Appendix 5-F

Brucejack Project: Geohazard and Risk Assessment

ERM

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

PRETIUM RESOURCES INC.

BRUCEJACK PROJECT
GEOHAZARD AND RISK ASSESSMENT

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October 15, 2013
Project No: 1008-010

Ian Chang, P.Eng., Vice President, Project Development
Pretium Resources inc.
Suite 1600 – 570 Granville Street
Vancouver, BC, V6C 3P1

Dear Mr. Chang,

Re: Brucejack Project Geohazard and Risk Assessment

Please find attached a copy of the above referenced report dated October 15, 2013.

Should you have any questions or comments, please do not hesitate to contact the undersigned. We appreciate having the opportunity to work on such an interesting and challenging project.

Yours sincerely,

BGC ENGINEERING INC.
per:

Kris Holm, M.Sc., P.Geo.
Senior Geoscientist

EXECUTIVE SUMMARY

This report provides a geohazard and risk assessment of landslides and snow avalanches for the Brucejack project in northwest British Columbia, including proposed minesite facilities and the access road. Terrain stability mapping and overview description of geohazards were also completed for the proposed transmission line corridor on the east side of the Salmon Glacier Valley. The geohazard risk assessment completed for this study involved geohazards identification and estimation of geohazard likelihood, chance of impact of an element at risk, and cause some type of damage or loss. Geohazards identified as having the potential to impact existing or proposed facilities included snow avalanches, debris flows, debris floods, debris avalanches, and rockfall.

BGC estimated order-of-magnitude likelihoods of geohazard occurrence and their likelihood of causing a loss. For the purpose of baseline assessment these estimates considered existing and unmitigated conditions. Consequences were estimated for geohazard scenarios with respect to human safety, economic loss, environmental loss, and reputation loss to Pretium Resources Inc. The likelihood and consequence ratings for each facility were combined using a risk matrix that defined relative risk values ranging from Very Low to Very High for each facility.

Tabulation of geohazard scenarios and associated risk is provided in Appendix B, with risk assessment results summarized in Table E-1. Snow avalanches pose the highest relative risk in the minesite area, primarily due to their high frequency of occurrence. Flooding and snow avalanches pose the highest relative risk along the access road.

Table E-1. Summary Risk Statistics for the Unmitigated Case

Facility	Hazard Type(s)	Facility Risk	Safety Risk
Operations Camp (Minesite)	Landslide	Low	Low
	Avalanche	Moderate	High
Minesite Roads	Avalanche	-	High
Access Road	Landslide	Moderate	Low
	Flood	High	Moderate
	Avalanche	Low	Moderate
Transfer Station	Avalanche	Very Low	Low
Airstrip	Flood	High	-

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LIMITATIONS

BGC Engineering Inc. (BGC) and Alpine Solutions Avalanche Services (Alpine Solutions) prepared this document for the account of Pretium Resources Inc. The material in it reflects the judgment of BGC and Alpine Solutions 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 and Alpine Solutions accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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1.0 INTRODUCTION

1.1. General

BGC Engineering Inc. (BGC) was retained by Pretium Resources Inc. (Pretium) to complete a landslide and snow avalanche geohazard and risk assessment for the Brucejack project in northwestern British Columbia. The proposed project configuration includes mine facilities near Brucejack Lake and an access road from Highway 37 up Wildfire Creek, Bowser River and Knipple Glacier. A transmission line is proposed from Stewart up Bowser River to Knipple Glacier then west to the proposed mine near the south side of Brucejack Lake. Terrain stability mapping and overview description of geohazards were also completed for the proposed transmission line corridor. However, the transmission line was not included in the risk assessment as proposed transmission tower locations and an alignment are not yet available. Geohazard risk to the transmission line is largely associated with damage to the towers. Therefore without knowing the tower locations it is impossible to determine if they could be impacted.

This assessment is based on interpretation of approximately 1:20,000-scale air photographs, helicopter overview flights and fieldwork completed by BGC and Alpine Solutions in 2012 and 2013.

Descriptions of snow avalanche geohazards were completed by Alpine Solutions Avalanche Services (Alpine Solutions). These are referenced throughout the report and are summarized in more detail in Appendix A. Terrain stability mapping for the transmission line corridor was completed by Polly Uunila, P.Geo. of Polar Geoscience Ltd.

1.2. Use of this Report.

The information provided in this report includes identification of landslide and snow avalanche geohazards and estimation of their corresponding risks to proposed facilities. The assessment considers naturally occurring geohazards only; geohazards resulting from mine development (e.g. stability of cuts and fills) are not considered in this report. The appropriate use of this assessment requires some understanding of geohazard terms, which are defined in the text. In particular, we define three key terms used in this assessment as follows:

Geohazard: Landslide, fluvial, glacial, or snow avalanche process with the potential to result in some type of undesirable outcome. For example, this could include a debris flow hazard area intersecting the footprint of a facility. The term geohazard refers to the specific nature of the process (type, frequency, magnitude), but not the type of consequences.

Geohazard scenario: Specific undesirable outcome that could result from a geohazard event. For example, this could include a debris flow impact to a facility resulting in a one day loss of function. The term geohazard scenario refers to the specific nature of the consequences, but not their severity in terms of economic, environmental, safety, or reputation loss, or the likelihood this will occur.

Geohazard risk: Likelihood of a geohazard scenario occurring and resulting in a particular severity of consequence, defined in terms of economic, environmental, safety, or reputation loss. For example, this could include the likelihood of debris flow impact to a facility resulting in $1M of economic loss.

The geohazard descriptions in this report should be read with reference to the terrain and snow avalanche maps accompanying this report. These are provided as follows:

- Drawings 1A-9A show terrain stability mapping and landslide geohazards in relation to proposed facilities.
- Drawings 1B-9B display snow avalanche geohazards in relation to proposed facilities.

The landslide and snow avalanche hazard extents on Drawings 1-9 are shown as shaded polygons identifying existing geohazard initiation zone and runout areas. The polygons should be regarded as transitions, not sharp boundaries, and show hazard potential only. They do not provide information on geohazard likelihood or risk.

The arrowed landslide paths (Drawings 1A-9A) show general path trajectories. The path arrows extend into general runout areas but do not represent geohazard extents, which are shown by the shaded polygons.

The geohazard processes within the study area all have a range of possible magnitudes and likelihoods of occurrence, with the larger events occurring less often. However, at this stage of study and with the information available, it is impossible to establish complete frequency-magnitude relationships for each hazard. It is also not possible to identify all conceivable consequences of hazard events at all scales, as these include uncertainties such as worker position, the final design of project facilities, and the dependence of one facility on the function of another. Moreover, these geohazard scenarios and associated risks to the project will change at different project stages and in accordance with landscape modifications that will occur during mine development.

These limitations make it important to limit the use of this document to its intended objectives which are:

- To identify areas with existing landslide and avalanche geohazards to guide location planning of project facilities
- To identify reasonably conceivable geohazard scenarios to guide the initial prioritization, planning and costing of geohazard risk reduction measures
- To form the geohazard basis for detailed design of geohazard risk reduction measures at later project stages
- To support the application for an Environmental Assessment Certificate

1.3. Scope of Work

Pretium provided the following drawings showing the current project layout: Drawing 100000-10-003 Overall Plant site and General Arrangement dated April 2013. The scope of work included terrain stability and landslide inventory mapping; identification of landslide and snow avalanche hazards that could potentially impact facilities, and estimation of geohazard risk for the facilities listed in Table 1-1 and shown on Drawings 1-18. Assessment of glacial hazards (e.g. crevasses) for road sections on the Knipple Glacier were outside the scope of this assessment.

Table 1-1. List of proposed facilities requiring assessment

Facility
• Mine and Mill Site Area
• Summit Road
• Knipple Glacier Tracked Vehicle access route
• Knipple Lake transfer station
• Bowser Lake Airstrip
• Access Road from Highway 37

1.4. Organization of the Report

This report is organized by the following sections:

- 1.0 addresses the principal scope of work and study objectives, and provides overview descriptions of the geologic setting and climate.
- 2.0 provides a summary of the methods that were used to generate the terrain stability maps that form the framework for landslide geohazard mapping for this project (methods to generate the avalanche maps are described in Appendix A).
- 3.0 describes the geohazards identified across the site. This section should be read in conjunction with the landslide geohazard and snow avalanche hazard maps (Drawings 2-9).
- 4.0 provides a summary of BGC's risk assessment procedure, with the results provided in Section 5.0.
- 5.0 summarizes the risk assessment results tabulated in Appendix C.

1.5. Physiographic Setting

The Brucejack property lies in the coastal mountains of northwestern British Columbia, about 55 km north of Stewart. Valley glaciers fill the upper portions of the larger valleys from just below tree line and upwards. The valleys are typical of glaciated or formally glaciated valleys of the B.C. Cordillera, where gentle upper slopes drop into steeper valley walls that grade into broad and gently sloping valley floors. Elevations in the project area range from 400 masl at Bowser Lake to over 1,800 m at the nearby highest peaks.

The area was glaciated repeatedly during the Quaternary Period (past 2.6 Ma), with the most recent continental scale ice age lasting until approximately 10,000 years ago (the Fraser Glaciation). Holocene glaciers culminated in about the mid-19th century during the Little Ice Age[1], and higher elevation facilities near Brucejack Lake are located within the Little Ice Age glacial trimline[2]. Progressive warming and glacial retreat has prevailed since, and based on the position of the Little Ice Age (LIA) glacial trimline, the Knipple Glacier has retreated about 1.5 kilometers since the LIA maxima. The tree line lies at about 1,240 m elevation.

Valley glaciers west of Bowser River have blocked the river in the past creating ice-dam lakes. Glaciolacustrine material was noted upstream of Frank-Mackie Glacier. These glaciers have now retreated and are no longer capable of damming Bowser River.

1.6. Geologic and Geomorphic Setting

The Brucejack minesite area lies within the Stikinia Terrane (Lechner, 2008), one of almost twenty fault-bounded crustal blocks that make up the B.C. Cordillera (Monger and Price, 2002). The minesite area is underlain by Upper Triassic volcaniclastic and epiclastic sedimentary rocks of the Stuhini Group and Lower to Middle Jurassic volcanic, volcaniclastic, and sedimentary rocks of the Hazelton Group. An angular unconformity (erosional surface) marks the contact between the sedimentary rocks of the Stuhini Group and medium- to coarse-grained sandstones of the Jack Formation, the basal formation of the Hazelton Group. The access road is underlain by Jurassic shales of the Bowser Lake Group from the highway to Bowser Lake, then by Upper Triassic to Lower Jurassic volcanic breccia of the Unuk River Formation along Bowser River (Coombe and Jakobesen 1993).

The Bowser River valley contains floodplain deposits of stratified, well-sorted fluvial gravels alternating with overbank silty deposits. In steeper valleys (e.g. Wildfire valley), these deposits form mostly narrow fringes along the active channel. Thicker fluvial and colluvial deposits have also formed fans at the outlet of tributary creeks where they meet the main valley channel. Lower slopes above valley bottoms are mostly overlain by glacial till, with thin colluvium and bedrock exposed on steeper slopes. The till consists of poorly sorted, usually matrix-supported subangular or subrounded clasts in a silty-sand matrix. On steeper slopes and above treeline, most slopes are underlain by colluvium discontinuously overlying bedrock, with thicker colluvial deposits at the base of bedrock gullies.

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[1] The Little Ice Age (LIA) is a period of glacial advance in the last 1000 years, culminating in approximately the early 18th to mid 19th century (Menounous et al. 2009).

[2] The glacial trimline is a terrain feature indicating an area recently subject to glacial processes, in this case showing the glacial extent at the LIA glacial maxima.

1.7. Climate Setting

The climate and meteorology of the study area is described in detail in a meteorology baseline report by Rescan (2012a). In summary, the study area is generally a temperate or northern coastal rainforest, with subarctic conditions at high elevations. In mountainous terrain an orographic influence of increased precipitation with increased elevation is often observed and this same effect is expected within the project area, resulting in highly variable precipitation and air temperature. The mean annual precipitation in the vicinity of the minesite is approximately 1,600 mm, with approximately 45% of it falling as snow between November and March. The length of the snow-free season varies from about May through November at lower elevations and from July through September at higher elevations.

2.0 TERRAIN STABILITY MAPPING

2.1. Terrain Stability Mapping Methods

Terrain stability mapping involves the subdivision of landscape into geomorphic units (terrain polygons), based on criteria established for a particular study. Terrain mapping and the various standards that are involved in it form a BC-wide standard practice requested by regulators for road construction and mining activity.

For the Brucejack project, terrain mapping techniques were used to delineate areas with distinct surficial geology, terrain stability, erosion potential and landslide hazard characteristics (Drawings 1-9). Criteria used to map these characteristics are described below. Mapping methods were based on guidelines described by the Resources Inventory Committee (1996), using the terrain classification of Howes and Kenk (1997).

Bioterrain mapping completed by Rescan (2012b) was used as a starting point for the terrain stability mapping of the mine site and access road. Bioterrain mapping completed by Jen Shypitka P.Geo was used as a base for the transmission line corridor. Bioterrain mapping is a modified method of terrain mapping that focuses on the attributes that influence ecology. In contrast, terrain stability mapping focuses on the attributes that influence terrain stability. As such, polygons were added or redrawn and terrain labels were modified as required for terrain stability mapping purposes. Terrain mapping was based on digital airphoto interpretation of 1:20,000, 2010 airphotos. Terrain stability mapping for the mine site and access road was completed by B. Waddington P.Geo of BGC Engineering. Polly Uunila P.Geo. of Polar Geoscience completed terrain stability mapping for the transmission line.

Areas of similar features are delineated as polygons. Symbols describing material types and drainage classes were added to all terrain polygons. All polygons intersecting the proposed general arrangement of roads and fixed facilities, as well as the transmission line corridor, were also assigned terrain stability classes. Surface erosion potential ratings were also added to polygons intersecting the proposed access road and transmission line corridor. All polygons are numbered for location reference.

2.2. Fieldwork

Fieldwork was completed from August 19-23, 2013 by Greg Hunchuk, M.Eng., P.Eng., P.Geo. of BGC. The fieldwork focused on locations subject to geohazards with the potential to impact proposed facilities. Helicopter-based inspection was completed for other areas. Terrain interpretations also considered bioterrain fieldwork completed by Rescan (2012b), overview assessment of access route geohazards by BGC (2012a), geotechnical review of the access road (BGC 2012b), preliminary geohazards assessment of the proposed transmission line corridor (BGC 2012c) and a previous Terrain Stability Assessment for the access road (Cypress 2011).

Fieldwork for avalanche hazard assessment was completed in March 19 2012, and April 28 – 29, 2013, as indicated in Alpine Solutions (2013).

2.3. Mapping Reliability

The minimum size of terrain polygons that can be mapped at a 1:20,000 scale terrain mapping is about 2 ha. Thus local variations in terrain conditions over areas of 2-3 ha, or over distances of less than about 150 m, may not be identified. As a result, within any polygon, variations in slope steepness, material characteristics and soil moisture should be expected. In addition, terrain stability ratings assigned to terrain polygons intersecting the proposed road alignment or parts of the plant site, for example, are represented by the entire polygon. Consequently, small features may not be reflected in the assessment.

2.4. Drainage Classes

Drainage classes rate the potential for water to drain from a given polygon in relation to water supply (Table 2-1), and were assigned to all terrain polygons. These drainage classes assist with the design of drainage and erosion control structures.

Table 2-1. Example materials and locations for each drainage class (RIC 1996).

Drainage Class	Description	Example materials and locations
Rapid (r)	Water is removed rapidly in relation to supply	Exposed rock
Well (w)	Water is removed from the soil readily but not rapidly	Sand and coarser grained sediments, typically on upper slopes
Moderate (m)	Water is removed from the soil somewhat slowly in relation to supply	Coarser grained sediments, typically on mid-lower slopes
Imperfect (i)	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season	Coarser to finer grained sediments on lowermost slopes, gully bottoms, and in moist areas of floodplains
Poor (p) Very Poor (vp)	Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen	Bogs in bedrock depressions, marshy or wet areas of floodplains

2.5. Erosion Potential

The potential for surface erosion in a watershed is primarily determined by the inherent erodability of the material and the magnitude of erosive forces. The erodability of a soil is determined by the material textural properties, such as particle size, structure and cohesion. The magnitude of erosive forces is determined by the quantity of surface runoff and its associated energy, which are related to precipitation and slope characteristics. Erosion Potential ratings (Table 2-2) were applied to all terrain to identify potentially erodible terrain following disturbance by road building. This rating forms part of the criteria used to select terrain for more detailed evaluation in a Terrain Stability Field Assessment (TSFA). A terrain stability assessment of the access road was completed in March 2011 by Cypress Forest Consultants Ltd. (Cypress 2011).

Table 2-2. Surface erosion potential class (Forest Practices Code 1999).

Erosion Potential Class	Description	Management Implications
VL – very low potential	Flat or gently sloping terrain, organic soils, floodplains, bedrock	No or only very minor surface erosion
L – low potential	Gentle slopes, short slopes, dense soils	Expect minor erosion of fines in ditch lines and disturbed soils
M – moderate potential	Moderate steep slopes and long slopes; erodible (fine-textured) soils (e.g. clay)	Expect moderate erosion when water is channeled down road surfaces or ditches
H – high potential	Moderate steep slopes and highly erodible soil textures (e.g. silt, sand)	Significant erosion problems can be created when water is channeled onto or over exposed soil on these sites
VH – very high potential	Steep slopes with erodible soil textures, active surface/gully erosion	Severe surface and gully erosion problems can be created when water is channeled onto or over these sites

2.6. Terrain Stability Interpretations

Terrain stability ratings refer to the potential for landslide initiation within the polygon, following disturbance by road construction or removal of forest cover (RIC 1996). Terrain stability ratings range from Class I (stable) to Class V (unstable) (Table 2-3) and were added to all terrain polygons intersecting proposed facilities. These ratings were specifically developed for Forestry applications. They typically form part of criteria to identify terrain requiring further evaluation in a Terrain Stability Field Assessment (TSFA), although in this case a TSFA has already been completed for the access road (Cypress 2011). It is important to note that terrain stability classes do not identify terrain subject to landslide hazards from terrain upslope of the polygon. This information is contained in the geomorphological process part of the terrain polygon symbol, as described in the legend on the terrain and landslide hazard maps.

The classes are based primarily on slope steepness, surficial material type, and geomorphological processes occurring within the polygon (e.g. gully erosion or existing landslides). Terrain stability criteria adapted by BGC for this project are shown in Table 2-4. The criteria are applied using judgment and may vary depending on local terrain conditions. For example, a slope morphology that includes irregular, near-surface bedrock would typically be rated as more stable than a similar slope with a smooth profile, because bedrock irregularities tend to stabilize soil against failure. Polygons with existing landslides in bedrock or surficial material are automatically assigned Class V ratings.

Table 2-3. Terrain stability ratings for road construction (RIC 1996).

Terrain Stability Class	Interpretation
I	No significant stability problems exist.
II	There is a very low likelihood of landslides following road construction. Minor slumping is expected along road cuts, especially for 1 or 2 years following construction.
III	There is a low likelihood of landslide initiation following road construction. Minor slumping is expected along road cuts, especially for 1 or 2 years following construction.
IV	Expected to contain areas with a moderate likelihood of landslide initiation following road construction.
V	Expected to contain areas with a high likelihood of landslide initiation following road construction.

Table 2-4. Criteria used by BGC for assigning terrain stability classes. Legends for the individual symbols can be found on each of the landslide geohazard drawings

<table>
<tr><th rowspan="3">Terrain Stability Class</th><th colspan="9">Slope Class</th></tr>
<tr><th>1</th><th colspan="2">2</th><th>3</th><th colspan="4">4</th><th>5</th></tr>
<tr><th>0.5%
(0-3°)</th><th colspan="2">6-27%
(3-15°)</th><th>28-49%
(15-26°)</th><th colspan="2">50-60%
(26-30°)</th><th colspan="2">61-70%
(31-35°)</th><th>>70%
(>35°)</th></tr>
<tr><td rowspan="2">I</td><td>Mv, Mb; F^{G}p, F^{G}u; Fp; L^{G}p, L^{G}u; Rp, Ru</td><td colspan="8"></td></tr>
<tr><td></td><td colspan="2">Rj, Ru</td><td colspan="6"></td></tr>
<tr><td rowspan="2">II</td><td></td><td colspan="2">Mv, Mb; F^{G}f,
F^{G}u, F^{G}j; Ff, Fj;
Cf; Dv; L^{G}j, L^{G}u</td><td colspan="6"></td></tr>
<tr><td></td><td colspan="5">Ruh, Rum, Rur with Mw, Cv, Ra</td><td colspan="3"></td></tr>
<tr><td rowspan="4">III</td><td colspan="2"></td><td colspan="3">L^{G}a</td><td colspan="4"></td></tr>
<tr><td colspan="2"></td><td colspan="4">Mv, Mb; F^{G}ak, F^{G}a; Cv, Cb</td><td colspan="3"></td></tr>
<tr><td colspan="4"></td><td colspan="2">aCk;Rk</td><td colspan="3"></td></tr>
<tr><td colspan="2"></td><td colspan="4">L^{G}a</td><td colspan="3"></td></tr>
<tr><td rowspan="3">IV</td><td colspan="4"></td><td colspan="5">L^{G}k, L^{G}s</td></tr>
<tr><td colspan="4"></td><td colspan="5">Mb-V; Cb-V; (-V refers to dissected slopes)</td></tr>
<tr><td colspan="7"></td><td colspan="2">Mv, Mb; F^{G}k, F^{G}s; Cv;
Cb, L^{G}k, Uks, Us</td></tr>
<tr><td rowspan="2">V</td><td colspan="7"></td><td colspan="2">Mks-V; FGks-V; Cvb-V;
L^{G}ks-V, L^{G}s-V, Uks-V</td></tr>
<tr><td colspan="9">all materials and landforms that are unstable (i.e. include the initiation zone of mass movements:
-F”, -R”s, and/or –R”b*)</td></tr>
</table>

3.0 HAZARD ASSESSMENT

3.1. General

This section provides overview description of landslide and snow avalanche geohazards with the potential to affect proposed facilities. Geohazard types discussed include rockfall, debris flood, flood, snow avalanche, and ice fall.

This information forms the basis for the risk assessment described in Section 4.0, including assignment of hazard likelihoods, consequences, and associated risk. Appendix A provides additional information on snow avalanche hazards at proposed facility locations.

Geohazards describe in this section assume existing, unmitigated conditions for the purpose of baseline geohazard and risk assessment.

3.2. Minesite

The minesite is located on an alpine plateau adjacent to Brucejack Lake. The following facilities will be located in this area:

- Two explosive storage facilities – preliminary position
- Detonator storage – preliminary position
- Topsoil stockpile
- Substation
- Water treatment plant
- Portal fuel storage
- Conveyor portal and truck portal
- Overhead electrical
- Mill building including administration, mine dry, truck shop and warehouse
- Tailings pipeline
- Helipad
- Upper and lower laydown area
- Batch plant, fuel storage, and aviation fuel tank
- Pre-production ore storage
- Diversion channel
- Waste rock transfer storage
- Garbage and incinerator area
- Operations camp
- Sewage system, water pumps, and storage tank
- Proposed new transmission tower location
- Scale house

- Four air raise locations
- Site access roads

The western edge of the operations camp footprint extends to the base of a slope subject to rockfall hazard. Avalanche paths intersect the footprint of the operations camp, and the road between the operations camp and incinerator. No landslide or avalanche geohazards were identified at the other mine site facilities.

3.3. Access Road

A 70 km access road has been constructed into the Mine site, leaving Highway 37 approximately 35 km south of Bell 2 (Drawings 1-5). It follows Wildfire and Scott Creeks to Bowser River, travels up Bowser River to Knipple Glacier, and then ascends the glacier to Brucejack Lake. Hazards identified along the access road include debris avalanches, debris floods, floods, rockfall, and snow avalanches. These are tabulated in Table 3-1 and summarized in Sections 3.3.1 to 3.3.5. Estimated average hazard probabilities are provided for each hazard type in Appendix B.

Table 3-1. Geohazard Types Identified along the Access Road

Access Road Segment	Road Km Reference (+/-50m)	Hazard Type
Wildfire Creek (0-17 km)	2.3-2.7	Debris avalanche
Scott Creek (17-35 km)	30-31.5	Snow avalanche
	33.8-34.2	Debris flow
Bowser River to Knipple Glacier (35-59 km)	36.6-36.7	Flood
	38.0-38.3	Flood
	39.5-40.0	Snow avalanche
	41.0-45.4	Flood
	43.7-44.2	Snow avalanche
	45.2	Snow avalanche
	45.3-45.4	Rock Fall Impact
	47.8-51.8	Flood
	52.0-54.0	Flood
	54.8-55.8	Snow avalanche
	55.7-56.7	Snow avalanche
	57.7-58.0	Rockfall
	57.8-59.3	Snow avalanche
	58.7-59.0	Rockfall
Brucejack Lake	71.2-71.3	Rockfall
	72.1-72.5	Rockfall
	71.7-73.0	Snow avalanche

3.3.1. Wildfire Creek (0-17km)

From Km 0 to Km 17 the access road runs along the north side of Wildfire Creek. It traverses 20° to 30° slopes with a thin cover of surficial material overlying bedrock. Below the road Wildfire creek is in a steep rock-walled canyon subject to rock fall and debris avalanches. Between Km 2.3 and 2.7 the access road climbs out of Wildfire Creek canyon across a slope potentially subject to shallow debris avalanches.

3.3.2. Scott Creek (17-35 km)

From Km 17 to Km 35 the road follows Scott Creek to where it meets the Bowser River. From the head of Wildfire creek the road traverses 5-15° terrain, ascending through a broad pass before descending steeper slopes (20-30°) on the north side of a Tributary of Treaty Creek toward the valley floor at Todeda Lake. The road is potentially subject to snow avalanche hazard between Km 30 and 31.5.

3.3.3. Bowser River to Knipple Glacier (35-59 km)

From Scott Creek the access road descends to Bowser River at a gradient of 10-15% and joins a previously built access road at approximately Km 35. From here the access road traverses floodplains on the north side of the river to Knipple Lake.

Based on vegetative evidence and the fresh appearance of floodplain deposits along poorly confined channel sections, most of the section from Km 36 to 54 will be subject to flooding, bank erosion and channel avulsion hazards (Photograph 3-1). Rock fall hazard has been mapped in 3 sections where the road is located below rock slopes. Snow avalanches have been mapped as intersecting the road at 6 locations.

Photograph 3-1. Looking west up access road along Bowser River floodplain at approximately KP 53.7, subject to flooding and channel avulsion.

3.3.4. Knipple Glacier (59- 71 km)

The road will travel up the Knipple Glacier for 10 km, exiting the glacier southeast of Brucejack Lake. The most heavily crevassed parts of the glacier are mapped on Drawings 2 and 3. However, assessment of glacial hazards (specifically crevasses) for road sections on the Knipple Glacier was outside the scope of this assessment.

3.3.5. Brucejack Lake (71-73 km)

After leaving Knipple Glacier the access road traverses lower slopes on the south side of Brucejack Lake to the Brucejack mine site. The access road crosses a talus slope for approximately 200 m where it will be potentially exposed to rock-fall hazard (Photograph 3-2). Much of the route from the glacier along Brucejack Lake is subject to avalanche hazard.

Photograph 3-2. Area of rockfall hazard along access road at approximately KP 72. Photograph by BGC, looking west.

3.4. Transfer Station

A Transfer Station is proposed on the northwest side of Knipple Lake. A large avalanche path (Path AR6) is estimated to reach the western side of the footprint (approximately 20% of the footprint) of the Knipple Transfer Station pad with an estimated return period of 100 years or longer. Avalanches are not expected to reach the eastern side of the Knipple Lake Transfer Station pad where primary fixed facilities (camp) are expected to be located. Landslide geohazards were not identified at this location.

3.5. Airstrip

An airstrip is located adjacent to the access road between Km 50 and 51 (Drawing 3). The footprint of the airstrip is subject to flood hazard.

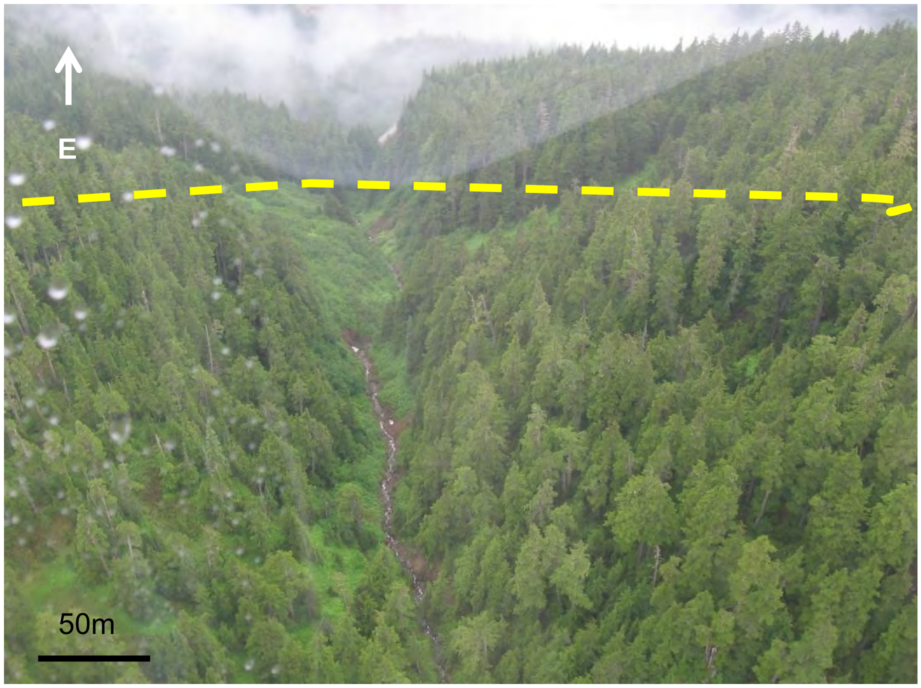
3.6. Transmission Line

The proposed transmission line corridor begins at the Long Lake hydroelectric generation facility, currently under construction about 14 km north of Stewart, BC. The line is proposed to follow a route on the east side of the Salmon Glacier Valley to the proposed Knipple Transfer Station area, west of Knipple Lake. The line then follows a route along a ridge on the southwest side of the Knipple Glacier to the mine site. At the time of this assessment, no alignment or tower locations were available.

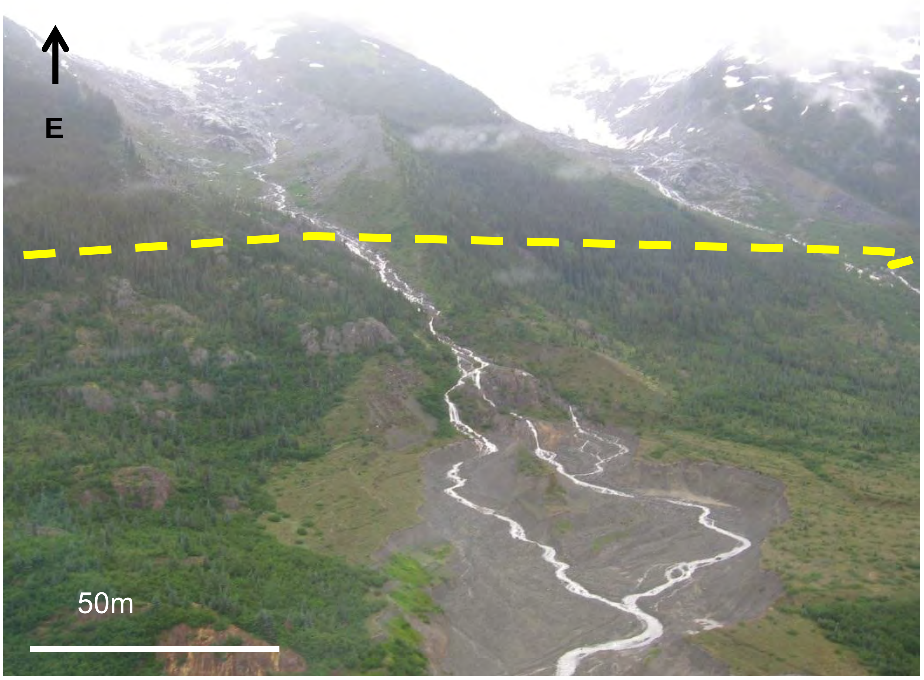
This section provides reconnaissance level identification of geohazard types along the corridor based on preliminary work by BGC (2012c) supplemented by overview helicopter field observations in August 2013, and a preliminary avalanche hazard assessment by Alpine Solutions (2013). No ground-based fieldwork was completed and no individual hazard sites were inspected. Given that no alignment or tower locations were available at the time of assessment, the transmission line was not included in the geohazard risk assessment. This is because risk to the transmission line is associated with damage to the transmission towers. Without knowing the tower locations it is not possible to determine which geohazards could potentially impact them.

Where the transmission line corridor traverses steeper side slopes it will cross channels that are subject to debris flows, floods and channel avulsion. Rockfall, debris avalanche and rock avalanche hazards exist within the corridor, but their potential to impact the transmission line will depend on tower locations. Examples of several potential hazards are shown in Photograph 3-3 to Photograph 3-6.

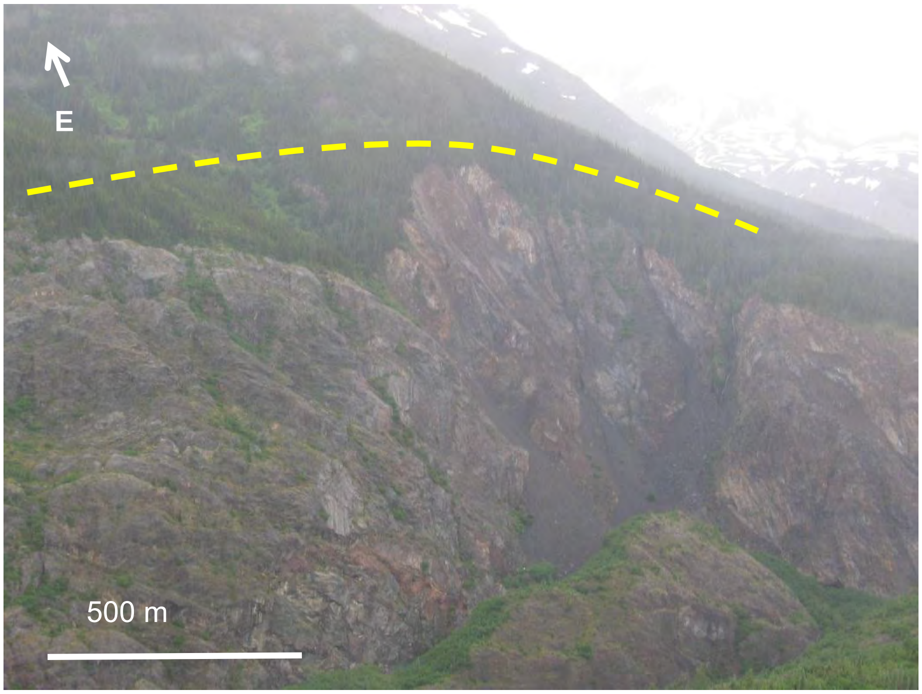
Northwest of Knipple Lake, the proposed transmission line crosses the upper part of steep ridges and rock slopes. Four tributary glaciers cross the proposed route along this section. BGC understands that they will be spanned and no poles will be placed on ice. Rock fall is possible from steep rock slopes in this area. Snow avalanche hazards along the Salmon Glacier valley are primarily due to steep starting zones originating from east of the transmission line. Snow avalanche hazards from Knipple Lake to the mine site are mainly due to steep slopes leading away from ridge top. The level of avalanche hazard will depend on the final transmission line alignment. More detail regarding avalanche hazard for the proposed transmission line corridor is provided in Alpine Solutions (2013).



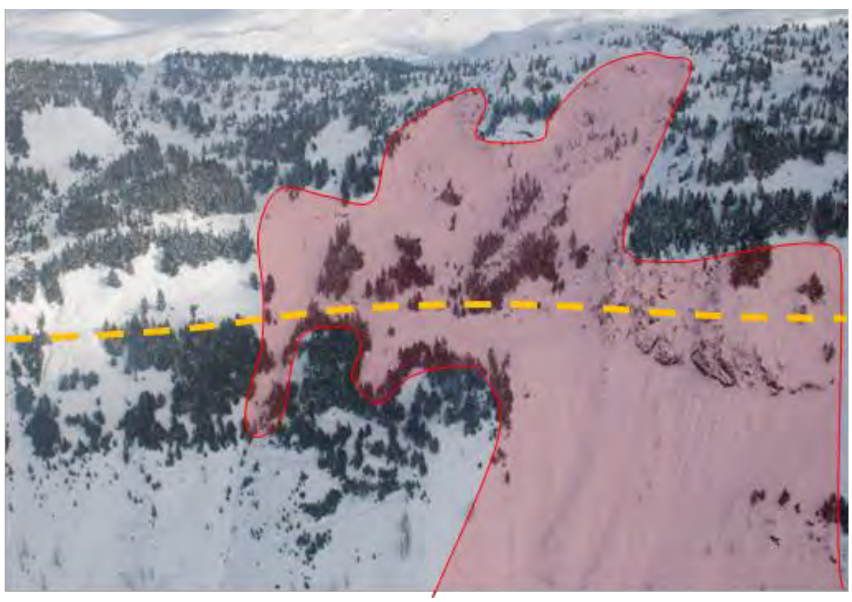
Photograph 3-3. **View upslope at a debris flow gully approximately 3.0 km north of Long Lake. Photograph by BGC. Proposed transmission line route shown in dashed yellow (very approximate).**



Photograph 3-4. **Active channel draining a glacier approximately 29 km north of Long Lake, Photograph by BGC. Proposed transmission line route shown in dashed yellow (very approximate).**



Photograph 3-5. **Area of active rock fall approximately 39 km north of Long Lake, Photograph by BGC. Proposed transmission line route shown in dashed yellow (very approximate).**



Photograph 3-6. **Area of active avalanche activity (Path TL7) approximately 5.4 km north of Long Lake. Proposed transmission line route shown in dashed yellow (very approximate). Photograph by Alpine Solutions.**

4.0 RISK ASSESSMENT

4.1. General

Risk is a measure of the probability and severity of an adverse effect to health, property or the environment, and is estimated by the numerical product of hazard probability and consequences (AGS 2007). The geohazard risk assessment completed for this study involved identification of geohazards and estimation of the likelihood that a geohazard event will occur, impact an element at risk, and cause some magnitude and type of damage or loss. The principal steps in this risk assessment are:

1. Identification of geohazard scenarios, as defined in Section 1.2 and described further in Section 4.2.
2. Estimation of the likelihood that a geohazard scenario will result in some kind of undesirable outcome in the categories of mine economics, environment, company reputation, and human safety. Methods to estimate the likelihood of an undesirable outcome are described in Section 4.5.
3. Estimate the economic, environmental, and safety consequences of the unwanted outcome, as described in Section 4.6.
4. Combine the likelihood of unwanted outcome and consequences to arrive at a *risk* classification ranging from Very Low to Very High, as described below with reference to Table 4-1.

Risk estimates considered in this report represent an “unmitigated” case, which is a necessary assumption to estimate geohazard risk for the purpose of prioritizing mitigation measures. It does not consider any existing or proposed geohazard mitigation measures, such as berms, barriers, avalanche control, closures of areas to personnel, portal canopies, drainage channel covers, tower reinforcements, or slope reinforcement. In the case of safety, workers outside buildings are assumed to be in vehicles. The risk estimates do not consider every possible consequence resulting from a geohazard occurrence. Rather, the estimates consider a range of potential outcomes that guide the prioritization of hazard mitigation.

Table 4-1 shows the risk evaluation matrix used to combine likelihood of unwanted outcome and consequence assessment to determine a risk rating. The probability of the undesirable outcome and the severity of the consequence define an intersection point in the matrix that ranks the risk scenario from Very Low to Very High. The risk ranking of all sites can then be used to prioritize risks for potential further study or more detailed design of risk reduction measures.

The top five rows of Table 4-1 guide possible responses by a mine owner to each risk level, but depend on the owner’s risk tolerance criteria.

The following sections describe the components of the risk assessment method. Hazard scenarios and their respective risks are tabulated in Appendix C.

Table 4-1. Risk evaluation matrix

Corporate Geohazard Risk Evaluation Matrix

Risk Evaluation and Response

VH	Very High	Risk is imminent and could happen at any time irrespective of particular triggers; short-term risk reduction required; long-term risk reduction plan must be developed and implemented
H	High	Risk is unacceptable; long-term risk reduction plan must be developed and implemented in a reasonable time frame. Planning should begin immediately
M	Moderate	Risk may be tolerable; more detailed review required; reduce risk to As Low As Reasonably Practicable
L	Low	Risk is tolerable; continue to monitor and reduce risk to As Low As Reasonably Practicable
VL	Very Low	Risk is broadly acceptable; no further review or risk reduction required

Likelihood Descriptions and Indices

Likelihood of Undesirable Outcome

Likelihood Descriptions		Probability Range	1	2	3	4	5	6
Event can be expected at least once per year	Very Likely	>0.9	M	H	H	VH	VH	VH
Event typically occurs every few years	Likely	0.1 to 0.9	L	M	H	H	VH	VH
Event possible within the lifetime of a temporary facility	Moderate	0.01 to 0.1	L	L	M	H	H	VH
Event unlikely within the lifetime of a temporary facility	Unlikely	0.001 to 0.01	VL	L	L	M	H	H
Event very unlikely within the lifetime of a temporary facility	Very Unlikely	0.0001 to 0.001	VL	VL	L	L	M	H
Event is extremely unlikely within the lifetime of a temporary facility	Extremely Unlikely	<0.0001	VL	VL	VL	L	L	M

Consequence Descriptions and Indices

Indices	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Catastrophic
Safety	Minor workforce injury; no public impact	Workforce lost-time accident; no public impact	Workforce long-term disability; minor public injury	Workforce fatality; serious public injury	Multiple workforce fatalities (<10); public fatality	Multiple workforce fatalities (>10); multiple public fatalities
Environment	Insignificant	Localized short-term impact; recovery within days or weeks	Localized long-term impact; recoverable within the lifetime of the project	widespread long-term impact; recoverable within the lifetime of the project	Widespread impact; not recoverable within the lifetime of the project	Loss of a significant portion of a valued species
Economic	Negligible; no business interruption; <$10,000	Some asset loss; minimal business interruption; <$100,000	Serious asset loss; up to 1 day business interruption; <$1M	Major asset loss; up to 1 week business interruption; <$10M	Severe asset loss; up to 1 month business interruption; <$100M	Total loss of asset; >1 month business interruption; >$100M
Reputation	Negligible impact	Slight impact; recoverable within days	Local publicity; recoverable within weeks	National publicity; temporary (weeks to months) loss of market share	International publicity; long-term (years) loss of market share	May threaten corporation's survival

4.2. Likelihood Estimates

Hazard likelihood is defined as the chance that the hazard event of a particular magnitude will occur. Table 4-2 defines ranges of annual frequency or likelihood of hazard occurrence used in the analysis. Hazard frequency is numerically equivalent to hazard likelihood. The term likelihood is used where processes occur less than once per year, and the term frequency is used where processes (e.g. snow avalanches) occur greater than once per year. Hazard frequencies or likelihoods are also listed for particular hazard scenarios in the risk assessment tables (Appendix B). Linear facilities often cross multiple paths of hazards such as avalanches and debris flows. In these cases the frequency of events impacting the facility will be higher than the likelihood of an event on a particular path. For a given hazard type, the probabilities listed in Appendix B correspond to the estimated average likelihood of an event occurring at any of the hazard segments identified in Section 3.3.

Table 4-2. Qualitative definitions of hazard frequency or likelihood

Hazard Likelihood	Annual Frequency or Likelihood
Very high	>0.9
High	0.1 to 0.9
Moderate	0.01 to 0.1
Low	0.001 to 0.01
Very low	0.0001 to 0.001
Extremely low	<0.0001

Table 4-3 describes how hazard probability categories were estimated for various hazard types. The ratings should be considered order-of-magnitude estimates, and are primarily based on surface observation and qualitative judgment. Given the uncertainty of the likelihood estimates, conservative estimates were used.

Table 4-3 Estimation of hazard probabilities for various geohazards

Geohazard Type	Classifiers	Likelihood Estimate of Hazard Occurrence
Snow Avalanche	Mature forested terrain (and/or gentle terrain < 20°) with no steep slopes, or evidence of avalanche paths nearby (within 200 – 500 m, depending on size of nearby avalanche path[1])	Low
	Area of interest is upslope or adjacent to defined avalanche path displaying visible historic forest trim lines (portions of the forest that have been determined to be affected previously by snow avalanche impact); if area is above treeline, or in deforested area, likelihood is based on subjective assessment of terrain characteristics.	Moderate
	Well-defined avalanche path is directly upslope or adjacent to area of interest, with direct evidence of avalanches reaching the site (no mature vegetation and/or small avalanche-damaged trees); Area of interest is likely within the defined runout zone of an avalanche path, but is unlikely to be in an avalanche track; if area of interest is above treeline, or in deforested area, likelihood is based on subjective assessment of terrain parameters.	High
	Area of interest is within well-defined runout zone, or within a well-defined avalanche path; the surrounding landscape is open, possibly with stunted and/or damaged trees and shrubs; if area of interest is above treeline, or in a deforested area, likelihood is based on subjective assessment of terrain characteristics.	Very High
Debris flow	Channel gradient sufficiently steep to generate debris flows, but poorly defined source areas, vegetated channel, fan with mature vegetation, and debris flow lobes difficult to discern on the ground	Low
	Channel gradient sufficiently steep to generate debris flows; contains well-defined source areas; second growth fan area, mostly with deciduous trees and young conifers; debris flow lobes and levees well visible and boulders on deposits somewhat loose.	Moderate
	Channel gradient sufficiently steep to generate debris flows; well-defined, active debris producing source area; steep and bare channel, fan bare or covered with low pioneer vegetation; lobes and levees of previous flows easily discernible, boulders on levees and debris flow deposits are very loose.	High

[1] [1]An avalanche *path* is defined as the entire possible extent of exposure from a single avalanche course and typically includes 3 segments: the starting zone, track, and runout zone. An avalanche *track* is the segment of the avalanche path in which large avalanches are at maximum speed and have not yet begun to decelerate. The runout zone is the segment of the avalanche path in which large avalanches decelerate and stop.

Geohazard Type	Classifiers	Likelihood Estimate of Hazard Occurrence
Debris flood	Channel gradient not sufficiently steep to generate debris flows; poorly defined source areas; no signs of previous landslide damming lin the upper watershed, normally graded deposits visible on channel edges, heavily vegetated channel, fan with mature vegetation; and deposits difficult to discern on the ground.	Low
	Channel gradient not sufficiently steep to generate debris flows; contains well-defined source areas; second growth fan area, mostly with deciduous trees and young conifers; signs of previous landslide dams; occasional paired terraces, clast-supported to matrix-supported deposits visible on natural exposures, but still imbricated.	Moderate
	Channel gradient not sufficiently steep to generate debris flows; well-defined, active debris producing source area; abundant signs of previous landslide dams, steep and bare channel, fan bare or covered with low pioneer vegetation; several paired terraces on either side of creek channel, deposits from previous events easily discernible, deposits are loose, contain large clasts (>0.5 m), poorly discernible imbrication, more matrix supported than clast-supported	High
Flood Inundation	Mature forest, low terrace	Low
	Mature forest, river level	Moderate
	Sparsely vegetated flood plain	High
	Unvegetated flood plain, active channels	Very High
Rock fall	Steep cliff; no visible evidence of rock fall talus	Low
	Steep cliff; rock fall boulders covered by moss or lichen	Moderate
	Steep cliff; rock fall boulders or talus sporadically covered with some moss; fresh boulders; well defined talus slope; abundant impact-scarred vegetation	High
	Steep cliff; abundant bare boulders on talus slope; active raveling observed during field work; no vegetation in runout area	Very High

[1]An avalanche *path* is defined as the entire possible extent of exposure from a single avalanche course and typically includes 3 segments: the starting zone, track, and runout zone. An avalanche *track* is the segment of the avalanche path in which large avalanches are at maximum speed and have not yet begun to decelerate. The runout zone is the segment of the avalanche path in which large avalanches decelerate and stop.

4.3. Magnitude Estimates

Table 4-4 summarizes the size classes used to describe landslides and avalanches. These were estimated based on regional scale airphoto interpretation and surface field observation. They consider the estimated volume at failure source areas and deposits (if existing).

Detailed landslide mapping, subsurface investigation or slope stability modeling, and estimation of frequency-magnitude relationships were not completed at this project stage. As such, size estimates should be considered order-of-magnitude ranges.

Table 4-4. Landslide Size Classification(after Jakob, 2005).

Size Class	Volume Range (m^3)	Discharge Range (m^3/s) (for debris flows)
0	< 10^1	n/a
1	< 10^2	< 5
2	10^2 - 10^3	5 – 30
3	10^3 - 10^4	30 – 200
4	10^4 - 10^5	200 – 1500
5	10^5 – 10^6	1500 – 12,000

Table 4-5. Avalanche Size Classification (McClung and Schaerer, 2006).

Size	Destructive Potential	Typical Mass (tonnes)	Typical Path Length (m)	Typical Impact Pressures (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, or break a few trees.	10^3	1000	100
4	Could destroy a large truck, several buildings, or a forest with an area up to 4 hectares.	10^4	2000	500
5	Largest snow avalanches known. Could destroy a village or a 40 ha forest.	10^5	3000	1000

4.4. Geohazard Scenarios

This risk assessment is based on the identification of geohazard scenarios, which are defined as specific undesirable outcomes that could result from a geohazard event. Geohazard scenarios follow from the hazard assessment (Section 3.0). They are not exhaustive and do not represent every possible negative outcome of a geohazard event. Rather, they are selected as representative, typical scenarios that can guide decision making on risk reduction measures to reduce risk to within tolerable levels.

Geohazard scenarios and are based on the results of the hazard assessment described in Section 3.0. These are listed in the “Hazard Identification” columns on the left side of the table in Appendix B. For each facility, the Process/Scenario column identifies the type of hazard process potentially affecting the facility. The Direct Consequence column describes the type of consequence potentially resulting from a particular process/scenario, should it occur.

4.5. Likelihood of Undesirable Outcome

The likelihood of an undesirable outcome is a product of the:

1. frequency or likelihood of the hazard occurring, as described in Section 3.1;
2. spatial probability ($P_{S:H}$) that the hazard, should it occur, impacts the element at risk, as described in Section 4.5.1;
3. temporal probability ($P_{T:H}$) that the element at risk (facility or worker) is present in the hazard zone when the hazard occurs (considered certain for fixed facilities), as described in Section 4.5.2;
4. vulnerability of the element at risk to damage or loss (the likelihood of the undesirable Table 4-6 defines categories used for likelihoods of an undesirable outcome, based on the product of the probabilities listed above).

Table 4-6. Definitions of likelihood of undesirable outcome.

Likelihood of Undesirable Outcome	Description	Probability Range
Very Likely	Damaging event occurs at least once per year	>0.9
Likely	Damaging event occurs every few years	0.1 to 0.9
Moderately Likely	Damaging event possible over the lifetime of a mine	0.01 to 0.1
Unlikely	Damaging event unlikely during the lifetime of a mine	0.001 to 0.1
Very Unlikely	Damaging event very unlikely during the lifetime of a mine	0.0001 to 0.001
Extremely Unlikely	Damaging event extremely unlikely to occur	< 0.0001

4.5.1. Estimates of Spatial Probability of Impact

Spatial probability ($P(S:H)_i$) is defined as the chance that the hazard, should it occur, reaches the element at risk ($P(S:H)_i$). The ratings were applied as part of the process to estimate relative risk for the purpose of prioritizing mitigation. They are based on judgment, considering factors such as geohazard type and extent relative to the facility size and location.

Fixed facilities were assigned a probability of spatial impact of 0.5 to 1, based on the extent of the hazard runout zone relative to the facility. In the category workers safety or machinery damage, the value depends on factors that are uncertain, such as the position of machinery or workers. Values were assigned depend on the estimated hazard extent in relation to elements at risk.

For moving vehicles on roads, spatial probability involves estimation that an event would impact the road section traversed by vehicles. The value of $P(S{:}H)_i$ was estimated based on the average width of an individual geohazard event with respect to the entire width of the hazard zones for a particular hazard type.

4.5.2. Estimates of Temporal Probability of Impact

Temporal probability ($P(T{:}S)_i$) is the chance the element at risk is actually present within the hazard zone when the hazard occurs. This value was assigned as 1 (certain) for fixed facilities.

In the category of safety of workers, estimates of the likelihood that a worker is present are subject to greater uncertainty. The value of $P(T{:}S)_i$ was assigned as 1 (certain) for permanently staffed facilities, and 0.1 for occasionally occupied facilities. In the case of moving vehicles, $P(T{:}S)_i$ was assigned for individual vehicle users based on an estimated average proportion of time a moving vehicle would spend in the hazard zone. This was estimated for a "typical" vehicle travelling an average of 30 km/hr, twice per day, 7 days/week, and 7 months/year.

4.5.3. Estimates of Vulnerability

Vulnerability is defined as the likelihood the element at risk will sustain damage or loss of function (the undesirable outcome) if impacted by a geohazard. Vulnerability estimates consider an "unmitigated" case. This is a base case assumption used to estimate geohazard risk for the purpose of prioritizing mitigation measures. It assumes that no geohazard mitigation measures are considered, such as berms, barriers, avalanche control, closure of areas to personnel, portal canopies, drainage channel covers, tower reinforcements, or slope reinforcement. In the case of safety, workers outside buildings are assumed to be in vehicles.

Definitions of vulnerability ratings described in this section are shown in Table 4-7, and the levels of vulnerability used in analysis are shown in Table 4-8. They are based on judgment, considering factors such as geohazard type and magnitude, and should be considered as order of magnitude ranges.

Table 4-7. Definitions of vulnerability categories.

Vulnerability Category	Vulnerability
Very Low	0.01
Low	0.1
Moderate	0.5
High	1

Table 4-8. Levels of vulnerability used in analysis

Element At Risk	**Geohazard Type**	**Vulnerability:** (Environment, Economic, Reputation[1])	**Vulnerability:** (Safety[1])
Roads	Landslide: Size Class 0 to 1	Low	Moderate
	Landslide: Size Class > 1	Moderate to High	High
	Snow Avalanche: Size Class (All)	High	Low to High
	Flooding	High	High
Buildings	Landslide: Size Class 0 to 1	Moderate	Low
	Landslide: Size Class >1	Moderate	Low
	Snow Avalanche: Size Class <3	Moderate	Low

[1]Consequence types are defined further below.

4.6. Estimates of Consequences

In Appendix B, each line describes a hazard scenario resulting in a particular type of consequence. Consequences are defined as follows:

- Human Safety
- Environmental Impacts
- Economic Impact
- Reputation Impacts

Safety involves the potential for loss of life. Loss of a single life is considered a Major consequence in Table 4-1. Safety is treated separately from the other consequence types (e.g. for hazard scenarios involving loss of life, only the consequence estimate for safety is made).

In the case of damage to facilities, consequence estimates are made in the categories of Environmental, Economic, and Reputation. Environmental consequences include the potential for facility damage to result in delivery of contaminants (e.g. tailings, ARD, sediment) to streams. Economic consequences consider repairs to machinery or facilities, and production losses. Reputation consequences include potential for negative publicity resulting, for example, in loss of market share. Some interdependence exists amongst these categories. For example, a geohazard event resulting in environmental contamination may affect the company's reputation as well as cause economic loss.

Economic consequence estimates, particularly those associated with production loss, are sensitive to particular mine operation plans. As such, these estimates should be reviewed by Pretium.

5.0 RESULTS

Risk assessment results are tabulated in Appendix B. Changes in infrastructure layout or addition of new facilities will modify the presently assessed risk. Table 5-1 provides a summary of risk results for the unmitigated case. Proposed facilities considered in the assessment but where no landslide or avalanche geohazard scenarios were identified include:

- Two explosive storage facilities
- Detonator storage
- Topsoil stockpile
- Substation
- Water treatment plant
- Portal fuel storage
- Conveyor portal and truck portal
- Overhead electrical
- Mill building including administration, mine dry, truck shop and warehouse
- Tailings pipeline
- Helipad
- Upper and lower laydown area
- Batch plant, fuel storage, and aviation fuel tank
- Pre-production ore storage
- Diversion channel
- Waste rock transfer storage
- Garbage and incinerator area
- Sewage system, water pumps, and storage tank
- Proposed new transmission tower location
- Scale house

These facilities are not shown in the table.

Table 5-1. Summary Geohazard risk Statistics for the Unmitigated Case

Facility	Hazard Type(s)	Facility Risk	Safety Risk
Operations Camp (Minesite)	Landslide	Low	Low
	Avalanche	Moderate	High
Minesite Roads	Avalanche	-	High
Access Road	Landslide	Moderate	Low
	Flood	High	Moderate
	Avalanche	Low	Moderate
Transfer Station	Avalanche	Very Low	Low
Airstrip	Flood	High	-

6.0 CLOSURE

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

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APPENDIX A
SNOW AVALANCHE HAZARDS

PRETIUM RESOURCES INC.

BRUCEJACK PROJECT

AVALANCHE HAZARD ASSESSMENT

PROJECT NO:	1204-001	DISTRIBUTION:	
DATE:	October 15, 2013	BGC:	2 copies
DOCUMENT NO:	NA	ASAS:	2 copies

EXECUTIVE SUMMARY

Pretium Resources Inc. (Pretium) is planning to develop a mine in the Coast Range of northwestern British Columbia, approximately 60 km north of Stewart, BC (Figure 1-1). The project includes several mine site facilities, a transmission line, and an access road. Studies that have been completed previously indicate that the project is in the vicinity of snow avalanche terrain. Pretium requested that Alpine Solutions Avalanche Services (Alpine Solutions) undertake an avalanche hazard assessment to determine the locations, likelihood and potential consequences of avalanches affecting the project.

The avalanche hazard assessment identified approximately 15 avalanche paths (or avalanche hazard areas where there are multiple overlapping paths) that affect planned facility locations and access roads, and several of these locations are affected annually. The preferred transmission line route traverses though numerous avalanche hazard areas although avalanche hazard to the line cannot be determined accurately until the alignment and structure (tower) locations are finalized. Potential consequences of avalanches reaching Brucejack mine facilities, transmission line, worksites, and roads include damage to infrastructure, worker injury (or fatality), and project delays. Potential consequences of static snow loads on transmission towers include damage to towers and foundations, and potential loss of electrical service to the mine. Options for avalanche mitigation are provided, and the memorandum concludes with the following recommendations:

- Operation of the mine during regular avalanche season (October through June) should involve an active avalanche management program to reduce risk to project personnel and equipment. The program should include the use of personal protective equipment (PPE) as well as avalanche safety training for all workers exposed to avalanche hazards. In addition, daily hazard and risk assessments by a qualified Avalanche Technician (or team of technicians) to forecast periods of elevated avalanche hazard so that closure of hazard areas can be implemented until hazard is reduced by means of avalanche explosive control or natural settlement. Avalanche explosive control methods may include hand charging, helicopter explosive control, and pneumatic explosive launchers (avalaunchers).
- Sections of the access road affected by Paths AR4, AR8 and KG1 are exposed to high frequency events that may have high consequences to traffic. Depending on traffic volume along the access road and the tolerance for extended closures of these sections, consideration should be given to the installation of fixed Remote Control Avalanche Systems (RACS) in the starting zones of these paths. The RACS would facilitate the ability to conduct avalanche control remotely during reduced visibility when helicopters cannot fly (darkness, and during storms).
- The area affected by icefall hazard at Path AR8 should receive constant monitoring throughout the winter, and regularly controlled using explosives to limit the chance of large icefall events impacting a vehicle.

- The segment of the Access Road which transits the Knipple Glacier should be reassessed on a regular basis due to the effects of glacial recession on avalanche runout distance on the glacier.
- During winter, snow berms should be constructed in areas at the mine site affected by short slopes or avalanches to Size 2, in order to reduce the frequency of small avalanches reaching facilities.
- If possible, transmission line structures (towers) should be located away from avalanche paths in order to reduce the requirement for avalanche mitigation. If this is not possible, additional analysis should be completed to determine the most optimal mitigation option. Mitigation may include designing towers for avalanche impact, diversion structures, or earthworks upslope of the tower.
- The final design of the transmission line should involve collaboration with an Avalanche Specialist/Engineer in order to optimize structure (tower) and conductor locations.
- Construction of the transmission line during avalanche season should include an avalanche management program to reduce risk to personnel and infrastructure.
- Any changes to layout of facilities and roads, in subsequent stages of mine development, should be reassessed for avalanche hazard.

This avalanche hazard assessment report is identical to a previous version submitted to Pretium on June 5, 2013, except for the drawing references. These references have been updated to refer to the drawing numbers in the main geohazard risk report that this report is appended to.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1. General

Pretium Resources Inc. (Pretium) is planning to develop a mine in the Coast Range of northwestern British Columbia, approximately 60 km north of Stewart, BC (Figure 1-1). The project includes several mine site facilities, a transmission line, and an access road. Studies that have been completed previously indicate that the project is in the vicinity of snow avalanche terrain. Pretium requested that Alpine Solutions Avalanche Services (Alpine Solutions) undertake an avalanche hazard assessment to determine the locations, likelihood and potential consequences of avalanches affecting the project. Options for avalanche mitigation are provided, and the memorandum concludes with recommendations. The results of this assessment will be used for mine permitting, and operational planning.

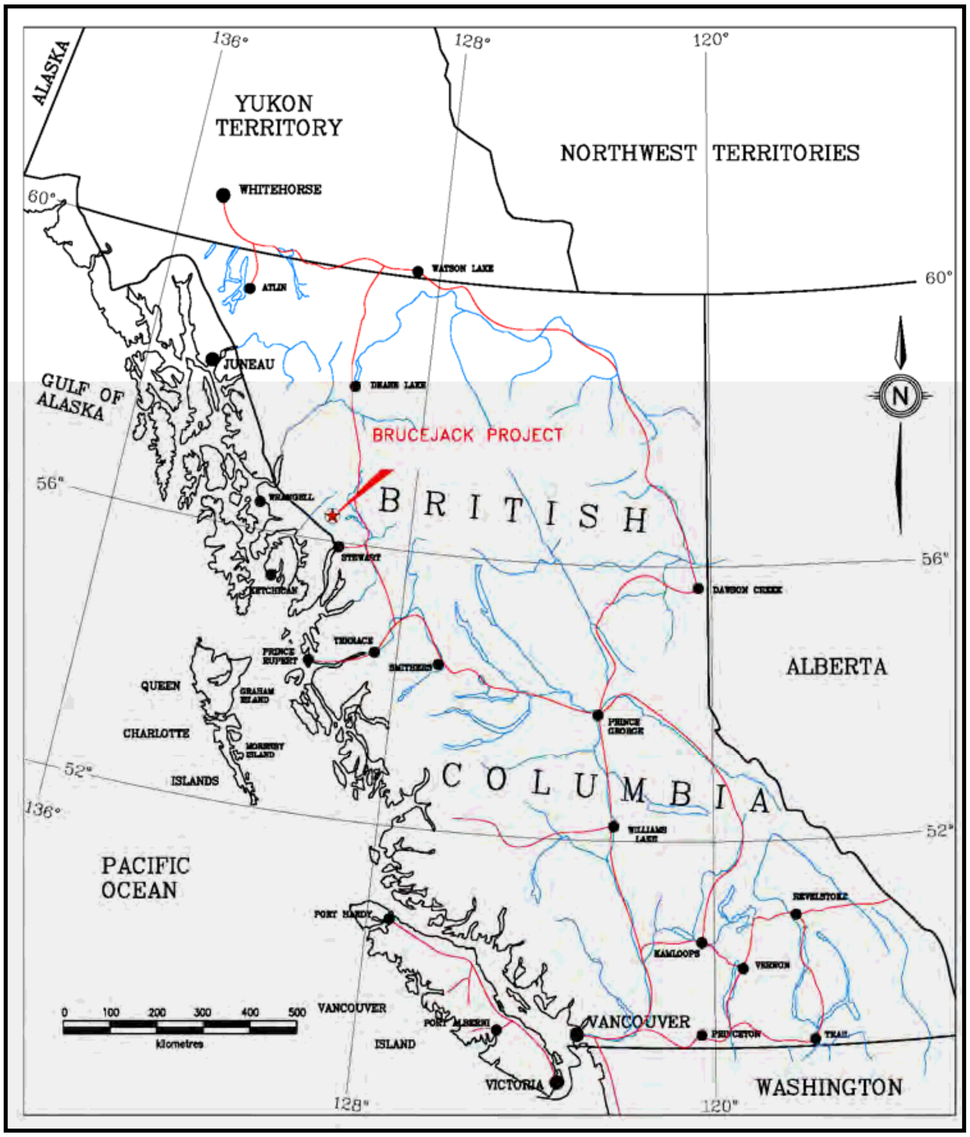

Figure 1-1. Brucejack project location

1.2. Scope of Work

The following maps and documents were provided by Pretium:

- Figure 18.11 Brucejack Overall Site Plan GA – Mine and Process Plant.
- Tetratech - Pretium Feasibility Study Drawings 100000-20-000, 001, 002, 101, 102, 103, 104, 105, 201, 301, 302, 303, 304, 305, 306, 501.
- Digital shape-files representing facility layout.
- 3 maps by Cypress Forest Consultants illustrating Access Road General Arrangement (including Glacier Road).
- Figure 8.2-2 Brucejack Project: Alternative Power Line Routes.
- Brucejack Road Risk Rating and Inspection Procedure.

In addition, numerous aerial photographs (1:20,000 scale), were provided by BGC Engineering Inc. Sketches of the preferred transmission line route were provided by Valard Construction Ltd.

The avalanche hazard assessment was completed for the mine site area and the access road from Highway 37. The preferred transmission line route was also reviewed for general avalanche hazard areas. The work included terrain analysis from topographic maps and aerial imagery. A helicopter overview flight was undertaken in March 2012 to confirm the avalanche path locations and terrain characteristics. Ground survey was completed April 28-29, 2013.

This report provides the following information:

- Identification and description of avalanche hazard to facilities and mine operations.
- An estimate of potential consequences of avalanches to facilities and mine operations.
- Options for mitigation.
- Recommendations.

This avalanche hazard assessment report is identical to a previous version submitted to Pretium on June 5, 2013, except for the drawing references. These references have been updated to refer to the drawing numbers in the main geohazard risk report that this report is appended to.

2.0 LIMITATIONS

This document provides an overview of snow[1] avalanche hazards which affect the proposed Brucejack mine project. Estimated magnitudes, frequencies, and areal extent of individual avalanche paths are based on a climate analysis, map and imagery interpretation, helicopter overview flights, and ground analysis for specific fixed infrastructure that is potentially affected by avalanches. Analysis of individual avalanche paths was limited to terrain and vegetation analysis; no numerical modeling has been completed.

Sources of uncertainty associated with avalanche runout boundaries illustrated on avalanche hazard mapping include:

- limited avalanche occurrence history (data) for the area; and
- lack of vegetation indicators (trim lines) where avalanches runout into non-forested terrain.

Although other geohazards exist in the region, the scope of this assessment is limited exclusively to avalanches. In addition, any significant artificial or natural alteration of the landscape or terrain due to forest fire, landslides, or other geotechnical event may change the nature (magnitude/frequency/intensity/runout) of avalanche hazard, necessitating a re-assessment for the area affected.

[1] The qualifier "snow" will not be included from here on. It was added here to make it clear that there is no mention of "rock avalanches" or "debris avalanches" in this report.

3.0 PHYSIOGRAPHY

3.1. Location

The Pretium mine site is located at the head of the Knipple Glacier, approximately 60 km north of Stewart, BC, and 38 km southwest of Bell II. The access road begins at the intersection of Highway 37 and Wildfire Creek, approximately 30 km south of Bell II, and extends to the mine site via the Wildfire Creek, Scott Creek, Bowser River, and Knipple Glacier valleys. The preferred transmission line route extends from the Long Lake Hydroelectric Project north of Stewart to the mine via the Salmon Glacier valley and the ridge on the south side of the Knipple Glacier. A second optional route for the transmission line follows the access road corridor from a potential connection point to the Northern Transmission Line at Highway 37.

3.2. Snow Climate

Snow climate refers to the general character of climate factors that contribute to snowpack and avalanche formation. Historical meteorological records often provide information on the frequency, timing, and sometimes magnitude of future avalanches. In addition, estimates of average and maximum snowpack depth can provide information on how often thresholds for avalanche triggering are exceeded.

Although historical climate and avalanche records for the Brucejack area is limited, regional BC Government snow pillow and snow survey records in the region provide baseline snowpack information. In addition, avalanche technicians working on site during winter 2012/2013 have collected avalanche occurrence records for several avalanche paths in the area.

The proposed Brucejack mine area is located in a transition zone between maritime and continental climate zones. As a result, there are significant temperature and moisture fluctuations that occur in an average winter. These fluctuations often contribute to a layered snowpack, which leads to lingering avalanche conditions most winters. In addition, the effects of wind and terrain orientation lead to increased snowpack variability which can contribute to challenging avalanche forecasting conditions.

Avalanche season typically begins in October at the higher elevations (above 1400 m), and often extends until late June or early July. At valley bottom elevations, avalanches can be expected from November to late May though can occur earlier or end later in extreme years.

Typical storm patterns can produce high intensity snowfall with strong winds depositing significant amounts of snow on lee (the side of slopes away from the principal wind direction) aspects. Temperature increases associated with some storms can produce rain-on-snow conditions up to treeline elevations (1200-1400 m), and sometimes above. An average winter will include 10-20 large storm events, most of which can produce widespread avalanche conditions.

4.0 AVALANCHE HAZARD ASSESSMENT

4.1. Background on Snow Avalanches

Snow avalanches generally occur in areas where there are steep open slopes or gullies, and deep (more than 50 cm) mountain snow packs. Risks associated with avalanches are normally due to exposure to the high impact forces that occur, as well as the effects of extended burial for any person caught in an avalanche. Impact forces vary significantly depending on avalanche size. Although the smallest avalanches can be insignificant to a human, larger avalanches may produce impact forces capable of destroying trucks, buildings, or several hectares of mature forest.

Characteristics of Snow Avalanches:

Avalanches may initiate in either dry or wet snow. Although an avalanche may start in dry snow, it could become moist or wet during its descent. Wet snow avalanches can be deflected and often channeled by terrain features, including gullies. Conversely, large, fast-flowing dry avalanches tend to flow in a straighter path, and may overrun terrain features.

Most large, dry avalanches consist of a dense component that flows primarily along the ground, and a less dense powder component that travels above and sometimes ahead of the flowing component. In some cases these components can separate and move independently. The dense-flowing component and powder component may reach speeds up to 60 m/s (200 km/h). Impact pressures from dense flows are much greater than the powder component due to the density of the snow.

Avalanche terrain is usually associated with steep, open slopes in the mountains that allow an accumulation of snow before it releases in a destructive event. In addition to the steep slopes that the snow accumulates on, any area exposed to this release of snow is also considered avalanche terrain. Terrain is often subdivided into features that are connected, which generally contain or channel the volume of avalanche events into a common deposition area. These features are called avalanche paths.

Avalanche season is the time of year when avalanches may occur, and is dependent on when the ground roughness in starting zones is covered by snow, and the threshold for avalanches is exceeded. For the Brucejack area, avalanche season below 1,000 m generally occurs between November and May. For elevations above 1,200 m, avalanche season can extend into October and June, or even summer months if cool, wet conditions persist.

Avalanche Path:

An avalanche path generally consists of a starting zone, a track, and a runout zone. Avalanches start and accelerate in the starting zone, which typically has a slope incline greater than 30°. Downslope of the starting zone, most large avalanche paths have a distinct track in which the slope angle is typically in the range of 15 to 30°. Large avalanches decelerate and stop in the runout zone where incline is usually less than 15°. Smaller avalanches may decelerate and even stop on steeper slopes (15 to 24°).

Within forested terrain, larger avalanche paths are often discernible as vertically oriented swaths of open forest terrain, bordered by trim lines (mature forest on either side of the swath). Smaller avalanches, however, can occur in more subtle paths, and can occur on large cut banks in a road cut.

Runout zones generally have vague trim lines, and analysis is required by an experienced avalanche specialist to determine estimates of maximum avalanche extent (often extends into mature forest). In terrain around cliffs, some avalanche paths can be much more subtle to observe, and can be confused with rock fall and/or geotechnical events.

Avalanche Frequency:

Avalanche frequency is the reciprocal of avalanche return period and is typically referred to as an order of magnitude ranging from 1:1 (annual) up to 1:300 (1 in 300) years. Each winter, the probability of an avalanche with a specified return period is constant.

Avalanche frequency is dependent upon snow supply and terrain. Frequency decreases with distance downslope in the track and runout zone. Snow supply is determined by:

- the frequency of snowfalls and amount of snow; and
- the wind transport of snow into the starting zone.

Snow and weather conditions vary from year to year; therefore, the frequency of avalanches is not uniform.

The primary terrain factors in avalanche formation are incline, slope orientation (aspect) with respect to wind and sun, slope configuration and size, and ground surface roughness. Slope configuration is important because features such as gullies will often have more frequent and larger avalanches than open slopes. Ground roughness determines the threshold snow depth for avalanches to occur, which is particularly important in light snow climates where snow may not exceed threshold depths during some winters.

Avalanche Magnitude:

Avalanche magnitude relates to the destructive potential of an avalanche and is defined according to the Canadian avalanche size classification system. This classification system is summarized in Table 4.1, which provides a general description of destructive potential, magnitude, and typical path length.

Table 4-1. Canadian classification system for avalanche size (McClung & Schaerer, 2006)

Size	Destructive Potential	Typical Mass (t)	Typical Path Length (m)	Typical Impact Pressures (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, or break a few trees.	10^3	1000	100
4	Could destroy a large truck, several buildings, or a forest with an area up to 4 hectares.	10^4	2000	500
5	Largest snow avalanches known. Could destroy a village or a 40 ha forest.	10^5	3000	1000

Magnitude is often related to frequency. In general, large destructive avalanches occur less frequently, while smaller ones occur on a more regular basis. Magnitude and frequency are also co-related to a specific location in an avalanche path. For example, a road location near the toe of an avalanche path will be affected by avalanches on a less frequent basis, but they will be larger avalanches. Both low-frequency large avalanches and higher-frequency small avalanches may affect a road crossing that is higher up in the avalanche path.

4.2. Brucejack Avalanche Hazard

Avalanche paths (and hazard areas where multiple overlapping paths exist) that affect the Project were identified by reviewing topographic relief and vegetation features on maps and aerial photos, as well as available Google Earth ortho-imagery and digital elevation models (DEM). In addition, field reconnaissance (helicopter overview flights and ground based survey) was completed on March 19, 2012, and from April 28 to 29, 2013.

Approximately 15 avalanche paths or hazard areas reach (or potentially reach) project infrastructure or access roads, and many locations are estimated to be affected on an annual basis. Drawings of the avalanche paths and hazard areas are illustrated in the main geohazard risk report that this report is appended to. Avalanche paths and hazard areas are labeled according to Table 4-1, referring to the element at risk, with the exception of paths along the Knipple Glacier which may affect both the transmission line and access road.

Table 4-1. Avalanche path label and corresponding element at risk.

Avalanche Path Label	Element at Risk
TL1, TL2, …, TLx	Preferred transmission line route
AR1, AR2, …, ARx	Access road and Knipple Transfer Station
MS1, MS2, …, MSx	Facilities at or near the mine site, access road, and transmission line
KG1, KG2, …, KGx	Access road and transmission line corridor on glacier

Details of avalanche hazards, and potential consequences are outlined in the following sections for the mine site, access road, Knipple Transfer Station, and transmission line.

4.2.1. Mine Site

The mine site is located on a broad alpine plateau in undulating terrain on the southwest side of Brucejack Lake. The area is bounded by the Knipple Glacier to the east and south, the Sulphurets Glacier to the west, and rising alpine slopes to the north. Elevations at the mine site area range from 1350 m to over 2000 m. The proposed facilities assessed include:

- two explosives and storage facilities – preliminary position;
- detonator storage – preliminary position;
- topsoil stockpile;
- substation;
- water treatment plant;
- portal fuel storage;
- conveyor portal and truck portal;
- overhead electrical;
- mill building including administration, mine dry, truck shop and warehouse;

- tailings pipeline;
- helipad;
- upper and lower laydown area;
- batch plant, fuel storage, and aviation fuel tank;
- pre-production ore storage;
- diversion channel;
- waste rock transfer storage;
- garbage and incinerator area;
- operations camp;
- sewage system, water pumps, and storage tank;
- proposed new transmission tower location;
- scale house;
- four air raise locations; and
- site access roads (not including mine access road).

These facilities are all located away from avalanche paths and areas with the exception of the operations camp, some sections of the site access roads, and the pre-production ore storage and diversion channel area. Short slopes that currently exist (ranging from 10 to 40 m in height), or will be created during construction, may be expected to affect other facility areas; however the hazard and consequences would normally be assessed on a site specific basis during construction and operations.

Table 4-2 provides a summary of avalanches reaching the mine site area and Drawing 1B in the main geohazard risk report that this report is appended to illustrates the approximate hazard locations.

Table 4-2. Mine site avalanche hazards.

Path or Area ID	Avalanche Atlas Polygon Label	Facility Affected	Approximate Elevation of Facility (m)	Facility Position in Path	Length of Facility Affected (m)	Return Frequency		
						Size 2	Size 3	Size 4
Mine Site 2	MS2	Pre-production ore storage and diversion channel	1,390 to 1,370	RZ	300	-	1:10	-
Mine Site 5	MS5	Site access roads	1,460 to 1,420	RZ	800	1:1	1:3	-
Mine Site 8	MS8	Operations camp and site access roads	1,450	RZ	300	1:1	-	-

Notes: RZ = Runout Zone

The nature of the hazards to facilities at the mine site, and the nature of hazards associated with avalanches reaching Brucejack Lake are described in the following sections.

4.2.1.1. Operations Camp

Size 2 avalanches from Path MS8 are estimated to reach the southwest end of the operations camp with an annual return frequency. Potential consequences include damage to vulnerable infrastructure (e.g. windows or non-structural component of building if built within the runout area) and worker injury or fatality if workers are in the runout area when the avalanche occurs.

4.2.1.2. Site Access Roads

Size 2 and 3 avalanches from Path MS5 and Size 2 avalanches from Path MS8 are estimated to reach site access roads annually. Potential consequences include damage to infrastructure and vehicles, and worker injury or fatality if workers are in the runout area when the avalanche occurs.

4.2.1.3. Pre-production Ore Storage and Diversion Channel Area

The pre-production ore storage, and diversion channel area are exposed to Size 3 avalanches from Path MS2 approximately once every ten years. Potential consequences are limited to damage to any vulnerable materials stored in this area during avalanche season, as well as worker injury or fatality if workers are in the runout area when the avalanche occurs. The diversion channel is expected to be buried during avalanche season.

4.2.1.4. Avalanches Reaching Brucejack Lake

Avalanches up to Size 3 may reach Brucejack Lake from Path MS1 as well as short steep slopes on the north side of Brucejack Lake. If avalanches reach the lake when the surface is not frozen, waves may develop. As a result of the small size or slow speed of the avalanches when they reach the lake, these waves are not expected to be destructive.

4.2.2. Access Road

The mine access road begins at Highway 37 near the confluence of Wildfire Creek and the Bell Irving River, approximately 30 km south of Bell II. The road extends northwest following the Wildfire Creek drainage for approximately 12 km before heading west to Scott Pass (677 m elevation) and then down Scott Creek drainage to the Bowser River valley (400 m elevation), 35 km from Highway 37. The access continues west along the Bowser River valley for approximately 15 km to the Knipple Transfer Station.

From the Knipple Transfer Station, the road ascends to the northwest to reach the south side of the toe of the Knipple Glacier, and along a short ramp to the Knipple Glacier. From here a glacier road extends up the center of the Knipple Glacier for approximately 15 km to the mine site at approximately 1400 m. The glacier road is proposed to be located near the centre of the Knipple Glacier, although the location may vary depending on crevasse restrictions.

Fourteen avalanche paths or areas are estimated to affect the access road, and two paths approach within 50 m (Table 4-3 and Drawings 1B to 5B). One area (Path AR8) is affected by large ice blocks falling off bluffs above the road. Several avalanche paths on the southwest and northeast side of the Knipple Glacier could affect the road if it was realigned during the project (to avoid crevasses). Potential consequences include damage to vehicles, occupant injury or fatality, and road delays for avalanche debris cleanup. Avalanche path characteristics for the Knipple Glacier segment are expected to change with glacial recession, so this segment will need to be reassessed regularly.

Areas within Paths AR4, AR8, and KG1 have increased hazard and consequences due to the high frequency of avalanches and ice falls reaching the affected areas, as well as magnitudes large enough to severely damage vehicles, injure occupants, and delay the flow of traffic during storms when helicopter avalanche control is not feasible.

Table 4-3. Access road avalanche hazards (table continues over 2 pages).

Path or Area ID	Avalanche Atlas Polygon Label	Facility Affected	Approximate Elevation of Facility (m)	Facility Position in Path	Approximate Length of Facility Affected (m)	Return Frequency		
						Size 2	Size 3	Size 4
Access Road 1	AR1	Access Road	580	-	-	-	-	P
Access Road 2	AR2	Access Road	580	-	-	-	-	P
Access Road 4	AR4	Access Road	400	RZ	600	1:1	1:3	-
Access Road 5	AR5	Access Road	440	RZ	540	>1:1	1:1	-
Access Road 6	AR6	Access Road	420	RZ	140	>1:1	-	-
Access Road 6.5	AR6.5	Access Road	470	RZ	250	1:1	-	-
Access Road 7	AR7	Access Road	600 to 470	RZ	1,000	-	1:3	1:10
Access Road 7	AR7	Knipple Transfer Station (west end only)	470	RZ	100	-	-	1:100
Access Road 8	AR8	Access Road	730 to 660	RZ	700	1:1	1:3	-
Knipple Glacier 1	KG1	Access Road	730 to 650	RZ	700	1:1	1:3	-

Path or Area ID	Avalanche Atlas Polygon Label	Facility Affected	Approximate Elevation of Facility (m)	Facility Position in Path	Approximate Length of Facility Affected (m)	Return Frequency		
						Size 2	Size 3	Size 4
Mine Site 1	MS1	Access Road	1,440 to 1,370	RZ	2,000	>1:1	1:1	-
Mine Site 2	MS2	Access Road	1,370	RZ	300	1:1	1:10	-
Mine Site 5	MS5	Access Road	1,420 to 1,440	RZ	600	>1:1	1:3	-
Mine Site 9	MS9	Access Road	1,455	RZ	100	1:3	-	-
Mine Site 10	MS10	Access Road	1,455	RZ	150	1:3	-	-

Notes: RZ = Runout Zone; P = Potential to reach access road or facility

4.2.3. Knipple Transfer Station

The Knipple Transfer Station is located at the valley bottom near the confluence of the Salmon and Knipple valleys (Drawings 2B, 3B, and 6B). Large avalanches occurring in Path AR6 are estimated to reach the west end (approximately 20%) of the Knipple Transfer Station pad with an estimated return period of at least 100 years. Avalanches are not expected to reach the eastern side of the Knipple Lake Transfer Station pad where primary fixed facilities (camp) are located. Potential consequences of avalanches reaching the site include damage to infrastructure and injury or fatality for any personnel located in the runout area.

4.2.4. Transmission Line

4.2.4.1. Avalanche Hazard

The preferred transmission line route begins at Long Lake where a hydroelectric generation facility is currently being built, approximately 14 km north of Stewart BC. Although the exact alignment has not been finalized, the line is proposed to follow a route on the east side of the Salmon Glacier Valley to the proposed Knipple Transfer Station area. The line is then proposed to follow a route along a ridge on the southwest side of the Knipple Glacier to the mine site. The preferred route is illustrated in Drawings 1B to 3B and 6B to 9B. An optional transmission line route for the project follows the access road alignment from the BC Hydro Northern Transmission Line (NTL) at Highway 37.

Initial analysis indicates that there are approximately 20 to 25 avalanche paths that affect the preferred transmission line route, although they would only pose a hazard if supporting structures (towers) were built in avalanche paths, or conductors were low enough to the ground to be affected by the powder (airbourne) component of the flow. Potential consequences include damage to towers or conductors, and interruption of service to the mine. In addition, worker injury or fatality may occur if the line is built, or if maintenance is undertaken, in avalanche hazard areas during avalanche season. The final alignment of the transmission line (including specific structure locations) is expected to be detailed during the next phase of the Project, and will be assessed further for avalanches at that time.

The optional transmission line alignment parallels the access road from the NTL adjacent to Highway 37, and is potentially affected by the same avalanche paths that affect the access road. There may be additional paths that affect the line depending on the final alignment. Potential consequences to the Project would be the same as the consequences of avalanches reaching the preferred transmission line alignment.

4.2.4.2. Static Snow Forces

In addition to avalanche hazard, transmission line towers may be subject to forces of snow creep and glide, depending on their location. Although snow creep and glide are not fast moving events, they may generate forces that may exceed the bending strength of the tower or the strength of the foundation. If towers built on slopes are not designed to withstand these forces, potential consequences may include damage to towers and associated impact to conductors resulting in interruption of services to the mine.

5.0 Options for Mitigation

Avalanche mitigation strategies typically incorporate location planning (for fixed facilities), structural or earthworks mitigation, avoidance during avalanche season, or the implementation of an active avalanche management plan (generally for access roads and worksites that can be evacuated). The type of mitigation often depends on the element at risk, and its requirement for un-interrupted access (or not).

The hazard to the structures (towers) along the transmission line may be reduced by location planning which may include locating towers away from the centre of avalanche paths, and spanning avalanche paths as much as possible. If this is not feasible, the construction of splitting wedges (Figure 5-1) or earthworks can reduce or eliminate the hazard to towers. Alternatively towers may be reinforced with concrete and/or steel to protect from avalanche impact forces and snow creep and glide forces (Figure 5-2).

Figure 5-1. Example of splitting wedge to protect structure (McClung & Schaerer, 2006)

Figure 5-2. Example of reinforced tower

Measures to reduce risk to roads and worksites may include permanent or semi-permanent mitigation including:

- earthworks (diversion and catchment berms) to contain or divert avalanches away from worksites, access roads, or facilities;
- snow berms (constructed annually) to contain or divert avalanches away from worksites, access roads, or facilities; and
- structural walls or snow sheds.

Due to high costs of building structural walls or snow sheds, the feasibility of these are typically evaluated in a business case comparison of options that would balance cost of construction and maintenance versus costs associated with temporary closure of areas or roads during periods of high hazard.

Avalanche mitigation for worksites and access roads typically involve an active avalanche management plan. An active avalanche management plan normally includes a daily hazard and risk assessment process by Avalanche Technicians for all affected worksites and access routes. When hazard is high, sites are evacuated until hazard is reduced by application of explosives, or natural settlement. Other measures in an avalanche management plan include:

- worker safety training sessions;
- the use of Personal Protective Equipment (e.g. avalanche transceivers) and rescue equipment; and
- an Avalanche Emergency Response Plan.

For avalanche hazard areas that require high reliability (i.e. reduced closure time), Remote Control Avalanche Systems (RACS) can be used. Further details regarding RACS are provided in Section 5.1.

5.1. Remote Avalanche Control Systems

Remote avalanche control systems (RACS) utilize fixed infrastructure installed in or near avalanche starting zones. The systems are designed to deploy explosive charges and trigger avalanches in any weather, and anytime day or night, via a remote communications link. Remote systems generally have high initial cost, but this may be offset by costs savings due to reduced operational delays.

Types of RACS that are currently available include gas exploders, sophisticated remote control mortar systems, and other remote devices which can remotely deliver explosives to starting zones. During times when avalanche control is required, a technician establishes a communications link between the infrastructure and a control computer, and a firing sequence is initiated. This can be accomplished from an office or field computer.

Remote control gas exploders are currently the most prominent type of remote systems in use today. In addition to hundreds of operations in Europe and Asia, several highways, parks, and ski areas in North America, and some mining operations in South America rely on them for effective control in active areas. Other systems that either launch explosives into starting zones, or hang charges above starting zones, may be preferred for some situations.

Examples of three different types of RACS are illustrated in Figure 5-3, 5-4, and 5-5. Figure 5-3 illustrates a single remote control gas exploder and associated control shelter (which would support an array of exploders), Figure 5-4 illustrates a mortar based system, and Figure 5-5 illustrates a tethered (air-blast) explosive system (Wyssen Tower).

Typically a business case study is undertaken prior to installing RACS system. Cost savings from reduced closure time and the efficiency and safety gained in using RACS typically must offset cost of installation and operation.

Figure 5.3 Gas-exploder (left) and control shelter (right).

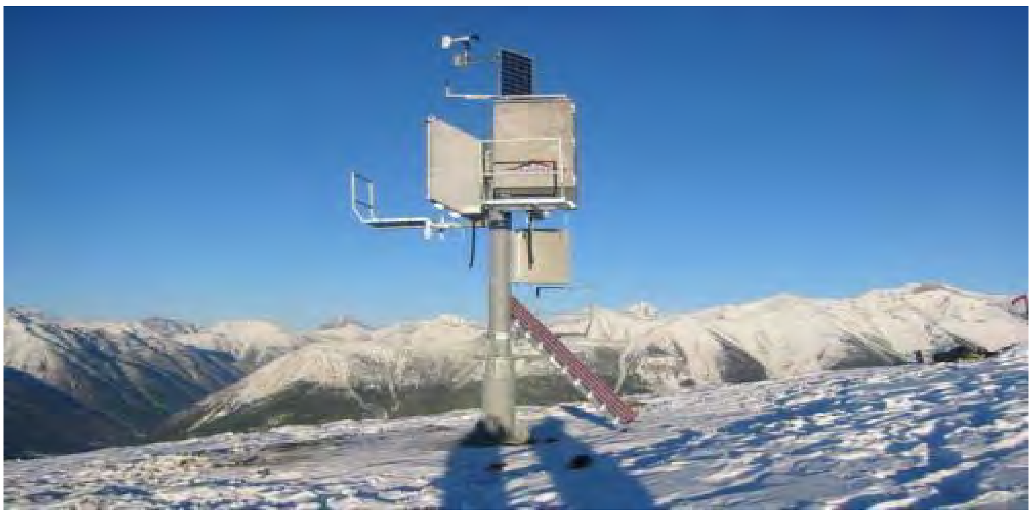

Figure 5-4. Mortar based RACS.

Figure 5-5. Wyssen Tower (courtesy of Wyssen Avalanche Control AG).

6.0 Summary and Recommendations

6.1. Summary

An avalanche hazard assessment has been completed for the Brucejack mine project. Mine facilities and access routes are exposed to 15 avalanche paths (or avalanche hazard areas where there are multiple overlapping paths) that affect planned facility locations and access roads, and several of these locations are affected annually. The preferred transmission line route traverses though 20 to 25 avalanche hazard areas although avalanche hazard to the line cannot be determined accurately until the alignment and structure (tower) locations are finalized. Potential consequences of avalanches reaching Brucejack mine facilities, transmission line, worksites, and roads include damage to infrastructure, worker injury (or fatality), and project delays. Potential consequences of static snow loads on transmission towers include damage to towers and foundations, and potential loss of electrical service to the mine.

6.2. Recommendations

Alpine Solutions recommends the following:

- Operation of the mine during regular avalanche season (October through June) should involve an active avalanche management program to reduce risk to project personnel and equipment. The program should include the use of personal protective equipment (PPE) as well as avalanche safety training for all workers exposed to avalanche hazards. In addition, daily hazard and risk assessments by a qualified Avalanche Technician (or team of technicians) to forecast periods of elevated avalanche hazard so that closure of hazard areas can be implemented until hazard is reduced by means of avalanche explosive control or natural settlement. Avalanche explosive control methods may include hand charging, helicopter explosive control, and pneumatic explosive launchers (avalaunchers).
- Sections of the access road affected by Paths AR4, AR8 and KG1 are exposed to high frequency events that may have high consequences to traffic. Depending on traffic volume along the access road and the tolerance for extended closures of these sections, consideration should be given to the installation of fixed Remote Control Avalanche Systems (RACS) in the starting zones of these paths. The RACS would facilitate the ability to conduct avalanche control remotely during reduced visibility when helicopters cannot fly (darkness, and during storms).
- The area affected by icefall hazard at Path AR8 should receive constant monitoring throughout the winter, and regularly controlled using explosives to limit the chance of large icefall events impacting a vehicle.
- The segment of the Access Road which transits the Knipple Glacier should be reassessed on a regular basis due to the effects of glacial recession on avalanche runout distance on the glacier.

- During winter, snow berms should be constructed in areas at the mine site affected by short slopes or avalanches to Size 2, in order to reduce the frequency of small avalanches reaching facilities.
- If possible, transmission line structures (towers) should be located away from avalanche paths in order to reduce the requirement for avalanche mitigation. If this is not possible, additional analysis should be completed to determine the most optimal mitigation option. Mitigation may include designing towers for avalanche impact, diversion structures, or earthworks upslope of the tower.
- The final design of the transmission line should involve collaboration with an Avalanche Specialist/Engineer in order to optimize structure (tower) and conductor locations.
- Construction of the transmission line during avalanche season should include an avalanche management program to reduce risk to personnel and infrastructure.
- Any changes to layout of facilities and roads, in subsequent stages of mine development, should be reassessed for avalanche hazard.

7.0 CLOSURE

This document was prepared by Alpine Solutions Avalanche Services (Alpine Solutions) for the account of Pretium Resources Inc. The material in it reflects Alpine Solutions' best judgment in light of the information available to Alpine Solutions at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Alpine Solutions accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions, based on this report.

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We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

ALPINE SOLUTIONS AVALANCHE SERVICES
per:

Brian Gould, P.Eng.
Senior Avalanche Specialist

REFERENCES

Alpine Solutions Avalanche Services (ASAS). 2012. Brucejack Avalanche Hazard Assessment and Risk Analysis. Draft Memorandum submitted May 31, 2012.

Canadian Avalanche Association (CAA). 2002. Guidelines for Snow Avalanche Risk Determination and Mapping in Canada. McClung, D.M., Stethem, P. A. Schaerer, and J.B. Jamieson (eds.), Canadian Avalanche Association, 23 pp.

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Mears, A., 1992, Snow-Avalanche Hazard Analysis for Land Use Planning and Engineering. Colorado Geological Survey Bulletin 4Dept.ept of Natural Resources, Denver, Colorado.

APPENDIX B
GEOHAZARD RISK TABLES

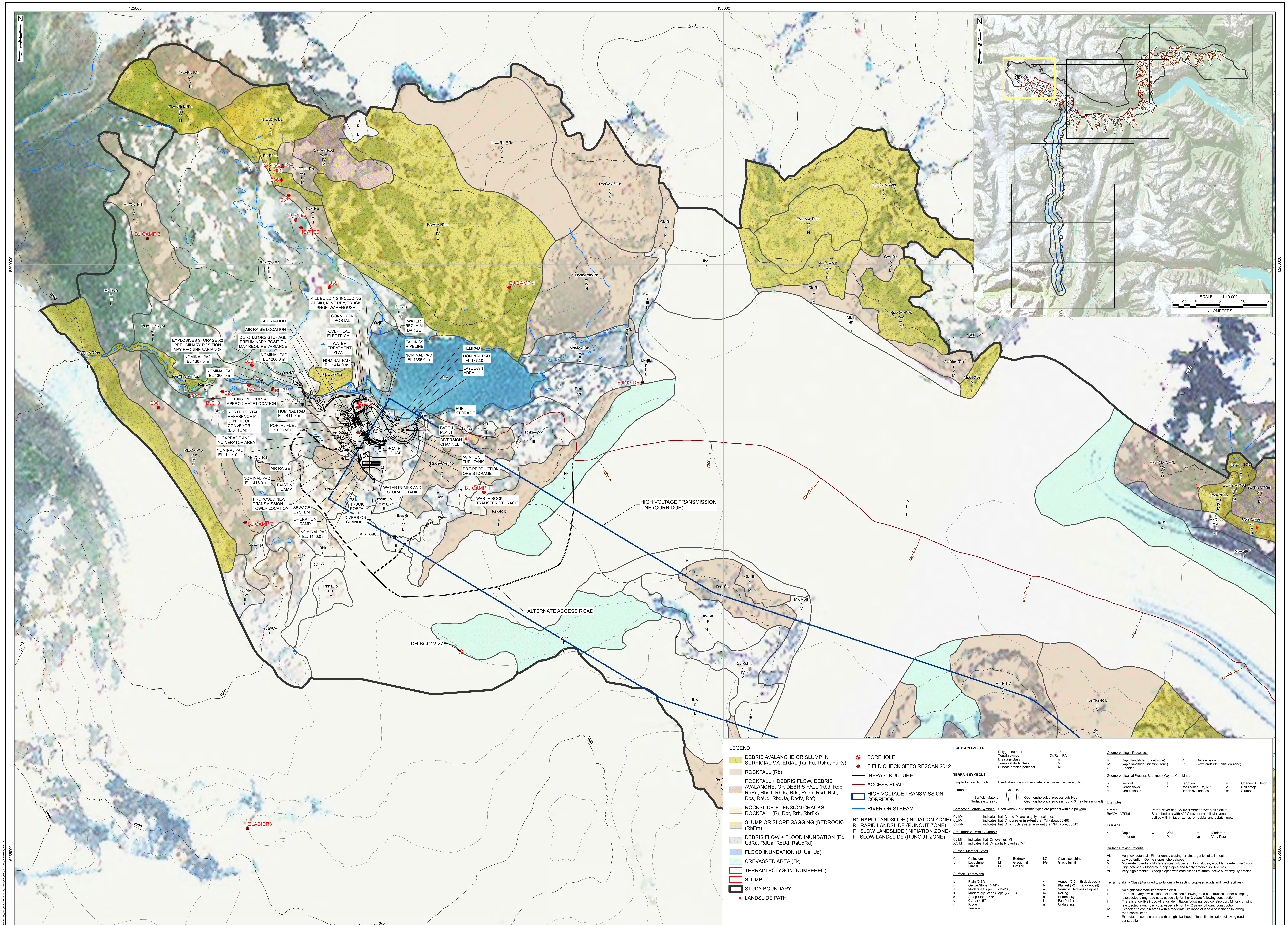
TABLE B-1 BRUCEJACK PROJECT GEOHAZARD RISK TABLE

HAZARD IDENTIFICATION			ANNUAL HAZARD P		ANNUAL PROBABILITY OF UNWANTED OUTCOME						CONSEQUENCE ESTIMATION (OPERATION)					UNMITIGATED
Facility	**Process/Scenario**	**Direct Consequence**	$P_{H(min)}$	$P_{H(max)}$	$P_{S:H}$	$P_{T:H}$	V	$P_{(min)}$	$P_{(max)}$	Likelihood	Safety	Environment	Economic	Reputation	*Max Cons.*	Risk
Operations Camp	Size 0-1 rockfall	Damage to building	0.01	0.1	0.01	1	0.5	5.0E-05	5.0E-04	Very Unlikely	-	2	3	2	3	LOW
		Fatality	0.01	0.1	0.01	1	0.1	1.0E-05	1.0E-04	Very Unlikely	4	-	-	-	4	LOW
	Size 2 avalanche	Damage to building	1	10	0.5	1	0.5	2.5E-01	2.5E+00	Very Likely	1	1	1	1	1	MODERATE
		Fatality	1	10	0.1	0.1	0.1	0.001	0.01	Unlikely	4	-	-	3	4	MODERATE
Minesite roads	Snow Avalanche Impact (Size 2-3)	Injury or fatality	1	10	1	0.1	0.1	0.01	0.1	Moderate	4	-	-	-	4	HIGH
Transfer Station	Snow Avalanche Impact (size 4)	Injury or fatality	0.001	0.01	0.2	0.1	1	0.00002	0.0002	Very Unlikely	4	4	4	4	4	LOW
		Damage to Building	0.001	0.01	0.1	1	0.5	0.00005	0.0005	Very Unlikely	-	1	4	4	4	LOW
Airstrip	Flood inundation	Damage to airstrip	0.05	0.2	1	1	1	0.05	0.2	Likely	-	2	3	2	3	HIGH
Access Road (Km)	Size 2-3 debris avalanche	Damage to road	0.01	0.1	1	1	0.9	9.0E-04	9.0E-03	Unlikely	-	2	2	2	2	LOW
		Damage to vehicle	0.01	0.1	0.1	0.001	0.9	5.4E-07	5.4E-06	Extremely Unlikely	-	2	2	2	2	VERY LOW
		Fatality	0.01	0.1	0.1	0.001	0.9	5.4E-06	5.4E-05	Extremely Unlikely	4	-	-	-	4	LOW
	Size 3 debris flood	Damage to road	0.01	0.1	1	1	0.9	4.5E-03	4.5E-02	Moderate	-	2	3	2	3	MODERATE
		Damage to vehicle	0.01	0.1	0.5	0.0001	0.9	2.7E-07	2.7E-06	Extremely Unlikely	-	2	2	2	2	VERY LOW
		Fatality	0.01	0.1	0.5	0.0001	0.9	5.4E-06	5.4E-05	Extremely Unlikely	4	-	-	-	4	LOW
	Size 0-1 rockfall	Damage to road	0.1	1	1	1	0.5	5.0E-04	5.0E-03	Unlikely	-	2	2	2	2	LOW
		Damage to vehicle	0.1	1	0.01	0.002	0.9	1.8E-06	1.8E-05	Extremely Unlikely	-	2	2	2	2	VERY LOW
		Fatality	0.1	1	0.01	0.002	0.9	9.0E-05	3.6E-04	Very Unlikely	4	-	-	-	4	LOW
	Flood inundation	Damage to road	0.05	0.2	1	1	0.9	9.0E-03	3.6E-02	Moderate	-	2	4	2	4	HIGH
		Damage to vehicle	0.05	0.2	0.2	0.02	0.9	1.8E-04	7.2E-04	Very Unlikely	4	2	2	2	4	LOW
		Fatality	0.05	0.2	0.2	0.02	0.9	1.8E-03	1.8E-02	Moderate	4	-	-	-	4	HIGH
	Snow Avalanche Impact (Size 2-4)	Damage to vehicle	0.1	1.00	1	0.01	1	1.0E-03	1.0E-02	Unlikely	-	2	2	2	2	LOW
		Spill into Bowser floodplain from truck overturn	0.1	1.00	1	0.01	1	1.0E-02	1.0E-01	Moderate	-	3	3	3	3	MODERATE
		Fatality	0.1	1.00	1	0.01	1	1.0E-02	1.0E-01	Moderate	4	-	4	-	4	HIGH
Access Road (km 59 area?)	Icefall impact	Injury or fatality	1	10	1	0.01	0.1	2.0E-07	2.0E-06	Extremely Unlikely	4	-	-	-	4	LOW

Very High	**0**
High	**5**
Mod	**4**
Low	**11**
Very Low	**3**
TOTAL	**23**

Note: Only facilities where geohazard scenarios were identified are included in this table

DRAWINGS



LEGEND

- DEBRIS AVALANCHE OR SLUMP IN SURFICIAL MATERIAL (Rs, Fu, RsFu, FuRs)
- ROCKFALL (Rb)
- ROCKFALL + DEBRIS FLOW, DEBRIS AVALANCHE, OR DEBRIS FALL (Rbd, Rdb, RbRd, Rbsd, Rbds, Rds, Rsdb, Rsd, Rsb, Rbs, RbUd, RbdUa, RbdV, Rbf)
- ROCKSLIDE + TENSION CRACKS, ROCKFALL (Rr, Rbr, Rrb, RbrFk)
- SLUMP OR SLOPE SAGGING (BEDROCK) (RbFm)
- DEBRIS FLOW + FLOOD INUNDATION (Rd, UdRd, RdUa, RdUd, RsUdRd)
- FLOOD INUNDATION (U, Ua, Ud)
- CREVASSED AREA (Fk)
- TERRAIN POLYGON (NUMBERED)
- SLUMP
- STUDY BOUNDARY
- LANDSLIDE PATH
- BOREHOLE
- FIELD CHECK SITES RESCAN 2012
- INFRASTRUCTURE
- ACCESS ROAD
- HIGH VOLTAGE TRANSMISSION CORRIDOR
- RIVER OR STREAM

R" RAPID LANDSLIDE (INITIATION ZONE)
R RAPID LANDSLIDE (RUNOUT ZONE)
F" SLOW LANDSLIDE (INITIATION ZONE)
F SLOW LANDSLIDE (RUNOUT ZONE)

POLYGON LABELS

Polygon number	123
Terrain symbol	Cv/Rs – R"b
Drainage class	w
Terrain stability class	V
Surface erosion potential	M

TERRAIN SYMBOLS

Simple Terrain Symbols: Used when one surficial material is present within a polygon

Example: Cb – Rb
Surficial Material
Surface expression
Geomorphological process sub-type
Geomorphological process (up to 3 may be assigned)

Composite Terrain Symbols: Used when 2 or 3 terrain types are present within a polygon

Cv.Mv indicates that 'C' and 'M' are roughly equal in extent
Cv/Mv indicates that 'C' is greater in extent than 'M' (about 60:40)
Cv//Mv indicates that 'C' is much greater in extent than 'M' (about 80:20)

Stratigraphic Terrain Symbols

Cv|Mj indicates that 'Cv' overlies 'Mj'
/Cv|Mj indicates that 'Cv' partially overlies 'Mj'

Surficial Material Types

C	Colluvium	R	Bedrock	LG	Glaciolacustrine
L	Lacustrine	M	Glacial Till	FG	Glaciofluvial
F	Fluvial	O	Organic		

Surface Expressions

p	Plain (0-3°)	v	Veneer (0-2 m thick deposit)
j	Gentle Slope (4-14°)	b	Blanket (>2 m thick deposit)
a	Moderate Slope (15-26°)	w	Variable Thickness Deposit)
k	Moderately Steep Slope (27-35°)	m	Rolling
s	Steep Slope (>35°)	h	Hummocky
c	Cone (>15°)	f	Fan (<15°)
r	Ridge	u	Undulating
t	Terrace		

Geomorphologic Processes

R	Rapid landslide (runout zone)	V	Gully erosion
R"	Rapid landslide (initiation zone)	F"	Slow landslide (initiation zone)
U	Flooding		

Geomorphological Process Subtypes (May be Combined)

b	Rockfall	e	Earthflow	a	Channel Avulsion
d	Debris flows	r	Rock slides (Rr, R"r)	c	Soil creep
d2	Debris floods	s	Debris avalanches	m	Slump

Examples

/Cv|Mb Partial cover of a Colluvial Veneer over a till blanket
Rs//Cv – VR"bd Steep bedrock with <20% cover of a colluvial veneer; gullied with initiation zones for rockfall and debris flows.

Drainage

r	Rapid	w	Well	m	Moderate
i	Imperfect	p	Poor	vp	Very Poor

Surface Erosion Potential

VL Very low potential - Flat or gently sloping terrain, organic soils, floodplain
L Low potential - Gentle slopes, short slopes
M Moderate potential - Moderate steep slopes and long slopes; erodible (fine-textured) soils
H High potential - Moderate steep slopes and highly erodible soil textures
VH Very high potential - Steep slopes with erodible soil textures, active surface/gully erosion

Terrain Stability Class (Assigned to polygons intersecting proposed roads and fixed facilities)

I No significant stability problems exist.
II There is a very low likelihood of landslides following road construction. Minor slumping is expected along road cuts, especially for 1 or 2 years following construction.
III There is a low likelihood of landslide initiation following road construction. Minor slumping is expected along road cuts, especially for 1 or 2 years following construction.
IV Expected to contain areas with a moderate likelihood of landslide initiation following road construction.
V Expected to contain areas with a high likelihood of landslide initiation following road construction.

SCALE 1:10 000
500 250 0 500 1000 1500
METRES

NOTES:
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100 m CONTOUR INTERVAL (PRETIUM)
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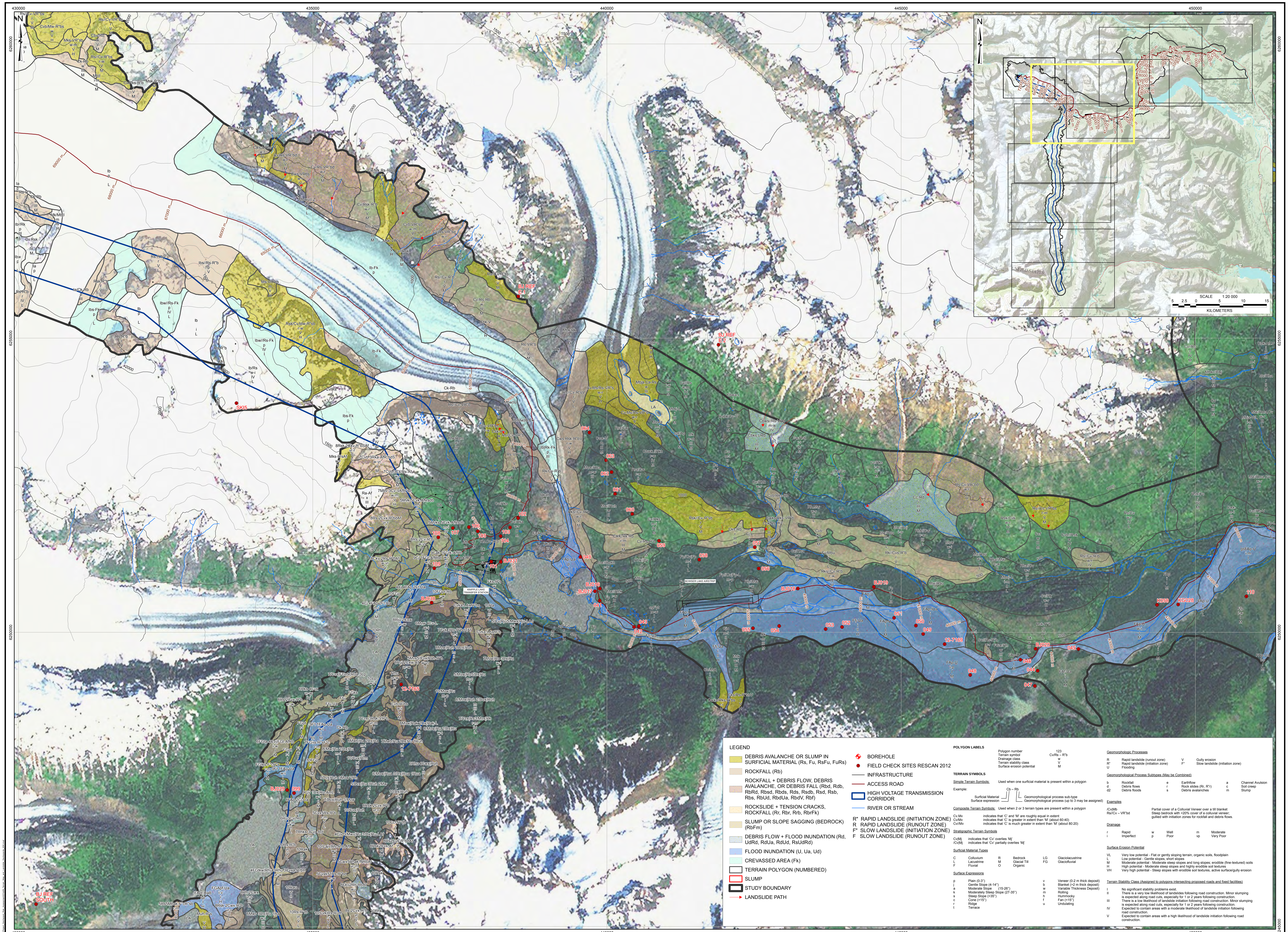

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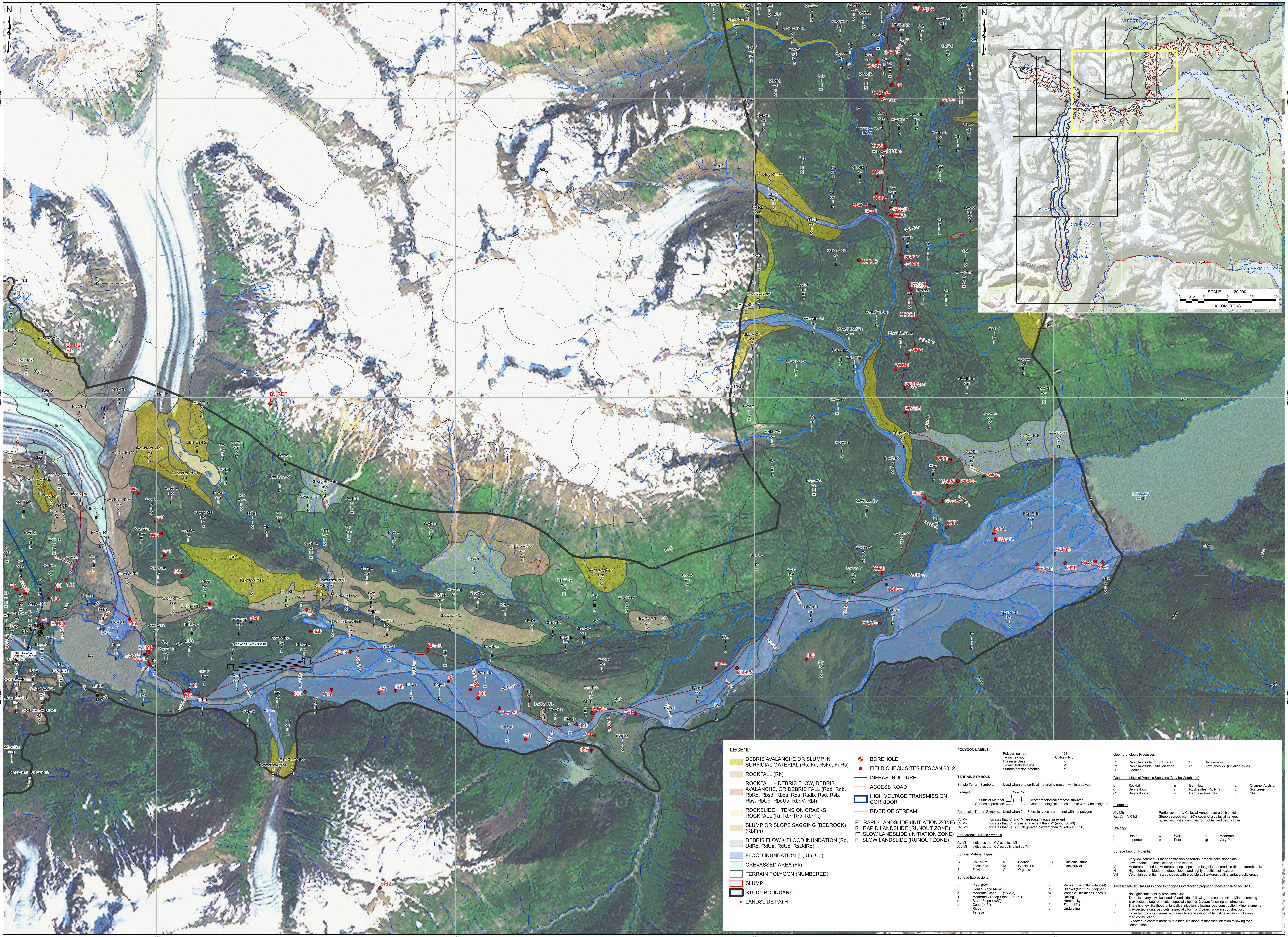

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METRES

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NAD 1983 UTM Zone 9N

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TITLE: TERRAIN MAP AND LANDSLIDE GEOHAZARDS
PROJECT No.: 1008010
DWG No.: 3A
REV.:

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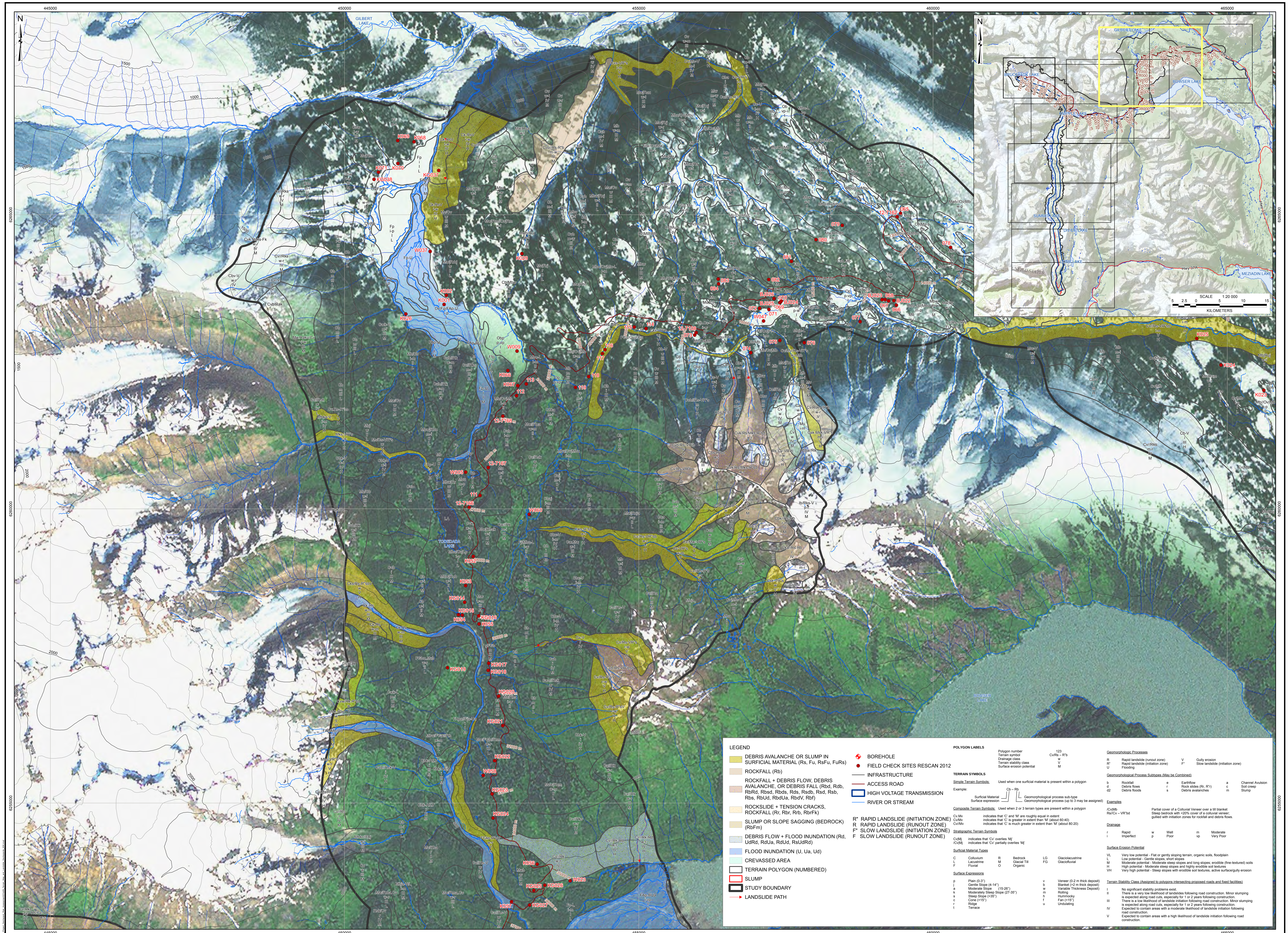

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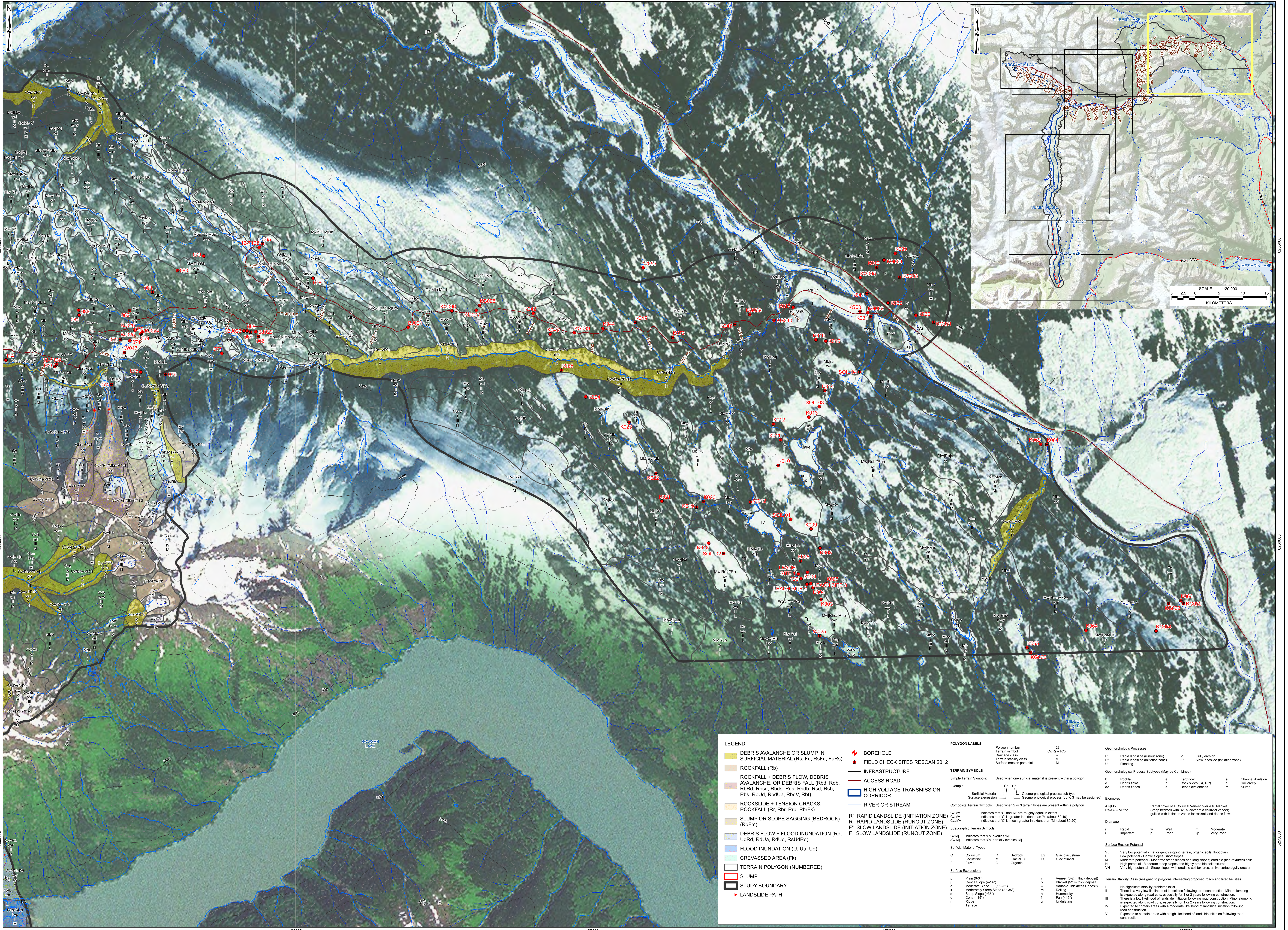

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100 m CONTOUR INTERVAL (PRETIUM)
NAD 1983 UTM Zone 9N

REV.	DATE	REVISION NOTES	DRAWN	CHECK	APPR.

SCALE:	1:20 000
DATE:	OCT 2013
DRAWN:	IL, MIB-C
DESIGNED:	BW
CHECKED:	
APPROVED:	

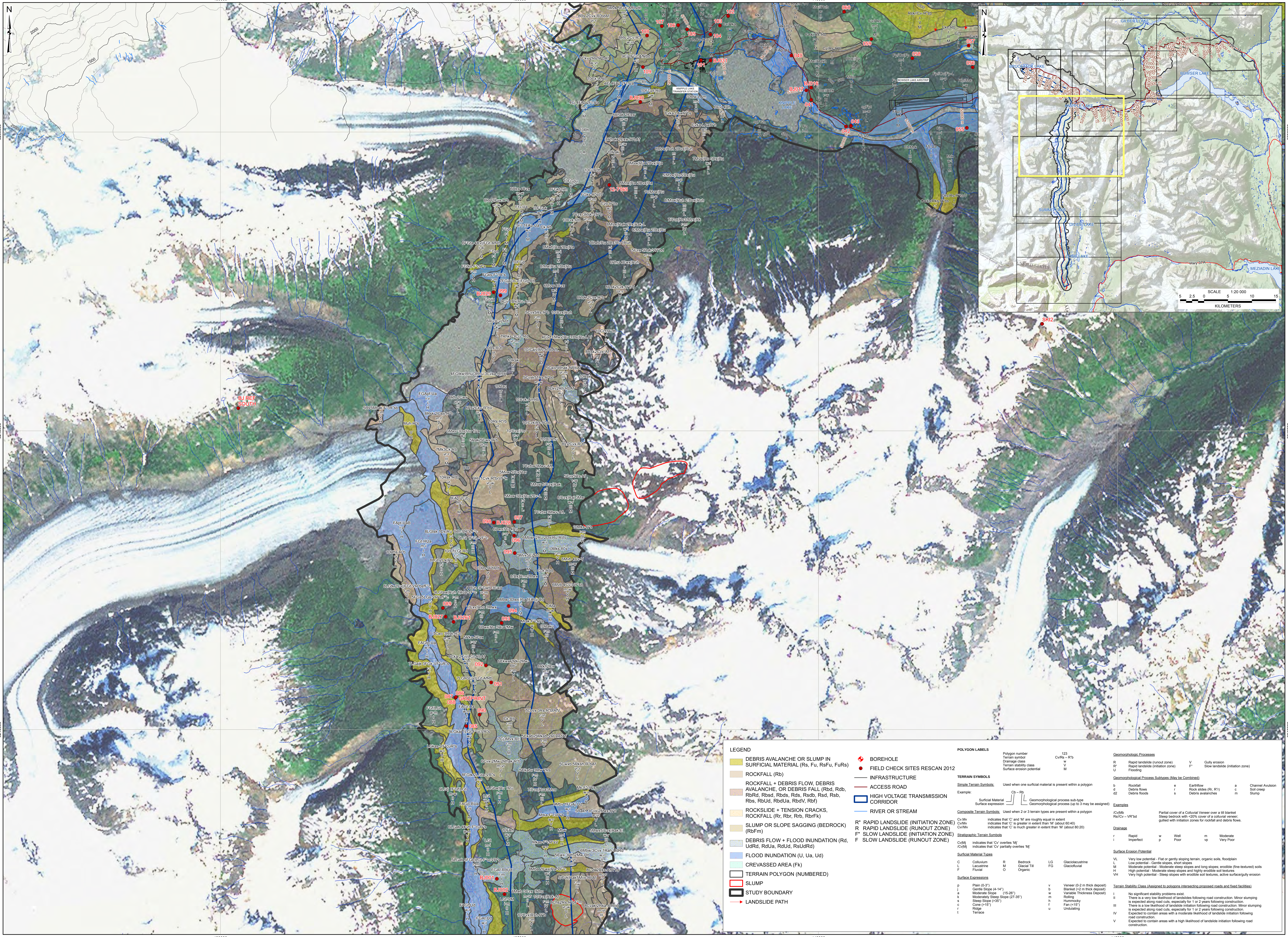
PROFESSIONAL SEAL:
DRAFT

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: PRETIUM RESOURCES INC.

PROJECT: BRUCEJACK PROJECT GEOHAZARD AND RISK ASSESSMENT
TITLE: TERRAIN MAP AND LANDSLIDE GEOHAZARDS
PROJECT No.: 1008010
DWG No.: 5A
REV.:

DWG TO BE READ WITH BGC REPORT TITLED "BRUCEJACK PROJECT GEOHAZARD AND RISK ASSESSMENT" DATED OCTOBER 2013



430000 435000 440000 445000

SCALE 1:20 000

1000 500 0 1000 2000 3000

METRES

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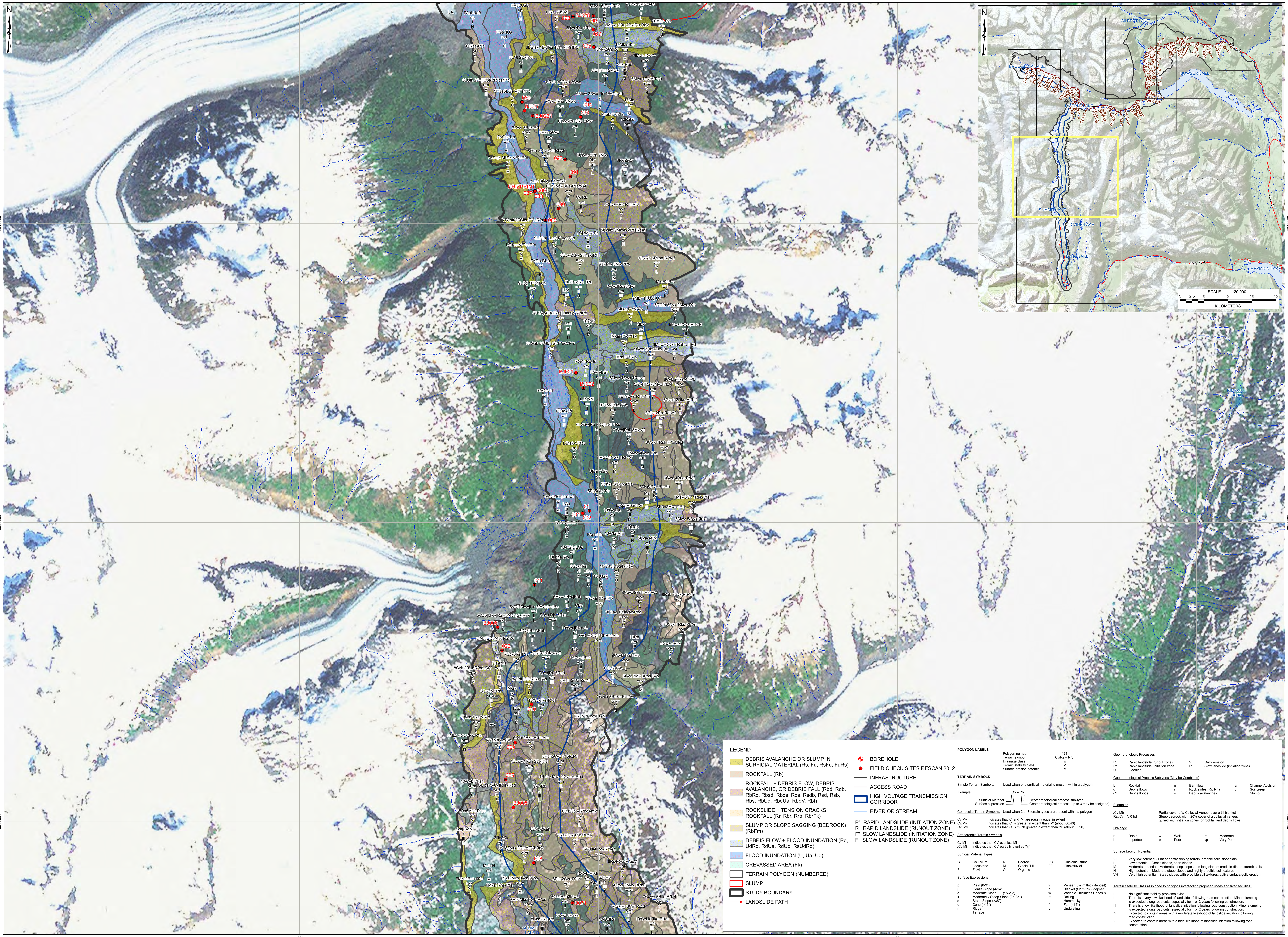
TITLE: TERRAIN MAP AND LANDSLIDE GEOHAZARDS

PROJECT No.:	DWG No.:	REV.:
1008010	6A	



LEGEND

- DEBRIS AVALANCHE OR SLUMP IN SURFICIAL MATERIAL (Rs, Fu, RsFu, FuRs)
- ROCKFALL (Rb)
- ROCKFALL + DEBRIS FLOW, DEBRIS AVALANCHE, OR DEBRIS FALL (Rbd, Rdb, RbRd, Rbsd, Rbds, Rds, Rsdb, Rsd, Rsb, Rbs, RbUd, RbdUa, RbdV, Rbf)
- ROCKSLIDE + TENSION CRACKS, ROCKFALL (Rr, Rbr, Rrb, RbrFk)
- SLUMP OR SLOPE SAGGING (BEDROCK) (RbFm)
- DEBRIS FLOW + FLOOD INUNDATION (Rd, UdRd, RdUa, RdUd, RsUdRd)
- FLOOD INUNDATION (U, Ua, Ud)
- CREVASSED AREA (Fk)
- TERRAIN POLYGON (NUMBERED)
- SLUMP
- STUDY BOUNDARY
- LANDSLIDE PATH
- BOREHOLE
- FIELD CHECK SITES RESCAN 2012
- INFRASTRUCTURE
- ACCESS ROAD
- HIGH VOLTAGE TRANSMISSION CORRIDOR
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R" RAPID LANDSLIDE (INITIATION ZONE)
R RAPID LANDSLIDE (RUNOUT ZONE)
F" SLOW LANDSLIDE (INITIATION ZONE)
F SLOW LANDSLIDE (RUNOUT ZONE)

POLYGON LABELS

Polygon number	123
Terrain symbol	Cv/Rs – R"b
Drainage class	w
Terrain stability class	V
Surface erosion potential	M

TERRAIN SYMBOLS

Simple Terrain Symbols: Used when one surficial material is present within a polygon

Example: Cb – Rb

Surficial Material; Surface expression; Geomorphological process sub-type; Geomorphological process (up to 3 may be assigned)

Composite Terrain Symbols: Used when 2 or 3 terrain types are present within a polygon

Cv.Mv	indicates that 'C' and 'M' are roughly equal in extent
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Stratigraphic Terrain Symbols

Cv|Mj	indicates that 'Cv' overlies 'Mj'
/Cv|Mj	indicates that 'Cv' partially overlies 'Mj'

Surficial Material Types

C	Colluvium	R	Bedrock	LG	Glaciolacustrine
L	Lacustrine	M	Glacial Till	FG	Glaciofluvial
F	Fluvial	O	Organic		

Surface Expressions

p	Plain (0-3°)	v	Veneer (0-2 m thick deposit)
j	Gentle Slope (4-14°)	b	Blanket (>2 m thick deposit)
a	Moderate Slope (15-26°)	w	Variable Thickness Deposit)
k	Moderately Steep Slope (27-35°)	m	Rolling
s	Steep Slope (>35°)	h	Hummocky
c	Cone (>15°)	f	Fan (<15°)
r	Ridge	u	Undulating
t	Terrace		

Geomorphologic Processes

R	Rapid landslide (runout zone)	V	Gully erosion
R"	Rapid landslide (initiation zone)	F"	Slow landslide (initiation zone)
U	Flooding		

Geomorphological Process Subtypes (May be Combined)

b	Rockfall	e	Earthflow	a	Channel Avulsion
d	Debris flows	r	Rock slides (Rr, R"r)	c	Soil creep
d2	Debris floods	s	Debris avalanches	m	Slump

Examples

/Cv|Mb	Partial cover of a Colluvial Veneer over a till blanket
Rs//Cv – VR"bd	Steep bedrock with <20% cover of a colluvial veneer; gullied with initiation zones for rockfall and debris flows.

Drainage

r	Rapid	w	Well	m	Moderate
i	Imperfect	p	Poor	vp	Very Poor

Surface Erosion Potential

VL	Very low potential - Flat or gently sloping terrain, organic soils, floodplain
L	Low potential - Gentle slopes, short slopes
M	Moderate potential - Moderate steep slopes and long slopes; erodible (fine-textured) soils
H	High potential - Moderate steep slopes and highly erodible soil textures
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Terrain Stability Class (Assigned to polygons intersecting proposed roads and fixed facilities)

I	No significant stability problems exist.
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NAD 1983 UTM Zone 9N

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METRES

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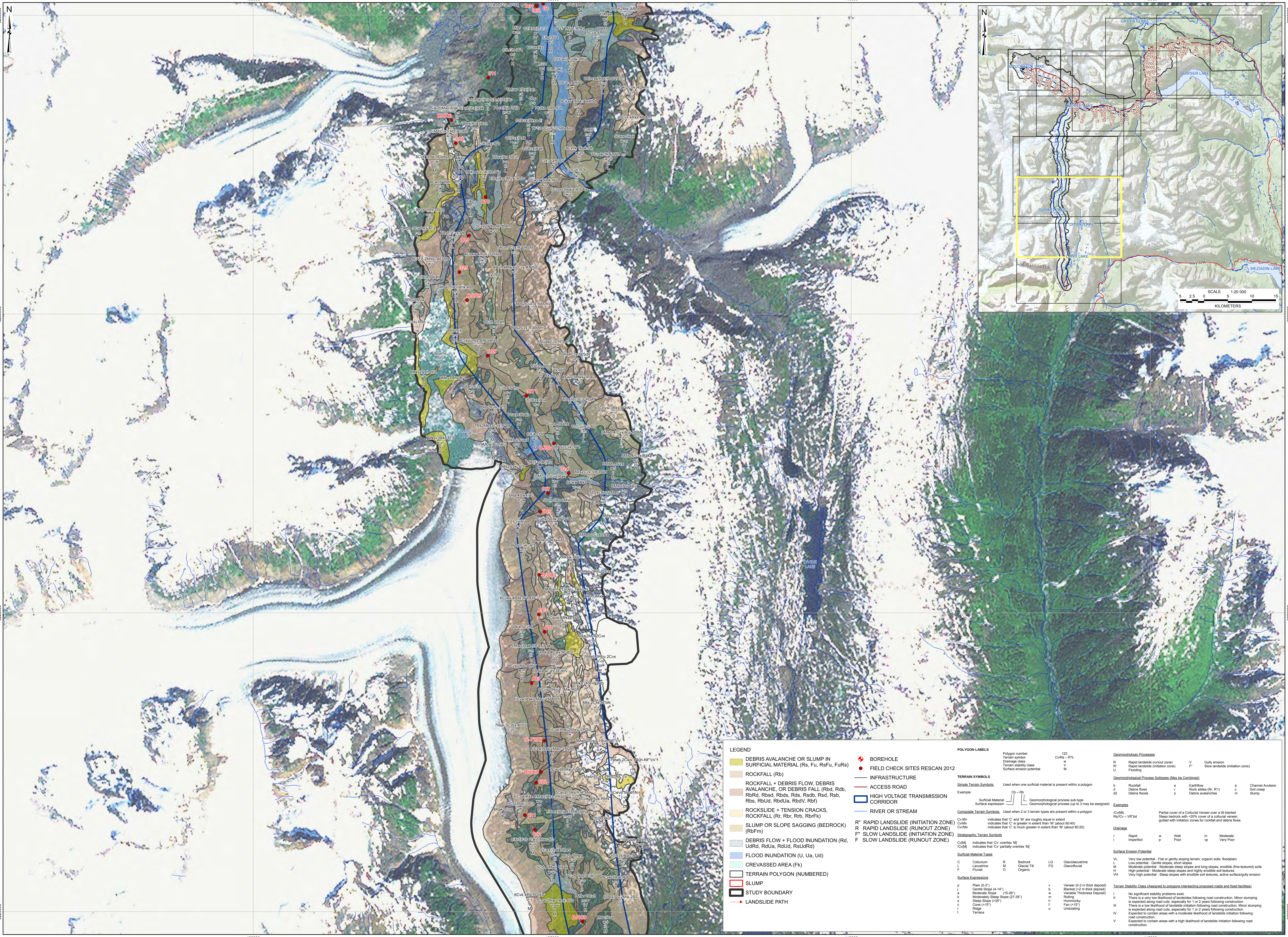
TITLE: TERRAIN MAP AND LANDSLIDE GEOHAZARDS

PROJECT No.:	DWG No.:	REV.:
1008010	7A	



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PROJECT No.: 1008010 | DWG No.: 8A | REV.:

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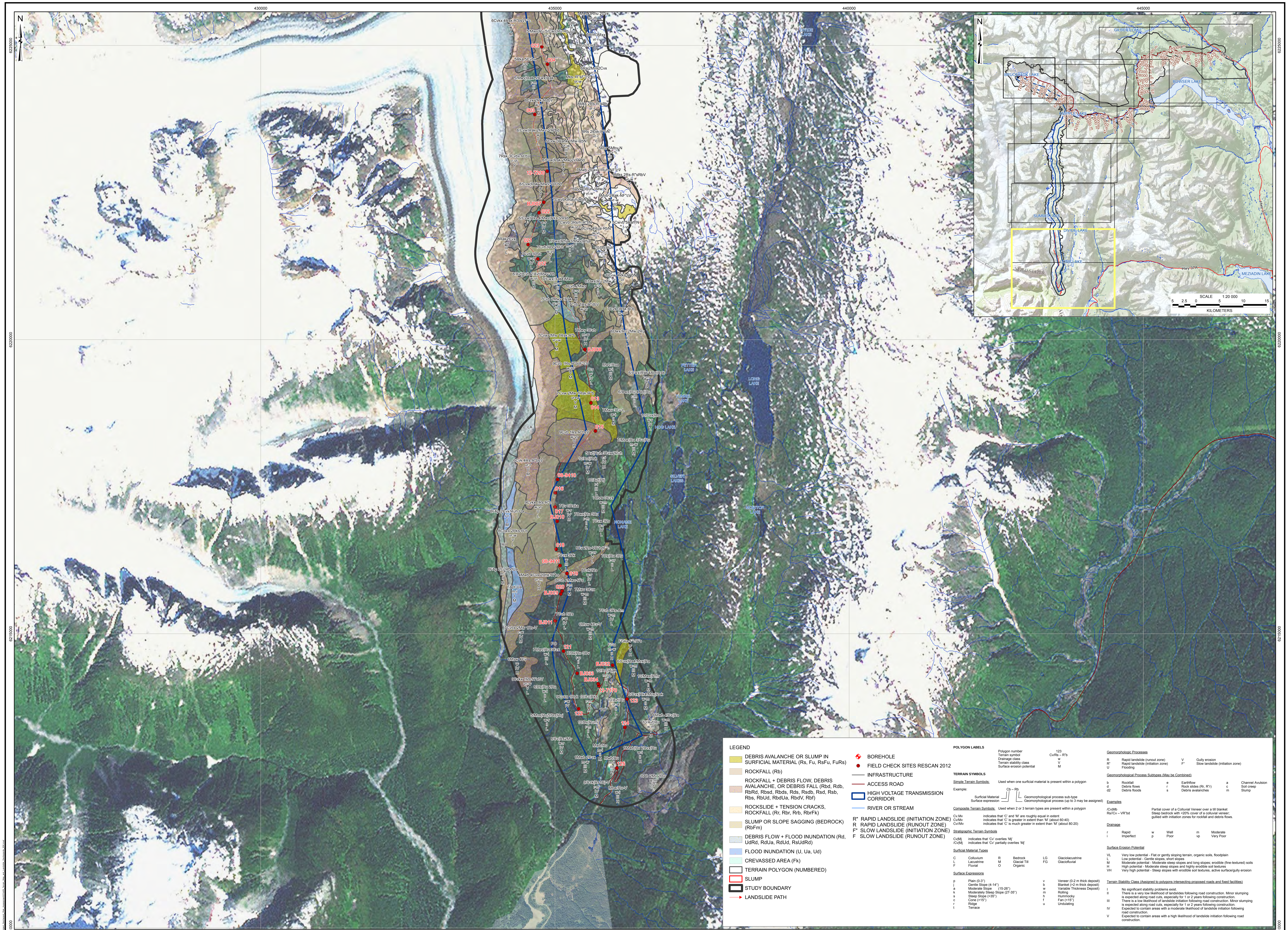

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NAD 1983 UTM Zone 9N

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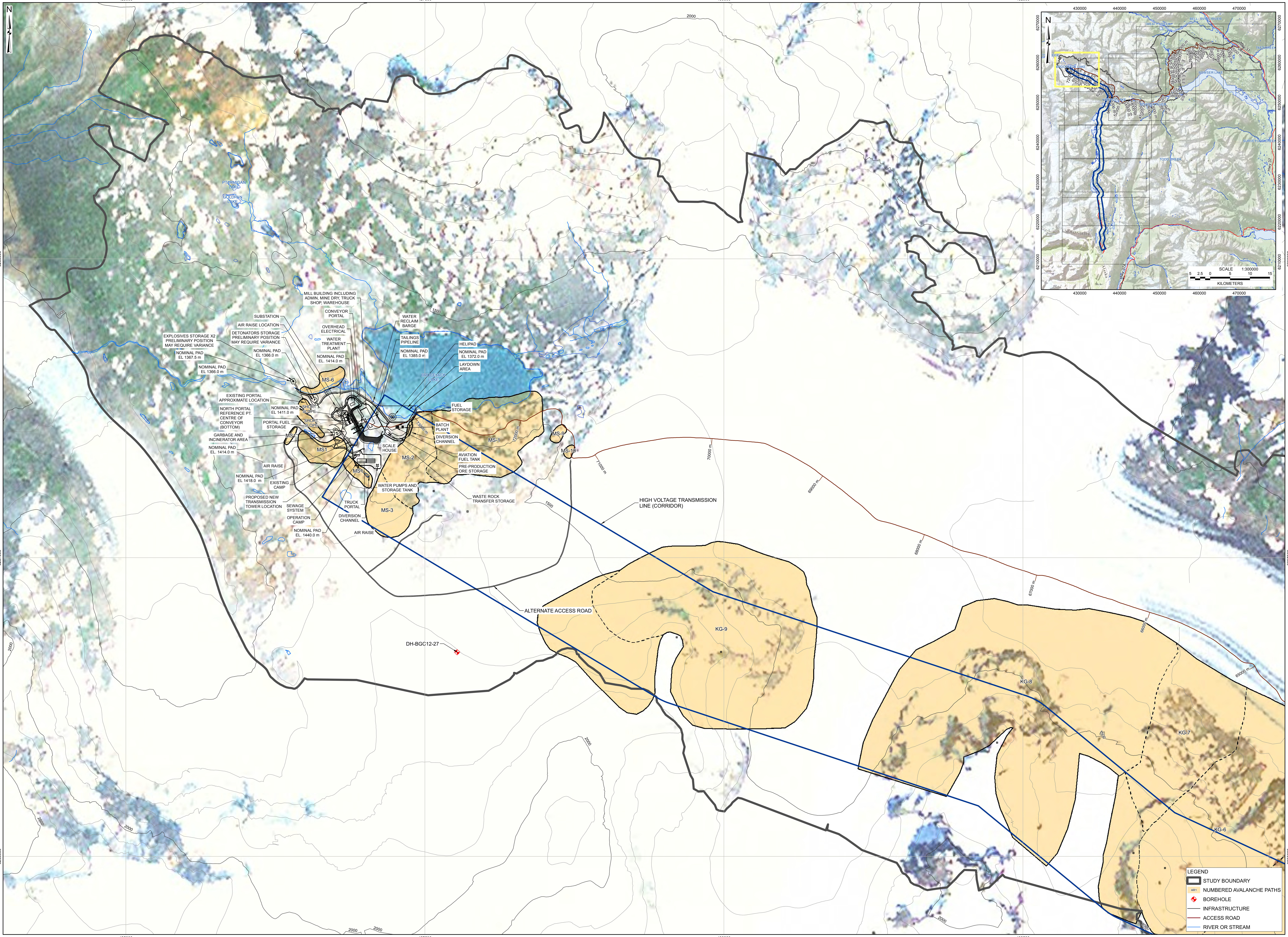

SCALE 1:10000

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METRES

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TITLE: AVALANCHE GEOHAZARDS

PROJECT No.:	DWG No.:	REV.:
1008010	1B	

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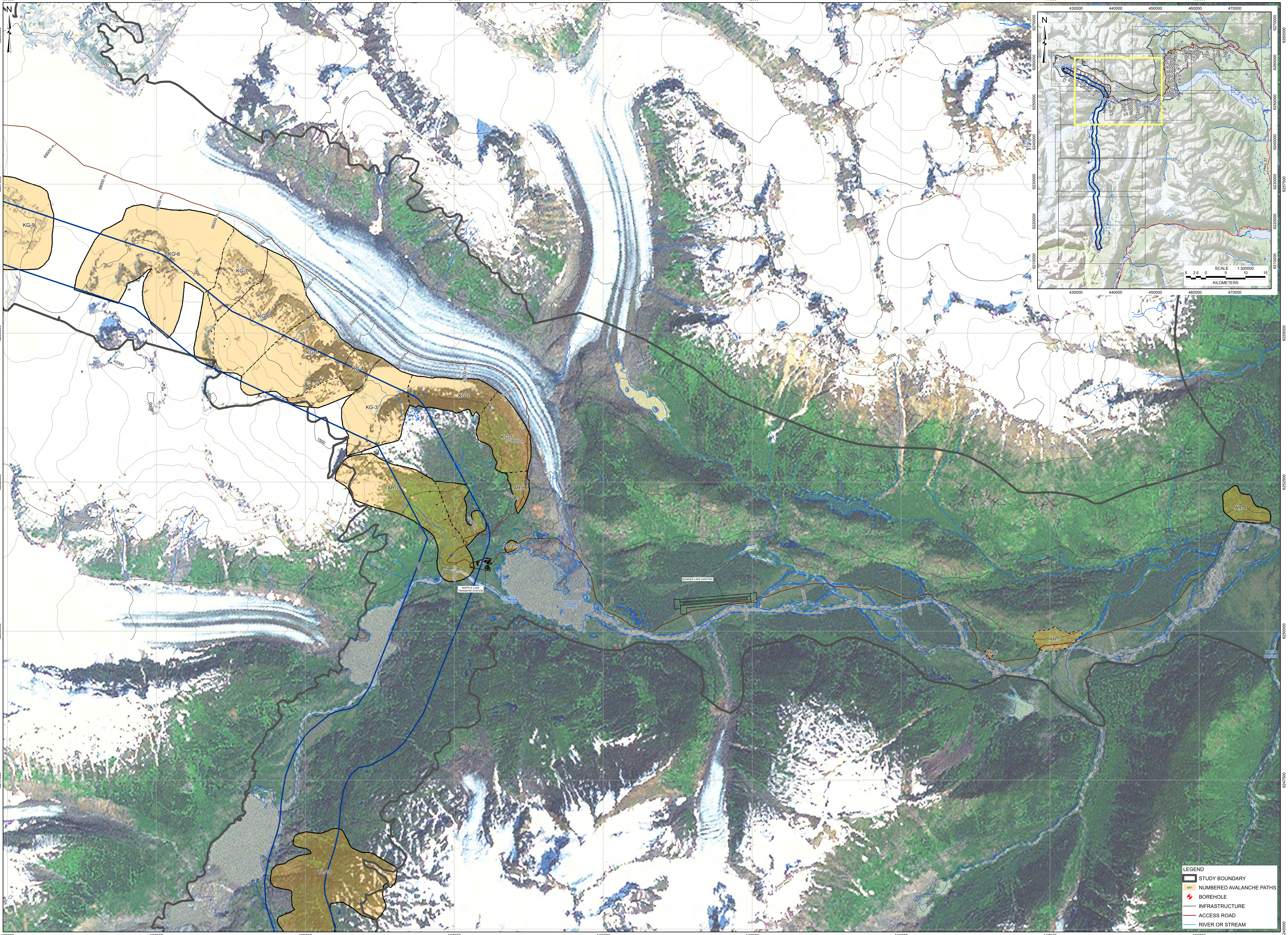

SCALE 1:20000

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PROJECT No.: 1008010 | DWG No.: 2B | REV.:

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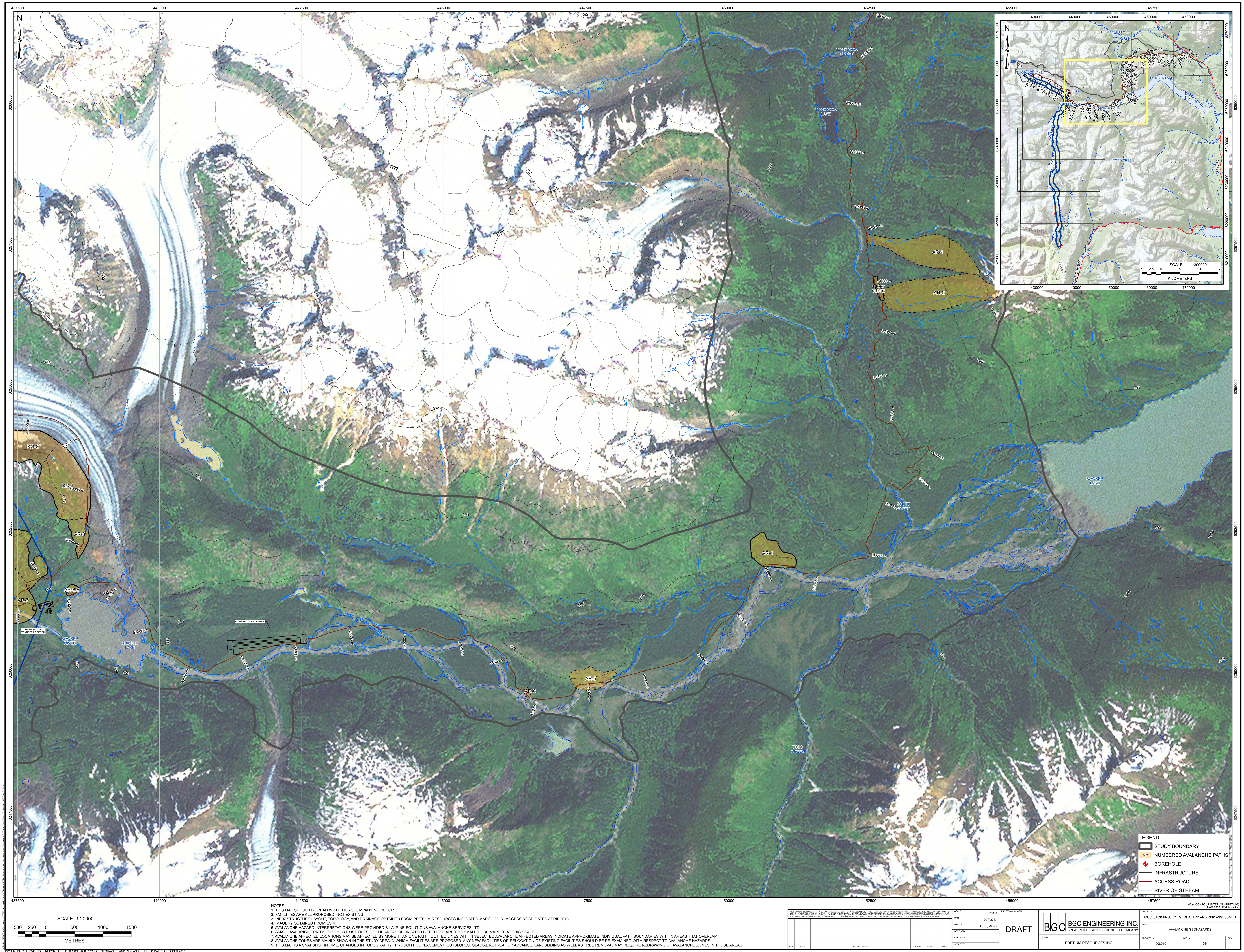

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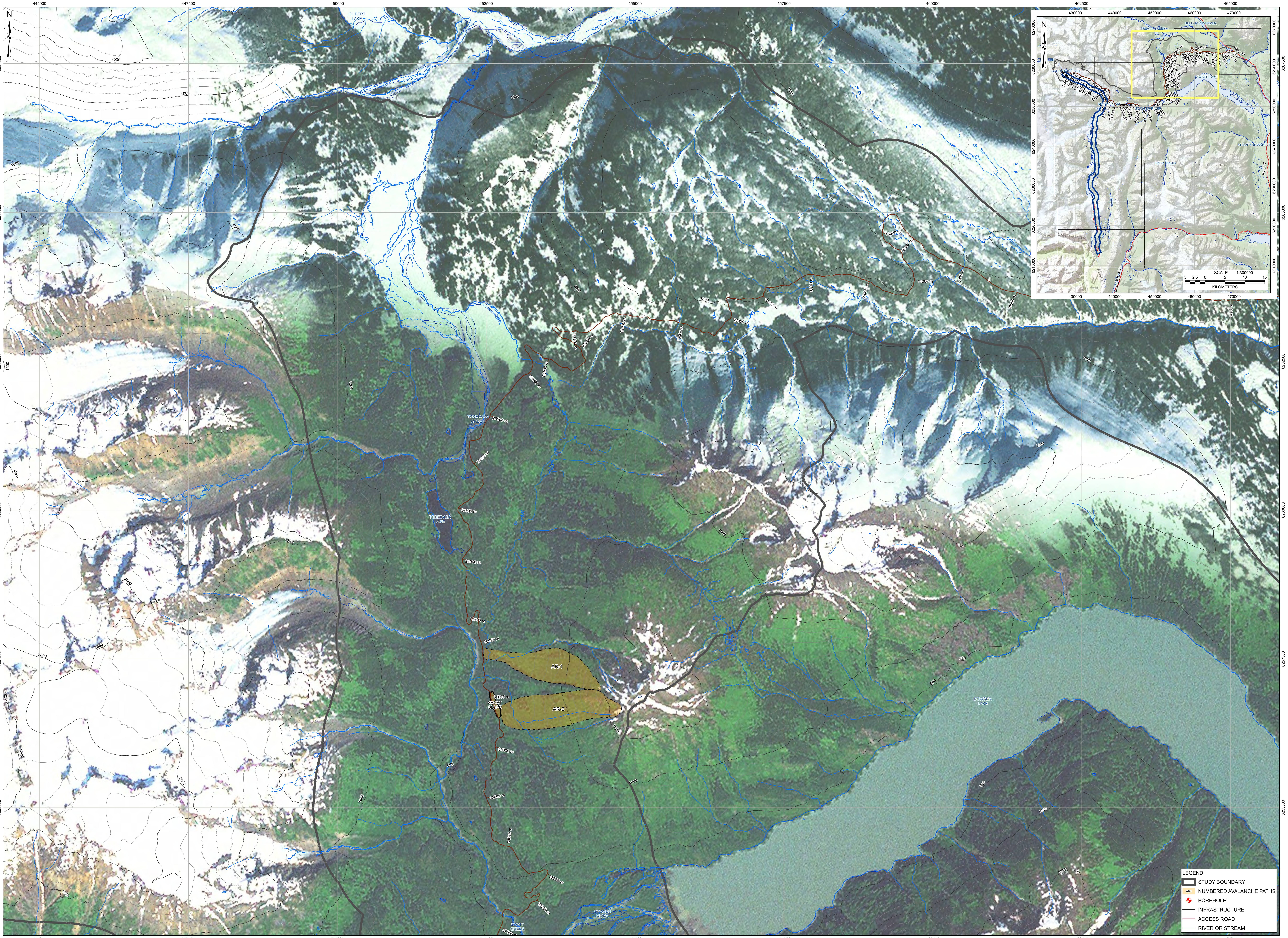

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500 250 0 500 1000 1500

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DWG TO BE READ WITH BGC REPORT TITLED "BRUCEJACK PROJECT GEOHAZARD AND RISK ASSESSMENT" DATED OCTOBER 2013

SCALE:	1:20000
DATE:	OCT 2013
DRAWN:	IL, LL, MIB-C
DESIGNED:	BG
CHECKED:	
APPROVED:	

PROFESSIONAL SEAL:

DRAFT

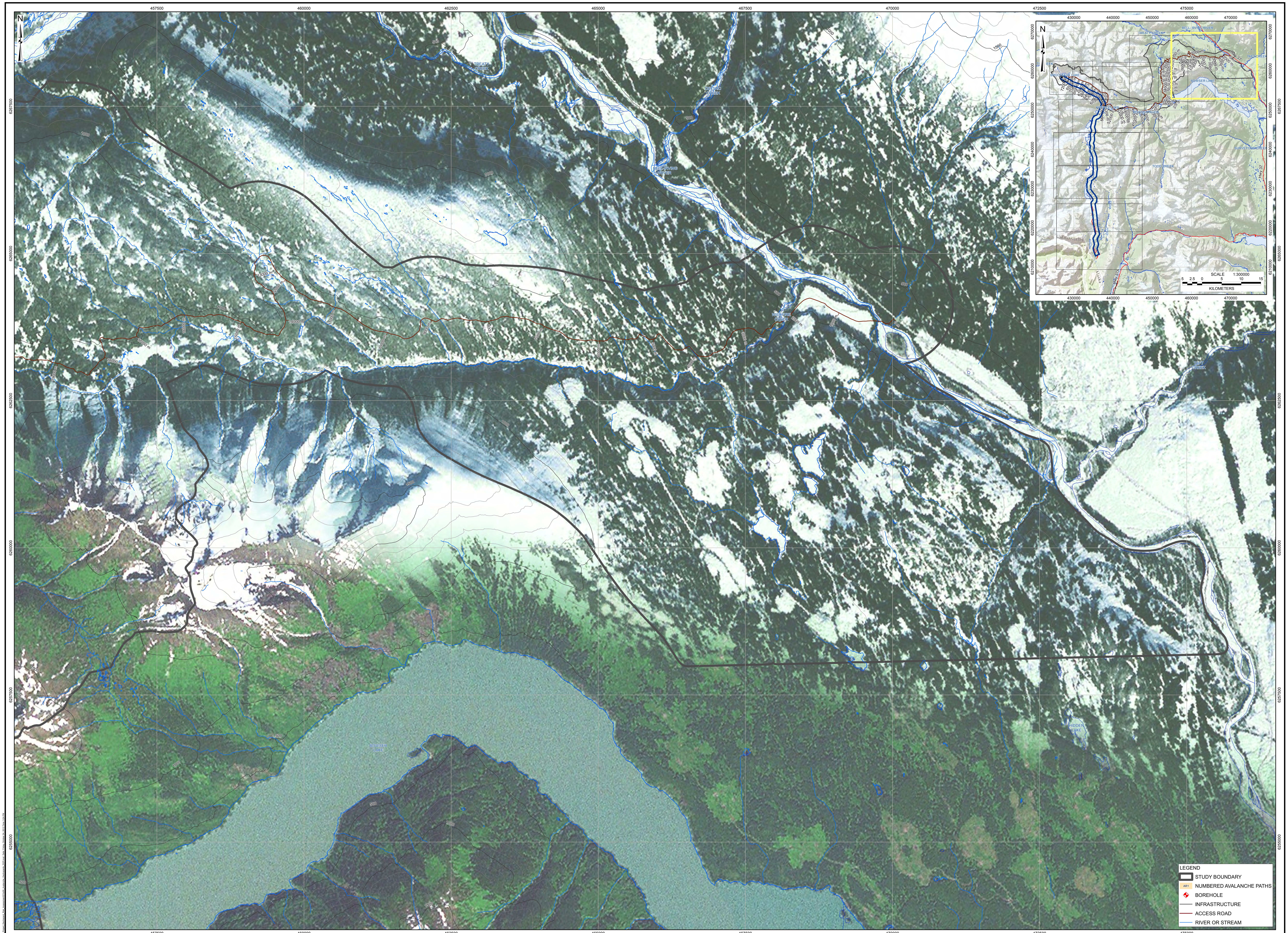
BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: PRETIUM RESOURCES INC.

PROJECT: BRUCEJACK PROJECT GEOHAZARD AND RISK ASSESSMENT

TITLE: AVALANCHE GEOHAZARDS

PROJECT No.:	DWG No.:	REV.:
1008010	4B	



SCALE 1:20000

500 250 0 500 1000 1500

METRES

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DRAFT

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AN APPLIED EARTH SCIENCES COMPANY

CLIENT:
PRETIUM RESOURCES INC.

PROJECT:
BRUCEJACK PROJECT GEOHAZARD AND RISK ASSESSMENT

TITLE:
AVALANCHE GEOHAZARDS

PROJECT No.:	DWG No.:	REV.:
1008010	5B	

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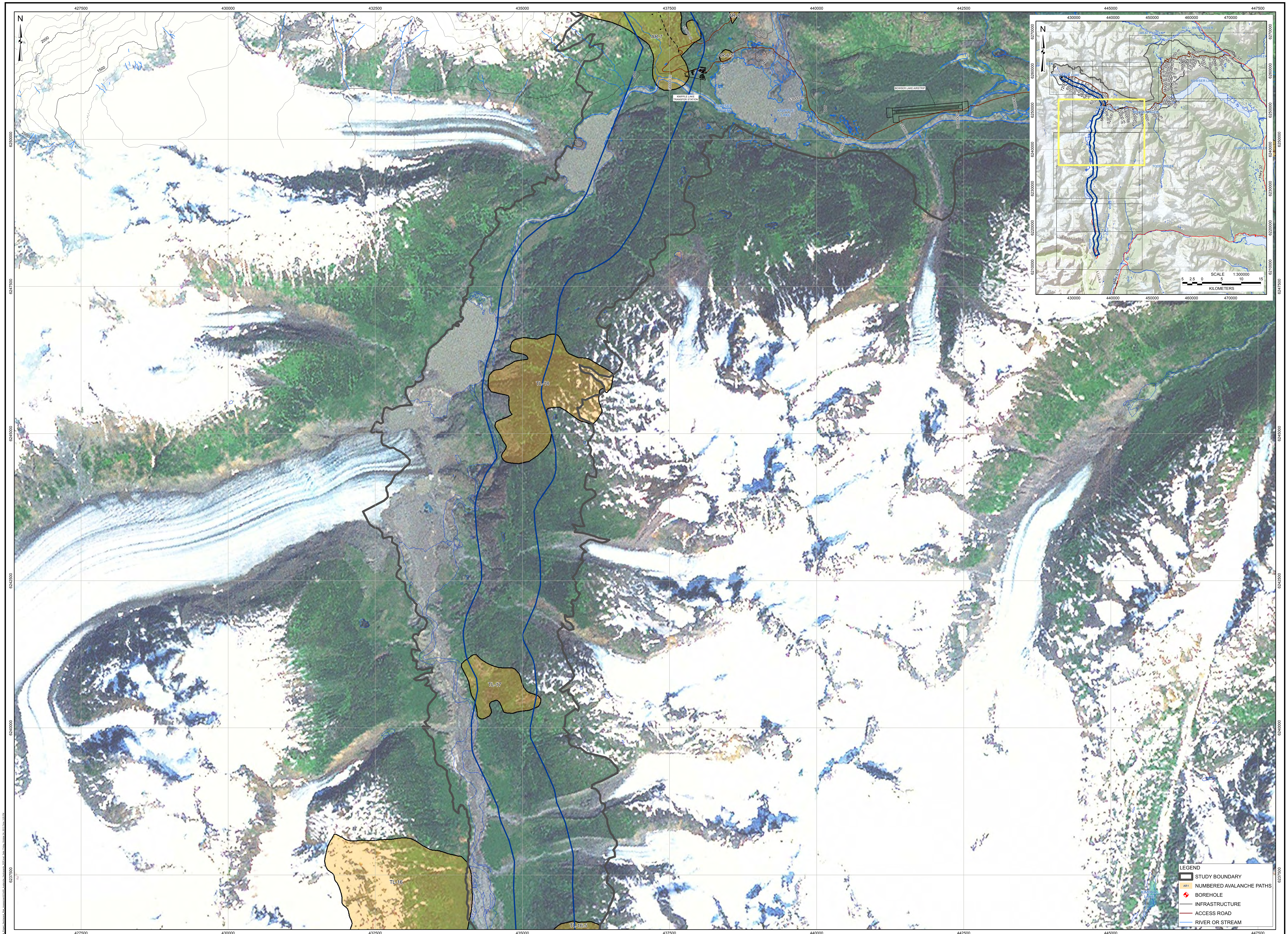

100 m CONTOUR INTERVAL (PRETIUM)
NAD 1983 UTM Zone 9N

SCALE 1:20000

500 250 0 500 1000 1500

METRES

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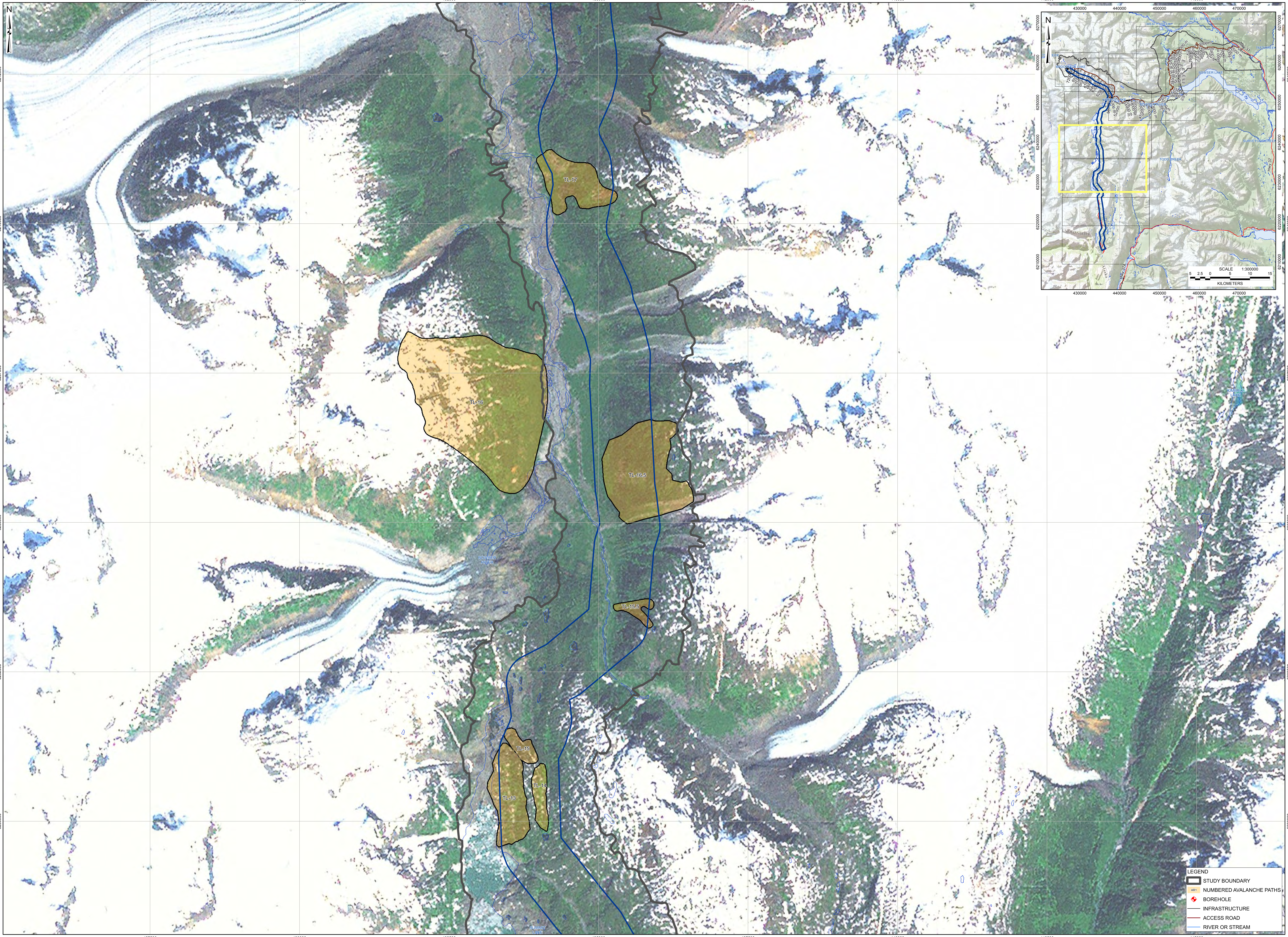

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METRES

100 m CONTOUR INTERVAL (PRETIUM)
NAD 1983 UTM Zone 9N

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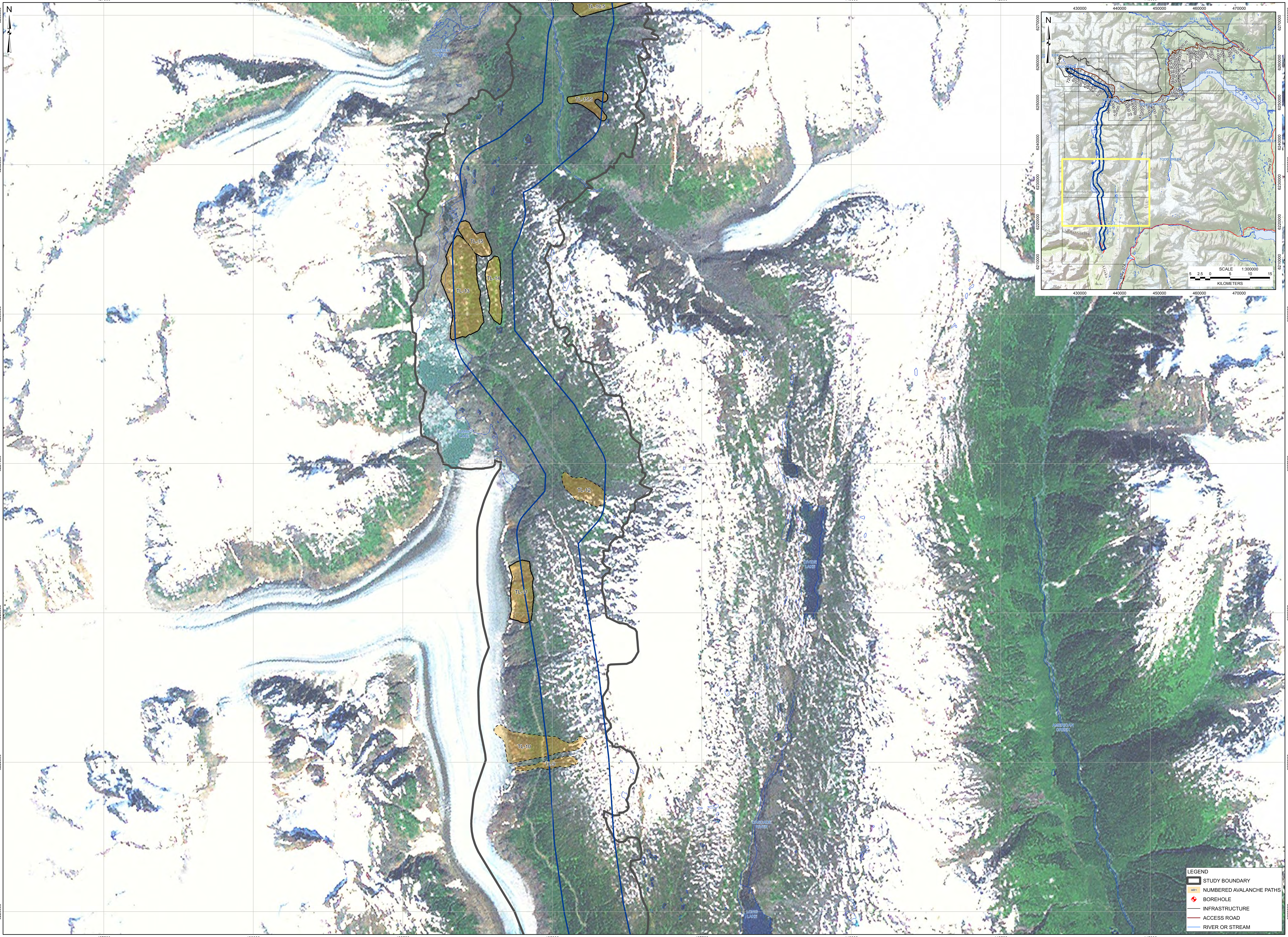

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PROJECT: BRUCEJACK PROJECT GEOHAZARD AND RISK ASSESSMENT

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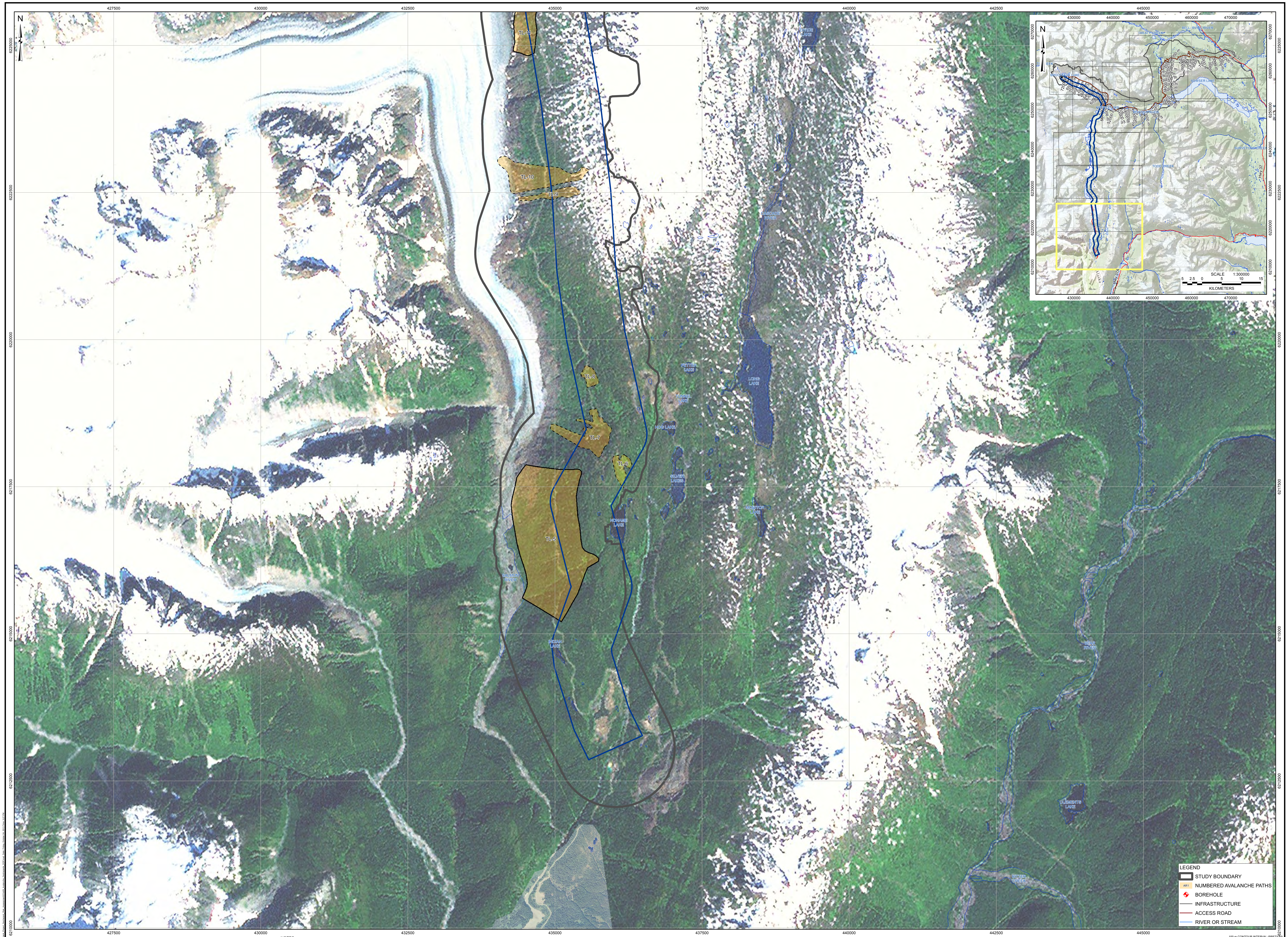

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METRES

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