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June 6, 2019

Mr. Stefan Maunz
0717133 BC Ltd
[redacted]
Revelstoke, BC V0E 2S3 Email: [redacted]

Project No.: 192-02067-P
Subject: Proposed Residential Subdivision
1794, 1838 Hay Rd, 1738 Grizzly Lane, Revelstoke, BC
(Proposed Single-Family and Multi-Family Residential Units)
Geotechnical Assessment

Dear Mr. Maunz:

1.0 INTRODUCTION

As authorized by Mr. Stefan Maunz, EXP Services Inc (EXP) has carried out a geotechnical assessment for the development of the above noted properties into single/multi-family residential lots and several local roadways.

This report describes the investigation carried out, presents the results, and provides geotechnical recommendations relevant to single/multi-family residential construction, local roadway construction, and site servicing installation. These guidelines are general in nature with the understanding that detailed geotechnical design and construction reviews for each individual residential project will be the responsibility of the geotechnical engineer-of-record for that project.

EXP's assessment has not included investigation directed to environmental and archaeological, geohazard or global slope stability issues. These issues are outside the scope of EXP's work on this project and are the responsibility of others.

2.0 SITE DESCRIPTION

The proposed site is identified as 1794, 1838 Hay Rd, and 1738 Grizzly Lane in Revelstoke, BC. To the north is Grizzly Lane and several existing residences. To the south is a forested area followed by further residential development and Aspen Crescent. West is Hay road and several existing residences, and east is a steep slope up to Camozzi Road. The site currently exhibits a single-family residence within the northwest portion of the site. The northern portion of the site is currently a cleared field, the southern portion of the site is currently forested.

The site is generally flat/undulating with an approximately 8m to 15m high moderately steep to steep slope (1.2H:1V to approximately 2H:1V) to the east up to Camozzi Road.

Based on the provided concept plan we understand the proposed development is to consist of approximately 39 single and multi (duplex) family residential units, 20 townhomes, and several local roadways and parking areas. Details of the proposed residential units were not available at the time of this report. We also understand that the existing structures on the property would be demolished.

3.0 FIELD AND LABORATORY INVESTIGATION

The field investigation included 6 testpits (TP19-01 thru' TP19-06) advanced with a tracked excavator to depths up to 4.5m below existing site grade. Locations of the testpits are shown on the attached drawing no. 19202067-01. Personnel from EXP logged the testpits in the field on April 18, 2019 and soil samples obtained from the test pits were returned to EXP's laboratory for classification. Testpit logs are included at the end of the report.

Generally, subsoils encountered in the 6 testpits at the site were similar and consisted of a surficial 0.4m to 0.6m thick layer of topsoil underlain by soft to firm silt/sand with some pore holes extending to approximately 1.3 to 1.9m below ground surface. Below the silt and sand was a deposit of compact grey to rusty sand and gravel with trace quantities of silt which extended beyond the limit of the testpit. The exception to this was testpit TP19-03 which was located within a low-lying swampy area at the northeast of the site. At this location a surficial layer of loose/firm fill material comprised of silt and sand with large roots, tree branches, organics, logs, etc. was encountered extending to approximately 1.5m below ground surface. Underlying the fill material was a deposit of soft-firm silt underlain by loose sand extending the approximately 3.3m below ground surface. Underlying the silt and sand was the grey to rusty compact sand and gravel extending beyond the limit of the testpit.

Groundwater was not encountered at any of the testpits during the investigation. Groundwater levels may vary depending on seasonal changes and climatic events.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Subject to considerations discussed in the following paragraphs, the site is, from a geotechnical standpoint, considered feasible for development as a single and multi-family residential subdivision.

4.2 Slope Stability

Utilizing the provided topographical survey data and the results of our field investigation EXP carried out a preliminary slope stability analysis of the existing slope to the east of the site. The topographical data indicates the existing slopes to the east of the site are up to 15m high with slopes ranging in steepness from 1.2H:1V to 2H:1V. Based on our analysis the slopes generally exhibit a minimum factor of safety 1.2 to 1.3. Typically for residential subdivision a minimum factor of safety 1.5 is required. Based on this we recommend that the foundations for the proposed residences be setback from the slope

toe by a distance equal to the greater of half the total height of slope or a theoretical 2.5H:1V slope down from the slope crest.

If the above setback does not correspond with the footprint plan, the buildings could potentially be moved closer to the slope if the rear foundation walls were designed to act as retaining walls. Should the preceding be the preferred option, additional slope stability analysis would be necessary to evaluate the achievability of the minimum required factor of safety.

4.3 Foundations (lightly loaded residential structures)
The upper soil units (fill, topsoil, silt and sand) are not considered suitable materials for support of lightly loaded residential structures. The grey sand and gravel deposit represent a suitable bearing layer for support of shallow foundations for structures. Structural fill constructed directly over the sand and gravel deposit and in accordance with section 4.5 below, will also represent a suitable bearing stratum for shallow foundations. The following recommendations are provided subject to review and approval or amendment by the geotechnical engineer-of-record.

- Allowable bearing capacity for foundation design should not exceed 100 kPa.
- For protection from frost, perimeter footings for heated spaces and footings for unheated spaces should be buried at least 1200mm to 1500mm respectively below final adjacent ground surface.
- Minimum width of footings should be 600mm, unless greater minimum widths are required by the BC Building Code (Part 9).

Where footings are to be placed directly on native sand and gravel deposit, it is recommended the bearing surface be blinded with a 100mm thick layer of 19mm minus crushed sand and gravel (road base material), which should be moisture-conditioned and compacted with vibratory equipment (1000 lb. plate tamper minimum) to at least 100% of Standard Proctor Maximum Density prior to placing footings.

4.4 Slab-on-Grade
The slab-on-grade floors should be supported on a minimum 100mm thick compacted porous gravel base course meeting requirements for radon control purposes as required by the BC Building Code. The base course should be placed either directly on the native sand and gravel deposit or on compacted granular structural fill placed directly over this layer. The upper soils layers (fill, topsoil, silt and sand) that were encountered above the sand and gravel deposit should be stripped from the building site, as should any existing old foundations, abandoned utilities, old trench backfill, debris, and the like.

A vapour barrier and rough-in piping for radon control purposes should be installed beneath the slab-on-grade as required by the BC Building Code.

4.5 Structural Fill

Structural fill is defined as fill placed underneath any load bearing area including building foundations, floor slab areas and pavement. Stripping prior to structural filling should extend laterally outside the perimeter of the building foundation by a distance equal to the depth of structural fill beneath the foundation (1V:1H splay).

It is recommended that structural fill should consist of approved, clean sandy soil (such as on-site native sand and gravel deposit); free of organics or deleterious materials that can be suitably moisture conditioned for compaction. Prior to placement of structural fill, all existing fill and topsoil should be stripped to expose the native sand and gravel. The sub-grade surface should then be moisture-conditioned and compacted to 100% Standard Proctor Maximum Dry Density, (SPMDD) ASTM D698. Structural fill should be placed in lifts, each not exceeding 200mm loose thickness and compacted to 100% SPMDD ASTM D698.

4.6 Site Grading Fills

For practical and economic reasons, site grading fill to support roadways and parking areas could consist of selectively excavated (free of deleterious materials), on site silt and sand materials and soils from the on-site sand and gravels deposit provided the materials are at a suitable moisture content conducive to achieving the required degree of compaction.

Prior to excavating or placing site fills, all existing fill soils and topsoil should be stripped. Following stripping, the subgrade in areas to receive fill should be moisture-conditioned (if required) by scarifying and watering and then thoroughly compacted with large vibratory equipment. Site grading fill material should be moisture-conditioned (if necessary) to within 2% of the optimum moisture content for compaction. It should be spread in thin lifts and each lift compacted to at least 98% of SPMDD ASTM D698 for the bulk of the fill, and to 100% of SPMDD ASTM D698 in the top 0.3m.

Permanent cut and fill slope faces should be sloped no steeper than 2H: 1V. Fill slope faces should be over-filled and then trimmed back to the final face so as to ensure compaction of the surficial fill zone.

Permanent slope faces should be vegetated with suitable plant species to reduce erosion. Drainage grades should be designed so as to avoid channeling of concentrated run-off water down permanent slope faces. Where necessary, ditches to intercept and control run-off water and surficial soils sloughing should be provided.

4.7 Surface Drainage

Surface runoff must be carefully controlled to avoid flooding and erosion problems within each building site and on neighbouring sites. All building sites should be shaped and graded to direct runoff away from buildings. Permanent drainage pathways should be constructed to direct runoff to approved discharge locations, such as drainage ditches and storm drains.

4.8 Sub-surface Drainage

Where the floor slab elevation is below adjacent exterior grade, a sub-drainage system should be installed around the foundation perimeter. The perimeter drain should consist of a minimum 100mm diameter rigid plastic perforated pipe, surrounded by at least 150mm thickness of 25mm drain rock that is in turn covered with a non-woven filter cloth. The perimeter drain should be installed with invert elevation no less than 100mm lower than the underside of the adjacent interior floor slab.

The perimeter drain should discharge by gravity to the storm sewer system or (if gravity connection is not feasible) to separate pumped sump that discharges to the storm sewer system or another suitable location. Direct piped discharge to on-site infiltration systems (rockpits) for disposal of sub-surface drainage is not recommended. If rockpits are proposed the perimeter drainage system should discharge to daylight, then over land to the rock pit.

Where the lowest interior floors are above adjacent exterior finished grade and the grade is sloped away from the building for positive drainage, perimeter drain systems should not be required.

4.9 Roof Drainage

Roof drainage systems should discharge via acceptable overland or piped routes to the overall subdivision storm drainage system or to suitably designed rock pits (drywells) located a minimum of 5m clear distance from any permanent structure.

4.10 Seismic and Liquefaction

The interactive website (http://earthquakescanada.nrcan.gc.ca) maintained by Natural Resources Canada was used to obtain site-specific seismic ground motion parameters for seismic design and analysis. Seismic design in the province of British Columbia is based on the 2018 British Columbia Building Code (2018 BCBC). In accordance with the 2015 National Building Code of Canada (2015 NBCC) and 2018 BCBC, structures must be capable of withstanding seismic ground motions having a two (2) percent risk of exceedance over a 50-year design life, corresponding to a return period of 1 in 2,475 years. Based on interpolated seismic hazard values from Natural Resources Canada, the corresponding peak ground acceleration (PGA) and the five (5) percent damped spectral response accelerations for periods (T) of 0.2 seconds, 1.0 seconds and 2.0 seconds are presented below.

Return Period	PGA	Sa (0.2)	Sa (1.0)	Sa (2.0)
1 : 2,475yr	0.064	0.146	0.070	0.043

Using the spectral acceleration values, Fa and Fv values were obtained from tables (Table 4.1.8.4B and 4.1.8.4D, respectively) provided in the 2018 British Columbia Building Code. According to the 2018 British Columbia Building Code, the site is considered a **Site Class D**, with a **Fa** value of **1.24**, and an **Fv** of **1.55**. These foundation factors can be used to estimate the base shear loads prior to the onset of soil liquefaction or, provided that structural measures are implemented, to address the consequences of soil liquefaction such as the impact of loss of bearing capacity, and lateral and vertical permanent ground movements.

EXP's investigation did not include assessment of the soil stratigraphy at depths greater than 4m below ground surface. As groundwater was not encountered during the investigation it is anticipated that if soils layers loose enough to liquefy are present below the ground water table that they would be sufficiently deep that punching failure of shallow footings for the proposed light buildings should not occur.

4.11 Excavation

As a preliminary guideline, un-shored temporary excavations sloped at 1H:1V can be assumed. Depending on soil and groundwater conditions, flatter slopes could be required. Where space constraints dictate the need for steeper slopes, temporary shoring will be required. All temporary excavation slopes and shoring should be constructed in accordance with WorkSafe BC regulations.

4.12 Cuts and Fills

4.12.1 Structural Fill Slopes

Permanent fill banks within the proposed subdivision should be designed and constructed to a maximum 2H:1V slope. Structural fills for support of buildings should consist of approved, clean sandy soil (such as on-site native sand and gravel deposit). Structural fill should be suitably moisture-conditioned and placed and compacted in thin lifts (200mm thick) to at least 100% Standard Proctor Maximum Dry Density (SPMDD).

Prior to placement of structural fills, the sub-grade should be stripped down to approved bearing soils (approved native sand and gravel deposit), and the sub-grade should be benched and stepped so as to provide a horizontal or near-horizontal interface. Where the sub-grade is loose or becomes loosened during

stripping, it should be compacted to at least 95% SPMDD prior to fill placement. The sub-grade should be inspected by EXP after stripping and benching and prior to placement of fill.

Engineered fills should be wide enough so as to extend laterally beyond the perimeter of any proposed future structure by a distance equal to at least the depth of engineered fill below the structure (1V:1H Splay).

4.12.2 Cut Slopes

In general, permanent cuts into native silt and sand to sand and gravel within the proposed subdivision should be designed and constructed to a maximum 2H:1V slope. Slopes subject to seepage should be cut at 3H:1V or flatter but can be steepened by first putting in subdrains to remove the seepage. Steep to vertical slopes can be achieved by installation of retaining walls subject to design, review and approval by a professional engineer. Slope design should incorporate measures at the toe, to control surface raveling and sloughing and surface runoff. Exposed soils on the face of the cut slopes should be vegetated/hydro seeded or covered by rocks, (but should not be blanketed with a loose growing medium) to mitigate surficial erosion.

4.13 Surfacing (Gravel and Asphalt)

4.13.1 Subgrade Preparation

Fill and topsoil exposed at subgrade elevation should be sub-excavated to underlying silt or sand and gravel and replaced with an additional thickness of sub-base material.

Subgrades consisting of the on-site silt and sand soils or site grading fill should be moisture-conditioned (as necessary) by scarifying and watering, and then compacted with heavy vibratory equipment so as to achieve a density of at least 95% MPMDD (Modified Proctor Maximum Dry Density) ASTM D1557 in the upper 0.3m.

The entire subgrade should be proof-rolled to check for soft areas which may require additional excavation and replacement as recommended on-site by the geotechnical engineer.

4.13.2 Asphalt Pavement for Light Vehicle Traffic

For all areas where asphalt pavement for light vehicle traffic is proposed, the following minimum structure is recommended:

- 50mm Asphalt Pavement
- 75mm Base Course
- 300mm Sub-base Course

4.13.3 Asphalt Pavement for Truck Traffic

For all areas where asphalt pavement for truck traffic is proposed, the following minimum structure is recommended:

- 75mm Asphalt Pavement
- 100mm Base Course
- 450mm Sub-base Course

4.13.4 Material Specifications

Surfacing materials and placement procedures should be in accordance with specifications provided in MMCD Platinum.

4.14 Buried Services

Pipe bedding, backfill materials and compaction requirements for utility services should be designed and completed in accordance with the latest version of the Master Municipal Construction Documents (MMCD). All excavation for the installation of utilities should be carried out in compliance with the latest WorkSafe BC Regulation.

5.0 DESIGN AND CONSTRUCTION REVIEW REQUIREMENTS

The final design should be reviewed by the geotechnical engineer for conformance with the intent of recommendations of this report and subsequent reports, if any. Construction review by the geotechnical engineer during the course of construction should include:

- Bearing surfaces and sub-grades;
- Confirmation of allowable bearing pressure for footings;
- Suitability of materials for structural fill;
- Compaction of structural fills;
- Geotechnical aspects of perimeter sub-drainage;
- Backfills;
- Base course for interior floors.

6.0 CONCLUSION

This report has been prepared for the purpose of design for the exclusive use of 0717133 BC Ltd., the City of Revelstoke, and their designated representatives and may not be used by other parties without the written permission of EXP Services Inc. The information provided in the report is valid as of this date. However, conditions that are beyond our control or that may occur with the passage of time may invalidate, either in whole or in part, the results, conclusions and recommendations presented herein. Any third party using this report for bidding or construction purposed should perform such independent study as deemed necessary to satisfy himself of the subsurface conditions to be expected and procedures to be used in conducting works at the site.

This report is based on the information obtained from limited testpits and on interpretation of the observed site conditions. It is possible that different soil conditions may be encountered during excavation at locations where no testpits have been excavated. EXP Services Inc. should be notified immediately to review any new findings and to provide any necessary amendments.

Use of this report is subject to the attached "Statement of General Conditions".

We trust this report meets with your requirements, however, should any questions arise, please do not hesitate to contact the undersigned.

Sincerely,

exp Services Inc.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
S. W. PRIME
35777
7 Jun 2019

Stephen Prime, P. Eng.
Project Engineer

Reviewed by:

J. T. Hall, Branch Manager
Senior Associate

Enclosure: "Statement of General Conditions"
Dwg. 19202067-01 – Testpit Location Plan
Testpit Logs

STATEMENT OF GENERAL CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is made. Geotechnical studies and reports do not include environmental consulting unless specifically stated in the geotechnical report.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF THE REPORT

The Report has been prepared for the specific site, development, design objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS "APPROVED USERS". The contents of the Report remain our copyright property and we authorize only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of the Report by those parties. The Client and Approved Users may not give, lend, sell or otherwise make the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorized use of the Report.

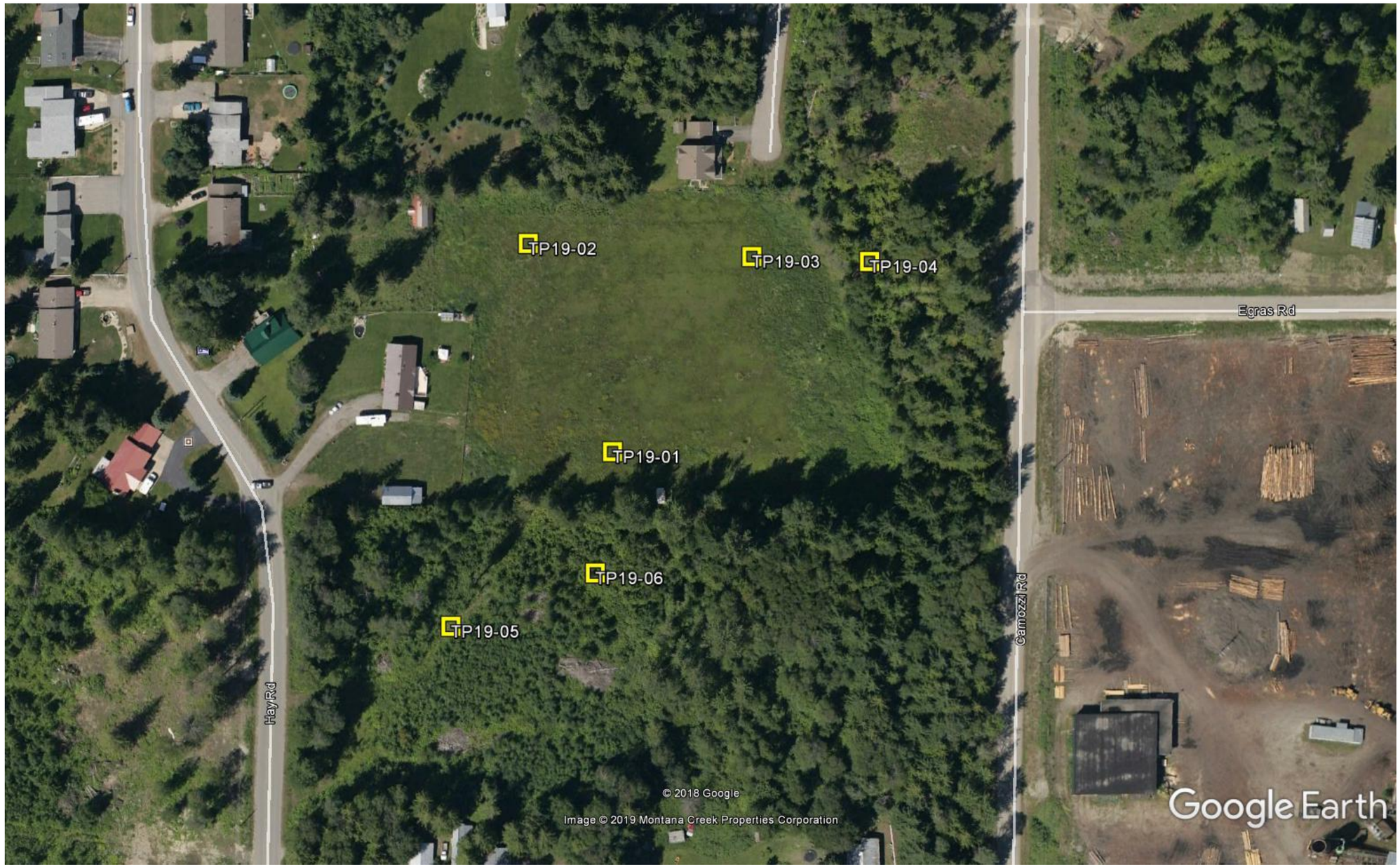
5. INTERPRETATION OF THE REPORT

a. Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and engineering estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgemental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilising the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarising such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk, Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special

considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b. Reliance on Provided information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons provided information.

c. To avoid misunderstandings, exp. Services Inc. should be retained to work with the other design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to engineering issues. So to, exp. Services Inc. should be retained to provide field reviews during the construction, consistent with building codes guidelines and generally accepted practices.



exp.	**0717133 BC Ltd**	**TESTPIT LOCATION PLAN (Approximate Locations)**	Des.	SP	Job	19202067-P
			Drn.	SP	Date	June 2019
	Residential Subdivision		Chk.	KH	Dwg No.	
			Scale	As Shown	19202067-01	

Date: April 18, 2019
Our File: KAM-19202067-P

TEST PIT LOGS
HAY ROAD SUBDIVISION
REVELSTOKE, BC

TP19-01

DEPTH, m		DESCRIPTION	REMARKS
From	To		
0	0.4	Topsoil, rootmat with grass.	
0.4	1.3	Silt, fine, some sand, dark grey, moist, firm	
1.3	End	Sand & gravel, trace silt, well graded 4" minus size, compact to dense, grey. Some sloping from north to south on surface.	
3.5		End of testpit. No seepage noted.	

TP19-02

DEPTH, m		DESCRIPTION	REMARKS
From	To		
0	0.4	Topsoil, rootmat with grass.	
0.4	1.9	Silt, fine, some sand, dark grey, moist, firm	
1.9	2.5	Sand & Gravel, very clean, well graded, grey, compact to dense.	
2.5	3.1	Sand & Gravel, very clean, well graded, orange, compact to dense.	
3.1	End	Sand & Gravel, very clean, well graded, grey, compact to dense	
4.1		End of testpit. No seepage noted.	

TP19-03 – Low-lying area south of Grizzly

DEPTH, m		DESCRIPTION	REMARKS
From	To		
0	0.3	Rootmat, grass	
0.3	1.5	FILL – Silt, sand, organics, large roots, tree branches, logs, moist, soft	
1.5	2.0	Silt, some fine sand, grey, some pore holes, soft to firm, moist	
2.0	3.3	Sand, trace to some silt, rust stained, very wet, loose.	
3.3	End	Sand & gravel, very clean, well graded, grey, compact to dense.	
4.5		End of testpit No seepage noted	

MC: Moisture Content, %

TEST PIT LOGS
HAY ROAD SUBDIVISION
REVELSTOKE, BC

TP19-04

DEPTH, m		DESCRIPTION	REMARKS
From	To		
0	0.5	Rootmat, grass & tree roots	
0.5	End	Gravelly Sand, with fine sand and some silt, grey, loose, dry to medium moist.	
3.0		End of testpit. No seepage noted.	

TP19-05

DEPTH, m		DESCRIPTION	REMARKS
From	To		
0	0.45	Rootmat & forest cover	
0.45	1.5	Sandy silt, wet, soft, grey, some pore holes	
1.5	End	Sand & gravel, clean, coarse, well graded, dense, grey, medium moist.	
3.1		End of testpit. No seepage noted	

TP19-06

DEPTH, m		DESCRIPTION	REMARKS
From	To		
0	0.6	Topsoil, rootmat & silt – old 1” corroded steel line in ground following shallow trench, no wires, no water	
0.6	1.5	Silt, sand, wet, soft, grey	
1.5	End	Sand & gravel, clean, coarse, well graded, dense, grey, medium moist	
2.8		End of testpit. No seepage noted.	

MC: Moisture Content, %