SQUAMISH - LILLOOET
REGIONAL DISTRICT

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DELIVERED ELECTRONICALLY (VIA LLE's WEBSITE SYSTEM)

March 5, 2015

Dear Lillooet Lake Estates Site Owner:

Re: Issuance of Do Not Occupy Recommendation regarding Sites Located in the Purple Zone and the Red Zone

Background

Last April, the Squamish-Lillooet Regional District (SLRD) recommended that residents should not occupy sites located within the 800 foot corridor around Catiline Creek (400 feet on either side). This Do Not Occupy recommendation was supported by the geotechnical information available at that time and was based on the Land Use Contract (LUC) creek protection corridors and the recommendations set out in the 1976 geotechnical report associated with the LUC. As well, the SLRD advised owners of sites located outside the 800 foot corridor that the existing geotechnical hazards may extend further than the 800 foot corridor to the entire development. The SLRD also advised that the provincial government was funding a Debris-Flow Hazard and Risk Assessment of the Catiline Creek fan (Assessment) which, once completed, would provide an updated picture of the geotechnical hazards within the study area.

Assessment Findings

BGC Engineering Inc. (BGC) has now completed the Assessment and issued a final report dated January 22, 2015 (BGC Report) which identifies both individual risk and group risk within the study area. A copy of the BGC Report in its entirety is available at www.slrd.bc.ca/catiline-creek-debris-flow-hazard, and we strongly encourage you to read through it.

We have enclosed two excerpts from the BGC Report: the Executive Summary, which provides a general overview of the Assessment; and the Risk to Individuals Map, which identifies the risk zones associated with Catiline Creek.

- The Purple Zone sites are subject to a greater than 1:1,000 risk of fatality per year. This is the highest risk level within the study area, exceeding existing risk tolerance guidelines for existing developments as outlined in the BGC Report.

- The Red Zone sites are subject to a greater than 1:10,000 risk of fatality per year. This is the next highest risk level within the study area, exceeding existing risk tolerance guidelines for existing developments as outlined in the BGC Report.

- The Yellow Zone sites are subject to a greater than 1:100,000 risk of fatality per year. This risk level is tolerable, according to existing risk tolerance guidelines for existing developments as outlined in the BGC Report.

Recommendation to Not Occupy Purple Zone and Red Zone Sites

On the basis of this updated information, the SLRD recommends that people should not use or occupy Purple Zone sites or Red Zone sites. The SLRD strongly urges all affected residents to voluntarily comply with this Do Not Occupy recommendation.

Your site is identified in the BGC Report as being located outside of the Purple Zone and the Red Zone. As such, the Do Not Occupy Recommendation does not apply to you.

Next Steps

In the coming weeks, the SLRD Board will consider the BGC Report further in light of the newly quantified risk zones. Regarding the indicated conceptual mitigation options, the SLRD will facilitate stakeholder negotiations to discuss the potential to implement remedial works to reduce the risks to tolerable levels. The SLRD will also approach the Province of British Columbia, on behalf of residents, with the objective of achieving provincial participation in a collaborative approach to protect life safety.

The SLRD will also be installing updated signage along the Forest Service Road to identify the sites within the Purple Zone and the Red Zone and to communicate the Do No Occupy Recommendation to members of the public and visitors.

You may keep apprised of any Board decisions related to this matter through the Board's open meeting process, the SLRD website or by joining the Lillooet Lake Estate/Heather Jean Properties group email list by contacting Jeannette Nadon, Communications Coordinator at (604) 894-6371 ext. 239 or toll-free at 1-800-298-7752 or by email at jnadon@slrd.bc.ca.

If you have specific questions, you may wish to contact SLRD Chief Administrative Officer Lynda Flynn by phone at 604-894-6371 ext. 231 or toll-free 1-800-298-7753 or by email at lflynn@slrd.bc.ca.

Sincerely,

Jack Crompton
Chair of the Squamish-Lillooet Regional District Board

cc:
Squamish-Lillooet Regional District Directors
Lillooet Lake Estates Ltd.
Heather Jean Properties Ltd.
DL 4901 Lillooet Lake Holdings Co. Ltd.
Lynda Flynn, SLRD Chief Administrative Officer

Enclosures:
(1) Executive Summary and (2) Risk to Individuals Map (both excerpted from the BGC Report)

EXECUTIVE SUMMARY

BGC Engineering Inc. (BGC) was retained by the Squamish-Lillooet Regional District (SLRD) as agent for Emergency Management BC (EMBC) to assess debris-flow hazards and risks on Catiline Creek on the north side of Lillooet Lake. The primary objectives of this assessment were to:

- Assess geohazard safety risk for residential development located at the outlet of the Catiline Creek drainage
- Develop conceptual debris-flow risk reduction options and costs.

BGC assessed risk for four debris flow scenarios representing a range in debris-flow return periods from 5 - 30 to 3000 - 10,000 years. Debris flows were numerically simulated for each scenario at volumes ranging from 6000 m^3 for the smallest event to 300,000 m^3 for the largest event. The risk assessment involved estimating the probability that debris flows will impact residential dwellings and cause loss of life. It considered the existing channel configuration and conservatively assumed that no evacuation is possible during the event.

This assessment used two different metrics to estimate safety risk: individual risk and group risk. Individual risk evaluates the chance that a specific individual (the person judged to be most at risk) will be affected by the hazard. Group risk, also known as societal risk, evaluates the chance that any people present in the area will be affected by the hazard.

Results were compared to quantitative risk tolerance or risk acceptance criteria to help guide the development of options to reduce risk to tolerable levels. Such criteria have not been defined for British Columbia by formal legislation. For this study, estimated risks were compared with individual risk tolerance criteria formally adopted by the District of North Vancouver, British Columbia (DNV 2009), and with group risk tolerance criteria formally adopted in Hong Kong (GEO 1998) and previously applied by DNV. The DNV criteria for individual landslide risk tolerance are as follows (DNV 2009):

- Maximum 1/10,000 (10-4) risk of fatality per year for existing developments
- Maximum 1/100,000 (10-5) risk of fatality per year for new developments.

In summary, BGC's best-estimate of individual risk exceeded 1:10,000 risk of fatality per year for 76 of the 114 occupied, residential-classed lots within the study area. Of these, 18 lots exceeded 1:1,000 annual risk of fatality, more than one order of magnitude above the DNV individual risk tolerance threshold. Estimated group safety risk also fell entirely into the "Unacceptable" range when compared to the above risk tolerance standards.

Table E-1 summarizes mitigation options and estimated costs. Each option was developed for 100,000 m^3 and 300,000 m^3 design volumes, which correspond to approximately 1000 – year and 10,000 year return period events, respectively. The estimated cost of mitigation for the smaller design volume is about half that of the larger option, primarily due to lower earthworks requirements.

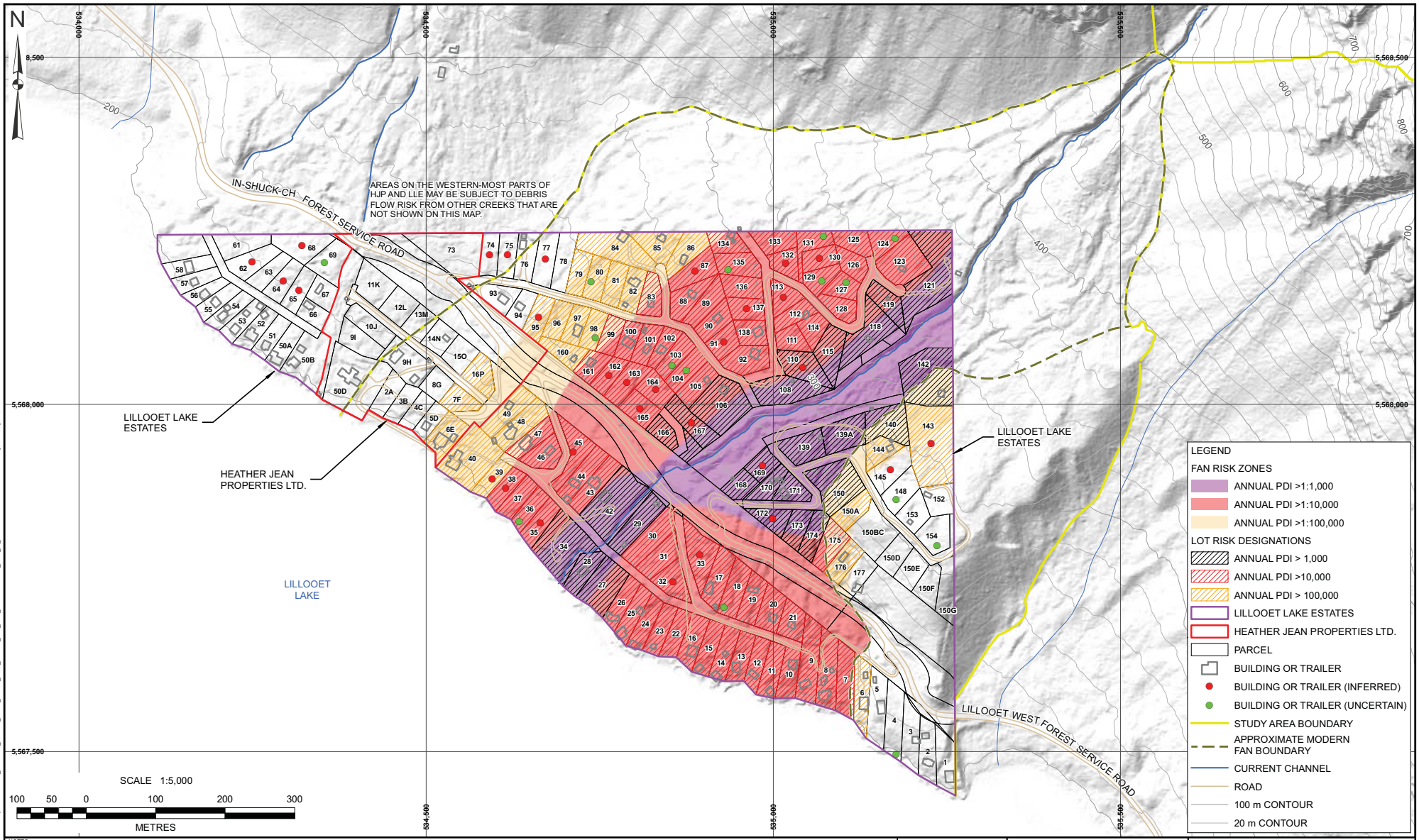
The larger design volume is intended to reduce risk to tolerable levels according to DNV standards (e.g. tolerable residual risk). Preliminary analyses suggest that mitigation of the smaller design volume may reduce individual safety risk but not group risk to tolerable levels according to DNV criteria. This is subject to confirmation during detailed mitigation design. While risks other than safety were not quantified in this assessment, the mitigation options listed in Table E-1 would also reduce risk for a broad spectrum of other elements on Catiline fan including roads, utilities, and water and power transmission.

Table E-1. Mitigation Options and Costs.

Risk Reduction Option		Description	Design Volume	Conceptual Level Cost Estimate1
1	Increase capacity of existing channel	Widen, deepen, and straighten the existing channel to increase the peak flow rate that the channel is able to convey.	100,000 m^3	$ 4.0 M
			300,000 m^3	$ 9.1 M
2	Diversion structure at fan apex	Excavate a diversion channel that captures debris flows at the fan apex and directs flow along the undeveloped land on the east margin of the fan, across the forest service road to Lillooet Lake.	100,000 m^3	$ 4.7 M
			300,000 m^3	$ 8.1 M
3	Retention barrier at fan apex	Construct a debris retention barrier on the fan near the fan apex to capture debris during a debris flow event.	100,000 m^3	$ 17.9 M
			300,000 m^3	$ 31.2 M

Note:
1) Cost estimates are 'conceptual level', associated with an accuracy of roughly -50% to +100%, and intended for comparison purposes only.

Of the options above, Options 1 and 2 provide the greatest level of risk reduction for the estimated cost. The estimated costs for Options 1 and 2 include replacement of the FSR bridge. Alterations to the BC Hydro line or purchase of private land adjacent to the existing channel may also be required, but have not been included in the cost estimate. Ongoing maintenance costs to maintain channel capacity are also not included. Option 3 is the highest cost option, requires a larger structural footprint, and provides less storage potential.



NOTES:
1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "CATILINE CREEK DEBRIS-FLOW HAZARD AND RISK ASSESSMENT", AND DATED JANUARY 31, 2015.
3. THIS MAP SHOULD NOT BE USED AT A SCALE LARGER (MORE DETAILED) THAN SHOWN ON THIS MAP.
4. THIS MAP REPRESENTS A SNAPSHOT IN TIME. THE OCCURRENCE OF GEOHAZARD EVENTS OR CHANGES IN DEVELOPMENT MAY WARRANT THE RE-DRAWING OF SOME AREAS.
5. AREAS ON THE WESTERN-MOST PORTION OF CATILINE FAN MAY BE SUBJECT TO ADDITIONAL DEBRIS FLOW RISK THAT IS NOT SHOWN ON THIS MAP.
6. BUILDING OUTLINES AND ROADS PROVIDED BY MCELHANNEY, DATED JULY AND AUGUST 2014. IN AREAS OF TREE COVERAGE ONLY PARTIAL BUILDING OUTLINES COULD BE IDENTIFIED.
7. BUILDING POINTS (UNCERTAIN) WERE DIGITIZED BY BGC IN AREAS OF PARTIAL TREE COVERAGE AND SHOULD BE CONSIDERED APPROXIMATE.
8. BUILDING POINTS (INFERRED) WERE PLACED AT THE CENTROID OF THE LOT AND ARE CASES WHERE NO BUILDING WAS IDENTIFIED, BUT BC ASSESSMENT OR RESIDENT INTERVIEW DATA IMPLIED THAT A BUILDING SHOULD EXIST.
9. BASE TOPOGRAPHIC DATA BASED ON LIDAR FROM MCELHANNEY, DATED JULY AND AUGUST 2014. CONTOUR INTERVAL IS 20 m.
10. STUDY AREA BOUNDARY IS ILLUSTRATED BY THE CATILINE CREEK APPROXIMATE MODERN FAN BOUNDARY.
11. THE FAN BOUNDARY AS DRAWN IS APPROXIMATE AND DELINEATES THE LANDFORM. THE BOUNDARY SHOULD NOT BE CONSTRUED AS A HAZARD MAP, NOR DOES IT SHOW THE SPATIAL EXTENT OF POTENTIAL DEBRIS-FLOW IMPACT.
12. PROJECTION IS UTM NAD 83 ZONE 10.
13. UNLESS BGC AGREES OTHERWISE IN WRITING, THIS DRAWING SHALL NOT BE MODIFIED OR USED FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH BGC GENERATED IT. BGC SHALL HAVE NO LIABILITY FOR ANY DAMAGES OR LOSS ARISING IN ANY WAY FROM ANY USE OR MODIFICATION OF THIS DOCUMENT NOT AUTHORIZED BY BGC. ANY USE OF OR RELIANCE UPON THIS DOCUMENT OR ITS CONTENT BY THIRD PARTIES SHALL BE AT SUCH THIRD PARTIES' SOLE RISK.

SCALE:	1:5,000
DATE:	JAN 2015
DRAWN:	LL
CHECKED:	SK
APPROVED:	KH

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: SQUAMISH-LILLOOET REGIONAL DISTRICT

PROJECT: CATILINE CREEK DEBRIS-FLOW HAZARD AND RISK ASSESSMENT

TITLE: RISK TO INDIVIDUALS

PROJECT No.: 1358 001

DWG: 08

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