Pretium Resources Inc.

BRUCEJACK GOLD MINE PROJECT
Summary of the Application for an Environmental Assessment Certificate / Environmental Impact Statement

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August 2014

BRUCEJACK GOLD MINE PROJECT

SUMMARY OF THE APPLICATION FOR AN ENVIRONMENTAL ASSESSMENT CERTIFICATE / ENVIRONMENTAL IMPACT STATEMENT

August 2014
Project #0194151

Citation:

ERM Rescan. 2014. *Brucejack Gold Mine Project: Summary of the Application for an Environmental Assessment Certificate / Environmental Impact Statement*. Prepared for Pretium Resources Inc. by ERM Rescan: Vancouver, British Columbia.

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1. Introduction

1. Introduction

Pretium Resources Inc. (Pretivm) is proposing to develop, construct, and operate the Brucejack Gold Mine Project (the Project), located in northwestern British Columbia (BC), approximately 950 kilometres (km) northwest of Vancouver and 65 km north-northwest of Stewart.

The proposed Project is a 2,700 tonne-per-day (tpd) operation that will extract and process gold and silver ore using the long-hole stoping method. The Project is subject to a review under the BC *Environmental Assessment Act* (BC EAA; 2002b), and the federal *Canadian Environmental Assessment Act, 2012* (CEAA 2012). This document represents both the Application for an Environmental Assessment (EA) Certificate (Application) pursuant to the BC EAA and an Environmental Impact Statement (EIS) pursuant to the CEAA 2012. The Application/EIS is being submitted to the British Columbia Environmental Assessment Office (BC EAO) and the Canadian Environmental Assessment Agency (CEA Agency) to meet the requirements of the BC EAA and CEAA 2012.

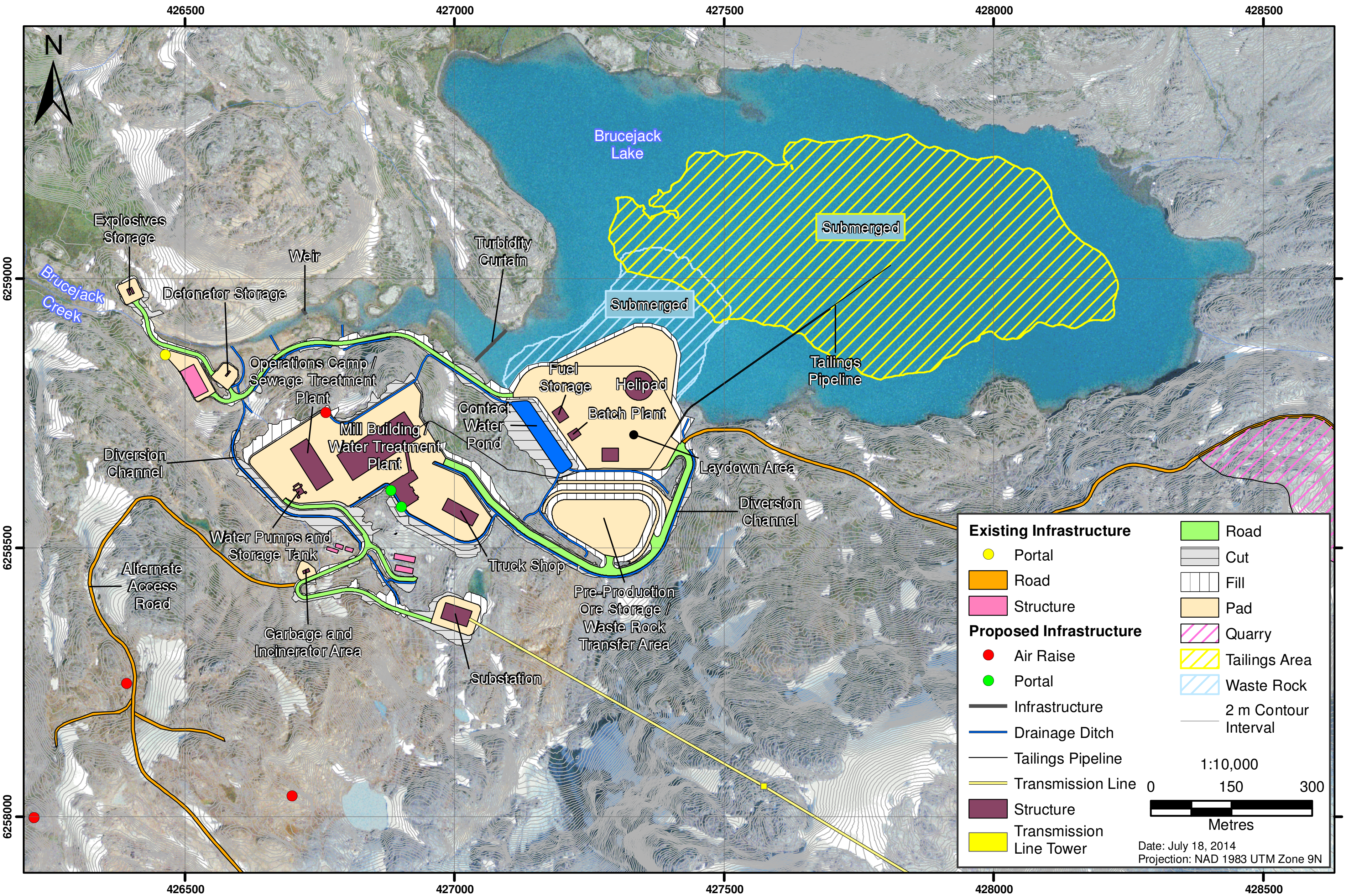
The Project is located within the Regional District of Kitimat-Stikine (RDKS) and Electoral Area A of the Regional District of Bulkley Nechako (RDBN). The Project is located on Crown land, and within the Nass Area as defined in the *Nisga'a Final Agreement* (NFA; NLG, Province of BC, and Government of Canada 1998). The Project is also located within the traditional territories of Skii km Lax Ha and Tahltan Nation, and the Métis also have a historical presence in the area.

The Project will resemble other, similar underground mining operations. Gold- and silver-bearing ore will be processed using conventional crushing, grinding, flotation, and gravity separation techniques. Forty-five percent of development waste rock and 47% of tailings will be stored underground as backfill; the remaining waste rock and tailings will be deposited under water in Brucejack Lake. The life-of-mine (LOM) is expected to comprise 22 years, which excludes a two-year Construction phase, a two-year Closure phase, and a minimum three-year Post-closure phase. The overall surface footprint of the Brucejack Mine Site and immediate infrastructure will comprise about 31 hectares (ha); access to the Project will be via an existing 73-km-long exploration access road from Highway 37. Electrical power will be supplied via a new 55-km-long transmission line that will connect with the provincial grid at the Long Lake Hydro Project, near Stewart.

In the 1980s, there was some underground exploration at the site, which included about 5 km of underground workings. Supporting Pretivm's ongoing advanced exploration work is a collection of infrastructure facilities; these items include water and sewage treatment plants and associated outfalls, an office, a camp, a portal, and a waste rock disposal area located at the southeast corner of Brucejack Lake. A mine area general arrangement drawing, showing existing and planned infrastructure, is provided in Figure 1-1.

Although the formal regulatory EA process for the Project was initiated in 2013, preliminary environmental studies began in 2009. Pretivm has used the EA process as a planning tool to ensure that decisions regarding the Project have been considered in a careful and precautionary manner. This approach has minimized potentially adverse biophysical and human environment effects, including potential effects on established and asserted Aboriginal rights and interests.

Figure 1-1
Mine Area General Arrangent



The Project has undergone extensive design reviews and changes to mitigate or eliminate potential adverse effects on the environment. The footprint of Project components has been minimized, and the need to discharge to surface water (other than from the immediate mine site area) has been avoided. In addition, Pretivm has relied heavily on environmental baseline data and predictive modelling in the development of tailings, waste rock, and effluent disposal methods.

This Application/EIS is intended to demonstrate that the Project will be undertaken in an environmentally acceptable manner that will provide social and economic benefits. The Project will promote economic prosperity throughout BC, particularly in the northwest region. The Project will provide employment and commercial opportunities, while generating local, provincial, and federal tax revenues. The Project can be implemented without lasting adverse local or regional environmental or economic effects, and without undermining family or community well-being, public health or established and asserted Aboriginal rights and interests. Responsible mining practices, in compliance with the principles of sustainable development, will guide the implementation of the Project.

1.1 PURPOSE OF APPLICATION / ENVIRONMENTAL IMPACT STATEMENT

As previously noted, the Project is subject to the BC EAA and CEAA 2012. With this document, Pretivm is making an Application under Section 16 of the BC EAA for the proposed Project, and is also submitting an EIS under the CEAA 2012. This document, including its main text and appendices, collectively constitutes the Proponent's joint Application/EIS, and has been prepared in accordance with the Application Information Requirements (AIR; BC EAO 2014) issued by the BC EAO on May 2, 2014 and the Environmental Impact Statement Guidelines issued by the CEA Agency on May 24, 2013 (EIS Guidelines; CEA Agency 2013).

1.2 ORGANIZATION OF SUMMARY OF THE APPLICATION FOR AN ENVIRONMENTAL ASSESSMENT CERTIFICATE AND ENVIRONMENTAL IMPACT STATEMENT

This summary presents the key aspects of the Application/EIS and is organized to generally follow the structure of the full Application/EIS which is organized into parts and chapters in accordance with both the AIR (BC EAO 2014) as well as the EIS Guidelines (CEA Agency 2013). The EIS Gudelines (CEA Agency 2013) require the summary to reflect the following components:

- Introduction and Environmental Assessment Context;
- Project Overview;
- Scope of Project and Assessment;
- Alternative Means of Carrying Out the Project;
- Public and Aboriginal Engagement;
- Summary of Environmental Effects Assessment;
- Mitigation Measures; and
- Proposed Significance Determination.

In order to easily locate where the information relevant to the listed components are reflected, Table 1.2-1 provides cross-referencing between the EIS Guidelines requirements and the sections in this summary.

Table 1.2-1. Concordance between Summary and EIS Guidelines

EIS Guideline Requirements	Relevant Section of this Summary
• Introduction and Environmental Assessment Context	1. Introduction
• Project Overview	2. Project Background and Overview 4. Summary of Project Description
• Scope of Project and Assessment	4. Summary of Project Description 5. Assessment Process 6. Assessment Methodology
• Alternative Means of Carrying Out the Project	3. Project Design and Alternatives Assessment
• Public and Aboriginal Engagement	5.3 Information Distribution and Consultation
• Summary of Environmental Effects Assessment	7. Predictive Studies
• Mitigation Measures	8. Assessment of Potential Effects, Mitigation, and Significance of Residual Effects
• Proposed Significance Determination	11. Proponent Conclusions

2. Project Background and Overview

2. Project Background and Overview

2.1 THE PROPONENT

Pretivm is a publicly traded company; its common shares trade on the Toronto (TSX: PVG) and New York (NYSE: PVG) stock exchanges. It maintains an office in Vancouver, BC. Pretivm was incorporated under the *Business Corporations Act* (2002a) in 2010. Pretivm acquired the mineral tenures that comprise the Project, from Silver Standard Resources Inc. in 2010. The gold and silver resources of the Brucejack property and the adjacent Snowfield property are the company's core assets. Pretivm intends to develop, manage, and operate the Brucejack Gold Mine Project; the Snowfield property is a longer-term opportunity, where the mineral tenures are in good standing until 2025.

Pretivm's corporate governance practices are consistent with applicable current Canadian regulatory guidelines and standards. The Pretivm Board of Directors is mandated to ensure that the company's financial, environmental, and social obligations are responsibly managed. Pretivm operates under the direction of Robert A. Quartermain, B.Sc. (Hons), M.Sc., D.Sc., P.Geo., as President and Chief Executive Officer, and Joseph J. Ovsenek, B.A.Sc., P.Eng., LLB, as Executive Vice President and Chief Development Officer.

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2.2 PURPOSE OF THE PROJECT

The natural resource development objectives outlined in the Government of Canada's (2012) *Economic Action Plan,* and BC's *Mineral Exploration and Mining Strategy* (BC MEM 2012) support the need for and purpose of the Project. The Project would supply gold and silver concentrate to overseas markets, which would support industrial development needs and growth in China, India, and other emerging markets.

The Project is predicted to result in substantial benefits to the region and the province, as well as Canada as a whole. Benefits will be realized through employment and business opportunities to supply goods and services directly and indirectly to the Project, as well as other spin-off economic benefits associated with workers spending their incomes within their communities and elsewhere. In addition, the Project will contribute tax revenues to local, provincial, and federal governments.

2.3 PROJECT LOCATION, ACCESS, AND HISTORY

The Brucejack property is located at 56°28'20" N latitude by 130°11'31" W longitude, which is approximately 950 km northwest of Vancouver and 65 km north-northwest of Stewart. The Project can be accessed via a 73-km road that extends from Highway 37 to the current exploration camp adjacent to Brucejack Lake. The road, with the exception of the Knipple Glacier section, will require upgrading to improve safety, allow traffic to travel at speeds of up to 40 km/hour, and accommodate the higher traffic loadings and volumes from both construction and operation activities. To be referred to as the Brucejack Access Road, the road upgrading will include minor re-alignments of the sharper curves, reductions of the steeper grades, and additional surfacing of some sections. A Project location map is provided in Figure 2.3-1.

Exploration of the Brucejack property and the surrounding region dates back to the 1880s, when placer gold was discovered in the vicinity. Placer mining was conducted intermittently throughout the early 1900s until the mid-1930s, when prospectors discovered copper-molybdenum mineralization on the Sulphurets property approximately 6 km northwest of Brucejack Lake. From 1935 to 1959, the area was relatively inactive with respect to prospecting, and claims were not staked until 1960 when prospectors staked the main claim group covering the known copper and gold-silver occurrences. These collectively became known as the Sulphurets property, a larger claim group that included what is now the Brucejack property. Between 1986 and 1991, the Newcana Joint Venture (comprising Newhawk Gold Mines Ltd. and Lacana Mining Corp.) developed small precious metal veins on what would later become the Brucejack property.

During the late 1980s, a small underground mining operation was developed and operated briefly by Catear Resources at the Goldwedge Property northwest of Brucejack Lake. From 1991 to 1992, Newhawk Gold Mines Ltd. conducted exploration on the Brucejack property, and in 1999 Silver Standard Resources Inc. acquired its initial interest in the property and conducted exploration activities in 2009 and 2010, until its sale to Pretivm.

2.4 PROJECT SCHEDULE

The Project will have a two-year Construction phase and a 22-year LOM. The Closure phase is assumed to last two years, followed by a Post-closure monitoring phase that will be a minimum of three years, to ensure that closure facilities and structures are functioning as predicted.

2.4.1 Construction Phase

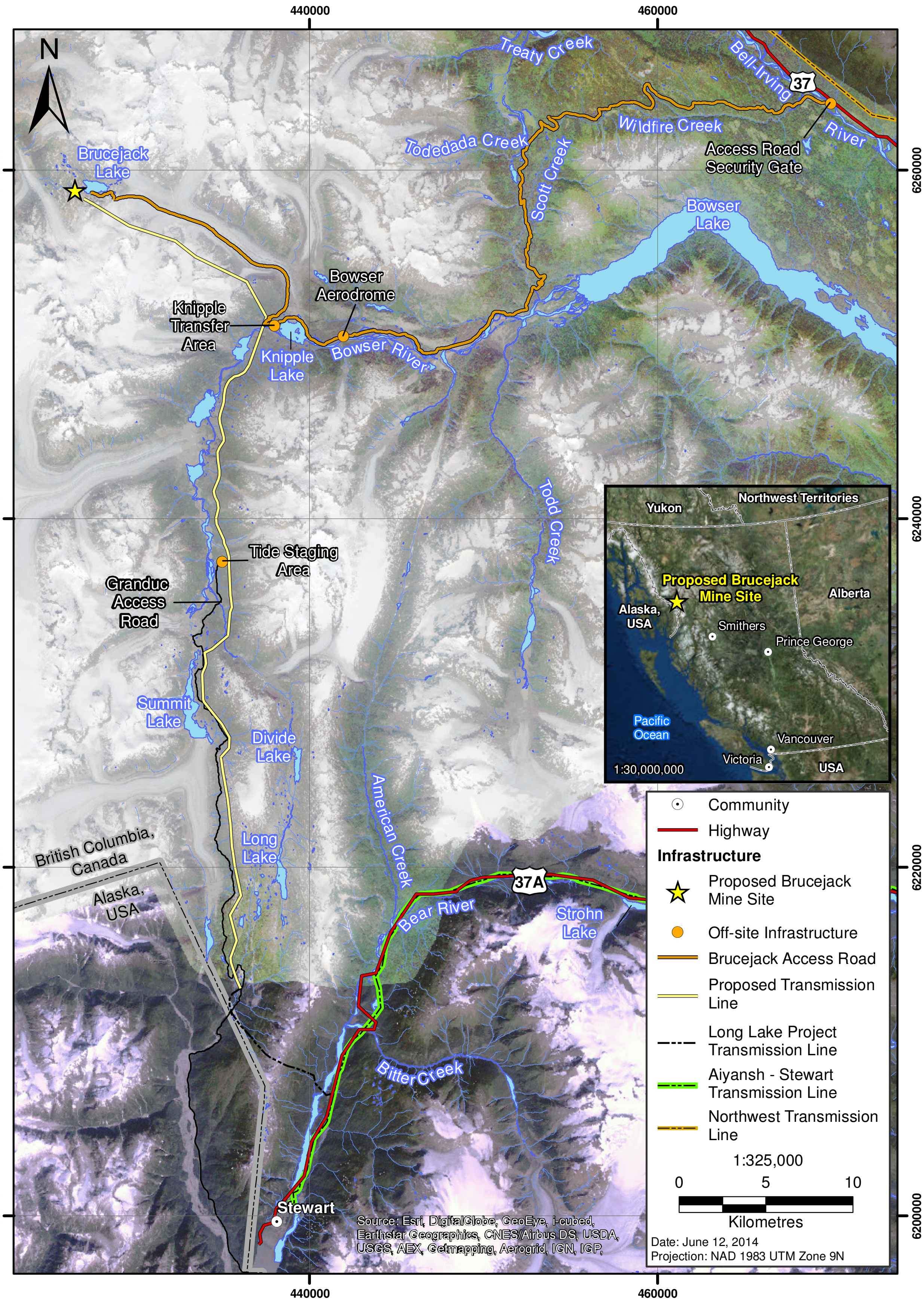
The upgrade of the existing 73-km access road to the Project site will be a priority during the early Construction phase. The Knipple Transfer Area will be used as a staging area for mine construction, and for transferring loads from highway trucks to vehicles equipped for glacier travel. The site will be cleared and levelled, and a camp, a fuel storage area, and a transfer station building will be constructed. The Bowser Aerodrome will be constructed at the site of a historical gravel airstrip for chartered air traffic proposed for crew transfers. The Tide Staging Area, which will include a temporary camp for up to 90 persons, will be developed near the old Granduc mill site, to support the installation of the transmission line.

A significant amount of underground development will be required prior to the start of production. Initial access to underground workings will be provided through the existing exploration portal. Waste rock from this work will be deposited into Brucejack Lake and development ore will be stockpiled for later processing in the mill. Underground development workings will culminate in the creation of production stopes and installation of the necessary facilities for mining, crushing, and conveying ore to the surface. Explosives storage facilities will be provided for both surface and underground development activities.

A new water treatment plant will be constructed near the existing exploration portal to treat water pumped from underground workings during the development stages and water that comes in contact with surface disturbances.

Figure 2.3-1

Project Location Map



About 847,000 m^3 of rock will be excavated from a quarry to be developed east of the Brucejack Mine Site. This material will be needed to create the pads for site roads, the haul road, the mill/portal/truck shop/camp area, substation, etc. Excavation will be done using bulldozers with rippers, and conventional drill and blast techniques; benching will be used for the deeper cuts. Some of the rock from these excavations will be used to construct the laydown area near the shore of Brucejack Lake. Diversion and collection ditches will be constructed to direct clean water away from disturbed areas and to collect contact water for treatment.

The mine site area currently hosts a range of minor facilities, initially intended to support historical small-scale mining activities. A new construction camp will initially be assembled on the mill pad; it will be renovated once the mill building and process plant machinery have been constructed and installed. The paste plant will be commissioned and the tailings pipeline installed from the mill building to Brucejack Lake. The surface truck shop will be constructed and equipped to handle both surface and underground mobile machinery. The water treatment plant will also be moved from the exploration portal to the mill building. A new sewage treatment plant for the mine area will be installed to support the construction camp and will be retained for the Operation phase.

The substation will be constructed and connected to the transmission line and site power distribution as early in the Construction phase as possible. The diesel generators installed for the Construction phase will be retained for emergency power during the Operation phase.

2.4.2 Operation Phase

Once construction is complete, the mill will begin processing ore drawn from underground workings as well as ore stockpiled from the Construction phase. Stockpiled ore will be crushed at the stockpile and then transported to the mill by truck. The mill will then produce a gold-silver bearing flotation concentrate and gold-silver doré. Production levels will build to the projected 2,700 tpd of ore by Year 2 as underground development proceeds. Overall production volumes will begin to taper off around Year 18, finally ceasing in Year 22.

Initially, waste rock and tailings will be deposited primarily to Brucejack Lake, but as stope voids become available, more material will be deposited underground as backfill. Tailings will be incorporated in the paste backfill. Tailings not used as backfill will be transported by pipeline to the deeper areas of the lake. The discharge point in the lake will be raised as required to offset the backpressure of overlying tailings.

Concentrate from the mill will be transported down the Knipple Glacier on specially equipped vehicles and then transferred to highway trucks at the Knipple Transfer Area. Fuel and other supplies will be backhauled to the mine using the same fleet of vehicles.

2.4.3 Closure and Post-closure Phases

Upon the completion of the Construction phase, disturbed areas such as the Tide Staging Area that are not required for Operation will be recontoured and reclaimed using stockpiled soil and overburden. This reclamation work will continue throughout the Operation phase to minimize reclamation obligations at Closure.

When mining operations cease, the facilities at the mine site will be dismantled and removed. These facilities will include the underground mining equipment, portal structures and conveyor, truck shop, most of the Brucejack Camp, explosives magazines, fuel storage, and batch plant. Where practical, surface disturbances will be recontoured and returned to a natural appearance. Soil that was salvaged and stockpiled during the initial Construction phase will be re-applied to reclaimed areas.

A similar approach will be taken at the other Project components. At the Knipple Transfer Area, the camp, transfer station, and other infrastructure will be removed and the disturbed areas reclaimed. At the Bowser Aerodrome, all infrastructures will be removed and reclamation will be carried out. The Brucejack Transmission Line will be dismantled at Closure and the towers and conductors will be removed using helicopter support. The Tide Staging Area will be partially reclaimed once the transmission line is constructed. This area will be used again at the end of the Project as a staging area for transport out of the towers and conductors after which it will be closed.

The initial closure process is expected to take two years. The water treatment plant will be available for active water treatment during the Closure phase. Monitoring will be conducted during the Post-closure phase.Project Tenure

The Brucejack property is located on provincial Crown land, and consists of 11 mineral claims (totalling 3,199.28 ha) that cover the target mineral resource. All claims are in good standing until January 31, 2025. These claims are in addition to a large block of mineral claims held by Pretivm that comprise the Bowser property. The Bowser property includes an additional 249 mineral claims totalling 100,937.2 ha in and around the Brucejack property. The claims extend from the proposed mine site area east to Highway 37, including parts of the Bowser River, Scott Creek, and Wildfire Creek watersheds, and along parts of the transmission line right-of-way. The Project is situated within the Sulphurets District, Iskut River, and Skeena Mining District.

There are also placer claims in the general area around the Brucejack property held by Pretivm and Seabridge Gold Inc..

2.5 REGIONAL AREA

The Brucejack property is located in a sparsely populated area in the Boundary Range of the Coast Mountain physiographic belt. The climate is typical of northwestern BC, with cool, wet summers and relatively moderate but wet winters. The widely varying terrain hosts a broad range of ecosystems. Nine Biogeoclimatic Ecosystem Classification (BEC) system units occur within the region, including both coastal and interior units. Six of the nine BEC units are forested and cover about 42% of the region, while the three alpine and parkland BEC zones collectively contribute more than 58% of the regional area. The Project is centred on the Valley of the Kings (VOK) and West Zone deposits, which are located immediately southwest of Brucejack Lake at 1,400 m above sea level.

The Project is located within areas covered by the Cassiar-Iskut Stikine Land and Resource Management Plan (BC ILMB 2000) and the Nass South Sustainable Resource Management Plan (BC MFLNRO 2012). Components of the Project are located within the Nass Area as defined by the NFA, where Nisg̱a'a Nation has rights and interests (NLG, Province of BC, and Government of Canada 1998).

Several historical and current human activities are within close proximity to the proposed Project area. These include mineral exploration and production (e.g., Granduc copper mine, Eskay Creek gold and silver mine), hydroelectric power generation (e.g., Long Lake and Forrest Kerr projects), forestry (historically between Highway 37 and Bowser Lake, south of the Wildfire Creek and Bell-Irving River confluence), and road construction and use (current Brucejack exploration access road).

There are three registered guide outfitting licences in the region, together with eight commercial recreation licences, four Wildlife Management Units within which hunting is permitted, and trapping licences. No provincial or national parks, provincial or federal protected areas, or ecological reserves are located near proposed Project infrastructure.

2.6 PROJECT BENEFITS

In accordance with federal and provincial government priorities, developments such as the Project in question will support economic development opportunities while contributing to local, provincial, and national economies, as well as create long-term employment opportunities locally, regionally, and beyond.

The construction of the Project is expected to directly and significantly impact BC, whereas regional impacts will be mostly felt in the RDKS, and to a lesser extent within the RDBN. Direct Construction expenditures in BC were estimated at approximately $663.5 million, $134.0 million of which were estimated as direct household income. Further, the Construction phase is anticipated to create 870 person-years of direct employment, or as much as 440 full-time jobs. Supplier-related employment in BC is estimated at 3,042 person-years, with an additional 2,273 person-years of employment in the rest of Canada. Tax revenue for direct, indirect, and induced Project activities during the Construction phase is expected to total approximately $64.3 million in BC, with $35.9 million in federal, $23.1 million in provincial, and $5.3 million in local tax revenue.

During the LOM, direct mine operating expenditures in the province were estimated to reach approximately $2,398.7 million. Average expenses relating to mining were estimated at $32.4 million per year; processing expenses were estimated at $48.2 million per year; and general and administrative services were estimated at approximately $28.2 million per year. Labour income was estimated at $1,469.0 million as related to the employment at the mine; $856.1 million was estimated to be generated in labour income in supplier industries in BC with an additional $575.4 million in household income to workers outside of BC.

During the Operation phase, the Project is estimated to create approximately 12,535 person-years of direct employment with an additional 16,603 person-years in supplier industries in BC, and an additional 9,830 person-years of employment in the rest of Canada. In the RDKS, 1,760 person-years of employment will be created with an additional 1,760 person-years of employment in the RDBN. The operation of the mine will also substantially contribute to the tax revenue of approximately $526.9 million, with $257.1 million in federal, $180.9 million in provincial, and $37.7 million in local tax revenue.

The potential benefits of the Project include:

- increased provincial, national, and international gold and silver supply and export;
- the provision of training, skills development, and well-paying employment opportunities for local and other communities, including Aboriginal peoples;
- the support of local and regional businesses through the purchase of goods and services; and
- the contribution to provincial and Canadian tax revenues and gross domestic product.

3. Project Design and Alternatives Assessment

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3. Project Design and Alternatives Assessment

3.1 ALTERNATIVE MEANS OF UNDERTAKING THE PROJECT

The assessment of alternative means of developing the Project outlines the main decisions that Pretivm has made to construct and operate the Project in a manner that minimizes adverse environmental, cultural, and socio-economic effects and maximizes beneficial effects. Alternatives explore functionally different, but feasible, design specifications or component locations.

Chapter 4 of the Application/EIS describes the processes and criteria that Pretivm and its consultants have used to select alternative means, and lists key design changes made to the Project. These alternative considerations comply with the requirements set out in a range of provincial and federal legislation, as well as Project-specific requirements.

Table 3.1-1 provides a summary of the preliminary screening steps used to assess the technical and economic feasibility of various design options to determine which alternative means to assess. Of these initial options, those deemed economically and technically feasible were evaluated as alternative means based on assessing performance objectives (based on economic, technical, environmental, and social criteria). Table 3.1-2 summarizes the full alternatives assessment that was conducted for the following Project components: transportation route and mode for concentrate, materials, and personnel; ore production and processing options; and mine waste disposal.

3.2 SUMMARY OF PROJECT DESIGN CHANGES

Throughout the Project planning process, Pretivm has made Project design decisions that, overall, minimize potential environmental and related social effects to Aboriginal people and the public. Table 3.1-3 provides a list of the key design changes for the Project.

Table 3.1-1. Brucejack Gold Mine Project Options Screening Table Based on Basic Technical and Economic Feasibility Criteria

Major Component of Project	Sub-component	Option	Technically Feasible? (Y/N)	Technical Rationale	Economically Feasible? (Y/N)	Economic Rationale	Screening Result
Project Access and Transport	Ground Access from Highway 37 to Knipple Transfer Area	Use existing exploration road from the east with some minor upgrades	Y	Use of existing exploration access road, including required upgrades, during Project life is technically feasible.	Y	Few upgrades needed, so economically feasible.	Select
		New road along Bowser River Valley connecting to Granduc Access Road to the south	N	Unfeasible due to steep surrounding terrain and extensive geohazards, such as avalanches along the Bowser River Valley, posing unacceptable risk. This route would also significantly increase travel distance to rail head, and create new disturbance.	N	Would not be economically supported to build a road through the surrounding terrain as would require extensive geohazard and avalanche mitigation, as well as increased concentrate transport cost to rail head.	Discard
		Combination of road access and barge across Bowser Lake	N	Used previously for transport of personnel and some materials and equipment to the vicinity of the proposed Knipple Transfer Area; however, due to the inability to utilize the barge during winter (frozen lake) or poor weather, does not meet criteria for reliable continuous and long-term access to the transfer area, therefore unfeasible.	Y	Economically feasible for limited use as demonstrated in the past. There would be additional costs associated with extra handling (loading and offloading the barge) and management of shipping delays caused by ice or poor weather.	Discard
	Ground Access into the Brucejack Mine Site from Knipple Transfer Area	Existing exploration route (includes ~12 km of travel over Knipple Glacier)	Y	Feasible using specially equipped vehicles over glacier; viability is demonstrated as this route is currently in use for exploration and will accommodate Project scheduling and load requirements.	Y	This route is economically supported because it only requires minor upgrades to existing road.	Select
		A road involving tunnels to avoid glacier travel	N	Mine Site is surrounded by glaciers and steep, mountainous terrain with many geohazards; not feasible to build a safe road route in the area without substantial engineered structures such as lengthy tunnels that would also pose more risk to build and operate.	N	Would not be economically supported to build a route through the surrounding terrain as would require significant modification to achieve slope stability and other required road safety features.	Discard
	Personnel Transport Method to Knipple Transfer Area	Fixed-wing air from major centres	Y	Feasible as the proposed Bowser Aerodrome would allow year-round air access, and air travel would reduce transport times for staff compared to land travel; however, in inclement weather conditions, air travel would not be feasible, so a ground access method would also be needed.	Y	Economically feasible.	Assess Further
		Land via private vehicle from Highway 37	Y	Technically feasible.	Y	Economically feasible.	Assess Further
		Land via bus from Highway 37	Y	Technically feasible, as demonstrated through current practice.	Y	Economically feasible.	Assess Further
Power for the Project	Primary Power Supply	Transmission line: east option	Y	Technically feasible.	N	Economically unfeasible.	Discard
		Transmission line: south option	Y	Technically feasible.	Y	Economically feasible.	Assess Further
		Transmission line: Bear River to American Creek, then split to the mine to the west and Highway 37 process plant to the east (for final processing to doré)	N	Technically feasible, but would require significant additional right-of-way. This route was considered to support on-site final flotation concentrate processing, but the decision to complete final processing off-site means this option would no longer be suitable for use, rendering it unfeasible.	Y	Feasible, but economically no longer supported if flotation concentrate is processed off-site.	Discard
		On-site diesel generation	N	Unfeasible, as logistically unacceptable due to volume of diesel fuel requiring transport to mine site to generate sufficient electricity to power Project, and increases risks.	N	Unfeasible as fuel and transport costs would not be supported by Project economics.	Discard
		On-site hydro	N	Unfeasible, as insufficient capacity to power Project, largely due to seasonal limitations.	N	Unfeasible as hydro power would add significant additional costs, without meeting power requirements.	Discard
		Wind	N	Unfeasible, as insufficient capacity to power Project as not consistent or predicable source of power.	N	Unfeasible as wind energy would add significant additional costs, without meeting power requirements.	Discard
		On-site solar	N	Unfeasible, as insufficient capacity to power Project.	N	Unfeasible, solar power would not consistently meet power requirements.	Discard

(continued)

Table 3.1-1. Brucejack Gold Mine Project Options Screening Table Based on Basic Technical and Economic Feasibility Criteria (continued)

Major Component of Project	Sub-component	Option	Technically Feasible? (Y/N)	Technical Rationale	Economically Feasible? (Y/N)	Economic Rationale	Screening Result
Ore Production and Processing	Mining Method	Open pit	N	Unfeasible, as method is more suitable to near surface orebodies, not for type and orientation of VOK and West Zone orebodies; would also generate much larger volumes of waste rock that would be onerous to manage compared to underground mining.	N	Economically unfeasible, due to high initial capital costs, and dilution of ore grades, and increased tonnages to be milled/tailings to be disposed, leading to increased costs and delays, as well as unsupported costs to mitigate technical risk.	Discard
		Underground method 1: block caving / sublevel caving	N	Unfeasible, as this is an unselective method applicable to large bodies of homogenous low-grade ore, but not the high-grade VOK and West Zone orebodies, which are not geotechnically suited to this mining method, and which would be diluted through this method.	N	Unfeasible, due to high initial capital costs, and dilution of ore grades, and increased tonnages to be milled/tailings to be disposed, leading to increased costs and delays, as well as unsupported costs to mitigate technical risk.	Discard
		Underground method 2: shrinkage stoping	N	Unfeasible, as this is an inefficient mining method for the style of mineralization; shrinkage stoping is suited to vertical to sub-vertical narrow vein deposits rather than massive deposits like VOK and West Zone orebodies.	Y	Economically feasible.	Discard
		Underground method 3: room and pillar	N	Unfeasible, as designed for flat or gently sloping deposits typical of potash, uranium, limestone, and salt deposits; not appropriate for vertical/sub-vertical mining of the VOK and West Zone orebodies ore.	Y	Economically feasible.	Discard
		Underground method 4: long-hole open stoping	Y	Feasible as a suitable method given the type and orientation of ore body; allows mining flexibility, dilution control, and disposal of waste rock and tailings as backfill.	Y	Economically feasible.	Select
		Underground method 5: cut-and-fill	N	Unfeasible, as used on less massive deposits or where a higher degree of selectivity is required, therefore not suitable method. May have localized application in some areas, though none identified.	N	Economically unfeasible as this lower productivity, higher operating cost method is not appropriate as a primary method at the Project.	Discard
	Ore Comminution	Option 1: three stages of crushing and two stages of ball mill grinding	Y	Technically feasible.	Y	Economically feasible.	Assess Further
		Option 2: one stage of crushing and grinding in a SAG mill grinding/ball mill grinding/pebble crushing (SABC) circuit	Y	Technically feasible.	Y	Economically feasible.	Assess Further
	Location of Initial Ore Processing into Flotation Concentrate	On-site in a process plant at the mine site	Y	Technically feasible.	Y	Economically feasible.	Select
		Off-site near Highway 37	N	Unfeasible due to logistics of transport of large volumes of ore off-site.	N	Not economically feasible due to prohibitive costs to operate.	Discard
	Location of Final Flotation Concentrate Processing into Gold-silver Doré	On-site by Proponent	Y	Technically feasible.	Y	Economically feasible.	Assess Further
		Off-site by third party	Y	Technically feasible.	Y	Economically feasible.	Assess Further
Wastewater Management	On-site Construction / Operation Camp Treated Sewage Effluent Discharge Location	Discharge into Brucejack Lake	Y	Technically feasible.	Y	Economically feasible.	Select
		Discharge to Brucejack Creek	N	Unfeasible as will likely not meet water quality permitting requirements during low flow periods.	Y	Economically feasible.	Discard
	Contact Water Treatment Method	Veolia ACTIFLO® High Rate Clarifier	Y	Feasible, as technically suitable technology to treat Project contact water contaminants, and viable to achieve water quality guidelines.	Y	Economically feasible	Select
		Reverse osmosis	N	Unfeasible, as, it is not suitable to treat the specific contact water contaminants for the Project. Greater maintenance requirements to clean membranes that require handling and disposal of chemicals not required for other treatment options.	N	Not economically feasible due to increased costs related to technical inefficiencies.	Discard
		Ion exchange	N	Unfeasible, as it is not suitable to treat the specific contact water contaminants for the Project. Greater maintenance requirements to replace and dispose of resin not required for other treatment options.	N	Not economically feasible due to increased costs related to technical inefficiencies.	Discard
	Treated Contact Water Discharge Location	Discharge into Brucejack Lake	Y	Feasible during mine operations, when Brucejack Lake will no longer be used as camp drinking water source as is current practice.	Y	Economically feasible.	Select
		Discharge to Brucejack Creek	N	Unfeasible, as would not be acceptable due to technical challenges to meet water quality permitting requirements during seasonal low flows.	Y	Economically feasible.	Discard

(continued)

Table 3.1-1. Brucejack Gold Mine Project Options Screening Table Based on Basic Technical and Economic Feasibility Criteria (completed)

Major Component of Project	Sub-component	Option	Technically Feasible? (Y/N)	Technical Rationale	Economically Feasible? (Y/N)	Economic Rationale	Screening Result
Solid Waste Disposal	Waste Rock Disposal Method	Backfill into stopes of underground mine	Y	Backfilling into stopes is technically feasible for much but not all of the anticipated waste rock volumes, providing structural support allowing underground mining expansion to proceed more safely, and becomes more feasible later in the Project lifespan when large underground volumes are available.	Y	Backfilling is a low cost option that is economically feasible.	Assess Further
		Subaqueous deposition into Brucejack Lake	Y	Technically feasible and lake volume would accommodate waste rock.	Y	Economically feasible.	Assess Further
		Disposal into surface rock storage facilities (RSFs)	N	Unfeasible as RSFs would be technically onerous to build in the limited space available on site with associated geohazards, and would require perpetual management to address water quality issues.	Y	Creation of RSFs would be economically possible were it technically viable.	Discard
	Tailings Disposal Method	Backfill as paste into stopes of underground mine	Y	Backfilling of paste into stopes is feasible for almost half of the anticipated tailings volume.	Y	Economically feasible.	Assess Further
		Subaqueous deposition into Brucejack Lake	Y	Deposition of tailings into the lake is technically feasible and the lake has adequate capacity.	Y	Economically feasible.	Assess Further
		Deposition as conventional slurry into a tailings storage facility (TSF)	N	Unfeasible, as a TSF would be technically onerous to build and maintain in the challenging terrain of the Project.	Y	Creation of a TSF would be economically possible were it technically viable.	Discard
		Dry stacking of filtered tailings	N	Unfeasible due to climatic conditions with high average precipitation.	N	Not economically viable due to long-term management of the dry stack tailings.	Discard
	Controlling Sediment Release from the Lake	Process waste rock through a wash plant to remove a component of fine sediment. Wash water treated by settling pond, aided by flocculants.	N	Not feasible in winter when rock will freeze after washing, making transportation and placement unsafe. Would require additional sludge management. Does not address sediment release from tailings.	Y	Economically feasible.	Discard
		Deposit flocculated tailings to base of growing tailings mound.	Y	Technically feasible. Discharge through the mound acts as filter to remove fines for the effluent and dissipates energy of the effluent stream decreasing the ability to suspend material. Reduces potential sediment release at the lake outlet as a result of tailings deposition, does not address sediment release from waste rock. Operations require constant flow through to maintain partial fluidity of tailings mound.	Y	Economically feasible.	Select
		Install a turbidity curtain at lake outlet to remove suspended sediment	Y	Technically feasible. Proven technology used successfully in nearby Eskay Creek Project. Addresses elevated suspended sediment from both tailings and waste rock deposition. Challenges during freeze/thaw and under-ice season.	Y	Economically feasible.	Select
		Install a turbidity curtain around the waste rock dump area	Y	Technically feasible. Proven technology used successfully in nearby Eskay Creek Project. Addresses elevated suspended sediment from waste rock deposition. Challenges during freeze/thaw and under-ice season.	Y	Economically feasible.	Select
		Construct an outlet control structure (dam) to retain water in the lake if TSS levels are too high to allow time for suspended material to settle out of the upper water column	Y	Technically feasible. Effectiveness of a structure for settling suspended material limited by amount of storage capacity of the control structure and the lake, especially during freshet. Restriction of flows would have downstream environmental impacts. Challenges during freeze/thaw and under-ice season. Requires real-time TSS monitoring.	Y	Economically feasible.	Assess Further
		Add flocculants to the lake	N	Not technically feasible due to volumes of flocculant required and related chemical effects on the lake.	Y	Economically feasible.	Discard
	Solid Waste Disposal Method for Non-Hazardous Waste	On-site landfill	N	Unfeasible due to there not being an appropriate location on-site to accommodate waste over the Project life, finding soil to cover waste, and managing the site in winter conditions.	Y	On-site waste disposal would be the most economically feasible alternative due to minimized transportation and equipment costs.	Discard
		Off-site landfill	Y	Feasible as this is a standard approach to disposal of waste for mines where off-site facilities are available, and there are available landfill sites located in the mine-site region.	Y	Economically feasible.	Assess Further
		Incineration, and disposal in off-site existing landfill	Y	Incineration of solid waste is technically feasible for many solid waste products (i.e., food waste). Some materials (such as plastics and rubber) would not be suitable for incineration.	Y	Economically feasible.	Assess Further

Table Legend

Select	Utilize option for the Project
Assess Further	Carry forward option into detailed alternatives assessment
Discard	Eliminate option from further consideration

Table 3.1-2. Summary of Brucejack Gold Mine Project Alternatives Evaluation

Major Component of Project	Sub-Component	Alternative	Performance Objective Attribute Ratings				ASSESSMENT RESULTS	
			Environmental	Social	Technical	Economic	OVERALL RATING	Project Decision
Project Access and Transport	Personnel Transport Method to Knipple Transfer Area	Fixed-wing air from major centres	Preferred	Unfeasible (In Poor Weather) Preferred (In Good Weather)	Unfeasible (In Poor Weather) Preferred (In Good Weather)	Acceptable	Unfeasible (In Poor Weather) Preferred (In Good Weather)	Fly in good weather, and use bus in poor weather
		Land via private vehicle from Highway 37	Acceptable	Challenging	Challenging	Acceptable	Challenging	
		Land via bus from Highway 37	Acceptable	Preferred (In Poor Weather) Acceptable (In Good Weather)	Preferred (In Poor Weather) Acceptable (In Good Weather)	Preferred	Preferred (In Poor Weather) Acceptable (In Good Weather)	
Power for the Project	Primary Power Supply	Transmission line: east option	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Use South Transmission Line
		Transmission line: south option	Preferred	Preferred	Preferred	Preferred	Preferred	
Ore Processing	Ore Comminution	Option 1: three stages of crushing and two stages of ball mill grinding	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Use SABC Circuit (Option 2)
		Option 2: one stage of crushing and grinding in a SAG mill grinding/ball mill grinding/pebble crushing (SABC) circuit	Preferred	Acceptable	Preferred	Acceptable	Preferred	
	Location of Final Flotation Concentrate Processing into Gold-silver Doré	On-site by Proponent	Acceptable	Acceptable	Challenging	Preferred	Challenging	Process Final Flotation Concentrate Off-site by third party
		Off-site by third party	Preferred	Preferred	Preferred	Acceptable	Preferred	
Solid Waste Disposal	Tailings Disposal Method	Backfill as paste into stopes of underground mine	Preferred	Preferred	Preferred	Preferred	Preferred	Backfill as paste when feasible; otherwise deposit in Brucejack Lake
		Subaqueous deposition into Brucejack Lake	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
	Waste Rock Disposal Method	Backfill into stopes of underground mine	Preferred	Preferred	Preferred	Preferred	Preferred	Backfill into stopes where feasible; otherwise deposit in Brucejack Lake
		Subaqueous deposition into Brucejack Lake	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	
	Sediment Control	Turbidity curtain at the outlet of Brucejack Lake	Preferred	Preferred	Preferred	Preferred	Preferred	Install turbidity curtains at the outlet or Brucejack Lake and around the waste rock disposal site in the lake
		Turbidity curtain around the waste rock disposal area	Preferred	Preferred	Preferred	Preferred	Preferred	
		Outlet control structure at the outlet of Brucejack Lake	Challenging	Acceptable	Challenging	Challenging	Challenging	
	Solid Waste Disposal Method for Non-Hazardous Waste	Off-site landfill	Preferred	Acceptable	Preferred	Acceptable	Preferred	Food waste will be incinerated and other waste disposed in off-site landfill
		Incineration, and disposal in off-site existing landfill	Acceptable	Preferred	Acceptable	Preferred	Acceptable	

Table 3.1-3. Key Brucejack Gold Mine Project Design Changes and Related Environmental and Social Benefits

Redesigned Project Component	Description of Design Change	Benefits of Changes to the Environment	Benefits of Changes to Aboriginal Peoples	Benefits of Changes to the Public
Mining method	The original mine proposal included an underground mine plus up to four open pits, generating 8.7 Mt of waste rock. This waste rock would have been deposited in the underground workings and in two separate areas of Brucejack Lake. The current mine plan does not include open pits and will generate 4.5 Mt of waste rock, to be deposited underground and in one area of Brucejack Lake.	• Smaller Project footprint • Less waste rock to manage and haul • Fewer waste rock deposit areas • Simpler water management • Reduced acid rock drainage concerns	• Reduced area of disturbance • Reduced environmental risk	• Reduced environmental risk
Ore processing method	The original Project proposal included two process plants: a conventional flotation concentrator at the mine site to produce bulk gold-silver flotation concentrate/gravity concentrate, and a cyanide leach plant located near the Bell-Irving River to produce gold-silver doré, each with its own tailings storage area. Tailings from the flotation plant would have been disposed in Brucejack Lake, while the leach plant would have required a lined side-hill tailings storage facility with a capacity of 2.4 Mt. The current Project proposal does not include a leach plant and associated tailings storage facility. Concentrate will be transported to an off-site smelter for further processing.	• Reduced area of disturbance and ultimate tailings volume to be managed • Elimination of use of cyanide • Reduced long-term water management concerns • Reduced electric power consumption	• Reduced area of disturbance • Improved safety with elimination of cyanide transportation, storage, and use • Reduced environmental risks	• Improved safety with elimination of cyanide transportation, storage, and use • Reduced environmental risks • Reduced electric power consumption
Layout of surface facilities	The original Project proposal incorporated separate buildings for the mill, crusher, warehouse and truck shop, and a trailer-style mine camp. The current Project proposal consolidates the mill, crusher and warehouse into a single building, and uses a more compact mine camp.	• Reduced area of disturbance • Reduced Construction phase waste rock to be managed • Reduced electric power consumption	• Reduced area of disturbance • Safer for mine employees	• Reduced electric power consumption • Safer for mine employees
Employee transportation	The original Project proposal for employee transportation was by road to and from the site along the access road from Highway 37. The current proposal incorporates the Bowser Aerodrome, a re-establishment and expansion of an historical airstrip at the head of Bowser Lake.	• Potential benefits for wildlife and fisheries	• Reduced traffic on Highway 37 and Brucejack Access Road • Protection of wildlife and fisheries	• Reduced traffic on Highway 37 and Brucejack Access Road
Glacier travel	The original Project proposal did not consider the implications of transporting supplies and concentrate over the glacier. The current proposal incorporates the Knipple Transfer Area as a staging area for the use of specially equipped vehicles for glacier travel, as well as detailed management plans for this travel.	• Reduced environmental risk from accidents	• Increased safety for glacier travel	• Increased safety for glacier travel
Water treatment	The original Project proposal recognized that surface water treatment would be required, but gave little detail. Treatment of surplus underground water was not considered to be necessary. Subsequent analysis has demonstrated that underground water may exceed allowable metal concentrations for discharge. The current proposal includes details of facilities for treatment of excess groundwater pumped from the underground operations, and surface contact water. The proposed treatment facilities will allow the Project to operate in a manner consistent with the Metal Mining Effluent Regulations (SOR 2002-222) and *Environmental Management Act* (2003) with regards to effluent .	• Project discharges consistent with the Metal Mining Effluent Regulations and *Environmental Management Act* standards with regards to effluent waters	• Water quality protected	• Water quality protected
Tailings disposal	Originally, the tailings pipeline would have discharged at a depth of 70 m directly into Brucejack Lake. This location was efficient and inexpensive. The current plan is for initial discharge at a depth of 80 m, with the discharge passing through a sand filter mound on the lake bottom. The sand filter will reduce the release of suspended sediments into the lake. As backpressure in the tailings pipeline increases as a result of the build-up of tailings above the mound, a second outfall will be established at about 60-m depth with the same type of sand filter.	• Containment of tailings fines to the bottom of the lake, keeping them out of the water column where they could potentially be more mobile • Improving certainty of achieving regulatory discharge standards	• Potentially reduced adverse downstream effects on water quality and fisheries	• Potentially reduced adverse downstream effects on water quality and fisheries
Turbidity curtain	To address the potential for the release of increased total suspended solids (TSS) from Brucejack Lake to Brucejack Creek, turbidity curtains will be installed near the outlet of the lake and around the waste rock disposal area in the lake. These turbidity curtains would capture excess TSS. TSS may be generated by the dumping of waste rock in to the lake, tailings that could be disturbed by the semi-annual turnover of the lake water column, or by malfunction of the tailings discharge sand filter.	• Restriction of excess TSS flowing to Brucejack Creek, thereby avoiding adverse effects on the aquatic environment and water quality • Improving certainty of achieving regulatory discharge standards	• Potentially reduced adverse downstream effects on water quality and fisheries	• Potentially reduced adverse downstream effects on water quality and fisheries

4. Summary of Project Description

4. Summary of Project Description

4.1 REGIONAL GEOLOGY

The Brucejack property is located in the western Stikine terrane (or Stikinia), the largest of several allocthonous terranes in the Intermontane Belt of the Canadian Cordillera. The Stikine terrane in northwestern BC consists of a series of unconformity-bound tectonostratigraphic elements, including: Palaeozoic island-arc rocks of the Stikine assemblage, Mesozoic island-arc rocks of the Upper Triassic Stuhini Group and Lower to Middle Jurassic lower Hazelton Group, and Middle to Upper Jurassic overlap assemblage sedimentary rocks of the Bowser Lake Group.

Adjacent properties host significant precious and base metal resources (e.g., Snowfield, Kerr-Sulphurets-Mitchell [KSM]), as well as a number of high-potential mineral occurrences. The KSM deposits, along with the Snowfield and Brucejack deposits together comprise what is commonly referred to as the Sulphurets Mining Camp.

The Sulphurets Mining Camp is located on the eastern limb of the broad McTagg anticlinorium, a major north-trending mid-Cretaceous structural culmination in the western Skeena fold belt. Sedimentary and volcanic rocks of the Upper Triassic Stuhini Group form the core of the anticlinorium, and are successively replaced outwards towards the west, north, and east of the core by progressively younger rocks of the Lower to Middle Jurassic volcanic and lesser sedimentary rocks of the Hazelton Group followed by sedimentary rocks of the Bowser Lake Group. Plutonic rocks are located in the western and northern parts of the Sulphurets Mining Camp, and occur as dikes, sills, and plugs, which generally intrude Stuhini Group rocks.

4.2 PROJECT GEOLOGY

Geology on the property can generally be characterized as a northerly-trending, broadly arcuate, concave-westward structural-stratigraphic belt of variably altered rocks. The arcuate trend is outlined by the stratified rocks and the intensely quartz-sericite-pyrite altered rocks up to several hundred metres or more across, and approximately five kilometres in strike extent. Most of the defined mineral resources on the property are located within the intensely altered zone.

More than 40 gossanous zones of gold, silver, copper, and molybdenum mineralization have been identified along the length of the arcuate band of altered rocks. High-grade gold (± silver) mineralization is generally associated with vein-stockwork systems of varying intensity. The focus of the Project is on the VOK and West zones. The currently hypothesis for the mineralization on the property is that it represents a deformed transitional meso- to epithermal porphyry-associated quartz stockwork in pervasively altered lower Hazelton Group rocks.

4.3 MINERAL RESOURCES

The mineral resources of the VOK zone, in the measured and indicated categories, total 15.3 million tonnes (Mt) containing 8.7 Moz of gold and 7 Moz of silver. A further 5.9 Mt are inferred with contained gold and silver of 4.9 and 3.9 Moz, respectively. The West zone adds 4.9 Mt of measured and indicated ore, containing 0.9 Moz of gold and 41.9 Moz of silver, and inferred resources of 4.0 Mt containing 0.8 Moz of gold and 10.6 Moz of silver.

4.4 GEOCHEMICAL CHARACTERIZATION

Based on extensive testing and analysis, most of the ore and the immediately adjacent host rocks are considered to be currently or potentially acid-generating (PAG) rock. The elements arsenic, cadmium, copper, lead, selenium, and zinc are considered to be likely parameters of concern (POCs), based on leachate concentrations from humidity cells and field barrels containing waste rock. Subaqueous columns with waste rock material present elevated leachate concentrations of arsenic, antimony, molybdenum, selenium, and zinc. Tailings in the humidity cells and subaqueous column tests are not expected to generate acid rock drainage. Possible POCs for tailings materials are arsenic, antimony, molybdenum, and selenium as per leachates from humidity cells and subaqueous columns.

4.5 PROJECT CONSTRUCTION

As previously discussed, the two-year Construction phase will begin with the access road upgrade and construction of a transmission line from the Long Lake Hydro Substation near Stewart, which will be supported by a temporary camp and staging area located near the old Granduc mine mill site. Significant underground development work will be required to prepare the initial stopes for the proposed long-hole open stoping and longitudinal long-hole open stoping mining methods. This work will include the development of two new declines and related portals to permit access to the ore and to house a conveyor to transport ore to the surface. Ramps will be developed to connect underground work areas and stoping levels will be established. Other work will prepare the crusher gallery, ventilation raises, shops, pumping systems, electrical substation, explosives and fuel storage areas, etc. During the Construction phase, underground seepage water and surface contact water will be treated in an existing temporary water treatment plant.

Concurrent with the underground development, surface development will include excavation of diversion and contact water collection ditches for surface water; preparation of access and haul roads on the mine site; development of pads for the construction of the mill building, operations camp, and substation; erection of a new camp at the mine site; preparation of a construction laydown area on fill deposited in Brucejack Lake; clearing and surfacing of a transfer area, including a small camp, between the toe of Knipple Glacier and Knipple Lake to facilitate the transfer of materials and supplies from highway trucks to specially equipped vehicles for travel over the Knipple Glacier; improvement of an existing historical airstrip on the flats east of Knipple Lake to allow air access; and installation of systems for power distribution and sewage treatment. Waste rock from pad development will be deposited in Brucejack Lake.

As Construction progresses, the mill building and truck shop will be erected and equipment will be installed in them. The mine site camp will be upgraded for operations, the permanent water treatment plant will be installed in the mill building, and the tailings pipeline will be installed to deposit tailings at depth in Brucejack Lake.

4.6 MINE DEVELOPMENT AND OPERATIONS

Ore produced during the Construction phase will be stored on a prepared pad, located east of the mill building. Once the mill machinery is installed, this ore will be hauled to the mill for processing. Once the mill is operational and underground development progresses to the point of supplying adequate ore, commercial production will commence.

The mining sequence in any lens of a given block will begin with the extraction of the primary stopes on the first (lowest) level. Wherever possible, the first primary stope will be located near the middle of the lens to develop a pattern of stope extraction that moves outwards to the extremities of the lens while progressing upwards towards the top. Bulk emulsion will be used for blasting. Non-electric detonators will be used for lateral development while electric programmable detonators will be used for stoping operations.

The primary means of backfilling at the Project will be paste fill, generated from unclassified mill tailings mixed with adequate cementitious binder, to meet the strength requirements of re-exposure. Waste rock will consume stope voids that might otherwise receive mill tailings in the form of paste fill. Over the LOM, 45% of development waste rock and 47% of tailings generated from milled ore will be returned underground. The balance will be disposed of in Brucejack Lake.

A fleet of load-haul-dump vehicles and trucks will be used for material loading and transport from the various underground working areas through an internal ramp system that will connect all levels to the centrally located crusher. The rate of lateral development will be greatest in the early years, including the Construction phase, and will begin to taper off after about Year 8. Mine production will continue for about 22 years at a rate of about 2,700 tpd.

Ore will be hauled by load-haul-dump vehicles to an underground jaw crusher that will deposit crushed ore to a transfer conveyor that will in turn transport ore to the main conveyor for transport to the portal. At the portal the ore will be transferred to a third conveyor for transport to the mill building.

Permanent fans will provide ventilation by forcing air down the declines, through the internal ramps, and exhausting to surface via dedicated raises that will connect the various working levels to surface in each zone. The primary fans will be located at each of the main surface portals, and complemented by booster fans located in the exhaust raises, in a common push-pull configuration. An electric mine air heating system will be used, with a propane system available as a back-up.

Groundwater seeping into the mine will be collected and pumped to the surface water treatment plant for treatment before being used for process water in the mill.

Underground openings will be designed with reference to geotechnical investigations to ensure stability. Support will be installed as required. The proper design of support systems and backfilling of stopes suggest that there will be very low probability of surface subsidence as a result of the mining.

4.7 PROJECT CAPITAL AND OPERATING COSTS

The total estimated initial capital cost for the design, construction, installation, and commissioning of the Project is $663.5 million. The LOM average operating cost for the Project is estimated at $156/t of ore milled.

4.8 MINERAL PROCESSING

The Brucejack mill will use a combination of conventional bulk sulphide flotation and gravity concentration to recover gold and silver. The process plant will produce a gold-silver bearing flotation concentrate and gold-silver doré from melting the gravity concentrate produced from the gravity concentration circuits.

The concentrating process will include:

- primary crushing underground;
- a conveying system for crushed ore;
- a surge bin;

- primary grinding and gravity concentration;
- rougher/scavenger flotation;
- bulk flotation concentrate regrinding and gravity concentration;
- cleaner flotation;
- gravity concentrate smelting to produce doré;
- flotation concentrate dewatering, bagging, and load out; and
- tailings thickening and transport to the paste plant or mixing plant for disposal.

A portion of the flotation tailings will be used to make paste for backfilling the excavated stopes in the underground mine, and the balance will be stored in Brucejack Lake.

The concentrate from the flotation process will be thickened, filtered, and bagged in two-tonne bags prior to being transported to off-site smelters in shipping containers. The gravity concentrates will be upgraded by conventional tabling followed by smelting to produce gold-silver doré.

The concentration process will use a number of reagents, flocculants, and anti-scalants. The transportation, storage, use, and disposal of these chemicals will be subject to management plans, including the hazardous materials and waste management plans. To ensure containment in the event of an accidental spill, the reagent preparation and storage facility will be located within a containment area designed to accommodate 110% of the content of the largest tank. The storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during normal operation. Appropriate ventilation, fire and safety protection, and Material Safety Data Sheet stations will be provided in the area.

4.9 WATER MANAGEMENT

Clean surface runoff will be diverted around surface infrastructure and discharged to natural drainages. Water that comes in contact with surface infrastructure will be collected and stored in a contact water pond sized to handle worst-case anticipated flows. Water will be pumped from this pond to the water treatment plant.

Underground seepage will be collected and pumped to the water treatment plant. Pumping systems will have built-in redundancy to handle anticipated flows reliably. Treated water will be used as process water, in the paste backfill, or for fluidizing flows in the tailings discharge pipeline.

The Operation phase water treatment plant will be located in the mill building. It will consist of two modules, each with a capacity of 400 m^3/hour. The water treatment plant will use a proprietary process developed by Veolia. It includes reaction tanks and clarifiers, the use of sodium hydroxide (to lower pH), coagulants and flocculants, and microsand as a seed for flocculation. Sludge from the process will be thickened and treated in a filter press before being sent to the tailings stream for disposal in Brucejack Lake.

The water treatment plant will supply most of the Project's water needs at the Brucejack Mine Site. Any required make-up water for the mill that is not supplied by the water treatment plant will be drawn from Brucejack Lake.

Potable water for the camps and permanent facilities will be sourced from groundwater wells or surface flows and will be treated as necessary to meet standards for human consumption.

4.10 WASTE MANAGEMENT

Waste streams for the Project will include waste rock, tailings, and hazardous and non-hazardous waste from shops, laboratories, camps, and offices. Waste management for hazardous and non-hazardous wastes will involve the segregation of waste into appropriate management streams. Project waste collection and disposal facilities will include an incinerator at the Brucejack Mine Site and the Knipple Transfer Area, and waste collection areas for recyclable and hazardous wastes. Processes will be in place for the safe disposal of sewage effluent and sludge.

4.10.1 Waste Rock

Stopes will be backfilled with development waste rock wherever possible, but both initial pre-development waste rock from the first 18 months of construction and some waste rock generated later in mine life will be hauled to the surface for subaqueous disposal in Brucejack Lake. Waste rock excavated from the surface infrastructure areas to create development sites will also be disposed subaqueously in the lake.

Waste rock from bulk sampling campaigns conducted by Pretivm and a previous operator of the Project has been disposed of in Brucejack Lake without significant adverse effects.

Most of the waste rock from the Construction and Operation of the Project will be PAG rock. PAG rock disposed in Brucejack Lake will have a minimum depth of water cover of 1 m. Non-PAG rock from a nearby quarry will be used to cap submerged waste rock in order to create a causeway for dumping into deeper water. Geotechnical assessments have been completed to guide the design of construction and operation of the dump and causeway to reduce the risk of dump instability. A turbidity curtain will be installed around the waste rock disposal area to restrict the release of suspended sediments into the rest of the lake.

4.10.2 Tailings

The Project is expected to produce about 18 Mt of flotation tailings over the LOM. These tailings are expected to be non-PAG. Almost half of the tailings will be used to make paste to backfill the underground stopes and the rest will be discharged at depth in Brucejack Lake.

Tailings from the flotation process will be directed to the paste plant, where they will be mixed with a cementitious binder and pumped underground for placement in mined-out stopes. Tailings destined for Brucejack Lake will first be diluted in an agitating mixing tank to ensure efficient operation of the agitator, pump, and pipeline, while keeping the deposit at the lake bed fluidized. The pipeline will slope continuously downwards to the lake to allow drainage in the event of a flow stoppage. There will be two pipelines into the lake: the first will discharge at a depth of about 80 m, and the second at a depth of about 60 m.

Coarse sand or gravel will be placed over the pipeline terminus to filter the slurry being discharged and prevent transport of the tailings solids toward the upper layers of the lake. This deposit will remain generally fluidized by the flow of tailings from the pipe. The deposit at the pipeline terminus will thicken over time and bury the deepest section of the outfall.

There will be a constant flow through the pipeline at all times to keep the deposit at the end of the outfall fluidized. When the thickened tailings are used in the backfill plant, water will be discharged through the tailings discharge system to keep a pathway in the mound covering the discharge point fluidized.

If the backpressure from the overlying tailings at the outfall becomes too great to allow efficient pumping of tailings through the deposit, the tailings will be switched to the second outfall.

4.10.3 Hazardous Wastes

Pretivm is already registered as a hazardous waste generator for waste oil and batteries at its exploration site, and has procedures in place for the storage and handling of these materials. The registration will be amended as needed for additional materials during Construction and Operation. Existing procedures will be revised for hazardous waste management and spill response during the Construction phase and adopted through time to accommodate the Operation and Closure phases.

4.10.4 Non-hazardous Waste

Waste will be recycled to the extent feasible. Waste collection areas will have provisions to segregate waste according to disposal methods and facilities to address spillages, fire, and wildlife attraction. Kitchen, camp, and office wastes will be incinerated. Specific procedures and separate secure storage areas will be designated for waste prior to recycling or removal from the site. Waste that cannot be recycled or incinerated will be disposed off-site.

4.10.5 Sewage

The existing exploration site sewage treatment plant will continue to be used and will have additional units added as necessary for the construction camp population (i.e., Brucejack Camp during Operation phase). There will be a sewage lift station underground to pump to the main sewage treatment plant. The mill building will have a sewage lift station inside and a heat-traced pipeline to the camp sewage treatment plant. The truck shop will have a sewage lift station inside and a heat-traced holding tank outside. A truck will transfer sewage from the holding tank to the sewage treatment plant at the camp. Effluent from the sewage treatment plant will be of appropriate quality for direct discharge to Brucejack Lake. Sludge from the plant will be incinerated or hauled off site for disposal at a licensed facility.

The Knipple Transfer Area and Tide Staging Area camps will have septic systems with tanks and drainfields.

4.11 ANCILLARY AND OFF-SITE INFRASTRUCTURE

4.11.1 Brucejack Mine Site

Infrastructure at the Brucejack Mine Site will include the mine portals and related facilities—a ventilation air heating and conveyor system, the mill building, Brucejack Camp, truck shop, substation, incinerator, explosives magazines—each of which will have a prepared pad and interconnecting roads. A laydown area will be constructed at the edge of Brucejack Lake and will include a batch plant, fuel storage area, and helicopter landing area. A temporary ore and waste rock storage area will be constructed adjacent to the laydown area. A quarry will be developed east of the mine area, south of Brucejack Lake, to provide non-PAG rock for construction purposes. Details of some of these facilities are provided in the following section.

4.11.1.1 Mill Building

The mill building will be a large pre-engineered steel building that will house the process equipment to concentrate the ore, reagent and concentrate storage areas, assay and metallurgical laboratories, warehouse, administration offices, mine dry, maintenance facilities, potable water treatment plant, and the water treatment plant.

4.11.1.2 Brucejack Camp

The current exploration camp will be retained for the Construction phase, although some units will be removed to make way for other infrastructure. A new camp will be constructed for operations, consisting of multi-storey modular buildings constructed of wood framing with insulated metal-clad walls and roof. The new permanent camp will accommodate 330 people with a combination of single and multi-person dormitories and will include a kitchen, recreation and exercise facilities, camp offices, and a sewage treatment plant. The remaining exploration camp facilities will be converted to other uses for the Operation phase.

4.11.1.3 Truck Shop

The truck shop will be a standalone pre-engineered steel building with insulated roof and walls to be located about 60 m east of the portal. It will include bays for heavy and light equipment, a welding bay, a wash bay complete with pressure washer, shop warehouse, mechanical room, electrical room, emergency vehicle bays, first aid and emergency equipment storage, and washrooms. The truck shop will be equipped for major service to both surface and underground vehicles.

4.11.1.4 Explosives Storage

Separate surface magazines will be provided for explosives and detonators. They will be located suitable distances from other surface facilities to provide safety in the event of an accident and will meet regulatory requirements for security of storage.

4.11.1.5 Laydown Area

The laydown area will be a constructed pad built out into Brucejack Lake using waste rock, with a cap of non-PAG rock. A secure fuel storage area will be included that will have an impermeable liner with the capacity of 110% of the largest storage tank. A concrete batch plant will produce concrete for construction and for ongoing underground development.

4.11.1.6 Temporary Ore and Waste Rock Storage Area

Ore excavated during the Construction phase will be stored temporarily on a constructed lined pad adjacent to the laydown area. This ore will be processed once the mill is available. Waste rock will be stored temporarily at the waste rock storage area during inclement weather conditions when underground vehicles are unable to safely transport waste rock to the dump area at Brucejack Lake. This rock will be transferred to the lake disposal area as soon as conditions permit.

4.11.1.7 Quarry

A quarry will be developed in non-PAG rock about 1,600 m east of the mill to provide construction fill where required. Rock excavated from this site will be hauled along the access road that follows the south shore of Brucejack Lake to the mine site area. Rock will be mined at the quarry site using conventional drill and blast methods.

4.11.1.8 Brucejack Lake Outlet Weir

Pretivm will construct a concrete weir across the outlet of Brucejack Lake. This small structure is intended to allow confident year-round monitoring of flows from Brucejack Lake. It is not intended to restrict flows into Brucejack Creek or to increase the storage capacity of Brucejack Lake.

4.11.1.9 Turbidity Curtain

A turbidity curtain, consisting of an impermeable plastic fabric suspended from a float-equipped cable anchored to both sides of Brucejack Lake between the proposed waste rock dump and the mouth of the lake, will be installed to reduce the potential for suspended sediments to flow out of the lake and into Brucejack Creek. The curtain will be weighted at the bottom, which will be suspended about 10 m above the bottom of the lake.

4.11.2 Off-site Infrastructure

The Project will be supported by a range of off-site infrastructure facilities, including the upgraded exploration road, to be called the Brucejack Access Road; the Bowser Aerodrome near the west end of Bowser Lake; the Knipple Transfer Area where materials, supplies, and concentrates will be transferred between highway vehicles and vehicles specially built or equipped for travel over the Knipple Glacier; the Brucejack Transmission Line; and the Tide Staging Area.

4.11.2.1 Brucejack Access Road

The existing 73-km access road from Highway 37 will be upgraded to provide access to the Brucejack Mine Site. The Brucejack Access Road begins at about km 216 on Highway 37, crosses the Bell-Irving River on a single-span bridge and follows the valley of Wildfire Creek to Scott Creek drainage, passes Todedada Lake in the Todedada Creek Valley, and then proceeds over the pass to follow Scott Creek to the Bowser Valley. The road then follows Bowser Valley to the toe of the Knipple Glacier. A constructed ramp allows tracked vehicles to access the glacier; the road then continues for about 12 km to its apex near Brucejack Lake, where another 2 km of road leads to the proposed mine site.

The road will require additional upgrading to increase the speed limit to 40 km/hour and to handle the higher traffic loadings from both Construction and Operation phase activities. The work will include widening of the road surface in locations with limited sight distances, minor re-alignments of the sharper curves, and reductions of the steeper grades. It is not anticipated that any upgrades to stream crossings will be required.

Pretivm has experience using ski resort-type snowcats to prepare the running surface for other tracked equipment during the winter, when the glacier may be covered by many metres of snow. The road surface is maintained as high above the ice level as possible with compact snow to maintain a snow running surface well into summer. Summer maintenance of the Brucejack Access Road on the Knipple Glacier consists mainly of leveling the snow surface as it melts in the warmer months.

The length of road on the south side of Brucejack Lake between the Knipple Glacier and the Brucejack mine site is called Lakeshore Drive, and often has high avalanche risks during the winter. During times when it is unsafe to travel on Lakeshore Drive, an alternate snow route over the VOK is available. This VOK bypass road traverses around to the south of the property, eventually meeting up at km 71 of the primary road on the Knipple Glacier. This road is only available in the winter and also provides access to the upper elevations of the property for avalanche control measures.

4.11.2.2 Bowser Aerodrome

Regular chartered flights will transport mine personnel to and from the Project site from the point of origin to an aerodrome to be located west of Bowser Lake. In inclement weather conditions where aircraft are unable to fly, personnel will be bused from Terrace or Smithers to the Knipple Transfer Area.

The Bowser Aerodrome will be constructed at the site of the historical gravel airstrip, which will be improved and expanded to provide a safe and maintainable facility for the chartered air traffic. A small hill about 450 m west of the proposed aerodrome will be partially excavated to reduce the hazard of the hill on the take-off and approach glide path.

4.11.2.3 Knipple Transfer Area

The Knipple Transfer Area facility will be located west of Knipple Lake, about 55 km by road from Highway 37 and 16 km from the Brucejack Mine Site. The transfer area will include a camp sized to accommodate 22 people, with associated diesel-generated power system, potable water and sewage management systems, transfer station, fuel dispensing system, helipad, and laydown area. It will occupy a development footprint of about 5 ha. All deliveries to and from the Brucejack Mine Site will report to this facility. Loads from highway-legal trucks will be transferred onto tracked or otherwise properly equipped vehicles that will transport the load across the glacier and to the mill site. Similarly, loads from the mill site will be managed in reverse order.

4.11.2.4 Brucejack Transmission Line

Starting at the Long Lake transmission line tie-in west of the substation, the 138-kV Brucejack Transmission Line will follow the bedrock slopes on the east side of the Salmon Glacier to the terminus of the Knipple Glacier. From the Knipple Glacier, the transmission line will generally follow the upper crest of the bedrock slope south of the glacier to the Project site.

The transmission line design includes the use of special single-steel monopole towers to span the snowfields and larger snow avalanche areas, allow helicopter placement, lengthen the spans between structures, and eliminate the need for an access road or track along the transmission line route. Towers will average about 25 m in height, with locations to utilize local high points in the terrain. Tower locations will be selected to span watercourses and limit potential adverse riparian effects, unless no practicable alternative exists. Mitigation measures will be implemented if there are potential adverse effects of tower locations on streams.

There will be limited tree clearing with no removal (trees bucked and left in place along the corridor) where permissible. In riparian areas tree cutting will be limited to topping of taller trees that may interfere with the conductors, with other vegetation being left in place.

4.11.2.5 Tide Staging Area

The Tide Staging Area will be located north of the airstrip near the site of the historical Granduc processing plant. It will be a relatively small, cleared area to be used for a short-term transmission line construction camp, and storage and staging of equipment and materials for the construction of the Brucejack Transmission Line. There is a history of this area being used to stage equipment and materials for the Project.

The construction camp will accommodate up to 90 people, with potable water and sewage management systems that meet regulatory requirements.

4.12 AVALANCHE HAZARD

Project facility sites have been assessed for avalanche hazards. The Brucejack Mine Site facilities are located away from avalanche paths and areas, with the exception of some sections of the site access roads, and the pre-production ore storage and diversion channel area. Mitigation measures will provide safety and protection for these areas.

Fourteen avalanche paths or areas are estimated to affect the Brucejack Access Road, and two paths approach within 50 m. Extreme avalanches to Size 4 are estimated to reach the west end (approximately 20%) of the Knipple Transfer Area pad with an estimated return period of at least 100 years.

Initial analysis indicates that there are approximately 20 to 25 avalanche paths that affect the proposed transmission line route, although they would only pose a hazard if supporting structures (towers) are built in avalanche paths, or conductors are low enough to the ground.

Avalanche risk will be managed with a comprehensive Avalanche Management Plan (Section 29.4) that will include on-site avalanche technicians during avalanche prone periods and active avalanche mitigation.

4.13 PROJECT WORKFORCE

4.13.1 Construction

The Construction phase workforce will range from 390 people in Year 2 to 440 people in Year 1. These workers will initially be housed at the exploration camp, the Tide Staging Area camp, and an existing road construction camp near the proposed Bowser Aerodrome site. The exploration camp will be supplemented by a new structure that will eventually become the Brucejack Camp used for operations. Part of the exploration camp will be demolished to allow installation of surface infrastructure. The road construction camp will be decommissioned once the Knipple Transfer Area camp is available.

4.13.2 Operation

It is proposed that the underground mine workforce will operate with a two week on, two week off rotation, with 11-hour shifts. The overall size of the workforce will vary over time depending upon the amount of development work required in the underground workings from about 619 people in the early years, and slowly tapering to a low of 431 people in the final three years of Operation. The Operation phase workforce will be accommodated at the Brucejack Camp at the Brucejack Mine Site, and at the Knipple Transfer Area camp.

4.14 CLOSURE AND RECLAMATION

Pretivm has prepared a conceptual closure and reclamation plan, as required under the *Mines Act* (1996b). The infrastructure sites will be closed and reclaimed including the Brucejack Mine Site Area, Bowser Aerodrome, Knipple Transfer Area, Brucejack Access Road, and Brucejack Transmission Line. Reclamation will be carried out in most areas.

This plan includes progressive reclamation to reduce overall reclamation obligations at Closure and to allow adaptations to the plan based on experience gained during the progressive reclamation activities. Available growth media will be salvaged and stockpiled during Construction to provide materials for re-establishing productive land use after the Project's closure.

During the Closure phase, machinery, equipment, reagents, fuel, lubricants, explosives, and structures at the are no longer required will be removed from the Brucejack Mine Site and sold, recycled, or disposed of in a licensed facility. Portals will be sealed for safety and water management purposes. Above-ground sections of pipelines will be removed. A ditch will be excavated upslope of the major cut slope to reduce the volume of surface runoff over exposed the PAG rock surface. The pads will be left in place and recontoured to cover concrete pads and foundations. Salvaged soils will be loosely spread and re-vegetated with a native grass seed mixture.

A similar approach will be taken for other Project components. The bridges and culverts will be removed along the Brucejack Access Road and the road surface will be ripped in preparation for reclamation. Stockpiled soils will be spread on the surface and the soils re-vegetated with native species. At the Knipple Transfer Area, the camp, transfer station, and other infrastructure will be removed and the disturbed areas reclaimed. At the Bowser Aerodrome, infrastructure will be removed and reclamation will be carried out. The Brucejack Transmission Line will be dismantled and the towers and conductors will be removed using helicopter support. The Tide Staging Area will be partially reclaimed once the transmission line is constructed. This area will be used again at the end of the Project as a staging area for transport out, of the towers and conductors.

Total closure cost is estimated at $9,053,579. Post-closure monitoring is estimated to cost about $154,000.

5. Assessment Process

5. Assessment Process

5.1 PROVINCIAL AND FEDERAL ENVIRONMENTAL ASSESSMENT REQUIREMENTS

Proposed mine projects that meet a certain annual or daily throughput threshold must undergo EAs in accordance with provincial and federal legislation. Provincial assessments for metal mines are triggered at a throughput of 75,000 tpa; federal assessments for gold mines at a throughput of 600 tpd. The Project exceeds both thresholds.

The Project is subject to a coordinated provincial-federal EA process conducted under the principles of the now-expired Canada–British Columbia Agreement for Environmental Assessment Cooperation (the Agreement; CEA Agency 2004). The Agreement aligns key aspects of the assessment process to minimize duplication and improve efficiency (e.g., conducting joint public comment periods, coordinating Aboriginal consultation, using common documents that meet the requirements of both governments, and establishing common working groups to facilitate the review process).

5.1.1 Provincial Environmental Assessment Process

The provincial EA process, under the BC EAA, has two stages: the pre-Application and Application review stages. Although Pretivm has been collecting environmental data and completing environmental studies since 2009, the pre-Application stage formally began in January 2013, with the submission of a Project Description by Pretivm to the BC EAO. On February 6, 2013, the BC EAO issued a Section 10 order indicating the Project was reviewable, and on July 4, 2013 issued a Section 11 order describing the scope, procedures, and methods for conducting the provincial EA process.

Pretivm then prepared a draft AIR for the Project, which outlined the information that must be included in the Application, including the methods to be used to conduct the effects assessment. The BC EAO held a public comment period on the draft AIR between November 13 to December 13, 2013, and also sought comments from the technical working group established by the BC EAO to participate in the EA process. Pretivm revised the AIR to incorporate the public and working group comments and the BC EAO issued the AIR on May 2, 2014.

The formal submission of the Application will trigger a 30-day screening period, during which the BC EAO (with feedback from the EA Working Group) will determine whether the submission meets the requirements outlined in the AIR. If the Application/EIS is determined to be sufficient, it will enter the Application review stage, comprising a 180-day review, which will involve the EA Working Group, Aboriginal groups, local government, and the public. These groups will have opportunities to provide comments on the Application; Pretivm is required to track and respond to all of the comments.

During the Application review stage, the BC EAO will prepare an Assessment Report that summarizes the results of the assessment. At the end of the Application review stage, the BC EAO will refer this report along with its recommendation and the draft EA certificate, which includes a Certified Project Description and conditions that must be met by Pretivm if a certificate is issued, to the Minister of the Environment and the Minister of Energy and Mines. The Ministers' decision is made within 45 days of a referral and is posted to the BC EAO's e-PIC website. Once issued, the EA Certificate is a legally binding document granting conditional approval for the Project to proceed.

5.1.2 Federal Environmental Assessment Process

The federal EA process began with the submission of a Project Description by Pretivm to the CEA Agency in January 2013 (Rescan 2013a). The Project Description was screened and accepted for a 45-day review period by the CEA Agency for the purposes of determining whether a federal EA was required for the Project. The CEA Agency held a public comment period between February 8 to 29, 2013 on the Project Description to seek comments on the Project and its potential effects on the environment.

On March 26, 2013, the CEA Agency issued the Notice of Commencement which stated that a federal EA is required. The issuance of the Notice of Commencement started the 365-calendar day, government time limit; the “clock” can only be stopped by the CEA Agency if it is deemed there is insufficient information available for the purpose of conducting the EA or preparing the report with respect to the EA of the designated project.

The CEA Agency issued draft EIS Guidelines for the Project on March 26, 2013, which was followed by a mandatory public comment period of 30 days, which ran from March 26 to April 25, 2013. The purpose of the EIS Guidelines is to identify the minimum information requirements for the preparation of an EIS in accordance with the CEAA 2012 and specifies the scope of the assessment and factors to be considered. Following the public review period, final EIS Guidelines for the Project were issued on May 24, 2013 (CEA Agency 2013). This EIS constitutes a submission in accordance with the federal EIS Guidelines for the project.

Once the EIS is submitted, the CEA Agency and federal working group members may coordinate with the BC EAO to screen the EIS for conformity against the EIS Guidelines; however, the screening step is not a legislated requirement. Technical review comments on the EIS from the federal Working Group will be provided to Pretivm for response.

Like the provincial process, the CEA Agency prepares an assessment report that summarizes the key findings, mitigation, and consultation issues related to the EA process for the Project. The EA Report is subject to a fourth and final public comment period prior to being submitted to the federal Minister of the Environment for their review and decision.

After taking into consideration the EIS, public comments, and the adequacy of consultation activities conducted with Aboriginal groups by the CEA Agency, the Minister of the Environment is required to issue an EA Decision Statement. Under Section 53(1) of the CEAA 2012, if the Minister finds that the Project is not likely to cause significant adverse effects, then, as required by Section 54(1), the Minister will issue an EA Decision Statement that describes the mitigation and follow-up conditions that the Proponent must comply with.

5.2 NISG̲A’A FINAL AGREEMENT

The contemporary Nisg̲a’a Nation is a constitutionally recognized government with protected rights and interests as defined by the NFA, which came into effect as of May 2000 under the *Constitution Act* (1982). The NFA grants Nisg̲a’a rights including right to self-government, law-making authority, and rights over land and resources in the Nass Area (NLG, Province of BC, and Government of Canada 1998). The NFA exhaustively sets out the Aboriginal rights and title of Nisg̲a’a (Chapter 2, Section 23); the full and final settlement in respect of the Aboriginal rights and title of Nisg̲a’a (Chapter 2, Section 22); and provides that Nisg̲a’a releases any other Aboriginal right different to those set out in the NFA to Canada (Chapter 2, Section 26).

Under the NFA, Nisg̲a’a owns approximately 1,992 km^2 of Nisg̲a’a Lands in fee simple, has wildlife harvesting rights in the Nass Wildlife Area (16,101 km^2), rights to harvest migratory birds in the Nass Area

(28,838 km^2), and rights to harvest fish and aquatic plants (NLG, Province of BC, and Government of Canada 2008).

The BC EAO Section 11 Order confirms that portions of the proposed Project lie within the Nass Area as identified in the NFA (Figures 27.1-1 and 27.1-2). BC and Canada, in undertaking the EA of the Project, are required to comply with Chapter 10 of the NFA. In compliance with Chapter 10 of the NFA, Pretivm has advanced an extensive engagement process with Nisga'a Lisims Government (NLG) who represents Nisga'a Nation.

5.3 INFORMATION DISTRIBUTION AND CONSULTATION

5.3.1 Aboriginal Information Distribution and Consultation

The BC EAO Section 11 Order requires Pretivm to consult with Skii km Lax Ha and Tahltan Nation. The CEA Agency also requires key EA documents be made available to the Métis Nation BC.

As required by the BC EAO Section 11 Order, Pretivm authored an Aboriginal Consultation Plan that outlines the approach to Aboriginal engagement during the pre-Application/pre-EIS phase, and a plan for consultation during the Application/EIS review stage. Skii km Lax Ha and Tahltan Nation had the opportunity to review and comment on the plan. Skii km Lax Ha provided comments and the plan was altered to address the comments.

Pretivm met with Skii km Lax Ha and Tahltan Nation in November 2011 to provide an overview of the Project. The BC EAO/CEA Agency established the Brucejack Gold Mine Project EA Working Group in May 2013 and invited Skii km Lax Ha and Tahltan Nation to be represented in the group.

Pretivm hosted five site tours for Aboriginal groups from 2012 to 2013. Skii km Lax Ha representatives participated on two tours; Tahltan Nation has been invited but has not yet toured the site. Pretivm held five open houses in communities in northwest BC in conjunction with the BC EAO during the public comment period for the draft AIR. Two of these communities are predominantly Tahltan (Iskut and Dease Lake); Hazelton is the closest Skii km Lax Ha community. In addition to providing public notice in advance of the open houses and public comment period, Pretivm also notified Skii km Lax Ha, Tahltan Nation, Métis Nation BC, and other Aboriginal groups in the vicinity of the Project about these activities.

Pretivm has collaborated extensively with Tsetsaut Ventures (a Skii km Lax Ha-owned company) to hire employees of Aboriginal descent for environmental field programs, as well as for work at the Project. Pretivm is in discussions with Tahltan Nation Development Corporation regarding road work. Pretivm will adopt policies or develop strategies that consider the needs of workers from Aboriginal and regional communities, with the intention of increasing the local employment and participation in the Project. To date, Pretivm has provided on-site training through Tsetsaut Ventures.

Pretivm has been tracking consultations with Aboriginal groups and the issues that have been raised during these consultations. The issues and Pretivm's responses are documented in the Application/EIS along with consultation summary tables. Pretivm has authored two Pre-Application Aboriginal Consultation Reports, which Skii km Lax Ha and Tahltan Nation have had the opportunity to review and comment on. Where comments were provided (by Skii km Lax Ha) the reports were modified accordingly.

Pretivm will continue to consult with Aboriginal groups during the Application/EIS review stage, according to the Aboriginal Consultation Plan, and will provide Aboriginal groups with copies of the Application/EIS and written responses to their comments, and will attend the EA Working Group meetings to address questions and present project information. Pretivm will notify Aboriginal groups and Métis about the public comment period on the Application/EIS. Comments from Aboriginal groups and Métis, Pretivm's responses to the comments, and consultations undertaken with Aboriginal groups and Métis on the Application/EIS, will be summarized in a forthcoming Aboriginal Consultation Report.

5.3.2 Nisga'a Nation Information Distribution and Consultation

The Section 11 Order requires Pretivm to consult with Nisga'a Nation, as represented by NLG. As noted above, Pretivm prepared an Aboriginal Consultation Plan which outlined the approach to consultation with NLG during the pre-Application/pre-EIS phase, and a plan for consultation during the Application/EIS review stage. NLG had the opportunity to review and comment on the plan and did not request any revisions.

Pretivm met with NLG in November 2011 to provide an overview of the Project. The BC EAO/CEA Agency established the Brucejack Gold Mine Project EA Working Group in May 2013, and invited NLG to participate. Nisga'a Nation had the opportunity to review and comment on the draft AIR. NLG provided comments and the AIR was revised to incorporate the comments.

In 2013, Pretivm hosted one Nisga'a site tour, and another that was open to all members of the EA Working Group. Nisga'a Nation representatives participated in the first tour. Pretivm held five open houses in communities in northwest BC in conjunction with the BC EAO during the public comment period for the draft AIR. One open house was held in Gitlaxt'aamiks (New Aiyansh).

To date, Pretivm has contracted road work to Nass Area Enterprises and has provided on-site training through Tsetsaut Ventures.

Pretivm has been tracking consultations with NLG and the issues that have been raised during these consultations. The issues and Pretivm's responses are documented in the Application/EIS along with consultation summary tables. Pretivm has authored two Pre-Application Aboriginal Consultation Reports, which NLG has had the opportunity to review and provide comments. NLG did not provide comments.

Pretivm will continue to consult with NLG during the Application/EIS review stage, according to the Aboriginal Consultation Plan, and will provide NLG with copies of the Application/EIS, provide written responses to NLG comments, and attend the EA Working Group meetings to address questions and present project information. Pretivm will notify NLG about the public comment period on the Application/EIS. Comments from NLG, Pretivm's responses to the comments, and consultations undertaken with NLG during the Application/EIS review stage, will be summarized in a forthcoming Aboriginal Consultation Report.

5.3.3 Government Agency Information Distribution

Pretivm has consulted with government agencies primarily through the EA Working Group, but has also met and corresponded regularly with provincial and federal regulatory agencies. Pretivm hosted four site visits for government agencies between 2012 and 2013. Comments from agencies and Pretivm's responses to the comments are summarized in the Application/EIS. Many provincial and federal agencies provided comments on the draft AIR, and the AIR was revised to address the comments.

Pretivm will continue to consult with government agencies during the Application/EIS review stage, including providing the EA Working Group with copies of the Application/EIS, providing written responses to agency comments, and attending EA Working Group meetings to address questions and present project information.

5.3.4 Public Information Distribution and Consultation

Pretivm has consulted with the public, including local governments, tenure holders, and stakeholders since 2011, in accordance with its Public Consultation Plan. Since 2011, public consultations have included a public comment period on the draft AIR (November to December 2013), open houses in five communities in northwest BC (Stewart, Hazelton, Gitlaxt'aamiks, Dease Lake, and Iskut in November 2013), meetings with local governments (2011 to 2012), and interviews with land users and tenure holders (2012 to 2013). Pretivm published public notices in local newspapers advertising the dates of open houses and the draft AIR comment period. Pretivm also notified local governments about the opportunities for public participation and provided posters to local government offices for posting in the communities where the open houses were being held. Communications with the public are documented and summarized in the Application/EIS, as are the issues raised by local governments, tenure holders, stakeholders, and the public, along with Pretivm's responses to these issues. Comments received during the public comment period on the draft AIR, as well as issues and questions raised during the open houses, are also included in the Application/EIS.

As a member of the EA Working Group, the RDKS was provided the opportunity to participate in a site tour, but was unable to attend. In order to increase public awareness about the Project, Pretivm participated in numerous conferences and panels since 2011. Since 2012, Pretivm has made numerous donations to communities in the region.

Pretivm will continue to consult with the public during the Application/EIS review stage, as outlined in the Public Consultation Plan. The Application/EIS will be available on the BC EAO's website, and Pretivm will advertise future open houses and the public comment period for the review of the Application/EIS.

6. Assessment Methodology

ERM

6. Assessment Methodology

Chapter 6, Assessment Methodology, describes the methodological approach adopted for the Project, in accordance with the AIR (BC EAO 2014) and EIS Guidelines (CEA Agency 2013).

The assessment process included analysis of baseline studies, stakeholder feedback (including that of Aboriginal groups), and the re-evaluation of Project designs (including evaluation of alternatives and improved mitigation measures). These iterations all contributed to the refinement of EA scoping, and allowed for the avoidance of certain effects and the design of mitigation measures to reduce the scale of unavoidable residual effects.

The baseline against which the EA was carried out is described, according to criteria related to regional and historical overviews that deal respectively with current environmental conditions and historical and current projects. The findings of site-specific baseline studies are presented for each subject area, the details of which are provided in appendices to this Application/EIS.

Issues scoping is fundamental to focusing the Application/EIS on those issues where there is the greatest potential to cause significant adverse effects, and to focus the assessment on those aspects of the environment that are of greatest importance to society. Each assessment chapter of the Application/EIS includes a description of the issues scoping process used to identify potential effects, as well as the process used to select assessment boundaries and to determine the potential interaction or cause-effect pathways between Project activities and environmental, social, economic, health, and heritage components. Components were scoped in consultation with key stakeholders, including Aboriginal communities and the EA Working Group, or they may also have been scoped as a legislated requirement.

During the development of the AIR, a scoping exercise was conducted with technical experts to explore potential Project interactions with candidate components, and to identify the key potential adverse effects associated with that interaction. The scoping document was circulated for review and approval by the EA Working Group; feedback from that process has been integrated into the Application/EIS.

The primary output from the scoping exercises was an impact scoping matrix that consists of a list of candidate components that could be affected by Project components and/or physical activities. A secondary outcome of the scoping workshops was the identification of a number of “intermediate” and “receptor” components. Intermediate components are specific attributes of the biophysical environment that, if affected, act as a pathway to pass on those changes to receptor components. Where a receptor component is perceived as important by the public, scientists, government agencies, Aboriginal groups, or other stakeholders, these are referred to as receptor VCs.

Intermediate components were the subject to predictive studies, the results from which are considered in the effects assessment for relevant receptor VCs (e.g., changes in air quality and noise and any applicable ambient objectives were be used to support the effects assessment for human health and wildlife receptor VCs). The determination of significance of residual effects was conducted only on receptor VCs.

Assessment boundaries define the maximum limit within which the EA is conducted. They encompass the areas within, and times during, which the Project is expected to interact with the identified components, whether intermediate or receptor VCs.

As far as the effects assessment and mitigation are concerned, each assessment chapter provides a detailed discussion of the key potential effects arising from the Project components and activities, as well as discussion and evaluation of mitigation measures that may be taken to reduce the potential for significant adverse effects. Formulating mitigation measures to avoid, minimize, restore or offset adverse effects to receptor VCs allows for specified EMPs to be compiled. Where proposed mitigation measures are not sufficient to eliminate an effect, a residual effect is identified. Predicted residual effects are therefore the potential consequences of the Project on the receptor VCs and each assessment chapter of the Application/EIS describes direct, indirect, and induced residual effects of the Project as applicable.

To characterize the residual effects, and understand their likelihood, significance, and level of confidence in their assessment, a standard set of criteria (magnitude, extent, duration, frequency, reversibility, resiliency, and context) are used to support a determination of significance. An assessment of probability of the residual effect occurring is also made but is not considered when evaluating the significance of an effect. Confidence in the outcomes or conclusions of the effects assessment is also evaluated. The assessment of residual effects and their significance are summarized for each subject area using a standard tabular format.

The potential for cumulative effects arises when the residual effects of a project overlap or interact with the same resource or receptor that is affected by the residual effects of other historical, existing, or reasonably foreseeable future projects or activities. The cumulative effects assessment (CEA) considers the potential environmental, economic, health, social, and heritage cumulative effects of the Project according to the requirements of the EAO and CEA Agency (as described in the AIR and EIS Guidelines), through well-understood cause-effect pathways. Past, present, and future projects and activities that may affect the Project are described in detail, and such scoping then allows for assessment, mitigation formulation, and characterization of residual cumulative effects to be undertaken.

Cumulative residual effects are those adverse effects remaining after the implementation of all mitigation measures, and are therefore the expected consequences of the Project on the selected VCs. Each assessment chapter of the Application/EIS describes direct, indirect, and induced cumulative residual effects of the Project as applicable. Of importance are the cumulative residual effects that are characterized as significant, since these are vital informants in the decision-making on the part of the EAO and CEA Agency.

7. Predictive Studies

7. Predictive Studies

7.1 AIR QUALITY

Air quality is an important environmental factor in ensuring the conservation of local vegetation, wildlife, and human health. The Project activities will result in air emissions to the ambient environment. The change in ambient air quality needs to be assessed to ensure conservation of the environment and compliance with federal and British Columbia regulations.

Meteorology and air quality data have been collected since 2009 and 2012 respectively, to establish understanding of the baseline levels. Data collected by projects in the area were also considered. Air quality was identified as an intermediate component as a result of the scoping process, with change of the following criteria air contaminants (CACs) identified as air quality indicators:

- NO_2;
- SO_2;
- CO;
- TSP;
- PM_{10};
- $PM_{2.5}$;
- dustfall; and
- acid deposition.

The change in ambient air quality can potentially affect the following intermediate components and receptor VCs: surface water hydrology, terrain and soils, surface water quality, wetlands, wildlife, and health.

Emissions associated with each component and activities have been determined and an emission inventory was compiled for both the Construction and Operation phases. The emission rates from the emission inventory were used in the CALPUFF dispersion modelling to predict an increase in concentration of CACs. CALPUFF is a multi-layer, multi-species, non-steady-state puff dispersion model that is capable of simulating the effect of time- and space- varying meteorological conditions on pollutant transport, transformation, and removal. In order to perform dispersion modelling using CALPUFF, meteorological data were processed by CALMET. CALMET data were created using on-site observation data from three meteorological stations (Brucejack Lake, Scott Creek, and Wildfire Creek). MM5 prognostic data were also provided to characterize upper air conditions. The three meteorological stations are permanent 10-m towers. The observational data from the stations and MM5 prognostic data were used to create a CALMET output file with a resolution of 0.5 km.

For the Construction phase, all indicators were below the relevant criteria, except PM_{10} and dust deposition; however, the exceedances for PM_{10} is limited to an area immediately south of the Knipple Transfer Area, since exceedances occur only less than 2% of the time in a year. The maximum 30-day dust deposition rate is higher than the BC objective of 2.9 $mg/dm^2/day$ but the exceedances were limited to less than 100 m on either side of the access road.

7.2 NOISE

Noise, generally defined as undesirable sound, is characterized in terms of the pressure of the sound wave. It has intrinsic importance to employee, local residents, and fauna as noise can directly affect the health of humans and wildlife. Noise may also result in psychological and physiological effects in humans, as well as avoidance behaviour in wildlife populations that cause them to not access important habitats.

The Project region is a relatively remote and undisturbed area. The regional noise environment is characterized by natural noise sources, such as wildlife and wind, with small areas of increased noise levels close to anthropogenic sources, such as roads and mine explorations.

Noise has been selected as an intermediate component through the scoping process due to the potential impacts on humans (workers and users of the area) and wildlife. Sources of emission were identified and included in the noise model. The noise modelling was used to predict noise levels from continuous noise sources during the Construction and Operation phases, and to predict sound exposure level and peal sound levels from single events. The main sources of continuous noise are the operating equipment, which increased noise level from baseline approximately 5 km from the sources. Event noise (e.g., blasting and helicopter noise) led to greater increases, but these noise levels were not continuous.

The noise levels predicted for the Construction and Operation phases were compared to various impact criteria for human receptors and wildlife receptors. These results, presented using different matrices, were further discussed in Chapter 18 (wildlife) and Chapter 21 (health) assessments.

7.3 HYDROGEOLOGY

Groundwater is valued as a source of water for human consumption and for its intrinsic links with surface water. Changes to groundwater fluxes can affect water levels and flows in surface water bodies, thereby influencing aquatic ecosystems, vegetation and wildlife. Groundwater is also a potable water resource when water quality is adequate. Changes to groundwater fluxes may occur during the Construction, Operation, Closure, and Post-closure phases.

Groundwater/hydrogeology was identified as an intermediate component as a result of the scoping process, with the following identified as groundwater indicators:

- Groundwater quantity: changes to groundwater flow volume and movement assessed on the basis of increases or decreases in hydraulic heads as a result of the project; and
- Groundwater quality: changes to concentrations of total and dissolved metals, nutrients, turbidity, total suspended solids, and groundwater temperature.

Changes in the amount of groundwater discharged to Brucejack Lake and Creek (i.e., changes in groundwater baseflow) during the project may contribute to changes in surface water quantity and quality and therefore may contribute to effects on the downstream aquatic receiving environment, wildlife, vegetation and human health.

Hydrogeological data specific to the Brucejack Project site have been collected since 2010, and a hydrogeology baseline program was initiated in 2011 to characterize groundwater quantity and quality at the site. A three-dimensional numerical groundwater flow model was developed and calibrated to steady-state and transient baseline conditions. The model was then used to simulate the effects of the underground mining method on groundwater flow patterns. Predictive water quality modeling was completed to evaluate potential changes in groundwater quality as a result of the project. Predicted changes to groundwater quality and quantity include:

- **Groundwater Flow Direction and Water Table Elevation:** During Operations, groundwater flow within the LSA becomes largely directed towards the dewatered mine workings. The elevation of the water table is drawn down substantially, up to approximately 400 m, within the footprint of the underground workings. The cone of depression associated with 10 m or more of drawdown due to mine dewatering has an approximate areal extent of 2 km by 3 km.
- **Groundwater Discharge to Surface Water Bodies:** In general, the surface water features closest to the proposed underground mine are expected to be most impacted by mine dewatering (i.e., Camp, VOK, and Brucejack Creeks). The average groundwater discharge to Brucejack Creek (at hydrometric station BJL-H1) is predicted to decrease by approximately 20% during Operations; baseflow is simulated to recover fully in the Post-Closure phase.
- **Groundwater Quality – Underground Mine:** No effects to groundwater quality are predicted during the Construction and Operations phases, as groundwater flow is directed towards the underground workings, where seepage water will be collected by the mine dewatering system and treated prior to discharge. In the Closure and Post-closure phases, residual groundwater quality effects (e.g., enrichment of select parameters above background concentrations) may occur along flow paths towards Brucejack Lake and Brucejack Creek, as well as long (decadal-scale) flow paths towards the Sulphurets drainage.
- **Groundwater Quality – Plant Site and Quarry**: No change to groundwater quality due to infiltration of quarry water is expected during Construction and Operations. In the Closure and Post-Closure Periods, total Se may occur at concentrations exceeding background conditions and guidelines in the quarry runoff. During Construction and Operations no groundwater is predicted to discharge to the plant site, though in the Closure and Post-closure phases the quality of groundwater discharging to the plant site may warrant monitoring for parameters including total Al, As, Zn, and dissolved Al.

7.4 SURFACE WATER HYDROLOGY

Surface water hydrology is a key component of the physical and biological environment, and is linked to ecosystem components. The Project could affect surface water hydrology by altering streamflows, channel morphology, and glaciers. Such effects may occur during the Construction, Operation, Closure, and Post-closure phases. Alteration of surface water hydrology could potentially affect receptor VCs that have linkages with surface water hydrology. These receptor VCs include surface water quality, aquatic resources, fish and fish habitat, terrestrial ecology, wetlands, navigation, commercial and non-commercial land use, and current use of lands and resources for traditional purposes.

The 2009 to 2012 hydrometric program was initiated to characterize the spatial and temporal variation in flows in the baseline study area. Automated hydrometric stations recorded water levels during open water periods to monitor surface water flows in order to characterize the hydrological variation in these waterbodies. Manual flow measurements throughout the year were used to validate and augment the automated record of data.

The assessment of changes in the condition of the surface water hydrology is evaluated using three sub-components for surface water hydrology (i.e., streamflows, channel morphology, and glaciers). Key potential effects on these subcomponents are:

- Brucejack Mine Site water management components and activities could affect streamflows in Brucejack Creek, and in its downstream watersheds (i.e., Sulphurets Creek and Unuk River watersheds). Streamflow indicators including annual runoff, monthly distribution of runoff, peak flows, and low flows could be altered;

- Brucejack Access Road, Brucejack Transmission Line, Bowser Aerodrome, and Knipple Transfer Area have the potential to alter channel morphology in Wildfire Creek, Todedada Creek, Scott Creek, and Bowser River watersheds; and
- Brucejack Access Road could affect Knipple Glacier ablation by increasing dustfall values, and by depositing debris on the glacier surface.

A water balance model was developed to estimate effects of the Project on streamflows. Further, a preliminary study was performed to assess the potential effects of the Project on channel morphology. Likewise, an initial approximation of the impacts of the access road on glaciohydrology was quantified. Predicted adverse effects of the Project on surface water hydrology indicators include:

- *Streamflows:* Brucejack Mine Site activities are expected to decrease the low flows in Brucejack Creek (at hydrometric station BJL-H1) by up to 24% during the Closure phase. These changes are spatially confined to the LSA boundary, and temporally limited to the Closure phase (i.e., two years). Low flows are not expected to decrease compared to baseline flows during other phases of the project.
- *Channel Morphology:* Culverts in the Wildfire Creek watershed are expected to affect the morphology of their down-drainage slopes by increasing gully formation and potentially downslope mass movements. Based on a preliminary assessment, channel morphology in the vicinity of one bridge within the Wildfire Creek watershed (i.e., the Wildfire Creek Bridge) and at four low-gradient unconfined bridges in the Bowser River watershed (i.e., Bridges #18 to 21) are less stable than channel morphology at other access road bridges. Channel morphology could be sensitive to maintenance and decommissioning activities at these bridges.

7.5 TERRAIN AND SOILS

The potential effects of the Project on soil quality and quantity and terrain stability were identified and evaluated within the LSA by the predictive study. To assess the effects, the Project was grouped into three sub-areas: the mine site sub-area, the access road sub-area (which includes the Bowser Aerodrome, Knipple Transfer Station, and access road), and the transmission line sub-area (which includes the transmission line and tide staging area). To assess loss and changes to soil productivity, soils were grouped into three classes of ecologically functional soils: poor, medium, and good.

The effects of the Project development on soil quantity are described in this assessment as areas lost, and the effects of the Project on soil quality are defined as areas altered or degraded. Examples of activities that result in soil loss include soil removal or burial during clearing for infrastructure, development of overburden or rock storage, and road construction. These construction activities eliminate or severely limit the ability of soils to support vegetation and provide other ecological functions. Soil alteration can occur when Project activities change soil characteristics or properties but have either neutral or beneficial effects on soil productivity. Degradation may occur in the form of soil compaction, contamination, erosion, and hydrological or other changes that decrease soil productivity.

Anticipated loss of soil associated with the development of the Mine Site Sub-area may occur to 63.9 ha of ecologically functional soil, although most of this is rated poor. Construction associated with the access road sub-area may result in the loss of 35.2 ha of ecologically functional soil. The loss of soil associated with the Transmission Line Sub-area is 4.7 ha. As indicated in the Soil Management Plan (Section 29.13), some of this material will be salvaged during Construction and used in reclamation during mine closure. Since the success of reclamation depends on many factors and biotic conditions in the LSA are generally harsh, a conservative approach is to not account for reclamation in this assessment and present the worst-case scenario.

It is estimated that 187.3 ha of ecologically functional soil (rated as poor) will potentially be degraded by Project activities at the mine site sub-area. Degradation of soil quality is associated with erosion, compaction, stripping and stockpiling operations, alteration of soil drainage patterns, and dust deposition with high metal contents. The extent of affected land and the severity of these adverse effects are generally expected to be the highest during the Construction and Closure phases.

Soil alteration may occur on 715.5 ha in the access road sub-area, and 11.5 ha may be altered in the transmission line sub-area. Alteration in these areas is predicted due to dust deposition adjacent to infrastructure, especially due to road use. Soil alteration may include increases in productivity because of dust deposition or reductions in soil density (due to tilling or soil remediation works).

Due to geotechnical engineering design, mitigation, and monitoring, it is not expected that the Project will result in residual effects for terrain stability.

Project-related changes to terrain and soils are expected to provide pathways to effects on six receptor VCs, including terrestrial ecosystems, wildlife, human health, wetlands, surface water quality, and fish.

8. Assessment of Potential Effects, Mitigation, and Significance of Residual Effects

ERM

8. Assessment of Potential Effects, Mitigation, and Significance of Residual Effects

8.1 ASSESSMENT OF POTENTIAL CLIMATE EFFECTS

8.1.1 Settings

Anthropogenic climate change, driven by greenhouse gas (GHG) emissions, is a global issue that has implications for both human and natural systems and could lead to significant effects on resource use, production, and economic activity over the life of the Project.

Since the lifetime of carbon dioxide (CO_2) in the atmosphere is 50 to 200 years and GHGs collect and fully mix in the global atmospheric pool, GHG emissions are cumulative in nature; new GHG emissions add to historical emissions to contribute to the greenhouse effect and climate change. Reported global CO_2 emissions in 2010 totalled 31,350 Mt. The national 2011 inventoried carbon dioxide equivalent (CO_2e) emissions totalled 702 Mt, with BC contributing 59 Mt. In the same year, the national mining sector accounted for 36 Mt CO_2e, and BC mining emissions contributed 1.7 Mt CO_2e. For individual non-energy mining facilities in BC required to report their emissions, annual CO_2e emissions ranged from 14 to 300 kt.

8.1.2 Assessment

The climate effects assessment process involved a scoping process that identified climate as a receptor VC, with GHG emissions as the indicator. A spatial boundary was defined by Project GHG sources for facility and land-use change emissions and a temporal boundary was defined as 200 years after Post-closure. The assessment quantified Scope 1 to 3 GHG emissions (direct, imported electricity use, and third-party emissions) for each Project phase, along with GHG mitigation measures and the residual effects of climate. A CEA was not required due to the negligible value of Project emissions, compared with aggregate world emissions.

The Project will emit GHG emissions throughout the Project's lifetime, from fuel and energy consumption, and land-use change. GHG emissions will primarily occur during the Construction and Operation phases and will be negligible during the Closure and Post-closure phases.

The Project is estimated to emit an annual average of about 62 kt CO_2e/year during the Construction phase and about 36 kt CO_2e/year during the Operation phase at the facility-level (Scopes 1 to 3). Land-use change is estimated to result in zero net GHG emissions after mitigation is applied. The estimated facility-level residual GHG emissions are considered to be negligible when compared with international, national, and provincial anthropogenic GHG emission levels, and are considered to be low when compared with industry norms for metal mining. Therefore, the residual effect on climate of increasing atmospheric GHG levels is rated as not significant for the Construction and Operation phases.

The Proponent will continue to monitor and mitigate the Project GHG footprint over the Project life, such as by implementing fuel and energy efficiency improvements, re-vegetation during the Closure phase, and other measures as outlined in the Air Quality Management Plan provided in Section 29.2.

8.2 ASSESSMENT OF POTENTIAL SURFACE WATER QUALITY EFFECTS

8.2.1 Settings

Water quality is a critical component of the biological and physical environment and is protected under both provincial and federal legislation. Water quality constitutes the physical, chemical, biological, and aesthetic characteristics of water, which are determined by a variety of regional and local factors.

A surface water quality baseline was conducted for water courses within four general areas: Brucejack watershed, Sulphurets/Unuk watershed, Bowser River watershed, and Wildfire Creek/Scott/Todedada watersheds. The baseline program allowed for the prediction, assessment, and identification of mitigation and management of potential Project-related effects, and was incorporated into mine and mine waste management planning. The baseline study area reflects proposed and existing Project infrastructure and considered watersheds over a range of spatial scales from local (i.e., immediately downstream of Brucejack Lake) to regional (i.e., Unuk River at the international border). Physical limnology and surface water quality data were collected from 11 lake/wetland sampling sites and 42 stream sampling sites over 2008 to 2013 in the baseline study area. Historical water quality data (1987 to 2001) was also incorporated to define background conditions of the Brucejack watershed (Newhawk 1989; Price 2005), which is an advanced exploration site with a long history of mineral exploration.

The hydrological regime is an especially important determinant of surface water quality in the baseline study area, affecting water quality at study area sites in two ways:

1. Increased discharge during freshet, glacial melt, and heavy rainfall events dilutes concentrations of major ions and total dissolved solids.
2. Increased sediment load and transport during high-flow periods leads to increased concentrations of TSS and particle-associated metals.

Study area streams typically experience a low-flow period between November and May, and higher flows between June and October associated with freshet, summer glacial melt, and fall heavy-rain events. In its baseline condition, water courses within the Brucejack watershed are soft and nutrient-poor with moderate acid sensitivity and very low TSS, turbidity, and total organic carbon; total metal concentrations generally increase along the flow path of Brucejack Creek from the lake outlet to Sulphurets Glacier. Watercourses in off-site areas are predominantly glacial and have elevated alkalinity and total metals concentrations and low concentrations of total organic carbon and nitrate. Todedada Lake is the least acid-sensitive of the lakes that were sampled, and has moderately hard, conductive water with elevated TSS and turbidity.

8.2.2 Assessment

For the effects assessment for the Project, surface water quality was selected as a receptor VC. Alteration of surface water quality could potentially affect other receptor VCs that have linkages with surface water quality, including aquatic resources, fish and fish habitat, wildlife, and human health.

Changes in surface water quality caused by Project activities have the potential to occur through various pathways during the life of the Project, many of which overlap in terms of definition and scope. Six potential pathways to effects on surface water quality were assessed: discharges, ML/ARD, erosion and sedimentation, leaching of nitrogen residues generated from blasting, groundwater and surface water interactions and seepage, and atmospheric deposition.

The potential and likelihood for residual effects varies with Project area (i.e., the mine site area versus off-site Project infrastructure areas). Therefore, on-site Project components and physical activities during different phases of the Project, and off-site areas are discussed separately.

The surface water quality effects assessment was governed by two key assumptions:

- The assessment and determination of any potential residual and cumulative effects assumed that all guidelines, mitigation and management plans, best management practices, regulations, and operating standards designed to reduce effects on surface water quality and aquatic resources will be strictly adhered to.
- The assessment and determination of discharge-related potential effects on downstream receiving environments relies upon the accuracy of water quality modelling data results.

8.2.2.1 Brucejack Mine Site Area and Receiving Environment

Predictive water quality models were used to estimate Brucejack Lake outflow and downstream receiving environment water quality during the Construction, Operation, Closure, and Post-closure phases. Semi-quantitative and best-judgment assessment approaches were used for the mid- and far-field receiving environment, i.e., areas downstream of boundaries of the model domain (Sulphurets and Unuk watersheds).

Arsenic was identified as a contaminant of potential concern (COPC) during the Construction, Operation, Closure, and Post-closure phases (HQ range: 1.1 to 1.6). Loadings of arsenic are associated with subaqueous waste rock deposition upstream at Brucejack Lake as well as contact water from the underground mine. Arsenic concentrations will decline during the final years of the Operation phase as well as within the Closure and Post-closure phases; predicted concentrations range from below guidelines, to slightly above guidelines at site BJ 200 D/S, which is on Brucejack Creek, about 400 m downstream of the Brucejack Lake outlet.

In water quality model sensitivity analyses, two additional COPCs were identified as per the upper case: chromium and zinc. These COPCs are restricted to this single case and the effect is as water quality improves over time. No exceedances are predicted beyond Operation (chromium) or beyond Closure (zinc).

Effects on surface water quality are predicted to be restricted to the Brucejack watershed, and are not expected to affect surface water quality of mid- and far-field receiving environments. The potential for transboundary effects on surface water quality on the lower Unuk River in Alaska is considered extremely low.

Based on the environmental effects assessment, the residual effect for the Brucejack Mine Site is assessed as not significant.

Cumulative effects are not expected with any past, present, or reasonably foreseeable projects or activities.

The water quality monitoring program discussed in the Aquatic Effects Monitoring Plan in Section 29.3 will verify accuracy of the predictions of the Application/EIS, ensure detection of measureable alterations in surface water quality, allow for identification of potential causes, and include the provision of additional mitigation or adaptive management strategies.

8.2.2.2 Off-site Areas (Ancillary Project Infrastructure)

Residual effects are assessed qualitatively using best judgement approaches because of the short duration and limited scope and duration of Project activities in off-site areas.

The off-site areas generally pose minimal risk of effects to surface water quality, due to the limited extent of Project activities in these areas. It is likely, however, that some change in surface water quality of receiving watercourses in off-site areas will occur at some point during the life of the Project, given this high-runoff environment and associated potentials for ML/ARD and sedimentation/erosion effects to receiving waters, as well as low background nitrogen concentrations. Water quality responses to run-off include increased concentrations of TSS, metals, and salinity, but tend to be temporary and localized (Forman 1998). Further, watercourses in off-site areas are of generally high flow and the receiving environment would provide a correspondingly high dilution capacity. Thus it is expected that incremental changes to water quality resulting in guideline exceedances are unlikely to occur.

Considering these potential effects on surface water quality, the limited extent and duration of Project activities in the LSA, and mitigation to minimize effects, the overall Project-related residual effect on surface water associated with off-site Project infrastructure is assessed as not significant.

8.3 ASSESSMENT OF POTENTIAL AQUATIC RESOURCES

8.3.1 Settings

Aquatic resources in the Project area are characterized by communities of primary and secondary producers typical of low productivity, glacial-influenced alpine freshwater ecosystems. In the mine site area, the glacial-dominated, high-altitude environment influences the low abundance of aquatic organisms, and high concentrations of metals in the sediments from proximity to mineralized surficial geology. The characteristics of the high-alpine environment are also present in the off-site infrastructure areas; the abundance and diversity of primary and secondary producers are generally low in the Bowser watershed. Productivity and diversity was greater in the more forest-influenced Wildfire Creek and Todedada Lake.

8.3.2 Assessment

Aquatic resources are defined as all aquatic organisms aside from fish and wildlife. The effects of the Project on these resources are predicted to be not significant. The effects assessment on aquatic resources combines the predictive modelling for the air quality, surface hydrology, and surface water quality with qualitative analysis to determine the magnitude, extent, and significance of Project effects. The majority of potential effects will be restricted to the mine site area in the Brucejack watershed. The aquatic resources effects assessment draws on the analysis of the site water balance and water quality modelling to identify:

- erosion and sedimentation, as a result of ground disturbance and runoff;
- changes in surface water quantity, surface water quality, and sediment quality, as a result of the operation of the sewage treatment plant, site water management including operation of the water treatment plant, and the deposition of waste rock and tailings into Brucejack Lake; and
- habitat loss from the deposition of waste rock and tailings in Brucejack Lake.

These effects will be mitigated by best management practices, engineered controls, and other management measures. Details of many of these mitigation and management measures relevant to aquatic resources are described in the relevant EMPs provided in Chapter 29.

The Aquatic Effects Monitoring Plan (Section 29.3) will be used to test the predictions of the effects assessment, identify any un-anticipated effects, and provide information for the adaptive management of the Project activities. As a result of these mitigation and management measures, all of the Project-related effects on aquatic resources are predicted to be short term, modest, and restricted to the vicinity of Project activities. All effects from the Project are identified as not significant. Furthermore, no cumulative effects are identified because of the local spatial extent of potential Project effects.

8.4 ASSESSMENT OF POTENTIAL FISH AND FISH HABITAT EFFECTS

8.4.1 Settings

The proposed Brucejack Mine Site is located in the upper reaches of the Sulphurets Creek watershed, which is a tributary of the Unuk River. The Brucejack Access Road travels through the upper Bowser River and Wildfire Creek watersheds, both of which are tributaries of the Bell-Irving River, which flows into the Nass River. The planned transmission line will follow the upper Bowser River south, and cross over into the Salmon River watershed, which flows into the Pacific Ocean at Hyder, Alaska.

Baseline fish and fish habitat studies were conducted in 2010, 2011, and 2012 within the fish and fish habitat study area. Many rivers in the fish and fish habitat study area are glacial and feature high turbidity, low temperatures, and low aquatic productivity.

Water bodies in the immediate vicinity of the Brucejack Mine Site, including Brucejack Lake and Brucejack Creek, contain no fish; the 200-m-long cascade located in Sulphurets Creek, approximately 1,300 m upstream of the confluence with the Unuk River, restricts fish from accessing on-site waterbodies. Baseline activities upstream of the cascades included over 9,700 electrofishing seconds of sampling, 45 hours of gillnetting, and 1,445 hours of minnow trapping effort; no fish were captured. Furthermore, gillnetting and minnow trapping efforts in Brucejack Lake have not resulted in the capture of any fish, and the lake is confirmed as non-fish-bearing (Newhawk 1989; Price 2005). The first 1,300 m of Sulphurets Creek upstream from the confluence with the Unuk River is primarily a long, low-gradient riffle with trace amounts of instream cover and marginal fish habitat. Dolly Varden (*Salvelinus malma*) are present in Sulphurets Creek below the cascade, but no fish species are present above the cascade. No salmon species are present within Sulphurets Creek.

A linear survey was conducted parallel to the headwater reaches of the Bowser River, which assessed stream crossings along the proposed Brucejack Transmission Line route. Only one crossing was found to be fish-bearing: the crossing of the Bowser River.

Several fish species are known to occur in the fish and fish habitat study area, outside of the Brucejack Mine Site. These include Bull Trout (*S. confluentus*), Dolly Varden, Rainbow Trout (*Oncorhynchus mykiss*), Coastal Cutthroat Trout (*O. clarkii*), Mountain Whitefish (*Prosopium williamsoni*), and the Pacific Salmon species: Chinook Salmon (*O. tshawytscha*), Coho Salmon (*O. kisutch*), and Sockeye Salmon (*O. nerka*). Of these, Coastal Cutthroat Trout and Bull Trout are blue-listed (provincially rare species) in BC (BC MOE 2009).

8.4.2 Assessment

Fish and fish habitat VCs were assessed for a number of potential Project-related residual effects. The assessment concluded that Project activities will cause residual effects to fish and fish habitat for direct mortality, erosion and sedimentation, change in water quality, and habitat loss and alteration. However, these effects were assessed to be not significant.

Effects on fish and fish habitat as a result of a change in water quality (discharge from the mine site) was determined to be not significant. There is negligible potential that Brucejack Lake discharge will lead to an increase in fish tissue metal concentrations downstream in Lower Sulphurets Creek (below the cascades) or in the Unuk River. An Aquatic Effects Monitoring Program will be established to confirm assessment predictions on fish, monitor fish health, and ensure that water quality treatment mitigation measures perform as expected.

All potential residual effects to fish and fish habitat will be mitigated through the implementation of management plans (e.g., Soils Management Plan, Spill Prevention and Response Plan) and adherence to standards and best practices (e.g., Fisheries and Oceans Canada's operational statements, construction operating window for instream work, site isolation, riparian re-vegetation, controlled access, water quality maintenance, spill kits, and equipment maintenance). The Project will not result in fish habitat loss; therefore, a fisheries offsetting plan is not required.

8.5 ASSESSMENT OF POTENTIAL TERRESTRIAL ECOLOGY EFFECTS

8.5.1 Settings

Terrestrial ecosystem baseline studies to support this EA were undertaken in 2012 and completed in 2013. The goal of this baseline program was to characterize ecosystems, vegetation, terrain, and soils that could potentially be affected directly or indirectly by the Project, including those within the vicinity of the proposed Brucejack Mine Site, the Brucejack Transmission Line, and the Brucejack Access Road. Predictive Ecosystem Mapping and Terrestrial Ecosystem Mapping were used to characterize ecosystems within the relevant RSA and LSA, respectively.

The proposed Brucejack Mine Site is situated above the treeline; the area features alpine ecosystems as well as an abundance of sparsely vegetated terrain. Ecosystems within the Mine Site sub-area are influenced by the recent deposition of the soil parent material, heavy snow pack, wind, and cold temperatures. As a result, the ecosystems present are largely within the Alpine Group, including Alpine Fellfield, Heath, and Meadow classes.

The Brucejack Access Road travels through old valley bottom forests dominated by subalpine fir and Engelmann spruce, and along dry glaciofluvial terraces supporting early seral pioneer ecosystems. Close to Highway 37, the Brucejack Access Road bisects forests greater than 400 years old. The soils are brunisols and podzols derived from glacial till blankets and veneers. As the road travels over the height of land, skirting Todedada Wetland along upper Scott Creek, it crosses the ESSFun and ESSFunp subzones. These BEC units are very wet and very cold conditions with snowpacks lasting to early summer

The Brucejack Transmission Line is situated in mature forest and recently deglaciated terrain, dominated by scoured rock, eroding moraine, and glaciofluvial deposits. In the lower elevations of the valley, along the Salmon River, the terrain is predominately composed of floodplain built up with coarse gravels and sands. Soils show little pedogenesis, typical of areas recently deglaciated. They include some Dystric Brunisols, but most are of the Regosol soil order. Terrain north of the Salmon Glacier, along the Bowser River, is dominated by recently deposited glacial sediments. These sediments include glacial till veneers in upslope areas, medium and coarse textured morainal landforms, and glaciofluvial sediments. These glacial sediments are modified by post-glacial processes, such as mass wasting and surface erosion. Colluvium is common, with related landforms being talus slopes, colluvial fans, and boulder fields.

Within the RSA and LSA, five sensitive ecosystems types considered locally threatened, fragile, or inherently sensitive to disturbance defined were identified through mapping or field surveys. Of those identified, there are 12 BC Conservation Data Centre-listed ecosystems, 12 riparian and floodplain ecosystems, 6 alpine ecosystems, and 10 parkland ecosystems.

Within the LSA, culturally/economically important plants include, but are not limited to, blueberry (*Vaccinium* spp.*)*, soapberry (*Shepherdia canadensis*), thimbleberry (*Rubus parviflorus*), raspberry (*Rubus ideaus*), salmonberry (*Rubus spectabilis*), devil's club (*Oploplanax horridus*), and pine mushroom (*Tricholoma magnivelare*).

Seventy-six rare plant or lichen species were identified within the LSA, consisting of 19 vascular plant, 42 lichen, and 15 moss species. Some of these species are of high global priority, due to their worldwide rarity, habitat limitations, small populations, vulnerability to extirpation, or other considerations. Of these, 59 species listed by the BC Conservation Data Centre were identified in the LSA, including 34 macrolichens, 13 vascular plants, and 12 mosses. Of the 17 species considered rare but previously undocumented in BC, new to science, or ranked as Status Unknown (i.e., uncertain by the BC Conservation Data Centre), six are vascular plants, eight are lichens, and three are mosses. None of the rare species found are currently listed under the *Species at Risk Act* (2002c) or by the Committee on the Status of Endangered Wildlife in Canada. In total, 231 tracked species occurrences (element occurrences) were recorded.

Most rare plants were found in open, non-forested areas associated with special habitat features such as cliffs, rock outcrops, or ecotonal areas between forested and non-forested habitat. Some non-forested habitats were found to have overall high species richness and numerous rare plants and lichens.

Two invasive plants—common tansy (*Tanacetum vulgare*) and oxeye daisy (*Leucanthemum vulgare*)—were identified along the east side of Highway 37. These species are classified as noxious under the *Weed Control Act* (1996c), and "extremely invasive to very invasive" by the Northwest Invasive Plant Council (2012).

As part of the baseline studies, soil, lichens, berries, and plant tissue samples were collected to establish baseline metal concentrations. Fifty soil, 22 lichen, and 31 berry samples were obtained from across the LSA. These samples were analyzed for a suite of metals to establish baseline metal concentrations and to guide end land use planning.

8.5.2 Assessment

Terrestrial ecology was selected as a receptor VC because of its key role in the maintenance of wildlife habitat, nutrient cycling, productivity, biodiversity, site stabilization, and carbon sequestration. It is recognized that Aboriginal groups place value on all ecosystems and their interconnections; accordingly, all vegetated ecosystems were included in the assessment. Terrestrial Ecology receptor VCs were divided into the following categories for the purposes of the assessment:

- alpine ecosystems;
- parkland ecosystems;
- forested ecosystems;
- floodplain ecosystems;
- rare ecosystems;
- culturally/economically important plants; and
- rare plants and lichens and associated habitat.

Project-related effects on terrestrial ecology receptor VCs were identified through reviews of a range of relevant literature, and professional judgement and experience. Seven potential effects were identified:

- high impact surface disturbance (including soil erosion and compaction as well as loss of soil fertility);
- dust effects (eutrophication and acidification of soils);
- edge effects;
- introduction and/or spread of invasive plant species;
- windthrow;
- fragmentation; and
- alteration of hydrological connectivity.

The key potential Project-related effects on terrestrial ecology receptor VCs were characterized using a risk model, which accounts for interconnections that occur across the landscape. The risk model identifies the probability that a Project effect will interact with a receptor VC, and the consequence (i.e., the relative importance of the ecosystem function) of that interaction. The results of the model identify the level of risk to each receptor VC. This information is used to inform Project planning, management, and mitigation strategies in order to avoid, minimize, or restore for adverse effects of the Project on terrestrial ecology receptor VCs.

Project-related activities pose a high risk to 41 ha, a moderate risk to 467 ha, a low risk to 5,316 ha, and no risk to 19,575 ha in the LSA (25,564 ha).

Based on the current Project design, there are no anticipated losses of rare ecosystems in any of the three sub-areas. There is also no anticipated alteration of rare ecosystems within the Mine Site or Transmission Line sub-areas. Rare ecosystems may be indirectly affected by fragmentation, edge effects, changes in hydrology, fugitive dust, and/or windthrow along the Brucejack Access Road.

It is estimated that 84 ha (1.3%) of the soapberry habitat within the LSA may be impacted by Project activities, the majority of which would occur along the Brucejack Access Road. An estimated 137 ha (1.6%) of devil's club habitat may be affected along the Brucejack Transmission Line. Approximately 74 ha (1.5%) of the total pine mushroom habitat could be directly affected by Project activities along the Brucejack Access Road.

There are 25 lichens (including red- and blue-listed species with NatureServe ranks ranging from a *Species at Risk Act* (2002c) list candidate to apparently secure), 2 mosses (including a red-listed species with a NatureServe rank of critically imperiled to imperiled) and 7 vascular plants (including blue listed species with NatureServe ranks ranging from imperilled to vulnerable) that may be indirectly impacted by the Project activities. The Project-related residual effects of loss and/or alteration of ecosystem function or extent will result in not significant effects on alpine, parkland, forested, and floodplain ecosystems and culturally/economically important plant habitat. The Project-related residual effects of loss and/or alteration of rare plant and lichen species or associated habitat will result in a not significant effect.

The cumulative loss of terrestrial ecosystems within the relevant CEA boundary (total area of 374,422 ha)—excluding the Project—is 5,358 ha. The Project may result in the loss of 217 ha of alpine ecosystems, 178 ha of forested ecosystems and 15 ha of floodplain ecosystems. The cumulative loss of terrestrial ecosystems within the CEA boundary—including the Project—is 5,769 ha, including 1,706 ha of alpine ecosystems, 4,051 ha of forested ecosystems and 225 ha of floodplain ecosystems. The Project contributes approximately 7.1% of the total cumulative loss of ecosystems expected within the CEA boundary.

The cumulative alteration (i.e., through potential indirect effects) of terrestrial ecosystems within the CEA boundary—excluding the Project—is 20,582 ha. The Project may result in the alteration of 196 ha of alpine ecosystems, 983 ha of forested ecosystems and 102 ha of floodplain ecosystems. The cumulative alteration of terrestrial ecosystems within the CEA boundary—including the Project is 21,749 ha, including 3,385 ha of alpine ecosystems, 17,654 ha of forested ecosystems, and 710 ha of floodplain ecosystems. The Brucejack Gold Mine Project contributes approximately 5.88% of the total cumulative alteration of ecosystems expected within the CEA boundary.

No rare plants within the CEA boundary will be directly affected by the Project. The KSM Project will remove six rare plants and lichens during construction; 34 plant and/or lichen species will be removed within the Kerr Pit and 25 rare plant and lichens will be lost due to pit development, including six vascular plants, three mosses, and 16 lichens. Nineteen rare plants and lichens may be degraded/altered through potential indirect effects in areas adjacent to the KSM Project and 25 lichens, 2 mosses, and 7 vascular plants may be altered due to the Brucejack Gold Mine Project activities.

Implementation of relevant environmental management plans including a Soils Management Plan, Ecosystem Management Plan, Invasive Plant Management Plan, Rare Plant and Lichen Management Plan, will avoid and minimize adverse effects to ecosystem functions resulting from the Construction, Operation, Closure, and Post-closure activities of the Project.

The Project-related residual effects of loss and/or alteration of ecosystem function or extent are considered to be not significant. The Project-related residual effects of loss and/or alteration of rare plant and lichen species or associated habitat area also considered to be not significant.

The Project's residual effects, in combination with the residual effects of past, present, and future projects, will result in effects on alpine, forested, and floodplain ecosystems that are considered not significant. Parkland ecosystems and culturally/economically important plant habitat were not included in the CEA because effects to these receptor VCs are expected to be undetectable.

The significance of cumulative residual effects of loss and/or alteration of rare plant and lichen species or associated habitat cannot be determined based on currently available information.

8.6 ASSESSMENT OF POTENTIAL WETLAND EFFECTS

8.6.1 Settings

Wetlands were characterized within a 31,848-ha LSA, defined by a buffer extending at least to the height of land or a 1-km buffer around the outer limits of the proposed infrastructure and linear developments.

Wetland surveys were completed in July and September 2012, establishing 91 wetland survey plots. Survey methods followed *Field Description of Wetland and Related Ecosystems in the Field* (MacKenzie and Shaw 1999) and *Wetlands of British Columbia: A Guide to Identification* (MacKenzie and Moran 2004). Surveys identified all five federally defined wetland classes and 11 provincially described wetland associations. In addition, wetland types were also identified through ecosystem mapping and Terrain Resource Information Management (TRIM) data.

A total of 517.8 ha of wetlands and 18 distinct wetland communities were mapped in the LSA. Fens and swamps accounted for 300 ha (58%) of all wetlands, and 11 of the 18 identified site associations. The Wetland Herb and Ws06 wetland communities accounted for the largest area, and TRIM Marsh accounted for the most occurrences.

8.6.2 Assessment

The assessment for wetlands included effects of the Project on wetland extent and wetland functions. No spatial overlap of the Project infrastructure and wetlands is expected, so wetland extent is not expected to be affected by the project.

Wetland function was assessed using a risk-based approach to determine Project effects; under this approach, risk is defined as the probability that an adverse event will occur, multiplied by the consequences of an adverse event (Sayers, Hall, and Meadowcroft 2002). To calculate the probability rating, six possible Project effects on wetlands were assessed: hydrological connectivity, fragmentation, edge effect, dust, sedimentation and water quality, and invasive species. Consequence (the value of each wetland) was assessed on five components including: rare/listed species or ecosystems, hydrological function, biochemical function, functional diversity (ecological function), and habitat function.

Residual effects are expected on wetland functions adjacent to the Brucejack Access Road and Brucejack Mine Site. These effects on function, however, are considered to be not significant. Of mapped wetlands, 32.9 ha (6%) are at high risk of being affected, 62.8 ha (12%) are at moderate risk, and 422.1 ha (82%) are at low risk; therefore, the magnitude of effect is minor. The residual effects are local in extent, albeit long term, and will be within the range of natural variation at a landscape-level scale.

Adherence to the mitigation and management strategies described within the Environmental Management and Monitoring Plans (Chapter 29) will minimize the probability of effects on hydrological functions, biochemical functions, functional diversity, or habitat function.

Cumulative effects for the Project and projects within or directly adjacent to the RSA were assessed. The KSM, Northwest Transmission Line, Long Lake Hydroelectric, Treaty Creek Hydroelectric, Brucejack Exploration, and Sulphurets projects were reviewed in the CEA. Data were not available for wetland extent and effects on function for the Sulphurets, Long Lake, and Treaty Creek projects; however, the KSM, Brucejack Exploration, and Northwest Transmission Line projects had information on wetland extent and function effects.

A residual cumulative effect on the loss of wetland extent and alteration of function is expected due to additive losses in the region. However, this effect is not expected to be significant, because of the limited loss of wetlands associated with the Brucejack Exploration Project and limited alteration of function associated with the proposed Brucejack Gold Mine Project. Compensation and reclamation activities planned for the KSM Project will also mitigate cumulative effects on regional wetland extent and function. The Northwest Transmission Line EA identified that less than 7% of wetlands along the right-of-way would be affected, which is similar to the Brucejack Gold Mine Project. In summary, the potential cumulative effects on wetland extent and function of the proposed Brucejack Gold Mine Project and other projects in the area are considered to be not significant.

8.7 ASSESSMENT OF POTENTIAL WILDLIFE EFFECTS

8.7.1 Settings

Wildlife baseline field surveys were conducted following the inventory standards established by the BC Resources Information Standards Committee within the relevant RSA and LSA. The baseline RSA covers approximately 374,433 ha, and was delineated to reflect the area anticipated to provide habitat for wildlife that may come in contact with proposed Project infrastructure during the course of a season or lifetime. The LSA for baseline studies covers approximately 31,847 ha, and includes a buffer extending to the height of land or 1.0 km around the outer limits of the proposed Project infrastructure and associated linear developments.

Field surveys were conducted from 2010 to 2013 for moose, mountain goats, grizzly bears, wolverine, hoary marmots, bats, landbirds, raptors, waterbirds, and amphibians. Furbearers were also assessed in the wildlife baseline in which a literature review was conducted of available trapping data, rather than field surveys, and supplemented with incidental field data.

Habitat suitability models were developed to provide a means of identifying the spatial extent and distribution of habitats across the landscape and were used to assess the potential effects of the proposed Project. Habitat suitability models were developed for moose, mountain goat, grizzly bear, black bear, hoary marmot, American marten, and fisher within the RSA and LSA, in conjunction with ecosystem mapping studies.

The RSA includes good low-elevation habitat for moose and bears along the Bell-Irving and Bowser Rivers and moderate-quality low elevation habitat along the Unuk River. The majority of moose observed during aerial surveys were located in these three valley systems. The forested areas of these valleys also supported habitat and populations of migratory birds and furbearers. DNA studies for bears indicated that the majority of grizzly bears use the low-elevation habitats on the eastern side of the RSA during spring and early summer, and are present at high-elevation during summer. Many of them move to the Unuk River in fall, likely to fish for salmon.

Mountain goats are present on nearly all of the mountains within the RSA; substantial populations on the massif are bounded by the Unuk and Bowser Rivers and Treaty Creek, on the Snowslide range and the mountain chain to the south of the Bowser River. The Brucejack Access Road travels through the high-quality habitat in the Bell-Irving and Bowser river valleys. The Brucejack Mine Site is located in the alpine; the mountains surrounding the site supports mountain goats, but the site itself comprises predominantly gravels, talus, and some alpine meadow, and is not good habitat for goats. Hoary marmot are present in most alpine meadows, including those adjacent to the Brucejack Mine Site.

8.7.2 Assessment

Wildlife and wildlife habitat (i.e., moose, mountain goats, grizzly bears, American marten, hoary marmots, bats, landbirds, raptors, waterbirds, and amphibians) were assessed as VCs for a number of potential Project-related residual effects.

Moose (disruption of movement, direct mortality, and indirect mortality), mountain goat (sensory disturbance and indirect mortality), grizzly bear (disruption of movement, direct mortality, indirect mortality, and attractants), American marten (attractants), and western toad (direct mortality) were wildlife VCs assessed for residual effects due to the Project.

In order to mitigate for residual effects to wildlife and wildlife habitat from the Project environmental management plans will be developed, including wildlife, traffic, and noise management plans. Residual effects from the access road include direct and indirect mortality and sensory disturbance, and are addressed in the Transportation and Access Management Plan (Section 29.16). Residual effects from sensory disturbance included Project noise, traffic and aircraft noise, and blasting noise and are also addressed in the Noise Management Plan (Section 29.11). With mitigation and monitoring, no significant Project-related residual effects are expected.

Identified residual effects were also carried forward to the CEA and assessed within a larger wildlife CEA boundary that was specific to the range of each wildlife VC. Past, present, and future projects within the CEA boundary that interacted with the VCs were identified and included in the assessment. Some projects within the CEA boundary were excluded due to no interaction with the wildlife VCs or lack of data to perform the analysis. Cumulative effects due to the Brucejack Gold Mine Project were assessed as not significantly contributing to negative effects on wildlife. The analysis took into account that the Project has a relatively small footprint area, with the majority at the Brucejack Mine Site located outside of high-quality habitat for most wildlife VCs. In addition, the Project will lead to little traffic increase on Highway 37, and changes in the quality of water that discharges into the Unuk and Sulphurets rivers are predicted to be undetectable.

All cumulative residual effects to wildlife and wildlife habitat will be addressed in the Project-specific mitigation and management plans with additional mitigation to address the cumulative effects. These additional measures include contributing to and participating with regional-based initiatives such as the Northwest Wildlife and Environmental Management Advisory Group. It is also assumed that the proponents of other projects and activities within the CEA boundary will implement mitigation and management plans similar to those identified for the Brucejack Gold Mine Project. With regional-based mitigation and monitoring plans and initiatives, no significant cumulative residual effects due to the Project are expected.

8.8 ASSESSMENT OF POTENTIAL ECONOMIC EFFECTS

8.8.1 Settings

The Project is situated in the RDKS, a sparsely populated and relatively undeveloped region of BC. The economic RSA includes the RDKS and Electoral Area A of the RDBN. The major communities in the RDKS are Terrace, Stewart, Hazelton, New Hazelton, Dease Lake, Telegraph Creek, and the Nisga'a villages. The major community in the RDBN's Electoral Area A is the Town of Smithers. Communities are generally small and, in many cases, far removed from major population and governance centres and from one another.

In 2011, the economic RSA had a population of about 42,752; a high percentage of the population is of Aboriginal descent (30.0%). Of that, 21,730 people were in the labour force with a participation rate of 64.0% and unemployment rate of 12.1%, above the provincial unemployment rate of 7.8%. The average income in the RDKS was $35,795, whereas the average employment income was substantially higher at $55,590; both were below the provincial averages.

Economic development in the northwest BC, including the economic RSA, stems largely from the development of the area's abundant natural resources. Main economic activities in the region include mining, forestry, energy, fishing, and transportation. In 2011, main industries in the region, by employment, included health care and social assistance, public administration, retail trade, manufacturing, educational services, construction, and accommodation and food services; in total, these industries represented 65.7% of the total employment in the RSA. Approximately 6.6% of employed worked in agriculture, forestry, and fishing and hunting, while only 2.7% worked in mining, quarrying, and oil and gas extraction.

Overall, the economic RSA has been the focus of significant investment in infrastructure projects, utilities, and mineral exploration over the last five years, with mining providing an important source of employment for the region.

8.8.2 Assessment

Through the provision of direct employment and expenditures, the Project is expected to impact economic conditions locally, regionally, and provincially. Specifically, the Project is expected to have an effect on the labour market, incomes and government revenues, as well as business activity. The Project's anticipated positive economic effects are discussed in Chapter 1, Project Overview, and potential adverse economic effects of their projects are discussed in Chapter 19, Assessment of Potential Economic Effects.

The assessment of potential adverse economic effects was supported with primary and secondary research conducted between May 2012 and April 2014. Primary research included meetings and interviews with knowledge holders in Smithers, Terrace, and the Hazelton area. Secondary research included compiling and accessing information from a number of sources including Statistics Canada (Census, National Household Survey), Aboriginal Affairs and Northern Development Canada (AANDC), BC Stats, and others.

During a scoping exercise, it was assessed that the Project has the potential to result in adverse effects related to one economic VC: labour market. Two VCs—income production and revenue, and economic activity—are related to providing economic benefits and are discussed is the context of project benefits in Chapter 1, Project Overview.

The potential overall adverse effects of the Project on the labour market are listed below.

- Through the provision of direct, indirect, and induced employment, the Project has the potential to affect the employment levels and labour participation of vulnerable groups within the economic RSA. Mitigation measures for this effect include communication of the Project schedule and workforce requirements with Aboriginal and non-Aboriginal communities and educational institutions, and implementing human resources policies and programs that give first opportunity for employment to residents of the LSA communities. Residual adverse effects are not predicted for this effect.
- Direct Project employment and procurement may increase competition for local labour and inflate wage expectations within the economic RSA. Despite the mitigation measures, the development of the Project is likely to result in moderate competition for labour and wage inflation. As a result, a residual effect is predicted.
- The economic RSA is predicted to lose approximately 431 to 619 full-time mine-related positions, and an estimated 755 positions in supplier industries contributing to the unemployment level in the region. Proposed mitigation measures include advance communications of Project closure plans, the enhancement of worker skills and experience during employment associated with the Project, and the provision of workforce transition programs. Accordingly, a residual effect is predicted.

Two residuals effects were identified in the economic effects assessment: increased competition for labour and wage inflation, and decrease in employment at Closure. These adverse residual effects on the labour market are expected to occur during Construction, Operation, and Closure. After mitigation measures have been implemented, the magnitude of residual effects is expected to be moderate; stronger effects are expected for the decrease in employment at Closure. In sum, all adverse residual effects of the Project on the economic environment are rated not significant.

The residual effects were also carried forward to assess Project cumulative effects. In addition to the Project-specific mitigation, there is expected to be additional mitigation required to address cumulative effects. Specifically, it is assumed that the proponents of other projects and activities, in particular other mine developments in the RSA, will implement mitigation and benefit enhancement measures that are similar to those identified for the Project. Also, the proponent commits to working with governments and other proponents where and when appropriate to participate in the development of other measures, such as government plans and programs. In sum, the two adverse residual cumulative effects on the economic environment (i.e., increased competition for skilled labour and wage inflation, and decreased employment at Closure) are rated not significant, as they are expected to be moderate in magnitude.

There may be competition for skilled labour with the planned construction of new developments in the region; however, the specialized skillsets and qualifications of workers required for the Project may not necessarily overlap with the requirements for workers at other projects in the region. For the second effect, the coinciding closure of future projects and resulting termination of employment may cause the unemployment rate to deviate from historical baseline variations, should most of the proposed projects be constructed. If only a few of the proposed projects proceed, or the closure of future projects do not coincide, then changes are predicted to be similar to what has been previously experienced in the region.

8.9 ASSESSMENT OF POTENTIAL SOCIAL EFFECTS

8.9.1 Settings

The social RSA includes the RDKS and Electoral Area A of the RDBN. In 2011, the population of this area was approximately 42,752, over 30% of which identified as Aboriginal (compared with 4.8% across BC). The population has generally declined over the past decade or more, largely due to the loss of jobs, particularly among non-Aboriginal communities. The proportion of males and females has remained relatively unchanged in the last 10 years, with males (51%) slightly outnumbering females (49%). Almost 65% of the population is between the ages of 18 to 64 years, with 23% of the population aged 17 years and under; the median age is around 40 to 42.

LSA communities within the RSA include:

- the communities if Dease Lake, Stewart, Smithers, and Terrace;
- three Tahltan Nation reserve communities;
- four Nisga’a Nation communities;
- Hazelton and New Hazelton; and
- five Gitxsan Nation reserve communities.

Educational attainment levels across the RSA are close to, but generally lag slightly behind, provincial averages. A notable difference in educational attainment is between residents of Aboriginal reserve communities and non-Aboriginal communities. The portion of the population without a high school certificate, diploma, or degree is almost double in Aboriginal communities in the RSA than in the five non-Aboriginal communities.

With respect to community well-being, as measured by the Community Well-being Index, of the bottom 100 communities of the Community Well-being Index for BC in 2006, all were Aboriginal communities.

Further, evidence from northwest BC indicates that women, Treaty Nations, and First Nations face challenges or barriers in terms of employment, income, and social development in the resource sector.

Regional infrastructure of the RSA is adequate and, in several cases, has been recently upgraded. The larger communities are generally well-serviced with relatively minor housing concerns. Aboriginal communities, however, have general concerns about the adequacy of housing both with respect to supply and overall condition.

Further, the delivery of emergency, health, and social services varies across the region. Many services are provincial responsibilities that are delivered through ministry-specific, agency, or affiliate organization offices depending on the size and location of the community. Federal agencies, especially AANDC, tend to have a larger role, at least in funding if not delivery, of such services in First Nations reserve communities. Volunteers and non-government organizations play an increasingly important role in the delivery of many social and health services, especially in smaller communities.

8.9.2 Assessment

The potential social effects considered in the assessment include effects on: education, skills development and training; community infrastructure, services and housing; and worker and family well-being. A range of social indicators were selected to assess baseline setting and evaluate the potential effects of the Project on the social conditions. The analysis is based on the most up-to-date federal, provincial, and local data available from Statistics Canada, AANDC, BC Stats, and other sources. Further, to provide additional context and for verification of statistical and secondary source data, field work was carried out in the LSA communities that included meetings and interviews with community managers and leaders, regional representatives, First Nations leaders and administrators, government agencies and service providers, community organizations, and other knowledge holders.

The potential adverse social effects identified include the following.

- Education, Skills, and Training:
  - During the Construction and Operation phases, educational facilities and programs that deliver mining-related training may be adversely affected by an increase in demand for services due to issues such as limited funding, access, and capacity. At Closure, there could be a decrease in demand for educational programs. Proposed mitigation measures for this effect include communication, in advance, with educational institutions to provide information on workforce job categories, the Project development schedule, and training needs. A residual adverse effect is predicted for the Operation phase.
- Community Infrastructure, Services, and Housing:
  - There will be an increased demand for infrastructure and housing as a result of population in-migration. An increase in demand during the Construction and Operation phases has the potential to have an adverse effect for Aboriginal communities, given the current housing capacity and overcrowding issues. Also, a decrease in demand at Closure could lead to the deterioration of community infrastructure and housing in all LSA communities; however, population out-migration is not considered to be extensive enough to cause a residual effect. This effect will be mitigated by communicating the Project development schedule to Aboriginal and non-Aboriginal communities in the LSA. A residual effect is predicted for the Construction and Operation phases on Aboriginal communities.
  - There will be increased demand on health and social service: Population growth in a relatively short period of time has been associated with mining projects, and has been shown to place pressure upon health, social, and emergency services because communities do not have

the time to adapt. During the Operation phase, health and social services will have more time to build capacity to meet the increases in demand over time. At Closure, there will be a decrease in demand; however, the adverse effect is predicted to be limited or even negligible. This effect will be mitigated by communicating the Project development and workforce schedule to Aboriginal and non-Aboriginal communities in the LSA. A residual adverse effect is predicted for the Construction and Operation phases.

- Family and Worker Well-being:
  - During the Construction and Operation phases, there may be an indirect adverse effect around an increase in transient workers being present in LSA communities due to Project-related employment opportunities, leading to adverse effects on worker and family well-being. This effect will be mitigated by communicating the Project development and workforce schedule, and the workforce rotation schedule to communities where workers are being picked up/dropped off. A residual adverse effect is predicted for the Construction and Operation phases.
  - Increased Levels of Stress and Anxiety on Families due to Rotational Work - Increased stress on workers and families in the LSA is a potential indirect adverse effect of the Project during Construction and Operations, as a result of rotational work schedule, and at Closure when jobs are lost. Pretivm will have programs to assist employees who are experiencing work or family stress, such as an Employee Assistance Program. A residual adverse effect is predicted for the Construction and Operation phases.
  - Increase in Poor Lifestyle Choices – During Construction and Operations, higher income levels without the experience or knowledge of money management can lead to poor choices. Pretivm will offer programs or will connect workers to external service organizations that have programs to assist employees who are experiencing difficulty with issues such as substance abuse. A residual adverse effect is predicted for the Construction and Operation phases.

After the implementation of mitigation measures, there is one residual effect predicted for education, skills development, and training (i.e., increased demand for educational programs in the LSA); two residual effects for community infrastructure, service, and housing (i.e., increased demand for infrastructure and housing as a result of population in-migration, increased demand on health and social services); and three residual effects family and worker well-being (i.e., increase in transient workers coming into LSA communities, increased levels of stress and anxiety on workers and families due to rotational work, and increase in poor lifestyle choices). After characterizing the residual effects, all residual effects are rated as not significant.

All six adverse residual social effects were carried forward to assess the Project's cumulative effects. In addition to the Project-specific mitigation, it is assumed that the proponents of other projects and activities—in particular other mine developments in the RSA—will implement mitigation and benefit enhancement measures similar to those of the Project. All cumulative adverse residual effects are rated as not significant.

8.10 ASSESSMENT OF POTENTIAL HEALTH EFFECTS

8.10.1 Settings

The human health risk assessment involved a comprehensive and systematic process designed to identify, analyze, and evaluate the effects of the Project on human health. Baseline studies reviewed the existing levels of contaminants and noise in the LSA and RSA, established a benchmark for evaluating the potential future effects of the Project, and characterized pre-disturbance conditions for the purpose of the closure and reclamation activities. Noise, air quality, drinking water quality, and country foods quality contribute to overall human health. As part of the human health risk assessment, data was reviewed for baseline noise, air quality, drinking water quality, and country foods.

8.10.1.1 Noise

A noise monitoring program was established in 2012, which involved recording noise levels over 24-hour periods in March and September/October. Results of the noise monitoring program captured both the noise levels and the sources of noise. Natural background sources included birds, mammals, waves, and wind while anthropogenic sources included helicopters, airplanes, vehicles, and machinery. The average, minimum, and maximum noise levels ranged from 32.5 to 64.7 decibels (dBA), 15.7 to 37.3 dBA, and 67.6 to 121.9 dBA, respectively. Noise results are similar to measurements taken at other proposed mine sites and are below the estimated baseline level for rural areas.

8.10.1.2 Air Quality

Air quality is an important environmental factor in ensuring the conservation of local vegetation, wildlife (including country foods), and human health. Local ambient air quality was characterized from July to September 2012 through dustfall stations and passive air sampling systems (PASS). The average dustfall deposition rates ranged from 0.2 to 0.7 $mg/dm^2/day$; with a maximum observation of 2.67 $mg/dm^2/day$. All results fall within the range of BC's pollution control objective. The average dustfall deposition rates observed during the 2012 studies were consistent with that of other dustfall monitoring studies conducted in region.

Baseline CACs from the PASS results analysis showed that NO_2 and SO_2 concentrations in the Wildlife Creek area, and SO_2 concentration in the Brucejack Lake area were below detection limits during the entire sampling period. The NO_2 results from the Brucejack Lake area averaged approximately 4 $\mu g/m^3$. There is currently no 30-day average criterion for NO_2 in Canada or BC, but the 30-day average of 4 $\mu g/m^3$ is much lower than the Canadian annual maximum desirable standard of 60 $\mu g/m^3$.

The average O_3 concentration ranged from 20 to 57 $\mu g/m^3$. Health Canada states that the monthly 1-hour O_3 averages between May and September should be in the range of 49 to 78 $\mu g/m^3$ (25 to 40 ppb) when the source is away from anthropogenic influence (Health Canada 1999). Ambient O_3 concentrations measured at the PASS sampling stations are approximately within this range.

8.10.1.3 Country Foods

Country foods are defined as animals, plants, and fungi used by humans for nutritional or medicinal purposes that are harvested through hunting, fishing, or gathering of vegetation (Health Canada 2010). These foods are an important part of a healthy diet, have medicinal qualities, and are of high cultural and traditional importance. People obtaining country foods by hunting; trapping; collecting berries, mushrooms, and medicinal plants from the country foods LSA; and by fishing inside and downstream of the country foods LSA, can be affected by the quality of the country foods they consume.

The quality of country foods is directly related to the quality of the surrounding environmental media (e.g., soil, water, and vegetation). Chemicals accumulated from the environment may be present in the edible tissue portions of the country foods consumed by people. The potential for adverse effects in human consumers due to chemicals present in country foods depends on the concentration of the chemical, which type and portion of the country food is eaten (e.g., roots or leaves, muscle tissue or liver), life stage of the consumer (e.g., toddler or adult), quantity of food consumed, and frequency of consumption.

Animal and plant species were selected for evaluation based on current harvesting and consumption patterns by local people. The Project is located in a relatively remote location, distant from the population centres of Stewart, Smithers, and Terrace. Thus the primary consumer group of country foods was identified as local First Nations. The country foods baseline LSA is within Skii km Lax Ha Traditional Territory. Nisg̱a'a Lands and Nass Wildlife Area are to the southeast of the Project while the Brucejack Access Road, Brucejack Transmission Line, Knipple Transfer Area, and Bowser Aerodrome are all within the Nass Area as defined by the NFA. The Project is also in close proximity to the southern part of the Tahltan territory; approximately 9 km of the Brucejack Access Road falls within the Tahltan Traditional Territory. Skii km Lax Ha hunt, trap, fish, and gather country foods within the Brucejack Access Road and Brucejack Transmission Line areas. Therefore, Skii km Lax Ha were identified as human receptors for the country foods assessment.

In total, five different country food groups were evaluated, including: large terrestrial mammals (moose), small terrestrial mammals (snowshoe hare), birds (grouse), fish (Dolly Varden/Bull Trout), and berries (huckleberry, Bog blueberry, Alaskan blueberry, and Canada buffaloberry).

This assessment predicted no unacceptable health risks to people from consuming any of the country food groups evaluated under the existing pre-Project conditions. This means that consumption of these country foods at the quantities and frequencies used in the assessment would be considered safe and would not affect human health under pre-Project conditions.

8.10.1.4 Drinking Water

Water quality samples collected as part of the surface water quality program discussed above were compared to drinking water guidelines. Within Brucejack Lake, maximum mercury concentration was found to exceed provincial drinking water guidelines while minimum, mean, median, and 95th percentile concentrations did not. Exceedance of the mercury drinking water quality guidelines in Brucejack Lake is associated with samples from August 1988. A total of ten samples from August 1988 exceeded the BC maximum drinking water quality guidelines; however, the exceedance was due to high mercury detection limits for nine out of ten samples. For those nine samples, where detection limits are greater than the guideline, no conclusions can be made about whether the concentration of mercury actually exceeds the drinking water quality guidelines. Lead and arsenic concentrations marginally exceeded Canadian drinking water quality guidelines in Knipple Lake. No other exceedances were identified.

The marginal baseline exceedance of relevant drinking water guidelines combined with low consumption frequency of surface water by potential users is unlikely to result in human health effects due to drinking water under pre-Project conditions.

8.10.2 Assessment

Human Health was identified as a receptor VC, with four sub-components: noise, air quality, drinking water quality, and country foods quality. The human health assessment relied on data acquired during baseline studies and future modelled noise, air quality, and country foods quality. The human health assessment followed a science-based approach recommended by Health Canada to protect people from adverse health effects caused by exposure to noise or COPCs in water, air, and country foods.

8.10.2.1 Noise

The noise levels predicted for the Construction and Operation phases were compared to various impact criteria for human receptors. Human health residual effects (e.g., sleep disturbance for off-duty workers, complaints from the Skii km Lax Ha Lodge) were identified. While the magnitude of noise effects was identified as major during the Construction and Operation phases, mitigation measures not included reflected in the predictive noise modelling could be incorporated during the Project detailed design phase that are expected to reduce the potential magnitude of effects to minor.

The duration of the effect was considered medium term in the Construction phase and long term during the Operation phase. The frequency of effect is considered regular and reversible while the spatial extent of effect was identified as landscape. The resiliency of human receptors was considered to be low and neutral in context. The human health effects assessment due to noise was based on a quantitative assessment, and includes conservative assumptions, allowing for a higher confidence in the characterization. Workers would likely anticipate that noise levels would be elevated at an operational mine site, may be more likely to accept the elevated noise levels, and may be able to adapt to or further mitigate (e.g., through use of ear-plugs) the elevated noise levels so that sleep disturbance is not experienced. Residents of the Skii km Lax Ha Lodge would be willing to apply mitigation measures or relocate the lodge if noise levels become a concern. Therefore, the likelihood of occurrence of residual health effects due to elevated noise levels at the Skii km Lax Ha Lodge is considered low. With mitigation, the residual effect to human health due to exposure to noise is considered not significant at worker camps and non-worker noise receptor locations.

8.10.2.2 Air Quality

Potential changes in air quality, particularly due to NO_2, PM_{10}, and $PM_{2.5}$, may have residual effects to human health at receptor locations closest to the proposed infrastructure. The magnitude of the potential residual effects to human health due elevated CACs during Construction and Operation phases of the Project at worker camps and the Skii km Lax Ha Lodge is considered moderate. However, there are additional mitigation measures that could be applied in order to decrease the magnitude of the potential effect, if monitoring during the Construction or Operation phases indicates that risk to human health is possible. The duration of the potential residual effects due to exposure to CACs is considered far future and irreversible due to potential chronic effects. The frequency of potential human health residual effects due to elevated CACs is considered to be regular and limited to landscape category. Resiliency of human receptors was assumed to be low while the context of air quality was considered to be high. Given the remote location of the Project, its limited use, and the adaptive management and monitoring plans in place, the likelihood of occurrence of residual effects due to elevated CAC levels within the worker camps and non-workers human receptor locations is considered low. Based on the preceding significance descriptors and the availability of additional mitigation that can be implemented if monitoring results indicate possible health effects due to elevated CACs, the residual effect is considered not significant for worker camps and non-worker receptor locations.

8.10.2.3 Drinking Water Quality

Changes in drinking water quality outside of the mine site area have the potential to affect human health; because the effects assessment for drinking water quality in the Brucejack Access Road area was qualitative, the potential for residual effects cannot be ruled out. If they do occur, the residual effects will be localized and infrequent, since the potential for exposure to untreated surface water is low due to access restrictions, and land users would only be present transiently and for relatively short periods of time. The potential residual effect would be reversible in the short term. Guidelines for drinking water are based on chronic exposures and, therefore, comparison of surface water concentrations to these guidelines when considering transient land use (and transient drinking water use) is likely to overestimate the risk since exposure would be acute and an individual is likely to recover quickly from the exposure (if effects were to occur at all). In addition, it is not recommended that surface water be consumed for drinking water unless it is treated. The likelihood of residual effects on human health due to drinking water quality as a result of Project activities and infrastructure is low with a high level of confidence. With mitigation, the residual effect to human health due to consumption of (untreated) surface water as drinking water is considered not significant.

8.10.2.4 Country Foods

Country food harvesting is not expected to occur at the mine site area as public access will be restricted along the Brucejack Access Road and a no hunting policy will be in place for on-site workers. No residual effects on human health due to the consumption of country foods (outside of the mine site area) were identified through a predictive, quantitative screening level risk assessment. As a result, there is no potential for cumulative effects. The overall effect of the Project on human health due to changes in country foods quality is not significant.

8.11 ASSESSMENT OF POTENTIAL HERITAGE EFFECTS

8.11.1 Settings

8.11.1.1 Protected Archaeological Sites

The Heritage Effects RSA is based on the permitted area outlined in the 2013 *Heritage Conservation Act* (1996a) Heritage Inspection Permit; the LSA includes the Project footprint, plus a 1-km buffer. Ten archaeological sites are located within the RSA, six of which are located outside of the LSA. Four of these sites (HcTo-1, HdTn-1, HdTn-2, and HdTo-7), consist of subsurface lithic material (Seip et al. 2012; Farquharson et al. 2012). One site (HcTj-1) consists of two historic graves (documented as the graves of Simon Gunanoot and his father Nah-Gun), a historic cabin, and associated features (Marshall, Marr, and Palmer 2008). The site has also been documented in the Community Heritage Registry maintained by the RDKS and is protected by the BC *Cremation, Interment, and Funeral Services Act* (2004). One site (HdTj-1) is a historically significant battle site and commemorative location of a subsequent peace treaty, reportedly between Nisga'a and Tahltan. The site was listed as a Provincial Heritage Site as part of the NFA.

Four sites are located within the LSA and may be affected by the Project. Archaeological site HbTm-1 is a prehistoric subsurface lithic scatter consisting of two small andesite flakes located east of Summit Lake on a small break-in-slope. HcTn-1 is a prehistoric single artifact find of an obsidian utilized flake located on a surface exposure west of Brucejack Lake. HcTk-1 is a post-contact culturally modified tree site located west of the northwestern corner of Bowser Lake and east of Scott Creek. The site consists of two large culturally modified Douglas fir trees. HbTm-2, situated on a man-made, levelled knoll, is an aircraft wreck site located east of Summit Lake. The wreckage, from a staged helicopter explosion, was created as part of a movie set for the filming of *The Thing* (1982).

8.11.1.2 Protected Historic Sites

Numerous historical and recent land use features, generally associated with mineral exploration and extraction, have been observed within the LSA, including, but not limited to, cabins, claim stakes, recently blazed trees, and coreboxes. These sites are not protected by the *Heritage Conservation Act* (1996a) or other means.

8.11.1.3 Protected Paleontological Sites

There are paleontological remains of dinosaur footprints, turtle shells, and fern and gingko leaves in the sediments of the Bowser Basin, and fossils on the western side of Mount Dilworth. However, there are no records of significant protected paleontological finds within the LSA.

8.11.2 Assessment

Three receptor VC sub-components were initially considered for this assessment. Archaeological resources were included in the assessment, while historical resources and protected paleontological resources were excluded because they are not expected to interact with the Project.

Archaeological sites within the RSA, but outside of the LSA, are not anticipated to have interactions with the Project, because these sites are over 1 km from anticipated impact areas. Of the four sites that fall within the LSA (HbTm-1, HbTm-2, HcTn-1, HcTk-1), two are no longer protected by the *Heritage Conservation Act* (1996a). Archaeological site HcTn-1 is a prehistoric archaeological site that was mitigated through surface collection during the site visit. HbTm-2 is an aircraft wreck related to a movie production; the site was documented, to prevent confusion with a genuine aircraft wreck. Sites HbTm-2 and HcTn-1 have both been designated as legacy sites.

Two protected archaeological sites within the LSA may potentially be indirectly affected by the Project. HbTm-1, a prehistoric archaeological site, is approximately 165 m northwest of the Granduc Access Road and 346 m west of the centreline for the Brucejack Transmission Line. HcTk-1 is a post-contact culturally modified tree site. Its site boundaries are approximately 15 m from the existing Brucejack Access Road. Project activities associated with the movement, excavation, disturbance of soil, and the removal of vegetation have the highest potential for interactions between the Project and protected archaeological resources.

The assessment of potential for residual effects on heritage resources takes into account mitigation and management measures that will take place prior to anticipated impacts. Such mitigations and management measures include site avoidance, Project personnel education, and implementation of the Heritage Management Plan and Chance Find Procedure. Once mitigation and management measures have been implemented, the potential for residual effects on heritage resources are not anticipated. Similarly, once mitigation and management measures have been implemented, the potential for cumulative effects on heritage resources are not anticipated.

8.12 ASSESSMENT OF POTENTIAL NAVIGATION EFFECTS

8.12.1 Settings

Effects to navigational safety and access were assessed for the Project; navigation relates to common law rights, and potentially to the health, socio-economic conditions, and cultural heritage of Aboriginal peoples. Navigation was identified as a VC of the Project.

The *Navigation Protection Act* (NPA; 1985) came into effect on April 1, 2014, as the result of amendments to the former *Navigable Waters Protection Act* (NWPA). The baseline assessment work on navigational effects for the Project, originally conducted in 2012, was designed to meet the provisions of the NWPA, such as in the Minor Works and Waters Order (2009). Project works have since been assessed against the amended criteria contained in the Minor Works Order (2014), and affected waters have been assessed against the physical and public utility criteria used to interpret navigability in case law precedent and related new guidance by Transport Canada.

There are no waters affected by the Project on the List of Scheduled waters, and Pretivm currently does not intend to not opt-in to the NPA regime for any waters potentially affected by the Project. Some Project related works were previously approved and permitted under the NWPA (Appendices 23-A, 23-B); these works are automatically opted into the NPA regime, and any terms or conditions imposed on them remain in effect (Transport Canada 2014). Pretivm has five years to determine if it will choose to opt-out of the NPA regime for these works.

Baseline data collected for use in the navigation effects assessment included:

- physical waterway crossing characteristics;
- hydrological information; and
- information pertinent to public utility from land use studies, traditional knowledge/traditional use studies, and navigation-specific consultation conducted for the Project.

Public utilization of waterbodies within the Project area was determined by distributing surveys and conducting phone interviews with several key stakeholders. In addition, Aboriginal traditional knowledge/traditional use and desk-based research played an important role in determining historical navigational use (Chapter 25; Appendices 25-A and 25-B; Rescan 2013b). Project components and physical activities which may affect navigability were identified during a desk-based study utilizing preliminary site plans and Geographic Information Systems. A transmission line study and preliminary bridge site plans from 2011 aided in this study.

8.12.2 Assessment

The assessment of navigation was conducted for effects to navigational safety and access. A total of 58 works interacting with 55 waters were assessed for the Project, including 49 transmission line crossings, seven bridge crossing, and the subaqueous tailings and waste rock disposal in Brucejack Lake. Of these, six works have already been permitted by Transport Canada under the NWPA for the Brucejack Access Road.

A navigability assessment of the remaining potentially affected waters was conducted, based on physical and public utility criteria. The Bowser River, associated with a proposed transmission line crossing, was assumed to be navigable; all others are considered by Pretivm to be non-navigable for the purposes of the NPA.

Regardless of the determination of navigability for each potentially affected waterbody, potential effects to navigational safety and access were considered. Temporary effects to navigation safety and access could occur during the construction and decommissioning of one stream crossing associated with mine site roads and along the 49 transmission line stream crossings. There would also be potential for similar effects during decommissioning of the seven bridges along the Brucejack Access Road that have existing authorizations under the NWPA. These potential effects would persist for the period of time that active construction or decommissioning was occurring at each crossing. These temporary potential effects could be fully mitigated by use of appropriate signage, when required.

There is the potential for effects to safe navigation on Brucejack Lake related to waste rock which could be fully mitigated by appropriate signage, if required. Tailings deposition will be at depth in Brucejack Lake, thus not resulting in any residual effect to navigation. As a result of effluent, waste rock, and tailings discharge to Brucejack Lake, changes in outflow rate from Brucejack Lake is expected that could affect streamflow rates in downstream receiving waters such as Sulphurets Creek and the Unuk River. However, the expected change in streamflow rate is expected to be negligible in downstream waterbodies (less than 1% change from baseline conditions through all Project phases) such that no residual effects on safe navigation in these waterbodies is expected.

Mitigation measures to address navigational safety effects include appropriate signage, as noted above, and installing bridges and aerial cables at sufficient heights to not interfere with navigation. Mitigation measures to address temporary access effects will include appropriate signage during construction, the avoidance of permanent structures within the high water mark, and sufficient transmission line cable height to not interfere with navigation. Any additional appropriate mitigation measures identified by Transport Canada would be implemented.

Overall, no residual effects to navigation are expected. As no Project-related residual effects were identified, no cumulative effects are expected.

8.13 ASSESSMENT OF POTENTIAL COMMERICAL AND NON-COMMERCIAL LAND USE EFFECTS

8.13.1 Setting

Potential effects of the Project on commercial and non-commercial land use and visual quality considers land management objectives, commercial land uses such as guide outfitting, trapping, forestry, utilities, mineral, oil and gas, commercial recreation (e.g., heli-skiing, river rafting, fish camps, and angling guides), and public (or non-commercial) land uses including recreation (e.g., hunting, fishing and hiking), and parks and protected areas. Commercial and non-commercial land uses are described in relation to an LSA and RSA, while areas valued for their visual quality are described within a visual quality LSA.

Land use in the Project's study areas is informed by the Cassiar-Iskut Stikine Land and Resource Management Plan (BC ILMB 2000) and the Nass South Sustainable Resource Management Plan (BC MFLNRO 2012). The land use RSA overlaps four WMUs: 6-14 (less than 1%), 6-16 (about 38%), 6-17 (less than 1%), and 6-21 (about 6%). The LSA overlaps 4% of WMU 6-16 and 0.3% of WMU 6-21. The Brucejack Mine Site is located within WMU 6-21, while the Brucejack Access Road and transmission line are located within WMU 6-16.

There are no provincial or national parks, federal or provincial protected areas within the land use LSA. Border Lake Provincial Park is located on the western edge of the land use RSA. Other provincial parks located outside of the land use RSA include Ningunsaw Park and Ningunsaw Ecological Reserve, Lava Forks Park, Bear Glacier Lake Park, and Meziadin Lake Park.

Three guide outfitting licence areas overlap the land use RSA (licences 601074, 600502, and 601036). The Brucejack Mine Site and a portion of the Brucejack Access Road lie within licence 601074, while the Brucejack Transmission Line and the remainder of the Brucejack Access Road lie within licence 601036.

The land use LSA overlaps three registered traplines: TR 621 T003, TR 616 T011, and TR 616 T012. The RSA overlaps TR 621 T001, TR 614 T101, and TR 617 T015. The Brucejack Mine Site is located within licence TR 621 T003 while the transmission line and a portion of the Brucejack Access Road are located within the TR061T012. The remainder of the Brucejack Access Road is located within TR 616 T011.

Two commercial recreation licences intersect the LSA (licences 6406136 and 6406985), and three intersect the land use RSA (licences 6407503, 6406943 and 6403593).

The land use LSA overlaps two forest districts (Skeena Stikine and Kalum) and two Timber Supply Areas (the Cassiar and Nass). There are three forest licences within the land use LSA and seven forest licences within the land use RSA. There are two water licences within the land use LSA and three within the land use RSA.

Power infrastructure within the land use RSA includes the 138-kV Aiyansh-Stewart Transmission Line and the recently completed 31-megawatt Long Lake Hydroelectric Project.

Public used of the land use study areas is undocumented. The public visit the Salmon Glacier viewpoint approximately 25 km north of Stewart BC. There are no formal hiking trails, snowmobile routes, or designated recreational sites within the land use study area.

Within the LSA, there is private land in the vicinity of the proposed transmission line.

8.13.2 Assessment

Commercial land use and non-commercial land use were selected as VCs for the effects assessment. Effects on non-commercial land use were not assessed due to low public use of the LSA and lack of interaction with the Project. Key effects on commercial land use included in the assessment were: 1) changes in access or ability to access or use land use areas; 2) change to the quality of experience of the natural environment; and 3) changes to the distribution and abundance of wildlife.

During the Construction and Operation phases, the Project has the potential to affect guide outfitter licence 601036 due to a change in the distribution and abundance of wildlife, and commercial recreation licences 6406136 and 6406985 due to a change in the quality of experience of the natural environment. These residual effects were determined to be not significant.

Measures to mitigate potential effects on commercial land uses include: restricting public access and enforcing speed limits on the access road to minimize unauthorized hunting and vehicle-wildlife interactions, and implementing a Transportation and Access Management Plan (Section 29.16), Noise Management Plan (Section 29.11), and Wildlife Management and Monitoring Plan (Section 29.21). A measure to mitigate impacts on 6406136 includes coordinating and communicating helicopter flight schedules during the heli-ski season (between December 16 and April 19) during all phases of the Project.

Residual effects on licence 601036 and 6406985 were carried forward to the CEA, and were assessed within a larger wildlife CEA boundary. The CEA concluded there would be no significant cumulative residual effects due to the Project.

8.14 ASSESSMENT OF POTENTIAL EFFECTS TO CURRENT USE OF LANDS AND RESOURCES FOR TRADITIONAL PURPOSES

8.14.1 Setting

Current use of lands and resources for traditional purposes by Aboriginal people includes fishing, hunting and trapping, plant gathering, and utilization of camps/cabins, trails, burial sites, and cultural landscapes. The chapter focuses on current uses of land and resources by Skii km Lax Ha, Nisg̱a’a, Tahltan and Metis.

Skii km Lax Ha fish in the watercourses in the fish and fish habitat study areas. They fish for trout in Todedada Lake, 150 m away from the Brucejack exploration access road, and in Gilbert Lake, located approximately 6 km north of the exploration access road, outside of the LSA. At the edge of the LSA, near the confluence of Wildfire Creek and the Bell-Irving River, Skii km Lax Ha fish for steelhead and rainbow trout. Within the fish and fish habitat RSA, Nisg̱a’a fish for sockeye and chinook salmon in Bowser Lake, where an estimated 8% of Nass River Sockeye spawn. No other fishing area in the fish and fish habitat study areas were identified by Nisg̱a’a, Tahltan, or Métis.

Skii km Lax Ha hunt in the wildlife study areas. Hunting areas identified by Skii km Lax Ha in the wildlife LSA include the north side of Mount Anderson on Bowser Lake, and the Scott Creek and Todedada Creek valleys (for moose, grizzly bear, black bear, and mountain goat). The exploration access road passes through the Scott Creek Valley. Hunting areas identified by Skii km Lax Ha, but not currently used in the LSA, include the Salmon River valley in the area of the transmission line corridor (for mountain goat and marmot), and at the confluence of Jeanette Creek and upper Bowser River, near Knipple Lake, and 140 m north of the exploration access road. Skii km Lax Ha hold trapline tenure TR 0616 T011, which overlaps the eastern half of the LSA and RSA, and the eastern half of the exploration access road. Marten, beaver, wolf, and wolverine are primarily trapped. Skii km Lax Ha have not used this trapline since 2009, but anticipate using it in the future.

To date, Nisga'a Nation has not provided information on hunting and trapping activities within the wildlife RSA. No information on the LSA or RSA by the Tahtan or Métis for hunting or trapping has been identified to date.

Skii km Lax Ha harvest plants in the terrestrial ecosystem study areas. Skii km Lax Ha plant-gathering include the upper Bowser River valley before it enters Bowser Lake. Cranberries are harvested from the marshy lowland in this area. The exploration access road runs through this area. No plant-gathering areas were identified around the Brucejack Mine Site. No plant gathering areas in the RSA or LSA have been identified by Nisga'a, Tahltan, or Métis to date.

Skii km Lax Ha cabin sites located in the LSA include Summit Lake along the along the Salmon River (adjacent to the Brucejack Transmission Line corridor); at the confluence of Jeannette Creek and the upper Bowser River (north side); at the confluence of Todd Creek and the upper Bowser River (south side); and at Todedada Lake. Skii km Lax Ha trails and travel corridors in the LSA include along the Salmon River valley, along Wildfire Creek and Wildfire Ridge, and along Scott Creek overland to Treaty Creek. No burial sites or graveyards have been identified within the LSA. No habitations, trails, burial sites, or cultural landscapes have been identified to date by Nisga'a, Tahltan, or Métis in the LSA. There is one known culturally modified tree in the LSA (designated heritage site, Borden number HcTk-1), located at the edge of the exploration access road near Scott Creek.

8.14.2 Assessment

The VCs included in the assessment were fishing opportunities and practices, hunting/trapping opportunities and practices, plant-gathering opportunities and practices, and habitations, trails, burial sites, and cultural landscapes. The assessment focused on key effects related to: 1) a change in access or ability to access or use land use areas; 2) a change in the quality and experience of the natural environment; 3) a change in the abundance and distribution of resources; and 4) a change to the quality of resources. The effects were assessed for each of the Project phases.

Measures to mitigate potential effects included: restricting access to the Project site, implementing a "no hunting" policy for employees; and implementing a Wildlife Management and Monitoring Plan, an Ecosystem Management Plan, and a Transportation and Access Management Plan.

The residual effect was carried forward into the CEA, and assessed within the Skii km Lax Ha traditional territory. In the event that all reasonably foreseeable future projects commence on time and as designed, the cumulative residual effect of change in the abundance and distribution of resources on hunting and trapping opportunities and practices, even with the Brucejack Gold Mine Project, was rated as not significant. The CEA for wildlife (Section 18.9) determined that no significant adverse cumulative residual effects to moose, mountain goat, grizzly bear, marten, or migratory birds were anticipated. Therefore, the cumulative adverse residual effects to the abundance and distribution of wildlife resources were also characterized as not significant.

9. Accidents and Malfunctions

9. Accidents and Malfunctions

The management of risks and preparedness for unplanned events, such as accidents and malfunctions, are important to the success of the Project. In general, the accidents and malfunctions portion of the Application/EIS identifies unplanned events that could affect intermediate and receptor VCs, assesses the likelihood that the events will occur and at what severity, and establishes mitigation measures to prevent or respond to the events.

9.1 IDENTIFICATION OF POTENTIAL ACCIDENTS AND MALFUNCTIONS

A Failure Mode Effects Analysis was conducted to determine the significant accidents and malfunctions for the Project. Of the potential accidents and malfunctions identified, the majority were associated with cost (38%), production (26%), and health and safety (20%). Risks to reputation and the environment formed 8% each of the accidents and malfunctions. Of the 34 potential environmental accidents and malfunctions, 25 were rated as low risk due to varying combinations of likelihood and severity. Nine were rated as medium-risk with five of these occurring in the underground environment and not expected to substantially affect the surface environment.

The analysis identified four medium-risk accidents and malfunctions with potential environmental impacts:

- general failure of the tailings discharge systems and waste rock placement and storage leading to the release of suspended solids and metals above permitted levels from Brucejack Lake to Brucejack Creek and downstream;
- a vehicle accident leading to the release of gasoline, diesel, or concentrate;
- a vehicle collision or accident leading to the release of hazardous materials other than fuels or concentrate; and
- as a special case, spills and release of hazardous materials on glaciers and due to avalanches.

9.2 PREVENTATIVE, RESPONSE, AND CONTIGENCY PROCEDURES

9.2.1 General Failure of Tailings Discharge System, Waste Rock Placement, and Storage

A worst-case scenario would result from a malfunction of the tailings discharge system, damage to turbidity curtains, or slumping of the submerged waste rock pile. These events individually or combined could result in TSS and total metal levels above permitting levels discharging from the lake into the receiving environment. The potential for this occurrence will be mitigated through a range of design and response measures, including constant monitoring and maintenance of constant tailings flow and consistency; tailings will be deposited under a coarse sand or gravel filter, and de-aerated, and twin pipes will provide maintenance and emergency shutdown support. The waste rock will be regularly monitored for instability. Turbidity curtains will be in place at the outlet of Brucejack Lake and around the perimeter of the waste rock deposition area and will prevent sediments from migrating out of Brucejack Lake.

Response and contingency procedures will include detailed plans to address unexpected events and emergencies, including the unlikely potential for downstream water contamination or escape of tailings fines from tailings area. These plans include initial response plans and notifications, initial impact assessments, the activation of response groups, and the application of emergency shutdown or contingency procedures.

9.2.2 Spills Prevention and Response

This section discusses all spills resulting from accidents and malfunctions involving vehicle transport of fuels, concentrates, and hazardous materials. The Project access route crosses over rugged terrain including Knipple Glacier, and through high-risk avalanche areas. While spills can occur anywhere, they are more likely to be more common in high traffic areas around the mine site and transfer areas. Accordingly, spills of materials will potentially pose a substantial risk to the environment.

Spill prevention measures will include the installation of access road guard rails, berms to prevent over turning and/or capture load loss, and measures to prevent roads from attracting wildlife. All vehicles will meet relevant regulatory standards, and will adhere to regular inspection and maintenance schedules.

The access route will be governed by traffic control measures, including access control, speed limits, signage, vehicle check-in/check-out procedures, communication of road conditions, traffic convoying during periods of poor visibility, and road closures during periods of extreme weather conditions and avalanche hazard. All mine personnel will receive training for safe driving and emergency/spill response.

Additional preventative measures will apply to travel across the Knipple Glacier and areas with avalanche hazards. The glacier road route will be regularly inspected; alternative routes, such as an alternate snow route over the VOK, will be used when appropriate. The route will be clearly marked for night and usage in low-visibility conditions, and will have rescue equipment cached along the route. Explosives may be used to reduce the potential avalanche hazards. Personnel using the glacial and avalanche routes will receive specialized training; glacier haul equipment will be outfitted with Global Positioning System devices and will remain in radio communication with other haul vehicles and the camps. Personnel will also be provided with regular weather, road condition, and avalanche risk updates.

Spill Prevention and Response and Emergency Response plans will be implemented and include measures for identification and control of immediate dangers to human life or health, identification and control of spill source, elimination of additional potential spill sources, containment of spill, notification of authorities, recovery and cleanup, and incident investigation and reporting.

9.3 ASSESSMENT OF POTENTIAL RESIDUAL EFFECTS

Despite preventative, response, and contingencies measures, residual effects to the environment are expected from the failure modes discussed above.

9.3.1 General Failure of Tailings Discharge System, Waste Rock Placement, and Storage

The release of suspended solids and metals from the tailings discharge and waste rock into Brucejack Lake will trigger two potential residual effects: a decrease in surface water quality (primary effect) and a potential subsequent impact on aquatic resources and fish and fish habitat (secondary effect). The design of the tailings discharge system and procedures and mitigation measures associated with waste rock deposition are expected to limit the likelihood and severity of this failure mode. A tailings system malfunction would be readily detected by the operational control system and elevated TSS levels would be rapidly detected in the daily monitoring of lake outflow water quality. This will allow for the swift application of contingency and/or response measures in the event of a failure.

Outflow from Brucejack Lake is the headwater source for Brucejack Creek. From there, Brucejack Creek joins Sulphurets Creek under the Sulphurets Glacier, approximately 2 km downstream of Brucejack Lake. It is expected that elevated TSS and total metal concentrations would persist along the length of Brucejack Creek until the confluence with Sulphurets Creek. Once Brucejack Creek joins Sulphurets

Creek, it is expected that elevated TSS and total metals in Brucejack Creek would become indistinguishable from the background TSS load originating from the Sulphurets Glacier.

The effect(s) of elevated TSS on fish and fish habitat will be negligible because the nearest fish population is in the lower reach of Sulphurets Creek (downstream of the cascade) and in the Unuk River. Any increase in suspended solids or metals from Brucejack Lake and discharging into the upper reaches of the Sulphurets Creek are not expected to be distinguishable from other background sources particularly beyond Sulphurets Lake, which is approximately 13 km upstream of the nearest fish-bearing waters in the lower reach of Sulphurets Creek and in the Unuk River.

Based on these and other management plans, the overall assessment for the residual effects of elevated sediment release from Brucejack Lake is considered to be not significant.

9.3.2 Spills of Fuels, Concentrates, and Hazardous Materials

The potential residual effects of fuels, concentrates, hazardous materials, and spills depend on whether the spill would occur on water or land. Spills on water spills may lead to potential effects on surface water quality (primary effect), and potential effects on aquatic resources, fish and fish habitat, wetlands, air quality, and/or terrain and soil (secondary effects).

Fuel spills into water pose the greatest concern because of their ability to rapidly spread on the surface, their acute toxic impact on aquatic resources, and the volume of fuel to be transported. Bowser River, Knipple Lake, Bowser Lake, Scott Creek, Wildfire Creek, and/or Bell-Irving River—as well as smaller order tributaries of these systems—are all located close to access roads. The potential effects on surface water quality will be direct as various hydrocarbon compounds from the fuel spill are immediately introduced to the watercourse.

The effects on fish and fish habitat will be through direct toxicity of the water column, physical effects of contact with spilled fuels, and ingestion of primary and secondary producers. Petroleum products are toxic to fish and aquatic organisms. Behavioural changes in fish after sublethal exposure to spilled petroleum products typically are responses to the physiological changes caused by the toxins. Fish populations will move away from areas with undesirable water quality and eventually re-stock these areas after water quality has recovered. The fish-bearing waterbodies adjacent to roads have salmon. In addition, Bowser Lake is significant to local Aboriginal groups and Nisga'a.

The potential magnitude of spills is expected to vary from minor to major depending on the type and amount of material spilled and the receiving environment. Spills, if they occur, will be from vehicles with a limited capacity with a very low probability of the loss of entire load into the receiving environment. Planned preventative measures mean that spills will rarely occur. Contingency measures focus on rapid containment and clean-up. Because of their potentially greater effects and their potential to spread quickly, fuel spills receive additional preventative and contingency measures and practices. These include floating booms, use absorbent materials, and specialized training for personnel. Other spill types, such as concentrate spills in water, are not acutely toxic and are less likely to spread. Accordingly, the effects of these spills will be localized and limited to turbidity effects. Spills of other hazardous materials are expected to remain local because they will involve much smaller volumes. Rapid clean-up procedures, including removal of affected materials, mean no long-term presence of the spill materials in the environment. Hence, the residual presence of fuels, concentrates, and hazardous materials are very low.

Based on the application of these measures, the residual effects of spills were assessed to be not significant for all VCs.

10. Aboriginal Groups and Nisga'a Nation

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10. Aboriginal Groups and Nisga'a Nation

10.1 ASSESSMENT OF EFFECTS TO ASSERTED OR ESTABLISHED ABORIGINAL RIGHTS AND INTERESTS

The Application/EIS summarizes the potential adverse effects on asserted or established Aboriginal rights and interests arising from the Project during the Construction, Operation, Closure, and Post-closure phases. The assessment identifies measures to mitigate or accommodate for these effects, and provides a summary of past and planned consultation activities that Pretivm undertook with Aboriginal groups.

Aboriginal groups considered in the assessment include Skii km Lax Ha and Tahltan Nation (represented by the Tahltan Central Council); in addition, the EIS Guidelines issued by the CEA Agency (2013) require the inclusion of the Métis (represented by Métis Nation BC).

All major components of the proposed Project infrastructure lie within the traditional territory claimed by Skii km Lax Ha. Neither the Brucejack Mine Site nor the Brucejack Transmission Line is within Tahltan traditional territory. The eastern-most segment of the Brucejack Access Road, approximately the first nine km of road branching off to the west of Highway 37, is within Tahltan territory. Métis Nation BC, unlike other Aboriginal groups, does not claim territories; instead, on behalf of its citizens, it asserts rights and traditional uses over the entire province, with documented traditional land use in 95% of the provincial watersheds (MNBC 2010).

A brief overview of each Aboriginal groups' social, cultural, and economic context and current use of lands and resources for traditional purposes is provided. Consultations activities undertaken with Skii km Lax Ha and Tahtlan Nation include: discussions around capacity funding, provision of Project information, information on employment and contracting opportunities, meetings to discuss the Project, opportunities to provide traditional knowledge and traditional use information, consultation on the Aboriginal Consultation Plan and Pre-Application Aboriginal Consultation Reports, and memoranda summarizing the potential effects of the Project on Aboriginal rights and interests.

Consultation with the Métis has focused on providing opportunities to gather traditional knowledge and traditional use information, and distributing key documents relevant to the EA process. Pretivm has written to the Métis Nation BC, Tri-River Métis Association and Northwest BC Métis Association to provide the dates of the BC EAO-led open houses. Pretivm anticipates there may be further communication with Metis during the Application/EIS review stage. No anticipated impacts on Métis rights are currently anticipated.

The evaluation of potential impact to the exercise of Aboriginal rights is closely linked to the assessment of changes in current and anticipated future use of land and resources by Aboriginal groups for traditional purposes (e.g., fishing, hunting/trapping, gathering, and access to areas where these activities occur). In considering potential effects on Aboriginal rights, it is assumed these types of activities may occur in the vicinity of the Project, even if site-specific areas or activities were not well identified or characterized by Aboriginal groups.

Potential adverse effects of the Project on Aboriginal rights have been assessed for each Aboriginal group by adapting the assessment methodology framework described in Chapter 6. The methods follow three general steps: scoping the Aboriginal rights assessment (including selecting spatial boundaries); characterizing the impact of the Project on Aboriginal Rights; and finally, rating the impact on rights on a scale of low, moderate, or high.

Both indirect and direct effects on Aboriginal persons and VCs that are linked to Aboriginal rights have been considered:

- indirect effects under 5(1)(c) of the CEAA 2012 (i.e., human health, socio-economic, physical and cultural heritage, and current use of lands and resources for traditional purposes); and
- direct effects that are potentially linked to Aboriginal rights (i.e., fish and fish habitat, wildlife, human health, terrestrial ecology (economically and culturally important plants), and physical and cultural heritage (habitations, trails, burial sites and cultural landscapes).

Based on the conclusions of the Aboriginal rights assessment, the Project is predicted to have a low level of impact on the exercise of Skii km Lax Ha and Tahltan Aboriginal rights.

Aboriginal groups have also identified an interest in employment and economic opportunities, and skills and training to create a skilled labour force. The proponent will implement measures to enhance these beneficial aspects of the Project.

10.2 ASSESSMENT OF NISGA'A NATION TREATY RIGHTS, INTERESTS, AND INFORMATION REQUIREMENTS

The Application/EIS assessed the environmental effects of the Project on residents of Nisga'a Lands, Nisga'a Lands, and Nisga'a interests during the Construction, Operation, Closure, and Post-closure phases pursuant to Chapter 10, 8(e) of the Nisga'a Final Agreement (NFA). The Application/EIS also assessed the effects of the Project on the existing and future economic, social, and cultural wellbeing of Nisga'a citizens pursuant to paragraph 8(f), Chapter 10 of the NFA.

The scope of the assessment of environmental effects on Nisga'a 8(e) interests focussed on the right of Nisga'a citizens to harvest fish and migratory birds. Environmental effects on Nisga'a 8(e) interests related to land, including Nisga'a Lands and Nisga'a fee simple lands (Category A and B lands), and other land-related interests, Nisga'a citizens' abilities to access Crown lands and Nisga'a citizens' rights to harvest wildlife were not assessed are not assessed because no interactions with the Project were identified.

The Project is predicted to have a low level of impact on Nisga'a citizens' right to harvest fish as a result of the potential for residual effects on fish species harvested by Nisga'a. No residual effects are predicted on migratory birds with the implementation of mitigation. The assessment concluded there will be no impacts on Nisga'a citizens' right to harvest migratory birds in the Nass Area.

The assessment of effects on Nisga'a 8(f) was informed by the economic, social, and cultural impacts assessment report and mitigation measures and environmental management plans identified for social, economic, and cultural VCs. The scope of the assessment considered the effects of the Project on Nisga'a interests as they relate to economic, social, and cultural well-being. A number of effects of the Project on economic well-being are positive. Potential adverse effects on Nisga'a employment and income, Nisga'a business capacity and investment, Nisga'a natural resource related earning and values, and NLG revenues and expenses were identified. Enhancement and mitigation measures include communications with NLG and educational institutions, workforce transition programs, human resources policies and programs, and the pursuit of Impact Benefit Agreements or other agreements with NLG.

Direct, indirect, and induced employment and Project expenditures on goods and services were expected to produce intermediate effects, which in turn may have an adverse effect on the social well-being of Nisga'a citizens and communities. Intermediate effects included the potential migration of people to, or back to, Nisga'a villages in response to economic opportunities during construction and operation of the Project, as well as an increase in disposable income levels in the communities which could lead to social issues. Enhancement and mitigation measures include communicating the Project development schedule and other information sharing with NLG, and programs for employees such as Employee Assistance Programs.

Potential effects of the Project on Nisga'a cultural well-being considered in the assessment include: reduced ability of Nisga'a citizens and Nisga'a mine workers to access culturally important resources and sites, and reduced ability of Nisga'a citizens and Nisga'a mine workers to participate in culturally important activities and ceremonies. Effects on Nisga'a land use activities (e.g., effects on traplines or other formal land or resource use tenures) in the vicinity of the Project are expected to be negligible. Environmentally induced impacts on Nisga'a cultural activities and practices are also predicted to be minimal. The cultural effects related to shift work and increased income may be either positive or negative and depend on a number of factors, while traditional land and resource use may be enhanced by mine development.

Effects on other interests raised by NLG during consultation include effects on the Knipple Glacier and effects of the access road on moose. Measures to minimize fugitive dust deposition include implementing best management practices related to erosion prevention and sediment control. The Proponent has committed to continue the glacier monitoring program to enable to glacier mass balance to be assessed on an annual basis. Due to NLG concerns related to the construction of the access road, the Proponent has committed to prepare a report for NLG, outside of the EA review, to assess the potential effects of the road on wildlife.

11. Proponent Conclusions

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11. Proponent Conclusions

The Application/EIS represents Pretivm's proposal for the Brucejack mine. The intent of the Application/EIS is to demonstrate that the Project will be environmentally, socially and economically beneficial and will meet the Government of Canada's objectives of responsible resource development. The Project will promote economic prosperity in British Columbia, especially northwestern BC. It will provide jobs, generate business opportunities, and produce local, provincial and federal tax revenues. Pretivm believes that the Project can be implemented without lasting adverse local or regional environmental or economic effects, and without undermining family or community wellbeing, public health or the rights and interests of potentially affected Aboriginal groups. The Project will be developed in accordance with responsible mining practices that comply with sustainable development standards.

For all potential effects, the Pretivm has successfully avoided adverse effects entirely, or reduced them to insignificance. For many potential effects, no residual effects are predicted once proposed mitigation measures are implemented. For other potential effects, although residual effects are predicted, these residual effects, after mitigation, are rated not significant. The material conclusions of Pretivm's assessments of the residual Project-related effects and cumulative effects related to the environmental assessment of the Brucejack Project are summarized in Table 11-1.

Pretivm believes that the Project offers both short-term and long-term economic benefits to the region, the province, and the country. The Project also poses a relatively low risk of adverse environmental, social, economic, health, are heritage effects. While some effects are unavoidable, Pretivm is committed to working with local communities, Aboriginal peoples, and regulatory agencies to ensure that such effects are minimized.

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Climate Effects (Chapter 12)				
Rise in atmospheric GHG levels	Construction	Fuel and energy efficiency. Complete re-vegetation during Closure, for any area cleared of vegetation.	Not significant	n/a
Rise in atmospheric GHG levels	Operation	Fuel and energy efficiency. Complete re-vegetation during Closure, for any area cleared of vegetation.	Not significant	n/a
Surface Water Quality (Chapter 13)				
Mine Site Area and Receiving Environment				
Change in water quality of receiving environment due to localized increases in sulphate and metal concentrations (contaminants of potential concern: arsenic)	Construction Operation Closure Post-closure	Implementation of ML/ARD Management Plan (Section 29.10), Waste Rock Management Plan (Section 29.18), Tailings Management Plan (Section 29.15), Water Management Plan (Section 29.19), Aquatic Effects Monitoring Plan (Section 29.3).	Not significant	n/a
Change in water quality due to localized increases in sulphate and metal concentrations (contaminants of potential concern: chromium, zinc)	Operation Closure	Implementation of ML/ARD Management Plan (Section 29.10), Waste Rock Management Plan (Section 29.18), Tailings Management Plan (Section 29.15), Water Management Plan (Section 29.19), Aquatic Effects Monitoring Plan (Section 29.3).	Not significant	n/a
Change in water quality due to localized increases in nitrogen as nitrate, nitrite, ammonia (leaching of blasting residues)	Construction Operation Closure Post-closure	Implementation of Waste Rock Management Plan (Section 29.18), Tailings Management Plan (Section 29.15), Water Management Plan (Section 29.19), Aquatic Effects Monitoring Plan (Section 29.3).	Not significant	n/a
Change in water quality of receiving environment due erosion and sedimentation	Construction Operation Closure Post-closure	Use of best management practices to minimize sediment entry to waterbodies; Dust suppression on roads; Implementation of Soils Management Plan (Section 29.13), Water Management Plan (Section 29.19), Aquatic Effects Monitoring Plan (Section 29.3).	Not significant	n/a
Off-site Areas (Ancillary Project Infrastructure)				
Change in water quality of receiving environment	Construction Operation Closure	Implementation of ML/ARD Management Plan (Section 29.10), Soils Management Plan (Section 29.13), Best Management Practices (BMPs).	Not significant	n/a

(continued)

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment (continued)

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Aquatic Resources (Chapter 14)				
Mine Site Area				
Erosion and sedimentation	Construction Operation Closure Post-closure	Use of BMPs to minimize sediment entry to waterbodies. Dust suppression on roads. Tailings deposition to the deepest section of Brucejack Lake (eastern portion of lake), with subaqueous discharge designed to add tailings to the deepest area into sand filter. Implementation of Soil Management Plan (Section 29.13), Water Management Plan (Section 29.19), Aquatic Effects Monitoring Plan (Section 29.3).	Not significant	n/a
Change in surface water quantity	Closure	Use of BMPs and engineered water management structures to maintain natural drainage networks, as much as feasible. Diversion of non-contact water into existing water courses. Implementation of Water Management Plan (Section 29.19).	Not significant	n/a
Change in surface water quality	Construction Operation Closure Post-closure	Implementation of ML/ARD Management Plan (Section 29.10), Waste Rock Management Plan (Section 29.18), Tailings Management Plan (Section 29.15), Water Management Plan (Section 29.19), Aquatic Effects Monitoring Plan (Section 29.3).	Not significant	n/a
Change in sediment quality	Construction Operation Closure Post-closure	Use of BMPs to minimize sediment entry to waterbodies. Dust suppression on roads. Implementation of ML/ARD Management Plan (Section 29.10), Waste Rock Management Plan (Section 29.18), Soil Management Plan (Section 29.13), Water Management Plan (Section 29.19), Aquatic Effects Monitoring Plan (Section 29.3).	Not significant	n/a
Habitat loss	Construction Operation Closure	Tailings deposition to the deepest section of Brucejack Lake (eastern portion of lake), with subaqueous discharge designed to add tailings to the deepest area into sand filter.	Not significant	n/a

(continued)

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment (continued)

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Aquatic Resources (Chapter 14; (continued)				
Off-site Project Infrastructure Areas				
Change in surface water quality	Construction Operation Closure	Implementation of ML/ARD Management Plan (Section 29.10), Waste Rock Management Plan (Section 29.18), Tailings Management Plan (Section 29.15), Water Management Plan (Section 29.19), and Aquatic Effects Monitoring Plan (Section 29.3).	Not significant	n/a
Fish and Fish Habitat (Chapter 15)				
Fish				
Blunt tissue trauma	Construction Operation Closure	Use of best management practices to minimize fish mortality with construction machinery; Adhere to DFO's operational statements. Adhere to appropriate construction operating window for instream work. Site isolation. Controlled access. Implement of no fishing policy for employees and contractors.	Not significant	Not significant
Erosion and sedimentation	Construction Operation Closure	Use of best management practices to minimize sediment entry to waterbodies. Adhere to DFO's operational statements. Adhere to appropriate construction operating window for instream work and the Soils Management Plan. Riparian re-vegetation. Dust suppression on roads. Work site isolation. Water quality maintenance.	Not significant	Not significant
Fish Habitat				
Erosion and sedimentation	Construction Operation Closure	Use of best management practices to minimize sediment entry to waterbodies; Adhere to DFO's operational statements; Adhere to appropriate construction operating window for instream work and the Soils Management Plan; Riparian re-vegetation; Dust suppression on roads; work site isolation; water quality maintenance.	Not significant	Not significant
Terrestrial Ecology (Chapter 16)				
Alpine Ecosystems				
Loss and/or alteration of ecosystem function and extent	Construction Operation	Minimize loss; reclamation	Not significant	Not significant

(continued)

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment (continued)

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Terrestrial Ecology (Chapter 16; continued)				
Forested Ecosystems				
Alteration of ecosystem function and extent	Construction Operation	Minimize loss and adaptively manage effects.	Not significant	Not significant
Floodplain Ecosystems				
Alteration of ecosystem function and extent	Construction Operation	Minimize loss and adaptively manage effects.	Not significant	Not significant
Rare Plants and Lichen				
Loss of species and/ or loss or alteration of habitat	Construction and/or Operation	Avoidance, minimize clearing areas and implement biodiversity strategy.	Not significant	Not determined
Wetlands (Chapter 17)				
Wetland Function	Construction Operation Closure Post-closure	Invasive species management, vegetation management, soil management measures along roadways, transportation and access management for the exploration road, wetland monitoring, and environmental effects management and monitoring.	Not significant	Not significant
Wetland Extent	Construction Operation	N/A	N/A	Not significant
Wildlife (Chapter 18)				
Moose				
Disruption of Movement	Construction Operation	Traffic and road management, snow clearing protocol (gaps in snowbanks), regional monitoring and avoid building infrastructure near moose travel networks.	Not significant	Not significant
Direct Mortality and Injury	Construction Operation	Traffic, road management and monitoring.	Not significant	Not significant
Indirect Mortality	Construction Operation Closure Post-closure	Minimize development of new roads, control access on existing project roads and regional monitoring.	Not significant	Not significant

(continued)

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment (continued)

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Wildlife (Chapter 18; continued)				
Mountain Goat				
Sensory Disturbance	Construction Operation	Practising the current BC Guidelines for air traffic near mountain goat habitat. Participate in monitoring program.	Not significant	Not significant
Indirect Mortality	Construction Operation Closure Post-closure	Road access limited to employees with no public access and regional monitoring.	Not significant	Not significant
Grizzly Bear				
Disruption of Movement	Construction Operation	Reduced speed limits and employee education, shuttling staff to the site to limit traffic.	Not significant	Not significant
Direct Mortality and Injury	Construction Operation	Yielding to wildlife, signage along roads, and vegetation management at identified wildlife crossings.	Not significant	Not significant
Indirect Mortality	Construction Operation Closure Post-closure	Restricting road access and gates at the entrance to the access road to deter trespassers.	Not significant	Not significant
Attractants	Construction Operation	Waste management protocol, and planting less attractive roadside vegetation.	Not significant	Not significant
American Marten				
Attractants	Construction Operation	Waste Management Protocol and deter entry into infrastructure.	Not significant	Not significant
Western Toad				
Direct Mortality and Injury	Construction Operation	Amphibian tunnels and culverts, monitoring, and management plans and adaptive management.	Not significant	Not significant

(continued)

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment (continued)

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Economic (Chapter 19)				
Labour Market				
Increase in competition for labour and wage inflation	Construction Operation	Communications with Aboriginal and non-Aboriginal communities; communications with educational institutions, human resources policies and programs. Mitigation measures developed by other projects.	Not significant	Not significant
Decrease in employment at Closure	Closure	Communications with Aboriginal and non-Aboriginal communities; workforce transition programs. Mitigation measures developed by other projects.	Not significant	Not significant
Social (Chapter 20)				
Education, Skills Development, and Training				
Increase in demand for educational programs in the LSA	Construction Operation	Communicate Project development and workforce schedule with LSA communities and educational institutions; Proponent to work with government and other proponents when and where appropriate at the regional and local levels.	Not significant	Not significant
Community Infrastructure, Services, and Housing				
Increase in demand for infrastructure and housing as a result of population in-migration	Construction Operation	Communicate Project development and workforce schedule with LSA communities; Proponent to work with government and other proponents when and where appropriate at the regional and local levels.	Not significant	Not significant
Increase in demand on health and social services	Construction Operation	Communicate Project development and workforce schedule with LSA communities; Proponent to work with government and other proponents when and where appropriate at the regional and local levels.	Not significant	Not significant
Family and Worker Well-being				
Increase in transient workers in LSA communities	Construction Operation	Communicate Project development and workforce schedule with LSA communities; Proponent to work with government and other proponents when and where appropriate at the regional and local levels.	Not significant	Not significant

(continued)

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment (continued)

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Family and Worker Well-being (cont'd)				
Increase in stress levels and anxiety on families due to work schedule	Construction Operation	Employee assistance program; Proponent to work with government and other proponents when and where appropriate at the regional and local levels.	Not significant	Not significant
Increased in poor lifestyle choices	Construction Operation	Human resource policies and employee assistance program; Proponent to work with government and other proponents when and where appropriate at the regional and local levels.	Not significant	Not significant
Health (Chapter 21)				
Health Effects due to Air Quality				
Health Effects due to SO_2, NO_2, TSP, PM_{10}, and $PM_{2.5}$ emissions (Workers at camps and non-workers)	Construction Operation	Air quality will be monitored and mitigation strategies will be adjusted accordingly to meet BC MOE Air Quality Standards and Air Quality Management Plan. Emission control systems (e.g., scrubbers, bughouses, and filters) will be used on stack and relevant ventilation systems to reduce emissions. Vehicles will be maintained regularly, using diesel with lower sulphur content, using add-ons such as cabin heaters to reduce idling, optimizing driving speed to reduce fuel usage and fugitive road dust, use larger haul trucks to minimize the number of trips required, minimize drop distance of material into surge bin, stockpiles or between conveyor belts. Mitigation Measures included in the project design, such as underground mining process. Maintenance of equipment and vehicles on a regular basis. Watering unpaved access road to maintain a minimum of a 2% moisture ratio and achieving at least 75% of dust control efficiency.	Not significant	Not significant

(continued)

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment (continued)

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Heritage (Chapter 22)				
Disturbance of archaeological sites protected by the *Heritage Conservation Act* (1996a).	Construction Operation Closure	Avoidance, education, mitigation, Heritage Management Plan.	Not significant	Not significant
Navigation (Chapter 23)				
Ability to safely navigate Ability to access navigable waters	Construction Operation Closure Post-closure	Appropriate signage while works are being constructed or removed from waterways. Aerial cables and bridge decks will be installed at heights that do not interfere with navigation. Clear-span bridge designs. Any Project personnel operating boats on the lake will be made aware of any hazards, if any exist, and appropriate signage will be displayed.	Not significant	Not significant
Commercial and Non-commercial Land Use (Chapter 24)				
Commercial Land Use				
Change in the experience of the natural environment (relevant to commercial licence 6406985).	Construction Operation	Noise Management Plan (Section 29.11), Transportation and Access Management Plan (Section 29.16).	Not significant	Not significant
Change to the abundance and distribution of wildlife resources (relevant to guide outfitter licence 601036).	Construction Operation Closure	Wildlife Management and Monitoring Plan (Section 29.21).	Not significant	Not significant

(continued)

Table 11-1. Summary of Residual and Cumulative Effects for the Brucejack Environmental Assessment (completed)

Residual Effects: Environmental	Project Phase(s)	Mitigation Measures	Significance of Residual Project Effects	Significance of Residual Cumulative Effects
Current Use of Lands and Resources for Traditional Purposes (Chapter 25)				
Hunting and Trapping Opportunities and Practices				
Change in location, timing, and amount of wildlife harvested by Skii km Lax Ha, and displacement of hunting and trapping activities due to change in the abundance and distribution of resources.	Construction Operation	Access restrictions and speed limits, no hunting policy for employees, Wildlife Management and Monitoring Plan (Section 29.21), helicopter flight paths (Chapter 18, Section 18.5).	Not significant	Not significant

[1] *Increased annual runoff values and increased low flows were not considered as negative impacts, and therefore no further assessment was undertaken.*
[2] *No interaction with other projects was identified.*
[3] *The increase is expected to be less than 1%.*
n/a = not applicable: CEA is not possible for Project level GHG emissions (CEA Agency 2003)

References

References

1982. *The Constitution Act, 1982*, Schedule B to the *Canada Act 1982* (UK). C. 11.

1985. *Navigation Protection Act*, RSC. C. N-22.

1996a. *Heritage Conservation Act*, RSBC. C. 187.

1996b. *Mines Act*, RSBC. C. 293.

1996c. *Weed Control Act*, RSBC. C. 487.

2002a. *Business Corporations Act*, SBC. C. 57.

2002b. *Environmental Assessment Act*, SBC. C. 43

2002c. *Species at Risk Act*, SC. C. 29.

2003. *Environmental Management Act*, SBC. C. 53.

2004. *Cremation, Interment and Funeral Services Act*, SBC. C.35.

2012. *Canadian Environmental Assessment Act, 2012*, SC. C. 19, s. 52.

Metal Mining Effluent Regulations, SOR/2002-222.

BC EAO. 2014. *Brucejack Gold Mine Project: Application Information Requirements for Pretium Resources Inc.'s Application for an Environmental Assessment Certificate*. Prepared by the British Columbia Environmental Assessment Office: Victoria, BC.

BC ILMB. 2000. *Cassiar Iskut-Stikine Land and Resource Management Plan*. British Columbia Integrated Land Management Bureau. http://ilmbwww.gov.bc.ca/slrp/lrmp/smithers/cassiar/index.html (accessed June 2013).

BC MEM. 2012. *Mineral Exploration and Mining*. Prepared by the British Columbia Ministry of Energy and Mines: Victoria, BC.

BC MFLNRO. *2012. Nass South Sustainable Resource Management Plan*. http://www.ilmb.gov.bc.ca/slrp/srmp/south/nass/index.html (accessed November 2012).

BC MOE. 2009. *BC Ministry of Environment*. BC Species and Ecosystems Explorer. http://a100.gov.bc.ca/pub/eswp/ (accessed January 2010).

CEA Agency. 2003. *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners*. Prepared by the Canadian Environmental Assessment Agency. http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=A41F45C5-1 (accessed July 2012).

CEA Agency. 2004. *Canada-British Columbia Agreement for Environmental Assessment Cooperation (2004)*. https://www.ceaa-acee.gc.ca/default.asp?lang=En&n=04A20DBC-1 (accessed May 2014).

CEA Agency. 2013. *Environmental Impact Statement Guidelines for the preparation of an Environmental Impact Statement for an Environmental Assessment Conducted pursuant to the Canadian Environmental Assessment Act, 2012, Brucejack Gold Mine Project*. Prepared by the Canadian Environmental Assessment Agency: Ottawa, ON.

Farquharson, K., M. Campbell, D. Walker, S. McKnight, and L. Seip. 2012. *KSM Project: Archaeological Impact Assessment, Final Report – Heritage Inspection Permit 2012-0192*. Prepared for Seabridge Gold Inc. by Rescan Environmental Services Ltd.: Vancouver, BC.

Government of Canada. 2012. *Economic Action Plan*. http://www.actionplan.gc.ca/en (accessed May 2014).

Health Canada. 1999. *National Ambient Air Quality Objectives for Ground-Level Ozone*. http://www.hc-sc.gc.ca/ewh-semt/pubs/air/naaqo-onqaa/ground_level_ozone_tropospherique/summary-sommaire/index-eng.php (accessed May 2014).

Health Canada. 2010. *Useful Information for Environmental Assessments*. 978-1-001-15153-3. Health Canada: Ottawa, ON.

MacKenzie, W. H., and J. R. Shaw. 1999. *Field Description of Wetlands and Related Ecosystems in British Columbia*. BC Ministry of Forests Research Branch: Smithers, BC.

MacKenzie, W. H. and J. R. Moran. 2004. *Wetlands of British Columbia: A Guide to Identification*. Land Management Handbook 52. BC Ministry of Forests Research Branch: Victoria, BC.

Marshall, A., A. Marr, and A. Palmer. 2008. *Archaeological Impact Assessments of Forestry Blocks and Roads Proposed by Clients within the Kalum and North Coast Forest Districts, BC*. Heritage Inspection Permit 2006-193. Report on file at the Archaeology Branch, Victoria, BC.

MNBC. 2010. BCTC Columbia Valley Transmission CPCN, Exhibit C9-3: Response to the British Columbia Utilities Commission- Commission Information Request on the Evidence of the Metis Nation BC, BCTC Application for a Certificate of Public Convenience and Necessity (CPCN) for the Columbia Valley Transmission Project" http://www.bcuc.com/Documents/Proceedings/2010/DOC_25662_C9-3-MNBC-response-IR-BCUC.pdf (accessed February 2014).

Newhawk. 1989. *Environmental and Socioeconomic Impact Assessment for the Sulphurets Property*. Prepared by Newhawk Gold Mines Ltd.: Vancouver, BC.

NLG, Province of BC, and Government of Canada. 1998. *Nisga'a Final Agreement*. Nisga'a Lisims Government, Province of British Columbia, and Government of Canada: New Aiyansh, BC.

Northwest Invasive Plants Council. 2012. *Welcome to the NWIPC*. http://www.nwipc.org (accessed October 2012).

Price, W. 2005. *Case Studies of ML/ARD Assessment and Mitigation: Placement of the Sulphurets Waste Rock in Brucejack Lake*. MEND Report 9.1c CANMET-MMSL 05-023(CR). July 2005 version.

Rescan. 2013a. *Brucejack Gold Mine Project: Project Description*. Prepared for Pretium Resources Inc. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2013b. *KSM Project: Application for an Environmental Assessment Certificate/Environmental Impact Statement*. Prepared for Seabridge Gold Inc. by Rescan Environmental Services Ltd. Vancouver, BC.

Sayers, P. B., J. W. Hall, and I. C. Meadowcroft. 2002. *Towards Risk-based Flood Hazard Management in the UK*. Proceedings of the Institution of Civil Engineers: Civil Engineering, 150: 36-42.

Seip, L., S. McKnight, D. Walker, M. Campbell, and K. Farquharson. 2012. *KSM Project: Archaeological Impact Assessment, Final Report – Heritage Inspection Permit 2008-128*. Prepared for Seabridge Gold Inc. by Rescan Environmental Services Ltd.: Vancouver, BC.

The Thing. 1982. Directed by John Carpenter. Universal Pictures Film.

Transport Canada. 2014. *Navigation Protection Program – Overview*. Government of Canada. http://www.tc.gc.ca/eng/programs-621.html (accessed January 2014).