

Geotechnical Assessment: Russman Road Subdivision

**Prepared for:
R.G. McCleod Developments**

October 18, 2024

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1. Introduction

R.G. McLeod Development Ltd. (the Client) retained SoilTech Consulting Ltd. (SoilTech) to conduct a geotechnical assessment for a 12 Lot subdivision of 5310 Russman Road, Prince George, BC. The legal description of the property is: DISTRICT LOT 10233, CARIBOO LAND DISTRICT, EXCEPT PLAN 16496, PID: 013-713-485. This assessment includes a landslide hazard assessment.

To conduct this assessment, we have:

- Reviewed the conceptual development plans.
- Carried out a site assessment of the property and surrounding area including:
 - A desktop study of internal project information, and public data relevant to the development, geology, and water conditions at the site.
 - A review of orthoimagery and LiDAR mapping of the subject property and surrounding area.
 - A field assessment including a site investigation and site reconnaissance.
- Reviewed the *Professional Practice Guidelines - Landslide Assessments in British Columbia* (Version 4.1) published by Engineers & Geoscientists British Columbia (EGBC Guidelines) on guidance on how to appropriately assess the potential landslide hazards.
- Assessed the landslide risk in relation to proposed development.
- Identified potential landslide hazards and carried out slope stability/deformation analysis to determine development setbacks.
- Considered the implication climate change may have on the potential hazards.

Based on the assessment findings, we have provided geotechnical analysis, discussion, and recommendations for:

- The anticipated subsurface conditions in the development area
- Radon ground gas
- Landslide hazard assessment
- Slope stability related development setbacks and restrictions
- General site preparation
- Re-use of in-situ soils
- Building site preparation including Structural Fill
- Shallow foundations
- Grade supported floor slabs
- Foundation drainage and backfill
- Frost penetration and protection
- Pavement structures
- Temporary excavations

2. Project Description

Based on our discussions with the Client and L&M Engineering Limited (L&M) and our review of the preliminary subdivision plans we understand the development will consist of and involve:

- A 12-lot residential subdivision
- Each lot having an onsite water well and sanitary system
- Defining a greenbelt (AG) zone and the possible clearing of some large areas of the remaining portions of the lots
- A paved access road with ditches for stormwater management

3. Site Assessment

To assess the site, we carried out a desktop study and a field assessment. For the desktop study we reviewed:

- Preliminary design drawings for the development prepared by L&M
- Internal information on nearby SoilTech projects.
- Government of Canada Open Maps – Surficial Geology.
- Geological Survey of Canada Bulletin 196 and Map 1288A (GSoC Map 1288A)
- BC Groundwater Wells and Aquifers data.
- LidarBC data.
- PGMap imagery and data.
- Google Earth Imagery.

The test pits investigation and site reconnaissance were carried out on May 12, 2023, and May 16, 2024.

3.1 Site Description and Background

The subject property is located at the crest of Cranbrook Hill adjacent to Foothills Boulevard. The slopes at the west end of the property are gentle and transition to moderately steep slopes with dendritic drainage channels. The slopes associated with the dendritic drainages are steeper than 20% gradient and are considered significant slopes. The property is undeveloped but a large portion of it has been previously logged and stumped. The property is currently mainly covered by immature forest with some mature fir that were left behind during previous logging. There are some wetter microclimates near the drainage channels with increased density of understory and deciduous species.

3.2 Geological Background

At the core Cranbrook Hill consists of bedrock ridge. The surficial geology of the hill and surrounding area can be attributed to a few major events following the Fraser Glaciation, the last period of ice sheet glaciation in BC.

- Glaciers advanced northeastwardly, bulldozing and grinding the earth beneath them, depositing lodgement till over top to the bedrock.
- As glaciers began to melt and retreat, the resulting melt water eroded some of the till.
- Meltwater was dammed for a period by stagnant ice to the south near Stoner/Red Rock causing a large glacial lake to form over much of the Prince George area.
- Glaciolacustrine sediments of silt, clay, and fine sand were deposited over the glacial lakebed.
- Wave action eroded some of the till and washed away much of the fine-grained components leaving a deposit of sand and gravel at the shoreline of the lake.
- Recurrent breaches and redevelopment of the ice dam caused the lake level to fluctuate.
- The fluctuating lake levels resulted in the alternating floating and grounding of large pieces of ice which disrupted and prevented the deposit of lake sediments in localized areas.
- In the last cycle of the lake the water level likely dropped slowly until the dam failed catastrophically, resulting in massive volumes of water flowing at high velocities which eroded large volumes of lacustrine and till deposits, including those on the Cranbrook Hill slope and toe.
- The meltwater flowed over the Prince George Bowl area eroding fine-grained soil while depositing sand, gravel and cobbles of varying proportions depending on the volume and velocity of the flow. Heavier larger particles (cobble and gravel) being deposited in high velocity areas and smaller particles (gravel and sand) in areas of lower velocity.

- Some large pieces of ice were grounded at the edges of the lake (dead Ice) and as they melted esker and kame formations were created from melt water flowing through and beneath the ice.
- Final melting of the dead ice depositing trapped soil over creating hummocks on the Cranbrook hill slope.
- The receding melt water and season precipitation since the last glaciation created dendritic drainages with alluvial fan deposits at the toe of the hill.

Through our Interpretation of the investigation data, public lidar data and GSoC Map 1288A we have created a surficial geology map of area (Figure 1.)

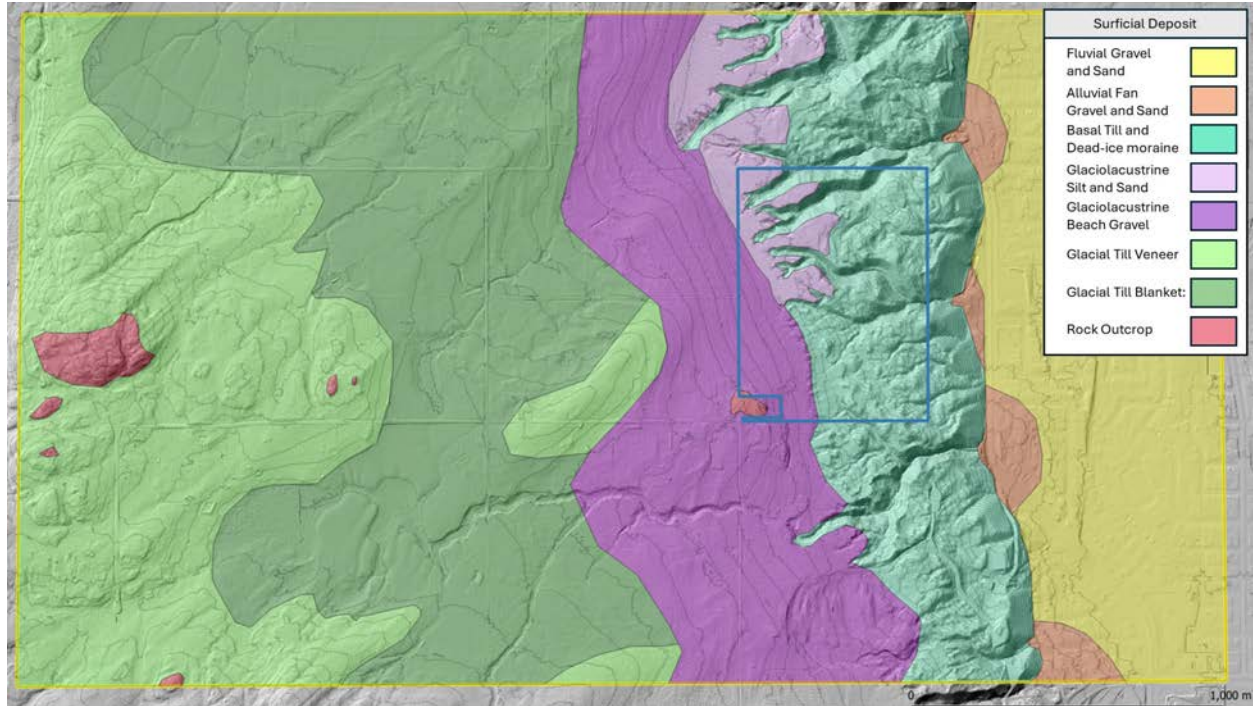


Figure 1. Surface geology mapping shown on a hillshade map created from 2019 LidarBC data.

3.3 Site Investigation

We carried out a test pit investigation for the subject property on May 12, 2023, and May 16, 2024, in the location shown in Figure 2. The test pits were excavated with excavator provided by The Client under the direction of our field personnel. We observed and recorded subsurface conditions at each location as the test pits were advanced. Soil samples were collected from excavated soil at select depths. The samples were submitted to our laboratory for soil index tests. Following our review and sample collection the test pits were backfilled with the excavated soil.

We classified the soil conditions in accordance with the Modified Unified Soil Classification System (MUSCS). Soil index tests were carried out select samples to determine soil properties and to confirm our field observations. The observed soil and groundwater conditions, sampling depths, field measurements and index test results are detailed in the test pit logs in **Appendix A**. Detailed laboratory reports for the soil index tests are in **Appendix B**.

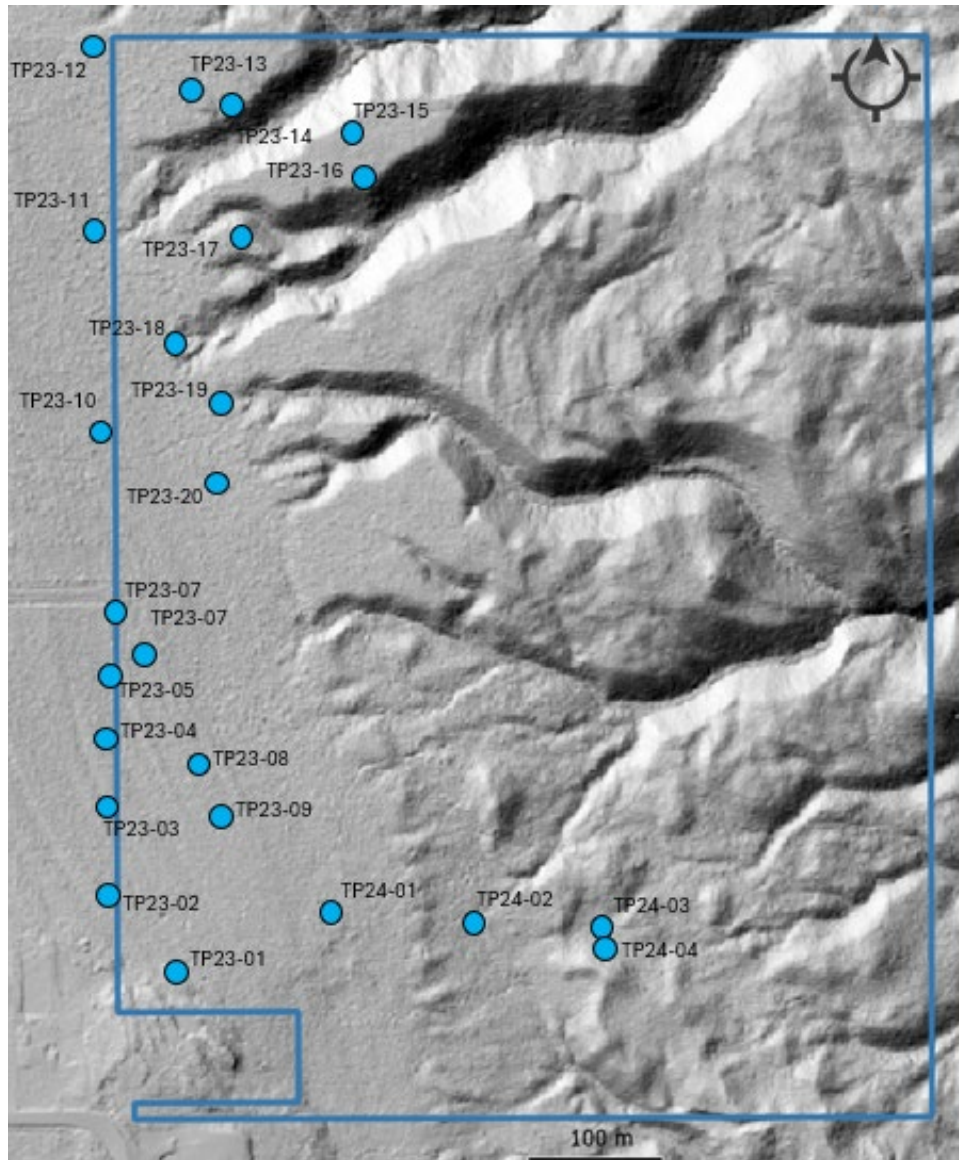


Figure 2. Subject property and test pit locations shown on a hillshade map created from 2019 LidarBC data

3.4 Subsurface Conditions

Subsurface soil conditions on the property are complex due to the deposition and erosional events described in Section 3.2 that created the landform. Generally, we observed the following soil units:

- Loose gravel and sand with trace to some silt and clay in TP23-02 to TP23-09.
- Very stiff Silt with varying sand concentration from 20 to 50% sand, with trace clay and with low to no plasticity.
- Glacial till consisting of gravel and sand in a matrix of silt with trace clay.

The soil units are deposited over bedrock. The thickness of the surficial soil deposits increased from south to north. Seepage was observed at the interfaces between the surficial soil and the till and/or bedrock layers. Some perched groundwater was observed over the bedrock interface in our 2023 test pits. We expect the observed groundwater is from water infiltrating the ground further uphill from seasonal precipitation and/or the spring melt

3.5 Significant Slopes

Slopes at a gradient greater than 20% are considered significant slopes what could pose a landslide risk. Figure 3 details the slope gradients for the slope features on and in the vicinity of the property. These slopes can be separated into the types:

- The global slope feature.
- The cut slope near the toe of Cranbrook Hill created by the historical meltwater channel.
- The dendritic drainage channel cut slopes.

We reviewed slopes on the site through lidar mapping and site reconnaissance. No signs of deep-seated movement were observed. Some surficial sloughing is present on the drainage cut slopes.

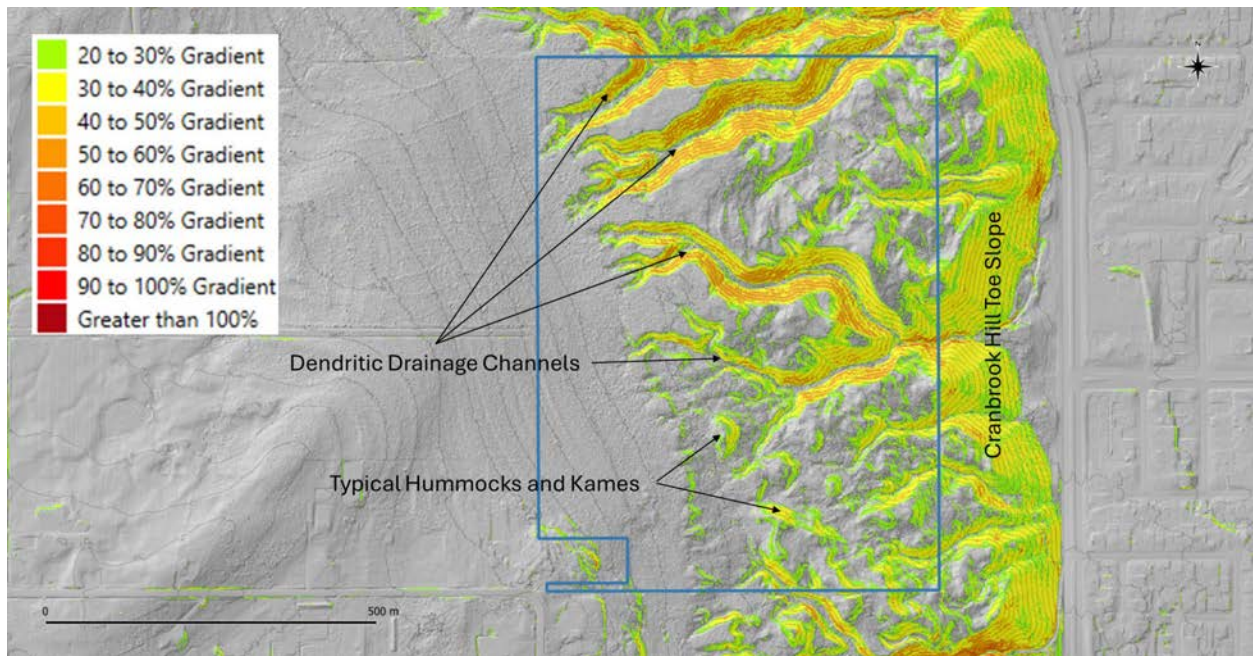


Figure 3. Slope gradients and features shown on a hillshade map created from 2019 LidarBC data.

4. Discussion and Recommendations

Subsurface conditions at the site are suitable for the proposed development with the following considerations:

- The anticipated natural soil conditions in the development area at the anticipated foundation and infrastructure depths consist of well consolidated silt and sand or glacial till, or bedrock.
- The natural soil has moderate to low permeability and are susceptible to frost.
- Development setbacks are required to locate the proposed development elements a safe distance from significant slopes.
- The natural soil found at the site is suitable for common fill and subgrade fill.
- Disturbed/loose soil and undocumented fill are not suitable for support of building foundations, buried services, or roads. Loose natural soil may be encountered in the foundation areas. It will have to be compacted or remediated with Structural Fill.
- The natural soil will provide adequate support for conventional shallow foundations.
- Foundations should bear on competent glacial till, bedrock, or Structural Fill.
- Perimeter foundation drainage systems are required for basements and crawl spaces.

- The pavement structure should be constructed over an adequately prepared subgrade consisting of bedrock or competent natural soil.
- Sidewalls of excavation in the natural gravel and sand may be prone to ravelling and sloughing thus require shallower safe excavation slope angles.

4.1 Anticipated Subsurface Conditions

Subsurface conditions on the property consist of gravel and sand or sand and silt over top of glacial till and/or bedrock. Considerations for development within these subsurface conditions are as follows:

- The natural soil and bedrock will provide good support for roads, foundations and other structural elements.
- Some of the insitu natural soil is too loose for support of roads and structural elements.
- The natural soil types have low to moderate permeability.
- The natural soil types are frost susceptible.
- The natural soil found at the site is suitable for common fill and subgrade fill.

4.2 Radon Gas

Buildings in the Prince George area have a moderate risk of exceeding radon related radiation concentrations of the recommended 200 Bq/m³ (6% to 30% of households exceed 200 Bq/m³). Radon Gas concentrations are typically highest in structures built over permeable soil such as the anticipated conditions for the subject property. We recommend installing a radon gas collection system for the houses and carrying out testing to determine whether an active or passive exhaust system is required to expel the collected gas.

4.3 Landslide Hazard Assessment

We referred to the *Professional Practice Guidelines: Natural Hazards, Landslide Assessment in British Columbia (Version 4.1, Published March 1, 2023)* published by the Engineers and Geoscientists of British Columbia (The Guidelines) for technical guidance on assessing and evaluating the landslide risk on the property. We assessed the three slope types identified in Section 3.5. These slopes could have the potential for slumps and spreads landslide types and could pose a low to moderate risk to the development. Based on the risk associated with these hazards, and the nature of the development we determined this risk assessment falls under Class 1 as detailed in *Appendix B: Landslide Assessment – Determining the Level of Effort* of the Guidelines.

The slopes on and in the vicinity of the property are generally stable in their current condition. Subsurface conditions in the section of Cranbrook Hill that slope that encompasses the subject property consist of bedrock with a veneer or blanket of surficial soil; therefore, the global landslide risk is very low. Considering the proposed development and the anticipated subsurface conditions there is potential for localized landslides on the following slope features (refer to Figure 3):

1. The dendritic drainage cut slopes
2. The steeper slope sections near the toe of Cranbrook Hill and East of the property boundary.
3. The Hummocks and Kames (mounds) created from the dead ice soil deposits.

We evaluated and analysed some of these features to determine development restrictions and provide recommendations to safely design and construct the proposed residential development.

4.3.1 Dendritic Drainage Cut Slopes and Cranbrook Hill Toe

Based on our understanding of the development plans and the study type recommendations in Section 3.2 of the EGBC Guidelines, we determined stability/deformation analyses as an appropriate approach for assessing the hazard related to the dendritic drainage cut slopes the slopes near the Cranbrook Hill toe (Items 1 and 2 from Section 4.3). This approach involves using limit equilibrium stability analyses to estimate the Factor of Safety (FoS) for various scenarios where the inputs include slope profiles, stratigraphy, estimated soil parameters, groundwater conditions, and external loads. To assess the risk associated with development activities in relation to the slope, the FoS resulting from each analysis scenario was compared to acceptable FoS risk tolerance criteria detailed in Table 1.

We carried out a slope stabilities analyses, using Geo5 Slope Stability Software, on several scenarios for the slope profiles within the dendritic drainage channels. The slope profiles used in our analyses were determined from the site development plans and the LiDAR data from LidarBC and PGMMap. We estimated the subsurface stratigraphy from the boreholes conditions and applied conservative soil properties based on the observations and field test data.

We analysed the following scenarios:

- The predevelopment site (current) conditions.
- The site excavation and proposed building development.
- Reducing the soil properties and simulating groundwater conditions (Sensitivity Analysis).

Table 1. Slope Stability FoS Criteria and Descriptions

FOS	Risk Tolerance Criteria
1.0	Tipping point, landslide is likely below this value.
1.5	SoilTech recommended risk limit for Safe Building Zones
1.3	SoilTech recommended risk limit for sensitivity analyses of Safe Development Zones
1.2	SoilTech recommended risk limit for seismic loading

The FoS values resulting from each analysis scenario were compared to the FoS acceptance criteria outlined in Table 1. The results of our analyses indicate our recommended FoS criteria can be met by implementing the development restrictions and recommendations provided in the Section 4.4. Our sensitivity analyses resulted in FoS greater or equal than 1.3. In these scenarios.

4.3.2 Hummocks and Kames

Due to the nature of their formation the hummocks and kames are isolated landforms deposited over the underlying global stratigraphy. Their formation process also created variable soil composition. Due to their isolated nature, they only pose a risk to development for buildings and infrastructure built on or below them.

4.3.3 Climate Change Impact

Severe precipitation and forest fires are climate change related events that could affect the landslide potential of slopes on the property. These types of events can affect slope stability and when coupled together can have even greater effect. Vegetation on steep slopes draw water, help maintain surficial stability and reduce erosion. Drought contributes to the likelihood of forest fires. Drought will also lead to desiccation of soil surface in some of the soil types present in the area with allow water infiltration. A severe rain event after forest fire and drought can cause increased erosion, landslip, and surficial soil transport and deposition.

As core of the hill is glacial till over bedrock, we expect climate change related events will not increase the likelihood of deep-seated slope stability failures. However, they could cause surficial land movement such as small sloughs and debris flows. These will occur along and in the path of the erosion water. With the restrictions and recommendations applied we expect there be low chance of the development zones being detrimentally affected by such erosion events. If significant erosion was to take place at the toe of dendritic drainage slopes there is a sufficient factor of safety incorporated into our recommendations to allow for some loss of soil at the toes. If such events occur the slopes should be re evaluated as some remediation work may be required.

4.4 Development Restrictions

To define safe development areas, we recommend implementing the following:

1. Establish a Safe Building Setback from the crest of the dendritic drainage slopes by projecting a 2.8 Horizontal to 1 Vertical (2.8H:1V) from the toe of the slope. A conceptual setback is shown in Figure 4.
2. Establish a Safe Building Setback of 10 m from the crest of the slope for the portion of the property south of the dendritic drainage channels as shown in Figure 4.
3. Implement a do not disturb area (City of Prince George Greenbelt (AG Zone) over and slope areas below the magenta line shown in Figure 4. A detailed description to outline the AG Zone is included in Appendix C.

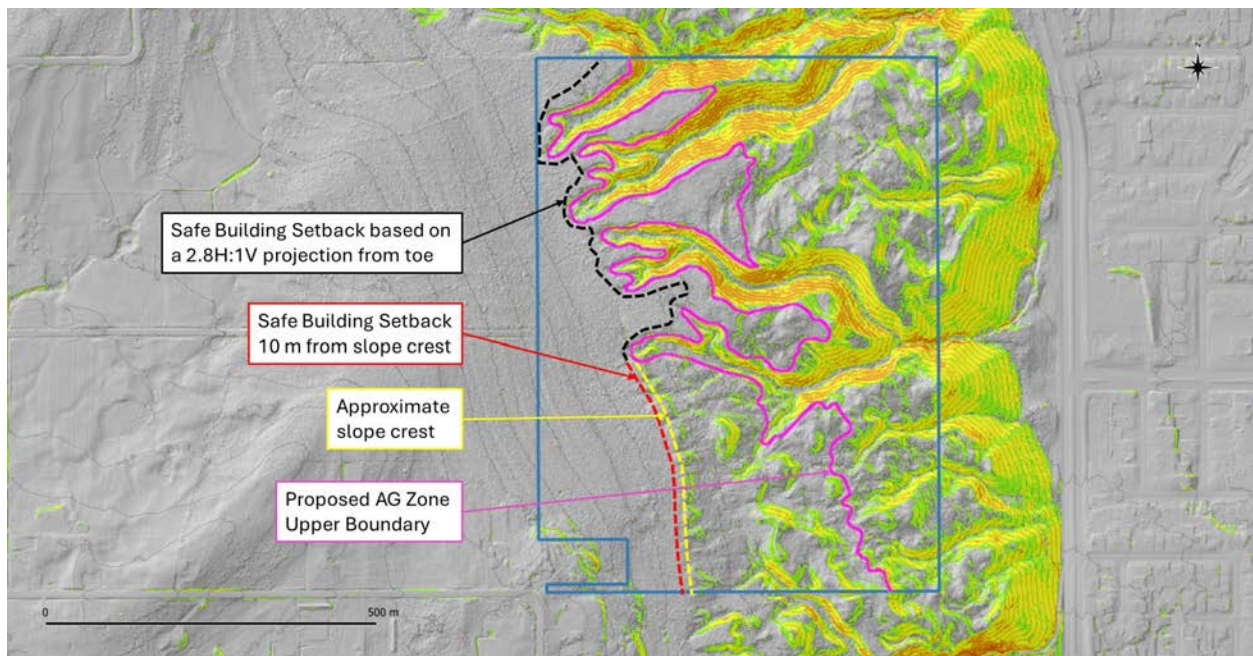


Figure 4. Conceptual development restrictions shown on a hillshade map created from 2019 LidarBC data

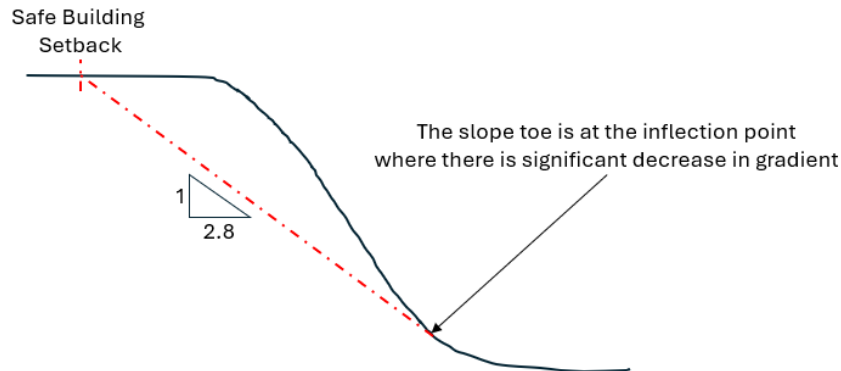


Figure 5. Typical detail for determining the location of safe building setbacks

4.5 General Site Preparation

Topsoil, undocumented fill, disturbed soils, soft/wet fine-grained soil, organic soil, and deleterious materials (wood, and construction debris, etc.) should be removed below roads, drive aisles, parking areas, sidewalks, building areas etc. and any other areas sensitive to settlement. Areas below buildings and other structural elements should be prepared as described in Section 4.6. Prepare road subgrades and pavement structures as detailed in Section 4.11. General site grading should include considerations for drainage and grading as discussed in Sections 4.9 and 4.11. To achieve the desired site grades and elevations, areas may have to be raised with common, subgrade or Structural Fill.

Common fill can be used in landscaped areas. The native soil at the site may be suitable for common fill if adequately moisture conditioned for compaction. Alternatively, approved imported soil can be used. To minimize settlement common and erosion fill should be placed in uniform layers and compacted to 95% SPD.

4.6 Building Site Preparation

Existing fill (undocumented), soft wet fine-grained soil and deleterious or organic soil are not considered suitable for the support of load bearing structures and should be removed from below building foundations and grade-supported floor slabs. Use an excavator equipped with a clean up bucket to minimize the disturbance to the bearing soil surface. If the soil at the base of the excavation is disturbed or loose, it may need to be compacted prior to the installation of the formwork or Structural Fill. If the resulting excavation is below the design elevation, raise the grade to the desired elevation with Structural Fill as detailed in Section 4.6.1. The prepared foundation grade bearing surfaces should consist of undisturbed natural soil or compacted Structural Fill placed over natural soil.

4.6.1 Structural Fill

Structural Fill consists of well compacted granular material meeting specifications for Select Granular Subbase (SGSB) or Crushed Base Course (CBC) as detailed in Section 4.11.1 or other material approved by the engineer of record. Structural Fill should:

- Be installed over competent natural soil.
- Extend laterally from the sides of the footings by a horizontal distance equal to the depth of fill below the footings to allow for a 45° (1 horizontal to 1 vertical, 1H:1V) distribution of stress through the compacted fill or until competent natural soil is encountered in the sidewalls of the excavation (Figure 6).

- Place the fill in maximum 300 mm thick layers, or less (dependent on the compaction equipment utilized).
- Be compacted to 100% SPD.

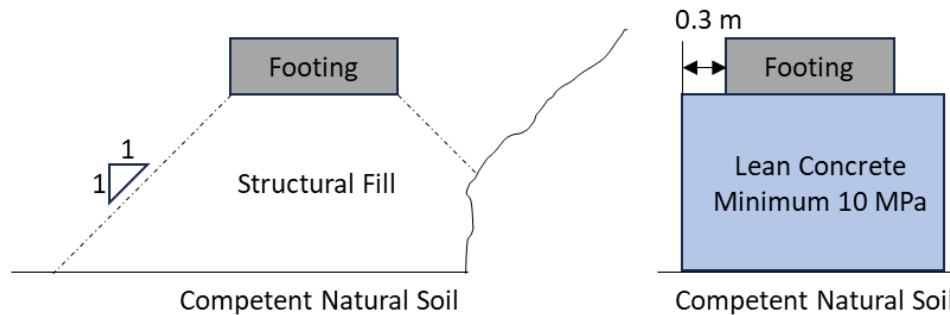


Figure 6. Structural Fill and lean concrete installation detail

Alternatively, a lean concrete mix with a minimum compressive strength of 10 MPa can be used in place of Structural Fill. The concrete should extend a minimum of 0.3 m horizontal distance where it bears on the natural soil from the edge of the footing or structure element as shown in Figure 6. It can be installed using formwork or pouring against the soil sidewalls of the excavation.

4.7 Spread Footing Foundations

Conventional spread footings area suitable for the proposed building development. Building foundations can bear on undisturbed Sand and Silt, Glacial Till, bedrock, or Structural Fill placed over natural soil or bedrock. The bearing surface for foundations should be prepared as detailed in Section 4.6. Design footings bearing using the factored bearing capacity values listed in Table 2.

Table 2. Factored Bearing Resistance Values based on Bearing Surface

Bearing Surface	Ultimate Limit State (ULS) ¹	Serviceability Limit State (SLS) ²
Natural Glacial Till or Structural Fill	225	150

¹The ultimate resistance factor values were calculated using a geotechnical resistance factor of 0.5

²For settlements less than 25 mm

4.8 Grade Supported Slabs

Prepare areas below structural and floor slabs as described in Section 4.6. A 100 mm thick level course of CBC should be implemented as a capillary break and to help achieve a flat level grade. If radon protection measures are required below the floor slabs the radon rock can replace the CBC layer. Radon protection systems should be installed as recommended in the current BC Building Code.

4.9 Foundation Drainage and Backfill

The natural soil stratum has moderate to low permeability and any water that infiltrates the foundation will not dissipate well. Perimeter foundation drain systems are required for basements and crawl spaces.

The type of backfill and level of compaction will depend on the intended use of the area next to the foundation. Building foundations can be backfilled following the recommendations for general site preparation in Section 4.5. To minimize the infiltration of water into the foundation backfill and the bearing soil below:

- Foundation backfill should be compacted to at least 95% SPD
- The surrounding exterior grade sloped away from the foundation at a minimum 2%
- The final surface should be hard-surfaced or landscape to discourage the infiltration of water

4.10 Foundation Frost Protection

Frost penetration depth is based on the air-freezing index and mean annual temperature for the site. For the Prince George, BC area the air freezing index is 928 Degree-Days °C, the mean annual temperature is 3.4 °C and the estimated maximum frost penetration depth is 2.4 m. The natural soil conditions have moderate potential for frost heave and minimum depth of soil cover is detailed below in Table 3.

Table 3. Minimum Soil Cover for Frost Protection Based on Heating and Insulation Scenario

Footing Type and Heating Conditions	Minimum Soil Cover
Exterior footings for a permanently heated (above 15 °C) structure with no below slab insulation and/or foundation wall insulation less than R 25	1.2 m
Exterior footings for a permanently heated structure with interior below slab insulation and/or foundation wall insulation greater than R 25	2.4 m or determine by analysis
Exterior and interior footings for a mildly heated building (0 to 15 °C)	2.4 m or determine by analysis
Exterior and interior footings for an unheated structure or an unheated portion of a structure	2.4 m

4.11 Pavement Structures

The site-specific traffic volumes are unknown. The access roads and other vehicle trafficked areas area intended to support loads from passenger vehicles and infrequent heavy truck traffic. We evaluated the structure using the design methods and guidelines from the AASHTO 1993 Pavement Design Method and Ministry of Transportation and Infrastructure (MoTI) design guidelines Technical Circular T-01/15. The recommended pavement structures for the road and driveways, based on the subgrade type, are detailed in Table 4.

Table 4. Recommended Pavement Structures

Pavement Component	Subgrade Type	
	Soil	Bedrock
Mix C Hot Mix Asphalt	65 mm	65 mm
Crushed Base Coarse (CBC)	200 mm	200 mm
Select Granular Subbase (SGSB)	600 mm	250 mm
Total	865 mm	515 mm

The pavement structure's design is based on it being supported by an adequately prepared subgrade as described in Section 4.11.3. Use aggregates meeting the requirements detailed in Section 4.11.1 and asphalt meeting the specifications detailed in the current MoTI Standard Specifications for Highway Construction. We recommend extending the pavement structures below any curbs and sidewalks.

4.11.1 Aggregates

Table 5. Aggregate Gradation Specifications

Particle Size (mm)	Percent Passing	
	CBC ¹	SGSB
75	–	95 – 100
37.5	–	–
25	100	–
19	80 – 100	35 – 100
9.5	50 – 85	–
4.75	35 – 70	15 – 60
2.36	25 – 50	–
1.18	15 – 35	–
0.300	5 – 20	3 – 15
0.075	0 – 5	0 – 5

¹ CBC to have minimum 60% one-face fracture by mass

Aggregates should withstand the deleterious effects of exposure to freeze-thaw, water, and general construction such as placing, grading, packing etc. Use aggregates that meet the Aggregate Quality specifications detailed in Section 202.04 of the current MoTI Standard Specifications for Highway Construction. For CBC use a crushed material with a minimum 60% one-face fracture by mass on particles larger than 4.75 mm. The SGSB can be a processed or pit run gravel. Gradation specifications for the aggregates can be found in Table 5.

4.11.2 Pavement Structure Construction

Apply the following recommendations and specifications to the construction of the pavement structures:

- Install the pavement structure over the prepared subgrade.
- Place SGSB and CBC in a maximum 300 mm thick layers and compact to 100% SPD. Bring the soil to near optimum moisture content for compaction where required.
- Proof-roll the CBC layer and repair any soft areas before placing any concrete or asphalt.
- Place the asphalt surface as per the supplier's recommended procedures and compact it to a minimum average degree of compaction of 98% for roads when comparing the in-situ density to the measured 75 Blow Marshall briquette density for the mix with no single measured location less than 95%.

4.11.3 Subgrade Preparation

The prepared subgrade should consist of competent natural soil or adequately compacted fill of a similar consistency. The natural Silty Gravel found at the site is suitable for subgrade fill. We recommend the following to prepare the subgrade:

- Remove any undocumented fill, organic soil, deleterious materials, soft wet fine-grained soil, and disturbed soil from below the proposed paved area. Extend the excavation beyond the edges of the pavement equal to the depth of the fill required below the pavement.
- Raise the grade of low areas to the design subgrade elevation with compacted soil that has similar properties and gradations to the surrounding subgrade soils.
- Place the fill material in uniform layers not exceeding 200 mm for fine-grained soil and 300 mm for granular soil.

- Compact the initial layers to 97% SPD and the final 300 mm of subgrade fill to 100% SPD. The soil will need to be moisture conditioned (dried/wetted) to near the optimum moisture content for compaction where required.
- Crown the subgrade at a minimum 2% slope away from the road centerline.
- Proof-roll the subgrade and repair any soft areas prior to installing the pavement structure.

4.12 Temporary Excavations

We recommend using slopes of 1 Horizontal to 1 Vertical (1H:1V) or shallower for excavations in the natural soil or adequately compacted fill. Measures should be taken to prevent erosion of side excavation slopes. Groundwater or surface water encountered during construction should be directed away from excavations. Prevent water ponding in excavations. Flatter excavation slopes may be required if very loose sandy, soft soil, fill, seepage, etc. is encountered in excavations or if unfavourable weather conditions are encountered. Consult a qualified engineer if such conditions are encountered or if excavation deeper than 5 m is required.

Care should be taken when excavating near all types of existing structures and foundations. Maintain a 2H:1V slope from the base of the structure to the base of excavations. If excavations are required to be closer to an existing structure a qualified engineer should be consulted as temporary construction support may be required.

5. Review and Quality Assurance

This assessment and our recommendations are based on preliminary site plans, conversations with the Client, and a test pit investigation. The final design drawings should be reviewed by SoilTech to confirm the intentions of the geotechnical design recommendations included in this report have been incorporated and are appropriate for the development. Subsurface conditions should be confirmed during construction. If the conditions (i.e., soil, groundwater, etc.) encountered during construction differ from those in our assessment they should be reviewed as alternate or additional recommendations may be required.

The foundation design and bearing surfaces during construction should be reviewed by SoilTech prior to installing foundation components to verify conditions and that they are adequate to support the proposed foundation. Testing should be completed on the Structural Fill to confirm it meets the required gradation and adequate compaction has been achieved. To issue applicable Building Code Schedules, the excavation for and installation of Structural Fill below foundations should be reviewed by SoilTech.

During the subgrade preparation and construction of the pavement structure have an experienced geotechnical engineer or technician review excavations, fill materials, fill placement and compaction, proof rolls and the installation of any geotextile and geogrid products. Depending on weather and site conditions, materials may need to be placed in smaller lift thicknesses, dried, or have water added to achieve recommended degree of compaction. Testing should be completed on pipe bedding, subgrade fill, pavement structure layers and the materials used to confirm specifications are met.

6. Limitations

This assessment was limited to the references used in our desktop study and the scope of our site investigation. The discussion and recommendations provided are based on the necessary assumption subsurface conditions across the site are consistent with our findings. If conditions encountered at the site are inconsistent with the findings described above, they should be reviewed by SoilTech or another qualified professional as alternate recommendations or design parameters may be required.

7. Closure

The findings of our landslide hazard assessment indicate, if our restrictions and recommendations are followed, the property can be safely developed for the intended residential use. This assessment has been completed by a qualified professional registered with the Engineers and Geoscientists of British Columbia. From our understanding of the EGBC Guidelines this assessment was carried out with the appropriate level of effort and study type for the nature of the proposed development. A completed Landslide Assessment Assurance Statement from the EGBC Guidelines is attached in **Appendix D**.

The information discussed in this report is based on SoilTech’s interpretation and understanding of current site conditions and the referenced documents. This report has been completed for the exclusive use of the recipient and their agents. We take not responsibly for any damages suffered from any use or reliance of information contained within this report by third parties or for use other than the intended purpose.

If there are any questions or if additional information is required, please contact the undersigned.

Sincerely,



Mike Warner, P. Geo.

Reviewed by,

Permit to Practice
No. 1001832



October 18, 2024

Hans Jorgensen, P. Eng.



Appendix A:

Investigation Logs

Modified Unified Classification System for Soils						
Major Division		Group		Soil Description	Classification Criteria	
Coarse Grained Soils more than 50% larger than 75 µm dual symbols used for soils with 5 to 12% fines	Gravels	Clean Gravels < 5% fines	GW		Well graded gravels and sandy gravels with trace or no fines	$C_u = D_{60}/D_{10} > 4$ $C_c = (D_{30})^2/D_{10}D_{60} = 1 \text{ to } 3$
			GP		Poorly graded gravels and sandy gravels with trace or no fines	Not meeting GW requirements
		Dirty Gravels > 12% fines	GM		Silty gravels and silty sandy gravels	Plasticity below A-Line or $I_p < 4$
			GC		Clayey gravels and clayey sandy gravels	Plasticity below A-Line or $I_p < 7$
	Sands	Clean Sands < 5% fines	SW		Well graded sands and gravelly sands with trace to no fines	$C_u = D_{60}/D_{10} > 4$ $C_c = (D_{30})^2/D_{10}D_{60} = 1 \text{ to } 3$
			SP		Poorly graded sands and gravelly sands with trace to no fines	Not meeting SW requirements
		Dirty Sands > 12% fines	SM		Silty sands and sand/silt mixtures	Plasticity below A-Line or $I_p < 4$
			SC		Clayey sands and sand/clay mixtures	Plasticity below A-Line or $I_p < 7$
Fine Grained Soils more than 50% smaller than 75 µm	Silts	$W_L < 50\%$	ML		Inorganic silts and sandy silts with slight plasticity	Based on Placidity Chart (see below)
		$W_L > 50\%$	MH		Inorganic silts with high plasticity	
	Clays	$W_L < 30\%$	CL		Inorganic clay and silty clays with low plasticity	
		$30\% < W_L < 50\%$	CI		Inorganic clay and silty clays with intermediate plasticity	
		$W_L > 30\%$	CH		Inorganic clay and silty clays with high plasticity	
	Organic Silts and Clays	$W_L < 50\%$	OL		Organic silts and silty clays with low plasticity	
		$W_L > 50\%$	OH		Organic silts and silty clays with high plasticity	
	Highly Organic	PT		Peat and other highly organic soils		

Soil Components				Relative Density and Consistency			
Fraction	Size	Weight Percentage	Description	Cohesionless		Cohesive	
				Relative Density	SPT Value (N)	Consistency	Undrained Shear Strength (kPa)
Gravel		35 - 50	and	Very Loose	0 - 4	Very Soft	0 - 10
Coarse	75 mm to 19 mm			Loose	4 - 10	Soft	10 - 25
Fine	19 mm to 4.75 mm			Compact	10 - 30	Firm	25 - 50
Sand		20 - 35	y/ey	Dense	30 - 50	Stiff	50 - 100
Coarse	4.75 mm to 2 mm			Very Dense	> 50	Very Stiff	100 - 200
Medium	2 mm to 425 µm					Hard	> 200
Fine	425 µm to 75 µm	10 - 20	some				
Silt or Clay	< 75 µm						
Cobbles	200 mm to 75 mm	1 - 10	trace				
Boulders	> 200 mm						
Relative Moisture				Plasticity Chart			
Coarse Grained							
Dry	Non-cohesive and free running						
Moist	Darker colour and sticks together						
Wet	Darker colour, sticks together and free water forms						
Fine Grained							
Moist, dry of plastic limit	hard, friable and powdery						
Moist, near plastic limit	Can be moulded						
Moist, wet of plastic limit	Usually weak and free water forms						
Wet, near liquid limit							
Wet of plastic limit							



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: frost disturbed silt and sand, organics, roots, some angular bedrock fragments.	Bulk				8			
		Bedrock								

Bedrock encountered at 0.3 m
 No groundwater encountered
 Test pit backfilled with excavated soil



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: Organics, roots, frost disturbed soil								
		GM: gravel and sand, some fines, loose, damp, greenish brown								
1		- Gravel 41.4%, Sand 50.6%, Silt and Clay 8.0%	Bulk				8			
2		- minor sloughing at 2.2 m - minor seepage at 2.4 m	Bulk				11			
		- trace pieces of angular bedrock, increasing with proximity to bedrock	Bulk				11			
		Bedrock								

Bedrock encountered at 2.8 m
 Minor seepage at 2.4 m
 Test pit backfilled with excavated material.



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: organics, roots, and frost disturbed soil								
0.5		GM: gravel and sand, some fines, loose, damp, greenish brown								
0.9		- groundwater stabilized at 0.9 m after 10 minutes								
1.0			Bulk				12			
1.1			Bulk				23			
1.5		Bedrock								

Bedrock encountered at 1.5 m
 Groundwater stabilized at 0.9 m
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: Organics, roots, frost disturbed soil								
		GM: gravel and sand, some fines, loose, damp, greenish brown								
1		- groundwater stabilized at 1.1 m after 10 minutes	Bulk				9			
			Bulk				23			
2		Bedrock								

Bedrock encountered at 1.9 m
 Groundwater stabilized at 1.1 m
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: Organics, roots, frost disturbed soil								
0 - 1		GM: Gravel and sand, trace fines, loose, damp, greenish brown - Gravel 56.0%, Sand 38.9%, Silt and Clay 5.1% - minor seepage at till interface	Bulk				5			
1 - 2		GP: Silt, and sand, some gravel, dense, damp, brown (glacial till) - Gravel 10.5%, Sand 34.0%, Silt 38.7% and Clay 16.9%	Bulk				12			
2			Bulk				9	31	67	31
		Bedrock								

Bedrock encountered at 2.5 m
 Minor seepage at 1.6 m
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: Organics, roots, frost disturbed soil								
		GM: gravel and sand, some fines, loose, damp, greenish brown								
		- minor seepage at till interface	Bulk				8			
1		GP: Gravel and sand, silty, dense, damp, brown (glacial till) - bedrock at 1.0 m.	Bulk				11			

End of test pit at 1.0 m
 Minor seepage at 0.8 m
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
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Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: Organics, roots, frost disturbed soil.								
0.5		GM: gravel and sand, some fines, loose, damp, greenish brown.	Bulk				5			
1.0		GM: Silt, clay, and sand, trace gravel, dense, damp, brown (glacial till).	Bulk				10			
1.5		- Gravel 5.9%, Sand 37.3%, Silt 36.8%, and Clay 20.0% - Fines portion is non-plastic	Bulk				9	0	27	27
2.0			Bulk				7			
2.6		Bedrock								

End of test pit at 2.6 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
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Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: Organics, roots, frost disturbed soil.								
		GM: gravel and sand, some fines, loose, damp, greenish brown.	Bulk				7			
1			Bulk				9			
		- groundwater stabilizes at 1.6 m	Bulk				10			
		Bedrock								

Bedrock encountered at 1.7 m
 Groundwater stabilized at 1.6 m
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		Fill: Organics, roots, frost disturbed soil								
		GM: gravel and sand, some fines, loose, damp, greenish brown								
1				Bulk				7		
2		- minor seepage at 1.9 m - Gravel 41.3%, Sand 46.0%, Silt and Clay 12.7%	Bulk Bulk				18 8			
		Bedrock								

Bedrock encountered at 2.2
 Minor seepage at 1.9 m
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		OM: Organic soil, disturbed, fequent roots, damp, dark brown/black								
		GM: gravel, sandy, some silt and clay, loose, damp, brown	Bulk				4.4			
1		MLG: Gravel and sand, silty, trace clay, trace cobbles, dense, damp, brown (glacial till)	Bulk				6.5			
			Bulk				8.5			

End of test pit at 1.8 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		OM: Organic soil, disturbed, fequent roots, damp, dark brown/black GM: gravel and sand, some silt and clay, loose to compact, damp,brown								
1			Bulk				7.4			

End of test pit at 1.8 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		OM: Organic soil, disturbed, frequent roots, damp, dark brown/black								
		GM: gravel, sandy, some silt and clay, loose, damp, brown								
1		MS: Silt, some sand, some clay, trace gravel, very stiff, low to no plasticity, damp, brown, layered	Bulk				9.1			
2		- Gravel 9.7%, sand 21.9%, Silt and Clay 68.4%	Bulk				15.6			

End of test pit at 2.0 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		<p>OM: Organic soil, disturbed, fequent roots, damp, dark brown/black</p> <p>MS: Silt and sand, trace clay, stiff, low to no plasticity, damp, brown, weak layering</p>								
1			Bulk				28			
2			Bulk				18.1			

End of test pit at 2.1 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		<p>OM: Organic soil, disturbed, fequent roots, damp, dark brown/black</p> <p>MS: Silt, sandy, trace clay, stiff, low to intermediate plasticity, damp (below plastic limit), brown</p>								
1			Bulk				19	25	32	7
2		- non-plastic below 1.9 m					9.1			
		- Gravel 0%, Sand 33.9%, Silt and Clay, 66.1%					9.6			

End of test pit at 2.7 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		<p>OM: Organic soil, disturbed, fequent roots, damp, dark brown/black</p> <p>MS: Silt and sand, trace clay, very stiff, low to no plasticity, damp (below plastic limit), brown</p>								
1			Bulk				22.5			
2			Bulk				24			
		- trace gravel below 2.3 m	Bulk				24.6			

End of test pit at 2.5 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		<p>OM: Organic soil, disturbed, fequent roots, damp, dark brown/black</p> <p>MS: Silt, sandy, trace clay, very stiff, low to no plasticity, damp (below plastic limit), brown</p>								
1		- some sand below 1.5 m	Bulk				20.6			
2			Bulk				17.8			
			Bulk				14.2			

End of test pit at 2.5 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		<p>OM: Organic soil, disturbed, fequent roots, damp, dark brown/black</p> <p>ML: Silt, trace to some sand, trace clay, stiff, low plasticity, damp (below plastic limit), brown</p>								
1			Bulk				24.5			
2			Bulk			200	35			
3		<p>MS: Silt and sand, trace clay, very stiff, non-plastic, damp, brown - Gravel 0%, Sand 48%, Silt and Clay 52%</p>	Bulk				18			

End of test pit at 3.0 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		<p>OM: Organic soil, disturbed, frequent roots, damp, dark brown/black</p> <p>MS: Silt, and sand, trace clay, stiff, low plasticity, damp (below plastic limit), brown with some mottling</p>								
1			Bulk				21			
2			Bulk				33.5			
		- some gravel below 2.5 m	Bulk				12.6			

End of test pit at 2.7 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		<p>OM: Organic soil, disturbed, fequent roots, damp, dark brown/black</p> <p>MS: Silt and sand, trace clay, stiff, low, damp, brown,layered</p>								
1			Bulk				16.5			
2		-wet of plastic limit	Bulk				32	26	37	11

End of test pit at 2.1 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Development Ltd.
Project Number: 23-H-008
Project: Russman Road Subdivision
Subcontractor: Client
Equip./Method: Hitachi ZX50U

Date Started: May 12, 2023
Date Finished: May 12, 2023
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		OM: Organic soil, disturbed, fequent roots, damp, dark brown/black								
1		GM: gravel, sandy, some silt and clay, trace cobbles, compact, damp, brown	Bulk				10.4			
			Bulk				10			

End of test pit at 1.9 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Developments Ltd.
Project Number: 23-H-008
Project: Russmand Road Subdivision
Subcontractor: Client
Equip./Method: CX145 Excavator

Date Started: May 16, 2024
Date Finished: May 16, 2024
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		OM: Organic matter, leaves, roots, partially decomposed, black								
		MLS: Silt and sand, some gravel, loose, moist, greenish brown (dead-ice moraine) - Gravel 22.6%, Sand 36.9%, Silt 29.5%, Clay 10.9%	Bulk				18.7			
1		BLDR: Phyllite, heavily weathered, minor schistosity, friable, platy, greenish grey								
		MLS: Silt and sand, some gravel, loose, moist, greenish brown (dead-ice moraine)								
2		BDRK: Volcaniclastic, moderately weathered, blocky, angular, green - weathering decreases with depth until refusal								

End of test pit at 2.4 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Developments Ltd.
Project Number: 23-H-008
Project: Russmand Road Subdivision
Subcontractor: Client
Equip./Method: CX145 Excavator

Date Started: May 16, 2024
Date Finished: May 16, 2024
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		OM: Organic matter, leaves, roots, partially decomposed, black								
0.2 - 1.3		SM: Sand and silt, trace to some gravel, trace clay, loose to compact, damp, light greenish brown - Gravel 12%, Sand 39%, Silt and Clay 41.3% - slight seepage at 1.3 m	Bulk				15.9			
1.3 - 2.9		GM: Sand, silty, trace to some gravel, trace clay, very dense, damp, light greenish brown (till) - Gravel 5.5%, Sand 49.1%, Silt 34.5%, Clay 10.8% - refusal at 2.9 m	Bulk				13.1			

End of test pit at 2.9 m
 Slight seepage at 1.3 m
 Test pit backfilled with excavated material



Client: R.G. McLeod Developments Ltd.
Project Number: 23-H-008
Project: Russmand Road Subdivision
Subcontractor: Client
Equip./Method: CX145 Excavator

Date Started: May 16, 2024
Date Finished: May 16, 2024
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		OM: Organic matter, leaves, roots, partially decomposed, black								
0.5		SM: Sand, some silt and clay, loose, moist to wet, brown and orange mottling	Bulk				17.3			
1.0		SM: Sand, silty, some clay, trace gravel, compact, damp, brown and light brown mottling - Gravel 1.2%, Sand 42.6% Silt and Clay 56.2%	Bulk				16.6			
2.0		SM: Sand, trace to some silt, trace clay, compact to dense, damp, light tan, blocky, silt laminations present (~1-3 mm). - Sand 81.9%, Silt 11.2%, Clay, 6.9%	Bulk				28			
3.0										

End of test pit at 3.1 m
 No groundwater encountered
 Test pit backfilled with excavated material



Client: R.G. McLeod Developments Ltd.
Project Number: 23-H-008
Project: Russmand Road Subdivision
Subcontractor: Client
Equip./Method: CX145 Excavator

Date Started: May 16, 2024
Date Finished: May 16, 2024
Logged By: MW
Location: See Figure 1
Elevation: Existing Ground

Depth (m)	Graphic Log	Stratigraphic Description	Sample Type	% Recovery	Blow Counts (N Value)	Pocket Pen (kPa)	Moisture Content (%)	Atterberg Limits		
								Plastic Limit	Liquid Limit	Plasticity Index
0		OM: Organic matter, leaves, roots, partially decomposed, black								
		MLS: Silt and clay, some sand, firm, wet of plastic limit, deep brown								
1		SP: Sand trace silt, compact, dry to damp, tan	Bulk				8.1			

End of test pit at 1.8 m
 No groundwater encountered
 Test pit backfilled with excavated material

Appendix B:

Soil Index Test Reports

Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

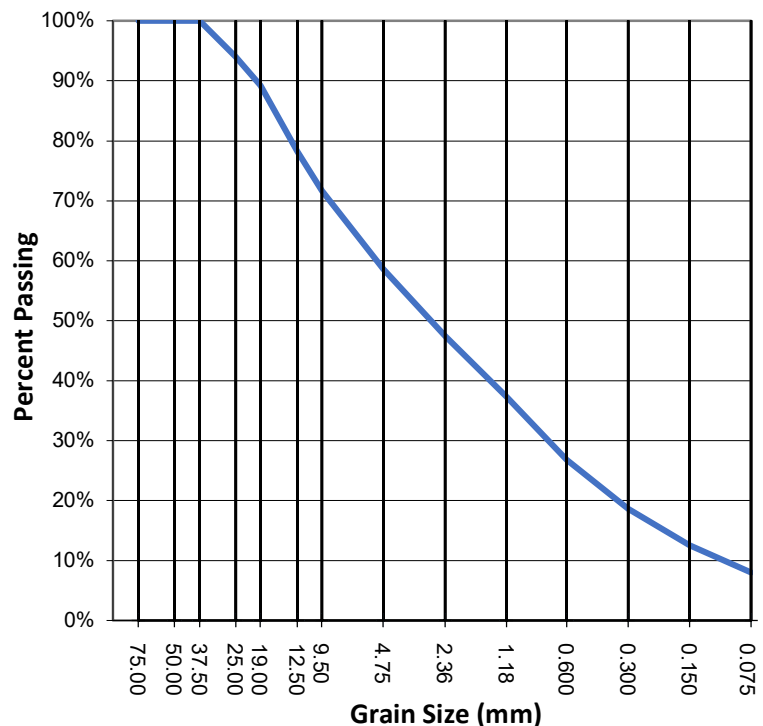
Project No. 23-H-008
Sieve Report No. SI01

Sample Details

Supplier Existing
Source TP23-02
Location 1.2 m
Description Sand and Gravel
Specification

Sampling Date 05-12-2023
Date Received 05-13-2023
Date Tested 04-04-2024
Sampled By MW
Tested By SD

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	94.0%		
19.0	89.2%		
12.5	78.2%		
9.5	71.7%		
4.75	58.6%		
2.36	47.4%		
1.18	37.4%		
0.600	26.8%		
0.300	18.6%		
0.150	12.6%		
0.075	8.0%		



Moisture Content 15.6%

Comments

Refer to to Moisture-Density Report No. X

Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

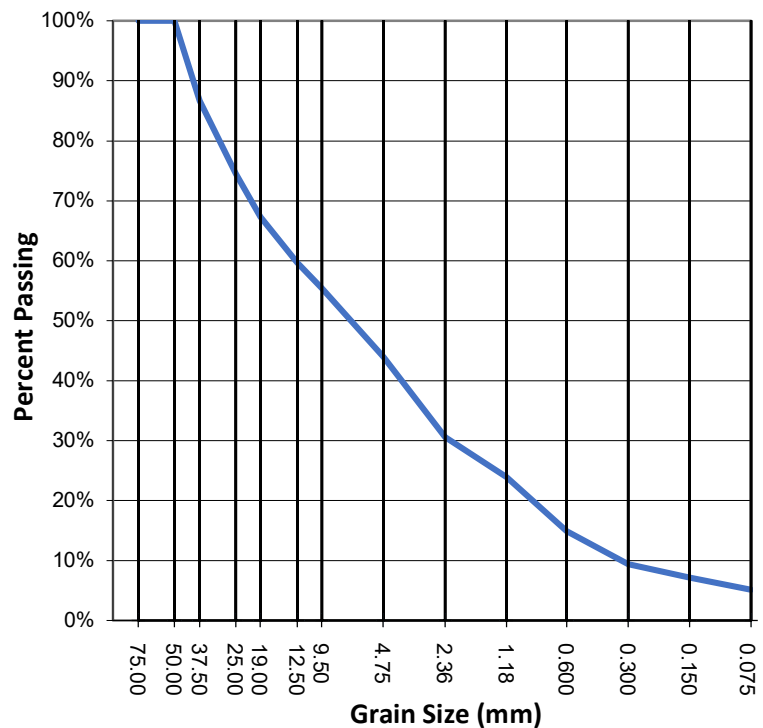
Project No. 23-H-008
Sieve Report No. SI02

Sample Details

Supplier Existing
Source TP23-05
Location 1.3 m
Description Sandy Gravel
Specification

Sampling Date 05-12-2023
Date Received 05-13-2023
Date Tested 04-04-2024
Sampled By MW
Tested By SD

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	86.7%		
25.0	74.5%		
19.0	67.3%		
12.5	59.7%		
9.5	55.4%		
4.75	44.0%		
2.36	30.6%		
1.18	24.0%		
0.600	14.9%		
0.300	9.4%		
0.150	7.2%		
0.075	5.1%		



Moisture Content 4.6%

Comments

Refer to to Moisture-Density Report No. X

Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
Sieve Report No. SI03

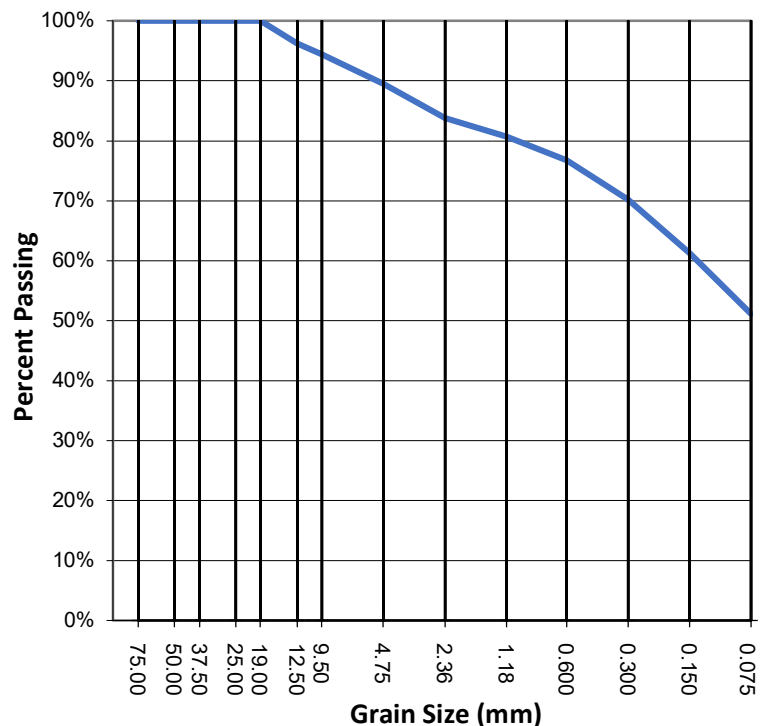
Sample Details

Supplier Existing
Source TP23-05
Location 2.4 m
Description Till
Specification

Sampling Date 05-12-2023
Date Received 05-13-2023
Date Tested 04-04-2024
Sampled By MW
Tested By SD

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	100.0%		
19.0	100.0%		
12.5	96.3%		
9.5	94.4%		
4.75	89.5%		
2.36	83.8%		
1.18	80.7%		
0.600	76.8%		
0.300	70.2%		
0.150	61.3%		
0.075	51.1%		

Moisture Content 23.6%



Comments
Refer to to Moisture-Density Report No. X



Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

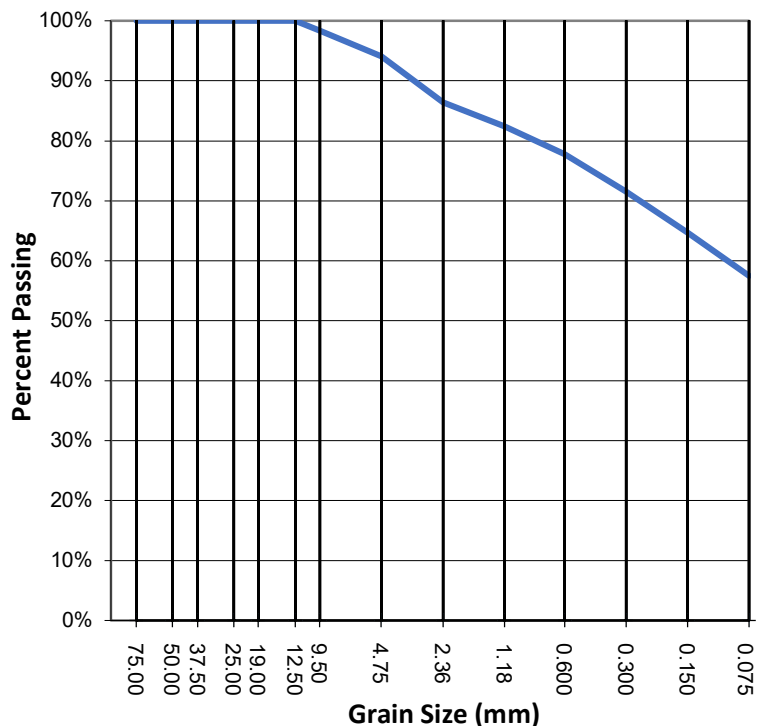
Project No. 23-H-008
Sieve Report No. SI04

Sample Details

Supplier Existing
Source TP23-07
Location 2.2 m
Description Till
Specification

Sampling Date 05-12-2023
Date Received 05-13-2023
Date Tested 04-04-2024
Sampled By MW
Tested By SD

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	100.0%		
19.0	100.0%		
12.5	100.0%		
9.5	98.3%		
4.75	94.1%		
2.36	86.4%		
1.18	82.4%		
0.600	77.8%		
0.300	71.5%		
0.150	64.7%		
0.075	57.5%		



Moisture Content 9.4%

Comments

Refer to to Moisture-Density Report No. X



Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

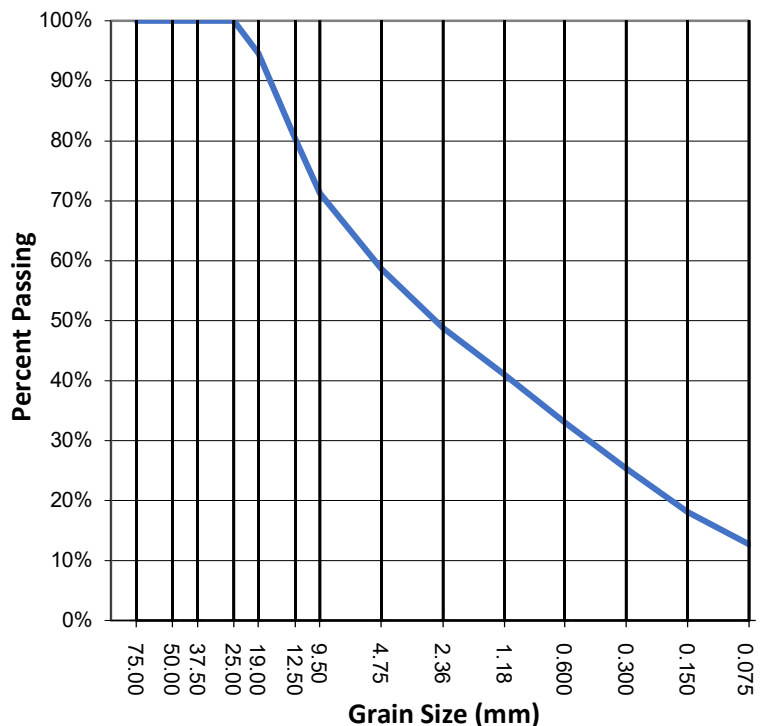
Project No. 23-H-008
Sieve Report No. SI05

Sample Details

Supplier Existing
Source TP23-09
Location 1.9 m
Description Gravel and Sand
Specification

Sampling Date 05-12-2023
Date Received 05-13-2023
Date Tested 04-04-2024
Sampled By MW
Tested By SD

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	100.0%		
19.0	94.6%		
12.5	80.3%		
9.5	71.2%		
4.75	58.7%		
2.36	48.8%		
1.18	41.0%		
0.600	33.1%		
0.300	25.4%		
0.150	18.1%		
0.075	12.7%		



Moisture Content 14.4%

Comments

Refer to to Moisture-Density Report No. X

Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
Sieve Report No. SI06

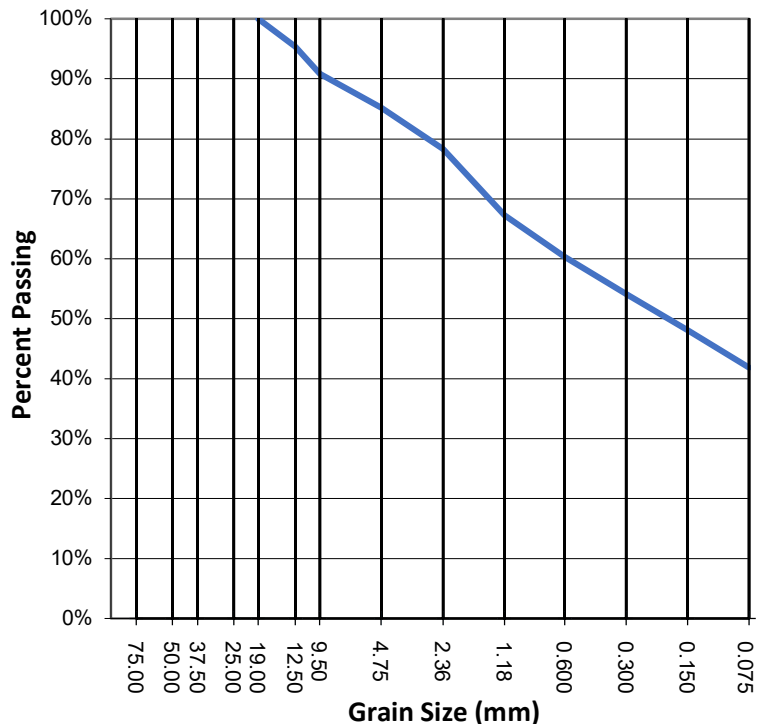
Sample Details

Supplier Existing
Source TP24-01
Location 0.6 m
Description Silty Sand
Specification

Sampling Date May 16, 2024
Date Received May 17, 2024
Date Tested May 22, 2024
Sampled By MW
Tested By PS

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	100.0%		
19.0	100.0%		
12.5	95.4%		
9.5	90.9%		
4.75	85.2%		
2.36	78.3%		
1.18	67.2%		
0.600	60.3%		
0.300	54.1%		
0.150	48.1%		
0.075	41.8%		

Moisture Content 18.7%



Comments

Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

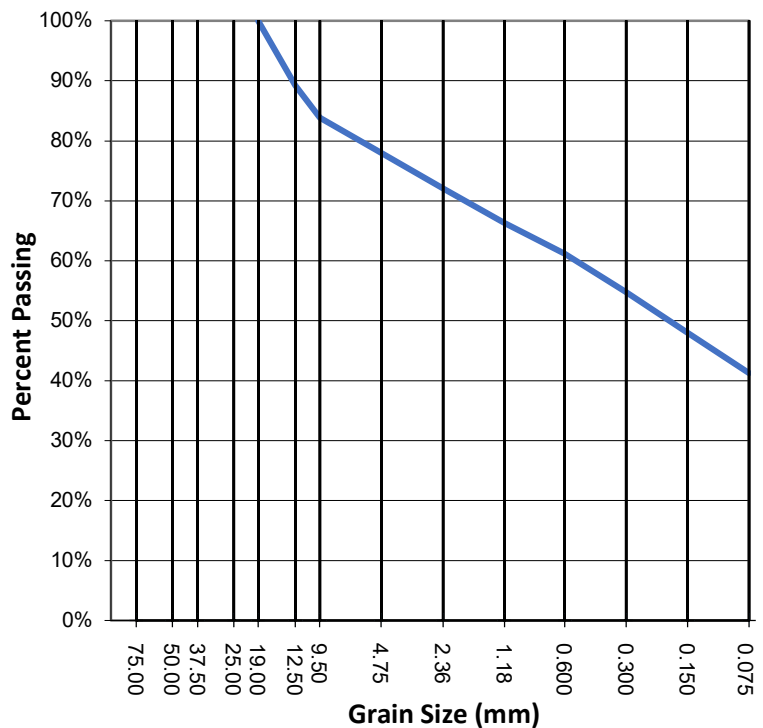
Project No. 23-H-008
Sieve Report No. SI07

Sample Details

Supplier Existing
Source TP24-02
Location 0.8 m
Description Till
Specification

Sampling Date May 16, 2024
Date Received May 17, 2024
Date Tested May 22, 2024
Sampled By MW
Tested By PS

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	100.0%		
19.0	100.0%		
12.5	89.2%		
9.5	83.8%		
4.75	78.0%		
2.36	72.0%		
1.18	66.3%		
0.600	61.2%		
0.300	54.8%		
0.150	48.0%		
0.075	41.3%		



Moisture Content 13.1%

Comments

Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

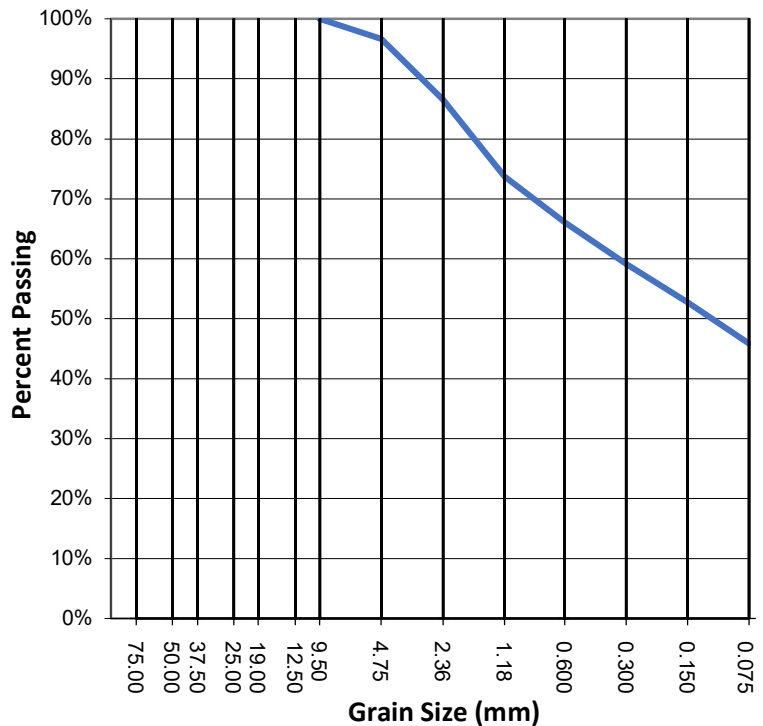
Project No. 23-H-008
Sieve Report No. SI08

Sample Details

Supplier Existing
Source TP24-02
Location 2.4 m
Description Till
Specification

Sampling Date May 16, 2024
Date Received May 17, 2024
Date Tested May 22, 2024
Sampled By MW
Tested By PS

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	100.0%		
19.0	100.0%		
12.5	100.0%		
9.5	100.0%		
4.75	96.7%		
2.36	86.5%		
1.18	73.7%		
0.600	66.1%		
0.300	59.1%		
0.150	52.7%		
0.075	45.9%		



Moisture Content 13.1%

Comments

Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
Sieve Report No. SI09

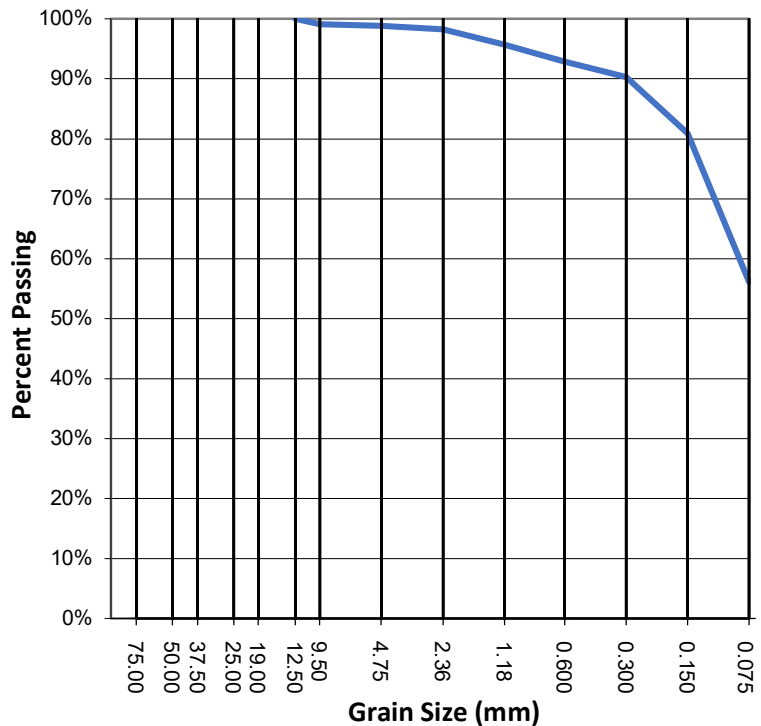
Sample Details

Supplier Existing
Source TP24-03
Location 1.3 m
Description Sand & Silt
Specification

Sampling Date May 16, 2024
Date Received May 17, 2024
Date Tested May 22, 2024
Sampled By MW
Tested By PS

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	100.0%		
19.0	100.0%		
12.5	100.0%		
9.5	99.1%		
4.75	98.8%		
2.36	98.2%		
1.18	95.7%		
0.600	92.9%		
0.300	90.3%		
0.150	80.9%		
0.075	56.2%		

Moisture Content 16.6%



Comments



Sieve Analysis

Reference ASTM C117 and C136

Project Details

Client R.G. McLeod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
Sieve Report No. S110

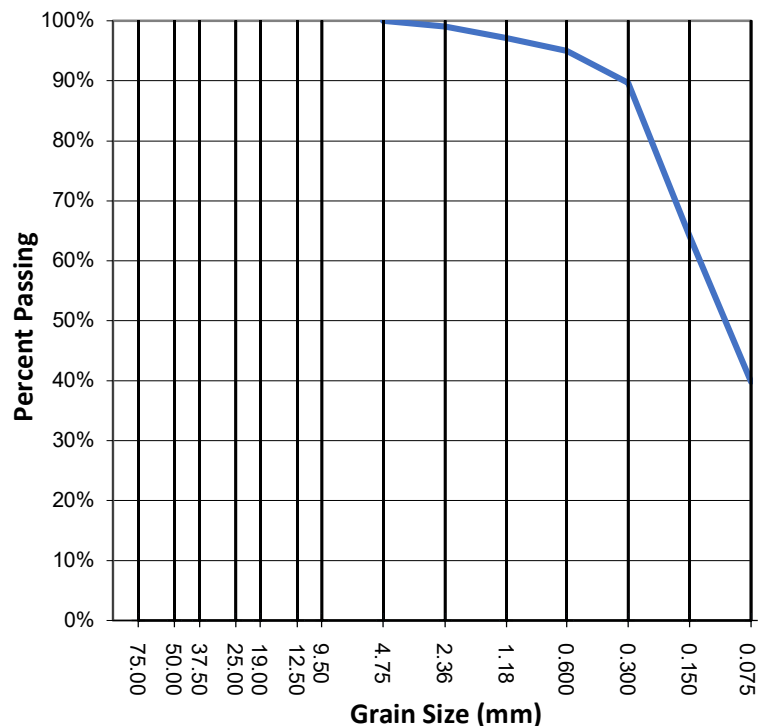
Sample Details

Supplier Existing
Source TP24-04
Location 1.0 m
Description Sand and Silt
Specification

Sampling Date May 16, 2024
Date Received May 17, 2024
Date Tested May 22, 2024
Sampled By MW
Tested By PS

Sieve Size (mm)	Percent Passing	Specifications	
		Min	Max
75.0	100.0%		
50.0	100.0%		
37.5	100.0%		
25.0	100.0%		
19.0	100.0%		
12.5	100.0%		
9.5	100.0%		
4.75	100.0%		
2.36	99.1%		
1.18	97.2%		
0.600	95.0%		
0.300	89.6%		
0.150	64.1%		
0.075	39.8%		

Moisture Content 8.1%



Comments



Particle Size Distribution Analysis

Reference ISO 13317-1 and ISO 13317-2.

Project Details

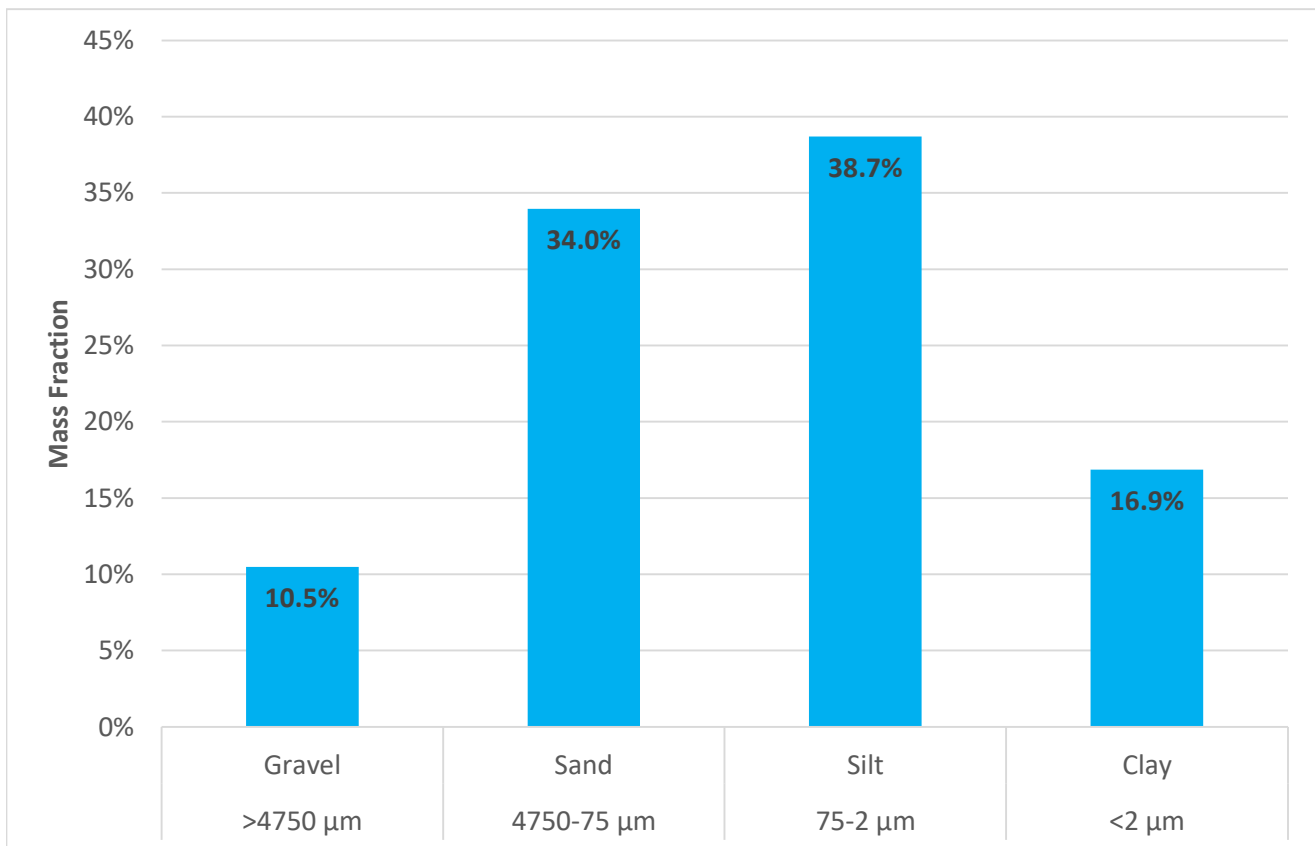
Client R.G. Mcleod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
PSD Report No. 1

Sample Details

Source TP23-05
Location 2.4 m
Description Till
Sampled By MW

Sampling Date May 12, 2023
Date Received May 12, 2023
Date Tested April 11, 2024
Tested By SD





Particle Size Distribution Analysis

Reference ISO 13317-1 and ISO 13317-2.

Project Details

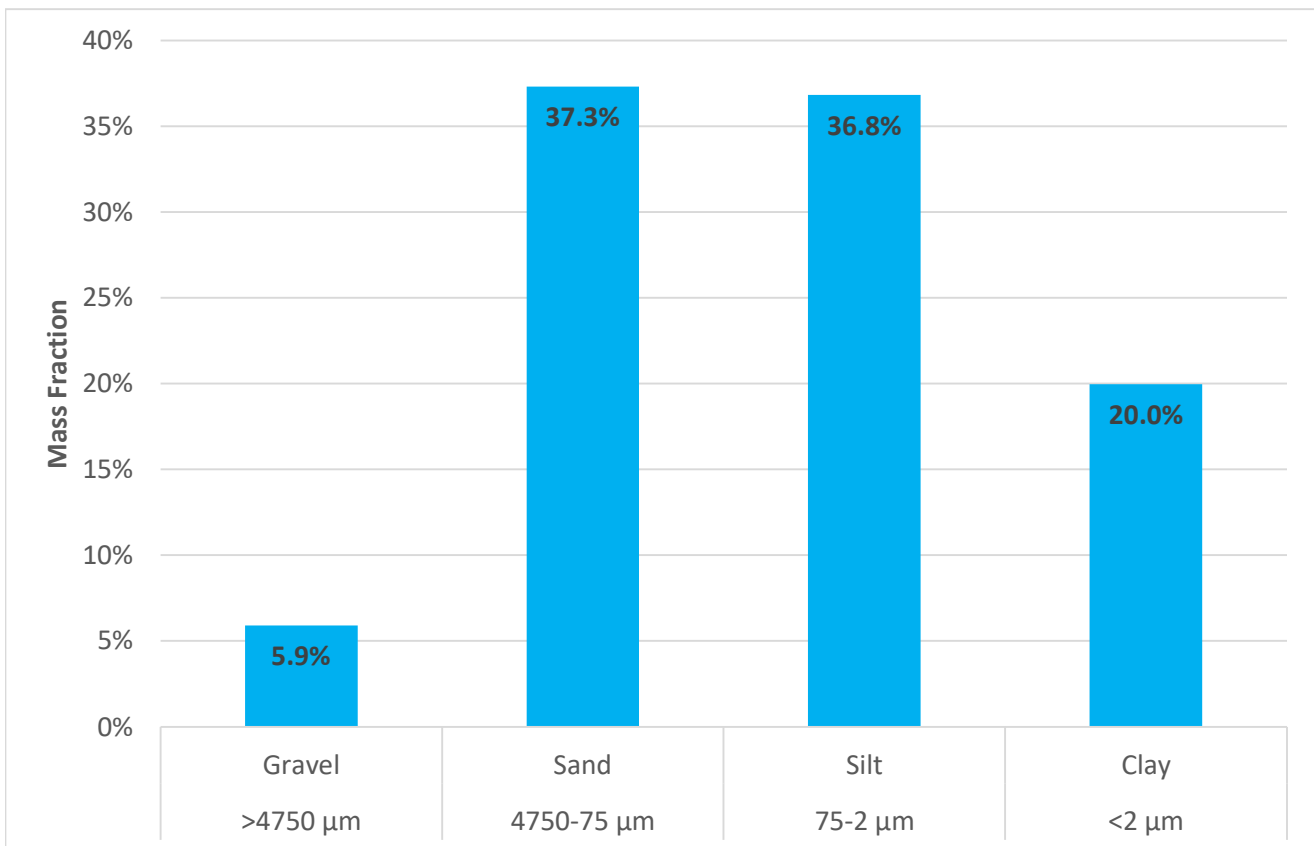
Client R.G. Mcleod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
PSD Report No. 2

Sample Details

Source TP23-07
Location 2.2 m
Description Till
Sampled By MW

Sampling Date May 12, 2023
Date Received May 12, 2023
Date Tested April 11, 2024
Tested By SD





Particle Size Distribution Analysis

Reference ISO 13317-1 and ISO 13317-2.

Project Details

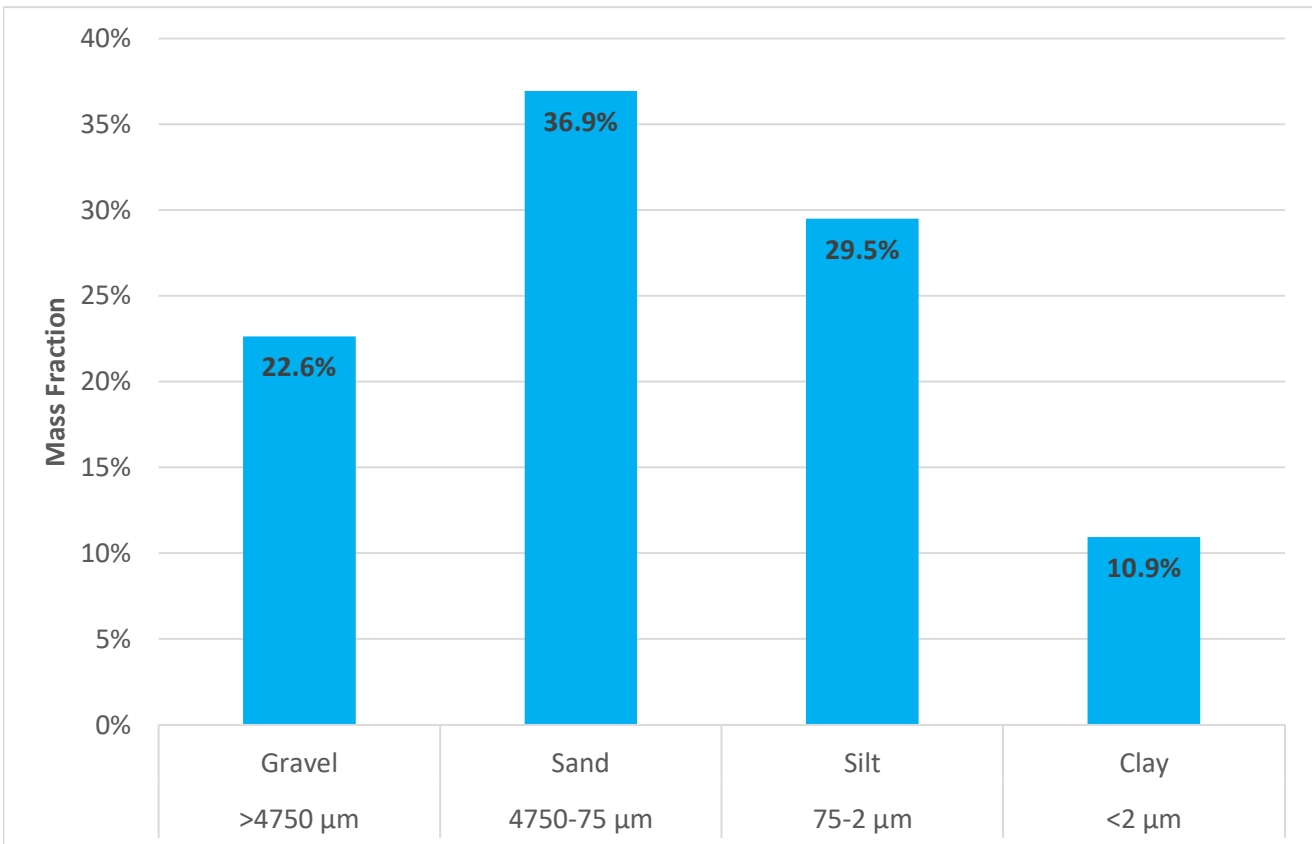
Client R.G. Mcleod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
PSD Report No. 3

Sample Details

Source TP24-01
Location 0.6m
Description Sand and silt
Sampled By MW

Sampling Date May 16, 2024
Date Received May 17, 2024
Date Tested May 28, 2024
Tested By SD





Particle Size Distribution Analysis

Reference ISO 13317-1 and ISO 13317-2.

Project Details

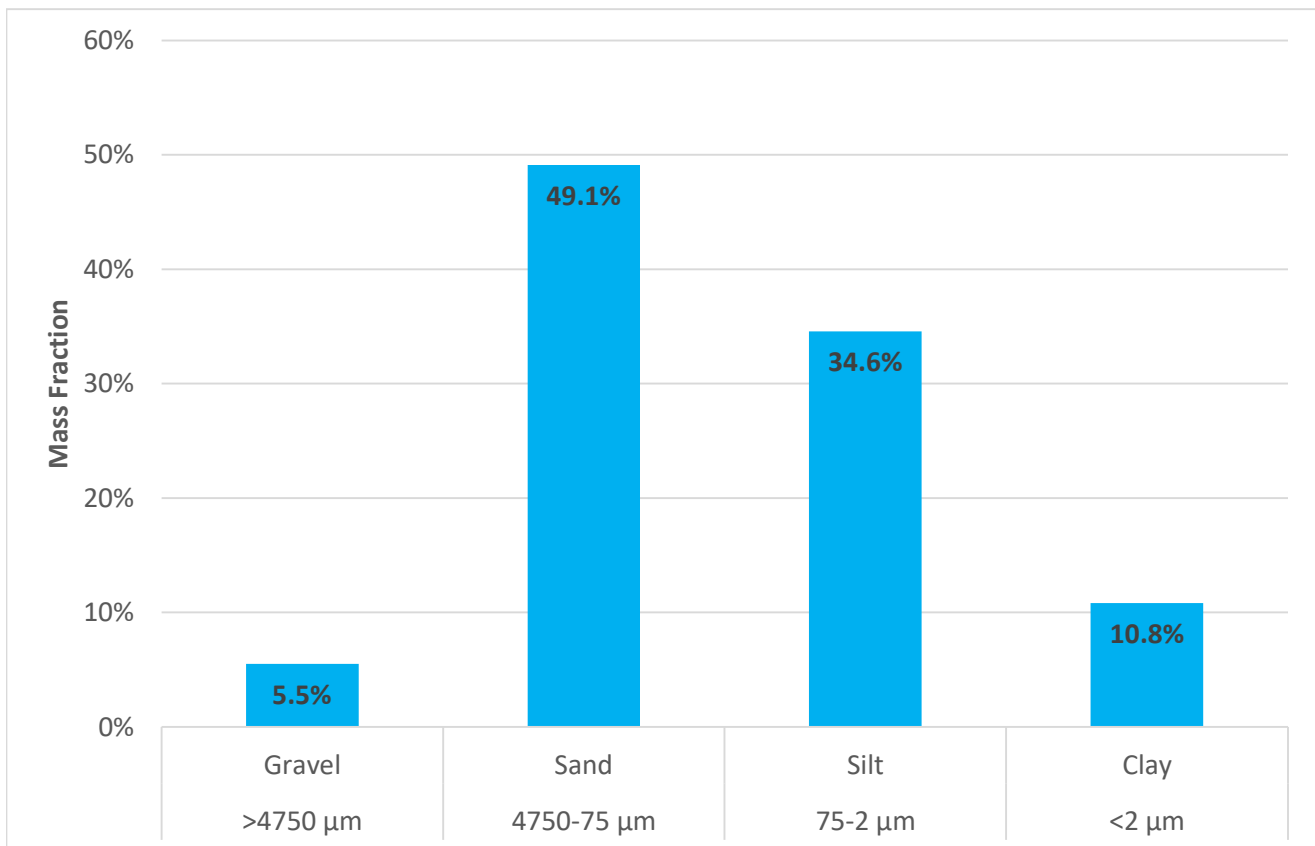
Client R.G. Mcleod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
PSD Report No. 4

Sample Details

Source TP24-02
Location 2.4 m
Description Till
Sampled By MW

Sampling Date May 16, 2024
Date Received May 17, 2024
Date Tested May 28, 2024
Tested By SD





Particle Size Distribution Analysis

Reference ISO 13317-1 and ISO 13317-2.

Project Details

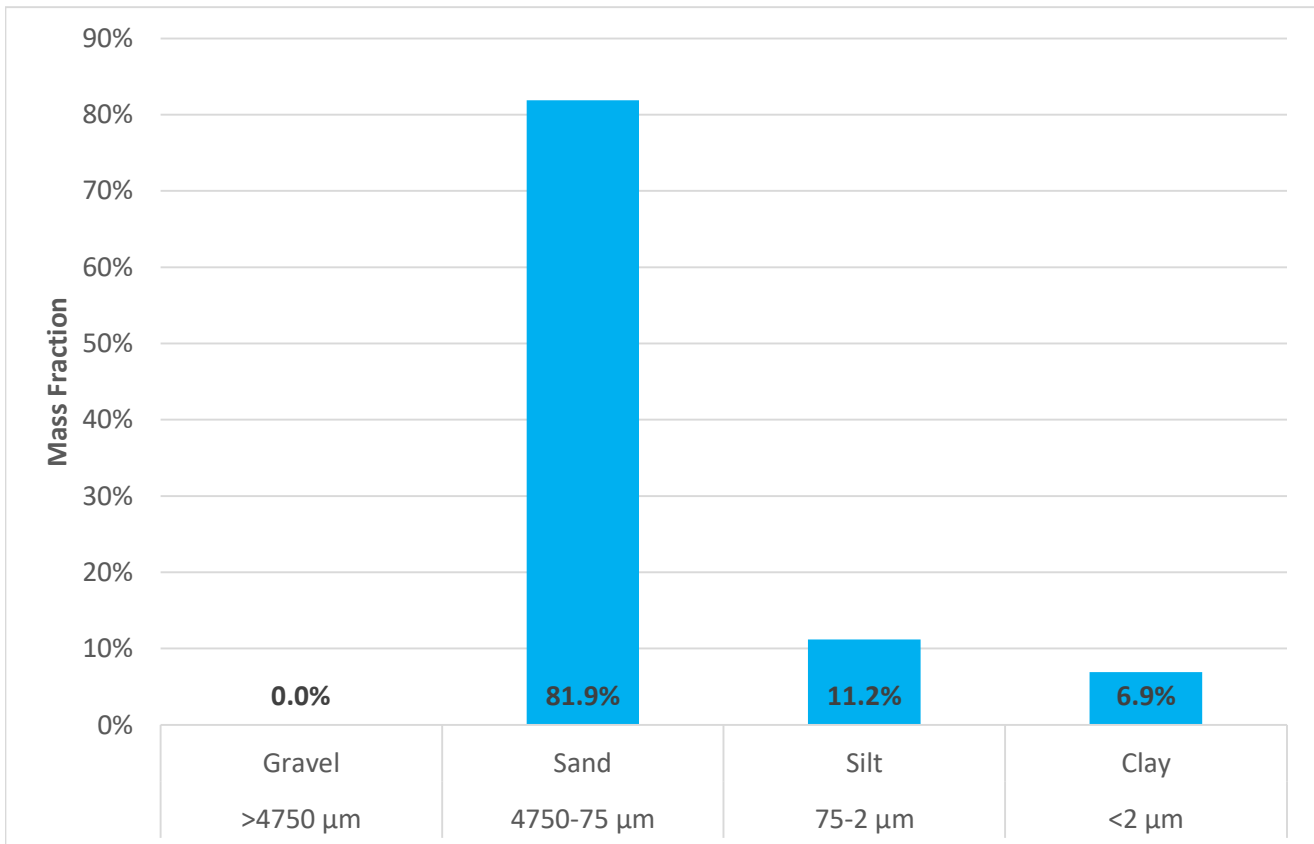
Client R.G. Mcleod Developments Ltd.
Project Russman Road Subdivision

Project No. 23-H-008
PSD Report No. 5

Sample Details

Source TP24-03
Location 2.5 m
Description Till
Sampled By MW

Sampling Date May 16, 2024
Date Received May 17, 2024
Date Tested May 28, 2024
Tested By SD





Liquid Limit, Plastic Limit and Plasticity Index of Soils

Reference ASTM D4318

Project Details

Client RG Mcleod Developments Ltd.

Project No. 23-H-008

Project Russman Road Subdivision

Location Prince George, BC

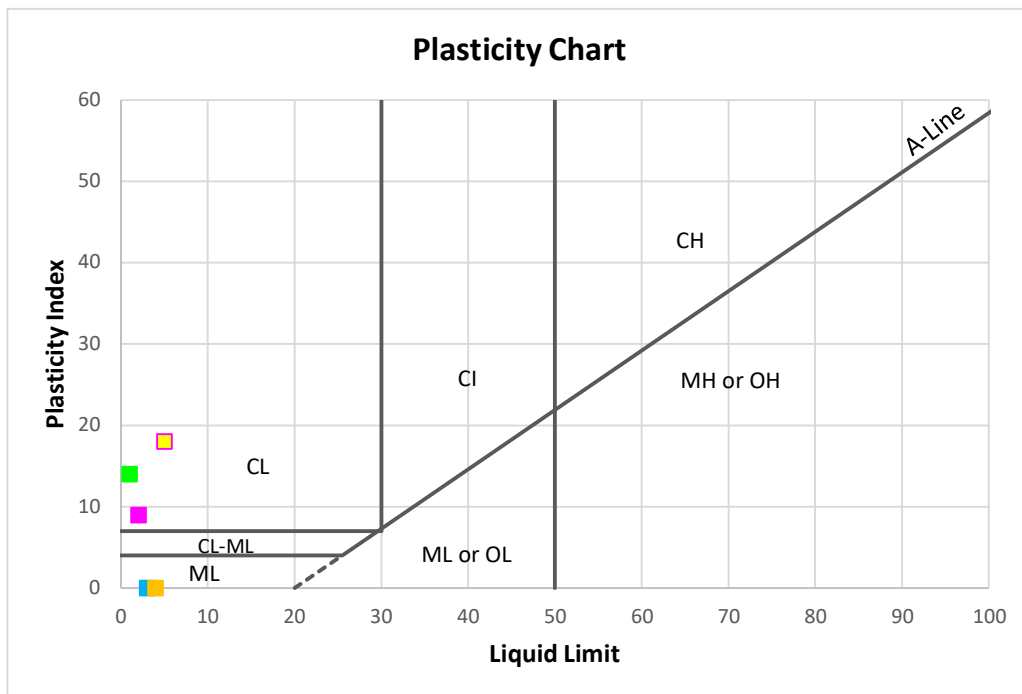
Sample Details

Sample Date May 12, 2023

Test Date 10-Apr-24

Sampled By MW

Tested By SD



Symbol	Sample ID	Location	Depth (m)	Passing 425 µm (%)	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Soil Type
■	3	TP24-02	2.4	57.5	18.7	36	22	14	CI
■	4	TP24-02	0.8	58.2	13.1	27	18	9	CL
■	5	TP24-02	2.4	62.5	13.1	ND	NP	ND	ML
■	6	TP24-03	1.2	91.6	16.6	ND	NP	ND	ML
■	7	TP24-03	2.5	94.0	28	33	15	18	CL

NP - Non-Plastic result

ND - Not Determined

Appendix C:

AG Zone Boundary

Appendix D:

Landslide Assessment Assurance Statement

LANDSLIDE ASSESSMENT ASSURANCE STATEMENT

Notes: This statement is to be read and completed in conjunction with the Engineers and Geoscientists BC *Professional Practice Guidelines – Landslide Assessments in British Columbia* (“the guidelines”) and the current *BC Building Code (BCBC)*, and is to be provided for Landslide Assessments (not floods or flood controls), particularly those produced for the purposes of the *Land Title Act*, *Community Charter*, or *Local Government Act*. Some jurisdictions (e.g., the Fraser Valley Regional District or the Cowichan Valley Regional District) have developed more comprehensive assurance statements in collaboration with Engineers and Geoscientists BC. Where those exist, the Qualified Professional is to fill out the local version only. Defined terms are capitalized; see the Defined Terms section of the guidelines for definitions.

To: The Approving Authority (or Client)

Date: July 26, 2024

City of Prince George

1100 Patricia Boulevard, Pince George, BC

Jurisdiction/name and address

With reference to (CHECK ONE):

- A. *Land Title Act* (Section 86) – Subdivision Approval
- B. *Local Government Act* (Sections 919.1 and 920) – Development Permit
- C. Community Charter (Section 56) – Building Permit
- D. Non-legislated assessment

For the following property (the “Property”):

5310 Russman Road, Prince George, BC. DISTRICT LOT 10233, CARIBOO LAND DISTRICT, EXCEPT PLAN 16496, PID: 013-713-485

Civic address of the Property

The undersigned hereby gives assurance that they are a Qualified Professional and a professional engineer or professional geoscientist who fulfils the education, training, and experience requirements as outlined in the guidelines.

I have signed, authenticated, and dated, and thereby certified, the attached Landslide Assessment Report on the Property in accordance with the guidelines. That report must be read in conjunction this statement.

In preparing that report I have:

[CHECK TO THE LEFT OF APPLICABLE ITEMS]

- 1. Collected and reviewed appropriate background information
- 2. Reviewed the proposed Residential Development or other development on the Property
- 3. Conducted field work on and, if required, beyond the Property
- 4. Reported on the results of the field work on and, if required, beyond the Property
- 5. Considered any changed conditions on and, if required, beyond the Property
- 6. For a Landslide Hazard analysis or Landslide Risk analysis, I have:
 - 6.1 reviewed and characterized, if appropriate, any Landslide that may affect the Property
 - 6.2 estimated the Landslide Hazard
 - 6.3 identified existing and anticipated future Elements at Risk on and, if required, beyond the Property
 - 6.4 estimated the potential Consequences to those Elements at Risk
- 7. Where the Approving Authority has adopted a Level of Landslide Safety, I have:
 - 7.1 compared the Level of Landslide Safety adopted by the Approving Authority with the findings of my investigation
 - 7.2 made a finding on the Level of Landslide Safety on the Property based on the comparison
 - 7.3 made recommendations to reduce Landslide Hazards and/or Landslide Risks

LANDSLIDE ASSESSMENT ASSURANCE STATEMENT

8. Where the Approving Authority has **not** adopted a Level of Landslide Safety, or where the Landslide Assessment is not produced in response to a legislated requirement, I have:
- 8.1 described the method of Landslide Hazard analysis or Landslide Risk analysis used
 - 8.2 referred to an appropriate and identified provincial, national, or international guideline for Level of Landslide Safety
 - 8.3 compared those guidelines (per item 8.2) with the findings of my investigation
 - 8.4 made a finding on the Level of Landslide Safety on the Property based on the comparison
 - 8.5 made recommendations to reduce Landslide Hazards and/or Landslide Risks
9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections

Based on my comparison between:

[CHECK ONE]

- the findings from the investigation and the adopted Level of Landslide Safety (item 7.2 above)
- the appropriate and identified provincial, national, or international guideline for Level of Landslide Safety (item 8.4 above)

Where the Landslide Assessment is not produced in response to a legislated requirement, I hereby give my assurance that, based on the conditions¹ contained in the attached Landslide Assessment Report:

A. SUBDIVISION APPROVAL

- For subdivision approval, as required by the *Land Title Act* (Section 86), “the land may be used safely for the use intended”
- [CHECK ONE]
- with one or more recommended additional registered Covenants
 - without an additional registered Covenant(s)

B. DEVELOPMENT PERMIT

- For a development permit, as required by the *Local Government Act* (Sections 488 and 491), my report will “assist the local government in determining what conditions or requirements it will impose under subsection (2) of [Section 491]”
- [CHECK ONE]
- with one or more recommended additional registered Covenants
 - without an additional registered Covenant(s)

C. BUILDING PERMIT

- For a building permit, as required by the *Community Charter* (Section 56), “the land may be used safely for the use intended”
- [CHECK ONE]
- with one or more recommended additional registered Covenants
 - without any additional registered Covenant(s)

¹ When seismic slope stability assessments are involved, Level of Landslide Safety is considered to be a “life safety” criteria, as described in Commentary JJJ of the *National Building Code of Canada (NBC) 2015*, Structural Commentaries (User’s Guide – NBC 2015: part 4 of division B). This states:

“The primary objective of seismic design is to provide an acceptable level of safety for building occupants and the general public as the building responds to strong ground motion; in other words, to minimize loss of life. This implies that, although there will likely be extensive structural and non-structural damage, during the DGM (design ground motion), there is a reasonable degree of confidence that the building will not collapse, nor will its attachments break off and fall on people near the building. This performance level is termed ‘extensive damage’ because, although the structure may be heavily damaged and may have lost a substantial amount of its initial strength and stiffness, it retains some margin of resistance against collapse.”

LANDSLIDE ASSESSMENT ASSURANCE STATEMENT

Hans Jorgensen, P. Eng.

Name (print)

July 26, 2024

Date

1215 Babine Road, Prince George, BC

Address

250-301-5024

Telephone

hans@soiltech.ca

Email

(Affix PROFESSIONAL SEAL and signature here)

The Qualified Professional, as a registrant on the roster of a registrant firm, must complete the following:

I am a member of the firm SoilTech Consulting Ltd.

(Print name of firm)

with Permit to Practice Number 1001832

(Print permit to practice number)

and I sign this letter on behalf of the firm.