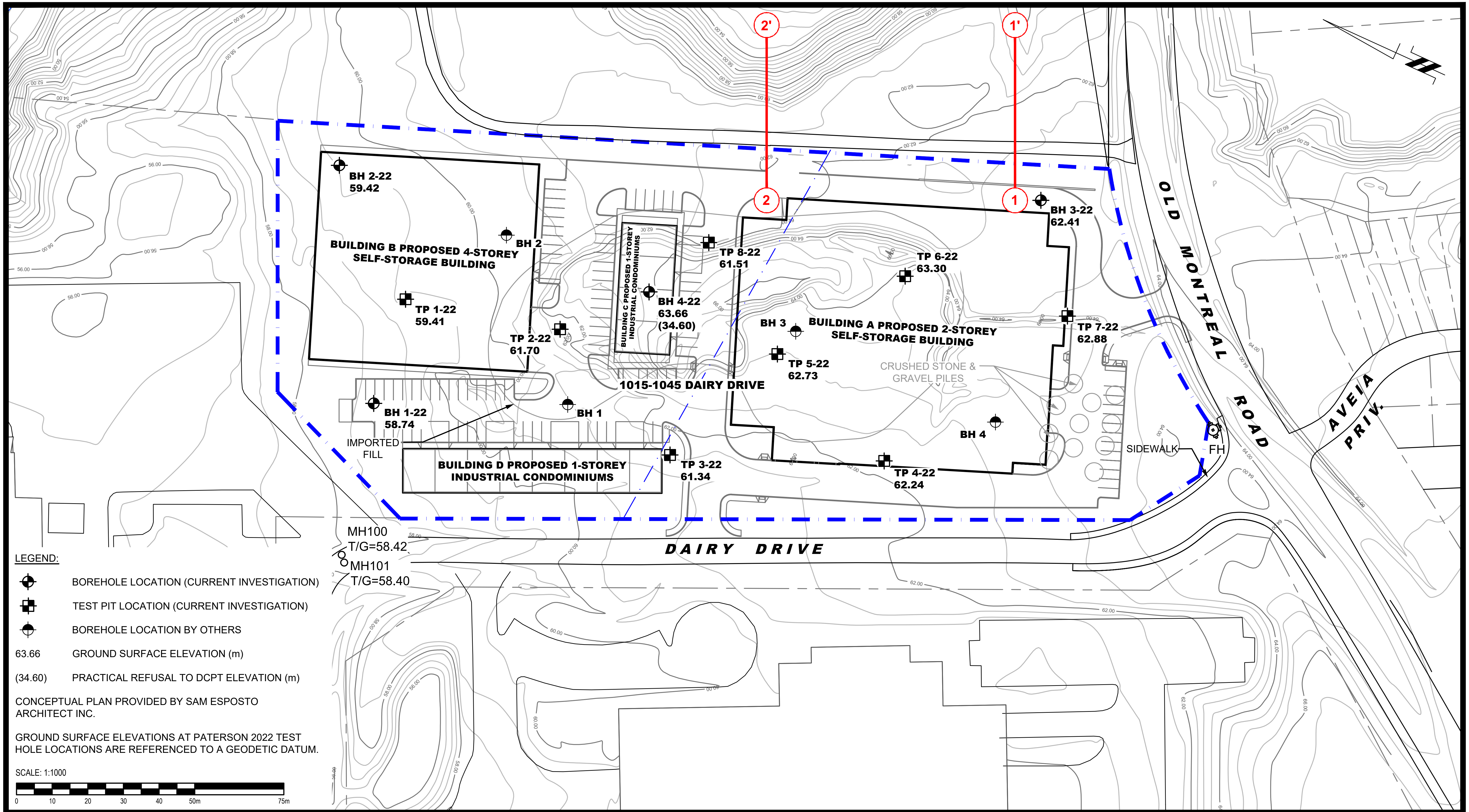


FIGURE 5 - SECTION 2-2' - EXISTING CONDITIONS - SEISMIC ANALYSIS



LEGEND:

⊕	BOREHOLE LOCATION (CURRENT INVESTIGATION)
▣	TEST PIT LOCATION (CURRENT INVESTIGATION)
⊕	BOREHOLE LOCATION BY OTHERS
63.66	GROUND SURFACE ELEVATION (m)
(34.60)	PRACTICAL REFUSAL TO DCPT ELEVATION (m)

CONCEPTUAL PLAN PROVIDED BY SAM ESPOSTO ARCHITECT INC.

GROUND SURFACE ELEVATIONS AT PATERSON 2022 TEST HOLE LOCATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:1000

0 10 20 30 40 50m 75m

PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
3	UPDATED TO NEW CONCEPTUAL PLAN	06/06/2024	SD
2	UPDATED TO NEW CONCEPTUAL PLAN	11/01/2024	SD
1	UPDATED TO NEW CONCEPTUAL PLAN	15/09/2023	SD

TSL-DAIRY INC.
GEOTECHNICAL INVESTIGATION
PROPOSED SELF STORAGE FACILITY
1015 - 1045 DAIRY DRIVE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1000
Drawn by: YA
Checked by: FA
Approved by: SD
Date: 01/2023
Report No.: PG6498-1
Dwg. No.: PG6498-1
Revision No.: 3

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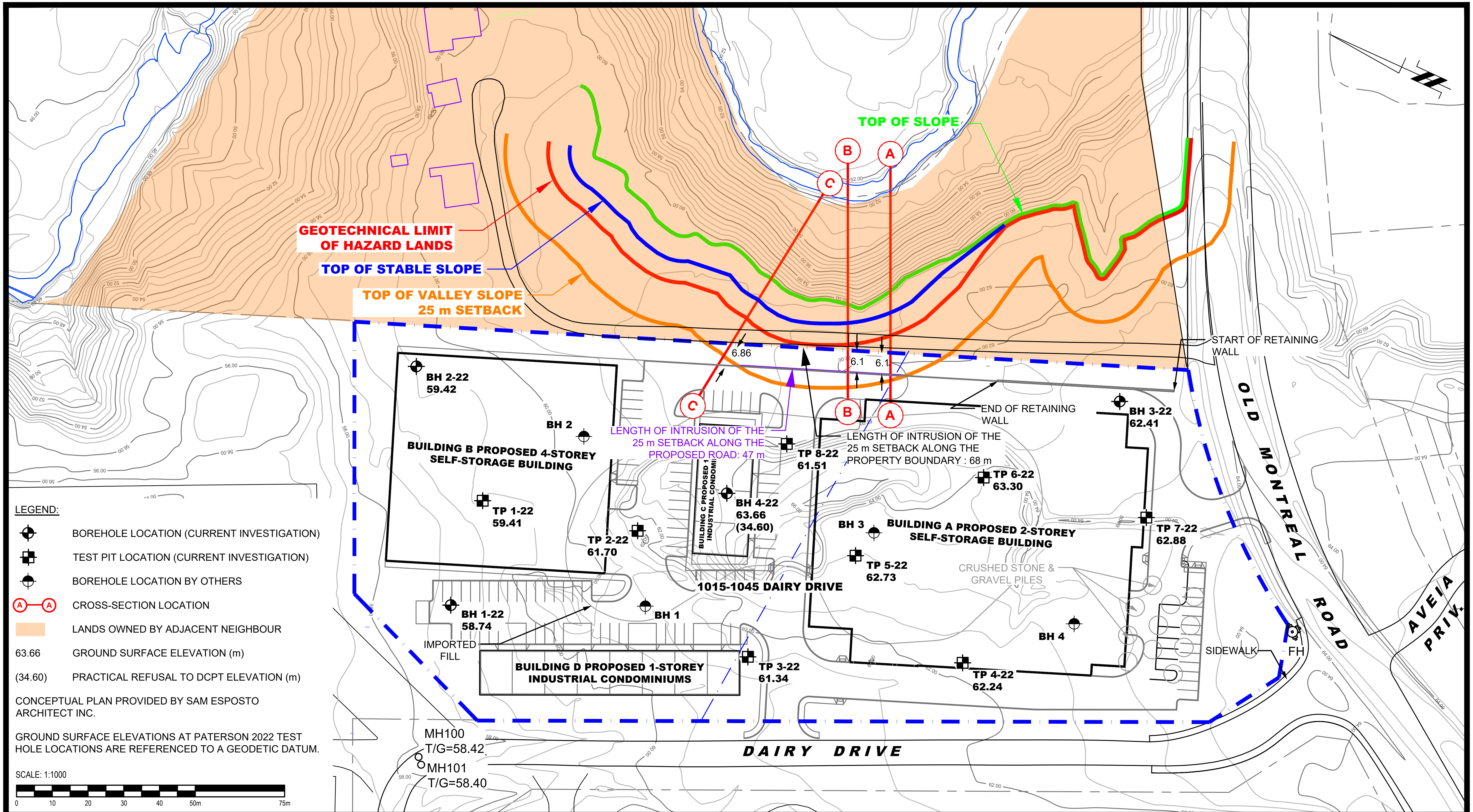
11x17



LEGEND:

⊕	BOREHOLE LOCATION (CURRENT INVESTIGATION)
▣	TEST PIT LOCATION (CURRENT INVESTIGATION)
⊕	BOREHOLE LOCATION BY OTHERS
Ⓐ—Ⓐ	CROSS-SECTION LOCATION
🟧	LANDS OWNED BY ADJACENT NEIGHBOUR
63.66	GROUND SURFACE ELEVATION (m)
(34.60)	PRACTICAL REFUSAL TO DCPT ELEVATION (m)

CONCEPTUAL PLAN PROVIDED BY SAM ESPOSTO ARCHITECT INC.

GROUND SURFACE ELEVATIONS AT PATERSON 2022 TEST HOLE LOCATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:1000

0 10 20 30 40 50m 75m

PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	UPDATED TO NEW CONCEPTUAL PLAN	06/06/2024	SD

TSL-DAIRY INC.

PROPOSED SELF STORAGE FACILITY
1015 - 1045 DAIRY DRIVE

OTTAWA, ONTARIO

Title:

SLOPE SETBACK PLAN

Scale: 1:1000
Date: 12/2023
Drawn by: ZS
Report No.: PG6498-1
Checked by: FA
Dwg. No.: PG6498-3
Approved by: SD
Revision No.: 1

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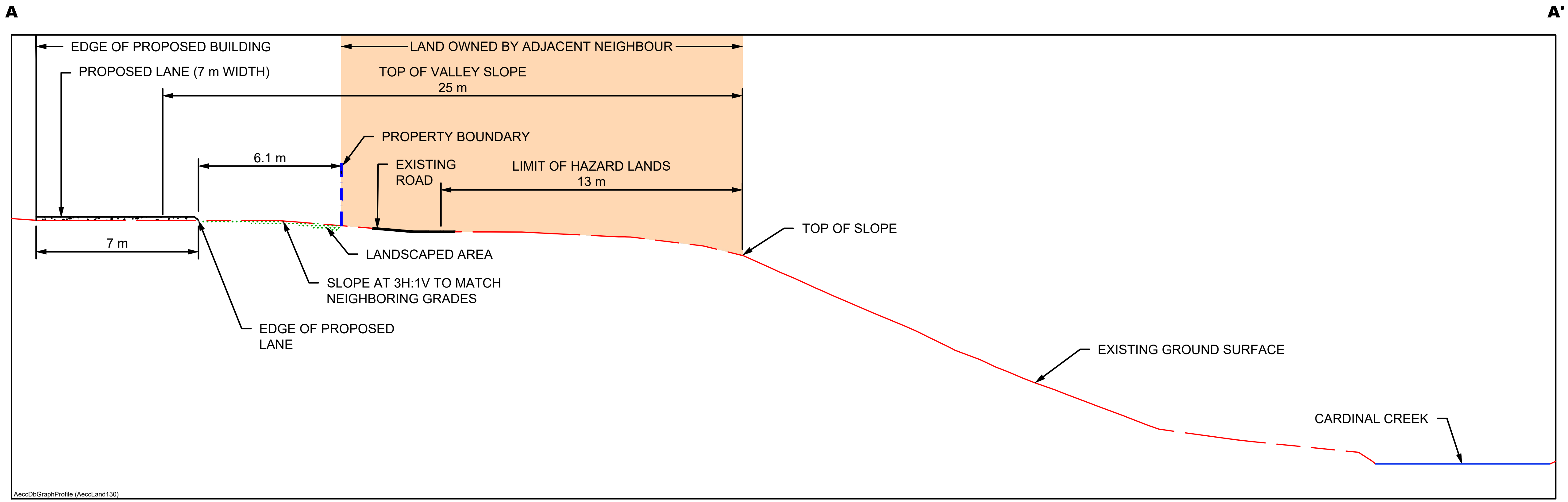

CROSS-SECTION A-A'

SCALE: 1:200

0 1 2 3 4 5 10m

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	AS PER REVISED CONCEPTUAL PLAN	06/06/2024	SD

TSL-DAIRY INC.

PROPOSED SELF STORAGE FACILITY
1015 - 1045 DAIRY DRIVE

OTTAWA, ONTARIO

Title:

CROSS-SECTION A-A'

Scale: 1:200
Date: 12/2023
Drawn by: ZS
Report No.: PG6498-1
Checked by: FA
Dwg. No.: PG6498-4
Approved by: SD
Revision No.: 1

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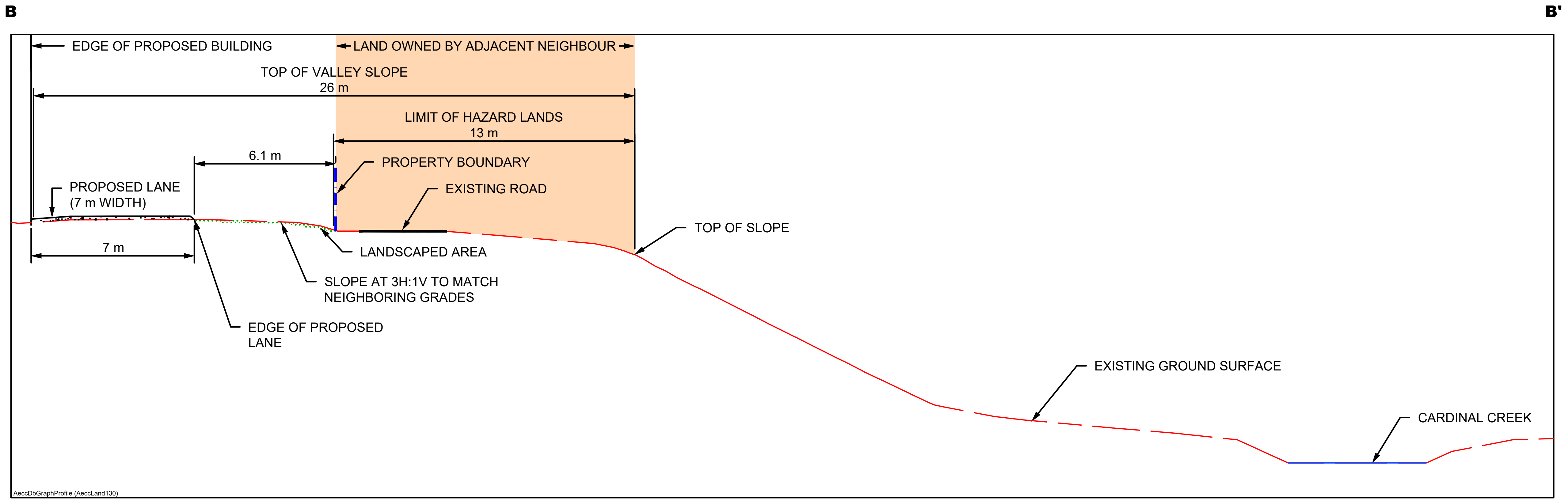

CROSS-SECTION B-B'

SCALE: 1:200

PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	AS PER REVISED CONCEPTUAL PLAN	06/06/2024	SD

TSL-DAIRY INC.

PROPOSED SELF STORAGE FACILITY
1015 - 1045 DAIRY DRIVE

OTTAWA, ONTARIO

Title:

CROSS-SECTION B-B'

Scale: 1:200
Drawn by: ZS
Checked by: FA
Approved by: SD
Date: 12/2023
Report No.: PG6498-1
Dwg. No.: PG6498-5
Revision No.: 1

11x17

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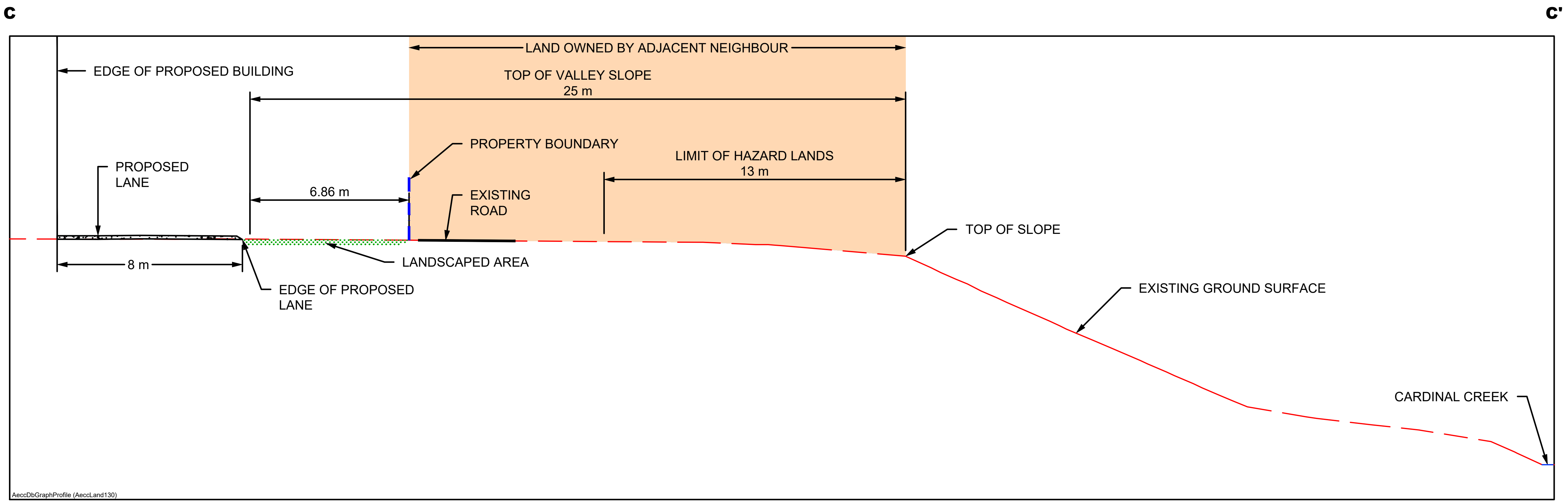

CROSS-SECTION C-C'

SCALE: 1:200

PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	AS PER REVISED CONCEPTUAL PLAN	06/06/2024	SD

TSL-DAIRY INC.

PROPOSED SELF STORAGE FACILITY
1015 - 1045 DAIRY DRIVE

OTTAWA, ONTARIO

Title:

CROSS-SECTION C-C'

Scale: 1:200
Date: 12/2023
Drawn by: ZS
Report No.: PG6498-1
Checked by: FA
Dwg. No.: PG6498-6
Approved by: SD
Revision No.: 1

11x17

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