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Preliminary Geotechnical Investigation – 501 Harmony Road, Corbyville, Ontario (Rev 2)

Palmer Project #

2200902

Prepared For

Black Bear Ridge GP Inc.

March 19, 2025

March 19, 2025

Alex Sharpe
Black Bear Ridge GP Inc.
501 Harmony Road
Corbyville, ON K0K 1V0

Dear Alex:

Re: Preliminary Geotechnical Investigation – 501 Harmony Road, Corbyville, Ontario (Rev 2)
Project #: 2200902

Palmer is pleased to submit the attached report describing the results of our preliminary geotechnical investigation for the project at the subject site ("the Site") located in Corbyville, Ontario.

The report provides site information from our site investigation, laboratory testing, records reviews, and our interpretations/recommendations for your consideration. This supersedes all other reports issued under the same title.

Thank you for the opportunity to be of service on this project. We trust that this report will be satisfactory for your current needs. If you have any questions or require further information, please contact our office at your convenience. This report is subject to the Statement of Limitations provided at the end of this report.

Yours truly,

Palmer

Alonzo Rowe, P.Eng.
Geotechnical Engineer

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1. Introduction

Palmer was retained by Black Bear Ridge GP Inc. (the Client) to undertake a preliminary geotechnical investigation in support of re-zoning approval and draft plan applications to the City of Belleville, ON.

In this stage of analysis, a preliminary geotechnical investigation is to provide a broad understanding of subsurface conditions across the Site by means of fourteen (14) exploratory boreholes drilled in July and September 2023.

The report is provided on the basis of the terms of reference presented above, and on the assumption that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the changes. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics and may not conform to generalized standards for services. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report deals with geotechnical issues only. Hydrogeological and environmental site assessments for the Site are provided in separate Palmer reports. It is reiterated that this report is considered preliminary and any recommendations made in this report will require refinement once the final site plan and grading plan have been provided to this office.

This report has been prepared for Black Bear Ridge GP Inc. and their designers. Use of this report by third party without Palmer's consent is prohibited. The limitations of the report presented within form an integral part of the document and they must be considered in conjunction with this report.

2. Site and Regional Geology

The project limits consist of 449 and 501 Harmony Road. The study area is situated within the Iroquois Plain physiographic region of Southern Ontario (Chapman and Putnam, 1984). The topography in this region typically consists of slightly sloping plains.

Bedrock geology mapping indicated that the site is underlain by bedrock comprised of limestones, dolostones, shale, arkose and sandstone (Ontario Geological Survey, 2011).

3. Field and Laboratory Work

The field work for the geotechnical investigation was carried out from July 24 to 27, 2023 and September 1, 2023 by drilling specialists subcontracted to Palmer. During this time, fourteen (14) boreholes (BH23-1 to BH23-14) were advanced. The locations of boreholes are shown on the Borehole/Monitoring Well Location Plan, **Drawing 1**. The boreholes were drilled to depths ranging from 2.5 to 8.3 m below existing ground surface (Elev. 118.8 to 102.1).

The boreholes were advanced with a power auger drilling machine, where soil stratigraphy was recorded by observing the quality and changes of augered materials which were retrieved from the boreholes, and by sampling the soils at regular intervals of depth using a 50 mm O.D. split spoon sampler, in accordance with the Standard Penetration Test (SPT) method (ASTM D 1586). This sampling method recovers samples from the soil strata, and the number of blows required to drive the sampler 300 mm depth into the soil (SPT 'N' values) gives an indication of the compactness condition or consistency of the sampled soil material. The SPT 'N' values are indicated on the borehole logs (Refer to **Appendix A**). The field work for this investigation was supervised by Palmer engineering staff, who also logged the boreholes and cared for the recovered samples.

Fourteen (14) monitoring wells were installed, one in each drilled borehole. The stabilized groundwater levels were measured on August 9, September 7 and September 13, 2023. The monitoring wells installation details and the measured groundwater levels are summarized in **Table 1** and shown in the individual borehole logs.

All soil samples obtained during this investigation were brought to our laboratory for further examination. These soil samples will be stored for a period of three (3) months after the day of issuing the draft report, after which time they will be discarded unless Palmer is advised otherwise in writing. In addition to visual examination in the laboratory, all soil samples from geotechnical boreholes were tested for moisture contents. Grain size analyses of six (6) selected soil samples were conducted and the results are presented in **Appendix B.**

The approximate elevations at the as-drilled borehole locations were surveyed using a differential GPS unit. The elevations at the as-drilled borehole locations were not provided by a professional surveyor and should be considered as approximate. Contractors performing the work should confirm the elevations prior to construction. The borehole locations plotted on **Drawing 1** were based on the survey and should be considered as approximate.

4. Subsurface Conditions

The borehole locations are shown on **Drawing 1**. General notes on soil sample description are presented on the "Explanation of Terms Used in the record of borehole" sheet in **Appendix A**. The subsurface conditions in the boreholes are presented in the individual borehole logs (**Enclosures 1** to **14** inclusive, **Appendix A**). The subsurface conditions in the boreholes are summarized in the following paragraphs.

4.1 Soil Conditions

Topsoil

A 50 to 200 mm thick layer of surficial topsoil was encountered at the surface of all boreholes except for Boreholes BH23-1 and BH23-5. It should be noted that the thickness of the topsoil encountered at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil at the site.

Fill Materials

Fill materials consisting of sandy silt, silty sand, and clayey silt were encountered at the surface of Boreholes BH23-1 and BH23-5 or below the topsoil in all other boreholes. The fill materials extended to depths ranging from about 0.7 to 2.4 m below existing ground surface (Elev. 122.4 to 106.0). The standard penetration 'N' values ranging from 1 to greater than 50 blows per 300 mm penetration indicated a loose to very dense compactness condition and illustrates variance of the soil within the fill materials. The in-situ moisture contents measured in the fill samples ranged from approximately 4% to 31%.

Silt / Sandy Silt / Sand and Silt (Till)

Silt to sandy silt were encountered below the fill materials in Boreholes BH23-1, BH23-4, BH23-5 and BH23-7 to BH23-9, below the gravel to sand and gravel in Boreholes BH23-3 and BH23-4, and below the sand in Boreholes BH23-10 and BH23-14. The silt to sandy silt deposit extended to depths ranging from 2.0 to 7.7 m below existing ground surface (Elev. 118.9 to 105.0). Boreholes BH23-3, BH23-7, BH23-8 and BH23-10 were terminated in the deposits. The standard penetration 'N' values ranging from 14 to greater than 50 blows per 300 mm penetration indicated a compact to very dense compactness condition. The natural moisture contents measured in the soil samples ranged from approximately 5% to 15%.

Grain size analyses were conducted on two (3) samples (BH23-4/SS7, BH23-7/SS9 and BH23-10/SS7) from the sandy silt or sand and silt till deposits. The results are presented on individual borehole logs and in **Appendix B**, with the following fractions:

Gravel:	3 to 5%
Sand:	38 to 42%
Silt:	42 to 51%
Clay:	5 to 15%

Clayey Silt

Clayey silt was encountered below the silt in Boreholes BH23-5 and BH23-7, below the fill materials in Borehole BH23-6 and below the sand in Borehole BH23-14. The clayey silt deposit extended to depths ranging from 3.0 to 6.4 m below existing ground surface (Elev.108.4 to 104.0). The standard penetration 'N' values ranging from 8 to greater than 50 blows per 300 mm penetration indicated a firm to hard consistency. The natural moisture contents measured in the soil samples ranged from approximately 5% to 12%.

Sand / Gravely Sand / Silty Sand (Till)

Sand to silty sand or gravely sand were encountered below the fill materials in Boreholes BH23-2, BH23-4, BH23-10 to BH23-12 and BH23-14, and below the silt in Borehole BH23-14. The sand deposit extended to depths ranging from 2.5 to 5.3 m below existing ground surface (Elev. 121.6 to 104.7). Boreholes BH23-2 and BH23-12 were terminated in the deposits. The standard penetration 'N' values ranging from 22 to greater than 50 blows per 300 mm penetration indicated a compact to very dense compactness condition. The natural moisture contents measured in the soil samples ranged from approximately 4% to 12%.

Gravel / Sandy Gravel / Sand and Gravel

Gravel to sandy gravel or sand and gravel were encountered below the fill materials in Boreholes BH23-3 and BH23-13, below the sand in Borehole BH23-2, BH23-4 and BH23-11, below the silt in Boreholes BH23-1, BH23-6, BH23-9 and BH23-14. The gravel deposits extended to depths ranging from 3.0 to 8.3 m below existing ground surface (Elev. 120.8 to 102.1). Boreholes BH23-1, BH23-4 to BH23-6, BH23-9, BH23-11, BH23-13, and BH23-14 were terminated in the deposits. The standard penetration 'N' values ranging from 22 to greater than 50 blows per 300 mm penetration indicated a compact to very dense compactness condition. The natural moisture contents measured in the soil samples ranged from approximately 5% to 12%.

Grain size analyses were conducted on three (3) samples (BH23-5/SS4, BH23-1/SS5 and BH23-14/SS7) from the sand and gravel deposits. The results are presented on individual borehole logs and in **Appendix B**, with the following fractions:

Gravel: 36 to 48%
Sand: 35 to 41%
Silt: 10 to 23%
Clay: 2 to 6%

Bedrock

Boreholes BH23-1 to BH23-6, BH23-9, BH23-11 to BH23-14 were all terminated on assumed boulders or bedrock upon practical refusal of auger. The refusal depths and elevations of assumed boulders or bedrock as found in the boreholes drilled and attempted are summarized below in **Table 1.** Bedrock around the site is typically shale or limestone of the Upper Ordovician. Additional drilling with rock coring is recommended to confirm bedrock presence and depth in the areas.

Table 1: Auger Refusal Depths

Borehole ID	Assumed Bedrock Depth (mBGS)[1]/ Elevation (m)
BH23-1	4.6 / 107.9
BH23-2	5.3 / 107.0
BH23-3	6.2 / 114.6
BH23-4	5.8 / 118.8
BH23-5	3.7 / 106.7
BH23-6	4.3 / 107.9
BH23-9	3.2 / 105.8
BH23-11	4.5 / 103.0
BH23-12	2.5 / 106.7
BH23-13	4.1 / 104.1
BH23-14	8.3 / 102.1

Note:
1. mBGS = meters below ground surface

4.2 Groundwater Conditions

Fourteen (14) monitoring wells (50 mm dia.) were installed to monitor stabilized groundwater levels. The stabilized groundwater levels were measured on August 9, September 7 and 13, 2023. The monitoring well installation details and the measured groundwater levels are summarized in **Table 2** and shown in the individual borehole logs.

Table 2: Monitoring Well Details and Water Levels

Monitoring Well ID	Screen Interval (mBGS)	Water Level Depth (mBGS)/ Water Level Elevation (m)		
		August 9, 2023	September 7, 2023	September 13, 2023
BH23-1	1.6 ~ 4.6	-	2.0/110.5	1.6/110.9
BH23-2	2.3 ~ 5.3	0.3/112.1	1.1/111.3	1.3/111.1
BH23-3	3.1 ~ 6.1	3.6/117.2	3.9/116.9	4.2/116.6
BH23-4	2.1 ~ 5.1	1.2/123.4	2.0/122.6	2.1/122.5
BH23-5	1.6 ~ 3.1	-	1.8/108.6	1.1/109.3
BH23-6	1.3 ~ 4.3	1.3/110.9	2.3/109.9	2.0/110.2
BH23-7	4.6 ~ 7.6	0.8/112.5	2.7/110.6	2.0/111.4
BH23-8	3.1 ~ 6.1	0.5/116.5	0.7/116.2	2.0/115.0
BH23-9	1.6 ~ 3.1	-	2.3/106.7	2.6/106.4
BH23-10	3.1 ~ 6.1	1.8/109.6	2.7/108.7	2.9/108.5
BH23-11	1.5 ~ 4.5	0.4/107.1	0.8/106.7	0.9/106.6
BH23-12	1.0 ~ 2.5	No GW Accu.	No GW Accu.	No GW Accu.
BH23-13	1.1 ~ 4.1	1.9/106.3	1.6/106.7	1.7/106.5
BH23-14	5.3 ~ 8.3	1.3/109.1	2.5/107.9	2.6/107.8

Note: mBGS = meter below ground surface

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to weather events.

5. Recommended Design Parameters for Soil

Suggested geotechnical parameters (unfactored) for soils encountered at the site are summarised in **Table 3**. The recommended soil parameters are based on SPT N-values, soil laboratory test results and supplemented by the judgement based on local and regional experience with these soil types.

Table 3: Recommended Soil Parameters for Design

SOIL TYPE	NEW GRANULAR FILL		EXISTING FILL	NON-COHESIVE NATIVE SOILS							COHESIVE NATIVE SOILS				
SPT 'N'	'A'	'B'	0-50	0-4	5-10	11-14	15-29	30-39	40–50	>50	0-2	3-9	10-14	15-29	30-50
Unit weight (kN/m^3)	22	21	19	18.5	19	20	21	21.5	22	22.5	18.5	19	20.5	21	21.5
Effective angle of internal friction (°), ϕ'	35	32	24	24	26	28	30	32	34	37	24	26	28	30	32
Effective cohesion, c' (kPa)	-	-	-	-	-	-	-	-	-	-	0	0	2	5	10
Undrained shear strength (kPa)	-	-	-	-	-	-	-	-	-	-	10	40	70	100	200
Coefficient of lateral earth pressure															
Active, K_a	0.27	0.31	0.42	0.42	0.39	0.36	0.33	0.31	0.28	0.25	0.42	0.39	0.36	0.33	0.31
At rest, K_o	0.43	0.47	0.59	0.59	0.56	0.53	0.50	0.55	0.60	0.80	0.59	0.56	0.53	0.50	0.60
Passive, K_p	3.69	3.25	2.37	2.37	2.56	2.77	3.00	3.25	3.54	4.03	2.37	2.56	2.77	3.00	3.25

SOIL TYPE	NEW GRANULAR FILL		EXISTING FILL	NON-COHESIVE NATIVE SOILS							COHESIVE NATIVE SOILS				
SPT 'N'	'A'	'B'	0-50	0-4	5-10	11-14	15-29	30-39	40–50	>50	0-2	3-9	10-14	15-29	30-50
Elastic modulus (MPa)	-	-	-	-	5	6.3	8	30	40	50	-	4	8	15	30
Poission's ratio	-	-	-	-	0.3	0.3	0.3	0.3	0.3	0.3	-	0.3	0.3	0.3	0.3
Modulus of subgrade reaction, k (MN/m^3) (*)	-	-	-	-	5/B	6.3/B	8/B	30/B	40/B	50/B	2/B	4/B	8/B	15/B	30/B
Lateral modulus of subgrade reaction, K_h (MN/m^3) (*)	-	-	-	-	5/B	6.3/B	8/B	30/B	40/B	50/B	2/B	4/B	8/B	15/B	30/B

6. Discussion and Recommendations

It is understood that general development plan at 449 and 501 Harmony Road may consist of low-rise residential buildings with one level basement, internal servicing and roadways. It should be noted that any recommendations made in this report should be considered preliminary. Additional analysis will be required once detailed site plans and grading plans are made available. Recommendations are generalized for this site.

6.1 Proposed Building Foundation Design Considerations

Based on the borehole information, the future low-rise buildings can be supported by spread and strip footings founded on the undisturbed native soils for a bearing capacity of 150 to 250 kPa at SLS (serviceability limit states), and for a factored geotechnical resistance of 225 to 375 kPa at ULS (ultimate limit states). The bearing values and the corresponding founding depths at borehole locations are summarized on **Table 4**.

Table 4: Bearing Values and Founding Levels of Spread and Strip Footings

BH No.	Anticipated Funding Material	Bearing Capacity at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth below Existing Grade (m)
BH23-1	Sandy Silt	150	225	1.8
BH23-2	Silty Sand	250	375	1.0
BH23-3	Gravel/ Sandy Silt Till	250	375	2.7
BH23-4	Silty Sand Till	250	375	2.5
BH23-5	Sandy Silt	250	375	1.8
BH23-6	Clayey Silt	250	375	2.5
BH23-7	Sandy Silt Till	250	375	1.8
BH23-8	Sandy Silt	250	275	1.8
BH23-9	Sandy Silt	200	300	1.8
BH23-10	Silty Sand	250	375	2.5
BH23-11	Sand/Gravely Sand	200	300	1.3
BH23-12	Sand	250	375	2.5
BH23-13	Sand and Gravel	250	375	2.5
BH23-14	Silty Sand	150	225	1.8

All footing bases must be inspected by qualified geotechnical engineering personnel prior to pouring concrete. The excavated footing bases can be covered with 50 mm thick lean concrete slab immediately after inspection and cleaning in order to avoid disturbance of the founding soil due to water, construction activity and weathering/drying.

Foundations designed to the specified bearing capacity at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential, if designed as per **Table 2**.

All foundations exposed to seasonal freezing conditions must have at least 1.5 metres of soil cover for frost protection.

In the vicinity of the existing buried utilities, all footings must be lowered to undisturbed native soils, or alternatively the services must be structurally bridged. Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper footing.

It should be noted that the recommended bearing resistances have been estimated by Palmer from the borehole information for the preliminary design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections to validate the information for use during the construction stage. Additionally, the site layout provided at the time of writing of this report is considered preliminary. The locations of the proposed buildings and infrastructure are expected to change and as thus, the corresponding soil at the final proposed locations will need to be further analysed.

6.1.1 Engineered Fill

Alternatively, consideration may be given to place an engineered fill pad for proposed foundations.

Prior to the placement of the engineered fill, all the existing fill or soft/disturbed native soils must be removed, and the exposed surface proof rolled. Any soft spots revealed during proof rolling must be sub-excavated and re-engineered. The engineered fill consisting of approved inorganic material must be placed in layers not exceeding 200 mm loose thickness and compacted to 100% Standard Proctor Maximum Dry Density (SPMDD) throughout. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the contractor is essential. Despite full time supervision, it has been found that contractors frequently bulldoze loose fill into areas and compact only the surface. This potential problem must be recognized and discussed at a pre-construction meeting. Procedures can then be instigated to reduce the risk of settlement resulting from poorly compacted fill. Detailed requirements for engineered fill are given in **Appendix C**.

The engineered fill pad should extend to at least 1 m beyond the edge of the foundations and extend outward at an angle no greater than 45^{o} to meet the subgrade, with a minimum thickness of 0.6 m on the approved subgrade soils. Footings founded on engineered fill can be designed for a bearing capacity value of 100 kPa at SLS, and for a factored geotechnical resistance of 150 kPa at ULS.

6.2 Floor Slab Drainage

The existing fill and soft/loose native are considered not suitable for supporting the floor slab. The floor slab can be supported on grade provided all existing fill and disturbed/weathered material, surficially disturbed native are removed or soft/loose native soils are improved using aforementioned ground improvement methodology, and the base thoroughly proof rolled. The backfill required to raise the grade can consist of inorganic soil, placed in shallow lifts (200 mm) and compacted to 98% of Standard Proctor Maximum Dry Density (SPMDD).

A moisture barrier consisting of at least 200 mm of 19 mm clear crushed stone should be installed under the floor slab.

For the building section with one level basement, a permanent perimeter and underfloor drainage system as outlined in **Drawings 2** or **3** will be required.

For the building section without basement, if the floor slab is more than about 300 mm higher than the exterior grade, then a perimeter drainage system is not considered to be necessary. If the floor is lower, then the perimeter drainage system shown on **Drawing 4** is recommended.

Site grading and finished floor slab elevation should consider groundwater levels. Floor slab and under slab drainage of the buildings should be set 0.5 m above the seasonal high groundwater level.

6.3 Excavations, Backfill and Groundwater Control

Excavations can be carried out with a heavy hydraulic backhoe. It should be noted that the (glacial) tills are non-sorted sediments and therefore may contain boulders. Possible large obstructions such as buried concrete pieces and existing foundations may also be encountered at the site and in the fill materials. Provisions must be made in the excavation contract for the removal of possible boulders in the till or obstructions in the fill material.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the fill materials and the loose cohesionless soils would be classified as Type 3 Soils above the groundwater table and Type 4 soils below the groundwater table. The compact to very dense silt, sand and gravel would be classified as Type 2 Soil above the groundwater table and Type 4 Soils below the groundwater table. The stiff to hard clayey silt would be classified as Type 3 Soils above the groundwater table and Type 4 Soils below the groundwater table.

It is anticipated that foundation excavations at the site will consist of temporary open cuts with side slopes not steeper than 1.5 horizontal to 1 vertical (1.5H:1V). However, depending on the construction procedures adopted by the contractor and weather conditions at the time of construction, some local flattening of the

slopes might be required. Where side slopes of excavations are to be steepened, then a positive excavation support system should be considered.

The existing fill in the boreholes is generally not suitable for re-use as backfill. The native soils free from topsoil and organics can be used as general construction backfill. Loose lifts of soil, which are to be compacted, should not exceed 200 mm. Depending on the time of construction and weather, some excavated material may be too wet to compact and will require aeration prior to its use.

Under floor fill should be compacted to at least 98% of Standard Proctor Maximum Dry Density (SPMDD). The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular ”B” should be used. Imported granular fill, which can be compacted with handheld equipment, should be used in confined areas.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should be compacted at the surface or be covered with tarpaulins to minimize moisture uptake.

It is expected that any seepage above the groundwater table can be removed by pumping from sumps in the building development area. However, due to the high groundwater level encountered at the Site, significant seepage should be expected once the excavations extend below the prevailing groundwater tables in the cohesionless sandy silt/silty sand/sand and gravel soils at the Site. Depending upon the actual thickness and extent of these soils, the prevailing groundwater level at the time of construction, “active, advance” dewatering measure using well points/eductors may be required to maintain the stability of the base and side slopes of the excavations in these areas. These ‘active dewatering’ measures would have to be installed and then operated for a week or two in advance of excavation work progressing to these areas. A contractor specializing in dewatering should be retained to design the active dewatering systems.

It should be noted that if the construction dewatering system/sumps result in a water taking of more than 50,000 L/day but less than 400,000 L/day, a registration should be made in the Environmental Activity and Sector Registry (EASR). If a water taking is more than 400,000 L/day, a permit to take water (PTTW), issued by the MECP, will be required. A separate Hydrogeological study by Palmer will assess the dewatering requirements for any excavations below the groundwater table.

It should be noted that final site grading plans will determine the extent of excavation and the recommendations made above are preliminary.

6.4 Earth Pressures

The lateral earth pressures acting at any depth on foundation walls may be calculated from the following expression:

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

where P_h = Lateral earth pressure acting at depth "h" (kPa)

K = Earth pressure coefficient, as shown in **Table 2** and horizontal backfill for permanent construction

γ = Unit weight of backfill, as shown in **Table 2**

h = Depth below finished grade of the point of interest (m)

q = Equivalent value of surcharge on the ground surface (kPa)

The above expression assumes that the perimeter drainage system as shown on **Drawing 2** to **4** prevents the build-up of any hydrostatic pressure behind the wall.

6.5 Pipe Support and Bedding

All topsoil, the fill materials, weak or disturbed soils or other objectionable material must be removed from excavation base prior to placement of pipe bedding.

The borehole information indicates that the native soils with SPT 'N' values of more than 10 blows per 300mm of penetration are capable of providing adequate pipe support using conventional Class "B" bedding, provided that construction dewatering using well points/eductors is conducted when the excavation is below the groundwater level. The recommended minimum thickness of granular bedding below the invert of the pipes is 150 mm where the subgrade consists of competent native soils or engineered fill.

Where the weak or otherwise unsuitable fill materials or native soils are present at the proposed pipe invert or trench invert elevation, the unsuitable fill material should be sub-excavated and replaced using conventional Class "B" bedding. In this case, the recommended minimum thickness of granular bedding below the invert of the pipes is 300 mm.

The bedding material and its minimum thickness for the pipes should be in accordance with the current revision of OPSD (Ontario Provincial Standard Drawing) and applicable municipal standards and may have to be increased depending on the pipe diameter and where the loose silty sand or loose sandy silt till layer subgrade conditions are encountered.

To avoid the loss of soil fines from the subgrade, uniformly graded clear stone should not be used unless, below the granular bedding material, a suitable, approved filter fabric (geotextile) is placed. The geotextile should extend along the sides of the trench and should be wrapped all around the uniformly graded bedding material.

The compacted granular base and the cover material for the pipe should consist of OPSS 1010 Granular "A" type material. All granular materials should be placed in loose lifts of 150mm thickness and then compacted. The granular bedding and cover materials should be compacted to 100% of Standard Proctor Maximum Dry Density (SPMDD) at a placement water content within ±2% of the materials optimum. Care should be exercised when compacting the cover material on top of the pipes to avoid damaging them.

6.6 Seismic Considerations

The 2012 Ontario Building Code (OBC 2012) came into effect on January 1, 2014 and contains updated seismic analysis and design methodology. The seismic site classification methodology outlined in the code is based on the subsurface conditions within the upper 30 m below existing grade.

The conservative site classification is based on physical borehole information obtained at depths of less than 30 m and based on general knowledge of the local geology and physiography. In this regard, Palmer's drilling program included boreholes drilled to depths up to 9.8 m below the existing ground surface. Based on the borehole information and our local experience, a Site Class D may be used for the building design.

Should optimization of the site class be recommended by the structural engineer, in situ geophysical testing or a deep borehole extending to 30 m may be considered.

6.7 Pavement Considerations

It is assumed that there will be roadways constructed in the development plan that will be assumed by the City of Belleville. It is critical that the pavement design follows the City of Belleville engineering standards as a minimum.

The new granular base/subbase should consist of a minimum thickness of 150 mm of OPSS Granular "A" compacted to 100% of the SPMDD, overlying the required remaining thickness of OPSS Granular "B" (to match-in with existing) compacted to 100% of the SPMDD. The subgrade must be compacted to 98% SPMDD for at least the upper 500 mm unless accepted by qualified geotechnical professionals.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas.

6.8 Geotechnical Quality of Excavated Soils

Reference to the borehole logs suggests that the excavated materials with respect to their compaction characteristics can be divided into three groups:

- **Group 1** comprises the native clayey silt and have moisture content very close to or above its optimum water content. This material will excavate in clods and would thus require a heavy pad footed compactor or hoe pack to break it down and adequately compact it. Given the water content of the clayey silt, it may not be possible to obtain a degree of compaction of this material much above 95% of SPMDD. This degree of compaction might be acceptable within landscaped areas above which pavements or infrastructure are not expected to be built in the future.

- **Group 2** soils comprise the cohesionless silts and sands. The compaction of these soils for site grading or backfill will require a very tight control of their moisture content during placement and compaction. At moisture contents more than 3% below the optimum, the soil will likely be dusty and “flour” like while at moisture contents ±1% higher than optimum, the soil will be “spongy” and will “pump”.

- **Group 3** soils consist of unsuitable materials because of their high moisture, organic inclusions, or deleterious inclusions, including all of the existing fill materials. These soils should be either disposed off-site or should be used only in “soft” landscaping areas where they can be placed with nominal compaction, and where surface settlements are tolerable.

As a general requirement, all backfill material should be placed in 200 to 300 mm thick loose lifts and compacted to at least 96% of SPMDD, at a placement moisture content within ±2% of the optimum. Below existing/future roads, the backfill must be Granular “A” or “B” material, and the top 1.5m of subgrade backfill below the underside of the pavement structure should be compacted to 98% of SPMDD.

7. Certification

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

This report was prepared and reviewed by the undersigned:

Prepared By:

Alonzo Rowe, P.Eng.
Geotechnical Engineer

Reviewed By:

Matthew D. St Denis, P.Eng.
Team Lead, Geotechnical Engineering East

8. References

ASTM International. 2018. ASTM D1586 / D1586M-18, Standard test method for standard penetration test (SPT) and split-barrel sampling of soils.

Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual, 4th Edition.

Chapman, L.J. and Putnam, D.F. 1984. Physiography of southern Ontario; Ontario Geological Survey

Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release— Data 128 – Revised.

Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release---Data 126-Revision 1.

General Comments and Limitations of Report

Palmer should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, Palmer will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes and test pits required to determine the localized underground conditions between boreholes and test pits affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole and test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

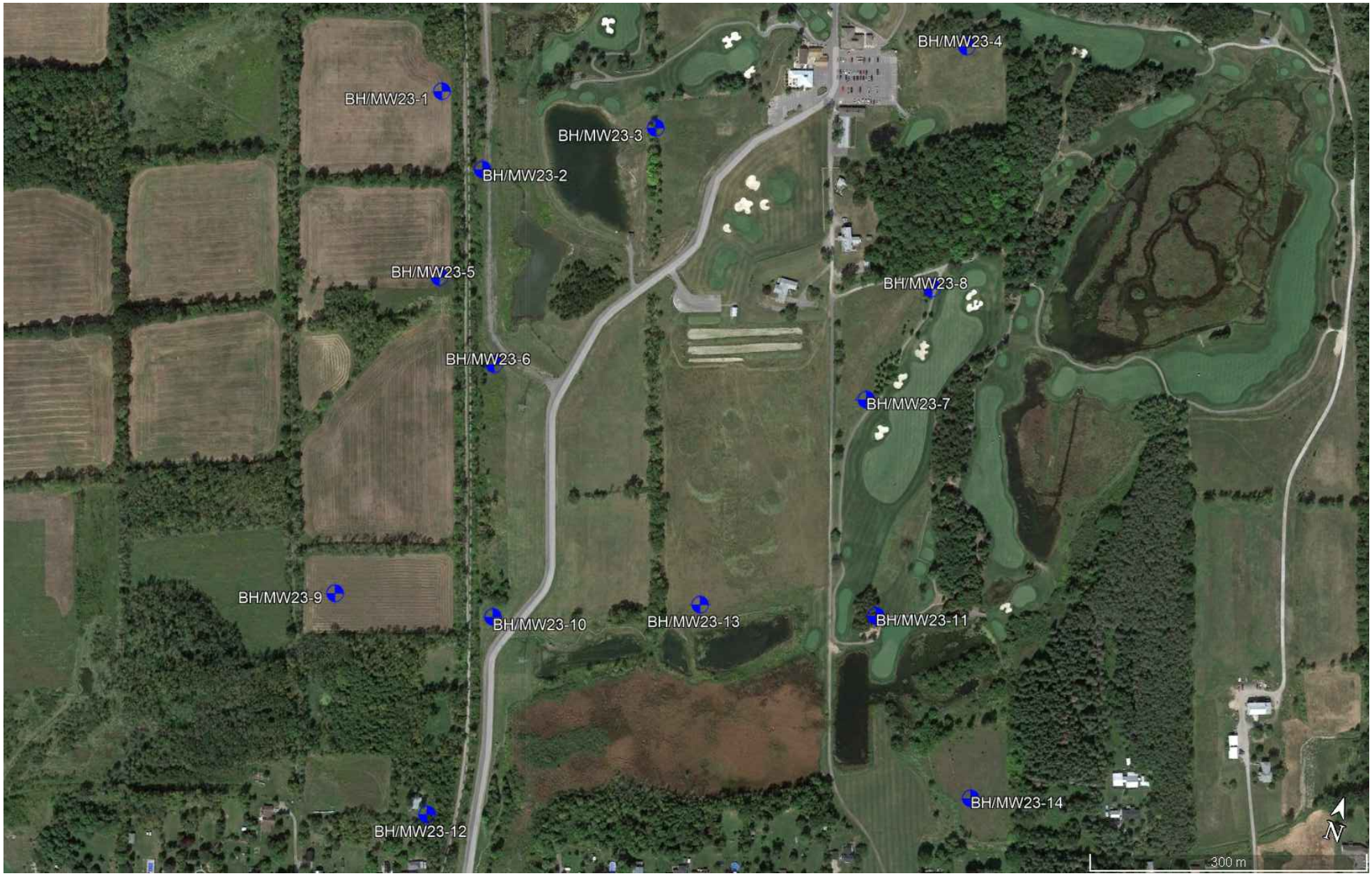
This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Palmer at the time of preparation. Unless otherwise agreed in writing by Palmer, it shall not be used to express or imply warranty as to the fitness of the property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

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

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Palmer accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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

Drawings

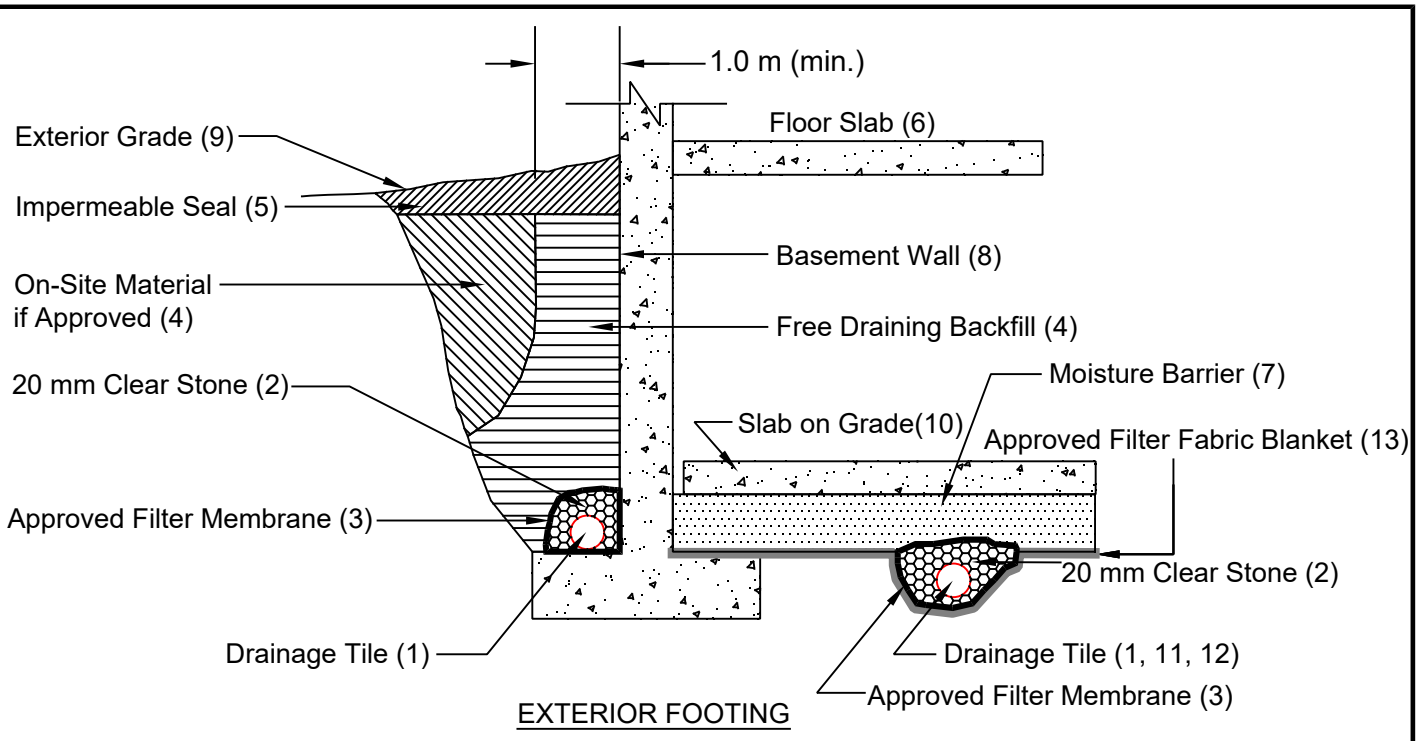


LEGEND

Borehole/Monitoring Well Location

Borehole Location

Client:	**Black Bear Ridge GP Inc**	Project No.: **2200902**	Drawing No.: **1**
Drawn: **IB**	Approved: **AR**	Title:	**Borehole/Monitoring Well Location Plan**
Date: **October, 2023**	Scale: **As Shown**	Project:	**Geotechnical Investigation** **BBR Geotech, Hydrog and ESA Studies, Corbyville, ON**
Original Size: **Letter**	Rev: **N/A**	Palmer™	871 Equestrian Court Oakville, Ontario L6L 6L7



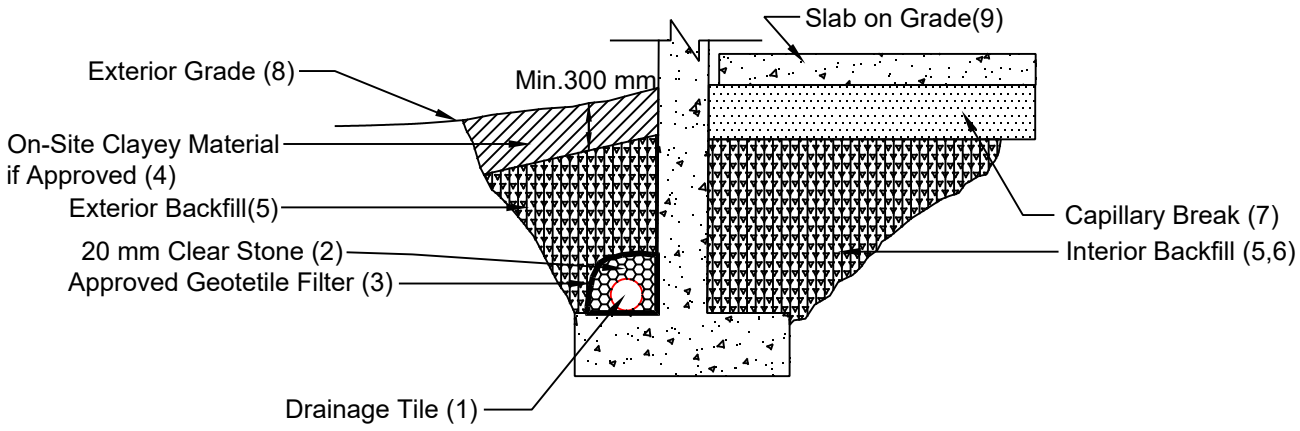
EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Free Draining backfill - OPSS Granular B or equivalent compacted to the specified density. Do not use heavy compaction equipment within 450 mm (18") of the wall. Use hand controlled light compaction equipment within 1.8 m (6') of wall. The minimum width of the Granular 'B' backfill must be 1.0 m.
5. Impermeable backfill seal - compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Maximum thickness of seal to be 0.5 m.
6. Do not backfill until wall is supported by basement and floor slabs or adequate bracing.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Basement wall to be damp proofed /water proofed.
9. Exterior grade to slope away from building.
10. Slab on grade should not be structurally connected to the wall or footing.
11. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
12. Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
13. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
14. Do not connect the underfloor drains to perimeter drains.
15. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Basement with Underfloor Drainage

(not to scale)

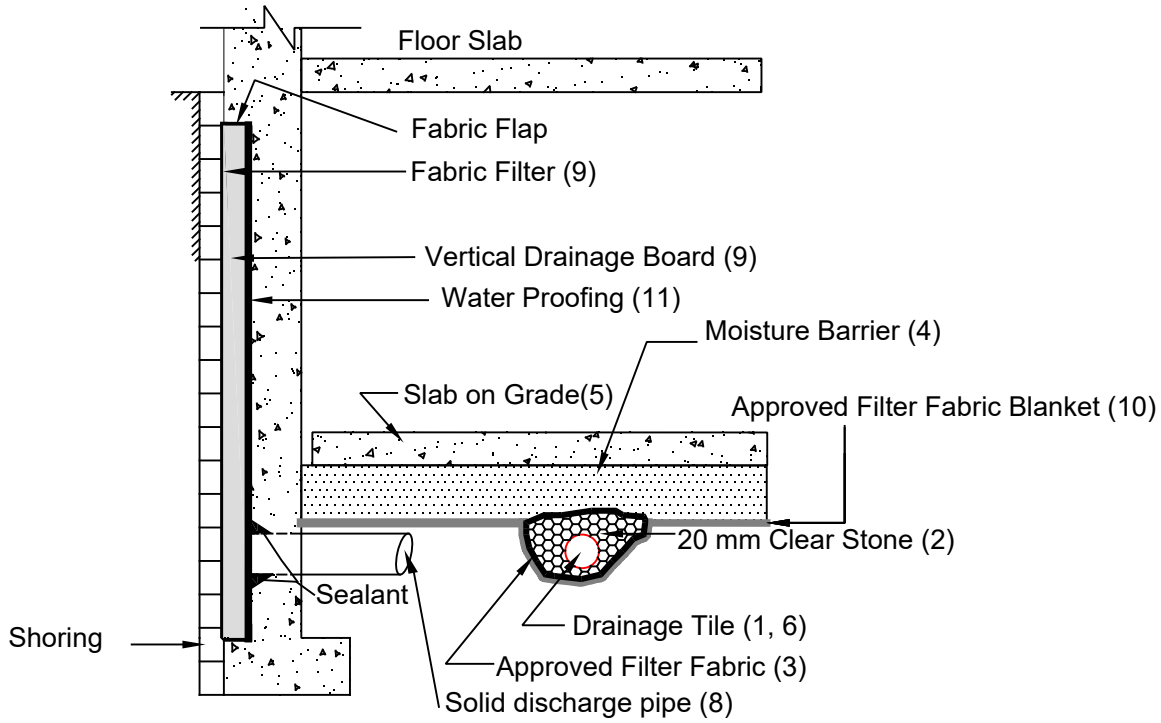


EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved geotetile filter (Terrafix 270R or equivalent).
4. The on-site clayey material, if approved, can be used as backfill in the upper 300 mm.
5. The interior and exterior fill adjacent to foundation walls should be OPSS Granular 'B' Type I. Compact to at least 98% SPMDD.
6. Do not use heavy compaction equipment within 450 mm (18") of the wall. Do not fill or compact within 1.8 m (6') of the wall. Place fill on both sides simultaneously.
7. Capillary break to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors (consult with archtect).
8. Exterior grade to slope away from building at min. 2%.
9. Slab on grade should not be structurally connected to the wall or footing.
10. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Slab on Grade Construction Without Underfloor Drainage
(not to scale)



EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet, spaced between columns.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
5. Slab on grade should not be structurally connected to the wall or footing.
6. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab. Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
7. Do not connect the underfloor drains to perimeter drains.
8. Solid discharge pipe located at the middle of each bay between the solider piles, approximate spacing 2.5 m, outletting into a solid pipe leading to a sump.
9. Vertical drainage board with filter cloth should be kept a minium of 1.2 m below exterior finished grade.
10. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
11. The basement walls should be water proofed using bentonite or equivalent water-proofing system.
12. Review the geotechnical report for specific details. Final detail must be approved before system is considered acceptable.

DRAINAGE RECOMMENDATIONS
Shored Basement wall with Underfloor Drainage System

(not to scale)

Appendix A

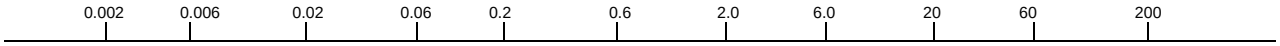
Borehole Logs

Notes On Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by PECG also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that, with the exception of those samples where a grain size analysis and/or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Explanation of Terms Used in the Record of Borehole

Sample Type

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Dimension type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Spoon sample
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

Penetration Resistance

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) required to drive a 50 mm (2 in) drive open sampler for a distance of 300 mm (12 in).

Dynamic Cone Penetration Resistance, N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) to drive uncased a 50 mm (2 in) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in).

Textural Classification of Soils

Classification	Particle Size
Boulders	>300 mm
Cobbles	75 mm-300 mm
Gravel (Gr)	4.75 mm-75 mm
Sand (Sa)	0.075 mm-4.75 mm
Silt (Si)	0.002 mm-0.075 mm
Clay (Cl)	<0.002 mm

Coarse Grain Soil Description (50% greater than 0.075 mm)

Terminology	Proportion
Trace	0-10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. sand and gravel)	>35%

Soil Description

a) Cohesive Soils

Consistency	Undrained Shear Strength (kPa)	SPT "N" Value
Very soft	<12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very stiff	100-200	15-30
Hard	>200	>30

b) Cohesionless Soils

Density Index (Relative Density)	SPT "N" Value
Very loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Soil Tests

w	Water content
w_p	Plastic limit
w_l	Liquid limit
C	Consolidation (oedometer) test
CID	Consolidated isotropically drained triaxial test
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement
D_R	Relative density (specific gravity, Gs)
DS	Direct shear test
ENV	Environmental/ chemical analysis
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified proctor compaction test
SPC	Standard proctor compaction test
OC	Organic content test
V	Field vane (LV-laboratory vane test)
γ	Unit weight

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LOG OF BOREHOLE BH23-01

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4902111.72 E 308623.04

Method: Solid Stem Augers

Diameter: 200 mm

Date: Sep 1, 2023

REF. NO.: 2200902

ENCL NO.: 1

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
112.5	Ground Surface						
0.0	**FILL:** sandy silt, some gravel, contains cobbles, trace to some sand, brown, moist, compact	1	SS	13		Concrete Sand 112	
1		2	SS	11		Bentonite	
111.1						Sand 111	
1.5	**SANDY SILT:** some gravel, contains cobbles, brown, moist, compact to dense	3	SS	14		W. L. 111.0 m Sep 13, 2023	Auger grinding
2						W. L. 110.5 m Sep 7, 2023	
109.6		4	SS	34		110	
3.0	**SAND AND GRAVEL:** trace silt, contains cobbles, brown, wet, compact to very dense	5	SS	28		Screen	Wet spoon below
4						109	
107.9						Bentonite	
4.6	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date W. L. Depth (mBGS) 7 Sept 2023 2.00 13 Sept 2023 1.58	6	SS	50/ initial 25mm			Auger and spoon refusal

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BH23-02

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

Method: Hollow Stem Augers

PROJECT LOCATION: Belleville, ON

Diameter: 229 mm

REF. NO.: 2200902

DATUM: Geodetic

Date: Jul 26, 2023

ENCL NO.: 2

BH LOCATION: See Borehole Location Plan N 4902043.94 E 308690.94

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
112.4	Ground Surface											
112.2 0.2	**TOPSOIL:** 125mm						Concrete					
0.1	**FILL:** sandy silt, some gravel, trace clay, brown, moist, compact		1	SS	11		Sand					
111.7							W. L. 112.1 m Aug 9, 2023					
0.7	**SILTY SAND:** some gravel, trace clay, contains cobbles, brown, moist, dense		2	SS	38		W. L. 111.3 m Sep 7, 2023					
1 110.9							W. L. 111.0 m Sep 13, 2023					
1.5	**GRAVELY SAND:** trace silt, contains cobbles, grey, wet, compact to dense		3	SS	22							
2	contains sand layers						Sand					
			4	SS	49		110					Wet spoon below
3 109.4												
3.0	**SAND:** some gravel, trace silt, contains cobbles, grey, wet, very dense		5	SS	54		109					
	contains gravelly sand layer						Screen					
4			6	SS	92		108					
			7	SS	50/ 50mm							
5	contains gravelly sand layers											
107.0												
5.3	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date / W. L. Depth (mBGS) 9 Aug 2023 0.25 7 Sept 2023 1.07 13 Sept 2023 1.32											Auger and Spoon refusal

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BH23-03

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4902139.85 E 308856.49

Method: Solid Stem Augers

Diameter: 150 mm

Date: Jul 24, 2023

REF. NO.: 2200902

ENCL NO.: 3

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
120.8	Ground Surface										
120.7 / 0.1	**TOPSOIL:** 125mm						Concrete				
0.1	**Fill:** sandy silt, trace gravel, contains rootlets, contains cobbles, brown to grey, moist, dense to compact		1	SS	44		Sand				
			2	SS	26		120				
			3	SS	22		Bentonite 119				
118.3											
2.4	**GRAVEL:** some sand, trace silt, grey, moist, dense		4	SS	43		118 Sand				
117.8											
3.0	**SANDY SILT TILL:** some gravel, trace clay, grey, moist, compact to very dense		5	SS	23		W. L. 117.2 m Aug 9, 2023				
			6	SS	55		W. L. 116.9 m Sep 7, 2023 W. L. 116.6 m Sep 13, 2023				
			7	SS	90/ 225mm		Screen 116				
115.5											
5.3	**SANDY SILT:** some gravel, contains cobbles, brown, moist, very dense		8	SS	50/ initial 125mm		115				
114.6			9	SS	50/ initial 125mm		Bentonite				Auger grinding
6.2	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date — W. L. Depth (mBGS) 9 Aug 2023 — 3.58 7 Sept 2023 — 3.86 13 Sept 2023 — 4.16										

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

Palmer

LOG OF BOREHOLE BH23-04

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4902319.86 E 309150.04

Method: Solid Stem Augers

Diameter: 150 mm

Date: Jul 27, 2023

REF. NO.: 2200902

ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
124.6	Ground Surface											
0.0 / 124.4	**TOPSOIL:** 200mm						Concrete					
0.2 / 123.9	**FILL:** silt, trace clay, trace sand, contains cobbles, brown, moist, compact		1	SS	21		Sand					
0.7	**FILL:** sand, some gravel, trace silt, contains cobbles, brown, moist, compact		2	SS	29		124 Bentonite					
			3	SS	11		W. L. 123.4 m Aug 9, 2023 123					
122.4							Sand W. L. 122.6 m W. L. 122.5 m Sep 13, 2023					
2.2 / 121.6	**SILTY SAND TILL:** some gravel, trace clay, contains cobbles, brown, moist, dense		4	SS	48		122					
3.0 / 120.8	**SAND AND GRAVEL:** trace silt, contains cobbles, brown, moist, very dense		5	SS	50		121 Screen					
3.7	**SANDY SILT TILL TO SAND AND SILT TILL:** some clay, trace gravel, brown to grey, moist, very dense		6	SS	50/ 125mm							
			7	SS	50/ 125mm		120					3 42 43 12
118.9			8	SS	50/ 100mm		Bentonite 119					
118.8 / 5.8	**SAND AND GRAVEL:** trace silt, grey, wet, very dense		9	SS	50/ initial 25mm							Auger and Spoon refusal
	END OF BOREHOLE: 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date / W. L. Depth (mBGS): 9 Aug 2023 1.15; 7 Sept 2023 1.99; 13 Sept 2023 2.07											

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BH23-05

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4901919.43 E 308679.52

Method: Solid Stem Augers

Diameter: 200 mm

Date: Sep 1, 2023

REF. NO.: 2200902

ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
110.4	Ground Surface										
0.0	**FILL:** clayey silt, trace sand, trace gravel, contains rootlets, brown, moist, loose to compact		1	SS	4		Concrete				
							Sand				
							110				
							Bentonite				
1			2	SS	14						
108.9							W. L. 109.3 m Sep 13, 2023				
1.5	**SANDY SILT:** some gravel, contains cobbles, brown, moist, compact		3	SS	30		W. L. 108.6 m Sep 7, 2023				Wet spoon below
2											
108.2							Screen				
2.2	**SAND AND GRAVEL:** silty to some silt, some clay, contains cobbles, brown, moist, dense		4	SS	44		108				36 35 23 6
3											
			5	SS	39		Bentonite				
106.7											Auger refusal
3.7	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date W. L. Depth (mBGS) 7 Sept 2023 1.77 13 Sept 2023 1.14										

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

Palmer

LOG OF BOREHOLE BH23-06

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4901846.81 E 308764.83

Method: Solid Stem Augers

Diameter: 150 mm

Date: Jul 24, 2023

REF. NO.: 2200902

ENCL NO.: 6

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
112.2	Ground Surface											
112.0	**TOPSOIL:** 100mm						Concrete					
0.1	**FILL:** silty clay, trace sand, trace gravel, trace organics, brown, moist, loose to very loose		1	SS	8		Sand					
							Bentonite					
1			2	SS	3		Sand					
110.7							111					
1.5	**CLAYEY SILT:** trace sand, trace gravel, brown to grey, moist, loose		3	SS	8		W. L. 110.9 m Aug 9, 2023					
2							W. L. 110.2 m Sep 13, 2023					
110.0							W. L. 109.9 m Sep 7, 2023					
2.2	**CLAYEY SILT:** some to trace sand, trace gravel, contains cobbles, grey, moist, very stiff		4	SS	26		Screen					
3												
			5	SS	27		109					
108.4												
3.7	**SAND AND GRAVEL:** trace silt, trace gravel, contains cobbles, grey, moist, very dense		6	SS	50/ initial 100mm							
4												
107.9							108					
4.3	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date / W. L. Depth (mBGS): 9 Aug 2023 1.26; 7 Sept 2023 2.28; 13 Sept 2023 2.00											Auger refusal

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: + 3, × 3: Numbers refer to Sensitivity; ○ 8 ε=3% Strain at Failure

LOG OF BOREHOLE BH23-07

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4901927.81 E 309160.36

Method: Solid Stem Augers

Diameter: 150 mm

Date: Jul 25, 2023

REF. NO.: 2200902

ENCL NO.: 7

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.3	Ground Surface											
113.2 / 0.1	**TOPSOIL:** 50mm					Concrete						
	FILL: sandy silt, trace clay, trace gravel, contains rootlets, contains cobbles, brown, moist, compact		1	SS	14	Sand	113					
			2	SS	26	W. L. 112.5 m Aug 9, 2023						
	contains gravel layer						112					
111.9 / 1.5	**SANDY SILT TILL:** some gravel, trace clay, contains cobbles, grey, moist, compact to very dense		3	SS	29							
						W. L. 111.4 m Sep 13, 2023						
			4	SS	30	Bentonite						
						W. L. 110.6 m Sep 7, 2023						
	contains gravelly sand layer		5	SS	52		110					
			6	SS	70							
							109					
						Sand						
			7	SS	85							
107.9 / 5.4	**CLAYEY SILT:** some gravel, trace sand, contains cobbles, grey, moist, hard		8	SS	97		108					
107.3 / 6.0	**SAND AND SILT:** some clay, trace gravel, contains cobbles, grey, moist, very dense					Screen						
			9	SS	80		107					5 38 42 15 Auger grinding
							106					
105.7 / 7.7	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was		10	SS	50/ initial 25mm	Bentonite						Auger refusal

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH23-07

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4901927.81 E 309160.36

Method: Solid Stem Augers

Diameter: 150 mm

Date: Jul 25, 2023

REF. NO.: 2200902

ENCL NO.: 7

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m							GR SA SI CL
	Continued											
	installed in the borehole. 2. Water Level Readings: Date W. L. Depth (mBGS) 9 Aug 2023 0.81 7 Sept 2023 2.67 13 Sept 2023 1.95											

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

Palmer

LOG OF BOREHOLE BH23-08

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4902062.26 E 309192.4

Method: Solid Stem Augers

Diameter: 150 mm

Date: Jul 26, 2023

REF. NO.: 2200902

ENCL NO.: 8

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS "N" 0.3 m	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
116.9	Ground Surface					
116.8	**TOPSOIL:** 100mm					
0.1	**FILL:** sandy silt, trace to some gravel, trace clay, contains rootlets, contains cobbles, brown, moist to wet, compact to dense	1	SS	13	Concrete Sand	
					W. L. 116.5 m Aug 9, 2023 W. L. 116.2 m Sep 7, 2023	
1		2	SS	38	116	
115.5						
1.5	**SANDY SILT:** trace to some gravel, trace clay, contains cobbles, contains boulders, brown, moist to wet, very dense	3	SS	52	Bentonite	
2	contains sand layers				115 W. L. 115.0 m Sep 13, 2023	
		4	SS	82		
3		5	SS	98/ 275mm	Sand	
		6	SS	50/ 100mm	113	
4		7	SS	50/ initial 100mm	Screen	Spoon bouncing
5		8	SS	98/ 225mm	112	
6		9	SS	95/ 225mm	111 Bentonite	
110.5						
6.5	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date W. L. Depth (mBGS) 9 Aug 2023 0.48 7 Sept 2023 0.71 13 Sept 2023 1.97					

STRATA PLOT

GROUND WATER CONDITIONS

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

Palmer

LOG OF BOREHOLE BH23-09

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

Method: Solid Stem Augers

PROJECT LOCATION: Belleville, ON

Diameter: 200 mm

REF. NO.: 2200902

DATUM: Geodetic

Date: Sep 1, 2023

ENCL NO.: 9

BH LOCATION: See Borehole Location Plan N 4901558.25 E 308671.03

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
108.9	Ground Surface											
108.8 / 0.1	**TOPSOIL:** 50mm						Concrete					
	FILL: sandy silt, trace gravel, contains cobbles, brown, moist, loose to compact		1	SS	9		Sand					
							Bentonite					
1			2	SS	11		108					
107.5							Sand					
1.5	**SANDY SILT:** trace gravel, contains cobbles, brown, moist, compact to dense		3	SS	20		107					
2						▽						
			4	SS	34		W. L. 106.7 m Sep 7, 2023					
							W. L. 106.3 m Sep 13, 2023					
106.0							106					
3												
3.0 / 105.8	**GRAVEL:** trace sand, grey, moist, very dense		5	SS	50/ initial 100mm		Bentonite					Auger refusal
3.2	**END OF BOREHOLE:**											Spoon refusal
	1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole.											
	2. Water Level Readings:											
	Date W. L. Depth (mBGS)											
	7 Sept 2023 2.26											
	13 Sept 2023 2.60											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

Palmer

LOG OF BOREHOLE BH23-10

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4901584.2 E 308843.37

Method: Solid Stem Augers

Diameter: 150 mm

Date: Jul 24, 2023

REF. NO.: 2200902

ENCL NO.: 10

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
111.4	Ground Surface											
111.3	**TOPSOIL:** 100mm						Concrete					
0.1	**FILL:** sandy silt, trace to some gravel, trace clay, contains rootlets, contains cobbles, brown, moist, compact to dense		1	SS	13		Sand					
							111					
1			2	SS	48							
							110					
			3	SS	27		Bentonite					
2						▽	W. L. 109.6 m Aug 9, 2023					
109.2												
2.2	**SILTY SAND:** some gravel, trace clay, contains cobbles, brown, moist, dense		4	SS	41		109					
108.4						▽	W. L. 108.7 m Sep 7, 2023					
3						▽	W. L. 108.5 m Sep 13, 2023					
3.0	**SAND AND SILT:** trace to some gravel, trace clay, contains cobbles, brown, moist, very dense		5	SS	50/ initial 125mm							
							108					Auger grinding
4			6	SS	50/ initial 125mm							
							107					
			7	SS	50/ 125mm		Screen					5 39 51 5
5												
			8	SS	50/ 125mm		106					
6												
105.0			9	SS	50/ 125mm		Bentonite 105					
6.4	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date / W. L. Depth (mBGS) 9 Aug 2023 1.80 7 Sept 2023 2.65 13 Sept 2023 2.87											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

Palmer

LOG OF BOREHOLE BH23-11

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

Method: Solid Stem Augers

PROJECT LOCATION: Belleville, ON

Diameter: 150 mm

REF. NO.: 2200902

DATUM: Geodetic

Date: Jul 25, 2023

ENCL NO.: 11

BH LOCATION: See Borehole Location Plan N 4901706.58 E 309240.53

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
107.5	Ground Surface											
107.4	**TOPSOIL:** 75mm					Concrete						
0.1	**FILL:** sandy silt, trace gravel, contains rootlets, brown, moist, very loose to compact		1	SS	4	Sand						
						W. L. 107.1 m Aug 9, 2023						
						Bentonite						
106.5						W. L. 106.6 m Sep 13, 2023						
1.0	**SAND:** trace silt, trace gravel, brown, moist to wet, compact		2	SS	24							
106.0						Sand						
1.5	**GRAVELY SAND:** trace silt, brown, wet, compact to very dense		3	SS	28		106					Wet spoon below
2			4	SS	41		105					
3			5	SS	44	Screen	104					
4			6	SS	68/ 250mm							
103.0							103					
4.5	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date / W. L. Depth (mBGS): 9 Aug 2023 0.37; 7 Sept 2023 0.82; 13 Sept 2023 0.85											Auger refusal

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

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

Palmer

LOG OF BOREHOLE BH23-12

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4901359.31 E 308837.37

Method: Solid Stem Augers

Diameter: 150 mm

Date: Jul 27, 2023

REF. NO.: 2200902

ENCL NO.: 12

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
109.2	Ground Surface											
109.1 / 0.0	**TOPSOIL:** 125mm											
0.1 / 108.5	**FILL:** sandy silt, trace clay, trace gravel, contains rootlets, contains cobbles, brown, moist, loose		1	SS	9		W. L. 109.2 m Aug 9, 20233		○			
0.7	**FILL:** trace to some gravel, trace clay, contains cobbles, brown, moist, compact to very dense		2	SS	27		Bentonite / Sand		○			
1							108					
			3	SS	50/ intial 100mm		Screen		○			Auger grinding Spoon bouncing
2 / 106.8							107					
106.7 / 2.4	**SAND:** some silt, trace gravel,		4	SS	50/ 50mm				○			
2.5	contains cobbles, brown, moist, very dense											Auger refusal
	END OF BOREHOLE: 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date / W. L. Depth (mBGS): 9 Aug 2023 No GW. Accu.; 7 Sept 2023 No GW. Accu.; 13 Sept 2023 No GW. Accu.											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

Palmer

LOG OF BOREHOLE BH23-13

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

Method: Solid Stem Augers

PROJECT LOCATION: Belleville, ON

Diameter: 150 mm

REF. NO.: 2200902

DATUM: Geodetic

Date: Jul 24, 2023

ENCL NO.: 13

BH LOCATION: See Borehole Location Plan N 4901662.47 E 309054.71

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
108.2	Ground Surface											
0.0 / 108.1	**TOPSOIL:** 175mm						Concrete					
0.2	**FILL:** sandy silt, trace clay, trace gravel, contains rootlets, brown, moist, very loose		1	SS	4		Sand					
							Bentonite					
1			2	SS	2		Sand					
							107					
			3	SS	1		W. L. 106.7 m …					
2							W. L. 106.5 m Sep 13. 2023					
106.0							W. L. 106.3 m Aug 9, 2023					
2.2	**SAND AND GRAVEL:** trace to some silt, contains cobbles, brown, wet, compact to very dense		4	SS	26		106					Wet spoon below
							Screen					
3												
	contains weathered shale fragments		5	SS	62		105					48 40 10 2
4												
104.1							Bentonite					
4.1	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date / W. L. Depth (mBGS) 9 Aug 2023 1.93 7 Sept 2023 1.58 13 Sept 2023 1.73		6	SS	50/ intial 25mm							Auger grinding

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ 8 ε=3% Strain at Failure

Palmer

LOG OF BOREHOLE BH23-14

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

Method: Hollow Stem Augers

PROJECT LOCATION: Belleville, ON

Diameter: 229 mm

REF. NO.: 2200902

DATUM: Geodetic

Date: Jul 25, 2023

ENCL NO.: 14

BH LOCATION: See Borehole Location Plan N 4901548.56 E 309396.65

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
110.4	Ground Surface							
110.0	**TOPSOIL:** 100mm						Concrete	
0.1	**FILL:** sandy silt, trace to some clay, trace gravel, trace rootlets, contains cobbles, brown to grey, moist, loose to compact		1	SS	8		Sand	
							110	
1			2	SS	13			
108.9							W. L. 109.1 m Aug 9, 2023	
1.5	**SILTY SAND:** trace clay, trace gravel, contains cobbles, grey, moist, compact		3	SS	13			
2								
108.2								
2.2	**SANDY SILT TILL:** some clay, trace gravel, grey, moist, compact		4	SS	18		108 W. L. 107.9 m W. L. 107.8 m Sep 13, 2023	
3			5	SS	23		107	
4								Auger grinding
106.3								
4.1	**GRAVELLY SAND:** trace silt, contains cobbles, grey, moist, dense		6	SS	37		106	
5							Sand	
104.7							105	
5.6	**CLAYEY SILT:** trace silt, contains cobbles, grey, moist, hard		7A	SS				
6								
104.0							104	
6.4	**SAND AND GRAVEL:** some silt, trace clay, contains cobbles, contains red fragments, grey, wet, dense to very dense		7B	SS	49		Screen	38 41 18 3
7								
							103	
8			8	SS	50/ intial 125mm			Wet spoon below

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

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa): 20 40 60 80 100

NATURAL UNIT WT (kN/m³)

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH23-14

PROJECT: Geotechnical Investigation - Black Bear Ridge

CLIENT: Black Bear Ridge GP Inc.

PROJECT LOCATION: Belleville, ON

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4901548.56 E 309396.65

Method: Hollow Stem Augers

Diameter: 229 mm

Date: Jul 25, 2023

REF. NO.: 2200902

ENCL NO.: 14

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued										
102.1											
8.3	**END OF BOREHOLE:** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date W. L. Depth (mBGS) 9 Aug 2023 1.29 7 Sept 2023 2.46 13 Sept 2023 2.58		9	SS	50/ intial 25mm		Bentonite				Auger grinding

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ 8=3% Strain at Failure

Appendix B

Geotechnical Laboratory Results

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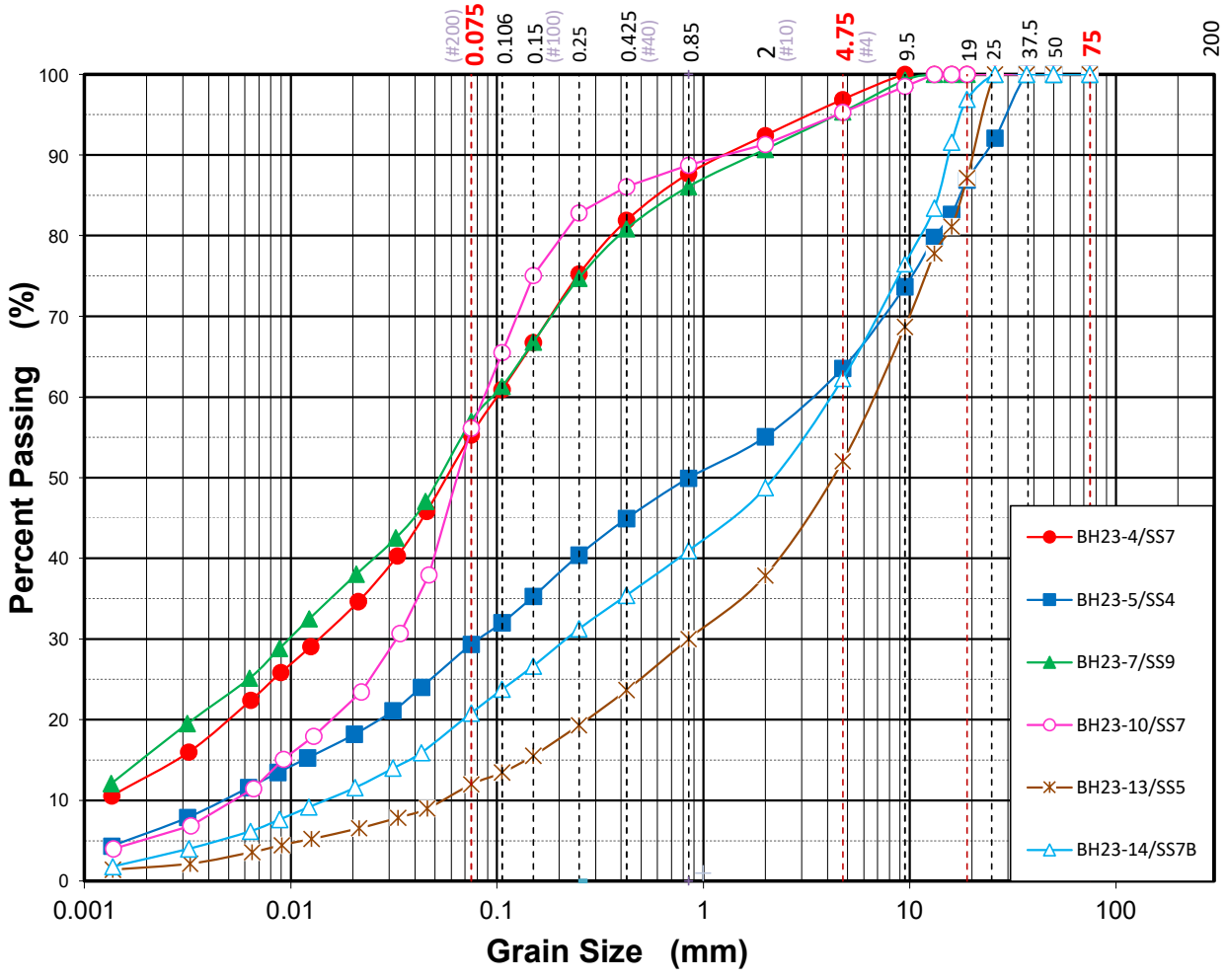
Palmer Environmental Consulting Group Inc.
871 Equestrain Ct, Unit 1
Oakville, ON L6L 6L7

Particle Size Distribution Report

Project No.:	2200902	Lab No.:	R23-003
Project Name:	Black Bear Ridge Geotechnical Investigation	Tested By:	BW
Client:	Black Bear Ridge GP Inc.	Checked By:	TO
Location:	Belleville, Ontario	Date:	10/19/2023

Test Results

Test No.	Sample No.	Clay	Silt	Sand			Gravel		Cobble+	Remarks
				Fine	Medium	Coarse	Fine	Coarse		
1	BH23-4/SS7	12	43	42			3			
2	BH23-5/SS4	6	23	35			36			
3	BH23-7/SS9	15	42	38			5			
4	BH23-10/SS7	5	51	39			5			
5	BH23-13/SS5	2	10	40			48			
6	BH23-14/SS7B	3	18	41			38			
7										
8										



Project: 2200902 **Appendix D**

GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted imported soil that meets specific engineering requirements, is free of organics and debris and that has been continually monitored on a full-time basis by a qualified geotechnical representative is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of the site or can be brought in from other sites. In general, most of Ontario soils are too wet to achieve the 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be considered for engineered fill. Imported non-cohesive granular soil is preferred for all engineered fill. Specifically, OPSS Granular 'B' sand and gravel fill material is recommended.

Adverse weather conditions such as rain make the placement of engineered fill to the required degree of density difficult or impossible; additionally, engineered fill cannot be placed during freezing conditions, i.e. normally not between December 15 and April 1 of each year.

The location of the foundations on the engineered fill pad is critical and certification by a qualified surveyor that the foundations are within the stipulated boundaries is mandatory. Since layout stakes are often damaged or removed during fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Excavations within the engineered fill pad must be backfilled with the same conditions and quality control as the original pad.

To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, contractors and all parties must be aware of the requirements. The minimum requirements are as follows, however, the geotechnical report must be reviewed for specific information and requirements.

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained from and samples must be provided to the geotechnical engineer for review, and approval before filling begins.
2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.
3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and Palmer. Without this confirmation no responsibility for the performance of the structure can be accepted by Palmer. Survey drawing of the pre and post fill location and elevations will also be required.
4. The area must be stripped of all topsoil and fill materials. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by an engineer prior to placement of fill.

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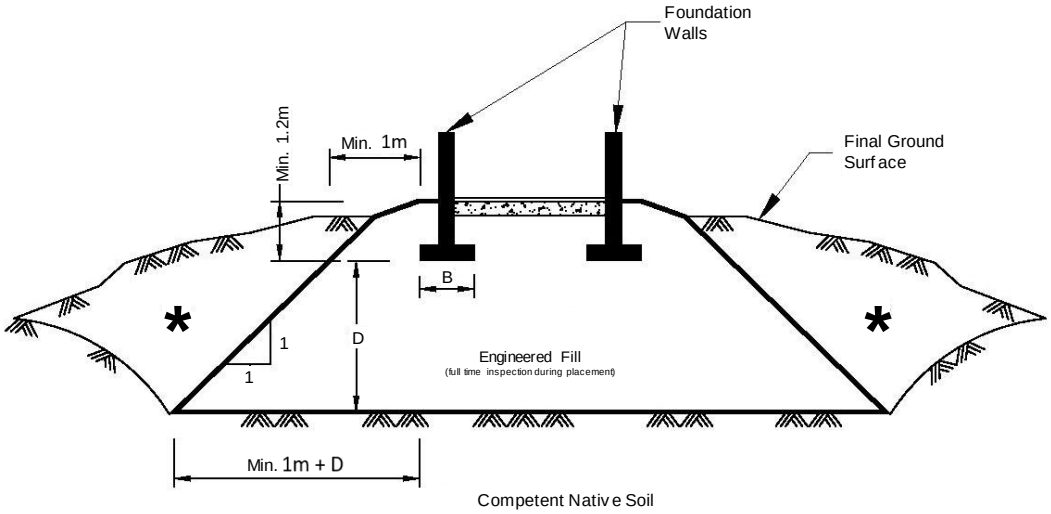
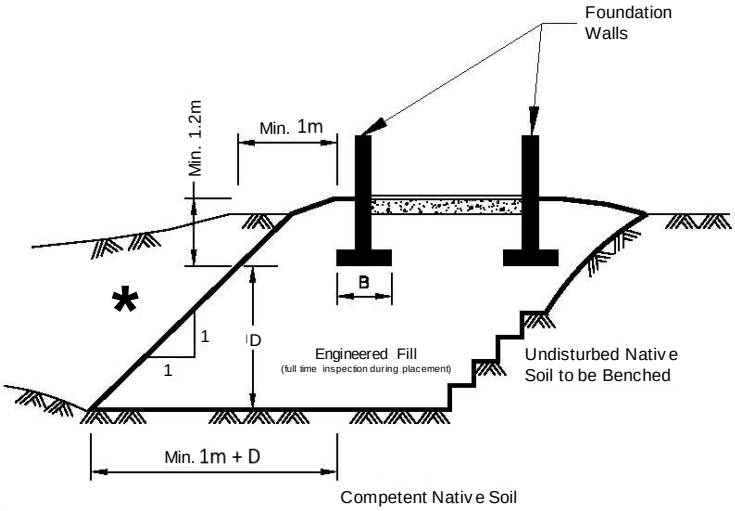
Appendix C

General Requirements for Engineered Fill

5. The approved engineered fill material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Engineered fill should not be placed during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur and should be evaluated prior to placing the fill.
6. Full-time geotechnical inspection by approved geotechnical engineering personnel during placement of engineered fill is required. Work cannot commence or continue without the presence of a geotechnical engineering representative.
7. The fill must be placed such that the specified geometry is achieved. Refer to the attached sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 1 m. The base of the compacted pad extends 1 m plus the depth of excavation beyond the edge of the footing.
8. A bearing capacity of 100 kPa at SLS (150 kPa at ULS) can be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings must be provided with nominal steel reinforcement.
9. All excavations must be made in accordance with the Occupational Health and Safety Regulations of Ontario
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from geotechnical consultant prior to footing concrete placements. All excavations must be backfilled under full time supervision by approved geotechnical engineering personnel to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of a geotechnical engineer.
11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any stoppage in work in order to promote rapid runoff of rainwater and to avoid any ponding surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and to protect from excessive moisture take up.
12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.
13. The geometry of the engineered fill as illustrated in these general requirements is broad in nature. Each project will have its own unique requirements. For example, if perimeter sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be extended.
14. These guidelines are to be read in conjunction with the Palmer report attached.





* Backfill in this area as per Palmer report