Geotechnical Investigation Report

1450 King Road, Burlington
WW21012079

Prepared for:

Quantum Realty Management, ATT: Shaun Harcus, Director, Facilities and Real Estate

2213 North Sheridan Way, Mississauga, ON, L5K 1A3

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1.0 Introduction

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited ("Wood") was retained by the Quantum Realty Management ("Client") to carry out a geotechnical investigation for the proposed re-design of the existing stormwater management facility and associated future re-development at 1450 King Road, located in the City of Burlington.

Currently, Quantum owns a portion of the 1450 King Road site. The balance is owned by the City of Burlington ("City") and operated as a dual cell (dry/wet) stormwater management (SWM) facility, providing quantity and quality control for the upstream King Forest Phase 1 Business Park. The proposed approach for the site would involve re-locating the SWM facility (located in the south-east corner) to the northern portion of the site, as part of the proposed development of the entire site, effectively exchanging the location of the SWM facility with potential development land in the north part of the site. This would allow the site to be re-developed so that the main building has frontage along North Service Road. Ultimately, the site is proposed to include a building, along with parking areas and two driveway accesses (both from North Service Road and King Road).

As per City's review comments dated June 15, 2021, Conservation Halton ("CH") requires "Accurate delineation of the erosion hazard and 7.5 metre regulatory allowance" and submission of a geotechnical assessment that determines the stable top of bank. In addition, a geotechnical exploration is required in order to support design of the proposed dry pond stormwater management facility (SWMF) and site grading in the development area.

The main purpose of this investigation is to provide geotechnical recommendations for design and construction of the proposed SWMF facility. In addition to the presenting the factual findings, this report outlines recommendations and discussion regarding; open-cut excavations, SWMF facility headwall structure, general backfill, lateral earth pressure coefficients, groundwater conditions, drainage and dewatering, and a slope assessment. A preliminary hydrogeological infiltration assessment is included.

The Client provided the following reports prepared for the subject site, and were reviewed for information when completing this report:

- McClymont and Rak Engineers Inc. (MRE) draft report titled "Geotechnical Investigation, Proposed Industrial Subdivision, King Forest Business Park - Ph 1, Burlington, Ontario", Report G1853, dated April 1997;
- Pinchin Environmental Ltd. (Pinchin) draft report titled "Phase I Environmental Site Assessment, 1450 King Road, Burlington, Ontario", Pinchin File: 95166, dated July 7, 2014; and
- EXP report titled "Phase I Environmental Site Assessment, 1450 King Road, Burlington, Ontario", Project Number HAM-00801175-A3, dated April 11, 2017.

In the 1997 MRE report, 33 boreholes were advanced to depths ranging between 2.0 to 5.0 m. Bedrock was encountered in sixteen boreholes at depths of 2.1 to 4.3 m. Bedrock was not encountered during the current investigation, with boreholes advanced to 5.2 m depth.

2.0 Authorization

Authorization to proceed with this investigation was received by Shaun Harcus of Quantum Realty Management on August 23, 2021. The scope of services authorized were as per the Wood proposal POGTW21642 Rev.1 revised August 23, 2021.

3.0 Terms of Reference

The findings of the investigation, together with Wood's comments and recommendations, are presented in this report. The anticipated construction conditions are also discussed but only to the extent that they may influence the design decisions. Any construction methods discussed express Wood's opinions only and are not intended to direct contractors on how to carry out the construction. Contractors should also be aware that the data and the interpretation presented in this report may not be sufficient to assess all the factors that may have an effect on construction.

This report was prepared with the assumption that the design will be in accordance with applicable standards and codes, regulations of authorities having jurisdiction, and good engineering practices.

Further, the recommendations and opinions expressed in this report are only applicable to the proposed project as described above.

There should also be an ongoing liaison with Wood during both the design and construction phases of the project to ensure that the recommendations in this report have been interpreted and implemented correctly. Also, if any further clarification and/or elaboration are needed concerning the geotechnical aspects of this project, Wood should be contacted immediately.

4.0 Site Description and Geological Setting

The Site is at the north-west corner of North Service Road and King Road, in Burlington, Ontario. The northern and western portions are vacant, vegetated with grasses with a few trees and shrubs. The south-east section serves as an existing storm water pond. A tributary of Indian Creek flows along the west boundary with heavily treed valley slopes. Two earthen stockpiles are present in the southwest and northeast corners of the site. Overall, the Site slopes down towards the south.

Based on *Surficial Geology of Southern Ontario (MRD128)*, released by the Ontario Geologic Survey, 2010, the surficial soils generally consist of clay to silt-textured till (derived from glaciolacustrine deposits or shale) and Paleozoic bedrock.

Based on *Paleozoic Geology of Southern Ontario (MRD219),* published by the Ontario Geologic Survey, 2007, the bedrock in the area consists predominately of shale of the Queenston Formation.

5.0 Method of Investigation

The investigation obtained information about the subsurface conditions at the site by means of sampled boreholes. Based on site-specific findings, and the general knowledge of the area, Wood has provided geotechnical recommendations pertaining to this project.

5.1 General Description of Field Work

The fieldwork for this investigation was carried out on September 24 and September 28, 2021. It consisted of twelve (12) sampled boreholes, and installation of two (2) groundwater monitoring wells, as indicated on the Figure 2 - Borehole Location Plan.

The number of boreholes, their locations and depths are summarized in the table below.

Table 5-1: Borehole Summary

BH ID	Location - UTM Coordinates		Surface Elevation (geodetic datum, m)	Depth (mbgs)*
	Easting	Northing		
BH1	593674.3	4798114.6	123.6	5.2
BH2	593607.5	4798048.0	122.2	5.2
BH3	593617.4	4798048.0	121.5	5.2
BH/MW4	593585.6	4797995.4	121.8	5.2
BH/MW5	593657.0	4798076.9	121.1	5.2
BH6	593645.6	4798052.5	120.7	5.2
BH7	593624.7	4798007.4	121.0	5.2
BH8	593599.7	4797960.0	120.8	5.2
BH9	593702.3	4798068.8	120.2	5.2
BH10	593670.0	4797996.3	119.4	5.2
BH11	593660.5	4797924.4	118.5	5.2
BH12	593734.9	4798009.4	116.7	5.2

*mbgs = metre below ground surface

The ground surface elevations and co-ordinates at each borehole location were surveyed by Wood, using NAD83 horizontal datum and CGVD28:78 (1978) vertical datum.

Boreholes were advanced using a track mounted drilling rig. The drilling rig was outfitted with 150 millimetre ("mm") solid stem augers.

Prior to intrusive activities, proposed borehole locations were marked out and utility clearance requests submitted to Ontario One Call and a private utility locator. Boreholes were repositioned where required to avoid conflict with underground utilities.

The drilling, sampling, and testing operations were conducted by Davis Drilling Limited of Milton, Ontario under the direction of Wood personnel who logged the various soil strata. All soil samples and auger cuttings were visually examined and classified in the field. Groundwater and drilling conditions, as well as any pertinent subsurface observations, were also recorded during drilling progression.

Samples were obtained through the overburden, by driving a standard split spoon-sampling device in accordance with the requirements of the Standard Penetration Resistance Test (ASTM D1586). This consisted of freely dropping a 63.5 kg (140 lb) hammer for a vertical distance of 0.76 m (30 inches) to drive a 51 mm (2 inch) diameter O.D. split-barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m (12 inches) was recorded as SPT 'N' value of the soil which indicated the consistency of cohesive soils or the compactness of non-cohesive soils.

Upon completion, the boreholes were backfilled to grade with a bentonite and cutting mixture in accordance with the requirements of Ontario Regulation 903, as amended.

Detailed borehole logs summarizing the sampling, field testing, laboratory test results, and subsurface conditions encountered at the borehole locations are presented in Appendix B.

5.2 Soil Classification Tests

The soil samples collected were returned to a Wood's Burlington laboratory for visual examination and further classification. The moisture content of each sample was determined and is indicated on the Record of Borehole Logs (Appendix A). In addition to moisture contents (ASTM D2216), four soil samples were submitted for grain size distribution including hydrometer testing of fine-grained soils (ASTM D7928 and D6913), and four soil samples (BH3 SS4, BH/MW4 SS2, BH/MW5 SS3, BH10 SS2) were submitted for Atterberg Limits (ASTM D4318).

Laboratory testing results of these samples are attached in Appendix B, and summarized in the table below.

Table 5-2: Results of Soil Classification Tests

BH	Sample	Depth (m)	Particle Size Distribution				Atterberg Limits			USCS Modified Group Symbol
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	
BH3	SS4	2.3-2.9	5	14	40	41	30	18	12	CI
BH/MW4	SS2	0.8-1.4	0	11	42	47	32	17	15	CI
BH/MW5	SS3	1.5-2.1	3	11	41	45	30	18	12	CI
BH10	SS2	0.8-1.4	1	10	39	50	34	18	16	CI

CI – Inorganic Clays of Medium Plasticity

All soil samples will be retained for three (3) months, and then disposed of unless a longer holding period is requested by the City.

6.0 General Subsurface Conditions

For a description of the soils and ground water conditions encountered at each borehole location during this investigation, reference should be made to the Record of Borehole Logs in Appendix A.

The following written descriptions are given to enhance the understanding of the individual sheets provided in Appendix A.

6.1 Topsoil/Surface Organics

Topsoil/ surface organics was encountered in all boreholes, with the exception of BH/MW4 and BH7. The measured topsoil thickness was measured 150 to 230 mm. It should be noted that testing for organic content was not carried out on the topsoil samples. Therefore, no commentary can be made as to the suitability of materials described as topsoil to support vegetation.

6.2 Fill

Silty clay, clayey silt and silt fill underlaid the topsoil/surface organics in all boreholes, except at boreholes BH/MW4 and BH10. The fill consisted of silty clay, clayey silt or silt. The fill layers extended to depths ranging from 0.2 to 3.7 m below existing ground surface (mbgs). The table below provides the fill depths and consistency or compactness at each location.

Table 6-1: Summary of Fill Material

BH #	Thickness (m)	Fill Base Elevation (geodetic datum / mbgs)	Fill Material	SPT 'N' Value (blows/0.3m)	Consistency/ Compactness
BH1	0.9	122.6 / 1.1	Silty Clay	10	Stiff
BH2	1.8	120.2 / 2.0	Clayey Silt	9,14,13	Stiff
BH3	0.5	120.9 / 0.7	Silt	7	Loose
BH/MW5	0.5	120.4 / 0.7	Clayey Silt	9	Stiff
BH6	0.5	120.1 / 0.7	Clayey Silt	7	Firm
BH7	0.2	120.8 / 0.2	Clayey Silt	N/A	N/A
BH8	0.1	120.5 / 0.3	Clayey Silt	11	Stiff
BH9	0.5	119.5 / 0.7	Clayey Silt	9	Stiff
BH11	0.5	117.8 / 0.7	Clayey Silt	7	Firm
BH12	3.5	113.0 / 3.7	Silty Clay	5, 6,13,16,8	Firm to Very Stiff

The fills are brown or grey in colouration and generally contained trace to some gravel, sand, clay and brick.

SPT testing yielded 'N' values ranging from 6 blows to 16 blows for 0.3 m of penetration. Natural moisture contents of the fills were between 4% and 26%.

6.3 Silty Clay

Native brown/mottled brown silty clay was encountered in boreholes BH2, BH3, BH/MW4, BH6 and BH11. Laboratory test results performed on one sample (BH/MW4 SS2) within this layer indicated silty clay with intermediate plasticity. Summaries of the results of the particle size analyses and Atterberg Limit determinations were presented in Table 5-2 of report Section 5.2.

The silty clay generally contained trace to some amounts of sand and trace gravel. The silty clay layers varied in thickness from 0.7 to 1.5 m.

SPT testing yielded 'N' values of 8 to 29 blows for 0.3 m of penetration, indicating firm to very stiff consistency. Natural moisture contents of the silty clay samples were between 14% and 25%.

6.4 Silty Clay Till

All boreholes were terminated in a deposit of native brown and/or grey silty clay till, which was encountered below the fill or silty clay. The silty clay till generally contained trace to some amounts of sand and trace gravel. The results of a particle size analysis carried out on three samples of silty clay till (BH3 SS4, BH5 SS3 and BH10 SS2) were presented in Table 5-2 of report Section 5.2.

SPT testing yielded 'N' values of 8 to 39 blows for 0.3 m of penetration, indicating firm to hard consistency. Natural moisture contents of the silty clay till samples were between 13% and 26%.

Although cobbles and boulders were not specifically encountered within the silty clay till, their presence should be anticipated based on the depositional history of these materials.

6.5 Groundwater Conditions

During and upon completion of drilling, observations were made including when water was encountered during sampling, water level upon completion, and whether any cave was present prior to backfilling. The following table summarizes these observations, along with water levels taken on October 27, 2021.

Table 6-2: Borehole Cave and Groundwater Observations

Location	Borehole Cave Depth Below Ground Surface / Elevation (mbgs) / (m)	Water Level Below Ground Surface / Elevation (mbgs) / (m)			
		Upon Completion*	October 27, 2021	November 2, 2021	November 5, 2021
BH1	open	dry	-	-	-
BH2	open	dry	-	-	-
BH3	open	dry	-	-	-
BH/MW4	open	dry	0.49/121.31	0.56/121.24	0.73/121.07
BH/MW5	open	dry	1.01/120.09	1.25/119.85	1.55/119.55
BH6	open	dry	-	-	-
BH7	open	dry	-	-	-
BH8	open	dry	-	-	-
BH9	open	dry	-	-	-
BH10	open	dry	-	-	-
BH11	open	dry	-	-	-
BH12	open	dry	-	-	-

Dry indicates an absence of visible seepage such that the groundwater level could not be established during the short time the borehole was open. The encountered groundwater levels are considered short-term and not indicative of stabilized or long-term readings. It should be noted that the groundwater conditions will vary subject to weather and seasonal fluctuations.

7 Slope Stability

7.1 Assessment of Existing Conditions -Visual Inspection

A visual inspection of the western limits of the site, which borders a tributary of Indian Creek, was conducted on August 27, 2021, by a Senior Geotechnical Engineer from Wood. The slope was inspected using the methodology from the Ministry of Natural Resources Technical Guide – River and Streams: Erosion Hazards Limits (2002). The slope was divided into three areas which had similar characteristics, denoted by A, B, and C as shown on the attached Figure 2.

The northern (Area A – adjacent the proposed stormwater management facility (SWMF)) and southern portions (Area C) of the slope were more gradual in nature compared to Area B. The slope of Area A and B was well vegetated and covered with either heavy scrub or forested with matured trees. No seepage or erosion features noted. The instability rating as per MNR Erosion Hazard Guide for Areas A and C is 'low'. No signs of slope instability were observed in the northern and southern portion. See slope stability rating in Appendix C.

The central part (Area B) of the slope along the SWMF appeared to be the steepest section. The slope was generally well vegetated and covered with either heavy shrubs or forested with mature trees. Localized areas were bare or lightly vegetated. No seepage areas were visible. Localized toe erosion features were observed. The instability rating as per MNR Erosion Hazard Guide for Area B is 'Slight'. See slope stability rating in Appendix C.

7.2 Slope Stability Analyses

The slope stability of two sections in the northern and central portions were analysed using SLOPE/W Version 8, a limiting equilibrium slope stability software with the GeoStudio 2016 package produced by Geoslope, a Seequent Solutions company. The slope geometry was modelled using cross section developed from the existing site survey used for Wood ProjectNo. TP110458 and conducted by MacKay, MacKay & Peters Limited (December 21, 2017). This survey was supplemented with LiDAR data obtained from Land Information Ontario's LiDAR DTM Halton 2018 Package B dataset. Deep-seated failures were examined using long-term (drained) analyses as it was found to be the most critical. Soil lithography was based on the nearest geotechnical boreholes (BH/MW-4 and BH-8). Soil parameters used for slope stability analysis were based on results of the geotechnical investigation and local experience.

A summary of the soil properties used in the analyses is provided in the following table.

Table 7-1: Geotechnical Parameters for Slope Stability Analyses – Existing Soils

Soil Type	Total Unit Weight, γ (kN/m^3)	Undrained Shear Strength, s_u (kPa)	Total Stress Friction Angle, ϕ_u (°)	Effective Stress Cohesion, c' (kPa)	Effective Stress Friction Angle, ϕ' (°)
V. Stiff Silty Clay Till	22	-	-	5	34

The Morgenstern-Price limit equilibrium method was used for the slope stability analyses. The slope stability models are provided in Appendix D.

The Ontario Ministry of Natural Resources (MNR) Technical Guide provides a minimum recommended design Factor of Safety for different land uses and associated risk to property and life. Based on the future land use (commercial building and storm water management facility), Category C 'Active Use' a design minimum factor of safety of 1.30 to 1.50 is recommended. A minimum 1.4 will be used as the criteria in this report.

Two sections were chosen for analysis as shown on Figure 2, 'A-A' and 'B-B'. These were selected as 'B-B' was the most adverse section, and 'A-A' as the transition between Area A and B. A summary of the slope results is listed in the table below.

Table 7-2: Slope Stability Analyses Results

Section	Condition	Factor of Safety Against Slope Instability	Figure
A-A	Existing	1.54	D.1
B-B	Existing	1.34	D.2

Based on the analysis, the existing slope at section A-A has the minimum required factor of safety against instability, while section B-B is marginally lower than the minimum required. Therefore, the physical top of slope is the long-term stable top of slope for at section A-A, while a section B-B a setback would be required to denote the long term stable top of slope.

In addition to the slope stability analysis, the MNR Guidelines requires consideration to toe erosion and an access allowance as this is considered a confined system. The overall "erosion hazard limit" is defined as the sum of:

"toe erosion allowance" + "allowance for stable slope" + "erosion access allowance".

The determinations of the respective allowances are described in the following paragraphs.

Toe Erosion Allowance

At Area A and C, the stream is shallow, narrow, slow flowing and at a distance less than 15 m from the slope toe. No evidence of active erosion was present along the slope toe from the creek. Based on the silty clay till soil type inferred to be in the stream bank and a bankfull width of less than 5 m, a toe erosion allowance of 1 m is conservatively applied as per Table 3 in MNR Technical Guide for Tills with no active erosion.

At Area B, the stream is shallow, narrow, slow flowing and at a distance less than 15 m from the slope toe. Localized toe erosion was observed. Based on the silty clay till soil type inferred to be in the stream bank, a toe erosion allowance of 5 m is conservatively applied as per Table 3 in MNR Technical Guide for Tills with active erosion.

Allowance for Stable Slope

The topography at cross section A-A was used to mode the most adverse condition within Area A and C. Based on the results of the slope stability analysis, the physical top of slope can be considered the long-term stable top of slope.

The topography at cross section B-B was used to model the most adverse condition within Area B. Based on the results of the slope stability analysis, an additional setback of 3 m is required as an allowance for stable slope. This setback was determined where the minimum factor of safety slip surface (of 1.4) would originate behind the physical top of slope.

Erosion Access Allowance

According to Conservation Halton requirements, the erosion access allowance is 7.5 m from the "Stable Top of Slope". Therefore, the required erosion hazard setback for Area A and C is 8.5 m, and for Area B, 15.5 m.

8 Discussion and Recommendations

It is understood, the major site works associated with construction of the storm water management facility will include excavating the dry pond, construction of a headwall at the north side of the pond, along with an oil/grit separator.

The field investigation consisted of sampled boreholes at 12 locations, installation of two monitoring wells, and infiltration testing at two (2) locations. A visual slope inspection and slope stability analyses of the existing conditions were also carried out.

The following subsections provide discussion and recommendations for anticipated works for use in design.

8.1 Foundations

Within and adjacent the dry pond potential structures include an oil/grit separator, a maintenance hole, concrete headwall, and stormwater management facility. As locations and founding elevations are not available, general foundation discussion will be provided.

Boreholes BH2, BH3, BH/MW4, BH/MW5, BH6, and BH7 were advanced within or in close proximity to the proposed storm water management facility. In general the soils consisted of topsoil at surface underlain by silty clay / clayey silt fill up to 2.0 m thick, but on average 0.5 m thick. Underlying the fill was firm to stiff native silty clay up to 1.4 m thick over firm to hard silty clay till. The topsoil and fills are not suitable materials to found upon. Foundations should be placed on native soils. Recommended bearing capacities for structures within or associated with the stormwater management facility, along with elevations encountered for the silty clay and silty clay till are provided per borehole in the table below. Wood should be consulted for site-specific foundation recommendations if other structures, including buildings, are to be erected on this site.

Table 8-1: Recommended Founding Grades and Geotechnical Resistances

BH#	Depth Below Existing Grade / Elevation (m)	Founding Stratum	Factored Ultimate Geotechnical Resistance at ULS (kPa)	Serviceability Geotechnical Resistance at SLS (kPa)
BH2	2 to 3 m / 120.2 to 119.2	Stiff silty clay	150	100
	3 to 4 m / 119.2 to 118.2	Very stiff silty clay till	300	200
BH3	1.2 to 2.2 m / 120.3 to 119.3	Very stiff silty clay	275	175
	2.2 to 4 m / 119.3 to 117.6	Hard silty clay till	300	200
BH4/MW	1.2 to 4 m / 120.6 to 117.9	Very stiff silty clay / very stiff to hard silty clay till	300	200
BH5/MW	1.2 to 4 m / 119.9 to 117.1	Very stiff to hard silty clay till	300	200
BH6	1.2 to 2.2 m / 119.5 to 118.5	Stiff silty clay to very stiff silty clay till	225	150
	2.2 m to 4 m / 118.5 to 116.7	Firm to stiff silty clay till	150	100
BH7	1.2 to 4 m / 119.8 to 117.0	Stiff to very stiff silty clay till	225	150

For founding depths below those provided in the table above, please consult with the geotechnical engineer to verify values. The geotechnical pressure values provided in the above noted table are intended to assess the feasibility and sizes of footings and are for vertical loads (no inclination) without load eccentricity. The ULS values will be less than those stated if inclined or eccentric loading conditions exist. The SLS value

provided should correspond to not more than 25 mm of total settlement with 10 mm to 15 mm of differential settlement.

The design frost depth penetration is 1.2 m below grade (OPSD 3090.101). All foundations should be covered by at least 1.2 m deep soil or equivalent synthetic thermal insulation.

8.1.1 Bedding for Appurtenances

It is anticipated that the headwall may be installed directly on the foundation soils without use of bedding. The maintenance hole is to be provided with 150 mm of granular bedding in accordance with OPSS 402. The bedding thickness for the oil/grit separator should be no less than 300 mm or as specified by the manufacturer/supplier. The bedding should comprise Granular 'A' (OPSS1010) compacted to 98% Standard Proctor Maximum Dry Density (SPMDD). The bedding material must extend beyond the footprint of the maintenance hole or oil/grit separator.

8.1.2 Lateral/Sliding Resistance

The resistance to sliding or horizontal/lateral resistance between the underside of the headwall footing, or base slabs of the oil/grit separator and maintenance hole should consider the appropriate interactions. In the case of cast-in-place (CIP) footings on native soil, the bond between the underside of the footing and the soil will be so rough that failure will occur in the soil beneath the footing. If a pre-cast foundation is used, the critical interaction will be the interface of the underside of the footing and the foundation soil, be it granular bedding or native soil. It is likely that the headwall, maintenance hole and oil/grit separator will all be pre-cast structures. The values in Table 8-2 assume that the foundation soils are not disturbed or loosened during excavation and footing construction.

Table 8-2: Summary of Parameters for Lateral Resistance

Interaction	Foundation Soil	Angle of Internal Friction, ϕ (°)	Angle of Interface Friction, δ (°)	Coefficient of Internal Friction, tan ϕ (°)	Coefficient of Interface Friction, tan δ (°)
CIP footing on native soil	Stiff to very stiff silty clay	28	-	0.53	-
	Stiff to hard silty clay till	30	-	0.58	-
Pre-cast footing on granular bedding	Granular A bedding	-	30	-	0.58
Pre-cast footing on native soil	Stiff to very stiff silty clay	-	26	-	0.49
	Stiff to hard silty clay till	-	28	-	0.53

Cohesion should be neglected in the calculation of lateral resistance.

8.2 Lateral Earth Pressure

Lateral earth pressures will be exerted on or by the backfill and soil adjacent to the walls of buried structures and retaining walls. Backfill placed behind buried structures and retaining walls should consist of free-

draining granular soil, compacted to a minimum of 98% of Standard Proctor Maximum Dry Density (ASTM D698). Backfill should be placed in loose lifts with a maximum thickness of 200 mm.

Based on a well compacted and drained backfill soil, the headwall and walls of any other buried structure should be designed to resist the horizontal pressure acting on the wall. The horizontal pressure P, at depth h, may be estimated using the following:

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

Where:

K	=	Lateral Earth Pressure
γ	=	unit weight
h	=	depth below final grade (m)
q	=	surcharge load (kPa), if present, plus 12 kPa due to heavy compaction equipment

The following are the recommended values for various materials are presented in the table below.

Table 8-3: Recommended Material Properties / Parameters for Lateral Earth Pressure

Material	Angle of internal friction (Φ') (°)	Bulk Unit Weight* (kN/m^3)	Active earth coefficient (K_a)	Passive earth coefficient (K_p)	At rest earth coefficient (K_o)
Granular 'A'	35	22	0.27	3.7	0.43
Granular 'B' Type I	32	21	0.31	3.3	0.47
Granular 'B' Type II	35	22	0.27	3.7	0.43
Silty Clay	28	20	0.36	2.8	0.53
Silty Clay Till	30	21	0.33	3.0	0.50

*If below groundwater level, effective unit weight ($\gamma = \gamma_b - \gamma_w$).

8.3 Excavations

Excavations for the dry pond and any associated structures will encounter different soil types including topsoil, fills, native silty clay / clayey silt, and silty clay till.

Excavations are expected to proceed below the groundwater level for all site works. Additional details are provided in Section 8.4 and the Preliminary Hydrogeological Assessment (Section 9.0).

It is anticipated excavations within topsoil, fills, native silty clay / clayey silt, and silty clay till can be completed using conventional excavation equipment. The presence of cobbles and/or boulders within the silty clay till are possible although not encountered during the investigation.

All excavations must comply with the current Occupational Health & Safety Act and Regulations for Construction Projects (OHSARCP). The side slopes of any excavations through the overburden, deeper than 1.2 metres, must be sloped as outlined in the Act. Based on the criteria in the Act, all fills must be considered as Type 3 soils, and Type 4 if saturated. The native silty clay / clayey silt and silty clay till is considered to be Type 2. Excavations within Type 2 soils may be carried out with unsupported side slopes that are sloped to 1.2 m or less from its bottom with a slope no steeper than 1H (horizontal) to 1V (vertical). The walls of

excavations in Type 3 soils should be 1H:1V or flatter. Some flattening of excavation sides may be required if saturated fills are encountered. For Type 4 soils, temporary side slopes of 3H to 1V from the base of the excavation are required by the OHSARCP. The designation must be verified onsite by qualified personnel during excavation.

If there is insufficient space to accommodate proper sloping of the excavation temporary shoring may be employed and is to meet OHSARCP.

8.3.1 Reuse of Excavated Soils

Topsoil, and any zones in the fill with high organic content are not suitable for reuse as engineered fill.

The existing granular fill is too silty to be reused as structural backfill. It may be used for general backfill or grade changes but not to serve as a base under any structural element / footing, within the MSEW, or directly behind a retaining wall.

The silty clay / clayey silt and silty clay till is considered suitable for reuse as fill, provided it can be properly compacted. Generally, heavy compaction equipment must be used in order to break-up and thoroughly re-compact clayey soils to prevent post-construction settlement. The soils must also be at suitable moisture contents for re-compaction. Typically, the optimum moisture content for clayey soils for recompaction is about 18%. The moisture contents recorded for the silty clay / silty clay till within the expected excavation limits varies from 13 to 25%, therefore, some moisture conditioning maybe required.

It is generally difficult to adequately place and compact cohesive soils in small, confined areas such as trenches. It may be more practical to import a granular fill, such as Granular 'A' where fill is needed within trenches.

8.4 Groundwater Control During Construction

Surface water should be directed away from the excavations and areas of structure backfill at all times. If conditions are similar to those observed during drilling boreholes of site investigation, groundwater inflow into the excavations within 3 meters of ground surface are expected to be low. Monitoring wells indicate static water levels within this depth and there is a potential for a higher inflow if any silt or sand layers are encountered within the excavation depth. It is anticipated inflows can be handled with the use of properly filtered sumps placed strategically within excavations and outside the footprints of any foundations.

8.5 Pipe Bedding, Cover and Backfill

8.5.1 Standard Requirements

The bedding and backfill material should meet the manufacturer's specifications as well as the applicable Ontario Provincial Standard Specifications (OPSS) standards.

Applicable OPSS standards may include:

- OPSS.MUNI 401 "Construction Specifications for Trenching, Backfilling, and Compacting"
- OPSS.MUNI 410 "Construction Specifications for Pipe Sewer Installation in Open Cut"

8.5.2 Pipe Bedding and Cover

For open-cut installation, the depth of the pipe bedding should be a minimum of 150 mm, and the pipe cover should be completed to at least 300 mm above the pipe crown. All bedding, clearance and cover materials should consist of Granular 'A' (OPSS 1010) compacted to 95% SPMDD in accordance with the OPSS.MUNI 410 requirements.

Care should be exercised to avoid compaction methods that may damage the pipe. The placement and thickness of the granular bedding should meet the pipe manufacturer's specifications.

8.5.3 Trench Backfilling

Backfill material from 300 mm above the top of pipe to surface level can consist of compactable native silty clay / clayey silt or imported Granular 'A' or 'B' Type I, and placed in lifts not to exceed 200 mm and compacted to 98% SPMDD.

9 Preliminary Hydrogeological Assessment

A preliminary hydrogeological assessment has been conducted to assess the hydrogeological conditions at the site. This included the installation of monitoring wells for groundwater level monitoring and hydraulic conductivity testing. Two (2) infiltration tests were intended to be completed. However due to high groundwater levels, the results of the testing were not deemed to be representative.

9.1 Monitoring Well Construction

To provide hydrogeological information, monitoring wells were installed within BH/MW-04 and BH/MW-05. The monitoring wells were constructed within the open borehole at the completion of drilling to the borehole depth. A 0.05 m (2") inside diameter PVC riser pipe with a 3 m length of 10-slot screen was set to the bottom of the open hole. No. 2 Silica sand was poured into the borehole to fill the borehole's annulus from the bottom of the screen to approximately 0.3 m above the screen. Bentonite was then poured into the borehole to approximately 0.5 m below ground surface. The bentonite was hydrated to provide a seal from the ground surface. The monitoring wells were completed with lockable J-plug caps and protective stick-up steel casings embedded in concrete. The wells were tagged and labelled in accordance with Ontario Regulation 903 (O. Reg. 903) of the Ontario Water Resources Act by the well drillers and the water well records were submitted to the MECP by the drilling subcontractor.

9.2 Infiltration Testing

As part of the drilling program, two (2) shallow boreholes (BH4A, BH5A) were advanced on September 28, 2021 using a track mounted drill rig to a depth of approximately 3 m depth for the purposes of conducting infiltration testing. The depth was selected based on the maximum depth of the infiltration testing equipment and the approximate depth of the proposed dry pond. The boreholes were advanced directly adjacent to boreholes BH4 and BH5 as described in Section 5. The boreholes were approximately 10 cm in diameter.

Infiltration testing was conducted following the boreholes being drilled on September 28, 2021 in order to determine the field saturated hydraulic conductivity and an estimate of infiltrate rates. However the testing yielded low hydraulic conductivity results and subsequently upon obtaining stabilized groundwater levels in the monitoring wells at these locations, it was determined that the infiltration testing results were not representative as the depths tested were below the groundwater level.

9.3 Hydraulic Conductivity Testing

Hydraulic conductivity testing (single well response slug tests) was conducted within BH/MW4 and BH/MW5 on November 2, 2021. For each of the slug tests, a non-vented pressure transducer programmed to record pressure at 10 second intervals was placed in the monitoring well and recorded the water level recovery. Manual water levels were measured in the monitoring well at the beginning, during, and end of each slug test to corroborate the transducer's pressure data, which provided a continuous record of the water level in the monitoring well during the test.

The hydraulic conductivity testing consisted of completing a rising head test in BH/MW4 and BH/MW5. The rising head tests were conducted by removing a volume of water over a short time period using a Waterra® inertial lift pump and allowing the water level to recover back to natural equilibrium.

The recovery data were analyzed using the Bouwer-Rice method (Bouwer & Rice, 1976) in AQTESOLV version 4.5. The software incorporates water level data collected during the hydraulic conductivity testing as well as monitoring well construction details in the estimation of the hydraulic conductivity of the screened soils. The results of the hydraulic conductivity testing are presented in Table 9-1 below.

Table 9-1: Hydraulic Conductivity Testing Results

Borehole No.	Test Type	Hydraulic Conductivity (m/s)	Screened Soil[1]
BH/MW4	Rising Head	2.7×10^{-8}	Silty Clay Till
BH/MW5	Rising Head	2.6×10^{-8}	Silty Clay Till

Notes: [1] From borehole logs.

The hydraulic conductivities estimated are 2.7×10^{-8} m/s at BH/MW4, and 2.6×10^{-8} at BH/MW5. It is noted that this hydraulic conductivity would be a measure of horizontal hydraulic conductivity. The full results of the analysis are found in Appendix E. The hydraulic conductivity results are within expected ranges of hydraulic conductivity values for the testing completed in the described screened soil conditions. The hydraulic conductivities are representative of the screened clayey soils. It should be noted that more or less permeable soils may be encountered during construction.

9.4 Hydrogeological Considerations

The findings of the geotechnical investigation and preliminary hydrogeological assessment indicates that a high groundwater table exists on the site, however the soils are generally silty clay till soils which will act as an aquitard. The presence of this high-water table will restrict the potential for low impact development (LID) measures to be utilized on the site. It may be possible for limited infiltration to occur at areas of higher elevation, however this is limited by the low hydraulic conductivity and thus low infiltration rate that would be expected.

For any excavation, either temporary or permanent as in the proposed dry pond, these excavations will receive a low rate of seepage from groundwater. Overtime the excavation would fill up to the normal groundwater level if the excavation does not have a free draining outlet and or is not pumped out. This low rate of seepage would not likely affect the function of the dry pond as the pond's volume would be significantly larger and the outlet would allow water to exit the pond quicker than the groundwater would seep into the pond.

It is noted that the proposed dry pond would result in a slight lowering of the groundwater levels in the vicinity of the pond. However due to the low hydraulic conductivity of the soils, this reduction would be limited to an area several meters surrounding the pond and normal groundwater level would be expected elsewhere unless effected by other conditions on the site.

10 Closure

Attached in Appendix F is a document prepared by the Geo-Professional Business Association (GBA) that provides important information regarding studies of the type performed. Also included in Appendix F is our Standard Limitations to Geotechnical Reports which is intended to clarify the scope and assumptions used in the preparation of this study.

We trust that this report is complete within our present terms of reference. If you have any questions, please do not hesitate to contact our office.

Yours very truly,

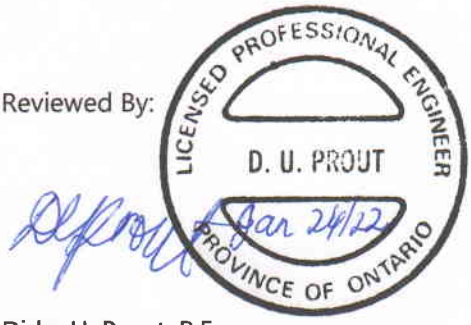
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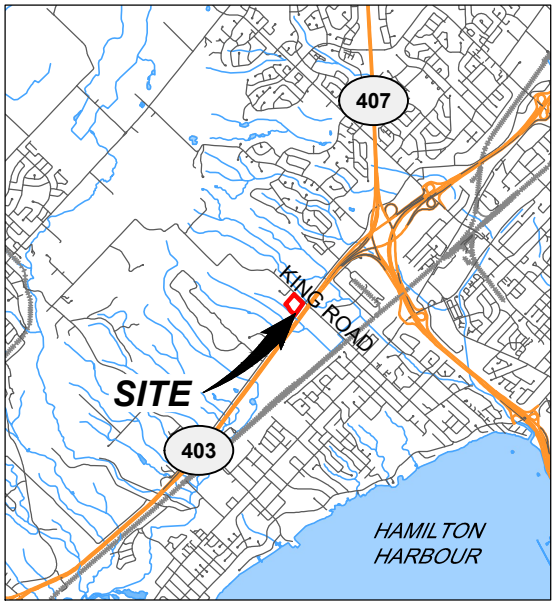
Taiwo Fowler, M.A.Sc.
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Hydrogeologist-in-Training

SI/TW/TR/NS/DUP/si/tf/tr
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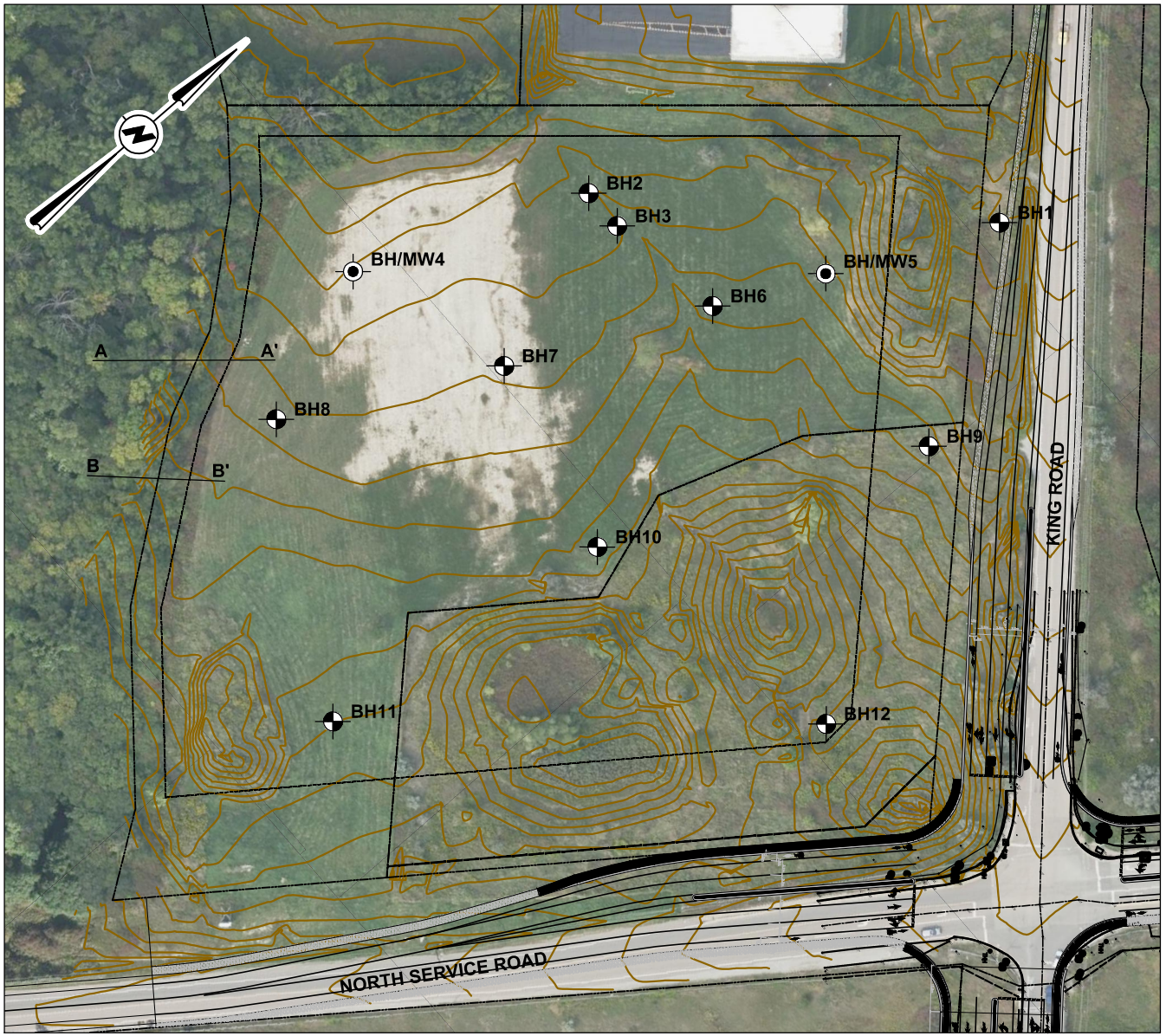
Figures



KEY PLAN

0 10 30 50m

SCALE 1:1,500



LEGEND:

- BOREHOLE LOCATION
- BOREHOLE/MONITORING WELL LOCATION

NOTES:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS REPORT No. WW21012079.

ALL LOCATIONS ARE APPROXIMATE ONLY.

REFERENCES:
BING IMAGERY AS OF NOVEMBER 22, 2021 (IMAGE DATE UNKNOWN), BING IMAGERY USED FOR ILLUSTRATION PURPOSES ONLY AND NOT TO BE USED FOR MEASUREMENTS.

CLIENT:
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wood.

DWN BY: LMK
CHK'D BY: TR
DATUM: NAD83
PROJECTION: UTM Zone 17
SCALE: 1:1,500

PROJECT:
SLOPE STABILITY
1450 KING ROAD
BURLINGTON, ONTARIO

DATE: NOV. 23, 2021
PROJECT No: WW21012079

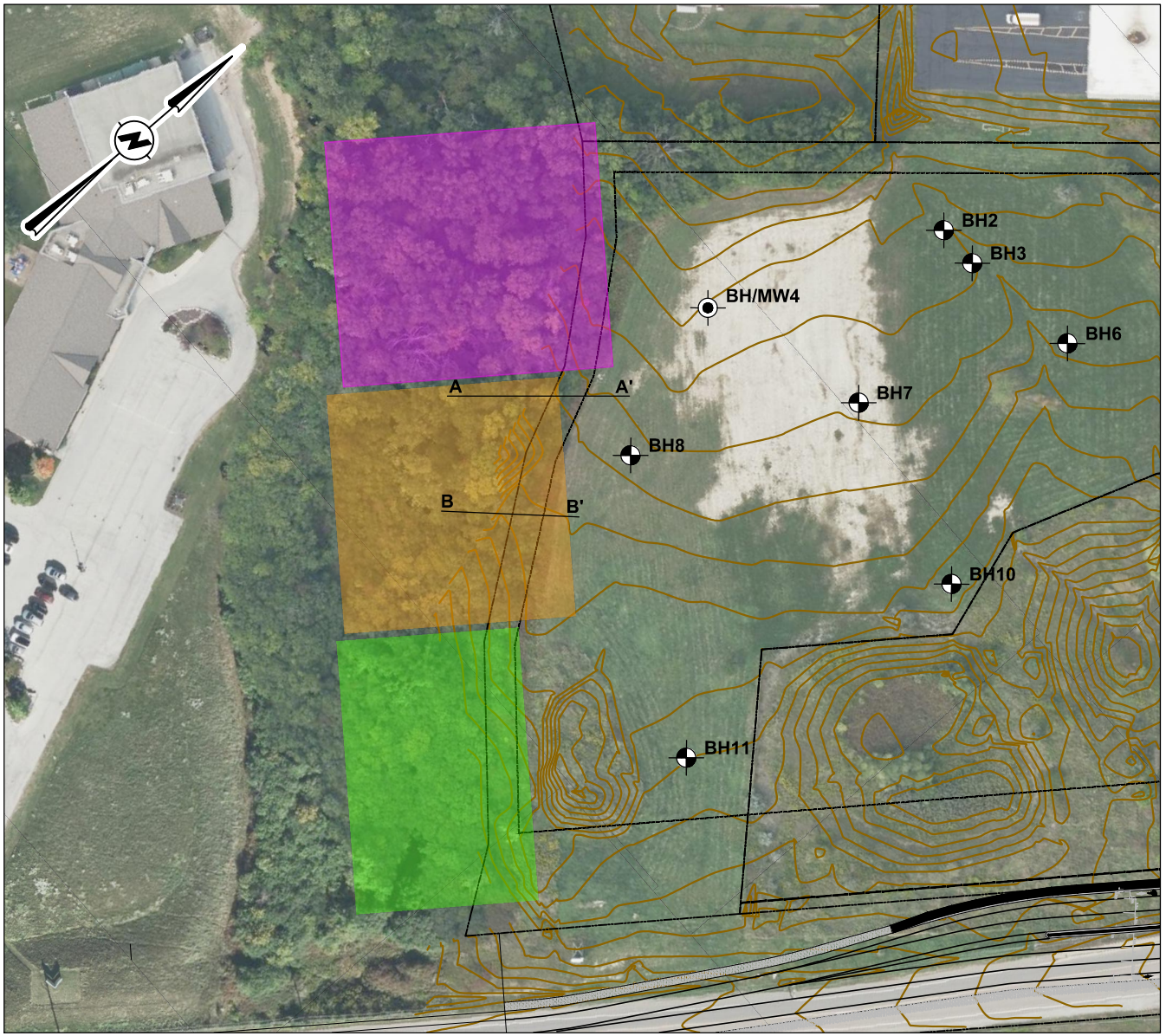
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BOREHOLE LOCATION PLAN

REV. No: 0
FIGURE No: 1

DATE PLOTTED: 11/23/2021 2:04:43 PM
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0 10 30 50m

SCALE 1:1,500



LEGEND:

- BOREHOLE LOCATION
- BOREHOLE/MONITORING WELL LOCATION
- AREA: A
- AREA: B
- AREA: C

NOTES:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE WOOD ENVIRONMENT & INFRASTRUCTURE SOLUTIONS REPORT No. WW21012079.

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wood.

DWN BY: LMK
CHK'D BY: TR
DATUM: NAD83
PROJECTION: UTM Zone 17
SCALE: 1:1500

PROJECT:
SLOPE STABILITY
1450 KING ROAD
BURLINGTON, ONTARIO

TITLE:
SLOPE STABILITY SECTION

DATE: NOV. 23, 2021
PROJECT No: WW21012079
REV. No: 0
FIGURE No: 2

DATE PLOTTED: 11/23/2021 1:58:05 PM
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Appendix A

EXPLANATION OF BOREHOLE LOG

This form describes some of the information provided on the borehole logs, which is based primarily on examination of the recovered samples, and the results of the field and laboratory tests. Additional description of the soil/rock encountered is given in the accompanying geotechnical report.

GENERAL INFORMATION

Project details, borehole number, location coordinates and type of drilling equipment used are given at the top of the borehole log.

SOIL LITHOLOGY

Elevation and Depth

This column gives the elevation and depth of inferred geologic layers. The elevation is referred to the datum shown in the Description column.

Lithology Plot

This column presents a graphic depiction of the soil and rock stratigraphy encountered within the borehole.

Description

This column gives a description of the soil stratums, based on visual and tactile examination of the samples augmented with field and laboratory test results. Each stratum is described according to the *Modified Unified Soil Classification System* (modified slightly so that an inorganic clay of "medium plasticity" is recognized).

The compactness condition of cohesionless soils based on standard penetration testing (SPT) and the consistency of cohesive soils (undrained shear strength) are defined as follows *(Ref. Canadian Foundation Engineering Manual, 4th Edition, 2006)*:

Compactness of Cohesionless Soils	SPT N-Value
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

Consistency of Cohesive Soils	Unconfined Compressive Strength	
	kPa	psf
Very Soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very Stiff	100 to 200	2000 to 4000
Hard	> 200	> 4000

SOIL SAMPLING

Sample types are abbreviated as follows:

SS	Split Spoon	TW	Thin Walled Open (Pushed)	RC	Rock Core	GS	Grab Sample
AS	Auger Sample	TP	Thin Walled Piston (Pushed)	WS	Washed Sample	AR	Air Return Sample

Additional information provided in this section includes sample numbering, sample recovery (%) and numerical testing results (SPT).

FIELD AND LABORATORY SAMPLING

Results of field testing (e.g., SPT, pocket penetrometer, and vane testing) and laboratory testing (e.g., natural moisture content, and limits) executed on the recovered samples are plotted in this section.

Definitions of Penetration Resistance

Standard penetration resistance 'N' – The number of blows required to advance a standard split spoon sampler 30 cm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 76 cm.

Dynamic penetration resistance – The number of blows required to advance a 50 mm, 60 degree cone, fitted to the end of drill rods, 30 cm into the subsoil, the driving energy being 474.5 Joules per blow.

INSTRUMENTATION INSTALLATION

Instrumentation installations (monitoring wells, piezometers, inclinometers, etc.) are plotted in this section.

WATER LEVEL

Water levels, if measured during fieldwork, are plotted in the depth/elevation column. These water levels may or may not be representative of the static groundwater level depending on the nature of soil stratum where the piezometer tips are located, the time elapsed from installation to reading and other applicable factors. Other information includes the depth of borehole cave-in, if any. This information is also included in the borehole log footer.

COMMENTS

This column is used to describe non-standard situations or notes of interest.

MODIFIED* UNIFIED SOIL CLASSIFICATION SYSTEM

*The soil of each stratum is described using the Unified Soil Classification System (Technical Memorandum 36-357 prepared by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S Army. Vol. 1, March 1953) modified slightly so that an inorganic clay of "medium plasticity" is recognized.

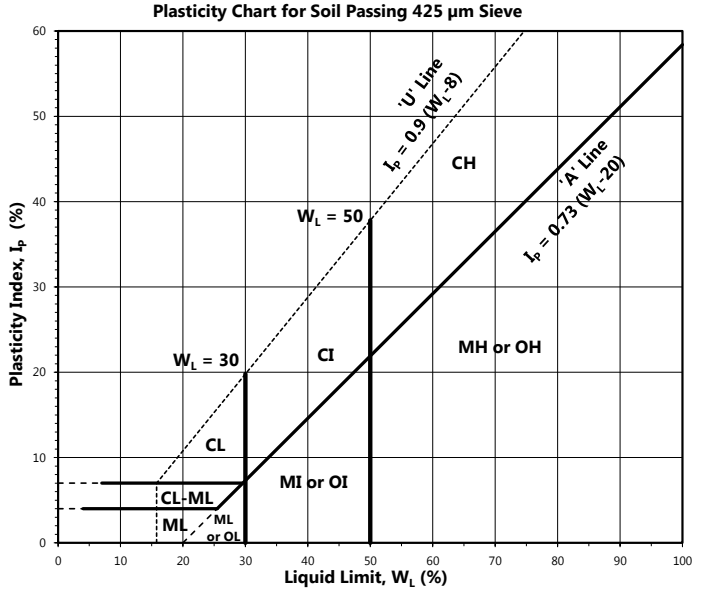
MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm	CLEAN GRAVELS (TRACE OR NO FINES)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (WITH SOME OR MORE FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR I_P LESS THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE OR I_P MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (TRACE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
			SP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (WITH SOME OR MORE FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR I_P LESS THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE OR I_P MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L < 50%	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)
		W_L > 50%	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L < 30%	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	
		30% < W_L < 50%	CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	
		W_L > 50%	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SLTS & CLAYS BELOW "A" LINE	W_L < 50%	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINES CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", e.g. SF IS A MIXTURE OF SAND WITH SILT OR CLAY
		W_L > 50%	OH	ORGANIC CLAYS OF HIGH PLASTICITY	
HIGH ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE

SOIL COMPONENTS

FRACTION	U.S STANDARD SIEVE SIZE			DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		PASSING	RETAINED	PERCENT	DESCRIPTOR
GRAVEL	COARSE	75 mm	19 mm	35 - 50	AND
	FINE	19 mm	4.75 mm	20 - 35	Y/EY
SAND	COARSE	4.75 mm	2.00 mm	10 - 20	SOME
	MEDIUM	2.00 mm	425 µm	1 - 10	TRACE
	FINE	425 µm	75 µm		
FINES (SILT AND CLAY BASED ON PLASTICITY)		75 µm			

OVERSIZED MATERIAL

ROUNDED OR SUBROUNDED:	NOT ROUNDED:
COBBLES 75 mm to 300 mm	ROCK FRAGMENTS > 75 mm
BOULDERS > 300 mm	ROCKS > 0.76 CUBIC METRE IN VOLUME



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MODIFIED USCS

Note 1: Soils are classified and described according to their engineering properties and behaviour.
Note 2: The modifying adjectives used to define the actual or estimated percentage range by weight of minor components are consistent with the Canadian Foundation Engineering Manual (4th Edition, Canadian Geotechnical Society, 2006.)

Rev Date: January 7, 2019

RECORD OF BOREHOLE No. BH1

Project Number: **WW21012079.2000**
Drilling Location: **E: 593674.3 N: 4798114.6**
Project Client: **Quantum Realty Management**
Drilling Method: **150 mm Solid Stem Augers**
Project Name: **1450 King Road Geotechnical Investigation**
Drilling Machine: **Track Mounted Drill**
Project Location: **1450 King Road, Burlington**
Date Started: **Sep 24, 21** Date Completed: **Sep 24, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 123.6 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: □ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) ▲ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	TOPSOIL 150 mm	123.5 0.2										
	Light Brown Silty Clay **FILL** Trace sand, gravel & brick Moist		SS	1	0	10			○			
							1	123				
		122.6	SS	2	75	10			○	17		
	Brown **Silty Clay Till** Some sand, trace gravel Stiff to Hard DTPL	1.1						122				DTPL- Drier than plastic limit APL- Around plastic limit WTPL- Wetter than plastic limit
			SS	3	96	32	2		○	18		
			SS	4	92	39		121	○	19		
							3					
			SS	5	100	31			○	18		
								120				
			SS	6	100	37	4		○	15		
		119.1										
	Grey	4.5						119				
			SS	7	100	31	5		○	16		
		118.5										
	Borehole Terminated	5.2										

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. BH2

Project Number: **WW21012079.2000**
Drilling Location: **E: 593607.5 N: 4798048.0**
Project Client: **Quantum Realty Management**
Drilling Method: **150 mm Solid Stem Augers**
Project Name: **1450 King Road Geotechnical Investigation**
Drilling Machine: **Track Mounted Drill**
Project Location: **1450 King Road, Burlington**
Date Started: **Sep 28, 21** Date Completed: **Sep 28, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

Lithology Plot	DESCRIPTION (Geodetic Ground Surface Elevation: 122.2 m)	Elev.	Depth	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	Field Testing	Lab Testing	Instrumentation / Installation
	TOPSOIL 175 mm	122.0	0.0							
	Light Brown Clayey Silt **FILL** Trace sand & gravel Stiff Moist	121.8	0.2	SS	1	100	9		18	
				SS	2	100	14		13	
		120.2	2.0	SS	3	100	13		20	
	Mottled Brown **Silty Clay** Trace sand and gravel Stiff DTPL	119.2	3.0	SS	4	100	8		20	
	Brown **Silty Clay Till** Trace sand and gravel Very Stiff DTPL	118.4	3.7	SS	5	67	19		15	
	Hard	117.7	4.5	SS	6	100	32		16	
	Very Stiff	117.0	5.2	SS	7	100	27		13	
	Borehole Terminated									

Field Testing: Penetration Testing — ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80

Lab Testing: Soil Vapour Reading — □ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) ▲ TOV (ppm) 100 200 300 400; W_P W W_L; Plastic Liquid; 20 40 60 80

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

DTPL- Drier than plastic limit
APL- Around plastic limit
WTPL- Wetter than plastic limit

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 47

RECORD OF BOREHOLE No. BH3

Project Number: **WW21012079.2000** Drilling Location: **E: 593617.4 N: 4798048.0**

Project Client: **Quantum Realty Management** Drilling Method: **150 mm Solid Stem Augers**

Project Name: **1450 King Road Geotechnical Investigation** Drilling Machine: **Track Mounted Drill**

Project Location: **1450 King Road, Burlington** Date Started: **Sep 28, 21** Date Completed: **Sep 28, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 121.5 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: □ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) ▲ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	TOPSOIL 150 mm	121.4 0.2										
	Light Brown / Grey Silt **FILL** Some Clay & sand Moist	120.9	SS	1	100	7		121	○	○ 14		
	Mottled Brown **Silty Clay** Trace sand & gravel Very Stiff DTPL	0.7	SS	2	100	19	1		○	○ 17		
			SS	3	100	16	2	120	○	○ 25		DTPL- Drier than plastic limit APL- Around plastic limit WTPL- Wetter than plastic limit
	Brown **Silty Clay Till** Some sand, trace gravel Hard DTPL	119.3 2.2	SS	4	100	32		119	○	○ 14		GR 5 SA 14 SI 40 CL 41
			SS	5	100	30	3		○	○ 14		
	Very Stiff	117.8 3.7	SS	6	100	22	4	118	○	○ 15		
			SS	7	100	28	5	117	○	○ 16		
	Borehole Terminated	116.4 5.2										

▽ No freestanding groundwater observed in open borehole upon completion of drilling.

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Scale: 1 : 47

RECORD OF BOREHOLE No. BH4

Project Number:	WW21012079.2000	Drilling Location:	E: 593585.6 N: 4797995.4
Project Client:	Quantum Realty Management	Drilling Method:	150 mm Solid Stem Augers
Project Name:	1450 King Road Geotechnical Investigation	Drilling Machine:	Track Mounted Drill
Project Location:	1450 King Road, Burlington	Date Started: Sep 28, 21	Date Completed: Sep 28, 21

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LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 121.8 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: SPT, PPT, DCPT; MTO Vane* Intact/Remould; Nilcon Vane* Intact/Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: COV (LEL), TOV (LEL) 2 4 6 8; COV (ppm), TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	Brown **Silty Clay** Some sand, trace gravel Very Stiff DTPL	SS	1	96	23			16						
		SS	2	100	29	1	121	17			0	11	42	47
	120.4 Brown **Silty Clay Till** Some sand, trace gravel Hard DTPL	SS	3	100	34	2	120	16						
	119.6 Very Stiff	SS	4	100	25		119	20						
		SS	5	100	29	3		14						
		SS	6	100	23	4	118	15						
		SS	7	100	24	5	117	16						
	116.7 **Borehole Terminated** 5.2													

DTPL- Drier than plastic limit
APL- Around plastic limit
WTPL- Wetter than plastic limit

Water level measurements in 50 mm dia. deep monitoring well: (screen from 3.7 m to 5.2 m)

Date	Depth (m)	Elevation (m)
10/27/2021	0.5	121.3
11/02/2021	0.56	121.2
11/05/2021	0.73	121.1

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

▼ Groundwater depth observed on October 27, 2021 at a depth of: 0.5 m.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

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RECORD OF BOREHOLE No. BH5

Project Number:	WW21012079.2000	Drilling Location:	E: 593657.0 N: 4798076.9
Project Client:	Quantum Realty Management	Drilling Method:	150 mm Solid Stem Augers
Project Name:	1450 King Road Geotechnical Investigation	Drilling Machine:	Track Mounted Drill
Project Location:	1450 King Road, Burlington	Date Started: Sep 28, 21	Date Completed: Sep 28, 21

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Geodetic Ground Surface Elevation: 121.1 m

Depth (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	Elevation (m)	Field Testing (Penetration Testing: SPT, PPT, DCPT; MTO Vane* Intact/Remould; Nilcon Vane* Intact/Remould; * Undrained Shear Strength (kPa) 20 40 60 80)	Lab Testing (Soil Vapour Reading: COV (LEL), TOV (LEL); COV (ppm), TOV (ppm); W_P, W, W_L; Plastic, Liquid)	Instrumentation Installation	Comments & Grain Size Distribution (%) GR SA SI CL
	TOPSOIL 175 mm					120.9				
0.2	Reddish Brown Clayey Silt **FILL** Trace sand Moist	SS	1	75	9			22		
0.7	Brown **Silty Clay Till** Some sand, trace gravel Very Stiff DTPL	SS	2	92	22	120		18		DTPL- Drier than plastic limit APL- Around plastic limit WTPL- Wetter than plastic limit
1.4	Hard	SS	3	100	36	119		13		3 11 41 45
2.2	Very Stiff	SS	4	100	27			15		
		SS	5	100	25	118		15		
		SS	6	100	17	117		17		
4.5	Stiff APL	SS	7	100	14			17		
5.2	**Borehole Terminated**					116				

Water level measurements in 50 mm dia. deep monitoring well: (screen from 3.7 m to 5.2 m)

Date	Depth (m)	Elevation (m)
10/27/2021	1.0	120.1
11/02/2021	1.25	119.9
11/05/2021	1.55	119.6

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

▼ Groundwater depth observed on October 27, 2021 at a depth of: 1.0 m.

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RECORD OF BOREHOLE No. BH6

Project Number: **WW21012079.2000**
Drilling Location: **E: 593645.6 N: 4798052.5**
Project Client: **Quantum Realty Management**
Drilling Method: **150 mm Solid Stem Augers**
Project Name: **1450 King Road Geotechnical Investigation**
Drilling Machine: **Track Mounted Drill**
Project Location: **1450 King Road, Burlington**
Date Started: **Sep 28, 21** Date Completed: **Sep 28, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

Geodetic Ground Surface Elevation: 120.7 m

Lithology Plot	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	FIELD TESTING: Undrained Shear Strength (kPa)	LAB TESTING: Soil Vapour Reading / Plastic & Liquid	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)
	TOPSOIL 175 mm	120.6 / 0.2										GR SA SI CL
	Reddish Brown Clayey Silt **FILL** Trace sand Moist		SS	1	75	7				15		
		120.1 / 0.7						120				
	Brown **Silty Clay** Some sand, trace gravel Stiff DTPL		SS	2	100	12	1			16		
		119.3 / 1.4						119				DTPL- Drier than plastic limit APL- Around plastic limit WTPL- Wetter than plastic limit
	Brown **Silty Clay Till** Some sand, trace gravel Very Stiff DTPL		SS	3	75	17	2			17		
		118.5 / 2.2						118				
	Stiff		SS	4	83	8	3			18		
			SS	5	92	9		117		21		
		116.6 / 4.1					4					
	Very Stiff		SS	6	100	18	5	116		16		
		115.6 / 5.2										
	Borehole Terminated											

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

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RECORD OF BOREHOLE No. BH7

Project Number: **WW21012079.2000** Drilling Location: **E: 593624.7 N: 4798007.4**

Project Client: **Quantum Realty Management** Drilling Method: **150 mm Solid Stem Augers**

Project Name: **1450 King Road Geotechnical Investigation** Drilling Machine: **Track Mounted Drill**

Project Location: **1450 King Road, Burlington** Date Started: **Sep 24, 21** Date Completed: **Sep 24, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

Geodetic Ground Surface Elevation: 121.0 m

Depth (m)	Description	Elevation (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	Field Testing: Penetration Testing (SPT ○ / PPT □ / DCPT ●)	Field Testing: MTO Vane* (△ Intact / ▲ Remould)	Field Testing: Nilcon Vane* (◇ Intact / ◆ Remould)	Lab Testing: Soil Vapour Reading COV (LEL) □ / TOV (LEL) ■	Lab Testing: COV (ppm) △ / TOV (ppm) ▲	Lab Testing: W_P / W / W_L (Plastic / Liquid)	Instrumentation Installation	Comments & Grain Size Distribution (%) GR SA SI CL
0.0	Brown Clayey Silt **FILL** Trace sand Moist	120.8												
0.2			SS	1	83	18						17		
	Brown **Silty Clay Till** Trace sand & gravel Very Stiff DTPL													
1		120	SS	2	88	29						16		
2		119	SS	3	100	28						22		DTPL- Drier than plastic limit APL- Around plastic limit WTPL- Wetter than plastic limit
			SS	4	100	16						22		
3.0	Stiff APL	118.0												
3		118	SS	5	100	13						26		
3.7	DTPL	117.2												
4		117	SS	6	100	13						14		
			SS	7	100	13						19		
5		116												
5.2	**Borehole Terminated**	115.8												

▽ No freestanding groundwater observed in open borehole upon completion of drilling.

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RECORD OF BOREHOLE No. BH8

Project Number: **WW21012079.2000** Drilling Location: **E: 593599.7 N: 4797960.0**

Project Client: **Quantum Realty Management** Drilling Method: **150 mm Solid Stem Augers**

Project Name: **1450 King Road Geotechnical Investigation** Drilling Machine: **Track Mounted Drill**

Project Location: **1450 King Road, Burlington** Date Started: **Sep 24, 21** Date Completed: **Sep 24, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 120.8 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: □ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) ▲ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	TOPSOIL 175 mm	120.6 120.8										
	Brown Clayey Silt **FILL** Some rootlets, trace sand	0.3	SS	1	75	11			○	17		
	Brown **Silty Clay Till** Some sand, trace gravel Hard DTPL		SS	2	92	34	1	120	○	15		
			SS	3	100	37	2	119	○	15		DTPL- Drier than plastic limit APL- Around plastic limit WTPL- Wetter than plastic limit
			SS	4	100	32		118	○	20		
			SS	5	88	34	3		○	14		
			SS	6	100	30	4	117	○	15		
			SS	7	100	33	5	116	○	17		
	Borehole Terminated	115.6 5.2										

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

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RECORD OF BOREHOLE No. BH9

Project Number: **WW21012079.2000**
Drilling Location: **E: 593702.3 N: 4798068.8**
Project Client: **Quantum Realty Management**
Drilling Method: **150 mm Solid Stem Augers**
Project Name: **1450 King Road Geotechnical Investigation**
Drilling Machine: **Track Mounted Drill**
Project Location: **1450 King Road, Burlington**
Date Started: **Sep 24, 21** Date Completed: **Sep 24, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 120.2 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: □ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) ▲ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	TOPSOIL 200 mm	120.0										
	Brown Clayey Silt **FILL** Trace sand & gravel Moist	0.2	SS	1	63	9		120	○	19		
		119.5										
	Brown **Silty Clay Till** Some sand, trace gravel Hard DTPL	0.7	SS	2	100	32	1	119	○	15		
		118.8										
	Hard to very Stiff	1.4	SS	3	83	30	2	118	○	15		DTPL- Drier than plastic limit APL- Around plastic limit WTPL- Wetter than plastic limit
			SS	4	100	24			○	14		
			SS	5	100	24	3	117	○	14		
		116.5										
	Grey	3.7	SS	6	63	21	4	116	○	13		
			SS	7	100	21	5		○	19		
		115.0										
	Borehole Terminated	5.2										

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

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RECORD OF BOREHOLE No. BH10

Project Number: **WW21012079.2000**
Drilling Location: **E: 593670.0 N: 4797996.4**
Project Client: **Quantum Realty Management**
Drilling Method: **150 mm Solid Stem Augers**
Project Name: **1450 King Road Geotechnical Investigation**
Drilling Machine: **Track Mounted Drill**
Project Location: **1450 King Road, Burlington**
Date Started: **Sep 24, 21** Date Completed: **Sep 24, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 119.4 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: □ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) ▲ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR	SA	SI	CL
	TOPSOIL 230 mm	119.2													
	Brown **Silty Clay Till** Some sand, trace gravel	0.2	SS	1	75	8		119	○	17					
	DTPL	118.7													
	Hard	0.7	SS	2	92	35	1		○	17		1	10	39	50
		118.0						118							
	Very Stiff	1.4	SS	3	92	20	2		○	20					
			SS	4	100	22		117	○	15					
			SS	5	100	26	3	116	○	16					
			SS	6	100	21	4		○	14					
		114.9						115							
	Grey Stiff	4.5	SS	7	100	13	5		○	15					
		114.2													
	Borehole Terminated	5.2													

DTPL- Drier than plastic limit
APL- Around plastic limit
WTPL- Wetter than plastic limit

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

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RECORD OF BOREHOLE No. BH11

Project Number: **WW21012079.2000**
Drilling Location: **E: 593660.5 N: 4797924.4**
Project Client: **Quantum Realty Management**
Drilling Method: **150 mm Solid Stem Augers**
Project Name: **1450 King Road Geotechnical Investigation**
Drilling Machine: **Track Mounted Drill**
Project Location: **1450 King Road, Burlington**
Date Started: **Sep 24, 21** Date Completed: **Sep 24, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 118.5 m		Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	DEPTH (m)	ELEVATION (m)	Penetration Testing: ○ SPT □ PPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	Soil Vapour Reading: □ COV (LEL) ■ TOV (LEL) 2 4 6 8; △ COV (ppm) ▲ TOV (ppm) 100 200 300 400; W_P W W_L Plastic Liquid 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	TOPSOIL 175 mm	118.4 0.2										
	Reddish Brown Clayey Silt **FILL** Trace sand, gravel Moist		SS	1	67	7			○	22		
		117.8						118				
	Mottled Brown **Silty Clay** Trace sand Very Stiff DTPL	0.7	SS	2	83	17	1		○	14		
		117.1						117				
	Brown **Silty Clay Till** Trace sand & gravel Very Stiff DTPL	1.4	SS	3	92	27	2		○	15		DTPL- Drier than plastic limit APL- Around plastic limit WTPL- Wetter than plastic limit
		116.3						116				
	Hard	2.2	SS	4	100	36			○	18		
		115.6					3					
	Very Stiff	3.0	SS	5	92	25		115	○	17		
		114.8										
	Grey	3.7	SS	6	100	22	4		○	14		
								114				
			SS	7	100	16	5		○	15		
		113.4										
	Borehole Terminated	5.2										

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

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RECORD OF BOREHOLE No. BH12

Project Number: **WW21012079.2000** Drilling Location: **E: 593734.9 N: 4798009.4**

Project Client: **Quantum Realty Management** Drilling Method: **150 mm Solid Stem Augers**

Project Name: **1450 King Road Geotechnical Investigation** Drilling Machine: **Track Mounted Drill**

Project Location: **1450 King Road, Burlington** Date Started: **Sep 24, 21** Date Completed: **Sep 24, 21**

Logged by: Compiled by: **TH** Reviewed by: **TR** Revision No.: **0, 12/3/21**

Geodetic Ground Surface Elevation: 116.7 m

Depth (m)	Description	Elevation (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' / RQD (%)	Field Testing: Undrained Shear Strength (kPa)	Lab Testing: Plastic / Liquid
0.2	**TOPSOIL** 150 mm	116.5						
	Brown Silty Clay **FILL** Trace sand & gravel Firm to stiff DTPL		SS	1	63	5		26
1		116	SS	2	50	6		18
2		115	SS	3	71	13		17
2.2		114.5						
	Very Stiff		SS	4	83	16		4
3.0		113.7						
	Firm		SS	5	50	8		18
3.7		113.0						
	Brown **Silty Clay Till** Trace sand and gravel Very Stiff DTPL		SS	6	100	21		15
4		112	SS	7	100	23		15
5.2	**Borehole Terminated**	111.5						

DTPL- Drier than plastic limit
APL- Around plastic limit
WTPL- Wetter than plastic limit

Wood
Environment & Infrastructure Solutions
3450 Harvester Road
Burlington, Ontario, L7N 3W5
Canada
Tel. No.: 1 (905) 335-2353
woodplc.com

▽ No freestanding groundwater observed in open borehole upon completion of drilling.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

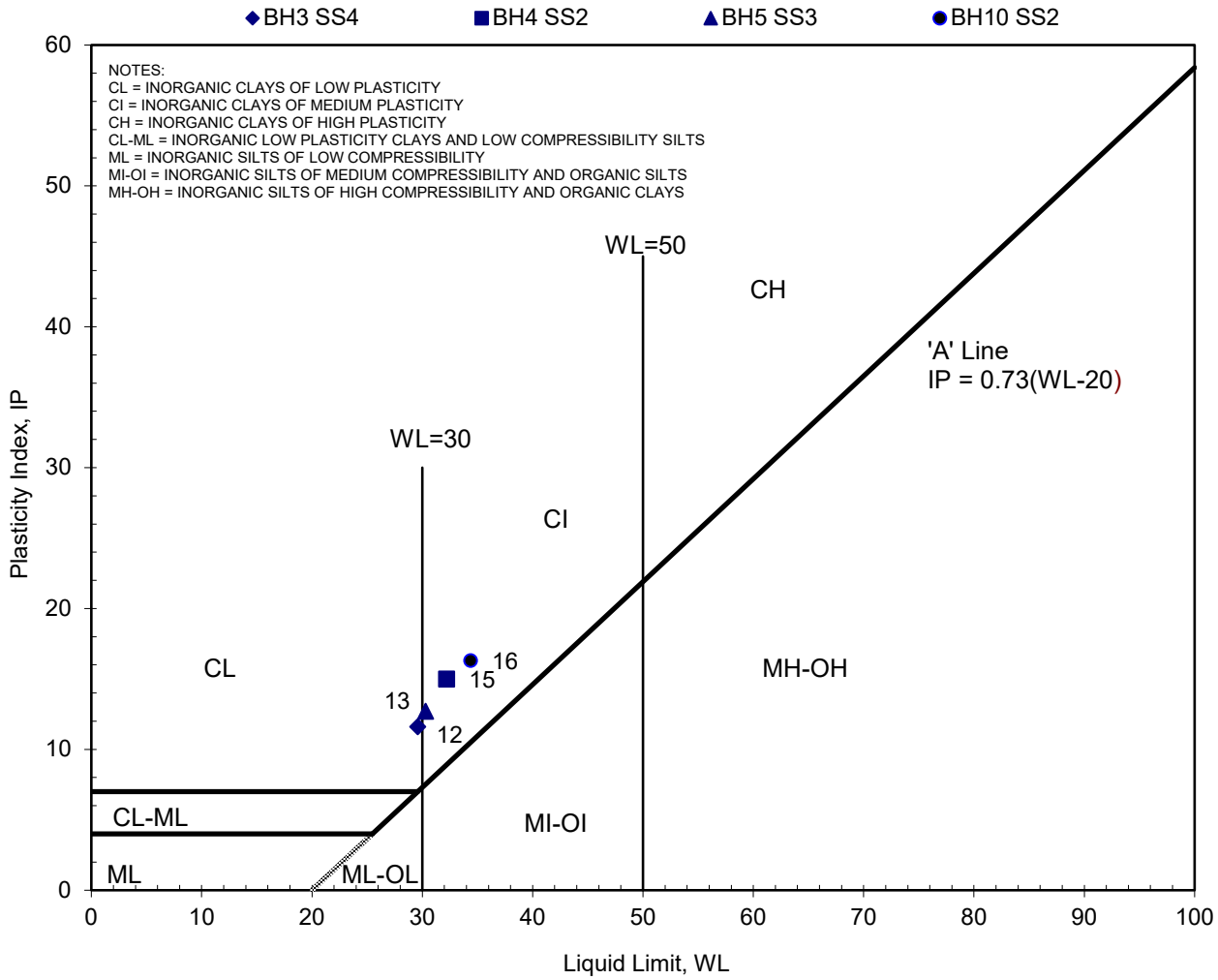
Appendix B

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOIL
LS 703/704

Client:	Quantum Realty Management	**Project No.:**	WW21012079
Sample Location:	1450 King Road, Burlington	**Date Tested:**	16-Oct-21
Sample Type:	Boreholes	**Tested By:**	KH

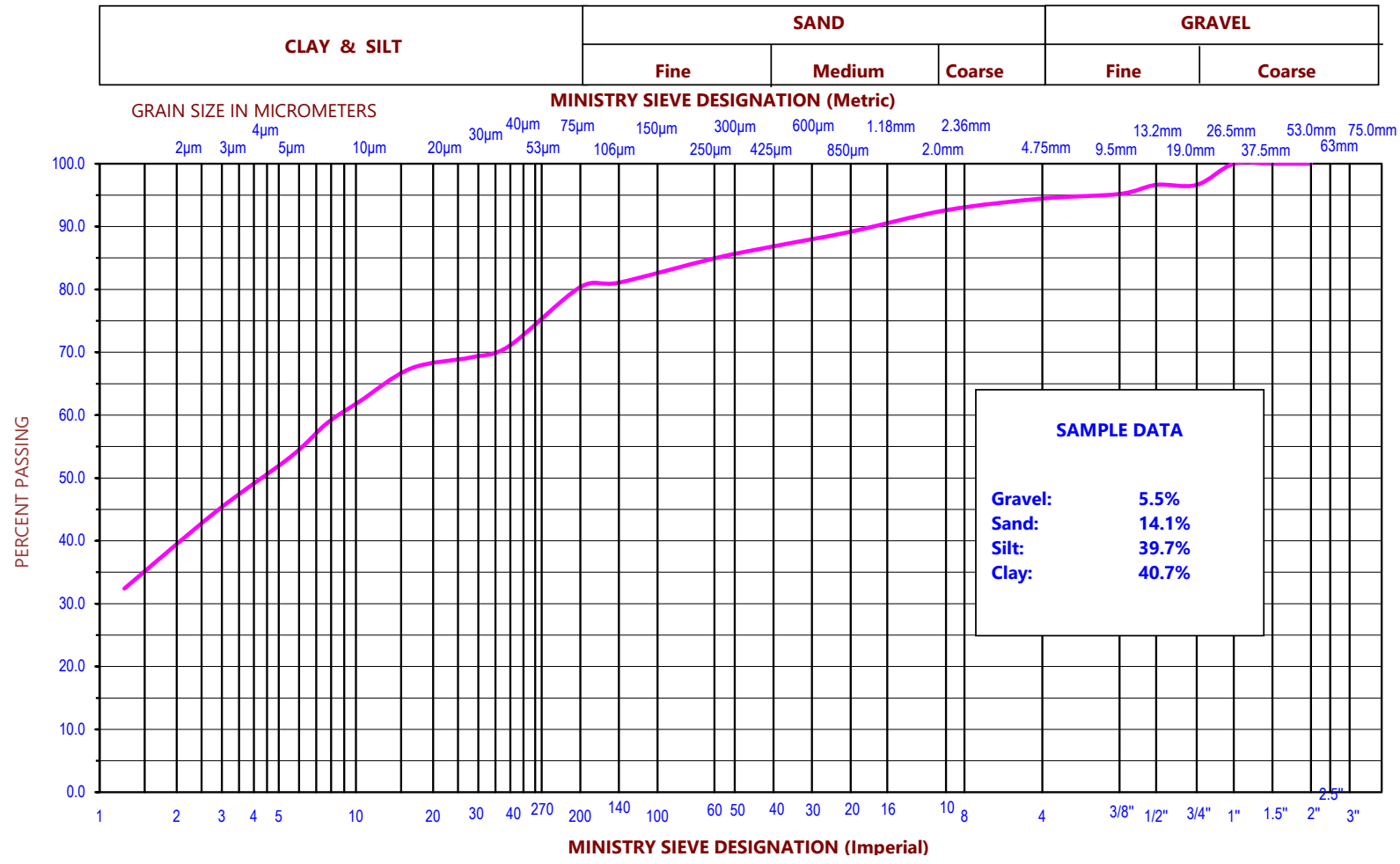
TEST RESULTS

Borehole No.	BH3	BH4	BH5	BH10
Sample No.	SS4	SS2	SS3	SS2
Depth				
Liquid Limit	30	32	30	34
Plastic Limit	18	17	18	18
Plasticity Index	12	15	13	16
Soil Classification	CI	CI	CI	CI
Natural Moiture Content %				



UNIFIED SOIL CLASSIFICATION SYSTEM

Determination of Particle Size Analysis of Soils LS 702

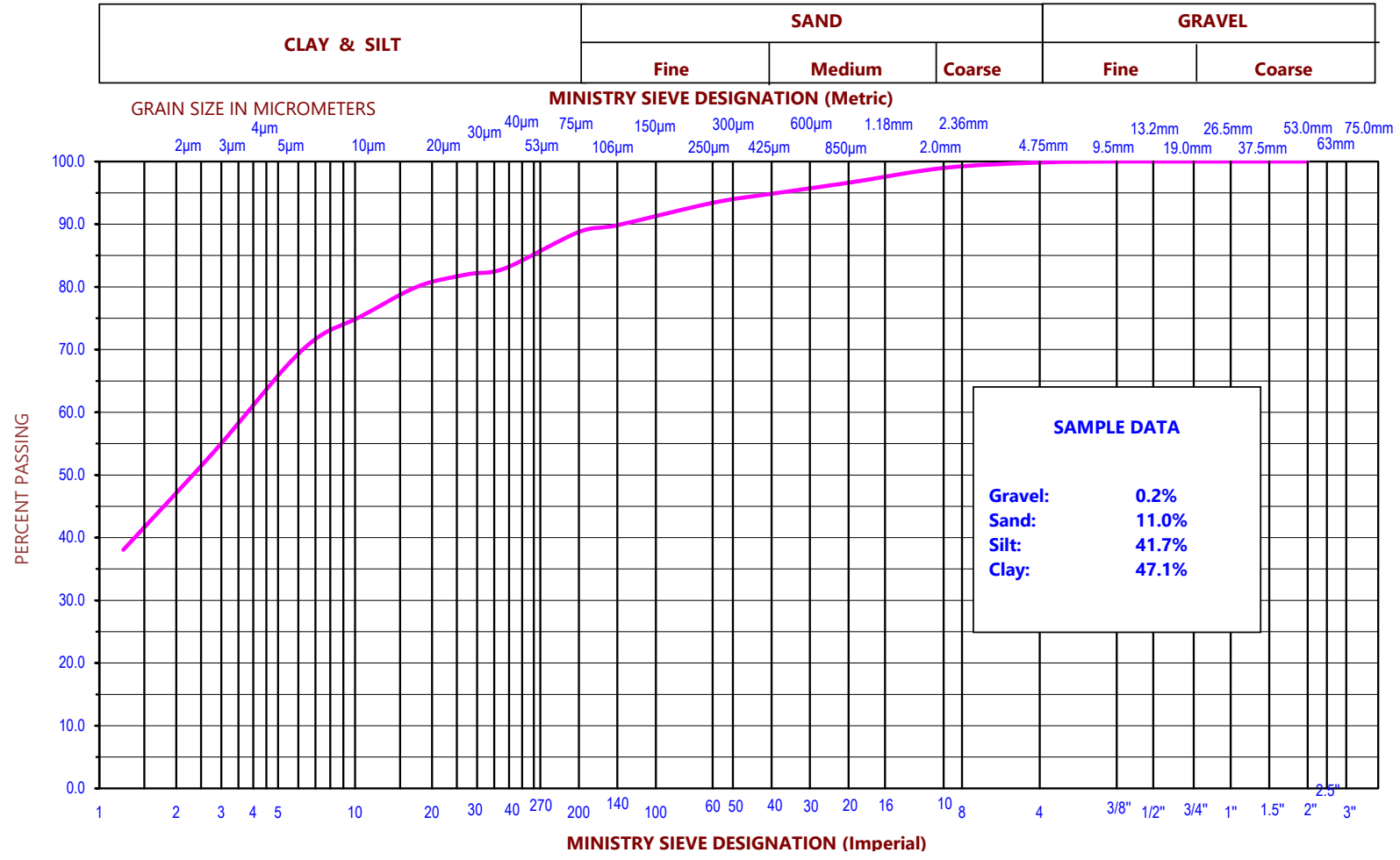


Sieve size (mm)	% Passing
53	100
37.5	100.0
26.5	100.0
19	96.6
13.2	96.6
9.5	95.2
4.75	94.5
2.00	92.6
0.85	89.2
0.425	86.9
0.250	84.9
0.106	81.1
0.075	80.4
0.0394	70.9
0.0282	69.2
0.0164	67.4
0.0103	62.2
0.0077	58.7
0.0056	53.4
0.0028	44.7
0.0013	32.4

Client:	Quantum Realty Management	**GRAIN SIZE DISTRIBUTION**	**Sample No.:**	S293-21
Job No.:	WW21012079	BH3 - SS4	**Tested By:**	HA
Date Received:	1 October 2021	**Silty Clay, some Sand, trace Gravel**	**Report Date:**	19 October 2021

UNIFIED SOIL CLASSIFICATION SYSTEM

Determination of Particle Size Analysis of Soils LS 702

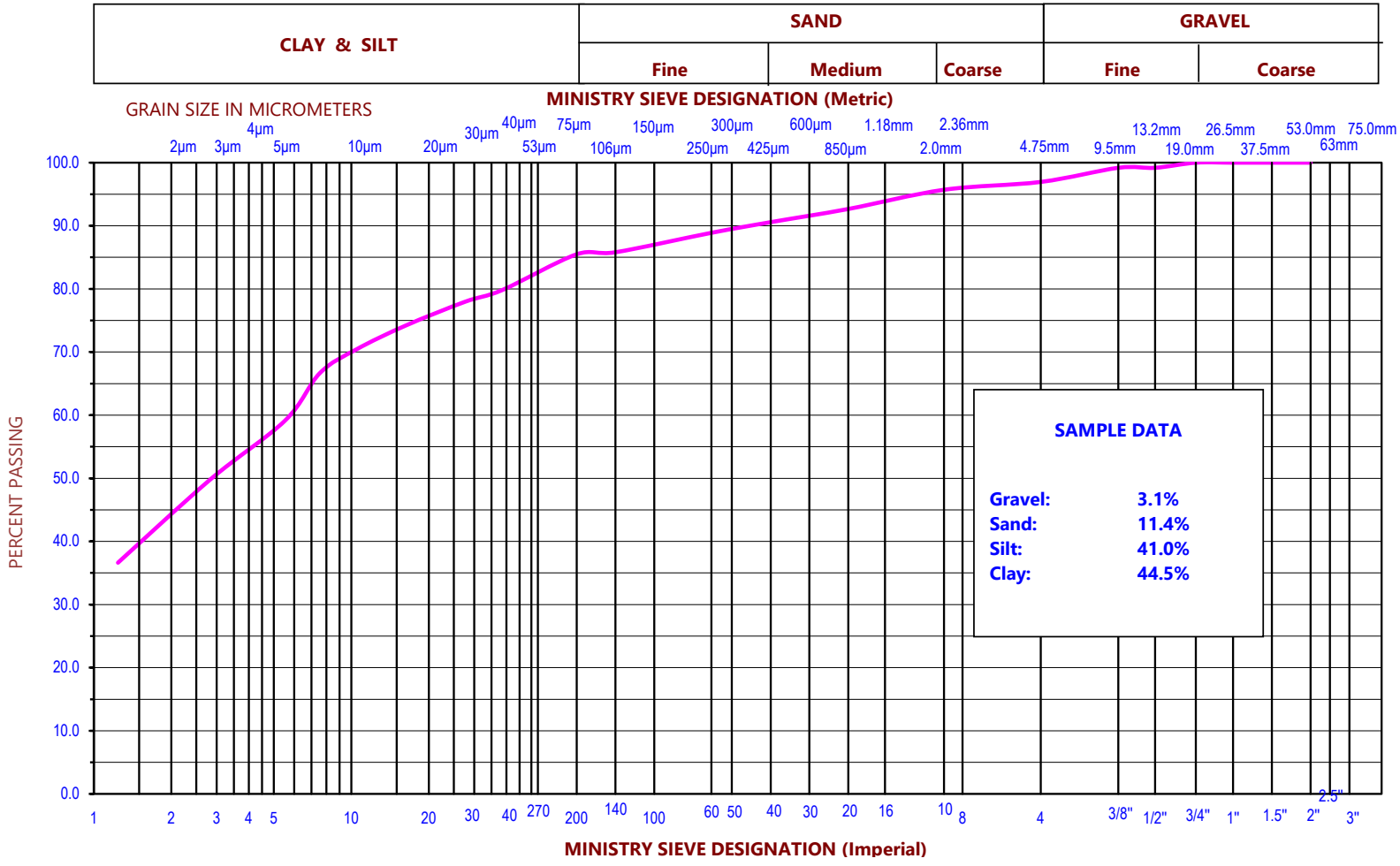


Sieve size (mm)	% Passing
53	100
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	99.8
2.00	99.0
0.85	96.6
0.425	94.9
0.250	93.4
0.106	89.8
0.075	88.8
0.0386	83.0
0.0274	82.0
0.0175	80.0
0.0104	75.2
0.0073	72.2
0.0054	67.4
0.0028	53.7
0.0012	38.1

Client:	Quantum Realty Management	**GRAIN SIZE DISTRIBUTION**	**Sample No.:**	S294-21
Job No.:	WW21012079	BH4 - SS2	**Tested By:**	HA
Date Received:	1 October 2021	**Silty Clay, some Sand, trace Gravel**	**Report Date:**	19 October 2021

UNIFIED SOIL CLASSIFICATION SYSTEM

Determination of Particle Size Analysis of Soils LS 702

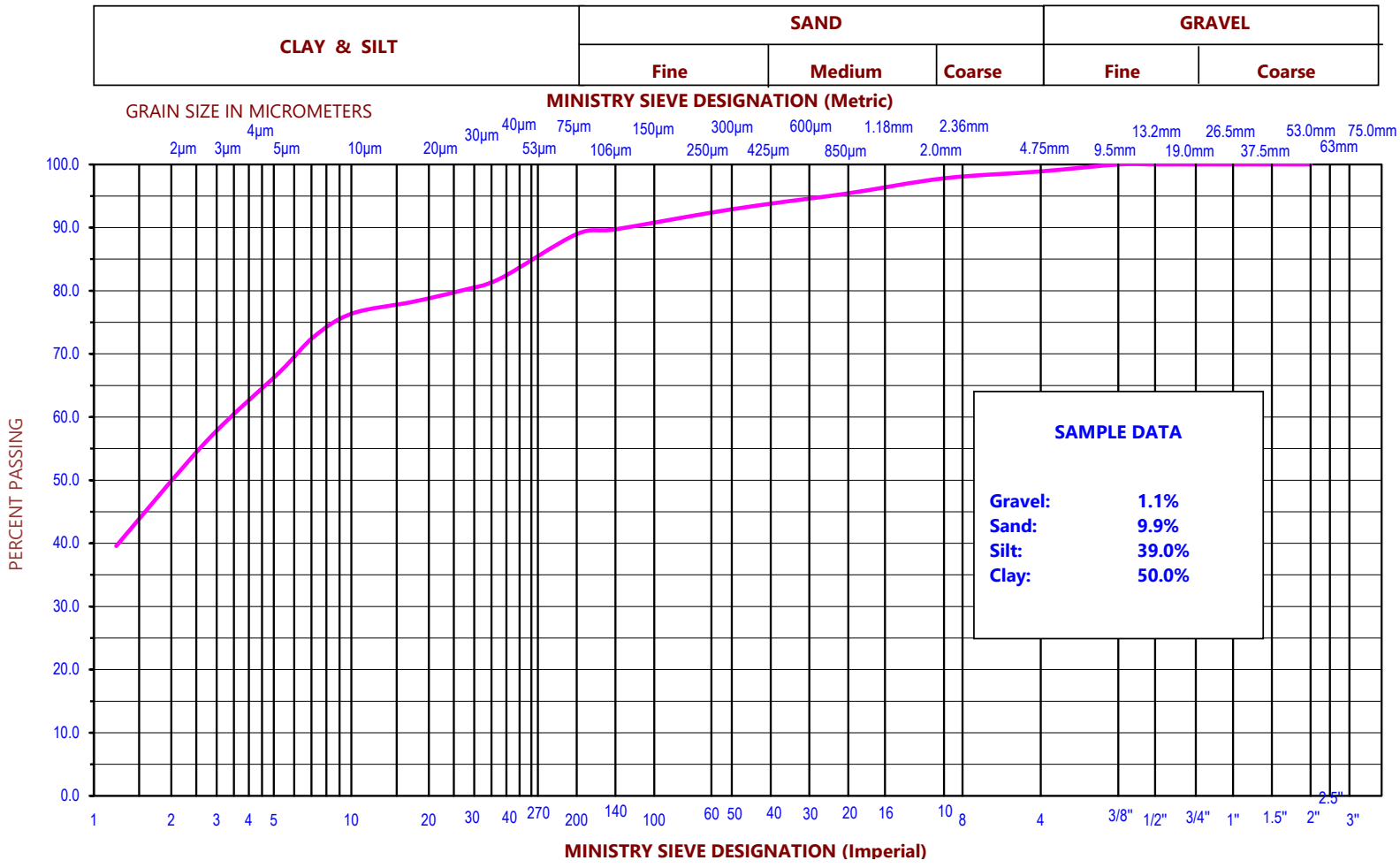


Sieve size (mm)	% Passing
53	100
37.5	100.0
26.5	100.0
19	100.0
13.2	99.2
9.5	99.2
4.75	96.9
2.00	95.7
0.85	92.7
0.425	90.6
0.250	88.9
0.106	85.8
0.075	85.5
0.0386	79.8
0.0276	77.9
0.0163	74.2
0.0105	70.4
0.0076	66.7
0.0055	59.2
0.0028	49.8
0.0012	36.6

Client:	Quantum Realty Management	**GRAIN SIZE DISTRIBUTION**	**Sample No.:**	S295-21
Job No.:	WW21012079	BH5-SS3	**Tested By:**	HA
Date Received:	1 October 2021	**Silty Clay, some Sand, trace Gravel**	**Report Date:**	19 October 2021

UNIFIED SOIL CLASSIFICATION SYSTEM

Determination of Particle Size Analysis of Soils LS 702



Sieve size (mm)	% Passing
53	100
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	98.9
2.00	97.8
0.85	95.4
0.425	93.8
0.250	92.4
0.106	89.7
0.075	89.0
0.0377	81.9
0.0270	80.1
0.0172	78.2
0.0101	76.4
0.0071	72.7
0.0053	67.2
0.0027	56.1
0.0012	39.6

Client:	Quantum Realty Management	**GRAIN SIZE DISTRIBUTION**	**Sample No.:**	S296-21
Job No.:	WW21012079	BH10 - SS2	**Tested By:**	HA
Date Received:	1 October 2021	**Silty Clay, trace Gravel & Sand**	**Report Date:**	19 October 2021

Appendix C

SLOPE STABILITY RATING CHART

Job Number:	WW21012079
Site Location:	1450 King Road - Area 'A' and 'C'
Property Owner:	Quantum Realty Management
Inspection By:	Thomas Ring
Inspection Date:	27-Aug-21
Weather:	Partly Cloudy, 23^{o}C

	RATING
1. SLOPE INCLINATION	
2H:1V to 3H:1V	6
2. SOIL STRATIGRAPHY	
Glacial Till	9
3. SEEPAGE FROM THE FACE	
None or Near bottom only	0
4. SLOPE HEIGHT	
2.1 to 5 m	2
5. VEGETATION COVER ON SLOPE FACE	
Well vegetated; heavy shrubs or forested with mature trees	0
6. TABLE LAND DRAINAGE	
Table land flat, no apparent drainage over slope	0
7. PROXIMITY OF WATERCOURSE TO SLOPE TOE	
Less than 15 metres from slope toe	6
8. PREVIOUS LANDSLIDE ACTIVITY	
No	0
Total	23

Rating	Instability Potential	Investigation Requirements
0-24	Low	Site inspection only, confirmation, report letter.
25-35	Slight	Site inspection and surveying, preliminary study, detailed report.
>35	Moderate	Boreholes, piezometers, lab tests, surveying, detailed report.

Additonal Remarks:
The instability rating for Areas 'A' and 'C' is low.
No further investigation is required beyond site inspection.

Rating as per Table 4.2 from the MNR Techncial Guide - River and Stream Systems: Erosion Hazard Limit (2002)

DRAFT

SLOPE STABILITY RATING CHART

Job Number:	WW21012079
Site Location:	1450 King Road - Area B
Property Owner:	Quantum Realty Management
Inspection By:	Thomas Ring
Inspection Date:	27-Aug-21
Weather:	Partly Cloudy, 23^{o}C

	RATING
1. SLOPE INCLINATION	
steeper than 2H:1V	16
2. SOIL STRATIGRAPHY	
Glacial Till	9
3. SEEPAGE FROM THE FACE	
None or Near bottom only	0
4. SLOPE HEIGHT	
5.1 to 10 m	4
5. VEGETATION COVER ON SLOPE FACE	
Well vegetated; heavy shrubs or forested with mature trees	0
6. TABLE LAND DRAINAGE	
Table land flat, no apparent drainage over slope	0
7. PROXIMITY OF WATERCOURSE TO SLOPE TOE	
Less than 15 metres from slope toe	6
8. PREVIOUS LANDSLIDE ACTIVITY	
No	0
Total	35

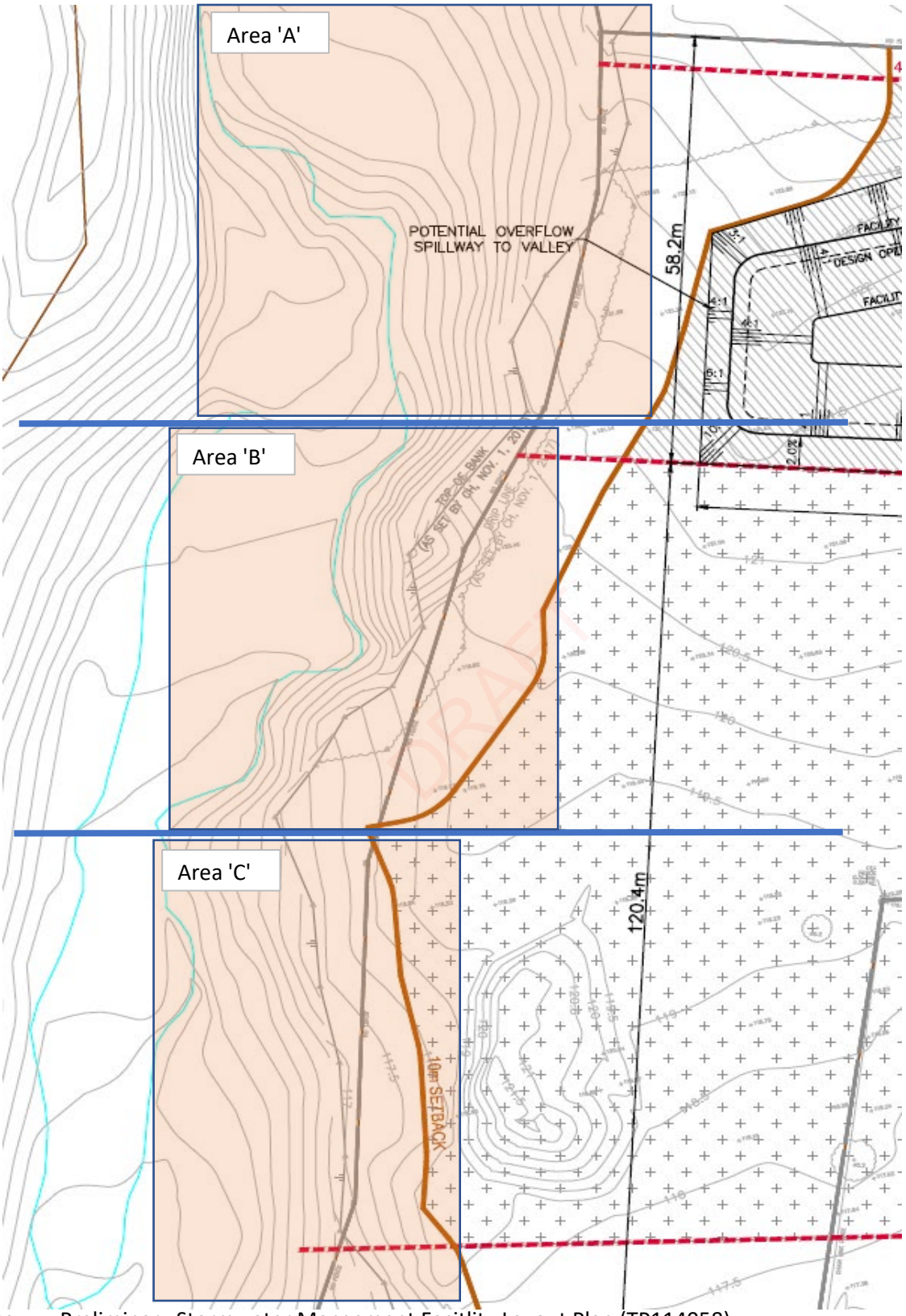
Rating	Instability Potential	Investigation Requirements
0-24	Low	Site inspection only, confirmation, report letter.
25-35	Slight	Site inspection and surveying, preliminary study, detailed report.
>35	Moderate	Boreholes, piezometers, lab tests, surveying, detailed report.

Additonal Remarks:
The instability potential for Area 'B' is slight.
In addition to the slope inspection, a survey and preliminary stability analysis is required.
Localized toe erosion was noted within Area 'B'

Rating as per Table 4.2 from the MNR Techncial Guide - River and Stream Systems: Erosion Hazard Limit (2002)

DRAFT

Topography



Source: Preliminary Stormwater Mangement Facitlity Layout Plan (TP114058)

Site Photo - Area A





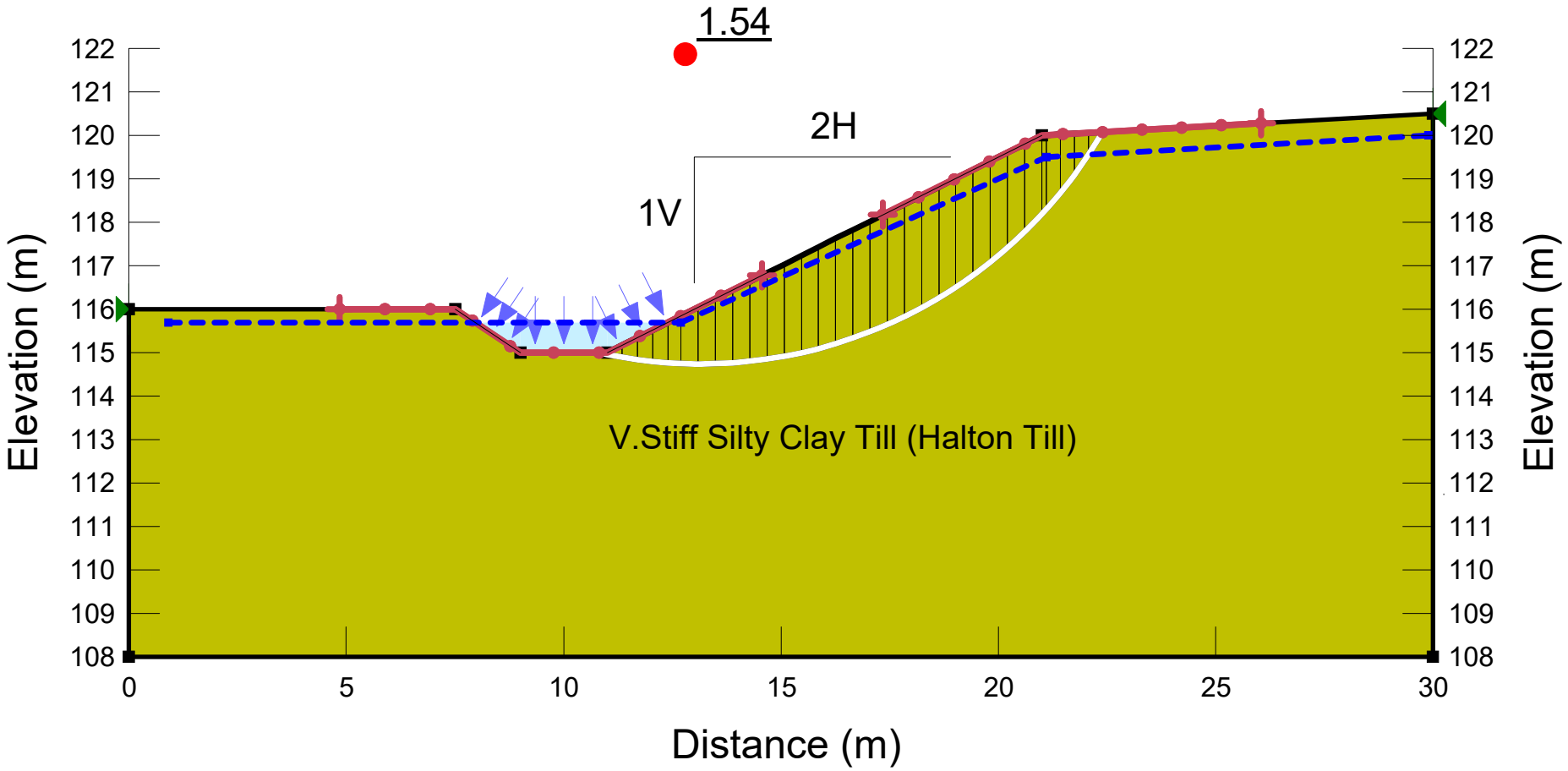
Site Photo - Area 'B'





Appendix D

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	V.Stiff Silty Clay Till (Halton Till)	22	5	34

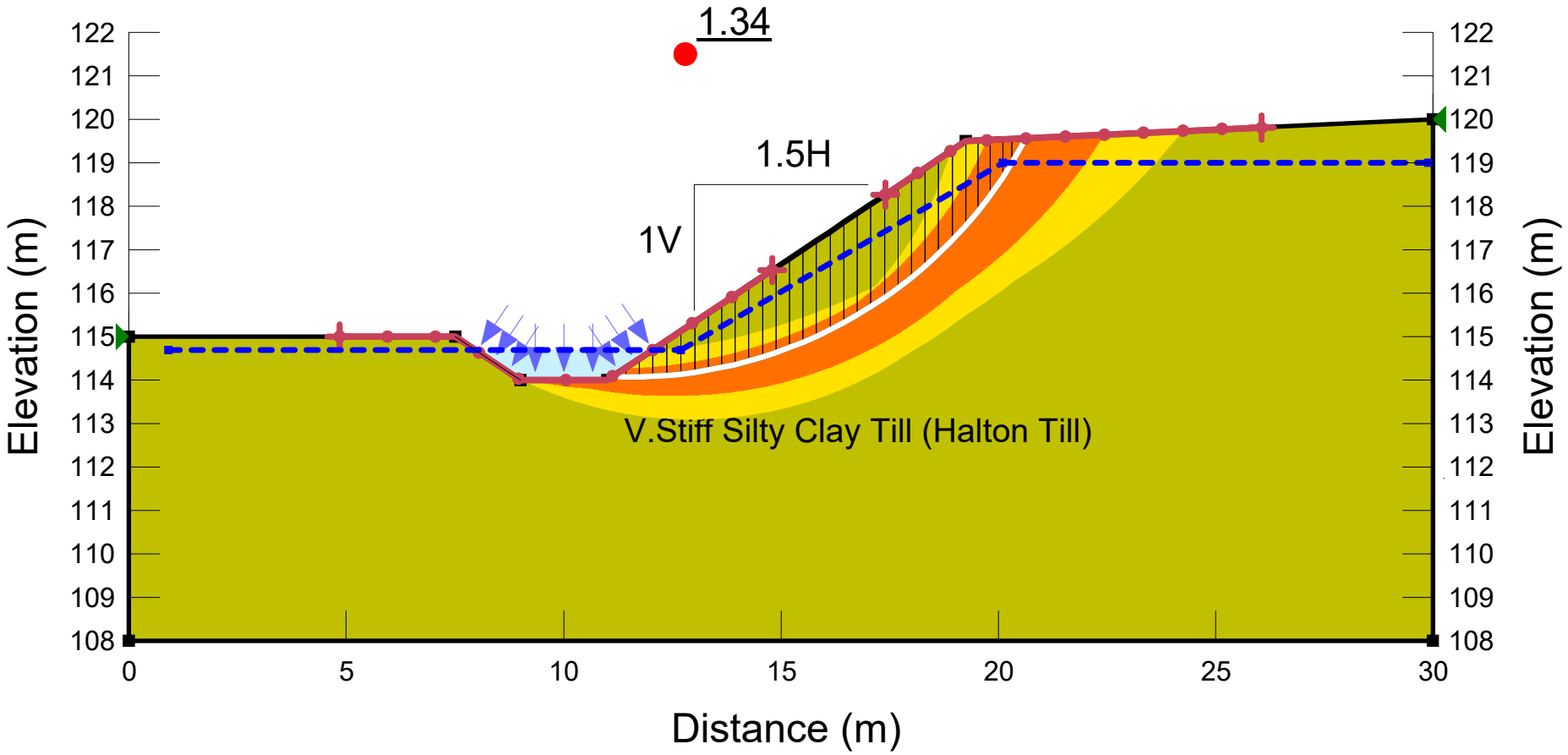


WW21012079 - 1450 King Road

Figure D.1: Area A - existing (long term)

Wood Environmental & Infrastructure Solutions, a Division of Wood Canada Limited

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	V.Stiff Silty ClayTill (Halton Till)	22	5	34



WW21012079 - 1450 King Road

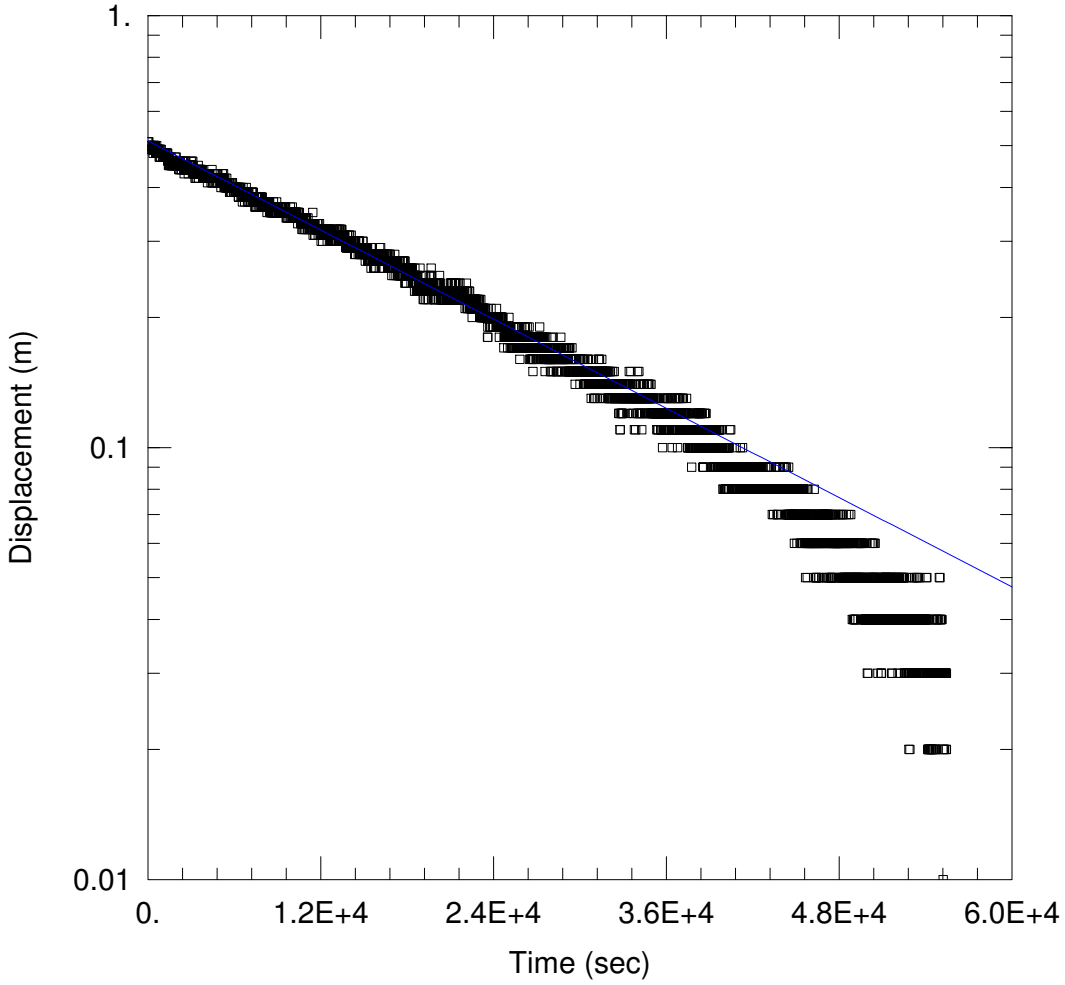
Figure D.2: Area B - existing (long term)

Wood Environmental & Infrastructure Solutions, a Division of Wood Canada Limited

WW21012079 Slope Stability Area B.gsz

1:147

Appendix E



WELL TEST ANALYSIS

Data Set: \...\BHMW4.aqt
Date: 11/26/21 Time: 09:45:19

PROJECT INFORMATION

Company: Wood
Client: Quantum Realty Management
Project: WW21012079
Location: Burlington
Test Well: BH/MW4
Test Date: November 3, 2021

AQUIFER DATA

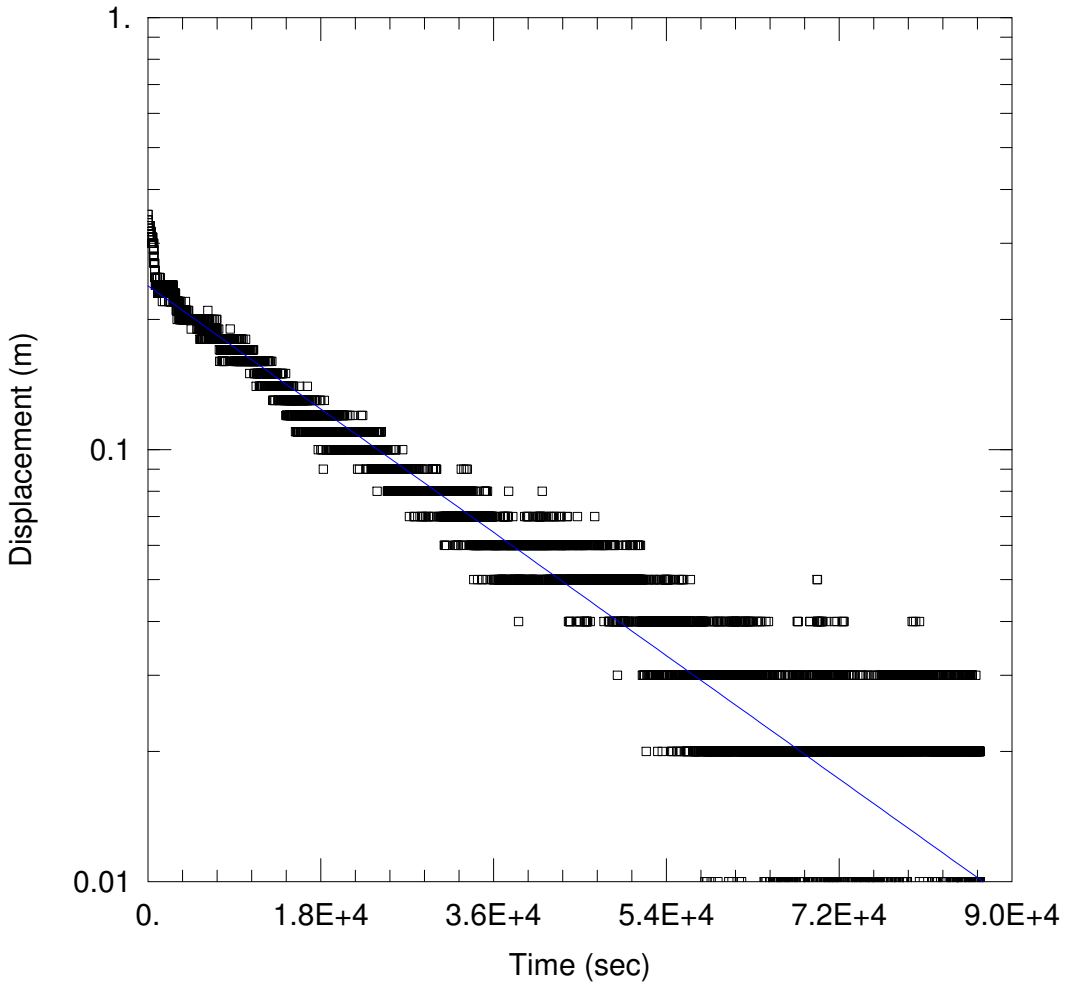
Saturated Thickness: 4.37 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH/MW4)

Initial Displacement: 0.51 m
Total Well Penetration Depth: 4.31 m
Casing Radius: 0.025 m
Static Water Column Height: 4.37 m
Screen Length: 1.5 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.699E-8 m/sec
y0 = 0.5128 m



WELL TEST ANALYSIS

Data Set: \...\BHMW5.aqt
Date: 11/26/21 Time: 09:49:31

PROJECT INFORMATION

Company: Wood
Client: Quantum Realty Management
Project: WW21012079
Location: Burlington
Test Well: BH/MW5
Test Date: November 3, 2021

AQUIFER DATA

Saturated Thickness: 3.76 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BH/MW5)

Initial Displacement: 0.35 m
Total Well Penetration Depth: 3.76 m
Casing Radius: 0.025 m
Static Water Column Height: 3.76 m
Screen Length: 1.5 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.565E-8 m/sec y0 = 0.2394 m

Appendix F

LIMITATIONS TO GEOTECHNICAL REPORTS

1. The work performed in the preparation of this report and the conclusions presented herein are subject to the following:

    a) The contract between Wood and the Client, including any subsequent written amendment or Change Order dully signed by the parties (hereinafter together referred as the "Contract");

    b) Any and all time, budgetary, access and/or site disturbance, risk management preferences, constraints or restrictions as described in the contract, in this report, or in any subsequent communication sent by Wood to the Client in connection to the Contract; and

    c) The limitations stated herein.

2. **Standard of care:** Wood has prepared this report in a manner consistent with the level of skill and are ordinarily exercised by reputable members of Wood's profession, practicing in the same or similar locality at the time of performance, and subject to the time limits and physical constraints applicable to the scope of work, and terms and conditions for this assignment. No other warranty, guaranty, or representation, expressed or implied, is made or intended in this report, or in any other communication (oral or written) related to this project. The same are specifically disclaimed, including the implied warranties of merchantability and fitness for a particular purpose.

3. **Limited locations:** The information contained in this report is restricted to the site and structures evaluated by Wood and to the topics specifically discussed in it, and is not applicable to any other aspects, areas or locations.

4. **Information utilized:** The information, conclusions and estimates contained in this report are based exclusively on: i) information available at the time of preparation, ii) the accuracy and completeness of data supplied by the Client or by third parties as instructed by the Client, and iii) the assumptions, conditions and qualifications/limitations set forth in this report.

5. **Accuracy of information:** No attempt has been made to verify the accuracy of any information provided by the Client or third parties, except as specifically stated in this report (hereinafter "Supplied Data"). Wood cannot be held responsible for any loss or damage, of either contractual or extra-contractual nature, resulting from conclusions that are based upon reliance on the Supplied Data.

6. **Report interpretation:** This report must be read and interpreted in its entirety, as some sections could be inaccurately interpreted when taken individually or out-of-context. The contents of this report are based upon the conditions known and information provided as of the date of preparation. The text of the final version of this report supersedes any other previous versions produced by Wood.

7. **No legal representations:** Wood makes no representations whatsoever concerning the legal significance of its findings, or as to other legal matters touched on in this report, including but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and change. Such interpretations and regulatory changes should be reviewed with legal counsel.

8. **Decrease in property value:** Wood shall not be responsible for any decrease, real or perceived, of the property or site's value or failure to complete a transaction, as a consequence of the information contained in this report.

9. **No third party reliance:** This report is for the sole use of the party to whom it is addressed unless expressly stated otherwise in the report or Contract. Any use or reproduction which any third party makes of the report, in whole or in part, or any reliance thereon or decisions made based on any information or conclusions in the report is the sole responsibility of such third party. Wood does not represent or warrant the accuracy, completeness, merchantability, fitness for purpose or usefulness of this document, or any information contained in this

document, for use or consideration by any third party. Wood accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on this report or anything set out therein. including without limitation, any indirect, special, incidental, punitive or consequential loss, liability or damage of any kind.

10. **Assumptions**: Where design recommendations are given in this report, they apply only if the project contemplated by the Client is constructed substantially in accordance with the details stated in this report. It is the sole responsibility of the Client to provide to Wood changes made in the project, including but not limited to, details in the design, conditions, engineering or construction that could in any manner whatsoever impact the validity of the recommendations made in the report. Wood shall be entitled to additional compensation from Client to review and assess the effect of such changes to the project.

11. **Time dependence**: If the project contemplated by the Client is not undertaken within a period of 18 months following the submission of this report, or within the time frame understood by Wood to be contemplated by the Client at the commencement of Wood's assignment, and/or, if any changes are made, for example, to the elevation, design or nature of any development on the site, its size and configuration, the location of any development on the site and its orientation, the use of the site, performance criteria and the location of any physical infrastructure, the conclusions and recommendations presented herein should not be considered valid unless the impact of the said changes is evaluated by Wood, and the conclusions of the report are amended or are validated in writing accordingly.

    Advancements in the practice of geotechnical engineering, engineering geology and hydrogeology and changes in applicable regulations, standards, codes or criteria could impact the contents of the report, in which case, a supplementary report may be required. The requirements for such a review remain the sole responsibility of the Client or their agents.

    Wood will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

12. **Limitations of visual inspections:** Where conclusions and recommendations are given based on a visual inspection conducted by Wood, they relate only to the natural or man-made structures, slopes, etc. inspected at the time the site visit was performed. These conclusions cannot and are not extended to include those portions of the site or structures, which were not reasonably available, in Wood's opinion, for direct observation.

13. **Limitations of site investigations**: Site exploration identifies specific subsurface conditions only at those points from which samples have been taken and only at the time of the site investigation. Site investigation programs are a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions.

    The data derived from the site investigation program and subsequent laboratory testing are interpreted by trained personnel and extrapolated across the site to form an inferred geological representation and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite this investigation, conditions between and beyond the borehole/test hole locations may differ from those encountered at the borehole/test hole locations and the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

    Final sub-surface/bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports.

    Bedrock, soil properties and groundwater conditions can be significantly altered by environmental remediation and/or construction activities such as the use of heavy equipment or machinery, excavation, blasting, pile-driving

or draining or other activities conducted either directly on site or on adjacent terrain. These properties can also be indirectly affected by exposure to unfavorable natural events or weather conditions, including freezing, drought, precipitation and snowmelt.

During construction, excavation is frequently undertaken which exposes the actual subsurface and groundwater conditions between and beyond the test locations, which may differ from those encountered at the test locations. It is recommended practice that Wood be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered at the test locations, that construction work has no negative impact on the geotechnical aspects of the design, to adjust recommendations in accordance with conditions as additional site information is gained and to deal quickly with geotechnical considerations if they arise.

Interpretations and recommendations presented herein may not be valid if an adequate level of review or inspection by Wood is not provided during construction.

14. **Factors that may affect construction methods, costs and scheduling**: The performance of rock and soil materials during construction is greatly influenced by the means and methods of construction. Where comments are made relating to possible methods of construction, construction costs, construction techniques, sequencing, equipment or scheduling, they are intended only for the guidance of the project design professionals, and those responsible for construction monitoring. The number of test holes may not be sufficient to determine the local underground conditions between test locations that may affect construction costs, construction techniques, sequencing, equipment, scheduling, operational planning, etc.

    Any contractors bidding on or undertaking the works should draw their own conclusions as to how the subsurface and groundwater conditions may affect their work, based on their own investigations and interpretations of the factual soil data, groundwater observations, and other factual information.

15. **Groundwater and Dewatering**: Wood will accept no responsibility for the effects of drainage and/or dewatering measures if Wood has not been specifically consulted and involved in the design and monitoring of the drainage and/or dewatering system.

16. **Environmental and Hazardous Materials Aspects**: Unless otherwise stated, the information contained in this report in no way reflects on the environmental aspects of this project, since this aspect is beyond the Scope of Work and the Contract. Unless expressly included in the Scope of Work, this report specifically excludes the identification or interpretation of environmental conditions such as contamination, hazardous materials, wild life conditions, rare plants or archeology conditions that may affect use or design at the site. This report specifically excludes the investigation, detection, prevention or assessment of conditions that can contribute to moisture, mould or other microbial contaminant growth and/or other moisture related deterioration, such as corrosion, decay, rot in buildings or their surroundings. Any statements in this report or on the boring logs regarding odours, colours, and unusual or suspicious items or conditions are strictly for informational purposes

17. **Sample Disposal**: Wood will dispose of all uncontaminated soil and rock samples after 30 days following the release of the final geotechnical report. Should the Client request that the samples be retained for a longer time, the Client will be billed for such storage at an agreed upon rate. Contaminated samples of soil, rock or groundwater are the property of the Client, and the Client will be responsible for the proper disposal of these samples, unless previously arranged for with Wood or a third party.

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

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