APPENDIX 34-B
MITCHELL GLACIER STABILITY STUDY

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BGC Project Memorandum

To:	**Seabridge Gold Inc.**	**Doc. no:**	**KSM11-12b**
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From:	**Lukas Arenson / Jack Seto**	**Date:**	**May 3, 2011**
Subject:	**Mitchell Glacier Stability Study: KSM Project, Recommendations**		
Project no:	**0638-011**		

1.0 INTRODUCTION

Seabridge Gold Inc. (Seabridge) is planning to develop the Kerr, Sulphurets, and Mitchell (KSM) Project, a major gold-copper deposit located in northwest British Columbia. One of the open pits, Mitchell Pit, is scheduled to undermine Mitchell Glacier, and will require the removal of a significant volume of glacier ice from its terminus to develop the pit. BGC Engineering Inc. (BGC) was retained by Seabridge to complete a desktop study reviewing the dynamics of Mitchell Glacier and assessing their impacts on safe pit development.

The scope of work for this project included the following tasks:

1. Review historical and current status of Mitchell Glacier (flow, extent, thickness, hydrology, etc.).
2. Describe potential hazards posed by Mitchell Glacier based on proposed mine development plan.
3. Present design recommendations for managing potential hazards from the glacier ice during mine operations.

BGC prepared a report that addresses Tasks 1 and 2 (BGC 2011). This memorandum provides recommendations (Task 3) as a separate document as requested by Seabridge. This memorandum is intended to be read in conjunction with the above-cited BGC report.

2.0 MITCHELL GLACIER DYNAMICS

This section summarizes BGC's understanding of the dynamics of Mitchell Glacier, which are described in more detail in BGC's accompanying report (BGC 2011).

Mitchell Glacier is a medium-sized, temperate glacier located in a V-shaped valley. The overall slope of the glacier surface is approximately 10 degrees while the overall slope of the glacier bed is approximately 8 degrees. The glacier ice generally thins out toward the glacier terminus and is approximately 100 m thick at a location 600 m from the 2008 glacier terminus.

The glacier bed is comprised of a thin to no till layer overlying bedrock. There are irregularities in the bed surface (e.g., ridges and rock knobs) that have induced localized crevassing on the glacier surface. Currently, a cave is visible at the glacier terminus, through which the majority of subglacial water flows into Mitchell Creek. There is also a circular crevasse pattern on the ice surface near the glacier front. This feature is indicative of the collapse of glacier ice above a subglacial cavity. However, there may be other cavities or tunnels that have not yet been identified. Nevertheless, the subglacial system appears to be simple with water flow channelled along the valley thalweg. The glacier terminus is unstable, with near-vertical walls of ice up to 80 m high and calving (i.e., breaking off) of ice blocks along crevasses.

Since 1982, Mitchell Glacier has been retreating at an average rate of 30 m/year. Based on current climate change projections for the region, it is expected to continue retreating at similar rates over the next twenty years.

The potential for Mitchell Glacier to surge or rapidly advance is considered very low because of the V-shape of the glacier valley, the relatively steep overall bed slope angle, and the absence of geomorphic evidence suggesting that surges have occurred at this glacier at some time in the past.

3.0 SAFE ICE EXCAVATION

As noted in BGC's report, Mitchell Glacier currently overlies a portion of the proposed Mitchell Pit and the glacier ice will need to be removed to develop the pit. Much of the glacier front will naturally melt away if historical trends of glacier retreat continue. However, the current pit development schedule requires that some of the glacier ice be excavated. This section presents BGC's recommendations for safe ice excavation, describes the basis for maintaining a setback between the toe of the glacier and the edge of Mitchell Pit, and provides an estimate of the volume of ice that will need to be removed from the glacier front given the proposed pit development schedule and meeting the setback requirement.

3.1. Ice Excavation

As previously noted, the Mitchell Glacier terminus is currently unstable, with near-vertical walls of ice up to 80 m high and ice blocks breaking off along crevasses. To improve the stability of the glacier face above the proposed pit walls, it is recommended that the glacier face be flattened to an overall slope of 1H:1V by excavating the ice in benches, with bench heights and widths of 10 m to 15 m. The bench walls can be near-vertical, or whatever slope angle is practical. The excavation should be carried out from the top down and ice blocks broken off from existing crevasses where possible. During and following ice excavation, some localized calving and toppling of crevassed ice blocks near the glacier front can be expected, particularly in localized areas where the glacier bed slope steepens, although benching of the ice face should limit the potential size of these ice blocks. The removal of ice from the glacier front, whether through natural retreat or ice excavation, is not expected to trigger a surge.

It has been suggested that the ice can be mechanically removed using a dragline, shovels and haul trucks, and by drill and blast. Appendix A presents possible schematics of how ice excavation can be carried out mechanically. Thick and solid ice is strong enough to support heavy equipment. However, the potential occurrence of thin ice due to subglacial cavities and deep crevasses could reduce the bearing capacity of the glacier ice. Therefore, we recommend that heavy equipment not work directly on the glacier ice unless it has been verified through geophysics and/or drilling that there is sufficiently thick and solid ice beneath to provide bearing support. Furthermore, the bearing capacity of the ice should be tested by incrementally increasing the size (i.e., load) of equipment onto the glacier ice and observing any subsequent deformations of the glacier ice. Access routes over the glacier ice should be covered with a thin (minimum 0.5 m thick) layer of random fill to fill crevasses and reduce bearing pressures on the ice surface.

It is anticipated that blasting may be required on occasion to break down blocks of ice that may be too large or bound to remove with a dragline or shovel. Compared to rock, ice absorbs a large proportion of the energy generated by a blast, and hence a higher concentration of blast holes would be required to break up a similar volume of ice (Andersland and Ladanyi, 2004).

3.2. Setback

While much is understood about the dynamics of temperate valley glaciers, apart from several glaciers at the Kumtor Mine in Kyrgyzstan, there is to BGC's knowledge no precedent for removing significant volumes of glacier ice, let alone monitoring the effects of such actions on glacier deformation. While flattening the slope of the glacier front should improve the overall stability of the ice face, there is still the potential for large ice blocks to break off from Mitchell Glacier along crevasses. Furthermore, Mitchell Glacier has only been directly monitored since 2008, and hence its dynamics are not fully understood (particularly for year-to-year variability in glacier retreat or advance). Consequently, a minimum setback distance between the toe of the Mitchell Glacier terminus and the edge of the pit wall is recommended at all stages of pit development to provide a buffer zone between personnel and equipment working in the open pit and the excavated glacier front. Given that the current thickness of glacier in the portion of the glacier to be removed ranges from approximately 75 m to 130 m, BGC recommends that the minimum setback distance be twice the average ice thickness, or 2 x 100 m = 200 m. The excavated face of Mitchell Glacier is not expected to be static. It may advance or retreat, depending on the annual mass balance, geometry of the bed of Mitchell Glacier near the toe, and the stability of the ice blocks near the excavated benches. The recommended 200 m minimum setback distance between the edge of the open pit and the toe of Mitchell Glacier should be maintained until observations through monitoring (cf. Section 3.4) and local experience would support optimizing this distance in the future.

3.3. Pit Staging Schedule and Glacier Retreat

Since 1982, Mitchell Glacier has been receding at an average rate of approximately 30 m/year, and is projected to recede at similar rates in the foreseeable future; however, inter-annual variability in the rate should be anticipated. Assuming that Mitchell Glacier continues to retreat at this same average rate, the location of the glacier terminus relative to its 2010 location has been projected over the proposed 40-year mining period of 2019 to 2058 and compared with the planned pit crest locations. Table 1 summarizes the projected locations and computed distances between the pit crest and glacier terminus over this period. Table 1 shows that the minimum distance between the pit crest and glacier terminus is projected to range from over 300 m in Year 1 (2019) to almost 900 m by Year 40 (2058). In fact, Mitchell Glacier is projected to naturally retreat at a faster rate than the pit is planned to expand.

Table 1. Projected Glacier Terminus

Phase (Year)	Planned Location of Pit Crest Relative to 2010 Glacier Terminus	Projected Glacier Retreat (Relative to 2010 Glacier Terminus)	Projected Distance Between Pit Crest and Glacier Terminus
Year 1 (2019)	-60 m[1]	270 m	330 m
Year 20 (2038)	300 m	840 m	540 m
Year 30 (2048)	420 m	1140 m	720 m
Year 40 / LOM (2058)	550 m	1440 m	890 m

[1] Terminus retreated past the year 1 pit outline by 2010.

The projected distances between the glacier terminus and pit crest exceed the recommended minimum setback of 200 m in all years, indicating that mining of the Mitchell Glacier ice may not be required to develop Mitchell Pit according to the proposed development plan.

3.4. Monitoring

To assess and react to any natural and mining related changes in glacier dynamics, as well as optimizing the setback distance, it is recommended to implement a glacier monitoring program. The same systems recommended for pit slope monitoring can be applied to glacier monitoring.

The monitoring methods should be based on repetitive surface deformation measurements. Some options are:

- Photogrammetric Mapping system using stereo images and computer processing to identify displacements between data sets;
- Ground Based LiDAR with successive scans and computer processing to identify displacements between data sets;
- Slope Stability Radar (SSR) or Work Area Monitor (WAM) for detailed glacier wall movements;
- D-GPS velocity monitoring on the glacier surface; and
- Time lapse photography using fixed cameras to evaluate glacier dynamics.

4.0 SUMMARY

Mitchell Glacier has been retreating at an average rate of 30 m/year since 1982. Current climate change projections for the region suggest that it should continue to retreat at similar rates. As glacier advance or retreat is controlled by climate, there may be some years during the mine life that the glacier retreats at a slower rate or even advances. Furthermore, there may be instances where the glacier bed slope near the excavated face steepens, potentially leading to localized instability of the glacier front. Glaciological baseline measurements have only been initiated in 2008, and continued monitoring and review of these measurements are required to confirm our understanding of the dynamics of Mitchell Glacier. Therefore, a minimum 200 m setback distance between the toe of the excavated glacier and the edge of the open pit is recommended. This setback will provide safety for personnel and equipment working in the open pit and infrastructure such as inlet structures or roads by providing a buffer zone for localized toppling of ice blocks near the glacier front and the potential advance of Mitchell Glacier.

Seabridge has developed a plan to stage pit development such that the rate of pit expansion is less than the observed historical rate at which Mitchell Glacier has been retreating. Based on the current mine plan and assuming that Mitchell Glacier will continue to retreat at an average rate of 30 m/year, the location of the terminus of Mitchell Glacier is projected to be no closer than 300 m from the pit crest over the proposed 40-year mine life. This exceeds the recommended minimum setback distance of 200 m in all years of pit development; consequently, no mechanical excavation of the glacier ice is anticipated to be required for the safe development of Mitchell Pit.

In the unlikely event that Mitchell Glacier does not retreat or retreats at a much slower rate than the projected 30 m/year, it is technically feasible to mechanically excavate the glacier ice. It is recommended that the front of Mitchell Glacier be excavated to an overall slope of 1H:1V. The glacier ice can be excavated in 10 m to 15 m high benches (near-vertical or whatever can be easily excavated). Some localized calving and toppling of ice blocks near the excavated face can be expected. Given the crevassed glacier surface and the likely presence of subglacial drainage tunnels and cavities, heavy equipment should not be working directly from the glacier ice surface unless it has been confirmed that the ice is sufficiently thick to provide bearing support, particularly above cavities. Ice excavation activities are not expected to trigger rapid glacier advance or surging.

The current recommendations for both the excavated slope face angle and the setback distance may be modified depending on the observations and monitoring made and experience gained after the first few years of mining.

5.0 CLOSURE

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Yours sincerely,

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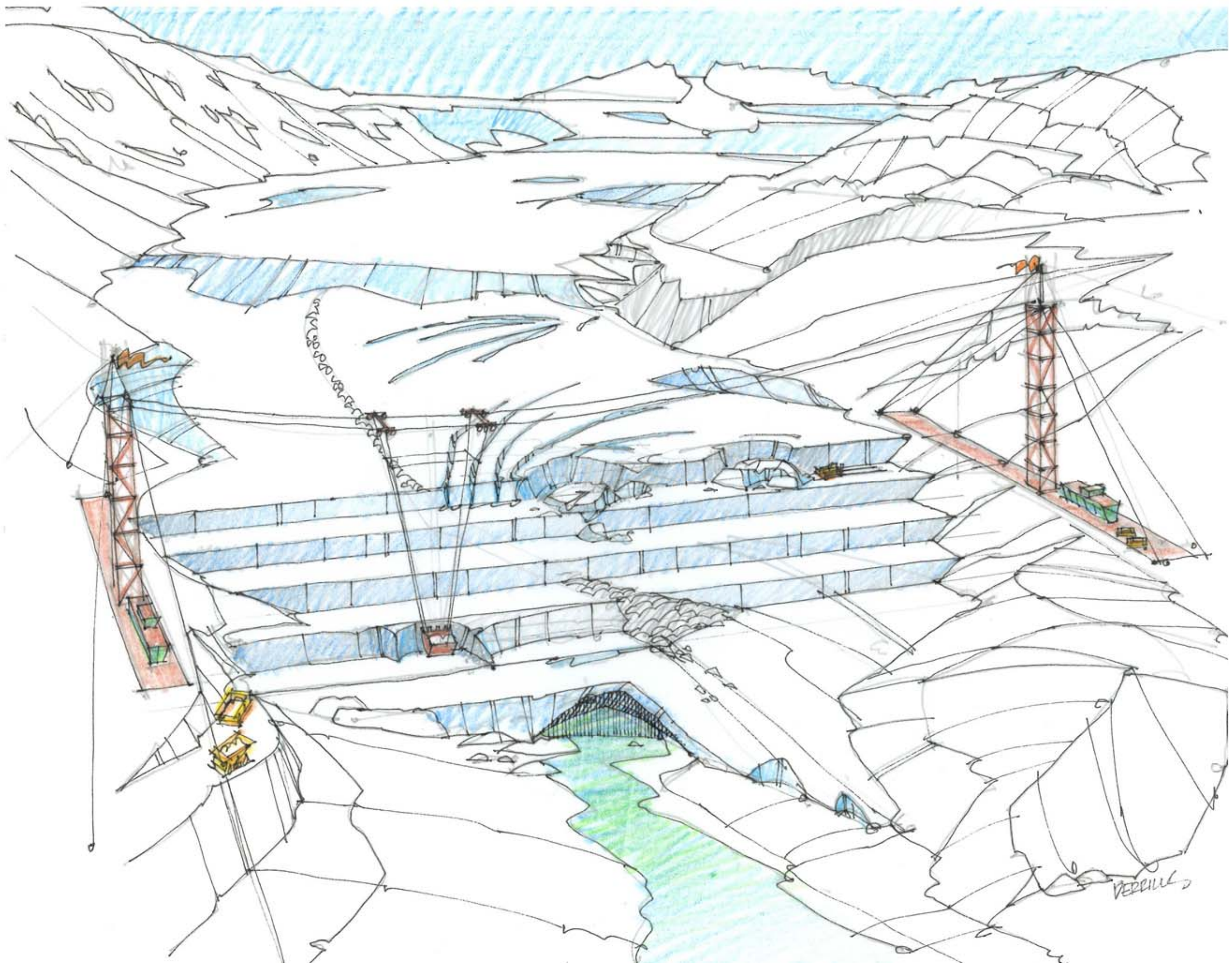
References

Andersland, O.B., Ladanyi, B. (2004). An Introduction to Frozen Ground Engineering. New York: ASCE & John Wiley & Sons. 363 p.

BGC Engineering Inc. (2011). KSM Project: Mitchell glacier Stability Study. Document No: KSM11-12: Report submitted May 3, 2011.

APPENDIX A
Drawings

Glacier Excavation Using Truck and Shovels.



Glacier Excavation using Valley Drag Line Crane