30. Closure and Reclamation

30.1 INTRODUCTION

This chapter provides a conceptual closure and reclamation plan for the Brucejack Gold Mine Project (the Project), consistent with the Brucejack Gold Mine Project Application Information Requirements (AIR). The AIR requires the conceptual plan to be based on the requirements for a permit approving the mine plan and the closure and reclamation program, pursuant to the *Mines Act* (1996a).

Closure and reclamation planning for the Project will contribute to the success of closure and reclamation during mining and at the end of mine life, which will minimize potential environmental effects of the Project. The Project's design as an underground mine with subaqueous lake deposition of PAG mine wastes has resulted in an extremely small mine site surface development footprint of approximately 24.0 ha, including the NPAG quarry (4.8 ha). This is compared to open pit mining operations which often have surface development footprints at scales of thousands of ha.

Mine development and operation will incorporate techniques to minimize surficial disturbance. There will be early-stage reclamation of some surface disturbances created during the Construction phase, such as around the buildings and site roads on the Mine Site, at the Tide Staging Area (used for construction only) and along the Brucejack Access Road widened sections. Stabilizing and rehabilitating surfaces where feasible will reduce the potential for degradation of the limited soil resource due to extended exposure to climatic factors, thereby reducing closure-related capital costs at the cessation of mining activities.

This Closure and Reclamation Plan includes several components:

- an overview of the regulatory framework related to closure and reclamation, including applicable legislation, standards, and guidelines;
- closure and reclamation objectives;
- conceptual plans for closing and reclaiming each component of the Project including the Brucejack Mine Site (the mine site), the Brucejack Transmission Line, the Brucejack Access Road, the Bowser Aerodrome, the Knipple Transfer Area, and the Tide Staging Area;
- conceptual information on the anticipated schedule for closure and reclamation activities;
- plans for reclamation monitoring;
- reclamation research programs that will be undertaken during operation;
- Pretivm's intentions for reclamation and closure of the Project in the event of premature closure of mining operations;
- estimate of closure and reclamation costs; and
- post-closure activities, including post-closure monitoring programs and monitoring costs.

The environmental management and monitoring systems developed for the Project are designed to protect, to the extent feasible, terrestrial, aquatic, heritage, and archaeological resources during mine Construction, Operation, Closure, and Post-closure phases. Environmental management plans are summarized in Chapter 29 of the Application/EIS. Concurrent with the initiation of mining, monitoring programs for wildlife, vegetation, and aquatic effects will be implemented to measure changes in either the terrestrial or aquatic environments. The results from monitoring programs will be used to improve environmental management systems, as appropriate and to support progressive reclamation and closure.

30.2 REGULATORY FRAMEWORK

30.2.1 British Columbia *Mines Act* and Health, Safety and Reclamation Code

The BC *Mines Act* (1996a) and Health, Safety and Reclamation Code for Mines in British Columbia (the Code; BC MEMPR 2008) require mining operations to carry out a program of environmental protection and reclamation to return, where practical, land, watercourses, and cultural heritage resources to a safe and environmentally sound state and to an acceptable end land use upon termination of mining. The *Mines Act* and the Code are administered by the Ministry of Energy and Mines (MEM). The Chief Inspector of Mines has authority for all permits and approvals under the *Mines Act* and the Code.

Proponents of mining projects are required to obtain a permit from the MEM prior to commencing any work on a mine site, in accordance with Section 10 of the *Mines Act*. Section 10 of the *Mines Act* (1996a) requires that a permit application must include "a plan outlining the details of the proposed work and a program for the conservation of cultural heritage resources and for the protection and reclamation of the land, watercourses and cultural heritage resources affected by the mine, including the information, particulars and maps established by the regulations or the code" (Section 10.1). As a condition of issuing a permit, the Chief Inspector may require a financial security for mine reclamation, and to provide for protection of, and mitigation of damage to, watercourses and cultural heritage resources affected by the mine (Section 10.4).

A financial security is required as a condition of all *Mines Act* permits (Sections 10.4 and 10.5) for all, or part of, outstanding costs associated with mine reclamation and the protection of land, watercourses, and cultural resources, including post-closure commitments. The security held under the *Mines Act* (1996a) can also be used to cover the requirements of legislation, permits, and approvals of other provincial agencies.

The objective of BC's reclamation security policy is to provide reasonable assurance that the Provincial Government will not have to contribute to the costs of reclamation and environmental protection if a mining company defaults on its obligations. In the case of a company default, the security amount should be sufficient to allow Government to successfully manage the environmental issues at the mine site, complete any outstanding reclamation requirements, and continue to monitor and maintain the site for as long as is required (BC MEM 2009). Typically, MEM reviews the reclamation security at a mine site every five years, or whenever significant changes occur at the mine. The security obligation may increase or decrease depending upon assessed liability at the time and financial factors such as real return bond yields. The costing developed for the Brucejack Gold Mine closure plan forms the basis for the Financial Security.

30.2.2 Metal Mine Effluent Regulations

The Metal Mine Effluent Regulations (MMER; SOR/2002-222), enacted in 2002, are relevant to the Project according to Section 2(1) of the Regulations which states that the Regulations apply in respect to mines that:

(*a*) at any time after June 6, 2002, exceed an effluent flow rate of 50 m^3 per day, based on effluent deposited from all the final discharge points of the mine; and

(*b*) deposit a deleterious substance in any water or place referred to in subsection 36(3) of the *Fisheries Act:* "no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water."Fish have never been found in the Brucejack watershed or

in Sulphurets Creek upstream of a 200-m cascade in Sulphurets Creek (Tripp 1987; Rescan 2010; Rescan 2013b; Rescan 2013c). The cascade is an impassable upstream barrier for fish and is approximately 1,300 m upstream of the Unuk River confluence and approximately 21 km downstream of the Project. The receiving environment (Brucejack Creek) is in the headwaters of Sulphurets Creek, which is a tributary to the Unuk River. The results of the predictive water quality modelling for the Project (Section 13.6) conclude that there will be no significant residual effects for water quality of the receiving environment (assessment point: BJ 200 m D/S) as a result of Project activities (Sections 13.6, 13.7). Further, incremental increases of water quality parameters due to chemical loading upstream at Brucejack Creek are expected to be negligible/ indistinguishable from background in Sulphurets Creek (mid-field receiving environment). Thus, the potential for any effects to occur in far-field fish-bearing waters (i.e., change in water quality ~21 km downstream of the outflow of Brucejack Lake and Brucejack Creek) is considered extremely unlikely; no Project activities are predicted to affect fish and fish habitat (water quality, sediment quality, and quantity, and aquatic resources) in lower Sulphurets Creek and the Unuk River downstream of the cascade (Sections 10.8, 13.6, and 14.6).

30.2.3 *Environmental Management Act* and *Canadian Environmental Protection Act*

The BC *Environmental Management Act* (2003) prohibits the discharge of waste to the environment unless specifically authorized. While there are different types of authorizations under the Act, most mining operations require air emissions, solid refuse, and effluent discharge permits (MOE 2013).

A permit authorizes the discharge of wastes from an industry, trade, business, operation, or activity to the environment, and sets the terms and conditions under which the discharge may occur so that pollution is prevented. The terms and conditions include limiting the quantity and quality of waste contaminants, monitoring the discharge and the receiving environment, and reporting information to the Ministry. Permits are ongoing authorizations and may be amended, transferred to other dischargers, suspended or cancelled (BC MOE 2013).

The *Canadian Environmental Protection Act* (1999) regulates the release of toxic substances into the environment, which includes potential contamination of soil by mining activities (Part 9 of the Act). The closure of the components of the Brucejack Project will be carried out in a manner to meet applicable regulatory requirements.

30.2.4 *Water Act*

In British Columbia, ownership of water is vested in the Crown as stated in the BC *Water Act* (1996b). The *Act* is the principal law for managing the diversion and use of Provincial water resources. Under the *Act*, approvals are required for making changes in and about a stream, to authorize construction of works, and the diversion and use of water and water withdrawals. The Brucejack Mine Site surface water management system will be constructed, operated and closed in compliance with the *Water Act*.

30.3 CLOSURE AND RECLAMATION OBJECTIVES

Part 10 of the Code focuses on reclamation and closure. Section 10.7 identifies reclamation standards. Section 10.7.4 (Land Use) indicates: “The land surface shall be reclaimed to an end land use approved by the chief inspector that considers previous and potential uses.” Section 10.7.5 (Capability) indicates: “Excluding lands that are not to be reclaimed, the average land capability to be achieved on the remaining lands shall not be less than the average that existed prior to mining, unless the land capability is not consistent with the approved end land use.” Section 10.7.6 (Long Term Stability) states: “Land, watercourses and access roads shall be left in a manner that ensures long-term stability.”

Pretivm's goal is to develop a conceptual Closure and Reclamation Plan for the Brucejack Gold Mine Project that will meet the requirements of the Code and provide assurance to the Province that the site will be left in a condition that will limit any future liability to the people of BC. The three objectives of the conceptual Closure and Reclamation Plan are to:

1. protect aquatic and terrestrial resources, most importantly by planning the mine to prevent or minimize adverse effects on water quality and associated aquatic resources, and by minimizing the terrestrial development footprint;
2. provide stable landforms; and
3. where feasible, establish post-mine productive land use(s) similar to those present pre-mine.

30.3.1 Provision of Stable Landforms

The design of the Project's mine-related surface development, such as the constructed pads, portals, ventilation shafts, and quarry, has been undertaken to ensure long-term stability during mine operations, following mine closure, and after reclamation works are complete. Stable landforms require a stable foundation. Field investigations were undertaken to enable feasibility level design of the pads that will be constructed to support the mill building, operations camp, truckshop, helipad and fuel storage, substation, and various other pads to provide a stable surface for the operations infrastructure. Geotechnical site investigations comprised geological mapping of decline routes for the underground operations, outlet of Brucejack Lake, and site road design. In summary, geotechnical and hydrogeological investigations have included:

- rock mass characterization;
- structural geology interpretation;
- excavation and pillar stability analysis;
- groundwater support design;
- geotechnical drilling;
- oriented drill core measurements;
- borehole televiewer surveys;
- laboratory testing of rock and overburden samples;
- installation of piezometers to measure groundwater pressures;
- specific gravity testing;
- geophysical surveys;
- test pit excavations; and
- geological modelling.

30.3.2 End Land Use Objectives

The pre-development land use and conditions form the basis for setting the end land use and capability objectives. The goal is to return the site to a use consistent with pre-mine land uses, wherever feasible. Biophysical information on the Project components (i.e., Mine Site, Access Road, Transmission Line, Bowser Aerodrome, Knipple Transfer Area, and Tide Staging area) has been obtained from the environmental and socio-economic baseline studies, which were initiated in 2010 and continued into 2012, as well as, from other studies carried out for the Project. These studies were undertaken in

consultation with the Brucejack Gold Mine Project Environmental Assessment Working Group which includes provincial and federal government agencies, the Skii km Lax Ha, Nisga'a Nation, and Tahltan Nation. The following description of the current conditions of the Project components forms the basis for determining the end land use objectives.

30.3.2.1 Brucejack Mine Site

The Brucejack Mine Site is located in a rugged area at approximately 1,400 m above sea level (masl). Surrounding peaks are up to 2,200 m in elevation. Glaciers and icefields surround the mineral deposits to the west, south, and east. Recent and rapid deglaciation has resulted in over-steepened and unstable slopes in many areas. Recently deglaciated areas typically have limited, if any, soil development; where present, soils are derived from glacial till and colluvium. The Brucejack Mine Site is located above the tree-line in the Coastal Mountain-heather Alpine (undifferentiated; CMAun) Biogeoclimatic Zone BEC zone. This zone has the harshest climate of any of the biogeoclimatic zones in British Columbia. Temperatures are low for most of the year, with much wind and snow. Temperatures remain low even during the growing season, which has an exceptionally short frost-free period. Mean annual temperatures range from 0° to 4°C.

The Mine Site area is predominantly barren rock (Plate 30.3-1). Approximately 80% of the Mine Site can be classified as non-vegetated and sparsely vegetated. Patches of snow, névé, and firn persist late into the year.

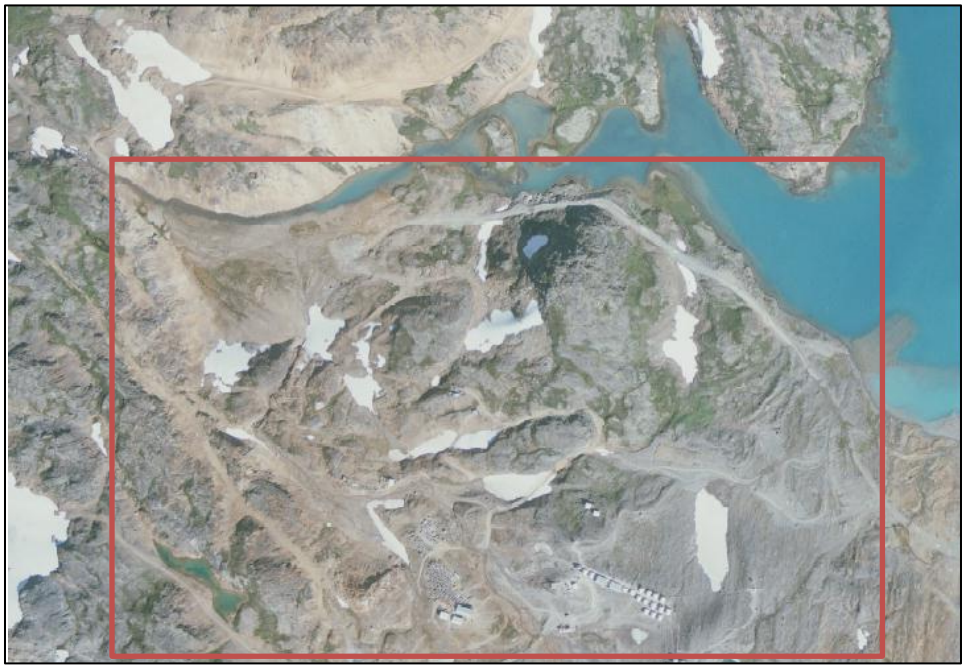


Plate 30.3-1. Brucejack Mine Site area (2014).

Vegetation community development within the mine site is influenced by the recent deposition of the soil parent material, excessive snow pack, wind, and low temperatures. Vegetation classes of the Alpine Group (MacKenzie 2012) are present as a mosaic across the landscape, the distribution of which is determined by soil depth, drainage, and microclimate. The vegetation includes small shrubs, lichen, and mosses. Most of the ecosystems within the mine site area are early seral, disclimax, or edaphic climax ecosystems. Early seral ecosystems, such as the areas mapped as alder thicket, are those early in the successional status chrono-sequence. These include non- and sparsely vegetated, pioneer seral,

and young seral communities. Edaphic ecosystems include those maintained by local climatic and soil conditions that enable an ecosystem to perpetuate itself. Alpine Tundra Class vegetation communities are dominated by hardy ericaceous shrubs that can withstand the desiccating winds common in alpine environments. Alpine vegetation classes include Alpine Fellfield, Heath, and Meadow classes (see Appendix 16-A (2012 Terrestrial Ecosystem Baseline Studies) for the detailed vegetation and terrain mapping of the Mine Site area). Extensive advanced exploration activities over the past 30 years have disturbed much of the proposed mine site area (Plates 30.3-2 to 30.3-4).

Plate 30.3-2. Overview of Brucejack Exploration (Future) Mine Site area (2013).

Plate 30.3-3. View of Brucejack Mine Site area activity.

Plate 30.3-4. View of Brucejack Mine Site area activity showing exposed surface materials.

The mine site will be located primarily on bedrock outcropping with some morainal material occurring as pockets with alpine vegetation. The end land use objective for the Mine Site is to provide for stable landforms with limited revegetation.

Access Road, Bowser Aerodrome, and Knipple Transfer Area

Road access to the Mine Site will be via the existing 73 km Brucejack Access Road from Highway 37. Minor road upgrades are planned to improve safety and to handle the higher traffic loads from both construction and operations activities. The Bowser Aerodrome and the Knipple Transfer Area will be located along the Brucejack Access Road.

The Access Road occurs at approximately 500 masl at the lower elevations and predominantly in forested ecosystems, wetlands, and floodplain ecosystems (Plate 30.3-5). Most of the forests are mature and old. Shrub-dominated and young seral forests occur in areas that were recently harvested, are subject to active flooding, or are in younger stages due to recent wildfire disturbance.

At higher elevations the road traverses upland ecosystems within the Very Wet Cold Interior Cedar Hemlock (ICHvc) subzone which typically possess a dense cover of hybrid white spruce and western hemlock trees. Subalpine-fir becomes the dominant tree species at higher elevations and in areas where colder air persists. Subalpine-fir (*Abies lasiocarpa*) is also the dominant tree species within the floodplain ecosystems of the ICHvc subzone, along with black cottonwood (*Populus balsamifera*) and some hybrid white spruce (*Picea glauca x engelmannii*).

Treed ecosystems often occur as elevated islands within braided stream systems and are very common in the Bowser River delta, between Bowser and Knipple lakes. Near the Bowser River delta, an abundance of flood and early seral ecosystems occur on the active fluvial deposits. Floodplain ecosystems in this area include low, medium and high bench ecosystems. The low bench ecosystems are often dominated by willows (*Salix* spp.) including variable willow (*Salix commutata*) and Barclay's willow (*Salix barclayii*; Plate 30.3-6). Medium and high bench floodplain ecosystems typically occur on soils with relatively xeric to

submesic moisture regimes with edaphic indicator species such as smooth-leaved mountain-avens (*Dryas integrifolia*), soopolallie (*Shepherdia canadensis*), and various species of lichens. The delta narrows to the west, towards Knipple Lake where the road continues along the high bench floodplain, bounded by steep colluvial slopes to the north, and the outflow to the south. Forested ecosystems are less common in this area due to recent deglaciation and soils are either poorly developed or absent. The edaphic climatic influence of the existing glaciers reduces the length of the growing season in this area.

Plate 30.3-5. Mature forested ecosystems close to Highway 37, along the Access Road.

Plate 30.3-6. Willow and other shrubs characteristic of historic Bower Aerodrome area with the remnants of a former airstrip.

Moose have been observed close to the western edge of Bowser Lake. Low elevation areas were found to have suitable bat habitat. A large proportion of bat detection occurred within these low elevation areas, including at a lake between the Wildfire Creek and McInnes Creek watersheds and a riparian habitat along the Scott Creek and Bowser River confluence. Waterbirds were observed along Bowser River, Knipple Lake, and at the confluence of Bowser River and Bowser Lake during spring staging. The largest abundance of waterbirds was observed during staging or spring pair surveys as opposed to during the brood survey, suggesting that the available habitat in the Brucejack Project area may be more important for staging than for breeding.

Hoary marmots were observed along the access route, especially in areas close to Knipple Glacier and Scott Creek. Areas of high value marten habitat were recorded along the eastern stretch of the Access Road and south along Scott Creek. Suitable short-eared owl nesting habitat was identified in a relatively small area near the mouth of the Bowser River. In general, areas with the highest average bird abundance and highest species richness were in the eastern half of the Access Road, including Scott Creek drainage near Todedada Lake, the upper Bowser River, and areas within 2 km of Highway 37. On average, more upland bird species and breeding territories were observed in roadside habitats compared to non-roadside habitat.

Western toad breeding sites were located within 5 km of the Access Road; five sites were less than 2 km away. Off-site areas including the access road corridor has suitable western toad habitat in many locations due to the low elevation riparian habitat connected to watercourses, waterbodies, and wetlands (e.g., the Bower River, Bowser Lake, Wildfire Creek, Scott Creek, Knipple Lake, Todedada Creek, Todedada Lake, and the Bell-Irving River), flat forest lands, and ditches associated with historical forestry access roads. The westernmost 15 km of the Brucejack Access Road is above treeline or occurs along the Knipple Glacier.

The end land use objective for the Access Road will be to match the current surrounding land use/cover that includes alpine, rock/moraine, glacier, forest, and grasses and shrubs, wherever feasible.

Brucejack Transmission Line

The Brucejack Transmission Line overlaps the greatest number of BEC units and grades from old forest in the south to early seral ecosystems and non-vegetated areas in the north. Beginning near the Long Lake Hydroelectric Project in the south, this area extends approximately 53 km to the top of the Knipple Glacier (south-east of the Brucejack Camp). The southern reaches are comprised of shallow colluvial veneers over bedrock and steep slopes, often exceeding 60% (Plate 30.3-7). Ecosystems in this area are transitional and within this transition area, there is a marked and observable difference in vegetation communities between site series. As the corridor proceeds north, western hemlock becomes a minor component of the canopy, eventually being replaced by mountain hemlock (*Tsuga mertensiana*). The understory becomes less vigorous and diverse as the climate becomes colder and wetter. Colluvium, moraine, rock, and ice are the dominant surficial materials mapped.

Most of the Transmission Line route is located either above tree line or in high subalpine areas. Transmission Line construction will be helicopter supported, with road based support limited to use of existing roads (e.g. Brucejack Access Road; Granduc Road).Transmission Line tower bases are expected to have dimensions of 2 m by 2 m, with some additional limited surface disturbance resulting from installation of the tower anchors and drill use at each site. Towers will be sited on bedrock as much as possible. Due to all these factors, surface disturbance and effects on vegetation as a result of the transmission line are expected to be very limited.

Plate 30.3-7. Forests along the south end of the Brucejack Transmission Line.

There is generally minimal disturbance/modification of areas associated with the Transmission Line construction and use. The end land use objective will be to return the Transmission Line corridor to vegetation cover/use that existed prior to development. The transmission line infrastructure will be removed.

30.4 DETAILED SOIL MANAGEMENT PLAN

The following is a discussion of soil and overburden salvage for each of the four general Project Component areas, identified as follows: Mine Site, Bowser Aerodrome, Knipple Transfer area, and Tide Staging area. Baseline soils information, including mapping and typical inspection site data, is presented in the 2012 Terrestrial Ecosystem Baseline Studies report (Appendix 16-A). Polygon references in the following text are from the soil and TEM maps presented in that report. Interpretation of the soil map along with detailed imagery, site photographs, and local topographic information provided additional information on potential salvage for the specific component footprints.

The following subsections generally describe the soil and/or overburden resources within the footprint of each of the four principal disturbances as well as the salvage issues likely to be encountered within the footprint polygon. Soil salvage operations will be based on actual conditions at the site.

30.4.1 Brucejack Mine Site

30.4.1.1 Soil Assessment

The Brucejack Mine Site is located in the high elevation, very cold Coastal Mountain-heather Alpine (undifferentiated; CMAun) BEC subzone. The future disturbance area has been estimated at about 24 ha; this area includes the proposed surface development at the mine site proper as well as the quarry (NPAG) (4.8 ha). Vegetation is sparse, generally covering less than 20% of the mine site. This sparseness is due to the occurrence of extensive bedrock in the area. That is, both the limited extent and poor quality of soils (many of which would not meet the definition of soils), are a result of limited weathering of parent materials and the site's location primarily on a gossan (mineralized, acidic rock on surface) (Plate 30.4-1); in addition to historical disturbance of soils due to advanced mineral exploration activities.

Plate 30.4-1. Brucejack Mine Site located on a gossan.

Where soils are present, they are generally rated as poor due to the high coarse fragment content, high mineral content, or lack of soil development or they occur as a thin veneer over bedrock. Most material proposed for salvage at the Mine Site is overburden, as the very limited surficial material that may have been present in some areas has been disturbed. The overburden comprises recently deposited/exposed morainal and residual (materials developed in-place) materials. A small area of Fair to Good rated soil material may be present along the shore of Brucejack Lake (Polygon 608; Figure 30.4-1) and between rock outcrops in some areas (Plate 30.4-2).

The overall lack and/or poor quality of soil or soil-textured material in the Brucejack Mine Site area requires that a key objective of the local salvage program will be to recover any surficial material that may be suitable for use as root zone material (growth medium) for reclamation. These suitable materials include any soil and/or overburden that exhibits suitable physical soil characteristics (contains some appreciable fines) and is not metal leaching or acid generating.

30.4.1.2 Soil Salvage

The Mine Site area is hummocky with rock outcrops and has patchy, shallow, soil development in residual/colluvial and morainal materials and extensive disturbed areas (Plate 30.4-3; Polygons 605, 608, 609, 610, 622, and 636). A small area of near level sediments of fluvio-lacustrine and fill (Polygon 608) occurs near Brucejack Lake, near the proposed Detonator Storage area. The plan is to salvage suitable soils/overburden for reclamation where surficial materials will be removed in preparation for the construction of the pads, roads, pipelines, and other structures.

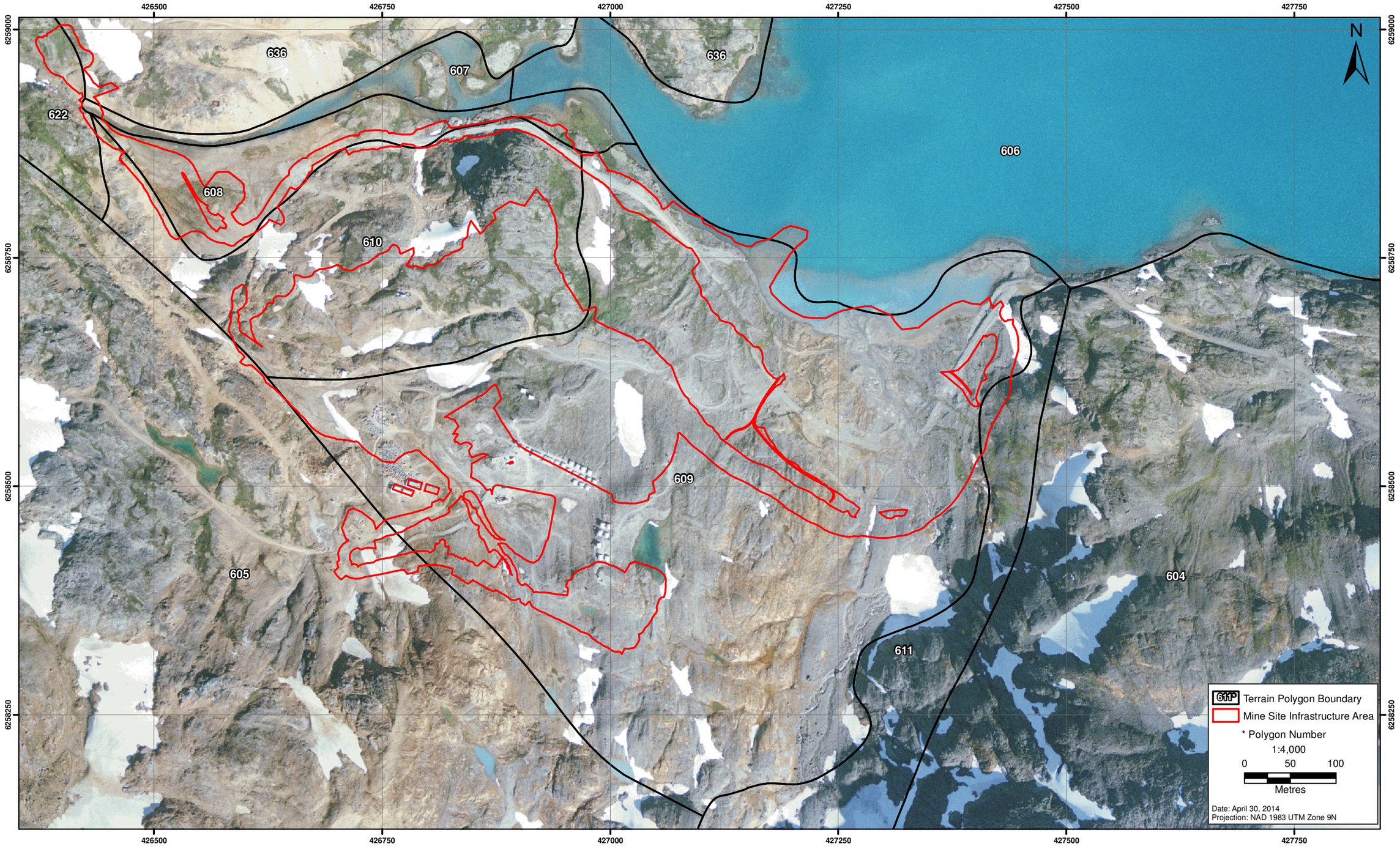
Soil salvage will be limited to the areas of unconsolidated surficial materials (morainal, colluvial/residual and fluvio-lacustrine) with suitable physical and chemical characteristics. The topsoil (brown soil; e.g., Plate 30.4-2), if sufficiently deep to allow separate salvage, will be separated from the overburden as the topsoil will include the root material and organically enriched surface and subsurface material. In areas where the developed soil profile is thin (most areas), the topsoil and its associated parent material will generally be salvaged in one lift, i.e., soil will not be selectively handled relative to the underlying suitable overburden. Salvage operations, most likely undertaken with an excavator, will be challenging due to the

hummocky to steep topography and the irregular depth to bedrock in these areas. Some materials already in stockpiles and or used as fill on-site may be suitable for reclamation use.

Plate 30.4-2. Stony soils in undisturbed area between rock outcrops at the Brucejack Mine Site.

Plate 30.4-3. Bowser Camp and Historic Newhawk Airstrip; Site of Proposed Aerodrome.

Figure 30.4-1
Terrain Mapping Polygons in the Brucejack Mine Site Area



An estimate of soil salvage volume has been made based on existing site information (Table 30.4-1). The amount of potentially salvageable material, from the mine site area is estimated to be about 16,145 m^3. This estimate is based on an average thickness of 0.3 m (combined soil and overburden) salvaged primarily from an area equivalent to approximately 35% of Polygon 609. Relatively small areas of potential salvage, 10% or less, are estimated from other polygons. No salvage is predicted from the quarry area.

Table 30.4-1. Potential Soil Salvage in the Brucejack Mine Site Footprint

Soil Polygon	Area (ha)	% Mine Site Footprint	Salvage Thickness (m)	Salvage Area (ha)	Extent of Polygon (%)	Salvage Volume (m^3)	Description
605	0.36	2	0.3	0.04	10%	108	residual overburden
608	1.31	5	0	0.13	10%	-	100% disturbed/non soil may be suitable
609	13.47	66	0.3	4.71	35%	14,144	morainal/residual non-soil
610	4.71	23	0.3	0.47	10%	1,413	bedrock/non-soil morainal/residual
611	0.01	0	0		0%	-	bedrock/residual; steep
622	0.23	1	0.3	0.16	70%	483	morainal veneer
636	0.1	0	0		0%	-	bedrock
Total	**20.19**	**100**		**5.51**		**16,148**	

30.4.1.3 Soil Stockpiling

The soil/overburden that is salvaged will be stockpiled in the Mine Site area in locations that will not be disturbed by mine operations. The soil/overburden stockpiles will be broadcast seeded with a native grass mixture such as the following:

- Alpine bluegrass (*Poa alpine*);
- Spike trisetum (*Trisetum spicatum*);
- Rocky mountain fescue *(Festuca saximontana*); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

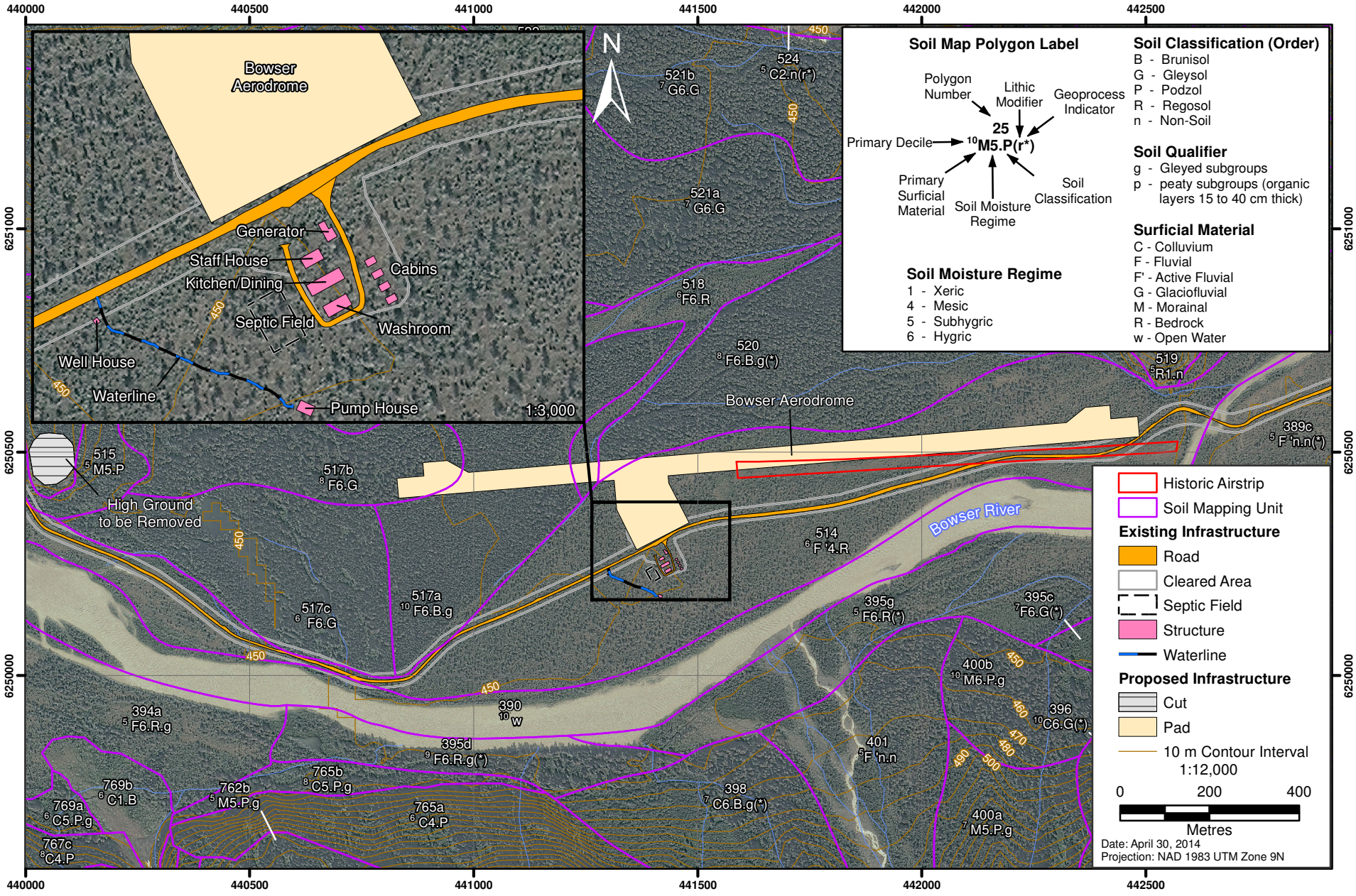
These plant species occur in the Mine Site area. The seed will be certified weed free and applied at 40 kg/ha. As the overburden stockpile material will have low organic matter content and low fertility, fertilizer (16-16-16 NPK) will be applied at 40 kg/ha to promote plant establishment. The seed is suitable for erosion control and will provide surface coverage. Seeding will occur in the spring or fall; the growing season is too short for summer seeding as the plants need to be established before fall.

30.4.2 Bowser Aerodrome

The Bower Aerodrome will be located approximately 2 km east of Knipple Lake. Currently, the old Newhawk airstrip, now overgrown, occupies 2.3 ha on the north side of Bower River (Plate 30.4-3). Pretivm's Bowser Camp is also located on the north side of the Bower River in proximity to the proposed Aerodrome; some of the existing camp facilities will also serve the Aerodrome (Figure 30.4-2). The overgrown historic airstrip will be cleared of brush in the area where it coincides with the new airstrip.

Figure 30.4-2

Soil Mapping of the Existing Bowser Camp, Historic Airstrip, and Proposed Aerodrome Facility



30.4.2.1 Soil Suitability

Soils cannot be salvaged from the historic airstrip or camp. The proposed aerodrome will occupy 9.7 ha and will overlap the historic airstrip by 0.3 ha at the western end. A remote hilltop leveling component (1.0 ha) will be required for aircraft use.

The proposed aerodrome will be located primarily on a lower bench of the Bowser River floodplain (Figure 30.4-2), in an area of immature, deciduous tree cover, in the Engelmann Spruce-Subalpine Fir Wet Very Cold subzone (ESSFwv) BEC subzone. Except for areas of past disturbance (airstrip and access road development) at the east end of the proposed aerodrome, the area is vegetated with deciduous shrubs and trees including willow, hybrid spruce, subalpine fir, soopolallie (*Shepherdia canadensis*), and dryas (*Dryas drummondii;* Plate 30.4-4).

Plate 30.4-4. Vegetation common in the aerodrome area.

The undisturbed soils include weakly developed, shallow, Regosols developed in rapidly pervious, coarse textured, gravelly to cobbly/bouldery material (Polygon 514) and slightly deeper developed Brunisols (Polygons 517a and 517b; Plates 30.4-5 and 30.4-6). The local water table fluctuates seasonally in association with local river water levels and may impact the root zone at its highest levels. Soil suitability for reclamation use is generally poor because of the combination of high coarse fragment content, coarse soil textures, and shallow soil development (low organic matter accumulation and content at depth). The underlying parent material (C horizon), for the soil polygon areas within the proposed airstrip footprint is rated poor but suitable and varies little from the surface soil material.

30.4.2.2 Soil Salvage

There is little soil to salvage in Polygon 514 in which 80% of the aerodrome will be located (Table 30.4-2). Clearing and grubbing operations will likely capture the extent of soil development in what appears to be a recently stabilized floodplain area. Grubbing material will be stockpiled for later re-use as surface amendments (0.1 m thickness for estimating purposes). The depth of soil salvage in Polygons 517a and 517b is generally restricted to the depth of moderate soil profile development, i.e., 0.3 m thickness (including the surface litter/duff material and mineral A and B horizons).

Plate 30.4-5. Gravelly soils in the Bowser Aerodrome area.

Plate 30.4-6. Gravelly soils and subsoils occurring in the Bowser Aerodrome site.

Table 30.4-2. Potential Soil Salvage in the Bowser Aerodrome Facility

Soil Polygon	Aerodrome Area (ha)	% of Aerodrome Facility	Thickness (m)	Extent of Salvage %	Salvage Volume (m^3)	Description
514	7	74%	0.1	80%	5,600	recent fluvial deposit
517a	1.24	13%	0.2	100%	2,480	older terrace, slightly deeper soil development
517b	0.76	8%	0.2	100%	1,520	older terrace, slightly deeper soil development
518	0.26	3%	0.2	100%	520	wet depression/ephemeral channel
520	0.2	2%	0.2	100%	400	older terrace, slightly deeper soil development
Total	**9.46**	**100%**			**10,520**	
Soil Polygon	**Area (ha)**	**% of High Ground**	**Thickness (m)**	**Extent of Salvage %**	**Salvage Volume (m^3)**	**Description**
515	0.2	21%	0.3	30%	182	70% excessively steep to salvage
674	0.75	79%	0.3	30%	676	excessively steep to salvage
Total	**0.95**	**100%**			**858**	

As with the irregular depositional pattern common to floodplain deposits, there may be deeper pockets of better quality (slightly to non-gravelly and/or finer textures) soil parent materials that could be preferentially salvaged compared to the surface, cobbly/bouldery materials. In the floodplain area, preference may be given to the salvage of physically more suitable (low coarse fragment content and moderate texture) “overburden” or parent materials rather than poor quality soil. Soil suitable for reclamation is not available over the existing airstrip and/or road disturbances.

All salvage depths are subject to confirmation at the time of supervised salvage. A check of soil depth and coarse fragment content will be undertaken over the undisturbed portion of the landscape prior to the initiation of salvage operations to confirm the salvage strategy for this area. Wet soil conditions can be anticipated in the slightly depressed terrain of Polygon 518; therefore, feasible work in this area will be scheduled outside of the anticipated period of high groundwater conditions. Excessively steep terrain will limit salvage on the hill top cut (Polygons 515 and 674).

The amount of potentially salvageable material from the Aerodrome development footprint is estimated to be 11,378 m^3 (10,520 m^3 aerodrome facility and 858 m^3 hilltop cut (Polygons 515 and 574) (Table 30.4-2). The estimate for the aerodrome is based primarily on an estimated average thickness of 0.1 m (combined soil and litter/duff) from an area equivalent to approximately 80% of the footprint within Polygon 514, and a thickness of 0.2 m for 100% of the footprint within Polygons 517a, 517b, 518, and 520. Equipment ability to salvage to 20 cm depth is expected to be constrained by large cobbles and rocky material present near to surface over much of the area, as well as inherent equipment limitations with such a shallow salvage depth. The estimate for the hilltop cut is based on an estimated average thickness of 0.3 m (combined soil B horizon and litter/duff) from an area equivalent to approximately 30% of the footprint within Polygons 515 and 674.

30.4.2.3 Soil Stockpiling

Soils/growth media will be stockpiled (likely windrowed) adjacent to the aerodrome in a location where they will not be disturbed during mining operations and adjacent to the cleared areas needed to provide safety clearance for the aerodrome. The salvaged soil material will include the vegetation removed during the salvage operation. This vegetation material will provide organic matter to the soil material and will be a source of native seed and plant material. This material will be loosely piled onto the stockpiled soils and will provide surface protection and reduce the potential for soil erosion. If required, the soil stockpiles will be broadcast seeded with a native grass mixture such as the following:

- Alpine bluegrass (*Poa alpine*);
- Tickelgrass (*Agrostis scabra*);
- Alpine timothy *(Phelum alpinum*s); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

These grasses occur in the aerodrome area and are suited to drought conditions such as occur with the gravelly, coarse textured surficial materials; they are also tolerant of floods which may occasionally occur in the aerodrome area.

30.4.3 Knipple Transfer Area Facility

30.4.3.1 Soil Suitability

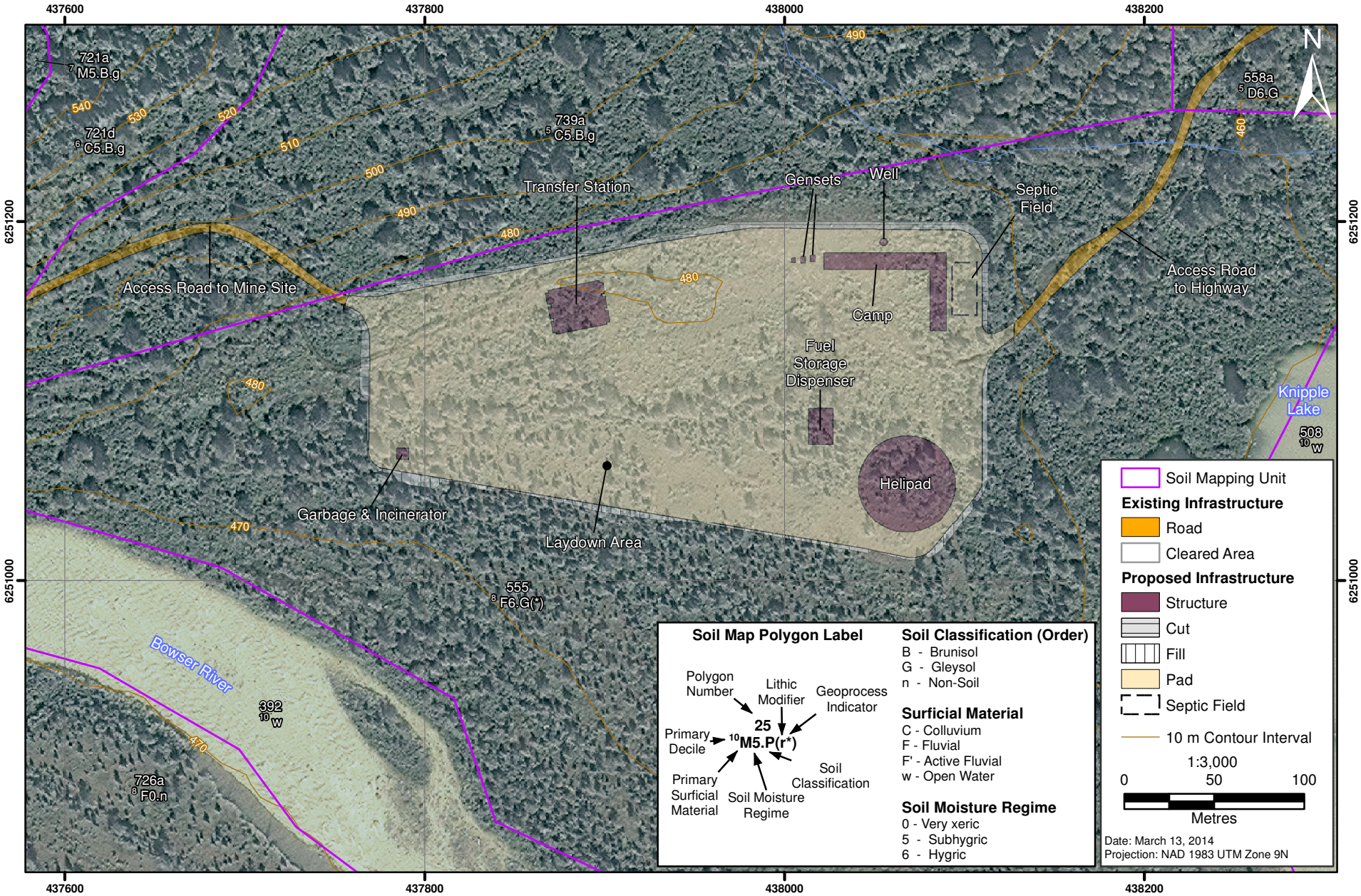
The proposed Knipple Transfer area will occupy approximately 5.3 ha. It is situated on an upper bench of the Bowser River floodplain, slightly elevated and west of Knipple Lake. It is in the Mountain Hemlock-Leeward Moist Maritime Variant (MHmm2) BEC subzone and has a cover of immature, deciduous trees. The soils are weakly developed Brunisols and Regosols, developed in rapidly pervious, coarse textured, gravelly to cobbly material (Polygon 555; Figure 30.4-3). The local water table is estimated to be well below the surface for the majority of the site, though in areas along the north side of the development, close to the toe of the slope, seepage may be anticipated.

Soil suitability for reclamation use is generally poor because of the combination of high coarse fragment content, coarse soil textures, and shallow soil development (low organic matter content). The depth of soil salvage will be generally restricted to the depth of moderate soil profile development, i.e., 0.3 m (including the surface duff material, if present). The soil parent material is suitable for use in reclamation but it is rated as poor for reclamation purposes.

30.4.3.2 Soil Salvage

The Knipple Transfer Area site exhibits the irregular depositional pattern common to floodplain deposits; it is therefore expected that there may be deeper pockets of better quality (slightly to non-gravelly and/or finer textures) soil parent materials that could be preferentially salvaged compared to the surface cobbly/bouldery materials. Preference may be given to the salvage of physically more suitable (low coarse fragment content and moderate texture) “overburden” materials rather than poor quality (very gravelly) soil. Soil salvage is not required over the existing disturbances (generally comprising road-related clearing and construction).

Figure 30.4-3
Soil Mapping of the Proposed Knipple Transfer Area Facility



The amount of potentially salvageable material from the Knipple Transfer Area development footprint is estimated to be 14,300 m^3. This estimate is based on an average thickness of 0.3 m (combined soil and litter/duff) from an area equivalent to approximately 90% of the 5.3 ha footprint within Polygon 555.

30.4.3.3 Soil Stockpiling

Soils will be stockpiled adjacent to the footprint of the Knipple Transfer Area pad, where they will not be disturbed until required for reclamation. The soil material salvaged will include the vegetation removed during the salvage operation. This vegetation material will provide organic matter to the soil material and will be a source of native seed and plant material. This material will be loosely piled onto the stockpiled soils and will provide surface protection and reduce the potential for soil erosion. If required, the soil stockpiles will be broadcasted seeded with a native grass mixture such as the following:

- Alpine bluegrass (*Poa alpine*);
- Tickle grass (*Agrostis scabra*);
- Alpine timothy *(Phelum alpinum*s); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

These grasses occur in the area and are suited to droughty conditions such as occurs with the gravelly coarse textured surficial materials.

30.4.4 Tide Staging Area

30.4.4.1 Soil Suitability

The Tide Staging area has been previously disturbed; it was prepared in 2012 and used as a mineral exploration staging site (Plate 30.4-7). It is located on the east side of Bowser River at the northern tip of the Granduc access road (Figure 30.4-4).

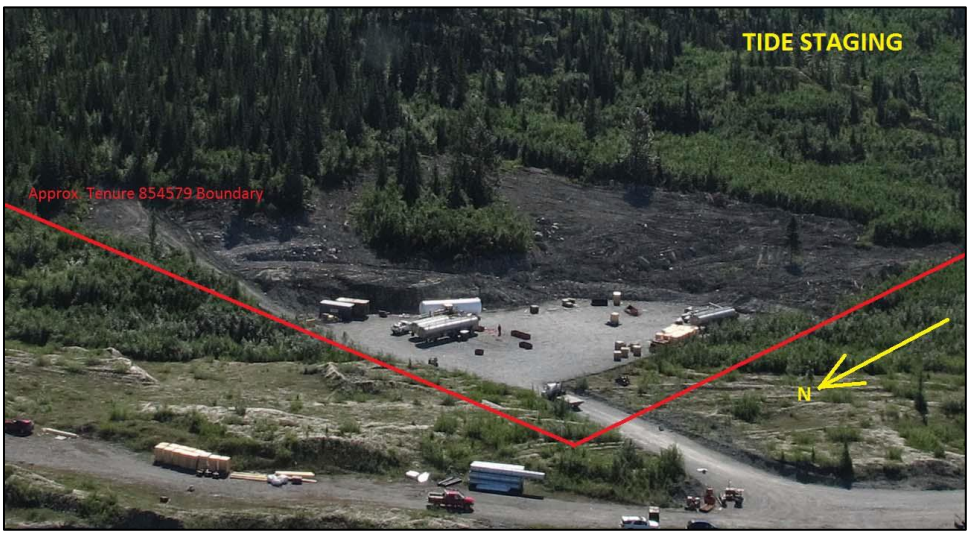
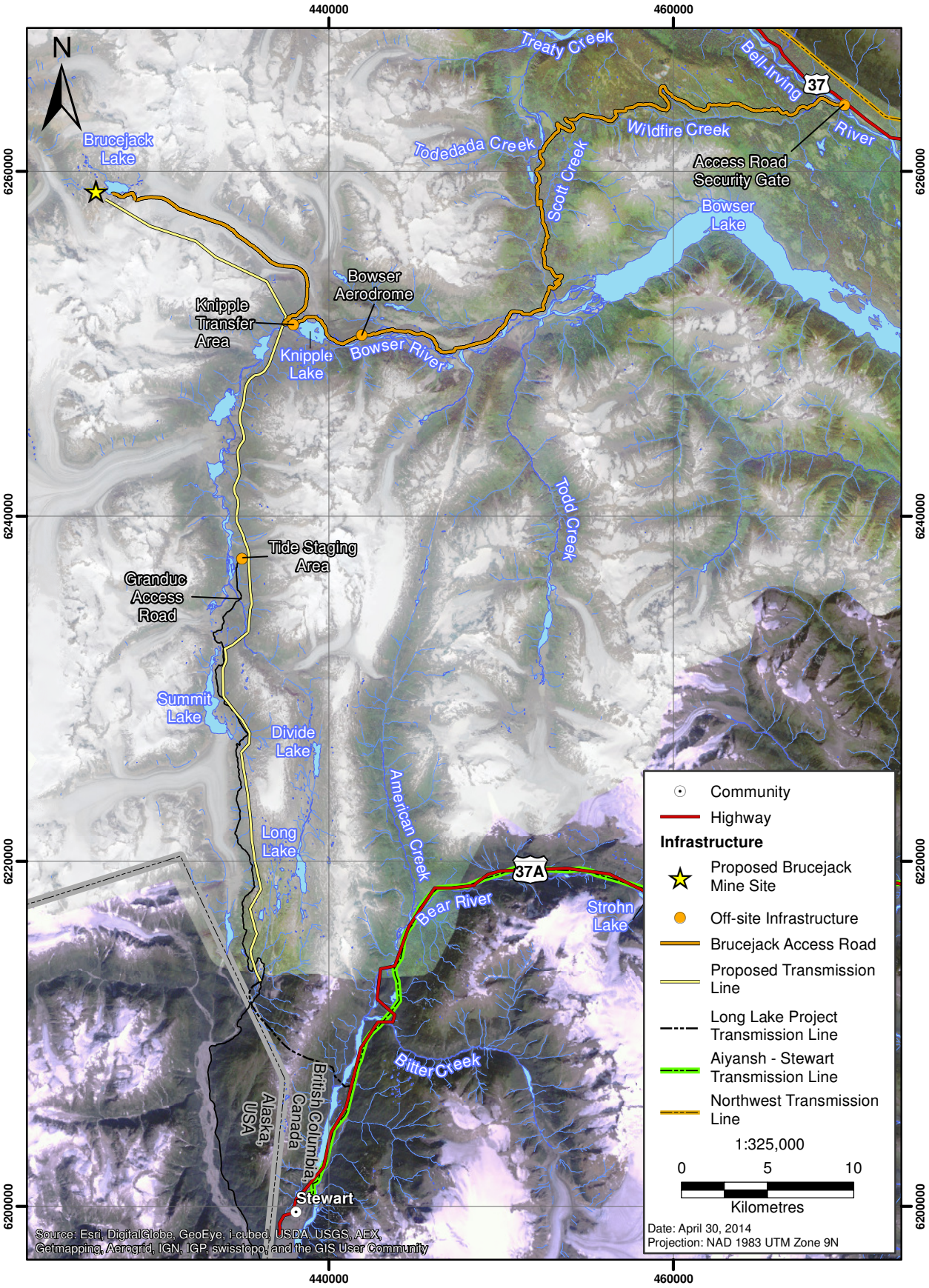


Plate 30.4-7. Tide Staging area (area outlined in red is the approximate tenure boundary).

Figure 30.4-4

Brucejack Gold Mine Project
Off-site Infrastructure



The Tide Staging area will be used for a construction camp and staging the proposed Brucejack Transmission LineLine construction infrastructure. The proposed area has been partially levelled and has been predominantly cleared except for a patch of trees in the centre of the area. It is located on a low, recent, glaciofluvial terrace located above and to the east of the Bowser River floodplain (Polygons 924 and 981; Plate 30.4-7). The area occurs in the MHmm2 BEC subzone and was partially covered with immature, deciduous (alder) trees and some shrubs (Plate 30.4-8). Soils are primarily weakly developed Regosols developed in rapidly pervious, coarse textured, gravelly to cobbly material. The footprint area includes non-soils, comprising recently active gravel/cobble strands (especially in northwest corner of the Staging Area; Polygon 924a). The local water table is estimated to be well below the surface. Irregular or unusual flooding may impact this site.

Soil suitability for reclamation use is generally poor because of the combination of high coarse fragment content, coarse (sandy) soil textures, and lack of or very shallow soil development (low organic matter content). Clearing and grubbing operations were carried out during the 2012 site development. If any additional clearing is carried out, grubbing material from this area will be stockpiled for later re-use as surface amendments (0.1m average thickness for estimating purposes). The soil parent material is suitable for use in reclamation but is rated poor.

30.4.4.2 Soil Salvage

The Tide Staging site exhibits the irregular depositional pattern common to glaciofluvial deposits and as such there may be deeper pockets of better quality (slightly to non-gravelly and/or finer textures) soil parent materials that could be preferentially salvaged compared to the very gravelly to cobbly/bouldery surface materials. Preference may be given to the salvage of physically more suitable (low coarse fragment and moderate texture) “overburden” materials rather than poor quality (very gravelly) surface soil if additional clearing is required. Currently, no soils have been salvaged from this area.

Plate 30.4-8. Coarse, gravelly soils located in the Tide Staging area.

30.4.5 Access Road

30.4.5.1 Soil Suitability

The Brucejack Access Road was constructed as a temporary, all-season exploration access road. Some upgrading of this road is required for Project operations. Cut slope/ditch remediation, alignment or grade amendments, and double lane blind corner amendments are required in some areas (Figure 30.4-5). The existing road has been constructed to a standard road width (running surface) of 5 m. A double lane width of 10 m will be required in some areas for operations. Some other proposed upgrades (Appendix 5-H) will also require some disturbance of the adjacent areas, however widening of parts of the road to a double lane will provide the greatest opportunity for soil salvage for later reclamation. Organic soils and other materials unsuitable for road fill were removed from the road footprint during its construction and placed adjacent to the road.

The road traverses morainal, colluvial, glaciofluvial, fluvial, rock, and organic deposits. The morainal soils will be the most suitable for reclamation. Some colluvial soils will be suitable for reclamation if there are sufficient fines to provide moisture holding capacity for vegetation establishment. The glaciofluvial and fluvial materials will be coarse textured and are generally gravelly so these soils have a low suitability for reclamation. The organic soils can be used as an organic amendment for the mineral soils. The soils will be assessed for reclamation suitability.

30.4.5.2 Soil Salvage

The amount of potentially salvageable material from the areas considered for upgrades along the road is estimated to be 5,557 m^3 (Table 30.4-3). This estimate is based on salvaging 0.50 m (combined soil and litter/duff) from areas occurring on morainal and colluvial materials.

Table 30.4-3. Potential Soil Salvage along the Access Road

Material	Area (m^2)	Soil Suitability	Salvage Depth (cm)	Soil Salvage Volume (m^3)
Morainal	7,017	Suitable	50	3,509
Colluvial	3,919	Suitable	50	1,960
Fluvial	3,835	Not suitable	0	
Glaciofluvial	1,741	Not suitable	0	
Active Fluvial	1,604	Not suitable	0	
Rock and Ice	1,802	Not suitable	0	
Organic	177	Suitable	50	89
Total	**20,096**			**5,557**

Spoil materials (including organic soils and other organic materials) that were placed or stockpiled along the road may be suitable for use in final road reclamation. This will be confirmed when closure and reclamation activities for the Access Road are carried out.

30.4.5.3 Soil Stockpiling

Currently there are 18 spoil areas and 7 laydown areas along the Access Road that can be used to stockpile soil that is salvaged for reclamation during the upgrading of the Road. Soils will be stockpiled in the spoil and laydown areas where they will not be disturbed until required for reclamation and where they are not near any waterways. Salvaged soils will include the vegetation removed during the salvage operation. This vegetation material will provide organic matter to the soil material and will be

a source of native seed and plant material. The soil will be placed in stable stockpiles with the surface being loosely piled to provide surface roughness for erosion control and seed establishment. The aboveground vegetative material will provide surface protection to the stockpiled soils and reduce the potential for soil erosion. If required, the soil stockpiles will be broadcast seeded with a native grass mixture such as the following:

- Alpine bluegrass (*Poa alpine*);
- Ticklegrass (*Agrostis scabra*);
- Alpine timothy *(Phelum alpinum*s); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

If necessary, the organic soils will be stockpiled separately to allow them to drain. Once they are drained, they can be mixed with any subsoil that will be salvaged during road construction. The subsoil may require fertilizer. Fertility tests, if required, can confirm this.

30.4.6 Brucejack Transmission Line

The proposed Brucejack Transmission Line route will follow bedrock-dominated terrain. Towers and lines will be installed by helicopter. Little surficial material is expected to be disturbed due to the small size of the tower footprints and use of helicopter support. Soils that are disturbed during construction will be seeded with a native seed mixture such as:

- Alpine bluegrass (*Poa alpine*);
- Spike trisetum (*Trisetum spicatum*);
- Rocky mountain fescue *(Festuca saximontana*); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

This seeding will provide a vegetative cover in the disturbed areas and reduce the potential for erosion.

30.5 CLOSURE AND RECLAMATION PLANNING

30.5.1 Introduction

This section describes the approaches that will be used to close and reclaim the various Project facilities. The infrastructure sites be closed and reclaimed include 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.

30.5.2 Brucejack Mine Site

Mine operations facilities at the Brucejack Mine Site will be located on eight constructed pads (Figure 30.5-1) and will include the following:

- mill building, including the water treatment plant (WTP) and;
- portal building;
- batch plant;
- helipad;
- contact water collection pond;

Figure 30.4-5
Access Road Upgrade Locations

ERM

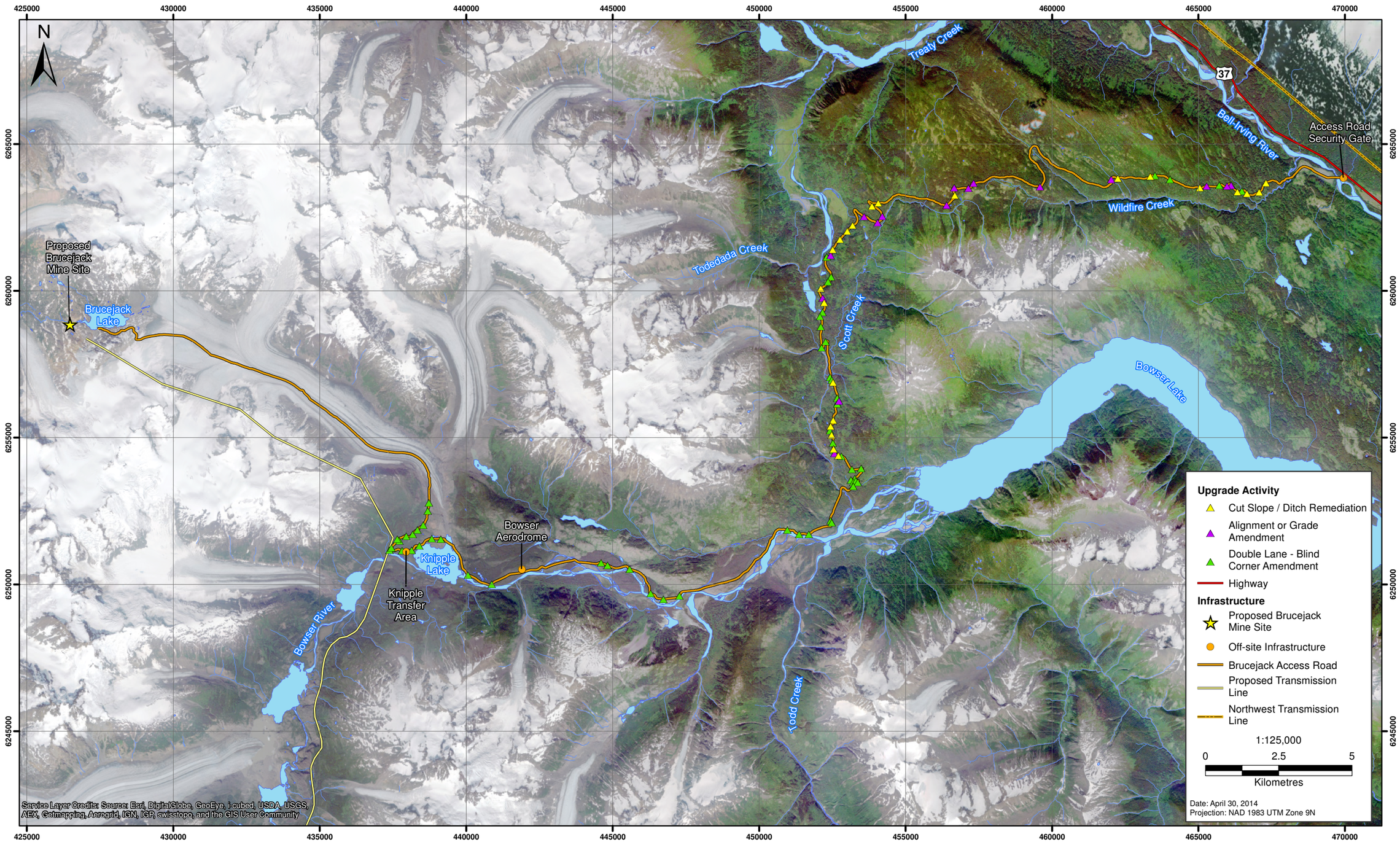
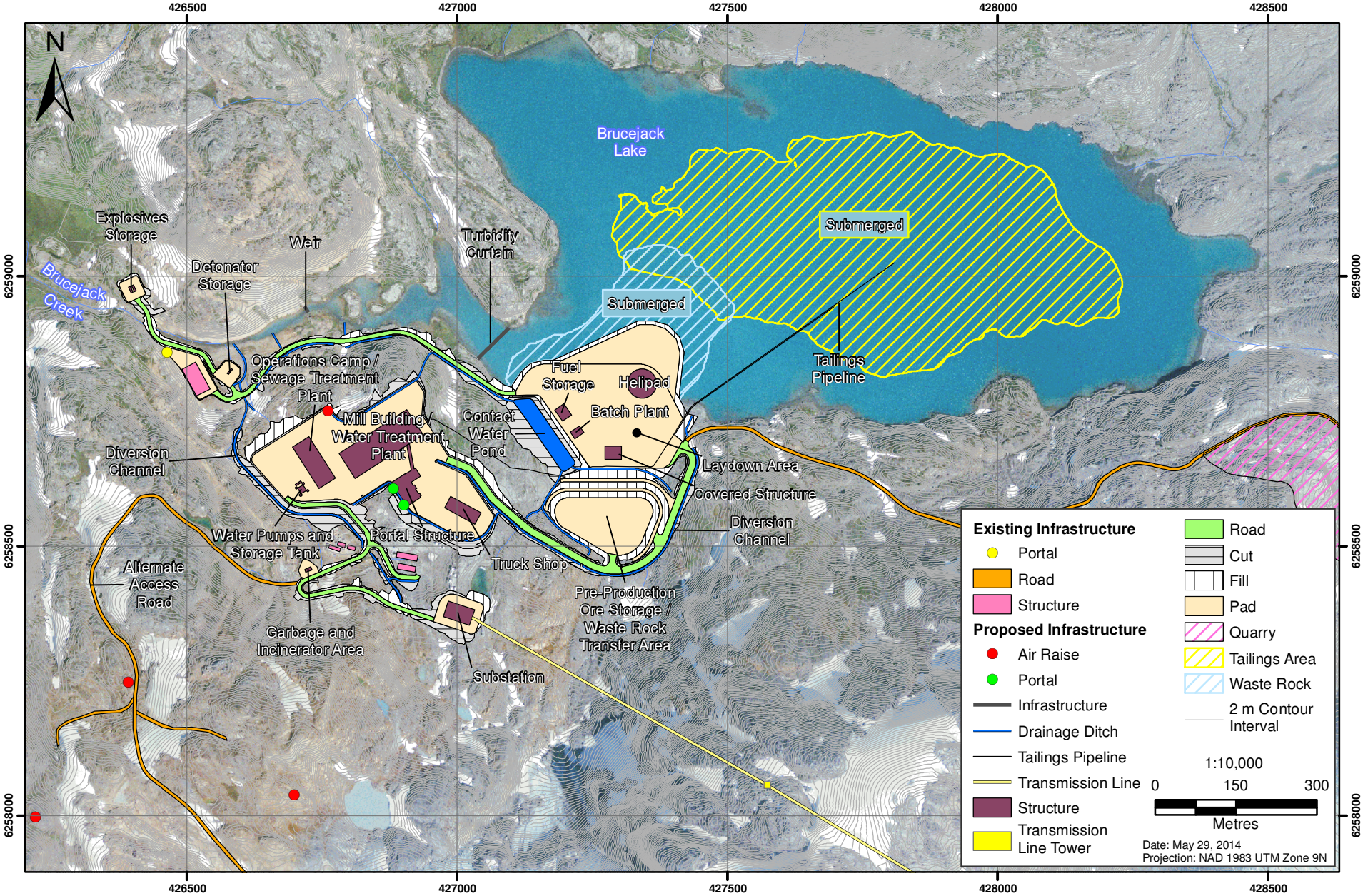


Figure 30.5-1
Brucejack Mine Site Layout



- substation;
- operations camp;
- water pumps and storage tank related to the operations camp;
- garbage and incinerator area;
- detonator storage area;
- explosives storage area; and
- preproduction ore storage area.

The mine site will also include a quarry, site roads, diversion ditches, two new portals, and an existing portal from a previous operation that will be used to support initial underground development. The existing portal will be retained as an alternate access to the underground.

Other facilities at the mine site will include several vent air raises, underground mining infrastructure, a portion of the Brucejack Transmission Line, a tailings discharge pipeline to Brucejack Lake, and existing buildings that will remain in use during operations. The following describes closure and reclamation activities proposed for each component at the Mine Site.

30.5.2.1 Mill Building

Facility

The mill building will be constructed with sheet metal on a concrete pad and will be approximately 33 m (height) × 64 m (width) × 144 m (length) (see Figure 30.5-1). It will include the facilities and equipment for ore processing, concentrate storage area, water treatment plant (WTP), paste plant, reagents storage, lab, warehouse, offices, dry, and other associated equipment and supplies storage. It will be constructed on three floors. Other infrastructure outside of the building will include the tailings thickener tank, a conveyor from the portals, and covered parking. A 650 m long exterior conveyor will carry the crushed ore from the decline conveyor to the mill building.

The WTP will treat contact water from the contact water collection pond and groundwater seepage from the underground mine. Details on water treatment plant design and proposed treatment process are provided in Section 5.12.16 of Chapter 5, Project Description. The WTP will include processing equipment, a chemical dosing system, storage tanks, agitators, and dosing pumps.

Closure

All equipment except the WTP portion will be removed from the mill building at closure. Reagents will be properly secured and removed off-site to appropriate facilities. Lubricants and oils will be drained from equipment and packaged for disposal at a designated off-site facility. Equipment will be transported off-site and sent for recycling or re-use. Conveyors will be dismantled, and the metal components removed off-site for sale or recycling. The conveyor belts will be cut up and disposed of in the excavated stopes. Remaining supplies will be used for various closure activities, as required. Any remaining reagents (i.e., that are not required for the WTP) will be taken off-site for resale or disposal. The motors and pumps and other equipment will be removed and taken off-site for re-use or recycling. All wiring and electrical equipment not required for WTP operation will be removed off-site and taken to a designated facility for disposal. Any hazardous materials will be removed to a designated off-site facility.

The building will either be reduced to the size needed for the WTP only, or the portion containing the WTP will be walled off from the remainder of the building. The WTP and remaining mill building will remain in place until it has been confirmed that water treatment will not be required following re-flooding of the underground workings, or if that treatment proves necessary – until treatment is no longer necessary.

When water treatment is no longer needed, the pipelines connected to the WTP within the mill building and their support structure will be taken off-site for disposal.

When it is no longer required, the mill building will be dismantled and the metal siding and roofing will be taken off-site for recycling. Any wood associated with the building will be burned. Any spills will be cleaned up and remediated as appropriate following applicable EMPs or taken off-site for disposal at a regulated facility. Inert materials that can be landfilled will be taken off-site to a designated landfill, or if determined acceptable by MOE and MEM, may be disposed underground. Some materials will be incinerated. The concrete pad will be left in place and covered with pad material.

30.5.2.2 Pipelines

Facility

The tailings pipeline will be used to transport tailings to Brucejack Lake; twin pipelines will run from inside the mill building to the lake shore at slopes between 0.3 and 15% (Appendix 5-H). The primary pipeline will be a 10" HPDE DR6.3 pipe. Approximately 640 m of the pipe will be located overland and 510 m will be located underwater. The secondary pipeline will discharge at a depth of 60 m with a total length of about 1,040 m, with about 400 m underwater. Much of the pipeline will traverse terrain subject to risk of avalanches. Therefore, the pipeline will be trenched and backfilled in most locations to protect the pipe. The tailings pipe will have a continuous downward slope from the mill building to the lake shore to permit the line to drain during shutdowns.

Approximately 0.7 km of pipeline will be constructed to transport water from Brucejack Lake to the Process Plant. Approximately 0.5 km of pipeline will transport water from underground and from the collection pond to the WTP.

Closure

At closure, the tailings pipeline will be disconnected from the mill building. Aboveground pipeline sections will be cut up and taken off-site for disposal in a landfill or placed in the underground. Areas around the cut pipe will be re-graded to provide stable slopes at the cut edges and to cover the pipe openings of the buried portions of the pipeline. The underwater tailings pipelines will not be removed.

The other pipelines will also be disconnected from facilities. Pipelines will be cut and taken off-site to a landfill or placed in the underground.

30.5.2.3 Portals, Vent Raises, and Underground

Facility

The two new portals used for the Project will be located east of the mill building in the Portal Structure. The portal structure building will contain the main access portal and the conveyor portal, mine air heaters, ventilation fans, the conveyor drive motor and mechanism, an electrical substation, a monorail located in the ceiling of the building for the mine air fan motor and components. The roof and the sides of the building will be constructed with sheet metal. The building will be located on a concrete pad. A conveyor will connect the conveyor portal to the mill building.

A portal constructed for the previous advanced exploration by Newhawk Gold Mines and used more recently by Pretivm (West Zone portal) is located near Brucejack Creek below the outlet of Brucejack Lake (Plate 30.5-1).

Plate 30.5-1. West Zone Portal developed by Newhawk Gold Mines and used by Pretivm for underground exploration.

Five vent air raises will be located on the Mine Site. Four of these raises will occur at high elevation terrain above the main Mine Site and one will be located along the Mine Site road west of the main substation.

Based on the current design, major underground infrastructure will include a crusher, conveyor belts, ventilation fans, an electric air heating system, conductors, transformers, pumping stations, water pipelines, water tanks, a maintenance facility, electrical substations, a fueling facility including a 20,000 L fuel diesel storage tank, a 5 cm diameter fuel line, an oil and grease storage area, a crane, explosive magazines, refuge areas, mine communications, and other ancillary installations. The explosives magazine will contain two 6,000 L tanks for storage of bulk emulsion.

Closure

At closure, all underground tanks including the fuel and emulsion tanks will be emptied. Fuels, oils, and lubricants will be removed from all equipment and taken to a designated facility for disposal. All mobile equipment and supplies will be removed from the declines. Non-mobile equipment and infrastructure will also be removed from the underground and sold, recycled, or appropriately disposed.

All mobile equipment and the mine air heaters, ventilation fans, electrical substation, and the monorail will be removed and taken off-site for re-use or recycling. The portal building will be dismantled and the sheet metal walls and roofing will be taken off-site for recycling.

Most stopes will be backfilled with waste rock and paste tailings during operations. At closure, the underground workings will be flooded to minimize development of ARD. Portals and air ventilation shafts will be sealed with concrete plugs when no longer required for access. The underground stopes

that will be developed for the Project will be extensive and extend to 1,000 m depth, so groundwater is not expected to rise to the level of the two main portal entrances (Chapter 9).

Water may extend above the top of the West Zone portal developed by Newhawk Gold Mines. Therefore, there is a potential for some seepage around the plug. If this occurs, this water will be directed to Brucejack Creek. Post-closure phase water quality predictions are included in Appendix 13-C.

30.5.2.4 Operations Camp/Sewage Treatment Plant

Based on the current design, the operations camp will be comprised of multi-storey modular wood frame buildings with insulated metal-clad walls and roofs to house 330 people, similar to the existing facility (Plate 30.5-2). The camp buildings will be located on rock pads. Each building will include heating and air-conditioning systems, electrical, accommodation and associated facilities, such as kitchen and dining, laundry, and recreational facilities.

Plate 30.5-2. Bunkhouse and kitchen (large buildings in foreground) to be retained for the permanent camp.

A sewage treatment plant, water pumps, and a water storage tank will be located adjacent to the operations camp. The sewage treatment plant will be modular.

Closure

At closure, the equipment in the camp will be removed from the buildings and taken off-site to be sold or recycled. Smaller modular units will be removed off-site and sold. The large buildings will be dismantled. Materials that can be recycled will be separated and taken off site for recycling. Materials suitable for landfilling will be taken off-site to a permitted landfill. Metal sheeting will be taken off-site for recycling. Wood used in the construction of the camp will be burned.

At closure, the sewage treatment plant modules will be taken off-site and sold or disposed of at a designated facility. Fuels and lubricants will be drained from the water pumps and the water tank will be drained. The pumps and water tank will be taken off-site and sold or recycled.

30.5.2.5 Truck Shop

Facility

The truck shop will be a stand-alone pre-engineered steel building with insulated roof and walls. It will be located about 60 m east of the portal structure. The building will have a footprint of about 1,500 m^2 and will include four bays for heavy and light equipment, a welding bay, a wash bay complete with pressure washer, shop warehouse, mechanical room, electrical room, a 5 t overhead crane, and washrooms.

Closure

At closure, all tools and small equipment will be taken off-site for re-use/re-sale. Oil, grease, and lubricants will be drained from the equipment and placed with other waste oils for removal from the site and recycling at a designated facility. The potable water system will be drained, dismantled, and taken off-site for re-sale or disposal. The transformers will be drained of oils and will be taken off site for re-sale or recycling. Wiring and cables will be removed from the building and taken to a designated facility off-site. The crane will be taken off-site for re-sale or re-use once it is no longer needed on-site. Wood materials such as benches or supports will be burned on-site. The interior metal structures such as shelving will be dismantled and taken off-site for re-sale or metal recycling. The pressure washer will be taken off-site for re-use or disposal.

The metal structure including the walls and roof will be dismantled and taken off-site for metal recycling. Any insulation or other non-burnable waste will be removed from the site and disposed of in a designated landfill. The concrete flooring will be left in place and covered with pad materials (NPAG rock and fill) when the pad is recontoured. Any exposed rebar will be taken off-site for metal recycling.

30.5.2.6 Fuel Storage

The mine and surface infrastructure will be heated using propane. The fuel will be stored in a tank farm which will include four 45,000 L tanks. The tanks will supply propane to the mine heaters by means of a buried pipeline.

Diesel fuel will be used for the mobile equipment for the mine operation and for the back-up power generation system. It will be stored in four 50,000 L double-walled tanks. A fueling station will be required and will include a receiving pump, a strainer, delivery pumps, and filters. A 5,000 L diesel storage tank will be located near the access portal to provide diesel for the underground equipment. Aviation fuel for helicopters will be stored in a 5,000 L double-walled fuel tank located adjacent to the helicopter landing pad. Three 5,000 L propane tanks will be located adjacent to the operations camp facilities and used for the operations camp.

Locations storing more than 100,000 L of fuel will have high density polyethylene (HDPE) liners draining to collection sumps. Sumps will be equipped with or pumped to oil water separators to meet requirements under the Petroleum Storage and Distribution Facilities Storm Water Regulation, or equivalent measures will be in place to meet these requirements.

Closure

At closure, any fuel remaining in the tanks will be removed off-site for recycling or use by others. The tanks and attached equipment will be removed off-site for re-use or will be recycled. The gravel over HDPE liners will be removed and stored in an adjacent area. Any spilled fuels on the liners will be mopped with fuel absorbent pads, and the pads will be incinerated. The liners will be cut up and

disposed of underground, likely in the twin declines. The gravel then will be re-spread over the surface. Smaller tank areas will be inspected for signs of drips/spills. Any materials affected by hydrocarbon spillage will be excavated and treated on-site, or removed off-site for treatment at an appropriate facility.

30.5.2.7 Detonator and Explosives

The detonators and explosives will be stored in separate areas in buildings or SeaCans, on separate pads (Figure 30.5-1).

Closure

Any remaining detonators or explosives will be taken off-site for disposal at a designated facility. The buildings will be shipped off site if portable or dismantled and the sheet metal siding and roofing will be taken off-site for recycling.

30.5.2.8 Incinerator and Waste Sorting Area

The Brucejack Mine Site will have an incinerator and waste sorting area during construction and operations. Material will be separated by waste type, including hazardous waste, hydrocarbons, chemicals, metals, and other wastes. Materials that are not incinerated will be taken off-site for disposal at the appropriate facility, on an on-going basis during operations (Sections 29.7, 29.17).

Closure

The incinerator will be removed once all demolition and clean-up has been completed. The ash from the incinerator will be taken off-site and placed in a designated landfill. The incinerator will be dismantled and removed off-site and taken to a designated facility for disposal or sold for re-use. The foundation of the incinerator will be left in place.

At closure, any remaining materials will be removed from the site.

30.5.2.9 Contact Water Collection Pond

Facility

A contact water collection pond will be constructed on the up-slope side of the pad which holds the batch plant and fuel storage facilities. Contact water from most of the mine site will be directed to this pond (refer to Section 5.10.4 and Appendix 5-C). The pond will be lined with an 80 mil HPDE liner. Water from the pond will be pumped to the WTP.

Closure

The contact water collection pond will be closed at the end of mining. For closure, sediment in the pond will be tested and, if suitable, disposed subaqueously in Brucejack Lake. Potential disposal alternatives include in the underground mine or to be shipped off-site to an appropriate disposal facility if necessary. The liner will be cut and placed in the underground, likely in the twin declines. A channel will be constructed connecting the pond to the lake thereby breaching the embankment.

30.5.2.10 Core Shack and Core

Core will be removed from the site as required by Pretivm. Discarded core will be removed from the boxes and stored on one of the pads. PAG core will be placed in the underground. The wood core boxes will be burned.

30.5.2.11 Turbidity Curtains Brucejack Lake

Turbidity curtains will be installed near the outlet of Brucejack Lake to mitigate potentially elevated levels of total suspended solids (TSS) as a result of waste rock and tailings deposition in Brucejack Lake. They may also be used temporarily at other locations, such as around the waste rock deposition zone in Brucejack Lake, during construction and early operations. These curtains will be constructed with impermeable PVC fabric.

Closure

Turbidity curtains near the lake outlet and any others remaining will be removed at Closure, once the deposition of waste rock and tailings to the lake is finished. The curtains will be removed, cut up, and disposed underground, likely in the twin declines.

30.5.2.12 Other Structures

Several modular buildings and structures used during mineral exploration (e.g. kitchen) will remain in on site during construction and operations (Chapter 5).

Closure

At closure, the equipment in these buildings will be removed and taken off-site to be sold or recycled. Materials that can be recycled will be separated and taken off-site to a designated facility. Materials that require disposal in a landfill will be taken-off site. The portables will be taken off-site and sold. Where buildings have to be dismantled, metal sheeting will be taken off-site for recycling. Wood will be burned.

30.5.2.13 Batch Plant

Facility

The batch plant will be required to supply concrete for the foundations of the buildings, for shotcrete for the underground workings for the life of mine (LOM), and as a binder for the paste tailings for the LOM. As well, the batch plant will be needed to provide concrete for sealing the portals and vent raises at closure.

Closure

The batch plant will be dismantled once the portals and vent raises have been sealed. Fuels, oils, and lubricants will be removed from the equipment in the batch plant, placed in containers and removed off-site for disposal in a regulated facility. The equipment will be removed and taken off-site for reuse and/or recycling. Electrical equipment will be removed and taken off-site for re-sale/re-use. The sheet metal walls and roofing will be dismantled and taken off-site for recycling. Any fuel/hydrocarbon spills will be cleaned from the concrete flooring. The concrete will be left in place and covered by pad materials (NPAG rock and fill) when recontouring takes place. Any wood associated with the facility will be burned.

30.5.2.14 Main Substation

Facility

The main substation for the mine operations will be located on a separate pad. It will consist of two oil-filled transformers with neutral grounding resistors. Remote grounds will be constructed in addition to substation yard grounding. Four 600 kW diesel generators will be installed at the main substation to

serve as an emergency power source. A pre-fabricated electrical house will contain switchgears to distribute the power to various points on site.

A dedicated power system programmable logic controller will connect to the 4.16 kV and 600 V switchgears as well as mine heating systems using fiber optic communication. The power lines will connect to the portal and mill building using a cable bridge. Approximately 1.6 km of single wood-pole overhead power lines will be constructed to provide power to the various buildings on the site.

Closure

The substation will be removed when as power is no longer needed for closure activities, such as for operating the batch plant. For closure, oil, lubricants, and fuel will be removed from the transformers and generators. The drained liquids will be placed in containers according to standard protocols and removed off-site. The hydrocarbons will be disposed of at a regulated facility. The generators and transformers will be taken off-site and sold or recycled. The electrical apparatus, such as the switchgear and housing will be disassembled and taken off-site for re-use, recycling, or disposal at a regulated facility. The wires, cables, cable trays, and all attachments will be disassembled. The cables, wiring, and various attachments and supporting structures will be removed and recycled or disposed of in a designated facility. The grounding systems will be removed and taken off-site and recycled.

30.5.2.15 Quarry

The quarry will occupy approximately 4.8 ha and will be located on a steep, bedrock slope (Figure 30.5-1). The quarry will be cut into the slope as required to provide material for the construction of the pads for the various facilities.

Closure

The quarry will be closed in a manner to achieve stable slopes. As well, the quarry will be closed to ensure there is escape terrain. No further reclamation is planned.

30.5.2.16 Pre-production Ore and Waste Rock Transfer Storage

Pre-production ore and temporary waste rock will be stored on the same pad. The waste rock will be placed in this area during periods when subaqueous deposition to the lake is not possible (e.g. poor weather conditions). The material may be PAG. Therefore, the Pre-production Ore Storage and Waste Rock Transfer storage area will be lined with an 80 mil HDPE geomembrane liner.

Closure

At closure, the pad will be limed as there may be PAG dust/fines present on the liner as a result of the previous ore and waste rock storage. The lime will be a thick layer to allow for the material to dissolve and neutralize any remaining PAG materials. Runoff from the limed HDPE will be monitored to confirm the ARD risk has been mitigated. Following confirmation this has occurred, the liner will be removed, cut up, and disposed underground.

30.5.2.17 Constructed Pads

Eight constructed pads will be located at the Mine Site to provide foundations for the facilities (Table 30.5-1). These pads will be constructed with compacted rock or general fill from the NPAG quarry (processed materials from the quarry) and, if suitable, in-situ fill. Any rock cut for pad construction will be deposited subaqueously in the lake. The fill areas will also be surfaced with crushed gravels from the NPAG quarry.

Table 30.5-1. Constructed Pads in the Brucejack Mine Site

Project Component	Area (ha)
Mill Building / Water Treatment Plant Pad	6.16
Mine Site Laydown Area Pad	4.28
Pre-Production Ore Storage	1.83
Existing Structure Pad	0.67
Substation Pad	0.47
Explosives Storage Pad	0.15
Detonator Storage Pad	0.15
Mine Site Garbage and Incinerator Area Pad	0.09
Total	**13.8**

Closure

At Closure, all structures will be removed from the pads, as described earlier. The pads will be left in place and recontoured to cover concrete pads and foundations. Recontouring will be planned such that drainage from PAG area will continue to be directed toward Brucejack Lake, rather than Camp Creek, during Post-Closure. This will allow for lake water dilution of such drainage/seepage during Post-Closure.

Reclamation

Although little vegetation occurs naturally at the Mine Site, the salvage of some subsoil will potentially allow for some reclamation of pad surfaces. The pads surfaces will occupy approximately 138,000 m^2. The amount of salvaged material has been estimated at approximately 16,148 m^3 (Table 30.4-1). This volume of salvaged material will provide a cover approximately 10 cm deep over the pad surfaces, which is considered too thin for vegetation establishment. Therefore, this subsoil material will be loosely and strategically placed on the pad surfaces to create microsites for the seed, moisture catchment, shelter of the seed from wind with some portions of the pad not receiving any soil, and provide a locally thicker soil cover to support vegetation establishment. As well, loosely applying the cover material will reduce the potential for compaction. Before the cover material is placed, the compacted pad surfaces will be lightly ripped to provide for surface drainage and reduce the potential of surface erosion of the pads which could result in instability of the pad landforms. The soils islands will be seeded with a native grass mixture such as the following:

- Alpine bluegrass (*Poa alpine*);
- Spike trisetum (*Trisetum spicatum*);
- Rocky mountain fescue *(Festuca saximontana*); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

These plant species occur in the Mine Site area. The seed will be certified weed free and will be applied at 60 kg/ha. As the subsoil has a low organic matter content and low fertility, fertilizer (16-16-16 NPK) will be applied at 40 kg/ha to promote plant establishment. The seed will provide surface coverage and erosion control of the soil islands and forage for marmots which occur in the Mine Site area. Seeding will be carried out in the fall or early spring.

30.5.2.18 Diversion and Collection Ditches

Approximately 2.5 km of diversion channels will be constructed to divert parts of two existing creeks (Camp Creek and Un-named Creek) and to capture non-contact (clean) run-off. The creeks will continue to drain to Brucejack Lake and Brucejack Creek following diversion (Figure 30.5-2). It is expected that the Camp Creek diversion channel can be constructed without excavation into PAG bedrock. Some PAG rock excavation is considered unavoidable for the Un-named Creek diversion. PAG rock sections of the diversion channels will be lined with 80 mil HDPE. Diversion channels with riprap will be constructed with geotextile beneath the riprap.

Approximately 1.2 km of collection ditches will be constructed to collect contact water. The collection ditches will direct the contact water to the contact water collection pond for water treatment. They will be lined with 80 mil HDPE.

At closure, a diversion channel will be constructed above the cut slope located above the mill building (Figure 30.5-2). The cut slope bedrock is predicted to be PAG and the diversion channel will reduce the amount of surface runoff crossing the exposed PAG rock. All HDPE liners in both the diversion channels and collection ditches will be removed at closure. The liners will be cut up and disposed in the underground mine, likely in the twin declines. Riprap in diversion channels will remain in place. No changes to diversion channel configurations are planned for Closure.

The post-mine water management system will be designed to continue to direct PAG drainage toward Brucejack Lake rather than Camp Creek in order to allow for dilution by lake water. Details of how this will be accomplished, including whether or not some or all collection ditches will be backfilled or left in place, will be provided in the *Mines Act* and EMA Permit application.

Reclamation

Any backfilled collection ditches will be broadcast seeded with a native grass mixture such as the following:

- Alpine bluegrass (*Poa alpine*);
- Spike trisetum (*Trisetum spicatum*);
- Rocky mountain fescue *(Festuca saximontana*); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

These plant species occur in the Mine Site area. The seed will be certified weed free and will be applied at 60 kg/ha. The backfilled material will have a low organic matter content and low fertility. Fertilizer (16-16-16 NPK) will be applied at 40 kg/ha to provide fertility for plant establishment. The seed is suitable for erosion control and will provide surface coverage.

30.5.2.19 Site Roads

Site roads will connect various mine site facility pad areas. These roads are designed with 8 m wide running surfaces and will be crowned gravel roads with ditch drainage; they will include safety berms where required. Approximately 12 culverts will be required along the site roads (Figure 30.5-2). These culverts will be constructed with corrugated steel. Rip-rap and/or filter cloth will be used for erosion protection at culvert inlets and outlets, as appropriate.

Closure

The site roads will be closed when the infrastructure to which they provide access is no longer required. The last site roads to be closed would be those providing within-mine site access to the

underground mine and to the water treatment plant. They will be closed at the end of the closure period, when it has been confirmed that water treatment is no longer required (Figure 30.5-3). As roads are closed, culverts will be removed to restore natural drainage. Steel culverts will be taken off-site for recycling or disposal. The areas where the culverts will be removed will be graded to provide stable slopes at exposed cuts. To the extent feasible and as necessary the road surfaces will be ripped as appropriate to allow for surface drainage and to reduce the potential of road surface failure with time. Ditches will be backfilled and graded to provide surface stability and reduce erosion potential.

Reclamation

The road materials and backfilled ditches are expected to provide poor substrates for revegetation. However, these areas will be broadcast seeded with the same mixture as above (collection ditches) to promote plant establishment. These plant species occur naturally in the area so are suited to the harsh climate.

30.5.3 Bowser Aerodrome

The aerodrome footprint will consist of both an airstrip and infrastructure facility (9.7 ha) and a remote hilltop leveling component (1.0 ha; Figure 30.4-2). It will be located on the north side of the Access Road. It will be a cleared area with a gravel base constructed with local material on site. The runway will be 1,524 m long and 30 m wide. The only new planned structure at the aerodrome will be a Field Electrical Centre which will include an electrical panel to support a lighting system on the airstrip, a generator, and a small (< 100 L) fuel tank. The existing Bowser Camp is also located on the south side of the Access Road.

Closure

The aerodrome will be closed and reclaimed when it is no longer required (Figure 30.5-4). The lighting along the runway will be disconnected from the power source and taken off-site to be sold. Any remaining fuel in the tank will be removed and the tank will be taken off-site for re-use or recycling. Lubricants and oils will be removed from the generator and will be taken off-site for disposal at a designated facility. The generator will be taken off-site for re-use or recycling.

Reclamation

The proposed runway and infrastructure area will occupy approximately 97,400 m^2. Part of it occurs over the historic Newhawk (1980's) airstrip. Soils were not salvaged from the historic airstrip area. Approximately 10,520 m^3 of soil will be salvaged in the undisturbed footprint area (Table 30.4-2). This volume of soil will be enough to cover approximately 1/3 of the runway footprint based on a 30 cm cover depth required to achieve vegetation establishment. Therefore, reclamation will involve lightly ripping the area and loosely placing soil over the runway footprint to create relatively large islands (> 3 m in diameter). The loosely placed material will provide microsites for moisture to support seedling establishment and reduce the potential for compaction.

The aerodrome occurs in the Engelmann Spruce-Subalpine Fir Wet Very Cold subzone (ESSFwv). The site is currently subject to flooding. It has gravelly, coarse textured soils and generally poor productivity. The area will be planted to willow and cottonwood which will provide for some wildlife habitat. The area will also be lightly seeded with a native grass mixture such as the following:

- Alpine bluegrass (*Poa alpine*);
- Ticklegrass (*Agrostis scabra*);
- Alpine timothy *(Phelum alpinum*s); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

Figure 30.5-2
Brucejack Gold Mine Project: Layout of Mine Site Infrastructure - End of Closure Phase / Monitoring Phase

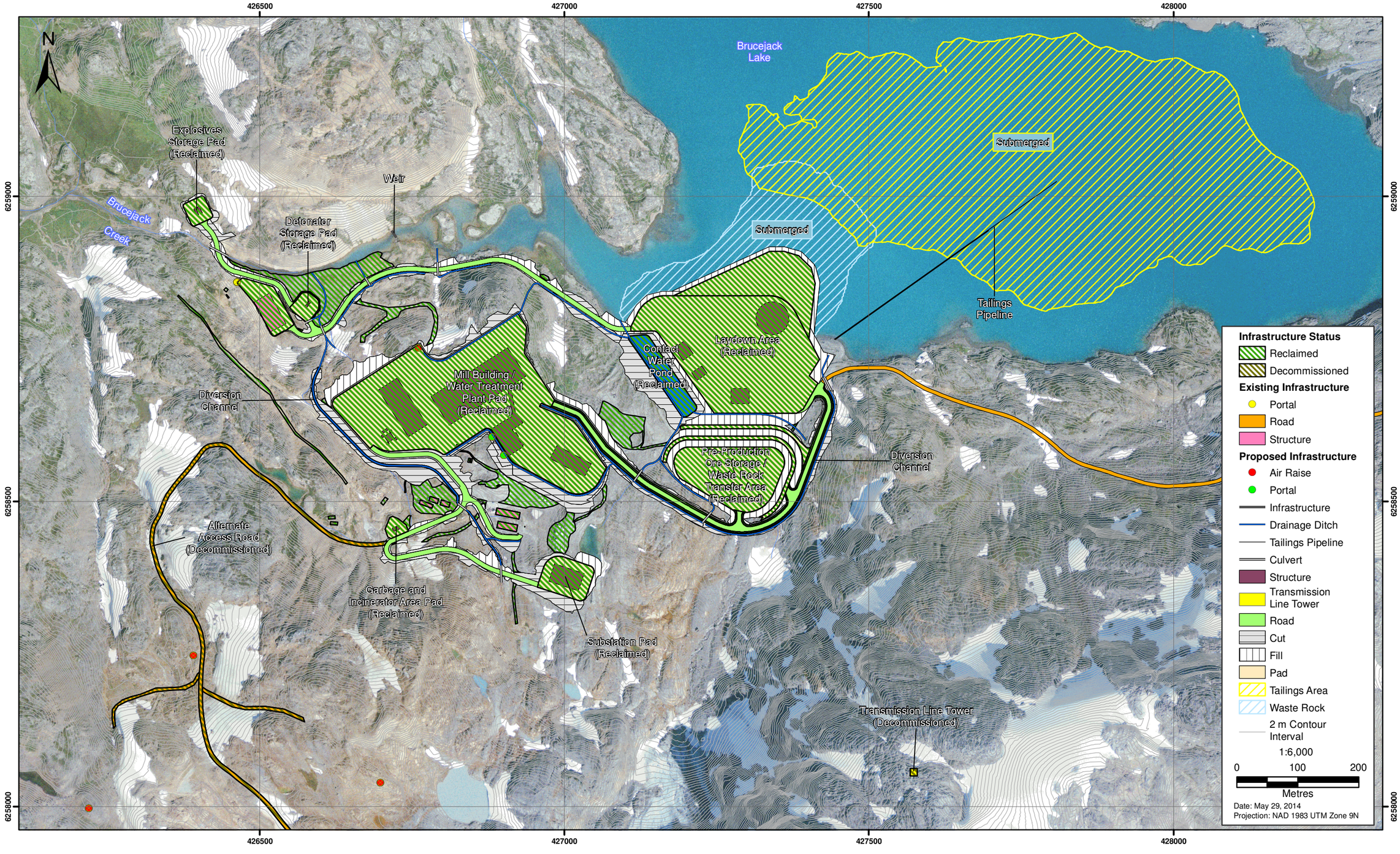


Figure 30.5-3
Brucejack Gold Mine Project: Layout of Mine Site Infrastructure - End of Post-Closure Phase

ERM

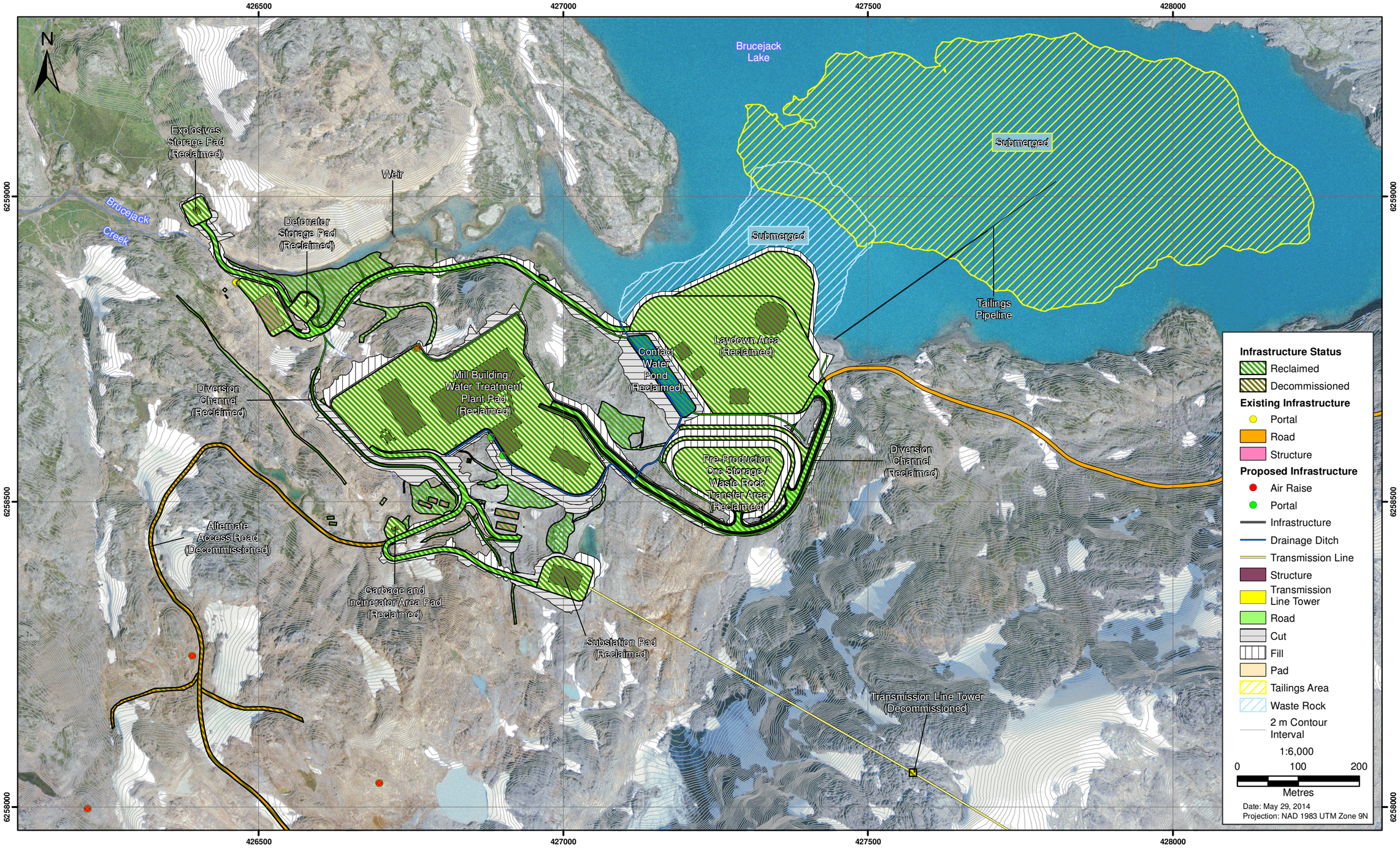
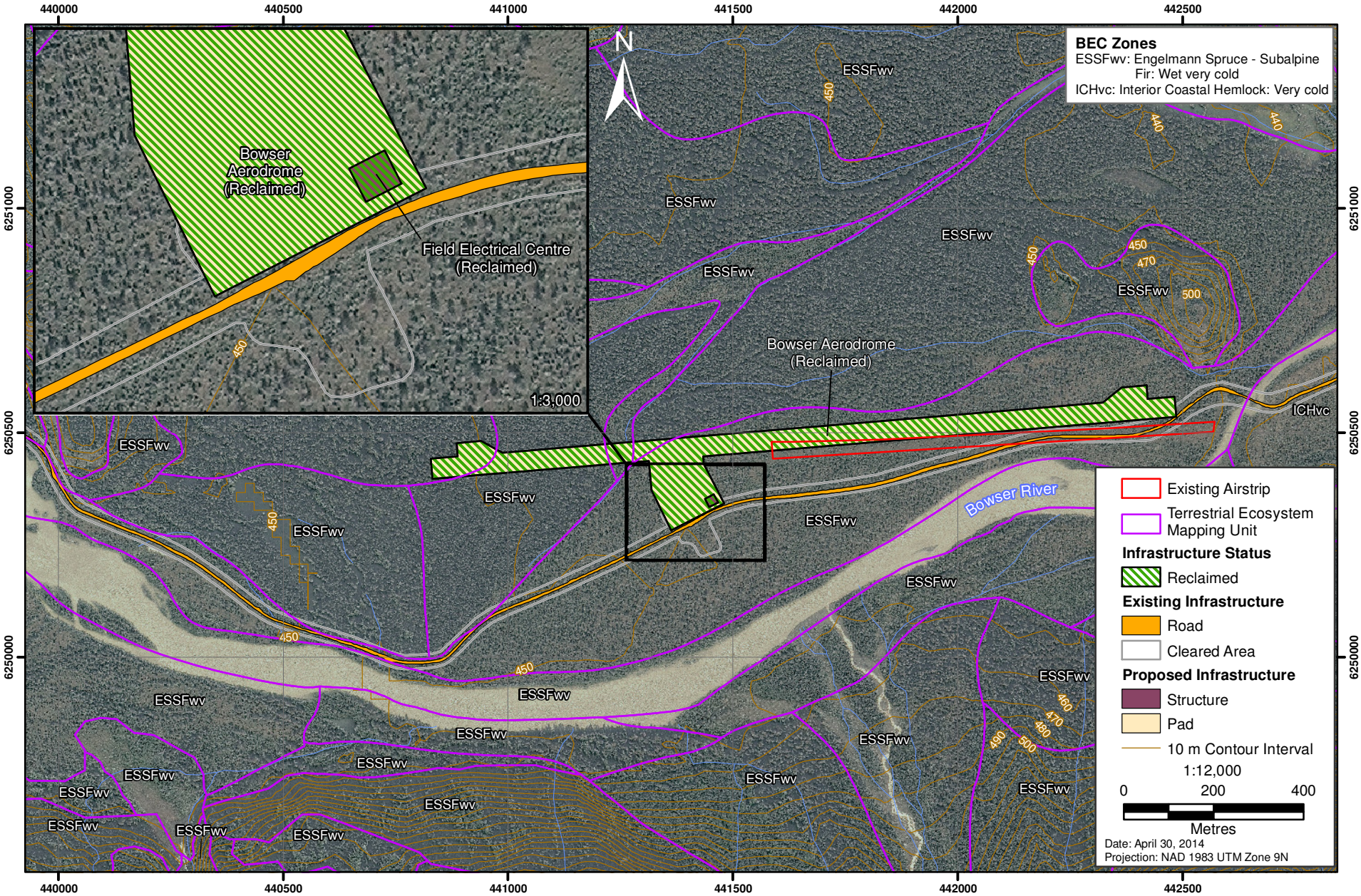


Figure 30.5-4
Bowser Aeordrome Closure Phase



These grasses occur in the aerodrome area and are suited to droughty conditions such as occurs with the gravelly coarse textured surficial materials. They are also flood tolerant as this area is subject to flooding.

The seed will be certified weed free and will be applied at 40 kg/ha. As the soils will have a low organic matter content and low fertility, fertilizer (16-16-16 NPK) will be applied at 40 kg/ha to promote plant establishment. The seed is suitable for erosion control and will provide surface coverage but should allow for the establishment of tree seedlings due to the relatively low seeding rate.

30.5.4 Knipple Transfer Area

30.5.4.1 Facility

The Knipple Transfer Area will be located long the Access Road, approximately 5 km west of the Bowser Aerodrome. The facility will be located on a compacted gravel/fill pad and occupy approximately 5.3 hectares.

The facility will include a camp, transfer station, fuel dispensing system, helipad, laydown area, septic field, and incinerator/waste sorting area (Figure 30.4-3). The camp will be sized to accommodate 30 people, complete with a kitchen, recreation area, dormitories, offices, and a septic field. A potable water system will be installed to distribute water. A wireless system will be installed for communications. A diesel generator with backup will provide power to the camp.

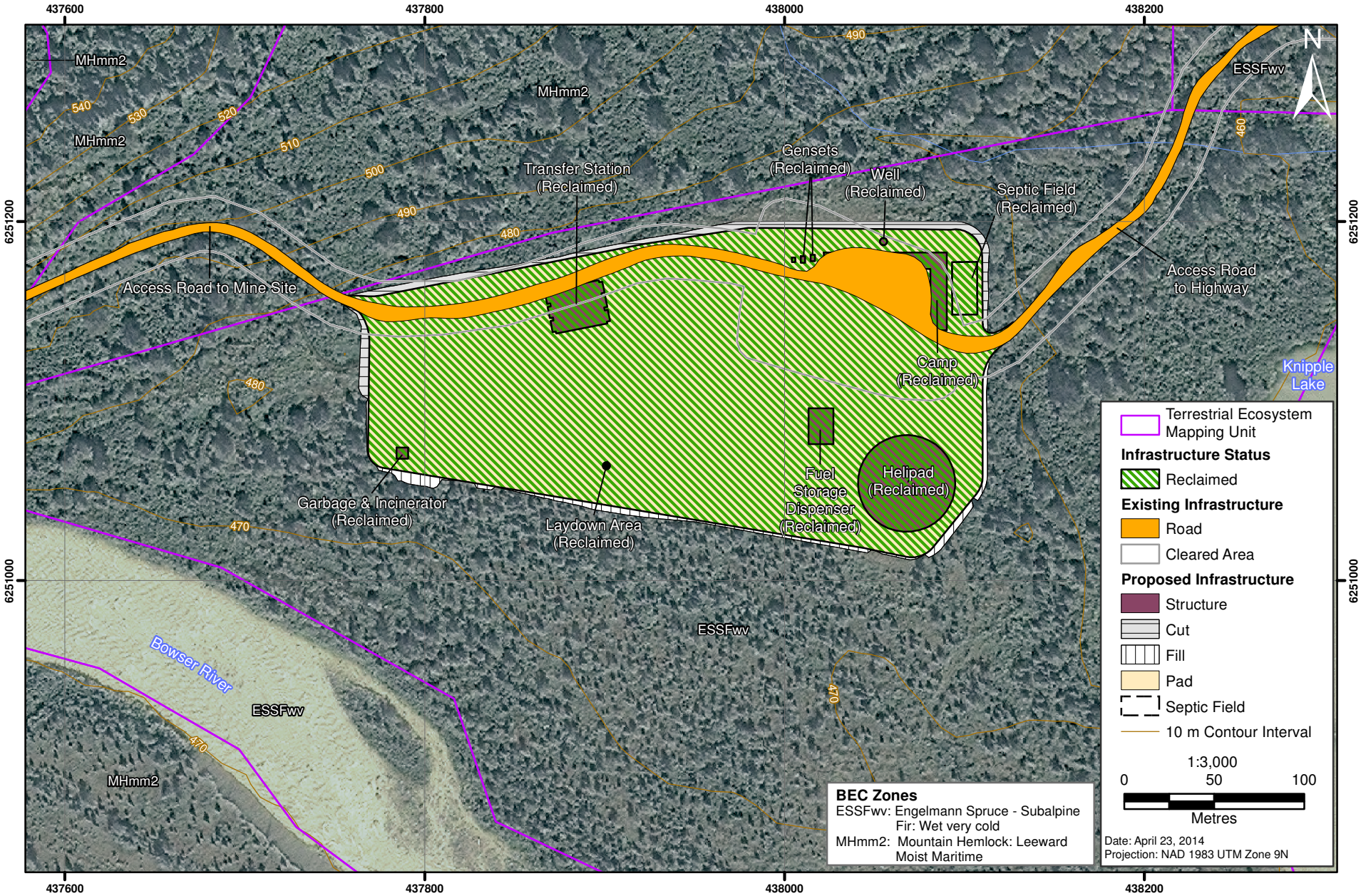
The transfer station will include a two-bay, pre-engineered building. Transfers between highway trucks and vehicles equipped for glacier travel will be performed within the transfer station building by a 5 tonne overhead crane and also outside in the transfer station yard with a mobile crane and forklift. Limited vehicle maintenance facilities will be included, principally for the tracked vehicle fleet. The building will have a concrete floor with collection sumps and an oil/water separator. Equipment and materials may be loose or preferably containerized. Concentrate will be loaded at the mill building site into 2 tonne bulk bags and then containerized prior to transport down to the Knipple Transfer Area. A mobile crane will be used to load/unload large shipments at the laydown area. A metal-covered structure will be constructed at the laydown area to store equipment temporarily during construction.

The Knipple Transfer Area will include a fuel dispensing system with facilities for diesel, gasoline, and aviation fuel including a double-walled 50,000 L tank for diesel. The fuel storage tanks will be double-walled type to minimize risks due to leaks. The fuel storage area will include containment with an impervious membrane under gravel to contain any spillage. It will have a capacity of 110% of the largest tank and be equipped with an oil/water separator. An additional diesel fuel tank will supply the camp generators. An incinerator will be installed. The Knipple Transfer Area will be closed and reclaimed when reclamation of the Brucejack Mine Site is sufficiently complete that its use is no longer required (Figure 30.5-5).

30.5.4.2 Closure

The camp will be constructed with modular units. At closure, connections to the modules will be disconnected (e.g., to generators). Loose equipment and supplies will be removed from the modules and taken off-site and sold or recycled. The potable water system will be dismantled and taken off-site and sold or appropriately disposed. The camp modular units will be removed off-site and sold.

Figure 30.5-5
Knipple Transfer Area Facility Closure Phase



The transfer station will be dismantled. All loose equipment and supplies will be removed from the building and taken off-site for re-use or recycling. The collection sumps and oil water separator will be drained and the waste containerized and taken to a designated facility for disposal. The overhead crane will be dismantled and will be taken off-site and sold. The building will be modular and will be taken off site for re-use. The concrete foundation will be left in place and covered with subsoil/soil.

Oil and fuels will be removed from the generators and tanks. The fuel will be taken off-site for disposal at a regulated facility. The generators will be taken off-site for re-use or recycling. The gravel base for the tanks will be moved aside and the liner removed. The liner will be taken off-site and disposed of in a regulated facility. The gravel will be spread back over the area. The fence will be removed around the incinerator and will be taken off-site for re-use. The ash from the incinerator will be placed in containers and taken off-site for disposal at a designated facility. The incinerator will be dismantled and taken off-site for re-use or disposal at a regulated facility. The well house will be modular and will be removed and taken off-site for re-use or re-cycling. The well pipe will be cut to ground level and capped.

The metal-covered structure constructed at the laydown area to store equipment during construction will be dismantled when no longer needed. The metal and other building materials will be removed off-site for recycling. All vehicles and equipment will be removed from the site. Any waste materials that cannot be recycled or re-used will be taken off-site to a regulated landfill.

Wood used in the construction of the camp and transfer station will be burned.

30.5.4.3 Reclamation

The pad surface will occupy approximately 5 ha. Approximately 14,300 m^3 of gravelly, coarse textured soil will have been stockpiled adjacent to the pad for reclamation. This volume of soil will cover approximately 95% of the pad surface to a depth of 30 cm. This material will be loosely spread over the pad surface which will likely result in most areas having a 30 cm thick cover and portions having a 25-30 cm thick cover. This material will be droughty because of the coarse texture of the native material occurring in this area.

The Knipple Transfer Area site is located in the Mountain Hemlock-Leeward Moist Maritime Variant (MHmm2) BEC subzone and has a cover of immature, deciduous trees (Figure 30.5-5). The area will be planted to willow and cottonwood which are suited to the area. These shrubs and trees will provide some wildlife habitat and browse. The area will also be lightly seeded with a native grass mixture such as the following:

- Alpine bluegrass (*Poa alpine*);
- Tickle grass (*Agrostis scabra*);
- Alpine timothy *(Phelum alpinum*s);
- Bluejoint reedgrass (*Calamagrostis canadensis*).

These grasses occur in the area and are suited to droughty conditions such as occurs with the gravelly coarse textured surficial materials.

The seed will be certified weed free and will be applied at 40 kg/ha. As the soils will have a low organic matter content and low fertility, fertilizer (16-16-16 NPK) will be applied at 40 kg/ha to promote plant establishment. The seed is suitable for erosion control and will provide surface coverage but should allow for the establishment of tree seedlings due to the relatively low seeding rate.

30.5.5 Brucejack Transmission Line

The Transmission Line will remain in operation until no longer needed for mining. The transmission line structures will be mostly steel.

30.5.5.1 Closure and Reclamation

The Transmission Line will be dismantled when no longer required for the Project. The towers will be de-strung and the towers will be removed. Helicopters will be used to remove the lines and towers from along the route. The tower foundations will be mostly constructed of concrete and will be limited in size. These will be left in place. Any areas that will be disturbed during this stage will be seeded with the mix described above for erosion control and to re-establish vegetation.

30.5.6 Access Road

The Brucejack Access Road will be closed once it is no longer needed for the Project. Access for subsequent monitoring will be by helicopter.

30.5.6.1 Closure

Access road closure and reclamation will be conducted generally west to east on both upper (above Knipple Glacier) and lower (between Knipple Glacier and Highway 37) sections. Decommissioning will require the removal of the bridges and culverts to restore natural drainage. There are approximately 23 bridges to be removed and 250 culverts. The bridges are constructed of steel. The culverts are generally 550 mm corrugated steel pipe. Sediment fencing, erosion control cloth, and riprap will be used to prevent sediment entering waterways during the removal of these structures.

Larger bridges will be dismantled and lifted out using a crane. Bridge structures will be hauled out on flatbed trailers and taken for recycling or re-use as appropriate. Culverts will be taken off-site for disposal, recycling, or re-use. The road surface will be reclaimed as the bridges and culverts are removed. The gate at Highway 37 will be removed.

30.5.6.2 Reclamation

The Brucejack Access Road includes gravel/borrow pits, laydown areas, quarries, and spoil areas (Table 30.5-2). The gravel/borrow pits occupy approximately 1.4 ha and the quarries 2.8 ha. The gravel pits and quarries will be resloped to ensure that they are stable and allow for escape by wildlife. No soil was salvaged during the development of these facilities. The remaining gravelly material is too coarse textured and has too low a moisture holding capacity for plant establishment and so the gravel pits will not be revegetated. The quarries are developed in rock and so will not be revegetated.

Table 30.5-2. Disturbed Areas along the Brucejack Access Road

Layer	Area (ha)
Road Surface	39.7
Gravel Pits	1.4
Laydown Areas	4.0
Quarries	2.8
Spoil Areas	4.9
Total	**52.7**

The laydown and spoil areas and the road surface will be compacted due to traffic. These areas will be ripped to allow for surface infiltration of water which will reduce the potential for slumping and erosion. As described earlier, approximately 5,500 m^3 of material will be salvaged from the areas to be widened for the upgrade. As well, there is spoil material from the construction of the exploration access road which is stockpiled in the spoil areas. This material may be suitable for reclamation and will be assessed for its suitability at closure if required. The plan is to use the material salvaged for reclamation, and potentially the spoil material, to reclaim the road surface in areas as close as possible to the areas where it is stockpiled. The plan is to spread approximately 20 cm of soil on the road bed to cover approximately 27,800 m^2. Some of the spoil will also be used for the reclamation of the laydown and spoil areas.

Reclaimed areas will be planted with the native seed mix such as described below, which is suitable for the area:

- Alpine bluegrass (*Poa alpine*);
- Ticklegrass (*Agrostis scabra*);
- Alpine timothy *(Phelum alpinum*s); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

Given the road is not very wide and close to a native seed source, native species are expected to populate the reclaimed areas.

30.6 PROGRESSIVE CLOSURE AND RECLAMATION

Pretivm will take advantage of opportunities to reclaim areas during construction that will not be required for the Project. This early reclamation will allow for the assessment of the success of the vegetation mixes, and reclamation approaches, and permit adaptations in subsequent reclamation efforts. As well, early reclamation will reduce the potential for surface erosion and consequential degradation to the environment.

30.6.1 Brucejack Mine Site

Some surface disturbance due to past mining and exploration activities has occurred in the Mine Site area including cut and fill slopes, roads, and drilling sites.

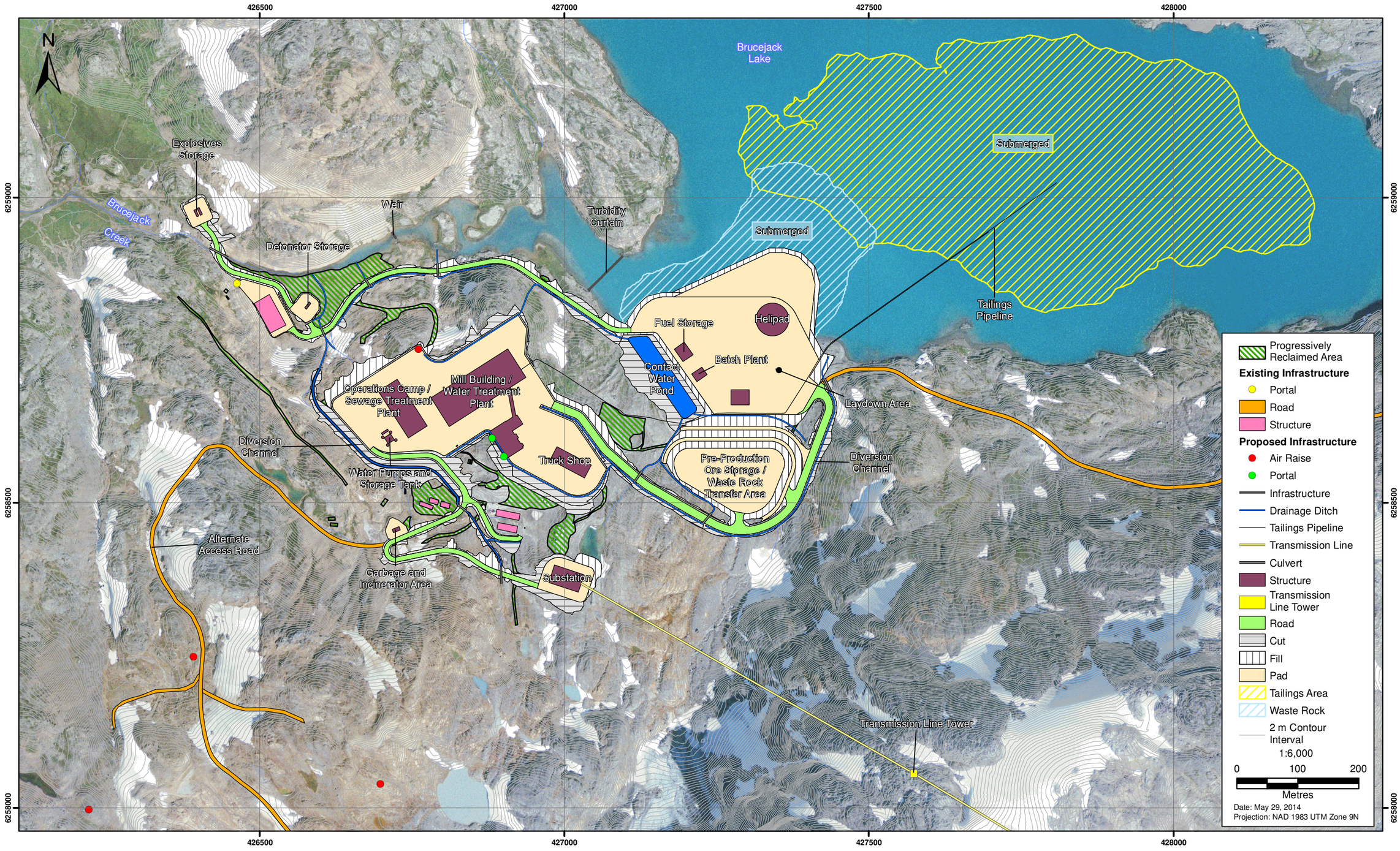
Many of the areas that are presently disturbed will be covered with future infrastructure. The areas that can be revegetated in the first five years of the Project include exploration disturbances that are outside of the areas required for new infrastructure, and site roads that will no longer be required for the Project (Figure 30.6-1). Approximately 2.5 ha of disturbed area that will not be required for future Project components will be reclaimed during the initial five years of the Project.

Some disturbed areas will be recontoured before seeding if needed to blend in with the natural landscape. Any extra soil that can be salvaged for later reclamation will be stockpiled where it will not be disturbed. Roads and compacted areas will be ripped before revegetation is carried out. The seed mix will be a native seed mix such as the following:

- Alpine bluegrass (*Poa alpine*);
- Spike trisetum (*Trisetum spicatum*);
- Rocky mountain fescue *(Festuca saximontana*); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

Figure 30.6-1
Areas Identified for Progressive Reclamation of the Brucejack Mine Site

ERM



These plant species occur in the Mine Site area. The seed will be certified weed free and will be applied at 40 kg/ha. As the subsoil has a low organic matter content and low fertility, fertilizer (16-16-16 NPK) will be applied at 40 kg/ha to promote plant establishment. The seed will provide surface coverage and erosion control. Seeding will be carried out in the fall or early spring.

Reclamation success will be affected by the in situ surficial materials which have low fertility, low organic matter, and may be high in coarse fragments. Reclamation success will also be affected by the severe cold climate as the Mine Site is located at a high elevation, in the alpine and above the tree line.

30.6.2 Tide Staging Area

The Tide Staging area occupies approximately 1.4 ha. Both the level and sloping portions of the staging area have been cleared. The level area is highly compacted as it is used for temporary truck parking and equipment storage (Plate 30.4-9).

As the Tide Staging site will be required to store the dismantled towers and recovered conductors in preparation to truck them out of the area, the site will only be partially reclaimed during operations to prevent erosion and to reduce the potential for establishment of invasive species or other unwanted vegetation. The recently cleared sloping portions of the Tide Staging area are subject to surface erosion and will be reclaimed as soon as possible. If the area is needed to accommodate a temporary construction camp for transmission line construction, any areas not covered by facilities will be reclaimed as soon as practical, when it is no longer required. When the area is no longer required, the steep cut slope will be pulled back to increase its stability. An excavator will be used to go across the slope and prepare loose ridges to reduce downslope surface erosion. The goal will be to have soil in the areas between the ridges also loosely placed. The ridges will slow and absorb surface water flow. The cross slope ridges will direct excess water across the slope to the adjacent non-cleared areas.

A silt fence may be required at the bottom edge of the cleared slope all around the staging area. The areas to be revegetated will be seeded with a native grass mixture similar to the following:

- Alpine bluegrass (*Poa alpine*);
- Tickelgrass (*Agrostis scabra*);
- Alpine timothy *(Phelum alpinum*s); and
- Bluejoint reedgrass (*Calamagrostis canadensis*).

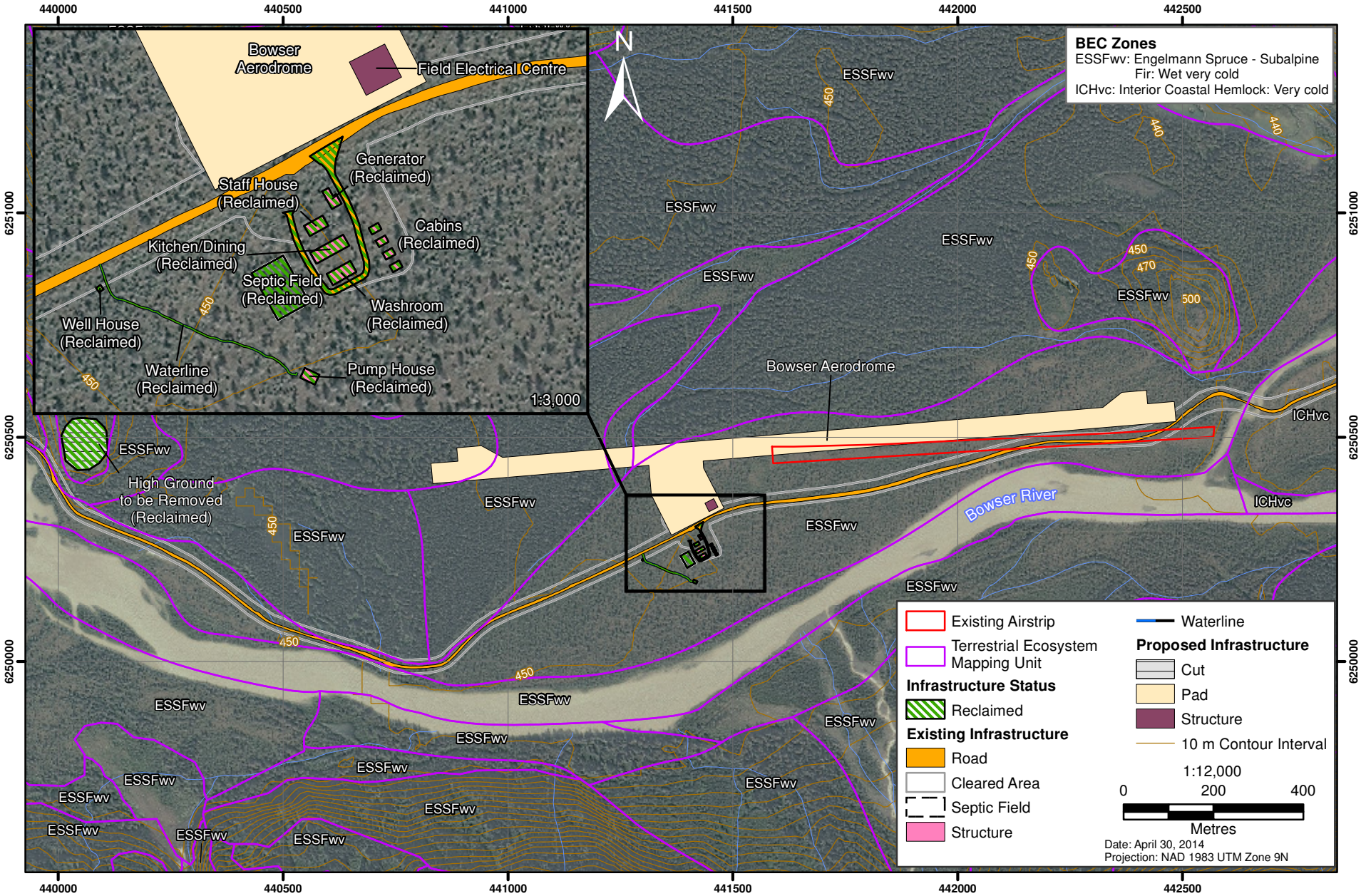
These grasses occur in the area and will provide protection from erosion. The seed will be certified weed free and will be applied at 40 kg/ha.

The staging area will be reclaimed at the end of the Project when grid power is no longer needed. Dismantling of the transmission line will take approximately one year. Once all materials and equipment have been trucked out, the level area will be ripped to 30 cm depth in two directions. An excavator will be used to pull part of the sloping area down towards the level area at the bottom of the slope which will result in a gently sloping area. The soil occurring on the slopes will be loosely spread over the level area with a goal of 30 cm surface thickness. The sloping area will then be reseeded with the previously mentioned mix at 40 kg/ha.

30.6.3 Bowser Camp

The Bowser Camp currently occupies approximately 0.5 ha. Most facilities at the existing Bowser Camp will be decommissioned once the camp at the Knipple Transfer Area has been completed (Figure 30.6-2). The Knipple Transfer Area camp will be constructed during the Construction Phase. As noted earlier, the Bowser Camp includes seven cabins, seven framed tents, a staff house, a kitchen/dining building, a washroom, a generator, a site road, a small well and pump house connected by a water line, and a septic field.

Figure 30.6-2
Progressive Reclamation - Bowser Camp



The lubricants and fuels will be removed from the generator and will be taken off-site for disposal at a designated facility. The generator will be taken off-site for re-use or recycling. The structures are modular and will be removed from the site and sold. The well house and pump house will be dismantled and the material will be taken off-site for recycling. The waterline will be buried underground and left in place. The ends of the pipes will be capped.

Reclamation will include ripping all of the compacted areas. The area will also be seeded with a native grass mixture similar to the following:

- Alpine bluegrass (*Poa alpine*);
- Tickle grass (*Agrostis scabra*);
- Alpine timothy *(Phelum alpinum*s);
- Bluejoint reedgrass (*Calamagrostis canadensis*).

These grasses occur in the aerodrome area and are suited to droughty conditions such as occurs with the gravelly, coarse textured surficial materials and are flood tolerant.

The seed will be certified weed free and will be applied at 40 kg/ha. As the soils will have a low organic matter content and low fertility, fertilizer (16-16-16 NPK) will be applied at 40 kg/ha to promote plant establishment. The seed is suitable for erosion control and will provide surface coverage but should allow for the establishment of tree seedlings, such as willow and alder, due to the relatively low seeding rate.

The high ground that will be removed to improve the aerodrome flight line will be revegetated as an early stage reclamation measure once the area has been graded. The previously described grass mixture for erosion control will be used to revegetate the site.

30.7 CLOSURE AND RECLAMATION SCHEDULE

The Project has four phases:

1. Construction (2 years).
2. Operation (22 years).
3. Closure (2 years).
4. Post-closure (minimum of 3 years).

The Brucejack Gold Mine Project includes several components which will be closed and reclaimed at different stages of the mine life. Below is an outline of the proposed closure and reclamation schedule for the Project (Table 30.7-1).

Areas disturbed during the operation phase and not required for the Project, will be reclaimed as soon as possible to reduce potential effects on the environment. The closure of the various components of the Project will be completed in a specific order as set out in Table 30.7-1. Some of these activities will be carried out concurrently, such as dismantling of structures and the removal of pipelines at the Mine Site and dismantling of the Transmission Line and the Knipple Transfer Area during the closure phase. The Access Road will be decommissioned during the Closure phase. This is related to the need for regular maintenance/safety oversight for the continued use of the glacier component of the road which would likely not be feasible if this is required only to support intermittent monitoring activity.

Table 30.7-1. Closure and Reclamation Schedule for the Brucejack Gold Mine Project

Phase	Length of Phase (years)	Location	Description and Sequence of Reclamation Activities
Construction	2	Mine Site	Some areas disturbed during exploration activities
		Tide Staging	Reclamation of Tide Staging at end of TL construction
		Access Road	Revegetation of areas along road disturbed during upgrading
		Bowser Camp	Removal of most structures; reclamation
Operation	22	Mine Site	On-going site disturbance
Closure	2	Mine site	Removal of underground equipment and structures
			Dismantling of surface structures
			Removal of aboveground pipelines
			Backfilling of contact water collection pond
			Construction of drainage ditch across backfilled contact water collection pond to Brucejack Lake
			Removal of diversion ditches
			Ripping of constructed pads; recontouring over concrete left in place; spreading of soil on pads; seeding of pads
			Sealing of portals and vent raises
			Removal of batch plant
		Transmission Line	Dismantling of Transmission Line
		Knipple Transfer	Dismantling of Knipple Transfer area, reclamation of footprint area
		Bowser Aerodrome	Dismantling of Bowser Aerodrome, reclamation of footprint area
		Mine Site	Closure and reclamation of site roads
		Access Road	Decommissioning and reclamation of Brucejack Access Road including removal of bridges and culverts
Post-closure	3		Monitoring

Monitoring will be the only activity occurring during post-closure. It is anticipated that monitoring will be required for approximately three years.

30.8 TEMPORARY MINE SHUTDOWN

In the event of any temporary shutdown, irrespective of length, a small contingent of maintenance staff will remain on site to implement care and maintenance activities. This is needed to protect the considerable investment in site infrastructure and equipment and to operate the WTP. Fuel will be removed from equipment that is not required, and used. Mine openings will have doors, gates, or buildings which can be locked during short term closure; therefore, any openings not required for maintenance purposes will be locked. All vent raises will have metal screens to prevent access; therefore, no additional measures would be needed for these. Road and transmission line monitoring and maintenance would be continued. The gate at the Bell-Irving River crossing near Highway 37 will be kept locked to prevent access to the Project area.

If an extended temporary shutdown of the Project occurs, longer than 1 year, constructed pads and slopes will be checked for stability and erosion and any areas requiring maintenance will be treated as soon as possible. Areas which have been revegetated will be checked and areas requiring additional surface treatment and/or seeding will be treated as soon as possible, if deemed necessary.

30.9 RESEARCH PROGRAMS

The areas disturbed during exploration activities at the Mine Site that will not be needed for Project infrastructure, will be reclaimed during the first five years. This activity will provide an opportunity to carry out research studies on the viability of planned native seed mixes and shrubs for final closure. The low temperatures and wind at the Mine Site naturally limit both soil development and vegetation establishment. Most areas that will be reclaimed have been disturbed, but regardless, site soils are poorly developed with generally low fertility. These are the conditions that will occur at closure on the pads and on the roads and therefore, the results of the research carried out at the early stages of the Project will be used to guide the final seed selection and reclamation approaches at closure. The mine will operate for approximately 22 years and this early reclamation and research will provide a good opportunity to test the seed mixes, fertility requirements, etc., as well as, various remediation approaches.

The areas disturbed along the Access Road during upgrading will be re-vegetated. These areas will be monitored for erosion control and vegetation establishment. The monitoring results will also be used to plan for erosion control and re-vegetation of the Access Road when it is closed at the end of the Project.

The Bowser Camp will be dismantled and reclaimed at the end of the Construction Phase. The camp occurs on floodplain and vegetation can be sparse because the soils are very coarse textured. There is no topsoil available for reclamation so the revegetation of the camp area will be challenging. Therefore, research on the types of plants suited to these conditions can be tested and, with time, achieve a good vegetative cover which will also be useful in the reclamation of the Knipple Transfer Area and Aerodrome at closure. The results of the research programs will be documented in the Annual Reclamation Reports.

30.10 CLOSURE COSTING

This section provides an estimate of closure and reclamation costs based on the approach to closure and reclamation described above and consistent with the approach taken in the MEM spreadsheets used for bonding purposes. The Post-closure Phase will occur over a minimum of three years after which the Project will be considered closed. Detailed costing of closure using the MEM spreadsheets will be developed as part of the bond development required for obtaining a Permit.

30.10.1 Closure Costing

The closure costs estimates are based on the closure activities proposed for each type of facility, as described. The estimated cost of closure for labour and equipment is provided in Table 30.10-1. The cost has been estimated at $8,421,079 including:

- Mine Site;
- Transmission Line;
- Access Road;
- Bowser Aerodrome; and
- Knipple Transfer Area.

The labour costs are based on 10 hour shifts per day, 7 days per week based on the labour as used for the Feasibility Study (Tetra Tech 2013). A blended labour rate of $110/h has been used to cover a range of wages for the various personnel.

Table 30.10-1. Labour and Equipment Costs for Closure of Infrastructure

Project Component	Infrastructure	Labour and Equipment Costs	Total Labour and Equipment Costs
Mine Site	Mine Site - Supporting Infrastructure	$255,750	
	Underground	$449,350	
	Mill Building/Water Treatment Plant	$2,057,375	
	Ancillary Structures Mine Site	$687,500	
	Concrete Seals	$462,000	
	Mine Site Utilities-Power & Electrical	$375,375	
	Mine Site Utilities-Water Systems	$343,750	
	Mine Site Utilities-Waste Disposal	$63,250	
	Tailings Pipeline	$99,000	
	Fuel Storage & Distribution	$173,250	
	Miscellaneous Equipment	$199,600	
	Mine Total		**$5,166,200**
Transmission Line			$1,255,000
Access Road			$2,026,473
Bowser Aerodrome			$268,044
Knipple Transfer Area			$337,863
Others			$3,254,879
TOTAL			**$9,053,579**

Mine Site supporting infrastructure includes:

- diversion channels;
- fencing/gates;
- site control;
- communication system;
- site fire alarm systems;
- yard lighting; and
- plant and instrument air.

Ancillary structures at the Mine Site include:

- portal surface infrastructure;
- permanent camp;
- emergency vehicles and medical clinic;
- truck shop and maintenance shop;
- truck wash/tire wash; and
- crushing and batch plant.

The site preparation, reclamation and material costs for the areas that are associated with the Project are included in Table 30.10-2 and have been estimated at $1,654,052. The costs include the cost of site preparation, soil placement, and re-vegetation. The material costs for the concrete seals for the portals and ventilation shafts are also included in this table.

The total cost for closing the Project facilities and the reclamation for the components of the Project including the Mine Site, the Transmission Line, the Access Road, the Bowser Aerodrome, and the Knipple Transfer Area has been estimated at $10,707,632. Estimates do not trucking off-site or off-site disposal.

Table 30.10-2. Site Preparation, Reclamation, and Material Costs

Project Component	Cost
Pads	$331,200
Concrete Plugs (ventilation)	$116,160
Concrete Plugs (portals)	$87,120
Site Roads	$55,425
Mine Total	**$589,905**
Knipple Transfer Area	$121,114
Tide Staging Area	$37,184
Bowser Aerodrome	$236,450
Others	$394,748
Brucejack Access Road Road Bed (new and existing)	$559,520
Brucejack Access Road Gravel Pits (1.4 ha)	$3,080
Brucejack Access Road Laydown Areas (4.0 ha)	$48,000
Brucejack Access Road Spoil Areas (4.9 ha)	$58,800
Access Road	$669,400
TOTAL	**$1,654,052**

30.11 CLOSURE AND POST-CLOSURE MONITORING

Monitoring is required under Section 10.7.30 of the Code to demonstrate that reclamation and environmental protection objectives including land use, productivity, water quality, and stability of structures are being achieved. The results of the monitoring program are to be included in the Annual Reclamation report (per Section 10.1.4 of the Code). The following is a description of conceptual post-closure monitoring plans proposed for the Brucejack Project. Monitoring is planned for a minimum of 3 years following closure. The length of time required for monitoring may be extended if the early results of the program indicate further monitoring is required.

Monitoring will be carried out on the following:

- landform stability;
- stability of portal and ventilation raise seals at the Mine Site;
- surface stability (absence of erosion);
- revegetation establishment;
- water level in the underground;
- groundwater quality;
- surface water quality related to the Mine Site; and
- aquatic resources related to the Mine site.

30.11.1 Structural Stability

The stability of various structures at the Mine Site will be monitored annually. This will include the pads, sealed portals and vent raises, site roads, and the quarry. If remediation is required, it will be carried out as soon as practical.

Sites of bridges and culverts and the decommissioned road bed and cut and fill areas along the Access Road will be checked for stability in the spring and fall and after high rainfall events. Any other areas identified where stability can be an issue, will be checked.

30.11.2 Stability of Decommissioned Openings

The seals and areas around the closed portals and ventilation shafts will be checked annually for structural integrity and to ensure the seals are performing as required and designed.

30.11.3 Surface Stability

The surface of the reclaimed and decommissioned sites will be checked annually for erosion. This will include the presence of rills, gullies, cracking, and signs of slumping. Rills and gullies on slopes can result in sediment entering nearby waterways. As well, eroding areas result in the loss of surface soils which may have high nutrient and organic matter. Loss of surface soils can expose less fertile soils that will be more difficult to vegetate. Surface erosion may also result in the exposure of bedrock which will prevent any opportunity of revegetation.

30.11.4 Reclamation

The areas which have been reclaimed will be checked annually for vegetation establishment and growth. Bare areas may indicate that the soils are compacted and roughing the surface soils may be required before reseeding. Areas with sparse vegetation will be re-seeded. The species may be changed to reflect the site conditions. For example, plants on coarse textured soils may be affected by insufficient moisture and may indicate that areas need to be re-seeded with a more drought resistant species. As well, fertilizer may be required to promote plant establishment where vegetation is sparse. Reclaimed sites will also be checked for noxious weeds.

30.11.5 Underground

The closure plan allows for the flooding of the underground. The water levels at each of the portals will be checked annually to determine when the underground is flooded.

30.11.6 Groundwater Quality

Groundwater monitoring will include sampling and water level measurements from wells up-gradient and down-gradient of mine components with expected environmental effects. The groundwater monitoring will be carried out annually for the 3 year post-closure period.

30.11.7 Surface Water Quality

Surface water quality will be monitored at sites with the potential to incur effects attributable to Project infrastructure as per the *Mines Act* and *Environmental Management Act* permit conditions. Sampling sites will be located downstream of infrastructure and at the outlet of Brucejack Lake, with both near-field and far-field exposure to Project activities, so that a gradient of potential effects can be assessed.

30.11.8 Aquatic Resources

Monitoring programs for biological aquatic resources and fish are required by the MMER and will form part of the permitting conditions (to be determined). However, as the closest fish-bearing waters will be 20 km downstream from Brucejack Lake; long-term monitoring of fish is not expected. Monitoring of aquatic resources including sediment quality, primary producers, and benthic invertebrates will occur downstream to capture any effects of the outflow of Brucejack Lake on the aquatic habitat in Brucejack Creek and Sulphurets Creek. The methodology will be consistent with the Aquatic Effects Monitoring Plan (Section 30.3). Sampling for aquatic resources will be conducted at the end of the third year of monitoring. This will be carried out by an aquatic biologist.

30.11.9 Monitoring Costs

Preliminary monitoring costs including field, laboratory, and reporting have been estimated at $153,900 over the 3 year period (Table 30.11-1). This does not include travel or accommodation.

Table 30.11-1. Monitoring Costs Estimated Over the Three Year Post-closure Period

Monitoring Program	Year 1	Year 2	Year 3	Total
Surface Water Quality	$22,720	$22,720	$22,720	$68,160
Aquatic Resources			$11,820	$11,820
Groundwater Quality	$12,320	$12,320	$12,320	$36,960
Reclamation	$12,320	$12,320	$12,320	$36,960
Total	**$47,360**	**$47,360**	**$59,180**	**$153,900**

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