

# **Pogo Reclamation and Closure Plan**



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## Acronyms

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish & Game
ADNR	Alaska Department of Natural Resources
BMP	Best Management Practices
CIP	Carbon-in-Pulp
DBH	diameter breast height
DMLW	Division of Mining, Land and Water
DSTF	Drystack Tailing Facility
ETAP	Eastern Tanana Area Plan
EPA	Environmental Protection Agency
GMU	Game Management Unit
HDPE	high density polyethylene
LOM	Life of Mine
Plan	Reclamation and Closure Plan
PMC	Plant Material Center
PVC	polyvinyl chloride
RTP	Recycle Tailings Pond
ROW	Right-of-Way
SRCE	Standard Reclamation Cost Model
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WMP	Waste Management Permit

## Units of Measure

°F	Fahrenheit
amsl	above mean sea level
ft	foot/feet
Ma	million annum
tpa	tons per annum
yd <sup>3</sup>	cubic yards

## 1.0 INTRODUCTION

Pogo Mine is an underground gold mine and mill in central Alaska, located approximately 38 miles northeast of Delta Junction (**Figure 1.1**). Northern Star (Pogo) LLC is the operator of the Pogo Mine.

This Reclamation and Closure Plan (hereafter, referred to as Plan) describes the post-mining land use and provides the basis for the reclamation and closure activities that will be implemented. Also incorporated in this Plan are field investigations to gather site-specific information to help guide final closure designs.

This Plan has been revised to reflect current knowledge of site conditions, closure plans, comments from state agencies, and projected reclamation and closure costs.

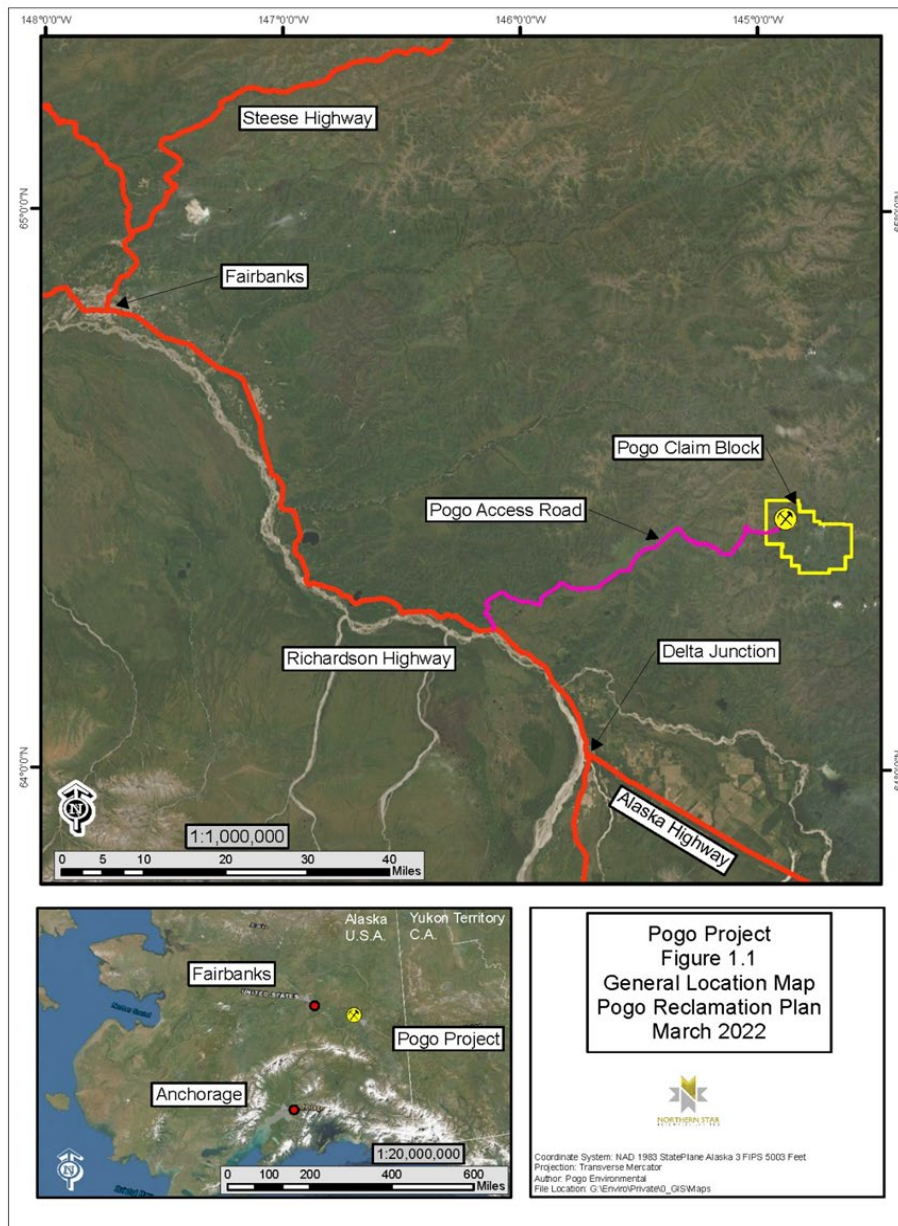
### 1.1 Purpose of this Document

This Plan is a working document that will be used to guide operations in conformance with the appropriate regulations from the Alaska Department of Natural Resources (ADNR), the Alaska Department of Environmental Conservation (ADEC), and the U.S. Army Corps of Engineers (USACE). As operations proceed, this Plan will be updated with new information to reflect current Best Management Practices (BMPs) and to reflect any changes to the design and operation of the facility.

The purpose of this Plan is to describe methods and procedures that will be used to ensure that operations are conducted in accordance with Alaska Statute AS 27.19.020, that states:

*“A mining operation shall be conducted in a manner that prevents unnecessary and undue degradation of land and water resources, and the mining operation shall be reclaimed as contemporaneously as practicable with the mining operation to leave the site in a stable condition.”*

Figure 1.1 – Pogo Mine Operations General Location Map





To achieve these directives, Pogo defined the following objectives for the reclamation and closure components of this Plan:

- The reclamation objective is to stabilize disturbed land surfaces against erosion and return the land to a post-mining land use of public recreation and wildlife habitat. This objective will be achieved by improving plant growth conditions and encouraging the succession of self-sustaining native and naturalized plant communities. Inactive areas that are not anticipated to be disturbed in the future will be reclaimed concurrent with mining.
- The closure objective is to ensure that water quality is not unduly influenced after mining operations cease. Successful reclamation and revegetation will play an important role in reaching this closure objective. As part of this goal, materials that could potentially cause degradation to the lands and waters of the state of Alaska will be stabilized, removed, or reclaimed.
- The issues Pogo believes to be most important to successfully achieve these reclamation and closure objectives are:
  - Successful stabilization and erosion control on steep dipping slopes,
  - Closure of the tailings drystack facility,
  - Closure of the underground workings, and
  - Closure of the mill site, lower camp, and other facilities.

## 1.2 Organization of this Document

This document is organized into five sections. **Section 1** is the introduction and provides an overview of the project and ecological setting. **Section 2** provides an overview of the operating profile and the nature and extent of the expected disturbance at closure. **Section 3** describes general revegetation guidelines, while **Section 4** describes the specific reclamation and closure prescriptions that will be applied to various project components. **Section 5** presents the performance standards for monitoring the effectiveness of the reclamation practices and the reclamation and closure cost estimate.

The appendices to this report include general procedures to be followed during construction, revegetation, and demolition, as well as material site reclamation plans, proposed vegetation test trials, and a reclamation cost estimate. All units of measure in this report are U.S. standard.

### 1.3 Agency Involvement

Reclamation of the Pogo project site falls under the jurisdiction of the ADNR, Division of Mining, Land and Water (DMLW), ADEC, and the USACE.

The State of Alaska's governor approved the State *Reclamation Act* on 6 June 1990. This act, administered by ADNR-DMLW, establishes performance standards of "...prevents unnecessary and undue degradation" and "leave the site in a stable condition" for mining reclamation and extended reclamation requirements to state, federal, and private land subject to cooperative agreements between state and federal agencies. Under the act, reclamation bonding is mandatory for mines disturbing more than five acres.

The ADEC regulates closure activities for specific site facilities and mines under Alaska Statute 46.03.100(f) and solid waste regulations (18 Alaska Administrative Code [AAC] 60). ADEC regulates treatment and discharge of wastewater under water regulations (18 AAC 70 and 18 AAC 72).

The USACE regulates dredge and fill activities associated with wetlands under Section 404 of the *Clean Water Act* (33 U.S.C. 1344).

#### 1.3.1 Reclamation Plan Review

**Table 1.1** summarizes the project stages from exploration to closure, and the pertinent reclamation and closure activities for each stage. This Plan was developed during Project Stage VI – Operating Life-of-Mine.

**Table 1.1: Project Development Stages**

Project Stage	Project Activity	Reclamation & Closure Activity
I	Grass Roots Surface Exploration	No surface disturbance.
II	Advanced Exploration	
	Stage 1 - Surface Exploration	As permitted by ADNR & USACE.
	Stage 2 - Underground Exploration	As permitted by ADNR & USACE.
III	Mine Environmental Assessment	Mine reclamation & closure plan developed.
	Mine Feasibility	Design for closure at the outset.
IV	Permitting for Mine Construction and Operations	Mine reclamation & closure plan approval by ADNR, ADEC, & USACE.
V	Mine Construction	Disturbance minimized to reduce impacts.
VI	Operating Life of Mine (LOM)	Concurrent reclamation where possible.
VII	Reclamation & Closure	Mine closure in accordance with mine reclamation & closure plan, permit requirements, & BMPs.

### 1.3.2 Financial Assurance

Financial assurance requirements by the ADEC and ADNR-DMLW ensure that performance criteria will be met during the reclamation process and that the owner or operator closes a project site according to state and federal regulations.

Pogo proposes to post financial assurance for the amount of the estimated reclamation, and closure costs as presented in **Appendix F** for the mill site lease area and access road.

## 1.4 Ecological Setting

The following sections provide a brief overview of the physical and biological baseline environment at the Pogo project. A more detailed description of the environment is included in the Pogo Environmental Impact Statement (Environmental Protection Agency [EPA] 2003).

The Pogo Mine is located near the Goodpaster River in the Tanana Uplands, an area of rolling hills and mountains on the north side of the Alaska Range in Interior Alaska (**Figure 1.1**). The Goodpaster is a major north side tributary to the Tanana River in the Yukon drainage basin. Elevations range from approximately 1,300 (feet) ft above mean sea level (amsl) along the alluvial floodplain to over 4,000 ft amsl along the ridge tops. An east-west trending ridge dominates the project site, with creeks to the south of the ridge draining first into Central Creek and then into the Goodpaster, and creeks on the north side draining directly into the Goodpaster River.

Southeast-facing slopes have closed forests of aspen, birch, and white spruce. Open communities of dwarf black spruce and birch are found on the north-facing slopes. The west-facing slopes in the headwaters of the Liese Basin have open stands of white spruce at lower elevations and alder at higher elevations. Exposed rubble and short-stature alpine vegetation characterize the surface of the ridges surrounding the basin. For the most part, vegetation is influenced by limited amounts of soil cover and discontinuous permafrost within much of the basin.

#### **1.4.1 Climate**

The climate in the Pogo project area is similar to other areas of interior Alaska. Wind speeds at higher elevations (>2,800 ft) are moderate to strong in winter and light to moderate in summer. The wind speeds at lower elevations are generally lighter. Winter temperatures range from -40 degrees Fahrenheit (°F) to 32°F. Summer temperatures range from 41°F to 86°F. Temperature inversions are common in the winter, particularly in mountain valleys.

The predicted mean annual precipitation ranges from 12 inches to 19 inches, with approximately 38% occurring as snowfall (Teck-Pogo Inc. 2002c).

#### **1.4.2 Soils & Vegetation**

Soils in the area vary from very poorly-drained, deep organic soils (Histosols), to well-drained but only moderately developed mineral soils (Cryochrepts and Cryumbrepts), to well-drained highly developed mineral soils (Spodosols) (Three Parameters Plus 2000).

Soils in the floodplain of the Goodpaster River are well drained on the higher elevation terraces, and poorly to somewhat poorly drained in more active but vegetated and detritus lined, lower elevation channels. Terraces are typically vegetated with larger diameter, 14 inches plus at diameter breast height (DBH), white spruce (*Picea glauca*), and support a sparse understory. Relic and seasonally active channels support a mixed forest typically dominated by white spruce, black spruce (*Picea mariana*), and paper birch (*Betula papyrifera*). The understory in these areas is denser, but highly variable due to the varying frequency of flooding and degree of saturation found in these channels.

Lowlands within the floodplain of the Goodpaster River and the adjacent lower elevation footslopes support poorly drained soils. These are very cold soils with organic mats of at least 8 inches. These soil types also extend well up the west-facing hillside above the area of the existing advanced exploration camp. Lowland and lower footslope soils often contain ice-rich permafrost within the upper 2 ft of the soil profile, and several of the soil pits in these areas filled with water shortly after the pit was dug. Permafrost is discontinuous in the project area, and its presence and depth is difficult to predict. Mineral soil horizons under these deep organic mats typically become very thixotropic upon exposure and thawing. *Histic Pergelic Cryaquepts* generally support open black spruce forests or scrub shrub vegetation types. These two vegetation types can also occur over cryohemists, however, the tussock sedge vegetation type, dominated by *Eriophorum vaginatum*, is more common.

Hillsides and upper mountain-slopes with a south to west aspect, or convex topography, can also support moderate- to well-drained mineral soils. Generally, these soils have a relatively thin organic mat (2 to 6 inches) overlying 6 to 24 inches of sandy loam material, which in turn overlies loose talus/colluvium or weathering rocks. In some areas, the loamy soil can be sparse to non-existent, and the organic mat resides directly on blocky talus/colluvium and/or frost-shattered weathered bedrock.

Soils on these landforms commonly support a closed black spruce forest type with relatively large diameter black spruce (12 inch + DBH) and a moderately sparse understory, or mixed forests with larger diameter spruce and paper birch. Where drainage is poor on these sites, such as in seeps or small depressions, mottles or organic stains are common in the sandy layer. The taxonomic classification of these soils is dependent on several variables, but most would fall into the *Typic Cryaquept*

classification. Ice-rich permafrost is uncommon in these areas; however, the colder, wetter soils can become slightly thixotropic upon removal of the organic mat and exposure to warmer temperatures (Teck Resources Inc. 1998).

### **1.4.3 Wildlife**

The project area comprises three types of shrub and forest habitats—lowland shrub needleleaf, riparian and lowland forest needleleaf, and upland forest needleleaf—that are dominated by varying proportions of white and black spruce (*Picea glauca* and *mariana*), quaking aspen and balsam poplar (*Populus tremuloides* and *balsamifera*), paper birch (*Betula papyrifera*), alder (*Alnus spp.*), and willows (*Salix spp.*). These habitat types support both resident birds (e.g., grouse, woodpeckers, chickadees) as well as a number of migratory species that occur only during the summer breeding season—principally songbirds (thrushes, warblers, sparrows, and flycatchers, many of which are neotropical migrants) and raptors. The three types present in the immediate vicinity of the underground project are among the lower diversity types in interior Alaska.

A few waterfowl and shorebirds occur in the wetlands of the Goodpaster River valley but in low densities; habitats suitable for breeding waterfowl are small and widely dispersed in this portion of the Goodpaster drainage. The project area supports a mammalian fauna typical of the boreal forest of the Yukon–Tanana Uplands of interior Alaska. Specific surveys to inventory the small mammals and furbearers have not been done in the project area, but species that are common elsewhere in interior Alaska include: red squirrels (*Tamiasciurus hudsonicus*), snowshoe hares (*Lepus americanus*), red foxes (*Vulpes vulpes*), and various shrews and arvicoline rodents (voles, mice, and lemmings). More information exists for big game species such as moose and bears due to their harvest by humans. The project area is located in the northwestern portion of Game Management Unit (GMU) 20D, which is considered less accessible to hunters than other subunits (Teck Resources Inc. 1998).

### **1.4.4 Surface Water**

The surface water environment in the project area is generally good and overall water quality and physical characteristics are typical of many subarctic Alaska streams.

Surface water in the Pogo project area is clear and non-glacial, with slight to moderate organic staining observed during spring runoff. Water quality and physical

characteristics are influenced by the source of the stream flow, which varies seasonally. During the open water season, which lasts from approximately late April through October, the source of stream flow is a combination of groundwater baseflow and precipitation runoff. Freezing conditions in the winter limit the source of stream flow to groundwater inputs.

The baseline hydrological conditions at the Pogo site have been investigated by analyzing on-site rainfall, snowpack, and stream discharge data as well as regional meteorological information. The short-term rainfall records on site have been correlated with long-term data at regional meteorological stations, and possible orographic (mountain) influences have been assessed. The runoff regime is characterized by spring snowmelt followed by runoff from summer rainfall events. Annual runoff depths have been quantified based on the monitoring results for the Goodpaster River and two tributary creeks, Sonora and Central Creek. Winter discharges often produce areas of aufeis, or glaciation, in the tributary creek valleys.

#### **1.4.5 Groundwater Hydrology**

The Pogo project consists of two main hydrogeologic areas: the upland area in the eastern portion of the site and the Goodpaster River valley to the west.

The groundwater table in the project area is a subdued replica of the topography with the water table at a higher elevation beneath the ridge than beneath the valley. Recharge of the groundwater system occurs predominantly in the upland areas. Regional discharge is to the Goodpaster River valley, with local groundwater discharge to Pogo Creek and Liese Creek. Groundwater flow in the sediments of the Goodpaster River is predominately horizontal and from the north to the south, parallel to the river.

The upland or Pogo Ridge area is underlain by low permeable bedrock consisting predominantly of igneous and metamorphosed sedimentary rocks. More pervious zones of broken rock may be present within the less fractured bedrock, but recent data gathered from the advanced exploration adit suggests that these zones are not extensive over large areas and as such are not significant pathways for groundwater flow. Permafrost was developed to a depth of up to 350 ft below ground surface on the north-facing slope of this ridge, while on the south-facing slope it is virtually absent. The water table beneath the ridge is deep and up to approximately 500 ft below the ground surface.

The Goodpaster River valley is underlain predominantly by highly permeable sands and gravels. These sediments are up to 100 ft thick in the center of the valley, with their thickness decreasing towards the valley flanks. The water table is located at approximately 2 to 8 ft below the ground surface. In the eastern portion of the valley, permafrost, which can be considered to be virtually impermeable, generally extends from the ground surface down to the bottom of the sediments. Closer to the existing river channel, the permafrost gradually thins and is underlain by unfrozen sediments.

Pogo began a hydrogeological characterization in 2012 in order to rebuild the groundwater flow model. The original model was initially established in 2002 and was updated in 2009 (Brown 2009). The current model includes the East Deep zone. The final model was released by SRK in May 2014 (SRK 2014).

## 1.5 Land Use

The Eastern Tanana Area Plan (ETAP) for State Lands (ADNR 2015) designates the uses that will occur on state lands within the eastern portion of the Tanana Basin and establishes guidelines that allow various uses to occur without conflicts. The ETAP goals for subsurface resources are:

- **Opportunities for Mineral Exploration and Development.** Provide opportunities through state land management for the exploration and development of mineral resources.
- **Economic Opportunities.** Provide economic opportunities and stability by managing state lands for the efficient and environmentally sound:
  - disposal of tailings,
  - development of state land and submerged land mining sites, and
  - siting of infrastructure to support development of mineral resources.
- **Environmental Quality and Cultural Values.** When developing subsurface resources, protect the integrity of the environment and affected cultural features to the extent feasible and prudent.

According to the ETAP (ADNR 2015), the Pogo project area is in the Delta Region (Management Unit D).



The Delta region consists of 3.4 million total acres of which 2.4 million acres are state land. This region is centered on Delta Junction and bordered on the north by Eielson Air Force Base and on the south, by the crest of the Alaska Range.

Lands within the leasehold locations for the Upland Mining Lease ADL 674057 and Millsite Lease ADL 416949 include subunits D-04 and D-15. The primary designated surface uses for the uplands within the claim block are forestry and minerals (Unit D-04). Unit D-15 is a corridor along the Goodpaster River. There are no specific prohibited uses. The unit is managed to protect and maintain habitat and public recreation values. Reclamation of the disturbed areas is expected to enhance wildlife habitat within 5 to 15 years by stimulating the growth of early successional forest, which will maintain the habitat and recreation values.

Tanana Valley State Forest (TVSF) land, Unit L-01, is located along access corridors. Management Unit L-01 includes most of the uplands between Shaw Creek and the Goodpaster River, and the bottomland along the Tanana River between Big Delta and Dot Lake as well as the uplands that surround Volkmar Lake.

Traditional resource use of the region has been for subsistence and recreation. Delta Region residents as well as owners of recreational properties in the Goodpaster area hunt moose, caribou, bear, rabbit, grouse, ptarmigan, buffalo, and dall sheep. Trappers in the area report the harvesting of furbearers such as lynx, marten, beaver, wolf, and fox. Recreational fishing in the region includes pike, grayling, trout, and silver and chum salmon. Several of these species are available year-round through winter ice fishing.

Numerous well-developed trails throughout the region are used by snowmobiles, skiers, and dog teams in the winter and spring months. Riverboats, canoes, river rafts, and kayaks are used by residents and visitors on many of the rivers in the region between mid-April and October. Primary among the recreational rivers in the regions are the Tanana, the Goodpaster, and the Clearwater.

## **2.0 OPERATIONS PROFILE / APPLICANT INFORMATION**

### **2.1 Surface and Mineral Lease Information**

The mine is 38 air miles northeast of Delta Junction, Alaska, and the property consists of 1,250 state mining claims covering an area approximately 41,880 acres (**Figure 1.1**). The Pogo claim block lies in Sections 13, 14, 22-27, and 34-36 within T5S, R14E, Sections 18, 19, and 29-34 within T5S, R15E, Sections 1-3, 10-15, and 36 within T6S, R14E, and Sections 3-11, 14-23, and 29-32 within T6S, R15E, Fairbanks Meridian. The operation is covered by Upland Mining Lease ADL 674057 and Millsite Lease ADL 416949. Information on mining claims and land status for Northern Star (Pogo) LLC is listed in the Pogo Mine Plan of Operations, Appendix A.

### **2.2 Corporation Officer Completing Application**

Name: Michael Eckert  
Title: General Manager  
Telephone: (907) 895-2834  
Date: September 1, 2023

### **2.3 Designated Contact Person**

Name: Russell Gossett  
Title: Environmental Manager  
Telephone: (907) 895-2831

### **2.4 Corporate Information**

Business Name: Northern Star Resources Limited dba Northern Star (Pogo) LLC

Entity Address: Level 4, 388 Hay Street  
Subiaco, WA 6008  
Australia

Address: 3204 International Street  
Fairbanks, Alaska 99701  
Telephone: (907) 895-2500

President: Stuart Tonkin  
Treasurer: Ryan Gurner  
Secretary: Hilary Macdonald

Northern Star (Pogo) LLC is an Alaska Limited Liability Company wholly owned by Northern Star Resources Limited.

## 2.5 Alaska Registered Agent

Name: Andrea Canfield, Stoel Rives LLP  
Address: 510 L Street, Suite 500.  
Anchorage, Alaska 99501-1959  
Telephone: 907.263.8450

## 2.6 Applicant Statement of Responsibility

Pogo recognizes its responsibility in the use of state lands and accepts that responsibility in its commitment to reclaim the Pogo project site. Pogo will meet the requirements of its reclamation plan and return the site to a safe and stable condition consistent with the approved post-mining land use. Pogo will meet all required local, federal, and state laws and regulations regarding reclamation activities.

## 2.7 General Description of the Project

The mine consists of the six major elements shown in **Figure 2.1** and described below.

### 1525 Portal/ Lower Camp Area (1000)

- 449-person camp with recreation and catering facilities
- Sewage treatment plant
- Water treatment plant
- Mineralized rock and low-grade ore stockpile
- Laydown areas for warehouse and supply
- Warehouses for mine supply
- Growth media stockpiles

*Airstrip Area (2000)*

- A 3,000-foot airstrip in the Goodpaster River valley just north of Liese Creek
- Site access roads connecting the plant site with the shop/camp facilities, construction camp area, airstrip, tailings site, borrow sites, and other facilities as needed
- Growth media stockpile

*Mill / Upper Camp Complex (3000)*

- Surface gold mill for recovery through gravity concentration, flotation, and Carbon-in-Pulp (CIP) process
- Tailings preparation facilities, including cyanide detoxification and filtration, to produce paste backfill for the underground mine workings and dewatered tailings material suitable for placement in a drystack facility on the surface
- Maintenance shops, office, warehouse complex
- 249-person camp with recreation and catering facility

*Dry Stack Tailings Facility/Recycle Tailings Pond Area (4000)*

- Drystack tailings facility
- Recycle Tailings Pond (RTP) water storage facility
- Diversion ditches
- Growth media stockpiles and connecting roads

*Mine (5000)*

- Underground long-hole drilling mine with adit access and conveyor for transfer of ore to a surface mill
- 1525 portal original exploration adit, ventilation, waste rock haulage, etc.
- 1875 portal primary access for workers, supplies, etc.
- 1690 portal conveyor access and ventilation
- 2150 portal intake ventilation, access for workers, supplies, etc.

Millsite Area (6000)

- All utilities, piping and items that connect the respective area
- Items not included in other areas

## **2.8 Planned Production**

Optimization of the mine plan and layout forecasts the development rock quantities shown in Table 2.1.

**Table 2.1: Development Rock Quantities**

<b>Forecasted</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>Total</b>
<b>Mineralized Ore to Surface</b>	433,394	485,900	475,024	475,024	1,869,342
<b>Mineralized Waste to Surface (red rock)</b>	485,752	450,604	452,317	452,317	1,840,990
<b>Total Mineralized Rock to Surface (development ore + red rock)</b>	919,146	936,504	927,341	927,341	3,710,332
<b>Non-mineralized Rock to Surface</b>	728,628	675,907	678,475	678,475	2,761,485
<b>Total Development Rock</b>	1,647,774	1,612,411	1,605,816	1,605,816	6,471,817

Mining and production operations are driven by the mine plan, site conditions, and operational priorities which change daily. General operating criteria for the mine are outlined below.

- Milling Rate
  - Average operating production 195 STph
  - Average eventual production 220 STph
- Mining Rate (Ore) same as milling rate
- Current projected mine life 10 years

## 2.9 Design Goals & Considerations

To protect the environment, all aspects of operations for the Pogo mine will be based on the following principles:

- Perform concurrent reclamation and planning for closure.
- Compliance with all relevant federal and state laws and regulations.
- Compliance with the amount of water discharged, including all federal and state rules and regulations during discharges.
- Manage the overall surface footprint of the project.
- Protect the Goodpaster River.
- Proper management and permitting of wetlands.
- Compliance with federal and state rules and regulations regarding the proper use and handling of hazardous materials, including cyanide, fuel, and mill reagents.
- Appropriately control stormwater and precipitation runoff from mill bench and the Drystack Tailings Facility (DSTF).

## 2.10 Nature & Extent of Land Disturbance at Closure

There are approximately 536 acres currently disturbed within the Millsite Lease area. Disturbances associated with mining operations are shown in **Table 2.2** and in **Figure 2.1**. Approximately 368 acres of disturbance are associated with the Pogo access road, material sites, and transmission line (approximately 159 acres for material sites, 208 acres for private portion of the access road, and 1 acre - power poles only).

**Table 2.2** also provides an estimate of the areas that will require natural and enhanced recovery methods and soils to be reshaped and relocated for recontouring. The goal of the revegetation program is to stabilize soil erosion so that native species may re-colonize the area. This will be accomplished using the two methods described below.

- Natural recovery will be implemented in minimally disturbed areas; scarification and fertilization of the disturbed and surrounding area may be undertaken to encourage natural recovery.
- Enhanced recovery will be implemented in highly disturbed areas using a combination of one or more of the following: growth media, fertilizer, native grass seed, or native shrubbery to immediately establish a vegetative cover to reduce soil erosion and prevent sediment loss into rivers and streams.



**Table 2.2: Mine Land Disturbance & Reclamation Methods**

Pogo ID	Minesite Facility Name	2022 Acres	Cover Layer below GM (ft)	GM Thickness (inches)	Rip/Scarify (Yes/No)	Seeding (Yes/No)	Cover Volume (yds)	GM Volume (yds)
<b>1525 Portal and Lower Camp Area</b>								
	Buildings - Lower Camp Area	1.00	3	6	Yes	Yes	4,840	807
	Buildings - D-wing Area & incinerator	0.91	3	6	Yes	Yes	4,404	734
	Buildings - 1525 Portal Area	0.76	3	6	Yes	Yes	3,678	613
E01	Road #8 - 1525 Portal Access Road	12.37	0	0	Yes	No	0	0
E02	Utilities	1.34	0	6	Yes	No	0	1,080
E02	Mineralized rock and low-grade ore stockpile	4.91	0	6	No	No	0	3,964
E02	Incinerator	1.42	3	6	Yes	No	6,879	1,147
E03	Lower Camp Stilling Pond	0.51	0	0	No	No	0	0
E03	North Gravel Pond	4.16	0	0	No	No	0	0
E03W	South Gravel Pond	3.17	0	0	No	No	0	0
E04	Construction Airstrip	1.99	0	0	Yes	No	0	0
E05	Lower Camp Creek Diversion Ditch	0.07	0	0	Yes	No	0	0
E06	Access Road Goodpaster Bridge	0.19	0	6	Yes	No	0	152
E07	Burn Pit	1.31	0	0	No	No	0	0
N01	1525 Portal	6.90	0	0	Yes	No	0	0
N02	Outfall 002 Pipeline Path	0.55	0	0	No	No	0	0
N04	D-wing	7.77	0	0	Yes	No	0	0
N04	1525 Laydown Areas	10.16	0	0	Yes	No	0	0
N05	Construction/Exploration Camp	11.92	0	6	Yes	No	0	9,613
N06W	#7 Road Access Road Goodpaster	10.33	0	6	Yes	No	0	8,334
<b>Subtotal</b>		<b>81.74</b>					<b>19,802</b>	<b>26,443</b>
<b>Airstrip Area</b>								
N03W	Access Road #6	6.50	0	6	Yes	No	0	5,247
N07	Airstrip Runway	45.17	0	6	Yes	No	0	36,436
N09	Borrow Source at Airstrip	0.54	0	0	No	No	0	0
N11	Laydown Area (Wire Farm)	10.93	0	0	Yes	No	0	0
N11	Airstrip Laydown Area	29.36	0	0	Yes	No	0	0
N11W	Laydown Area (Boneyard)	3.25	0	0	Yes	No	0	0
N31	ORTW (Inlet Pond and Mixing Pond)	18.45	0	6	Yes	No	0	14,885
<b>Subtotal</b>		<b>114.62</b>					<b>0</b>	<b>56,568</b>
<b>Mill and Upper Camp Area</b>								
	Buildings - 1875 Portal Area	0.13	3	6	Yes	Yes	629	105
	Buildings - 1690 Portal Area	0.05	3	6	Yes	Yes	242	40
	Buildings - Main Camp Area	1.71	3	6	Yes	Yes	8,276	1,379
	Buildings - Mill Area	2.91	3	6	Yes	Yes	14,084	2,347
N10	1690 Portal	2.92	0	6	Yes	Yes	0	2,355
N14	Mill Bench	24.11	0	6	Yes	Yes	0	19,449
N15	Road #3 to Mill to RTP	11.97	0	6	Yes	Yes	0	9,656
N16	Road #1	10.92	0	6	Yes	Yes	0	8,806
N16	Main Camp/1875 Portal	18.67	0	6	Yes	Yes	0	15,060
N25	Storm Water Pond	2.16	0	6	No	Yes	0	1,742
<b>Subtotal</b>		<b>75.55</b>					<b>23,232</b>	<b>60,934</b>
<b>Dry Stack Tailings Facility/ Recycle Tailings Pong Area</b>								
	Buildings - RTP Area	0.02	3	6	Yes	Yes	97	16
N15W	Road #4 to Mill to RTP	7.98	0	6	Yes	Yes	0	6,436
N17	Recycle Tailings Pond (RTP)	10.76	0	6	Yes	Yes	0	8,679
N18	Dry Stack Tailings Facility	89.30	1.5	6	Yes	Yes	237,183	72,035
N20	Access Road to RTP Seepage Well	1.38	0	6	Yes	Yes	0	1,110
N23	Diversion Ditches (Flume) (Old South Diversion Ditch, New South Diversion Ditch, North Diversion Ditch)	57.41	0	6	No	Yes	0	46,311
N32	Stilling Basin	2.89	0	6	No	Yes	0	2,329
<b>Subtotal</b>		<b>169.74</b>					<b>237,280</b>	<b>136,924</b>

Pogo ID	Minesite Facility Name	2022 Acres	Cover Layer below GM (ft)	GM Thickness (inches)	Rip/Scarify (Yes/No)	Seeding (Yes/No)	Cover Volume (yds)	GM Volume (yds)
<b>Site-Wide Area</b>								
N11	Growth Media	16.81	0	0	No	No	0	0
N21	Transmission Line	17.70	0	0	No	No	0	0
N28	Material Sites A	2.37	0	0	No	No	0	0
N28A	Material Sites D	1.94	0	0	No	No	0	0
<b>Subtotal</b>		<b>38.82</b>	-				<b>0</b>	<b>0</b>
<b>2150 Portal</b>								
N28D	2150 portal	14.84	0	0	Yes	Yes	0	0
	Buildings - 2150 Portal Area	0.12	3	6	Yes	Yes	581	97
<b>Subtotal</b>		<b>14.96</b>	-				<b>581</b>	<b>97</b>
<b>Total</b>		<b>495.42</b>					<b>280,894</b>	<b>284,796</b>

yd<sup>3</sup> – cubic yards

Figure 2.1: Pogo Mine As-Built

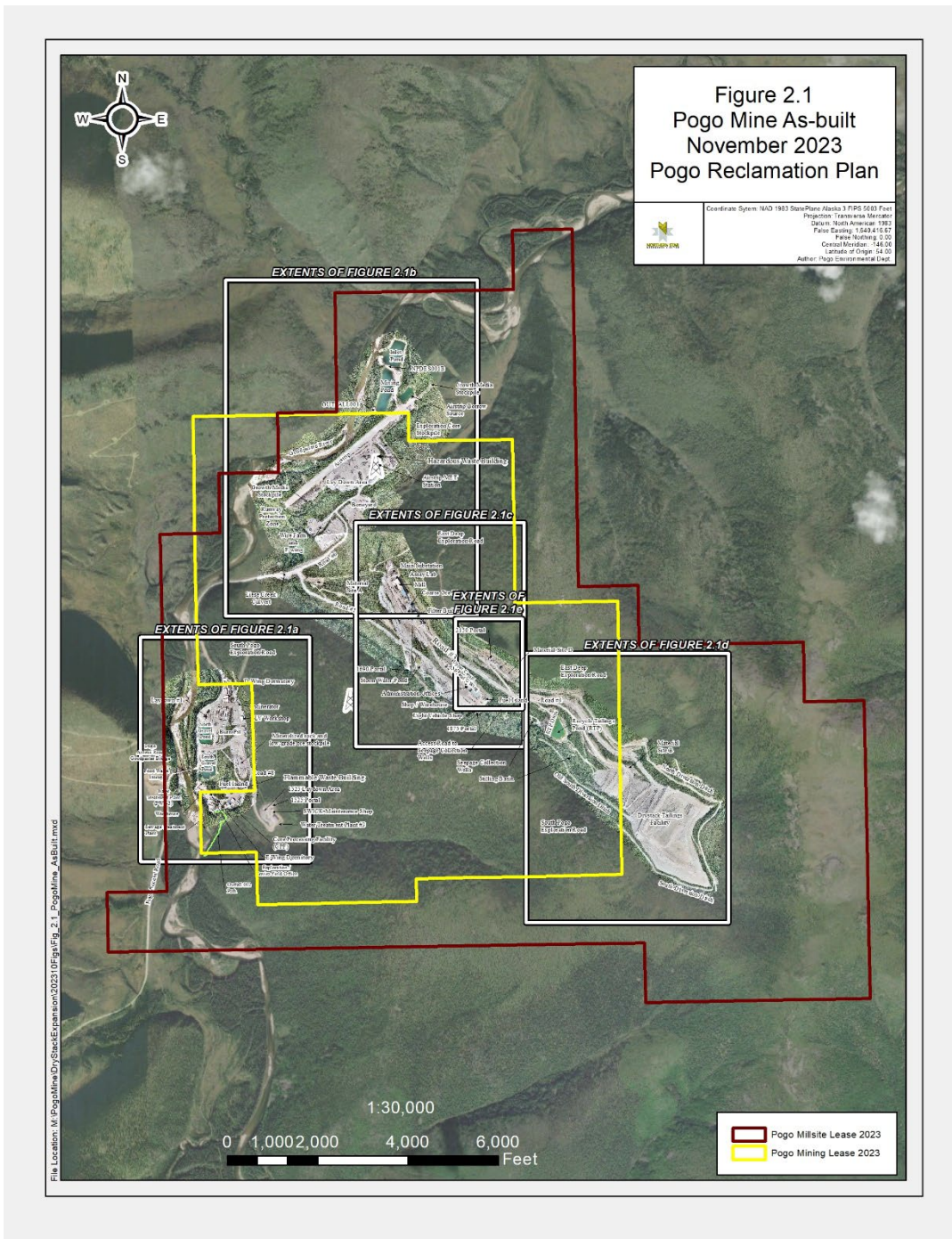


Figure 2.1a: 1525 Portal and Lower Camp As-Built

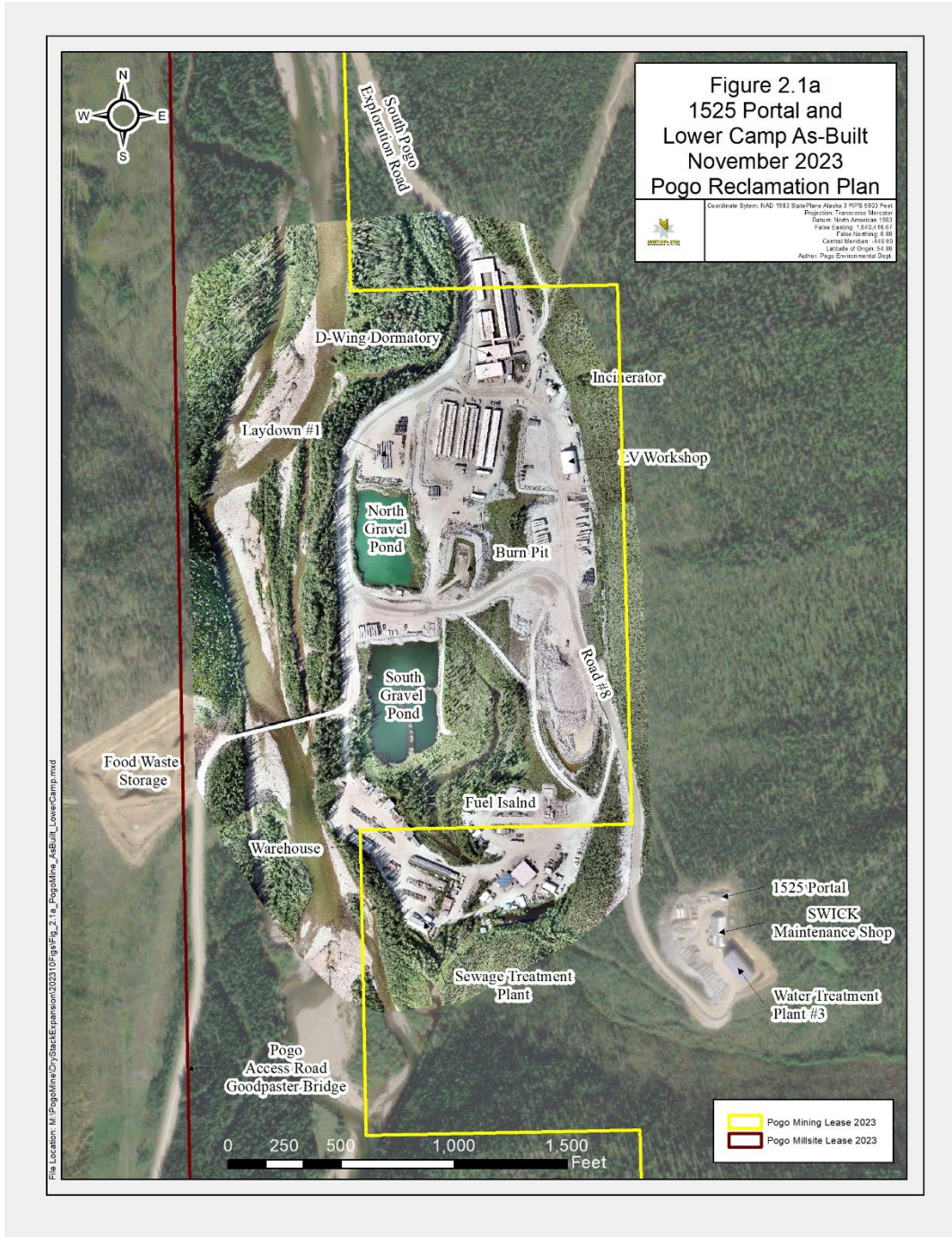


Figure 2.1b: Airstrip Area As-Built

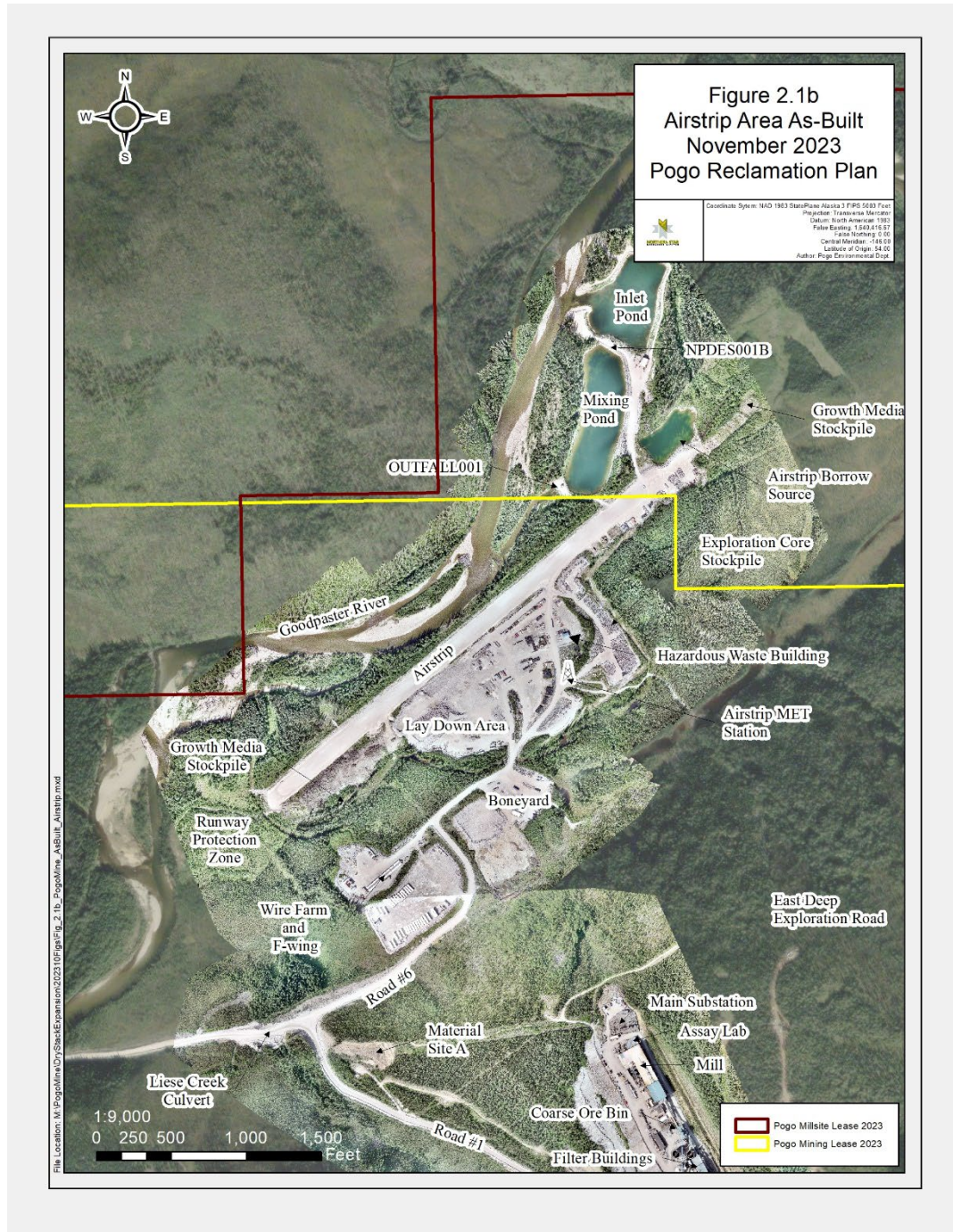


Figure 2.1c: Mill and Upper Camp Bench As-Built

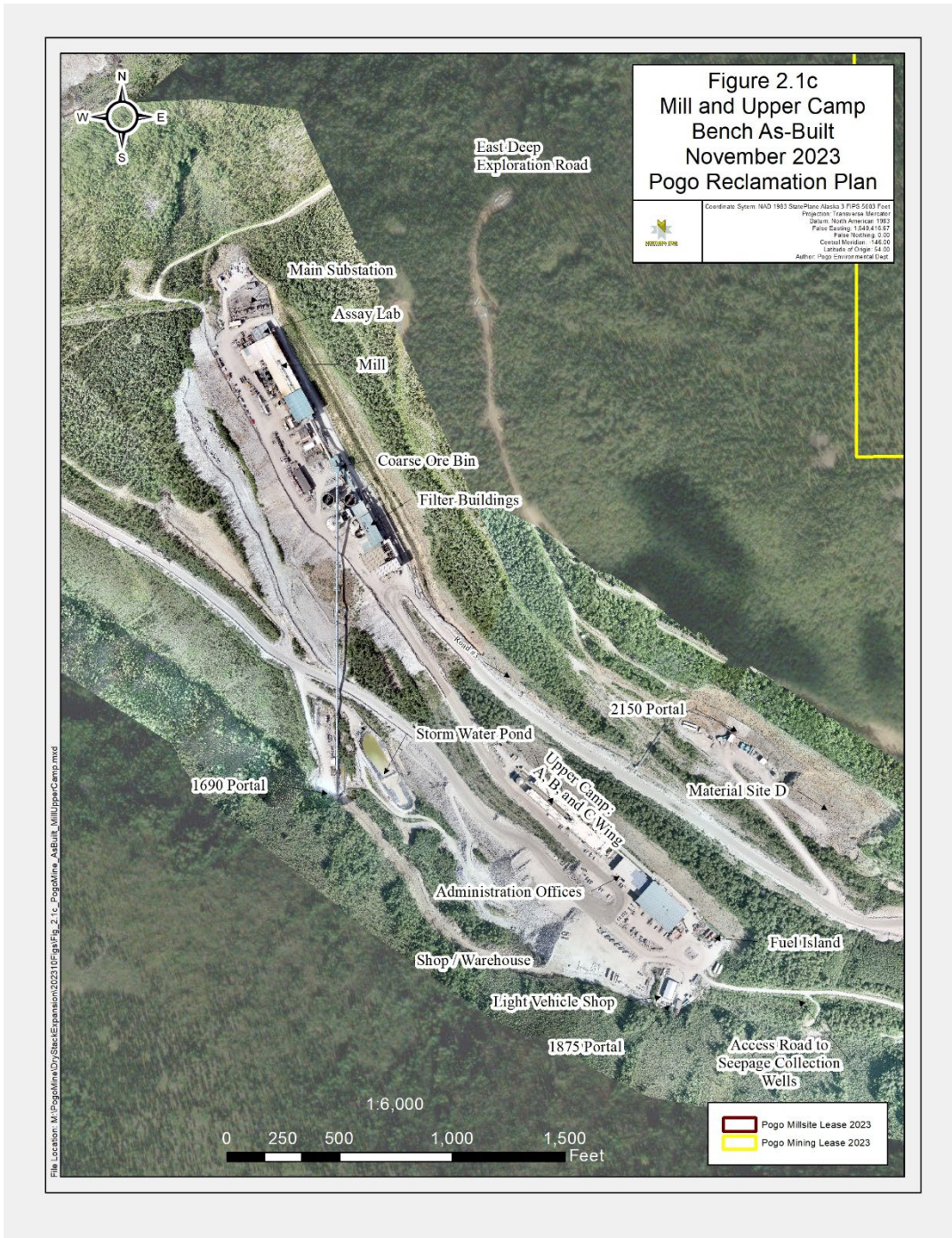


Figure 2.1d: RTP and DSTF Area As-Built

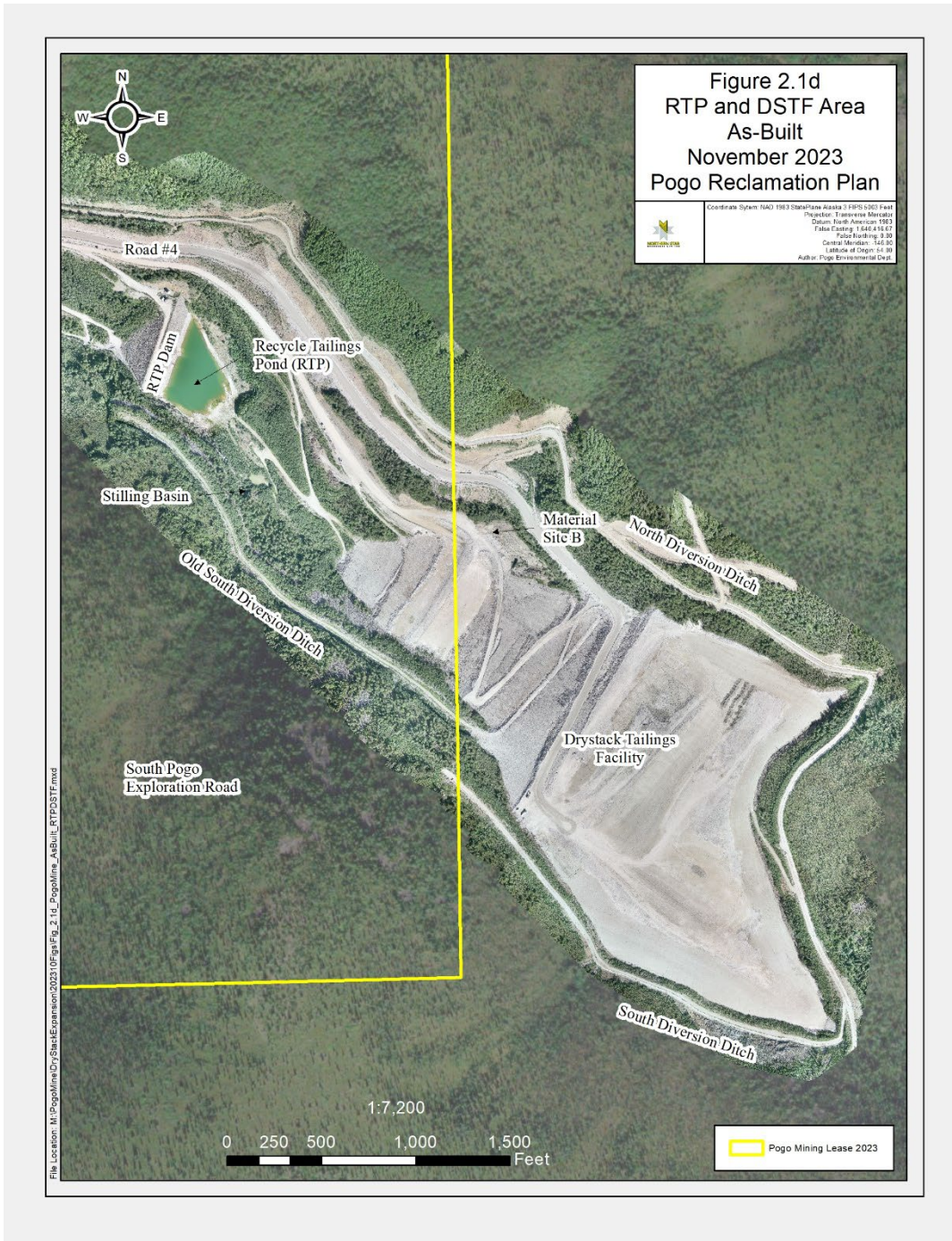


Figure 2.1e: RTP and DSTF Area As-Built





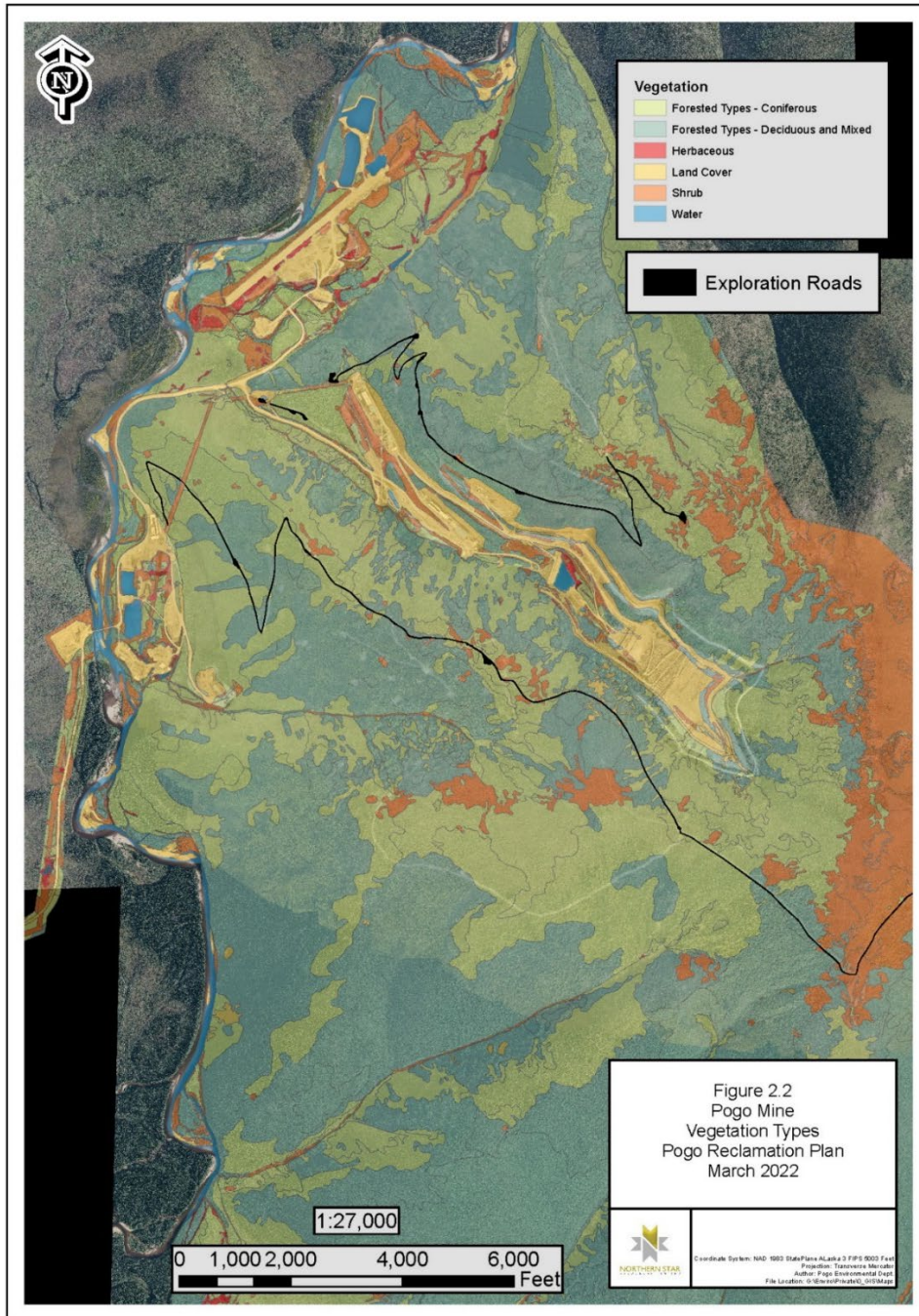
### **2.10.1** *Impacts to Vegetation*

A description of the types of vegetation found on the project site is presented in **Table 2.3**. Typical vegetation within the project footprint is presented in **Figure 2.2**. The major vegetation types are alluvial forest (terrace), open black spruce forest, closed broadleaf forest, and open black spruce forest (tussock sedge complex). Most of the impacted vegetation is a mosaic of alluvial forest (lowlands) and open black spruce forest with tussock sedge wetlands.

**Table 2.3: Vegetation Type Descriptions**

Vegetation Type	Soil Description
Alder Shrub Thicket	Somewhat poorly-drained Pergelic Cryaquepts or moderately well-drained Pergelic Cryochrepts, depending on the degree of slope. Hydric or non-hydric.
Alluvial Forest – Emergent Complex	See Alluvial Forests – Lowlands.
Alluvial Forest – Lowland	Loamy, mixed, non-acid Pergelic Cryaquepts. Hydric.
Alluvial Forest – Terraces	Moderately well-drained, coarse-silty, mixed, non-acid Aeric Cryaquepts; or Typic Cryofluvents. Hydric.
Alluvial Forest – Willow Shrub Thicket Complex	See Alluvial Forests – Lowlands.
Closed Black Spruce Forest	Moderately well- to somewhat poorly-drained Pergelic Cryorthents or Cryochrepts, variable. Predominantly non-hydric.
Closed Broadleaf Forest	Well-drained, coarse-silty, mixed, non-acid Aeric Cryaquepts (occasionally well-drained Typic Cryochrepts). Non-hydric.
Closed Mixed Forest	Moderately well-drained, coarse-silty, mixed, non-acid Aeric cryaquepts (Typic Cryochrepts). Non-hydric.
Disturbed – Filled Areas	Mixed soils.
Dwarf Birch Shrub Thicket	Dysic Pergelic Sphagnofibrists or Histic Pergelic Cryaquepts. Both hydric.
Emergent Aquatic Areas	Dysic Pergelic Sphagnofibrists or Typic or Pergelic Cryofibrists. Hydric.
Gravel Bars	Probable waters of the U.S.
Open Black Spruce Forest	Loam, mixed, non-acid Histic Pergelic Cryaquepts. Hydric.
Open Black Spruce Forest – Tussock Sedge Complex	Loamy, mixed, non-acid to acid Histic Pergelic Cryaquepts or Histic Cryaquepts. Hydric.
Open Mixed Forest	Complex mosaic of forests & shrub thickets, high degree of variability (Pergelic Cryohemists to Typic or Pergelic Cryorthods). Hydric and non-hydric soils.
Open Mixed Spruce Forest	Range from moderately well-drained Pergelic Cryochrepts to somewhat poorly-drained Pergelic Cryaquepts, again depending on the degree of slope and topography. Hydric or non-hydric.
Open Water	Waters of the U.S.
Tussock Sedge	Loamy, mixed, acid Histic Pergelic Cryaquepts or Histic Cryaquepts. Hydric.
Willow Shrub Thicket	Somewhat poorly drained Pergelic Cryaquepts or Pergelic Cryofluvents. Hydric.

Figure 2.2: Typical Vegetation Schematic



## 3.0 REVEGETATION GUIDELINES

Pogo will revegetate the project area utilizing the following guidelines:

- Institute recommended post-mining land use,
- Evaluate the final landform that will meet that use,
- Assess available plant species,
- Verify available plant growth media, and
- Combine and optimize each of these objectives.

The designated and traditional land use in the area is wildlife habitat and recreation (ADNR 2015).

Reclamation of the disturbed areas is expected to enhance wildlife habitat within 5 to 15 years by stimulating the growth of early successional forest which provides: willow and shrub browse for moose and other game; young aspen stands for Ruffed Grouse habitat; and grass areas, which provide forage, diversity, and cover for voles and other species.

### 3.1 Final Landforms

With the exception of stable highwalls, the final post-mining landforms will be blended into the undisturbed landscape through the use of contouring and vegetation. Reclaimed areas will be contoured with the objective of reducing infiltration, keeping the disturbed area to a minimum, and stabilizing the surface. To achieve these objectives, the primary design consideration for reclamation will be the overall slope angle as determined by stability and environmental considerations. The slope length of final landforms will be broken to reduce the water runoff velocity and consequent erosion if necessary.

Where required, highwall stabilization will include a combination of toe buttressing and benching. Examples of areas requiring stabilization include cuts at the mill bench, camp/shop bench, portal cuts, Material Sites A and D, and some rock cuts along the road and ditches.

Where possible, wetland areas will be established to increase the post-mining biodiversity of the project area. These wetland areas may include the reclaimed

material site areas, gravel ponds and the reclaimed recycle tailings pond area. Notwithstanding the material sites in Figure 3.1, all other wetland sites will be established. Pogo will attempt to reestablish disturbed wetland areas. Specific locations will be determined in consultation with ADNR.

### 3.2 Plant Species

The project revegetation program will build on previous work done in conjunction with advanced exploration. In 1998 and 1999, seed and fertilizer were applied to erodible areas on the winter road and an unstable slope cut into the hillside above the advanced exploration camp during previous placer operations. Anecdotal experience since construction of the mine demonstrates that the growth media stockpiles readily revegetate.

Further site-specific knowledge was gathered from test plots of various seed, fertilizer, growth media depth, and shrubbery applications. Test plots were established in 2013 near the Pogo Airstrip and the Off River Treatment Works, and in 2014 along the Drystack South Diversion Ditch. Annual test plots and related surveys were completed in 2018. **Appendix B** provides information on previous revegetation efforts.

Appendix E provides a summary of the results of the test plots trials. Three-years of data for the test plots indicated that the reclamation success standard can be achieved with moderate or minimal inputs.

Seed suppliers and the Alaska Plant Material Center (PMC) were contacted for recommendations of species for final closure based on results of the trials and commercial availability of locally adapted cultivars. The PMC indicated that many of the species use in the trials are no longer commercially available in Alaska. Based on the recommendations, the seed mix listed below is proposed for final reclamation. The species in the mix were included in the field trials and demonstrated to meet the 70% cover requirements while allowing invasion of native species from the surrounding area.

- 40% Tufted hairgrass var. Nortran
- 30% red Fescue var. Arctared
- 25% slender Wheatgrass var. Wainwright
- 5% Annual rye

The recommended rate is 40 pounds pure live seed/acre.

### 3.3 Plant Growth Media

The amount of growth media stripped and stockpiled is more than adequate to reclaim the overall disturbance. Growth media will consist of a combination of organic material, topsoil, and overburden that will serve to enhance revegetation efforts. Approximately 303,884 loose cubic yards of growth media was salvaged during construction activities and stored in 19 growth media stockpiles. Assuming that a 6-inch lift of growth media is applied over all the area that will require enhanced recovery, approximately 284,796 loose cubic yards of growth media is required. In addition, the overburden stockpiles have substantial plant growth, which indicates the material is a viable growth media cover. **Appendix B** provides details on the storage and use of growth media in revegetation procedures. The stockpiles will be protected from wind and water erosion using BMPs.

The results of revegetation trials indicate that the recommended 6 inches of growth media is adequate to support the proposed post-mining land use of public recreation and wildlife habitat. See Section 3.4 and Appendix E.

**Table 3.1** summarizes the growth media volumes from storage locations around the site based on the 2022 aerial photographs, surveys, and/or truck counts. The storage locations are shown in **Figure 3.1**.

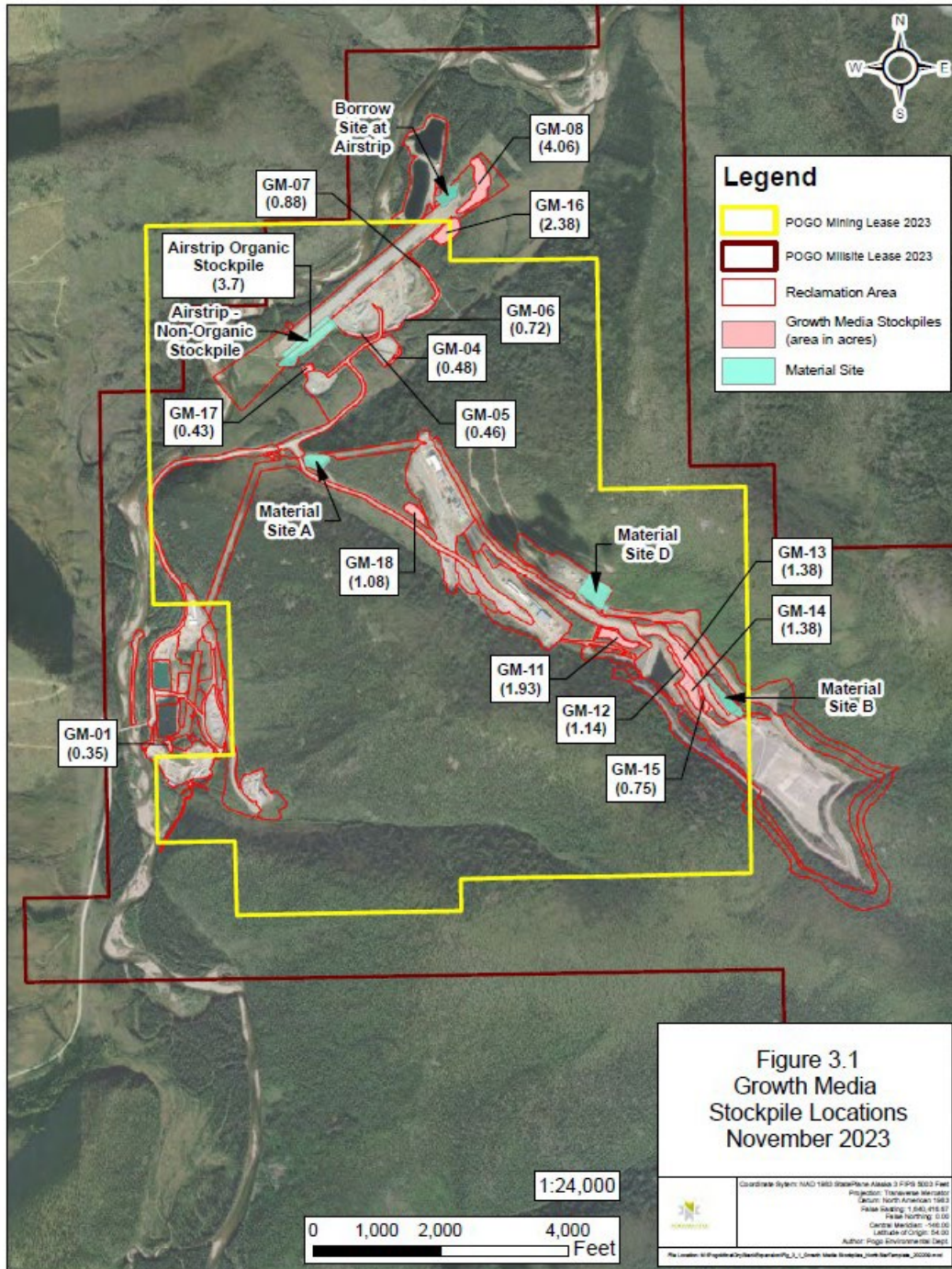
Relevant assumptions regarding growth media recovery and placement are listed below.

- As the drystack is constructed, growth media will continue to be salvaged. The construction phases of the drystack consist of (1) removal of material that is around the General Placement Area, and (2) removal of topsoil material that is designated for establishment of new diversion ditches, which is predicated on the favorable outcome of our geotechnical investigations.
- The Goodpaster River valley material site areas will be reclaimed as wetlands.
- All designated growth media stockpiles are anticipated to include mulched material expected to be about 5% of the growth media volume.
- After mixing in the growth media stockpiles, the organic mat will contribute 50% of its original volume to the growth media available for reclamation.

**Table 3.1: Growth Media Stockpiles**

Final Description	Area (acre)	Perimeter Length (feet)	Material Thickness (feet)	Estimated Volume (yd <sup>3</sup> )
GM-01	0.35	600	6	2,560
GM-04	0.48	956	6	3,488
GM-05	0.46	1,086	6	3,355
GM-06	0.72	1,745	6	5,280
GM-07	0.88	1,749	6	6,427
GM-08	4.06	2,400	15	74,052
GM-11	1.93	1,583	6	14,077
GM-12	1.14	1,678	6	8,284
GM-13	1.38	1,517	7	11,707
GM-14	1.38	1,203	6	10,090
GM-15	0.75	1,244	20	18,216
GM-16	2.38	1,430	15	43,417
GM-17	0.43	603	6	3,150
GM-18	1.08	983	8	9,829
Airstrip Organic Stockpile	3.70	2,104	20	89,953
<b>Total for Mine Site Growth Media</b>	<b>21.13</b>			<b>303,884</b>

Figure 3.1: Pogo Mine Material Sites and Growth Media Stockpile Layout





### 3.4 Revegetation Standards

The overall objective of the revegetation program is to establish a vegetative cover on all disturbed lands (except for those determined by ADNR to be reclaimed in a different manner or those determined by ADNR to be exempt from the cover criteria) that will flourish without need for fertilization or reseeding after a 5-year period. The standard for measuring revegetation success will be the establishment of a diverse cover of at least 70% as determined using a method approved by ADNR. This cover should be achieved without the application of topsoil, seed, fertilizer, or any water in addition to natural precipitation for the last three growing seasons in the 5-year period. If a cover of 30% has not been achieved by the end of the third growing season, Pogo will develop an action plan to address any potential problems that may be interfering with revegetation success.

The interim diversity objectives for the vegetative cover after a 5-year period will be such that no one graminoid will comprise more than 70% of the relative cover and no tree or shrub species will comprise more than 95% of the relative density value. These standards may be revised based on the revegetation test trials.

Revegetation progress for reclaimed lands and test plots are ongoing and are reported annually to ADNR as part of the Annual Monitoring Report.

Appendix E.2 provides a summary of the results of the test plots trials. Three-years of data for the test plots indicated that the reclamation success standard can be achieved with moderate or minimal inputs.

An overview of the data indicates that the total cover goal of 70% have been met in almost every trial variation of media/fertilizer/seed application. 100% cover is apparent in many of the trial plots, more than is actually desirable to encourage the pioneering of native species. Plant establishment appears to be responding most strongly to fertilizer rates and the application/type of seed than to the presence of, or particular depth of, growth media. Zero application of growth media produced a lower percentage of cover in some instances, though most were very close to the required 70% cover or exceeded the 70% cover. Overall, it seems the application of fertilizer and seed produced sufficient cover whether topsoil (growth media) was present or not. Three inches of growth media appears to be just as effective as six inches of growth media in

establishing the required cover in all four of the different ecotype studies: the broadleaf forest, wetlands, alluvial shrubs and alpine meadow. The Broadleaf Forest plots appear to be the most sensitive to the amount of growth media.

In summary, it appears that minimal to medium material and resource input is sufficient for meeting coverage requirements. Most plots met the 70% coverage goal, and all plots met the required 30% cover. Moreover, many of the plots reached 100% cover. Recommendations to achieve the reclamation goals while reducing the amount of material and resources used include minimal to medium growth media depths and reduction of fertilizer and/or seeding rates to certain ecotypes.

## 4.0 RECLAMATION AND CLOSURE PRESCRIPTIONS

This section describes the reclamation activities and the schedule planned for various project components. To the extent practicable, reclamation efforts will be carried out concurrent with mining activities to minimize the activities required after mining operations cease.

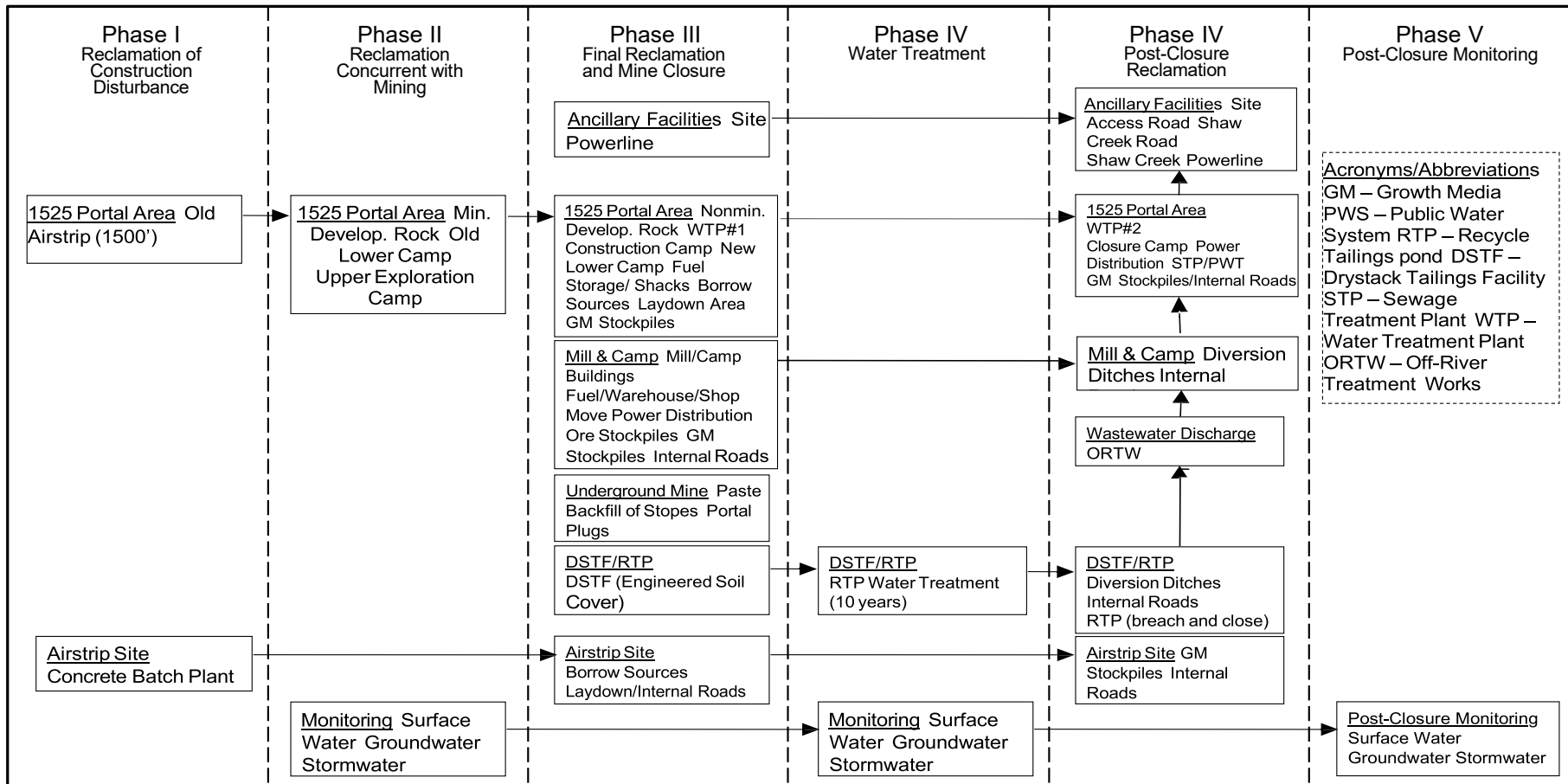
General construction, revegetation, and demolition procedures are described in **Appendices A, B, and C**. These methods will be applied to the prescriptions outlined in this section.

Reclamation scheduling is divided into five phases based on the design, construction, operation, and closure activities of the mine:

- Phase I: Reclamation of construction disturbance
- Phase II: Reclamation concurrent with mining
- Phase III: Final reclamation and closure of the mine site
- Phase IV: Water treatment and post-closure reclamation
- Phase V: Post-closure monitoring

**Table 4.1** shows the proposed reclamation sequence according to the phase, and each phase is described in more detail below. A list of equipment to be used for reclamation is included in Appendix F (Reclamation Cost Estimate & Financial Assurance Model).

**Table 4.1: Reclamation Schedule**



## 4.1 Phase I: Reclamation of Construction Disturbance

Any project disturbance from advanced exploration or construction that has not been reclaimed to date has been transferred to Phase II.

Phase I reclamation completed, prior to 2018, includes:

- 1525 Airstrip Facilities – The airstrip used during early exploration was regraded to remove berms and left in place. Floods and natural revegetation have reclaimed the site.
- Winter Road – The winter access road used prior to construction of Shaw Creek Road was reclaimed by seeding disturbed areas.
- Upper Exploration Camp – In 1998 and 1999, seed and fertilizer were applied to erodible areas on the winter road and an unstable slope cut into the hillside above the advanced exploration camp during previous placer operations.

## 4.2 Phase II: Reclamation Concurrent with Mining

Phase II reclamation will be undertaken concurrently with mining activities. All of the stockpiled mineralized development rock will be reclaimed during this phase.

### 4.2.1 *Upper Exploration Camp*

The upper exploration camp will be removed using the general procedures outlined in **Appendix C**, and revegetated using the general procedures outlined in **Appendix B**.

### 4.2.2 *Mineralized Development Rock Storage*

Development rock from the 1525 and 1875 portals is hauled to a temporary stockpile outside each portal where it is classified as mineralized or non-mineralized for its disposal location within the drystack. Mineralized rock is entombed within the DSTF.

Remaining mineralized rock stockpile material at the 1525 portal area will be moved to the DSTF. All liner materials will be placed in an ADEC-approved inert solid waste

disposal facility (not yet constructed), which may be in the drystack. Gravel materials underlying the liner of the mineralized rock stockpile will be used for surfacing site access roads or left in place and reclaimed by recontouring for drainage, tapering edges, and scarifying or ripping. Organic materials stockpiled will be placed on the area as needed to promote vegetation.

#### ***4.2.3 Non-Mineralized Development Rock Storage***

Non-mineralized rock is used for site construction and maintenance activities. All liner materials associated with the non-mineralized rock storage will be buried in an ADEC-approved inert solid waste disposal facility (not yet constructed), which may be in the drystack. Gravel materials underlying the liner will be used for surfacing site access roads or may also be left in place and reclaimed by recontouring for drainage, tapering edges, and scarifying or ripping. Organic materials stockpiled will be placed on the area as needed to promote revegetation. Establishment of a vegetative cover will be based on the results from the vegetation test trials outlined in **Appendix E**.

#### ***4.2.4 Alluvial Gravel Material Sites***

If not needed for ongoing facility maintenance or reclamation, the material sites developed in alluvial gravels during advanced exploration for project construction activities will be reclaimed as described in **Appendix D**. This Plan incorporates the use of benches, islands, and the development of riparian and wetland habitat to enhance wildlife use of the area. Material sites that are required for reclamation will be stabilized using BMPs.

#### ***4.2.5 Access Road Material Sites***

All access road material sites have been reclaimed per agreement with Harvey Templeton of DNR.

### 4.3 Phase III: Final Reclamation & Closure of the Mine Site

Phase III will consist of the major closure activities required to decommission the mine, remove the facilities from the property, and place the site in a stable condition. During Phase III, all facilities and structures not needed to support post-closure reclamation activities (Phase IV) will be removed following the general procedures outlined in **Appendix C**. A part of lower camp will be used as a temporary closure camp to support Phase III and IV activities.

Monitoring of groundwater, stormwater, and surface water will continue through Phase V.

#### 4.3.1 Fuel Storage & Hazardous Materials

All surplus fuel, hazardous materials, above-ground tanks, and piping will be removed following the general demolition procedures outlined in **Appendix C**.

A plan will be developed to comprehensively test for fuel contamination near the storage areas. If found, contaminated soil will be removed and treated in accordance with ADEC guidelines before the area is recontoured and revegetated.

#### 4.3.2 Liese Creek Mill Facilities

All buildings, materials storage areas, fencing, and supplies will be removed from the Liese Creek mill area using general demolition procedures outlined in **Appendix C**. An existing substation will provide power for Phase IV operation of the water treatment plant and support facilities.

The storm pond liner will be removed, cut into pieces and buried in an ADEC-approved inert solid waste disposal facility (not yet constructed), which may be in the drystack.

The highwall cut faces will be stabilized and left in place. Fill embankments will be reclaimed by pulling the outer crest of the fill over the pad to the highwall, grading to control surface water runoff towards Liese Creek, and blending with the local topography as much as possible. The recontoured surfaces will be ripped where compacted, covered with stockpiled growth media, and seeded and fertilized as needed.

Gravel pads and access roads will be recontoured for drainage, ripped or scarified, spread with growth media, and fertilized and seeded as necessary.

### **4.3.3 Liese Creek Camp, Office & Shop Facilities**

All buildings, materials storage areas, fencing, and related facilities will be removed from the Liese Creek camp and shop area using general demolition procedures (**Appendix C**).

The highwall cut faces will be stabilized and left in place. Fill embankments will be reclaimed by pulling the outer crest of the fill over the pad to the highwall, grading to control surface water runoff towards Liese Creek, and blending with the local topography as much as possible. The recontoured surfaces will be ripped where compacted, covered with stockpiled growth media, and seeded and fertilized as needed.

Gravel pads and access roads will be recontoured for drainage, ripped or scarified, spread with growth media, and fertilized and seeded as necessary.

### **4.3.4 Underground Mine**

In general, the closure plan and cost estimate for the mine involves removing salvageable<sup>1</sup> equipment, backfilling, installing cement plugs in all mine openings, and re-flooding as described in the Pogo Mine Underground Closure Study (Tetra Tech 2014). The tentative closure procedures follow.

Pumps and mobile mining equipment will be removed from the site. Chutes, conveyors, ventilation, piping, and electrical systems will be dismantled. Pipes supplying fuel and hazardous materials will be flushed before disposal. Components will be buried in designated areas within the underground workings of the mine during Phase III or the solid waste disposal facility (not yet constructed).

Mined-out stopes will be backfilled completely with cemented paste backfill. The relatively impervious nature of the paste backfill will seal mineralized areas of the wall rock and prevent oxidation and subsequent leaching. At mine closure, select areas of the connecting access declines will also be backfilled to compartmentalize

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<sup>1</sup> No salvage value is included in the reclamation and closure cost estimate.

the hydrogeology and to reduce the potential for water flow through the mine.

After the 1525, 1690, and 2150 mine openings are sealed, the mine workings will be flooded through the 1875 portal to accelerate groundwater level recovery towards pre-operational levels. The 1875 portal will then be sealed, and the remainder of the mine flooded through a surface borehole, which will be cemented at completion. The backfill, sealing, and flooding process is expected to be completed within 2 years.

To monitor potential effects of underground water into Goodpaster River, the groundwater monitoring wells installed downgradient from the underground workings MW04-213 and MW11-216 will be sampled throughout all phases of reclamation and closure.

#### **4.3.5 Portals**

Upon completion of mining, the 1525, 1690, and 1875 adits will be permanently stabilized and sealed using a combination of select paste backfill placement and concrete plugs to prevent access and drainage. The 2150 portal will be sealed to prevent access and maintain safety at the reclaimed site.

Adit plugs will be located in competent ground to resist the pressure head developed between natural groundwater and the plug elevation. The concrete used to construct the plug will be Type II Portland cement mixed with Type F fly ash to ensure low shrinkage and good sulfate resistance. A grout curtain will minimize seepage across the plugs.

Preliminary design of the plugs was carried out according to Lang's "Permanent Sealing of Tunnels to Retain Tailings or Acid Rock Drainage" (1999). **Table 4.2** summarizes Lang's criteria for monolithic plugs.

Final plug plans will be stamped by a professional engineer and submitted to the State for review and approval. The plug plans will include a site investigation to assess geotechnical, geochemical, and hydrogeological characteristics at each site. The final plug designs will consider static and dynamic failure mode, seepage rates for each plug, and the feasibility of long-term monitoring. The final plug designs will also include proposed construction methodology and quality assurance/quality control plans as well as an estimate of construction cost.



Groundwater levels were estimated based on both piezometer data and by modeling the pre-development heads (Adrian Brown, “Inflow to the Pogo Mine” report, 25 January 2002). For the purpose of this analysis, the highest modeled pre-development water table elevation was used as the driving head for all plugs. The design plug lengths for the various adits are shown in **Table 4.3**. The portal locations and design for the concrete plugs for the 1525, 1690, and 1875 portals are shown in **Figures 4.1, 4.2, and 4.3**.

At the 1690 portal, the external conveyor structure will be dismantled and salvaged where possible. Unusable components will be buried in the mine. Concrete conveyor footings less than one-foot thick will be broken and buried in place as fill material.

The highwall cut faces will be stabilized and left in place. Fill embankments will be reclaimed by pulling the outer crest of the fill over the pad to the highwall, grading to control surface water runoff, and blending with the local topography as much as possible. The recontoured surfaces will be ripped where compacted, covered with stockpiled growth media, seeded, and fertilized as needed.

Gravel pads and access roads will be recontoured for drainage, ripped or scarified, covered with growth media, seeded, and fertilized as necessary.

**Table 4.2: Summary of Recommended Design Criteria for Closure Plug**

Failure Mode	Design Criteria
Hydraulic jacking of rock	Factor of Safety > 1.3 for normal conditions Factor of Safety > 1.1 for earthquake conditions
Shear failure along contact or through rock mass	Factor of Safety > 3 normal condition Factor of Safety > 1.5 earthquake condition
Deep beam flexure	When the plug length is less than the largest dimension of the opening. Design to allowable concrete tensile stress according the ACI Code
Excessive seepage	Maximum hydraulic gradient ( $i$ ) dependent upon rock mass characteristics and if formation grouting is performed. Seepage limited to drips at plug and < 0.5 l/s downstream of plug ( $i=7-14$ for fair to good rock mass conditions)
Long-term degradation of concrete	Concrete > 25 MPa compressive strength, mix to resist sulfate, acid, and alkali-silica reactivity

Note: Criteria are for plugs with no reinforcement that are created in one continuous pour.

**Table 4.3: Plug Designs**

Adit	Design Water Head (ft)	Design Plug Length for Factor of Safety >3 (ft)
1525 exploration adit	477	19
1875 haulage adit	30	4
1690 conveyor drift	327	17

**Figure 4.1: Portal Closure Locations**

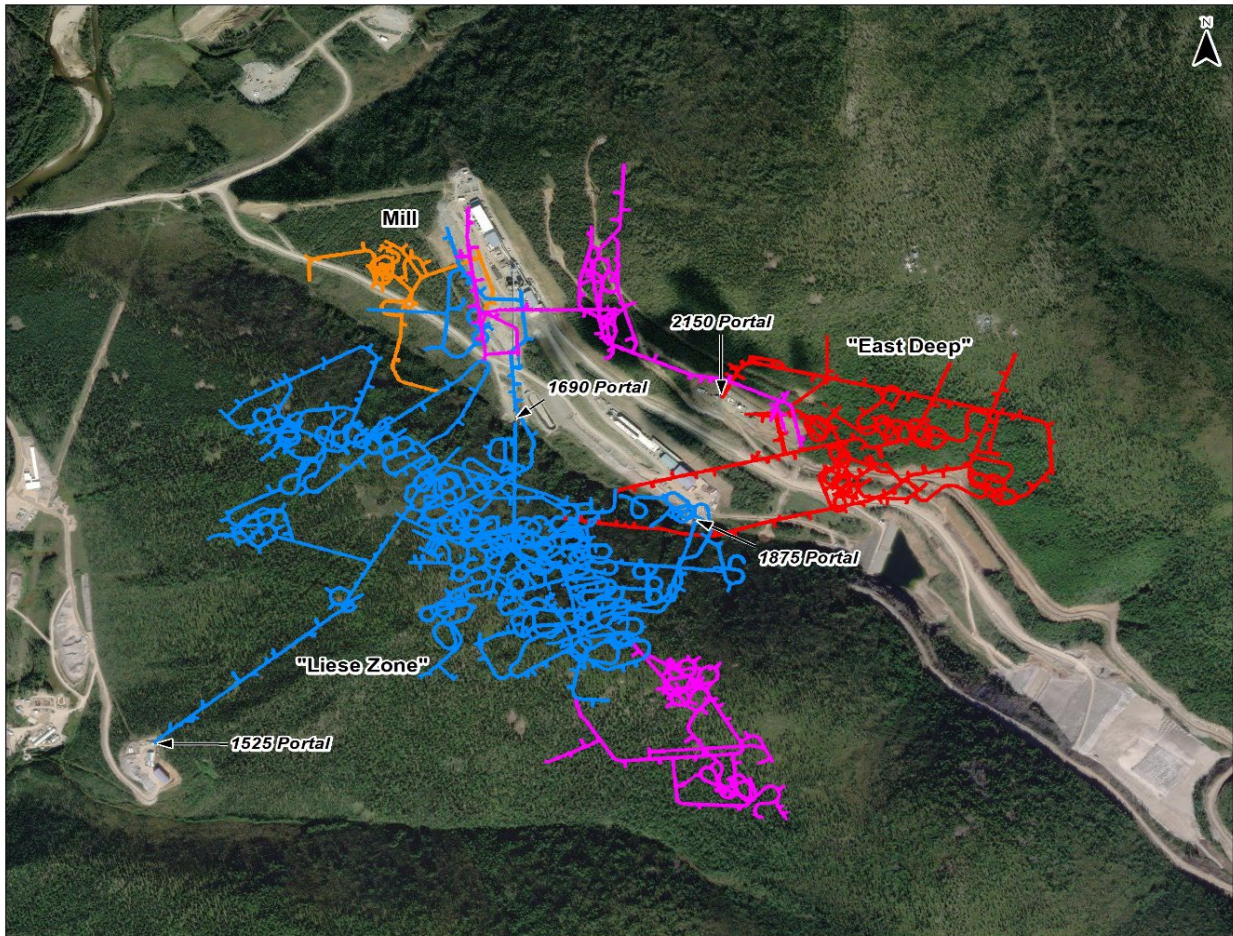
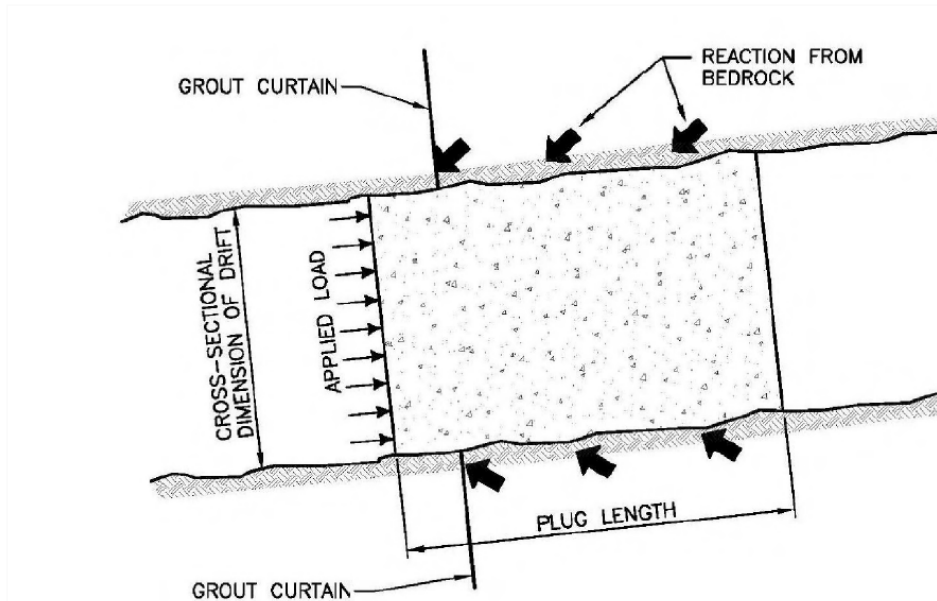


Figure 4.2: Portal Plug Longitudinal Section



Summary Table of Plug Characteristics

Location	Design Head	Plug Length	Grout Curtain Required
1525 Portal	477 feet	19 feet	yes ( $l=25$ )
1690 Portal	327 feet	17 feet	yes ( $l=19$ )
1875 Portal	30 feet	4 feet	yes ( $l=8$ )


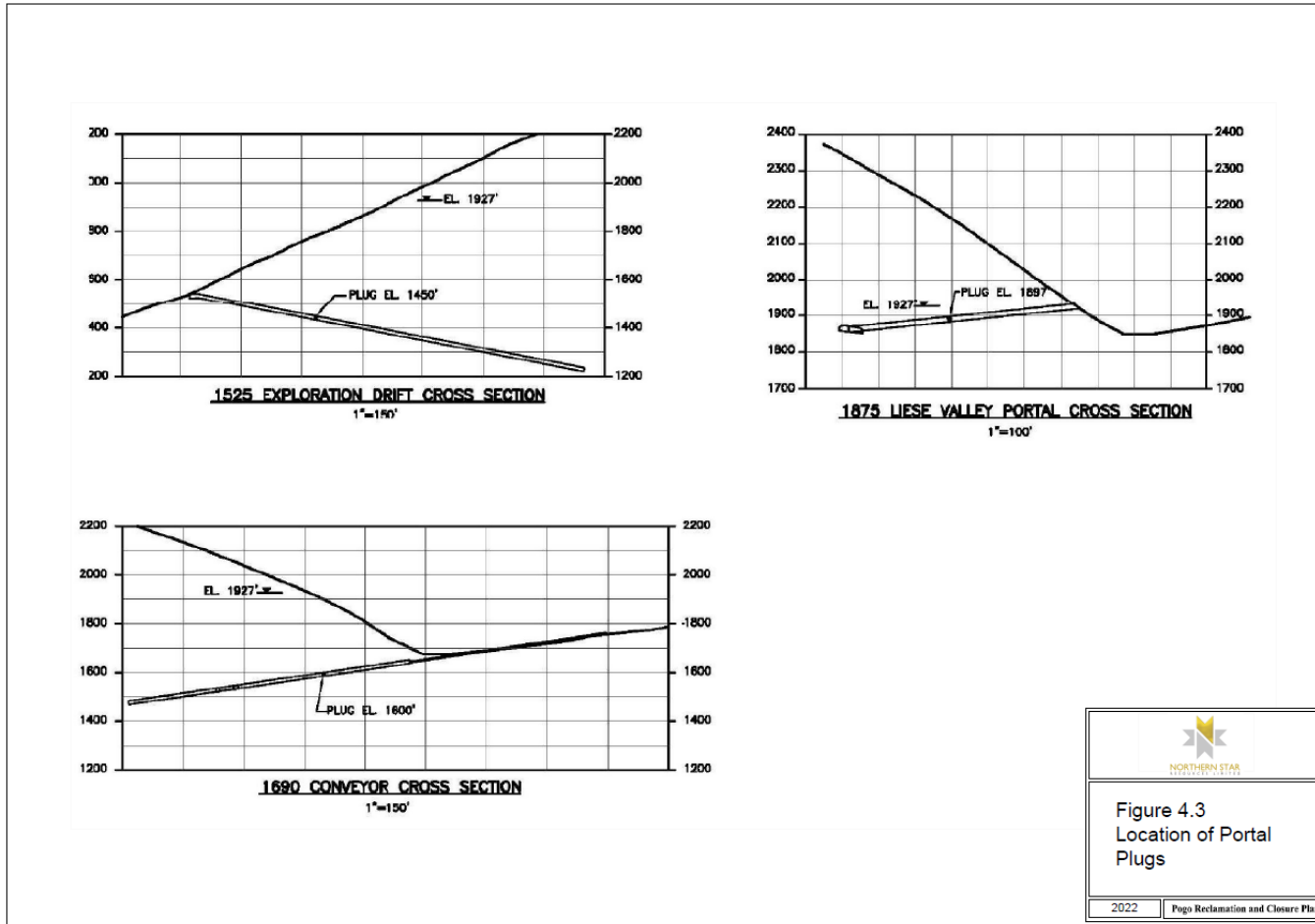


Figure 4.2  
Portal Plug  
Longitudinal Section

2022 | Pogo Reclamation and Closure Plan

Figure 4.3: Location of Portal Plugs



#### **4.3.6 Drystack Tailings Facility**

Tailings that are not placed underground will be dewatered through pressure filtration and placed in the general placement area of the drystack tailings facility. The second DSTF expansion will begin in 2023.

The drystack facility has two zones: the shell area, which provides structural stability and erosion control for the facility; and the general placement area, which is used for tailings and waste rock placement and is not required to contribute strength. Non-mineralized development rock will be used to construct the shell with a benched overall slope of 3H:1V to provide long-term stability.

The long-term reclamation and closure goal for the drystack is to establish an alpine grass meadow. The closure concept includes creating a final configuration that limits erosion potential; diverts runoff water from upstream in the watershed around the drystack in permanent ditches; and provides an engineered cover that includes an erosion resistant armor over the entire drystack with growth media to enhance revegetation.

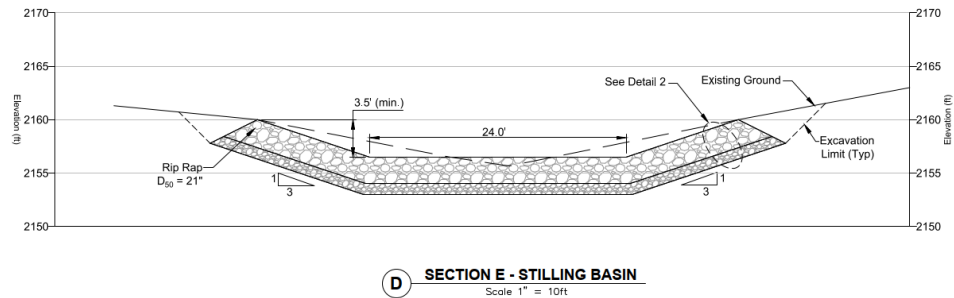
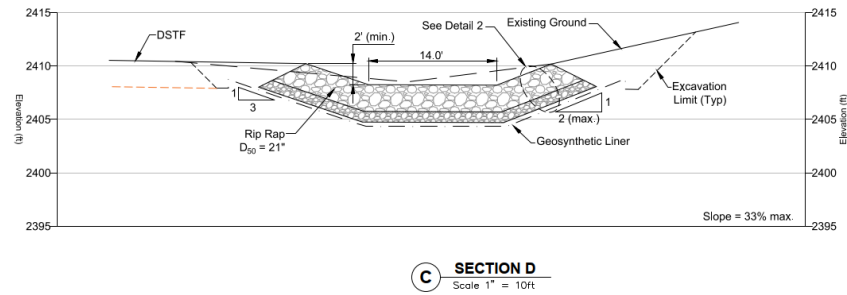
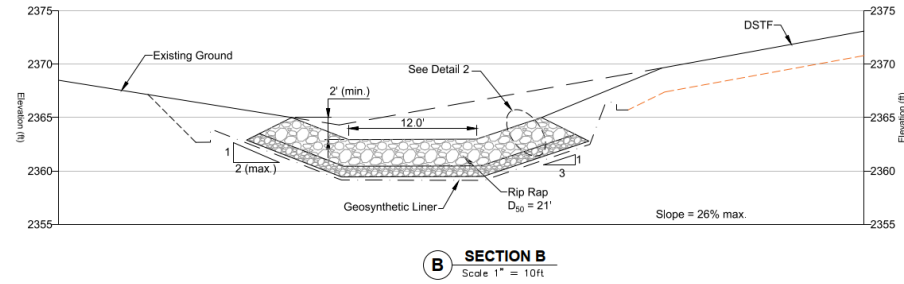
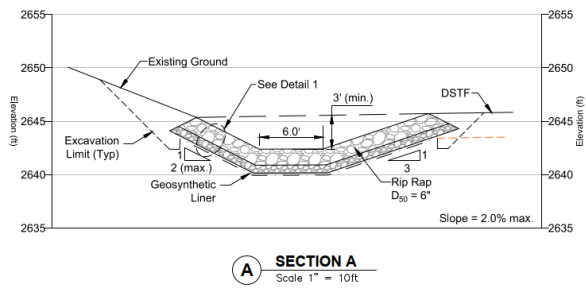
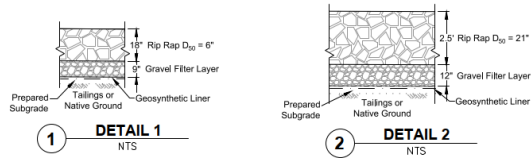
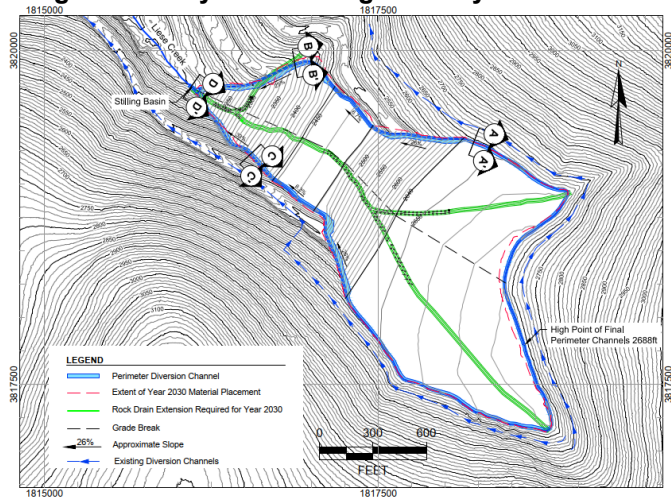
Details of the drystack closure are presented in **Figure 4.4**. The engineered soil cover will consist of 1 ft of non-mineralized development rock applied over the surface of the crowned drystack facility, followed by a 6-inch sand and gravel layer to provide support for an additional six inches of growth media. Pogo anticipates to achieve the maximum permitted design capacity of 20 MT by March 2024. The ongoing DSTF expansion will increase the capacity to 24 MT, which is expected to provide approximately three additional years of life to the dry stack. Drystack elevations are collected and reviewed quarterly, and material placement is monitored monthly.

A soil cover is proposed due to the relatively modest annual rainfall at the site, the low hydraulic conductivity of the drystack tailings material, and the lack of acid generating potential. It is not believed that additional measures to prevent infiltration, provide a capillary break, or to provide an oxygen barrier, are warranted.

Runoff control for the general placement area surface of the drystack facility will include crowning with a two percent slope to the closure perimeter ditches. The surface of the shell is being constructed with non-mineralized rock to prevent erosion of the drystack.

The closure perimeter ditches will be constructed as wide ditches with flat side slopes. This configuration has a significantly higher flow capacity than the maximum probable precipitation catchment potential. This design will allow for significant ice development and still maintain requisite freshet capacity. Riprap and geomembrane protection will be provided to prevent erosion on both sides of the ditch adjacent to the drystack face. The riprap requirements include graded filters to maintain soil particle stability.

**Figure 4.4: Drystack Tailings Facility Schematic Closure Configuration**



age

During mine operations, a field trial program was undertaken to evaluate the optimum cover depths. Performance was evaluated over a three-year period. Variables assessed during the field tests included various depths of engineered soil cover material, topsoil, vegetation type, soil amendments, and surface topography.

Results of the field trials were presented in the 2018 annual report and attached in Appendix E.2.

The results indicate that the recommended 6 inches of growth media is adequate to support the proposed post-mining land use of public recreation and wildlife habitat.

#### **4.3.7 Material Sites**

Remaining alluvial gravel material site areas will be reclaimed as described in **Appendix D**. This Plan will incorporate the use of benches and islands, as well as develop riparian and wetland habitat to enhance wildlife use of the area.

Material Site B and Material Site D will be reclaimed at the end of Phase III when no longer needed for closure materials. The highwall cut faces will be stabilized and left in place. Fill embankments will be reclaimed by pulling the outer crest of the fill over the pad to the highwall, grading to control surface water runoff towards Liese Creek, and blending with the local topography as much as possible. The recontoured surfaces will be ripped where compacted, covered with stockpiled growth media, and seeded and fertilized as needed.

#### **4.3.8 Internal Access Roads**

Access and service roads not specifically required for post-closure and reclamation monitoring will be ripped or scarified, covered with growth media, and fertilized and seeded as necessary. Highwalls or cut-banks associated with sections of these roads will be stabilized as needed.

#### **4.3.9 Water Management**

Upon the cessation of milling, all sumps, ponds, and drains will be filled, contoured, seeded, or stabilized to meet the requirements of the designated post-mining land



use. Monitoring wells not used for Phase IV and Phase V compliance monitoring will be plugged and abandoned according to **Appendix C**. Drinking water wells not needed to support the closure camp will be closed in a similar manner.

#### **4.4 Phase IV: Water Treatment and Post-Closure Reclamation**

Phase IV begins when site monitoring indicates that reclamation and revegetation have stabilized the drystack tailings facility sufficiently so that major additional earthworks will not be required. At this point, the vegetative cover on the drystack will begin taking hold, all the underground mine openings will be sealed and the mine workings flooded. In addition, the mill and camp facilities in Liese Creek will be decommissioned and reclaimed. Water quality will be monitored in the surface water and groundwater in Liese Creek downstream of the drystack facility to determine whether operation of the RTP and water treatment plant should continue.

The RTP, water treatment plant, and access roads to these facilities will remain in place during Phase IV as long as needed to treat the drystack runoff and seepage. When agency review of the site information indicates it is appropriate to do so, the remaining RTP water will be treated and discharged, the RTP dam will then be breached and reclaimed. Any tailings that were transported to the RTP over the life of the project would be capped in place in the bottom of the RTP reservoir and protected from erosion. It is anticipated this Phase IV water treatment will last ten years.

##### **4.4.1 Drystack Tailings Facility**

When the water quality data indicates that the RTP can be breached and reclaimed, a determination will be made as to any contingency measures that might be appropriate to help maintain water quality standards. The selection will be based on the circumstances and the current technology at the time. Based on the 4 to 6 gallons per minute of long-term seepage anticipated from the drystack, it is reasonable to expect that one or more of the contingency measures shown in **Table 4.4** will be both feasible and effective in protecting the environment. The goal would be to implement a system that would allow the RTP to be breached as soon as possible. For the purpose of estimating the reclamation costs, it has been assumed that the RTP and water treatment plant will remain in place and be in operation for ten years during Phase IV.

**Table 4.4: Contingency Measures to Mitigate Potential Drystack Seepage**

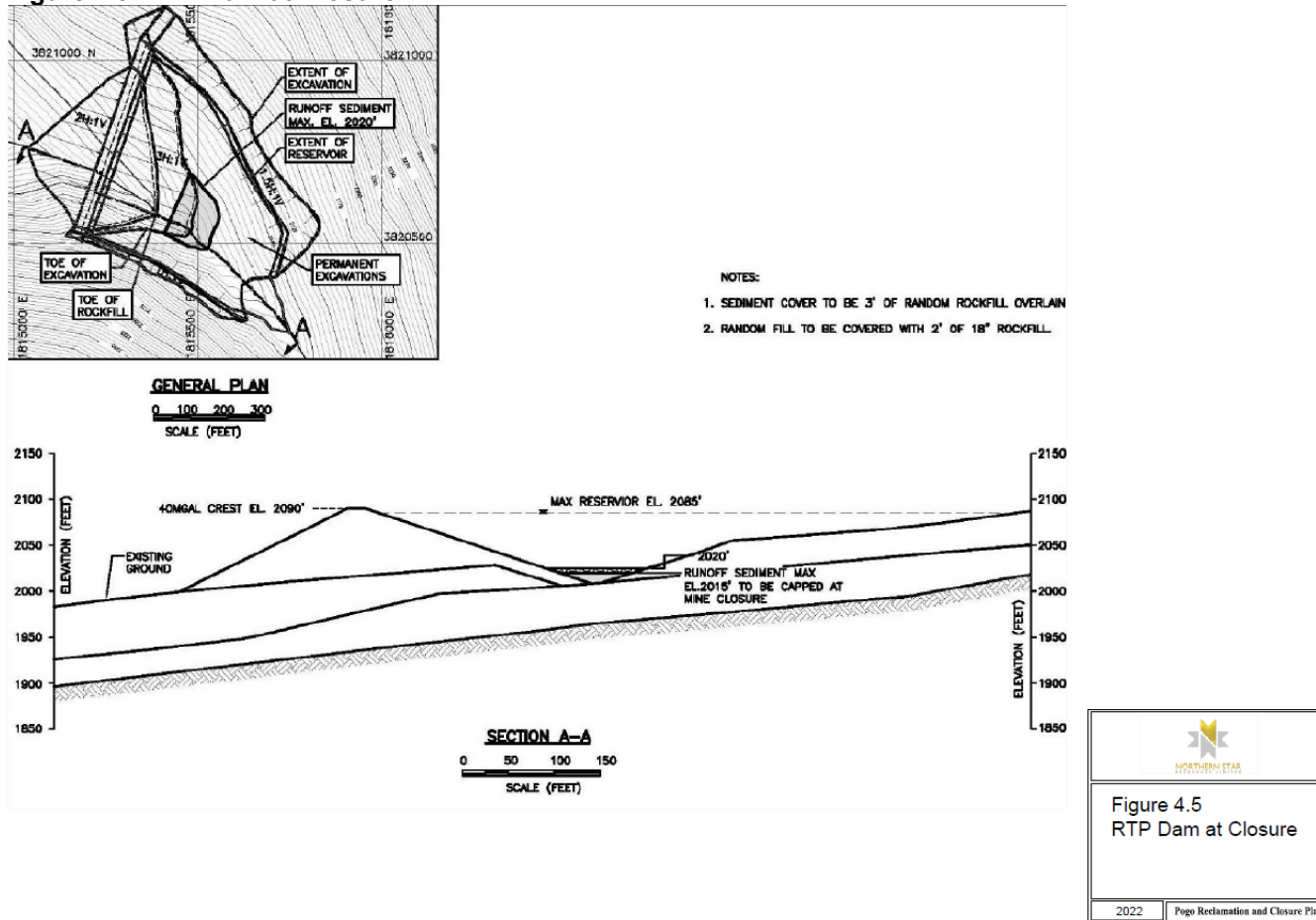
Contingency Approach	Activities
<b>Passive Measures</b>	None required
	Mixing with receiving water
	Natural attenuation
	Infiltration gallery
	Cut-off trench and grout curtain with aufeis (accumulated ice due to glaciation) retention of seepage in winter and release during freshet
<b>Active Measures</b>	Settling ponds with simple lime or chemical addition
	Seepage pumped from collection wells to aufeis retention system on Liese Creek hillside and release during freshet
	Seepage pumped from collection wells to active treatment system
	Cut-off trench and grout curtain with collection system and pumped to aufeis retention system on Liese Creek hillside and release during freshet
	Cut-off trench and grout curtain with collection system and pumped to active treatment system

#### **4.4.2 RTP Closure & Sediment Capping**

When appropriate, the RTP dam will be breached. Slopes will be trimmed to a maximum of 2Horizontal:1Vertical (H:V) side slopes on the dam, and a 50-ft-wide floodplain will be re-established. **Figure 4.5** shows the RTP dam in plan and section both at the end of the mine life and after reclamation. Disturbed areas will be recontoured for drainage and the channel re-establishment for Liese Creek. Foot slopes and the former impoundment area will be covered with growth media, seeded, and fertilized as necessary. Micro-wetlands sites will be established where possible. Steeper side slopes will be armored as necessary and shaped to blend with the natural talus slopes of the Liese Creek valley. Highwall cut faces will be stabilized and abandoned in place.

Any of the RTP liner covering the section of the RTP dam removed during the Phase III reclamation will be disposed of in an ADEC-approved inert solid waste disposal facility (not yet constructed), which may be in the drystack. The portion of the RTP liner covering the section of the RTP dam that will remain after completion of the Phase III reclamation activities will be left in place. Leaving the liner in place poses no long-term stability or environmental issues. The pumps and piping will be removed as described in **Appendix C**.

Figure 4.5: RTP Dam at Closure



During mine operations, some of the drystack tailing material will be eroded and deposited in the RTP as sediment. The Universal Soil Loss Equation was used to estimate that as much as 135 tons of sediment could be transported from the drystack during the mine life. This estimated rate is based on 6 tons per annum (tpa) initially, increasing to 20 tpa when the maximum drystack footprint is achieved. Assuming a safety factor of two, the estimate was rounded to 300 tons. This equates to approximately 0.1% of the RTP volume. The RTP sediment would be capped and protected from erosion by rock cover.

This rockfill should have a minimum thickness of 3 ft of random fill overlain by a minimum of 2 ft of material, with the majority being greater than 18 inches in size. The random fill and portions on the armoring material used to cap the sediments will come from excavating the breach through the RTP dam.

#### ***4.4.3 Site Transmission Lines***

Electrical transmission lines from the project site and distribution to the mine, mill, and ancillary facilities will be dismantled when no longer necessary for closure operations. Poles will be cutoff at ground surface and removed. Electric cables, supports, insulators, transformers, and other equipment and materials will be removed and sold for salvage. Disturbance created during transmission line decommissioning will be stabilized and protected against erosion. Seeds and fertilizer will be applied where natural revegetation is not expected to rapidly reinvade.

#### ***4.4.4 Pogo Access Road***

At the end of mine closure monitoring, the remaining camp facilities and equipment will be removed and the portion of the Pogo access road between Shaw Creek and the Goodpaster River will be reclaimed. The road surface will be recontoured for drainage, ripped or scarified, covered with growth media, seeded, and fertilized as necessary. Culverts and bridges will be removed and drainage channels re-established.

Gravel pads and other cleared areas will be recontoured for drainage, ripped or scarified, covered with residual organics from initial construction, and fertilized and seeded as necessary following final equipment removal.

The portion of the Pogo access road between the Pogo Gate and Shaw Creek will remain in place as a public access corridor into state lands. The Standard Reclamation Cost Estimate (SRCE) model includes costs to reclaim the access road as the final step for mine closure. Pogo understands that an easement will need to be maintained across the private land to facilitate all mine closure activities through the duration of reclamation and monitoring as estimated in this model.

#### ***4.4.5 Pogo Transmission Line***

Reclamation of the Pogo Transmission Line will also occur at the end of mine closure monitoring when the access road is reclaimed. All poles and ancillary facilities associated with the transmission line will be removed and pads and other cleared areas will be recontoured for drainage, ripped or scarified, covered with growth media, and fertilized and seeded as necessary following final equipment removal.

#### ***4.4.6 1525 Portal Area***

Upon agency approval, the water treatment plant located at the 1525 portal will be removed along with the warehouse, shops, and fuel storage under the guidelines of **Appendix C**. The water treatment plant and closure camp will be dismantled and removed from site following the general procedures outlined in **Appendix C**.

The highwall cut faces will be stabilized and left in place. Fill embankments will be reclaimed by pulling the outer crest of the fill over the pad to the highwall, grading to control surface water runoff, and blending with the local topography as much as possible. The recontoured surfaces will be ripped where compacted, covered with stockpiled growth media, and seeded and fertilized as needed.

Gravel pads and access roads will be recontoured for drainage, ripped or scarified, spread with growth media, seeded, and fertilized as necessary.

#### ***4.4.7 Off-River Treatment Works***

When discharge to the off-river treatment works is no longer necessary, the pump station, other surface facilities, and piping will be removed, and the system reclaimed following the procedure in **Appendix D**. Agency input will be sought during closure to assess the merits of permanently connecting the ponds with the river.

#### **4.4.8 Site Access Roads**

The remaining site access roads will be ripped or scarified, covered with growth media, seeded, and fertilized as necessary. Culverts will be removed and drainage paths re-established.

#### **4.4.9 Material Sites**

Material Site A will be utilized for stormwater control throughout the project and will be reclaimed during Phase IV when the upstream reclamation of mill site, camp area, and local roads has stabilized. Material Site B will also be reclaimed during Phase IV.

### **4.5 Phase V: Post-Closure Monitoring**

By Phase V, all surface disturbances will be stabilized, and water quality will be acceptable. Post-closure monitoring of groundwater, stormwater, and surface water could continue for a 30-year period after completion of Phase IV reclamation (depending on compliance history). The monitoring events will take place on years 1, 2, 5, 10, 15, 20, and 30 after stopping active water treatment (unless modified by the agencies).

#### **4.5.1 Control of Sedimentation**

During the post-closure monitoring period, all diversion and erosion control structures will be monitored to ensure their effectiveness and long-term stability. Modifications and maintenance will be performed as needed to ensure the long-term success of closure.

#### **4.5.2 Monitoring Wells & Well Closure**

After the post-closure monitoring period, all groundwater monitoring wells will be de-commissioned using the procedures outlined in **Appendix C**. Access to the wells will be scarified, seeded, and fertilized.

## 4.6 Temporary Closure

“Temporary closure” means the cessation of the mining and process plant operations for a period of not more than 3 years. If conditions require temporary closure to extend beyond 3 years, final reclamation will begin. Should temporary closure become an option, an extension is requested by the company and approved by ADNR and ADEC. Temporary closure scenarios include modifications to the Plan of Operation Management Plans, Reclamation and Closure Plan, along with state and federal permits, all coordinated with the appropriate agencies.

Temporary closure may include planned or unplanned cessation of the mining and beneficiation processes. Planned temporary closures, which have specific conditions defining their beginning and end include, but are not limited to, the following:

- Interruptions in the active beneficiation processes to provide planned periods of quiescence for metallurgical or operating reasons.
- Any other planned condition, which would interrupt the active beneficiation process including modification to process components or suppressed metal market conditions.
- Change in ownership requiring the temporary cessation of operations while operating permits are transferred to the new owner/operator.

Unplanned temporary closures may include, but are not limited to, the following:

- Closure because of unforeseen weather events.
- A failure in a major system component or a process failure, which causes the fluid management system, or a portion thereof, to shut down.
- The cessation of operations because of litigation.
- Bankruptcy of the mine operator.



In the case of suspension of operations, Pogo must notify the appropriate agencies within 3 days of suspending operations. Unanticipated suspension or cessation of operations expected to last greater than 90 days, but less than 3 years requires written authorization from ADNR and ADEC. No later than 10 days after operations have been suspended, Pogo will submit a suspension of operations plan with current information and specific details as required under Pogo's Waste Management Permit (WMP) 2018DB0001 and the Plan of Operations approval for the project.

Pogo Mine would maintain the project area in a safe and secure condition during a temporary closure and not allow the project area to be degraded or eroded during, or as a result of temporary closure. All water collection, treatment, monitoring, and reporting required by the reclamation plan would continue unless otherwise directed by the agencies.

While the mine operation is inactive, environmental monitoring programs would continue to be implemented. The need for implementation of interim reclamation activities or final reclamation on components of the mine would be addressed on the basis of environmental monitoring results and consultation with appropriate agencies.

#### **4.7 Final Reclamation**

Per the Plan of Operations Approval No. F20189500, not later than 30 days after the permanent cessation or abandonment of mining operations, Pogo shall notify the Authorized Officer at ADNR of the cessation of mining operations and provide a schedule for the final reclamation of the site.

Termination mining and milling/processing activities is defined in Pogo's WMP as the permanent cessation for those activities. Updated reclamation and monitoring plans must be submitted to ADEC within 90 days after commencing termination of mining and milling/processing. The final plan will be based on the actual conditions that exist at closure.

## 5.0 PERFORMANCE STANDARDS

Reclamation Performance Standards, 11 AAC 97, Mining Reclamation Regulations, are needed to assess the success of the reclamation program. The objective of the performance standards is to provide a stable condition that will “allow for the re-establishment of renewable resources on the site within a reasonable period of time by natural processes.”

Closure performance standards will be based on water quality criteria.

### 5.1 Objectives & Goals

Reclamation and closure performance objectives can be divided into four steps:

- Step 1 Establish stable soil conditions that can be expected to reduce waterborne soil erosion. The general procedures outlined in **Appendix B** will be used to accomplish this objective.
- Step 2 Establish a vegetative cover that will flourish without need for fertilization or re-seeding after a 5-year period.
- Step 3 Treat RTP water until Alaska Water Quality Standards are met without treatment, assumed to be 10 years.
- Step 4 Conduct post-closure monitoring activities to demonstrate that water quality goals are met.

### 5.2 Monitoring & Reporting

Pogo personnel will monitor the progress of Step 1 objectives by monitoring the water quality in accordance with the “Storm Water Pollution Prevention Plan” established for the project and any other applicable permits.

An annual report will be prepared summarizing the disturbance for the year, the status of revegetation, the results of any test trials, an updated schedule, maps of new disturbance, and any proposed modifications to the procedures outlined in this plan.

### 5.3 Reclamation Cost Estimate & Financial Assurance

The ADNR and ADEC will coordinate their financial assurance authority for performance of reclamation and facility closure and post-closure monitoring activities at the Pogo Mine. Proof of financial assurance, which may take any form mutually agreed upon by the agencies and Pogo Mine, is referred to as a “bond” in this section. Unless otherwise agreed between the agencies and Pogo Mine, the bond amount would be calculated on the basis of the Reclamation Plan and use of the SRCE Model Version 1.4.1 Build 16. The bond will address all costs that would be incurred by the agencies performing reclamation activities in the event of Operator default (**Appendix F**).

SRCE cost estimates are provided for:

LOM reclamation/closure estimate that accounts for the full build out of facilities and final closure at the current end of LOM in approximately 10 years. Physical reclamation would be completed in approximately 10 years of water treatment activities prior to moving into the post-closure phase.

The SRCE cost estimates are based on third-party implementation of the reclamation plan, no recycle or salvage costs recovery, and on-site disposal of all equipment and facilities with the exception of hazardous waste, which would be shipped off site to an appropriate hazardous waste disposal facility.

Financial assurance will be established by Pogo to provide for completion of the reclamation work described in this report. As summarized in **Appendix F**, reclamation and closure costs are estimated at \$94.39M for the Pogo Mine Site, the all-season road, transmission line, holding costs, and post-closure water treatment and monitoring. These estimates are based on an updated model described below.

The Pogo Mine Reclamation and Closure Plan was updated to reflect 2023 as-built conditions and current site knowledge. An updated closure cost estimate was also prepared. The SRCE model is more detailed than the approach used previously and projects a physical closure cost of \$88.25M for the mine site (including the 2-year holding costs) and \$6.14M for the access road and transmission line.

The Pogo SRCE included in **Appendix F** was developed to include all reclamation activities that were previously accounted for under the Mine and Right-of-Way (ROW) reclamation cost estimates. A “Basis of the Reclamation Cost Estimate for the Pogo Mine” is also included in the **Appendix F**. This document summarizes the effected facilities and documents the SRCE model calculations including development of cost unit rates, closure construction quantities, haul distances/profiles, equipment fleets and crews’ productivities, as well as additional assumptions used to prepare the SRCE model. Supporting documentation including site drawings and vendor quotes are also included in **Appendix F**.

Equipment costs are based on 2023 monthly rental rates obtained from N.C. Machinery. Labor rates are based on State of Alaska Department of Labor, “Laborers’ & Mechanics’ Minimum Rates of Pay” Issue 40 effective April 2023. Fuel costs are based on \$6.27/gallon (2022 vendor quote). The estimate is in constant 2023 dollars, with adjustment for inflation or discounting at 3.22% (the 5-year average of Anchorage CPI between 2018 and 2022).

## **5.4 Release of Financial Assurance**

Pogo will inspect reclaimed areas on an annual basis to determine if the general procedures outlined in **Appendix B** were performed adequately to meet the objectives. Pogo will propose that the financial assurance be released in steps as each phase is completed and the reclamation objectives have been met. Release of financial assurance will occur at the discretion of the agencies.

## **5.5 Post-Closure Public Access & Safety**

It is intended to restrict public access during the reclamation and post-closure monitoring phases of the project to protect the public. During reclamation, the portals will be capped and plugged to prevent access. Recontouring sideslopes during reclamation and removing access roads will also protect against public injury.

Public restrictions may be lifted at the discretion of the agencies during Phase V.

## 6.0 ACKNOWLEDGEMENTS

- A. It is understood that should the nature of the operation change, a modified or supplemental plan of operations and reclamation may be required.
- B. It is understood that approval of this Plan does not constitute:
  - 1. Certification of ownership to any person named herein; and
  - 2. Recognition of the validity of any mining claim herein.
- C. It is understood that a bond equivalent to the estimated cost of performing the agreed upon reclamation measures would be required before this Plan can be approved. Bonding and any bond reduction amounts would be set on a site-specific basis by ADNR in coordination with the cooperating agencies.
- D. It is understood that any information provided with this Plan or provided in the future, that is marked “Confidential” would be treated by the agency in accordance with that agency's laws, rules, and regulations.
- E. Northern Star (Pogo) LLC would conduct an environmental closure audit to determine if any previously unknown environmental liabilities exist as a direct or indirect result of the Pogo Mine project.

Northern Star (Pogo) LLC has reviewed and agrees to comply with all conditions in the Reclamation and Closure Plan. Northern Star (Pogo) LLC understands the bond would not be released until ADNR and ADEC give written approval of the reclamation work.

Northern Star (Pogo) LLC

By: \_\_\_\_\_

Title: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

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# **Appendix A**

## **General Construction Procedures**



## General Construction Procedures

Northern Star (Pogo) LLC recognizes that the construction method employed has a direct impact on the success of the reclamation process. The primary objective of minimizing disturbed areas will be considered during all phases of construction, and all activities will be conducted in a manner that will prevent or minimize disturbance of natural drainage systems and fish and wildlife resources. General procedures and guidelines to be followed during construction activities are outlined in this appendix.

### Facility Construction

Specific construction practices for facility types are presented below. These will be expanded as designs and specifications are developed.

#### *Roads*

All roads, whether proposed for exploration, construction, or production access, will be laid out on the overall site plan prior to flagging. An assessment will determine whether the road is necessary; whether it will provide temporary or permanent access; how surface runoff and erosion will be controlled; and what considerations are required for its final reclamation.

After a road is determined to be necessary, it will be flagged in the field. Consideration will be given to the following factors before the road is constructed:

- Minimize width needed for safe operations, berms, and drainage.
- Minimize cut and fill (follow natural contours where practicable or along ridge lines).
- Provide drainage and erosion control structures as needed (crowns, ditches, culverts, water bars, etc.).
- Salvage topsoil if feasible (i.e., when the safety of the operator is not compromised— seed to stabilize).
- Buy and plant trees or, if downed trees are available, build a brushberm (filter windrow) at the bottom of slopes to help limit erosion.
- Install culverts at intermittent streams.

- If possible, avoid areas that are wet and/or frozen. If this is unavoidable, leave vegetative mat in place and armor if necessary. Use geotextiles or rock to improve the sub-base and minimize rutting and erosion.
- Avoid steep grades when possible.
- Avoid areas where snow will drift, if possible, as these areas are often unstable and difficult to revegetate.

### *Laydown Areas*

All proposed laydown areas will be flagged in the field prior to construction. Other techniques will include:

- Preserving the natural drainage of the area when feasible.
- Removing brush and trees and stockpile separately.
- Not grubbing topsoil from permafrost or poorly drained areas.
- Removing topsoil (if grubbed) to designated growth media stockpiles.

### *Highwalls*

Highwalls will be cut into steep terrain to accommodate roads, facility pads, and the RTP. The following construction practices will ensure stability:

- Benching highwalls where feasible.
- Directing drainage away from top of highwall.
- Scaling the face to reduce the risk of falling debris.
- Using rock bolting or screens in some cases to enhance stability.

### **General Practices**

General practices to be followed during construction activities are described below. These will be expanded as the project design proceeds.

## *Timber*

Salvageable timber will be managed in a manner to prevent infestation by insects. The following general procedures will be followed:

- Salvageable trees will be cut from the stump using conventional methods (i.e., chain-saw, feller-buncher, or shear).
- Salvageable trees will not be pushed over with a dozer.
- Salvageable timber will be disposed of in a manner approved by the State of Alaska.

## *Surface Water Use*

Surface water may be obtained during construction to aid in compaction of structures or the construction of an ice road. Surface water may only be used at designated locations that have an approved "Temporary Water Use Permit." The following general procedures will be used during water filling operations:

- Water will be taken at the deepest area of the stream.
- Water trucks will not enter any body of water before, during, or after filling the truck with water.

Any water intake structure in fish-bearing water—including a screened enclosure, well point, sump, or infiltration gallery—will be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. Water velocity at the screen/water interface may not exceed 0.5 fps when the pump is operating and must not cause fish impingement on the screened surfaces. Screens aligned parallel to the stream current will require the least maintenance and will be least likely to impinge on fish.

# **Appendix B**

## **General Revegetation Procedures**

## **General Revegetation Procedures**

General procedures will be followed during the reclamation process. These procedures will be field adjusted where appropriate, and modified as more efficient and/or environmentally effective procedures are developed on site or in similar zones in Alaska. These will be submitted to ADNR for approval.

These prescriptions and improvements are designed to promote successful mine reclamation by providing good soil conditions for plant growth, establishing vegetation to control erosion, and enhancing natural ecological processes.

### **Establish Good Soil Conditions**

Good soil conditions will be established prior to seeding to ensure soil stability and the long-term success of revegetation efforts.

### *Soils Contouring & Grading*

The primary goal of soils contouring and grading is the immediate stabilization of the surface. The secondary goal is to establish a stable surface for revegetation.

Disturbed areas will be graded and contoured to control erosion. Slopes will be modified to control the velocity and direction of runoff, trap and retain water on site, and retard the flow of water as it moves off the disturbed areas. Topography, slope angle, type of soil, and rainfall intensity will be considered when determining the design for contouring. Techniques to be used may include re-sloping, terracing, contour benches or furrows, bioengineering with natural plant materials, and the use of geotextile material.

Slopes flatter than 2H:1V may have dozer gouges prepared for erosion control where appropriate. These gouges are constructed by operating the dozer perpendicular to the crest of the slope. Steeper slopes will be treated on a case-by-case basis to ensure the safety of the operator. These slopes would include quarry highwalls, mill bench highwalls, camp / shop bench highwalls, and other rock cuts along roads and ditches.

Areas that are likely to develop rills and gullies will undergo surface manipulation such as ripping and chiseling along the contour, contour furrows, and pits and/or terraces. Water bars will be placed as needed.

## *Soil Tillage*

During reclamation, soil may be compacted, decreasing the soil pore space. This limits water holding capacity and soil rooting volume, resulting in reduced root growth and seedling success. Soil tillage helps correct these adverse conditions and is particularly important during the critical first years of reclamation.

Areas that have been heavily traveled, such as roads, laydown areas, building pads, etc., will be ripped prior to scarification. If necessary, cross-ripping will be done in extremely compacted material.

Where appropriate, all compacted areas and areas likely to develop rills and gullies will be ripped to a minimum depth of 18 inches prior to growth media placement.

Ripping can have a greater impact on development of seedling roots than any other soil tillage treatment, as this technique will increase the soil volume available to roots and improve their ability to reach water and nutrients.

## *Growth Media*

Growth media in designated areas, such as overburden and topsoil, will be stockpiled for future use. These stockpiles will be seeded to prevent erosion and to enhance their biological properties, such as buried seeds, plant roots, rhizomes, and microbes, that aid in nutrient absorption. These properties decrease with time in stored topsoil.

If available, growth media will be stripped from material sites, laydown areas, and the mill site area. Depending on geotechnical design criteria and water quality considerations, growth media will not be stripped from areas with underlying ice-rich permafrost and fine-grained, poorly drained soils.

Approximately the top 6 inches to 18 inches of growth media will be stripped and stockpiled as topsoil, with the depth dependent on local conditions. The portion of soil containing plant roots will be used as a guide to segregate topsoil from overburden. Growth media will be stockpiled at prescribed locations as shown in **Figure 3.1** in **the Reclamation and Closure Plan**.

Generally, a 6-inch layer of growth media will be placed over disturbed areas, excluding rock cuts and slopes steeper than 2.5H:1V, that require additional growth media to support revegetation or efforts to promote natural re-invasion by native vegetation. The ongoing test trials (**Appendix E**) will help establish the areas requiring growth media. Stable highwalls will be left in place and will not require growth media.

A Growth Media Replacement Plan that includes depth of growth media placement over buried foundations and proposes a seed mix and fertilizer application rate will be submitted to ADNR for approval prior to Phase III reclamation activities.

### *Soil Amendments*

Disturbed areas are expected to be nutrient-poor, and an initial application of fertilizer will likely be required. However, upland forests of the boreal forest are generally found to leach nutrients, and fertilization may have a negative impact on the establishment of native plant species.

Initial field trials indicate that a fertilization rate of 300 pounds per acre of 20N-20P-10K is adequate. Fertilizer application rates will be adjusted based on additional field trials, the reclamation objective, and field conditions such as growth media organic content, soil temperature, and moisture content. Fertilizer will be applied prior to, or during, seeding operations.

Growth media will be tested for the most important nutrients involved in plant production in the boreal forest: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) (Magoun et al., 2000). Fertilizer rates will be adjusted accordingly.

Fertilizer will not be used within 100 feet of the Goodpaster River, its tributaries, or whenever conditions may facilitate transport of fertilizer to the river.

### *Mulch*

Mulch may be used to protect seeds and help retain soil moisture during the critical germination process. The benefits of using mulch produced from native tree and shrub twigs include: (1) provides nitrogen and nutrients as decomposition products, (2) supplies seeds, roots, and microorganisms needed to reestablish native vegetation, and (3) contributes woody debris for habitat enhancement. Mulch cover may not be appropriate for seed mixtures that require mineral soil and light for germination.

During the land clearing process, salvageable timber will be cut and decked. Other plant material may either be cut or chipped and incorporated as a soil amendment, or stockpiled for later use as mulch or woody debris applications.

### **Seeding**

Seeding methods are described below to ensure optimum conditions are present for seed growth.

## *Seedbed Preparation*

After or during placement of growth media, the seedbed area will be scarified. Scarifying improves rooting conditions in the soil surface by increasing the volume of large pores in the surface soil that allows for more water and air transport. Other advantages of preparing a rough surface include the ability to:

- trap moisture
- reduce wind shear
- minimize surface erosion
- increase infiltration
- create micro-habitats conducive to seed germination
- encourage native plant recolonization

## *Seeding*

The goal of the revegetation program is to stabilize soil erosion so that native species may recolonize the area. This will be accomplished using two methods:

- In minimally disturbed areas with existing duff or plant growth, scarification and fertilization of the disturbed and surrounding area may be undertaken to encourage natural recover.
- In highly disturbed areas, seeding will be conducted to immediately establish a grass cover to reduce soil erosion and prevent sediment loss into rivers and streams.

Test trials began in 1998 with revegetation of the winter road, and have continued with revegetation of portions of the advanced stage exploration project. These trials will continue throughout the life of the mine (**Appendix E**), or until an optimum program is established that meets the following objectives:

- identifies existing and introduced grass, legume, and woody species potentially suitable for temporary and/or permanent stabilization of stockpiles and recontoured areas.
- investigates potential requirements for soil amendments such as fertilizer, organic material, etc.
- determines the optimum grass cultivars, singularly or in mixtures, for stockpiled soil from the site areas, overburden and development rock, and tailings.



To date, winter road test trials have indicated the seed mixture presented in **Table B.1** is effective at stabilizing disturbed areas.

**Table B.1: Current Seed Mixtures**

Objective	Grass Species	Notes
Winter Road	Annual rye grass	Use 50/50 mixture of 40 pounds/acre. Add annual rye grass (up to 10%) to perennial mixture for early season planting. Late season follow up with perennials next spring. Use fertilizer mixture of 20N-20P-10K at 250 pounds/acre
Temporary – quick	Red fescue (Arctared)	Reapply fertilizer at 250 pounds/acre after grass cover is established (2 to 3 years)
Advanced Exploration	Annual rye grass	
Interim Reclamation	Red fescue (Arctared) stockpiles, erosion control devices, cut	Has proven to be effective on trial areas at MS7 and Mile 33

The timing of seeding considers the germination of the seed and its establishment. The preferred seeding time is in the spring, immediately following snowmelt and runoff when the soil surface is moist and temperatures are warming. However, fall seeding will be practiced when necessary. If seed is applied during the winter, the snow surface will be roughed to provide microsites for trapping the seed. Proposed seeding date cutoffs are presented in **Table B.2**.

Seed and fertilizer will be broadcast by hydroseeder, depending on the size and accessibility of areas to be treated. Alternatively, helicopter-seeding, currently planned for reclamation of the main access road and transmission line disturbances, may be used to revegetate the whole site.

**Table B.2: Seed Timing**

	Germinate & Establish Seedlings for Overwintering	Lie Dormant until Spring Breakup
Uplands	Spring breakup through July 30	October 15 through spring breakup
River Valley	Spring breakup through July 15	October 1 through spring breakup

## *Woody Debris*

Preliminary research indicates that woody debris may play an important role in forest ecosystems (Magoun et al. 1999). The function of woody detritus in forests may include the following:

- reducing erosion
- enhancing soil development
- storing carbon, nutrients, and water
- providing a seedbed for plants
- supplying an important habitat for microorganisms, invertebrates, and vertebrates

Small-scale natural disturbances such as wind throw, snow breakage, localized mortality from insects and disease, and activity by herbivores may be imitated. Woody debris from cleared areas will be utilized in this way to enhance the overall reclamation program.

# **Appendix C**

## **Demolition Procedures**

## General Demolition Procedures

Demolition will include:

- removal of all hazardous materials
- removal of all equipment and buildings
- removal of above-ground power and telephone lines
- burial of concrete foundations and footers
- removal of piping to just below grade
- approved on-site disposal of inert construction and demolition debris

## Hazardous Materials

All controlled and hazardous chemicals, fuels, and regulated materials will be removed from the site for recycling and/or disposal in an approved manner. Decommissioning will include pumping to remove any remaining hazardous materials in pipes, tanks, and other potential storage units. Tanks will be cleaned and purged following all applicable and relevant regulations.

Fuel tanks and steel infrastructures, such as walkways, will be disposed in designated areas of the underground mine workings. Uncontaminated gravel will be used to surface site roads. Contaminated gravels will be treated in a manner approved by ADEC. The synthetic liners will be removed to the solid waste disposal facility.

## Equipment & Buildings

All equipment will be removed from buildings and salvaged. Modular buildings will be shipped off site. Non-mobile buildings constructed on site will be dismantled. Reusable components will be shipped off site. Other portions will be burned or incinerated, as approved, or removed to the drystack tailings facility during Phase III and the solid waste disposal facility (not yet constructed) or designated area within the underground workings of the mine during Phase III.

All fencing will be dismantled and disposed of. the solid waste disposal facility (not yet constructed) or designated area within the underground workings of the mine during Phase III.

## **Above-Ground Power & Telephone Lines**

When electrical power requirements are no longer necessary, associated facilities such as conductors and insulators will be removed from the site for salvage or disposal. Wooden poles will be cut off at ground surface and removed from site. All above-grade lines will be removed, while any underground conduit below grade will remain in place.

## **Concrete Foundations & Footers**

A dozer will be used to break all concrete slabs prior to burial. Foundations will be buried in place with a minimum 12 inches of cover. Elevated slabs, walls, and footings will be broken to grade level and buried as fill material.

## **Piping**

All piping will be flushed, buried pipe will be excavated and hauled to the drystack tailing facility or onsite landfill. Buried pipes will be kept to a minimum but will mainly consist of water and sewage transfer pipes between the mill and camp benches. Buried water lines will be flushed before in situ disposal. Buried lines (other than water lines) will be blown free of liquids using compressed air to remove any residual fuel, antifreeze or hazardous chemicals unless otherwise approved by ADNR.

Surface piping will be flushed, if necessary, and removed to the drystack tailings facility (Phase III), solid waste disposal facility (not yet constructed) or the designated area within the underground workings of the mine during Phase III.

## **Inert Construction & Demolition Debris**

Inert construction and demolition debris will be burned or incinerated, as approved, or placed in the drystack tailings facility (Phase III) or within the underground workings of the mine during Phase III.

## **Septic & Leach Fields**

Surface components of the sewage treatment systems will be removed to the solid waste disposal facility (not yet constructed). The remaining below-ground portions will be abandoned in accordance with ADEC regulations.

## **Injection & Supply Wells**

Injection, water supply, and monitoring wells will be abandoned by removing all projecting casing and piping and plugging from the surface to the water table with concrete or bentonite. Concrete will not be used as a surface plug because of its susceptibility to frost jacking in ice-rich soils.

# **Appendix D**

## **Reclamation of Material Sites in Goodpaster Alluvial Gravels**

## **RECLAMATION OF MATERIAL SITES IN GOODPASTER ALLUVIAL GRAVELS**

Gravel Pond North and Gravel Pond South will be developed in support of the Pogo project. All other material sites will be used as contingencies in the event that additional material is required or some of the material sites do not prove viable.

Estimated extraction volumes are 190,000 cubic yards (yd<sup>3</sup>) from site MS-H and 70,000 yd<sup>3</sup> from MS-D, for a total 260,000 yd<sup>3</sup> of sand and gravel. This total is based on an estimated construction volume of 144,000 yd<sup>3</sup> plus an allowance for wastage/contingency, unusable native soil, and future maintenance requirements. The other material sites have not been included in this total because of their contingency status, although acreages and reclamation plans are included in this report.

In general, sand and gravel will be used for concrete aggregate, road surfacing, construction laydown areas, structural backfill, and in the RTP dam.

### **General**

Gravel mining during the construction will be conducted as follows:

1. The perimeter of the borrow pits will be surveyed, and the trees and brush removed from within the perimeter. Tree and brush removal will only be done if and when the particular borrow pit is required. Trees with diameter at breast height (DBH) greater than 9 inches will be decked and used for construction or support activities. Trees with DBH of 9 inches or less will be cut into short sections or chipped for use during reclamation. Growth media will be removed to the nearest designated growth media stockpiles in the airstrip facility area or the 1525 portal area. Brush will be either stockpiled or chipped and incorporated into the growth media.
2. Gravel will be excavated below the water table with either a backhoe or a dragline. The depth of the material sites will vary from 15 to 25 feet depending on the equipment available, the permafrost encountered, and the material found at depth. The sideslopes of the material sites are proposed to be approximately 1.75H:1V to ensure stability and to avoid wildlife entrapment.
3. A cleared buffer zone of 25 feet will be maintained between undisturbed vegetation and the material site limits. This will ensure minimal tree collapse into the material site due to bank thawing and erosion.



4. If gravel requirements and scheduling dictate that gravel is needed from areas where seasonal frost is present, blasting may be necessary. Some irregular areas around the perimeter will not be blasted, and once thawed during the summer, these areas will be reshaped to provide flat slope shoreline and shallow pond areas.
5. When explosives are necessary for gravel extraction during the winter months, Pogo will use appropriate charge sizes and setbacks from the river to prevent injury to fish. These parameters will be based on Alaska Department of Fish & Game's (ADF&G's) 1991 publication Blasting Standards for the Protection of Fish. Precautionary measures will also be taken to minimize nitrogen contamination of the gravels and surrounding area.
6. For the definition of the material site layouts for this permit application it is assumed that gravel extraction will be terminated where permafrost is encountered. As the frost comes out of the gravel, the gravel may be removed, but the general concepts of "upland areas" and "shallow bars" will be maintained.
7. Generally, "upland areas" and "shallow bars" will comprise approximately 20% of the material site areas.
8. Where possible, gravel will be excavated in a manner that maximizes shoreline irregularity.

### **Final Reclamation**

The objective of final reclamation is to establish wetland habitat with suitable features for waterfowl and shorebirds. This will include the following procedures:

1. Material site slopes and banks will be contoured immediately following completion of each sectional part or the entire operation, as appropriate. No gravel stockpiles will be left at the completion of operations.
2. Shoreline length and diversity will be maximized to the extent practicable.
3. Topsoil will be applied to disturbed areas where erosion is possible.
4. Native emergent plants may be transplanted in shallow areas as appropriate to improve habitat value for waterfowl. In addition, shrubs and other indigenous plant materials may be used to create pockets that should assist natural colonization and increase habitat values.
5. Perimeter vegetation within 100 feet of the material site perimeter will be fertilized so as to enhance vigor and seed production.

6. Because seeding with grass cultivars is likely to inhibit natural colonization, it will be limited to areas where rapid cover development is needed for erosion control.
7. Fertilizer and seed will be broadcast by hand or mechanically, depending on the size and accessibility of areas to be treated. Application rates will depend on the results of the test plots described in **Appendix E**. Fertilizer will not be used within 100 feet of the Goodpaster River or its tributaries.

Clearing activities at the material sites are expected to generate more growth media than will be required for use during material site reclamation. This material will be stored in the designated growth media stockpiles to be used during project reclamation.

# **Appendix E**

## **Revegetation Study Memo**

**Date:** November 19, 2018

**Subject:** Revegetation Study Memo for 2018 Annual Report

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**Figure 1: Broadleaf Forest 2014 (before) and 2017 (after 3 years of growth)**

Revegetation test trials were evaluated after three years of growth to compare the use of material and resources for meeting the coverage goals set forth in the Pogo Mine Reclamation and Closure Plan. The Plan defined the revegetation goals as:

- Diverse species cover of at least 70% for 3 years after seeding.
- Vegetation will flourish with no additional seeding or fertilizing after 3 years and still flourishing after 5 years.
- At least 30% cover after the first 3 years or reassess methods.
- No single species of grass more than 70% of cover.
- No tree or shrub more than 95% of cover.
- Discourage the invasion of non-native weeds.

Broadleaf, Wetland and Alluvial Shrub test plots were established in 2015; 2017 graphs (**Figure 2** through **Figure 4**) represent three growing seasons. Alpine test plots on the Drystack shell were established in 2016, the 2018 Alpine Meadow graph (**Figure 5**) also represents three growing seasons of data. Agrotain, a urea inhibitor that prevents the rapid volatilization of nitrogen, was included in all the 10-10-10 fertilizer mixtures. Seed mixes used for each plot type are described in **Table 1: Revegetation Plot Seed Mixes Summary**. The small size of the revegetation trial program precludes statistical analysis, as not enough data is available to support this type of analysis.

An overview of the data indicates that the total cover goal of 70% have been met in almost every trial variation of media/fertilizer/seed application. 100% cover is apparent in many of the trial plots, more than is actually desirable to encourage the pioneering of native species. Plant establishment appears to be responding most strongly to fertilizer rates and the application/type of seed than to the presence of, or particular depth of, growth media. Zero application of growth media produced a lower percentage of cover in some instances, though most were very close to the required 70% cover or exceeded the 70% cover. Overall, it seems the application of fertilizer and seed produced sufficient cover whether topsoil (growth media) was present or not. Three inches of growth media appears to be just as effective as 6 inches of growth media in establishing the required cover in all four of the different ecotype studies: the broadleaf forest, wetlands, alluvial shrubs and alpine meadow. The Broadleaf Forest plots appear to be the most sensitive to the amount of growth media.

In some cases, a reduction in fertilizer and seeding rates may be advised. A reduction in grass coverage would allow more colonization of native species. A reduction in fertilizer, especially when not needed to meet cover requirements, can help discourage invasive weeds as they are faster growing and more opportunistic than most native plant species.

It seems some seed mixes lead to better growth/coverage than other seed mixes. In most cases, zero application of seed was sufficient for meeting the 70% cover.

Willow cuttings were added to some of the alluvial shrub plots. The addition of the willow cuttings does not appear to significantly impact the total coverage; the required 70% coverage was met in all alluvial shrub plots.

In summary, it appears that minimal to medium material and resource input is sufficient for meeting coverage requirements. Most plots met the 70% coverage goal, and all plots met the required 30% cover. Moreover, many of the plots reached 100% cover. Recommendations to achieve the reclamation goals while reducing the amount of material and resources used include minimal to medium growth media depths and reduction of fertilizer and/or seeding rates to certain ecotypes.

Figure 2: Alluvial Shrub Plots

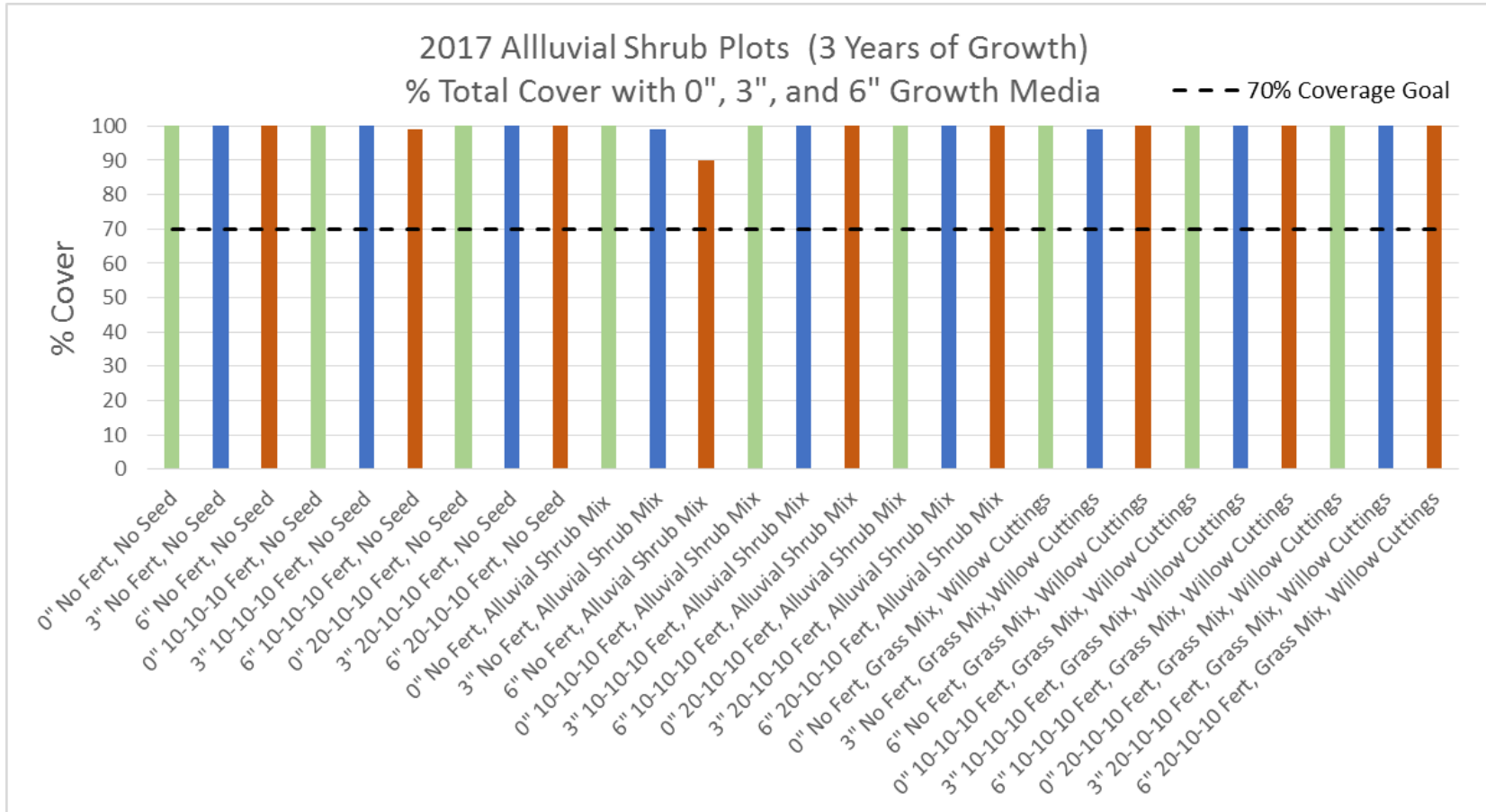


Figure 3: Broadleaf Forest Plots

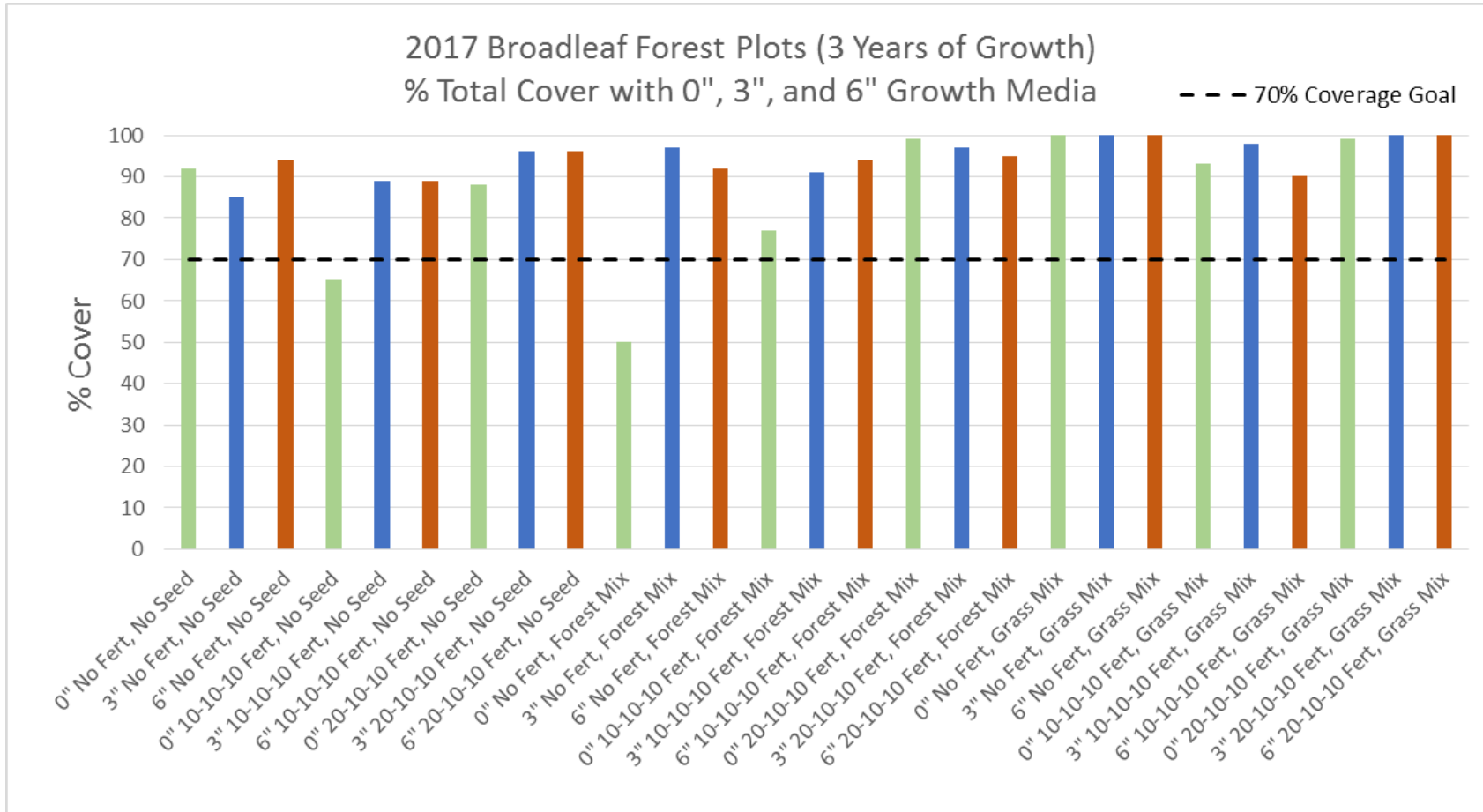


Figure 4: Wetland Plots



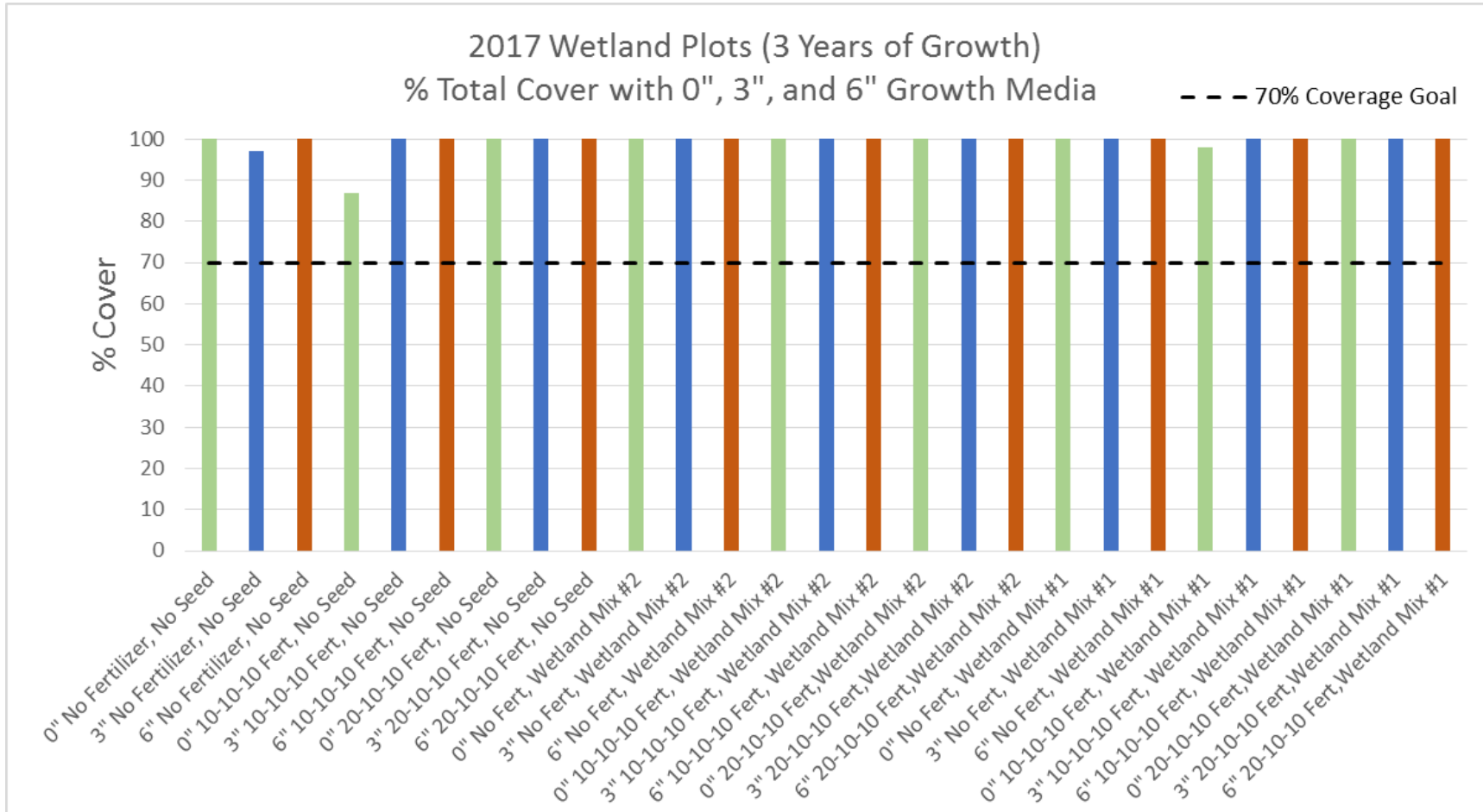


Figure 5: Alpine Meadow Plots

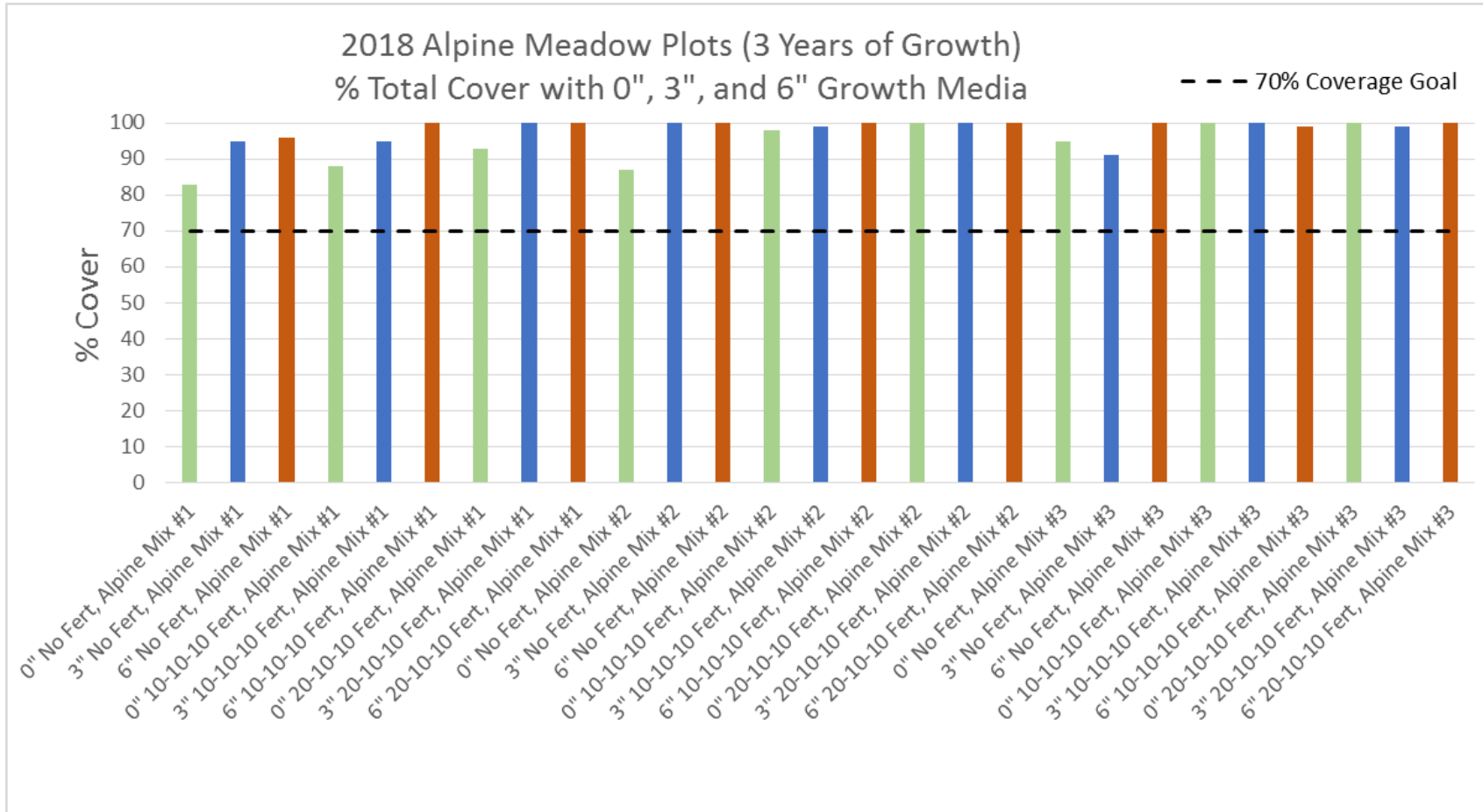


Table 1: Revegetation Plot Seed Mixes Summary

Species	Scientific Name	Percent of mixture
<b>Alluvial Shrub Seed Mix</b>		
Annual Ryegrass	<i>Lolium multiflorum</i>	10
Wainwright Slender Wheatgrass	<i>Elymus trachycaulus</i>	30
Alder	<i>Alnus sinuata</i>	15
Various Willow Species	<i>Salix ssp.</i>	45
<b>Willow Cuttings Grass Seed Mix</b>		
Annual Ryegrass	<i>Lolium multiflorum</i>	10
Wainwright Slender Wheatgrass	<i>Elymus trachycaulus</i>	90
<b>Broadleaf Forest Seed Mix</b>		
Annual Ryegrass	<i>Lolium multiflorum</i>	5
Wainwright Slender Wheatgrass	<i>Elymus trachycaulus</i>	5
Birch	<i>Betula papyrifera</i>	25
Aspen	<i>Populus tremuloides</i>	20
Alder	<i>Alnus sinuata</i>	25
White Spruce	<i>Picea glauca</i>	20
<b>Grass/Natural Invasion Seed Mix</b>		
Annual Ryegrass	<i>Lolium multiflorum</i>	10
Wainwright Slender Wheatgrass	<i>Elymus trachycaulus</i>	45
Alpine Bluegrass 'Gruening'	<i>Poa alpina</i>	45
<b>Wetland Seed Mix #1</b>		
Egan American Slough Grass	<i>Beckmannia syzigachne</i>	30
Polar Grass 'Alyeska' or 'Kenai'	<i>Arctagrostis latifolia</i>	30
Bering Hairgrass 'Norcoast'	<i>Deschampsia beringensis</i>	30
Wild Iris	<i>Iris setosa</i>	5
Northwest Territory Sedge	<i>Carex utriculata</i>	5
<b>Wetland Seed Mix #2</b>		
Wild Iris	<i>Iris setosa</i>	50
Northwest Territory Sedge	<i>Carex utriculata</i>	50
<b>Alpine Seed Mix #1</b>		
Annual Ryegrass	<i>Lolium multiflorum</i>	10
Red Fescue 'Arctared'	<i>Festuca rubra</i>	50
Wainwright Slender Wheatgrass	<i>Elymus trachycaulus</i>	40
<b>Alpine Seed Mix #2</b>		
Annual Ryegrass	<i>Lolium multiflorum</i>	10
Tufted Hairgrass 'Nortran'	<i>Deschampsia caespitosa</i>	30
Wainwright Slender Wheatgrass	<i>Elymus trachycaulus</i>	20
Alpine Bluegrass 'Gruening'	<i>Poa alpina</i>	20
Alpine Sweetvetch/ Eskimo Potato	<i>Hedysarum alpinum</i>	5
Field Oxytropis	<i>Oxytropis campestris</i>	5
Snow Parsley	<i>Cnidium cnidifolium</i>	1
Yarrow	<i>Achillea millefolium var borealis</i>	1
Silverberry	<i>Elaeagnus commutata</i>	5
Pasque Flower	<i>Pulsatilla vulgaris</i>	1
Pale Corydalis	<i>Corydalis sempervirens</i>	2
<b>Alpine Seed Mix #3</b>		
Annual Rye Grass	<i>Lolium multiflorum</i>	10
Red Fescue 'Arctared'	<i>Festuca rubra</i>	30
Wainwright Slender Wheatgrass	<i>Elymus trachycaulus</i>	20
Alpine Bluegrass 'Gruening'	<i>Poa alpina</i>	20

Species	Scientific Name	Percent of mixture
Alpine Sweetvetch or Eskimo Potato	<i>Hedysarum alpinum</i>	5
Field Oxytrope	<i>Oxytropis campestris</i>	5
Snow Parsley	<i>Cnidium cnidifolium</i>	1
Yarrow	<i>Achillea millefolium var borealis</i>	1
Silverberry	<i>Elaeagnus commutata</i>	5
Fleabane	<i>Erigeron</i>	1
Siberian Aster	<i>Eurybia sibirica</i>	2
Hairy Scorpion Weed	<i>Phacelia mollis</i>	1
Arctic Poppy	<i>Papaver radicum</i>	2

**Figure 6: Control Plots Alpine Seed Mixes on DSTF Shell 2 August 2018 (after 3 years of growth)**

