“BUILT ON THE ROCK”

GEOTECHNICAL INVESTIGATION REPORT

PROPOSED STORAGE FACILITY DEVELOPMENT,

16728 HIGHWAY 12.

MIDLAND, SIMCOE COUNTY, ON;

PROJECT NUMBER: 23-127-01

CLIENT: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE

ATTENTION: Edgar George

DATE: July 25, 2024

PREPARED BY: Green Geotechnical Ltd.
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1.0 EXECUTIVE SUMMARY

Green Geotechnical Ltd. (Green Geotechnical) was retained by U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE (U-Haul) to conduct a subsurface investigation and prepare a geotechnical investigation report for the proposed U-Haul storage facility at 16728 Highway 12, in the Town of Midland, Ontario. The site is forested and slopes from west to east, in an industrial and residential area between Prospect Boulevard and Heritage Drive. According to the RFP document titled "*Geotechnical Engineering Services,*" from U-Haul, ground finished floor elevations of their facilities are typically to be at or within 2 feet (0.6m) of existing grade. Based on the existing site grade changes, this will require regrading and potentially the importation of fill. No lot grading or servicing plans were available at the time of this investigation.

This report encompasses the geotechnical investigation conducted on February 26th to 28th 2024, to assess its geotechnical suitability for the proposed development. The field investigation consisted of advancing a total of eleven (11) exploratory boreholes (Boreholes 1 to 11) at the Property to termination depths ranging from approximately 4.6m (east end of site) to 8.1m (west end of site) below existing ground surface. Five (5) of the eleven (11) boreholes (Boreholes 1, 2, 7, 9, and 11) were installed with groundwater monitoring wells. All boreholes were dry and open immediately following drilling. Stabilized water levels were measured on March 13th, 2024. **All wells were dry except for Borehole 9, which had water at 3.3mbg.**

Based on the field investigation at this site, below the surficial topsoil and weathered/disturbed zones, the subsurface conditions predominantly consist of a very loose to very dense sand and silty sand, which typically became compact or denser at approximately ±1m to ±2m below grade. **The undisturbed native site soils are suitable for the support of conventional spread footings**, provided that all surficial topsoil and other highly organic soil areas, earth fill layers, weathered/disturbed native soils, and any otherwise deleterious materials such as loose, caved, or soft soils are removed, and excess water is pumped out prior to concrete placement. **The compact to very dense native soil conditions encountered will typically allow structure foundations placed directly on them to be designed with maximum net geotechnical reactions of 150 kPa (SLS) and factored geotechnical resistances (ULS) of 225 kPa as outlined in greater detail the table in Section 5.1**, subject to foundation inspection confirmation by Green Geotechnical. Greater capacity can be available at greater depths if required for specific components and can be assessed by Green Geotechnical on a case-by-case basis. Certain areas of the site indicate soft/loose soils at shallow depths which will allow for lower bearing capacities or require greater founding depths. A minimum soil cover of 1.4m or equivalent insulation is recommended for frost protection to footings in exterior or unheated areas.

Any regrading within the influence zones of building or roadways is anticipated to be done with the use of Engineered Fill. The undisturbed native soils beneath the topsoil, weathered/disturbed and soft/loose layers are considered suitable for the support of Engineered Fill pads for supporting the building foundations, and will allow structure foundations placed directly on them to be designed with maximum net geotechnical reactions of 150 kPa (SLS) and factored geotechnical resistances (ULS) of 225 kPa. All finished floors should be constructed at least 0.5m above the seasonally high groundwater level.

The site designation for seismic analysis is to be **Site Class C,** as per the Ontario Building Code. Consideration may be given to conducting a site-specific Multichannel Analysis of Surface Waves (MASW). Lateral earth pressure design parameters for below-grade structures are tabulated in Section 5.4.

The pavement subgrade is expected to comprise of native, undisturbed sand or silty sand soils, or clean earth fill compacted to a minimum of 98% of SPMDD. The exposed subgrade should be shaped and graded with a typical 3% cross-fall, directed towards continuous subdrains with inverts at least 0.3m below subgrade level. All topsoil, organic-rich, and otherwise deleterious material should be sub-excavated. The pavement subgrade should be assessed (proof rolled with a heavy rubber-tired vehicle, if deemed feasible by Green Geotechnical) and approved (no rutting or major deflections) by Green Geotechnical to ensure stability prior to the placement of the pavement granular courses. All unstable areas will require sub-excavation and re-compaction or increased thickness of granular subbase. It should be noted that the upper site soils are considered to be low to moderately frost susceptible. Adequate subgrade drainage is still recommended. The designs for asphalt, concrete, and aggregate surfaced pavement structures at this site are outlined in Section 5.5.

Trench bases are expected to consist primarily of native, undisturbed sand and silty sand soils, or clean earth fill compacted to a minimum of 98% of SPMDD. The native, undisturbed site soils as well as Engineered Fill will generally be suitable for support of underground services with conventional Class 'B' granular bedding. The granular bedding should consist of a well graded material such as Granular 'A'. Excavation bases should be free of standing water prior to and during bedding and service placement.

Laboratory testing was conducted on three select soil samples at various depths (BH2 SS2, BH4 SS4, and BH10 SS3) to determine estimated coefficients of permeability. The results of the soil gradation are appended and estimated Hydraulic Conductivities, Percolation Rates (T-Times), and Infiltration Rates are summarized in the Table in Section 5.7.

All samples had a corrosivity index of less than 10. An index of less than 10 indicates **corrosion protection measures are not required** for cast iron alloys. The full results of the analysis can be found in Appendix E.

We trust this report meets your requirements. Should you have any questions regarding the information presented, please do not hesitate to contact our office.

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2.0 SITE AND PROJECT BACKGROUND

Green Geotechnical Ltd. (Green Geotechnical) was retained by U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE (U-Haul) to conduct a subsurface investigation and prepare a geotechnical design report for the proposed storage facility development at 16728 Highway 12, in the Town of Midland, Ontario. The site is primarily forested and slopes from west to east, in an industrial and commercial area between Prospect Boulevard and Heritage Drive. A site location plan is provided as Figure 1.

Based on the RFP information document titled "*Geotechnical Engineering Services*" dated June 23, 2023, from U-Haul, and email/phone communications with U-Haul, it is understood the site will be developed for a U-Haul facility which may include multi-story structures, single-story warehouses, light modular storage structures, and vehicle shade canopies.

At the time of this investigation, no conceptual site, grading, or servicing plans were available. It is presumed that site grades will generally be altered to achieve more uniform, gentle grade changes. Any regrading within the influence zones of building or roadways is anticipated to be done with the use of Engineered Fill.

According to the RFP document, ground finished floor elevations are typically to be at or within 2 feet (0.6m) of existing grade. Based on the existing site grade changes, this will require regrading and potentially the importation of fill.

This report encompasses the geotechnical investigation conducted for the Property to assess its geotechnical suitability for the proposed development. The field investigation consisted of advancing a total of eleven (11) exploratory boreholes (Boreholes 1 to 11) at the Property, with five (5) of the 11 boreholes being installed as monitoring wells. The objective of the geotechnical investigation was to determine the prevailing subsurface soil and groundwater conditions, in order to provide geotechnical engineering recommendations for the design of the proposed building foundations, floor-slabs, lateral earth pressure and seismic design parameters, pavement design, pipe bedding, soil permeability, and chemical analysis of the corrosivity of three (3) select soil samples. In addition, comments are also included on the pertinent project construction aspects including excavation, backfill and groundwater control.

3.0 INVESTIGATION PROCEDURES AND METHODOLOGY

The field investigation was conducted on February 26th to 28th, 2024, and consisted of drilling and sampling a total of eleven (11) exploratory boreholes (Boreholes 1 to 11) extending to termination depths ranging from approximately 4.6m to 8.1m below existing ground surface.

The boreholes were staked out in the field by Green Geotechnical based on the proposed development and existing site features. The approximate borehole locations are shown on enclosed Borehole Location Plan as Figure 2.

Various utility locate agencies (including a private locate company) were contacted by Green Geotechnical to clear the borehole locations prior to the commencement of the field investigation.

The horizontal coordinates are reported relative to the Universal Transverse Mercator geographic coordinate system (UTM Zone 17T). It should be noted that the depths provided on the Borehole Logs are approximate and provided only for the purpose of relating borehole soil stratigraphy and should not be used or relied on for other purposes.

The borings were drilled by a specialist drilling contractor using a track mounted drill rig power auger and sampled at regular intervals with a conventional 50mm diameter split barrel sampler when the Standard Penetration Test (SPT) was carried out (ASTM D 1586). The field work (drilling, sampling, and testing) was observed full time and recorded by Green Geotechnical field staff, who logged the boring and examined the samples as they were obtained.

All samples obtained during the investigation were sealed into plastic jars and transported to our geotechnical laboratory for detailed inspection and testing. The borehole samples were examined (tactile) in detail by a geotechnical engineer and classified according to visual and index properties. Geotechnical laboratory testing consisted of water content determination on all samples, and grain size analysis on two (2) selected soil sample. The measured natural water contents of individual samples and the results of the grain size analysis test are plotted on the enclosed borehole logs at respective sampling depths. The results of the grain size analyses are also summarized in Section 4.7 of this report and are appended in Appendix B.

Groundwater levels were observed in the open boreholes upon the completion of drilling. Monitoring wells were installed in five (5) boreholes to facilitate one (1) stabilized groundwater level reading, which was taken on February 13th, 2024. The results of the groundwater level reading is enclosed in the borehole logs and summarized in Section 4.6 of this report.

Three (3) soil samples were collected at various borehole locations and depths for chemical analysis. The results of these analyses were compared to the 10-point soil evaluation procedure described in the American Water Work Association (AWWA) C 105 standard. These chemical analysis results are summarized in Section 5.8 of this report and the full results are appended in Appendix E.

4.0 SUBSURFACE CONDITIONS

The specific soil conditions encountered at each borehole location are described in greater detail on the Borehole Logs, with a summary of the general subsurface soil conditions outlined below. This summary is intended to correlate this data to assist in the interpretation of the subsurface conditions at the site. The borehole logs are enclosed in Appendix A.

It should be noted that the subsurface conditions are confirmed at the borehole locations only and may vary between and beyond the borehole locations. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of geologic change.

4.1 Topsoil

Surficial topsoil with a thickness of approximately 0.2m to 0.7m was encountered at the ground surface of all Boreholes. The topsoil was dark brown in colour.

Topsoil thicknesses provided in this report were obtained at the individual borehole locations, as measured through the collar of the open borehole. Thicknesses may vary between and beyond borehole locations and should not be used/relied upon for costing purposes.

4.2 Silty Sand

Native deposits of a silty sand, with trace gravel and clay content was encountered in all Boreholes (Boreholes 1-11). In Boreholes 1, 3, 4, 5, 6, 7, 8, 9, 10, and 11 the silty sand was underlying the surficial topsoil, with thicknesses ranging from approximately 0.5m to 2.3m. The silty sand zone was underlain by the native sand in Borehole 1. In Boreholes 2 and 5, the silty sand overlays the native sand layer. In Boreholes 3, 4, 6, 7, 9, 10, and 11 the silty sand layer underlies the surficial topsoil layer and extends to termination depth of the Borehole. The top 0.3 to 0.4m of silty sand underlying the surficial topsoil in Boreholes 1, 6, and 7 was weathered/disturbed.

The Standard Penetration Test result (N-Values) obtained from these strata ranged from 0 to over 50 blows per 300mm of penetration, indicating a very loose to very dense relative density.

The in-situ moisture contents of the silty sand samples ranged from 4 to 14 percent by weight, indicating a generally moist condition.

4.3 Sand

Native deposits of a sand, with trace to some silt, and trace gravel was encountered in Boreholes 1, 2, 5, and 8. In Borehole 1 the sand was underlying the silty sand, with a thickness of approximately 2.0m extending to termination depth (8.1m). In Borehole 2, the sand underlaid the silty clay to clayey silt layer and overlaid the silty sand layer with a thickness of approximately 1.5m. In Borehole 5 the sand was underlying the silty sand and overlaying a native sand and gravel layer. Thickness of this layer was approximately 1.5m. In Borehole 8, the sand underlaid the silty sand layer and overlaid the silty sand layer with a thickness of approximately 1.5m. The top 0.3m of sand in Borehole 5 underlying the surficial topsoil was weathered/disturbed.

The Standard Penetration Test result (N-Values) obtained from this layer ranged from 2 to over 50 blows per 300mm of penetration, indicating a generally very loose to very dense relative density.

The in-situ moisture contents of the sand samples ranged from 1 to 10 percent by weight, indicating a generally moist condition.

4.4 Sand and Gravel

Native deposits of a sand and gravel with trace silt was encountered in Borehole 5 underlying the sand layer and overlying the silty sand layer. Thickness of this layer was approximately 1.5m.

The Standard Penetration Test result (N-Values) obtained from this layer was 28 blows per 300mm of penetration, indicating a generally compact relative density.

The in-situ moisture content of the sand and gravel soil sample was 7 percent by weight, indicating a generally moist to condition.

4.5 Silty Clay to Clayey Silt

Native deposits of a silty clay to clayey silt with trace to some sand was encountered in Borehole 2 underlying the topsoil layer with a thickness of approximately 0.5m.

The Standard Penetration Test result (N-Values) obtained from this layer was 7 blows per 300mm of penetration, indicating a firm consistency.

The in-situ moisture content of the silty clay to clayey silt sample was 29 percent by weight, indicating a generally wet condition.

4.6 Groundwater

The depth of ground water and caving was measured in each of the boreholes immediately following the drilling. Water level measurements were made in the monitoring wells installed in Boreholes 1, 2, 7, 9, and 11, on March 13th, 2024. The ground water observations of all the boreholes are summarized as follows:

Borehole No.	Depth of Augering (m)	Depth to Cave (m)	Unstabilized Water Level (Depth) (m)	Stabilized Water Level in well on March 13th, 2024 (Depth) (m)
1	7.6	Open	Dry	Dry
2	4.6	Open	Dry	Dry
3	6.1	Open	Dry	N/A
4	5.0	Open	Dry	N/A
5	4.6	Open	Dry	N/A
6	5.0	Open	Dry	N/A
7	6.1	Open	Dry	Dry
8	4.6	Open	Dry	N/A
9	7.6	Open	Dry	3.3
10	6.1	Open	Dry	N/A
11	4.6	Open	Dry	Dry

Groundwater levels will fluctuate seasonally and depending on the amount of surface runoff and precipitation.

4.7 Geotechnical Laboratory Test Results

The geotechnical laboratory testing consisted of natural moisture content determination for all samples, while grain size analysis was conducted on three selected soil samples (Borehole 2, Sample 2, Borehole 4, Sample 4 and Borehole 10, Sample 3). The test results are listed on the enclosed Borehole Logs at the respective sampling depth.

The results (graphs) of the grain size analyses are appended and a summary of the results are as follows:

Borehole No. Sample No.	Sampling Depth below Grade (m)	Percentage (by mass)				Descriptions (MIT System)
		Gravel	Sand	Silt	Clay	
Borehole 2, Sample 2	0.6 – 1.2	0	86	10	4	SAND, trace silt, trace clay
Borehole 4, Sample 4	2.3 – 2.7	1	73	20	6	SAND, some silt, trace clay, trace gravel
Borehole 10, Sample 3	1.5 – 2.0	3	66	24	7	SILTY SAND, trace clay, trace gravel

5.0 GEOTECHNICAL ENGINEERING DESIGN

The following discussion and recommendations are based on the factual data obtained from this investigation and are intended for use by the owner and the design engineer. Contractors bidding or providing services on this project should review the factual data and determine their own conclusions regarding construction methods and scheduling.

This report is provided on the assumption that the design features relevant to the geotechnical analyses will be in accordance with applicable codes, standards, and guidelines of practice. If there are any changes to the site development features or any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Green Geotechnical should be retained to review the implications of these changes with respect to the contents of this report.

Based on the RFP information document titled "*Geotechnical Engineering Services*" dated June 23, 2023, from U-Haul, and email/phone communications with U-Haul, it is understood the site will be developed for a U-Haul facility which may include multi-story structures, single-story warehouses, light modular storage structures, and vehicle shade canopies.

At the time of this investigation, no conceptual site, grading, or servicing plans were available. It is presumed that site grades will generally be altered to achieve more uniform, gentle grade changes. Any regrading within the influence zones of building or roadways is anticipated to be done with the use of Engineered Fill.

According to the RFP document, ground finished floor elevations are typically to be at or within 2 feet (0.6m) of existing grade. Based on the existing site grade changes, this will require regrading and potentially the importation of fill.

5.1 Foundation Design Parameters

Based on the field investigation at this site, below the surficial topsoil and weathered/disturbed zones, the subsurface conditions predominantly consist of a very loose to very dense sand and silty sand. The undisturbed native site soils are suitable for the support of conventional spread footings, provided that all loose, caved, soft, or deleterious materials are removed, and excess water is pumped out prior to concrete placement. The surficial topsoil, weathered/disturbed native soils, high organic soil areas and/or any other deleterious materials are not suitable to support building foundations.

The compact to very dense native soil conditions encountered will allow structure foundations placed directly on them to be designed with maximum net geotechnical reactions (SLS) and factored geotechnical resistances (ULS) as outlined in the table below, subject to foundation inspection confirmation by Green Geotechnical. Greater capacity can be available at greater depths if required for specific components and can be assessed by Green Geotechnical on a case-by-case basis. Certain areas of the site indicate soft/loose soils at shallow depths which will support a lower bearing pressure as tabulated on the following page:

Borehole Number	Design SLS/ULS (kPa)	Approximate Founding Level	
		Depth (mbg)	Bearing Stratum
1	100 / 150 200 / 300	1.5 – 2.3 > 2.3	Silty Sand Silty Sand
2	75 / 115 150 / 225 200 / 300	0.6 – 1.1 1.1 – 3.0 > 3.0	Silty Clay to Clayey Silt Sand Sand
3	75 / 115 200 / 300	1.0 – 1.5 > 1.5	Silty Sand Silty Sand
4	200 / 225	> 1.5	Silty Sand
5	75 / 115 150 / 225 200 / 300	0.6 – 1.5 1.5 – 2.3 > 2.3	Sand Sand Sand and Gravel
6	200 / 300	> 1.5	Silty Sand
7	75 / 115 200 / 300	0.6 – 1.5 > 1.5	Silty Sand Silty Sand
8	200 / 300	> 2.3	Silty Sand
9	200 / 300	> 0.6	Silty Sand
10	100 / 150 200 / 300	0.6 – 2.3 >2.3	Silty Sand Silty Sand
11	100 / 150 200 / 225	1.5 – 2.3 > 2.3	Silty Sand Silty Sand

A minimum soil cover of 1.4m or equivalent insulation is recommended for frost protection to footings in exterior or unheated areas. Construction during cold weather should also ensure temporary frost protection of footing bases.

Native soils tend to weather rapidly and deteriorate on exposure to the atmosphere and surface water. The time between foundation excavation and concrete placement should be minimized as much as possible.

The minimum footing widths to be used in conjunction with the above recommended soil bearing pressures should be 0.5m for continuous footings and 0.9m for individual footings placed on native soils. The above recommended bearing capacities are based on estimated maximum total settlement of 25mm and differential settlement of 19mm.

It should also be noted that due to the variable conditions in the upper approximately ±1m to ±2m of the site, some downward stepping of footings should be anticipated in order to extend to competent soils. Footings stepped from one level to another must be at a slope not exceeding 7 vertical to 10 horizontal, and with a grade change not exceeding 0.6m.

Prior to placing foundation concrete, all excavated foundation subgrade soils should be cleaned of all deleterious materials such as topsoil, fill, softened or disturbed materials as well as any standing water. It is recommended that the foundations be inspected by Green Geotechnical in order to confirm the exposed soil conditions and recommended bearing capacities.

5.1.1 Foundations on Engineered Fill

At the time of this investigation, no conceptual site, grading, or servicing plans were available. It is presumed that site grades will generally be altered to achieve more uniform, gentle grade changes. Any regrading within the influence zones of building or roadways is anticipated to be done with the use of Engineered Fill.

The undisturbed native soils beneath the topsoil, weathered/disturbed, and soft/loose layers are considered suitable for the support of Engineered Fill pads for supporting the building foundations. The Engineered Fill pads should extend at least 1m beyond any building footprint at underside of footing elevation and extend out at a 1:1 (horizontal to vertical) slope down to the native soils. Unless the foundations are constructed immediately on the Engineered Fill pad, the Engineered Fill should be built up an additional approximately ±1m in elevation to serve as a protective cap of the Engineered Fill at underside of footing level from the effects of weathering.

All deleterious or otherwise unsuitable materials such as topsoil, fill, loose or weathered/disturbed materials, as well as any standing water must be removed prior to the placement of Engineered Fill. These materials do not constitute an adequate subgrade for support of Engineered Fill. After any unsuitable materials are removed, the exposed competent native soil subgrade must be inspected and approved by Green Geotechnical prior to placement of Engineered Fill. Engineered Fill placed to raise grades must consist of clean earth, free from any organic/topsoil or deleterious matter and must be placed in maximum 150mm thick lifts and compacted to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD). Any Engineered Fill construction must be completed under full time supervision by Green Geotechnical to monitor extent, lift thickness, compaction, material quality and the like.

For Engineered Fill with a thickness of at least 0.5m constructed on a compact native subgrade approved by Green Geotechnical, the recommended maximum net geotechnical reaction may be 150kPa (SLS) and the maximum factored geotechnical resistance at Ultimate Limit State (ULS) is 225kPa.

Prior to placing foundation concrete, all Engineered Fill should be cleaned of all deleterious materials such as softened or disturbed materials as well as any standing water. It is required that the foundations placed on Engineered Fill be inspected by Green Geotechnical in order to confirm the exposed soil conditions and recommended bearing capacities.

The minimum footing widths to be used in conjunction with the above recommended soil bearing pressures should be 0.6m for continuous footings and 1.0m for individual footings placed on Engineered Fill. The above recommended bearing capacities are based on estimated maximum total settlement of 25mm and differential settlement of 19mm.

It should be noted that for structures placed on Engineered Fill, nominal reinforcing steel (rebar) at a minimum be placed in the foundations comprising two (2) continuous 15M bars in the strip footings, and two (2) continuous 15M bars at the top and bottom of the foundation walls be provided. Any column footing will require 15M bars spaced at 0.3m on centre, in each direction of the column. The reinforcing steel requirements of the structure are to be reviewed by a structural engineer.

A copy of “Engineered Fill Earthworks Specifications” is enclosed in Appendix D of this report for reference purposes. These specifications should be included in the earthworks contract.

5.2 Slab-on-Grade Design Parameters

Groundwater levels recorded at this site were approximately 3m or lower below existing grades in March of 2024. All finished floor surfaces are recommended to be at least 0.5m above the prevailing seasonally high groundwater level.

All non-structural earth fill and any other deleterious or unsuitable materials must be removed prior to placement of new fill for grade raise. These materials do not constitute an adequate subgrade for support of Engineered Fill. After any unsuitable materials are removed, the exposed soil subgrade must be inspected and approved by Green Geotechnical at the time of construction. Any structural fill placed to raise grades, must be placed in maximum 150mm thick lifts and compacted to at least 98 percent Standard

Proctor Maximum Dry Density (SPMDD). Conventional lightly loaded concrete slab-on-grade or basement floors can be placed on the Engineered Fill. The vertical moduli of subgrade reaction for compacted fill soils at the site is 18,000 kPa/m.

It is necessary that building floor slabs be provided with a capillary moisture barrier and drainage layer. This is accomplished by placing the slab on a minimum 200mm layer of 19mm clear stone (OPSS.MUNI 1004) compacted by vibration to a dense state. The upper 50mm of the 200mm drainage layer may be replaced with 50mm of Granular A (OPSS.MUNI 1010) to provide a trafficable surface. The 19mm clear stone can be replaced in its entirety with Granular 'A' so long as a minimum 10mil poly-vapour barrier is used below the slab base. However, these do not replace the floor manufacturers' specific requirement(s) for a moisture and vapour barrier. A suitable non-woven geotextile filter (Terrafix 360R or equivalent approved by Green Geotechnical) must be installed (with a minimum 900mm overlap) below the capillary moisture break to properly filter the slab base from the subgrade. Otherwise, this could result in the loss of ground supporting the slab and clogging of the slab base.

Subfloor drainage is not required for at-grade buildings with no below grade levels. Perimeter drainage of the subgrade is required where exterior doors are flush to grade or in areas where the finished floor is less than 300mm higher than grade. This is to prevent impaired door function during winter months.

Regardless of the approach to slab floor construction, the floor slabs that are to have bonded floor finishes (such as tiles with adhesives) should be provided with a capillary moisture and vapour barrier and drainage layer. The floor manufacturers have specific requirements for moisture and vapour barrier, therefore, the floor designer/architect must ensure that a provision of appropriate moisture and vapour barrier conforming to specific floor finish product requirements is incorporated in the project specifications. Adequate testing must be carried out to ensure acceptable levels of moisture and relative humidity in the concrete slab prior to the installation of floor finish(es).

The under-slab vapour retarder specifications, selection and installation shall conform to ASTM E1745 and ASTM E1643. The moisture vapour measurement tests shall conform to RH: ASTM F2170, RH: ASTM F2420 and Calcium Chloride: ASTM F1869. The Surface Applied Moisture Vapour Barrier system shall meet the guidelines established in ASTM F3010-13.

5.3 Earthquake Design Parameters

The Ontario Building Code stipulates the methodology for earthquake design analysis. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification.

Under Ontario Regulation 88/19, the ministry amended Ontario's Building Code (O. Reg 332/12) to further harmonize Ontario's Building Code with the 2015 National Codes. These changes will help reduce red tape for businesses and remove barriers to interprovincial trade throughout the country. The amendments are based on code change proposals the ministry consulted in 2016 and 2017. The majority of the amendments came into effect on January 1, 2020, which includes structural sufficiency of buildings to withstand external forces and improve resilience.

Seismic hazard is defined in the Ontario Building Code (OBC) by uniform hazard spectra (UHS) at spectral coordinates of 0.2s, 0.5s, 1.0s and 2.0s and a probability of exceedance of 2% in 50 years. The OBC method uses a site classification system defined by the average soil/bedrock properties (e.g., shear wave velocity (vs), Standard Penetration Test (SPT) resistance, and undrained shear strength (s_u) in the top 30 meters of the site stratigraphy below the foundation level, as set out in the Ontario Building Code. There are 6 site classes from A to F, decreasing in ground stiffness from A, hard rock, to E, soft soil; with site class F used to denote problematic soils (e.g., sites underlain by thick peat deposits and/or liquefiable soils). The site class is then used to obtain peak ground acceleration (PGA), peak ground velocity (PGV) site coefficients Fa and Fv, respectively, used to modify the UHS to account for the effects of site-specific soil conditions.

Based on the above, it is recommended that the site designation for seismic analysis be **Site Class C,** as per the Ontario Building Code. It should be noted that the above site seismic designation is estimated on the basis of rational analysis of the undrained shear strength information obtained from the boreholes advanced at the site only up to about 8.1m depth below grade. Consideration may be given to conducting a site-specific Multichannel Analysis of Surface Waves (MASW) at this site to confirm the average shear wave velocity in the top 30m of the site stratigraphy. MASW testing often determines higher seismic site class ratings than those able to be determined from SPT testing, resulting in potential project cost savings.

The values of the site coefficient for design spectral acceleration at period T, F(T), and of similar coefficients F(PGA) and F(PGV) shall conform to Tables 4.1.8.4.B. to 4.1.8.4.I. using linear interpolation for intermediate values of PGA.

5.4 Lateral Earth Pressure Design Parameters

The appropriate values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follows:

Stratum/Parameter	γ	ϕ	K_a	K_o	K_p
Compact Granular Fill Granular 'B' (OPSS.MUNI 1010)	21	32	0.31	0.47	3.25
Earth Fill	18	28	0.36	0.53	2.76
Sand and Silty Sand (compact)	19	30	0.33	0.50	3.00
Sand and Silty Sand (loose)	19	29	0.35	0.52	2.88

where: γ = bulk unit weight of soil (kN/m^3)

φ = internal angle of friction (degrees)

K_a = Rankine active earth pressure coefficient (dimensionless)

K_o = Rankine at-rest earth pressure coefficient (dimensionless)

K_p = Rankine passive earth pressure coefficient (dimensionless)

The above earth pressure parameters pertain to a horizontal grade condition behind a retaining structure. Values of earth pressure parameters for an inclined retained grade condition will vary.

Walls subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following equation:

$$P = K[\gamma(h - h_w) + \gamma' h_w + q] + \gamma_w h_w$$

where, **P** = the horizontal pressure at depth, **h** (m)

K = the earth pressure coefficient

h_w = the depth below the groundwater level (m)

γ = the bulk unit weight of soil, (kN/m^3)

γ' = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)

q = the surcharge loading (kPa)

The above equation pertains to a horizontal grade condition behind a retaining structure. Values of earth pressure against retaining structures for an inclined retained grade condition will vary.

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall that would otherwise act in conjunction with the earth pressure, this equation can be simplified to:

$$P = K[\gamma h + q]$$

Resistance to sliding of retaining structures is developed by friction between the base of the footing and the soil. This friction **(R)** depends on the normal load on the soil contact **(N)** and the frictional resistance of the soil **(tan ϕ)** expressed as: **R = N tan ϕ**. This is an unfactored resistance. The factored resistance at ULS is **R_f = 0.8 N tan ϕ**.

5.5 Pavement Design

The pavement subgrade is expected to comprise of native, undisturbed sand or silty sand soils, or clean earth fill compacted to a minimum of 98% of SPMDD. The exposed subgrade should be shaped and graded with a typical 3% cross-fall, directed towards continuous subdrains and/or ditch-lines with inverts at least 0.3m below subgrade level.

All topsoil, organic-rich, and otherwise deleterious material should be sub-excavated. The pavement subgrade should be assessed (proof rolled with a heavy rubber-tired vehicle, if deemed feasible by Green Geotechnical) and approved (no rutting or major deflections) by Green Geotechnical to ensure stability prior to the placement of the pavement granular courses. All unstable areas will require sub-excavation and re-compaction or increased thickness of granular subbase. It should be noted that the majority of the upper site soils are considered to be low to moderately frost susceptible. Adequate subgrade drainage is still recommended.

An adequate granular working surface may be required to minimize subgrade disturbance and protect its integrity in wet periods. The fill material may consist of granular type material with a moisture content within ±2 percent of optimum moisture content. Fill materials and subgrade should be compacted to 98 percent of SPMDD.

Control of surface water is an important factor in achieving a good pavement life. The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (preferably at a minimum grade of 3 percent) to provide effective drainage toward subgrade drains. Grading adjacent to pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement. Continuous pavement subdrains should be provided along both sides of driveways and drained into respective catch basins and/or ditch-lines to facilitate drainage of the subgrade and the granular materials. The subdrain inverts should be maintained at least 0.3m below subgrade level. Continuous subdrains should also be provided for pavement areas along any curb-lines/sidewalks. Two lengths of subdrain stubs (each minimum 3m long) should be installed at each catch basin (refer to Appendix C - Pavement Drainage Details).

The below pavement design thicknesses are considered adequate for design traffic. However, if the pavement construction occurs in wet or inclement weather, it may be necessary to provide additional subgrade support for heavy construction traffic by increasing the thickness of the granular sub-base, base, or both. Further, traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of granular materials.

Granular A and B materials should meet the requirements of OPSS.MUNI 1010 and relevant municipal standards. Granular materials should be compacted to 98 and 100 percent SPMDD for the subbase and base respectively, at ±2 percent of the optimum moisture content, placed in lifts of 150mm or less.

It should be noted that in addition to adherence of the below pavement design recommendations, a close control on the pavement construction process will also be required in order to obtain the desired pavement life. Therefore, it is required that regular inspection and testing by Green Geotechnical be conducted during the pavement construction to confirm material quality, stability, thickness, and to ensure adequate compaction.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures must be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as possible when fill is placed, and the natural subgrade is not disturbed or weakened after it is exposed.

5.5.1 Flexible Pavement (Asphalt)

Based on the soil conditions encountered during our investigation, we recommend the following flexible pavement (asphalt) structure for light duty and heavy-duty traffic areas:

Pavement Structural Layers	Min. Thickness (mm)		Compaction Requirements
	Light Duty Traffic	Heavy Duty Traffic	
Hot Mix Asphalt Surface Course, OPSS 1150 HL 3	40	50	as per OPSS 310
Hot Mix Asphalt Binder Course, OPSS 1150 HL 8	60	80	
Base Course, OPSS.MUNI 1010, Granular A or 19mm CRLS	150	150	100 percent of Standard Proctor Maximum Dry Density (SPMDD) (ASTM D698)
Subbase Course, OPSS.MUNI 1010, Granular B or 50mm CRLS	300	450	98 percent of Standard Proctor Maximum Dry Density (SPMDD) (ASTM D698)

The above design assumes that sub-drainage of the granular fill will be provided. This should consist of continuous subdrains leading to catch basins and/or ditch-lines.

It should be reiterated that the subgrade soils are low to moderately frost susceptible. The subdrains are considered a valuable protection against frost heave damage and subgrade softening particularly impacting the long-term performance of the pavement.

An adequate granular working surface would likely be required in order to minimize subgrade disturbance and protect its integrity in wet periods. The fill material may consist of granular type material with a moisture content within ±2 percent of optimum moisture content, placed in lifts of 150mm or less. Fill materials and the subgrade should be compacted to 98 percent of SPMDD.

The granular subbase and base fill materials should be compacted to a minimum of 98% and 100% of Standard Proctor Maximum Dry Density (SPMDD), respectively, placed in lifts of 150mm or less. Asphaltic concrete materials should be rolled and compacted as per OPSS 310 based on density testing. **Due to the susceptibility of the site soils to construction traffic and weathering disturbance, care should be taken that construction occurs in the driest summer periods. If this is not possible, the granular subbase may require additional thickness, or the specific use of Granular B 'Type II.'**

5.5.2 Rigid Pavement (Concrete)

Alternatively, consideration may also be given to the use of rigid Portland Cement concrete pavement where there is intense truck use and turning of transport vehicles in conjunction with waste handling, loading docks or delivery facilities. The following table provides the minimum recommended rigid concrete pavement structure:

Pavement Layer	Compaction Requirements	Minimum Thickness
Portland Cement Concrete (CAN3-CSA A23.1) – Class C2	CAN3-CSA A23.1	225mm
Base Course: Granular 'A' or 19mm Crusher Run Limestone (OPSS.MUNI 1010)	100% SPMDD (ASTM D698)	200mm

It must be noted that this structure does not provide full protection of the subgrade from frost penetration, therefore, the pavement slab must be separated from any building structure. A truck loading bay is typically the lowest point in the pavement grading. It is recommended to provide a subgrade drain at the lowest point in the bay, usually at the trench drain, to facilitate an exit for subgrade drainage.

Sidewalks and concrete walkways should be provided with a minimum granular base thickness of 150mm, consisting of 19mm Crusher Run Limestone conforming to OPSS 1010 Granular 'A,' compacted to 98% of

SPMDD. The subgrade in the sidewalk and boulevard should be sloped to promote drainage to the nearest surface runoff drainage feature to help minimize concrete slab heaving.

For a sidewalk which will minimize long term maintenance, consideration can also be given to supporting the concrete surface sidewalk on a minimum of 1.4m thick of non-frost susceptible material to help minimize frost heaving of the concrete slab.

5.5.3 Aggregate – Surfaced Pavement Structures

Based on the soil conditions encountered during our investigation, we recommend the following pavement structure for a gravel–surfaced pavement structures:

Pavement Layer	Compaction Requirements	Minimum Thickness (Light Duty)	Minimum Thickness (Heavy Duty)
Surface Treated Base Course, OPSS.MUNI 1010, Granular A or 19mm CRLS	100 percent of Standard Proctor Maximum Dry Density (SPMDD) (ASTM D698)	350mm	400mm
Subbase Course, OPSS.MUNI 1010, Granular B or 50mm CRLS	98 percent of Standard Proctor Maximum Dry Density (SPMDD) (ASTM D698)	300mm	450mm

Consideration can also be given to placing Biaxial GeoGrid (such as Terrafix TBX 2500 or 3000) between the undisturbed native subgrade soils and between the subbase and base granular courses. This additional reinforcement will reduce the amount of rutting/deflections/settlements in the roadway. Consideration should also be given to a surface-treatment program on the base course of the gravel-surfaced pavement structure to minimize material loss. These options will increase the service life of the gravel-surfaced pavement structure and reduce (but not eliminate) the frequency of required maintenance.

Due to the surface materials being pervious, washout, traffic, etc., rutting/deflections/settlements in the roadway will still occur and regular maintenance will be required to maintain the gravel-surfaced pavement structure in good operational condition. This regular maintenance will likely be required in the spring and include material top-ups, regrading, re-compaction, and the re-application of surface treatment.

5.6 Pipe Bedding

Trench bases are expected to consist primarily of native, undisturbed sand and silty sand soils, or clean earth fill compacted to a minimum of 98% of SPMDD. The native, undisturbed site soils as well as Engineered Fill will generally be suitable for support of underground services with conventional Class 'B' granular bedding. Additional granular bedding may be necessary for stabilization of wet trench bases or particularly soft areas. The granular bedding should consist of a well graded material such as Granular 'A'. Excavation bases should be free of standing water prior to and during bedding and service placement.

Any soft, loose, or disturbed soils encountered as a result of groundwater seepage or construction traffic should be subexcavated and replaced with suitably compacted granular fill. Additionally, any loose or deleterious fill or organics encountered below proposed pipe inverts should be subexcavated and replaced with suitable compacted bedding material. Granular 'A' bedding material should be placed in thin lifts and compacted to a minimum of 95% of SPMDD. If HL8 coarse aggregate or 19mm clear stone is used this will require light tamping only. However, it should be cautioned that this HL8 aggregate or clear stone should not be used directly against native deposits unless a geotextile fabric is also considered as a complete wrap to prevent migration of fines into the bedding from the surrounding fine soil. Without proper filtering, this loss of ground could result in loss of support to the pipes and in possible future.

In areas where the soils become wet, unstable and dilatant (easily disturbed) such as saturated silts, clays and water bearing granular soils, careful construction techniques and dewatering should be followed. If the pipes are laid on disturbed, dilatant soil, significant post-construction settlements could occur after the trenches are backfilled. In such cases, disturbed soils must be removed. The bottom of wet trenches will have to be stabilized by dewatering. The placement of a thin layer of lean mix concrete or a 'mud slab' may be considered to prevent heaving of sensitive or easily disturbed sub-soils and prevent disturbance of sensitive sub-soils due to construction activity. If a 'mud slab' option is not used, then increasing the Class 'B' type bedding thickness in order to stabilize the subgrade soil is recommended.

5.7 Soil Permeability

Laboratory testing was conducted on three select soil samples at various depths (Borehole 2 Sample 2, Borehole 4 Sample 4, and Borehole 10 Sample 3) to determine estimated coefficients of permeability. The results of the soil gradation are appended and estimated Hydraulic Conductivities, Percolation Rates (T-Times), and Infiltration Rates based on the grain size analyses are summarized below:

Testing Location	Soil Description (MIT System)	Sampling Depth Below Grade (m)	Estimated Hydraulic Conductivity (cm/sec)	Estimated Percolation Rate (T-Time) (min/cm)	Estimated Infiltration Rate (mm/hr)
BH2 SS2	SAND, trace silt, trace clay	0.6 – 1.2	$2.0*10^{-3}$	8	75
BH4 SS4	SAND, some silt, trace clay, trace gravel	2.3 – 2.7	$4.2*10^{-5}$	18	33
BH10 SS3	SILTY SAND, trace clay, trace gravel	1.5 – 2.0	$1.0*10^{-5}$	20	30

Note: Based on geotechnical laboratory grain size analysis, the infiltration rates are estimated as per Table C1, ‘Approximate relationships between hydraulic conductivity, percolation time and infiltration rate’ of the Low Impact Development Stormwater Management Planning and Design Guide.

It should be noted that the hydraulic conductivities, soil permeabilities, and infiltration rates as noted above are estimated based on the composition of the soil samples tested. It should also be noted that the soil conditions may vary between and beyond the boreholes and there can also be variation within the soil layers. The design infiltration rates should be evaluated by the system designer based on applicable safety correction factor(s) as per the above reference document.

Green Geotechnical does not present the estimated hydraulic conductivities, permeabilities, or infiltration rates given in this report as a warranty of performance for the soils tested. The client or any third party using this information as a basis for the design, assumes all risks associated with their evaluation of this report and all other pertinent criteria used in the design. Green Geotechnical assumes no responsibility for the application of the above-noted hydraulic conductivities, permeabilities, or infiltration rates for use in design. Designs must be conducted by a qualified professional engineer with due regard to site-specific conditions and other design considerations.

5.8 Chemical Analysis

A total of three (3) selected soil samples (Borehole 6, Sample 3; Borehole 6, Sample 4; and Borehole 8, Sample 3) were submitted to Caduceon Environmental Laboratories for chemical analyses (Corrosivity Package) consisting of conductivity, resistivity, pH, redox potential, chloride, sulphate, and sulphide testing. A copy of the Certificate of Analysis is included in Appendix E – Chemical Analysis. These parameters are used for assessing soil corrosivity applicable to cast iron alloys, according to the 10-point soil evaluation procedure described in the American Water Work Association (AWWA) C 105 standard. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys. It should be noted that the analytical results only provide an indication of the potential for corrosion. A more recent study by the AWWA has suggested that soil with a resistivity of less than about 2000 ohm*cm should be considered aggressive. All samples had a resistivity greater than 2000 ohm*cm. A summary of the samples and their score is presented in the table below.

Severity Ranking	Borehole and Sample Number		
	BH6 SS3	BH6 SS4	BH8 SS2
Total Points	5	5	5
Corrosion Protection	Not Required	Not Required	Not Required

All samples had a corrosivity index of less than 10. An index of less than 10 indicates **corrosion protection measures are not required** for cast iron alloys. The full results of the analysis can be found in Appendix E.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Excavation and Backfill

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III – Excavations, Sections 222 through 242. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. For practical purposes, earth fill and the native site soils are classified as Type 3 soil above and Type 4 soil below the groundwater table.

Where workers must enter excavations advanced deeper than 1.2m, the trench walls should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates safe slopes of excavation by soil type as follows:

Soil Type	Base of Slope	Steepest Slope Inclination
1	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
2	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
3	from bottom of trench	1 horizontal to 1 vertical
4	from bottom of trench	3 horizontal to 1 vertical

Minimum support system requirements for steeper excavations are stipulated in the Occupational Health and Safety Act and Regulations for Construction Projects, and include provisions for timbering, shoring and moveable trench boxes.

The subsurface soils can be removed by conventional excavation equipment. Larger size particles (cobbles and boulders) that are not specifically identified in the boreholes may be present in the native soils. The size and distribution of cobbles/boulders/obstructions cannot be predicted with boreholes, as the sampler size is insufficient to secure representative particles of this size. The risk and responsibility for the removal and disposal of cobbles/boulders/obstructions and appropriate use of equipment must be addressed in the contract documents for foundations, excavations and shoring contractors.

Structures such as existing buried foundations, previously backfilled excavations, existing old wells/cisterns, drainage tiles, boulders, rubble, etc. may also be present at the site. The presence of these structures if encountered, will likely affect construction methods and cost if they exist within proposed structure areas.

The surficial topsoil, earth fill, and native soil layers with amounts of organics should not be reused as backfill in settlement sensitive areas (beneath floor slabs, trench backfill and pavement areas). However, these materials may be stockpiled and reused for landscaping purposes.

Unsaturated native coarse grained soils, such as the native sand and silty sand, that is free of organics, boulders, and deleterious inclusions, encountered above the groundwater table is considered to be suitable for reuse as backfill, so long as moisture content levels are within 2 percent of the optimum moisture content level.

It should be noted that native soils excavated from below the prevailing groundwater level (if encountered) will likely be too wet to compact to required compaction specification.

The moisture content of the backfill soils should be within 2 percent of their optimum moisture content. Any soil material with in-situ moisture content higher than 2 percent of its optimum moisture content could be put aside to dry or be tilled to reduce the moisture content so that it can be effectively compacted. Alternatively, materials of higher moisture content could be wasted and replaced with imported granular-type material which can be readily compacted.

In settlement sensitive areas, the backfill should consist of clean earth and should be placed in lifts of 150mm thicknesses or less, and heavily compacted to a minimum of 95 percent SPMDD at a water content close to optimum. The soils encountered on the site will and imported granular fill will be best compacted with a heavy smooth drum type roller.

It should be noted that the site soils have moderate to high hydraulic conductivity and will be difficult to handle and compact should they become wetter as a result of inclement weather or seepage. Hence, it can be expected that earthworks will be difficult during the wet periods (i.e., spring and fall) of the year and may result in increased earthwork costs.

6.2 Groundwater Control

Groundwater levels recorded at this site were approximately 3m or lower below existing grades in March of 2024. However, long term monitoring was beyond the scope of this investigation and the seasonal water table may fluctuate. Seepage above or near the groundwater levels should be handled adequately using filtered sump pumps placed at the base of the excavations for most of the site. More significant dewatering efforts will be required below the groundwater levels, and particularly in sandy/gravelly soil pockets.

Moderate to highly permeable soils were encountered in the boreholes. These soils may yield varying amounts of groundwater seepage into the excavation depending upon the type of soil and the depth of excavation. The amount of water seepage is expected to increase with the depth of excavation. Groundwater control will be required for excavations extending into/or below the prevailing groundwater level, prior to and during the subsurface construction. Without positive groundwater control, the subgrade in wet permeable soils will become weak/disturbed and lose its integrity to support. Consideration should be given to install a skim coat of lean concrete (mud-slab) to preserve the subgrade integrity in these areas, and to provide a working platform, as deemed appropriate by the project geotechnical engineer during construction.

All finished floor surfaces are recommended to be at least 0.5m above the prevailing seasonally high groundwater level.

It should be noted that excavations carried through and below the water bearing soils will likely experience loosening and sloughing of the base and sides unless the groundwater level is lowered first to at least 1.0m below the bottom of the excavation.

6.3 Quality Control

The foundation installations must be reviewed in the field by Green Geotechnical, the geotechnical engineer, as they are constructed. The on-site review of the condition of the foundation subgrade as the foundations are constructed is an integral part of the geotechnical design function and is required by Section 4.2.2.2 of the Ontario Building Code. If Green Geotechnical is not retained to carry out foundation evaluations during construction, then Green Geotechnical accepts no responsibility for the performance or non-performance of the foundations, even if they are ostensibly constructed in accordance with the conceptual design advice contained in this report.

The long-term performance of the pavement is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as practically possible. The design advice in this report is based on an assessment of the subgrade support capabilities as indicated by the boreholes. These conditions may vary across the site depending on the final design grades and therefore, the preparation of the subgrade and the compaction of all fill should be monitored by Green Geotechnical at the time of construction to confirm material quality, thickness, and to ensure adequate compaction.

The requirements for fill placement on this project have been stipulated relative to Standard Proctor Maximum Dry Density (SPMDD). In situ determinations of density during fill placement on site are required to demonstrate that the specified placement density is achieved. Green Geotechnical can provide sampling and testing services for the project as necessary, with our qualified technical staff.

Concrete will be specified in accordance with the requirements of CAN3 - CSA A23.1. Green Geotechnical maintains a concrete laboratory and can provide concrete sampling and testing services for the project as necessary.

7.0 LIMITATIONS AND REPORT USE

7.1 Procedures

This subsurface investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Green Geotechnical and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained by Green Geotechnical.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Green Geotechnical has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Green Geotechnical has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

7.2 Changes in Site and Scope

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Groundwater levels are particularly susceptible to seasonal fluctuations.

The discussion and recommendations are based on the factual data obtained from this investigation made at the site by Green Geotechnical and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructability issues and quality control may not be relevant or complete for the revised project. Green Geotechnical should be retained to review the implications of such changes with respect to the contents of this report.

This report was prepared for the express use of U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE and their retained design consultants and is not for use by others. This report is copyright of Green Geotechnical Inc., and no part of this report may be reproduced by any means, in any form, without the prior written permission of Green Geotechnical and U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE, who are the authorized users.

It is recognized that the regulatory agencies in their capacities as the planning and building authorities under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both expressed and implied.

We trust this report meets your requirements. Should you have any questions regarding the information presented, please do not hesitate to contact our office.

Sincerely,

Green Geotechnical Ltd.

Sean O'Grady, B.Sc.
Geoscientist in Training

Luke Kim, E.I.T.
Project Coordinator

TAKuchar

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Project Manager

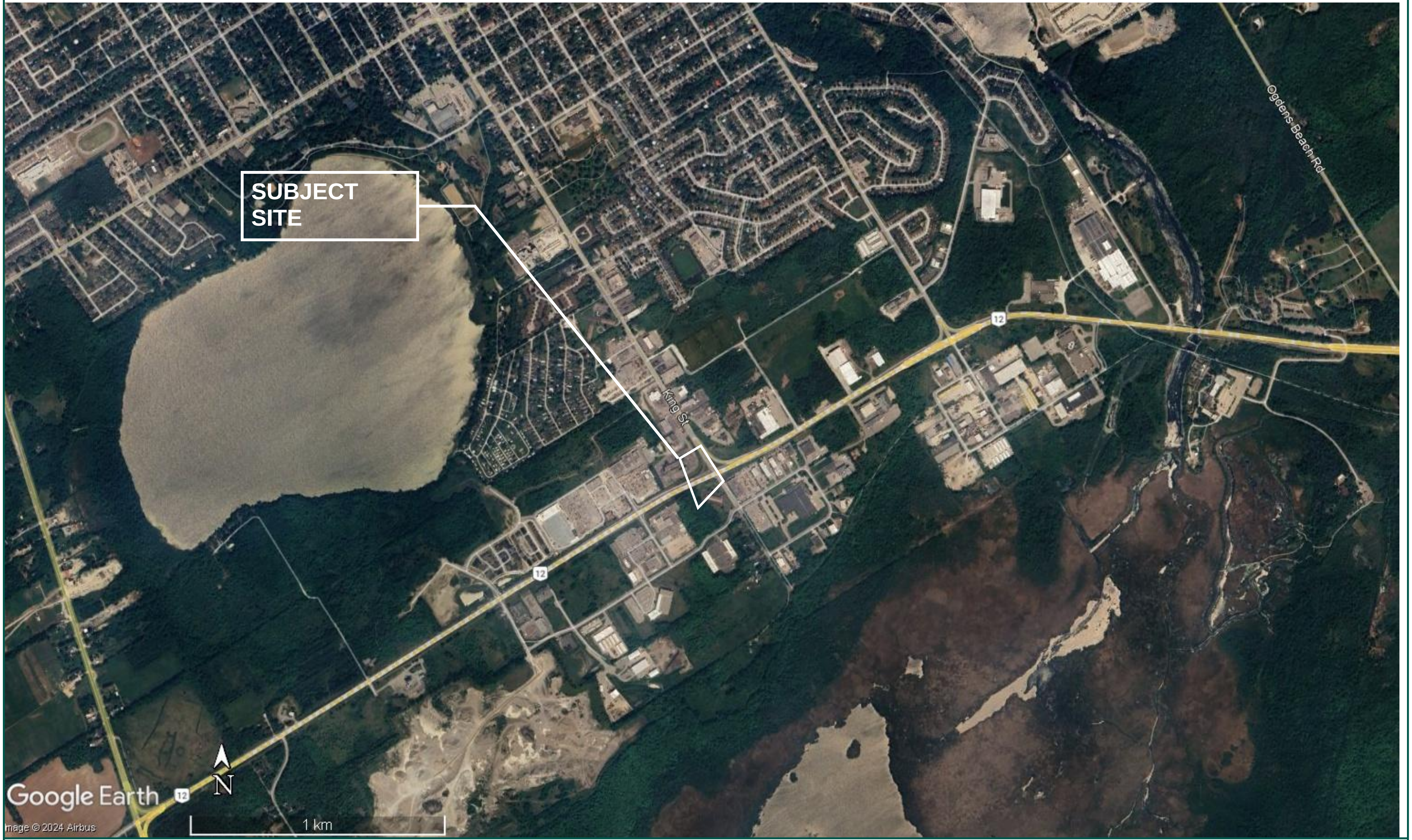
Steven Green

Steven Green, P.Eng.
President

LICENSED PROFESSIONAL ENGINEER
S. C. GREEN
100175284
July 25, 2024
PROVINCE OF ONTARIO

Enclosures: Figures and Appendices

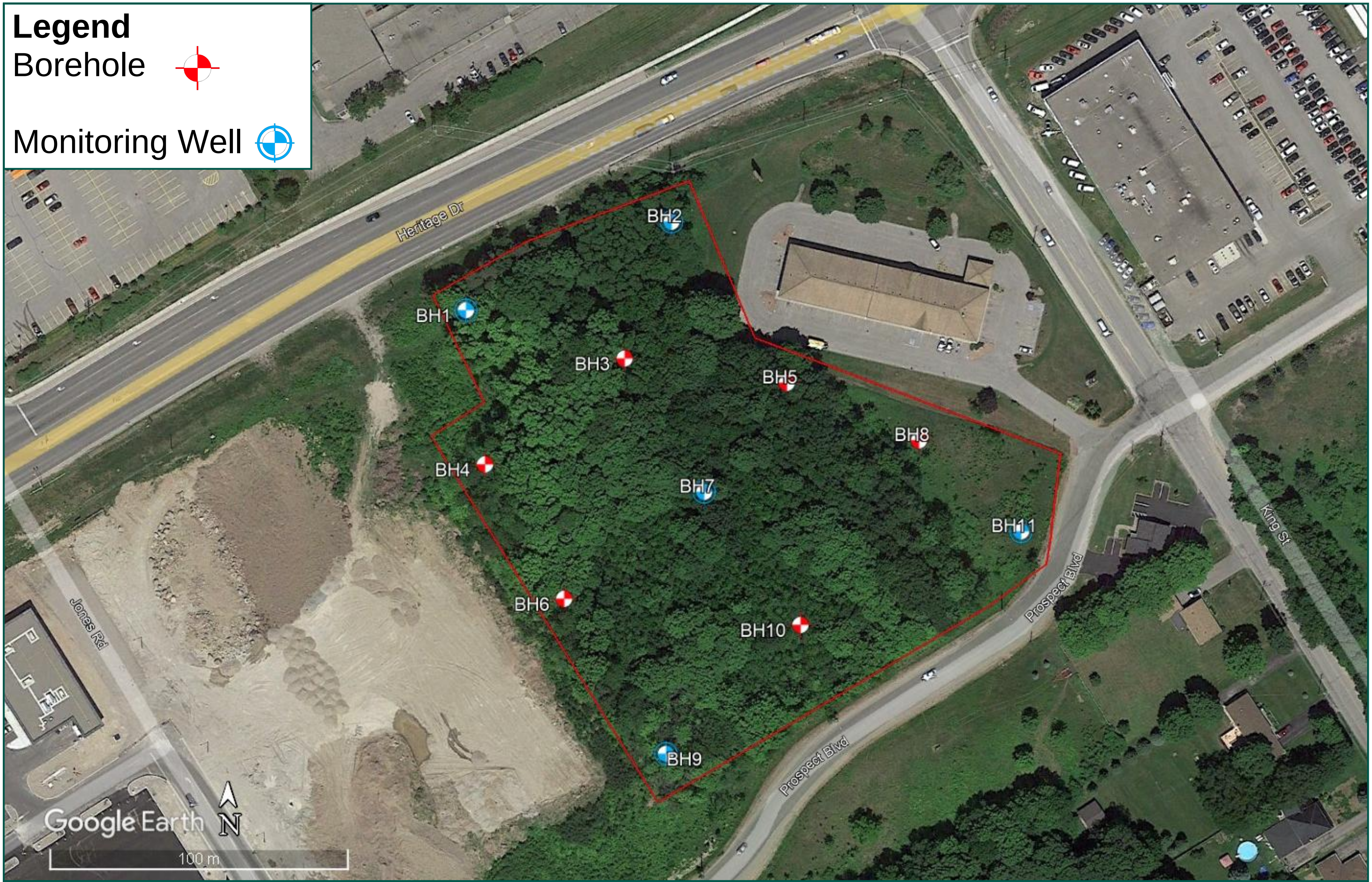
FIGURES



Title:

FIGURE 1: SITE LOCATION PLAN

Project: **Geotechnical Investigation - 16728 Highway 12, Midland, Ontario**	Drawn By: **SO**	Project Number: **23-127-01**	**GREEN GEOTECHNICAL** **576 Bryne Drive, Unit 'O', Barrie, ON** **705-503-9626** **info@greengeo.ca**
Reference: **Map Data © 2024 Google Earth**	Reviewed By: **TK**	Date: **Mar., 2024**	



Title:

FIGURE 2: - APPROXIMATE BOREHOLE LAYOUT PLAN - (EXISTING)

Project: **16728 Highway 12, Midland U-Haul**	Drawn By: **SO**	Project Number: **23-127-01**	**GREEN GEOTECHNICAL** **576 Bryne Drive, Unit 'O', Barrie, ON** **705-503-9626** **info@greengeo.ca**
Reference: **Map Data © 2024 Google Maps**	Reviewed By: **TK**	Date: **Mar., 2024**	

APPENDICIES

APPENDIX A

SYMBOLS and ABBREVIATIONS USED ON BOREHOLE LOGS

PROPORTIONAL TERMS

Term	Proportion
trace	0 to 10%
some	10 to 20%
-y or -ey	20 to 35%
and	>35%

MOISTURE DESCRIPTION

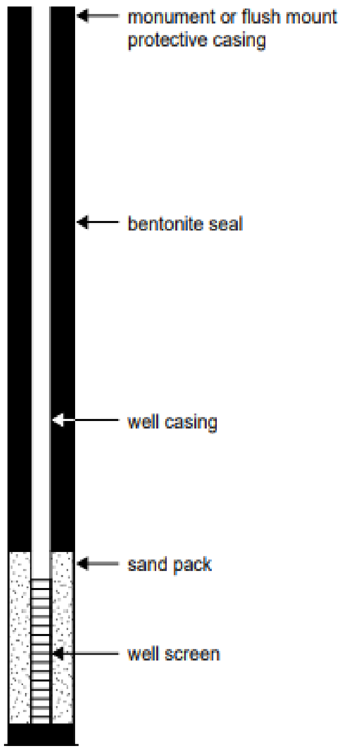
Term	Description
dry	No observable pore moisture
moist	Inferred pore moisture, no observable free water
wet	Weakened by moisture, free water on hands when handling

CONSISTENCY of COARSE-GRAINED SOILS

Consistency	Blow Count N
very loose	< 4
loose	4 to 10
compact	10 to 30
dense	30 to 50
very dense	> 50

Notes: SPT/DCPT 'N' values are 'raw' field blow counts, measured for 300 mm (12 inch) of penetration.

WELL LEGEND



CONSISTENCY of FINE-GRAINED SOILS

Consistency	Blow Count N	Undrained Shear Strength Su (kPa)	
very soft	< 2	< 12	Easily exudes between fingers when squeezed
soft	2 to 4	12 to 25	Easily intended by fingers
firm	4 to 8	25 to 50	Can be intended by strong finger or thumb pressure
stiff	8 to 16	50 to 100	Cannot be intended by thumb pressure
very stiff	16 to 30	100 to 200	Can be intended by thumb nail
hard	> 30	> 200	Difficult to intend by thumb nail

ASTM STANDARDS
ASTM D1568 Standard Penetration Test (SPT) - Driving a 51 mm O.D. split-barrel sampler ("split spoon") into soil with a 63.5 kg weight free falling 760mm. The blows required to drive the split spoon 300mm ("bpf") after an initial penetration of 150 mm is referred to as the N-Value.
ASTM D1568 Cone Penetration Test (CPT) - Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm^2 Into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.
ASTM D2573 Field Vane Test (FVT) - Pushing a four blade vane into soil and rotating it from the surface to determine the torque required to shear a cylindrical surface with the vane. The torque is converted to the shear strength of the soil using a limit equilibrium analysis.
ASTM D1587 Shelby Tubes (ST) - Pushing a thin-walled metal tube into the in-situ soil at the bottom of a borehole, removing the tube and sealing the ends to prevent soil movement or changes in moisture content for the purposes of extracting a relatively undisturbed sample.

SYMBOL	Description
AS	Auger Sample
CC	Continuous Core Sample
DC	Drill Cuttings
GS	Grab Sample
SS	SPT Spoon Sample
TS	Thin-walled / Shelby Sample
WS	Water Sample

SYMBOL	Description
▼	Measured in a piezometer or well
▽	Inferred water level based on observations during investigation

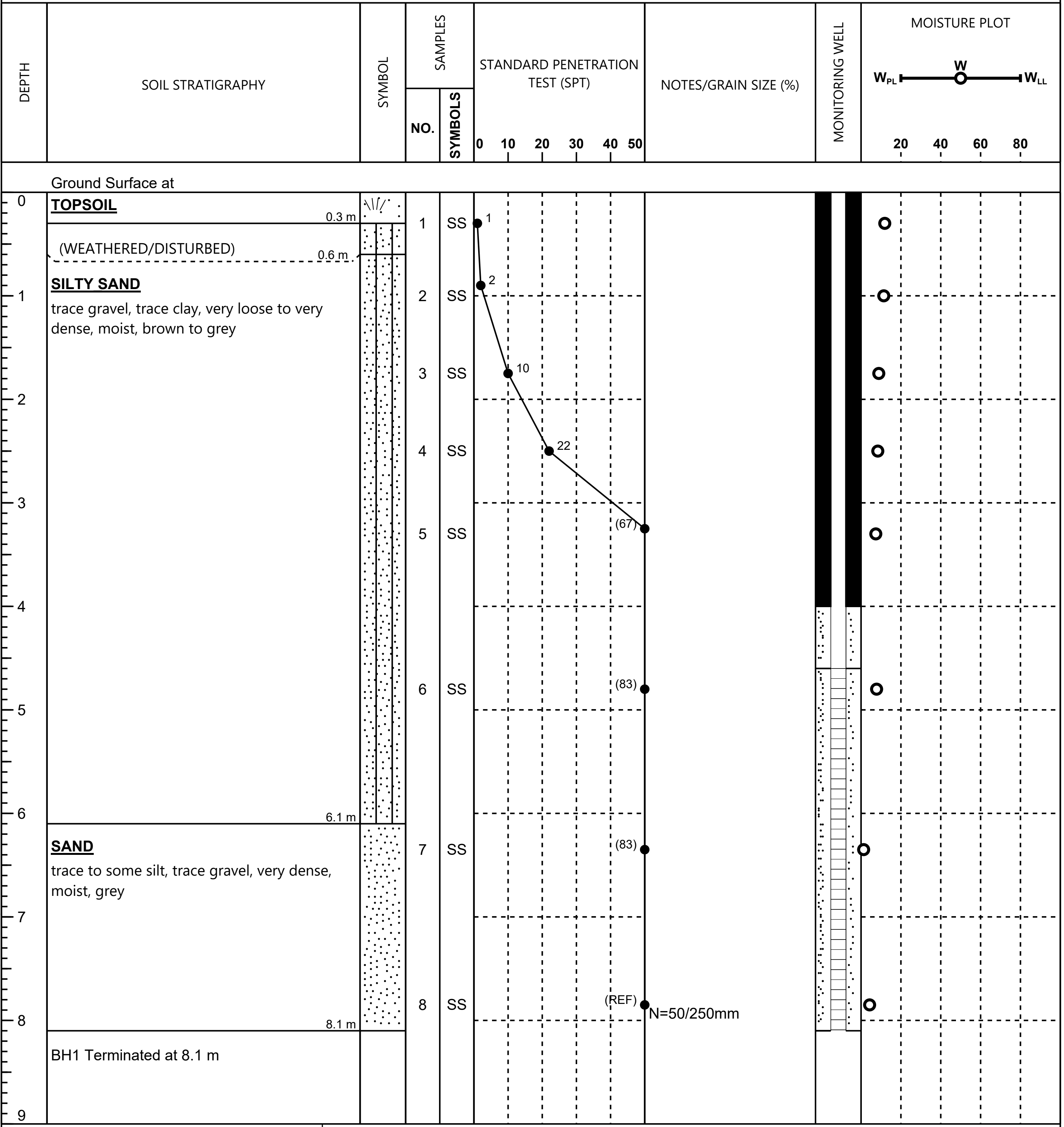
BOREHOLE LOG: BH1

Project: 16728 Highway 12
Project No.: 23-127-01

Site Address: Midland, Ontario
Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE

Easting: 589402
Northing: 4953591
Elevation:

Logged By: SO
Reviewed By: TK
Investigation Date: 2024-02-26



Ground Surface at

TOPSOIL

0.3 m

(WEATHERED/DISTURBED)

0.6 m

SILTY SAND

trace gravel, trace clay, very loose to very dense, moist, brown to grey

6.1 m

SAND

trace to some silt, trace gravel, very dense, moist, grey

8.1 m

BH1 Terminated at 8.1 m

NO.	SYMBOLS	SPT	NOTES/GRAIN SIZE (%)
1	SS	1	
2	SS	2	
3	SS	10	
4	SS	22	
5	SS	(67)	
6	SS	(83)	
7	SS	(83)	
8	SS	(REF)	N=50/250mm

Notes:
Borehole was open and dry upon completion of drilling.
Monitoring well was dry on 03-13-2024

BOREHOLE LOG: BH2

Project: 16728 Highway 12

Project No.: 23-127-01

Site Address: Midland, Ontario

Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE

Easting: 589474

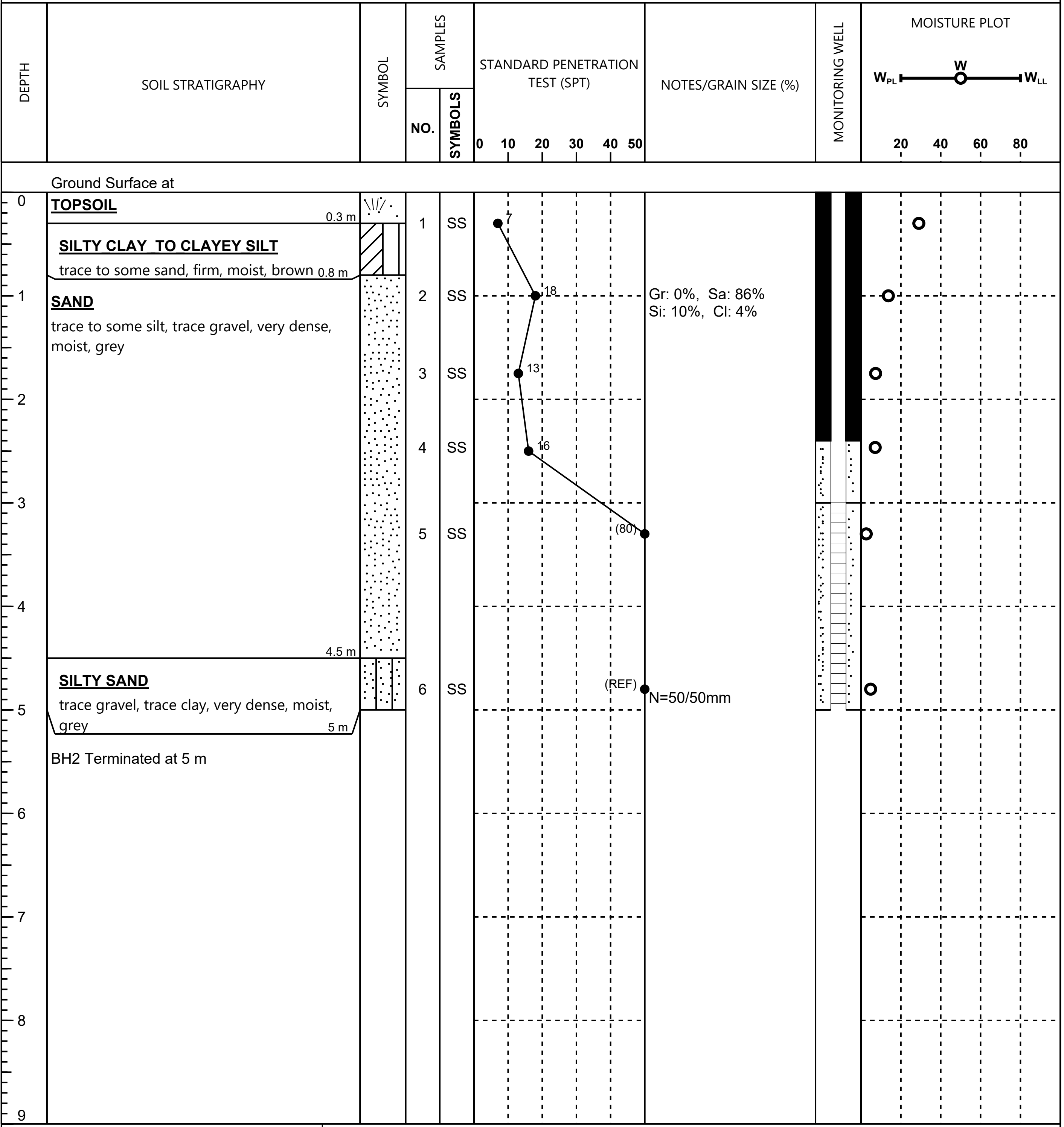
Northing: 4953624

Elevation:

Logged By: SO

Reviewed By: TK

Investigation Date: 2024-02-26



Ground Surface at

TOPSOIL

SILTY CLAY TO CLAYEY SILT

trace to some sand, firm, moist, brown

SAND

trace to some silt, trace gravel, very dense, moist, grey

SILTY SAND

trace gravel, trace clay, very dense, moist, grey

BH2 Terminated at 5 m

Gr: 0%, Sa: 86%
Si: 10%, Cl: 4%

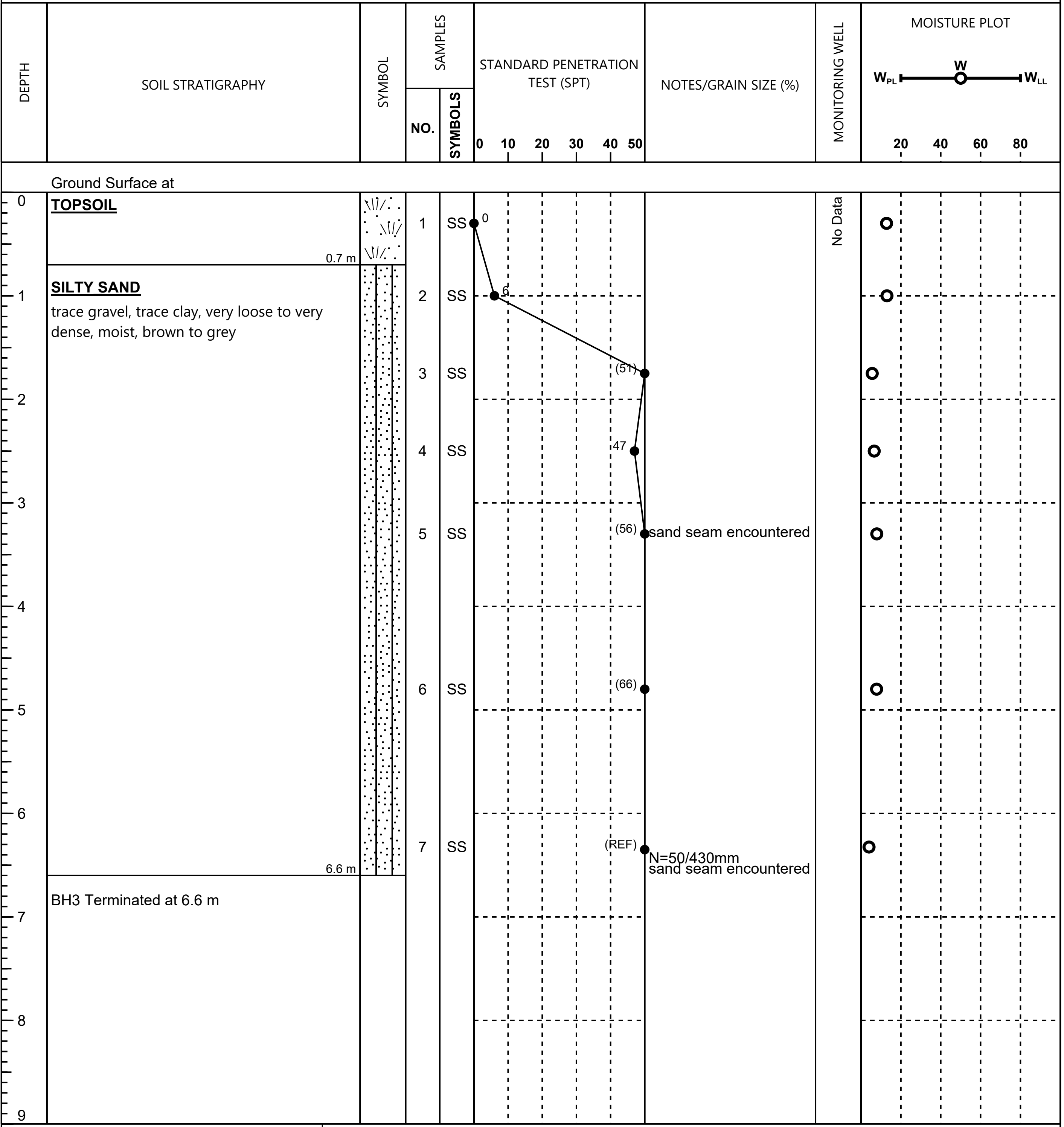
N=50/50mm

GREEN GEOTECHNICAL

Notes:
Borehole was open and dry upon completion of drilling.
Monitoring well was dry on 03-13-2024

BOREHOLE LOG: BH3

Project: 16728 Highway 12
Project No.: 23-127-01
Site Address: Midland, Ontario
Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Easting: 589445
Northing: 4953566
Elevation:
Logged By: SO
Reviewed By: TK
Investigation Date: 2024-02-26



TOPSOIL

SILTY SAND

trace gravel, trace clay, very loose to very dense, moist, brown to grey

BH3 Terminated at 6.6 m

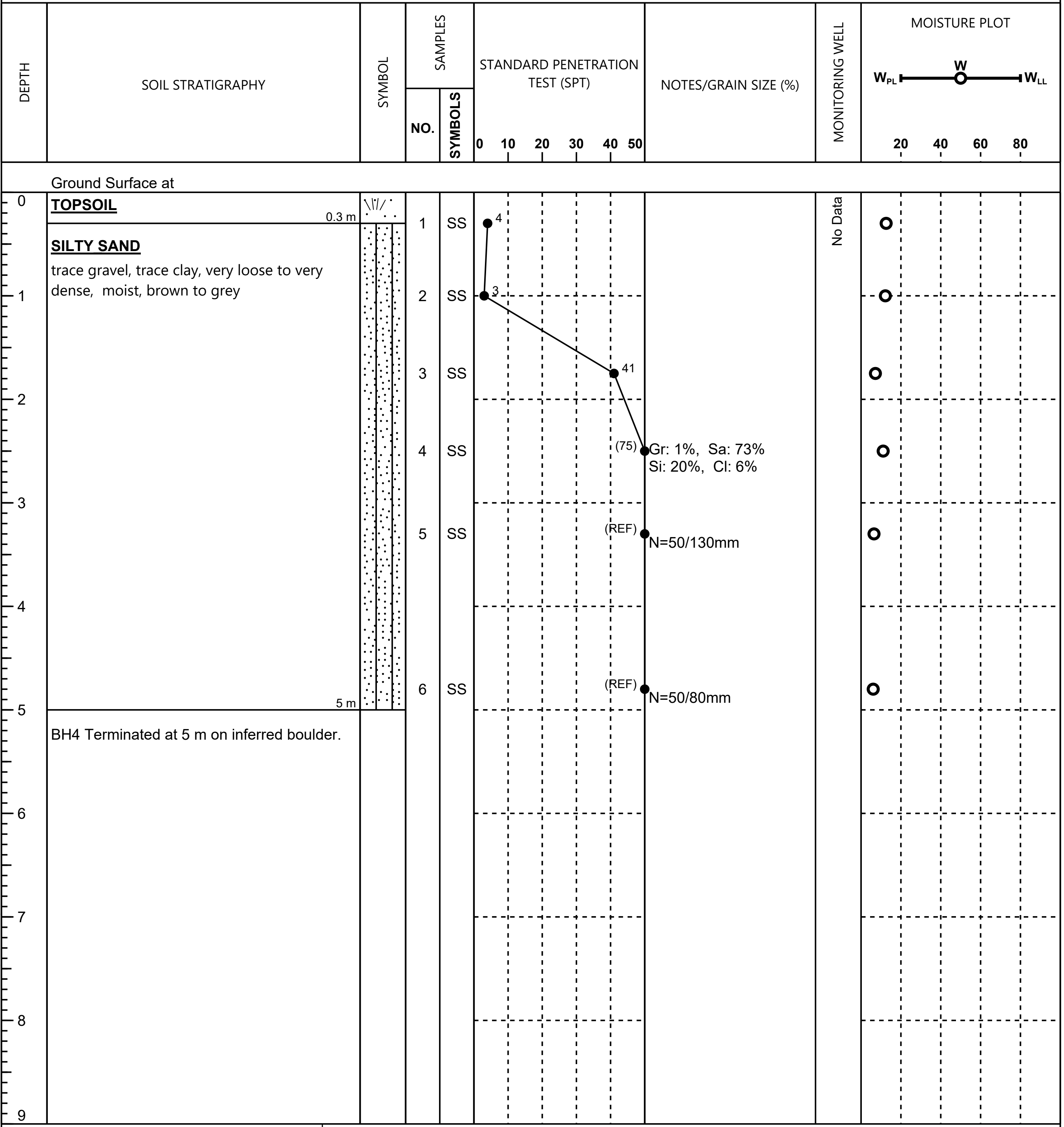
GREEN GEOTECHNICAL

Notes:
Borehole was open and dry upon completion of drilling.

RSLog / (No CPT) Soil Log with Piezometer (Letter) / green-geotechnical-ltd. / admin / March 28, 2024 02:47 PM

BOREHOLE LOG: BH4

Project: 16728 Highway 12
Project No.: 23-127-01
Site Address: Midland, Ontario
Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Easting: 589402
Northing: 4953536
Elevation:
Logged By: SO
Reviewed By: TK
Investigation Date: 2024-02-26



Ground Surface at

TOPSOIL (0 – 0.3 m)

SILTY SAND (0.3 m – 5 m)
trace gravel, trace clay, very loose to very dense, moist, brown to grey

BH4 Terminated at 5 m on inferred boulder.

NO.	SYMBOLS	SPT	NOTES/GRAIN SIZE (%)
1	SS	4	
2	SS	3	
3	SS	41	
4	SS	(75)	Gr: 1%, Sa: 73% Si: 20%, Cl: 6%
5	SS	(REF)	N=50/130mm
6	SS	(REF)	N=50/80mm

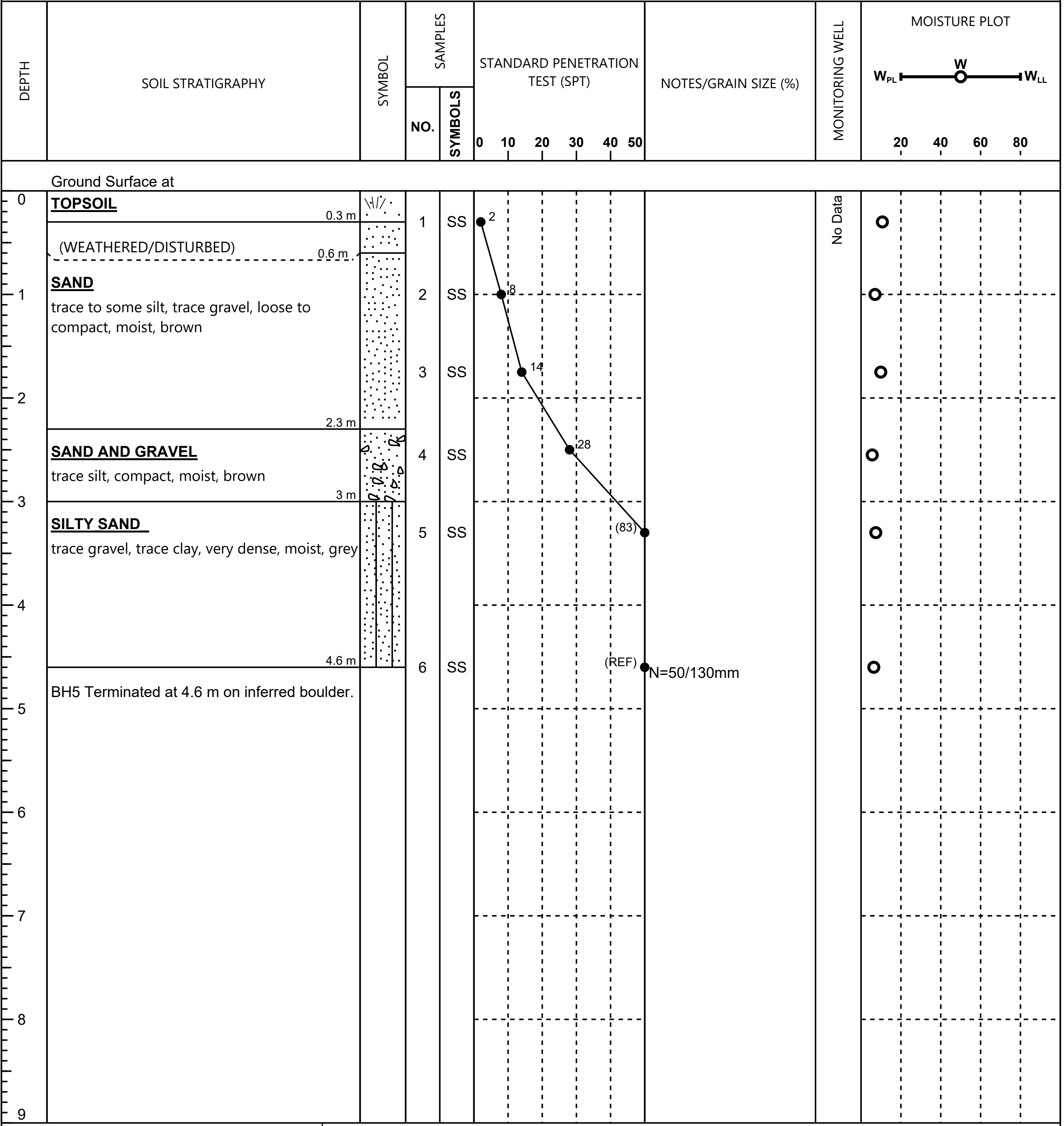
MONITORING WELL: No Data

GREEN GEOTECHNICAL

Notes:
Borehole was open and dry upon completion of drilling.

BOREHOLE LOG: BH5

Project: 16728 Highway 12
Project No.: 23-127-01
Site Address: Midland, Ontario
Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Easting: 589507
Northing: 4953559
Elevation:
Logged By: SO
Reviewed By: TK
Investigation Date: 2024-02-26

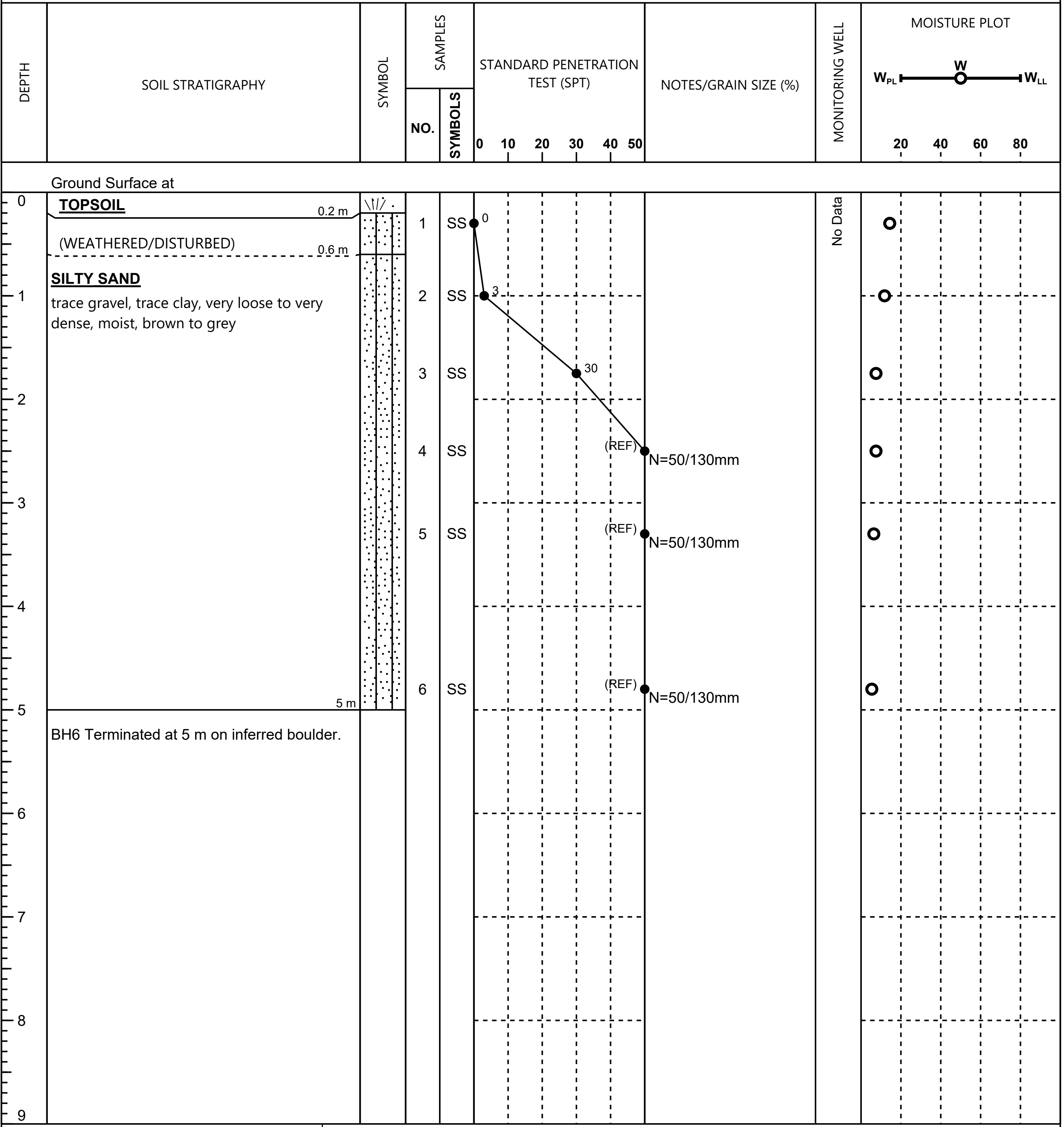


DEPTH	SOIL STRATIGRAPHY	NO.	SYMBOLS	STANDARD PENETRATION TEST (SPT)	NOTES/GRAIN SIZE (%)	MONITORING WELL
	Ground Surface at					
0	**TOPSOIL**	1	SS	2		No Data
0.3 m	(WEATHERED/DISTURBED)					
0.6 m	**SAND** trace to some silt, trace gravel, loose to compact, moist, brown	2	SS	8		
		3	SS	14		
2.3 m	**SAND AND GRAVEL** trace silt, compact, moist, brown	4	SS	28		
3 m	**SILTY SAND** trace gravel, trace clay, very dense, moist, grey	5	SS	(83)		
		6	SS	(REF)	N=50/130mm	
4.6 m	BH5 Terminated at 4.6 m on inferred boulder.					

Notes:
Borehole was open and dry upon completion of drilling.

BOREHOLE LOG: BH6

Project: 16728 Highway 12
Project No.: 23-127-01
Site Address: Midland, Ontario
Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Easting: 589435
Northing: 4953494
Elevation:
Logged By: SO
Reviewed By: TK
Investigation Date: 2024-02-26



Ground Surface at

TOPSOIL

(WEATHERED/DISTURBED)

SILTY SAND

trace gravel, trace clay, very loose to very dense, moist, brown to grey

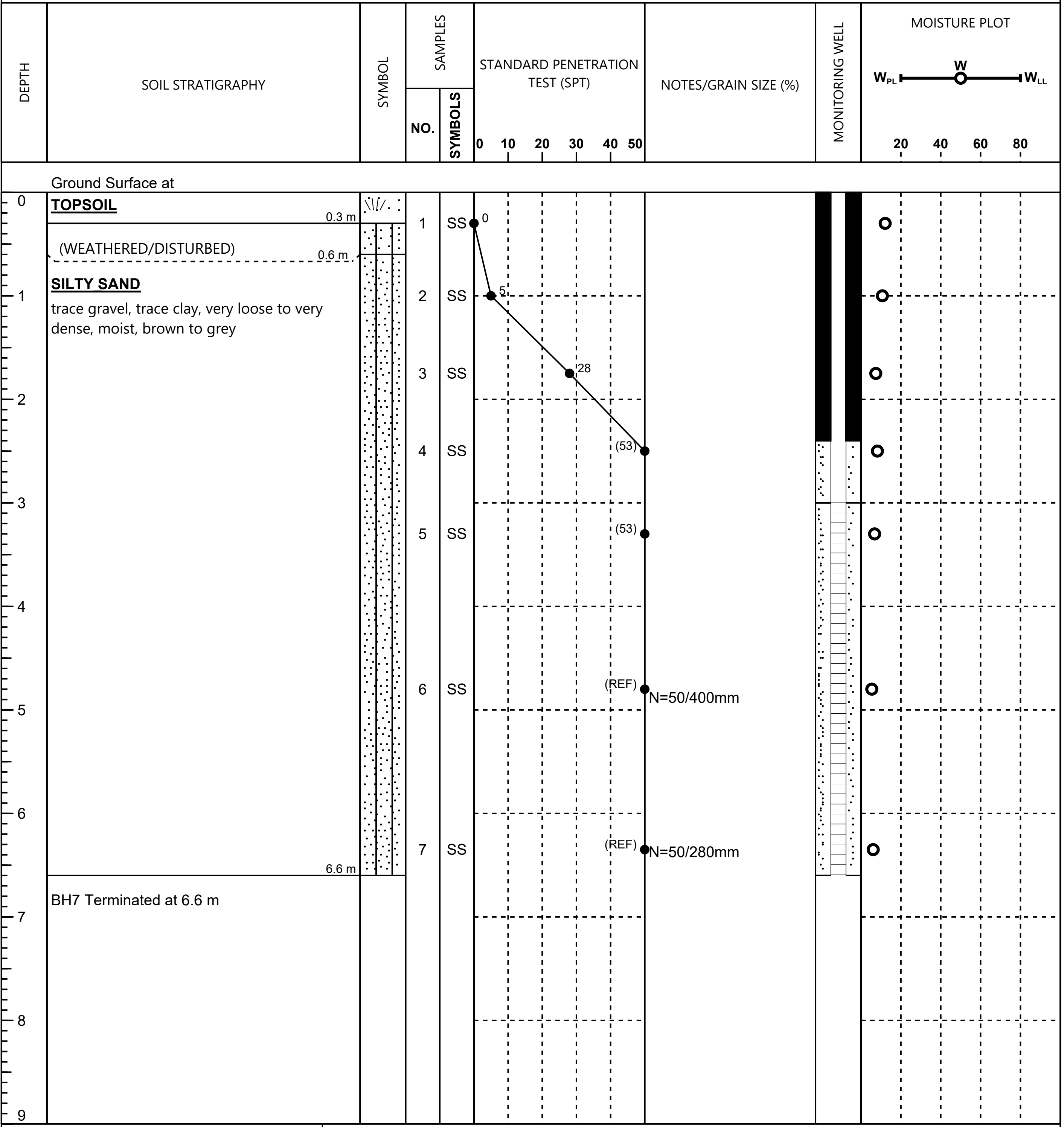
BH6 Terminated at 5 m on inferred boulder.

NO.	SYMBOLS	STANDARD PENETRATION TEST (SPT)	NOTES/GRAIN SIZE (%)
1	SS	0	
2	SS	3	
3	SS	30	
4	SS	(REF)	N=50/130mm
5	SS	(REF)	N=50/130mm
6	SS	(REF)	N=50/130mm

Notes:
Borehole was open and dry upon completion of drilling.

BOREHOLE LOG: BH7

Project: 16728 Highway 12
Site Address: Midland, Ontario
Easting: 589486
Northing: 4953536
Logged By: SO
Reviewed By: TK
Project No.: 23-127-01
Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Elevation:
Investigation Date: 2024-02-26



Ground Surface at

TOPSOIL (0.3 m)

(WEATHERED/DISTURBED) (0.6 m)

SILTY SAND
trace gravel, trace clay, very loose to very dense, moist, brown to grey (6.6 m)

BH7 Terminated at 6.6 m

NO.	SYMBOLS	SPT	NOTES/GRAIN SIZE (%)
1	SS	0	
2	SS	5	
3	SS	28	
4	SS	(53)	
5	SS	(53)	
6	SS	(REF)	N=50/400mm
7	SS	(REF)	N=50/280mm

Notes:
Borehole was open and dry upon completion of drilling.
Monitoring well was dry on 03-13-2024

BOREHOLE LOG: BH8

Project: 16728 Highway 12

Site Address: Midland, Ontario

Easting: 589549

Northing: 4953548

Logged By: SO

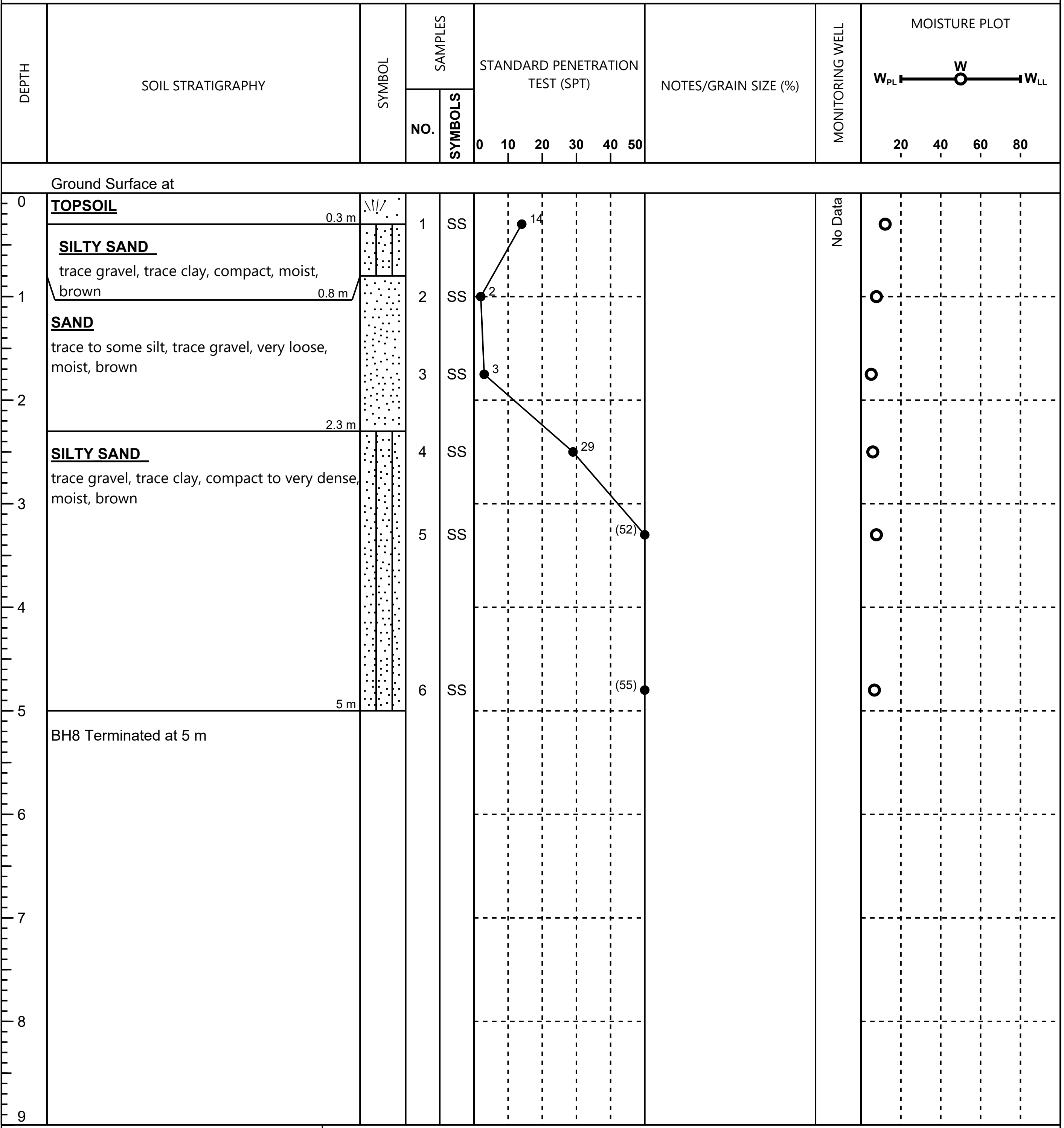
Reviewed By: TK

Project No.: 23-127-01

Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE

Elevation:

Investigation Date: 2024-02-26



Ground Surface at

Depth	Soil Stratigraphy
0–0.3 m	**TOPSOIL**
0.3–0.8 m	**SILTY SAND** trace gravel, trace clay, compact, moist, brown
0.8–2.3 m	**SAND** trace to some silt, trace gravel, very loose, moist, brown
2.3–5 m	**SILTY SAND** trace gravel, trace clay, compact to very dense, moist, brown
5 m	BH8 Terminated at 5 m

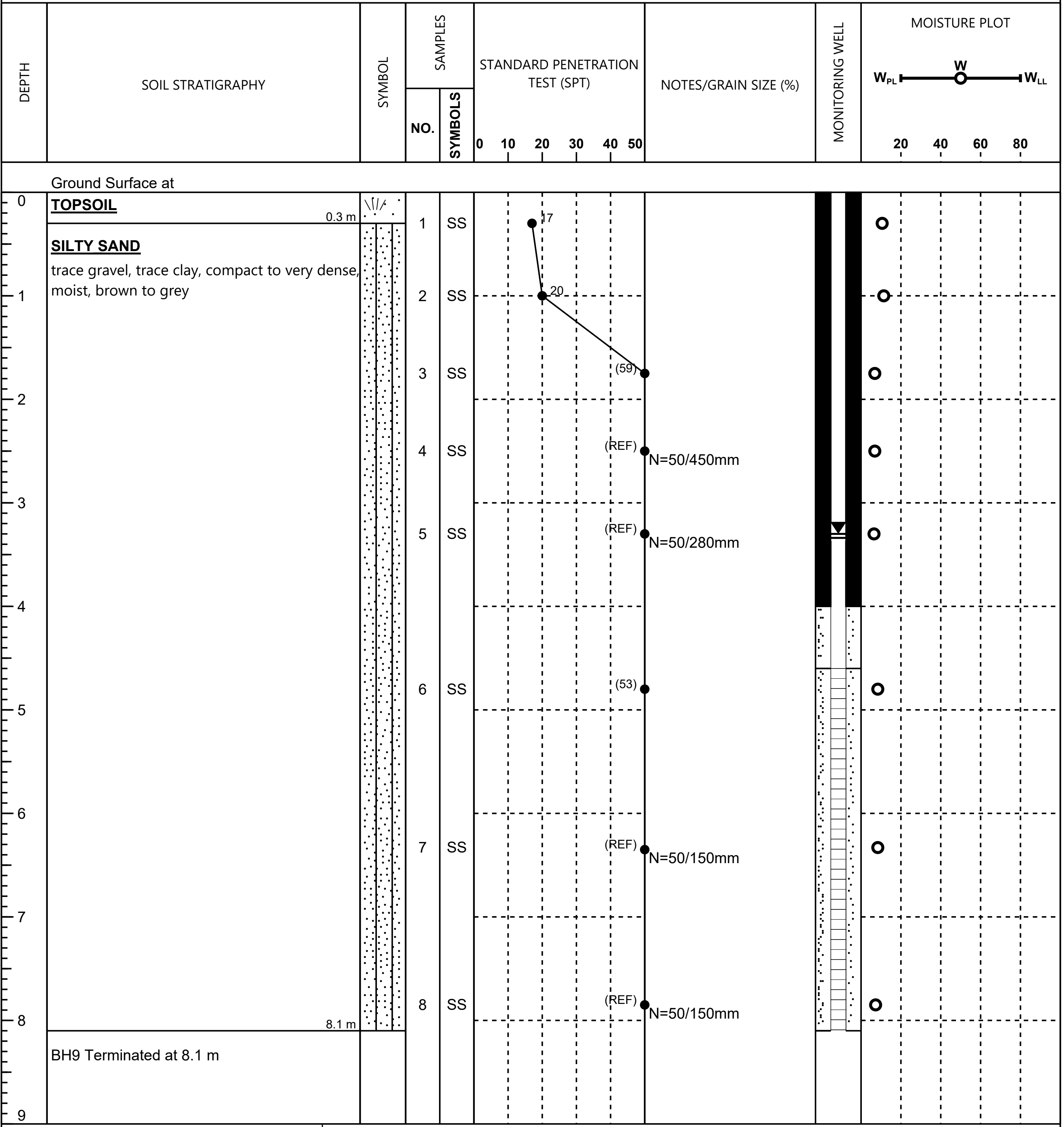
No.	Symbols	SPT
1	SS	14
2	SS	2
3	SS	3
4	SS	29
5	SS	(52)
6	SS	(55)

Notes:
Borehole was open and dry upon completion of drilling.

BOREHOLE LOG: BH9

Project: 16728 Highway 12
Site Address: Midland, Ontario
Easting: 589465
Northing: 4953441
Logged By: SO
Reviewed By: TK

Project No.: 23-127-01
Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Elevation:
Investigation Date: 2024-02-26



TOPSOIL

SILTY SAND

trace gravel, trace clay, compact to very dense, moist, brown to grey

BH9 Terminated at 8.1 m

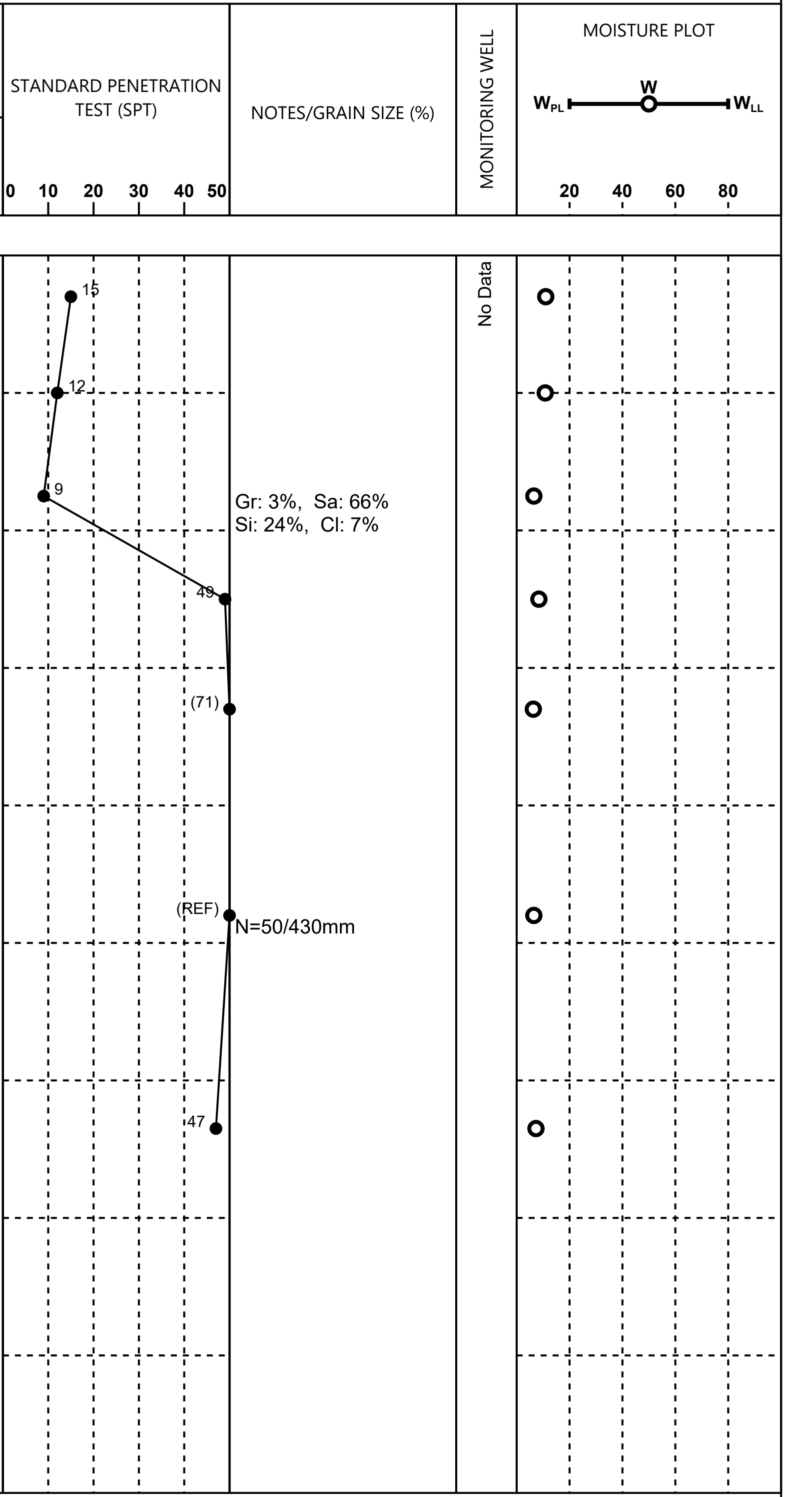
GREEN GEOTECHNICAL

Notes:
Borehole was open and dry upon completion of drilling.
Stabilized water level measured at 3.3 mbg on 03-13-2024

BOREHOLE LOG: BH10

Project: 16728 Highway 12
Project No.: 23-127-01
Site Address: Midland, Ontario
Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Easting: 589516
Northing: 4953480
Elevation:
Logged By: SO
Reviewed By: TK
Investigation Date: 2024-02-26

DEPTH	SOIL STRATIGRAPHY	SYMBOL
	Ground Surface at	
0	**TOPSOIL**	\\\|/
0.3 m	**SILTY SAND** trace gravel, trace clay, loose to very dense, moist, brown	
6.6 m	BH10 Terminated at 6.6 m	



SAMPLES NO.	SAMPLES SYMBOLS	STANDARD PENETRATION TEST (SPT)	NOTES/GRAIN SIZE (%)
1	SS	15	
2	SS	12	
3	SS	9	Gr: 3%, Sa: 66% Si: 24%, Cl: 7%
4	SS	49	
5	SS	(71)	
6	SS	(REF)	N=50/430mm
7	SS	47	

Notes:
Borehole was open and dry upon completion of drilling.

BOREHOLE LOG: BH11

Project: 16728 Highway 12

Project No.: 23-127-01

Site Address: Midland, Ontario

Client: U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE

Easting: 589578

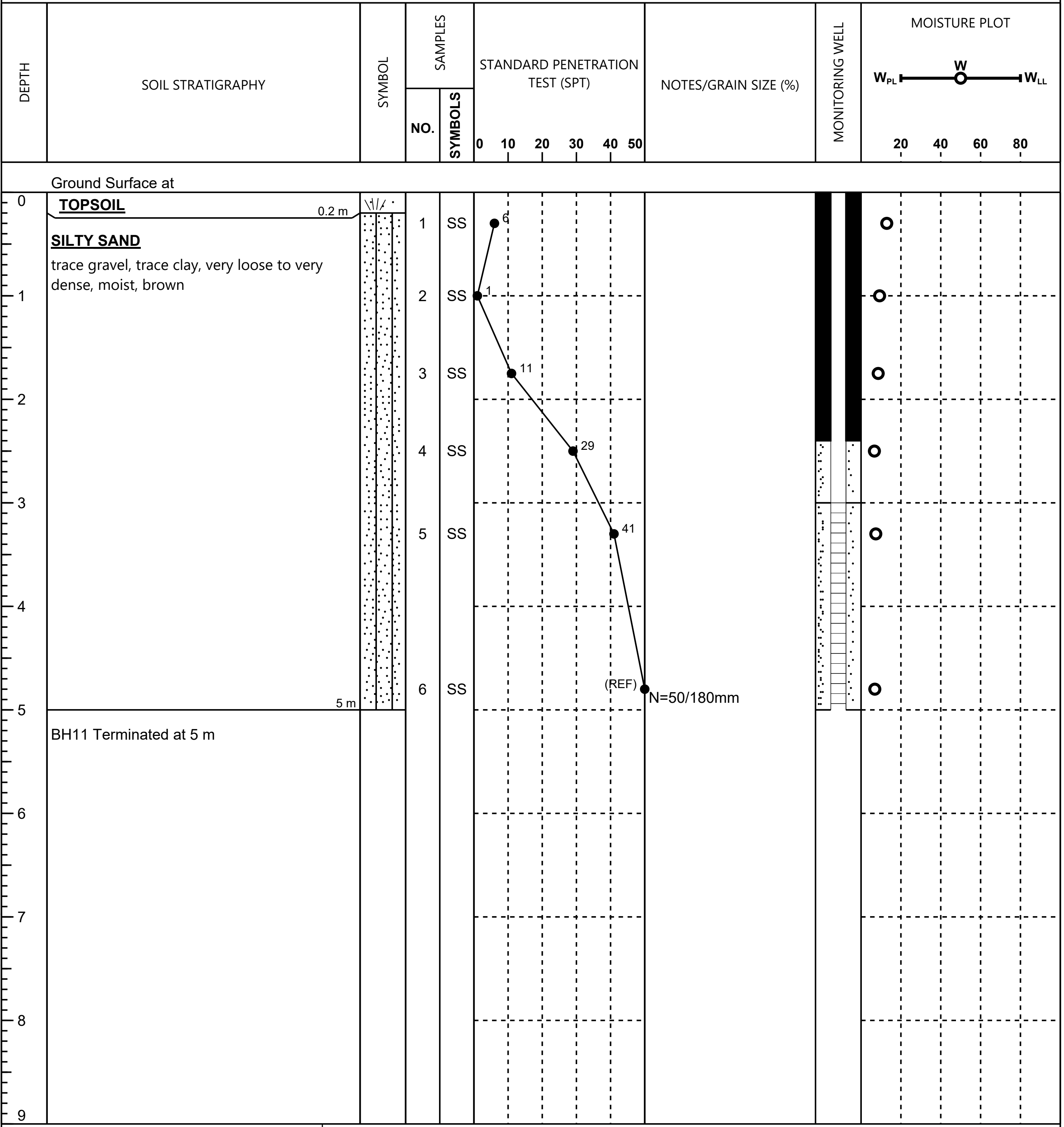
Northing: 4953517

Elevation:

Logged By: SO

Reviewed By: TK

Investigation Date: 2024-02-26



Ground Surface at

TOPSOIL

SILTY SAND

trace gravel, trace clay, very loose to very dense, moist, brown

BH11 Terminated at 5 m

NO.	SYMBOLS	STANDARD PENETRATION TEST (SPT)	NOTES/GRAIN SIZE (%)
1	SS	6	
2	SS	1	
3	SS	11	
4	SS	29	
5	SS	41	
6	SS	(REF)	N=50/180mm

Notes:
Borehole was open and dry upon completion of drilling.
Monitoring well was dry on 03-13-2024

APPENDIX B

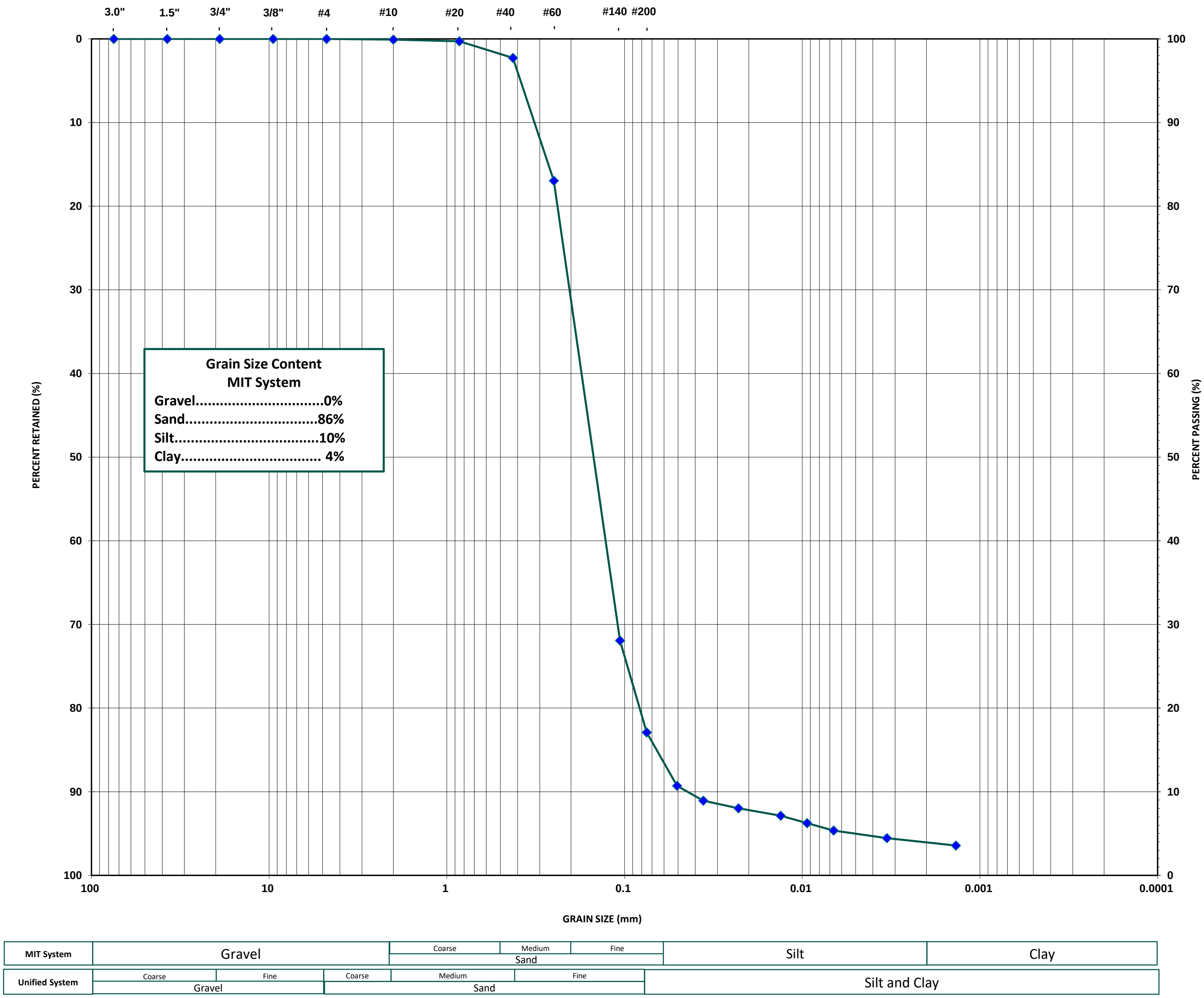
576 Bryne Drive, Unit 'O'
Barrie, ON
L4N 9P6

Hydrometer Analysis Form

Project Number:	23-127-01	**Location:**	Midland, ON	**Project Name:**	16728 Highway 12
Sample Date:	February 27, 2024	**Test Date:**	March 12, 2024	**Client Name:**	U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Sample Description:	Sand, trace silt, trace clay	**Lab Number:**	179	**Tested By:**	J. Duguid
Sample Location:	Midland, ON	**Sample Depth:**	2 to 4'	**Sampled By:**	SO
Borehole Hole:	2	**Sample Number:**		2	
Estimated Septic T-Time:		N/A		Unified Soil Classification	SM

Grain Size Distribution

U.S. Standard Sieve Sizes



Grain Size Content
MIT System
Gravel................................0%
Sand.................................86%
Silt....................................10%
Clay.................................. 4%

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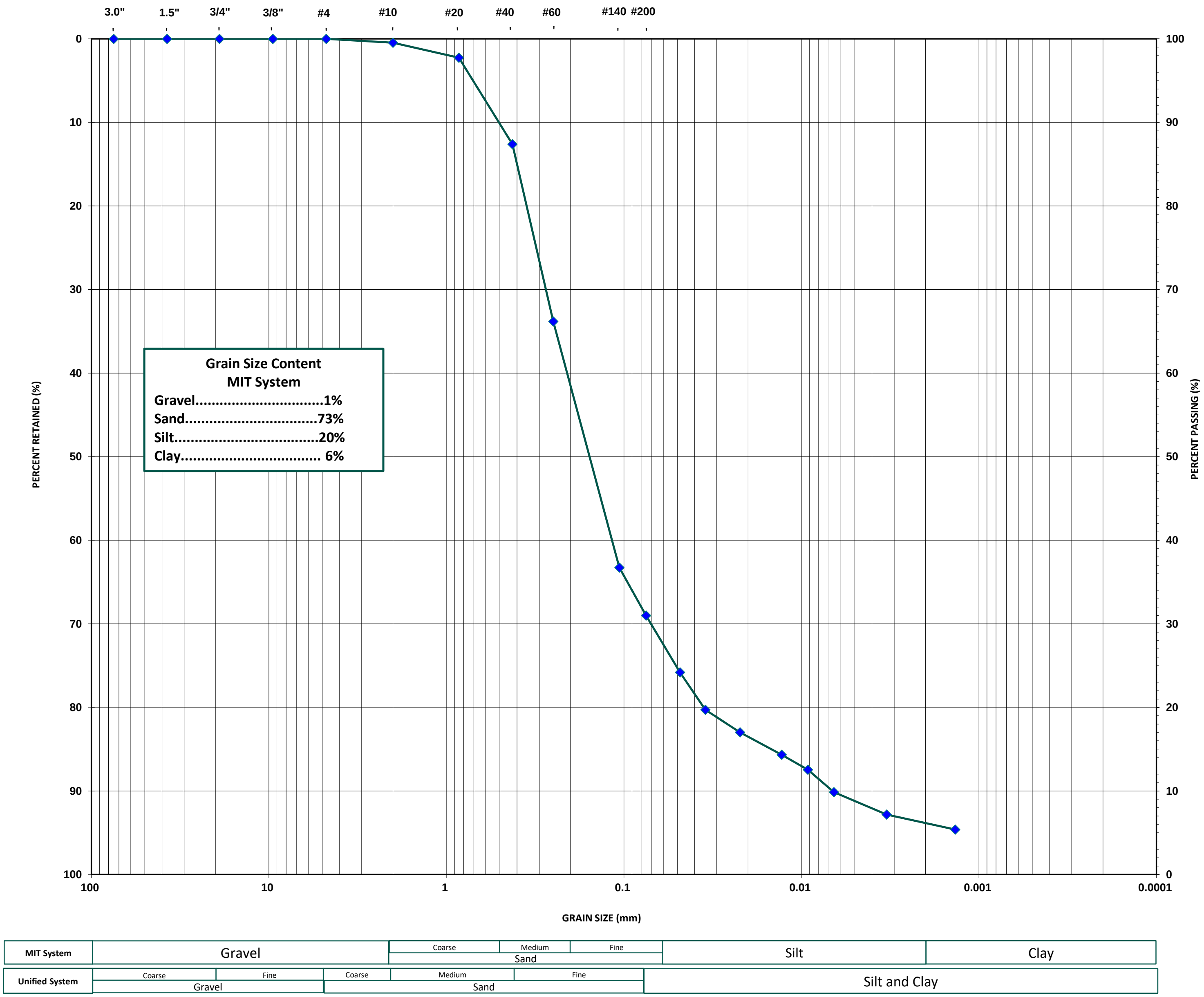
576 Bryne Drive, Unit 'O'
Barrie, ON
L4N 9P6

Hydrometer Analysis Form

Project Number:	23-127-01	**Location:**	Midland, ON	**Project Name:**	16728 Highway 12
Sample Date:	February 27, 2024	**Test Date:**	March 12, 2024	**Client Name:**	U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Sample Description:	Sand, some silt, trace clay, trace grave	**Lab Number:**	178	**Tested By:**	J. Duguid
Sample Location:	Midland, ON	**Sample Depth:**	7.5 to 9'	**Sampled By:**	SO
Borehole Hole:	4	**Sample Number:**		4	
Estimated Septic T-Time:	N			Unified Soil Classification	SM

Grain Size Distribution

U.S. Standard Sieve Sizes



Grain Size Content
MIT System
Gravel................................1%
Sand.................................73%
Silt....................................20%
Clay.................................. 6%

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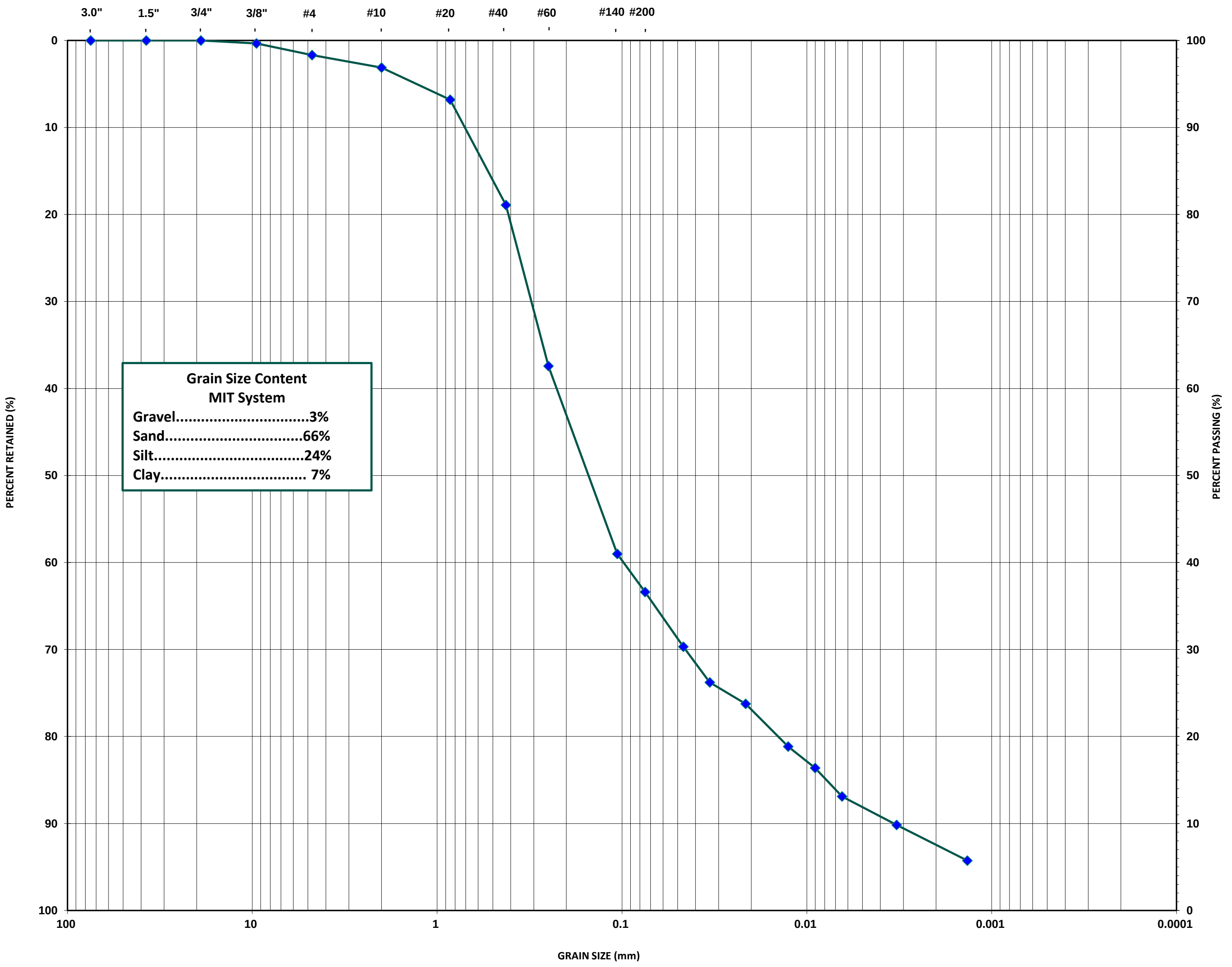
576 Bryne Drive, Unit 'O'
Barrie, ON
L4N 9P6

Hydrometer Analysis Form

Project Number:	23-127-01	**Location:**	Midland, ON		**Project Name:**	16728 Highway 12
Sample Date:	February 27, 2024	**Test Date:**	March 12, 2024		**Client Name:**	U-Haul Co. Canada Ltd., U-Haul Co. Canada LTEE
Sample Description:	Silty sand, trace clay, trace gravel		**Lab Number:**	180	**Tested By:**	J. Duguid
Sample Location:	Midland, ON	**Sample Depth:**	5 to 6.5'		**Sampled By:**	SO
Borehole Hole:	10		**Sample Number:**		3	
Estimated Septic T-Time:		N/A			Unified Soil Classification	SM

Grain Size Distribution

U.S. Standard Sieve Sizes



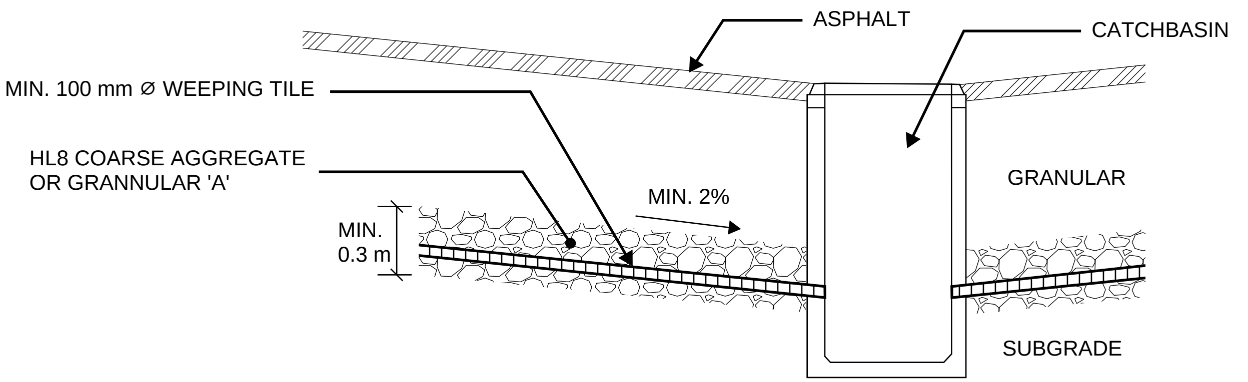
Grain Size Content
MIT System
Gravel...............................3%
Sand................................66%
Silt...................................24%
Clay.................................. 7%

MIT System	Gravel	Coarse	Medium	Fine	Silt	Clay
		Sand				

Unified System	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay
	Gravel		Sand			

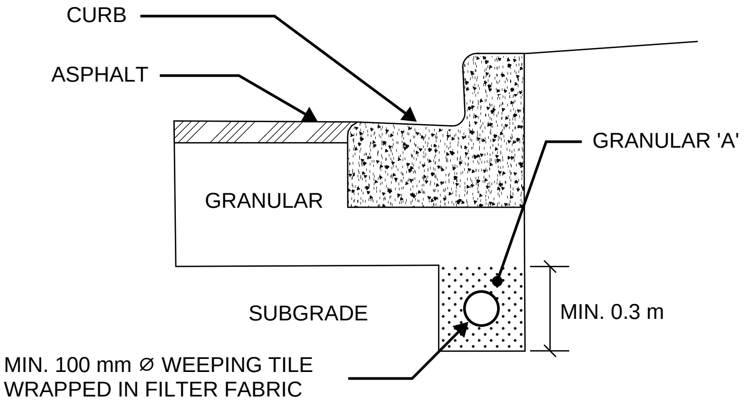
APPENDIX C

LONGITUDINAL SUBDRAIN CONNECTION TO CATCHBASIN

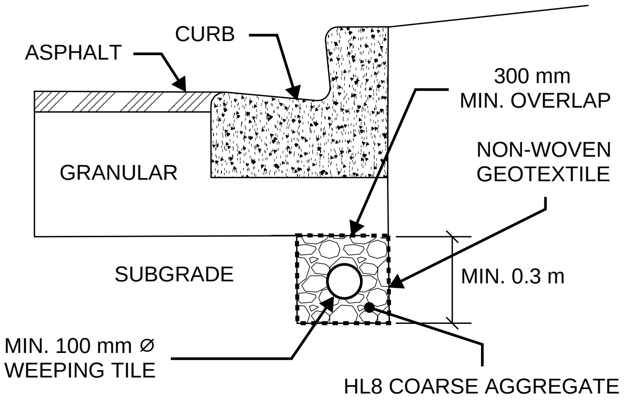


URBAN CROSS SECTIONS

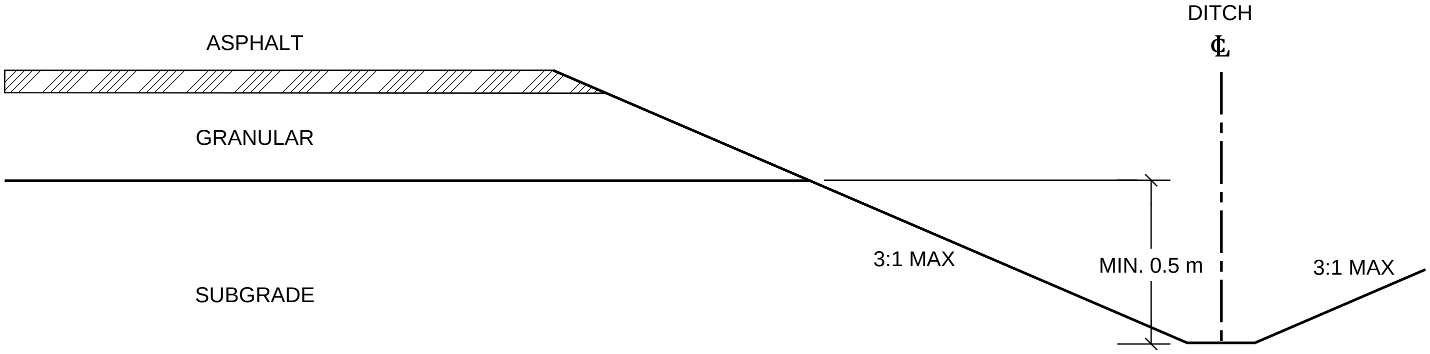
WEEPING TILE WITH FILTER FABRIC



WEEPING TILE WITHOUT FILTER FABRIC



RURAL CROSS SECTIONS



Title:

PAVEMENT DRAINAGE ALTERNATIVES

GREEN GEOTECHNICAL

576 Bryne Drive, Unit 'O', Barrie, ON
705-503-9626
info@greengeo.ca

APPENDIX D

ENGINEERED FILL SPECIFICATIONS

Overview

- Engineered Fill is a pre-approved material which has been placed under the full-time supervision of Green Geotechnical, including testing and inspection during construction to ensure subgrade stability, material quality, proper lift thickness, and adequate compaction have all been maintained.
- Engineered Fill is used to accommodate structural loads (such as for foundations, slabs, etc.) where site grades are being altered, or in order to accommodate structural design loads.
- Prior to concrete placement for footings and poured walls on Engineered Fill, Green Geotechnical must inspect the foundation subgrade soils, and reinforcing steel respectively.

Design

- Engineered fill material must be free of organic inclusions, construction debris, and any other deleterious material.
- Ideally, granular type soils, with less than 8% fines, such as OPSS 1010 Granular ‘B,’ are used.
- In sites where a high groundwater table or where wet conditions exist, (even with dewatering operations), in order to achieve stable layers and the specified compaction on the first one to two lifts, OPSS 1010 Granular ‘B’ Type II or 50 mm crusher run limestone may be advisable.
- The determination of whether the site soils are suitable for reuse as Engineered Fill, or if an imported material is to be used, is at the discretion of the opinion of the Geotechnical Engineer.
- Post construction settlement of the Engineered Fill is to be expected. The timeframe that this occurs varies based on the type of material used. Typically, time intervals of the following can be used:

	Self-Consolidation Settlement		**Foundation Loading Settlement**	
Material	**Settlement Rate**	**Time Rate**	**Settlement Rate**	**Time Rate**
Granular ‘B’ or Coarser	Minimal (0.2% D)	Immediate	Minor (0.5”, 12mm)	Immediate
Fine Sand	Minimal (0.5% D)	1-50 hours	Minor (0.75”, 19mm)	1-50 hours
Sandy Silt	Minor (0.75% D)	2-30 days	Minor (1”, 25mm)	2-30 days
Clayey Silt	Moderate (1% D)	3-6 months	Moderate (1.25”, 31mm)	3-6 months
Silty Clay	Major (1.5% D)	6-7 years	Major (1.5”, 37mm)	6-7 years

D is the depth of the Engineered Fill

- It is imperative for avoiding excessive settlements that the construction of foundations take into account the post-construction settlement period.
- Engineered Fill is to extend a minimum of 1m beyond the base of any structure’s foundations, and project down to the subgrade at a slope with a maximum steepness of 1H:1V.
- An allowable design bearing capacity of 150 kPa (SLS) can usually be used for Engineered Fill constructed on a stable, approved subgrade.
    - This is unless a different bearing capacity for the Engineered Fill has been recommended by the Geotechnical Engineer, based on the properties of the site soils.
- The Engineered Fill is to extend at least 1m above the highest foundation base elevation to provide the Engineered Fill at founding level(s) protection from frost, precipitation, runoff, wind, and weathering.
- Poured concrete footings are to be a minimum width of 0.6m for strip footings and 1.0m for individual footings.

- Reinforcing steel comprised of two (2) continuous 15M bars at the top and bottom of foundation walls, and 15M bars spaced at 0.3m in column pad footings, are required in all poured concrete foundations.

Construction

- Surveying should be done by the earthworks contractor or the surveying contractor to ensure that Engineered fill elevations and footprint are accurate and meet the specifications outlined in this document.
- The elevations should be provided to Green Geotechnical by the earthworks contractor or the surveying contractor at each placed lift of material, for recording compaction levels by elevation, and to ensure proper lift thickness.
- Topsoil and uncontrolled fill/deleterious material are to be excavated, leaving a stable, dry, native subgrade.
- Dewatering may be required, depending on the groundwater conditions at the site.
- Prior to the placement of any Engineered Fill, Green Geotechnical must approve the stability of the exposed native subgrade for Engineered Fill placement.
- Depending on the groundwater conditions and soil type at the site, a proof-roll with a heavy compaction roller or rubber-tire front-end loader with a full bucket may be required on the subgrade. Any noted unstable areas will have to be sub-excavated and brought back up with the placement of Engineered Fill.
- As previously mentioned, if wet conditions exist at the site, for the first one to two lifts of the Engineered Fill, the use of OPSS 101 Granular ‘B’ Type II or 50 mm crusher run limestone may be advisable.
- All material must be compacted to at least 98% SPMDD (Standard Proctor Maximum Dry Density) within 2% of OMC (Optimum Moisture Content).
- Green Geotechnical will take a sample of the Engineered Fill material to determine its SPMDD, OMC, and gradation.
- Green Geotechnical must test the compaction of the placed Engineered Fill at each lift.
- In wet site conditions, it is typically advisable that the first lift be static rolled, and that all subsequent lifts be compacted with vibration. In dry site conditions, compaction by vibration can occur at all lifts.
- Engineered Fill material shall be placed in maximum 150mm loose lifts.
  - The only exception to this is in the first one to two lifts placed in wet site conditions. Here, loose lifts shall be a maximum of 300mm-450mm.
- Engineered Fill should not be placed during months where freezing temperatures occur.

Certification

- Green Geotechnical must be present during Engineered Fill construction to approve the native subgrade, approve of and take a sample of the material, as well as record compaction and lift thickness at every lift.
  - Following this, a letter signed and sealed by a P.Eng. will be submitted certifying the Engineered Fill as being properly constructed, and displaying the field records.
- Green Geotechnical must inspect the foundation subgrade immediately prior to the placement of concrete for footings.
  - Following this, a letter signed and sealed by a P.Eng. will be submitted certifying the Engineered Fill foundation subgrade as being adequate to support the design bearing capacity.
- Green Geotechnical must inspect the reinforcing steel in the foundation walls prior to the placement of concrete. See the attached Typical Reinforced Wall Detail for more information.
  - Following this, a letter signed and sealed by a P.Eng. will be submitted certifying the reinforcing steel as being placed in accordance with the design.

APPENDIX E

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: -

REPORT No: 24-006979 - Rev. 0

Report To:
Green Geotechnical
576 Bryne Drive
Unit O
Barrie, Ontario L4N 9P6

CADUCEON Environmental Laboratories
112 Commerce Park Dr Unit L
Barrie, ON L4N 8W8

Attention: Sean O'Grady

DATE RECEIVED:	2024-Mar-14	CUSTOMER PROJECT:	23-12T-01
DATE REPORTED:	2024-Mar-21	P.O. NUMBER:	
SAMPLE MATRIX:	Soil		

Analyses	Qty	Site Analyzed	Authorized	Date Analyzed	Lab Method	Reference Method
Anions (Solid)	3	OTTAWA	PCURIEL	2024-Mar-18	A-IC-01	SM 4110B
Conductivity Meter (Solid)	3	OTTAWA	STAILLON	2024-Mar-20	A-COND-03	MECP E3530
pH Meter (Solid)	3	OTTAWA	STAILLON	2024-Mar-18	pH-03	MECP E3530
Redox Potential (Solid)	3	RICHMOND_HILL	JEVANS	2024-Mar-20	In House	SM 2580
Sulphide Solid (Subcontracted)	3	TESTMARK	CBURKE	2024-Mar-20		Subcontracted

R.L. = Reporting Limit
NC = Not Calculated
Test methods may be modified from specified reference method unless indicated by an *

		Client I.D.	BH6 SS4	BH8 SS2	BH6 SS3
		Sample I.D.	24-006979-1	24-006979-2	24-006979-3
		Date Collected	2024-02-26	2024-02-26	2024-02-26
Parameter	**Units**	**R.L.**	-	-	-
Conductivity @25°C	mS/cm	0.001	0.088	0.139	0.117
Resistivity (calculated)	Ohms*cm	-	11400	7180	8550
pH @25°C	-	-	8.02	7.62	7.68
Redox Potential	mV	-	402	396	436
Chloride	µg/g	5	114	108	108
Sulphate	µg/g	10	55	55	56

M. Dubien

Michelle Dubien
Data Specialist

Subcontracted Analyses

		Client I.D.	BH6 SS4	BH8 SS2	BH6 SS3
		Sample I.D.	24-006979-1	24-006979-2	24-006979-3
		Date Collected	2024-02-26	2024-02-26	2024-02-26
Parameter	**Units**	**R.L.**	-	-	-
Sulphide	µg/g	-	<0.3	<0.3	<0.3

Michelle Dubien
Data Specialist

GENERAL SAMPLE SUBMISSION FORM

CADUCEON™
ENVIRONMENTAL LABORATORIES
Client committed. Quality assured. Proudly Canadian.

SAMPLES SUBMITTED TO:

Kingston ☐
Ottawa ☐
Richmond Hill ☐
Barrie ☑
Windsor ☐

TESTING REQUIREMENTS

☐ O'Reg 153/04 Table (1 - 9) ______
☐ O'Reg 406/19 Table (1 - 9.1) ______
☐ RPI
☐ Coarse
☐ MISA
☑ Other: Corrosivity Package

Record of Site ______
SPLP Table (1-9.1) ______
☐ ICC
☐ Medium/Fine
☐ PWQO
☐ Agricultural
☐ O'Reg 558 TCLP
☐ Landfill Monitoring

REPORT NUMBER (Lab Use)

24-00697~~6~~9
im 24·02·14

Are any samples to be submitted intended for Human Consumption under any Drinking Water Regulations? ☐ Yes ☑ No (If yes, submit all Drinking Water Samples on a Drinking Water Chain of Custody)

Organization: Green Geotechnical
Contact: Sean O'Grady
Tel: (705) 331-7429
Fax:
Email: sean@greengeo.ca
Additional Info (email, cell, etc):
Address: laura@greengeo.ca →
Quote #:
P.O. #:
Invoicing Address (if different):
Project Name or #: 23-127-01
Additional Info:

ANALYSES REQUESTED

Corrosivity Package

Suspected Highly Contaminated

TURNAROUND SERVICE REQUESTED (see back page)

*Must be arranged in advance

☐	Platinum*	200% Surcharge
☐	Gold*	100% Surcharge
☐	Silver	50% Surcharge
☐	Bronze	25% Surcharge
☑	Standard	
☐	Specific Date:	______

* Sample Matrix Legend: WW=Waste Water, SW=Surface Water, GW=Groundwater, LS=Liquid Sludge, SS=Solid Sludge, S=Soil, Sed=Sediment, PC=Paint Chips, F=Filter, Oil = Oil

Lab No.	Sample Source and/or Sample Identification	WaterTrax (SPL)	Sample Matrix *	Date Collected (yy-mm-dd)	Time Collected	Indicate Test For Each Sample By Using A Check Mark In The Box Provided: Corrosivity Package												X	Field pH	Field Temp.	# Bottles/ Sample	Field Filtered Y/N
1.	BH6SS4		Soil	24-02-26	11:00	X															3	
2.	BH8SS2		soil	↓	↓	X															3	
3.	BH6SS3		soil	↓	↓	X															3	

1-3 Pass → O
1-3 Pass → RH
1-3 Pass → Testmark

SAMPLE SUBMISSION INFORMATION

	Sampled by:	Submitted by:
Print:	Sean O'Grady	Sean O'Grady
Sign:		
	Date (yy-mm-dd)/Time:	Date (yy-mm-dd)/Time:

SHIPPING INFORMATION

After Hours Drop Off ☐
Drop Off ☑
Courier (Client account) ☐
Courier (Caduceon account) ☐
Caduceon (Pick-up) ☐
# of Pieces:

REPORTING

XLSX ☐
XLSX / CofA Guideline ☑
CSV ☐
ESdat ☐

SAMPLE RECEIVING INFORMATION (LABORATORY USE ONLY)

Received By (print): [illegible]
Signature:
Date Received (yy-mm-dd): 24-03-14
Time Received: 11:05
Laboratory Prepared Bottles: ☐ ~~Yes~~ ☐ No
Sample Temperature °C: 15.6
Labeled by:

Comments:

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CofC, Feb 2024 Revision No: 25