March 26, 2015

Pheidias Project Management Corp
660 – 1188 West Georgia Street
Vancouver, BC V6E 4A2

Attention: Oberto Oberti

Re: Snow avalanche hazard mapping for mid and upper Jumbo Valley, Jumbo Glacier Resort

Dear Mr. Oberti:

This report presents the results of updated snow avalanche hazard mapping for the mid and upper Jumbo Creek valley, which is located approximately 45 km west of Invermere, BC. This area is included within the Glacier Resort Controlled Recreation Area (CRA).

Mapping was completed for the mid and upper Jumbo Creek valley, extending from the south end of the proposed resort village northwards to the head of the Jumbo Creek valley. The remainder of the CRA was not mapped during this project (i.e. North Glacier Dome, Commander, Farnham, and the Jumbo Creek access road south of the CRA).

This work was completed by Dynamic Avalanche Consulting Ltd. (DAC) on behalf of Pheidias Project Management Corp. (Pheidias), who is providing resort development services to Glacier Resorts Ltd. The work presented in this report is intended for the exclusive use of Pheidias and Glacier Resorts Ltd. (GRL).

1.0 Introduction

The mapping that accompanies this letter provides an update to avalanche hazard mapping previously completed by Alpentec (1990)[1]. The Alpentec mapping was presented on a 1:50,000 National Geographic System (NTS) base map, with hand-plotted line work based on a combination of air photo interpretation and field observations.

The updated hazard mapping presented in this report is presented on a 2005 high resolution orthophoto image with a 1:20,000 TRIM topographic contour base, compiled in a Geographic Information System (GIS). The mapping includes two avalanche paths (Pink Panther and Karnak) that were observed on the ground at a higher level of detail during completion of avalanche risk zoning for a Day Lodge and Service building (DAC, 2015)[2].

The reader is referred to DAC (2015) for additional discussion on snow avalanche characteristics and the snow climate for the project area.

[1] Alpentech Inc. 1990. Jumbo Valley Access Avalanche Map. Revised November 8, 1990.
[2] DAC, 2015. Jumbo Glacier Resort. Snow avalanche risk zoning for a Day Lodge and Service Building. Report prepared for Glacier Resorts Ltd. c/o Pheidias Project Management Corp. March 19, 2015.

2.0 Methods

The locations of the avalanche path boundaries shown on the accompanying map were determined based on the following methods:

- Discussions with GRL personnel: Oberto Oberti, Tommaso Oberti and Grant Costello;
- Phone interviews with RK Heliski guides: Graham Holt, Rod Gibbons, Andrew Nelson;
- Phone interview with Peter Schaerer, avalanche expert.
- Review of 1:20,000 TRIM and 1:50,000 NTS topographic map data;
- Review of historical aerial photographs: 30BC7099 #260-263 (1968); 30BC7821 #221-222 (1975); 15BC81118 #17-18 (1981); 30BC85062 #121,126 (1985); 15BCB95058 #72 (1995); BCB97099 #191 (1997); 30BCC05036 #22 (2005); 30BCC06066 #192 (2006)
- Review of Google Earth and Bing (dated 2005) imagery;
- Analysis of regional snow course and weather station data;
- Review of snow climate data provided by RK Heliski;
- Dynamic and statistical modelling of avalanche runout for paths presented in DAC (2015);
- Field survey of terrain and vegetation by helicopter and ski on Dec. 30, 2014.

The following materials were used and referenced in preparation of this report:

- Alpentech Inc. 1990. Jumbo Valley Access Avalanche Map. Revised Nov. 8, 1990.
- RK Heliski. 2014. Re: Extreme Avalanche Hazard at New Jumbo Glacier Resort (JGR) Day Lodge Building Site. Letter to BC Environmental Assessment Office, Oct. 30, 2014.
- Schaerer, 2014. Snow Avalanche Hazards at Jumbo Glacier Resort. Report prepared for Oberti Resort Design. Dated Nov. 26, 2014.
- Numerous site photographs taken on the ground and in the air, provided by Oberto Oberti, Grant Costello and RK Heliski.

On December 30, 2014 Alan Jones, P.Eng. and Greg Johnson, P.Eng. conducted a field investigation of terrain in select parts of the Jumbo Glacier Resort project area. An overview helicopter flight provided observations of the entire proposed CRA, including the Glacier Dome, Commander, Farnham, Upper Jumbo Creek, Day Lodge and Service Building, and Village development areas.

A detailed ground survey was completed at the Day Lodge and Service Building area, including observations of terrain and vegetation in the Pink Panther (South Wolverine) path from approximately 2375 m to the valley bottom near 1700 m.

3.0 Avalanche Hazard Mapping

The attached Snow Avalanche Hazard Overview Map shows the results of avalanche mapping for areas within the mid to upper Jumbo Creek Valley. Avalanche paths were identified using a combination of aerial imagery, topographic mapping, and field observations, supplemented by observations made from a helicopter (see Section 3.0 for methods). Detailed field observations and modelling were completed only for the Pink Panther and Karnak paths.

The avalanche paths are shown as polygons which indicate the approximate boundaries of the avalanche paths from the upper extent of the starting zone to lower, extreme runout position. These boundaries are intended to be representative of an approximate 100-year return period avalanche event. The one exception to this is the Pink Panther path, which was mapped in detail by DAC (2015); the boundary shown for this path represents a 300-year return period.

A total of 25 avalanche paths were identified in the project area, 10 of which are located on the west side of the valley and 15 are on the east side of the valley. Each path is provided a unique name based on one of Lev (1990), RK Heliski run names, or geographic feature names.

All of the identified paths are capable of producing Size 3 avalanches according to the Canadian Avalanche Size Classification system (McClung and Schaerer, 2006[3]) (Table 1). Some of the paths are also capable of producing Size 4 avalanches.

Table 1. Canadian Avalanche Size Classification (McClung and Schaerer, 2006).

Size	Description (Destructive Potential)	Typical mass (t)	Typical path length (m)	Typical impact pressure (kPa)
1	Relatively harmless to people.	<10	10	1
2	Could bury, injure or kill a person.	10^2	100	10
3	Could bury a car, destroy a small building (e.g. wood frame house), or break a few trees.	10^3	1000	100
4	Could destroy a railway car, large truck, several buildings or forest with an area up to 4 hectares (ha).	10^4	2000	500
5	Largest snow avalanches known; could destroy a village or forest up to 40 ha.	10^5	3000	1000

The frequency of avalanches within these paths was not assessed in this report, but all are located in an area of sufficiently high snow that annual Size 2-3 avalanches can be expected. Potential avalanche path frequencies should be evaluated in a greater level of detail during subsequent phases of the project.

[3] McClung, D. and P. Schaerer. 2006. The Avalanche Handbook. The Mountaineers Books, Seattle.342pp.

4.0 Summary

This report and the accompanying map identified 25 avalanche paths in the mid to upper Jumbo Creek Valley within the Jumbo Glacier Resort CRA. All of these paths are capable of producing Size 3 avalanches, and some are capable of producing Size 4 avalanches.

The mapping presented in this report represents the approximate 100-year return period path boundary, and is intended to be used for resort facility location planning, including the location of ski lifts, runs and trails.

Any area where residential development is anticipated should be mapped to a higher level of detail according to the avalanche risk zones defined in the *Guidelines for Snow Avalanche Risk Determination and Mapping in Canada* (CAA, 2002[4]). This level of work was completed for the Day Lodge and Service building area located near the Pink Panther avalanche path (DAC, 2015).

5.0 Closure

This report was prepared for the exclusive use of Pheidias Project Management Corp., and Glacier Resorts Ltd. Any use which a third part makes of this report, or any reliance on or decisions made based on this report are the responsibility of such third parties. Dynamic Avalanche Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

We trust that this report satisfies your present requirements. Should you have any questions, please contact the undersigned at your convenience.

Dynamic Avalanche Consulting Ltd.

Prepared by:

Alan Jones, M.Sc., P.Eng.
CAA Professional Member

[4] Canadian Avalanche Association. 2002. Guidelines for Snow Avalanche Risk Determination and Mapping in Canada. McClung, D., Stethem, C., Schaerer, P., Jamieson, B. (eds.) Canadian Avalanche Association.