BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
Suite 500 - 980 Howe Street
Vancouver, BC Canada V6Z 0C8
Telephone (604) 684-5900
Fax (604) 684-5909

September 20, 2022
Project No.: 1954004.06

Jamie Batchelor, MCIP, RPP, Planner
Rideau Valley Conservation Authority
3889 Rideau Valley Drive
PO Box 599
Manotick, ON K4M 1A5

Dear Mr. Batchelor,

Re: Landslide hazards affecting 3459 and 3479 St. Joseph Boulevard

1.0 INTRODUCTION

BGC Engineering Inc. (BGC) is pleased to submit this letter report to Rideau Valley Conservation Authority (RVCA) with commentary on landslide hazards affecting a proposed development at 3459 and 3479 St. Joseph Boulevard in Ottawa, Ontario. RVCA is reviewing a Zoning By-law Amendment application (the application) to establish four 6-storey buildings with 326 dwelling units. The project site is approximately 60 m from the toe of an escarpment that runs along St. Joseph Boulevard. Several large landslides have been mapped by the Geological Survey of Canada within 2 km of the site. RVCA is interested to know whether landslide hazards may be present that would warrant a landslide hazard and risk study to support the application.

RVCA requested the opinion presented in this letter report in an email dated August 4, 2022 and the work was conducted in accordance with the terms of a contract between RVCA and BGC dated May 19, 2022.

2.0 OBSERVATIONS

The following observations are based on a review of available topography, a geotechnical report submitted by Paterson Group Inc. (Paterson, November 6, 2019) to 8417709 Canada Inc. (the project proponent) and observations made during a brief field reconnaissance conducted by the undersigned on August 15, 2022.

The proposed development site is located in the Orleans area of eastern Ottawa, Ontario, and is located south of Regional Road 174, north of St. Joseph Boulevard and immediately east of a ramp between those two roads. Figure 01 shows the approximate extents of the proposed development and the borehole locations as interpreted from Paterson (November 6, 2019).

The proposed development site is at elevations of approximately 58 m to 59 m and is proximal to slopes in three directions, as follows:

1. An unnamed creek approximately 100 m west of the site flows east-northeast toward Ottawa River (see Figure 01). Creek valley slopes are typically 10 to 12 m high. Fill is present west of the creek valley, north of Regional Road 174, with anthropogenically modified slope heights on that side of the valley up to approximately 15 m. Maximum slope height is approximately 12 m on the east valley slopes closest to the project site.
2. A second unnamed creek approximately 350 m east of the site, with maximum slope height < 15 m, also shown in Figure 01. The natural slopes along this creek valley are typically < 10 m high. The nearest slope along the west side of the creek valley immediately north of St. Joseph Boulevard appears to have been modified through fill placement, resulting in locally steeper slopes up to approximately 15 m.
3. An escarpment immediately south of St. Joseph Boulevard, > 50 m from the southern perimeter of the site with slope height > 25 m, also shown in Figure 01.

The geotechnical report submitted by Paterson (November 6, 2019) includes observations from nine boreholes drilled to maximum depths of 6 m below the ground surface, with one dynamic cone penetrometer test (DCPT) below the drilled depth to refusal on a harder stratum. All six boreholes encountered stiff to very stiff silty clay to the depth of drilling, with a fill layer observed at the ground surface at one borehole location. The clay has variable sensitivity, with peak undrained shear strength typically > 100 kPa and remoulded strength typically ranging between 10 kPa to 30 kPa. No index testing of the soil is provided. Refusal of the DCPT sounding occurred at 23.7 m depth and may reflect till or bedrock below the clay. Since the boreholes and vane shear testing terminated at 6 m depth, there are no shear strength and sensitivity data available for the lower 17 to 18 m of overburden soils. The topographic position of the site within an eroded terrace below an eroded escarpment suggests that the deeper soils are most likely overconsolidated with similar or higher peak shear strengths; remoulded strengths and sensitivities are unknown below 6 m depth.

BGC conducted a ground traverse along the escarpment slope south of St. Joseph Boulevard, starting at the location of Princess Louise waterfall (see Figure 02 and Photo 1), and progressing west beyond the point where the escarpment curves to the southwest. BGC observed horizontally bedded limestone bedrock in several locations along the crest of the slope; these observation locations are shown on Figure 02. BGC observed the top of bedrock at approximately 83 m elevation near Princess Louise waterfall (Photo 2) and 80 m near the western end of the traverse at a culvert outlet discharging onto rock (Photo 3). Observations made along the traverse suggest that top of bedrock is at or above elevations with slope angle > 30 degrees, suggesting a minimum elevation of top of bedrock of 80 m along the length of the traverse. Ground elevations along the upland south of the escarpment slope crest range from 85 to 87 m, suggesting a maximum thickness of 7 m of overburden above bedrock, ranging from 0 m at the east end near the waterfall.

3.0 DISCUSSION

3.1. Slopes with potential for landslides

Three slopes are present within a few hundred metres of the project site. These are each discussed in turn in the following sub-sections, with reference to the numbering given in Section 2.0. The interpretations presented below are preliminary, based on a relatively brief review of limited data, and are thus subject to some uncertainty, potentially on the order of a factor of 10.

3.1.1. Unnamed creek west of the site (slope #1)

This creek valley has slopes with maximum height < 12 m on its east side, closest to the project site. According to a draft regional landslide hazard assessment by BGC (March 10, 2021), the maximum expected annual frequency of large, rapid retrogressive landslide (earth flow or earth spread) occurring at the eastern creek valley slopes is 9.2×10^{-7}, or $< 1 \times 10^{-6}$. The observed remoulded shear strength of the clay in the upper 6 m from the ground surface is > 10 kPa, suggesting low potential for rapid earth flow, which requires remoulded strength < 1 kPa, which could be present above the creek invert at depths greater than the borehole limits (i.e., from 6 m to 12 m depth). While this factor does not rule out the possibility of an earth flow or earth spread, it does make the likelihood of a landslide lower than the baseline estimate. Large landslide scars are absent along this creek, suggesting lower than average landslide frequency. Peak undrained shear strength is relatively high, indicating overconsolidated clay and suggesting lower than average landslide frequency. The distance between the northeast edge of the proposed development and the highest creek valley slopes is approximately 120 m, or 10 times the slope height. According to the draft regional landslide hazard assessment by BGC (March 10, 2021), the conditional probability of a large, rapid, retrogressive landslide extending at least 10 times the height of the affected slope is approximately 50%. Landslide frequency is therefore interpreted to be $< 1 \times 10^{-6}$ per year, and potentially much lower, for a large landslide to occur and reach the site.

3.1.2. Unnamed creek east of the site (slope #2)

The creek west of the site has natural slopes of 10 m height or less which have been modified in places through fill placement to be up to 15 m high. According to a draft regional landslide hazard assessment by BGC (March 10, 2021), the maximum expected annual frequency of large, rapid retrogressive landslide (earth flow or earth spread) occurring at the western creek valley's natural slopes is 1.5×10^{-7}. The presence of anthropogenic modification, including increased slope height, may increase landslide frequency from this background value. The absence of low remoulded strengths and presence of high intact strengths both serve to reduce landslide frequency, as discussed for the western creek valley slopes. The eastern creek valley slopes are approximately 350 m to 400 m from the project site, which is 35 times the height of the natural slopes. This setback distance from the creek slopes exceeds that observed in the draft regional landslide hazard assessment by BGC (March 10, 2021), which showed a maximum retrogression length of 29 times slope height for the 187 creek valley landslides in the Ottawa-Gatineau area considered

in that study. The conditional probability of a large, rapid, retrogressive landslide extending at least 35 times the height of the affected slope is therefore very low, and potentially not credible. Landslide frequency is therefore interpreted to be < 1 x 10^{-6} per year, and potentially much lower, for a large landslide to occur and reach the site.

3.1.3. Escarpment south of the site (slope #3)

The escarpment slope south of the site is > 25 m high, but with a maximum thickness of approximately 7 m of overburden soil above bedrock at the slope crest. According to the draft regional landslide hazard assessment by BGC (March 10, 2021), large, rapid retrogressive landslides are assumed to not be credible for slope height < 8 m. While the total slope height here is > 25 m, the height of slope that could potentially be involved in a rapid retrogressive landslide is < 8 m, suggesting that large, rapid landslides are not credible to occur and reach the site.

3.2. Landslide Hazard and risk guidelines

RVCA has been using provisional guidelines for landslide hazard and risk in consideration of the potential for large, rapid, retrogressive landslides in sensitive glaciomarine clay. These provisional guidelines refer to landslide hazard guidelines promulgated by Fraser Valley Regional District (1993, 2017 and 2020) and landslide risk guidelines from the Town of Canmore (2016 and 2018). In applying these provisional guidelines, a proponent may satisfy RVCA objectives by demonstrating that large, catastrophic landslides occurring and reaching the site have an annual frequency lower than 1 x 10^{-4} per year. If this landslide hazard target cannot be met, the proponent is required to show that landslide risk objectives can be met for both individual risk and group risk. Our preliminary analysis of landslide hazard suggests that the annual frequency of large landslides occurring and reaching the site is < 1 x 10^{-6} per year from either of the two nearby creeks. This is 100 times lower than RVCA objectives for large, catastrophic landslide frequency.

4.0 CONCLUSIONS

We offer the following conclusions regarding landslide hazard affecting the proposed development at 3459 and 3479 St. Joseph Boulevard:

- Landslide hazards are credible at the site and might initiate from two different creek valley slopes located west and east of the site.
- Large, rapid, retrogressive landslides in sensitive clay initiating along the escarpment south of the site are not credible.
- Landslide frequency is interpreted to be < 1 x 10^{-6} per year for each creek valley landslide source, which is 100 times lower than RVCA provisional landslide hazard objectives.

While there is some uncertainty in the analysis presented in this report, which is based on a draft regional landslide hazard assessment (BGC, March 10, 2021), we think it is unlikely that further study of landslide hazards would add value in supporting a land use decision for the proposed development site at 3459 and 3479 St. Joseph Boulevard.

5.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of Rideau Valley Conservation Authority. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

As a mutual protection to our client, the public, and ourselves, all documents and drawings are submitted for the confidential information of our client for a specific project. Authorization for any use and/or publication of this document or any data, statements, conclusions or abstracts from or regarding our documents and drawings, through any form of print or electronic media, including without limitation, posting or reproduction of same on any website, is reserved pending BGC's written approval. A record copy of this document is on file at BGC. That copy takes precedence over any other copy or reproduction of this document.

Yours sincerely,

BGC ENGINEERING INC.
per:

Pete Quinn, Ph.D., ing., P.Eng.
Principal Geotechnical Engineer

Reviewed by:

Dave Gauthier, Ph.D., P.Eng., P.Geo.
Senior Geological Engineer/Engineering Geologist

PQ/DG/mjp

Attachments:
Figures
Photos

REFERENCES

BGC Engineering Inc. (2021). Review of sensitive clay landslide hazards in the Ottawa area. Draft report 1954003 submitted to Rideau Valley Conservation Authority March 10, 2021.

Fraser Valley Regional District (FVRD) (2020). Hazard acceptability thresholds for development approvals.

Fraser Valley Regional District (FVRD) (2017). Hazard acceptability thresholds for development approvals.

Fraser Valley Regional District (FVRD) (1993). Hazard Acceptability Thresholds for Development Approvals by Local Government.

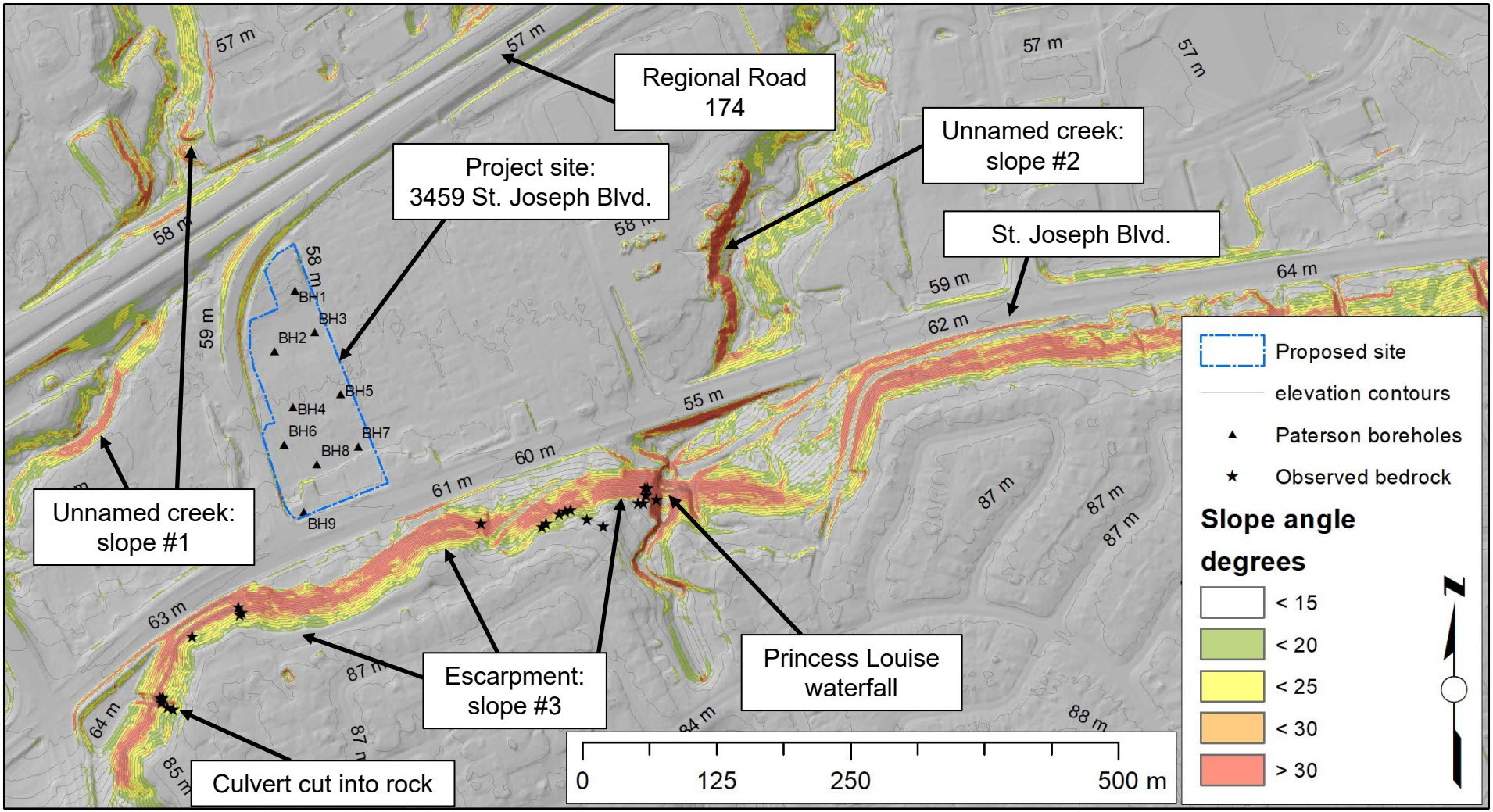
Paterson Group Inc. (2019). Geotechnical investigation: Proposed residential development 3459 and 3479 St. Joseph Boulevard, Ottawa, Ontario. Report PG5091-1 dated November 6, 2019.

The Town of Canmore (2016). Steep creek hazard and risk policy. Council resolution, approved September 20, 2016.

The Town of Canmore (2018). Canmore municipal development plan. Bylaw 2016-03, adopted October 2, 2018.

FIGURES

09-2022



NOTES:

1. This Figure should be read in conjunction with BGC's report titled "Landslide hazards affecting 3459 and 3479 St. Joseph Boulevard" and dated September 2022.
2. Topographic hillshade and slope angle derived from lidar topography provided by the City of Ottawa and is derived from a survey completed 2020.
3. Paterson borehole locations and site boundaries are interpreted from Paterson (2019).
4. Locations of observed bedrock were made by BGC on August 15, 2022.

PREPARED BY: PQ	FIGURE TITLE: Site location plan		
CHECKED BY: DG	CLIENT: Rideau Valley Conservation Authority		
APPROVED BY: PQ	SCALE: As shown	PROJECT NO: 1954-004.06	FIGURE NO: 01

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

PHOTOS

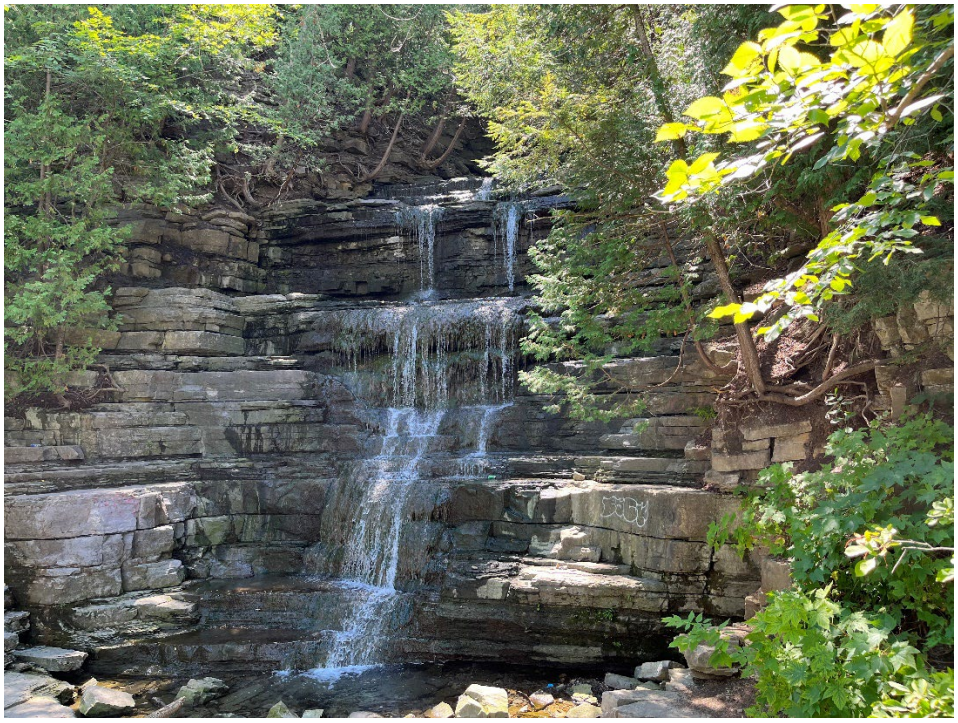


Photo 1. Princess Louise waterfall (see Figure 02). Photo taken by BGC 2022-08-15.

Photo 2. Bedrock at the ground surface above the slope crest west of Princess Louise waterfall at an approximate elevation of 83 m (see Figure 02). Photo taken by BGC 2022-08-15.

Photo 3. Culvert outlet with discharge onto bedrock at an approximate elevation of 80 m (see Figure 02). Photo taken by BGC 2022-08-15.