# Chapter 4 Environmental Consequences

This chapter describes the environmental impacts of project development for each alternative, determines the severity of those impacts on the human environment, and discusses whether those impacts could be mitigated.

The format used in this chapter to present the impacts for each resource is the same:

1. Impacts that would occur if no action were taken are described (Alternative 1)
2. Impacts for each of the three action alternatives (Alternatives 2, 3, and 4) are described
3. Cumulative impacts are discussed

How each of these steps was approached is described below.

## No Action Alternative

To standardize the process for determining impacts of the No Action Alternative on each resource, specific assumptions were made. These assumptions are shown in Table 4.0-1.

**Table 4.0-1 No Action Alternative Assumptions**

**1. Socioeconomics**

- No prison constructed at Fort Greely
- Construction of a National Missile Defence System (NMDS) at Fort Greely beginning in 2002, with completion by approximately 2004 (3 years).
- NMDS construction employment would average 400 jobs. Most of the construction labor force would be nonresidents and would be housed on site. The total NMDS-related population during operation (including employees, their dependents, and indirect population increase) would be approximately 350 residents.
- Natural gas pipeline construction between 2005 and 2008. Impacts on the Delta area would occur for 2 years during this period, with peak impact lasting for approximately 9 months. The large majority of workers would be nonresidents of the Delta area. There would be almost no increase in population from actual gas pipeline operation.
- Once the NMDS is constructed, the Delta area population should stabilize at approximately 2,100 residents, below the pre-base closure peak of 2,388 residents in 1993.

**2. Non-Resource Development**

**Residential land sales**

- Some additional private residential land would be needed for a portion of NMDS workers. There would be no sales of state land in the project area. Natural gas pipeline construction would not increase residential land needs.
- State land sales would adhere to the TBAP.

**Agricultural land sales**

- New agriculture land sales in the Delta area unlikely in the near future, unless there are substantial changes in operation expenses and the market and demand for farm-related products.

**Commercial and Industrial Activities**

- Existing, and possibly new, commercial and industrial activities (such as lodges, stores, and rock quarries) would occur in the existing developed Delta area at a pace consistent with ongoing needs or other actions in the area.

**Table 4.0-1 No Action Alternative Assumptions**

**Power**

- GVEA's Fairbanks to Delta power line would be upgraded for NMDS. This upgrade would not require more or higher poles, nor more clearing of the ROW.

**3. Resource Development**

**Timber**

- The current TVSF 5-year schedule for timber sales (FY 2003 to 2007) would be implemented, given existing winter trail access routes and market demand. The current 5-year schedule proposes harvesting four timber sales on the northwest side of lower Shaw Creek. See Section 3.17.1 for greater detail.
- The DOF would construct its planned all-season road to access timber along the Shaw Creek Hillside to harvest three of those sales totalling approximately 433 acres. This road likely would be constructed incrementally over the next several years, depending on sale of the proposed harvest units and additional capital funding. The road would be open to the public. Its route would be very similar to the Shaw Creek Hillside all-season road route proposed by the Applicant and would extend to Gilles Creek. Estimated *total* round trips on this road by logging trucks, for each of the three *entire* sales, are 142 (Fowler Creek), 285 (Keystone Bluff # 1), and 485 (Keystone Bluff # 2). These trips would average between approximately 2 and 3 truck round trips per day.
- The DOF eventually would construct its planned all-season road around Quartz Lake to access timber in the vicinity of Quartz Lake and Indian Creek near the South Ridge route for the all-season road option. It would be open to the public. Like the proposed Shaw Creek Hillside forestry road, it likely would be constructed incrementally and would be dependent on additional capital funding or timber sale activity. The current 5-year schedule for timber sales proposes four timber sales in the Quartz Lake and Indian Creek area, totalling approximately 610 acres. Of that total, two sales totalling approximately 470 acres would be accessed from the proposed new DOF road, while one sale of approximately 80 acres northeast of Quartz Lake would be accessed from the existing winter road on Shaw Creek Flats. Estimated total round trips on the DOF road by logging trucks, for each of the two entire sales using the road, are 266 (Quartz Lake # 1) and 950 (Indian Creek # 1). These trips would average between approximately 2 and 3 truck round trips per day.

**Mining**

- Mineral exploration likely would slow or perhaps decline from current levels either because a lack of Pogo permits would cool mining companies' interest in the area or because the Applicant decided not to proceed on economic grounds (e.g., low price of gold).

**Recreation**

- Slow increase in use of the Goodpaster River Valley.

## Alternatives

Section 2.5 (Action Alternatives Identification) discussed how the options were grouped into three categories; those options that were common to all alternatives (Table 2.5-1); those that differed between alternatives but were not related to surface access (Table 2.5-2); and finally, those that differed between alternatives and were related to surface access (Table 2.5-3). Figure 4.0-1 graphically presents all the options that differ between the action alternatives. Those on the left side of the figure are not related to surface access, while those on the right side of the figure are related to surface access. This figure can be used to track the discussions of individual resource section impacts in this chapter.

Note that Figure 4.0-1 does not contain those options that would be common to all alternatives (Table 2.5-1) because, by definition, there would be no difference in impacts between the alternatives. These common option impacts, however, are discussed in each individual resource section. As a convention, if a particular option would have no or only a low impact on a given resource, that option generally was not discussed.

# ALTERNATIVES ANALYZED IN THIS EIS

| AN ALTERNATIVE TO BE ANALYZED IN THIS EIS[1] | COMPONENTS NOT SURFACE ACCESS RELATED | | | | COMPONENTS SURFACE ACCESS RELATED | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | WATER DISCHARGE | | ACCESS | | | | |
| = | TAILINGS FACILITY LINER + | POWER SUPPLY + | DEVELOPMENT PHASE + | OPERATIONS PHASE + | TYPE + | ROUTE + | USE + | DISPOSITION + | POWER LINE ROUTE |
| | Options | Options | Options | Options | Options | Options | Options | Options | Options |
| **ALTERNATIVE 1** NO ACTION | Under the **No Action Alternative,** the project would not be developed and none of the options below would be implemented. | | | | | | | | |
| **ALTERNATIVE 2** Applicant's Proposed Project | Unlined | Power Line | Injection Wells | ▪ Injection Wells, and<br>▪ SAS<br>◆ At airstrip<br>◆ Above Pogo Ridge | All-Season Road | ▪ Shaw Creek Hillside, Richardson Egress<br>◆ Shaw Creek Road<br>◆ Tenderfoot | ▪ Pogo Project Only, or<br>▪ Pogo and:<br>◆ Industrial/ Commercial<br>◆ Everyone | ▪ Remove/Reclaim, or<br>▪ Road Left Open to:<br>◆ Industrial/ Commercial<br>◆ Everyone | Shaw Creek Hillside |
| **ALTERNATIVE 3** South Ridge Route Direct Discharge | Lined | " | Direct Discharge to Goodpaster River | Direct Discharge to Goodpaster River | " | South Ridge | " | " | South Ridge |
| **ALTERNATIVE 4** Winter Only Access Off-River Treatment Works | " | On-Site Generation | Off-River Treatment Works | Off-River Treatment Works | Winter Access Only<br>▪ Traditional Road<br>▪ Perennial Trail | Shaw Creek Flats | N/A[2] | N/A | N/A |
| Major Options Eliminated From Further Consideration[3] | | | Constructed Wetlands | | Railroad<br>Air Only (5,000-ft Airstrip) | Richardson Egress:<br>▪ Pipeline<br>▪ Keystone<br>Dean Cummings Crossing<br>Goodpaster Valley | | Convert to Recreational Trail | |

[1] Excludes those components/options common to all alternatives (Table 2.5-1).
[2] Not applicable to this alternative.
[3] See Appendix A.1.

**Figure 4.0-1**

## Cumulative Impacts

Cumulative impacts are defined as follows (40 CFR 1508.7):

> Cumulative impacts result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what government agency or private entity undertakes such actions. Cumulative impacts can result from individually minor impacts that, when viewed collectively over space or time, can produce significant impacts.

To standardize the process for determining cumulative impacts for each resource, specific scenarios were developed. These scenarios are presented in Table 4.0-2. For example, if the Pogo project were developed with an all-season road it is reasonable to assume that planned timber harvests would accelerate within the state forest through which it would pass. It is also reasonably foreseeable that another mine could be developed because of the increased access. Thus, the cumulative impact discussions consider accelerated timber harvests in the state forest, an extended Pogo Mine life because of discovery of additional reserves, development of a hypothetical Sonora Creek mine 8 miles from the Pogo ore body, and development of another hypothetical Slate Creek mine approximately 32 miles northeast of the proposed Pogo Mine site and accessed by extension of an all-season road.

When considering the projected cumulative impacts from the hypothetical mine scenarios, however, it should be noted that in Alaska it typically has taken from 10 to 15 years to bring a mine into production from the time a deposit is discovered. Because no other deposits have been discovered in the Pogo area yet, the likelihood of another mine coming into production during the life of the Pogo Mine project is low.

Note that for all three action alternatives, it was assumed that at the time of Pogo Mine closure the mine site would be accessible by an all-season road. The presence of the road was assumed either because Alternative 2 or 3 would be implemented or, if Alternative 4 were implemented, the planned DOF Shaw Creek Hillside road would have been constructed to the point that it would connect to the all-season road segment of the winter-only access option and effectively be operated like a complete all-season road. This assumption, therefore, provided a "worst-case" impact scenario. Thus, because all three alternatives would effectively provide all-season road access to the Pogo Mine site, cumulative impacts were determined largely by whether the all-season access road would be removed and reclaimed at the time of proposed Pogo Mine closure or would be maintained for extended Pogo Mine life, other resource development purposes, and public use.

Section 4.19 (Cumulative Impacts), near the end of this chapter, summarizes the cumulative impacts described for each resource below in both tabular format and a comparative discussion.

**Table 4.0-2 Cumulative Impact Assumptions**

**1. Socioeconomics**

- Pogo Mine development would not change the No Action Alternative scenario.
- Development of the Pogo Mine would occur early in the construction boom driven by the NMDS and gas pipeline.
- Mine construction would not measurably affect the Delta area population because construction jobs would be temporary, camp-supported, and filled primarily by nonlocal workers.

**Table 4.0-2 Cumulative Impact Assumptions**

- Between 100 and 135 of the mine's 385 employees would live in the Delta area with the all-season road option once the mine were in full production. Including dependents and indirect population effects, this option would result in between 260 and 350 mine-related Delta area residents.
- By the end of the decade (or once the NMDS and gas pipeline were constructed), development of the Pogo Mine with the all-season road option would result in a Delta area population of between 2,300 and 2,400, of which between 11 to 15 percent would be mine-related.

**2. Non-Resource Development**

**Residential land sales**

- Development of private lands in the Shaw Creek, Tenderfoot, Richardson, and Quartz Lake areas for homes and possibly businesses would be accelerated. Some new roads and GVEA ROWs would be needed to access residential land .

**Agricultural land sales**

- New agriculture land sales in the Delta area would be unlikely in the near future, unless there are substantial changes in operation expenses and the market and demand for farm-related products.

**Commercial and industrial activities**

- Commercial and industrial activities in the already developed Delta area would likely increase directly related to the scale and requirements of the project. This increase could include activities such as additional fuel, food, other service, or public facility-related development.

**Power**

- GVEA power line upgrade for NMDS also would be adequate for the Pogo project. If Pogo were constructed first, then the same upgrade would occur and be adequate for the NMDS.

**3. Resource Development**

**Timber**

- The Pogo access road would be available for timber harvesting from state lands, and DOF would not construct its own timber access road. The annually updated TVSF 5-year timber sale plan would incorporate an acceleration in timber sales and volume because of the road.

**Mining**

- An all-season road would increase access for mineral exploration and development in the Shaw Creek and Goodpaster River drainages, and possibly in adjacent drainages such as the Salcha River. New mineral developments might extend either access option farther than required just for the Pogo project. If new developments occurred, associated airstrips would be constructed.
- **For purposes of this analysis, three mine scenarios were considered.**

  **Extended life of the Pogo Mine** because of discovery of additional reserves. These reserves could be accessed underground from the existing tunnel network, or by one or more additional adits in the general vicinity of the present ore body. Minimal additional surface facilities would be developed (~20 acres of disturbance). Ore would be trucked or otherwise conveyed to the existing mill for processing. This extended mine life could cause a change in the number and type of traffic over time on the project access road.

  **Sonora Creek mine** (hypothetical) – Another ore deposit would be developed by the Applicant within the Pogo claim block at the head of Sonora Creek, approximately 8 road miles southeast of the Pogo ore body (Figure 3.17-4). Sonora Creek mine would be an underground mine. This scenario assumes an all-season road extended to this site (~75 acres of disturbance) with ore hauled by truck to the Pogo mill and tailings deposited in the proposed Pogo dry stack at the head of Liese Creek. Construction of minimal surface facilities is assumed at the site (~50 acres of disturbance), with the proposed Pogo facilities (such as mill, camp, and airstrip) used in its support.

  **Slate Creek mine** (hypothetical) – A deposit would be developed by another company on Slate Creek near the headwaters of the Goodpaster some 32 road miles northeast of the Pogo Mine site (Figure 3.17-4). This scenario assumes a complete stand-alone project with facilities that would include a mill, tailings disposal site, camp, and 3,000-ft airstrip (~240 acres of disturbance). It is assumed that ground access would be by extension of an all-season road from the existing airstrip at the proposed Pogo Mine site (~220 acres of disturbance).

**Table 4.0-2 Cumulative Impact Assumptions**

| |
|---|
| **Recreation** |
| Recreational access and activities along the all-season road corridor would increase. Easier access for motorized off-road vehicles (ATVs and snow machines) would enable them to travel well into the backcountry. A Division of Parks way-side would be developed at the Goodpaster River crossing. |
| **4. Access** |
| At time of Pogo Mine closure, the mine site would be accessible by an all-season road, either because Alternative 2 or 3 were implemented or, if Alternative 4 were implemented, because the planned DOF road would have been constructed to the point that it would connect to the all-season road segment of the winter-only access option and be effectively operated like the complete all-season road. It was assumed that an all-season road would be open to public use. |

# 4.1 Surface Water Hydrology

This section presents a discussion of the surface water hydrology. Surface water quality is discussed in Section 4.3.

## 4.1.1 No Action Alternative

Closure of existing mine area facilities currently operating under a 5-year underground exploration permit would result in cessation of water treatment plant discharge of treated mine inflow waters of between 50 and 150 gpm (Teck-Pogo Inc., 2002b, 2002f). Currently, this discharge is to the Goodpaster Valley alluvium through injection wells. This water ultimately discharges to the Goodpaster River (Teck-Pogo Inc., 2002h). The adit would be plugged, and collection of mine inflow waters would not be necessary for the No Action Alternative. Plugging of the adit and cessation of these flows is expected to result in no measurable or substantial changes in stream flow under this alternative.

The surface water hydrology of the Shaw Creek watershed without the construction of the Shaw Creek access route would be unaffected. DOF timber sales would result in road construction and timber harvesting that could cause some small changes in the hydrologic response of the Shaw Creek watershed to precipitation and snowmelt. These impacts would be low.

In areas near Shaw Creek Road, Quartz Lake, and along the Richardson Highway, additional development of private roads, residential construction, and commercial construction could result in substantial increases in stormwater runoff volumes and rates on a local basis. This development could occur in response to construction of the NMDS system.

Overall, the impacts on project area surface water from the No Action Alternative would be minimal.

## 4.1.2 Options Common to All Alternatives

### Underground Mine

Some uncertainty exists with respect to the possible connection of Liese Creek with the underground mine workings through the Liese Creek fault zone. Large quantities of water (up to the entire flow of Liese Creek) could flow through fault zone fractures to the underground workings, although this is not expected. If it were to occur, it would reduce the flow in the reach of Liese Creek below the mine and would reduce the flow into the wetlands located between Liese Creek and the Goodpaster River. If a substantial portion of the Liese Creek flow were to enter the mine through the fault, the quantity of water pumped from the underground workings would increase dramatically and be discharged to surface or subsurface waters after treatment. Such high flows into the mine through the Liese Creek fault zone would be mitigated by contingency plans (Teck-Pogo Inc., 2002b). A description of these plans may be found in the underground mine discussion in Section 4.2.2 below. If high inflows to the mine were caused by connection through the fault zone, Liese Creek would be diverted or contained within a conveyance so that losses to the underground workings would be minimized. Therefore, implementation of the contingency plans would likely result in small hydrologic effects to Liese Creek downstream of the mine.

### Tailings Disposal

- Underground Seepage from the tailings paste disposal underground is expected to be a minor flow of approximately 2 gpm (Teck-Pogo Inc., 2002h) and is not anticipated to affect the surface water hydrologic regime of Liese Creek or the Goodpaster River.

- Surface Dry Stack and RTP The surface water hydrologic regime of Liese Creek would experience substantial changes from the tailings and mineralized development rock placed in the upper reaches of the watershed and construction and operation of the RTP. These changes would occur because of:

- Diversion/retention of runoff waters
- Stormwater release from the RTP
- Seepage flows from the RTP
- Seepage flows from the dry-stack tailings
- Runoff and seepage following closure

The total annual watershed yield would be reduced by perimeter and toe ditches that would capture runoff in and near the dry stack and the RTP. In addition, runoff losses would be caused by seepage through the diversion ditch system surrounding the dry stack and RTP. Runoff water captured within the dry stack and RTP facilities would be recycled through the mill and reduce the quantity of makeup water required.

These changes in surface hydrology would be substantial modifications within the context of the Liese Creek Valley, but would be very small within the context of the overall hydrology of the Goodpaster River.

The RTP is designed to contain more than the maximum water storage volume during normal operating conditions, plus the runoff volume from the 100-year, 24-hour precipitation event. Based on deterministic computations, the estimated pond volume required is 30 million gallons. Use of a probabilistic method resulted in a more conservative 40-million-gallon design capacity, which is what the proposed designed is based on. Large-magnitude storms, however, may result in a release of RTP water through the emergency spillway into Liese Creek. The Applicant has predicted through modeling that the probability of this occurring is 22 times in 1,000 years (approximately 1 in 45 years). Given an 11-year projected project life, there is approximately a one in four chance that a storm discharge would occur from the RTP to Liese Creek during the life of the mine. The hydrologic effects on Liese Creek from this degree of storm discharge are likely to be masked by the effects of storm runoff from the watershed in general. The expected effect of such an event would be a reduction in the peak flow of Liese Creek due to routing water through the ditch and pond system, and a reduction in the total discharge because of water retention within the RTP surge capacity (Teck-Pogo Inc., 2002b).

### Mill and Camp

There would be changes to runoff volumes and rates due to capture and treatment of runoff from the mill and camp areas within the Liese Creek watershed. Runoff upgradient from the mill and camp would be captured in a diversion ditch and routed as noncontact water to Liese Creek. Runoff water from the mill and camp area would be captured and stored in the RTP for reuse. The effect of the capture on runoff from the mill and camp area is expected to result in a minor reduction in the flow of Liese Creek. These changes in hydrology to Liese Creek would cause minimal impacts to the overall hydrology of the Goodpaster River.

### Gravel Source

The gravel pits adjacent to the airstrip would be constructed approximately 200 ft southeast of the normal active channel of the Goodpaster River. Under extreme flood conditions, the gravel pits could become inundated. The magnitude of such a flood event, however, would be severe enough to result in natural widespread flood effects to the valley beyond simple inundation of the gravel pits. Therefore, the gravel pits would not alter the surface water hydrology of the Goodpaster River.

### Construction Camp

Potential impacts to surface water hydrology from this camp would be restricted to surface runoff from storm events and snowmelt. There is an existing stormwater management system at the camp that would serve to capture stormwater from the site during the construction phase. This area would generate additional runoff in comparison to natural conditions; however, routing through the stormwater pond and the relatively small area involved would result in no measurable effect on the surface water hydrologic regime of the Goodpaster River.

### Laydown Areas

The laydown areas are not anticipated to affect the surface water hydrologic regime of the Goodpaster River. Vegetation removal and soil compaction may cause an incremental increase in runoff volume and rate; however, this increase would not likely be measurable within the Goodpaster River.

## Water Supply

***Industrial*** The make-up water supply wells are located within the alluvium of the Goodpaster River and are therefore in communication with the Goodpaster surface flows. The use of these wells would be limited to periods when all other water sources could not provide sufficient water. This well use is expected to be intermittent and infrequent. Under drought conditions, make-up water from water supply wells may be necessary. When wells are needed, demand is expected to be up to 100 to 200 gpm (Hanneman, 2002d). Under such conditions, it is assumed the Goodpaster River would also be experiencing drought flows. Intermittent withdrawal of water from the water supply wells could impinge on in-stream flows to a minor degree, but is not expected to have a substantial effect on the stream flows of the Goodpaster River. Should extremely low Goodpaster River flow conditions develop, the mine could use bedrock water sources (e.g., wells above the dry-stack pile in upper Liese Creek) if sufficient reserves were available, thus mitigating potential effects on the low-flow conditions of the Goodpaster River.

***Domestic*** An average of 100 gpd for each of the 250 camp residents would be required for a total of 25,000 gpd. The average pumping rate to produce this quantity of water is 17 gpm (Teck-Pogo Inc., 2002b, 2002f). Although instantaneous pumping rates may be higher, the pumping would be intermittent, allowing time for drawdown to recover. Tests conducted on injection wells in this same material suggest a very high hydraulic conductivity capable of accepting or supplying water far in excess of an average 17-gpm rate. Domestic water wells are not expected to affect Goodpaster River surface water hydrology.

## Water Discharge

- **Domestic** There would be a single domestic wastewater treatment system for disposal of domestic wastewater. It would be located at the construction camp below the 1525 Portal in the Goodpaster River Valley and would treat camp domestic wastewater for discharge to the Goodpaster River at a location 0.2 mile downstream from the exploration camp as shown in Figure 2.3-1a. Operation of the system is not expected to result in a measurable change in flow rate to surface waters.

## Air Access

Construction and use of an airstrip in the Goodpaster Valley is anticipated to have no measurable surface water hydrologic consequences for the Goodpaster River. The potential influence of this facility on surface water hydrology may be a minor increase in the runoff volume and rate because of vegetation removal and soil compaction and is unrelated to the intensity of facility use. Implementation of stormwater BMPs for the airstrip would attenuate any such effects. The incremental increase in runoff volume and rate, if any, would not likely be measurable within the Goodpaster River.

## Vessel Navigation

The proposed Goodpaster River Bridge would not affect present or reasonably foreseeable vessel use of the Goodpaster River. From the recreational fleet perspective, there would be no effects either because of navigational impediments or public overland access. The bridge clearance would be 11.2 feet at normal high water, with 65 feet between piers, to allow safe passage of recreational airboats that might occasionally navigate the river. The mine access road leading to the bridge would be closed to public use during the life of the proposed project, and ADNR's ROW authorization would require the Applicant to remove and reclaim that segment of the road following mine closure.

There would be sufficient distance between the bridge and the upstream and downstream bends to allow proper vessel alignment for safe passage of vessels through the proposed bridge. The vessels that infrequently navigate the Goodpaster River are small and highly maneuverable, allowing them to safely and efficiently pass the proposed bridge. There are no other factors located within one-half mile of the proposed bridge that would create hazardous passage through the proposed structure.

It is unlikely that government agencies would respond by watercraft to an emergency in the vicinity of the proposed bridge, because the proposed location is 68 river miles from the mouth of the river and, due to the shallow nature of the river, it is not always navigable to typical riverboats. Emergencies on the Goodpaster River at or above the proposed bridge location would be responded to by a helicopter flight from one of the local helicopter service companies (Nay, 2003).

There are no alternate routes for vessels to bypass the proposed bridge location, but the proposed bridge would not prohibit entry of any vessels to a harbor of refuge.

Local hydraulic and atmospheric conditions would not increase the hazard of passage through the proposed bridge. Vessels that might occasionally encounter fog, an infrequent occurrence in this subalpine environment, would have to slow down to navigate through the bridge structure, but would be able to pass safely.

## 4.1.3 Options Not Related to Surface Access

**Alternative 2**

### Tailing Facility Liner

The unlined dry-stack and RTP facilities are not anticipated to affect the surface water hydrologic regime of Liese Creek or the Goodpaster River. Seepage from the dry stack that might otherwise be expressed as surface water flow would be captured within the RTP. In turn, seepage from the RTP would be captured within a seepage control system at the toe of the dam and recycled to the pond.

### Water Discharge

- Soil Absorption System
  - Adjacent to airstrip Discharge of excess treated water through an SAS in the Goodpaster River Valley was not anticipated to cause any measurable impact to the hydrologic flow regime for surface water of the Goodpaster. Continuous injection into this facility could result in a minor, but probably not measurable, increase in the flow of the Goodpaster River.
  - Saddle above Pogo Ridge The SAS could be optionally placed in the saddle above and southeast of Pogo Ridge at the top of either the Liese Creek or Easy Creek valley. If the SAS were located in Liese Creek Valley, there would be the potential that subsurface flows containing water discharged from the SAS could ultimately be collected by the RTP, which would result in a water balance problem. Thus, this discussion assumes that the SAS would be in Easy Creek Valley. The design of the system would be essentially the same as was described in Section 2.3.10, except that an approximately 2-mile pipeline would be required to transport water from the high-density sludge (HDS) coprecipitation treatment plant. If the

discharge from the SAS surfaced in the Easy Creek Valley, it would add to the flows in Easy Creek. The extent to which the discharge would surface is uncertain.

- Underground Injection Wells Discharge of treated water through underground well injection into the Goodpaster River alluvium was not anticipated to cause any measurable change to the surface water hydrologic regime.

  Tests conducted on the existing injection well show that a water level rise of up to 2 ft could occur within the alluvium. Tests conducted on the existing injection well, and groundwater flow modeling, show that a water level rise of up to 2.9 ft could occur within the alluvium at the maximum injection rate of 400 gpm (Davies, 2002b). Under most circumstances, and at distances of 100 ft or more from the injection wells, water level rises of 2 ft or less should be expected.

  The alluvium contains relic scour holes and residual channels that are now sloughs filled with alluvial ground water. An increase in the water level of the alluvium could raise the level of the sloughs. Should this occur, flow between sloughs may be established, but probably at a very low rate and very local to the injection well. The alluvium is in direct hydraulic communication with the surface water of the Goodpaster River. Continuous injection may result in a minor, but probably not measurable, increase in the flow of the Goodpaster River either through the alluvial contribution or the sloughs.

**Alternative 3**

### Tailing Facility Liner

Lined dry-stack and RTP facilities are not anticipated to affect the surface water hydrologic regime of the Goodpaster River or Liese Creek. Seepage from the dry stack that might otherwise be expressed as surface water flow would be captured by a liner system and routed to the RTP. Seepage from the RTP would be contained by a liner within the RTP. With or without a liner, seepage from the RTP would be captured within a seepage control system at the toe of the dam and recycled to the pond, thereby preventing surface or subsurface discharge.

### Water Discharge

- Direct Discharge to Goodpaster Treatment and direct discharge to the Goodpaster River would increase the base flow of the river by the discharge amount. The normal operational discharge during the operational phase is expected to be between 200 gpm (0.44 cfs) and 400 gpm (0.9 cfs), with a projected peak of 750 gpm (1.7 cfs). The Goodpaster River exceeds an average discharge of 100 cfs between April and October, with peak seasonal discharge exceeding 7,500 cfs. The minimum seasonal flow is approximately 40 cfs, and the 100-year low flow is approximately 10 cfs (Teck-Pogo Inc., 2002d). As a percentage, the maximum direct discharge (1.7 cfs) would comprise 1.7 percent of the average Goodpaster flow of 100 cfs, 0.02 percent of the peak seasonal discharge of 7,500 cfs, 4.25 percent of the minimal seasonal flow of 40 cfs, and 17.0 percent of the 100-year low flow of 10 cfs. Under all of these discharge conditions, except the 100-year low flow, the contribution to flow in the Goodpaster would not be substantial and it is unlikely that the maximum discharge would occur during Goodpaster River low flows, because high discharge rates are expected to only occur when surface runoff is at a maximum. Because of proposed management practices, however, water would not be discharged when a ratio of total river flow to discharge flow of 45 to 1 could not be met. Hence, as discussed above, actual increases would be expected to be limited to an approximately 2 percent increase in river flow, which would not be measurable.

The discharge during the development phase is expected to be a maximum of approximately 400 gpm (0.9 cfs). This value would be below discharges for the operations phase discussed above, and would represent correspondingly lower percentages of Goodpaster River flow.

## Alternative 4

### Water Discharge

- Off-River Treatment Works The off-river treatment works would divert water from the Goodpaster River through an intake channel to off-river ponds. After mixing with treated wastewater, the blended water stream would be discharged to a channel and re-enter the Goodpaster approximately 1,800 ft downstream of the intake channel (Figure 2.4-2). Impacts of this alternative downstream of the re-entry channel would be the same as for the direct discharge option in Alternative 3. Within the approximately 1,800-ft stretch of the Goodpaster River between the intake of the treatment works and re-entry channels, there would be a localized decrease of in-stream flow

Using an expected operations phase nominal treated wastewater discharge of 200 gpm (0.44 cfs) and a design mixing ratio of 25 to 1, the treatment works would require diversion of approximately 11.2 cfs (5,026 gpm) of river water. At the maximum expected treated wastewater discharge of 600 gpm (1.3 cfs), approximately 32.5 cfs (14,586 gpm) of river water would be required. During normal year nonwinter months, it is expected there would be ample river water available for mixing for even the maximum treated wastewater discharge rate.

The typical annual winter low flow for the Goodpaster River is approximately 40 cfs. No water would be taken from the Goodpaster for mixing in the treatment works unless a minimum of 20 cfs remained in the stretch of the river between the intake of the treatment works and re-entry channels. Thus, during typical winter low-flow conditions, approximately 20 cfs (8,980 gpm) of river water, approximately 50 percent of river flow, would be available for use in the treatment works. A 20 cfs flow would be adequate at a 25-to-1 ratio for mixing with a treated wastewater discharge of approximately 360 gpm, well above the nominal discharge rate of 200 gpm. Additional supplementation of river water would be possible with as much as approximately 2.2 cfs (1,000 gpm) of water from wells just north of the treatment works.

As with Alternative 3, it is unlikely that the maximum discharge would occur during Goodpaster River winter lows flows because high discharge rates are expected to occur when surface runoff is at a maximum, during breakup and after summer storms. Under normal conditions, during this winter low-flow period, the RPT volume would be at its lowest levels.

Because this option would not use river water for mixing when low flows in the Goodpaster River reached 20 cfs, modeling showed the RTP would overtop and discharge without treatment approximately 45 times in 1,000 years during major storm or runoff events. This frequency, although still low, is approximately twice that for the SAS discharge system in Alternative 2.

This option would not use river water for mixing when flows in the Goodpaster River were less than 20 cfs. This would affect the ability to discharge water and has an impact on the overall system water balance. If water discharges are limited during low flow conditions in the river, there is the potential that a higher volume of water would be carried through the winter in the RTP. This would result in less freeboard in the RTP for breakup flows. This effect is reflected in the Monte Carlo modeling which showed that the RTP would overtop more frequently for this option than for Alternative 2. Modeling showed the RTP would overtop and discharge without treatment approximately 45 times in 1,000 years during major storm or runoff events. This frequency, although still low, is approximately twice that for the SAS discharge system in Alternative 2. Note that the modeling conducted to determine this frequency of overtopping did not include use of supplemental groundwater from wells for dilution water in the mixing; therefore, this frequency is conservative.

## 4.1.4 Options Related to Surface Access

**Alternative 2**

### Surface Access

***Route***

- Shaw Creek Hillside all-season road    The surface water hydrologic effects of a Shaw Creek Hillside all-season road would be associated with the numerous crossings of streams that are tributary to Shaw Creek, and the bridges over Rosa, Keystone, Caribou, Gilles, and Shaw creeks, and the Goodpaster River.

  During and immediately following road construction (approximately 15 months), there would be substantial earthwork disturbance. This disturbance would result in increased runoff volumes and rates because of vegetation removal and soil compaction. Mitigation would occur through the use of stormwater runoff BMPs through and following the construction period until vegetation were re-established. Once vegetation were re-established, runoff would be mitigated for the remaining life of the road.

  Following construction, the road surface itself would yield additional runoff compared to native terrain; however, the limited disturbance of the linear road feature generally running perpendicular to drainages would minimally increase the quantity of runoff to any single receiving water course. Most of the road is at least 1 mile from Shaw Creek, and no surface water hydrologic impacts would occur directly to the creek.

  Bridge construction and use of adequately sized culverts to pass drainage and streams under the roadway would prevent alteration of the surface water flow regime.

  - Richardson Highway egress    Egress at the existing Shaw Creek Road would not cause additional surface water hydrologic effects. The Tenderfoot egress sub-option would result in additional temporary construction disturbance and life-of-roadway runoff as described above for the main roadway. Use of the existing Shaw Creek Road would minimize additional disturbed area runoff to surface water.

***Use***    Use of the all-season road during mine operations would not have any traffic-load-dependent effects on the flow rates and quantities of surface water.

***Disposition***    Removal and reclamation would eliminate all potential surface water effects. Leaving the road for various levels of use would continue the same degree of surface water hydrologic effects, regardless of the type of use. It is not likely that the surface water hydrologic effects would be measurable under any of the use scenarios.

### Power Line Route

- Shaw Creek Hillside The nature of power line construction and operation would have even fewer effects than the road.

## Alternative 3

### Surface Access

***Route***

- South Ridge all-season road This alternative would have six fewer bridges and fewer other stream crossings than the Shaw Creek Hillside all-season road. Because the roadway would be constructed along the divide between the Shaw Creek and Goodpaster River drainages, the potential for impacts to surface water hydrology, regardless of how minor, might impinge on two watersheds rather than one. A mitigating condition would be that the separation distance to substantial discrete streams from the road appears to be a half mile or more.

***Use*** Same as Alternative 2.

***Disposition*** Same as Alternative 2.

**Power Line Route** Same as Alternative 2.

## Alternative 4

### Surface Access

***Route***

- Shaw Creek Flats winter-only access Impacts would be the same as for Alternative 2, except for the Shaw Creek Flats winter-only access segment. This segment would not cause a major change to the hydrologic regime of surface water because it would only be used during winter.

  A potential temporary seasonal impact would be the tendency for ice roads to thaw later than surrounding areas, thus raising potential for blockage or rerouting of runoff flows during breakup. This temporary seasonal impact would be localized and minor in extent. Mitigation measures for these areas would be similar to Alternative 2 and resulting minor localized changes to the hydrologic flow regime of surface water would be inconsequential.

## 4.1.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would result in very low cumulative impacts on hydrologic flow regimes of surface water.

- All-season Road Maintained Development of timber resources, mining, and public recreational and other use all would have potential impacts on the hydrologic regime of surface water that could be cumulative with the activities of the Pogo Mine project. Extension of the life of the Pogo project, development of hypothetical Sonora Creek and Slate Creek mines, or other resource developments occurring because of continued existence of an all-season road individually would cause surface hydrologic impacts of a similar nature and magnitude to those from the proposed Pogo Mine project. Given the likely physical separation of the developments in different watersheds, the State of Alaska's management and regulatory tools, and the individual small impacts to the surface water hydrologic system, these mines and other resource developments would have low cumulative impacts on hydrologic flow regimes of surface water.

# 4.2 Ground Water

This section presents a discussion of the groundwater hydrology. Groundwater quality is discussed in Section 4.3.

## 4.2.1 No Action Alternative

Under the No Action Alternative, the exploration adit would be plugged and drill holes would be grouted. The groundwater level would rise to pre-exploration elevations. After groundwater levels were restored, the residual impacts on the groundwater system would be low.

## 4.2.2 Options Common to All Alternatives

### Underground Mine

Development of the underground ore bodies would initially result in local dewatering of the country rock in the vicinity of the mine. Water would be produced from the mine during development and operations. The L1 ore body is located approximately 500 ft below the water table, which would decline in elevation in a cone-shaped depression around the mine during operations. The flow of ground water in the area would be directed toward the underground openings of the mine, rather than the current flow toward the Goodpaster Valley floor. Also, the mine would directly underlie Liese Creek, which presents the possibility of drainage of Liese creek waters into the mine through the Liese Creek Fault zone. Model simulations (Brown, 2002) indicate that annual average mine inflow rates would vary from approximately 70 gpm to approximately 200 gpm during the life of the mine, with peak monthly average flows expected to be as high as 340 gpm. Life-of-mine average inflows are expected to be approximately 140 gpm.

Modeling results contain some uncertainty regarding the timing and quantification of inflows from Liese Creek, which could result in flows increasing beyond expected rates. Contingency plans have been developed to address any unexpected high flows. The contingency plans include conducting detailed advance hydraulic testing to determine water inflow potential before actual mining. If excessive inflows are discovered, grouting of fractures, avoiding high-flow areas, sealing the bottom of Liese Creek, or rerouting the creek in a sealed channel would be performed to limit inflows. The impacts of underground mine development on the groundwater flows systems in the area would be moderate as a result of the redirection of groundwater flow systems, but would be limited to the near vicinity of the mine. The impacts on groundwater systems in the Goodpaster Valley would be negligible as a result of the much larger ground water and surface water flows in the Goodpaster Valley than in the bedrock flow system.

### Tailings Disposal

- Underground The mine operational plan calls for backfilling the mine void space with tailings as mining progresses. These tailings are expected to have low values for hydraulic conductivity of approximately 2.9 ft per year, and post-closure groundwater flow through all mined areas is expected to be approximately 29 gpm. The hydraulic conductivity of the backfill material would be similar in magnitude to the hydraulic conductivity of the country rock and former orebody and is not expected to have a major distorting influence on the groundwater flow field.

A small amount of water contained in the pore spaces of the tailings would eventually drain out of the tailings as they resaturate and the groundwater flow system re-establishes itself.

Following closure, the pre-mining groundwater flow system is expected to re-establish itself. The mined areas would resaturate and ground water would resume its flow systems, receiving recharge from the land surface and discharging to the Goodpaster Valley. Drawdown resulting from mining is expected to recover relatively rapidly after mine closure, with flooding of the mine workings by the Applicant in approximately 2 years (Day, 2002a) and water levels returning to approximately the pre-mining condition approximately 50 years after mine closure (Brown, 2002).

The three adits proposed for access to the mine would all have surface access points below the pre-mining hydrostatic head of the orebody, meaning that ground water would have the potential to leak out of or around the mine adits after the groundwater flow field re-establishes itself. The mine adits would be hydraulically plugged with sufficient grouting in fractures and boreholes performed to reduce seepage through or around the adits to negligible rates.

Following closure and resaturation of the mine, ground water would flow through the backfilled underground tailings and the rock mass downgradient of the mine, ultimately discharging in the Goodpaster Valley. Chemical fate and transport modeling has been conducted to determine the likely water quality impacts on downgradient ground and surface water (Brown, 2001). See Section 4.3.2 for an evaluation of water quality impacts.

- Surface Dry Stack and RTP

  - Seepage from dry stack The surface dry stack is expected to release relatively small amounts of water as the interstitial water emplaced with the tailings drains. Model calculations suggest total outflow of interstitial water from the stack would be approximately 6 gpm shortly after completion of the dry stack and would decrease to approximately 1 gpm 50 years later, primarily due to the very fine-grain compacted tailings with low hydraulic conductivity (Davies, 2000). The low hydraulic conductivity of the tailings and higher summer evapotranspiration rates are expected to result in very little infiltration (and out-seepage) of precipitation or snowmelt (Nethery, 2000; Davies, 2002a).

    Water released from the dry stack is expected to flow through the colluvial deposits and weathered bedrock to the RTP. Following closure and decommissioning of the RTP, most of the water would mix with normal precipitation and shallow groundwater recharge and flow down the Liese Creek Valley. Any water that infiltrates into the bedrock flow system is expected to be a part of the groundwater flow system contributing water to the mined areas, and to represent only minor impacts to groundwater resources in the area between the dry stack and the mine.

The removal of topsoil and placement of 1.5 feet of nonmineralized development rock on the dry-stack facility footprint as an erosion control/drainage blanket prior to constructing the dry stack is not expected to impact the quantity of the seepage from the dry stack that would enter the ground water.

- Seepage from RTP The RTP would be constructed in Liese Creek Valley upstream of the mill, camp, and mine entrances. The dam would be constructed to minimize seepage under and around the dam by placement of liners at the toe of the dam and use of grout injections into fractured bedrock, if deemed necessary during construction. Most of the pond would not have an impermeable liner. This absence of a liner would create the potential for seepages out of the bottom of the RTP. These seepages are expected to be relatively small because of the low permeability of the rocks underlying the RTP. For the seepages that do occur (estimated to be approximately 5 gpm), return wells, which would be constructed downstream of the RTP, are expected to intercept and return approximately 80 percent of infiltrated water to the RTP (Davies, 2001). These wells are expected to be inclined as needed to intercept subvertical fractures in the bedrock system with the potential to convey water.

  Any discharges that escape the return wells are expected to enter the groundwater flow system discharging into the mine, or possibly to resurface farther downstream the Liese Creek valley. The bedrock groundwater flow system in this area has a general downward and downvalley flow direction toward the dewatered mine during operations. This water would then be captured by the mine water treatment system prior to discharge. The estimated flow rate of any seepage losses is expected to be less than 1 gpm. Following closure, the RTP would be decommissioned, and residual ground water that had been recharged through the RTP would enter the mine as it resaturates and would be commingled with the mine ground water.

## Gravel Source

Gravel extraction near the 3000-ft airstrip would require excavation below the water table. The pits would have a surface water inlet and an outlet only in conjunction with the off-river treatment works option. For all other water discharge options, there would be no connection with surface water They would also likely receive groundwater inflows from the up-valley side and lose water to the groundwater system on the down-valley side. Overall, the impacts on the groundwater system of the Goodpaster alluvial aquifer are expected to be low.

## Water Supply

***Industrial*** Industrial water supply would be provided from two wells tapping the Goodpaster alluvial aquifer. Projected demand is expected to be between 100 gpm and 200 gpm (Hanneman, 2002d). Water production at that rate is expected to have a minor impact on the Goodpaster aquifer or river.

***Domestic*** Domestic water supply would be obtained from the same wells used for industrial supply. The average demand is expected to be 17 gpm (Teck-Pogo Inc., 2002i), which is expected to have a negligible impact on the Goodpaster aquifer or river.

## 4.2.3 Options Not Related to Surface Access

**Alternative 2**

### Tailings Facility Liner

- ✦ Unlined Dry Stack and RTP  Same as discussed in Section 4.2.2.

### Water Discharge

***Development Phase*** **Industrial**

- Underground injection wells  The Pogo Mine project is expected to generate treated water that would require discharge during the development, operational, and closure phases of the project. This water would come from mine inflows of ground water and surface runoff from mine facilities. During development, water would be injected into three injection wells located in the Goodpaster Valley. Water has been successfully injected at average rates up to approximately 100 gpm since 2000, and testing and modeling have indicated that rates as high as 400 gpm, which is the expected maximum injection rate, are achievable (Davies, 2002b; AMEC, 2001a).

  Injection of water at high rates would result in increases in the elevation of the water surface and slight expansion of inundated areas of ponds and sloughs in the Goodpaster Valley as the groundwater table rose. During some times of the year, naturally high groundwater levels could coincide with groundwater levels that had been elevated 1 to 2 ft as a result of injection, resulting in surface discharge of injected water through low-elevation swales in the floodplain. The expected impacts of the water injection on the groundwater flow system are low.

***Operations Phase*** **Industrial**

The water management plan provides flexibility to direct water into either the SAS or the injection wells, depending on operational needs, quality of water produced, and permitting requirements. The proposed maximum rate for injection, 400 gpm, could occur intermittently throughout the project.

- Soil absorption system
  - ✦ Adjacent to airstrip  Discharge of ground water to the SAS would result in a local increase in groundwater elevations in the vicinity of the SAS of approximately 1 ft (Lyons and Davies, 2001). It is expected that this increase in groundwater elevation would occur over a limited area and the overall effect of the discharged water on the groundwater flow system would be low.
  - ✦ Saddle above Pogo Ridge  The discharge from the SAS would enter the ground water below the SAS and flow in the colluvium and fractured bedrock. A portion of this flow could enter the deeper groundwater system. A portion of this flow could also resurface and enter the surface water system.
- Underground injection wells  The impacts on groundwater elevations of discharging water into an underground injection well during operation would be the same as was described for the development phase.

**Alternative 3**

### Tailings Facility Liner

- Lined dry stack A liner system placed under the dry-stack facility would theoretically collect all seepage from the stack for treatment (if needed) and discharge. In practice, large-area man-made liners tend to leak as a result of seam imperfections and construction-related defects. These leakage rates are often characterized as being approximately equal in magnitude to low-permeability compacted earthen liners. Because the permeability of the tailings (approximately $10^{-7}$ meters per second) (Davies, 2001) is already in the same class as that for most typical earthen liner systems, the added benefits of installing a man-made or compacted earthen liner are concluded to be minimal.

- Lined RTP A lined RTP likely would reduce seepage loss from the facility. As a safety precaution, the system of return-flow wells downstream of the RTP should still be installed. The benefits provided by installing a liner under the RTP are considered minimal because predicted seepage rates are already expected to be low, the upstream face of the RPT dam would be lined, a hydraulic capture system downstream of the RTP would contain most of the seepage losses, and the remainder of the seepage losses would enter the mine and become incorporated into the mine water treatment system with minimal impact

**Alternative 4**

### Tailings Facility Liner

- Lined dry stack and RTP Same as Alternative 3.

## 4.2.4 Options Related to Surface Access

No impacts to groundwater flows are expected.

## 4.2.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would result in no or low cumulative impacts on ground water.

- All-season Road Maintained Cumulative impacts to groundwater resources could result from development associated with timber harvesting in the Shaw Creek Valley and development of the hypothetical Sonora Creek or Slate Creek mines. Assuming that sound management practices and permitting stipulations were adhered to, timber harvesting, mining, and other resource development activities distributed over such a large area would be expected to have low cumulative impacts on ground water.

# 4.3 Water Quality

This section addresses both surface water and groundwater quality. Where applicable, comparisons are made to State of Alaska Water Quality Standards (18 AAC 70) and Drinking Water Standards (18 AAC 80). The most stringent applicable criteria are presented. Discharges from the project are also subject to regulation under NPDES requirements, which are administered by EPA in Alaska. In addition, an underground injection control (UIC) permit would be required for some discharge options.

All discharged waters would be expected to comply with toxicity criteria and numerical water quality standards as defined by the federal NPDES permit, UIC permit, and state discharge permit(s) or certifications of federal permit(s). Therefore, the discharges from each option are evaluated for either meeting or failing to meet those regulatory requirements with the use of the following evaluation criteria:

- No or low impact — No or very low likelihood that a discharge would exceed permit standards.
- Moderate impact — Occasional non-compliance is possible.
- High impact — High risk of not obtaining a discharge permit and, if obtained, compliance reliability is low.

For those releases from the project that are not covered by a discharge permit with specific numeric limits, a more general set of evaluation criteria has been used. These criteria would apply to situations such as accidental or unplanned releases (e.g., fuel or chemical spills) and stormwater runoff. The following metrics have been applied:

- No or low impact — No planned release or low likelihood of occurrence; if an accidental release or spill occurred, the potential for impacts to environment or public interests would be negligible. Low likelihood of stormwater runoff that would be inconsistent with the goals of the stormwater NPDES permit.
- Moderate impact — There is a risk of accidental release, or a release has a low likelihood of occurrence but the impacts could be high. Moderate likelihood of stormwater runoff that would be inconsistent with the goals of the stormwater NPDES permit.
- High impact — A high potential for accidental release exists, and the severity of the release would be high. High likelihood of stormwater runoff that would be inconsistent with the goals of the stormwater NPDES permit.

## 4.3.1 No Action Alternative

Without development of the Pogo project, the only proposed activity that could affect water quality would be the construction of an all-season road by the DOF along a route similar to the Applicant’s proposed Shaw Creek Hillside all-season road for timber sales and subsequent logging in this area. With proper management and mitigation measures, the overall impacts on water quality are expected to be low. During road construction in the Shaw Creek watershed, disturbed surfaces could erode and increase sediment in runoff. Surface disturbance could cause increased suspended sediment in Shaw Creek and its tributaries. The increased sediment and turbidity levels would be temporary and could be mitigated by the proper use of construction BMPs, such as silt fences, during construction. Revegetation of disturbed areas after construction would help diminish sediment release to the creeks in the long term.

During road construction and logging operations, there is also the potential for fuel spills. A fuel spill into Shaw Creek or a tributary could seriously affect water quality. The chances for a fuel spill could be greatly reduced by proper fuel management. By transferring fuel and refueling equipment only in designated areas with spill containment facilities, the likelihood for a fuel spill to affect water quality would be small.

During logging, there is also the potential for impacts to water quality from increased erosion in logging areas and release of sediment to Shaw Creek and its tributaries. With proper erosion control, setbacks from creeks, and DOF BMPs, however, this impact would be small to moderate.

Overall, the impacts on project area water quality from the No Action Alternative would be small.

## 4.3.2 Options Common to All Alternatives

Water quality during mine operations was estimated for each of the major sources of water to the RTP, including actual site data where available (e.g., monitoring well data and seepage from development rock piles from exploration adit), bench-scale leaching tests (humidity cell and column tests), and geochemical modeling. For each water source and each parameter, a reasonable worst-case concentration was estimated. Where appropriate, a mean and standard deviation also were estimated based on the available data for the projected water quality.

To estimate the flow and quality of the water that would be discharged under the various discharge options for excess water from the project, a mass balance model was developed (Teck-Pogo Inc., 2002b, 2002f, 2002i; Hanneman, 2003a). The water quality and flow estimates for each source of affected water were input into this model. The water balance and water quality parameters were estimated by using the probability distributions for each flow and chemical parameter in the framework of a Monte Carlo model. The flows were combined based on the project flow sheet (Figure 2.3-7).

**Monte Carlo model** In general, a Monte Carlo model uses statistical input data to estimate the probability of different output information. For example, given statistical data on rainfall, the Monte Carlo model could estimate a probability distribution for flow rate of a given process stream (that is related to rainfall). The model was run as a time series by using weekly time steps during a 1,000-year period to provide a statistical basis for estimating flow and water quality. Key inputs to the model include precipitation and snowmelt estimates. These inputs provide a basis for runoff volumes from project facilities. Weekly estimates of precipitation were developed from an annual average precipitation value of 19 in. as described in Teck-Pogo Inc. (2002b). The output from the model provides the probability of flows and concentrations of key process streams (e.g., discharge from the RTP). Examples of water quality output from the model include the following for each chemical constituent for key flow streams:

- 95th percentile of the annual averages
- 95th percentile of annual maximum values

The 95th percentile of the annual averages is a value that represents the ranking of the 1,000 annual averages at the 95th percentile level. It is more conservative than using an annual average concentration for comparing a projected chemical concentration to a discharge criterion. The 95th percentile of annual maximum values is a very conservative value that represents the ranking of the 1,000 annual maximum values at the 95th percentile level. Generally, both the 95th percentile of the annual averages and the 95th percentile of annual maximum values are presented when estimating discharge water quality to represent a range of conservative values.

## Underground Mine

The mining of the Pogo orebody would cause the ground water in the mine area to drain into the mine workings. This action would lower the groundwater level in the area of the mine, as discussed in Section 4.2.2. This water would be collected throughout mining operations and would be pumped to a treatment plant. This section discusses water quality of the mine seepage during development and operations and after closure of the mine.

**Water quality during development and operations** A reasonable worst-case estimate was made of the quality of water seeping into the mine (Teck-Pogo Inc., 2002b). The quality of mine water was estimated for most parameters based on the maximum concentrations observed in the drainage from the existing exploration adit.

Arsenic concentrations were estimated by using the maximum value observed in the ground water in the ore zone from historical monitoring well data. This arsenic value was substantially higher than what had been observed in exploration adit drainage. Nitrate and ammonia are constituents that are expected to be present in the mine seepage from the explosives that are used in the mining operation. The concentrations of these two constituents would depend on the types of explosives used and how they are handled. Hence, the concentrations of these two constituents could be managed to a much greater extent by mining operational practices. The water quality estimates of mine seepage for nitrate and ammonia were based on water quality data from other mines and the expected management approach to operations and selection of types of explosives (Teck-Pogo, Inc., 2002b, Appendix C).

The estimate for cyanide was based on data from runoff and seepage from the mineralized rock pile (station SW26) (Teck-Pogo Inc., 2002b). This station contained elevated nitrate concentrations, which may interfere with total cyanide analyses (Mudder and Botz, 2002). Additionally, no cyanide had been introduced during construction of the exploration adit and no cyanide was expected to be present. Hence, the cyanide concentrations in this estimate may be overstated. Mercury concentration estimates were based on concentrations measured in the discharge from the exploration adit during a 10-day period in March and April 2000. The reasonable worst-case estimate (0.25 µg/L) was based on the maximum value measured during this period (Teck-Pogo Inc., 2002b). Subsequent monthly measurements of the seepage from the exploration adit during a 2-year period were generally non-detect at a concentration of 0.01 µg/L (Hanneman, 2003b). Hence, the reasonable worst-case value for mercury may overstate the expected concentrations. The estimate of the mine seepage water quality is presented in Table 4.3-1.

**Water quality after mine closure** After mining operations were complete, the mine workings would be sealed by using hydraulic plugs in the portals, vent raises, and internal development workings (Teck-Pogo, Inc., 2002b). The objective would be to prevent mine drainage from being released from the openings and to re-establish groundwater conditions similar to the pre-mining conditions. A detailed plan for plugging the mine is presented in the reclamation plan (Teck-Pogo Inc., 2002c). This plan would have to be approved by ADNR and ADEC prior to closure.

**Table 4.3-1 Water Quality Estimates for Mine Seepage**

| Parameter | Reasonable Worst Case Untreated | Units |
|---|---|---|
| TSS | 1,500 | mg/L |
| TDS (fault water) | 300 | mg/L |
| TDS (mine water) | 649 | mg/L |
| Cl | 5 | mg/L |
| $SO_4$ (fault water) | 85 | mg/L |
| $SO_4$ (mine water) | 283 | mg/L |
| Ammonia | 10 | mg/L |
| TKN | 10 | mg/L |
| $NO_3$ | 10 | mg/L |
| $CN_T$ | 20 | µg/L |
| As | 5,360 | µg/L |
| Cd | 0.5 | µg/L |
| Cr | 13 | µg/L |
| Cu | 20 | µg/L |
| Fe | 4,270 | µg/L |
| Pb | 70 | µg/L |
| Hg | 0.25 | µg/L |
| Mn | 717 | µg/L |
| Ni | 30 | µg/L |
| Se | 2 | µg/L |
| Ag | 0.1 | µg/L |
| Zn | 21 | µg/L |

TSS – Total suspended solids TDS – Total dissolved solids
TKN – Total Kjeldahl nitrogen $CN_T$ – Total cyanide
Note: Concentrations are dissolved.

As discussed in Section 4.3.2 (Ground water), it would take some time to re-establish groundwater levels. Although the ore would be removed during mining, some degree of mineralization in the country rock would remain. Once the mineralized rock were sufficiently flooded, conditions would return closer to the pre-mining conditions. After flooding, the geochemical conditions are expected to become more oxygen reducing as residual sulfide minerals consume the available oxygen. The reduction of available oxygen is expected to inhibit further oxidation of the remnant iron-sulfide minerals. Within the backfilled tailings, the pH would be elevated from the presence of cement in the paste backfill. The combination of higher pH and reduced oxygen conditions likely would result in some solubility of arsenic, but would further decrease the oxidation of remnant iron-sulfide.

Backfilling of the mine workings with cemented tailings and plugging of other openings would limit the water flow through the backfilled mine. This would result in limited transport of the soluble constituents from the mined area through the less permeable surrounding rock. The condition would be analogous to the current baseline conditions, in which there is an area of elevated arsenic concentrations (currently up to 5 mg/L), but the transport of the arsenic is limited.

Assuming effective plugging of the mine, estimates of the transport of arsenic, TDS, and selected metals were made by using groundwater flow and contaminant transport modeling (Brown, 2001). The modeling evaluated the transport of the dissolved constituents from the backfilled mine through the bedrock to the valley alluvium to the Goodpaster River. These estimates were made under a variety of assumptions, including the degree to which arsenic, metals, and cyanide dissolve from the backfill, variations in bedrock and alluvium hydraulic conductivity, variations in infiltration, variations in porosity, and the degree of adsorption of constituents to the rock surfaces during transport.

The results demonstrated that the factors that had the greatest impact on estimated water quality were the degree to which the arsenic and metals dissolved from the backfill over time and the degree to which these constituents adsorbed to the rock surfaces as the groundwater flowed from the backfilled mine. A summary of the results of these estimates for selected conditions is presented in Table 4.3-2 for arsenic, TDS, and cyanide. This table presents the estimated maximum increase in concentration over the existing conditions estimated to occur over time for four cases. This table presents the estimated increase in concentrations at three locations:

- Slope alluvium: unconsolidated material on the valley slopes
- Valley alluvium: sands and gravels in the valley bottom
- Goodpaster River: concentrations based on a flow of 33 cfs in the river

**Table 4.3-2 Estimated Long-Term Increase over Baseline in Arsenic, TDS, and Cyanide Concentrations in Water after Mine Closure**

| | Increase in Arsenic Concentration (µg/L) | | | Increase in TDS Concentration (mg/L) | | | Increase in Cyanide Concentration (µg/L) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Slope Alluvium | Valley Alluvium | River | Slope Alluvium | Valley Alluvium | River | Slope Alluvium | Valley Alluvium | River |
| High adsorption on rock surfaces minimum amount of source dissolved | <1 | <1 | <1 | 291 | 16 | 1 | 23 | 1 | <1 |
| No adsorption on rock surfaces minimum amount of source dissolved | 250 | 14 | 1 | 291 | 16 | 1 | 23 | 1 | <1 |
| High adsorption on rock surfaces maximum amount of source dissolved | 496 | 27 | 2 | 576 | 32 | 2 | 42 | 2 | <1 |
| No adsorption on rock surfaces maximum amount of source dissolved | 497 | 27 | 2 | 577 | 32 | 2 | 43 | 2 | <1 |

Data from Brown (2001)

The concentrations in both tables represent the estimated maximum increases in concentration that would occur for each location and set of assumptions. The time interval to reach these maximum values varies substantially between the different parameters. For example, it was estimated that it would take more than 100 years for the TDS and cyanide concentrations to reach their maximum, while it would take tens of thousands of years for the arsenic concentrations to reach their peak given the potential for arsenic to attenuate on the rock surfaces.

These estimates indicate there is potential for increased concentrations of contaminants downgradient of the mine over the long term. The cyanide concentrations may be somewhat conservative because of the degradation of the cyanide that may occur over time that was not accounted for in the contaminant transport model. Increased concentrations would be most notable in the slope alluvium with lower increases in the valley alluvium. The small increases in concentrations estimated for the Goodpaster River likely would not be detectable. Increased concentrations in the slope and valley alluvium may be detectable and could result in ground water at some locations that are currently near an arsenic concentration of 50 μg/L eventually exceeding this value. However, it is estimated that it would be a long time before these concentrations would reach their maximum levels, possibly in the thousands of years. Hence, this impact is expected to be moderate and would be localized in the area of the mine and adjacent slope and valley alluvium.

- Underground Tailings Disposal

All tailings from the cyanide leach circuit and approximately one-half of the flotation tailings produced would be dewatered, mixed with cement, and placed underground in previously mined areas. The majority of the tailings placed underground would be as a paste backfill. A small portion of the tailings would be placed without cement.

The quantity of water projected to drain from the backfill is expected to be small. It is estimated that the average flow would be approximately 2 gpm (Teck-Pogo Inc., 2002b). This water would flow from the backfill into the mine workings and would then be pumped out of the mine with the mine seepage.

Backfill seepage water would have a quality similar to the process water that would be entrained in the backfill. The estimate of this water quality was based on the results of pilot-scale tests conducted to evaluate cyanide leaching and cyanide destruction. Analyses of the water entrained in the tailings after cyanide destruction form the basis for this water quality estimate. For several parameters (cyanide, copper, iron, lead, zinc, and nickel), the projected concentrations used as model input were greater than the concentration measured in the bench-scale tests to account for the differences between bench- and full-scale operations. The predicted concentrations were derived from the performance of operating facilities (Nethery, 2000; Nethery, 2001; Nethery and Higgs, 2001). The estimated water quality for the backfill drainage is presented in Table 4.3-3. Because this water would be collected and treated with the mine seepage water, there are no separate impacts from this water during operation. The potential impacts of the backfilled tailings on water quality after closure are discussed under the previous mine closure section.

**Table 4.3-3 Water Quality Estimates for Backfill Drainage**

| Parameter | Mean | Standard Deviation | Reasonable Worst Case Untreated | Units |
|---|---|---|---|---|
| TSS | | | 250 | mg/L |
| TDS | | | 13,700 | mg/L |
| Cl | | | 27 | mg/L |
| $SO_4$ | | | 6,800 | mg/L |
| TKN | 15 | 13 | 64 | mg/L |
| $NO_3$ | | | 2.39 | mg/L |
| $CN_T$ | | | 1,000 | µg/L |
| As | | | 5,600 | µg/L |
| Cd | | | 10 | µg/L |
| Cr | | | 20 | µg/L |
| Cu | | | 1,000 | µg/L |
| Fe | | | 3,000 | µg/L |
| Pb | | | 30 | µg/L |
| Hg | | | 3 | µg/L |
| Mn | | | 10,100 | µg/L |
| Ni | | | 370 | µg/L |
| Se | | | 430 | µg/L |
| Ag | | | 2.4 | µg/L |
| Zn | | | 430 | µg/L |

Note: Concentrations are dissolved Teck-Pogo Inc. (2002b, Appendix H)

- Surface Dry Stack and RTP in Liese Creek

  - ✦ Surface Dry Stack Water quality estimates for seepage and runoff from the tailings dry stack are presented in Table 4.3-4. These estimates are based on site data, testwork, and geochemical modeling. The bases for these estimates are presented in (Teck-Pogo Inc., 2002b, Appendix C). It is projected that the seepage water quality would remain relatively consistent over the life of the project and after closure. The seepage quantity would be relatively low and would decrease with time, however, as the moisture in the dry stack drained. This decrease in seepage would be due primarily to the very fine-grain compacted tailings with low hydraulic conductivity as previously discussed in Section 4.2.2.

**Table 4.3-4 Water Quality Estimates for Tailings Dry-stack Seepage and Runoff**

| Parameter | Tailings Runoff Reasonable Worst Case | Tailings Seepage Mean | Tailings Seepage Standard Deviation | Tailings Seepage Reasonable Worst Case | Units |
|---|---|---|---|---|---|
| TSS | 400 | | | 5 | mg/L |
| TDS | 523 | 600 | 610 | 3,000 | mg/L |
| Cl | 164 | 12.2 | 12.3 | 34 | mg/L |
| $SO_4$ | 302 | 57.4 | 125 | 2,000 | mg/L |
| TKN | 0.5 | 1 | 1 | 17.8 | mg/L |
| $NO_3$ | 19.8 | | | 4 | mg/L |
| $CN_T$ | 20 | | | 50 | µg/L |
| As | 400 | 1,600 | 2,000 | 5,100 | µg/L |
| Cd | 0.4 | 0.35 | 2 | 5 | µg/L |
| Cr | 1.1 | 2.51 | 3.4 | 14 | µg/L |
| Cu | 3 | 4 | 7 | 34 | µg/L |
| Fe | 0.3 | 2,000 | 22,000 | 29,600 | µg/L |
| Pb | 0.4 | 0.9 | 2.5 | 5 | µg/L |
| Hg | 0.2 | 0.189 | 0.376 | 2 | µg/L |
| Mn | 380 | 108 | 182 | 4,750 | µg/L |
| Ni | 20 | 25 | 120 | 240 | µg/L |
| Se | 6 | 13 | 50 | 130 | µg/L |
| Ag | 0.2 | 0.069 | 0.064 | 2 | µg/L |
| Zn | 60 | 50 | 335 | 700 | µg/L |

Note: Concentrations are dissolved

The runoff water quality also would be relatively consistent over the life of the project. Some erosion of the dry-stack tailings would occur in the runoff during operation. Mitigation measures would be employed to reduce erosion, but some would occur. This erosion would result in somewhat increased suspended solids in the section of Liese Creek below the dry stack and deposition of tailings in the RTP.

The removal of topsoil and placement of 1.5 feet of nonmineralized development rock on the dry-stack facility footprint as an erosion control/drainage blanket prior to constructing the dry stack is not expected to impact either the quantity or quality of the seepage from the dry stack.

**During operation**, the impacts on the water quality in the reach between the dry stack and the RTP are expected to be moderate. This reach of creek would act as a drain from the dry stack to the RTP. The majority of the flow in this reach would be from dry-stack runoff with a small contribution of dry-stack seepage. During operations, most of the seepage would flow to the RTP where it would either be recycled to the mill or discharged after treatment. A small percentage of dry-stack seepage might flow to the groundwater flow system that contributes to the mine inflows. These waters would also be collected as part of the mine inflow collection, use, and treatment system.

**After mine closure**, the need to continue operation of the RTP would be evaluated. The RTP and water treatment system would remain in place as long as needed to treat the dry-stack runoff and seepage. When mining operations were complete, the dry stack would be closed with a soil cover and would then be revegetated. Erosion of the dry stack would diminish greatly after closure of the dry stack. When reclamation activities were completed, minimal erosion would be expected. Runoff quality would be greatly improved after closure. The improved quality of runoff would improve the water quality in the reach of Liese Creek between the dry stack and the RTP. After closure, the impacts on this reach of Liese Creek would be low. After reclamation of the site and the attainment of applicable water quality standards from any remaining sources to the RTP, the RTP would be reclaimed.

- RTP Seepage from the RTP is expected to be small, approximately 5 gpm, and would be collected by a series of collection wells below the dam. Seepage that is not collected by the seepage collection wells is expected to enter the groundwater flow system entering the mine. Impacts on Liese Creek water quality below the dam during operation would be low. An estimate of the projected water quality of the water in the RTP is presented in Table 4.3-5.

**Table 4.3-5 Projected Water Quality of Water in the RTP**

| Parameter | Mean Annual Average Dissolved | 95% Annual Average Dissolved | 95% Annual Maximum Dissolved | Units |
|---|---|---|---|---|
| TSS | 32.4 | 89.4 | 262 | mg/L |
| TDS | 281 | 396 | 559 | mg/L |
| Cl | 85.1 | 228 | 573 | mg/L |
| $SO_4$ | 102 | 168 | 230 | mg/L |
| TKN | 2.31 | 4.86 | 8.94 | mg/L |
| $NO_3$ | 7.04 | 13.8 | 18.1 | mg/L |
| $CN_T$ | 12.5 | 17.2 | 30.3 | µg/L |
| As | 184 | 488 | 1,136 | µg/L |
| Cd | 0.17 | 0.27 | 0.35 | µg/L |
| Cr | 3.14 | 6 | 11.6 | µg/L |
| Cu | 5.13 | 7.67 | 9.85 | µg/L |
| Fe | 678 | 1,230 | 1,660 | µg/L |
| Pb | 0.52 | 0.9 | 1.15 | µg/L |
| Hg | 0.0731 | 0.104 | 0.17 | µg/L |
| Mn | 364 | 885 | 1,320 | µg/L |
| Ni | 5.88 | 14.4 | 29.7 | µg/L |
| Se | 2.52 | 5.04 | 9.79 | µg/L |
| Ag | 0.06 | 0.08 | 0.1 | µg/L |
| Zn | 30.4 | 54.1 | 78.9 | µg/L |

As discussed in Section 4.1.2, there is the potential for the RTP to overtop and discharge during operations. This type of discharge is considered a low potential upset condition wherein the storm event(s) exceed applicable facility design criteria, resulting in an emergency spillway overflow condition rather than a planned discharge. The RTP is designed to contain 40 million gallons. As discussed in Section 2.3.9, the RTP has been designed to contain the runoff from the 24-hour, 100-year storm event and snowmelt runoff from the project. The Applicant has not proposed a discharge of untreated water over the RTP dam, and substantial design efforts have been made to reduce the risk of such a release to a statistically small level. There would still be a possibility, however, the RTP could overtop in a very large storm event, as discussed in Section 4.1.2 (Surface Water Hydrology). The Monte Carlo model estimated the RTP would overtop and discharge without treatment only infrequently (22 times in 1,000 years for Alternative 2 and 45 times in 1,000 years for Alternative 4) during major storm or runoff events. During such a release, the discharged water would flow down the spillway of the RTP, combine with water diverted from the upper part of the Liese Creek drainage basin, flow down Liese Creek, through the wetlands that separate Liese Creek from the Goodpaster River, and discharge to the Goodpaster River.

An estimate of the water quality impacts of such an event on the Goodpaster River was made by estimating the water quality in the RTP during a discharge event by using the Monte Carlo model. The projected water quality for the discharge from the RTP, water quality in the Goodpaster River during a storm event, and resulting water quality of the Goodpaster with the addition of the water from the RTP is presented in Table 4.3-6. As this table shows, the water from a RTP direct discharge is estimated to have higher concentrations of all constituents than the Goodpaster River water during a storm event. The Goodpaster River data is actual data collected during an August 2000 storm event. The mixing of the RTP discharge with the Goodpaster stormwater would result in small increases for a number of Goodpaster River water quality parameters. These predicted changes are within the range of analytical measurement variability, and the impact on the Goodpaster River would be characterized as low. Because of the infrequent nature of this event and the small decrease in water quality in the Goodpaster River, this release would have a minor impact to the Goodpaster River water quality.

As discussed previously, after closure when the RTP would no longer be needed to capture seepage and runoff from the dry-stack tailings, it would be drained and breached. The water drained from the RTP would be passed through the water treatment plant prior to discharge. After breaching the RTP, seepage from the RTP would no longer occur. Tailings that were deposited in the RTP from erosion of the dry stack during operation would be consolidated and capped at closure of the RTP (Teck-Pogo Inc., 2002c). Consolidation and capping would minimize the potential for the RTP to release sediment after closure.

**Table 4.3-6 Projected Water Quality of Stormwater Discharge from RTP, Goodpaster River, and Goodpaster River with Addition of Water from RTP**

| | RTP | Goodpaster River | | |
|---|---|---|---|---|
| Parameter | 95% of Annual Maximum of Stormwater Discharge | Goodpaster (SW15) During Storm Event | 95% of Annual Maximum with Addition of RTP Stormwater Discharge | Units |
| TSS | 162 | 46 | 46 | mg/L |
| TDS | 407 | 59 | 62 | mg/L |
| Cl | 74 | 0.1 | 0.26 | mg/L |
| $SO_4$ | 179 | 9.5 | 9.56 | mg/L |
| TKN | 3.3 | 0.6 | 0.6 | mg/L |
| $NO_3$ | 13.6 | 0.2 | 0.28 | mg/L |
| $CN_T$ | 13 | 5 | 5.2 | µg/L |
| As | 120 | 1.3 | 1.8 | µg/L |
| Cd | 0.26 | 0.03 | 0.031 | µg/L |
| Cr | 5.3 | 2.5 | 2.5 | µg/L |
| Cu | 7.4 | 1.9 | 1.9 | µg/L |
| Fe | 4,220 | 1,460 | 1,460 | µg/L |
| Pb | 1.53 | 0.85 | 0.85 | µg/L |
| Hg | 0.085 | 0.01 | 0.01 | µg/L |
| Mn | 860 | 60 | 60 | µg/L |
| Ni | 7.8 | 2 | 2 | µg/L |
| Se | 2.5 | 0.5 | 0.52 | µg/L |
| Ag | 0.16 | 0.01 | 0.01 | µg/L |
| Zn | 68 | 4.1 | 4.1 | µg/L |

Note: Concentrations are dissolved

## Mill and Camp Location

The mill and camp facilities would be located in Liese Creek drainage. Diversion ditches would be constructed to divert clean runoff away from these facilities to minimize the quantity of contact runoff from these facilities. All stormwater from these facilities would be collected in a sump and pumped to the RTP. The pumps in this sump would be connected to emergency standby power. In the event of failure of the pumps or failure of both primary and backup power, the runoff from the mill and camp would be directed into the underground mine, where it would be stored until it could be pumped to the RTP. As described in Section 2.3.10, the RTP water would be treated prior to discharge.

Blind sumps and secondary containment would be used in the mill to minimize the potential for spills within the mill building to mix with stormwater, as described in Section 2.3.19. Use of sumps and containment would prevent reagent or mill process water spills from mixing with stormwater and would minimize the potential that contaminants from these materials would enter the RTP. With the planned stormwater controls, the impact of the mill and camp on Liese Creek water quality is expected to be low.

## Milling Process

As discussed in Section 2.3.9, the milling process would maximize the use of recycle water and minimize the use of fresh water. Process water is only released from the mill in the water that is entrained in the tailings that are placed underground or in the surface dry stack.

The cyanide circuit would be kept fully isolated from the other portions of the processing; therefore, the only release of cyanide-containing fluids would be in the cyanide leach tailings that would be placed underground as paste backfill. These tailings would be treated to destroy cyanide prior to being placed as backfill; however, there would still be residual cyanide in these tailings. The impact of this residual cyanide would be to contribute cyanide to the mine drainage from the backfilled tailings, as discussed in Section 2.3.6.

In the milling process, the management of spills, as described in the previous section, would minimize the potential for reagents or process water to mix with other waters on the project. Milling reagents would be stored adjacent to the mill in a covered building with concrete diked areas (Section 2.3.17). This would minimize the potential that reagent spill would affect process water quality or migrate out of the mill facility.

### Development Rock Disposal

As discussed in Section 2.3.8, two basic types of development rock (mineralized and nonmineralized) would be produced during mine development and operation. Development rock that is referred to as "nonmineralized" may be more technically described as "weakly mineralized"; however, the term nonmineralized is used in this discussion for consistency with previous documentation. Evaluation of the ability of development rock to release contaminants was tested using laboratory tests and monitoring of the development rock piles that were produced during construction of the exploration adit. The mineralized and nonmineralized development rock would be managed differently, and, hence, a primary goal of the studies conducted was to develop criteria to distinguish mineralized from nonmineralized development rock.

**Development rock testing** The potential for release of contaminants from development rock was evaluated using acid-base accounting (ABA) testing and kinetic laboratory testing. ABA testing provides information on the quantities of potential acid generating and acid neutralizing minerals in the development rock. The kinetic tests are small scale tests that subject samples to conditions that simulate leaching that may take place during operations. The kinetic tests are run for long periods of time (several years) and leachate is monitored from the tests. A description of the tests is presented in Day (2000).

ABA testing was conducted on approximately163 ore and development rock samples from numerous rock types from the 1998 delineation drilling. Based on these results, samples were selected for additional testing. ABA and kinetic testing were subsequently conducted on 13 development rock samples. The rock samples were selected from locations that had a high likelihood of being mined or being exposed during mining. The samples were taken from locations to provide an even spatial coverage of rock to be mined. The availability of sufficient sample also was a factor in sample selection. Other key considerations were mineralogy of rock samples and arsenic content. Rock samples selected had average or higher than average arsenic content for the given rock type. These samples contained arsenic in the range of 6 to 7,400 mg/kg, and sulfur in the range of 0.08 to 2.98 percent. Rock types tested included gneiss, granodiorite, and altered rock near the ore vein.

Testing results on the development rock indicated:

- Acidic leachate would come from development rock (and ore samples also tested) that had a neutralizing potential to acid generating potential ratio (NP/AP) of less than 1.4.

- The initial NP/AP data on the larger sample set (163 samples) indicated that very few samples with a sulfur content less than 0.5 percent had the potential to generate acid (Day, 2002b).
- Sulfate release rates generally increased with increased sulfur content in the rock.
- Arsenic release rates were not well correlated to the arsenic content in the rock, particularly at low arsenic concentration. This was due in part to the presence of the mineral lollingite ($FeAs_2$). One sample was specifically selected with lollingite for ABA and kinetic testing to determine its response. Testing indicated that arsenic was released more rapidly from lollingite than from other arsenic containing minerals. Mineralogical evaluations indicated that lollingite was not common in the development rock or the ore (Day, 20022b).
- Of the 13 development rock samples tested, one sample (0.87 percent sulfur and 1477 mg/kg arsenic) became acidic (approximately pH 4). The other samples produced water that was near neutral or was alkaline. Arsenic release rates were highest for the one sample that became strongly acidic (0.14 mg/kg/week) (Teck-Pogo, Inc., 2003b, Appendix C).
- Other than the sample that contained lollingite, release rates of arsenic were low (maximum of 0.009 mg/kg/week) for samples with bulk arsenic concentrations up to 1000 mg/kg.

**Exploration adit development pile monitoring** During construction of the exploration adit, development rock was segregated into two categories based on sulfur and arsenic content. Development rock containing greater than 0.5 percent sulfur or 200 ppm arsenic was classified as “mineralized” development rock, and rock with concentrations less than both of those values was classified as “nonmineralized” development rock.

Development rock generated from the exploration adit included 82,000 tons of nonmineralized development rock and 44,000 tons of mineralized development rock. The mineralized and non-mineralized development rock piles had average arsenic concentrations of 592 and 43 ppm, respectively. The average sulfur concentrations were 0.62 and 0.21 percent, respectively. Each development rock type was placed on a lined pad below the existing 1525 Portal for collection of seepage water that migrated through each pile.

Seepage from the development piles was monitored. Initial monitoring began in August 1999 with a full set of parameters starting in April 2000. Monitoring data through July 2002 was reviewed for this document. Dissolved arsenic concentrations ranged from <.05 to 17 µg/L for the mineralized rock (monitoring station SW 26) and 2 to 12.9 µg/L for the nonmineralized rock (monitoring station SW 25B). No discernable trends were identified in arsenic concentrations with time for either pile. Dissolved cadmium concentrations in the nonmineralized pile runoff ranged from <0.05 to 4.6 µg/L, with a generally decreasing trend in concentration. Dissolved cadmium concentrations in the seepage from the mineralized pile were low with all concentrations below 0.5 ug/L. Dissolved zinc concentrations were generally low (concentrations less than 50 ug/L) from the nonmineralized rock pile at monitoring station SW25B; however, 7 of the 38 samples taken during the monitoring period were greater than or equal to 50 µg/L, with the highest concentration being 1800 ug/L.

It should also be noted that the pH for the seepage from the nonmineralized pile was depressed, especially through 2000, due to oxidation of ammonia from residual explosives (Day, 2001). During this period, the field pH was generally in the 6 to 7 range. In 2001, the pH was in the upper 6 range (generally 6.5 to 6.9 for the field measured pH.) The pH of the mineralized pile was generally in the 7 to 8 range throughout the monitoring.

**Evaluation of testing and monitoring data** Results of the sample testing program and development rock monitoring were used to characterize the reactivity and leachablity of the development rock to provide information that would be used to guide development rock management. A key question was which material could be treated as nonmineralized rock with little potential to release contaminants and which material would require special considerations for storage and disposal. This question focused on the upper limits for arsenic and sulfur concentrations for nonmineralized development rock. An arsenic cutoff concentration of 200 mg/kg was proposed by the Applicant prior to constructing the exploration adit in 2000. A value of 600 mg/kg was subsequently proposed in the Applicant's February 2002 Plan of Operations.

Other questions concerned the adequacy of the number of samples of development rock tested, the importance of the presence of lollingite in the development rock, interpretation of the monitoring data for exploration development rock piles seepage, and the quantity of development rock expected to fall within the arsenic concentration range of 200 to 600 mg/kg.

Kinetic testing included 13 different samples of development rock that were run in 19 different tests. The additional tests included the replicate tests and tests conducted on the same samples but at low temperatures. One sample became acidic during testing. This sample had a greater arsenic release rate than others tested. One sample was selected because it contained lollingite, and as discussed previously, this sample had a markedly different behavior (higher leaching) rate than the other non-acid generating samples. Hence there were 11 samples tested that were not acid generating and that did not contain significant amounts of lollingite. Of these 11 samples tested, four had arsenic concentrations greater than 60 mg/kg. Although these samples were selected to represent the range of development rock encountered, because of the small number of samples tested it will be necessary to consider these test results in conjunction with the results for the monitoring of seepage from the large development rock piles.

Presence of lollingite is a concern because it can result in relatively rapid arsenic release at low concentrations of arsenic. In the kinetic (humidity) cell tests, samples containing lollingite with arsenic concentrations of 142 mg/kg had the highest release rates of all samples tested (0.07 to 0.12 mg/kg/week) for the 12 non-acid generating samples (arsenic range of 6 to 7400 mg/kg). These release rates were three to 10 times higher than the next highest non-acid-generating development rock release rates sample (0.007 to 0.02 mg/kg/week). The development rock samples that had the next highest release rates had arsenic concentrations of 4300 mg/kg. These results are a potential concern because they indicate that it may be difficult to establish a cut-off concentration for arsenic due to the significant leaching that occurred relatively rapidly for samples with low arsenic concentrations. It is reported based on mineralogical analysis, however, that lollingite is an uncommon mineral in the Pogo development rock (Day, 2002b). The mineralogical analysis indicated that when lollingite was observed in development rock it was commonly present "as typically rare scattered grains" (Teck-Pogo Inc., 2002k).

Results from mineralized and non-mineralized exploration rock piles indicated arsenic release from both piles was low, with low resulting concentrations in the runoff and seepage from each pile. One concern with the monitoring data from the piles' discharges is the limited monitoring period of approximately two years. There is the potential for conditions in the piles to change with time as sulfide minerals are oxidized, resulting in higher releases of arsenic. Kinetic testing, however, indicated that high arsenic releases resulting from sulfide oxidation occur in samples with higher sulfide concentrations. This likely would not occur in the nonmineralized rock pile. The NP/AP data indicated that very few samples with a sulfur content less than 0.5 percent had the potential to generate acid.

An additional concern is that because the pH of seepage from the nonmineralized rock pile was lowered by oxidation of residual explosives, as previously described, there is a possibility that arsenic was attenuated. Arsenic is less mobile in the presence of ferric iron at pH 6 to 7 than above 7. The concern is that the lower pH that was observed in the nonmineralized seepage would not normally be present with nonmineralized development rock, and without this lower pH, higher arsenic concentrations in the seepage may be observed. Review of the pH of the seepage from the mineralized development rock shows higher pH measurements with readings generally in the 7 to 8 range. Arsenic concentrations in seepage from the mineralized rock piles were very slightly higher than the nonmineralized values, but still less than 20 µg/L. Therefore, assuming that the mineralized and nonmineralized rock had similar lollingite concentrations, it is unlikely that substantially higher arsenic concentrations would have been released from the nonmineralized development rock even if the pH had been higher.

Because release of arsenic has been low during the two years of the rock piles seepage and runoff sampling, it is likely that lollingite is not a significant contributor to arsenic release. The humidity cell tests indicated that the development rock samples containing lollingite had a high initial release rate and then decreased over time. If lollingite was present in appreciable quantities in the development rock, higher initial arsenic concentrations would have been expected in the discharge from the exploration development rock piles.

The Applicant's estimate of the quantity of development rock that would fall into the category of less than 0.5 percent sulfur and between 200 and 600 mg/kg arsenic was four percent of the development rock to be produced. This estimate was based on the analysis of material from the exploration adit and the assumption that a similar distribution of concentrations would be found in additional development work. For the exploration adit, if the arsenic cutoff had been set at 600 mg/kg the average of the nonmineralized stockpile would have increased from 43 to 56 mg/kg. The proportions of development rock with arsenic concentrations below 200 mg/kg and between 200 and 600 mg/kg could be different during future development with concentrations of arsenic potentially higher closer to the ore body.

**Evaluation of impacts from development rock** During mine development, mineralized and nonmineralized development rock would be managed separately. During operations, all development rock would be handled as mineralized rock unless otherwise analyzed and segregated on a round-by-round basis. During the course of the entire project, approximately 436,000 tons of mineralized development rock would be placed underground and, 237,000 tons would be placed on the surface in the tailings dry stack. Approximately 411,000 tons of nonmineralized development rock would be placed underground, and an additional 840,000 tons of nonmineralized development rock would be placed on the surface (Teck-Pogo 2002i). The following paragraphs evaluate this approach. This is followed by an evaluation of the benefits and impacts of placing the additional 237,000 tons of mineralized development rock underground in place of nonmineralized material.

The estimated 237,000 tons of mineralized rock to be placed on the surface ultimately would be encapsulated in the surface dry stack, which would minimize release of contaminants from this material over the long term. The compacted dry-stack tailings would have a very low hydraulic conductivity (estimated at $3.5 \times 10^{-9}$ meters per second) that would minimize water contact and contaminant transport from mineralized development rock. Prior to producing sufficient tailings for encapsulation, however, the mineralized development rock would be stored in upper Liese Creek Valley within the planned dry stack footprint (Figure 2.3-1 e). It is projected that all mineralized rock brought to the surface would be encapsulated in the dry-stack tailings pile by year 7 of the project.

Estimated water quality of the mineralized development rock seepage is presented in Table 4.3-7**.** This estimate is based on site data, testwork, and geochemical modeling (Teck-Pogo Inc., 2002b, Appendix C). The seepage and runoff from the temporary mineralized development rock disposal pile would flow to the RTP, with small quantities entering the groundwater flow system that contributes to mine inflows. This flow would have a moderate to high impact on the groundwater concentrations under the mineralized rock, and would occur between the mineralized rock storage and the RTP. This impact to ground water would be localized to this area and would not extend below the RTP. There also would be a moderate to high impact to surface water due to runoff from the mineralized development rock pile. These impacts to Liese Creek would be localized and confined to the area between the mineralized development rock pile and the RTP.

**Table 4.3-7 Water Quality Estimates for Mineralized Development Rock Seepage**

| Parameter | Mean | Standard Deviation | Reasonable Worst Case Untreated | Units |
|---|---|---|---|---|
| TSS | 33.3 | 45.7 | 107 | mg/L |
| TDS | 435 | 117 | 772 | mg/L |
| Cl | 37.3 | 27.7 | 89 | mg/L |
| $SO_4$ | 634 | 295 | 386 | mg/L |
| TKN | 10 | 1.8 | 15 | mg/L |
| $NO_3$ | | | 9 | mg/L |
| $CN_T$ | | | 20 | µg/L |
| As | 180 | 180 | 500 | µg/L |
| Cd | 0.5 | 1.4 | 5 | µg/L |
| Cr | 2.58 | 3.52 | 14 | µg/L |
| Cu | 4 | 2 | 30 | µg/L |
| Fe | 521 | 522 | 1,450 | µg/L |
| Pb | 0.9 | 2.5 | 5 | µg/L |
| Hg | 0.144 | 0.413 | 2 | µg/L |
| Mn | 235 | 666 | 980 | µg/L |
| Ni | 20 | 73 | 236 | µg/L |
| Se | 4 | 16.5 | 30 | µg/L |
| Ag | 0.029 | 0.024 | 2 | µg/L |
| Zn | 50 | 335 | 699 | µg/L |

Note: Concentrations are dissolved

Nonmineralized development rock is rock that has low levels of arsenic and sulfur and has a low potential to release contaminants when exposed to the environment. It would be used to construct the dry-stack toe berm, roads, and the RTP. Based on humidity cell and column leaching tests and the seepage data from the current piles of development rock from the exploration adit (Teck-Pogo Inc., 2002g; Hanneman, 2002e), the nonmineralized rock would be rock with less than 0.5 percent sulfur and less than 600 milligrams per kilogram of arsenic concentrations. Runoff and seepage from the nonmineralized rock would be expected to have low concentrations of arsenic and metals; therefore, they would have a low impact on water quality.

As an alternate approach, all of the mineralized rock could be placed underground in mined stopes. This would provide a secure long-term storage location. Such underground storage would provide the same degree of isolation expected for the backfilled tailings placed underground.

Because of mining logistics, the estimated total of 237,000 tons of mineralized rock likely would need to be temporarily stored on the surface and placed underground later as mine operations permitted. This would result in double handling this material. Estimated water quality coming from underground would be the same whether or not mineralized development rock were placed underground (i.e., the placement of additional mineralized rock underground would not be expected to result in lower water quality from the underground workings). The additional cost for placement of mineralized development rock underground was estimated to be $1.3 million (Hanneman, 2003d).

Encapsulation of mineralized development rock in the tailings dry stack is also expected to provide a secure long term storage location. It is expected that seepage from the dry stack would have similar chemical characteristics whether or not the mineralized development rock were encapsulated in the dry stack. Hence, the water quality model input was selected such that the mineralized development rock on the surface would not be considered a source of degraded water quality once it were placed in the dry stack.

From a water quality perspective, the difference in placement of the 237,000 tons of mineralized development rock underground, as compared to encapsulation in the dry stack, would be small. Although there may be a small increase in the level of protection by placement of this mineralized rock underground, the difference is believed to be sufficiently small that it would not change the estimate of water quality for the system.

## Gravel Source

- Expand Existing Gravel Pits and Develop New Pits Under this component option, the existing gravel pit near the 1525 Portal would be expanded and new gravel pits would be excavated adjacent to the proposed 3,000-ft airstrip, elsewhere in the Goodpaster River Valley, and in Liese Creek Valley. The gravel from these pits would be used to provide construction materials for project facilities. Because portions of the pits on the Goodpaster River Valley floor likely would be below the water table, the pits would contain water. It is likely that there would be elevated levels of suspended solids during excavation of these pits. These pits would not have a connection with other surface water bodies (i.e., Goodpaster River) during development, however, and there would be minimal impact from the gravel pits on water quality of other water bodies.

- Crush Development Rock The use of nonmineralized development rock for other construction purposes would have minimal impact on water quality. This option, however, would require careful testing and sorting of development rock to ensure that the rock used for general construction purposes did not have the potential for long-term release of contaminants. It is expected that this testing and sorting could be implemented and that crushed nonmineralized development rock would have a low impact on water quality. The use of nonmineralized development rock as construction materials would decrease the volume of gravel that would need to be mined.

## Laydown Area

The permanent laydown areas would be located below the 1525 Portal, adjacent to the airstrip, and near the mill. Materials to be stored in the laydown areas would include piping, equipment that is not in use, and various materials. Mill reagents would not be stored in the laydown areas but would be transported directly to the mill building for storage. No hazardous materials would be stored in the laydown areas. The impacts of laydown areas on water quality would be minimal.

## Water Supply

### *Industrial*

- Mine drainage The use of mine drainage as a source of industrial water supply for mill make-up water would reduce the quantity of mine water that would need to be treated and discharged compared to the use of fresh water for make-up water.
- RTP The use of RTP water as a source of industrial water supply for mill make-up water would reduce the quantity of mine water that would need to be discharged after treatment in comparison to the use of fresh water for make-up water.
- Wells During the periods when there were an insufficient quantity of water from mine drainage or the RTP, water from wells would be used to serve industrial needs. Because well water would not be used when other industrial sources were available, the use of well water would not contribute to additional quantities of water that would need to be discharged. Water pumped from wells for mill make-up water would ultimately be entrained in the tailings. The impacts of using well water under these circumstances would be minimal.

### *Domestic*

- Wells No direct water quality impacts are expected to result from the use of groundwater wells for domestic supply.

## Water Discharge

- Domestic Wastewater Domestic waste would be treated with a single ADEC-approved sewage treatment plant with a capacity of 75,000 gpd that would serve both the construction camp and the Liese Creek construction/permanent camp. This plant would be constructed below the 1575 Portal, and would discharge directly to the Goodpaster River at a point 0.2 miles below the construction camp.

  The domestic wastewater treatment system would be constructed for a maximum capacity of 700 residents anticipated during the construction phase (200 residents at the 1525 Portal construction camp and 500 residents at the Liese Creek camp). The anticipated domestic water use rate of 100 gpd per resident would result in a maximum domestic wastewater flow of 49 gpm (70,000 gpd).

  During the construction phase, domestic wastewater would be pumped from the construction camp to the sewage treatment plant. During the early portion of the construction/permanent camp development, domestic waste would be either trucked or pumped through a pipeline to the treatment plant.

  During the operations phase, lift stations in each of the main buildings would pump domestic waste to an aerated storage and collection tank near the mill. The waste then would be gravity fed to the treatment plant. The number of residents contributing to the domestic wastewater system would drop from 700 during construction to 250 during the operational phase. The anticipated domestic water use rate of 100 gallons gpd per resident would produce an average domestic wastewater flow of 17 gpm, or a total of 25,000 gpd.

  The domestic wastewater treatment plant would use high intensity ultraviolet for disinfection prior to discharge. Treated effluent would be discharged directly to the

Goodpaster River at a maximum rate of 50 gpm under an NPDES permit (Teck-Pogo Inc., 2002i).

The projected effluent water quality from the domestic wastewater treatment system is:

- Total suspended solids (TSS): 30mg/L monthly average, 60 mg/L daily maximum
- Biochemical oxygen demand (BOD): 30 mg/L monthly average, 60 mg/L daily maximum
- Fecal coliform (FC): 200 count/100 milliliters (mL) monthly average, 400 count/100 mL daily maximum

Table 4.3-8 presents a summary of the pertinent parameters of the background water quality of the Goodpaster River pertaining to a domestic wastewater discharge (Design Science & Engineering, 2002). This background water quality was used to conduct a mixing zone study of the treated domestic wastewater discharge.

**Table 4.3-8 Goodpaster River Background Water Quality**

| Parameter | Number of samples | Median | Mean | 5th Percentile | 95th Percentile |
|---|---|---|---|---|---|
| BOD5 (mg/L) | N/A | | | | 5 (estimate) |
| TSS (mg/L) | 35 | 25 | 4.5 | 1.5 | 14.3 |
| TKN (mg/L) | 26 | 0.13 | 0.19 | 0.05 | 0.48 |
| FC (FC/100 mL) | N/A | | | | 5 (estimate) |
| pH (su) | 29 | 6.9 | 6.9 | 6.1 | 7.7 |
| DO (mg/L) | 26 | 11.6 | 11.9 | 9.5 | 14.3 |
| DO (%) | 25 | 94.3 | 90.3 | 72.8 | 99.1 |
| Temperature (deg C) | 31 | 2.9 | 4.9 | 0.1 | 12.1 |

BOD – Five-day biological oxygen demand
TKN – Total Kjeldahl nitrogen
pH – Standard units
TSS – Total suspended solids
FC – Fecal coliform bacteria
DO – dissolved oxygen

Table 4.3-9 summarizes the results of the mixing zone analysis based on conservative predictions of the effluent water quality anticipated from the domestic wastewater treatment system. The parameter that would require the largest mixing zone dilution ratio based on a mass balance approach is fecal coliform bacteria. With the use of a conservative effluent discharge maximum of 50 gpm, the proportion of the stream providing dilution is 2.9 cfs, which constitutes approximately 7 percent (Design Science & Engineering, 2002) of the design 2-year 3-day (3Q2) low-flow event applicable to conventional and nontoxic substances (18 AAC 70.255).

**Table 4.3-9 Predicted Effluent Concentrations and Mixing Zone Analysis Results**[1]

| Parameter | Effluent Minimum Value | Effluent Maximum Value | Effluent Monthly Average | Effluent Daily Maximum | Effluent Target Criteria | Model Input Effluent Value | Minimum Dilution Ratio | Expected Conc. at Mixing Zone Edge |
|---|---|---|---|---|---|---|---|---|
| BOD5 (mg/L) | N/A | N/A | 30 | 60 | 30 mg/l | | | 7 |
| TSS (mg/L) | N/A | N/A | 30 | 60 | 30 mg/l | | | 16 |
| TKN (mg/L) | N/A | N/A | 15 | 30 | <=10 | 30 | 2.1 | 1.6 |
| FC (FC/100mL) | N/A | N/A | 200 | 400 | <=20 | 400 | 25.3 | 20 |
| pH (su) | 6.0 | 9 | 8 | N/A | 6.5-9.0 | | | |
| DO (mg/L) | 1.0 | N/A | 2.0 | N/A | >=7.0 | 1 | 2.4 | 9.2 |
| Temp (deg C) | N/A | N/A | 15 | 20 | <=15 | 20 | 1.7 | 12 |

[1] The NPDES permit may analyze other parameters of concern.

The results of the modeling to determine the size of the minimum mixing zone and computations to determine the dissolved oxygen sag indicate that all water quality standards could be met within a regulatory mixing zone that is 5 ft long, by 5 ft on the upstream edge and 7 ft along the downstream edge, which is approximately 22 percent of the wetted stream width of the modeled location, during the 3Q2 low-flow event (Design Science & Engineering, 2002). Under the conservative design and computational input parameters, the discharge of domestic wastewater to the Goodpaster River is expected to result in only localized measurable impacts to less than 7 percent of the design stream flow and to provide a zone of passage constituting 78 percent of the wetted stream width. Therefore, it is expected that the discharge of treated domestic wastewater to the Goodpaster River would result in low to very low impacts.

## Fuel Storage Location

Fuel storage at the construction camp below the 1525 Portal and at the airstrip would represent potential impacts to water quality from two primary sources: fuel spills and stormwater runoff. Stormwater runoff would be managed by using BMPs and is expected to have a negligible impact on water quality.

Temporary fuel storage for the development phase would include the existing eight 20,000-gallon fuel tanks at the construction camp previously used during exploration activities, and fifteen 20,000-gallon tanks to be erected at the airstrip. These tanks would be removed following the development phase. These fuel tanks would be located within a bermed and lined area with a volume greater than 110 percent of the largest individual tank. This secondary containment would decrease the potential for a fuel spill. The use of containment facilities for the fuel transfer operations would further minimize the potential for spills. Without mitigation, however, a fuel spill in this location would result in contamination of the alluvial aquifer, and seepage of contaminated ground water to the Goodpaster River also could occur. The impacts of a major spill could be high.

With proper use of spill containment facilities and the development of an SPCC plan by the Applicant prior to operation, the potential for a spill would be low, and if spills were to occur, they likely would be smaller. Therefore, overall, the impacts of temporary fuel storage at the construction camp and airstrip would be low.

## Air Access 3,000-ft Airstrip in Goodpaster Valley

### *Use*

- Pogo project only The use of the airstrip in the Goodpaster Valley is expected to have minimal impacts on water quality. The airstrip is projected to receive its greatest use during construction when the winter road would not be available and the all-season road were not yet completed. A potential concern is the occurrence of a fuel spill. A 5,000-gallon fuel tank containing Jet-A fuel would be located near the airstrip. Planned secondary containment at the fuel tank would reduce the risk of a release. The use of the airstrip by the Pogo project only would minimize the air traffic and potential fuel spills. Without mitigation, if a fuel spill were to occur, the ground water in the alluvial aquifer would likely be affected. Seepage of contaminated ground water to the Goodpaster River could also occur. The likelihood of a large spill is low, however, and full implementation of an SPCC plan would reduce the likelihood and severity of spills. Overall, the impacts are expected to be low.

- Pogo and other industrial/commercial users only With increased usage, there is the potential for increased risk of a spill if refueling were to occur at the airstrip. As with the use of the airstrip by the Pogo project only, however, the likelihood of large spills is low, and the severity of the spills would be reduced with mitigation.

- Everyone With structural source control BMPs in place and maintained by the Applicant, the option in which the airstrip would be open for use by all users is expected to have a low impact on water quality. The potential for spills under this option would be slightly greater than the previous two options because the airstrip could be used by members of the public, resulting in an increased volume of air traffic.

### *Disposition*

- Remove and reclaim Removing and reclaiming the airstrip at the end of the project would eliminate the potential for fuel spills in the future and could have a potential positive effect on water quality. There would be potential short-term impacts from construction activities required to remove the airstrip. These impacts could include exposed sediments that could be eroded to the Goodpaster River, resulting in higher suspended solids loads. These impacts would be short term and could be mitigated by using silt fences and other sediment control practices and BMPs during construction. Revegetation would mitigate long-term erosional impacts. Overall impacts from this alternative would be positive because reclamation of the airstrip would remove the potential for fuel spills in the long term, and the short-term impacts would be low.

- Open for Industrial/commercial resource users Maintaining the airstrip for future industrial resource users would potentially increase the possibility of a fuel spill if refueling activities took place at the airstrip. If refueling activities were conducted in an uncontrolled environment without ongoing training or maintenance of BMPs, the potential for a spill would be increased. The impact to the Goodpaster River of a spill from this location could be high if the spill migrated through the alluvial aquifer to the river. If BMPs were maintained by industrial/commercial resource users, the potential for a release would be low. If no storage of fuels or refueling took place on the airstrip, the potential for impacts would be low.

- Open for everyone Maintaining the airstrip for all users would potentially increase the possibility of a fuel spill if refueling activities took place at the airstrip. If refueling activities were conducted in an uncontrolled environment without ongoing training or maintenance of BMPs, the potential for a spill could be moderate. The impacts to the Goodpaster River of a spill from this location could be high if the spill migrated through the alluvial aquifer to the river. The maintenance of BMPs would decrease the potential of a spill and would decrease the potential impact if a spill occurred. If no storage of fuels or refueling took place on the airstrip, the potential impacts would be low.

## 4.3.3 Options Not Related to Surface Access

**Alternative 2**

### Tailings Liner Facility

- ✦ Unlined Dry Stack and RTP Same as discussed in Section 4.3.2.

### Power Supply

- Power line Construction of the power line could result in small temporary impacts on water quality from the construction of access roads and trails. With proper management and mitigation measures, the overall impacts on water quality are expected to be low. During construction of power line access roads and trails in the Shaw Creek and Goodpaster River watersheds, disturbed surfaces could erode and increase sediment in runoff. Sediment runoff could cause increased suspended sediment in creeks. The increased sediment and turbidity levels would likely be low because of the relatively small amount of construction required. These impacts would be temporary and could be mitigated by the proper use of silt fences and other sediment control practices and BMPs during construction. Revegetation of disturbed areas after construction would help diminish sediment release to the creeks in the long term. The impacts of this option on water quality are expected to be low.

### Water Discharge

#### *Development Phase*

- Underground injection wells As discussed in Section 4.2.3, the injected ground water would have the potential to surface in nearby sloughs. Therefore, impacts to both ground water and surface water need to be considered for this discharge. This discharge would be regulated by both NPDES and UIC permits. The discharge criteria would include drinking water standards (18 AAC 80), aquatic life criteria (18 AAC 70), and human health criteria (18 AAC 70).

  Water quality during the development phase was estimated to be similar to the estimate provided for the mine seepage water quality as presented in the previous underground mine section (Table 4.3-10). This estimate represents a conservative reasonable worst case.

  Mine seepage water would be treated in the HDS ferric coprecipitation/lime softening system and, if necessary, in a sulfide precipitation system that would remove metals and arsenic and lower TDS. Removal efficiencies for arsenic, metals, and TDS were estimated based on the performance of the current exploration adit treatment system, information from other mines, and water treatment literature data (Teck-Pogo Inc., 2002b, 2002f). No removal of chloride, sulfate, ammonia, nitrate, or cyanide was projected for the treatment system. A summary of treatment efficiencies used for estimating treated water quality is presented in Table 4.3-10.

Projected water quality for mine seepage after treatment but prior to well injection during the development phase is also presented in Table 4.3-10. The effluent concentration estimates for the water treatment plant are presented as dissolved. These estimated discharge concentrations are based on reasonable worst-case conditions; therefore, these are conservative concentrations. Also presented in this table are the expected discharge criteria based on the recently (June 26, 2003) adopted State of Alaska water quality standards (18 AAC 70). The State of Alaska would be responsible for permitting this discharge. These were developed as dissolved criteria.

It is expected that a site-specific criterion of 650 mg/L for TDS would be applied in consideration of the quality of the receiving water. The receiving water quality used for site-specific criterion for TDS and to calculate the discharge criteria for the hardness-dependent metals was based on the water quality expected in the sloughs, which would be the surface water that would first receive the discharge. It was assumed that the majority of the water in the sloughs would come from groundwater discharge, and therefore, that the sloughs would have a TDS and hardness similar to those parameters of the ground water in the area.

**Table 4.3-10 Alternative 2, Development Phase Projected Water Quality to be Discharged to Injection Wells, and Expected Discharge Criteria**

| Parameter | Basis of Treatment Plant Effluent Concentration (Dissolved) | Estimated Treated Effluent (Dissolved) | Expected Discharge Criteria[2] | Units |
|---|---|---|---|---|
| TSS | Fixed at 20 | 20 | 30 | mg/L |
| TDS | Equal to 85% of influent | 552 | 650 | mg/L |
| Cl | Equal to Influent[1] | 5 | 250 | mg/L |
| $SO_4$ | Equal to Influent[1] | **283** | 250 | mg/L |
| $NH_3$ [4] | Equal to Influent[1] | **10** | 5.9[3] | mg/L |
| TKN [4] | Equal to Influent[1] | 10 | 10 | mg/L |
| $NO_3$ [4] | Equal to Influent[1] | 10 | 10 | mg/L |
| $CN_T$ | Equal to Influent | **20** | 5.2 | µg/L |
| As | Fixed at 30 | 30 | 50 | µg/L |
| Cd | Fixed at 0.3 | 0.3 | 0.64 | µg/L |
| Cr | Fixed at 30 | 30 | 231 | µg/L |
| Cu | Fixed at 10 | 10 | 29 | µg/L |
| Fe | Fixed at 300 | 300 | 1000 | µg/L |
| Pb | Fixed at 1 | 1 | 11 | µg/L |
| Hg | Fixed at 0.1 | 0.1 | 0.77 | µg/L |
| Mn | Fixed at 50 | 50 | 50 | µg/L |
| Ni | Fixed at 30 | 30 | 168 | µg/L |
| Se | Equal to Influent[1] | 2 | 4.6 | µg/L |
| Ag | Fixed at 0.1 | 0.1 | 37 | µg/L |
| Zn | Fixed at 15 | 15 | 382 | µg/L |

1 Treated effluent concentrations of these parameters are equivalent to the water quality estimates for the mine drainage; these parameters would not be effectively treated by using the HDS ferric coprecipitation system.
2 Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated by using a hardness of 400 mg/L.
3 Based on ammonia chronic criteria for temperature between 0 and 14ºC and pH of 7.
4 All forms of nitrogen in combination must not exceed 10mg/L.
Note: Parameter values that are estimated to exceed their water quality criterion in Table 4.3-10 and subsequent tables are shown in **bold**.

Based on this comparison using the dissolved concentrations, the water injected into the well would meet the discharge criteria for all parameters except sulfate, ammonia, and cyanide. Those parameter values that are estimated to exceed their water quality criterion in Table 4.3-10 and subsequent tables are shown in bold. As discussed in Section 4.3.2, the cyanide concentrations used in this estimate may be overstated. Lower concentrations in the discharge during the development phase may result in meeting the cyanide discharge criteria. Additionally, the estimated cyanide discharge concentration is based on a total cyanide analysis. The water quality standards are based on a WAD cyanide analysis. Total cyanide analyses include all forms of cyanide including strong metal-cyanide complexes, weak and moderately strong metal-cyanide complexes, and free cyanide. WAD cyanide includes all but the strong metal-cyanide complexes. WAD cyanide is expected to be lower than a total cyanide analysis, and, hence, the WAD cyanide concentrations are expected to be lower than presented in this table.

The sulfate value is slightly above the discharge criterion, hence, it is likely that the sulfate concentrations would exceed the criteria only occasionally. The reasonable worst-case ammonia concentration is estimated to be about twice the criteria (for the assumed temperature and pH). The frequency of ammonia exceeding the criteria would depend primarily on operational practices for selecting and using explosives in the mine; therefore, operational changes could be made to reduce the potential for exceeding the criteria. If the cyanide did not exceed or infrequently exceeded the criteria, the resulting concentrations would be considered to be a potentially moderate impact from a permitting and compliance perspective.

There may be some attenuation for certain parameters within the ground water. However, because of the potential for injected water to surface in a relatively short period of time, the degree of attenuation may be low. Therefore, there is the potential for the discharge to exceed the discharge criteria in nearby sloughs. In the portions of the Goodpaster River that receive input from either the ground water or sloughs, increases in concentrations in the Goodpaster may occur. The concentrations in the Goodpaster River are expected to be lower than the concentrations in the ground water or sloughs due to dilution. If the concentrations of the water that is discharging to the Goodpaster occasionally exceed water quality criteria, these occurrences would be considered a moderate impact. It is expected that if an exceedance of water quality criteria did occur, it would be localized to the Goodpaster River near the area of groundwater or slough discharge due to dilution in the Goodpaster River.

***Operations Phase***

Water treatment would occur at two treatment plants with a combined nominal capacity of 500 gpm, and a combined maximum capacity of 750 gpm. Water would be discharged either to the SAS or to an injection well. Water discharged during the operations phase of the project would include water from the mine and the RTP, as presented in the conceptual flow diagram and water balance shown in Figures 2.3-5 and 2.3-7, respectively. This water would be treated by HDS ferric coprecipitation/lime softening prior to discharge.

- Soil absorption system
  - Adjacent to airstrip The SAS was described in Section 2.3.10. The expected influent and effluent from the SAS are presented in Table 4.3-11. The effluent quality

presented in this table is the expected water quality just as it exits the SAS prior to contacting the underlying ground water. This water quality estimate was based on a series of column studies that evaluated the removal efficiency of water contaminants under different soil column conditions (Teck-Pogo Inc., 2000f).

Under the UIC requirements, the influent to the SAS would be required to meet drinking water standards and the effluent from the SAS would be required to meet the aquatic life and human health standards. The State of Alaska adopted dissolved water quality criteria June 26, 2003 (18 AAC 70). It is expected that EPA will approve these water quality criteria prior to issuance of the final NPDES permit. EPA requires that all permit effluent limitations be in “total recoverable” concentrations. Hence, two sets of criteria are presented in Table 4.4-11 and in subsequent tables. As presented in Table 4.3-11, the influent to the SAS is expected to achieve drinking water standards for the 95th percentile of the annual average for all parameters except nitrate, and is expected to exceed TDS, chloride, sulfate, total Kjeldahl nitrogen (TKN), and nitrate for the 95th percentile of the annual maximum.

The effluent from the SAS is expected to exceed the dissolved and total recoverable discharge criteria for the 95th percentile of the annual average for nitrate, cyanide, cadmium, copper, and lead. The $95^{th}$ percentile of the annual average also would exceed the total recoverable criteria for manganese. As discussed previously, the estimated cyanide concentrations are based on a total cyanide concentration and the criterion is based on a WAD analysis. Hence, the WAD cyanide concentrations are expected to be lower than what is presented in this table.

For the 95th percentile of the annual maximum, TDS, chloride, sulfate, nickel, and selenium would be exceeded for dissolved and total criteria in addition to those exceeded for the annual average. Manganese also would be exceeded for total criteria only. These additional parameters at the 95th percentile of the annual maximum would likely exceed the discharge criteria less frequently than for the 95th annual average. Because the influent to the SAS and the discharge from the SAS are estimated to exceed the expected discharge criteria for a number of parameters, this discharge was defined as having a high impact from a permitting and compliance perspective, and may not be permittable.

Although the regulatory compliance standards applicable to aquatic life and human health for this discharge likely would be the point at which the water is discharged from the SAS to the ground, additional analysis was conducted to determine the processes that would occur in the ground water.

**Table 4.3-11 Alternative 2, Operations Phase Projected Water Quality of Influent and Effluent from Soil Adsorption System and Expected Discharge Criteria**

| | Influent to SAS | | Effluent from SAS | | Effluent from SAS | | Expected Criteria | | |
|---|---|---|---|---|---|---|---|---|---|
| Parameter | 95% Annual Average Dissolved | 95% Annual Maximum Dissolved | 95% Annual Average Dissolved | 95% Annual Maximum Dissolved | 95% Annual Average Total | 95% Annual Maximum Total | Water Quality Criteria - Dissolved | Permit Basis Criteria - Total Recoverable | Units |
| TSS | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | mg/L |
| TDS | 433 | **551** | 433 | **551** | 433 | **551** | 500 | 500 | mg/L |
| Cl | 108 | **251** | 108 | **251** | 108 | **251** | 230 | 230 | mg/L |
| $SO_4$ | 206 | **272** | 206 | **272** | 206 | **272** | 250 | 250 | mg/L |
| $NH_3$[2] | | | | | | | | | |
| TKN | 7.14 | **10.24** | 5.00 | 7.17 | 5.0 | 7.2 | 10 | 10 | mg/L |
| $NO_3$ | **14.4** | **17.7** | **14.4** | **17.7** | **14** | **18** | 10 | 10 | mg/L |
| $CN_T$ | 22.2 | 33.4 | **15.5** | **23.4** | **16** | **23** | 5.2 | 5.2 | µg/L |
| As | 30 | 30 | 18.0 | 18 | 21 | 21 | 50 | 50 | µg/L |
| Cd | 0.295 | 0.3 | **0.30** | **0.3** | **0.34** | **0.34** | 0.1 | 0.1 | µg/L |
| Cr | 9.11 | 13.1 | 5.47 | 7.86 | 6.4 | 9.1 | 29 | 29 | µg/L |
| Cu | 10 | 10 | **9.50** | **9.5** | **10** | **10** | 2.9 | 3 | µg/L |
| Fe | 300 | 300 | 225 | 225 | 703 | 703 | 1000 | 1000 | µg/L |
| Pb | 1 | 1 | **1.0** | **1** | **1.6** | **1.6** | 0.59 | 0.60 | µg/L |
| Hg | 0.1 | 0.1 | 0.1 | 0.1 | 0.12 | 0.12 | 0.77 | 0.77 | µg/L |
| Mn | 50 | 50 | 50.0 | 50 | **56** | **56** | 50 | 50 | µg/L |
| Ni | 23.9 | 30 | 14.3 | **18** | 15 | **19** | 17 | 17 | µg/L |
| Se | 5.62 | 8.79 | 3.37 | **5.27** | 4.4 | **6.9** | 4.6 | 5 | µg/L |
| Ag | 0.0914 | 0.1 | 0.09 | 0.1 | 0.23 | 0.26 | 0.4 | 0.4 | µg/L |
| Zn | 15 | 15 | 10.5 | 10.5 | 11 | 11 | 39 | 40 | µg/L |

[1] Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated using a hardness of 27 mg/L.
[2] Ammonia not estimated in Monte Carlo model.
Note: Parameter values that are estimated to exceed their water quality criterion are shown in **bold**.

Fate and transport modeling was conducted for the ground water downgradient of the SAS to determine concentrations of key constituents in ground water prior to reaching the Goodpaster River (Teck-Pogo Inc., 2002f). This modeling evaluated two different discharge flow rates to the SAS. These flows were the projected average flow of 144 gpm and the projected maximum flow rate of 365 gpm. The modeling indicated that, at the expected average discharge flow, only cyanide would be slightly above the criterion when it reached the Goodpaster River. For the maximum discharge rate, nitrate and iron would also be exceeded. The modeling results are uncertain because of the difficulty in modeling transient conditions stemming from sudden changes in river levels, which are known to occur and that would have a further dilutive effect on concentrations. Therefore, it is not certain that water quality criteria would be exceeded. With the attenuation and dilution expected in the ground water, and the probability of a wide zone of groundwater discharge of a diffuse nature, the increase in concentration for these parameters from this discharge to the Goodpaster River would likely be small.

Hence, this impact would be to the ground water in the vicinity of the SAS and downgradient of the SAS and potentially to the Goodpaster River where the ground water discharges to the river. If the concentrations of the ground water that discharged to the Goodpaster River exceeded water quality criteria frequently, the exceedances would be considered a high impact. It is expected that if an exceedance of water quality criteria did occur, it would be localized to the Goodpaster River near the area of groundwater discharge due to dilution in the Goodpaster River.

- ✦ Saddle above Pogo Ridge The expected influent and effluent from the SAS would be the same as presented in Table 4.3-11. The effluent quality shown in this table is the expected water quality just as the water exits from the SAS.

  The discharge criteria presented in this table assume that both NPDES and UIC permits are required and the SAS discharge would be required to meet both Water Quality Standards (18 AAC 70) and Drinking Water standards (18 AAC 80) as was required for the SAS in the Goodpaster Valley. The influent to and the effluent from the SAS would be expected to exceed the criteria for the same constituents as it would for the SAS in the Goodpaster River Valley.

  The water from the SAS would flow into the subsurface below the SAS into Easy Creek Valley. Some attenuation of the constituents in the water would occur as the water flowed through the colluvium or fractured bedrock. It is uncertain whether the flow would remain as subsurface flow or whether some surfacing of this discharge would occur.

- Underground injection wells In addition to the discharge to the SAS, Alternative 2 also includes the option to discharge treated water into up to three injection wells during operation. It is proposed that the injection wells would be used during the operations phase only under special circumstances, such as during rehabilitation of the SAS, discharge of clean RTP water, or mine drainage discharge, all of which would occur only when advanced sampling for potential contaminants had shown that the discharge could meet limits for injection well water quality.

## Alternative 3

### Tailings Facility Liner

- ✦ Lined Dry Stack and RTP The evaluation of seepage from the unlined surface dry stack and RTP (Sections 4.2.3 and 4.3.2) indicated that impacts from an unlined facility would be low. The addition of a liner would not substantially change the quantity of leakage or the impacts from the dry-stack seepage; hence, the impacts of this option would be the same as for Alternative 2.

### Power Supply

- Power line Same as Alternative 2.

### Water Discharge

#### *Development Phase*

- Direct discharge to Goodpaster Discharge of treated excess water during development would be directly to the Goodpaster River at a location 0.2 mile downstream from the exploration camp as shown on Figure 2.3-1a. This reach was selected as a discharge location because the river substrate is not suitable for fish spawning and, hence, would be a location where a mixing zone could potentially be applied. This river reach is adjacent to a large talus slope that appears to be a stable feature of the river based on historical aerial photographs (Teck-Pogo Inc., 2002d).

Mixing zone calculations were conducted (Teck-Pogo Inc., 2002d). A mixing zone could not be approved if there is the potential for mercury to bioaccumulate to high adverse levels [18 AAC 70.250 (a)(1)(A)]. It is uncertain whether mercury would bioaccumulate to high adverse levels from this discharge; hence, it is uncertain whether a mixing zone could be granted.

A minimum mixing ratio of 45 to 1 (total river flow to discharge flow ratio) was selected to provide sufficient mixing to meet both chronic water quality criteria at the edge of the mixing zone and acute water quality criteria at the point of discharge. The 45-to-1 total mixing ratio provides for a zone of passage for aquatic life that is greater than 50 percent of the river width. The mixing required within the mixing zone would be at a ratio of 25 to 1. (This ratio is for the river flow only within the mixing zone to the discharge flow.) The water would be discharged through a diffuser. The projected maximum discharge rate is 400 gpm. Actual flows would be varied, depending on the flow in the river. Discharges would not be made when the flow in the river was less then 10 cfs.

The size of the mixing zone was determined for the operations phase condition because the flows for that phase would be greater and the water quality would be lower than during the development phase. As a result, the size of the mixing zone would be larger for the operations phase. For the operations phase, it was conservatively assumed that mine inflows were at their peak, water consumption in the mill was zero (the mill was shut down), and the RTP was full at the beginning of the winter low-flow period. The analysis showed that a mixing zone extending 30 ft downstream from the outfall with a maximum width of 15 ft would provide adequate mixing (Teck-Pogo Inc., 2002d).

The projected water quality for the treated effluent and the quality at the edge of the mixing zone (25:1 dilution) during development are presented in Table 4.3-12. This water quality is based on a 25:1 ratio of river flow within the mixing zone to effluent flow. The discharge criteria included in this table used a hardness of 27 mg/L, which is a weighted average of the hardness in the river and the hardness of the discharge. 40 CFR 131.36 (c)(4)(ii) states “hardness values used shall be consistent with the design discharge conditions established for the flows and mixing zone.” The applicable water quality criteria presented in this table do not reflect the end-of-pipe water quality which would be achieved. The actual end-of-pipe effluent limitations would be back-calculated using the mixing zone and applicable discharge criteria as part of the NPDES discharge permit process. As previously described, two sets of criteria (dissolved and total recoverable) are presented. These represent the State of Alaska recently revised water quality criteria (dissolved) and the EPA criteria on which the NPDES permit would be based (total recoverable). The water quality at the edge of the mixing zone is projected to meet discharge criteria for all parameters.

**Table 4.3-12 Alternative 3, Development Phase Projected Water Quality for Direct Discharge to Goodpaster River**

| Parameter | Estimated Treated Effluent (Dissolved) | Estimated Concentration at Edge of Mixing Zone (Dissolved) | Estimated Concentration at Edge of Mixing Zone (Total) | Water Quality Criteria - Dissolved | Permit Basis Criteria - Total Recoverable | Units |
|---|---|---|---|---|---|---|
| TSS | 20 | 21.0 | 21 | 30 | 30 | mg/L |
| TDS | 552 | 117 | 117 | 500 | 500 | mg/L |
| Cl | 5 | 1.1 | 1.1 | 230 | 230 | mg/L |
| $SO_4$ | 283 | 33.0 | 33.0 | 250 | 250 | mg/L |
| $NH_3$ | 10 | 0.5 | 0.5 | | | mg/L |
| TKN | 10 | 1.0 | 1.0 | 10 | 10 | mg/L |
| $NO_3$ | 10 | 0.4 | 0.4 | 10 | 10 | mg/L |
| $CN_T$ | 20 | 0.8 | 0.8 | 5.2 | 5.2 | µg/L |
| As | 30 | 1.6 | 1.8 | 50 | 50 | µg/L |
| Cd | 0.3 | 0.04 | 0.04 | 0.1 | 0.1 | µg/L |
| Cr | 30 | 3.2 | 3.7 | 29 | 29 | µg/L |
| Cu | 10 | 1.8 | 2.0 | 2.9 | 3 | µg/L |
| Fe | 300 | 208 | 651 | 1000 | 1000 | µg/L |
| Pb | 1 | 0.26 | 0.41 | 0.59 | 0.60 | µg/L |
| Hg | 0.1 | 0.009 | 0.010 | 0.77 | 0.77 | µg/L |
| Mn | 50 | 23 | 26 | 50 | 50 | µg/L |
| Ni | 30 | 2.8 | 2.9 | 17 | 17 | µg/L |
| Se | 2 | 0.44 | 0.58 | 4.6 | 5 | µg/L |
| Ag | 0.1 | 0.008 | 0.019 | 0.4 | 0.4 | µg/L |
| Zn | 15 | 4.3 | 4.3 | 39 | 40 | µg/L |

[1] Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated by using a hardness of 27 mg/L. End-of-pipe discharge criteria/limits would require back-calculation to account for in-stream mixing.
[2] Based on ammonia chronic criteria for temperature between 0 and 14$^{o}$ C and pH of 7.
Note: Parameter values that are estimated to exceed their water quality criterion are shown in **bold**.

### *Operations Phase*

- Direct discharge to Goodpaster The discharge of treated water would be the same as described for the development phase. Flow rates for the discharge during operation would vary between zero and 750 gpm, depending on the flow in the river. No discharge would occur when the flow in the river was less than 10 cfs.

  The water quality of this discharge is presented in Table 4.3-13. It is based on the projected water quality of the discharge of the HDS coprecipitation treatment plant. The water quality at the edge of the mixing zone is also based on a 25:1 mixing ratio. The possible discharge criteria are based upon the applicable water quality criteria and do not reflect the end-of-pipe water quality which would be required. The actual end-of-pipe effluent limitations would be back-calculated using the mixing zone and applicable discharge criteria as part of the NPDES discharge permit process. The water quality after mixing at this ratio is projected to meet discharge criteria for all parameters.

**Table 4.3-13 Alternative 3, Operations Phase Projected Water Quality for Direct Discharge to Goodpaster River**

| | Direct Discharge to Goodpaster River from Water Treatment Plant | | Concentrations in Goodpaster River at Edge of Mixing Zone | | Concentrations in Goodpaster River at Edge of Mixing Zone | | Expected Criteria | | |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **95% Annual Average Dissolved** | **95% Annual Maximum Dissolved** | **95% Annual Average Dissolved** | **95% Annual Maximum Dissolved** | **95% Annual Average Total** | **95% Annual Maximum Total** | **Water Quality Criteria - Dissolved** | **Permit Basis Criteria Total Recoverable** | **Units** |
| TSS | 20 | 20 | 21.0 | 21.0 | 21.0 | 21.0 | 30 | 30 | mg/L |
| TDS | 433 | 551 | 113 | 117 | 113 | 117 | 500 | 500 | mg/L |
| Cl | 108 | 251 | 5.0 | 10.5 | 5.0 | 10.5 | 230 | 230 | mg/L |
| $SO_4$ | 206 | 272 | 30.0 | 32.6 | 30.0 | 32.6 | 250 | 250 | mg/L |
| $NH_3$[2] | | | | | | | | | |
| TKN | 7.14 | 10.2 | 0.9 | 1.0 | 0.9 | 1.0 | 10 | 10 | mg/L |
| $NO_3$ | 14.4 | 17.7 | 0.6 | 0.7 | 0.6 | 0.7 | 10 | 10 | mg/L |
| $CN_T$ | 22.2 | 33.4 | 0.9 | 1.3 | 0.9 | 1.3 | 5.2 | 5.2 | µg/L |
| As | 30 | 30 | 1.6 | 1.6 | 1.8 | 1.8 | 50 | 50 | µg/L |
| Cd | 0.295 | 0.3 | 0.04 | 0.04 | 0.04 | 0.04 | 0.12 | 0.13 | µg/L |
| Cr | 9.11 | 13.1 | 2.4 | 2.6 | 2.8 | 3.0 | 33 | 38 | µg/L |
| Cu | 10 | 10 | 1.8 | 1.8 | 2.0 | 2.0 | 3.8 | 4.0 | µg/L |
| Fe | 300 | 300 | 208 | 208 | 651 | 651 | 1000 | 1000 | µg/L |
| Pb | 1 | 1 | 0.26 | 0.26 | 0.41 | 0.41 | 0.84 | 0.90 | µg/L |
| Hg | 0.1 | 0.1 | 0.009 | 0.009 | 0.010 | 0.010 | 0.77 | 0.77 | µg/L |
| Mn | 50 | 50 | 23 | 23 | 26 | 26 | 50 | 50 | µg/L |
| Ni | 23.9 | 30 | 2.6 | 2.8 | 2.7 | 2.9 | 22 | 22 | µg/L |
| Se | 5.62 | 8.79 | 0.58 | 0.70 | 0.77 | 0.93 | 4.6 | 5 | µg/L |
| Ag | 0.0914 | 0.1 | 0.007 | 0.008 | 0.019 | 0.019 | 0.62 | 0.73 | µg/L |
| Zn | 15 | 15 | 4.3 | 4.3 | 4.3 | 4.3 | 51 | 52 | µg/L |

[1] Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated by using a hardness of 37 mg/L.
[2] Ammonia was not estimated in Monte Carlo model.
Note: Parameter values that are estimated to exceed their water quality criterion are shown in **bold**.

The water treatment plant would include advanced control systems providing for automated features that respond to changing conditions over short periods and for overall system modifications to meet potential future regulatory changes (i.e., lower arsenic standard) or unanticipated conditions. These contingencies would include flow-proportioned chemical feed systems and continuous pH, turbidity, and conductivity measurement and recording that reports to a computerized programmable logic controller (PLC). The PLC would generate operator alarms, activate alternative treatment or chemical feed, switch the plant to recycle, or initiate plant shutdown. These contingencies would minimize the occurrence of upset conditions. When upsets would occur, these contingencies would assist in detecting, recording, and adjusting for upsets to restore normal plant operations. In addition, the plant would be designed to allow for process changes if they become necessary as dictated by influent water quality and regulatory standards. Process changes could include addition of oxidants such as hydrogen peroxide to assist in arsenic removal, sulfide precipitation, and recarbonation.

## Alternative 4

### Tailings Facility Liner

- ✦ Lined dry Stack and RTP Same as Alternative 3.

### Power Supply

- On-site generation Under this alternative, power would be generated on site. The largest potential concern for water quality would be the additional fuel that would need to be transported and stored for the project. The Applicant has estimated that an additional 4.2 million gallons of diesel fuel per year would need to be supplied to provide on-site power generation for the 2,500-tpd operation. This amount of fuel would be more than a five-fold increase in the fuel requirements for the power line option (786,000 gallons per year). The 4.2 million gallons per year would require an additional 525 tanker trucks (8,000 gallons each), for a total of 625 fuel trucks each year. The risk of a fuel spill would increase proportionally.

  The probability of truck accidents and release was reported as 1.9 x$10^{-7}$ spills per mile of travel for rural two-lane roads (Harwood and Russell, 1990). Based on this rate, the probability of a fuel spill with project power supplied by on-site power generation (and the need to haul fuel for generators) over the life of the project for 11 years of operation and a 49-mile route would be approximately 6 percent. This calculation only considered a one-way trip because the return trip from the mine would be with an empty truck. This frequency provides an order-of-magnitude estimate because the conditions on the Pogo mine road would be different from those for which the statistics were developed (more difficult driving and road conditions). This option would have a moderate to high potential to affect water quality. A fuel spill near a wetland could have a local impact. A major spill near a creek could result in a high impact over a large area of the watershed.

### Water Discharge

***Development Phase*** Same as operations phase below.

***Operations Phase***

- Off-river treatment works Effluent from the HDS water treatment plant would be disposed of in an off-river treatment works. This treatment works would consist of two ponds (Figure 2.4-2) (Teck-Pogo, Inc., 2002e). The ponds would be adjacent to the river just upstream of the proposed airstrip. Water would flow into the first pond by gravity. The intake channel in the river would be large and deep to allow water flow during winter icing conditions. A small pump station and wet well would be installed at the outlet of the first pond to transport water to the second pond. The inlet to the pump would be screened to prevent fish movement into the second treatment pond where aeration, precipitation, and settling processes would occur for some parameters, particularly iron. Water would be pumped from the first pond to the second pond at a rate that would provide the adequate mixing ratio. Pumping of river water would be monitored so that the flow in the river immediately downstream of the off-river treatment works intake channel would not fall below 20 cfs.

  Effluent from the water treatment plant would be mixed with the water pumped from the first pond in an in-line mixer and then discharged to the second pond. The second pond would provide additional retention time for mixing prior to the discharge from the pond to the river by gravity flow. The system would be designed to handle an average annual effluent flow rate of 154 gpm, with a maximum rate of 600 gpm from the water treatment plant and a 25-to-1 mixing ratio.

It is expected that efficient controlled mixing would be provided with the use of this effluent discharge option. The expected water quality in the effluent from the HDS water treatment plant is presented in Table 4.3-14. The water quality after mixing with Goodpaster River water at a 25-to-1 ratio is also shown in this table. Expected discharge criteria are presented. Criteria that are hardness based are calculated for a hardness of 27 mg/L, which is the estimated 5th percentile of the hardness of the water upstream of the discharge. This value was used because no mixing zone would be allowed at the proposed location, which is in a potential spawning area. As previously described, two sets of criteria (dissolved and total recoverable) are presented. These represent the State of Alaska recently revised water quality criteria (dissolved) and the EPA criteria on which the NPDES permit would be based (total recoverable). If upstream natural conditions measured concurrently with the discharge were higher than the criteria listed in Table 4.3-14, the discharge criteria would be the upstream natural conditions.

The discharge from the HDS treatment plant mixed with the Goodpaster River water at a 25-to-1 ratio is expected to meet all water discharge criteria. As shown in Table 4.3-14, the discharge meets criteria for all parameters for even the conservative 95th percentile of the annual maximum.

This option would not use river water for mixing when flows in the Goodpaster River were less than 20 cfs. This would affect the ability to discharge water and has an impact on the overall system water balance. If water discharges are limited during low flow conditions in the river, there is the potential that a higher volume of water would be carried through the winter in the RTP. This would result in less freeboard in the RTP for breakup flows. This effect is reflected in the Monte Carlo modeling which showed that the RTP would overtop more frequently for this option than for Alternative 2. Modeling showed the RTP would overtop and discharge without treatment approximately 45 times in 1,000 years during major storm or runoff events. This frequency, although still low, is approximately twice that for the SAS discharge system in Alternative 2. Note that the modeling conducted to determine this frequency of overtopping did not include use of supplemental groundwater from wells for dilution water in the mixing; therefore, this frequency is conservative.

The off-river treatment works would be expected to provide conditions for well-controlled mixing of effluent and river water, as well as favorable conditions for consistent monitoring. The treatment works would also have a benefit of having the mixing occur out of the Goodpaster River. In addition, at 400 gpm, residence time would be approximately 24 hours, which would provide ample time to respond to potential upset conditions at the water treatment plant by closing the shutoff valve in the outlet works of the second pond (Teck-Pogo Inc., 2002i). The system also would have the flexibility to increase water pumped from the first pond into the second pond to provide greater dilution prior to mixed water and effluent reaching the river.

**Table 4.3-14 Alternative 4, Operations Phase Projected Water Quality to be Discharged to Off-River Treatment Works**

| Parameter | Discharge to Off-River Treatment Works from Water Treatment Plant | | Discharge from Off-River Treatment Works to River | | Discharge from Off-River Treatment Works to River | | Water Quality Criteria - Dissolved | Permit Basis Criteria - Total Recoverable | Units |
|---|---|---|---|---|---|---|---|---|---|
| | 95% Annual Average Dissolved | 95% Annual Maximum Dissolved | 95% Annual Average Dissolved | 95% Annual Maximum Dissolved | 95% Annual Average Total | 95% Annual Maximum Total | | | |
| TSS | 20 | 20 | 21.0 | 21.0 | 21.0 | 21.0 | 30 | 30 | mg/L |
| TDS | 433 | 551 | 113 | 117 | 113 | 117 | 500 | 500 | mg/L |
| Cl | 108 | 251 | 5.0 | 10.5 | 5.0 | 10.5 | 230 | 230 | mg/L |
| $SO_4$ | 206 | 272 | 30.0 | 32.6 | 30.0 | 32.6 | 250 | 250 | mg/L |
| $NH_3$[2] | | | | | | | | | |
| TKN | 7.14 | 10.2 | 0.9 | 1.0 | 0.9 | 1.0 | 10 | 10 | mg/L |
| $NO_3$ | 14.4 | 17.7 | 0.6 | 0.7 | 0.6 | 0.7 | 10 | 10 | mg/L |
| $CN_T$ | 22.2 | 33.4 | 0.9 | 1.3 | 0.9 | 1.3 | 5.2 | 5.2 | µg/L |
| As | 30 | 30 | 1.6 | 1.6 | 1.8 | 1.8 | 50 | 50 | µg/L |
| Cd | 0.295 | 0.3 | 0.04 | 0.04 | 0.04 | 0.04 | 0.1 | 0.1 | µg/L |
| Cr | 9.11 | 13.1 | 2.4 | 2.6 | 2.8 | 3.0 | 29 | 29 | µg/L |
| Cu | 10 | 10 | 1.8 | 1.8 | 2.0 | 2.0 | 2.9 | 3 | µg/L |
| Fe | 300 | 300 | 208 | 208 | 651 | 651 | 1000 | 1000 | µg/L |
| Pb | 1 | 1 | 0.26 | 0.26 | 0.41 | 0.41 | 0.59 | 0.60 | µg/L |
| Hg | 0.1 | 0.1 | 0.009 | 0.009 | 0.010 | 0.010 | 0.77 | 0.77 | µg/L |
| Mn | 50 | 50 | 23 | 23 | 26 | 26 | 50 | 50 | µg/L |
| Ni | 23.9 | 30 | 2.6 | 2.8 | 2.7 | 2.9 | 17 | 17 | µg/L |
| Se | 5.62 | 8.79 | 0.58 | 0.70 | 0.77 | 0.93 | 4.6 | 5 | µg/L |
| Ag | 0.0914 | 0.1 | 0.007 | 0.008 | 0.019 | 0.019 | 0.4 | 0.4 | µg/L |
| Zn | 15 | 15 | 4.3 | 4.3 | 4.3 | 4.3 | 39 | 40 | µg/L |

[1] Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated by using a hardness of 27 mg/L. Note that receiving water hardness value may change as additional site data is collected. See Appendix B of DEIS for draft NPDES permit that presents methodology.
[2] Ammonia was not estimated in Monte Carlo model.
Note: Parameter values that are estimated to exceed their water quality criterion are shown in **bold**.

## 4.3.4 Options Related to Surface Access

**Alternative 2**

### Access

***Route***

- Shaw Creek Hillside all-season road   The Shaw Creek Hillside all-season road would cross numerous tributaries to Shaw Creek and would bridge Rosa, Keystone, Caribou, Gilles, and Shaw creeks and the Goodpaster River. The potential water quality impacts for this option include:
  - Erosion and subsequent increased suspended solids during construction
  - Fuel spills during construction

- Runoff during operation
- Fuel or chemical spill during operation

With proper management and mitigation measures, the overall impacts on water quality are expected to be low during construction of the road. During construction in the Shaw Creek watershed, disturbed surfaces could erode and increase sediment loads in runoff. This could cause increased suspended sediment in Shaw Creek, the Goodpaster River, and their tributaries. The increased sediment and turbidity levels would be temporary and could be mitigated by erosion control BMPs, such as proper use of silt fences during construction. The appropriate specific erosion controls to be implemented may be determined by agency and company discussions. Revegetation of disturbed areas after construction would help diminish sediment release to the creeks in the long term.

During road construction, there is also the potential for fuel spills. A fuel spill into Shaw Creek, Goodpaster River, or their tributaries could seriously affect water quality. The chances for a fuel spill could be greatly reduced by proper fuel management. By transferring fuel and refueling equipment only in designated areas with spill containment facilities, the potential for a fuel spill to affect water quality would be small.

After road construction was complete, the road would be used to transport supplies to the mine. Impacts to water quality could occur during this period from runoff from the road and larger spills of material transported. Runoff from the road would include suspended particulate material that could increase suspended solids and turbidity in the surface water bodies. Additionally, runoff from the road would carry any fluids that were leaked from vehicles onto the road, including antifreeze, oil, or other vehicle-related fluids. These runoff-related impacts are expected to be small.

There is also the potential for larger spills of fuel or chemicals to occur. The types and quantities of materials that would be transported to the site during operation are presented in Table 2.3-2. The materials include cement, fuel (primary diesel), explosives, and reagents for the mill. Mill reagents would include lime, sodium cyanide, sulfuric acid, and sodium metabisulfite. Based on the quantities listed in Table 2.3-2, the number of annual truck trips required for fuels and reagents to be used in quantities of greater than 500 tons per year was estimated. These estimates are presented in Table 4.3-15.

**Table 4.3-15 Commodity Transport Frequency**

| Commodity | Quantity per Truck | Annual Number of Trucks |
|---|---|---|
| Fuel | 8,000 gallons | 100 |
| Cement | 27 tons | 520 |
| Lime | 20 tons | 50 |
| Cyanide | 20 tons | 50 |
| Sodium metabisulfite | 20 tons | 50 |
| Sulfuric acid | 20 tons | 25 |

Based on these estimates, there would be approximately one truck each week transporting lime, cyanide, and sodium metabisulfite; approximately two tankers per week for fuel; and approximately 10 trucks per week transporting cement. Sulfuric acid would be transported at an average of one truckload every 2 weeks. A spill of any of these commodities would have the potential to affect surface water quality if the spill occurred near a wetland or a creek. A large spill of fuel or other liquid commodity would have the potential to affect ground water if it occurred at most locations along the route. Spills of some solid commodities (e.g., cement and lime) would have a somewhat lower potential for contaminating surface water or ground water. A direct spill into a surface water body (e.g., wetland or creek) would have the greatest impact.

The probability of truck accidents and releases was reported as 1.9 $x10^{-7}$ spills per mile of travel for rural two-lane roads (Harwood and Russell, 1990). As an example, the probability of a fuel spill with project power supplied by power line (i.e., without need to haul fuel for on-site power generation) over the life of the project for 11 years of operation and a 49-mile route would be approximately 1 percent over the life of the project. This calculation only considered a one-way trip because the return trip from the mine is with an empty truck. This frequency provides an order-of-magnitude estimate because the conditions on the Pogo mine road would be different than those for which the statistics were developed (more difficult driving and road conditions). Cement, lime, cyanide, and sodium metabisulfide would have lower probabilities of spills because of the fewer number of trips. The probability of a cyanide release would likely be lower because of the secure shipping containers planned to be used to transport cyanide. Overall, the likelihood of a substantial release is expected to be low. However, the impact of a large spill into a surface water body would be high.

The potential for a spill would be mitigated by operational processes to improve the safety of travel on the road, including having all traffic in contact with Pogo security and each other while traveling on the road. The overall impact of commodity transport by this access route to water quality would be moderate.

The use of the existing Shaw Creek Road egress would not cause any additional potential impacts to water quality. The proposed Tenderfoot egress option would have minor additional impacts to water quality because construction of this new section of road would be required, but these impacts would be small and temporary.

***Use***

- Pogo project only The potential for accidents and subsequent spills would be minimized if road use were restricted to Pogo-related vehicles only. With lower levels of traffic on the road, drivers properly instructed, and no personal vehicles allowed on the road, this option would have the minimum potential for accidents, spills, and subsequent potential impact to water quality.

- Pogo and other industrial/commercial users only This option could have a somewhat higher volume of traffic from other exploration activities and industrial/commercial operations. If all such drivers were instructed on the procedures for driving on the access road, the risks of an accident and subsequent spill would be moderate. The risk of a spill would be higher than the Pogo-related use only option because of the higher volume of traffic.

- Use by everyone Opening the entire road to everyone during project operation would increase the potential for an accident with a subsequent potential for a spill and an impact to water quality. With drivers on the road who have not gone through specific instructions for driving the road and the higher traffic volume, the risk of an accident with a truck carrying commodities to the mine (fuel or mill reagents) would increase. The risk of an impact to water quality would be moderate.

- ✦ Security gate at Gilles Creek This option would have the same impacts described above for road use by everyone, except those impacts would only occur in the lower two-thirds of Shaw Creek Valley.

### *Disposition*

- Remove and reclaim Removal and reclamation of the all-season road at the end of the project would eliminate the potential for spills from road traffic and would have a potential positive effect on water quality. There would be potential short-term impacts from construction activities required to remove the road. These impacts could include exposed sediments that could be eroded to Shaw Creek and its tributaries and to Goodpaster River, resulting in higher suspended solids loads. These impacts would be short term and could be mitigated by using silt fences, other controls to provide protection from sediment erosion, and BMPs. Revegetation would limit long-term erosion issues. Overall impacts from this alternative would be positive because of the removal of the access road, and the impacts would be short-term.

- Leave open for industrial/commercial users Use of the road by industrial/commercial users would have a higher potential for accidents and spills of commodities that could cause an impact to water quality. The types and quantities of materials transported under this option and the degree of maintenance that the road would receive after the closure of the Pogo project would affect the potential impacts to water quality. If a substantial amount of commercial traffic were maintained carrying commodities similar to the type during the Pogo project operation, the impacts would be moderate.

  - ✦ Leave open to everyone Unrestricted use of the road after mine closure would have the highest potential for accidents and spills of commodities that could cause an impact to water quality. With drivers on the road who have not gone through specific instructions for driving the road and the higher traffic volume, the risk of an accident with a truck carrying commodities to a mine (fuel or mill reagents) would increase. The risk of an impact to water quality would be in the moderate range.

  - ✦ Reclaim past Gilles Creek This option would have the same impacts described above for the option of leaving the road open to everyone, except those impacts would only occur in the lower two-thirds of Shaw Creek Valley.

## Power Line Route

Impacts from the Shaw Creek Hillside power line route are expected to be low and would be the same as described for the Alternative 2 power line option in Section 4.3.2.

# Alternative 3

## Access

### *Route*

- South Ridge all-season road The South Ridge all-season road would have the potential for impacts similar to those described for the Shaw Creek hillside route. The potential for erosion from construction activities, however, would be more severe given the greater steepness of the road profile and more difficult soil conditions (Teck-Pogo, Inc. 2000b). The potential for accidents and spills would be moderate because of the more exposed conditions, ice, higher winds, and greater potential for whiteout conditions in the winter. The potential for an individual spill to affect a water body would be lower because of the distance of the road from active drainages during the ridge portion of the route. This option would have a moderate potential to affect water quality through spills into drainages over the life of the project.

***Use*** Same as Alternative 2.

***Disposition*** Same as Alternative 2.

**Power Line Route** Same as Alternative 2.

## Alternative 4

### Access

***Route***

- Shaw Creek Flats winter-only access Construction-related impacts to water quality on the winter-only access route in Shaw Creek Valley are expected to be relatively minor and short term. Road construction in the section between the Shaw Creek and Goodpaster River valleys would be the same as for the all-season road. At the end of each winter, when the ice that formed on the road melts, any leaks or small spills that occurred on the road surface would enter nearby surface water. Contaminants contained in the winter road would include fluids that could potentially leak from vehicles, including oil, antifreeze, and fuel. The larger spills could be removed prior to breakup to mitigate these releases. The impact of a release is expected to be minor.

  In this option, all surface transportation of materials would occur annually during an approximately 8-week window. It is estimated that 35 trucks per day traveling in convoys 7 days per week, 24 hours per day, would be required to transport fuel and supplies to the mine for the entire year. The conditions during this transportation period would likely be very difficult. A large portion of the transport would be done during the dark, with a high potential for adverse weather conditions. The potential for an accident and subsequent spill would be considerably higher, given these travel conditions; therefore, this option would have a potentially high impact on water quality. For example, a large fuel spill near a tributary to Shaw Creek could result in a high impact to water quality in the tributary and to a substantial portion of Shaw Creek. Some spill cleanup could occur, but with ice or partial ice cover on the tributary or creek, spill containment would be difficult.

  - Traditional winter road construction standards Road construction on most portions of the Shaw Creek Flats winter-only access route would not have an impact on water quality because no excavation or soil disturbance would occur.

  - Perennial winter trail construction standards This sub-option would be similar to the traditional winter road except the trail surface would be bladed flat and would require small cuts and fills and limited removal of some surface organics. This road preparation would initially contribute to an increase in erosion and increase in suspended solids in the surface water bodies adjacent to the road. These impacts would be relatively minor and of short duration if properly managed with the use of sediment controls and revegetation. Because some construction activities would occur in the winter, controls would need to be in place the following spring to prevent erosion.

The potential for accidents and subsequent spills would be slightly lower for this option than for the traditional winter road. This reduced potential for accidents results because the window of availability for the perennial winter trail would be approximately 2 weeks longer than the traditional winter road, which would result in a somewhat lower number of daily truck trips. This option, however, would also have a high potential to affect water quality.

## 4.3.5 Cumulative Impacts

- All-season Road Reclaimed Absence of an all-season road would limit other resource development activities and human use, and would result in no or low cumulative impacts to water quality.

- All-season Road Maintained An extended mine life for the Pogo project itself would have little effect on water quality because there likely would be a relatively small increase in surface disturbance, and because the existing water treatment and discharge system likely would continue to be used.

  The construction of two hypothetical mines in the Goodpaster River Valley would have potential impacts on water quality in the following areas:

  - Roads to the new mines that would increase road construction and truck traffic
  - Additional discharges of excess mine water

  Extension of the Pogo project road from the Pogo mine to the hypothetical Sonora and Slate Creek mines would result in water quality impacts. During road construction in the Goodpaster River watershed, disturbed surfaces could erode and increase sediment in runoff. This could cause increased suspended sediment in the Goodpaster River. The increased sediment and turbidity levels would be temporary and could be mitigated by the proper use of silt fences and other BMPs during construction. Revegetation of disturbed areas after construction would help diminish sediment release to the creeks in the long term.

  Additional truck traffic would contribute to a greater risk of accidents, spills, and subsequent releases to surface water and ground water. If these additional mines were of similar size to Pogo, the truck traffic would increase several-fold. Additionally, the transport of ore from the hypothetical Sonora Creek mine to the Pogo mill would add a potential for a spill of the ore into a water body. The initial impact of such a spill would be primarily an increase in suspended solids of the water body. With time, sulfide minerals could oxidize if they were not removed from the water body. Removal of the spilled ore could be accomplished, but that action would also lead to an additional short-term increase in suspended solids.

  Discharges of excess water from the hypothetical Sonora Creek and Slate Creek mines are assumed to be similar to those expected from the Pogo mine. Treatment of the effluent from these sources would result in a water quality similar to that of water to be discharged from Pogo. Slight increases in concentrations of a few parameters would be likely, including chloride and sulfate, but the differences would be difficult to detect under most flow conditions. In summary, the cumulative impacts of additional mines in compliance with the proper permits would be low.

# 4.4 Air Quality

The National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS) presented in Table 3.8-1 set primary and secondary standards for air pollutants. The primary ambient air quality standards define levels of air quality that are necessary, with an adequate margin of safety, to protect the public health. The secondary ambient air quality standards define levels of air quality that are necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant [40 CFR 50.2(b)]. Public welfare includes impacts on flora, fauna, and soils. The air quality permitting processes are designed to ensure that projects meet these standards. Therefore, a project operating under the terms of an air quality permit is considered to have no major impacts on air quality.

## 4.4.1 No Action Alternative

The No Action Alternative would have very low air quality impacts, and would not affect the ability of other potential projects in the area to be permitted because of air quality concerns. Although there would be minute impacts in the general area as a result of long-range transport of air pollutants from any developed project, the distances between projects would be such that air quality aspects of any one project would not affect the ability of any of the other projects to be permitted.

Overall, the impacts on project area air quality from the No Action Alternative would be minimal.

## 4.4.2 Options Common to All Alternatives

The options common to all alternatives would have low and insubstantial impacts on long-term air quality. Through the construction permit process for air quality, all action alternatives would be required to demonstrate compliance with AAAQS, which meet or exceed the NAAQS. Compliance with these standards is considered adequate to protect the public welfare, and would be ensured by conditions developed in the operating permit process. The results of preliminary modeling conducted with and without on-site generation indicated that all alternatives could meet air quality permitting requirements (Hoefler Consulting Group, 2002).

The construction and operating permit processes would address the release of regulated air pollutants from all stationary sources as well as fugitive dust from operations associated with the project. Stationary sources would include the milling process and camp operations, and fugitive dust sources would include tailings disposal, development rock disposal, and the gravel production. Mobile sources, including vehicles, aircraft, and transportable equipment, are regulated at a national level through manufacturing regulations.

Construction of the project potentially would result in short-term, localized impacts on soils, vegetation, and visibility in the immediate area as a result of fugitive dust. In addition, operation of construction equipment and construction camp generators would result in products of combustion being released to the atmosphere. Although short-term construction impacts are not specifically addressed in the permitting process and there are no specific thresholds for fugitive dust, general air quality regulations require that reasonable precautions be taken to prevent particulate matter from being emitted to the ambient air during construction [18 AAC 50,045(d)]. In addition, emissions from construction equipment and generators are regulated on a national level by manufacturing regulations. As a result, only low and insubstantial impacts on air quality would occur during construction.

Although the options common to all alternatives would have low or insubstantial impacts on air quality, some sub-options would have less impact on the environment than others. Sub-options that limit the use of the airstrip would have less impact on air quality than the sub-options that allow more use of this component. Similarly, removal of the airstrip at the end of the Pogo project would limit the duration of the impact on air quality compared to continued use of the airstrip.

## 4.4.3 Options Not Related to Surface Access

Because the Pogo Mine site is located more than 200 kilometers (125 miles) from any Class I area, none of the alternatives would require an analysis of impacts on a Class I area. In addition, construction and operation of any alternative are not anticipated to have an impact on any Class I area.

**Alternative 2**

### Power Supply

- Power line This alternative would not have an impact on local air quality. It would, however, have low impact in the vicinity of the power generation source, but that source is currently operating under an existing air quality permit.

  At 2,500 tpd, the Pogo project would use approximately 10 MW of power, with up to 14 MW used for the 3,500-tpd scenario. GVEA's available capacity is approximately 90 MW (Ballistic Missile Defense Organization, 2000), with an additional 60-MW projected to be installed by the end of 2004. Thus, there would be ample power available for the proposed project under this alternative.

**Alternative 3**

### Power Supply

- Power line Same as Alternative 2.

**Alternative 4**

### Power Supply

- On-site Generation Preliminary modeling of project emissions with and without on-site power generation was conducted (Hoefler Consulting Group, 2002). Results show very little difference in impacts between the two power supply options. Results of the preliminary modeling indicated both power options could meet air quality permitting requirements and the on-site power generation option would have a low impact on local air quality.

## 4.4.4 Options Related to Surface Access

All access-related options would have low or insubstantial impacts on air quality. Generation of fugitive dust from use of gravel roads and the airstrip, however, would have a small effect on adjacent vegetation. The Shaw Creek Flats winter-only access option would have fewer fugitive dust impacts than use of the full-length all-season road. In addition, the sub-options limiting use of the all-season road to just Pogo project traffic would have less impact on air quality than the sub-options that would allow increased use of this component by other users. Similarly, removal of the all-season road at the end of the Pogo project would limit the duration of fugitive dust impacts on air quality in comparison to continued use of the road.

### 4.4.5 Cumulative Impacts

- All-season Road Reclaimed Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts on air quality other than those of fugitive dust associated with road reclamation.
- All-season Road Maintained Only very low cumulative impacts on air quality would occur from development associated with timber harvesting, extension of Pogo Mine life, and development of the hypothetical Sonora Creek or Slate Creek mines.

  Although there would be minute impacts in the general area of any other developed project as a result of long-range transport of air pollutants, the distances between projects likely would be such that air quality emissions of any one project would not affect the ability of any other projects to be permitted. The permitting processes are used to ensure that cumulative impacts of new as well as existing projects do not result in exceeding the NAAQS and AAAQS.

  The construction and use of new access roads to the hypothetical Sonora Creek and Slate Creek mines would generate additional fugitive dust during construction and operation of the roads themselves as well as other facilities associated with these hypothetical projects. Fugitive dust also would be generated by an airstrip associated with a new Slate Creek mine. Such fugitive dust impacts would be small and limited to the local area.

  Overall, air quality cumulative impacts from maintaining the all-season road would be very low.

## 4.5 Noise

Noise impacts were considered in the context of meeting the noise impact criteria for the Pogo Mine project. These impacts were primarily considered for human noise-sensitive receivers. These receivers include permanent residences, such as those along Shaw Creek Road, and areas that people frequent such as the Quartz Lake Recreation Area. The noise criteria used were derived from the EPA noise guidelines for residential areas and from FHWA traffic noise abatement criteria. The criteria were described in Section 3.9.3 (Noise and Vibration Criteria). These noise guidelines and regulations provide specific, measurable criteria by which noise impacts related to a project can be determined, and they were used in this analysis as the basis for determining the degree of noise impacts. General information on reference noise levels for equipment, noise level predictions, and impact projection methods is provided. Noise impacts on animals also are discussed.

### 4.5.1 No Action Alternative

Dominant noise sources would continue to include local fixed-wing aircraft and helicopter overflights, existing mining and exploration operations, local area snow machines and ATVs (both recreational and local access use), aircraft overflights from USAF training missions, and heavy truck traffic on the Richardson Highway. Other less noticeable noise sources that would continue under this alternative include passenger vehicle traffic and miscellaneous residential, recreational, and commercial activities, including chain saws, generators, and occasional small weapons firing.

Proposed projects that could have an effect on the existing noise environment include construction and operation of the NMDS and construction of a natural gas pipeline, as well as other smaller industrial and commercial activities, such as mining exploration, timber harvesting, and quarry activities. Actual changes in the area's noise levels would vary by project type, location of noise-sensitive receivers, and the type of equipment necessary for the project to be developed.

Overall, no major changes in project area noise levels were projected from the No Action Alternative.

## 4.5.2 Options Common to All Alternatives

There are several primary noise-producing components of mining projects. The three main noise components for the Pogo Mine project would be general mining activities (those activities related to ore retrieval and processing), aircraft flights of supplies and personnel, and mining-related traffic on the mine access routes and along the Richardson Highway. Of these three components, only the general mining activities were expected to produce essentially the same noise level regardless of the alternative selected. The noise levels produced by aircraft and vehicle traffic would vary depending on the type of access, the route, and the design options.

Because of the differences in potential noise levels resulting from the project's various noise sources, several independent models for noise prediction were used in this analysis. The individual noise levels were then summed, logarithmically, to determine the overall noise level for each alternative. The following subsection describes the modeling methods and the general results of the calculations.

**Calculations of Mine Area Noise Levels** Given the existing moderately high level of air traffic in the project area, the limited number of flights that might occur during as well as after mine closure under any use and disposition option, and the limited number of sensitive receivers in the vicinity, changes in noise levels were not projected to be noticeable. Thus, no major differences in noise levels were projected under any of the airstrip use and disposition options.

Noise level projections for operational mine areas were made by using the methods described in EPA (1971b), as well as with information from other acoustical sources related to the type of potential noise-producing activities expected for this project. Reference noise levels for equipment were taken from measured noise levels of equipment in use at actual construction sites or mining operations, and from EPA and FHWA sources. Table 4.5-1 provides some reference noise levels for mining and construction equipment that could be used during construction and operation of the mine. For a sound level perspective, refer to Table 3.9-1.

Noise levels were expected to be the highest during initial construction of the mine site and support facilities. Once construction was completed, and most of the noisiest equipment were moved underground, noise levels for aboveground mine operations would be dominated by haul trucks, maintenance facilities, and other mine-related ancillary facilities.

For the purpose of determining the project noise levels and potential noise impacts, a general "distance versus sound level" table and graph were derived for general activities during construction and operation of the mine. An additional "sound level versus distance" table and graph also were developed for mine traffic on the different access routes. The simple tables and graphs of noise levels do not assume any additional noise reduction from topographical shielding or foliage, and can therefore be considered the “worst case” noise levels that could be produced from the mine and haul routes.

**Table 4.5-1 Reference Mining and Construction Equipment Noise Levels**

| Description[1] | Hourly Use (Minutes[2]) | Sound Level[3] |
|---|---|---|
| Haul trucks, CAT 78X, Dresser 685 or equivalent | 45 – 60 | 72 – 88 |
| Material handlers, Hitachi 3500 or equivalent | 45 – 60 | 84 – 88 |
| Motor graders, CAT 24H or 16H or equivalent | 20 – 40 | 78 – 82 |
| Dozer, Cat D10/11 or equivalent | 20 – 40 | 88 – 92 |
| Loader, Cat 988 or equivalent | 20 – 40 | 84 – 88 |
| Backhoe, CAT 325 or equivalent | 20 – 40 | 76 – 80 |
| Rock drill, IR-DM-M2, TEI jumbo or equivalent | 10 – 15 | 90 – 92 |
| Compactor | 45 – 60 | 86 – 88 |
| Light-duty trucks, service trucks, compressors, pumps, light plants, and other small engine powered equipment | 45 – 60 | 65 – 81[4] |

1 Normal equipment used for mining operations like those proposed for the Pogo project.
2 Average use per hour during normal mining activities.
3 Range of noise levels under normal operation as measured at a distance of 50 ft. For haul trucks, both the idle and nominal maximum operational noise levels are provided.
4 Assumes a mixture of compressors, light plants, small engine-powered generators, welders, and other operational and maintenance equipments. This mixture would be a minimal component of sound under normal operation, and was not expected to result in major changes in the overall noise levels.

For Pogo Mine construction and operations, two separate calculations were performed, one representative of the summer months and another for the winter months. The two calculations were performed to account for the more efficient sound propagation in cold air during winter months.

The winter calculations are representative of the operational noise levels that may be experienced at distances greater than 500 ft from the mine site during periods when temperatures are below 20ºF. The calculations assume soft ground cover, such as snow, and do not provide for actual noise reductions from area topography.

The summertime calculations were similar to the winter noise level calculations, but assume a higher temperature and slightly softer ground cover. These levels would be typical during summer months when temperatures are more moderate and ground cover consists of field grass or other foliage. Again, a direct line of sight between the receiver and the mine is assumed in the calculations. Figure 4.5-1 presents typical mine-related levels of construction noise. Figure 4.5-2 presents typical mine-related levels of operational noise after most noise-producing equipment would be moved underground. Each figure shows the two temperature and ground cover scenarios used to perform the noise calculations.

**Figure 4.5-1 Typical Mine Construction Noise Levels**

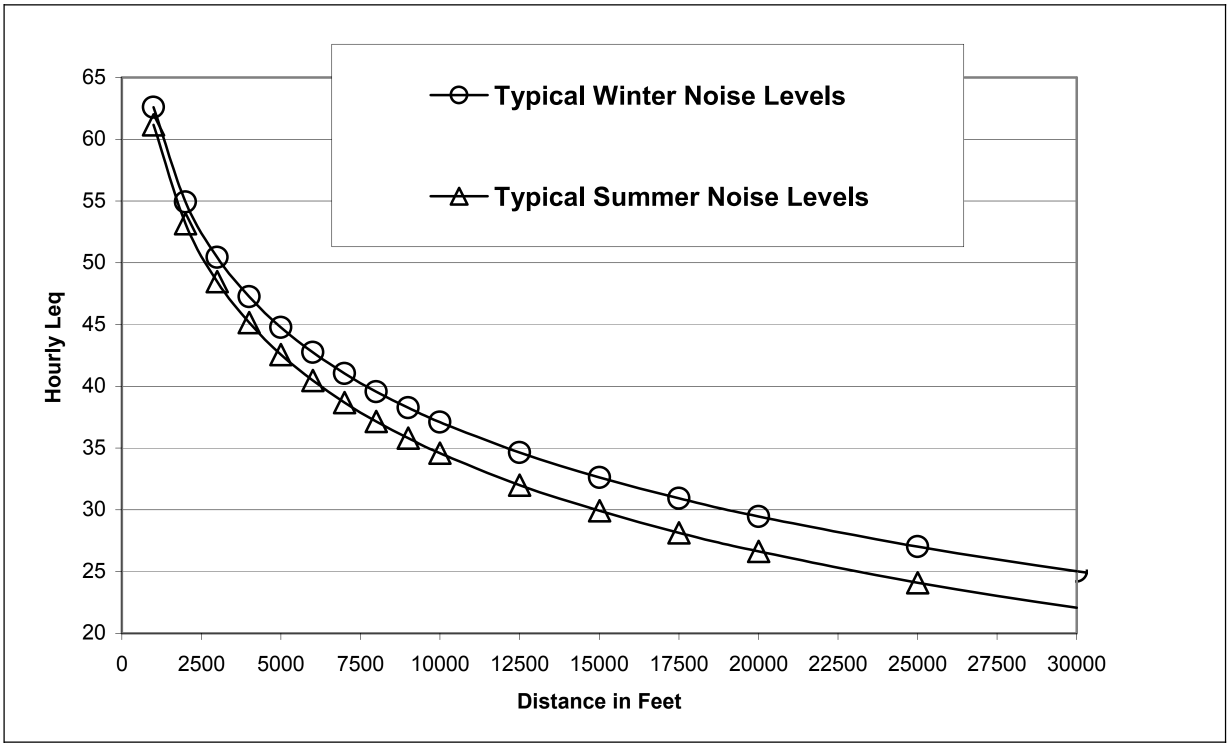
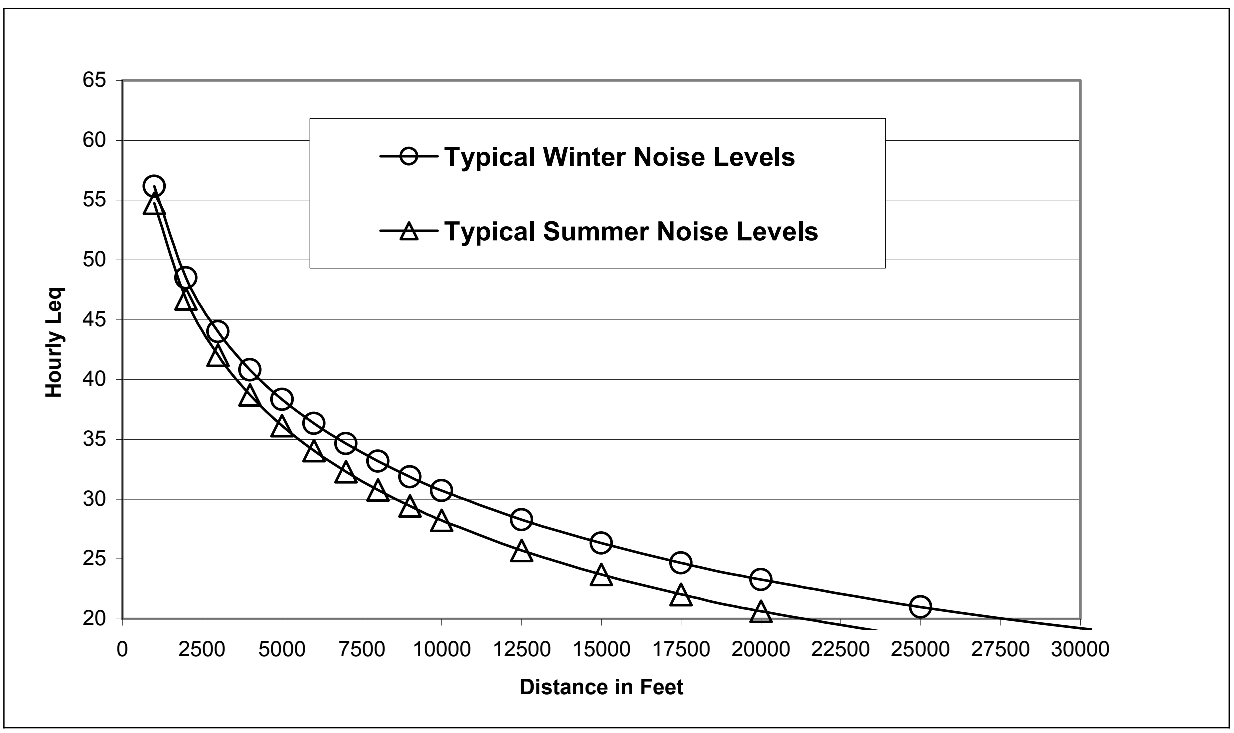



**Figure 4.5-2 Typical Mine Operational Noise Levels**



For noise-sensitive receivers located in the vicinity of Shaw Creek Road, Quartz Lake, Big Delta, and Delta Junction, noise from general construction or operations at the mine was not projected to cause any change over the existing noise environment. All these locations are a long distance from the mine site, and with the additional topographical reductions, noise levels from mine construction and operations were projected to remain below 25 dBA $L_{eq}$. There may be times, however, when atmospheric conditions make some noise from mine activities audible at certain locations. Even under extreme conditions, however, no high noise impacts were projected.

During initial construction, noise levels on the nearby Goodpaster River, between Pogo and Liese creeks, were projected to range from 30 to 40 dBA. Mine operational noise levels in the same area were projected to range from 25 to 35 dBA. Because this area has low human use, and visitors use motorized vehicles such as ATVs and outboard motors in the summer and snow machines in the winter, no high noise impacts were projected.

In addition to the general mining equipment noise, noise from blasting also was investigated for potential noise impacts. Because the distances to noise-sensitive human receivers would be in excess of 15 miles, blasting noise was not projected to result in a change in the existing noise environment at any noise-sensitive locations. Thus, no high blasting-related noise impacts were projected during construction or operation of the Pogo Mine.

Noise levels due to construction and operation of the mine were not expected to have high adverse effects on local wildlife. Loud noises from short-term events, such as blasting, is known to startle nearby wildlife and cause birds to "flutter," but wildlife normally return to their usual lifestyles shortly after such an event (Holthuijzen, 1989). Wildlife tend to habituate to noise from steady-state sources, such as trucks and generators, and such noise alone generally does not result in major changes in normal wildlife patterns. As a complement to other project-related human activities, however, such noise would contribute to wildlife avoidance of the mine site and access route vicinities.

No vibration impacts were projected under any of the alternatives because the distances between the mine, potential haul routes, and vibration-sensitive receivers are sufficiently large that vibration levels were not projected to be noticeable.

As at any remote industrial project site, construction and operations workers would be exposed to varying levels of noise, both during their shift work and during their off hours because they would live in on-site quarters. The mill and other mine area facilities would be designed and operated to reduce noise propagation and to insulate workers from noise. All mine area facilities would be required to meet strict MSHA noise standards designed to limit the levels of noise and periods of time to which mine workers may be exposed.

### Air Access

***Construction Air Traffic*** During initial construction, the mine site airstrip would support operations during the period when Goodpaster Winter Trail access would not be available and the permanent all-season access road not yet completed. Depending on when appropriate permits were received, this period could range from 6 to 12 months.

During this period, there would be between approximately 55 and 70 round trip flights per week, or 8 to 10 flights per day, to the mine area airstrip. These would include Twin Otter, Cessna Caravan, Cessna 206 and 207, DC-3, C-26, Caribou, and SkyVan aircraft. Heavy-lift helicopters also might be used to transport time-sensitive items that could not be transported by fixed-wing aircraft.

Although there is a moderately high level of existing air traffic in the area, the additional Pogo air traffic during construction could result in a high level of impact if flight paths were to be located over groups of cabins on the lower Goodpaster River. Modification of flight paths could substantially reduce such noise impacts.

***Airstrip Use and Disposition*** Given the existing moderately high level of air traffic in the project area, the limited number of flights that might occur during mine operations as well as after mine closure under any use and disposition option, and the limited number of sensitive receivers in the vicinity, the changes in noise levels were not projected to be noticeable. Thus, no major differences in noise levels were projected under any of the airstrip use and disposition options.

## 4.5.3 Options Not Related to Surface Access

### Alternative 2

Same as described in Section 4.5.2.

### Alternative 3

Same as Alternative 2.

### Alternative 4

**Power Supply**

- On-site Generation Same as Alternative 2, except there would be a mine site power plant. Because generators would use sound-reducing equipment, however, on-site power generation was not projected to result in a major change in the noise levels projected for general mining operations as described in Section 4.5.2.

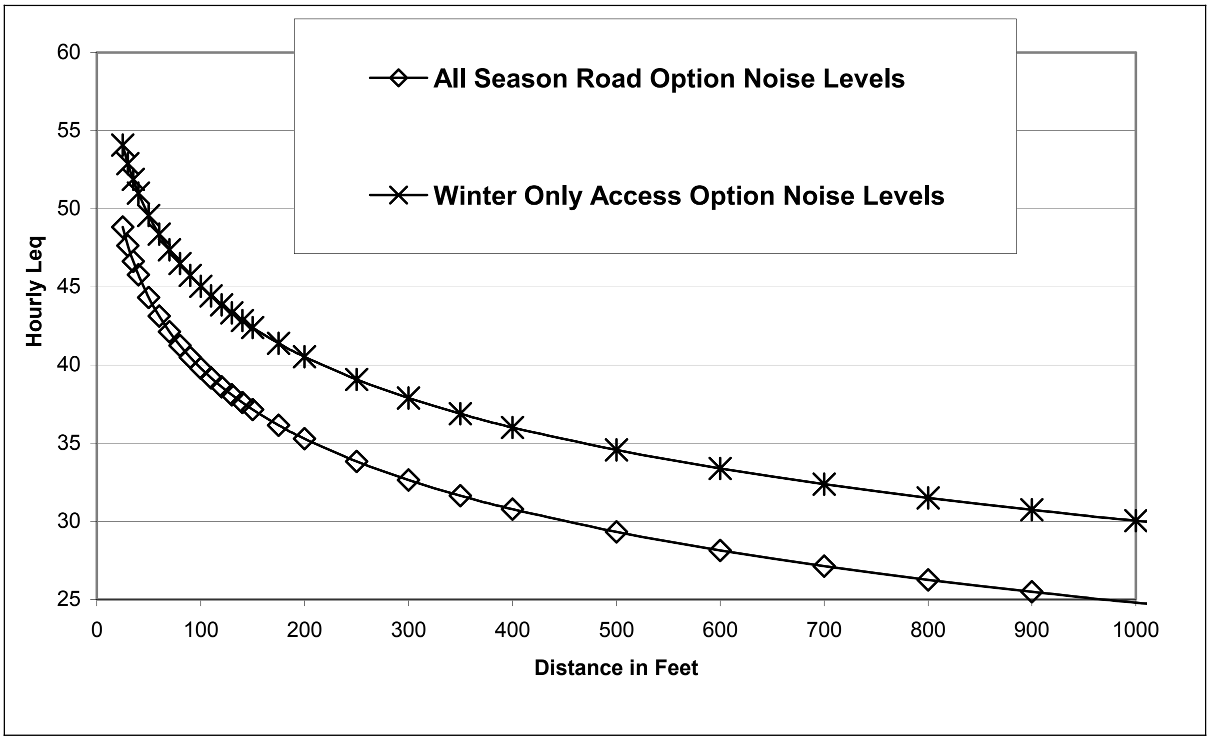
## 4.5.4 Options Related to Surface Access

To provide information on noise levels related to the access routes under consideration, detailed modeling was performed for traffic noise levels related to the access options. The analysis assumed a generic, “worst-case” scenario of vehicles accessing the mine site under all-season road and winter-only access options. Calculation methods and results are discussed below, with an impact analysis provided separately for each access option.

**Calculations of access road traffic noise levels** As with the calculations of operational noise levels, calculations of access road traffic noise assumed a direct line of sight to the roadway, and did not assume any topographical shielding or reduction due to foliage. Figure 4.5-3 presents projected noise levels for the access route under all-season road and winter-only access options assuming a speed of 35 mph. For a sound level perspective, refer to Table 3.9-1.

For the all-season road option, the average nominal Pogo-related traffic to and from the mine was assumed to be one heavy truck, one medium truck, and two cars per hour. For the winter-only access option, traffic was assumed to be three heavy trucks, two medium trucks, and two cars per-hour. Figure 4.5-3, presents the projected maximum hourly noise levels for the all-season road and winter-only access options assuming a speed of 35 mph. As shown in Figure 4.5-3, the winter-only access option was projected to produce noise levels that would be approximately 5 dBA higher than those projected for the all-season road option. These higher noise levels would be due to the more intense traffic use over a shorter time period for the winter-only access (30 to 35 trucks per day versus 5 to 7). The noise levels presented in Figure 4.5-3 can be considered worst-case, and actual noise levels might be 3 to 7 dBA lower due to shielding from area topography.

**Figure 4.5-3 Projected Maximum Hourly Noise Levels for the All-Season Road and Winter-Only Access Options**




## Alternative 2

### Surface Access

***Route*** Under this alternative, mine site surface access would be provided with use of the Shaw Creek Hillside all-season road, with egress from the Richardson Highway provided either by the Shaw Creek Road/Rosa sub-option or by a new Tenderfoot egress sub-option.

- Shaw Creek Road/Rosa egress Seven residential structures were identified close to the existing Shaw Creek Road between the Richardson Highway and the beginning of a new Hillside all-season road (Ridder, 2001). The residences were numbered from 1 to 7, beginning at the Richardson Highway and moving toward the end of the existing road. This information was used to project traffic noise levels at each of the seven residences. The average nominal Pogo-related traffic on the all-season road to and from the mine was assumed as used above for Figure 4.5-3: one heavy truck, two medium trucks, and two cars per hour. The noise from this traffic was added to the existing background noise levels. The results of these traffic noise projections are shown in Table 4.5-2.

**Table 4.5-2 Pogo-Related Traffic Noise at Residences Located Near Shaw Creek Road**

| Receiver #[1] | (Name) | ~ Distance to Shaw Creek Road[2] | Shielding[3] | Existing Noise[4] | Projected Total Noise[5] | Projected Increase in Noise[6] |
|---|---|---|---|---|---|---|
| R1 | (Harrild) | 300 | No | 42 | 42 | 0 |
| R2 | (Newman-1) | 350 | Some | 35 | 36 | +1 |
| R3 | (Newman-2) | 100 | No | 32 | 39 | **+7** |
| R4 | (Teck-Pogo Inc.) | 40 | No | 32 | 44 | **+12** |
| R5 | (Naegele) | 240 | No | 32 | 36 | +4 |
| R6 | (Thorn) | 200 | No | 32 | 36 | +4 |
| R7 | (McNabb) | 910 | No | 32 | 33 | +1 |

1 Receivers were numbered from Richardson Highway toward the end of Shaw Creek Road, and include resident's name.
2 Distance from house to closest point on Shaw Creek Road in feet. For receivers 6 and 7, distance is to proposed new road alignment.
3 All residences, except one, have a direct line-of-site to the road; however, Receiver # 2 is shielded from the road by topography foliage.
4 Estimated existing noise level from measurements in similar areas.
5 Projected noise level combining Pogo-related traffic with existing noise level. This level is the noise level at outside wall of the residence, and does not consider the noise abatement characteristics of the wall and insulation.
6 Values in **bold** font indicate moderate or greater impact.

Between a moderate and high traffic noise impact was identified at receiver R4 due to the closeness (40 ft) of the residence to Shaw Creek Road. The future projected noise level of 44 dBA at this location represents a major increase in noise levels (12 dBA). This absolute noise level, however, usually is not considered a high level in most areas because it is the equivalent of a quiet rural residential area with no activity (Table 3.9-1). Thus, under the noise criteria described in Section 3.9.3 (Noise and Vibration Criteria), although the R4 receiver would experience a sizeable (greater than 10 dBA) *change* in noise levels, it would not be a high impact because the absolute level would be only approximately 44 dBA, well below the 50-dBA criterion for a high impact.

Increases in traffic noise levels of 4 dBA or greater also were identified at receiver locations R3, R5, and R6. Noise levels at these three receivers were projected to increase above existing levels by 4 to 7 dBA, resulting in total noise levels of 39 dBA at R3 and 36 dBA at R5 and R6. These noise levels would be equivalent to a bedroom or quiet living room (Table 3.9-1). Under the noise criteria described in Section 3.9.3 (Noise and Vibration Criteria), these increases were considered moderate. For reference, an increase of 3 dBA is generally considered barely perceptible by an average human ear, and increases of approximately 5 dBA are normally noticeable to most humans. The other five receivers in the vicinity of Shaw Creek Road were projected to experience increases of 4 dBA or less, which were considered a low impact.

Although the modeled results described above do not indicate high impacts under the common noise criteria used for this analysis, that does not mean residents would not be aware of the increased noise levels. The increase would represent a definite change for some residents from the relative isolation they now enjoy.

**Shift-change traffic — TAPS crossing bus station** The Applicant proposes to locate an employee parking area and bus station approximately 2.4 miles from the end of the existing Shaw Creek Road and approximately 750 ft southwest of the TAPS crossing (Figure 2.4-4). Employees would leave personal vehicles in a fenced, secured area, and would be transported to and from the mine by buses. Shift changes would occur every 4 days, and could be at any time of the day or night. Because of the distance to the mine site, it would take approximately 4 hours from the time buses left the TAPS crossing parking area/bus station with the incoming shift until the buses returned to the parking area/bus station with the outgoing shift. Thus, there would be two approximately one-hour peak periods of shift-change traffic on Shaw Creek Road approximately 4 hours apart. During shift changes, up to 180 personal incoming shift vehicles could arrive at the TAPS parking area/bus station, and up to the same number could depart the parking area/bus station approximately 4 hours later.

A traffic noise analysis, similar to the one described above, was performed to determine the increase in noise that shift-change traffic would cause at each of the seven receiver locations close to the existing Shaw Creek Road if the bus station were located near the TAPS crossing. The results of that analysis are shown in Table 4.5-3.

**Table 4.5-3 Shift-Change Traffic Peak-Hour Noise Levels for Residences Located Near Shaw Creek Road With Bus Station Near the TAPS Crossing**

| Receiver #[1] (Name) | | ~ Distance to Shaw Creek Road[2] | Shielding[3] | Existing Noise[4] | Projected Total Noise[5] | Projected Increase in Noise[6] |
|---|---|---|---|---|---|---|
| R1 | (Harrild) | 300 | No | 42 | 48 | **+6** |
| R2 | (Newman-1) | 350 | Some | 35 | 46 | **+11** |
| R3 | (Newman-2) | 100 | No | 32 | **53** | **+21** |
| R4 | (Teck-Pogo Inc.) | 40 | No | 32 | **59** | **+27** |
| R5 | (Naegele) | 240 | No | 32 | 49 | **+17** |
| R6 | (Thorn) | 200 | No | 32 | 49 | **+17** |
| R7 | (McNabb) | 910 | No | 32 | 40 | **+8** |

[1] Receivers were numbered from Richardson Highway toward the end of Shaw Creek Road, and include resident's name.
[2] Distance from house to closest point on Shaw Creek Road in feet. For receivers 6 and 7, distance is to proposed new road alignment.
[3] All residences, except one, have a direct line-of-site to the road; however, Receiver # 2 is shielded from the road by topography foliage.
[4] Estimated existing noise level from measurements in similar areas.
[5] Projected noise level combining Pogo-related traffic with existing noise level. This level is the noise level at outside wall of the residence, and does not consider the noise abatement characteristics of the wall and insulation.
[6] Values in **bold** font indicate moderate or greater impact.

Hourly average noise levels were projected to range from 40 to 59 dBA during each of the hour-long periods when workers were driving to and from the TAPS crossing parking area/bus station. Five of the seven residences either measured 50 dBA or greater, or had increases over existing noise levels of 10 dBA or greater. Under the project criteria, R1 would experience a moderate impact, R2 and R7 would experience a moderate to high impact, and R3 to R6 would experience a high impact. Receivers R3 and R4 were projected to have peak-hour traffic noise levels at or above 52 dBA, and increases of 20 dBA or greater.

**Mitigation** Because of the low existing noise levels and the projected high impacts from shift-change traffic, the following noise mitigation could be considered:

- Restrict shift changes to daytime hours between 8:00 AM to 6:00 PM on weekdays. This time restriction would eliminate increased noise levels during evenings, at night, and on weekends when increased noise would be most bothersome to residents.
- Encourage car-pooling or worker- or Applicant-chartered buses, to reduce the total number of vehicles using the TAPS crossing parking area/bus station. Reducing traffic by 50 percent could reduce noise levels by 4 to 6 dBA.
- Locate the bus station adjacent to the Richardson Highway so that only the buses would traverse Shaw Creek Road.

Under ideal conditions, a 10-dBA reduction from implementation of the second and third mitigation measures would reduce impacts to low or moderate for all receivers, except R3 (moderate to high) and R4 (high). Attaining a full 10-dBA reduction, however, would depend on the success of reducing traffic by 50 percent, and the more problematical success of limiting vehicle speeds to 25 miles per hour. Other mitigation measures for traffic noise, such as a noise wall, were not considered feasible or reasonable, given the location of the road, and required access to the properties from Shaw Creek Road.

**Shift-change traffic ─ Richardson Highway bus station** If the bus station were located adjacent to the Richardson Highway, rather than near the TAPS crossing, approximately six buses would traverse Shaw Creek Road for shift changes rather than the workers' vehicles. Table 4.5-4 presents peak-hour noise levels for the same residences assuming six buses, five passenger cars, one medium truck, and one heavy truck during a 1-hour period.

Hourly average noise levels were projected to range from 36 to 54 dBA during each of the hour-long periods when buses were driving to and from the mine site. For each residence, these values were approximately 5 dBA lower than those in Table 4.5-3 with the bus station located near the TAPS crossing. Four residences measured increases over existing noise levels of greater than 10 dBA, with receiver R4 reaching a level greater than 50 dBA. Under the project criteria, R2 would experience a moderate impact, R3, R5, and R6 would experience a moderate to high impact, and R4 would experience a high impact.

It is important to remember that the peak-hour levels of traffic noise shown in both Tables 4.5-3 and 4.5-4 would occur only during two, 1-hour periods approximately 4 hours apart, and only once every 4 days.

**Table 4.5-4 Shift-Change Traffic Peak-Hour Noise Levels for Residences Located Near Shaw Creek Road With Bus Station on the Richardson Highway**

| Receiver #[1] | (Name) | ~ Distance to Shaw Creek Road[2] | Shielding[3] | Existing Noise[4] | Projected Total Noise[5] | Projected Increase in Noise[6] |
|---|---|---|---|---|---|---|
| R1 | (Harrild) | 300 | No | 42 | 44 | +2 |
| R2 | (Newman-1) | 350 | Some | 35 | 41 | **+6** |
| R3 | (Newman-2) | 100 | No | 32 | 48 | **+16** |
| R4 | (Teck-Pogo Inc.) | 40 | No | 32 | **54** | **+22** |
| R5 | (Naegele) | 240 | No | 32 | 44 | **+12** |
| R6 | (Thorn) | 200 | No | 32 | 44 | **+12** |
| R7 | (McNabb) | 910 | No | 32 | 36 | +4 |

1 Receivers were numbered from Richardson Highway toward the end of Shaw Creek Road, and include resident's name.
2 Distance from house to closest point on Shaw Creek Road in feet. For receivers 6 and 7, distance is to proposed new road alignment.
3 All residences, except one, have a direct line-of-site to the road; however, Receiver # 2 is shielded from the road by topography foliage.
4 Estimated existing noise level from measurements in similar areas.
5 Projected noise level combining Pogo-related traffic with existing noise level. This level is the noise level at outside wall of the residence, and does not consider the noise abatement characteristics of the wall and insulation.
6 Values in **bold** font indicate moderate or greater impact.

- Tenderfoot egress Under this sub-option, only very low impacts were identified because of the distance between any noise-sensitive receivers and the proposed route. Noise from trucks could, at times of low ambient noise, be audible at residences R6 and R7, located closest to the proposed intersection of the Tenderfoot egress route and the proposed extension of Shaw Creek Road. These noise levels, however, would be below the project criteria, and only very low impacts were projected. Noise from the trucks was not projected to exceed the existing ambient levels at the other five receivers near Shaw Creek Road.

***Use***

- Road open to everyone

  - Shaw Creek Road/Rosa egress An analysis of this sub-option was performed. It assumed that 25 passenger vehicles not related to the Pogo project, 5 medium trucks, and 5 heavy trucks per hour were allowed to use the Hillside all-season road *in addition to* Pogo-related traffic. Unlike the shift-change traffic scenarios discussed above, this traffic could occur during any 1 or more hours of the day or night. This traffic volume would account for the worst-case scenario of allowing everyone to use the Shaw Creek Hillside all-season road. Under this scenario, projected hourly noise levels increased by approximately 1 to 2 dBA over the option for only Pogo project-related use (excluding shift-change traffic). This slight increase in noise levels could result in an additional traffic noise impact at receiver location R4 adjacent to the existing Shaw Creek Road. That additional worst-case scenario impact in and of itself would be low because the projected increase would be less 5 dBA or less. This increase, however, would be in addition to increases from Pogo-related traffic. For receiver R4, these combined increases would approach 50 dBA, which has been defined as a high impact (Table 3.9-2). A level of 50 dBA, however, is considered quiet, or the equivalent of light auto traffic at 100 ft (Table 3.9-1). No other additional noise impacts were projected under the different use options for the all-season road option.

***Disposition*** Of the all-season road disposition options, only removal and reclamation of the road would provide a substantial reduction in noise levels. If the road were left open for commercial and industrial uses, or left open for use by everyone, future noise levels would depend on the actual extent of use. Under either of these two options, however, future noise levels were not expected to exceed those projected during mine operations by more than 1 to 2 dBA as described immediately above in the road use subsection (Table 4.5-2and Figure 4.5-3).

### Power Line Route

- Shaw Creek Hillside Construction of this route was projected to result in very low noise impacts to any residences because of the distance from the alignment to noise-sensitive receivers.

### Air Access

Airstrip Traffic It was estimated that approximately 100 flights per year, or approximately two per week, would be required to support the mine area facilities under this all-season road alternative. Because of the moderately high level of existing air traffic in the area, flight paths that avoid sensitive areas, and the relatively limited number of aircraft that would access the airstrip, a low noise impact was projected.

## Alternative 3

### Surface Access

***Route*** Access from the Richardson Highway to the South Ridge all-season road would pass near Quartz Lake, but would be substantially farther from the cabins on the lower Goodpaster River. The distance from the South Ridge all-season road route to sensitive receivers in these areas would be more than 1,000 ft; therefore, only low noise impacts were projected at receivers in this area. This level of impact does not mean that noise from vehicles would not be audible. The projected noise from truck operations, however, would be well below the impacts criteria in Section 3.9.3 (Noise and Vibration Criteria) and was not projected to exceed 25 to 30 dBA $L_{eq}$, which is equal to or below the average ambient noise for the locations at issue. There would be potential for Quartz Lake residents and lower Goodpaster River cabin owners, during times of low ambient noise, to hear some road traffic. These noise levels would have a low impact, and noise from trucks would be unlikely to be audible inside the residences.

***Use*** The three use options for the all-season road under this alternative were not projected to cause a noticeable change in overall noise levels.

***Disposition*** Same as Alternative 2.

### Air Access

Airstrip Traffic Same as Alternative 2.

## Alternative 4

***Route*** Under Alternative 4, winter-only access would be constructed in the Shaw Creek Flats. Projections on Figure 4.5-3 show that noise levels would exceed the ambient levels at locations within 350 ft to 400 ft of the proposed Shaw Creek Flats winter route. No noise-sensitive receivers were identified; therefore, no noise impacts were identified.

***Use*** Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, as the DOF road, which would be open to the public, was extended toward Gilles Creek, noise impacts from public and logging use of the DOF road would begin to approach those described for Alternative 2, except the daily Pogo traffic noise would not occur.

### Air Access

Airstrip Traffic Under this winter-only access alternative, an estimated 500 flights per year (versus 100 for Alternatives 2 and 3) would use the airstrip, an average of between 1 and 2 flights per day. The additional aircraft under this alternative still were not projected to cause a noticeable increase in the overall noise environment. As described under Alternative 2, the proposed flight paths would avoid sensitive areas and only low noise impacts were projected.

## 4.5.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative noise impacts other than those associated with road reclamation.

- All-season Road Maintained The primary area for cumulative noise impacts concern would be at the residences located along the existing Shaw Creek Road. It would be possible with continued all-season road operation that traffic could increase substantially over time from logging, other industrial/commercial developments, and a road open to the public. For a least one residence on Shaw Creek Road, this cumulative increase could approach a high impact.

  In other areas, because most of the additional noise sources would be sporadic in nature and would occur over a large area, it is not possible to accurately quantify and provide cumulative noise levels. Existing and future noise sources, however, when combined with noise levels from Pogo Mine operations, were not projected to result in any high local *long-term* noise impacts. There may be times, in certain areas, where the combined noise from different sources might result in a noise level increase of greater than 3 but less than 10 dBA, which has been defined as moderate. Such an increase, however, most likely would be short term in nature, and would not result in more than a short-term noise impact.

  An extension of the life of the Pogo project because of discovery of additional deposits in the near vicinity of the Pogo ore body would have relatively few additional cumulative noise impacts because most of the existing noise-producing infrastructure would still be used. Development of a hypothetical Sonora Creek mine or a hypothetical Slate Creek mine would increase the geographic distance over which human-generated noise would occur, but because noise levels attenuate relatively quickly with distance from the source, high noise levels would be restricted to the near vicinity of these hypothetical new mines.

  As is shown in Figures 4.5-1 through 4.5-3, noise level increases would occur within 2 to 3 miles of a mine during construction and within 1 to 2 miles of a mine during operations. In addition, noise level increases could be expected within 1,000 ft of a mine access route. Because these hypothetical mines would be in a remote area, with low existing noise levels, there would be potential for noise level increases along trails and other areas that would be used by nonmotorized users such as cross-country skiers, hikers, and mushers. The actual increase in noise would depend greatly on the distance from the mine to the trail, weather conditions, and topography between the trail and the mine or haul route. Unless a trail were within 2 miles of a mine, however, the noise level increase would be less than 3 to 5 dBA; therefore, no high noise impact would occur. There would be times, however, when mining operations might be audible at greater distances due to atmospheric conditions. As discussed earlier, however, noise level increases would be within the EPA criteria, and overall mine-related noise levels would remain at or below 32 to 35 dBA at distances greater than 1 to 2 miles from the mine site. Thus, human noise as a factor disturbing the natural tranquility of these presently remote areas could affect the experiences of nonmotorized backcountry users, but cumulatively it largely would be below the levels considered to be a high impact based on intensity of noise levels (Table 3.9-1).

## 4.6 Wetlands

Unless otherwise stated, the degree of wetland impacts is discussed below in the context of the Shaw Creek drainage, the Goodpaster River drainage, and the north side of the Tanana River drainage from the Goodpaster River mouth to where the Tanana and Delta rivers join. Wetland regulation is aimed at protecting water resources, and this area encompasses the hydrologic units that would be directly affected by project activities. The degree of wetland impacts is related to several other resources (e.g., wildlife, surface and groundwater hydrology, and water quality) that are discussed in more detail elsewhere in Chapter 4.

Section 3.11 lists wetland functions expected in the four main hydrogeomorphic (HGM) wetland types of the project area. The ways in which those functions might be affected by project activities are briefly discussed below, by function. Note that clearing is defined as removal of vegetation above ground level, but with no major damage to the vegetative mat on the ground surface. Surface disturbance is defined as major damage to or removal of the vegetative mat. And the word “disturbance” alone is used generically to include clearing and surface disturbance.

**Modification of Groundwater Discharge** Slope wetlands perform the function of modifying groundwater discharge. This function would be eliminated in areas that were filled, or possibly would be displaced to areas adjacent to the filled area, resulting in those areas becoming wetter. In areas that were cut – for example, on the upslope sides of roads or building pads – groundwater discharge might still occur, but that discharge would no longer occur through an organic soil layer; the resulting runoff would be faster without the surface soil and vegetation to moderate the flow, and might cause erosion or sloughing of soils. This change in groundwater discharge might also lower base flow in creeks downstream. Groundwater flow might be disrupted where project activities cause subsurface changes, such as compaction of soils or backfill with material that has transmissivity different from that of the natural substrate. Disruption of groundwater flow might alter the locations of groundwater discharge upslope or downslope of the areas of disturbance. Clearing of wetlands above the herbaceous layer would not likely alter this function.

**Modification of Stream Flow** All project area wetland types moderate stream flows, but in different ways. Flat wetlands lessen storm flows in streams, primarily by catching precipitation on vegetation and absorbing it in their soils. Slope, riverine, and depressional wetlands similarly slow runoff of direct precipitation, but also slow downstream release of incoming surface flows by resistance of their vegetation and microtopography. Depressional wetlands also detain water by their topography. Riverine wetlands provide a wider flow path for storm waters overtopping stream banks, as well as depressions where those overflows may be detained. Cutting, filling, or grading a wetland would eliminate its ability to perform these stream-modification functions because the water absorption capacity of the soil would be eliminated, along with the microtopographic relief and vegetation of the site that provide roughness against surface water flow. Fills that cut across riverine wetlands, isolating those wetlands from the corresponding creek, would eliminate the floodwater storage function of isolated wetlands. Clearing of overstory vegetation would not alter performance of stream-modification functions. Increased impervious area in a watershed, such as that formed by roads and work pads, would enhance the importance of wetlands downstream of those surfaces for moderating flows to creeks.

**Maintenance of Soil Thermal Regime** The function of maintaining soil thermal regime is performed by wetlands on permafrost. Although most riverine wetlands probably do not have permafrost, slope, flat, and depressional wetlands may perform this function. In wetlands overlying permafrost, the thick moss cover and organic soil surface insulate the soil against warming in the summer. In addition, the shade from vegetation limits soil warming. When moss and organic soil layers or overstory vegetation are removed by clearing, cutting, or grading, the permafrost may thaw. Mineral fill material has less insulative quality than does organic soil; therefore, filling over wetland surfaces might also lead to degradation of permafrost on that site and in immediately adjacent areas. In some areas, filling would have the effect of eliminating the impermeable layer in the soil and improving drainage through the soil, leading to the conversion of the site to nonwetland. As such a site turned to upland, its wetland vegetation and fauna support functions would be lost, and upland vegetation and fauna support functions would be gained. The ability of the wetland to moderate stream flows would be enhanced by better infiltration (thus recharging ground water) and absorption of water by unsaturated soils. In low-lying areas, and those with ice-rich permafrost, thawing may lead to more ponded conditions and, in some places, to collapse of soils and degradation of permafrost beyond the originally disturbed area. Ponding or degradation of permafrost could lessen the ability of the wetland to moderate stream flows and to retain sediments because of vegetation loss, and would alter the type of wetland vegetation and fauna the wetland would support. Thawing of permafrost may result in exposure of mineral and organic soil that may be subject to erosion and subsequent degradation of water and habitat quality. After perturbation, a maintenance of the soil thermal regime in a wetland is not regained until a moss and organic soil layer is regenerated. This regeneration may require many decades. On some sites, such as those with coarse soils, permafrost may not be regenerated.

**Export of Detritus** Vegetated riverine wetlands and slope wetlands produce organic matter that may be exported to downstream systems in dissolved and particulate forms. This organic carbon may be dropped directly into streams or may be carried into streams by runoff and flood waters. This carbon serves as an energy source for aquatic organisms, supporting downstream food webs. Activities that remove vegetation from wetlands, such as cut and fill, eliminate the ability of wetlands to perform this function. Clearing of shrubs and trees would reduce the amount of organic material available for export, although the debris and decaying vegetation resulting from clearing might provide a temporary source of additional material for export. Construction of fill pads that isolate vegetated wetlands from streams would inhibit this function.

**Modification of Water Quality** Slope, riverine, and depressional wetlands perform the function of modifying water quality, which entails removal of suspended and dissolved materials from incoming surface water and retention or conversion of those materials to another form. This function has particular importance in areas where pollutants are generated that wetlands might “treat” before water is discharged to downstream aquatic systems. Filling a wetland would eliminate the function of treating water because the vegetation, soil, and microbes that perform the function would be covered. Excavating or cutting wetlands would severely reduce performance of treating or modifying water quality because several of the features instrumental in the modification would be eliminated: plants, microtopography, soil, and microbes. Clearing wetlands above the herbaceous ground surface would not substantially detract from the function of modifying water quality. The importance of this function would increase in wetlands downstream of soil disturbance, stockpiles, and fill activities.

**Contribution to Abundance and Diversity of Wetland Fauna and Vegetation** The functions of contributing to the abundance and diversity of wetland fauna and vegetation are performed by all wetlands. Cutting, filling, and grading wetlands would eliminate their ability to support wetland vegetation and fish and wildlife other than disturbance-adapted species. Excavation in low-lying areas, as for gravel pits, might convert wetlands from vegetated sites to ponds that would support different plant and animal species, including fish. Clearing of wetlands would degrade the habitat quality for most animal species that had used the wetlands before clearing. If inappropriately designed, access roads across wetlands that support fish could block access to aquatic habitat. Most project activities would disturb wildlife in adjacent wetlands, limiting their ability to support sensitive wildlife species. Similarly, dust particulates moved during snow plowing, pollutants in water, and increased runoff might slightly alter the plant species in wetlands adjacent to developed areas.

## 4.6.1 No Action Alternative

Construction of the NMDS and a natural gas pipeline would cause some loss of wetlands through placement of fill or by ground disturbance that causes degradation of permafrost and draining of soils, and would cause degradation of wetland functions by clearing, excavation, and backfill.

Virtually all commercial, industrial, military, and residential growth in the Delta area would entail or promote development of land, primarily along existing roads, for homes, yards, commercial sites, or material sources. A small portion of that developed land would be in wetlands in the lower Shaw Creek drainage. Such development generally would avoid use of wetlands because of their relatively poor building qualities and their regulatory constraints.

The DOF's proposed timber harvests generally would not include substantial wetland areas, but access roads to the timber likely would. Roads would be built in the Quartz Lake area and along the Shaw Creek Hillside, roughly in the same location as the Applicant's proposed Shaw Creek Hillside all-season road. Both forestry roads would entail loss of wetlands along an estimated 10 to 20 percent of their lengths. These roads also would open up new areas for use by ATVs, which tend to use and damage wetlands.

Recreationists would continue to seek new areas to explore, hunt, fish, and use for building cabins. The use of ATVs to support these activities would continue to increase, along with resulting wetland damage.

Overall, the impacts on wetlands in the project area from the No Action Alternative would be minimal until the new forestry road is developed up the Shaw Creek Valley. As that road extends to Gilles Creek, effects of off-road ATV use could gradually grow to become a major impact to wetlands. The degree of impact would depend on how much ATV use grows and whether ADNR or hunting and fishing regulations were implemented to effectively control off-road ATV use.

## 4.6.2 Options Common to All Alternatives

Although approximately 30 percent of the mine area is wetland (Table 3.11-1), 40 percent of the area that would be disturbed for the facilities would be in wetlands (including cut, filled, and cleared areas). This disproportionate use of wetlands results from the need to site mine facilities on flatter, low-lying areas, which also tend to be wetlands. The acreages of mine area wetland impacts are shown on Table 4.6-1.

**Table 4.6-1 Acreage (and Percentage of the Cut, Filled, and Cleared Area) of Wetlands, Waterways, and Uplands Cut, Filled, or Cleared in the Mine Area[1]**

| Type of Water Body | Area Cut or Filled | Area Cleared Only |
|---|---|---|
| Wetland | 152 (39) | 14 (33) |
| Other potential waters of the U.S. | | |
| Pond | 1 | 0 |
| Broad river | 0 | 1 |
| Gravel bar | 3 | 1 |
| Total of all water bodies disturbed | 155[2] (41) | 16 (37) |
| Upland disturbed, including areas already filled (26 acres) | 228 | 27 |
| **Total wetlands and uplands** | **383** | **43** |

[1] The numbers shown are for Alternative 2. Alternative 3 would require filling 1 more acre of wetland than Alternative 2 at the airstrip for an additional fuel storage area. Alternative 4 would require clearing 6 fewer acres of wetlands than Alternative 2 or 3 because a power line would not be built at the mine. Alternative 4 would require filling 12 to 13 more acres of wetlands than Alternative 2 or 3 because of increased storage space needed for fuel and other supplies to last through the period when winter-only road access were not available.

[2] Rounding error

### Tailings Treatment Facility

Together, the dry-stack tailings pile, RTP, and associated access roads and diversion ditches would require approximately 43 acres of cut or fill in wetlands (Figures 2.3-1 and 2.3-1e). The access road and ditches would generally be in nonwetlands. Because the tailings pile and RTP must lie in the bottom of a valley, they would be constructed primarily in wetlands – the dry-stack tailings pile located primarily in flat wetlands and the RTP primarily in slope wetlands. Both would eliminate a portion of Liese Creek and its adjacent riverine wetlands. A nonmineralized stockpile and growth media pile would also be located in valley-bottom slope wetlands. All of the functions of these wetlands would be eliminated, including attenuation of flows in Liese Creek, organic matter export, and wetland flora and fauna support. The effects on wetlands would be high in the context of the Liese Creek Valley, but minor in the context of the Goodpaster and Shaw drainages; all effects would be imperceptible in these contexts.

After mine closure and reclamation, parts of the RTP area likely would regain depressional wetland status if graded to hold water. They would regain some stream flow moderation and fauna and flora support functions.

### Mill and Camp

The mill and camp and associated access roads, construction road, and diversion ditches would require cut or fill of approximately 27 acres of wetlands (Figures 2.3-1, 2.3-1c, and 2.3-1d). The mill site would be mostly located in uplands. The other components would be located largely in flat and slope wetlands, impinging on riverine wetlands only minimally. These components would eliminate functions similar to those described for the tailings disposal system. All these facilities would be laid out roughly parallel to the slope; therefore, they would likely disrupt the groundwater discharge function of the remaining slope and riverine wetlands downslope. Wetlands downslope of the road, mill, and camp pads might become drier because they would not receive water from upslope. Again, the impacts on wetlands would be high only within the context of the Liese Creek Valley, but would be minor and undetectable in the context of the Goodpaster and Shaw Creek drainages. After mine closure, the mill and camp pads would be ripped and recontoured. After many decades, these sites could regain some wetland functions such as wildlife support and stream flow attenuation, even if they did not regain wetland status.

### Gravel Source

Gravel would be excavated near the airstrip, below the 1525 Portal, at the mouth of Liese Creek Valley, above the dry stack in Liese Creek Valley, and on the west side of the Goodpaster River south of the 1525 Portal (Figures 2.3-1, 2.3-1a, and 2.3-1b). Growth media piles would be similarly dispersed throughout the mine area.

The borrow sources in Liese Creek Valley would require excavating approximately 3 acres of slope and flat wetlands. The proposed gravel pits and growth media piles at the airstrip would require cutting or filling approximately 3 acres of slope, flat, and riverine wetlands. The north pit at the 1525 Portal would be located in 4 acres of flat and slope wetlands, and the growth media piles there would require filling approximately 2 acres of slope and flat wetlands. The gravel pits on the west side of the Goodpaster River south of the 1525 Portal area and the associated road and growth media piles would entail cut or fill of approximately 30 acres of flat and slope wetlands next to the river and of riverine wetlands. Approximately 9 acres of that fill would be temporary.

Gravel excavation or placement would eliminate most functions of the affected wetlands, including stream flow attenuation, organic material export, maintenance of permafrost, and vegetation and wildlife (potentially including fish) support. The ability of the wetland soil and vegetation to filter pollutants from adjacent development also would be lost. Groundwater discharge would still occur in the gravel pits.

The gravel pits on the Goodpaster Valley floor, even those sited in uplands, likely would become ponds; therefore, gravel pit development would result in a net gain of wetlands or water bodies. The ponds would support wetland fauna after reclamation, and some likely would become accessible to fish in the Goodpaster River. The adverse impacts of wetland elimination would be moderate in a local context because a substantial wetland area would be lost; however, the adverse effects would be offset by pond creation, resulting in a negligible impact overall.

### Construction Camp

The construction camp would largely use existing disturbed pads (Figure 2.3-1a). Additional surface disturbance for the camp, water treatment plant, and roads would affect approximately 6 acres of primarily flat and slope wetlands. Most of these fills would be adjacent to existing surface disturbance, and some of the functions of wetlands may have already been degraded. The functions of these wetlands would be eliminated. The water quality improvement functions of the remaining downslope wetlands in the 1525 Portal area would become even more important for cleansing of water before it flowed into the Goodpaster River. The impact of the loss of these wetlands would be moderate on a local scale; the functions of these wetlands are more important than those in other areas because of their proximity to the river, but the absolute area of loss would be small. In the context of the Goodpaster and Shaw drainages, the impact would be low.

### Laydown Area

Impacts of laydown areas at the airstrip and mill are addressed in discussions for those project components. The laydown area at 1525 Portal would require placing fill in approximately 10 acres of slope and flat wetlands near the Goodpaster River (Figure 2.3-1a). The functions of these wetlands would be eliminated, including maintenance of base flow to the river, attenuation of flood flows, detritus export, and wildlife and vegetation support. The laydown area would also adversely affect adjacent wetlands through generation of dust and water containing low levels of pollutants. Therefore, the water quality maintenance functions of adjacent wetlands would become more important. The laydown area would probably disrupt the groundwater discharge function of downslope wetlands. Filling of wetlands in the 1525 Portal laydown area represents a moderate impact in a local context because it is a substantial area of a relatively important type of wetland, near the Goodpaster River. In the context of the Goodpaster and Shaw drainages, the impact would be low.

### Water Supply

- Wells The impact of water supply wells would be negligible, limited to small surface disturbance during drilling of the wells and installation of pipes leading to or from the wells (Figure 2.3-1a). Wetland surfaces would be disturbed, but no functions would be eliminated. This impact would be negligible for all wells.

### Water Discharge

- Domestic wastewater The sewage treatment plant near the 1525 Portal would require filling less than an acre of flat wetland. The functions of that wetland area would be lost. The impact would be negligible.

### Fuel Storage Location

Temporary fuel storage for the development phase would occur below the 1525 Portal and at the airstrip within areas directly disturbed for other components discussed above. This disturbance would represent a minor impact given the low risk of a substantial spill and the short duration of the development phase.

### Air Access

- Airstrip The airstrip itself would be sited to largely avoid wetlands (Figures 2.3-1, 2.3-1b, and 3.11-2). Approach and departure clearance requirements, however, would necessitate clearing taller vegetation from 8 acres of wetland and gravel bar (flat, some slope), and construction of the airstrip, apron, and roads would require filling approximately 4 acres of flat and slope wetlands. Laydown areas would require filling 9 to 22 acres of flat and slope wetlands. The wildlife support functions of the cleared wetlands would be degraded; other functions of cleared areas would not be substantially affected. Clearing in wetlands or uplands adjacent to riverine wetlands would detract from their fish habitat qualities. Filling of meandered dry channels could cause some localized scouring of river channels. Such fill would eliminate the functions of affected wetlands, including stream flow moderation, detritus export, groundwater discharge, and vegetation and wildlife (including fish) support. Loss and alteration of riverine side channel wetlands would be a major impact locally (loss of fish habitat and localized alteration of flooding and scour), but a minor one in the context of the Goodpaster and Shaw Creek drainages. The other wetlands that would be affected would be on the margins of much larger wetlands that would generally remain undisturbed. Because the wetlands are near other affected wetlands and connected to the Goodpaster River, that loss would represent a moderate impact in a local context.

The access road from the construction camp and 1525 Portal area to the airstrip would require cut and fill in 13 acres of wetland and the Goodpaster River gravel bar. It would be located primarily in flat wetlands, but would cross riverine wetlands at Liese Creek, on the gravel bar, and in some areas of slope wetlands. The access road would eliminate functions of those areas, including moderation of stream flows and wildlife support. Elimination of these functions would represent a moderate adverse impact locally because the area of wetland loss would be substantial, and those wetlands are near the Goodpaster River, but a low impact in the context of the Goodpaster and Shaw drainages.

***Use and Disposition*** Use only by the Pogo project during mine operations and removal and reclamation at mine closure would have the impacts described above. Use of the airstrip by other industrial/commercial users or by everyone, during and/or after mine closure, could lead to slightly more development in the immediately adjacent wetlands if such users received approval to establish permanent operations. This additional development likely would not lead to substantial adverse effects on wetlands.

## 4.6.3 Options Not Related to Surface Access

**Alternative 2**

### Power Supply

- Power line Using power from the regional grid would require constructing a transmission line from near the Richardson Highway to the mine site. This construction activity would require clearing and slightly disturbing the ground surface of approximately 119 or 158 acres of wetlands and other water bodies, depending on the route. The effects of this clearing for each route are discussed in Section 4.6.4 below.

  The power line from the Goodpaster River to the mill and camp area would require clearing approximately 6 acres of wetlands and minimal excavation and backfill in wetlands to install the power line. Wildlife habitat functions would be slightly degraded. This degradation of wildlife habitat function would represent a minimal impact on wetlands.

### Water Discharge

- Soil Absorption System
  - Adjacent to airstrip This option would be constructed primarily in uplands, but would require eliminating the upper ends of two side channels of the Goodpaster River. The stream flow moderation and wildlife, particularly fish, support functions of these waterway areas would be lost. This loss of wetland functions represents a minor additional impact to wetlands (after the lower ends of the channels are filled for the airstrip).
  - Saddle above Pogo Ridge The exact location of this option has not been defined. Because much of the area above Pogo ridge is wetland, elimination of up to 7 acres of flat wetland is assumed for this option. Additional wetland area would likely be disturbed for site access and installation of the pipe to the site. The functions of

these wetlands would be eliminated, including permafrost maintenance and flora and fauna support. This loss of wetland functions would be a minor impact because it would not affect areas outside the area directly disturbed and would occur far from creeks. The affected wetland acreage would be greater than if located at the airstrip, but the value of the wetlands that would be affected on Pogo Ridge is lower than that of the channels that would be affected at the airstrip; thus, the two options are approximately equivalent

- Underground Injection Wells Under certain circumstances these wells would have the capacity to increase the groundwater table level and result in surface discharge through low-elevation swales and otherwise dry sloughs in the general vicinity of the wells. This surface discharge could create small, scattered, wetland-like areas. Their formation, however, likely would be sporadic and ephemeral. Thus, if this situation were to occur, the wetland benefits would be small.

## Alternative 3

### Power Supply

- Power line Same as Alternative 2.

### Water Discharge

- Direct Discharge to Goodpaster This option would entail a negligible impact to wetlands (0.1 acre) where the road to the discharge point would be constructed across complexes of flat, slope, and riverine wetlands.

## Alternative 4

### Power Supply

- On-site generation On-site power generation would require the transport, transfer, and storage of approximately 4.2 million gallons of diesel fuel annually. Fuel storage would be located at the airstrip. Transport and transfer of fuel would substantially increase the risk of spills into wetlands. These activities also would increase road traffic, which would result in an increase in dust and sediment-laden road runoff into wetlands adjacent to the road. Given the moderate risk of a serious spill, the moderate risk that the spill would occur in wetlands (based on proportion of the access road crossing wetlands and storage in Goodpaster Valley wetlands), and the small acreage of wetland that likely would be directly affected, these impacts would be moderate and higher than potential fuel spill impacts associated with use of a power line. On-site generation also would require larger fuel storage areas at the airstrip, mostly in wetlands.

### Water Discharge

- Off-river treatment works The treatment works would be constructed largely in the pits left after excavation of gravel from an upland site at the north end of the airstrip. The effects of the gravel extraction are described in Section 4.6.2 above. The treatment works would have no additional wetland effects beyond those described above for the gravel pits, which are essentially the same between the alternatives.

## 4.6.4 Options Related to Surface Access

The acreages of impacts to wetlands resulting from surface access and power line construction from the Richardson Highway to the Goodpaster River Bridge are shown in Table 4.6-2 for each alternative. The same impacts by HGM wetland type are shown in Table 4.6-3.

### Alternative 2

#### Surface Access

##### *Route*

- Shaw Creek Hillside all-season road This section discusses the impacts of the road itself; the effects of its use are presented under the road use section below.

  This alternative would cut or fill 120 acres of wetlands and other waterways. Of the 23 borrow sites that would be used for road construction, 15 would be located completely in uplands. The other eight would affect wetlands, but at only four of those sites would wetlands constitute more than 10 percent of the area. The functions of the wetlands cut or filled would essentially be eliminated. These wetlands would be affected as described earlier in this section. Comparison of the HGM wetland types that would be affected by cut or fill (Table 4.6-3) to the amount of those types present in the corridor (Table 3.11-4) shows the route would disproportionately affect flat wetlands (60 percent used versus 43 percent present) and avoid use of slope wetlands (28 percent used versus 44 percent present).

**Table 4.6-2 Acreage and (Percentage of Cut, Filled, and Cleared Area) of Wetlands, Waterways, and Uplands Cut, Filled, or Cleared for Surface Access and Power Line Construction[1]**

| Type of Water Body | Alternative 2–Shaw Creek Hillside: Cut and Filled | Alternative 2–Shaw Creek Hillside: Cleared Only[2] | Alternative 3–South Ridge: Cut and Filled | Alternative 3–South Ridge: Cleared Only[2] | Alternative 4 –Shaw Creek Flats Winter-Only Access: Cut and Filled[3] | Alternative 4 –Shaw Creek Flats Winter-Only Access: Cleared Only[4] |
|---|---|---|---|---|---|---|
| Wetlands | 93 (12) | 157 (26) | 75 (10) | 118 (22) | 99 (19) | 50 (96) |
| Other potential waters of the U.S. | | | | | | |
| Pond | 23[5] | 1[6] | 0 | 1[6] | 0 | 0 |
| Broad river | 0 | 0 | 0 | 0 | 0 | 0 |
| Gravel bar | 5 | 0 | 0 | 0 | 5 | 0 |
| Subtotal | 120[7] (16) | 158[8] (26) | 75 (10) | 119[8] (22) | 103 (20) | 50 (96) |
| **Total all wetlands** | **278** | | **194** | | **153** | |
| Uplands | 641 | 453 | 684 | 415 | 404 | 37 |
| Total wetland and upland | 761 | 611 | 759 | 534 | 507 | 87 |
| **Total by alternative** | **1,372** | | **1,293** | | **594[9]** | |

1 Includes camps, airstrips, and gravel pits; does not include power line for Alternative 4.
2 Clearing would occur primarily for the power line.
3 Includes perennial winter trail area graded below soil surface (approximately 24 acres).
4 Perennial winter trail area cleared only.
5 Existing gravel pit.
6 Ponds within corridor would not be cleared.
7 Rounding error.
8 Primarily within the area cleared for the road or for power line operation. Power line construction might require an additional 29 acres of fill or soil disturbance under Alternative 2 and an additional 17 acres under Alternative 3.
9 Clearing for the Shaw Creek Hillside power line ROW (with winter-only access) would affect 161 acres of wetlands. If this option were selected, it might also require up to an additional 32 acres of fill or soil disturbance in wetlands for power line construction.

**Table 4.6-3 Acreage and (HGM Class Percent of Total) of Cut, Fill, or Clearing by Hydrogeomorphic Wetland Type for Surface Access and Power Line Construction[1]**

| Hydrogeomorphic Wetland Type | Alternative 2–Shaw Creek Hillside | | Alternative 3–South Ridge | | Alternative 4–Shaw Creek Flats Winter-Only Access | |
|---|---|---|---|---|---|---|
| | Cut and Filled[2] | Cleared Only[3] | Cut and Filled | Cleared Only[3] | Cut and Filled[4] | Cleared Only[5] |
| Flat | 59 (60) | 60 (38) | 50 (67) | 58 (48) | 71 (69) | 21 (42) |
| Slope | 28 (28) | 62 (39) | 20 (27) | 38 (32) | 22 (21) | 27 (54) |
| Depressional | 23[6] (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Riverine | 11 (11) | 36 (23) | 5 (6) | 23 (19) | 10 (10) | 2 (4) |
| Subtotal | 120 (100) | 158[7] (100) | 75 (100) | 119[7] (100) | 103 (100) | 50 (100) |
| **Total by alternative** | **278** | | **194** | | **153** | |

1 Includes camps, airstrips, and gravel pits; does not include power line for Alternative 4.
2 Percentage does not include depressional wetland type. See note 6. If depressional acreage were included, these percentages would be: flat – 49, slope – 23, riverine – 9, depressional – 19.
3 Clearing would be primarily for the power line.
4 Includes perennial winter trail area graded below soil surface.
5 Perennial winter trail area that is only cleared.
6 This existing borrow source is presently an open-water pond. This acreage was not used in calculation of HGM wetland type percentages to provide a better reflection of proportional impacts to relatively undisturbed wetlands.
7 Primarily within the area cleared for the road or for power line operation, power line construction might require an additional 29 acres of fill or soil disturbance under Alternative 2 and an additional 17 acres under Alternative 3.
8 Clearing for the Shaw Creek Hillside power line ROW (with winter access only) would affect 161 additional acres of wetlands: flat – 64, slope – 63, depressional – 0, riverine – 34. If this option were selected, it might also require up to an additional 32 acres of fill or soil disturbance in wetlands for power line construction.

The most important functions lost in flat wetlands would be moderation of stream flow (absorption of precipitation), maintenance of permafrost, and flora and fauna support. Important functions lost in slope and riverine wetlands include groundwater discharge, stream flow moderation, detritus export, and flora and fauna support. The functions of slope wetlands tend to be more important than functions of flat wetlands because slope wetlands tend to be more nutrient rich and water flows through them to sites downslope. Adverse impacts on slope wetlands are more likely to have effects off site than impacts on flat wetlands.

Riverine wetland and water body types would be affected in proportion to their presence in the corridor. Riverine wetlands would be crossed approximately 20 times by the road. Most of the crossing lengths have been minimized by crossing perpendicularly. As in Alternatives 3 and 4, riverine wetlands would be paralleled in the bottom of Wolverine Creek Valley. Riverine wetlands are the most important of the wetland types because effects on them almost certainly extend offsite through water movement and because of their importance to sustaining fish and wildlife populations. The sole depressional water body that would be cut or filled is an existing gravel pit. Its functions would not likely be affected by further gravel extraction. Effects of clearing for the road would be minimal because clearing generally would not occur more than 5 ft beyond cut and fill slopes.

In addition to wetland functions lost on site, the road could have adverse effects on off-site wetlands. Dust and water-borne pollutants generated on the road could slightly alter the vegetation of adjacent wetlands. The road would alter downslope drainage. In wetlands with substantial downslope surface and shallow subsurface water movement (slope and riverine), the road would block that drainage, directing it to cross culverts. The continuing downslope flow would be more concentrated and could potentially cause erosion if not appropriately dissipated. Drainage changes would cause some wetlands to become wetter and others to become drier. These effects are not expected to extend far upslope or downslope, assuming appropriately spaced and sized cross culverts. The road would create more impermeable surface in the Shaw Creek and Goodpaster River drainages; downslope wetlands (and uplands) would effectively attenuate the resulting increased runoff.

Mitigation measures assumed to be implemented include:

- Clearing only within the cut or fill footprint on low-gradient wetlands, with clearing to 5 ft beyond the cut or fill footprint in wetlands on hillsides and sand dunes, and farther only as necessary to maintain safe sight distances
- Use of frequent cross culverts to maximize maintenance of natural drainage conditions
- Use of measures to prevent erosion at culvert inlets and outlets
- Use of appropriate measures, based on site-specific conditions, to minimize erosion in ditches and on cut and fill slopes

While the impacts on wetlands from the road itself would be substantial within each wetland complex through which it passes, the effects would be minor in the context of the Shaw Creek and Goodpaster drainages. The impacts would be dispersed along the 49-mile route, predominantly in the Shaw Creek drainage that supports extensive wetlands. The impacts would be focused on flat wetlands, which are the driest and least valuable of the wetland types in the area.

- Tenderfoot egress  The direct wetland impacts would be the same as for the option above because the additional segment of road would not cross wetlands. Construction on unstable upland soils above Rosa Creek would create a higher potential for erosion or slope failure that could adversely affect wetlands along the creek. These impacts, however, would be low.

***Use***

- Pogo project only  Use of the road by Pogo operators would cause off-site wetland impacts resulting from degraded road runoff and dust, which would slightly alter vegetation near the road. Accidental spills of pollutants would have more distinctly adverse effects on wetland biota. Disturbance to sensitive wetland-dependent wildlife could extend to many hundred feet from the road.

Although measures would be implemented to limit traffic to Pogo Mine operations, some trespass would inevitably occur. Availability of a road would tempt ATV users to access the road beyond the gates. Because of their relative openness, wetlands might serve both as the route to access the road from the Richardson Highway and as travel routes, once ATVs left the mine road away from the highway. Vehicle use in wetlands would damage vegetation and organic surface soils. In extreme cases, this damage would be enough to cause erosion, water quality degradation, and habitat damage. Pogo operators would be able to distinguish between those using the road legally and those not. Pogo operators would have some incentive to limit unauthorized road use because of commitments made during the mine permitting process and safety concerns. The secondary impacts to wetlands caused by the road would be minor in the context of the Shaw and Goodpaster drainages because the wetland resources of those drainages are vast, management could limit the impacts, and the impacts likely would be widely dispersed.

- Pogo project and other industrial/commercial users only Use of the road by other industrial and commercial operators would increase the off-site wetland impacts resulting from degraded road runoff and dust, potential pollutant spills, and disturbance to sensitive wetland-dependent wildlife. Trespass impacts would be slightly greater because management would be more difficult. The impacts would still be minor in the context of the Shaw and Goodpaster drainages.

- Use by everyone This option would have the same impacts as discussed above, plus impacts caused by individual road users. These users would increase traffic and its associated dust, water quality, and wildlife impacts. Such use would substantially increase the dispersion of ATVs into areas where they are presently not used. Moose hunting, in particular, would provide a draw for ATV users into the Shaw Creek Valley. As stated above, wetlands likely would experience a disproportionate share of that use, and would be damaged. Habitat and water quality impacts would result. Because ATV use is largely unregulated, mitigation of this damage likely would not occur. Habitat and water quality impacts would begin immediately and grow over time. Adverse effects on wetlands in some side drainages would be high. Depending on how many users the area attracted, the routes they took, whether ADNR could effectively limit off-road ATV use, and whether hunting regulations were changed to effectively limit ATV use, these secondary effects of the road could become moderate over time in the context of the Shaw Creek and Goodpaster River drainages.

  - Security gate at Gilles Creek The impacts for this option would be the same as described above east of Gilles Creek. The impacts west of the Gilles Creek gate would be the same as for use by everyone described above. Over time, the adverse impacts to wetlands from off-road ATV use could grow to become moderate within the context of the Shaw drainage.

***Disposition***

- Remove and reclaim No additional wetland impacts would result.

- Open for industrial/commercial users The effects described under use above for Pogo and other industrial/commercial users only would continue beyond the Pogo mine life, resulting in more minor roadside wetland degradation. The impacts would be minor.

- Open for everyone Impacts for this option would be the same as under use by everyone above, but would continue indefinitely. The adverse wetland impacts would be high in certain localities, but moderate in the context of the Shaw and Goodpaster drainages.

  - Reclaim past Gilles Creek Impacts for this option would be the same as for remove and reclaim above east of Gilles Creek. The impacts would be the same as for leave open to everyone above east of Gilles Creek.

## Power Supply

- Power line route This alternative would clear 158 acres of wetlands and other water bodies. Approximately 29 acres of primarily cleared area also might be filled or the soil might be disturbed for spur trails and power pole installation. Approximately 26 percent of the power line route would be located in wetlands or water bodies (Table 4.6-2).

Because the power line route would closely follow that of the all-season road, generally just a single, combined corridor would be cleared for both components. The power line would diverge from the road only in the Caribou Creek area and in upper Shaw Creek, where the road climbs onto the ridge to cross the divide into Wolverine Creek Valley (Figure 2.4-3). The power line would traverse extensive wetlands at the crossing of Caribou Creek, twice where it crosses Shaw Creek, in the valley that stretches eastward from upper Shaw Creek, throughout Wolverine Creek Valley, and across the mouth of Contact Creek Valley (Figure 3.11-1).

Where the line followed the proposed road across wetlands, power poles would be placed as close to the road as possible to minimize disturbance of wetlands. Some clearing and spur trail development would be necessary between the access road and the power line for equipment access for pole installation and stringing line. Clearing in wetlands in the power line corridor would generally be limited to areas where vegetation was more than 10 ft tall; in those areas, vegetation would be cleared near ground level by hand, hydro-ax, or other mechanical means, and the vegetation mat would be left intact where feasible. Most wetland access would be on low-ground-pressure vehicles. The portion of the power line between upper Shaw Creek and the divide above Wolverine Creek would be accessed in winter or by helicopter. At the spur trails, fill would be placed as needed to create ramps extending 20 to 40 ft beyond the toe of the road embankment. The spur trails would be sited to minimize disturbance to wetlands. At each pole structure, some ground leveling might be required for pole installation, and pole and anchor installation would require augering or excavation and backfill. Some of the wetlands would require special pile foundations for the poles.

Table 4.6-3 shows the acreages, by HGM wetland type, within the power line corridor on which vegetation would be cleared. Clearing impacts would be distributed among wetland types approximately proportionately to the presence of those types or with a slightly higher proportional impact on riverine wetlands. The primary wetland function that would be altered by the power line installation and maintenance would be wildlife support; understory vegetation also would change. Excavation and backfill and some equipment movements would disturb the soil organic mat. This mat disturbance could lead to degradation of permafrost that could result in conversion of some wetland areas to uplands or could potentially lead to collapse of ground in ice-rich areas. Clearing also could potentially result in degradation of permafrost in the cleared area. Wetland functions would be lost in the wetland areas that would be filled for spur trail development.

Where the power line route diverges from the road route in upper Shaw Creek Valley, the cleared transmission line corridor might serve as a travel corridor for ATV users desiring access to the valley followed by the transmission line. Such ATV use would damage wetlands. Desire for access to that valley is expected to be limited.

The following mitigation measures are assumed to be implemented:

- No operation of heavy equipment in wetlands where equipment could cause substantial disturbance to the root mat
- Span wetlands whenever possible

While affecting an extensive area by clearing, the power line effects on wetlands would be minor in the context of the Shaw Creek and Goodpaster River drainages, for the following reasons: Most functions of the wetlands would remain undisturbed; the affected functions would be altered only to a minor degree; the wetlands disturbed would be predominantly of a lower value than the wetlands that dominate the Shaw Creek drainage; the wetlands disturbed would be a minimal proportion of the project area wetland resource; and clearing would lead to minimal additional use by off-road ATVs.

**Sutton Creek** In the Applicant's Proposed Project, the power line would cross the Shaw Creek / Goodpaster divide via Sutton Creek (Figure 2.3-2), to the north and away from the road corridor. As a result of public comments on the DEIS, a new sub-option was considered with the power line following the road corridor over the divide.

Wetlands disturbance in the Sutton Creek segment of the power line would total approximately 4 acres. Because the boundaries between wetlands and uplands are more distinct along this route, the power line likely could be sited to avoid some of these wetlands. Wetlands disturbance if the power line were routed adjacent to the road over the divide would total approximately 6 acres. Because the power line would traverse primarily mosaics of wetlands/uplands along this route, wetlands would be more difficult to avoid.

While fewer wetlands would be affected by the Sutton Creek route, the absolute difference would be small, and following the road route over the divide would remove all wetlands impacts from the Sutton Creek drainage.

## Alternative 3

### Surface Access

#### *Route*

- South Ridge all-season road This alternative would cut or fill 75 acres of wetlands or other water bodies (Table 4.6-2). The 46-mile-long route generally follows ridges or upper parts of hill slopes. It is largely in uplands, including crossings of many areas mapped as mosaics of uplands with up to 25 percent wetlands. As in the other alternatives, this option would cut or fill a lower proportion of wetlands (10 percent of total cut and fill area) than are mapped in the project area (15 percent of project area), demonstrating some avoidance of wetlands. The route would cross extensive wetlands only in the Wolverine Creek Valley and along the Goodpaster River at the mouth of lower Contact Creek in the same manner as would the other alternatives. Of the 19 borrow sites along this route, 18 would be predominantly in uplands. While the total (upland and wetland) area cut and filled would be approximately the same as for Alternative 2, the area of wetland and water body cut or filled for Alternative 3 would be approximately 22 acres less than for Alternative 2 (not counting the existing gravel pit pond referenced under Alternative 2 above), and would be 29 acres less than for Alternative 4.

  The same types of on-site and off-site wetland functional losses would result from Alternative 3 as were described for Alternative 2, but the degree of those losses would be less than those for Alternative 2. Not only would fewer wetlands be cut or filled under Alternative 3, but also a lower proportion of the more important riverine wetlands would be used than under Alternative 2. Comparing the HGM wetland types that would be affected by cut or fill (Table 4.6-3) to the amount of those types present in the corridor (Table 3.11-4) shows the route would disproportionately affect flat wetlands (67 percent used versus 61 percent present) while somewhat avoiding use of slope wetlands (27 percent used versus 36 percent present). Impact on riverine wetlands, the most important in the project area, would be small and less than under Alternative 2 or 4.

The wetland impacts of this alternative would be minor in the context of the Shaw Creek and Goodpaster River drainages. They would be widely dispersed over a large area and would be focused on the least important wetland type; and the loss of wetland function would be small relative to the project area's entire wetland resource.

***Use***

- Pogo project only  Same as Alternative 2. Road use impacts would be minor.
- Pogo project and other industrial/commercial users only  Same as for Pogo project only use above, plus more effects of on-road use (dust, sediment-laden runoff, potential pollutant spills, and wildlife displacement) and more trespass of ATV users that would travel off the road. Trespassing ATV damage of wetlands would probably be less than along the Shaw Creek route because this route crosses fewer wetlands that are likely to be traversable by ATVs and the moose hunting draw into the Goodpaster Valley likely would be less. Road use impacts would still be minor.
- Use by everyone  This option would increase the effects of on-road use (dust, sediment-laden runoff, and wildlife displacement) because there would be more users. Because this option would open the road to all users, off-road use of ATVs likely would be substantially more than under options that limit road use. This route crosses fewer wetlands that could be easily traveled by ATVs than does the Shaw Creek route, but limits the number of points ATVs would depart from the road. Also, there may be less incentive to travel off-road into the wet lowlands in the Goodpaster Valley than in the Shaw Creek Valley, where moose hunting likely provides more of a draw. The direct and indirect impacts associated with this option would be higher than for restricted road use, but still low in the context of the Shaw and Goodpaster drainages because the proportion of wetlands that likely would be damaged would be minimal.

***Disposition***

- Remove and reclaim  Same as Alternative 2.
- Open for industrial/commercial users  Same as Alternative 2, but with more trespass off-road ATV use. Ongoing impacts would still be minor in the context of the Shaw and Goodpaster drainages.
- Open for everyone  Same as for the option immediately above, but with more off-road vehicle use. The impacts would still be minor.

## Power Supply

- Power line route  This alternative would clear approximately 119 acres of wetlands and other water bodies for the power line corridor. Up to approximately 17 additional acres might be cleared for access to the power line corridor, might be filled for spur trail construction, or might have the soil disturbed for power pole installation. Approximately 22 percent of the power line route would be located in wetlands (Table 4.6-2). The South Ridge power line would lie in the same general corridor as the South Ridge all-season road, but for most of its length would be offset from it by one-quarter to one-half mile or more (Figure 2.4-3). The road would cross the power line route many times but, unlike

Alternative 2, the power line and road would seldom share the same clearing. The power line would traverse extensive wetlands near Quartz Lake, at the Indian Creek crossing, in the headwaters of Sand Creek (tributary to the Goodpaster River), throughout the Wolverine Creek Valley, and across the mouth of the Contact Creek Valley (Figure 3.11-1). Construction methods would be the same as for Alternative 2.

Both flat and slope wetlands would be cleared in lower proportion than their presence in the corridor. Riverine wetlands would be cleared in greater proportion, with almost all of that clearing in the Wolverine Creek Valley (shared by Alternative 2 route). The types of impacts on wetland functions would be the same as for Alternative 2.

The cleared power line corridor would be unlikely to experience intensive ATV use because ATV users would be more likely to either use the road legally or, if the road were closed to the public, ATV users sufficiently motivated to travel the same direction as the power line likely would trespass on the road. Mitigation measures would be used to restrict ATV use on the power line ROW.

While affecting an extensive area by clearing, the South Ridge Route power line wetland impacts would be minor because most functions of the wetlands would remain undisturbed, the affected functions would be altered only to a minor degree, the wetlands to be disturbed would be predominantly of a lower value than valley-bottom wetlands that dominate the lower Goodpaster and Shaw Creek drainages, and the wetlands to be disturbed are a minimal proportion of the project area wetland resource. Implementing the same mitigation measures suggested for Alternative 2, including use of helicopter or winter access across extensive wetland areas, would reduce wetland impacts to a low intensity.

## Alternative 4

### Surface Access

#### *Route*

- Shaw Creek Flats winter-only access    The winter-only access route would cut or fill 103 acres and clear vegetation on 50 acres of wetlands and other water bodies (Table 4.6-2). This route combines a 15-mile Shaw Creek Flats winter-only access segment with 31 miles of the Shaw Creek Hillside all-season road (Figure 2.4-3). The all-season road portion of this alternative would have the same type of construction and would incorporate the wetland avoidance and minimization measures described for Alternative 2. That portion of the road would require cut and fill of approximately 79 acres, and its impacts would be similar to those discussed above for Alternative 2.

The first 15 miles of this alternative would cross extensive wetlands on the floor of Shaw Creek Valley before connecting with the Shaw Creek Hillside all-season road route. Because much of this winter-only access route has historically been used by the military, and has recently been used for winter forestry roads, the first approximately 9 miles would require minimal clearing of the existing surface vegetation across an area of approximately 44 acres. Depending on the construction mode, the remaining 6 miles would require more intensive clearing or disturbance of approximately 24 acres. Thus, while for Alternatives 2 and 3 the acreage to be cleared would be primarily for the power line (Table 4.6-2), for this alternative, clearing would be necessary for portions of the winter-only access route.

Two design options were considered for this 6-mile segment: a traditional winter road and a perennial winter trail.

**Traditional winter road construction standards** With the use of traditional winter road construction standards, approximately 6 miles would be cleared down to the ground vegetation, but the organic soil mat would not be bladed. Atop the cleared area along all 15 miles of the Shaw Creek Flats winter-only access route, a snow and ice road would be built for use each winter.

The acreages in Tables 4.6-2 and 4.6-3 include both the winter-only access segment and the all-season road segment of the alternative. The acreages of cut and fill in wetlands for this alternative shown in Table 4.6-2 are for the perennial winter trail construction standards (discussed below). The option consisting of traditional winter road construction standards would cut and fill 24 fewer acres in wetlands than are shown in Table 4.6-2. Conversely, the acreage only cleared of vegetation would be 24 acres greater.

Like the other alternatives, this alternative would use flat wetlands for cut and fill activities in much greater proportion to their presence in the project area, and would avoid slope wetlands. The effects on wetland functions would be similar in kind to the effects described for Alternative 2 for the all-season road segment that is the same as Alternative 2, but would differ for the first 15 miles of this route. Clearing for a traditional winter road would entail clearing all the way to the ground, but would not cut the vegetative mat. This clearing would eliminate the shading effects of trees and shrubs and reduce the insulating effect of the surface vegetative mat, likely resulting in an increase of depth to permafrost. Permafrost degradation could result in ground collapse in some areas, resulting in ponding and soil exposure.

Depression of the soil surface from vegetation clipping and ground collapse could lead to minor rechannelization of surface water flows, although this is expected to be minimal because the terrain is so level. Exposure of soils or channelization of flows could lead to water quality degradation. This degradation of water quality is expected to be minor because the area is so flat. Clearing also would alter the flora support function (leading to conversion to grass and sedge plant communities) and wildlife support function of these wetlands. These functional changes to wetlands have likely already occurred along most of the first 9 miles of the route due to past military and timber harvesting activities.

Clearing the new 6-mile segment across wetlands could ease its use by ATVs during late winter and nonwinter months, which could damage the wetland surface. Because this alternative would use an existing cleared route for the first 9 miles, this effect would be expected only in the last 6 miles. Once the 15 miles of winter road route were traversed, ATV users would reach the all-season road, from which they might access other wetlands. This alternative would promote substantially less off-road ATV use than would Alternatives 2 or 3 because of the extreme wetness of the winter road corridor that would have to be traversed to access the all-season road during nonwinter periods.

While this alternative would affect a larger acreage of wetland than the other alternatives, 68 acres of the affected wetlands would remain wetlands and retain wetland functions, being altered only by clearing down to the organic mat. As for the other alternatives, the wetland impacts of this alternative would be high on a local basis, but low in the context of the Shaw Creek and Goodpaster River drainages. They generally would be widely dispersed, focused on the less important wetlands, and would represent only a small incremental loss of wetland function in the context of the extensive project area wetlands.

**Perennial winter trail construction standards** The difference between this option and the traditional winter road option is that the ground surface would be leveled at the start of construction along the 6-mile stretch from the end of the existing 9-mile relatively cleared winter trail/road to where the winter route would join the Shaw Creek Hillside all-season road route. Cut and fill activities would affect 24 more acres of wetlands than would the traditional winter road option. Wetland functions would be affected in the ways described above for the traditional winter road. Along the 6-mile segment requiring more blading, however, more of the insulative organic mat would be removed and more mineral soil would be exposed. There would be greater potential for permafrost thaw, soil collapse, surface flow channelization, and water quality and habitat degradation than for the traditional winter road option.

The wetland impacts of this option would be high on a local basis, but low in the context of the Goodpaster River and Shaw Creek valleys for the reasons described under the traditional winter road option above. Mitigation measures that would minimize these effects include:

- Active and immediate revegetation of exposed soils with native grasses and sedges
- Monitoring of changes in surface water flows and minor redirection of flows to prevent erosion

**Power Supply**

- Power line route Although the power supply option for Alternative 4 has been defined as on-site generation, as discussed above, there is no reason that a power line could not be selected as the power supply option for the Preferred Alternative to complement winter-only access. If that were to occur, the Shaw Creek Hillside power line route would be used, the same as with Alternative 2. Thus, the effects of constructing this route, in conjunction with winter-only access, would be similar to those described under Alternative 2. It would entail clearing approximately 161 additional acres of wetlands and other water bodies (51 more acres of clearing for ice road and power line than for Alternative 2).

This alternative, however, would have additional minor power line impacts because the first approximately 15 miles of the power line would not be constructed in conjunction with an all-season road. Thus, heavy equipment for pole installation and line stringing would have to be walked down the power line ROW, rather than on the all-season road, likely requiring clearing of vegetation closer to the ground. Up to approximately 32 additional acres might be cleared for access to the power line corridor, might be filled for spur trail construction, or might have the soil disturbed for power pole installation (3 more acres than for Alternative 2).

Clearing for this power line would be more likely to induce ATV use than would the power line for either of the other alternatives because no adjacent all-season road would exist for the first 15 miles. The effects of the power line would be low because most wetland functions would not be substantially affected by construction and the associated

ATV use likely would be low. The low adverse construction effects could be mitigated further by constructing power line segments across wetlands near Keystone Creek in winter or with helicopter support.

### 4.6.5 Cumulative Impacts

- All-season Road Reclaimed Absence of an all-season road would limit other resource development activities and human access. Cumulative wetland impacts to the time the road was removed would include those from the Pogo project itself, the road to the mine, and off-road ATV use from the road. These cumulative wetland impacts would be moderate with the Shaw Creek Hillside all-season road and low with the South Ridge all-season road in the context of the Shaw and Goodpaster drainages. Either alternative would have affected a relatively low proportion of wetlands in those drainages, but the Shaw Creek Hillside all-season road likely would have led to more unregulated and damaging off-road activity in wetlands.

- All-season Road Maintained Mine developments such as a hypothetical Sonora Creek mine would increase wetlands impacts, but its location close to the Pogo project infrastructure would limit those impacts to an assumed 75 acres. A hypothetical Slate Creek mine accessed by extension of the Pogo all-season road would directly eliminate an assumed additional 200 acres of wetlands, including some of high value in the Goodpaster River Valley. The impacts would be limited through permitting processes.

  The maintained road would accelerate timber harvests. While these harvests would focus on uplands, roads would require some wetland crossings, including impacts to valuable slope and riverine wetlands. Timber harvests also could have some minor off-site impacts on wetlands related to sediment-laden runoff and higher peak stream flows. These effects would be greater with a Shaw Creek Hillside all-season road than with a South Ridge all-season road because more timber harvests likely would occur in the Shaw Creek drainage, which contains more wetlands.

  An all-season road open to everyone would cause a moderate cumulative impact to wetlands in the Shaw Creek and Goodpaster River drainages. A few hundred acres of wetlands would be eliminated; a few hundred more would be slightly degraded by proximity to commercial and industrial structures and activity; and more would be severely degraded by recreational and subsistence activities, particularly those employing ATVs. While the impacts would affect a small proportion of the wetlands in the Shaw and Goodpaster drainages, the effects would be detectible on the scale of those drainages.

  Wetlands impacts related to residential and commercial land development near the Richardson Highway would continue to be stimulated by ongoing resource extraction and public use activities associated with the road.

## 4.7 Surface Disturbance

Table 2.3-6 presents the acreage of existing and expected new disturbance, grouped by project component and the options associated with each action alternative. The acreages vary between the alternatives primarily because of differences in length of the surface access and power line routes, the additional area that would be disturbed at the mine site to provide more laydown area and greater fuel storage capacity necessary for a once-a-year resupply effort under the winter-only access option, and in the water discharge option. This section focuses on the differences in disturbance between the alternatives based on Table 2.3-6. Note that clearing is defined as removal of vegetation above ground level, but with no major damage to the vegetative mat on the ground surface. Surface disturbance is defined as major damage to, or removal of, the vegetative mat. And the word "disturbance" alone is used generically to include clearing and surface disturbance.

### 4.7.1 No Action Alternative

The current DOF 5-year schedule for timber sales (2003–2007) in the Delta area includes four sales on the north side of the lower Shaw Creek drainage and the Tenderfoot area, and four sales in the Quartz Lake and Indian Creek area (ADNR, 2002). These eight sales would disturb approximately 1,313 acres, not including new timber access roads.

With respect to the Pogo project, existing disturbed areas occur along the potential access routes and at the mine site. Up to 55.3 disturbed acres exist along the winter-only access route (Table 3.12-1). Approximately 33 acres of disturbance presently exist at the mine site from Pogo exploration activities by the Applicant and a previous claims owner (Section 3.12).

### 4.7.2 Options Common to All Alternatives

Approximately 383 acres of disturbance would occur with these common options, all located at the mine site. There would be no substantive differences in disturbance for these options between the alternatives, except for the gravel source option. If gravel were made from crushed mine development rock, as opposed to being mined from gravel pits, approximately 72 fewer acres would be disturbed, leaving a total of approximately 311 acres.

### 4.7.3 Options Not Related to Surface Access

Table 4.7-1 shows how disturbance acreage would vary between the alternatives for options not related to surface access.

**Table 4.7-1 Approximate Clearing or Surface Disturbance (Acres) for Options Not Related to Surface Access[1]**

| | Alternative | | |
|---|---|---|---|
| **Component/Option/Sub-option** | **2** | **3** | **4** |
| **Power Supply** | | | |
| ▶ Power line[2] (differs by route) | 602 | 525 | |
| ▶ On-site generation (extra fuel storage and laydown for winter access) | | | 22.7 |
| **Wastewater Discharge** | | | |
| ▶ Soil absorption system | 4.4 | | |
| ▶ Direct discharge to Goodpaster River | | 0.5 | |
| ▶ Off-river treatment works | | | 13.1 |

[1] Includes existing disturbed acreage
[2] Vegetation clearing only

For the power supply component, a power line option would require approximately 602 or 525 acres of clearing, depending on the route. For the on-site generation option, Alternative 4 would require an additional approximately 22.7 acres of surface disturbance for fuel storage

(6.1 acres) and laydown area (16.6 acres) to accommodate storing a full year's supply of fuel and supplies delivered in a short span for winter-only access.

## 4.7.4 Options Related to Surface Access

Table 4.7-2 shows how disturbance acreage would vary between alternatives for options related to surface access.

**Table 4.7-2 Approximate Clearing or Surface Disturbance[1] (Acres) for Options Related to Surface Access[2]**

| Component/Option/Sub-option | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| **Surface Access Route** | | | |
| ▶ Shaw Creek Hillside all-season road | 770 | | |
| ✦ Tenderfoot egress from Richardson Highway | 43 | | |
| ▶ South Ridge all-season road | | 768 | |
| ▶ Winter-only access | | | 594 |
| **Power Line Route[3]** | | | |
| ▶ Shaw Creek Hillside | 602 | | |
| ▶ South Ridge | | 525 | |
| **Goodpaster Winter Road[4]** | 32 | 32 | 32 |

1 Includes existing disturbed acreage.
2 Includes ROW, construction camps, airstrips, and gravel sources.
3 Vegetation clearing only.
4 Used during first two winters of project development for all alternatives.

### Surface Access

#### *Route*

The Shaw Creek Hillside all-season road option would cause surface disturbance to approximately 770 acres if the Shaw Creek/Rosa option were used for the Richardson Highway egress. If the Tenderfoot egress option were used, an additional approximately 43 acres of surface disturbance would occur, for a total of 813 acres. The South Ridge all-season road option would cause surface disturbance to 768 acres. The winter-only access option would disturb approximately 594 acres. This lower disturbance figure reflects the use of existing disturbed winter trails/roads that would eliminate the need for disturbing approximately 15 miles roughly paralleling the route of the all-season road in lower Shaw Creek Valley.

### Power Line Route

The Shaw Creek Hillside power line route would clear approximately 602 acres for Alternative 2 while the South Ridge power line route would clear approximately 625 acres for Alternative 3.

## 4.7.5 Cumulative Impacts

Disturbance is itself an impact on other resources, and those impacts, including cumulative impacts, are described for each affected resource in the other sections of this chapter. Thus, a cumulative impacts discussion for disturbance is not applicable.

# 4.8 Fish and Aquatic Habitat

In this section, discussion of impacts is considered in the context of the fish populations in the entire drainages of both the Goodpaster River and Shaw Creek. Availability of habitat types varies along a drainage, and while some species use an entire drainage during their various life stages, others are restricted to certain sections for one or more life stages. Thus, impacts in one section of the drainage can have variable effects on populations. This discussion addresses only those project options found to affect water quality, as described in Section 4.3, and those from operational accidents, facility failures, environmental upsets, increased access, and construction activities. In this context, over time the project would have low to moderate impacts on fish habitat and fish populations in the Goodpaster River and Shaw Creek drainages depending on the option selected for each of its components. Other combinations of options, however, could have a relatively moderate to higher impact and could have major impacts on local aquatic habitat over the life of the mine.

## 4.8.1 No Action Alternative

Impacts under this alternative would come mainly from angling and boating and would follow historical patterns. The present decline in the Delta area population due to the closure of Fort Greely would not result in an appreciable decline in recreational use because present and past effort has been predominantly from nonlocal users and, in the Goodpaster River, by private landowners (Parker, 2000a). Access limitations in both drainages also help keep use low and restricted to the lower parts of both drainages. Harvest and angling effort in the two drainages has increased only slightly over the past 5 years and is lagging behind Alaska's growth rate.

Construction and operation of the NMDS would result in the Delta area population stabilizing at approximately 2,100 residents, below the pre-Fort Greely base closure peak of 2,388 residents in 1993. Even with the high employment during the construction phase of this project, increases in recreational use would be small to moderate due to the limited access to both drainages and the finite number of private parcels in the Goodpaster drainage.

Mineral exploration in both drainages would continue to have no to low impact if recent exploration methods continue to be used. Impacts would be highly localized and come from accidental spills of petroleum products; runoff containing sulphides, metals, and arsenic from exploration sites; and local erosion at staging areas. Considering the likely volume of spills, the present water quality of tributaries draining mineralized zones, as described in Section 3.7 (Water Quality), and natural erosion from floods, impacts would be low.

Impacts could arise from habitat alteration and increased access from incremental development of all-season logging roads by the DOF. Impact would fall primarily in the Shaw Creek drainage. The proposed forestry road would follow closely the Applicant's proposed Shaw Creek Hillside route and would eventually end at Gilles Creek. This road would be open for public use. With proper road design, stream crossings, and maintenance, in addition to logging practices that protect streams, fish, and habitat, the impacts from erosion, sedimentation, stream blockages, and bank destruction would be low to nonexistent. Increased access to the tributary stream crossings would offer angling opportunities that would minimally affect grayling populations due to the small size, seasonal use, and present harvest regulations of the tributaries. The extension of the Quartz Lake logging road into the Goodpaster drainage would be located in the uplands miles from the river and would not cross any fish-bearing streams.

Under the No Action Alternative, impacts on fish and aquatic habitat would remain low to nonexistent.

## 4.8.2 Options Common to All Alternatives

These component options and sub-options would have no to low overall impact on fish and aquatic habitat, with the exception of the gravel source, airstrip location and management, and regulation of angling.

### Gravel Source

Siting gravel pits in the floodplain would cause some trapping of fish following flooding. During flood events, fish, especially juveniles, seek calmer water and often are found not only in tributary streams (Morsell, 2000), but also commonly in flooded riparian habitat. Fish could become trapped in gravel pits when a flood receded. In 1992, the Chena River Dam floodgates were closed to protect Fairbanks from flooding. After drawdown, substantial numbers of fish were found trapped in isolated ponds (Fleming, 1992). These pond-trapped fish would most likely be predominantly juvenile chinook and grayling. Because the majority of spawning and likely juvenile use in the river for both chinook and grayling occurs downstream of the proposed gravel pits, impacts to the populations should be low. Because movement patterns of young of the year fish within the river are unknown, however, and significant spawning occurs adjacent to and above the proposed gravel pits, impacts may be higher. These impacts could be mitigated, where feasible, by reducing the number and size of gravel pits, and by building perimeter berms around, and providing outlets to the Goodpaster River from, the gravel pits.

### Air Access

- Airstrip Location The proposed location of the airstrip abuts an outside bend of the Goodpaster River. Outside bends are where erosion and bank failure normally occur during floods and high discharge. Impacts would arise from floods and bank erosion from airstrip clearing. The flooding of the airstrip then could lead to channel alterations and ensuing downstream sedimentation and possible loss of spawning and macroinvertebrate habitat. These impacts would range from low to moderate based on the severity, timing, and frequency of flood events. Erosion due to airstrip construction could have a major local impact if it occurred during salmon spawning.

  The USFWS recommended that to protect the airstrip from erosion and the river from sedimentation, considering the potential for contaminant migration toward the river, a 300-ft buffer should be maintained between the airstrip and the river. From the perspectives of local topography and flight safety, however, the airstrip location cannot meet both the 300-ft buffer recommendation and FAA runway alignment requirements. Mitigation and reclamation measures to maintain river bank stability are expected to prevent encroachment on the airstrip.

***Use*** The level of impact from airstrip use would be related to management during and after the life of the mine. Impacts, which would arise directly from accidents involving either aircraft or fuel storage and routine spillage from refueling and indirectly from recreational use, would be minimal. The most restrictive management options would have low overall impact. During mine operations, direct impacts on fish and habitat would be low if access were limited to project needs only and proposed fuel storage and handling procedures were implemented. This management option would also result in minimal indirect impact. Overall impact could increase with access open to other commercial users because of increased traffic volume, but would still be low because indirect impacts would be minimal. Opening the airstrip to everyone would raise overall impacts to a low to moderate range because both direct and indirect impacts would increase because of increased traffic volume, use by the public not trained in fuel spill prevention and control, and recreational activities. Indirect impact would come predominantly from angling and, if necessary, could be mitigated through state regulatory authority.

***Disposition*** At the end of the Pogo project, reclamation of the airstrip would essentially result in no impact to habitat, provided reclamation were successful, i.e., revegetated prior to a severe flood event. Impact from keeping the airstrip open for other users would be low if there were little industrial use, no fuel storage, and bank armoring was installed during mine reclamation. Recreational use impacts can be mitigated as discussed above.

**Angling** Indirect impacts to grayling and chinook salmon populations could arise from workers angling in their off hours and could be high. Catch-and-release grayling fishing can cause mortality rates above 10 percent (Clark, 1993), and are likely substantially higher for salmon exhausted at the end of a 1,000-mile journey. Although present regulations prohibit salmon angling, they must be enforced. Substantial portions of these populations migrate past the mine site during the course of the open water season. This potential impact would be mitigated because the Applicant intends to enforce a "no fishing" policy by workers (Hanneman, 2001).

## 4.8.3 Options Not Related to Surface Access

### Alternative 2

All component options and sub-options for Alternative 2 would have no to low overall impacts on fish and aquatic habitat, with the exception of water discharge.

### Water Discharge

***Development Phase***

- Underground injection wells As discussed in Section 4.2 (Ground Water), water injected at high rates would have a potential to surface in nearby sloughs. Estimated water quality under worst-case scenarios raises the possibility that mercury concentrations could frequently exceed by 10 times the aquatic life water quality criteria (Section 4.3, Water Quality). Given the potential of injected water to surface, there could be a high impact on fish and aquatic habitat in these sloughs. The nearest slough to the injection wells, however, is isolated from the main stem at all but high-flow conditions. Although sloughs with main stem connections are important habitat for salmonid fry, isolated sloughs are likely used only as refugia for all ages of salmonids during high-water events, and high water would dilute mercury concentrations. Thus, impact from injection wells under the worst-case scenario would be highly localized within the drainage. Mercury under these worst-case scenarios would be below acute concentrations to nonindigenous fish and aquatic invertebrates. Given the temporary use of the injection well (2 years) and the worst-case scenario, impacts on aquatic resources in the river would be low, localized, and short term.

***Operations Phase***

- Soil absorption system
  - Goodpaster River Valley Projected water quality of the treated discharge as it leaves the SAS and enters the ground water is expected to exceed water quality criteria for a number of parameters (Section 4.3.3). Ground water is critical for

incubation of fish eggs and for maintaining winter flows. Modeling the fate and transport of this discharge from the SAS, located in the Goodpaster floodplain prior to reaching the Goodpaster River, found that all but three parameters under maximum discharge rates and all but one parameter under average discharge rates meet water quality criteria. The increase in concentration for these parameters to the river likely would be small, due to attenuation and dilution, and limited to locations where ground water enters the river. Impacts to fish would be low and localized. Moderate impacts could be expected in a larger area in the short term if process upsets or facility failures were to occur, but these are highly dependent on timing and duration. Depending on where the ground water would reach the river, overall impacts to the aquatic resources of the river in the long term would be low to moderate, and would be localized.

- ✦ Above Pogo Ridge    Locating the SAS above Pogo Ridge would provide more attenuation and dilution to the discharge prior to reaching the Goodpaster River. Thus, impacts to the river would be less than with siting the SAS in the floodplain. It is unknown, however, if the flow would remain subsurface or would surface in Easy Creek Valley. If flow surfaced prior to reaching the river, impacts would be similar to those described above.

- Underground injection wells    Injection wells would be used only under special circumstances, such as during rehabilitation of the SAS, discharge of clean RTP water, or mine drainage discharge, all of which would occur only when advanced sampling for potential contaminants had shown that the discharge could meet injection limits for well water quality. Therefore, impacts would be low.

## Alternative 3

All component options and sub-options for Alternative 3 would have no to low overall impacts on fish and aquatic habitat, with the exception of direct water discharge to the Goodpaster River.

### Water Discharge

#### *Development and Operations Phases*

- Direct discharge to Goodpaster    This option would use an underwater diffuser bar to discharge water to the river in a stable area below the exploration camp (Figure 2.3-1a). Habitat in this area is not suitable for fish spawning. The nearest spawning area is approximately 250 ft downstream of the discharge point (Morsell, 2001). As described in Section 4.3 (Water Quality), a minimum mixing ratio of 25 parts river water to one part discharge would create a mixing zone approximately 30 ft long and 15 ft wide. No discharge would occur during flows of less than 10 cfs (a 100-year event in late winter). The mixing zone would be sufficient to meet water quality standards at the edge of the zone for all parameters, except iron during high flows. This process would have a high impact on aquatic resources in the immediate vicinity of the diffuser pipe, and a low impact outside the mixing zone.

  The potential for process upsets and facility failure also must be considered during the life of the project. Given the right timing, duration, frequency, and volume, these upsets and failures could lead, over time, to bioaccumulation of metals in the local habitat far larger than estimated for the mixing zone. This bioaccumulation could alter benthic communities and distribution, growth, and survival of fish. Upsets also could cause disruptions in fish behavior relating to homing and habitat selection if the mixing zone reached bank to bank. Because the probable frequency of this combination of events is low and the dilution factor high, the impact to the aquatic resources in the river would be moderate and localized.

## Alternative 4

All component options and sub-options for Alternative 4 would have no to low overall impact on fish and aquatic habitat, with the exception of on-site power generation and water discharge through an off-river treatment works.

### Power Supply

- On-site generation This option would require transporting an additional 4.2 million gallons of diesel fuel annually to the mine site. This transportation requirement would substantially increase the risk of accidents and spills during transport and storage and could result in a moderate to high impact on local fish and aquatic habitat that could be temporally substantial to the chinook population if occurring during the low flows of winter or during spawning. This risk would be eliminated by using a power line to bring power to the mine site.

### Water Discharge

#### *Development and Operations Phases*

- Off-river treatment works This option would have less impact to the river than a direct discharge because it would have an estimated 24-hour holding capacity following an upset, allowing mitigation measures to be taken. During an upset or low flows, the outlet pipe gate from the treatment pond would be closed and treated effluent would be stored in the RTP.

  Process failures, mine shutdowns, and environmental upsets such as severe winter weather and extended low flows could exceed RTP storage capacity and result in overflow into Liese Creek. If such overflow into Liese Creek were to occur, it would be expected in the spring after breakup in the Goodpaster, but before breakup in Liese Creek (Teck-Pogo Inc., 2002i). With Liese Creek frozen, as well as the wetlands it drains into, overflow would flow directly into the Goodpaster.

  A combination of process failures and environmental upsets, such as severe winter weather and especially flooding, would lead to localized impacts as described for the direct discharge option in Alternative 3, but would be less severe in the case of flooding because of dilution.

  Historical winter low flows in the Goodpaster River are approximately 40 cfs. Because the Applicant would maintain a flow in the river of at least 20 cfs during water withdrawal for the treatment works, and considering the 1,800-ft reach of the river that would be affected, there would be minimal to no impacts on fish.

  The primary pond would provide benefits because it would have slack water habitat that grayling fry and, during high water, juvenile salmon would use. It also would offer overwintering habitat. Some entrapment of juvenile salmonids would occur at the pumping station, but it would be minimal under the project design.

In severe floods, some entrapment of juvenile salmonids would occur in the secondary pond, but this entrapment would have a low impact on the overall population. Construction of gravel berms around the second pond could mitigate this impact.

Considering its storage capability, the low probability of the combination of upset events that would exceed this capability, and the unknown effects of severe winter weather on the process facilities, impacts to the aquatic resources of the river from the off-river treatment works would be low to moderate, and localized.

## 4.8.4 Options Related to Surface Access

**Alternative 2**

### Surface Access

***Route***

- The Shaw Creek Hillside all-season road would have, overall, a low to moderate level of impact on fish and habitat, depending on the road use options permitted. The route would require six crossings of fish-bearing streams. Four of these streams, Caribou, Gilles, and Shaw creeks and the Goodpaster River, are known to have important fish habitat and substantial fishery resources. The level of direct impacts from this route would be related to road design, i.e., width, alignment, drainage, type of crossings, construction timing, and type and volume of traffic. Alignment and drainage would affect the amount of sediment and vehicle pollution (oil and other lubricant spills) entering the streams while crossing placement and type could affect erosion and blockages of fish movements. Road width and traffic volume would affect the probability of accidents spilling hazardous materials that, in time and place, could affect fish and aquatic habitat. Traffic volume and type also would determine the amount of routine vehicle pollution and risk of accidents.

The Applicant proposes to minimize these potential impacts by siting a two-lane road in uplands above the wetland complex of the creek, aligning crossings perpendicular to all fish-bearing streams with the use of bridges, limiting traffic to project needs only, and instituting safety procedures during transport. Timing of construction at stream crossings, or other mitigation measures approved by ADFG, would minimize disruptions during spawning, especially for grayling and salmon. While construction activities and operation would affect some erosion and sedimentation even under BMPs, the overall impacts on fish and aquatic habitat would be low and localized.

Accidents that spilled hazardous materials at or near stream crossings could have a high impact on fish, depending on time of year and drainage. For example, a hazardous material spill that found its way into Caribou Creek during May or June would have a major effect on the grayling population of the drainage through displacement of spawners and/or death of adult fish and eggs. A mid-winter spill, however, would have no impact at Caribou Creek because no fish are present then, but it would have a high impact at Gilles Creek, upper Shaw Creek, and the Goodpaster River because of low flows and overwintering fish. The risk of such accidents, however, is considered low for the majority of the route because of the proposed alignment location. Accident risk, however, would be higher in both drainages along the 18-mile segment that crosses the divide between the Shaw Creek and Goodpaster drainages.

- ✦ Richardson Highway egress Both Richardson Highway egress options would require crossing Rosa Creek. Other than this crossing, the Tenderfoot option is entirely in uplands and would have no impact on fish or aquatic resources. The Shaw Creek/Rosa egress option could require widening and straightening the present road that abuts wetlands and directly parallels the creek for a short distance, and would parallel Rosa Creek for approximately 1 mile. Overall impacts on fish from this option would be low

***Use*** During mine operations, direct impacts on fish and aquatic habitat would be low if road use were limited only to the Pogo project or to Pogo and other industrial/commercial users. This option also would result in minimal indirect impact from angling at stream crossings. There would be no indirect impact if the Applicant's "no fishing" camp policy were extended to its employees using the road, as well as to employees of other industrial/commercial users.

Opening the road for public use would raise overall impact to a low to moderate range because both direct and indirect impacts would increase due to traffic volume and recreational activities. Indirect impacts would occur predominantly from angling and, on the Goodpaster River, boating. State regulatory authority, which is mandated to manage fishery resources for maximum public benefit, could mitigate angling impact through fishing regulations. This could result in length of season limits, as well as limits on size and methods of take.

There is presently no such authority to regulate boating on the Goodpaster, and use of an all-season road by everyone would increase the number of boats on the Goodpaster. The level of impact from boats would be highly dependent on type, use level, and river characteristics, and could thus range from minimal to moderate. Motorized boating during low flows would disrupt spawning behavior and dislodge and suffocate eggs. It also would affect water quality because of exhaust emissions and erosion, and could disturb riparian habitat by undercutting banks through wake action.

- ✦ Security gate at Gilles Creek This option would have the same impacts described above for road use by everyone, except the impacts would only occur in the lower two-thirds of Shaw Creek Valley. This option would eliminate impacts from angling and boating on the Goodpaster.

***Disposition*** At the end of the Pogo project, the most restrictive access option, reclamation, would have minimal impacts to fish and aquatic habitat. The most liberal option, leaving it open for everyone, would have a low to moderate impact for the same reasons as discussed above for the operational phase.

## Alternative 3

### Surface Access

#### *Route*

- The South Ridge route would offer a lower risk to fish and habitat than the Shaw Creek Hillside all-season road because it would require only one stream crossing, the Goodpaster River. Thus, this route would potentially affect only one drainage, instead of two, as for Alternative 2.

***Use*** This alternative would have minimal to low overall fish and aquatic habitat impacts within the range of management options, as discussed for Alternative 2.

***Disposition*** Same as Alternative 2, except reclamation would still allow recreational access to the Goodpaster by ATVs because a cleared path would remain for some time following reclamation. Such access from the ridge to the upper Goodpaster Valley likely would result in erosion problems, as historical ATV use has shown.

## Alternative 4

### Surface Access

***Route***

- The Shaw Creek winter-only access would cause a moderate impact on fish and habitat. The route would cross at least five streams, two crossings of Shaw Creek, one of Caribou and Gilles creeks, and the Goodpaster River. It would be located in the lower Shaw Creek wetlands and then follow the same route over the drainage divide as the Shaw Creek Hillside all-season road. Impacts would arise almost solely from the risk of accidents at or near stream crossings. With 30 to 35 trucks a day for 50 to 60 days during mid-winter, hauling 800,000 gallons of fuel and 200 tons of cyanide per year, the relative risk of accidents would be high, especially on the steep 18-mile section over the divide between the Shaw Creek and Goodpaster drainages. An accident near the upper Shaw Creek or Goodpaster crossing would cause high impacts to overwintering fish during low flows of winter.

***Use*** Winter-only access effectively would eliminate road use impacts by the public; however, this condition would last only until the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek. At that time, impacts from road use would be the same as for Alternative 2.

## 4.8.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts to fish and aquatic habitat.

- All-season Road Maintained Direct and indirect cumulative impacts on fish and aquatic habitat would occur from extraction of timber and mineral resources and increased recreational use from access opportunities and population growth. Erosion from roads, accidents, facility failures, environmental upsets, and recreational use all would alter habitat to some degree. While impacts could be minimal in any one occurrence, over time these impacts cumulatively would result in habitat loss and smaller, though still viable, fish populations. The brunt of this impact would fall on recreational users of the Goodpaster River through implementation of more restrictive regulations on fish harvest and possibly access.

  Additional mineral development beyond the proposed project would increase the risk of impacts by either extending the period of active mining, as under the scenario of finding additional reserves at Pogo or development of a hypothetical Sonora Creek mine, or simply by increasing the number of active mines, as under a hypothetical Slate Creek mine scenario. The latter would result in greater potential impacts than the former because access would cover an additional 25 miles of the Goodpaster River. The risks of upset from accidents and natural events in these scenarios would exist, but design, construction, and permitting stipulations, as well as State of Alaska management practices, could mitigate such risks to fish and aquatic habitat.

  Overall, cumulative impacts would be moderate, and would be high only locally.

# 4.9 Wildlife

In this section, potential wildlife impacts are discussed in the context of the wildlife populations and habitat in the Goodpaster River and Shaw Creek drainages and, where the home range of a species is large, in adjacent drainages.

Wildlife impacts address effects on wildlife itself as well as wildlife habitat. Two types of impacts are considered – direct and indirect. Direct impacts are those that directly affect animals (collisions with vehicles or power lines and physical barrier to movements) and habitat (direct elimination of habitat by construction of project facilities such as the airstrip, road, mill, and camp). Indirect impacts are the effective loss of habitat through avoidance because of human contact and associated activities and noise.

Attention in this section is focused on species that are generally considered of primary importance for ecological, aesthetic, subsistence, or recreational purposes. Threatened, endangered, and sensitive species are discussed separately in the following section (4.10).

Note that clearing is defined as removal of vegetation above ground level, but with no major damage to the vegetative mat on the ground surface. Surface disturbance is defined as major damage to, or removal of, the vegetative mat. And the word “disturbance” alone is used generically to include clearing and surface disturbance.

## 4.9.1 No Action Alternative

- **Habitat** Habitat disturbance from non-resource development in the project area would be minimal. Low-level development of residential and recreational cabin land, as well as some low-level commercial and industrial development, could occur within the Richardson Highway corridor, and would be commensurate with population growth. The NMDS would not be built within the project area, but construction of a natural gas pipeline and access roads would cause surface disturbance of between 300 and 400 acres parallel to the TAPS ROW within approximately 2 miles of the Richardson Highway. These activities would cause minor habitat loss in the context of the project area.

  Implementation of the DOF’s 5-year harvesting plan in the Shaw Creek drainage and Quartz Lake/Indian Creek areas and the associated road development would affect wildlife habitat. Eight timber sales are planned that would disturb approximately 1,313 acres, not including new timber access roads (ADNR, 2002). Construction by DOF of roads into these areas over several years for ongoing timber sales would result in long-term timber harvesting within those units of the TVSF. These timber harvests would alter habitats and therefore species composition. If harvesting were done using BMPs in a manner that prevented degradation of the vegetative mat, however, and according to the principles of sustained yield management, such harvesting would result in low habitat loss in the context of the project area.

- **Birds** Direct habitat loss for birds would be low, except locally for timber harvest areas. Loss of forest habitat would cause a change in species composition, with forest-dwelling species being replaced by those preferring early stages of vegetative succession. Both the impacts to the former and benefits to the latter would be high only on a local basis. Indirect impacts would be minimal, even on a local basis.

- **Mammals** In the same manner as for birds, direct habitat loss for mammals would be low, except locally for timber harvest areas. Loss of forest habitat would cause a change in species composition, with forest-dwelling small mammal species being replaced by those preferring early stages of vegetative succession. Marten, however, are dependent on larger, homogeneous stands of mature spruce timber. If ongoing harvests were to fragment larger spruce stands, the forest fragmentation could have a high impact on marten in the context of the Shaw Creek drainage.

  For large mammals with large home ranges, these vegetative changes generally would have low impacts. If timber harvesting occurred at various locations across the Shaw Creek Hillside on an ongoing, regular basis, however, there likely would be benefits to some species. An increase in "edge effect," which would occur with timber harvesting in an otherwise homogeneous forest, is generally favorable to many species by interspersing different habitats within a smaller area. Vegetative succession following clearing would produce more deciduous species such as willow, which is a favorite moose browse. For moose, these benefits largely would be high only on a local basis, but if a dispersed timber harvest pattern of a thousand or more acres were to occur on the hillside within a 10- to 15-year period, the increased food supply for moose might be of substantial benefit on a greater than local basis.

  Indirect impacts would be minimal, largely related to timber harvest activities and to other uses, including recreational, of the all-season timber road system. Such indirect habitat loss likely would be high only on a local geographical and temporal basis.

  Overall, impacts from the No Action Alternative would be low, with both high impacts and high benefits occurring at a local level.

## 4.9.2 Options Common to All Alternatives

These common options are all located at the mine site.

- **Habitat** As a group, these options and sub-options would directly disturb approximately 383 acres of habitat, all in the mine site area. The large majority of disturbance would occur in the following habitat classes: upland needleleaf forest, upland mixed forest, lowland needleleaf forest, riverine needleleaf forest, and riverine mixed forest. No rare or uncommon habitat classes would be disturbed. Even within a local context, this direct habitat loss would be low.

  Most of the mine area disturbance would occur on medium-value Conservation Priority Index habitats, but nearly half of all disturbance in the airstrip area complex would occur on high-value habitats. This disturbance would cause a high impact only on a local basis, however.

- **Birds**

  **Direct impacts** These options and sub-options would not directly affect nesting or other important habitats for waterbirds or raptors.

  Direct impacts would occur to several passerine species whose small territories and home ranges fall within the footprints of these mine area components, particularly the dry tailings stack and RTP, the mill, and the camp. This loss would be high only on a local basis, however, because the habitat types are common in the Goodpaster drainage and throughout the Interior, and the species affected also are widespread.

**Indirect impacts** Indirect impacts for small passerine species would be negligible because the species would adapt to life adjacent to the facilities. There would be some minimal indirect habitat loss, primarily to predator species that would tend to avoid the activities associated with the mine area. Because the majority of their prey species such as small mammals (voles, shrews, and hares) and passerines likely would not experience much indirect habitat loss, these predators would experience only minimal indirect habitat loss, considering the relatively large areas within which they hunt. Thus, indirect habitat loss to birds would be low.

- **Mammals**

**Direct impacts** Direct impacts for large mammals (moose, caribou, wolf, and bear) would be small, given their large home ranges and the availability of suitable habitat in the Goodpaster drainage, and would be low even on a local basis. No critical habitat for these species occurs in areas to be cleared for these options.

Larger furbearers (lynx, coyote, red fox, wolverine, and martin) would experience some direct habitat loss, but given the size of their home ranges, impacts would be moderate and only on a local basis. For short-tailed and least weasels, direct habitat loss would be high only on a local basis. There would be no substantial direct habitat loss for largely water-dependent furbearers (river otter, beaver, mink, and muskrat) because these options would not directly affect water bodies or waterways.

Direct impacts would occur to small mammals (voles, shrews, and hares) whose territories and home ranges fall within the project footprint. This loss would be high only on a local basis because similar habitat is common in the Goodpaster drainage and throughout the Interior, as are the species that would be affected.

**Indirect impacts** Some indirect habitat loss for moose would occur because individuals generally would avoid the activities associated with the major facilities, but they likely would use suitable habitat in areas adjacent to project operations. Given the relatively large home range of this species and its ability to accommodate to some human activity, this indirect habitat loss would be high only on a local basis.

A longer term indirect impact to moose could occur. The Alaska Board of Game has adopted intensive management for the project area with the intent of increasing the number of moose for human consumption. The presence of the Pogo mine facilities and other possible mining activities, however, would cause a more conservative approach in wildfire suppression and likely would reduce the potential for increasing the number of moose near the mine area from favorable habitat changes caused by naturally occurring wildfires.

Based on recent movements of the Fortymile Caribou Herd (FCHPT, 2000), for the more critical period from May through September, caribou cows and calves likely would not be found in the vicinity of the proposed mine site. Only during the less critical October through April period of rut, early winter, winter, and early spring would some individuals on the edge of the herd’s distribution be expected near the proposed mine site. Caribou are more sensitive to disturbance than moose, and individuals encountering the facilities and activities at the mine site likely would avoid the area to a much greater extent. Because of their substantially larger home range, and the current absence of other large human activity centers in the upper Goodpaster drainage, the indirect loss of habitat from avoidance of the mine area facilities would be low to caribou.

Wolves also would be subject to indirect habitat loss because they would avoid the mine area facilities. Like other large mammal species, because of their large home range, and because at present there are no other large human activity centers in the Goodpaster drainage, the indirect loss of habitat from avoidance of the mine area facilities would be low. Wolves using the den site in the vicinity of Indian Creek, however, likely would abandon the site as mine area and airstrip development occurred.

Both black and brown bears would experience some unpredictable level of indirect habitat loss. These losses would not be high, however, because of the large home ranges of the bears and the present lack of other large human activity centers in the area. Nonetheless, some bears would be displaced to other areas. Brown bears in particular have a low tolerance for, and seek to avoid, human activity. They would be affected to a greater extent than black bears, and the frequency of brown bear use in the vicinity of the proposed mine area would decrease. Black bears also would tend to avoid the area, but they are normally more accommodating to human activity than brown bears. Both species could be attracted to improperly handled garbage, which could result in their death. Both species are common throughout the Interior.

Water withdrawal from the RTP for mill operations during winter could produce conditions that could entrap large mammals, most likely moose. Water drawdown could produce ice shelves, voids with thin ice covering, or thin ice that might cause a moose attempting to cross the RTP to fall through and become injured or might preclude escape from the RTP. The number of moose that might be so affected would be quite small, however.

The dry-stack tailings pile, RTP, and the mill and camp complex would disrupt movement patterns of large mammals to some extent. Because these sites would not be fenced, some animals, most likely moose, would occasionally wander into these facilities. These animals usually would not be harmed, but probably would need to be herded out by project personnel. In unusual cases, the animals might have to be tranquilized and moved.

Indirect impacts for most smaller mammal species would be relatively minor because most would adapt to the presence of the facilities. Wolverine and marten, however, have a low tolerance for human activities, and indirect habitat loss for these species likely would occur in the vicinity of the proposed mine and some habitat fragmentation would occur. Because there are no other large human activity centers in the area, this loss would not be high in the context of the overall Goodpaster drainage throughout which these species are found.

The solid waste disposal facilities should be maintained in a manner that would not attract wildlife such as black bears. All putrescent wastes would be incinerated and the residual ash material buried. If these procedures were not rigidly adhered to or the prohibition against feeding of animals were not strictly enforced, however, bear-human contacts might occur that would result in serious injury to workers and the death of wildlife.

Removal of the airstrip at mine closure would allow the relatively high-value habitat to begin to recover through reclamation and plant succession. It also would reduce the indirect habitat loss by substantially reducing human activity in the area.

### Gravel Source

Expanding existing gravel pits and developing new ones (including rock quarries), rather than crushing development rock for gravel, would cause surface disturbance to an additional approximately 66 acres in the vicinity of the mill and camp, and on the Goodpaster Valley floor below and south of the 1525 Portal and adjacent to the airstrip. If the off-river treatment works water discharge option were constructed (see Alternative 4 later in this subsection), approximately 13.1 acres (20 percent) of this total would be excavated for the two ponds, thus producing gravel that would be available for construction purposes.

With the exception of 4 acres of Conservation Priority Index high value habitat in the vicinity of the airstrip (discussed under Alternative 4 later in this subsection), disturbance generally would be to lower value habitat. And, if the gravel pits were reclaimed as ponds, habitat benefits would accrue. Still, mining gravel would have a moderate local overall habitat impact compared to crushing development rock for gravel.

## 4.9.3 Options Not Related to Surface Access

### Alternative 2

### Power Supply

- Power Line

  - **Habitat** Construction of a power line would require clearing vegetation on approximately 602 or 525 acres, depending on the route. This clearing would contrast with approximately 23 acres of additional disturbance required for diesel fuel storage tanks and laydown area for on-site power generation for Alternative 4. Power line clearing generally would not seriously damage the ground surface vegetative mat, however, and in a few areas, no clearing at all would be required because the existing natural height of vegetation would be too low to interfere with power line construction or operation. Thus, following clearing, the altered habitat would still provide support to wildlife, though of a different species composition.

  - **Birds**

    **Direct impacts** Construction of a power line would result in clearing vegetation on approximately 602 or 525 acres, and thus a direct habitat loss for birds. This habitat loss would affect species nesting on the ground and in low brush as well as forest-dwelling species because both brush and trees would be disturbed. Because of the narrow and linear nature of the disturbed ROW over a distance of approximately 43 miles, as well as its route across different habitats, these impacts would be high only on a local basis to most species. For larger species that may nest in some of the trees that would be removed (e.g., raptors), loss of some nest sites likely would occur. Because it is unlikely that nest trees are a limiting factor in raptor populations in the project area, loss of a few nests would not cause a high impact on more than a local basis because of the larger home ranges of these species.

    **Bird-power line collisions** Collisions with power lines and electrocutions cause millions of bird deaths annually in the United States. The power line option would pose a collision threat primarily to raptors and waterfowl, but could cause death to many smaller species. The degree of threat would be related to the size and design of the structures, the line (wire) profile, and the geographic location of the power line with respect to key habitats and flight pathways

The Applicant's proposed typical structure size and design would mitigate several concerns. In timbered areas, the approximately 70-ft height would mean the lines themselves likely would be below the tops of trees. The horizontal cross member H-pole construction would separate the lines by more than 15 ft laterally and substantially reduce the chance for electrocution. This design also would allow line wires to be strung on one horizontal plane rather than at different elevations vertically. In addition, phase wires would be of the same diameter, and no overhead ground wire is proposed for the lower geographic elevations nearer waterfowl areas. Wires would have daytime visual markers where they crossed Shaw Creek and the Goodpaster River.

Although there is little information about flight pathways in the project area, collisions might be reduced by use of daytime visual markers along more of the power line, especially at elevations above timberline where birds do not expect obstacles to free flight. Whether markers would be effective, however, is unknown, and such markers would increase risk of power line failure from wind and ice loads in these exposed areas. Overall, the project area is not likely a prime corridor for major bird movements, and collision impacts are expected to be high only on a local basis. There are likely to be differences in the probability of collisions between the two power line routes. These differences are discussed later for each alternative.

**Indirect impacts** Indirect impacts for all bird species would not be high. These option facilities are either passive in nature (e.g., the power line and water discharge facilities) or would be located within or immediately adjacent to other areas of activity (e.g., laydown area and fuel storage). Smaller species would adapt to nearby local activity disturbances, and while larger species with greater home ranges would tend to avoid areas of activity, the relatively small size of the facilities would not cause a high indirect habitat loss, considering the size of the species' areas of activity.

- **Mammals**

**Direct impacts** While not inconsequential in acreage, habitat impacts would be high only on a local basis to most small mammals and furbearers because the cleared power line ROW would be narrow and linear in nature, the ROW would cross different habitats, and the ground surface and vegetation would not be substantially disturbed. Because of their much larger home ranges, direct habitat loss would not be high for large mammals.

Clearing of the ROW could have advantages for some species. An increase in "edge effect," which would occur when the ROW were cleared through otherwise homogeneous forest, is generally favorable to many species by interspersing different habitats within a smaller area. Vegetative succession following clearing would produce more deciduous species such as willow, which is favorable to moose as browse. While favorable, because of the linear nature of the ROW, such benefits would be high only on a local basis.

Impacts from construction and use of temporary fuel storage tanks below the 1525 Portal and lower airstrip would be moderate to small mammals and only on a local basis.

**Indirect impacts** The power line and its ROW would be passive facilities, and would not cause any high indirect habitat loss during normal operation. When routine maintenance were required, or if an emergency were to occur, such activities could cause some indirect habitat loss, especially to larger mammals. Such activities would be infrequent and of limited duration, however, and would have a high impact only locally and within a short time frame.

The power line ROW could serve as an access corridor for ATVs into a presently remote, relatively inaccessible area, regardless of the road use status. If substantially increased access were to occur, the greatest wildlife impact likely would occur from increased use by moose, caribou, and bear hunters with a resulting increase in harvests for these species. More restrictive hunting regulations likely would be required to compensate for the increased harvests.

### Water Discharge

- Soil Absorption System

  - **Habitat** A soil absorption facility for RTP discharge would cause surface disturbance of approximately 4.4 acres. If located in the Goodpaster Valley near the airstrip, this facility would be situated completely in Conservation Priority Index high-value habitat, and if located in the saddle above and southeast of the Pogo Ridge mill site, it would be situated in Conservation Priority Index low-value habitat. While impacts would be high only on a local basis at both locations, direct habitat impacts would be higher at the airstrip location. Location of the SAS southeast of Pogo Ridge, however, would substantially expand the footprint of the mine facilities and would have a greater indirect impact on wildlife.

- Underground Injection Wells Underground injection to an existing bored and cased well in the vicinity of the existing 1525 Portal would have low impacts on wildlife.

## Alternative 3

### Power Supply

- Power Line Same as Alternative 2.

### Water Discharge

- Direct Discharge to Goodpaster A direct discharge to the Goodpaster River would cause surface disturbance to approximately 0.5 acre in a linear fashion. This disturbance would be a minimal impact.

## Alternative 4

### Power Supply

- On-Site Generation

  - **Habitat** On-site power generation would require an additional approximately 23 acres of disturbance near the airstrip for diesel fuel storage tanks and laydown area to hold a full year's supply of fuel and supplies. There would be no additional disturbance needed for generators because a substation for the power line option would occupy the same area. This habitat loss would be moderate in the context of other surface disturbance at the airstrip complex. On-site generation, however, would avoid clearing vegetation on approximately 602 or 525 acres of power line ROW, as would occur with Alternatives 2 and 3, respectively.

On-site generation, however, would require moving an additional approximately 4.2 million gallons of fuel to the mine site during a short winter window. The transportation of fuel would pose a greater risk to wildlife and habitat from spills than would the power line option.

## Water Discharge

- Off-River Treatment Works

  - **Habitat** This two-pond treatment facility would be constructed in approximately 13.1 acres adjacent to the airstrip. Excavated gravel would be used for project construction purposes.

    Approximately 4 acres of this facility would be in a Conservation Priority Index high-value habitat, generally mapped as uplands with a vegetation type of alluvial forests-terrace, a relatively common habitat type in the Goodpaster Valley. The location of the off-river treatment works facility was based on necessary proximity to the river, as well as avoidance of wetlands. Therefore, even if rock were crushed for aggregate, this would not avoid construction of the off-river treatment works. Although these 4 acres would be disturbed, the relatively common occurrence of this habitat type in the Goodpaster Valley would result in a low impact in the context of the Goodpaster Valley.

  - **Birds**

    **Direct impacts** The direct habitat loss for the off-river treatment works would be high only to small passerines and only on a local basis.

    **Indirect impacts** Indirect impacts due to activities associated with the off-river treatment works would cause little additional indirect habitat loss above that described earlier for the other mine area facilities, and would be moderate on a local basis. Noise from the diesel generators would have to meet OSHA standards and likely would cause only low indirect loss of habitat for birds.

  - **Mammals**

    **Direct impacts** The direct habitat loss for the off-river treatment works would be high only to small mammals and only on a local basis.

    **Indirect impacts** Indirect impacts due to activities associated with the off-river treatment works would cause very little additional indirect habitat loss above that described earlier for the other mine area facilities and would be moderate on a local basis. Although noise from the diesel generators would have to meet OSHA standards, this noise would add to the general noise level from other Liese Creek Valley facilities and would likely be more noticeable to mammals. This increased noise level could result in some small level of incremental avoidance by larger furbearers and large mammals.

## 4.9.4 Options Related to Surface Access

**Alternative 2**

### Surface Access

***Route***

- Shaw Creek Hillside all-season road

  - **Habitat** This option would cause surface disturbance to approximately 770 acres, and construction of its companion power line would clear approximately 602 acres, for a total of approximately 1,372 acres (Table 2.3-6). Table 4.9-1 presents a breakdown of disturbance, by habitat type as shown in Figure 3.10-1, for each of the three surface access options. Table 4.9-1 also shows the disturbance that would occur to Conservation Priority Index habitats as shown in Figure 3.14-1.

    Three habitat types individually would compose more than 10 percent of the disturbed area: upland mixed forest (18 percent), upland needleleaf forest (18 percent), and lowland needleleaf forest (37 percent). Collectively, disturbance to these three habitats would constitute approximately 73 percent of all disturbances. From the Conservation Priority Index perspective, approximate disturbance percentages would be low-value (27 percent), medium-value (66 percent), and high-value (7 percent) habitats.

    Although the absolute total of approximately 1,372 acres of disturbance that would occur for the Shaw Creek Hillside all-season road and power line is large, it is small in the context of the project area. Also, the approximately 602 acres within the power line ROW would only be cleared, with little actual surface disturbance. The habitat loss for Alternative 2 would not be high for the following reasons: the linear nature of the corridors, the low impacts or absence of impacts on rarer or uncommon habitat classes, the abundance within the project area as well as in interior Alaska of the habitat types that would be primarily disturbed, and the low disturbance to Conservation Priority Index habitats.

**Table 4.9-1 Acreage and Percentage of Surface Access and Power Line ROW Disturbance by Habitat Type and Conservation Priority Index Habitats[1]**

| | Alternative 2 Shaw Creek Hillside | | Alternative 3 South Ridge | | Alternative 4 Winter-Only Access | |
|---|---|---|---|---|---|---|
| **Habitat Type** | **Acres** | **Percent** | **Acres** | **Percent** | **Acres** | **Percent** |
| Alpine meadow | 10 | < 1 | 21 | 1.6 | 10 | < 1 |
| Alpine dwarf scrub | | | 16 | 1.2 | | |
| Subalpine needleleaf woodland | 63 | 4.6 | 149 | 11.5 | 63 | 5.4 |
| Cliff | < 1 | < 1 | 1 | < 1 | < 1 | < 1 |
| Bluff meadow | | | | | | |
| Upland tall scrub | | | 102 | 7.9 | | |
| Upland needleleaf woodland | 86 | 6.2 | 95 | 7.3 | 86 | 7.2 |
| Upland broadleaf forest | 27 | 1.9 | 249 | 19.3 | 22 | 1.9 |
| Upland mixed forest | 243 | 17.7 | 404 | 31.3 | 146 | 12.4 |
| Upland needleleaf forest | 254 | 18.5 | 96 | 7.4 | 219 | 18.5 |
| Upland north-facing needleleaf forest | 21 | 1.5 | 29 | 2.3 | 21 | 1.8 |
| Lowland meadow | | | < 1 | < 1 | < 1 | < 1 |
| Lowland low scrub | 6 | < 1 | < 1 | < 1 | 24 | 2.0 |
| Lowland broadleaf forest | 74 | 5.4 | 7 | < 1 | 38 | 3.2 |
| Lowland needleleaf forest | 501 | 36.6 | 45 | 3.4 | 483 | 40.8 |
| Lakes and ponds | 9 | < 1 | 8 | < 1 | | |
| Riverine barrens | 1 | <1 | | | 1 | <1 |
| Riverine scrub | 1 | < 1 | | | < 1 | <1 |
| Riverine broadleaf forest | < 1 | < 1 | | | | |
| Riverine mixed forest | 6 | < 1 | < 1 | < 1 | 3 | < 1 |
| Riverine needleleaf forest | 30 | 2.2 | 21 | 1.6 | 28 | 2.4 |
| Rivers and streams | 38 | 2.7 | 19 | 1.5 | 37 | 3.1 |
| Human modified | 3 | < 1 | 14 | 1.1 | < 1 | < 1 |
| Cloud and shadow | | | 16 | 1.3 | | |
| **Total** | **1,372** | **100** | **1,293** | **100** | **1,182** | **100** |
| **Conservation Priority Index** | | | | | | |
| Low | 373 | 27.2 | 416 | 32.2 | 357 | 29.9 |
| Medium | 908 | 66.2 | 843 | 65.2 | 795 | 66.6 |
| High | 91 | 6.6 | 17 | 1.3 | 42 | 3.5 |
| Cloud and shadow | | | 17 | 1.3 | | |
| **Total** | **1,372** | **100** | **1,293** | **100** | **1,194** | **100** |

[1] Habitat types as shown in Figures 3.10-1 and 3.14-1.

## ✦ Birds

**Direct impacts** The Shaw Creek Hillside all-season road and power line would pass primarily through habitat of negligible value to trumpeter swans, with a few locations having low habitat value for swans. While the route would pass through or close to other waterfowl habitat in places, because the route is on the hillside, and not in the Shaw Creek Valley, it would have little effect on waterfowl habitat.

Direct impacts from the all-season road and power line on other species would be similar to those described earlier for a power line in Section 4.9.3 (Alternative 2), and would be high only on a local basis.

Bird collisions with power lines are discussed in Section 4.9.3 (Alternative 2). For this particular route, collisions likely would be lower than for the South Ridge alternative because for most of its route in the Shaw Creek Valley the power line would be within forest habitats. Collisions are expected to be of importance only on a local basis. The major area of concern, other than the crossings of Shaw Creek and the Goodpaster River, would be the approximately 10-mile segment located above timberline between the Shaw Creek and Goodpaster River valleys. If daytime visual markers on the lines were not used in this segment, bird collisions would be more likely to occur. There would be some collisions with road vehicles, primarily by small passerines, but these would have minimal impact.

**Indirect impacts** The indirect impacts would be the same as discussed in Section 4.9.3 (Alternative 2), and would not be high.

✦ **Mammals**

**Direct impacts** Direct impacts from this alternative would be high only to small mammals and only on a local basis.

Based on the low-, medium-, and high-value habitats presented for moose, caribou, and brown bear in Figures 3.14-3, 3.14-5, and 3.14-6, respectively, Table 4.9-2 presents, on a species basis, the acres and percentages of surface access and power line ROW surface impacts on these habitats for each alternative.

Except for a limited area of high-value moose habitat in the upper Rosa Creek and Keystone Creek drainages, the Hillside all-season road would traverse primarily medium-value moose habitat in the Shaw Creek Valley and low- or medium-value habitats over the Shaw Creek and Goodpaster River divide (Figure 3.14-3). A percentage breakdown of approximate overall moose habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (40 percent), medium-value (50 percent), and high-value (6 percent) habitats.

In a similar manner, the Hillside all-season road would cross primarily medium-value caribou habitat in the Shaw Creek Valley, and while climbing to and descending from the Shaw Creek and Goodpaster River divide. Along the top of the divide, however, this alternative would traverse approximately 6 miles of high-value habitat (Figure 3.14-5). A percentage breakdown of approximate overall caribou habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (28 percent), medium-value (63 percent), and high-value (5 percent) habitats.

For brown bears, which prefer more open, unforested habitats, the Hillside all-season road would traverse only low-value habitats throughout the length of the Shaw Creek Valley. While climbing to and descending from the Shaw Creek and Goodpaster River divide, the road would cross medium-value habitat. Along the top of the divide, however, this alternative would traverse the same approximately 6 miles of high-value habitat as for caribou (Figure 3.14-6). A percentage breakdown of approximate overall brown bear habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (45 percent), medium-value (44 percent), and high-value (7 percent) habitats.

For wolves, which move easily among many habitats as predators, relative habitat values are similar to those of their larger prey species, primarily moose and caribou, discussed above.

**Table 4.9-2 Acreage and Percentage of Low-, Medium-, and High-Value Habitat Disturbance, by Species and Alternative, for the Surface Access and Power Line ROWs[1]**

| Species | Alternative | Habitat Value: Low | | Medium | | High | | Negligible or Cloud/Shadow[2] | |
|---|---|---|---|---|---|---|---|---|---|
| | | Acres | Percent | Acres | Percent | Acres | Percent | Acres | Percent |
| **Moose** | 2 | 550.4 | 40.1 | 690.6 | 50.3 | 83.9 | 6.1 | 47.7 | 3.5 |
| | 3 | 563.9 | 43.6 | 538.3 | 41.6 | 117.1 | 9.1 | 73.3 | 5.7 |
| | 4 | 413.9 | 35.0 | 682.4 | 57.8 | 38.6 | 3.3 | 46.8 | 4.0 |
| **Caribou** | 2 | 387.5 | 28.2 | 861.9 | 62.8 | 73.2 | 5.3 | 49.9 | 3.6 |
| | 3 | 783.8 | 60.6 | 264.2 | 20.4 | 185.2 | 14.3 | 59.5 | 4.6 |
| | 4 | 263.7 | 22.3 | 807.6 | 68.4 | 73.2 | 6.2 | 37.1 | 3.1 |
| **Brown bear** | 2 | 618.4 | 45.0 | 608.8 | 44.4 | 94.2 | 6.9 | 51.2 | 3.7 |
| | 3 | 73.2 | 5.7 | 945.5 | 73.1 | 214.5 | 16.6 | 59.5 | 4.6 |
| | 4 | 576.2 | 48.8 | 472.9 | 40.0 | 94.2 | 8.0 | 38.3 | 3.2 |

[1] Based on Figures 3.14-3, 3.14-5, and 3.14-6.
[2] Parts of satellite image obscured by clouds.

Because of the linear nature of the all-season road and power line corridors, the relatively small impacts of these corridors on the high-value habitats of these species, and the abundance of the potentially affected medium- and high-value large mammal habitats within the project area as well as in interior Alaska, the direct habitat loss from Alternative 2 would not be high for these large mammal species.

Collisions with all-season road vehicles would occur for both small and large mammals. Although the project area generally does not receive large snowfalls, the cleared road surface flanked by snow berms would be favored for movements by larger animals, particularly moose, when snow depths were high. Because of the small number of vehicles that would use the road under the Applicant’s Proposed Project, this mortality would not be high even on a local basis.

If the road were open to other industrial/commercial users or open to everyone, traffic would increase proportionally, as would collisions. This increased mortality likely would be moderate only on a local basis. If the road were to remain open for use after mine closure, this mortality would continue.

Extending public access into new areas can result in changes to game population numbers from greater hunting success. Such changes can result in management restrictions such as hunting season length, animal size and sex restrictions, methods of take, and bag limits.

**Indirect impacts** Indirect impacts generally would be low for small mammals and certain larger species such as moose and black bear. Noise and activity would be limited to the narrow road corridor and individuals would adapt to these as they have to similar resource roads throughout interior Alaska. The Shaw Creek Hillside all-season road, however, would skirt and then enter a moose rutting area on the northwest side of Shaw Creek Valley. Except for the intense use of the road for a period during construction, the road-related noise and activity should have only a small effect on moose rutting.

Other species such as brown bears and wolverines, however, tend to avoid human activity and likely would avoid the area of the road corridor other than for crossing. The tendency to avoid the road corridor would not cause major habitat fragmentation for these species. For marten, however, a more wilderness species, the road corridor likely would serve as more of a behavioral barrier to movements and could cause some habitat fragmentation. Habitat fragmentation would be a low to moderate impact for this species.

- **Security gate at Gilles Creek** Impacts would be similar to those described above, except that public use would extend to only to the lower two-thirds of Shaw Creek Valley. This shorter road available to public use would lower collision mortality and reduce the area of easily accessible hunting.

## Power Supply

- Power Line

  - **Route** In the Applicant's Proposed Project, the power line would cross the Shaw Creek / Goodpaster divide via Sutton Creek (Figure 2.3-2), to the north and away from the road corridor. As a result of public comments on the DEIS, a new sub-option was considered with the power line following the road corridor over the divide. This sub-option would have approximately the same habitat impact, but by consolidating the two corridors, as occurs for the large majority of the remainder of this alternative's route, it would remove almost all wildlife impacts from Sutton Creek with minimal additional impacts adjacent to the road.

# Alternative 3

Impacts from this alternative generally would be the same as for Alternative 2 except as discussed below.

## Surface Access

### *Route*

- South Ridge all-season road

  - **Habitat** This option would cause surface disturbance to approximately 768 acres, and construction of its companion power line would clear approximately 525 acres, for a total of approximately 1,293 acres (Table 2.3-6). This disturbance would represent approximately 79 acres, or approximately 6 percent, fewer acres affected than for Alternative 2.

    Three habitat types individually would comprise more than 10 percent of the disturbed area: subalpine needleleaf woodland (12 percent), upland broadleaf forest (19 percent), and upland mixed forest (31 percent). Collectively, disturbance to these three habitats would constitute approximately 62 percent of all disturbances. Because the all-season road in this alternative would be located at a higher altitude than for Alternative 2, more upland than lowland habitat types would be disturbed, particularly upland broadleaf forest.

From the Conservation Priority Index perspective, approximate disturbance percentages would be low-value (32 percent), medium-value (65 percent), and high-value (1 percent) habitats. (Individual percentages do not total 100 because of cloud and shadow areas on aerial photographs.) This distribution would be relatively similar to that for Alternative 2, except that only 1 percent of disturbance by this alternative would be to high-value index lands in comparison to 7 percent for Alternative 2.

In the same manner as discussed for Alternative 2, while the absolute total of approximately 1,293 acres of disturbance that would occur for the South Ridge all-season road and power line is large, it is small in the context of the project area, and the area within the power line ROW would only be cleared. Because of the linear nature of the corridors, the low level or absence of impacts on rarer or uncommon habitat classes, the abundance of the habitat types within the project area as well as in interior Alaska that would be primarily disturbed, and the low disturbance to Conservation Priority Index habitats, the habitat loss for Alternative 3 would not be high.

- **Birds**

**Direct impacts** Direct impacts generally would be the same as for Alternative 2. Because the South Ridge all-season road and power line route climbs relatively quickly to altitude, and only passes through habitats of negligible value to trumpeter swans and waterfowl, they would not have high impacts on these species.

Bird collisions in general with the power line for this alternative likely would be higher than for the Shaw Creek Hillside alternative because for approximately 25 miles the power line would be above timberline along the South Ridge. If daytime visual markers on the lines were not used in this segment, bird collisions would be more likely to occur.

**Indirect impacts** Same as Alternative 2.

- **Mammals**

**Direct impacts** As with Alternative 2, direct habitat loss from this alternative would be high only to small mammals and only on a local basis.

The South Ridge all-season road leaves the lowlands soon after leaving Quartz Lake and climbs to and follows the crest of the Shaw Creek and Goodpaster River divide, unlike the Hillside all-season road, which traverses lowlands for the length of the Shaw Creek Valley before crossing the divide. This altitude difference primarily accounts for the differentiation in habitat impacts between these two alternatives.

The South Ridge all-season road would traverse primarily low- and some medium-value habitats throughout its length. For approximately 5 miles along the crest of the divide, however, just before this route joins with the Hillside all-season road route, this alternative would pass through or adjacent to high-value moose habitat (Figure 3.14-3). A percentage breakdown of approximate overall moose habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (44 percent), medium-value (42 percent), and high-value (9 percent) habitats. This disturbance would be approximately 50 percent more high-value habitat than for Alternative 2.

This alternative would cross primarily low-value caribou habitat for most of its route before joining with the Hillside all-season road route. For a distance of approximately 3 miles on the divide, however, in the vicinity of Shaw Creek Dome, this alternative would traverse high-value caribou habitat (Figure 3.14-5). A percentage breakdown of approximate overall caribou habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (61 percent), medium-value (20 percent), and high-value (14 percent) habitats. While this alternative would cross more than twice as much low-value habitat as Alternative 2, it also would cross almost three times as much high-value habitat as Alternative 2.

For brown bear, this alternative would cross or be immediately adjacent to medium- and high-value habitats for its entire length, including an approximately 5-mile segment of high-value habitat along the crest of the divide in the vicinity of Shaw Creek Dome (Figure 3.14-6). A percentage breakdown of approximate overall brown bear habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (6 percent), medium-value (73 percent), and high-value (17 percent) habitats. Thus, this alternative would cross a substantially greater distance of medium-value habitat than would Alternative 2, and 2 ½ times the distance of high-value habitat.

The relative disturbance to wolf habitats would be similar to that for Alternative 2.

Because of the linear nature of the all-season road and power line corridors, the relatively small impacts of these corridors on high-value habitats of the species discussed above, and the abundance of the potentially affected medium- and high-value large mammal habitats within the project area as well as in interior Alaska, the direct habitat loss impacts from Alternative 3 would be the same as for Alternative 2, and would not be high for these large mammal species. This alternative, however, would disturb roughly twice the acreage of high-value habitats for moose, caribou, and brown bear than would Alternative 2.

Vehicle collision mortality would the same as Alternative 2.

Indirect impacts Indirect impacts generally would be the same as for Alternative 2. This alternative, however, would avoid the moose rutting area in Shaw Creek Valley, and its long run above timberline along the Shaw Creek and Goodpaster River divide would not pose the same habitat fragmentation concern for marten as would Alternative 2.

### Alternative 4

Because the Shaw Creek Flats winter-only access route follows the Shaw Creek Hillside all-season road route, except for the first approximately 15 miles in lower Shaw Creek Valley, the impacts of this alternative would be similar to those of Alternative 2, except in lower Shaw Creek Valley.

## Surface Access

### *Route*

- Shaw Creek Flats winter-only access
  - **Habitat** This option would cause surface disturbance to approximately 594 acres (Table 2.3-6). This disturbance would represent approximately 176 fewer acres

affected, or approximately 23 percent less, than for the Shaw Creek Hillside all-season road in Alternative 2. It would represent a similar approximately 174 fewer acres affected, or 27 percent less, than for the South Ridge all-season road route in Alternative 3. Because a major portion of the Shaw Creek Flats winter-only access segment of this option already exists as winter trails/roads, approximately 44 acres of predominately wetlands have already been cleared of larger vegetation.

Because of its similarity to the Shaw Creek Hillside route in Alternative 2, this alternative would primarily affect the same three habitat types: upland mixed forest (12 percent), upland needleleaf forest (18 percent), and lowland needleleaf forest (41 percent). Collectively, disturbance to these three habitats would constitute approximately 71 percent of all disturbances.

From the Conservation Priority Index perspective, approximate disturbance percentages would be low-value (30 percent), medium-value (66 percent), and high-value (4 percent) habitats. This distribution would be relatively similar to that for Alternative 2, except that only 4 percent of disturbance by this alternative would be to high-value index lands compared with 7 percent for Alternative 2. This lower disturbance to high-value index lands is largely because Alternative 2 would traverse approximately 85 acres of high-value index lands compared with only approximately 37 acres for Alternative 4.

- **Birds**

**Direct impacts** The Shaw Creek Flats winter-only access traverses habitats of low and high value to trumpeter swans in the southern half of the Shaw Creek Valley. Likewise, much of this area is important waterfowl habitat. Because of the temporal nature of winter trail construction, however, direct habitat loss for these species would not be high.

Because this alternative would use the same power line route as Alternative 2, direct impacts from the power line would be the same as for Alternative 2. Road vehicle collisions with birds would be fewer because of the limited window of activity, and because very substantially fewer birds would be present at that time.

**Indirect impacts** Because the winter-only access would be constructed and used only in winter, when the large majority of bird species would be absent, this alternative would cause minimal indirect habitat loss.

- **Mammals**

**Direct impacts** Direct habitat impacts on caribou and brown bears would be very similar to those for Alternative 2. For moose, however, this alternative would cross approximately 54 percent less high-value habitat than would Alternative 2 (Table 4.9-2). Like Alternative 2, however, direct habitat impacts would not be high.

Vehicle-wildlife collisions would be more likely to occur because of substantially greater winter traffic, especially if deep snow were to accumulate and cause animals to use the road surface for movements. These indirect impacts, however, would be locally low to moderate, depending on the particular winter.

**Indirect impacts** Indirect impacts would be very small for approximately nine months of the year when surface access to the mine site would not occur. During winter-only access construction and use, however, vehicle noise and activity levels would be very high. This would cause disturbance to moose, and caribou if they were in the vicinity, at a critical time (mid- and late winter) when energy reserves are low.

Winter-only access effectively would eliminate road use impacts by the public; however, this condition would last only until the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek. At that time, impacts from road use would be the same as for Alternative 2.

## 4.9.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would reduce resource development and related direct and indirect cumulative impacts on wildlife considerably, particularly caribou.

- All-season Road Maintained

  - **Habitat**

**Non-resource development** The mine-induced increase in population in the Delta area of approximately 260 to 350 for an all-season road could accelerate development of private residential lands in the Shaw Creek, Tenderfoot, Richardson Highway, and Quartz Lake areas, as well as some low-level commercial and industrial development within the Richardson Highway corridor. The associated habitat disturbance, including new roads and residential and commercial power line ROWs, could be high on a limited local basis in these areas if such development were concentrated. Impacts would be low on a greater than local basis. Winter-only access would induce an increase in population of only a third to a half that for the all-season road. Residential development and associated habitat disturbance from this option likely would low.

**Timber** More planned state timber sales, on a faster schedule, would occur on the Shaw Creek Hillside with a Pogo-related all-season road than if DOF were to incrementally construct its planned all-season forestry road over a period of years. Over the long term, however, the amount of timber removed from the hillside likely would not differ substantially between these scenarios. Cumulative habitat disturbance on the Shaw Creek Hillside, therefore, likely would not differ substantially from that for the No Action Alternative.

Because construction of the proposed DOF forestry road for the area that would be accessed by a Pogo-related South Ridge all-season road would occur further in the future, building the South Ridge all-season road would provide accelerated access to state timber resources and likely result in harvesting on a faster schedule.

The winter-only access option also would accelerate Shaw Creek Hillside timber sales, but to a lesser degree than would an all-season road because of the seasonal nature of the access, and because of competition with mine-related traffic during the limited window for winter use. Long-term impacts of habitat disturbance to the Shaw Creek Hillside from this option also would not differ substantially from those for the No Action Alternative.

Both an all-season road option and the winter-only access option, however, would provide access to other timber resources near the head of the Shaw Creek drainage, in the mid-Goodpaster River drainage, or in both drainages. An all-season road would provide considerably greater flexibility than would winter-only access. If long-term timber harvests were to occur in these areas over time with the use of BMPs in a manner that prevented degradation of the vegetative mat, and according to the principles of sustained yield management, such harvesting would have a low impact in the context of the project area. For some species, such as moose, timber harvesting can be beneficial because of favorable browse conditions during early plant succession.

**Mining** An extension of the life of the Pogo project because of discovery of additional deposits in the near vicinity of the Pogo ore body could cause disturbance to an additional approximately 20 acres. This additional disturbance would cause relatively few additional cumulative impacts because most of the existing infrastructure would still be used.

An access road to the hypothetical Sonora Creek mine from the Pogo mine site would cause surface disturbance to approximately 75 acres, and the mine area facilities would cause surface disturbance to another approximately 50 acres. This combined disturbance would not affect any rare or uncommon habitats, and would be high only on a local basis. A power line extension from Pogo, largely above timberline at this altitude, would cause little habitat disturbance.

A hypothetical Slate Creek mine road would cause surface disturbance to approximately 240 acres, and the mine area facilities would cause surface disturbance to another approximately 220 acres. This combined disturbance likely would not affect any rare or uncommon habitats, and would be high only on a local basis. A power line extension up the Goodpaster Valley floor likely would require clearing a ROW through several stands of white spruce. This clearing would have habitat impacts similar to those discussed earlier for the power line to Pogo, and these impacts would be high only on a local basis.

An all-season road extending an additional 32 miles from the Pogo Mine to such a hypothetical Slate Creek mine in the headwaters of the Goodpaster River, however, would cause habitat disturbance substantially deeper into this area of the Yukon-Tanana Uplands. It also would increase the feasibility of other mining projects in the area. While the actual acreage of disturbance for this hypothetical mine would be small and would be high only on a local basis, this greater area of disturbance would enlarge the overall area subject to the beginning of habitat fragmentation through development and other human activities. Although this habitat fragmentation could have some effects on several species, it likely would be of most concern to caribou.

A likely effect of increasing mineral exploration and development activity would be harassment of wildlife by aircraft, both intentional as well as unintentional, particularly by low-flying helicopters. In combination with general, nonmineral-related aviation and the USAF aerial combat training, these activities could substantially increase cumulative impacts on caribou. Of particular concern is disturbance of the Fortymile Caribou Herd during its critical calving period.

### ✦ Birds

The direct and indirect impacts to birds from development of hypothetical mines at both Sonora and Slate creeks would be small and similar to impacts discussed earlier for an all-season road and power line to the Pogo Mine. Relatively little direct habitat loss would occur, and much of that would be linear in nature.

Extension of the power line would represent a small addition to the network of power lines slowly being built throughout the Interior, and would incrementally increase the cumulative impacts of bird strikes.

### ✦ Mammals

The direct impacts to mammals from development of hypothetical mines at both Sonora and Slate creeks would be low and similar to impacts discussed earlier for an all-season road and power line to Pogo. Relatively little direct habitat loss would occur, and much of that would be linear in nature. There would be some cumulative effect of such habitat loss, however, that would reduce wildlife numbers and diversity within the project area.

Indirect impacts could be somewhat greater because extension of an all-season road to the head of the Goodpaster River Valley cumulatively would increase human noise and activity levels, particularly affecting brown bears, marten, and wolverines, which have a tendency to shun human activity and would tend to avoid the area. In light of a history of roads creating more roads in interior Alaska, this road extension could begin habitat fragmentation for these species in the middle and upper Goodpaster Valley. With time, this habitat fragmentation could create cumulative impacts for these species, and for caribou.

**Caribou** The cumulative impact of direct loss of caribou habitat from development of a hypothetical Sonora Creek mine would be low. Recent movements of the Fortymile Caribou Herd (FCHPT, 2000), for the more critical period from May through September, have shown that caribou cows and calves likely would not be found in the vicinity of the proposed mine site. Only during the less critical October through April period of rut, early winter, winter, and early spring would some individuals on the edge of the herd’s distribution be expected near the proposed mine site. Because of the very large home range of the caribou, and the current absence of other large human activity centers in the upper Goodpaster drainage, development of a hypothetical Sonora Creek mine itself would cause a small, incremental loss of indirect habitat for caribou, considering its location relatively close to the proposed Pogo Mine. In conjunction with the Pogo development, however, a hypothetical Sonora Creek mine would definitely cause a cumulative impact within the Pogo claim block.

An all-season road and power line from the Richardson Highway to the Pogo Mine would bring year-round human activities to, and begin the habitat fragmentation process at, the fringe of the recent annual range of the Fortymile Caribou Herd. An extension of these facilities to a hypothetical Slate Creek mine in the upper Goodpaster River Valley, with corresponding mine development, however, would expand year-round human activities and push the perimeter of habitat fragmentation to the edge of the herd’s present summer range (Figure 3.14-4) (FCHPT, 2000).

While extension of an all-season road from the Pogo Mine to Slate Creek and development there of a new stand-alone mine would result in more cumulative direct loss of caribou habitat, this habitat loss in itself would not be high, given that a major portion of the loss would be road-related and linear, as well as in the Goodpaster Valley bottom, as opposed to the more important alpine caribou habitat.

The cumulative impacts of indirect habitat loss, however, would be more problematic. Caribou generally are sensitive to new development and human activities, and a

Slate Creek mine would be well inside the edge of the herd's recent annual range, except during the key calving and post-calving period of May and June when the herd is usually well to the east (FCHPT, 2000). During the remainder of the year, however, caribou would avoid the mine facilities and human activities within that portion of their traditional recent range. In the context of the herd's entire annual range, this development in and of itself likely would not constitute a high impact; however, it would definitely have a cumulative impact.

Based on the existing TBAP, which would retain this area in public ownership, caribou habitat fragmentation is not likely to occur because of direct habitat loss, but rather would be more likely to occur from indirect habitat loss. Thus, although a road extension from Pogo to Slate Creek and subsequent mine development would not in and of themselves likely cause high cumulative indirect loss of habitat, habitat fragmentation could occur in conjunction with other indirect habitat loss that could occur if other road extensions and developments were to happen,. It is not possible to predict the degree of cumulative indirect habitat loss with any certainty because further road extensions and developments are only speculative; however, based on the likely mineral potential of the area, the State of Alaska's constitutional directive to develop its resources, the existing TBAP, and the history of Alaska road development in general, additional cumulative indirect impacts would be very likely.

# 4.10 Threatened, Endangered, and Sensitive Species

No federal or state-listed threatened or endangered plant or animal species are known or expected to occur in the project area (Burgess and Ritchie, 2000). Because of limited suitable nesting habitat in the project area, no high impacts would occur to the American peregrine falcon or bald eagle. The following discussion, therefore, pertains to the sensitive species identified in Section 3.15 as being found in the project area, including the American Peregrine Falcon.

## 4.10.1 No Action Alternative

The impacts to sensitive species from the No Action Alternative would be related to the DOF's planned timber harvests in the TVSF, and would be similar to those discussed in Section 4.9 (Wildlife).

## 4.10.2 Options Common to All Alternatives

These mine area options could have some effect on all of the identified species.

A peregrine falcon nest site near the confluence of Indian Creek and the Goodpaster River is located less than a mile from the northeast end of the proposed 3,000-ft airstrip in the Goodpaster Valley. This site had an active, though unsuccessful, peregrine nest in 1998, but was unoccupied in the other 6 years from 1994 through 2000, inclusive. Surveys have shown that most other nest sites in the project area have been active during the same period, indicating that the Indian Creek site may be more marginal nesting habitat.

The activity that would be associated with construction and operation of the airstrip might cause indirect habitat loss if this nest site were to otherwise remain unused for the duration of the mine project. If the site were abandoned due to project activity, it would constitute a high impact within the context of approximately 18 miles of the upper Goodpaster Valley between Central Creek and the Glacier and Rock creeks area. It would not constitute a high impact, however, within the context of the project area as a whole. Because there would be no direct habitat disturbance to the nest site, at mine closure the site again would be available for nesting.

Three bald eagle nests were identified within the project area, all on the Goodpaster River. Two are located more than 12 miles downriver from the mine site, but one recently active nest is located approximately 3 miles upriver from the northeast end of the proposed 3,000-ft airstrip. Because the nest tree is located around the bend from the proposed airstrip site, relatively little project noise or activity would be discernable other than aircraft activity.

It is not possible to predict whether project construction and operation would cause abandonment of the nest site. There appears to be other suitable nesting habitat along the Goodpaster River (Burgess and Ritchie, 2000), and a number of bald eagle nests occur along the Tanana River between the Goodpaster River and Shaw Creek (Ritchie and Rose, 1999). If the site were abandoned due to project activity, it would constitute a high impact within the context of the upper Goodpaster Valley, but not within the context of the project area as a whole. Because there would be no direct habitat disturbance to the nest site, at mine closure the site again would be available for nesting.

The location of the construction camp, mill and campsite, and dry-stack tailing pile avoids the locations of identified northern goshawk nests, which are at least 1.5 miles from mine facilities and located in different drainages. The noise and human activity might cause abandonment of one or two nests for the duration of the mine project. Because of the abundance of goshawk habitat in the middle and upper Goodpaster Valley, as well as throughout the project area, this nest abandonment would be of only local importance.

Harlequin ducks could be displaced up or down the Goodpaster River during construction and operation of the mine facilities. This displacement likely would affect only a few individuals, would be limited to the project's duration, and would be of only local importance, given the availability of harlequin habitat throughout the rest of the middle and upper Goodpaster Valley.

In the mine area, olive-sided flycatcher territories were found in lower Pogo Creek and middle Liese Creek valleys. The Pogo Creek territory would not be directly affected by project construction or operation, but might be indirectly affected by noise and other activities. Given the small territory of this species, it is unlikely this territory would be abandoned. The territory in Liese Creek Valley, however, is south of the creek on the north side of Pogo Ridge, in the vicinity of the proposed entrance to the 1875 Portal. This territory could be directly affected, causing abandonment. If it were abandoned, it would constitute a high impact only on a local basis because of the availability of similar habitat throughout the Goodpaster Valley.

While lynx do tolerate human activity, they tend to avoid it. Mine-related activities likely would cause lynx to avoid the mine area for the project's duration. Given the size of the home range of this species, such avoidance would be moderate and only on a local basis.

## 4.10.3 Options Not Related to Surface Access

### Power Supply

- Power Line The only non-access related option that could affect any of these species would be bringing power to the mine by power line in Alternatives 2 and 3. Construction of a power line could cause the loss of some raptor nest sites, depending on the route. This potential loss of nest sites is discussed below in Section 4.10.4 for each route option.

Bird collisions with power lines were discussed in general in Section 4.9.3 (Alternative 2), including mitigation measures to reduce such collisions. Because portions of both routes would traverse forested habitats, there would be a risk of collision for northern goshawks. This risk of collision is discussed below in Section 4.10.4 for each route option.

## 4.10.4 Options Related to Surface Access

The only sensitive species for which different impacts could be expected between access related alternatives would be the northern goshawk. While peregrine falcon nesting occurs on the bluffs north of the Richardson Highway near Shaw Creek Road, these sites have been exposed to traffic for many years. Any increase in traffic attributable directly or indirectly to the Pogo project is expected to have a low impact on such nest sites and the birds inhabiting them. For the other sensitive species, there likely would be no meaningful differential impacts.

For these other sensitive species, no high impacts would occur from any of the three alternatives either because important habitats would not be affected (peregrine falcon, bald eagle, and harlequin duck) or because construction and operation of the narrow, linear access and power line routes through large areas of suitable habitats would have relatively minor direct or indirect impacts (olive-sided flycatcher and lynx).

**Alternative 2**

### Surface Access

***Route***

- Shaw Creek Hillside all-season road It is possible that some nest trees could be removed when clearing the ROWs. Northern goshawks nests along the access routes have been surveyed, and the Shaw Creek Hillside road and power line route would be in close proximity to three nests that were determined to be active in 1999 and 2000. Because it is unlikely that nest trees are a limiting factor in raptor populations in the project area, and because medium- and high-value goshawk habitat is found throughout the project area, loss of a few nests would not constitute a high impact on more than a local basis because of the larger home ranges of this species.

**Alternative 3**

### Surface Access

***Route***

- South Ridge all-season road This road and its associated power line, would traverse only high-value goshawk habitat for virtually all of its route from the Quartz Lake area until shortly before it joins the Shaw Creek Hillside all-season road route on the Shaw Creek and Goodpaster River divide.

  This route would be close to one nest that was determined to be active in 1999 and 2000. Impacts from this alternative would be similar to those for Alternative 2, but likely would be somewhat larger because of the substantially greater distance of high-value habitat that would be crossed. Still, direct and indirect impacts would not be high on more than a local basis.

#### Alternative 4

### Surface Access

***Route***

- Shaw Creek Flats winter-only access This route would have impacts similar to those for Alternative 2, but they would be lower in lower Shaw Creek Valley because the winter-only access segment of the route would pass through less timbered habitat.

## 4.10.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human access. There would be no cumulative impacts on threatened or endangered species, and no or low cumulative impacts to sensitive species.

- All-season Road Maintained There would be no cumulative impacts on threatened or endangered species. Cumulative impacts on sensitive species would be low in the context of the project area, but some impacts would occur. The combined DOF timber sales and the Pogo-related clearing for surface and power line access, as well as for mine area facilities, would reduce available habitat. For sensitive species with broad habitat requirements, such impacts would be small. For species with more specific habitat requirements, the impacts could be greater. For example, although a hypothetical Sonora Creek mine would have almost no incremental cumulative impacts on peregrine falcons, bald eagles, or harlequin ducks, the extension of an all-season road from Pogo up the Goodpaster River Valley to a hypothetical Slate Creek mine would. The more specific habitats of these species would be closely approached or paralleled by such a road, at the mouths of Indian Creek, Rock Creek, and all along the Goodpaster, respectively. While there would be no direct habitat loss, indirect habitat loss would be possible.

  As stated in Section 4.9, it is not possible to predict the degree of cumulative indirect habitat loss with any certainty because further road extensions and developments are only speculative; however, based on the likely mineral potential of the area, the State of Alaska's constitutional directive to develop its resources, the existing TBAP, and the history of Alaska road development in general, additional cumulative impacts would be very likely.

# 4.11 Socioeconomics

Analysis of the socioeconomic impacts of the Pogo project differs from other resource analyses in this document because there are few specific options for which a measurable difference in impact would be expected. This is because socioeconomic impacts and benefits result from whether or not the project as a whole proceeds, and not from which particular options are selected. An exception is whether surface access would be by an all-season road or winter-only access. Therefore, in this section, the impacts discussions are not grouped under specific options, but rather treat the project more in its entirety.

## 4.11.1 No Action Alternative

### ✦ Delta Area Employment and Unemployment

Employment in the Delta area is expected to change in response to two key forces: the construction and operation of the NMDS and the construction of the natural gas pipeline. After declining to and leveling off at approximately 720 jobs as a result of base downsizing (including the remaining 22 base personnel), Delta area employment is likely to start climbing again as construction of the NMDS begins. The NMDS construction labor force would average 400 workers for a 3-year period, pushing Delta area employment to 1,150 (not including the self-employed).

Once operational, the NMDS would directly employ an average of approximately 150 workers on a permanent basis (ADOL, 2002). The indirect and induced employment resulting from NMDS operations is expected to be small. Indirect jobs would be created as a result of local spending by the military on goods and services in support of system operations. Induced jobs would be created as a result of NMDS personnel spending their payroll dollars locally. Because the Delta area service and support infrastructure is not well developed, nearly all NMDS service and supply requirements would be met through Fairbanks or other urban areas. Assuming a multiplier of 1.2 (meaning that for every NMDS job, 0.2 additional jobs would be created locally in the support sector), 30 additional jobs would eventually be created in the Delta area. It is important to understand that this is an estimate only. No detailed research has been conducted on the potential socioeconomic impacts of the NMDS on the Delta area.

With a permanent employment impact of approximately 180 jobs (direct, indirect, and induced employment), total Delta area employment would level off at approximately 900 jobs, perhaps by 2005 or 2006, depending on continued NMDS development. Of course, while development has begun, completion of NMDS development is not a certainty, and without it, local employment could be expected to remain at approximately 720 jobs.

Construction of a natural gas pipeline through the Delta area could also create temporary employment opportunities for local people. The economic impacts of pipeline construction, which have not been quantified, likely would occur concurrently with NMDS construction.

### ✦ Delta Area Population

With development of the NMDS, the population will rise, first during a construction phase, then during normal operations. During construction, employment is expected to average 400 jobs, with a peak of 500. Because of the duration of the construction effort (3 years) the local population impact could be somewhat higher than for the typical construction project. Still, most of the construction labor force would be nonlocal and would be housed on site.

Total NMDS-related population (including employees and their dependents) is expected to be approximately 300 residents. Although no specific data is available, the indirect and induced effects are likely to be small, generating approximately 50 additional residents. This addition of residents would bring the total NMDS population impact to approximately 350 residents.

It is also possible that gas pipeline construction could occur during construction of the NMDS. At this time, it is not possible to predict what the local employment and population impacts of pipeline construction might be. Suffice to say, after a period of decline due to base realignment, the Delta area could be the scene of substantial, temporary construction-related economic activity due to construction of both the NMDS and gas pipeline.

Construction and operation of a prison in the Delta area is not considered as viable and has not been considered for the No Action Alternative.

In summary, for the No Action Alternative, Delta area population is expected to increase as NMDS development continues. An influx of nonlocal construction workers will occur as NMDS construction continues and if pipeline construction were to occur. This construction-related boom would occur over several years (depending on the timing of the projects). It is very difficult to predict what the permanent, local population, and economic impacts of this construction boom might be, and no research has been conducted on the subject, either as part of NMDS EIS or pipeline impact assessments.

As of 2002, the Delta area population stood at between 1,700 and 1,750 residents, according to the ADOL. The addition of 350 NMDS-related residents would push the area total to near 2,100 residents.

- **Delta Area Income**

In the No Action Alternative with development of the NMDS, per capita income for the Delta area should start increasing again. The degree of that increase would depend on the number of local people employed in the NMDS project and their income from those jobs. Similarly, to the extent that local workers participate in the construction of a gas pipeline, an increase in local income levels could result.

Income changes due to NMDS or the gas pipeline would be expected to occur in the Delta Junction and Big Delta areas. Predicting the magnitude of those changes is beyond the scope of this analysis. No change in per capita income would be expected in the Healy Lake area for the No Action Alternative.

- **Delta Area Public Services**

The Delta area is experiencing socioeconomic dislocation as a result of base realignment. The long-term effect of base closure on services provided by the City of Delta Junction is unclear. To the extent that there is decline in the nonmilitary population, population-based revenues, such as municipal assistance and state revenue sharing, could decline. This drop in revenue could affect the city's ability to provide basic services, such as road maintenance, emergency services, and community hall operations. Development of the NMDS could partially offset any long-term decline due to realignment and mitigate any potential long-term affects on local public services.

- **Delta Area Housing**

According to the 2000 Census, the Delta area housing stock, including Delta Junction, Big Delta, and Fort Greely, totaled 1,008 units in 2000. Approximately 60 percent of these housing units were occupied (603 units). Among the unoccupied units, 81 are for seasonal, recreational, or occasional use. Of the 324 remaining vacant housing units, 228 are at Fort Greely.

The housing demand spike created by the NMDS construction-related population is temporary and should begin easing in 2004. The construction effort is expected to peak at 500 workers. The availability of military housing as well as construction camp housing will determine the impact on the local housing market as employment scales up.

The long-term housing situation is uncertain. At this point, it is unclear what the final personnel requirements will be for NMDS operations (the scale of the development itself has been, and is likely to continue to be, subject to revision). According to the most recent published information (ADOL, 2002), 150 personnel will be required to staff the Fort Greely facility, including 50 military and 100 civilians. The total NMDS-related population of approximately 350 residents would require approximately 105 housing units (based on an average household size of 3.25 persons per household, the 2000 Census average for Fort Greely). The fort's current housing inventory totals 354 units. Housing demand related to construction of a natural gas pipeline would presumably be met with temporary facilities provided by construction contractors.

✦ **Socioeconomic Conditions in the Fairbanks North Star Borough**

According to ADOL projections, the Fairbanks North Star Borough is expected to grow at an annual rate of slightly less than 1 percent during the next 12 years. The ADOL "middle" case projection shows the borough growing at a rate of 0.95 percent annually through 2003, 0.84 percent annually through 2008, and 0.77 percent annually through 2013. These growth rates would push the borough's population to 88,012 by 2003, 91,773 by 2008, and 95,367 by 2013 (ADOL, 2002).

The local economy will continue to be based on the military, the University of Alaska, tourism, and oil industry activity. Other basic economic activity, including mining, transportation, regional health care, state government, and federal government, will continue to play a role in the local economy. Construction of a gas pipeline could increase the relative importance of oil and gas activity in the area. There are no foreseeable events that are likely to fundamentally change the socioeconomic composition or outlook for the area.

## 4.11.2 Options Common to All Alternatives

Among the options common to all alternatives, only airstrip operation and disposition have the potential to affect socioeconomic conditions in the Delta area, although these potential affects are nonmeasurable. For example, if the airstrip were open to use by Pogo and other industrial users, or open to everyone, it could in some measure facilitate additional industrial and commercial activity in the area. This industrial and commercial activity could create additional economic growth, population growth, and demand for public services. Prediction of the nature or magnitude of this activity, if it were to occur at all, is too speculative, however. Of course, if the airstrip were open to Pogo only, this potential for additional industrial or commercial activity in the area would not exist.

The same is true for the airstrip disposition options. If left open to other industrial users or open to everyone, it would be possible that additional industrial and commercial development would be facilitated. This development could create new economic activity, population growth and demand for public services. Removal and reclamation of the airstrip would eliminate this potential.

## 4.11.3 Options Not Related to Surface Access

### Power Supply

Power supply options could result in slightly different socioeconomic consequences. The grid power option (Alternatives 2 and 3) would have greater potential for supporting additional industrial and commercial activity than the on-site generation option (Alternative 4). With grid power in place, other mine developers could enjoy a substantial construction and operation cost savings, compared to constructing a new power line or providing on-site generating capacity. This savings alone would be unlikely to be the determining factor in mine (or other industrial) development, but it could certainly be an important factor. To the extent that grid power availability does facilitate additional industrial/commercial development, this option could create new economic activity, population growth, and demand for public services.

The probability of the power line remaining after Pogo Mine closure is small for the following reasons: no other major ore deposit in the project area that could benefit from a power line is currently identified; bringing a major project into production normally takes at least 10 years; the life of the Pogo Mine is estimated at only 11 years; and the power line would be removed under all the alternatives.

## 4.11.4 Options Related to Surface Access

The magnitude of Pogo mine socioeconomic effects on the Delta area would depend on mine access. With an all-season road, a larger proportion of the mine's employees could reside in the local area because work and off-work periods would be shorter, and employees would be bused to and from the mine site. With winter-only access, employees would work for longer periods, have longer off-work periods, and be flown to and from the site, conditions that would allow workers to live more distant from the Delta area.

- **Delta Area Employment**

  Because mine workers would be housed on site and transportation would be provided to and from Fairbanks, a majority of the workers would be drawn from the Fairbanks labor market under any access option. It is not possible to predict with any degree of certainty the number of mine workers that would actually choose to reside in the Delta area. For purposes of this analysis, however, it is assumed that approximately 25 to 35 percent of the mine's workers would reside in the Delta area with an all-season road. That range suggests that between 100 and 135 of the mine's 385 employees would live in the Delta area once the mine were in full production.

  The number of indirect and induced (collectively termed indirect) jobs created in the Delta area would be less than might be the case with a higher level of development in the local service and support sectors. Mine development near an urban area, such as the Fort Knox mine near Fairbanks, can have a multiplier effect of nearly 2.0. The multiplier effect means that for every job at the mine, another job would be created in the local support sector. In the case of Pogo, the multiplier effect in the Delta area would be much smaller. Almost no mine operation spending could be expected; therefore, most of the multiplier effect would stem from the goods and services required by the mine employees who resided locally. A great deal of local econometric modeling (which is beyond the scope of this analysis) would be required to definitively determine the local multiplier. It is sufficient for this analysis to assume that the local multiplier would probably be no more than about 1.3; i.e., for every job at the mine, 0.3 job would be created in the local support sector. Based on this multiplier, 100 to 135 mine employees residing in the Delta area could create another 30 to 40 jobs in the local economy. This additional local employment would bring the total local employment impact to between 130 and 175 jobs for local residents under the all-season road option. This additional local employment would have a very substantial positive effect on the local economy.

It is important to recognize that this employment estimate is contingent on several factors. Most important among these factors is availability of local labor and local housing. If there were little interest among local residents in joining the mine's workforce, there could be a much lower level of local employment. Further, the number of available housing units could determine how many nonlocal mine workers choose to relocate to the Delta area. The estimate made in this analysis that 25 percent to 35 percent of the mine's labor force would reside locally is based on the assumption that there would be both a high level of local labor interest and sufficient housing to induce some nonlocal workers to relocate to the Delta area.

With the winter-only access option, fewer mine workers would reside locally. The number of local resident workers would depend, in part, on provisions made by the mine operator to provide transportation between the mine site and the Delta area. By providing transportation between the Delta area and the mine site, the community could realize greater local economic benefit from mine operations than would otherwise be the case. Nevertheless, the level of local participation in the mine workforce would be lower in the winter-only access option. Again, understanding the high degree of uncertainty associated with these estimates, it is assumed that 10 to 20 percent of the mine's labor force, or between 40 and 80 workers, would reside in the Delta area with the winter-only access option. With this option, there would likely also be a lower multiplier effect. Applying a slightly lower multiplier than was used in the all-season option analysis (1.2 versus 1.3), indirect employment could range between 10 and 15 additional jobs in the local support sector. This level of indirect employment would bring total mine-related employment with the winter-only access option to between 50 and 95 jobs. While this employment effect is lower than the all-season road option, it would still represent a substantial positive impact on the local economy.

Access options concerning use of an all-season and/or winter-only access during Pogo project operation also have socioeconomic implications. First, both options would increase access for mineral exploration and development in the area. This improved access could facilitate new or expanded mine development and operations that would create additional economic activity, population growth, and demand for public services. It is too speculative, however, to attempt to quantify this potential increase in economic activity.

The all-season road option also could result in increased timber harvests from state lands. This increased timber harvest, of course, assumes that the all-season road would be open to other industrial/commercial users. Similarly, if an all-season road were open to all users, an increase in recreational traffic to and through the Delta area could occur. In both of these instances, however, the local socioeconomic effects likely would be low.

### ✦ Delta Area Population

With an estimate of total local mine-related employment (including direct and indirect) of between 130 and 175 jobs with the all-season road option, it is possible to roughly predict the local population impact (Table 4.11-1). Including mine workers, their dependents, and indirect population effects, a total population impact of between 260 and 350 residents could result. This estimate is based on a participation rate of 0.5. The participation rate indicates the relationship between the number of jobs in an economy and the total population of the area. A participation rate of 0.5 means that for every job, there are two residents in the local area. The historical participation rate in the Southeast Fairbanks Census Area, which includes the Delta area, is approximately 0.42. In comparison, the Fairbanks participation rate is about 0.58 and the Alaska average is 0.61. The participation rate of the Southeast Fairbanks Census Area is typical of rural areas, where there are a large number people unemployed or not in the labor force, but probably does not give an accurate picture of the population effects of the Pogo mine. An urban participation rate of approximately 0.6 is too high, however, given the limited employment opportunities available to spouses and dependents of mine workers. Therefore, a mid-range rate of 0.5 is used in this analysis.

A population effect of between 260 and 350 residents with the all-season road option would be equal to approximately 15 percent to 20 percent of the Delta area's 2002 population of approximately 1,716 residents. It is important to recognize that this analysis does not suggest that the Pogo mine would draw between 260 and 350 new residents to the Delta area. The number of new residents probably would be smaller. Actual local population effects would be contingent on many factors, particularly availability of local housing, the availability of local skilled labor at the time operations commence, labor market conditions in Fairbanks, and a variety of other factors. In any case, given the economic hardship now being experienced in the Delta area due to base closure, this potential population effect would be substantial and positive.

**Table 4.11-1 Employment and Population Effects of the Pogo Mine All-Season and Winter-Only Access Options**

| | All-Season Road | Winter-Only Access |
|---|---|---|
| Direct employment | 100 - 135 | 40 - 80 |
| Indirect employment | 30 - 40 | 10 - 15 |
| Total employment | 130 - 175 | 50 - 95 |
| Mine-related population | 260 - 350 | 100 - 190 |
| Delta area total[1] | 1,716 | 1,716 |
| Percent of Delta area total | 15% - 20% | 6% - 11% |

[1] Based on 2002 ADOL data, including Delta Junction, Big Delta, Fort Greely, and Healy Lake.

Including their dependents and the indirect and induced population, total Delta area population effects would be between 100 and 190 residents under the winter-only access option. This figure is equal to between six percent and 11 percent of the 2002 population of approximately 1,716 residents. This estimate also is based on a participation rate of 0.5, applied to the approximately 50 to 95 new local jobs created as a result of the mine. Again, actual population effects would depend on several factors, including availability of local skilled labor, housing availability, and perhaps most importantly, provisions made by the mining company to transport employees between the Delta area and the mine. As with the all-season road option, these population effects would have a substantial, positive impact on the local economy.

### ✦ Delta Area Income

According to ADOL (2000a), the statewide average annual earnings for workers in the hardrock mining industry in 1999 was $66,048. Applying this average to the 385 jobs created at the Pogo mine suggests that annual payroll from the mine would total approximately $25.4 million. This estimate does not include labor overhead such as health insurance benefits, the cost of other benefits, or payroll taxes paid by the employer. An average annual salary of approximately $66,000 would be approximately 130 percent above the nonagricultural wage and salary employment average for the Southeast Fairbanks Census Area.

The positive effects of the all-season road option on personal income would be substantial. With the all-season road option, the assumption is that between 100 and 135 of the mine jobs would be held by people living in the Delta area (including current residents who gain employment at the mine and nonlocal mine employees who relocate to the Delta area). Local mine payroll, therefore, would be between $6.6 million and $8.6 million annually (Table 4.11-2). Indirect and induced payroll also would be created in the Delta area. Based on a weighted-average salary for the retail, service, and local government sectors combined, the average annual support sector salary for the Southeast Fairbanks Census Area is $19,350. Based on that average, the 30 to 40 jobs created in the local support sector would account for between $580,000 and $770,000 in annual payroll. This amount would bring total mine-related payroll in the Delta area to between $7.2 million and $9.4 million annually. This amount would represent 15 percent and 20 percent of the total non-agricultural wage and salary payroll in the Southeast Fairbanks Census Area.

**Table 4.11-2 Income Effects of the Pogo Mine All-Season and Winter-Only Access Options (millions)**

| | All-Season Road | Winter-Only access |
|---|---|---|
| Direct mine payroll | $6.6 – $8.6 | $2.6 – $5.3 |
| Indirect | $0.6 – $0.8 | $0.2 – $0.3 |
| Total | $7.2 – 9.4 | $2.8 – $5.6 |
| Census area total[1] | $47.1 | $47.1 |
| Percent of census area total | 15% to 20% | 6% to 12% |

[1] Southeast Fairbanks Census Area total for 1999. Source: ADOL

The winter-only access option also would have substantial positive impacts on local personal income, although less so than for the all-season road option. With the winter-only access option, the assumption is that between 40 and 80 of the 385 mine jobs would be held by people living in the Delta area. This employment of Delta residents would generate direct local payroll of between $2.6 million and $5.3 million. The 10 to 15 support jobs created as a result of Pogo Mine operations would generate another $200,000 to $400,000 in annual payroll. This additional payroll would bring total mine-related payroll, in the winter-only access option, to between $2.8 million and $5.7 million annually. The total payroll would represent between 6 percent and 12 percent of total nonagricultural wage and salary payroll in the Southeast Fairbanks Census Area.

- **Delta Area Public Services**

The effect of mine development and operations on public services in the Delta area is difficult to predict. As indicated above, between 10 percent and 35 percent of the mine's workforce could eventually reside in the Delta area, depending on the access option. Some portion of this workforce, however, would be composed of people who already live in the area. They would place no additional demands on local public services. A relatively high unemployment (and what is probably a high level of underemployment), coupled with mining-related training opportunities, suggests it is reasonable to assume that current residents would comprise a large portion – perhaps half or more – of the mine's local workforce.

If it is assumed that nonlocal workers relocating to the Delta area would account for half of the mine's local work force; the actual population gain due to the mine would be between 130 and 175 new residents with the all-season road option. With the winter-only access option, it is assumed that fewer nonlocal mine workers would relocate to the Delta area; therefore, less additional demand would be placed on local public services.

The effect of the Pogo Mine project on the local school system likely would be low. Typically, school-age children comprise approximately 20 percent of a community's population. More precisely, statewide, school-age children account for 22 percent of Alaska's total population according data published by ADOL. Based on this percentage, the 130 to 175 mine-related residents new to the Delta area would include between 30 and 40 school-age children. This addition of school-age children would represent an increase in enrollment of between 5 percent and 6 percent over the FY 2001 DGSD enrollment total of 630 students (not including telecommuting students enrolled in the district's Charter Cyber School). School funding is based in part on enrollment; therefore, these mine-related children would bring with them additional state foundation formula funding.

A mine-related increase in Delta area population would result in a slight increase in demand for other public services (e.g., community center, library, and emergency response services). Offsetting the costs associated with this increase in demand for public services, the mine-related population also would bring with it some increase in revenue from user fees and population-based revenue sources such as state revenue sharing and municipal assistance. The City of Delta Junction does not levy property or sales taxes.

In summary, the mine-related population would not have an adverse effect on local ability to provide public services or the cost of those services. Also, it is important to note that if the community is concerned about potential adverse impacts of the mine's population on local public services, it would be possible to completely eliminate such impacts by asking the mining company to not provide transportation to the mine from the Delta area. Even in the case of the all-season road, the mine operator could take steps to discourage nonlocal employees from relocating to the Delta area. This approach, of course, would eliminate any potential economic benefit the area might enjoy if nonlocal employees were encouraged to relocate to the area.

### ✦ Delta Area Housing

In large measure, the availability of local housing would determine the number of nonlocal mine workers who choose to relocate to the Delta area. If adequate housing were not available, either due to location, quality, or price, workers would choose to live somewhere else, probably in the Fairbanks area. Previously it was assumed the mine would bring between 130 and 175 new residents to the Delta area if the all-season road option were constructed, and between 50 and 95 new residents for the winter-only access option. These estimates assumed these people would find suitable housing in the area.

To predict the number of housing units that would be required to meet housing demand, estimates of average household size are needed. Statewide, the average household includes 2.74 members, according to 2000 Census data. The typical household in the Southeast Fairbanks Census Area is slightly larger, with 2.8 persons per household. If it is assumed that the average household size for the mine-related population would be the same as the average for the census area, the mine-related demand for housing would be between 45 and 60 units for the all-season road option, and between 20 and 35 units for the winter-only access option. These unit figures are for the housing required to meet the needs of the nonlocal mine workers who choose to relocate to the Delta area.

According to the 2000 Census, the total housing stock in the Delta Junction, Big Delta, and Fort Greely areas was 1,008 units in 2000. Approximately 600 of these housing units were occupied in 2000. Among the unoccupied units, 80 were for seasonal, recreational, or occasional use. Of the roughly 330 remaining vacant housing units, 228 were at Fort Greely. The 100 vacant housing units in the Delta area outside of Fort Greely probably included a broad range of housing in terms of quality and price.

While the 2000 Census indicates a large amount of vacant housing, the NMDS construction project has apparently temporarily consumed available housing in the area. Although vacant housing remains in the Delta area, this housing is primarily military housing and therefore unavailable to the civilian population. (Some of the construction workforce is housed on base.) The housing demand spike created by the NMDS construction-related population is temporary and should begin easing in 2004. If Pogo Mine construction were to begin during NMDS construction, essentially no local housing would be available to the mine's nonlocal construction labor force. However, no local housing impact would be expected, because the construction effort would be camp supported.

Based on the most recent available published data (ADOL, 2002), NMDS operations personnel in Delta will total 150, including 50 military and 100 civilians. This number is subject to change, however, and could increase. The impact of this population on the Delta housing market will depend on the availability of base housing to civilians, something that has not yet been determined. If the civilian labor force must live off base, Pogo operations could be occurring when there is little available housing in the Delta area. It is important to stress, however, that a housing shortage would not necessarily have negative socioeconomic consequences. It could be argued that if demand exceeds supply, housing costs could go up, which is good for property owners, and perhaps bad for renters. In any case, as long as the mine operator provides transportation from Fairbanks, the housing supply from which miners are choosing includes the entire Fairbanks area. Mine workers would not be required to live in the Delta area.

In summary, the effects of Pogo on the housing market could be substantial, though generally positive. Local homeowners could expect to see the value of their homes rise. Some new construction could be expected, creating additional economic opportunity for local builders. It is possible that renters could see a rise in rental rates, as the demand for rental housing increases. These conclusions apply to both the all-season road and winter-only access options, with the effects somewhat more pronounced for the former for which greater demand for local housing is expected.

### ✦ Socioeconomic Impacts in the Fairbanks North Star Borough

The socioeconomic effects of the Pogo mine on the FNSB also depend on the access option. In either case (all-season road or winter-only access), however, the socioeconomic effects would be positive, though low in relation to the overall economy. For example, the winter-only access option could result in as many as 355 to 515 new jobs in the FNSB economy. That job increase only would account for between 1.1 percent and 1.6 percent of the nonagricultural employment in the borough. Impacts on population, housing, school enrollment, and other public services would be similarly proportioned.

The Pogo Mine would directly account for between $17 million and $19 million in payroll in the Fairbanks economy under the all-season road option, and between $20 million and $23 million in the winter-only access option (Table 4-11.3). These income figures represent between 1.5 and 2.0 percent of total Fairbanks wage and salary income. The mine also would create jobs and income in the local support sector. Based on a multiplier of 1.5 (one direct job creates another half job in the support sector), the mine indirectly would create between 125 and 170 jobs in the Fairbanks support sector. These jobs would account for between $3 million and $4 million in payroll, based on an assumed average wage in the annual support sector of $25,000. This additional payroll would bring the total Pogo-related income effects in Fairbanks to between $20 million and $27 million annually, or between 1.7 and 2.4 percent of the Fairbanks total.

**Table 4.11-3 Socioeconomic Effects on the Fairbanks North Star Borough (FNSB) of the Pogo Mine All-Season Road and Winter-Only Access Options**

| Mine-Related | FNSB | All-Season Road | Percent of FNSB Total | Perennial Winter Trail | Percent of FNSB Total |
|---|---|---|---|---|---|
| Direct employment | – | 250-285 | 0.7 – 0.9 | 305 – 345 | 0.9% – 1.1% |
| Indirect employment | – | 125-140 | 0.4 | 150 – 170 | 0.50% |
| Total mine-related employment | 32,538 | 325-425 | 1.0 – 1.3 | 355 – 515 | 1.1% – 1.6% |
| Direct payroll ($ million) | | $17 -$19 | 1.5 – 1.7 | $20 – $23 | 1.7% - 2.0% |
| Indirect payroll ($ million) | | $3.1 - $3.5 | 0.2 – 0.3 | $3.8 – $4.2 | 0.3% - 0.4% |
| Total mine-related payroll ($ million) | | $20.1 - $22.5 | 1.7 – 2.0 | $23.8 – $27.2 | 2.0% - 2.4% |
| Population | 82,840 | 650-850 | 0.8 – 1.0 | 710 – 1,030 | 0.9% – 1.2% |
| Housing | 33,291 | 240-315 | 0.7 – 0.9 | 260 – 380 | 0.8% – 1.1% |
| School enrolment | 16,000 | 145-185 | 0.9 – 1.2 | 155 – 225 | 1.0% – 1.4% |

## 4.11.5 Cumulative Impacts

### ✦ Delta Area Employment

With both the all-season road and winter-only access options, cumulative employment depends on the timing of development and operations. If mine construction begins in 2003, the project could be coming on line during construction of the NMDS and/or the natural gas pipeline. By the end of the decade (or once these projects are complete and operational and the mine is in full production), a total of between approximately 310 and 355 new permanent jobs would be added to the local economy in an all-season road option. This additional employment includes approximately 100 to 135 Pogo jobs and approximately 150 NMDS jobs. This estimate also includes approximately 30 to 40 indirect Pogo jobs and approximately 30 indirect NMDS jobs.

With the winter-only access option, a total of between approximately 230 and 275 new permanent jobs would be added to the local economy. This additional employment includes approximately 40 to 80 direct Pogo jobs and 150 direct NMDS jobs. This estimate also includes approximately 10 to 15 indirect Pogo jobs and 30 indirect NMDS jobs.

Cumulative impacts under both the all-season and winter-only access options, therefore, would have major positive economic effects in the Delta area. Under the all-season road option, the employment gain would represent an increase of between approximately 56 percent and 80 percent over the current nonagricultural employment total of approximately 720 jobs. In the winter-only access option, the increase would be between approximately 43 percent and 50 percent.

### ✦ Delta Area Population

Mine construction would not be expected to measurably affect the Delta area population. Mine construction jobs would be temporary, camp-supported, and filled primarily by nonlocal workers.

Cumulative population impacts from mine operations depend on the timing of development and operations. The project could be coming on line during construction of the NMDS and/or the natural gas pipeline. By the end of the decade (or once these projects were complete and operational and the mine were in full production), the total population effect of these two developments would total between approximately 610 and 700 persons. The net increase in Delta area population would be less than the total population effect because some of the predicted population effect includes people already living in the area. The total Delta area population would rise to approximately 2,300 to 2,400 residents (Table 4.11-4). Therefore, the Pogo Mine would have a substantial effect on the local population, directly or indirectly accounting for between approximately 11 percent and 15 percent of this population.

The total population effect of Pogo and NMDS under the winter-only access option would be between approximately 445 and 540 persons. The Delta area population would increase to between approximately 2,100 and 2,200 residents within 10 years. The Pogo Mine would directly or indirectly account for approximately 5 to 9 percent of this population. Although less important than the all-season road option, the effects of Pogo under this option would still be positive for the local economy.

**Table 4.11-4 Cumulative Employment and Population Effects of Pogo Mine and NMDS**

| | Pogo | NMDS | Cumulative |
|---|---|---|---|
| **All-Season Road** | | | |
| Direct employment | 100 - 135 | 150 | 250 - 285 |
| Indirect employment | 30 - 40 | 30 | 60 - 70 |
| Total employment | 130 - 175 | 180 | 310 - 355 |
| Population | 260 - 350 | 350 | 610 – 700 |
| Delta area population | | | 2,300 – 2,400 |
| **Winter-Only Access** | | | |
| Direct employment | 40 - 80 | 150 | 190 - 230 |
| Indirect employment | 8 – 15 | 30 | 38 - 45 |
| Total employment | 48 - 95 | 180 | 230 - 275 |
| Population | 95 - 190 | 350 | 445 – 540 |
| Delta area population | | | 2,100 – 2,200 |

### ✦ Delta Area Income

Data is not available on the earnings that would be earned by the NMDS workforce; therefore, it is not possible to predict cumulative payroll effects. It is possible, however, to provide an estimate of the total personal income effects, based on per capita income data. Per capita income in the Southeast Fairbanks Census Area was approximately $22,400 in 2000 (U.S. Department of Commerce, 2001). Under the all-season road option, cumulative effects would push the Delta area population to between approximately 2,300 and 2,400 residents. Applying the 2000 per capita income estimate to this population suggests that total annual personal income in the Delta area would rise to between approximately $52 million and $54 million. This estimate may understate actual personal income because the mine and NMDS-related populations likely would have higher household income levels due to the higher paying mine and military jobs. Based on average per capita income for the 2000 census area, personal income in the Delta area in 2000 is estimated at approximately $40 million. Cumulative effects of the all-season road option would include a very substantial increase in per capita income of between 30 percent and 35 percent.

Under the winter-only access option, population effects would be lower; therefore, personal income effects would be lower, though still substantial. Under the winter-only access option, Delta area population would climb to between approximately 2,100 and 2,200 and personal income would rise to between approximately $47 million and $49 million. This higher personal income would represent an increase of between 18 percent and 23 percent over the estimated 2000 total.

### ✦ Delta Area Public Services

Under the all-season road option, the total Delta area population would rise to approximately 2,300 to 2,400 residents during the next 10 years, assuming that both the Pogo Mine and NMDS were developed. Under the winter-only access option, the

Delta area population would rise to between approximately 2,100 and 2,200. These population increases would place additional demands on public services.

The cumulative effect on local schools could be substantial, with the number of school-age children in the area potentially increasing over current levels by between 35 percent and 40 percent in the all-season road option. This increase in school-age children could push the number of school age children in the area to between 700 and 750. Under the winter-only access option, the number of school-age children in the Delta area would increase by between 23 percent and 30 percent, or up to a total of between 675 and 700. This increase could have potentially substantial effects on school district operations. School enrollment, however, has declined sharply in recent years, resulting in the closure of schools in Fort Greely and Healy Lake. Facilities are in place, therefore, to accommodate at least some of the potential long-term increase in enrollment.

The demand for other public services also would increase, although not necessarily at a rate proportional to population increase. Emergency response services, for example, serve residents and travelers. In any case, in the absence of detailed impact assessment information on the NMDS, it is not possible to predict, in detail, cumulative public services effects.

### ✦ Delta Area Housing

Total cumulative housing demand for the Delta area under the all-season road option would be expected to total between approximately 820 and 860 units. Under the winter-only access option, total cumulative housing demand would be expected to total between approximately 750 and 785 units.

The total housing stock in the Delta area in 2000 was 1,008 units, according to the census. A substantial number of these units are seasonal, recreational, or occasional use housing, or otherwise generally not a part of the available housing inventory. Construction of the NMDS has apparently consumed most of the available housing; therefore, vacancy rates are very low. NMDS construction in the Delta area is expected to be complete in 2004, when the construction labor (which is expect to peak at 500 jobs) is replaced with an operational labor force of 150 (including 50 uniformed and 100 civilian personnel). At that time, local housing demand would decline, with availability of base housing for the civilian population a key factor.

Housing demand related to operation of the Pogo Mine and NMDS could push local housing demand to a level in excess of available housing. A number of factors, however, would determine the actual impact on the local housing market. First, whether existing on-fort vacant housing would be made available. Second, given the local economic stimulus that the NMDS and Pogo projects would bring to the Delta area (particularly the NMDS), it is likely that the private sector would respond by developing new housing. Third, if adequate housing were not available at the time these two projects go into operation, the federal government likely would construct new housing for the NMDS-related population. Fourth, if adequate housing were not available for the mine-related population, nonresident workers would simply choose to live elsewhere, probably Fairbanks, a community with a much larger housing inventory.

A more detailed assessment of cumulative housing impacts is not possible in the absence of detailed data on the NMDS. In any case, the cumulative effects on the local housing market would be generally positive, resulting in increased valuations and additional housing construction. At the same time, local rental rates could rise.

- **Borough Formation**

Development of the Pogo Mine could, but is unlikely to, indirectly hasten the formation of a borough government in the Delta area. Increased population generally results in increased demand for public services of the kind sometimes provided by borough governments. Pogo Mine development alone would not increase the area population to levels above that of pre-military base closure. However, NMDS-related development, plus Pogo-related development, could push the area's population to higher levels.

It is beyond the scope of this study to assess the feasibility of borough formation in the Delta area. However, the key issue regarding borough formation is the ability of the Delta area to generate revenues to support borough government operations. Borough formation becomes feasible when an area reaches a certain threshold in terms of taxable residential, commercial, and industrial development.

The Delta area could become part of a borough in one of two ways: either through internal initiative, based on a perceived need for more or better public services, or the remote possibility that a neighboring borough might seek to annex the Delta area, if the area includes attractive revenue sources.

Neither case appears likely. The cumulative effects scenario includes development of both the Pogo Mine and the NMDS. In this scenario, the largest source of local economic activity, the military, is not subject to property taxes (and federal purchases are not subject to sales taxes). Federal payments in lieu of taxes could provide money to a borough-run school district, but a Delta borough with powers beyond school operations is still unlikely to generate the needed tax revenues.

Concerning annexation, a mine's potentially high property valuations could represent an attractive source of revenue for nearby boroughs. However, it is unlikely that any of the boroughs adjacent to the Delta area (Fairbanks North Star, Denali, and Matanuska-Susitna boroughs) would find that the potential revenue from taxation of the Pogo Mine (and other taxable property) would cover the costs of expending services to the very large Southeast Fairbanks Census Area.

# 4.12 Land Use

The severity of land use impacts was considered in the context of whether land use changes would occur that would be in conflict with existing state and local government land use plans. Based on the existing land use inventory discussed in Section 3.17 (Land Use), and applicable land management plans, there would be no major conflicts with the land use plans or land management policies of the TBAP, the TVSF Management Plan, or the FNSB Comprehensive Plan from development of any of the alternatives. Therefore, there would be no major impacts on land use.

Certain components of project alternatives, however, could cause substantial *changes* to existing residential and recreational land uses in the project area, although these changes still would be consistent with the TBAP, TVSF Management Plan, or FNSB Comprehensive Plan. These changes in existing land use would be considered as impacts to some. Conversely, land use changes also could be of substantial benefit to new recreational, commercial, and industrial users of the area.

### 4.12.1 No Action Alternative

Under the No Action Alternative, land use changes would be consistent with existing state land use plans. Changes would occur commensurate with current economic development trends in the Delta area and construction of the NMDS and a natural gas pipeline. New residential, commercial, and industrial activities (housing, lodges, stores, and quarries) would occur in the existing developed Delta area at a level consistent with ongoing needs or other actions in the area.

Construction of the NMDS would cause a temporary, 2- or 3-year increase of commercial and industrial land sales in the Delta area. There could be some increase in residential land sales. Natural gas pipeline-associated activities would last only during the approximate 2-year construction phase of the project, with housing needs presumably met with temporary facilities provided by construction contractors. Private land sales for residential, business, and industrial purposes would continue to meet local needs.

The current DOF 5-year schedule for timber sales (2003–2007) in the Delta area includes four sales on the north side of the lower Shaw Creek drainage and the Tenderfoot area and four sales in the Quartz Lake and Indian Creek area (ADNR, 2002). These eight sales would affect approximately 1,313 acres, not including new roads. Implementation of this harvesting plan would affect existing land uses although it would be consistent with the TVSF Management Plan. Two state timber sales totaling approximately 264 acres are planned in the Keystone Bluff area of lower Shaw Creek Valley (ADNR, 2002).

The DOF planned road for the Shaw Creek timber harvest would follow closely the Applicant's proposed alignment for the Shaw Creek Hillside all-season road in the lower and middle portions of the drainage. This road likely would be constructed incrementally over the next several years, depending on sale of the proposed harvest units and additional capital funding. It would be open to use by the public, as well as by logging trucks. These timber sales would cause land use changes that would affect existing residents of Shaw Creek Road, as well as trappers, mushers, a commercial recreational tour company, and recreationists currently accessing the backcountry of the Shaw Creek drainage.

The DOF eventually would construct its planned road around Quartz Lake to access timber in the vicinity of Quartz Lake and Indian Creek near the route for the South Ridge all-season road route. Like the proposed Shaw Creek Hillside forestry road, it likely would be constructed incrementally and would be dependent on additional capital funding or timber sale activity. It would not be constructed to the standards of the Applicant's proposed road. Both planned timber roads, assuming they were open for public use, could cause a substantial change in current land use in the vicinity of the roads.

Historically, the number of daily truck round trips during timber harvest activities associated with a particular timber sale in the Delta area have varied between 1 and 15. Normally, an operator delivers two loads per day, and the customary spread is from one to four loads per day. Timber sale contracts normally have a duration of 3 to 5 years, but could be as long as 10 years (Joslin, 2002). Depending on the sale, the estimated total number of truck trips for timber sales in the project area on the DOF 5-year schedule varies between 142 and 950 (over a 3- to 10-year period), with an estimated approximately two to three daily round trips (Table 3.17-2).

Overall, because land use changes under the No Action Alternative would be consistent with existing state land use plans, land use impacts would be negligible.

## 4.12.2 Options Common to All Alternatives

### Air Access

***Airstrip Use and Disposition*** The use and disposition of the airstrip could have a major impact on other commercial and industrial land uses in the project area. Closing the airstrip to everyone but the Pogo project could have a major negative effect on potential new commercial and industrial activities, such as mining.

Allowing other commercial and industrial users to access the airstrip would provide commercial air operators with new service options supporting new commercial and industrial activities in the project area, as well as fly-in recreationists. Removing and reclaiming the airstrip at the conclusion of the Pogo project could have a major impact on commercial air operators, and to potential new mine development in the area.

## 4.12.3 Options Not Related to Surface Access

**Alternative 2**

### Power Supply

- Power Line A power line would make power available in the upper Shaw Creek and Goodpaster River valleys and thus could be beneficial to potential new commercial and industrial land uses in those areas. It would not be of benefit to scattered residential users in these areas because of the high cost of a substation required for such users.

  A cleared power line ROW would be a moderate benefit to new recreational users because backcountry areas currently with difficult access for recreationists would be more accessible to both motorized and nonmotorized users.

**Alternative 3**

### Power Supply

- Power line Same as for Alternative 2, except the power line would not access Shaw Creek Valley.

**Alternative 4**

### Power Supply

- On-site generation This option could have an impact on other potential commercial and industrial users. Additional mineral development in the area could be slower because lack of a power line to the Pogo Mine site would require on-site generation at new sites or separate construction of a power line.

## 4.12.4 Options Related to Surface Access

The type and location of surface access, and the power line route, could be important for existing and new residential, commercial, and industrial land uses in the Pogo area, although there would not be conflicts with existing land use plans.

## Alternative 2

### Surface Access

***Use*** The Shaw Creek Hillside all-season road would not cause substantial changes to existing land use in Shaw Creek and Goodpaster River valleys if it were open only for use by the Pogo project or industrial / commercial users. Existing land uses in these valleys, however, could be substantially changed if the road were open to public use because it would provide access to presently remote areas. In particular, some existing land uses, such as the Goodpaster recreational cabins located downstream from a new Goodpaster River access point near the mine site, would be affected. Recreationists, fishers, and other new users in the upper drainage could be expected to travel down the Goodpaster River and through the lower reaches, affecting those cabin owners.

Conversely, all-season road access could benefit new commercial/industrial land users. Increased access to more remote areas of the Shaw Creek and Goodpaster drainages could substantially benefit potential users considering new developments in these areas.

- Richardson Highway egress Regardless of whether the Shaw Creek Hillside all-season road were open to public use or whether Shaw Creek/Rosa or the Tenderfoot sub-option were built, the Shaw Creek area in general could experience some increase in residential use during project operations by workers building homes to reduce commuting time to the Applicant’s bus terminal. This increased residential use could depend on how work shifts were structured, and would be moderated by the fact that there is limited residential property available in this area. Commercial and industrial land sales and development as a result of the Pogo Mine could cause changes to existing land uses in the Shaw Creek, Tenderfoot, and nearby Richardson Highway areas because the Delta area economy would experience development and growth as a result of the Pogo Mine.

- Security gate at Gilles Creek Limiting public access to the lower two-thirds of Shaw Creek Valley would substantially reduce likely changes to existing land uses beyond Gilles Creek that would occur if the public were able to use the road to reach the Goodpaster River.

***Disposition*** Removing and reclaiming the Shaw Creek Hillside all-season road after the Pogo Mine project were completed would be a substantial impact to new residential, commercial, and industrial land uses that occurred because of the initial construction of the road, but existing land uses along Shaw Creek Road would not be substantially affected.

Historically, however, few roads in Alaska have ever been removed and reclaimed after a period of use. They either become part of the maintained state road system, or are abandoned and revert to four-wheel drive or ATV trails that still allow access. A decision at this time by ADNR to remove all or a portion of an all-season road could be changed in the future through a public involvement process pursuant to the TBAP.

If the road were open to the public during project operation, removing and reclaiming the road would be a substantial impact to existing commercial, industrial, recreational users, and any businesses such as lodges, stores, or other service-related industries that developed to support new backcountry users.

**DOF forestry road** It should be noted that the planned road for the DOF Shaw Creek timber harvest would follow closely the Applicant’s proposed Shaw Creek Hillside all-season road alignment in the lower and middle portions of the drainage. Thus, if the winter-only access option were selected and the DOF road were built, all the impacts discussed above likely would still occur because the DOF road would eventually connect with the southern end of the all-season portion of the winter-only access. If the proposed Shaw Creek Hillside all-season road were constructed, however, the DOF road would not be built because the former would provide necessary access to timber resources on state lands. Spur roads, however, would be constructed as needed to support timber sale activities.

### Alternative 3

#### Surface Access

***Use*** Impacts would be similar to those for Alternative 2, except that the impacts to existing residential and other users near the Richardson Highway would occur in the vicinity of the highway and Quartz Lake rather than in the Shaw Creek Road area.

### Alternative 4

#### Surface Access

***Use*** The option of Shaw Creek Flats winter-only access would not cause substantial changes to existing land use in Shaw Creek Valley if it were open only for use by the Pogo project or industrial / commercial users. Some existing land uses in Shaw Creek Valley, however, could be changed if the road were open to public use, even though only seasonally, because it would provide a limited increase in access to presently remote areas.

Winter-only access, because of its seasonal nature, would be a benefit to existing residential and recreational uses in the Shaw Creek and Goodpaster valleys, including the Goodpaster cabin owners, even if it were open to public use, because users would be able to access the upper reaches of the Shaw Creek and Goodpaster drainages only in winter, which they can largely do now. Similarly, trappers, commercial sled dog tour operators, and other backcountry users would consider winter-only access less of an impact on their operations than an all-season road.

For potential recreational users, however, winter-only access, even if open for pubic use, would not allow increased access to the more remote areas of the Shaw Creek and Goodpaster River drainages during the 9 months when winter-only access were not passable.

The Shaw Creek Flats winter-only access option, compared to the all-season road options, generally would not be as beneficial to potential commercial and industrial users. While the winter-only access option likely could be used by other resource developments, it would not be as favorable as an all-season road because of its seasonal nature. New mineral and timber activities, and associated commercial land uses, likely would be slower to develop than with the all-season road option.

If the winter-only access option were selected and the DOF constructed its forestry road along the Shaw Creek Hillside, the DOF forestry road likely would connect with the all-season road segment of the winter-only access option. Because the forestry road would be open for public use, its presence would obviate the whole purpose of the winter-only access option, which is to isolate the all-season road segment from year-round public access. Impacts then would be similar to those discussed above for the Applicant's Proposed Project (Alternative 2).

## 4.12.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would change some then-existing land uses by removing the access that had allowed Pogo project development. There would be no cumulative impacts on land use because all uses still would be consistent with the TBAP.

- All-season Road Maintained The surface access and power line corridors to the Pogo Mine would provide the necessary infrastructure for a hypothetical Sonora Creek mine, and likely also a hypothetical Slate Creek mine, thus increasing commercial/industrial uses of these corridors. Use of these corridors by other mining companies would have cumulative impacts on existing and new land uses.

  An extension of the life of the Pogo project because of discovery of additional deposits in the near vicinity of the Pogo ore body would have relatively few additional cumulative impacts because most of the existing infrastructure would still be used.

  Road and power extensions from the Pogo mill to a hypothetical Sonora Creek mine would provide the necessary infrastructure for this new mining operation. Pogo Mine access and power would contribute substantially to the feasibility of new commercial/industrial land uses in the area, cumulatively affecting land uses. Mining-related service industries, such as air and land transport for mining activities, would consider the Pogo and Sonora Creek mine infrastructure important for their businesses.

  If the Pogo access road and power line were extended up the Goodpaster Valley to a hypothetical Slate Creek mine, this activity also would cause substantial changes to existing land uses, but still would be consistent with the TBAP. Remote reaches of the upper Goodpaster would become more economically accessible to new commercial and industrial land uses, possibly opening up other adjacent mining areas in the future. Existing trappers, recreationists, and other users of the area likely would consider such infrastructure a substantial change to existing land uses, while new commercial and industrial land users would consider such infrastructure a substantial benefit.

# 4.13 Subsistence

Because Native subsistence was identified as a scoping issue, the focus of the subsistence discussion in this EIS is on Upper Tanana Athabaskan subsistence uses. This focus is not meant to suggest that non-Natives are not subsistence users. Where non-Natives reside in the target Native communities, they also likely conduct seasonal harvest activities in the project area and may consider these activities subsistence uses. The ADFG subsistence use information, on which much of this analysis is based, includes community practices and not solely those of Native residents. Non-Native subsistence uses by residents of non-Native communities are included elsewhere in the EIS under sport hunting and fishing, and these non-Native users may individually consider themselves subsistence users.

In this section, potential subsistence impacts are discussed in the context of three direct impact criteria: subsistence resource availability, access to resources, and competition for resources for the Upper Tanana River Valley as used by Tanana Athabaskans. Factors influencing these criteria include:

- Availability — Changes in resource abundance and/or resource damage, displacement, or contamination. These changes to wildlife are based on the fish and wildlife impacts discussed elsewhere in this chapter.
- Access — Transportation corridors that would increase access or physical, regulatory, and/or social barriers that could restrict access
- Competition — Pogo project personnel, new and/or outside (the region) users, or existing users who harvest subsistence resources more frequently because of new or improved access to traditional harvest areas

References to historical and current Upper Tanana Athabaskan subsistence uses are defined as follows:

- Recent — Within the last 10 years
- Lifetime — Beyond the last 10 years

References to duration of impacts are defined as follows:

- Short-term — 1 year or less
- Moderate-term — More than 1 and up to 2 years
- Long-term — More than 2 years

References to important and key subsistence resources and species mean resources as measured by harvest effort, harvest amounts, or cultural importance.

Unless otherwise indicated, subsistence resource uses and use areas are based on SRB&A (2002a). The environmental effects described in this section are based on a more detailed analysis in SRB&A (2002b).

## 4.13.1 No Action Alternative

Under the No Action Alternative, there would be no or low effects on the availability of subsistence resources. Except for the local areas that would be accessed by the DOF's planned timber harvest roads in the Shaw Creek Valley and the vicinity of Quartz Lake and Indian Creek, there also would be no or low effects on access to and competition for subsistence resources. In those local areas accessed by the DOF timber harvest roads, there would be moderate effects to access (new transportation corridor) and competition (road users) for important subsistence resources (moose, caribou, waterfowl, and upland birds). These effects on access and competition, however, would be spread out over time, because the roads likely would be constructed incrementally.

The planned DOF all-season road and associated Shaw Creek timber harvest would occur in current and lifetime subsistence use areas for Upper Tanana Athabaskans. Recent subsistence use occurs in the affected area for caribou, moose, and upland birds. Recent use areas for waterfowl are adjacent to the proposed road corridor. Lifetime subsistence use occurred in the affected area for moose and upland birds.

Planned timber harvests in the vicinity of Quartz Lake and Indian Creek that would be accessed by winter roads would have no or low effect on subsistence resources. The planned DOF all-season road and associated harvests in this area that would be accessed by a proposed all-season road around Quartz Lake, however, would have a moderate effect on access to and competition for current Upper Tanana Athabaskan subsistence resources of moose, waterfowl, upland birds, and berries.

The effects of both roads on subsistence access and competition would be long-term, but could be mitigated if access to the roads by recreational users and other members of the public were restricted.

## 4.13.2 Options Common to All Alternatives

A portion of the mine area itself overlaps recent and lifetime Upper Tanana Athabaskan subsistence use areas for caribou and moose harvest. It also overlaps the lifetime use areas for trapping and harvest of upland birds. Thus, there is potential for a direct effect.

The primary effect of mine area development on wildlife would be its displacement from the mine area. Development of mine area facilities would have a low effect on subsistence availability except in the immediate mine area. Access to subsistence resources at the mine site by subsistence users would be diminished because hunting would be prohibited in the immediate mine area for public safety purposes. This area, however, is small within the context of the overall subsistence use area for caribou, moose, and upland birds. Competition for subsistence resources surrounding the immediate mine area would not be affected because of the Applicant’s no hunting and fishing policy for employees. Thus, effects of these common options would be high only at the mine site facilities. The duration of this impact would be long-term.

Recent Upper Tanana Athabaskan caribou and moose subsistence use areas are substantially larger than the footprint of the mine site, and the lack of availability of the mine site for subsistence hunting would not affect the overall pattern of subsistence use because other areas are available for harvesting these species. And, there would not necessarily be any increased effort, cost, and/or risks if subsistence hunters were unable to hunt at the mine site because this location is not a readily accessible area from any community. It would be more of a noticeable reduction in opportunity to hunt in a traditional place that was used by one’s relatives and ancestors. In this regard, it could be construed as a loss of a part of one’s homeland for hunting, but not the primary or most used hunting area.

### Fuel Storage Location

- Temporary Storage The proposed temporary (2 year) fuel storage to be located below the existing 1525 Portal on the valley floor and at the airstrip would not be within the recent subsistence use area for fish. Recent subsistence fishing areas, however, are located downstream of the site in the Goodpaster River. If contamination from these facilities were to affect downstream areas, and fish in them, it could affect subsistence fishing. Any fish damage, decline, displacement, or contamination would affect availability to subsistence fishers. Furthermore, concerns about contamination could lead to reduced fish consumption (SRB&A and Usher, 1997). The fear of contaminated resources could long outlast any actual direct impacts to the fish resources. Depending on the duration and severity of contamination of the river, it could have a moderate effect on subsistence fishing uses.

  Fish is an important subsistence resource; the Goodpaster River is in the recent subsistence fish use area and the impact, depending on severity, likely would be clearly detectable to traditional subsistence users. Individual subsistence users and groups of users likely would be affected. Although there are substantial other areas available for subsistence fishing, and the overall pattern of subsistence uses would not be seriously jeopardized, the Goodpaster River is a currently used and highly regarded river by descendents and related kin of Athabaskans who used this area traditionally. The probability of such contamination from these facilities during the 2-year development phase, however, is low.

### Air Access

***Airstrip Use and Disposition*** How the airstrip would be managed during the period of mine operation, and whether the airstrip would be reclaimed at conclusion of operations, would affect access to the vicinity of the mine and therefore subsistence. For all three subsistence impact criteria of availability, access, and competition, the most restrictive airstrip use and disposition options (airstrip open only to Pogo project use during mine operations, and removal and reclamation at the end of mine operations) would have low effects. Conversely, the least restrictive options (airstrip open to everyone during and after mine operations) would have moderate to high effects.

## 4.13.3 Options Not Related to Surface Access

### Alternative 2

Except for the components discussed below, impacts for this alternative would be of the same nature and degree as discussed for options common to all alternatives in Section 4.13.2 above.

### Power Supply

- Power line Clearing of a power line ROW would create an access corridor for recreational as well as subsistence users; thus, access would be increased. This increased access could increase competition between recreational and subsistence users, and potentially among subsistence users. Increased access would occur over the life of the Pogo project in winter (snowmachine access), but possibly all year in current and lifetime use areas for important subsistence species. Thus, this option could have a moderate impact on access to and competition for subsistence resources. Mitigation measures to restrict ATV use of the power line ROW could limit access to some extent. To whatever geographic extent the road were open for use by everyone, however, the power line ROW likely would provide little access advantage because it would so closely follow the road alignment. In these co-aligned areas, the impacts would be small.

**Alternative 3**

Impacts for this alternative would be of the same nature and degree as discussed for options common to all alternatives in Section 4.13.2 above.

### Power Supply

- Power line Same as Alternative 2.

### Water Discharge

- Direct discharge to Goodpaster To the extent this option were to cause low to moderate impacts on fish and aquatic habitat from process upsets and facility failures which could lead to bioaccumulation of metals, as discussed in Section 4.8.3 (Fish), it could lead to impacts on subsistence fisheries farther downstream in the Goodpaster River, as discussed in Section 4.13.2 above. Depending on the duration and severity of contamination, such impacts could have a moderate effect on subsistence fishing uses. Because the probable frequency of the combination of events that would cause such impacts is low, and the dilution factor high, this option would have a low subsistence impact.

**Alternative 4**

### Power Supply

- On-site generation This option would require greater on-site fuel storage and movement of approximately 4.2 million gallons fuel annually by tankers over surface access. These requirements would substantially increase the risk of fuel spills at stream crossings and from transfers between tankers and storage tanks, raising the same concerns for impacts to fish, fish habitat, and subsistence fisheries farther downstream as discussed in Section 4.13.2 above. Depending on the duration and severity of contamination, such impacts could have a moderate effect on subsistence fishing uses.

### Water Discharge

#### *Development and Operations Phases*

- Off-river treatment works Impacts from this option could be the same as for Alternative 3; however, this option would have a lower probability of affecting water quality than would a direct discharge to the Goodpaster because of its more controlled environment and its 24-hour holding capacity following an upset. Therefore, the potential for impacts to subsistence resources with this option would be the lowest of the discharge options.

## 4.13.4 Options Related to Surface Access

Options related to surface access have the greatest potential to affect subsistence uses. The three key options are route location, who would use the road during mine operations, and disposition of the road after completion of the Pogo project.

## Alternative 2

### Surface Access

#### *Route*

- The Shaw Creek Hillside all-season road would have a low effect on the availability of subsistence resources. Depending on who would use the road during mine operations and disposition of the road after completion of the Pogo project, this alternative would have the potential to substantially increase access to resources in the Shaw Creek and upper Goodpaster River drainages, as well as the surrounding areas. Such increased access would result in increased competition for subsistence resources between recreational and subsistence users, and among subsistence users. Although improved access to an area could be viewed as a positive benefit for subsistence users, the overwhelming view at the 2002 subsistence workshop (SRB&A, 2002a) was that increased access was negative and would facilitate additional people entering an area, drive game farther away, and increase competition for resources. Based on workshop input, people who already use the area are satisfied with the current level of accessibility and providing increased or easier access would only complicate their lives and make it harder for them to secure resources.

    - Richardson Highway egress The Shaw Creek/Rosa egress option has more overlap with current subsistence use areas (e.g., caribou, moose, waterfowl, and berries) than does the Tenderfoot egress. Because Shaw Creek Road already provides access to these subsistence resources, and the Tenderfoot option would not provide materially greater access to these resources, there would be little difference in effects between the two options.

***Use and Disposition*** For access and competition criteria, the most restrictive road use and disposition options (road open only to Pogo project use during mine operations and removal and reclamation at the end of mine operations) would allow the least access into the Shaw Creek and upper Goodpaster River drainages and would have the fewest impacts on subsistence. Conversely, the least restrictive options (road open to everyone during and after mine operations) would allow the greatest access and would have the most effects.

Opening the all-season road even to just other industrial and commercial users would augment the potential for increased access and competition for resources, and complicate enforcement of policies designed to restrict competition with existing resource users.

Opening the road to everyone would serve to open an area currently difficult for the general public to access. In addition to accessing the Shaw Creek and Goodpaster River drainages, if hunters and recreationists were able to use the road to cross the Goodpaster River, it could ease some of the problems of reaching the high country north and northeast of Healy Lake. Restricting road use to the west side of the Goodpaster River, however, would reduce this possibility. To the extent that opening the road to the general public would result in increased use of this area, this option would have the greatest effect on existing subsistence uses by creating substantially increased access and competition in current use areas for key species for a long time period over a potentially large geographic area, resulting in subsistence users needing increased hunting effort, having greater costs, not going to traditional areas as often, and having reduced harvest. This impact would be major within the local and regional context for present-day subsistence hunters who are descendents and related kin of Athabaskans who used this area traditionally.

The Shaw Creek Hillside all-season road would be located in recent Upper Tanana Athabaskan subsistence use areas for the harvest of caribou, moose, waterfowl, and upland birds, and in the lifetime subsistence use areas for moose, upland birds, and trapping. Caribou, moose, waterfowl, and upland birds are important subsistence species. Thus, there would be a direct effect from this alternative on access to and competition for subsistence uses of these species for Upper Tanana Athabaskan subsistence users as well as other traditional subsistence users. The duration of these impacts would be long-term. These impacts would be similar to the No Action Alternative impacts from construction and operation of the planned DOF forestry road.

At the same time, the recent subsistence use areas for these species are substantially larger than the immediate area of the Shaw Creek Hillside road. For those individuals who go to the Shaw Creek Flats area for waterfowl or to the surrounding area for caribou and/or moose, however, this road, regardless of access management policy, would have an effect on their activities. Traditional users may avoid the area because of the new road and traffic, and this avoidance (or social barrier) likely would increase if the road were open to non-Pogo users. In this sense, the road has the potential to be regarded as a loss of a part of one's homeland for hunting, not necessarily the primary or most used hunting area, but a hunting area that was historically and is currently used.

If the road were successfully managed to limit use to only the Pogo project, and if the Applicant's no hunting and fishing policy were strictly enforced, impacts likely would not affect the overall pattern of subsistence use. This is because other areas would be available for harvesting these species, and the restrictive road use policies and road removal would diminish the potential for new users to penetrate east, northeast, and southeast from the Shaw Creek Hillside and the mine area. If these policies were enforced, and the road removed and reclaimed, there would be a moderate effect on historic users of the area.

Less restrictive road use and road disposition policies could result in a substantial increase of recreation users into the area and expansion east and southeast from the road, which has the potential for a major impact on traditional subsistence users (e.g., direct effects).

- Security gate at Gilles Creek This option would have the same impacts described above for road use by everyone, except the impacts would only occur in the lower two-thirds of Shaw Creek Valley. Access to the mine vicinity and the potential for sport hunters and other recreationists to use the road to cross the Goodpaster River and ease some of the problems of reaching the high country north and northeast of Healy Lake would not exist.

## Power Supply

- Power line The effects of the Shaw Creek Hillside power line route would be related primarily to increased access. Because this route would be very close to the Shaw Creek Hillside all-season road, the power line's increased access impacts would be of little or no additional consequence.

## Alternative 3

### Surface Access

#### *Route*

- The South Ridge all-season road would be located in recent Upper Tanana Athabaskan subsistence use areas for the harvest of caribou, moose, fish, and berries, and in lifetime subsistence use areas for moose and trapping. Thus, there would be a direct effect from this alternative on access to and competition for subsistence uses of these species. The duration of these impacts would be long-term. The South Ridge all-season road impacts generally would be the same as those for Alternative 2, recognizing that subsistence use patterns along this route are slightly different.

***Use and Disposition*** Same as for Alternative 2.

## Alternative 4

### Surface Access

#### *Route*

- Shaw Creek Flats winter only access would have impacts similar to the Shaw Creek Hillside all-season road option, except for the initial winter access route. The Shaw Creek Flats route would cross wetlands and transect recent Upper Tanana Athabaskan subsistence use areas for caribou, moose, waterfowl, and upland birds.

  Shaw Creek Flats is a traditional and current harvest area for “stray” caribou and a well-used waterfowl hunting area. Any fuel or cyanide accidents on the flats resulting in resource damage, decline, displacement, or contamination would affect availability to subsistence users. As discussed previously in Section 4.13.3 (Alternative 2), contamination concerns could lead to reduced resource consumption and years of wondering if the resources from the area as well as “downstream” were safe to eat. The larger the accident, the greater the concerns, and the greater the effect on subsistence harvesting and consumption.

***Use and Disposition*** Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, as the DOF road, which would be open to the public, was extended toward Gilles Creek, subsistence impacts from public use would begin to approach those described for Alternative 2.

## 4.13.5 Cumulative Impacts

- All-Season Road Reclaimed Absence of an all-season road would considerably reduce resource development and recreational access to subsistence use areas that are currently difficult to access; therefore, it would have substantially fewer cumulative impacts.

- All-Season Road Maintained The direct subsistence impacts from the possible extended life of the Pogo Mine, and a hypothetical mine development in the headwaters of Sonora Creek just east of the Pogo Mine, would be similar to those already discussed above for the Pogo project because of the mine’s closeness to the Pogo Mine infrastructure.

A Slate Creek mine near the headwaters of the Goodpaster River approximately 25 miles northeast of Pogo that would be accessed by an all-season road, however, would provide even greater access into a currently inaccessible area, especially if open to use by the public. Such a road would extend well inside the edge of the Fortymile Caribou Herd's recent annual range, which would be a particular concern to subsistence users.

With the exception of caribou and moose, however, the area between the Pogo Mine site and a hypothetical Slate Creek Mine site is outside recent Upper Tanana Athabaskan subsistence use areas. The area is within the lifetime subsistence use area for caribou and upland birds. Although such a road from Pogo to a Slate Creek Mine would not in itself have a major impact on current subsistence uses because it is outside of current subsistence use areas, subsistence users likely would perceive it as a further cumulative encroachment on the "wilderness" to the north, and another step toward connecting to the Taylor Highway and "surrounding" the village of Healy Lake with roads and modernization.

Construction of a new road represents a classic fear of cumulative impacts from a road, because, in the view of the subsistence workshop attendees (SRB&A, 2001), "roads beget more roads." The land use policies that would permit a road to the Pogo Mine site could do likewise for other resource developments, and through the Alaska Industrial Development and Export Authority (AIDEA) or other vehicle might even help fund more roads. Thus, retaining an all-season road to Pogo could have a major cumulative impact on subsistence resources. These impacts, however, could be mitigated if the State of Alaska undertook appropriate land and resource management policies for the area that would limit public access to, and impacts on, subsistence resources.

# 4.14 Cultural Resources

In this section, cultural impacts are discussed in the context of guidelines contained in Section 106 of NHPA (36 CFR 800). These guidelines define the process for considering effects on cultural resources by projects that use federal moneys or permits. No high impacts to cultural resources are expected from project development.

Losses of cultural resources normally occur from primary effects, such as destruction from project activity where no information has been gathered. Secondary effects may include increased pedestrian travel over cultural resource sites and uses of newly created access that result in unauthorized visitation or, at worst, site looting.

If impacts to a site cannot be avoided, damages may be mitigated through archaeological data recovery. Archaeology is a study that involves the removal from the ground or final resting place of information to a processing and analysis laboratory. A site may be physically removed, but the information, including measurements, photographs, and matrix samples, is salvaged through careful removal techniques and scientific inquiries. Important artifacts can be removed for preservation in perpetuity. Reconstruction of the site occurs in the completion of reports about the excavation and inquiries. Thus, while sites and artifacts may be taken from their surface and subsurface placement, information such as who lived at the site, their activities, and the importance of the site lives on through careful documentation and recording.

EPA, as lead federal agency, in consultation with COE and SHPO, has determined that some cultural resources sites may meet the following three criteria: (1) they could be eligible for the National Register of Historic Places (NRHP) under 36 CFR 60.4; (2) they could be adversely affected by construction of the Pogo project; and (3) they have not yet been mitigated under permits previously issued by the SHPO. These sites, therefore, could require mitigation through data recovery under a programmatic agreement (PA) among the EPA, COE, Advisory Council on Historic Preservation, SHPO, and Teck-Pogo Inc. The PA contains provisions for discovery of prehistoric, historic, and paleontological remains during construction, operation, and closure of the Pogo Mine. A draft of the PA is contained in Appendix F.1.

The following is drawn from Harritt (2002) unless otherwise indicated.

## 4.14.1 No Action Alternative

Depending on the particular project, DOF timber sales or land-altering construction projects, such as a natural gas pipeline, upgrade of the GVEA Fairbanks-Delta power line, or DOF forest road construction, would be subject to SHPO review either under NHPA Section 106 or the Alaska Historic Preservation Act before construction could commence. Municipal land may undergo the same type of process, at the discretion of the city, but private land development is not subject to Section 106 review unless the development involves federal funds or permits.

Gradual increases in the numbers of houses and recreational uses of the area and an increase in private residential land sales could eventually result in damage to cultural resources as house sites and surrounding properties are developed. Increased recreational use of the project area such as seasonal hunting and fishing would increase the likelihood that artifacts present on the surfaces of sites would experience an additional degree of vulnerability to looting and other types of damage.

Overall, impacts to cultural resources from the No Action Alternative would be low.

## 4.14.2 Options Common to All Alternatives

Based on the documented cultural resources sites in the mine site vicinity, the large majority of mine facilities would have no effect on known cultural resources (Yarborough, 2000; Teck-Pogo Inc., 2002a). It is possible, however, that unknown resources could be present. The State of Alaska plan of operations approval would stipulate that in the event cultural resources were discovered as a result of construction, development, or operation of the Pogo project, activities at that location would be stopped until the SHPO was consulted and an evaluation of the resource could be carried out.

Facilities on the Goodpaster Valley floor near the existing portal, however, including the existing advanced exploration camp, existing airstrip, gravel pit clearing, and explosives storage, are located relatively close to XBD-184, a prehistoric surface feature. Although this site is across the Goodpaster River from these facilities, they would present a situation in which that site could be vulnerable to inadvertent or secondary damage. Such damages could result from activities related to further development and operation of the facilities or from intentional disturbance caused by looting activities. To protect the resource from such an impact, a rudimentary data recovery effort may be prescribed as a requirement of Section 106 compliance.

Definitive locations for potential domestic and industrial water wells, however, have not yet been identified. To meet Section 106 requirements, prospective well locations would be located only in areas that would not affect cultural resources. It is anticipated that cultural resources can be protected by modifying locations of these facilities where necessary. If a particular well could not be located to avoid adverse effects on the cultural resources, data recovery would be carried out to meet Section 106 compliance requirements prior to drilling.

## 4.14.3 Options Not Related to Surface Access

Impacts to cultural resources for the options not related to access would be similar to those described above for options common to all alternatives. To meet Section 106 requirements, locations of these options would be reviewed by the SHPO to determine effects on cultural resources. It is anticipated that cultural resources could be protected by modifying locations of these facilities where necessary. If a particular site could not be located to avoid adverse effects on the cultural resources, data recovery would be carried out to meet Section 106 compliance requirements prior to construction.

## 4.14.4 Options Related to Surface Access

**Alternative 2**

### Surface Access

***Route***

- Three cultural resources sites have been documented along the Shaw Creek Hillside all-season road and power line routes, all east of Keystone Creek: XBD-246, a historic trapper's camp; XBD-235, a house depression, cache pits, and hearth scatters; and XBD-247, buried, prehistoric hearth material (Yarborough, 2001). XBD-235 has been determined to be eligible for the NRHP, while XBD-246 and XBD-247 were determined not to be eligible for listing. After this site was identified, the Shaw Creek Hillside all-season road alignment was altered and placed approximately 200 ft from the XBD-235 site area. Therefore, no effects to this site are anticipated.

  Evaluations of potential impacts on sites XBD-246 and XBD-247 cannot be completed until determinations have been made concerning NRHP eligibility. In the opinion of the field investigator these sites likely would not be eligible. If they were determined to be eligible, however, then alteration of the road and power line alignments to avoid these sites, similar to the one made for XBD-235, would result in a finding of no impact, regardless of whether the sites were eligible for the NRHP.

  As in the case of XBD-235 described above, alteration of planned modifications to avoid damaging the documented resources would result in a finding of no impact, regardless of whether the sites were eligible for the NRHP. Alternatively, in the event modifications to the road had to be made, measures would be required to mitigate damage to the resources.

  - Shaw Creek/Rosa egress    There are seven documented sites in the area: XBD-015, graves and caches; XBD-031, a prehistoric lithic scatter site; XBD-071, prehistoric Meade site; XBD-130, reported site designated as BM Shaw; XBD-131, early man Broken Mammoth site; XBD-157, a prehistoric lithic scatter; and XBD-200, the Fowler Farm archaeological site 4. Some sites are clearly eligible for the NRHP; others have not been evaluated. Therefore, if upgrading activities were to occur, Section 106 may require an archaeological compliance survey and/or data recovery prior to initiating such modifications of this route segment.

  - Tenderfoot egress    This option would avoid the highest concentration of known cultural resources located near the Richardson Highway. Determination of potential impacts on cultural resources cannot be made, however, until an actual route is established. If this egress sub-option were selected, a field compliance survey and review by the SHPO would be conducted to meet the requirements of the Section 106 process. If this sub-option were constructed, the road would provide access to areas where cultural sites are located, increasing contacts with these resources and thereby increasing the likelihood of looting and other types of damage to the sites.

***Use and Disposition*** Restricting the use of any portion of the access road during Pogo project operations, or after project closure, would mitigate likely damage to cultural resources by limiting the number of people traveling through the area and thereby reducing opportunities for looting. The fewer the users, the less likely impacts would occur to cultural resources.

Any further modification to the terrain along the route related to the removal and reclamation of the road would be subject to the Section 106 review process that should protect cultural resources.

## Alternative 3

### Surface Access

***Route***

- Only a single isolated chert flake has been documented along the South Ridge all-season road and power line corridor (Yarborough, 2000). The location where the flake was found does not have high potential for containing cultural resources because of the distance to a water source, among other factors.

  If this access option were selected, a review of the South Ridge corridor would be required by the SHPO prior to initiation of construction activities. Also, any modifications to the existing Quartz Lake and DOF roads would require such a review prior to initiation of modifications of those roads.

  If the South Ridge access corridor option were constructed, it would provide access to areas where cultural sites are located, increasing contacts with these resources and thereby increasing the likelihood of looting and other types of damage to the sites.

***Use and Disposition*** Effects from restricting use of the road during mine operations and after mine closure, and from removal and reclamation of the road, would be the same as for Alternative 2.

## Alternative 4

### Surface Access

***Route***

- Shaw Creek Flats winter-only access This route would use the existing TAPS access road located one-half mile south of Shaw Creek on the northern side of the Richardson Highway. Because this segment of the route has not been surveyed, if this option were selected, a field compliance survey and review by the SHPO would be conducted to meet the requirements of the Section 106 process.

  Of particular concern in this area would be potential impacts of the project on XBD-016, the Shaw Creek II site, which contains protohistoric and historic graves and cache features. The winter road/trail route would not affect known cultural resources on Shaw Creek Flats. From its intersection with the Shaw Creek Hillside all-season road route, effects on cultural resources would be the same as for Alternative 2.

## 4.14.5 Cumulative Impacts

- All-Season Road Reclaimed Absence of an all-season road would limit other resource development activities and human access, and would result in essentially no cumulative impacts on cultural resources.

- All-Season Road Maintained Almost all lands in the project area, including those on which the Pogo Mine project would be developed, are owned by the State of Alaska. All development, therefore, would occur with protection of cultural resources through the Section 106 process and AS 41.35. Most cumulative impacts, therefore, would occur just from human presence. Thus, the expected increase in population in the Delta area, coupled with Pogo Mine development, would slowly increase the potential for impacts to cultural resources. Recreational use of the state lands in particular would increase that potential.

  If an all-season road were maintained after completion of Pogo Mine operations, it would increase the potential for cumulative impacts on cultural resources from human activities. Additional mineral development beyond the proposed project would further increase potential cumulative impacts by either extending the period of active mining, as under the scenario of finding additional reserves at Pogo or development of the hypothetical Sonora Creek mine, or simply by increasing the number of active mines as under the hypothetical Slate Creek mine scenario. If a road to a Slate Creek Mine were constructed and open to public use, the potential for impacts to cultural resources would further increase.

# 4.15 Visual Resources

The relative level of potential visual impacts of the project components was identified and evaluated based on the combination of visual quality and integrity, visual absorption capability (VAC), and viewer sensitivity values. The severity of visual impacts was considered in the context of landscape changes noticeable to viewers looking at the landscape from their homes and recreational cabins, or from parks, recreation, or preservation areas, highways, ATVs, aircraft and other travel modes, and other important cultural sites and features.

The following viewers have been identified as potentially having a high regard for the scenic integrity of the project area:

- Cabin owners along the Goodpaster River
- Residents and travelers along the Richardson Highway
- Residents and travelers along Shaw Creek Road
- Clearwater Lake residents and visitors
- Quartz Lake residents and visitors
- Other recreational users of the area, including backcountry and airborne viewers

Visual contrast is defined as a measure of physical change in the landscape that would result from introduction of a project (USFS, 1995). For example, the presence power line H-poles, transportation access routes, mill and camp facilities, tailings disposal site, and other ancillary facilities of the Pogo Mine project would cause physical change in the landscape. The severity of visual impacts was determined by analyzing how these changes would be viewed and perceived from sensitive viewpoints. Certain factors are considered and incorporated when analyzing visual contrast and impacts to sensitive viewers. These factors include:

- Distance — The contrast of project-related changes is usually less as viewing distance increases.
- Angle of observation — The apparent size of a project-related change is directly related to the angle between the viewer's line of sight and the slope on which the project change would occur.
- Duration of view — If the viewer has only a brief glance of the change, the contrast may not be of great concern. If the change is subject to view for a long period of time, however, the contrast may be very high.
- Relative size and scale — The contrast created by the change is directly related to its size and scale in comparison to the surroundings in which it is placed.
- Light conditions — The amount of contrast can be substantially affected by the light conditions. The direction and angle of lighting can affect color intensity, reflection, shadow, form, texture, and many other visual aspects of the landscape.

Visual contrast levels are analyzed by combining landform/vegetation contrast levels with structure (project component) contrast levels. These contrast elements are described as:

- Landform/vegetation contrast — The change in vegetation cover and patterns that would result from construction activities.
- Structure contrast — The compatibility of the proposed project component with other structures in the landscape and the existing natural landscape.

Generally, strong visual contrasts in the landscape viewed from high-sensitivity viewpoints within 1 mile would result in high visual impacts. Visual impact levels generally get lower as visual contrasts become weaker or as the distance from the viewpoint increases. These contrasts are defined as:

- High — Strong and moderate visual contrast associated with the presence of a project component or construction activities associated with the project that are visible from high-sensitivity viewpoints (e.g., recreationists and other users in the upper reaches of the Goodpaster River) within the 0- to 0.5-mile distance zone.
- Moderate — Weak visual contrasts visible from high-sensitivity viewpoints within the 0.5- to 1-mile (e.g., foreground) distance zones and strong or moderate visual contrast visible in the 1- to 3-mile (e.g., Goodpaster Winter Trail and Quartz Lake users, and Shaw Creek Road residences adjacent to the proposed Shaw Creek Hillside route) distance zone.
- Low — Weak visual contrast visible from high-sensitivity viewpoints within the 1- to 3-mile distance zone and strong, moderate, or weak contrast visible within the 3-mile and beyond (e.g., travelers along the Richardson Highway viewing the Shaw Creek Flats and Hillside routes and the Goodpaster River cabin owners) distance zone. Lower scenic quality impacts would result.

Clearing of vegetation for the power line and access routes and the actual presence of these and other project components would contrast with the natural setting of the existing environment, especially in those areas outside the Richardson Highway corridor. The contrast would vary, however, depending on its distance from the viewpoint, duration of view, and scale of the component related to the existing environment.

The visual analysis also used USGS digital elevation data (terrain data), land cover information, and photographs taken with a 35-millimeter lens during a time of year that leaves were off the deciduous trees to capture views when potential changes would be most visible.

Following is a discussion of the potential impacts on visual resources. The nine simulated views within the Pogo Mine project area represent typical constituent views of the access components.

## 4.15.1 No Action Alternative

The No Action Alternative would result in probable visual impacts from other projects in the Delta area, including: a natural gas pipeline; construction of the NMDS; and the DOF's 5-year plan forestry road in the Shaw Creek drainage.

A natural gas pipeline would require clearing of vegetation in a corridor close to the TAPS ROW near the Richardson Highway. Highway travelers would not consider this additional ROW clearing in the same general location to be a high impact.

Commercial, industrial, and private land sales and development would increase because of the NMDS. Formerly natural, undeveloped areas would be cleared to provide locations for these new land uses, and there would be high long-term impacts on visual resources.

The DOF's 5-year timber sale plan in the Shaw Creek drainage and Quartz Lake areas would require clearing of vegetation, all-season road development, and harvesting of various stands of timber. Some of these changes in visual quality and scenic integrity could be substantial to backcountry, recreational, or airborne viewers.

Components of these projects would be visible in foreground, middle-ground, and background views. Generally, the observed visual impacts would be higher in the foreground views and less substantial in the middle-ground and background views. The concern levels, scenic class, and scenic integrity of visual resource areas also describe the importance of the probable visual impacts.

For example, the Quartz Lake area has a low scenic class rating due to visible development and infrastructure around the lake with distinctive scenic attractiveness and a moderate level of scenic integrity in the foreground views; however, the concern level is high. The middle-ground views also have a high concern level, but are considered a moderate scenic class and have very high existing scenic integrity. Quartz Lake scenic resources have been affected by the Division of Park's existing parking lot and boat ramp facility. The DOF's planned road development around Quartz Lake would not substantially affect the views of concerned viewers, including existing residents of, and visitors to, Quartz Lake because even though the concern level is high, the road should not be viewable from the lake.

Overall, visual impacts from the No Action Alternative would be low.

## 4.15.2 Options Common to All Alternatives

Liese Creek valley has been identified as a visual resource area with high scenic values, distinctive scenic attractiveness, and provides viewers with distinctive foreground and background views. The location of the existing exploratory mining operation is considered to have low to very low scenic integrity. The disposal of tailings above ground in the valley would have higher impacts on the existing visual resources than would underground disposal. Views of above ground tailings piles would have high visual impacts to recreationists because of the low VAC of the area due to slope and topography.

The dry-stack tailings pile would be evident to viewers from the air, and in certain areas from the ground and river. The distance and duration of the viewpoints, however, would determine the importance of the view of this distinctive landscape. Airborne viewers would be substantially affected by the tailings location. The dry-stack tailings pile likely would be relatively well screened by vegetation from viewers on the Goodpaster River, and impacts would be low.

Recreationists would have obscured foreground and middle-ground views of the mill and camp development in an area with distinctive foreground and background views while traveling down the Goodpaster River. Airborne viewers also would have obscured views of the mill and camp development due to the valley's slope and topography. These views would not cause high visual impacts to recreationists floating the river, but could cause moderate impacts to airborne viewers desiring a totally primitive experience.

Mitigation measures could include use of additional screening vegetation and materials to adequately buffer the tailings, mill, and camp developments from sensitive viewpoints. There would be unavoidable impacts to scenic resources from the tailings pile that could not be mitigated.

Continued use of the airstrip at the end of the Pogo project also would have impacts to existing visual resources and scenic integrity. Backcountry users desiring a nonmotorized experience would see greater aircraft activity, as well as more recreational users, in the project area if the airstrip were open to everyone during and after the project's operation. Mitigation measures would include restrictions and limitations on the use of the airstrip.

## 4.15.3 Options Not Related to Surface Access

**Alternative 2**

### Power Supply

- Power line A power line would have very substantial visual impacts because of the scale, distance, and viewer recognition of power poles compared to on-site power generation.

  Figure 4.15-1 illustrates a potential view of the Goodpaster River Bridge and power line near the mine site. The view of the bridge, looking downstream, would be the same for all alternatives; however, the view of the power line is specific only to Alternatives 2 and 3. The power line poles would have high visual impacts on airborne viewers of this stretch of the Goodpaster River, as well as viewers directly on or along the river.

**Alternative 3**

### Power Supply

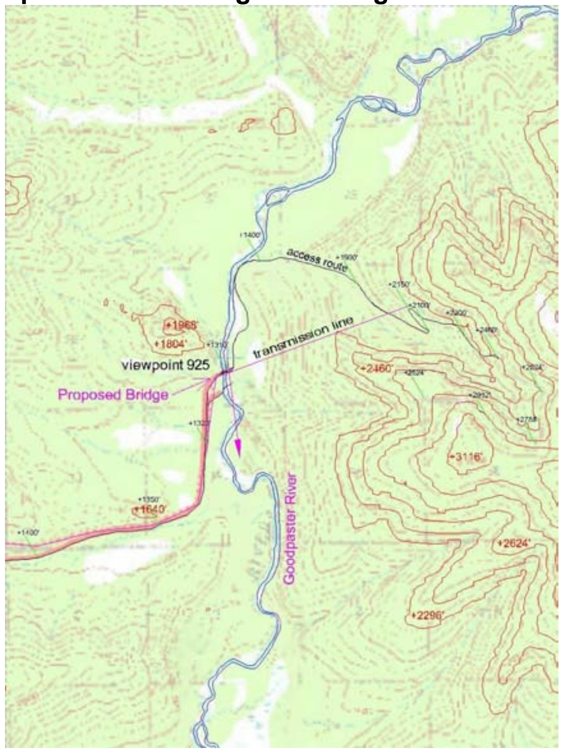
- Power line Same as Alternative 2.

**Alternative 4**

### Power Supply

- On-site generation This option would require additional surface disturbance for fuel storage at the airstrip. This option would have moderate impacts on intermittent views of recreationists on the Goodpaster River. These impacts, however, would be substantially less than for a power line.

**Figure 4.15-1 View of Goodpaster River Bridge Crossing and Power Line Route Near Mine Site**

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## 4.15.4 Options Related to Surface Access

**Alternative 2**

### Surface Access

***Route***

- The Shaw Creek Hillside all-season road and power line would be located in an area with predominately background views, high concern levels, moderate scenic class, and very high scenic integrity.

  The majority of the route is in an area of predominately high VAC. This siting of the route along lower elevations of the hillside would have low impacts on the visual resources in the area as viewed from the Richardson Highway. Views of the road and power line corridor, however, still would be evident to any concerned backcountry users and airborne viewers.

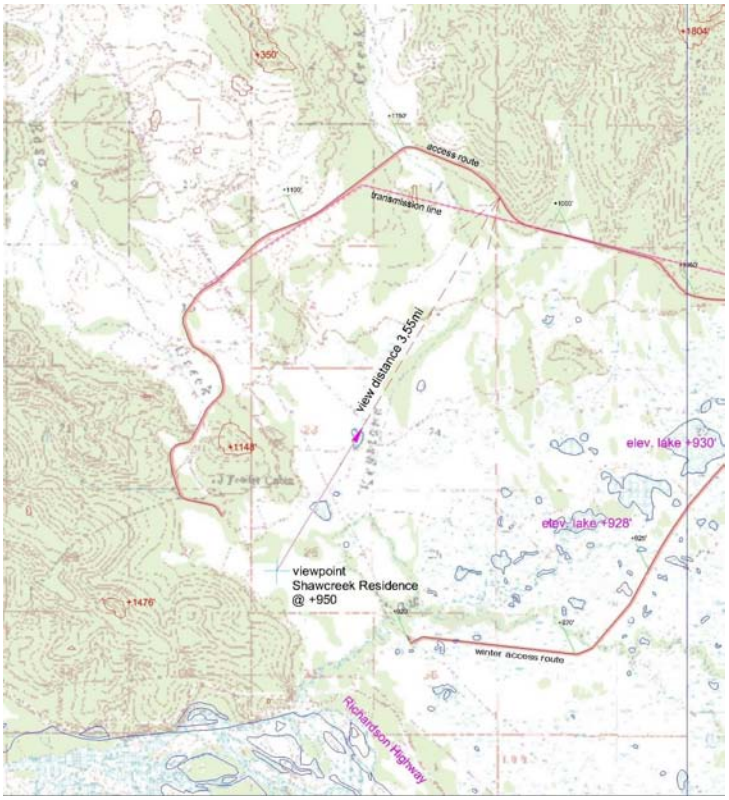
  Residents along the existing Shaw Creek Road also would be concerned viewers of this route. Figure 4.15-2 illustrates a potential view of the Shaw Creek Hillside access road and power line from a residence on Shaw Creek Road. The background views from this area would cause high visual impacts to existing residents due to their close viewing distance (approximately 3.5 miles) and the substantial contrast in natural landforms from development along the hillside. The power line poles would be visible, though minimally so. Although the road itself would not be visible, the line of vegetation cleared for the road would be visible against the base of the hills.

  Richardson Highway travelers also would be concerned viewers of this route. Figure 4.15-3 illustrates a potential view of the Shaw Creek Hillside access road and power line from the Richardson Highway. An existing GVEA power pole is in the foreground view of the figure, with distant views (approximately 5 miles) of the road and power line. This route would be only briefly visible intermittently to a highway traveler because there are dense vegetative screens along the edge of the highway, obscuring views across the flats and toward the hillside.

  Proper siting and development of the road and power line corridor within topographical considerations (i.e., at lower elevations), with adequate vegetative buffers/screens, where feasible, would mitigate visual impacts.

  - Tenderfoot egress The Tenderfoot egress option is located in an area with low VAC due to steep slopes and topography as viewed from the Richardson Highway. Development of this option would have moderate to high impacts on the visual resources in this area because of its low VAC and high viewer sensitivity.

**Figure 4.15-2 View of Shaw Creek Hillside Road and Power Line Routes from a Shaw Creek Residence**



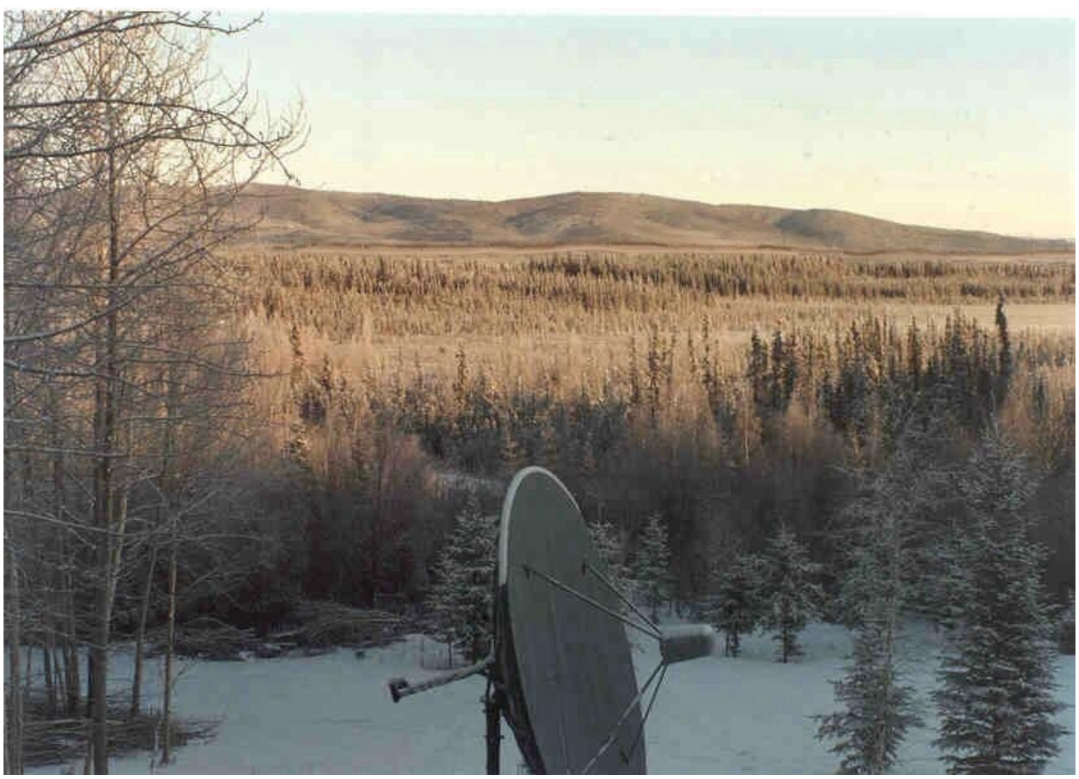



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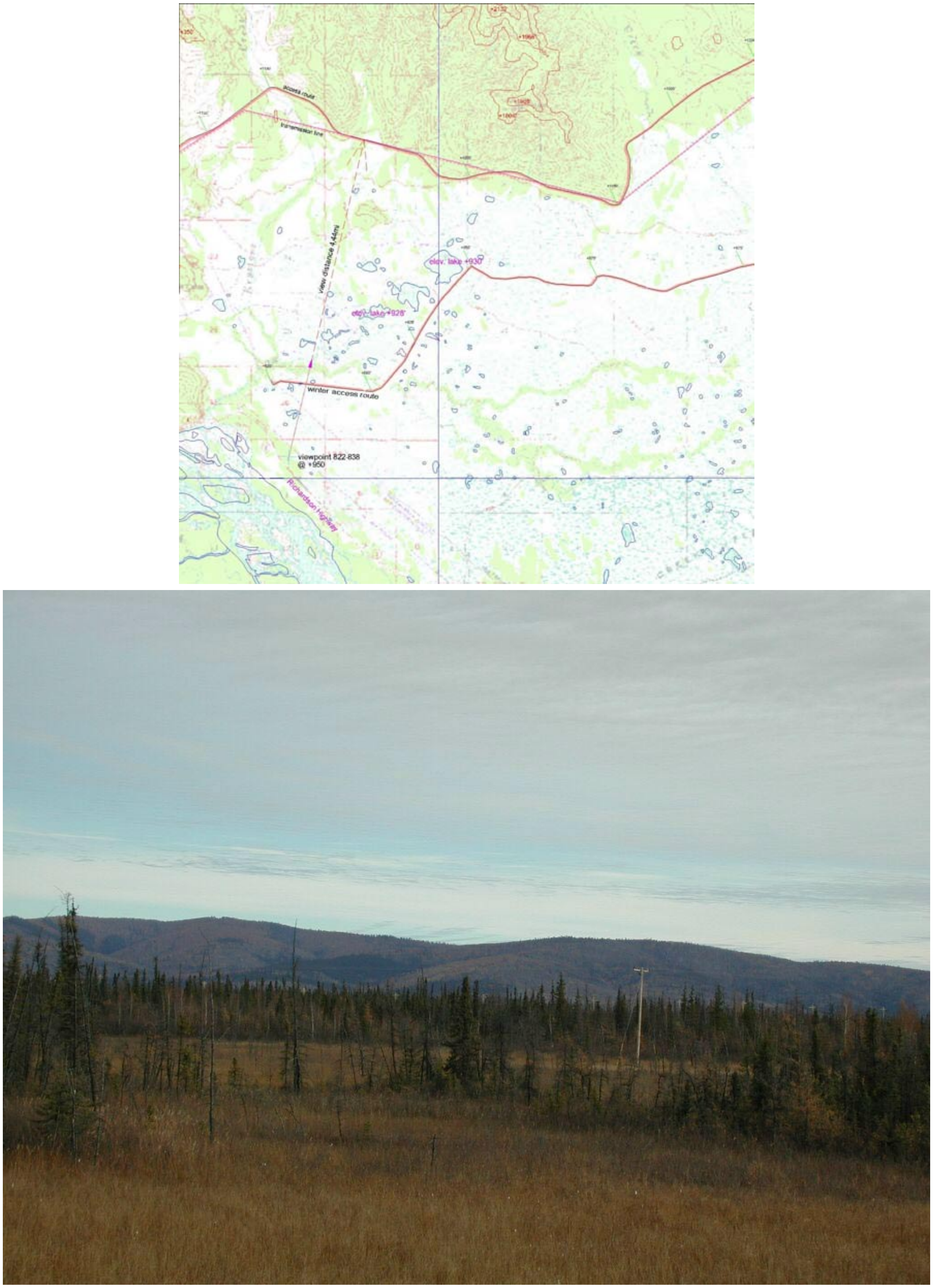
**Figure 4.15-3 View of Shaw Creek Hillside Road and Power Line Routes from the Richardson Highway (Existing GVEA Power Line in Foreground)**

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***Use*** While visual impacts would be low from use only by Pogo-related traffic, additional impacts would occur if the route were open to other users. There would be greater disturbances (such as light and dust) potentially viewable for longer periods of time. Increased road dust would be generated, especially during dry seasonal conditions. There also would be an increase in vehicle lights in the late evenings, early mornings, and during other periods of low natural daylight, particularly in winter.

The other road use options would have an increasing impact on visual resources in the following ascending order: industrial/commercial users and open to everyone.

***Disposition*** Removing the road and power line and reclaiming the landscape at mine closure would have the fewest impacts on currently existing visual resources. Current visual appearance would be restored as vegetation reclaimed the corridor over time, and there would be no traffic to generate light and dust impacts.

The other road disposition options would have an increasing impact on visual resources in the following ascending order: industrial/commercial users and open to everyone. The last category would have greater visual impacts (light, dust, and headlights) than for use only by the Pogo project because there likely would be more traffic.

## Alternative 3

### Surface Access

#### *Route*

- The South Ridge route is located in an area with predominately background views, high concern levels, moderate to high scenic class (Shaw Creek Dome), and very high scenic integrity. The route is primarily located in a zone with low VAC because of the visible higher elevations along the South Ridge slopes.

  Goodpaster River cabin owners, Goodpaster Winter Trail and other backcountry users, Clearwater Lake visitors, Richardson Highway travelers, Quartz Lake residents and visitors, and airborne viewers would be concerned viewers of this route.

  The route would have moderate to high impacts on visual resources in the area due to the low VAC and the sensitivity of concerned viewers and their proximity to foreground, middle-ground, and background views. The impacts to visual resources would be considered high to Goodpaster River cabin owners. Visual impacts would be higher than for Alternative 2, and would be inconsistent with the visual guidelines in TBAP.

  Figures 4.15-4 through 4.15-8 illustrate potential views of the South Ridge all-season road and power line routes from typical viewpoints at Goodpaster River cabins, near the Goodpaster Winter Trail, and the Quartz Lake and Clearwater Creek recreation areas.

  The view distances from the Goodpaster cabin locations, shown in Figures 4.15-4 and 4.15-5, would be greater than 9 miles. Background views of the road, but not the power poles, would be observable from these Goodpaster River sites, and visual impacts would be high to cabin owners, even though the viewing distance would be substantial. These concerned viewers are expected to be highly sensitized to any visual changes in the landscape because of their historical views of the natural landscape. Any impacts to existing visual resources, therefore, would be considered high by this user group.

  Figure 4.15-6 illustrates a potential view of the South Ridge Road and power line routes from the Goodpaster River Winter Trail at an elevation of approximately 1,200 ft.

Background views of the road and power line would be fairly visible because of the relatively short viewing distance (approximately 3.5 miles) and therefore would cause high visual impacts to winter trail users.

Figure 4.15-7 illustrates a potential aerial view of the South Ridge power line route from above Quartz Lake in the vicinity of a private dock on the north end of the lake. The potential road corridor would not be visible from the lake elevation in this area; however, the tops of power poles would be visible from the lake in the middle ground at a distance of approximately 2.5 miles. Locating the power line corridor more closely along the proposed road corridor (behind the highest elevation in this area) would eliminate this potential view.

Figure 4.15-8 illustrates a potential view of the South Ridge Road and power line route from the south portion of Clearwater Lake. The view distance is more than 15 miles. The road, but not the power line, would be visible. Even though there are few topographic landforms between Clearwater Lake and the potential route, the observed contrast, and its importance, would be substantially diminished because of the distance.

Mitigation would include the avoidance of steep slopes and cut banks where possible and use of construction methods that minimize steep bank cuts and erosion. Adequate vegetative buffers/screens along the length of the corridor and hydroseeding downhill slopes also would mitigate visual impacts. Some moderate to high impacts on scenic resources could not be avoided because of the disturbances to steep slopes and contrast between existing landforms and the road and power line.

***Use*** Because the South Ridge all-season road and power line would have higher visual impacts than Alternative 2, use by others than the Pogo project would have correspondingly greater impacts than Alternative 2. The other road use options would have an increasing impact in the same ascending order as for Alternative 2.

***Disposition*** Same as for Alternative 2, except that because the visual impacts of this alternative would be greater than for Alternative 2, they would remain longer before vegetation obscured them.

**Figure 4.15-4 View of South Ridge Access Route from Cabin on Goodpaster River**

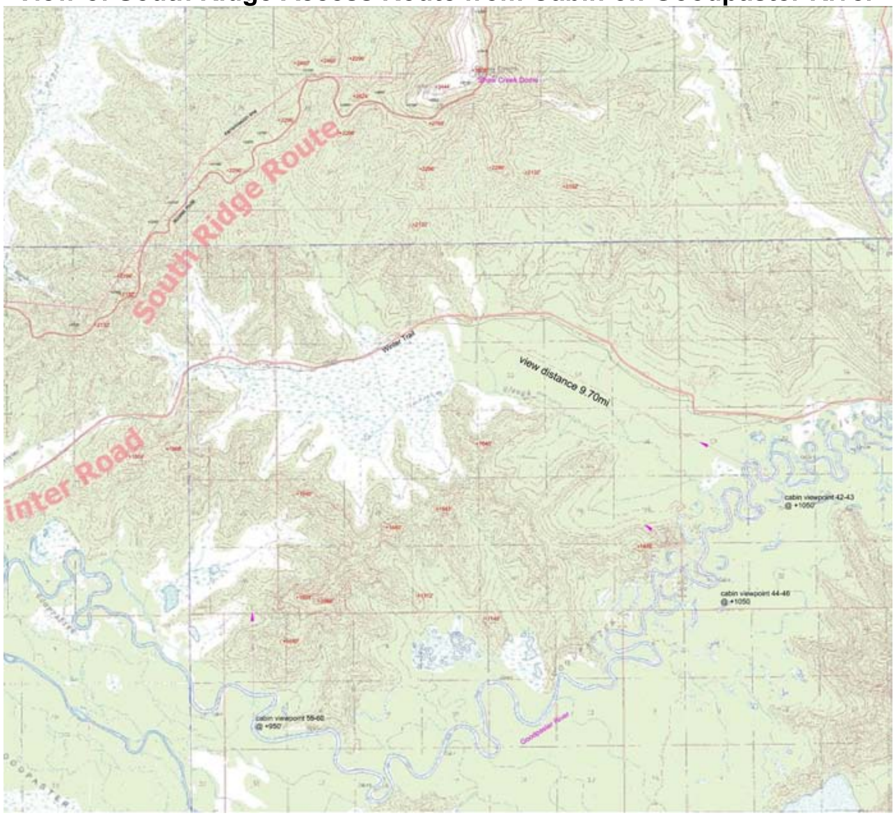


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**Figure 4.15-5 Aerial View of South Ridge Access Route from Cabin on Goodpaster River**

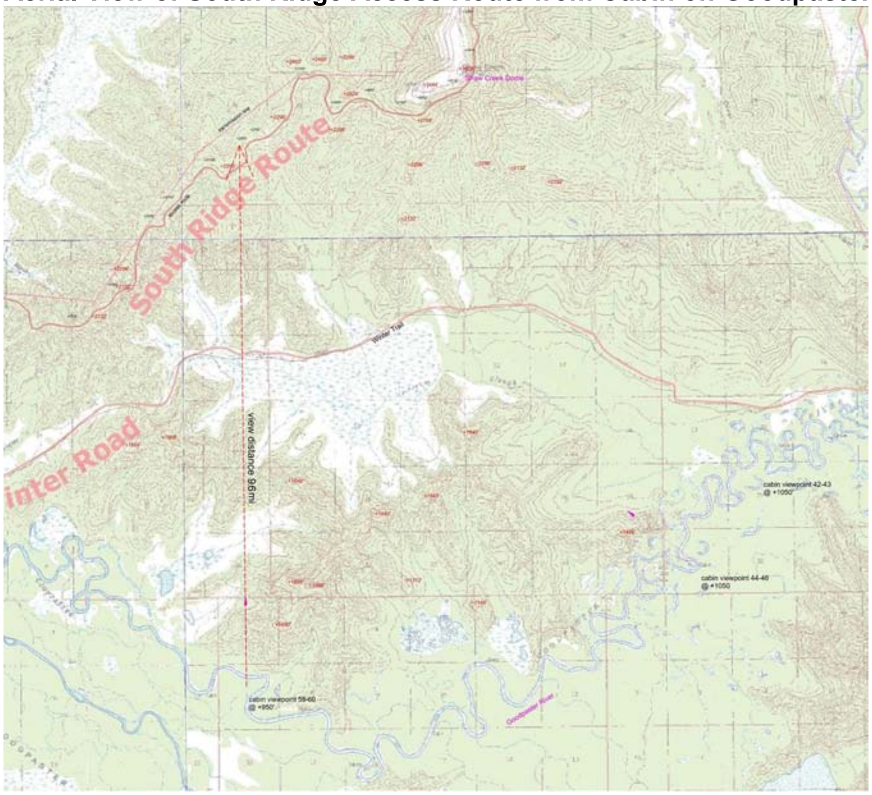


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**Figure 4.15-6 View of South Ridge Access and Power Line Routes from Goodpaster Winter Trail**

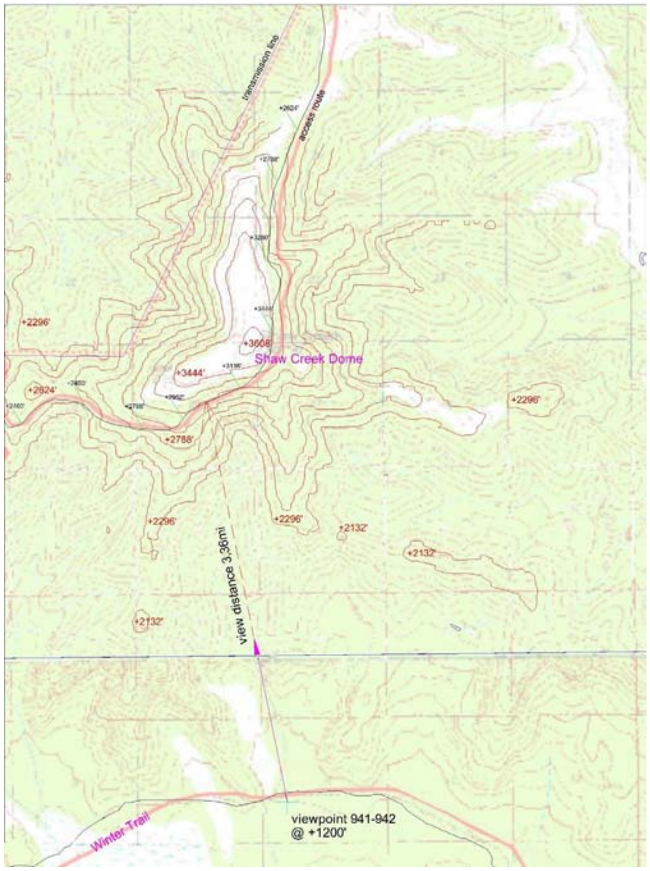


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**Figure 4.15-7 Aerial View of South Ridge Power Line Route from Quartz Lake**

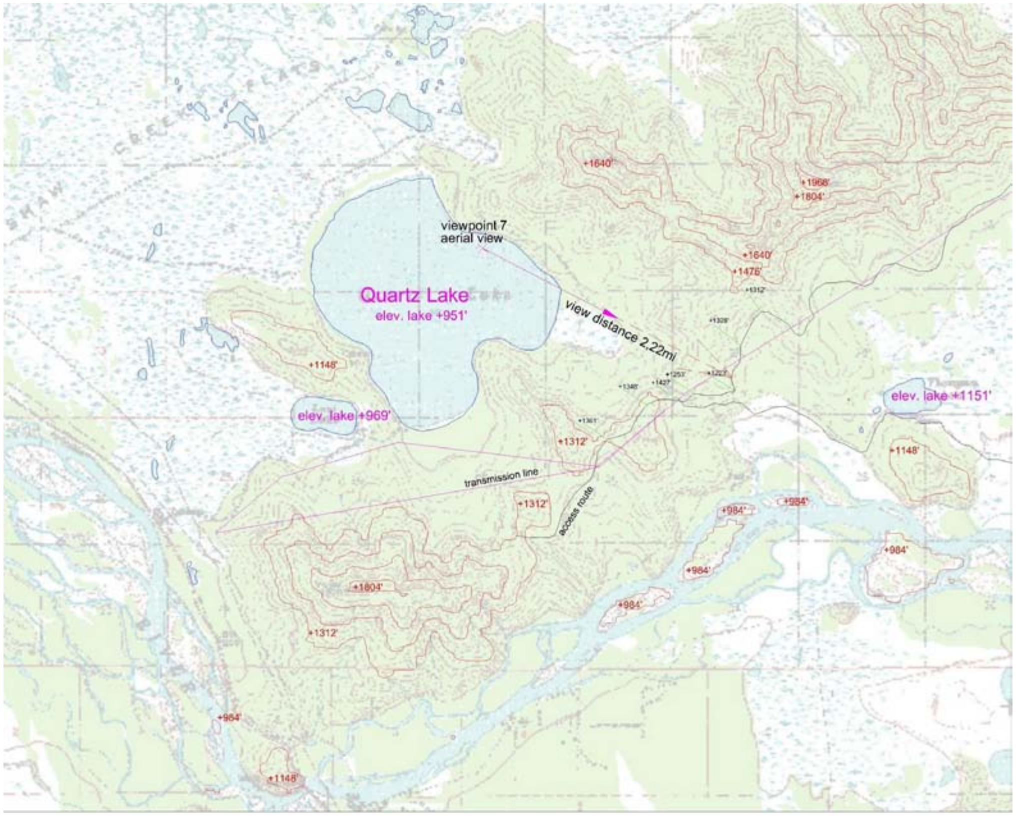


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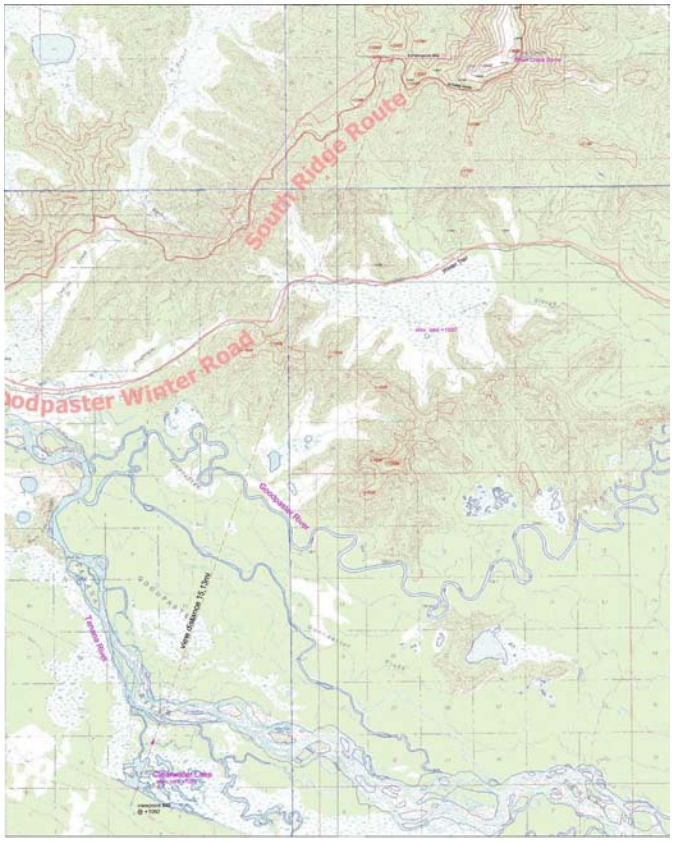
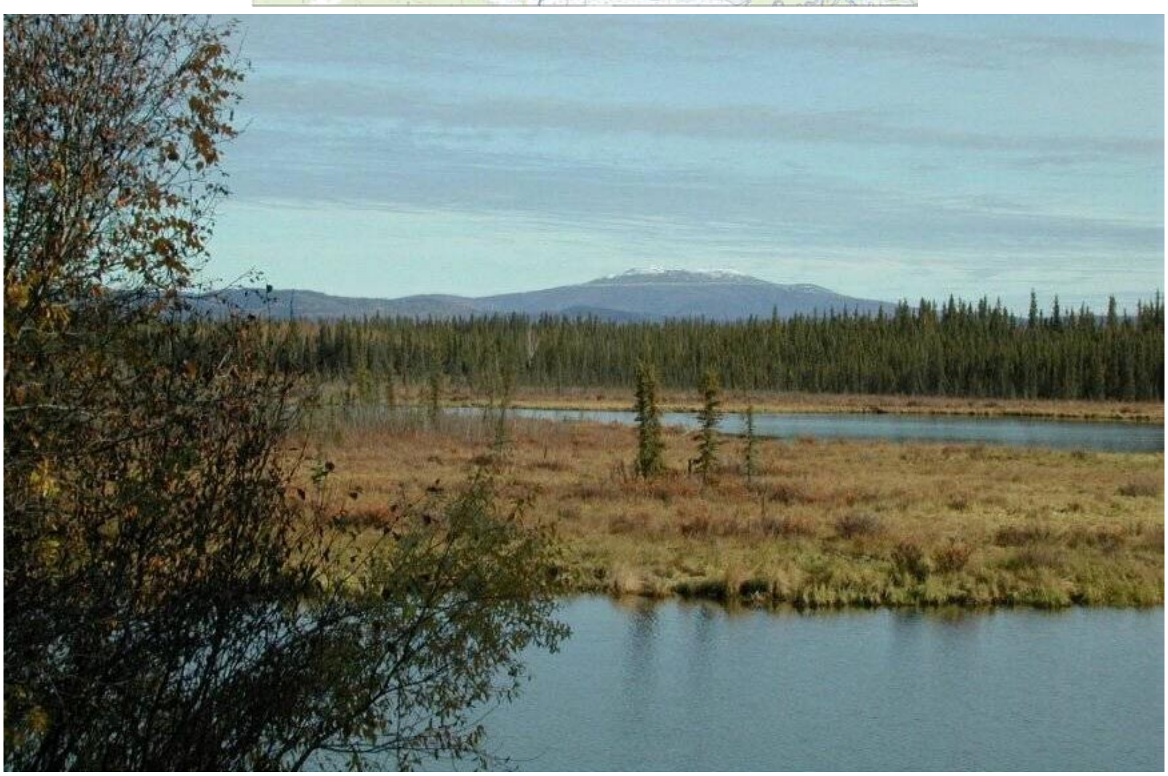
**Figure 4.15-8 View of South Ridge Access and Power Line Routes from Clearwater Creek Recreation Area**



M. R. Stearns Planning + Design LLC

## Alternative 4

### Surface Access

#### *Route*

- The Shaw Creek Flats winter-only access route is located in an area with middle-ground and background views, high concern levels, moderate scenic class, and very high scenic integrity. The route across Shaw Creek Flats would not be visible from the Richardson Highway because of the low elevation of the flats and its high VAC.

  Overall, the road would have low impacts on scenic resources because of the high VAC of the Shaw Creek Flats and Hillside areas. Additional vegetative buffers/screens along the Richardson Highway corridor could mitigate any potential visual impacts.

***Use*** Use of the winter-only access route by users other than the Pogo project would have low impacts on existing visual resources and scenic integrity because of the nature of a winter road/trail and its limited window of operations compared to the all-season road options in Alternatives 2 and 3.

***Disposition*** Impacts for the all-season road segment would be the same as for Alternative 2. The winter-only access segment simply would not be used again for project purposes and would be available for use by anyone, much as a majority of the route is today.

## 4.15.5 Cumulative Impacts

- All-season Road Reclaimed Removal and reclamation of the all-season road would result in a slow restoration process as vegetation reclaimed the corridor over time, and there would be no or low cumulative visual impacts.

- All-season Road Maintained Components of the Pogo Mine project would contribute cumulatively to the visual resource impacts discussed above under the No Action Alternative.

  A hypothetical Sonora Creek Mine, within the Pogo claim block, and Slate Creek Mine, 25 miles northeast of Pogo in the upper Goodpaster drainage, would cumulatively contribute to impacts on existing scenic resources because of the clearing of natural vegetation for related surface and air access, power, and other mine-related facilities. Cumulative impacts from extension of the life of the Pogo project itself would be relatively small because of the impacts that would already have occurred in the mine vicinity.

  Road and power corridors to Pogo would provide the necessary infrastructure for the Sonora Creek Mine, and likely would provide a major portion of the infrastructure for the Slate Creek Mine, thus increasing potential industrial and commercial activities in these corridors.

  Such activities would have cumulative impacts on visual resources. A road extension from the Pogo mill to a hypothetical Sonora Creek Mine would be minimally visible from the Goodpaster River, and would not cause high visual impacts for river users. Because of its relatively short length and location close to the substantial Pogo infrastructure, it also would not cause a high visual impact to airborne viewers.

If a road were extended from Pogo up the Goodpaster Valley to a hypothetical Slate Creek Mine, however, the road extension could have a high visual impact to floaters on the river, as well as airborne viewers, in the context of the upper Goodpaster Valley.

Mine site facilities at both hypothetical mines would be in locations with low VACs because of steep slopes, lack of vegetation, and surrounding elevations. These mining facilities would contribute cumulatively to visual contrast in areas where existing natural vegetation is predominant. In the case of a Sonora Creek mine, these visual impacts would be high only to ground viewers within the context of the Sonora Creek drainage, but would not be high in a larger context to airborne viewers because of the proximity of the mine to the substantial Pogo infrastructure.

For a hypothetical Slate Creek Mine, visual impacts from mine site facilities would be high to ground viewers within the context of the Slate Creek drainage. In conjunction with a road up the Goodpaster Valley, these facilities would cause high visual impacts for airborne viewers within the context of the upper Goodpaster Valley.

## 4.16 Recreation

Severity of impacts with respect to recreation were considered in the context of whether the physical setting, social conditions, or available recreational activities and use areas (ROS classification) would be substantially affected by any components of the project.

Based on the ROS inventory data in Chapter 3 (Figure 3.17-5), some project options would cause changes to the existing physical setting and social conditions. While some changes would be small, some could be considered major by both existing and new recreational users.

Figure 4.16-1 combines existing recreation use areas, ROS classes, and Alternatives 2, 3, and 4 to display changes in ROS classes from those shown in Figure 3.17-5. If the physical setting, social conditions, or available recreation activities in the study area would be substantially affected by an alternative, the ROS class, and therefore recreational experience, would change accordingly (USFS, 1998).

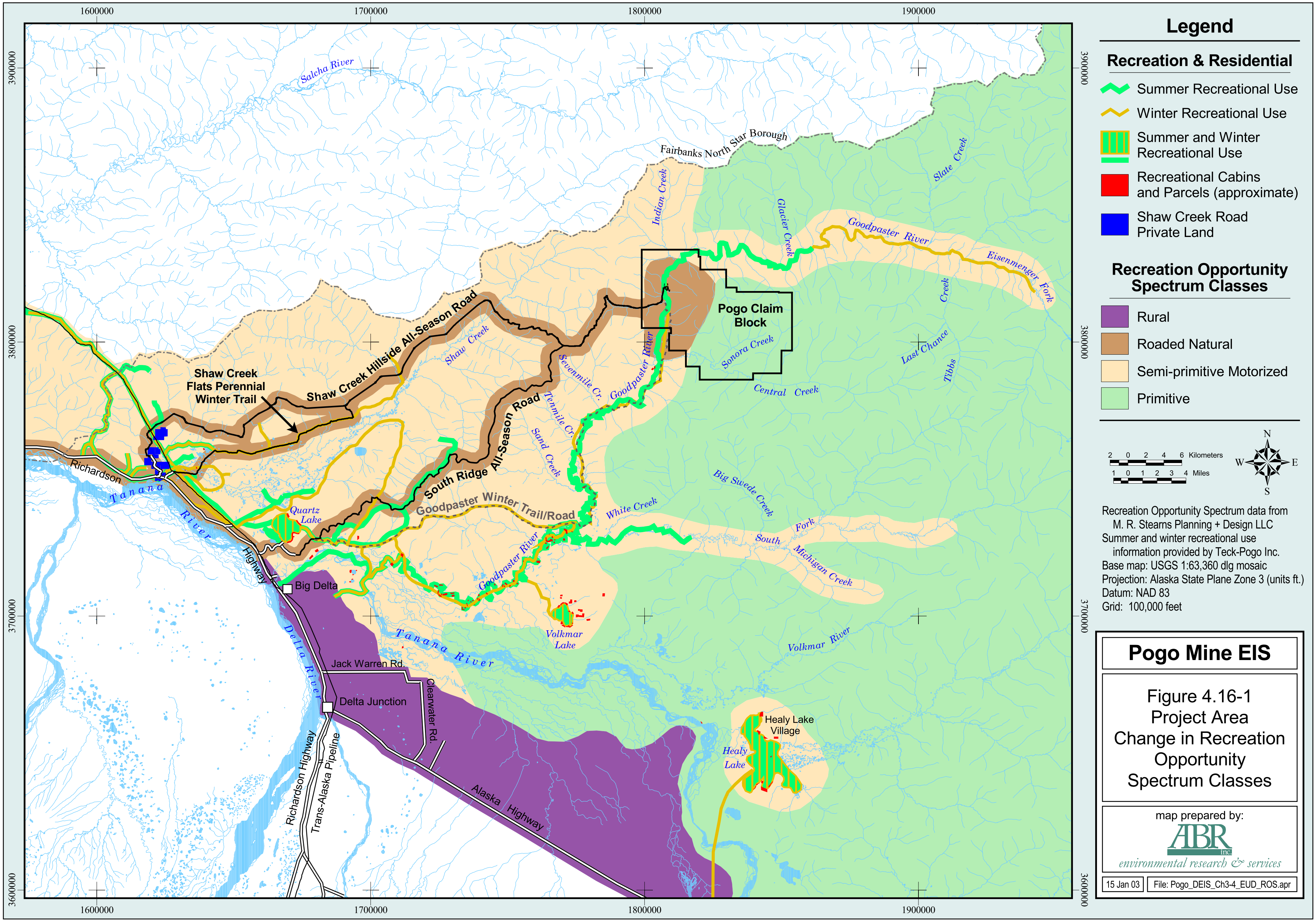
The introduction of new modes of access to the Pogo Mine project area would change the physical and social settings, as well as recreational activities and use areas, if the new access modes were made available to recreational users.

### 4.16.1 No Action Alternative

Scoping comments indicated the project area has a high value in terms of recreational resources. Recreation use likely would continue to increase, especially in areas already accessible to user groups.

The additional workforce in the Delta area, required by the NMDS and the proposed natural gas pipeline, would have a low impact on the existing recreational opportunities, recreation use areas, and recreation activities of the area.

Private residential land sales supporting the larger population would increase as a result of the NMDS, affecting some existing semi-primitive motorized ROS classes, especially those located near the Richardson and Alaska highways.



Legend
Recreation & Residential
Summer Recreational Use
Winter Recreational Use
Summer and Winter Recreational Use
Recreational Cabins and Parcels (approximate)
Shaw Creek Road Private Land
Recreation Opportunity Spectrum Classes
Rural
Roaded Natural
Semi-primitive Motorized
Primitive
Kilometers
Miles
N
E
S
W
Recreation Opportunity Spectrum data from M. R. Stearns Planning + Design LLC
Summer and winter recreational use information provided by Teck-Pogo Inc.
Base map: USGS 1:63,360 dlg mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 100,000 feet
Pogo Mine EIS
Figure 4.16-1
Project Area
Change in Recreation Opportunity Spectrum Classes
map prepared by:
ABR Inc.
environmental research & services
15 Jan 03
File: Pogo_DEIS_Ch3-4_EUD_ROS.apr
1600000
1700000
1800000
1900000
3900000
3800000
3700000
3600000
Salcha River
Fairbanks North Star Borough
Indian Creek
Glacier Creek
Slate Creek
Goodpaster River
Eisenmenger Fork
Creek
Pogo Claim Block
Sonora Creek
Last Chance
Tibbs
Central Creek
Shaw Creek
Shaw Creek Hillside All-Season Road
Shaw Creek Flats Perennial Winter Trail
Sevenmile Cr.
Tenmile Cr.
Sand Creek
South Ridge All-Season Road
Goodpaster Winter Trail/Road
White Creek
Big Swede Creek
South Fork
Michigan Creek
Richardson
Tanana River
Quartz Lake
Highway
Big Delta
Delta River
Volkmar Lake
Volkmar River
Jack Warren Rd.
Delta Junction
Clearwater Rd.
Healy Lake Village
Healy Lake
Alaska Highway
Richardson Highway
Trans-Alaska Pipeline

The DOF's 5-year timber harvesting plan would construct all-season road corridors in areas that are currently primarily primitive ROS class. This would open up areas in the Shaw Creek drainage to recreational users and affect its ROS class. Existing ROS classes would change from primitive and semi-primitive motorized to roaded natural and semi-primitive motorized. Because these roads would be open for public use, recreational access would be greater and easier. This increased access would have a high impact to existing recreational users in the vicinity of the forestry road, but would have a substantial positive benefit to prospective recreational users.

Overall, recreational impacts from the No Action Alternative would be low, except for areas accessed by the planned DOF forestry roads where recreational use would increase substantially.

## 4.16.2 Options Common to All Alternatives

The airstrip would be located in the semi-primitive motorized ROS class. If the airstrip were open to everyone during mine operations, and were to remain open after mine closure, it would be a substantial benefit to prospective recreational users, particularly to those desiring to hunt, fish, or float the Goodpaster River. Availability of an airstrip would have a low effect on existing recreational users of the mine area because there is currently little recreational use. Recreational cabin owners on the lower Goodpaster River, however, could be affected moderately by floaters and fishers who would float into the lower river past these cabins. Increased river use would alter their present isolation and could cause changes in fishing bag and size limits, as well as an increase in littering and vandalism.

## 4.16.3 Options Not Related to Surface Access

### Alternative 2

#### Power Supply

- Power line A power line route would be located in roaded natural, semi-primitive motorized, and primitive ROS classes. The cleared power line ROW would provide a benefit of backcountry access for new motorized and nonmotorized recreational users, depending to what extent mitigation measures were implemented to limit access. This increased access, however, would have a high impact on existing recreational users. Mitigation measures would be used to limit ATV access along the power line ROW.

### Alternative 3

#### Power Supply

- Power line Same as Alternative 2.

### Alternative 4

#### Power Supply

- On-site generation The mine site would be located in the semi-primitive motorized and primitive ROS classes. On-site power generation would cause a small increase in noise and other activity levels in the vicinity of the mine and access route due to the generators and the additional fuel transportation requirements. This disturbance would have a low to moderate impact on primitive and semi-primitive motorized ROS classes.

## 4.16.4 Options Related to Surface Access

The existing ROS classes of the Shaw Creek Hillside route, the South Ridge route, and the Shaw Creek Flats winter-only access route are roaded natural, semi-primitive motorized, and primitive.

The changes to the ROS classes in the vicinity of the project would vary depending on the use of the road access (Pogo project only versus everyone) and the disposition of the road at the end of the Pogo project (reclaimed versus open for everyone).

For purposes of this analysis, Figure 4.16-1 illustrates the changes in ROS classes for Alternatives 2, 3, and 4 that unrestricted all-season road or winter-only access would produce.

### Alternative 2

#### Surface Access

***Use and Disposition*** Opening the Shaw Creek Hillside road just for the Pogo project or allowing only Pogo and other commercial/industrial users and then removing and reclaiming the road at the end of the Pogo project would have low impacts on existing recreational users, many of whom do not want an improved road (Ridder, 2002). Availability of the road would, however, have a high impact on prospective motorized recreational users. The cleared road and power line ROWs still could be available for motorized and nonmotorized recreational access for some time, however, even if they were removed and reclaimed.

Permanent access with the use of the Shaw Creek Hillside all-season road open to everyone could have a high impact on existing recreational users desiring remote and primitive recreational experiences because interactions with other recreational users would be greater due to increased access. A particular example would be the recreational cabin owners on the lower Goodpaster River. If the public were able to drive to the Goodpaster River Bridge near the mine site, it could become a popular launching site for floaters and fishers and bring them into the lower river and past these cabins. This river use could change the current relative isolation of the cabins, and could cause changes in fishing bag and size limits, and an increase in littering and vandalism.

If the Shaw Creek Hillside road were open to everyone during mine operations and after Pogo Mine closure, the primitive and semi-primitive areas traversed by the Shaw Creek Hillside route would change ROS class to roaded natural. Some areas adjacent to the Shaw Creek Hillside route in the valleys would change from primitive to semi-primitive motorized because these areas would now be accessible to a greater number of motorized recreational users.

- Richardson Highway egress The Shaw Creek/Rosa Richardson Highway egress option would have low recreation impacts to existing or prospective recreational users because Shaw Creek Road already exists. In a similar manner, the Tenderfoot egress option would have low recreation impacts on existing or prospective recreational users because this area already contains roads and trails, including a forestry road from the Richardson Highway and ATV trails beyond Rosa Creek.

- Security gate at Gilles Creek If the road were open for everyone, but with a security gate at Gilles Creek, the same impacts described above for road use by everyone would occur, but only in the lower two-thirds of Shaw Creek Valley.

Impacts to Goodpaster recreational cabin owners and other existing recreational users north of Gilles Creek would not occur. Potential recreational users, however, would not receive the benefits of easy access to the mid-Goodpaster River.

**Alternative 3**

### Surface Access

***Use and Disposition*** Impacts from the South Ridge all-season road would be the same as for Alternative 2, except the ROS class changes from primitive and semi-primitive to roaded natural would occur to areas traversed along the South Ridge route. In the same manner as for Alternative 2, areas adjacent to the South Ridge route, including higher elevations, would change from primitive to semi-primitive motorized because these areas would be accessible to a greater number of motorized recreational users.

Permanent all-season road access along this route could have slightly more impacts on the owners of Goodpaster Valley recreational cabins because parts of the access road would be visible from the cabins.

**Alternative 4**

### Surface Access

***Use and Disposition*** The changes to ROS classes would be the same as for Alternatives 2 and 3, except the changes would be seasonal. Because the specific purpose of the winter-only access option would be to limit public access to the Shaw Creek and Goodpaster valleys, it would not be open for public use.

Use of the winter-only access route by Pogo-related traffic or other industrial or commercial users would lower the quality of existing nonmotorized recreational experiences, but this impact would be limited to the area of the road corridor. Because this alternative would reduce the number of new recreational motorized vehicles, it would not affect traditional recreational experiences in the primitive and semi-primitive areas as much. Snow machines still would use traditional routes to access these areas, however.

There would be few impacts on the recreational cabin owners on the lower Goodpaster River because the Goodpaster River Bridge at the mine site would not be accessible to floaters and fishers, as would occur with a publicly accessible all-season road in Alternatives 2 and 3.

Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, as the DOF road, which would be open to the public, was extended toward Gilles Creek, recreational impacts from public use would begin to approach those described for Alternative 2.

## 4.16.5 Cumulative Impacts

- All-season Road Reclaimed Although removal and reclamation of the all-season road would result in a definite impact on new recreational users because access would be reduced, there would be no cumulative impacts.

- All-season Road Maintained Pogo mining activities, as well as the potential for extending the life of the Pogo project and the hypothetical Sonora Creek and Slate Creek mines, would substantially affect ROS classes in these areas. Primitive and semi-primitive motorized ROS classes would change to semi-primitive motorized and roaded natural.

If the road were open to public use, recreational access would increase and be easier as far as the headwaters of the Goodpaster River. Thus, if construction of an all-season road to Pogo were to occur and cause additional mines or other developments farther up the Goodpaster Valley, and if the road were open to public use, it could have a high cumulative recreational impact on existing recreational users as well as a high beneficial cumulative recreational benefit to prospective recreational users.

# 4.17 Safety

In this section, safety impacts are discussed in the context of workers as well as members of the public who could come into contact with project-related activities such as a winter or all-season road. Safety issues related to workers in the mine and mill and at other project facilities are not considered because they would be covered by specific MSHA regulations that are beyond the scope of this EIS.

## 4.17.1 No Action Alternative

Under this alternative, the DOF would construct all-season road access from the end of the existing Shaw Creek Road to three timber sales in the Fowler Creek and Keystone Bluffs areas. The number of log truck round trips per day on Shaw Creek Road would depend on the number of years it would take to harvest a particular sale. If only one sale area were being harvested actively, there would be an estimated two or three round trips per day. If all were being harvested simultaneously, there would be an estimated eight round trips per day.

Overall, safety impacts from the No Action Alternative would be low.

## 4.17.2 Options Common to All Alternatives

Increased traffic on the Richardson Highway would have negligible safety impacts; however, additional signing and possibly construction of turning lanes or lighting at the junction of the access road with the Richardson Highway might be necessary.

## 4.17.3 Options Not Related to Surface Access

No safety impacts were identified for the options not related to access.

## 4.17.4 Options Related to Surface Access

### Alternative 2

**Surface Access**

***Route***

- Richardson Highway egress Use of the existing Shaw Creek Road as initial access to the Shaw Creek Hillside all-season road would cause some safety risk to residents of the six year-round residences accessed from the road. After the Shaw Creek Hillside all-season road was built, during intense periods of mine construction, traffic would average approximately 50 vehicles per day, roughly evenly split between semi-tractor trailers and light vehicles.

  During mine operations, there would be an estimated average of 10 to 20 mine-related vehicle round-trips per day on Shaw Creek Road, excluding shift change-related traffic. Depending on the project's particular needs, the number of trucks and other vehicles on a given day could be substantially higher than the average; on other days there might be few or no trucks or other vehicles.

If the Applicant's shift-change bus station were located near the TAPS crossing, there would be two, approximately one-hour periods every 4 days, during each of which up to 180 vehicles would traverse the road. If the bus station were located on the Richardson Highway, the number of vehicles during each of these periods would be reduced to approximately six buses. The former location option would have a higher safety risk along Shaw Creek Road than would the latter location.

Shaw Creek Road is relatively narrow at present, but is well maintained and has been improved recently. The State of Alaska has reviewed expected traffic volumes and vehicle sizes, including logging truck traffic from proposed DOF timber sales and shift change traffic, and believes Shaw Creek Road can accommodate this traffic safely. DOT/PF may have to conduct a traffic impacts analysis, in conjunction with issuance of a drive way permit, which may result in specific mitigation measures being required. Because the road could be upgraded in the future if necessary, speed limits could be adjusted if appropriate, and the Applicant's policy would be to adhere to all speed limits, the safety risk from Pogo-related traffic would be low.

If the Tenderfoot egress option were selected, the Shaw Creek Road safety issue would not be relevant. The Tenderfoot route, however, would require switchbacks that would introduce a different safety issue for that option.

If the all-season road were open to everyone during mine operations, and the existing Shaw Creek Road were used, a small increase in the same issue of safety risk to residents identified above would occur. The increased risk would be due to more traffic (public and logging operations), and because typical users likely would not be as observant of speed limits as would drivers under specific direction from the Applicant. The safety risk, while increased, would still be low. If the all-season road were to remain open to everyone after mine closure, this low risk would continue. These impacts could be mitigated by ADOT/PF traffic management measures on both existing Shaw Creek Road and the all-season road.

- Security gate at Gilles Creek  If the road were closed to public use with a security gate near the end of the existing Shaw Creek Road, public use of the existing Shaw Creek Road would be restricted and impacts to residences would be low. If the all-season road were completely open to public use, traffic on Shaw Creek Road would increase substantially compared to that at present, and impacts would be increased. A security gate at Gilles Creek likely would reduce public use measurably because it would prevent access to the last half of the road, but traffic still would be considerably higher than if the security gate were located near the end of Shaw Creek Road. Safety impacts, however, still would be low.

## Alternative 3

### Surface Access

#### *Route*

- South Ridge all-season road  This alternative would have the same volume of Pogo-related traffic as Alternative 2. The safety-related issue would pertain to the approximately 2.1 miles of the Quartz Lake access road that would be shared with traffic generated by Quartz Lake cabin owners, fishers, boaters, snowmachiners, and other recreationists. This current traffic level is higher than that on Shaw Creek Road. In a manner similar to that described for Alternative 2, before the Pogo project would be able to use the Quartz Lake access road, the State of Alaska would review existing conditions and determine whether the road needed to be widened or otherwise upgraded based on its design criteria and the expected traffic volume and size of the vehicles, including expected logging truck traffic from proposed DOF timber sales. Although the road is currently somewhat narrow, because it would be upgraded if necessary, is well maintained, has been recently improved, and because the Applicant's policy would be to adhere to all speed limits, the safety risk would be low.

In winter, this route would subject traffic to higher winds, drifting snow, and poorer visibility than would the Shaw Creek Hillside all-season route because of its considerably longer segment above timber line.

### Alternative 4

#### Surface Access

##### *Route*

- Shaw Creek Flats winter-only access Use of winter-only access would require movement of large volumes of supplies during a relatively short window under very cold and dark conditions that would be more likely to cause accidents. While similar work is done elsewhere in Alaska under these conditions, and the safety risk would be low, it would be a tangible risk and a higher one than that associated with an all-season road.

  If winter-only access were open to everyone, there would be a moderate safety risk. Maintaining traffic control under these conditions just for project trucks would be a challenge. If other users were to be on the road/trail at the same time, the chances of an accident, particularly with a snow machine, would be substantially higher. During the movement of supplies to the Pogo Mine site over the Goodpaster Winter Trail in 1997-1998, the Applicant had to have smaller warning vehicles at both ends of each convoy on this public trail to intercept other users.

## 4.17.5 Cumulative Impacts

- All-season Road Reclaimed Removal and reclamation of the all-season road would have no cumulative safety impacts.

- All-season Road Maintained If the Shaw Creek Road option for egress from the Richardson Highway were used, and the mine access road were open for use by everyone, there could be a cumulative safety impact on residences along Shaw Creek Road from public use and timber harvest-related traffic in addition to use by the Pogo project. If this status were maintained after mine closure, cumulative safety impacts likely could increase if other major developments, such as the hypothetical Sonora Creek and Slate Creek mines, were to occur and public use intensify. These impacts could be mitigated by ADOT/PF traffic management measures on both existing Shaw Creek Road and the all-season road.

# 4.18 Technical and Economic Feasibility

Technical and economic feasibility impacts are discussed in this section in the context of whether they could be a major factor in the Applicant's decision about whether to construct the project, and whether they could serve as substantial economic impediments to long-term project stability. Although most options for a particular component had technical and economic advantages and disadvantages for the Applicant, few were considered different enough to warrant discussion.

## 4.18.1 No Action Alternative

This alternative is not applicable for the technical and economic feasibility criteria.

## 4.18.2 Options Common to All Alternatives

### Gravel Source

Gravel is on the critical path for project construction. It would be needed for two purposes immediately at the start of development; for concrete aggregate for the civil works' foundations in the mine area (water treatment plant, mill, camp, and shop facilities), and as a road topping for mine area roads. Crushing development rock for gravel at this early stage would not be an option. Most of the nonmineralized rock that would be generated from underground would not be available until later in the two-year project development period. Underground mine development must follow completion of the appropriate surface facilities described above. Advancing underground development before beginning the surface civil works isn't possible because you cannot treat mine water without a new water treatment plant, and you cannot have underground development without a shop to maintain the equipment. Thus, from a timing perspective, crushing development rock to make gravel would not be feasible or practicable.

From another perspective, experience during the Pogo Mine exploration phase has demonstrated that underground development rock does not make a good traffic surface for high volume roads (Hanneman, 2003e). At the existing advanced exploration facilities, gravel has been used to top the surface of the high volume roads because the development rock breaks down under traffic loads and becomes mud. Thus, from a technical perspective, crushing development rock to make gravel would not be feasible or practicable. Also, a gravel road topping has helped to reduce sedimentation both on the surface and underground, where reduced sedimentation in the mine sumps has been an important factor in water treatment plant efficiency.

Another need for gravel may arise for topping portions of the mine access road. Test work at potential material sites along the proposed Shaw Creek Hillside road alignment has shown the rock in most of the proposed material sites does not conform to Alaska test method (ATM) T-13 degradation, or to Los Angeles Abrasion American Society for Testing and Materials (ASTM) C131-96 specification for coarse abrasion testing of coarse rock (Shannon and Wilson, Inc., 1999, 2000). Thus, while the rock from these sites would still be suitable for bulk fill, topping material with sufficient hardness for the road surface would have to be hauled long distances from select material sites. Two of the material sites may contain rock suitable for crushing and use for road topping, and it would be advantageous in some areas for the Applicant to do so rather than haul gravel from the vicinity of the mine. Some of the gravel from the mine area sites, however, could be used for access road topping.

Even if nonmineralized development rock were suitable for crushing, which it is not, the direct cost to produce approximately 140,000 cu yd of aggregate for use in the mine area would be approximately three to four times greater than mining pit run gravel by expanding existing borrow pits and developing new ones as proposed by the Applicant. A reasonable cost estimate for pit run gravel at the Pogo site is approximately $4 per cu yd. Thus, crushed development rock would cost between approximately $1.1 million and $1.7 million more than mined gravel (Rowley, 2002a).

## 4.18.3 Options Not Related to Surface Access

### Tailings Facility Liner

**Dry-stack tailings pile** Permeabilities of the fine-grained dry-stack tailings themselves were not considered to be greatly different than permeabilities of an installed liner system. Also, most seepage that would occur from the dry stack would be captured by the RTP. Still, from strictly a water quality perspective, a lined tailings facility likely would provide some measure of increased impermeability and transmission of drainage to the RTP. From a tailings pile stability perspective, however, a liner would be more problematic.

The original dry-stack tailings pile stability analysis assumed a worst case scenario that included saturation of the general tailings placement zone. It did not include saturation of the shell zone. Placement of an impermeable liner beneath the general placement zone likely would cause saturation of the tailings pile and result in occurrence of the worst case scenario, which was not the design intent. Thus, saturation caused by the impervious liner likely would increase stability risk. Overall, there would be little benefit to water quality from installation of a liner under the dry-stack tailings pile, while there would be increased risk to stability from the liner.

Installation of an erosion control/drainage blanket before tailings would be placed in the dry-stack tailings facility was predicted to have no effect on the dry stack's stability, but it would permit clearing and stockpiling of organic and soil growth media to insure a sufficient volume for reclamation.

**RTP** The primary purpose of the RTP would be to capture runoff and seepage from the dry-stack tailings facility consistently, reliably, thoroughly, and predictably, during both mine operations and post closure activities.

Seepage from the dry stack would migrate downgradient below the surface, nearer the colluvium/weathered bedrock interface. An effective seepage interception and collection system would be needed to provide appropriate management of this subsurface flow. Given the nature of the flow system that would develop, the most effective interception system would be one perpendicular to the direction of subsurface flow, i.e., a cutoff wall.

The proposed RTP dam face liner system and grout curtain would establish an effective interception cutoff wall to collect this seepage. The upstream toe of the dam face liner system would be embedded in a trench in weathered bedrock filled with grout, with a drilled curtain of pressure-grouted holes extending below the toe through the weathered bedrock layer and into fresh bedrock.

A full liner under the RTP basin would not provide substantially better long term seepage collection and would introduce increased operational and performance risks for a number of reasons, including:

- A full basin liner would fail to collect the seepage at issue because the upstream toe of the liner would not have the robust cutoff wall required to collect the subsurface seepage. If such a cutoff wall at the upgradient end of the liner were required, it would follow that another liner upstream of that cutoff wall also would be needed, etc. It is thus a cutoff wall perpendicular to the flow that would be needed to capture seepage, not a liner.

- Due to the narrowness of Liese Creek Valley, and its steep slopes, hydrostatic uplifting forces from upwelling ground water beneath the liner could result in long-term liner instability, especially during periods when the RTP reservoir would be drawn down to provide storm surge volume.
- The nature of Liese Creek Valley geometry is such that a large portion of any full basin liner would be on very steep slopes. The south slopes of the reservoir exceed the maximum slopes recommended for effective liner installation (2.2 to 2.5 H to 1 V).

A full basin liner thus would not completely capture the desired seepage and provide the long-term reliability necessary to manage dry-stack seepage. From the economic perspective, if a liner were feasible, a very rough estimate for the cost of a full basin liner under the RPT is approximately $1.5 million.

## 4.18.4 Options Related to Surface Access

**Alternative 2**

### Surface Access

***Route***

- Richardson Highway egress The Tenderfoot Richardson Highway egress option would require construction of an essentially new, approximately 3.5-mile road to the vicinity of the end of the existing Shaw Creek Road.

  Although constructible, the route would cross difficult terrain, with poor soils and likely permafrost. Deep incised gullies indicate loess deposits that would require deep side hill cuts. Ascent and decent segments would require 5 to 7 percent grades for approximately 1.5 miles on each side of the ridge. Switchbacks would be required, with several curves having a radius less than the design criterion for 500 ft, and possibly less than the minimum of 300 ft.

  No detailed estimate of the cost of constructing this road has been made, but a reasonable construction cost estimate would be between approximately $2.5 million and $3.0 million (Rowley, 2002b). This expense would be a substantial additional cost to be borne by the project to avoid using the existing public Shaw Creek Road.

**Alternative 3**

### Surface Access

***Route***

- South Ridge all-season road Soil and topography conditions along the first several miles of this route are difficult. They are characterized by steep slopes, many small drainages, and probable ice-rich soils, compared with good terrain and soil conditions on the Shaw Creek Hillside route. The steep slopes and angular talus in the vicinity of Shaw Creek Dome along the South Ridge route likely would make construction difficult. The elevated and exposed terrain and severe winds experienced in the Delta region would make maintenance more difficult and driving more hazardous, especially in blowing snow conditions. This route would be expected to be available for use approximately 10 fewer days than would the Shaw Creek Hillside route.

## Alternative 4

### Surface Access

#### *Route*

- The Shaw Creek Flats winter-only access option is technically feasible in that an annual winter road/trail could be constructed between the Richardson Highway and an all-season road beginning in the vicinity of Gilles Creek. The major technical concern is whether such winter-only access would be useable for an adequate period of time so that the Applicant would be able to transport all the required supplies to the mine site each year. An analysis of the winter-only access option showed that to maximize the annual window of use, the perennial winter trail option was more favorable than a traditional winter road because the former could be constructed more quickly, lengthening the use window by up to 2 weeks (Metz, 2001a, 2001b). The perennial winter trail, therefore, would have fewer economic feasibility impacts than a traditional winter road because it would increase the probability of success for the annual winter resupply effort by up to 25 percent over a traditional winter road.

  From an economic feasibility perspective, a winter-only access option is more problematic. Constructing, operating, and reclaiming a remote mine dependent on only 8 to 10 weeks of annual surface access for major resupply, with reliance of air support into a 3,000-ft airstrip for the remainder of the year, raises many economic feasibility issues. These include (Teck-Pogo Inc., 2001c; Metz, 2002; Puchner, 2002):

  - There would be only a short window for mobilization of construction equipment and supplies for the development phase, including construction of the all-season road segment.
  - Annual resupply of almost a year's worth of fuel, equipment, and materials would have to occur during an 8- to 10-week window. For almost 10 months of the year, the project would be dependent solely on air support, which would be susceptible to weather interruptions and capacity constraints.
  - Capital costs for access were estimated to be approximately 53 percent higher. Storage for a year's worth of diesel, propane, cement, reagents, and other materials would have to be constructed and maintained at the mine site. There also would be costs for a cement storage facility at a Fairbanks bagging plant and a staging area near the winter trailhead. Power line construction would be more expensive because there would be 15 fewer miles of adjacent road. During construction, there would be additional costs such as air support for personnel, fuel, food, and supplies; equipment standby rental while waiting for demobilization the next winter; and extended project and contractor overheads.
  - Total annualized operating costs were estimated to be approximately 118 percent higher. Freight was estimated to cost approximately 60 percent more per ton with winter-only access. Personnel air transportation costs would be very substantial. There would be additional rental costs for idled shipping containers awaiting the next winter's resupply window. Cement would have to be bagged for shipment, rather than handled in bulk. And, there would be finance costs for the stored inventory. Power line maintenance would be more costly.

An additional concern is whether winter-only access could successfully resupply the mine site on an annual basis. The Applicant's study indicated that winter-only access might not be available in 1 out of 13 years. Metz (2002) indicated the Applicant's study may be optimistic in light of the continued warming trend for central Alaska documented by Osterkamp and Romanovsky (1999). The Applicant's study did not include data from the winters of 2000-2001 and 2001-2002, and does not account for the long-term climate warming indicated in weather records for Big Delta (USDI/Bureau of Land Management, 2002). The mean annual air temperature for Big Delta has steadily increased since 1977. Most of the warming is a result of warmer, milder winters in central Alaska. Metz concluded that the actual frequency of conditions allowing for an adequate winter-only access window may be even lower than indicated in the Applicant's study.

In final analysis, the decision to proceed with a project is based on the probability that investors assign to its economic feasibility and the risk that assumptions will change. Anything that cannot be controlled increases risk. Because factors such as the price of gold and the cost of borrowing already are outside the control of potential investors, minimizing other project risks becomes very important. While each individual aspect of a winter-only access option arguably may be technically and economically feasible, the option must be viewed as a whole. If some factor outside the Applicant's control (short, warm winter with little snow; flooded airstrip; forest fire; or major equipment breakdown unable to be replaced by airlift) caused just one aspect of that option to fail, it could have serious economic consequences for the project. This susceptibility to factors that could affect economic stability greatly concerns investors because roadless isolation of the mine site would provide very little backup safety margin.

Thus, winter-only access would add capital and operating costs, increase the project's economic burden, and introduce an unreasonable level of complexity and business risk. The increased economic burden and unreasonable business risk were considered to have a major impact on the economic feasibility of the project.

### 4.18.5 Cumulative Impacts

Cumulative impacts are not applicable for the technical and economic feasibility criteria.

## 4.19 Cumulative Impacts

### 4.19.1 Tabular Summary of Cumulative Impacts

As defined earlier, cumulative impacts result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonable foreseeable future actions, regardless of what government agency or private entity undertakes such actions. Cumulative impacts can result from individually minor impacts that, when viewed collectively over space or time, can produce significant impacts.

Examination of the cumulative impacts identified in the individual resource sections earlier in this chapter showed that the overwhelming factor determining cumulative impacts was whether the all-season access road would be removed and reclaimed at Pogo Mine closure or would be maintained for other resource development purposes and/or for public use. This factor applied not only to Alternatives 2 and 3, which contain a complete all-season road by definition, but also to Alternative 4 with its winter-only access option. Applicability to all three action alternatives results because it would be highly likely that, by the time of Pogo Mine closure, the planned

DOF road would have been constructed to the point that it would connect to the all-season road segment of the winter-only access option and be effectively operated like the complete all-season road options for Alternatives 2 and 3. Thus, the critical issue affecting cumulative impacts was not a choice of which alternative; rather, it was a management issue. That is, at Pogo Mine closure, would the road be removed and reclaimed, or would it be left in place for other resource development purposes and for public use?

Therefore, rather than present a summary of cumulative impacts on an alternative basis, Table 4.19-1 summarizes the impacts from a resource-by-resource perspective on the basis of whether the all-season access road would be removed and reclaimed at Pogo Mine closure or maintained for other resource development purposes and public use.

**Table 4.19-1 Summary of Cumulative Impacts**

| All Season Road Removed and Reclaimed at Mine Closure | All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use |
|---|---|
| **4.1 Surface Water Hydrology** | |
| Absence of an all-season road would limit other resource development activities and human use, and would result in very low cumulative impacts on hydrologic flow regimes of surface water. | Development of timber resources, mining, and public recreational and other uses all would have potential impacts on the surface water hydrologic regime that could be cumulative with the activities of the Pogo Mine project. Extension of the life of the Pogo project, development of hypothetical Sonora Creek and Slate Creek mines, or other resource developments occurring because of continued existence of an all-season road, individually would cause surface hydrologic impacts of a nature and magnitude similar to those from the proposed Pogo Mine project. Given their likely physical separation in different watersheds, the State of Alaska's management and regulatory tools, and the individual small impacts to the surface water hydrologic system, these mines and other resource developments would have low cumulative impacts on hydrologic flow regimes of surface water. |
| **4.2 Groundwater Hydrology** | |
| Absence of an all-season road would limit other resource development activities and human use and would result in very low cumulative impacts on ground water. | Cumulative impacts on groundwater resources in the area could result from development associated with timber harvesting, extension of Pogo Mine life, and development of the hypothetical Sonora Creek or Slate Creek mines. Assuming sound management practices and permitting stipulations, and because such development activities would be distributed over such a large area, there would be low cumulative impacts on ground water. |
| **4.3 Water Quality** | |
| Absence of an all-season road would limit other resource development activities and human use, and would result in very low cumulative impacts on water quality. | Cumulative impacts on water quality could result from increased traffic associated with timber harvesting, extension of Pogo Mine life, and development of the hypothetical Sonora Creek or Slate Creek mines. During road extension construction, disturbed surfaces could erode and increase sediment in runoff that could cause increased suspended sediment in waterways. Such increased sediment and turbidity levels would be temporary and could be mitigated by the proper use of BMPs during construction and revegetation. These impacts cumulatively would be small.<br>Additional transport of fuel, chemicals, and ore would increase risk of an accident and subsequent release that could affect water quality. The degree of increased risk would be proportional to the increase in commodity transport. If discharges from the hypothetical mines were similar to those projected from Pogo, slight increases in concentrations of a few parameters could occur, but the differences would be difficult to detect under most flow conditions. Overall, water quality cumulative impacts from maintaining the road would be low. |
| **4.4 Air Quality** | |
| Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts on air quality other than those of fugitive dust associated with road reclamation. | Although there would be minute impacts in the general area of any other developed project as a result of long-range transport of air pollutants, the distances between projects likely would be such that air quality emissions of any one project would not affect the ability of any other projects to be permitted. The permitting processes are used to ensure that cumulative impacts of new as well as existing projects do not result in exceeding the NAAQS and AAAQS standards.<br>The construction and use of new access roads to the hypothetical Sonora Creek and Slate Creek mines |

**Table 4.19-1 Summary of Cumulative Impacts**

| All Season Road Removed and Reclaimed at Mine Closure | All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use |
|---|---|
| | would generate additional fugitive dust during construction and operation of the roads themselves as well as other facilities associated with these hypothetical projects. Fugitive dust also would be generated by an airstrip associated with a new Slate Creek mine. Such fugitive dust impacts would be small and limited to the local area. Overall, air quality cumulative impacts from maintaining the all-season road would be very low. |
| **4.5 Noise** | |
| Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative noise impacts other than those associated with road reclamation. | The primary area for cumulative noise impacts concern would be at the residences located along the existing Shaw Creek Road. With continued all-season road operation, it would be possible that traffic could increase substantially over time from logging, other industrial/commercial developments, and a road be open to the public. For a least one residence on Shaw Creek Road, this cumulative increase could approach a high impact<br>In other areas, noise from road use and scattered developments is not projected to result in any high local long-term noise impacts. There may be times in certain areas, however, when cumulative noise from different sources could result in a substantial, temporary short-term noise level increase. |
| **4.6 Wetlands** | |
| Absence of an all-season road would limit other resource development activities and human access. Cumulative wetland impacts to the time the road was removed would include those from the Pogo project itself, the road to the mine, and off-road ATV use from the road. These impacts would be moderate with the Shaw Creek Hillside all-season road and low with the South Ridge all-season road, in the context of the Shaw and Goodpaster drainages. | Mine developments such as a hypothetical Sonora Creek mine would increase wetland impacts, but the location of the hypothetical mine close to the Pogo project's infrastructure would limit those impacts to an assumed 75 acres. A hypothetical Slate Creek mine accessed by extension of the Pogo all-season road would directly eliminate an assumed additional 200 acres of wetlands, including some of high value in the Goodpaster River Valley. Impacts would be limited through permitting processes.<br>The maintained road would accelerate timber harvests. Although these harvests would focus on uplands, roads would require some wetland crossings, including impacts to valuable slope and riverine wetlands. Effects would be greater with a Shaw Creek Hillside all-season road than with a South Ridge all-season road because more timber harvests likely would occur in the Shaw Creek drainage, which contains more wetlands.<br>An all-season road open to everyone would cause a moderate cumulative impact to wetlands in the Shaw Creek and Goodpaster River drainages. A few hundred acres of wetlands would be eliminated; a few hundred more would be slightly degraded by proximity to commercial and industrial structures and activity; and more would be severely degraded by recreational and subsistence activities, particularly those employing ATVs. While the impacts would affect a small proportion of the wetlands in the Shaw and Goodpaster drainages, the effects would be detectible on the scale of those drainages.<br>Wetland impacts related to residential and commercial land development near the Richardson Highway would continue to be stimulated by ongoing resource extraction and public use activities associated with the road. |
| **4.7 Surface Disturbance** | |
| Not applicable. | Not applicable. |

**Table 4.19-1 Summary of Cumulative Impacts**

| All Season Road Removed and Reclaimed at Mine Closure | All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use |
|---|---|
| **4.8 Fish and Aquatic Habitat** | |
| Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts to fish and aquatic habitat. | Direct and indirect cumulative impacts would occur from extraction of timber and mineral resources, and increased recreational use from access opportunities and population growth. Although impacts could be minimal in any one occurrence, over time these impacts cumulatively would result in habitat loss and smaller, though still viable, fish populations. The brunt of this cumulative impact would fall on recreational users of the Goodpaster River through more restrictive regulations on fish harvest and possibly access.<br>Additional mineral development would increase risks due to land disturbance and upsets from accidents and natural events. A hypothetical Slate Creek mine would involve an additional 25 miles of road on the Goodpaster River Valley floor adjacent to the river. Proper design, construction, and permitting stipulations, as well as State of Alaska management practices, could mitigate such risks. Overall, cumulative impacts would be moderate, and high only locally. |
| **4.9 Wildlife** | |
| Absence of an all-season road would reduce considerably resource development and related direct and indirect cumulative impacts on wildlife, particularly caribou. | Cumulative direct impacts to habitat, birds, and mammals under the TBAP from scattered timber and mining resource developments could be high on a scattered local basis, but would be low in the context of the Shaw Creek and Goodpaster River valleys.<br>If these developments were connected by an all-season road it likely would increase resource development further, which could have a moderate cumulative indirect habitat effect on some wildlife species. A likely effect of increasing mineral exploration and development activity would be harassment of wildlife by aircraft, both intentional as well as unintentional, particularly by low-flying helicopters. In combination with general, nonmineral-related aviation, and the USAF's aerial combat training, these activities could substantially increase cumulative impacts on caribou. Of particular concern would be disturbance to the Fortymile Herd during its critical calving period.<br>Extension of an all-season road to a hypothetical Slate Creek mine would expand year-round human activities and push the perimeter of habitat fragmentation to the edge of the herd's summer range. It is not possible to predict the degree of cumulative indirect habitat loss because road extensions and developments are only speculative; however, based on the likely mineral potential of the area, the State of Alaska's constitutional directive to develop its resources, the existing TBAP, and the history of Alaska road development in general, additional cumulative indirect impacts would be very likely. |
| **4.10 Threatened and Endangered Species** | |
| There would be no cumulative impacts on threatened or endangered species.<br>Absence of an all-season road would substantially reduce cumulative impacts on sensitive species. | There would be no cumulative impacts on threatened or endangered species.<br>Cumulative impacts on sensitive species would occur, especially if the road were extended to a hypothetical Slate Creek mine. The degree of cumulative impacts is not possible to predict because future developments are speculative. |

**Table 4.19-1 Summary of Cumulative Impacts**

| All Season Road Removed and Reclaimed at Mine Closure | All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use |
|---|---|
| **4.11 Socioeconomics** | |
| Absence of an all-season road would lower the probability for other resource developments in the project area, and could slow long-term economic growth based on such development. | By end of decade, with construction of the NMDS and/or a natural gas pipeline and Pogo, a cumulative total of between ~430 and 605 new permanent jobs could be added to the local economy for substantial positive economic effect. Most of the increase would be due to NMDS.<br>Total Delta area population would rise to ~ 2,300 to 2,400. Pogo would directly or indirectly account for between 11 and 15 percent of population, a substantial effect. Estimated personal Delta area income would increase from ~$45 million in 2000 to ~$52 million to $54 million.<br>The cumulative effect on local schools could be substantial, and demand for other public services also would increase, though not necessarily at a rate proportional to population increase.<br>Although housing availability could be tight during NMDS construction, longer term cumulative effects on local housing market generally would be positive, resulting in increased valuations and additional housing construction. At the same time, local rental rates could rise. |
| **4.12 Land Use** | |
| Absence of an all-season road would limit other resource development activities and human use, and would change then existing land uses by removing the access that had allowed for mining development. | Cumulative impacts would be low because all uses likely would be compatible with adopted land use plans. *Changes* to existing land uses, however, could be substantial. A road to a hypothetical Slate Creek mine likely would cause changes to existing land use even though such change would be compatible with adopted land use plans. Remote reaches of the upper Goodpaster River would become more economically accessible to new commercial/industrial land uses, possibly opening up other adjacent mining areas in the future. Existing trappers, recreationists, and other users of the area likely would consider such infrastructure a substantial change to existing land uses, while new commercial and industrial land users would consider such infrastructure a substantial benefit. |
| **4.13 Subsistence** | |
| Absence of an all-season road would considerably reduce resource development and recreational access to subsistence use areas that are currently difficult to access, and thus would have substantially fewer cumulative impacts. | Direct subsistence impacts of a hypothetical Sonora Creek mine would be similar to those for the Pogo Mine because of its closeness to the Pogo Mine infrastructure. A Slate Creek mine near the headwaters of the Goodpaster River accessed by an all-season road would provide even greater access into a currently inaccessible area, especially if open to use by everyone. Such a road would extend well inside the edge of the Fortymile Caribou Herd's recent annual range. Road extension into the herd's range is a particular concern of subsistence users.<br>With the exception of caribou and moose, however, the area between the Pogo Mine site and a hypothetical Slate Creek mine site is outside recent subsistence use areas. Although a road to such a mine would not in itself have a high impact on current subsistence uses because it is outside of current subsistence use areas, subsistence users likely would perceive it as a further cumulative encroachment of the "wilderness" to the north and another step toward connecting to the Taylor Highway and "surrounding" the village of Healy Lake with roads and modernization.<br>Construction of a new road represents a classic fear of cumulative impacts from a road, because, in the view of the subsistence workshop attendees, "roads beget more roads." The land use policies that would |

**Table 4.19-1 Summary of Cumulative Impacts**

| All Season Road Removed and Reclaimed at Mine Closure | All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use |
|---|---|
| | permit a road to the Pogo Mine site could do likewise for other resource developments, and through AIDEA or another vehicle might even help fund more roads. Thus, maintaining an all-season road could have a major cumulative impact on subsistence resources. These impacts, however, could be mitigated if the State of Alaska undertook appropriate land and resource management policies for the area that would limit public access to, and impacts on, subsistence resources. |
| **4.14 Cultural Resources** | |
| Absence of an all-season road would decrease human presence considerably, and surface artifacts and other cultural resources would be less vulnerable to looting and other types of damage. | No major cumulative impacts would be expected from major developments because adherence to cultural-resource protection procedures under CFR 800, Section 106, would be required. Because additional road users would increase the likelihood that surface artifacts would be more vulnerable to looting and other types of damage if the road were maintained after Pogo Mine closure, cumulative impacts could be increased. If a road to a hypothetical Slate Creek mine were open to public use, the potential for impacts to cultural resources would further increase. |
| **4.15 Visual** | |
| Removal and reclamation of the all-season road would result in a slow restoration process as vegetation reclaimed the corridor over time, and there would be no or low cumulative visual impacts. | Hypothetical mines developed because the all-season road were maintained would cumulatively contribute to visual impacts because of natural vegetation clearing for surface and air access, power, and other mine-related facilities.<br>A road extension from Pogo to a hypothetical Sonora Creek mine would be minimally visible from the Goodpaster River, and would have low visual impacts for river users. Because of its relatively short length and location close to the substantial Pogo infrastructure, the road extension also would have low visual impact to airborne viewers. Visual impacts from mine site facilities themselves would be major only to ground viewers within the context of the Sonora Creek drainage, but would be low in a larger context to airborne viewers because of proximity of the facilities to the substantial Pogo infrastructure.<br>A road extension up the Goodpaster Valley to a hypothetical Slate Creek mine could have a high visual impact to floaters on the river, as well as airborne viewers, in the context of the upper Goodpaster Valley. Visual impacts from mine site facilities themselves would be high to ground viewers within the context of the Slate Creek drainage. In conjunction with a road up the Goodpaster Valley, these facilities would have a high visual impact to airborne viewers within the context of the upper Goodpaster Valley. |
| **4.16 Recreation** | |
| Although removal and reclamation of the all-season road would result in a definite impact on new recreational users, there would be no cumulative impacts because there were no other current or foreseeable future actions identified that also would reduce access for recreation in the project area. | Pogo mining activities, as well at the potential for extending the life of the Pogo project and the hypothetical Sonora Creek and Slate Creek mines, would substantially affect ROS classes in these areas. Primitive and semi-primitive motorized ROS classes would change to semi-primitive motorized and roaded natural.<br>If the road were maintained and open to public use, and if additional mines or other developments occurred further up the Goodpaster Valley, recreational access would increase to these locations. Thus, road maintenance and public use could have a high cumulative recreational impact on existing recreational users as well as a high beneficial cumulative recreational benefit to prospective recreational users. |

**Table 4.19-1 Summary of Cumulative Impacts**

| All Season Road Removed and Reclaimed at Mine Closure | All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use |
|---|---|
| **4.17 Safety** | |
| Removal and reclamation of the all-season road would have no cumulative impacts on safety because there were no other current or foreseeable future actions identified that also would reduce safety issues in the Shaw Creek Road area. | If the Shaw Creek Road egress option were used and the road were open for use by everyone, there could be a cumulative safety impact on residences along Shaw Creek Road from public use and timber harvest-related traffic in addition to use by the Pogo project. If this status were maintained after mine closure, cumulative safety impacts likely would increase if other major developments were to occur and public use were to intensify. These impacts could be mitigated by ADOT/PF traffic management measures on both existing Shaw Creek Road and the all-season road |
| **4.18 Technical and Economic Feasibility** | |
| Not applicable. | Not applicable. |

## 4.19.2 Cumulative Impacts Summary Discussion

This subsection summarizes the cumulative impacts (Table 4.19-1). It first discusses cumulative impacts for the options common to all alternatives, and then discusses impacts for the options that differ between the alternatives.

- **Options common to all alternatives** The options common to all alternatives are shown in Table 2.5-1. Each option is for a project component located in the immediate vicinity of the mine site itself. Because of their small geographical distribution, the nature of the options themselves, and the design, construction, and mitigation measures that would be used to build and operate them, their impacts are largely localized. Thus, for all resources, cumulative impacts from these common options were determined to be low or nonexistent. Because by definition these options would be used regardless of which alternative were selected, cumulative impacts attributable to the proposed project were limited to the options that differ between alternatives.

- **Options that differ between alternatives** The options that differ between alternatives are shown in Figure 4-1. As discussed above in Section 4.19.1, examination of the cumulative impacts identified in the individual resources sections earlier in this chapter showed that the overwhelming factor determining cumulative impacts was whether the all-season access road would be removed and reclaimed at Pogo Mine closure or would be maintained for other resource development purposes and for public use. Thus, cumulative impacts in Table 4.19-1 were presented in that manner. This subsection summarizes those impacts for the removal/reclamation of the all-season road versus maintaining the road.

  - **Remove and reclaim the all-season road** Without exception, the removal / reclamation option was deemed either to reduce cumulative impacts for resources or to have no effect on cumulative impacts. For the majority of resources, simple lack of access by people and a lower probability of further resource development were the basis for the reduced cumulative impacts.

  - **Maintain the all-season road** For nine resources (surface water hydrology, groundwater hydrology, water quality, air quality, noise, threatened and endangered species, land use, cultural resources, and safety), cumulative impacts were considered low or very low, assuming continued state and federal regulatory controls, state management under existing land use plans, and implementation of appropriate mitigation.

    For two resources, socioeconomics and new recreational users, cumulative impacts of continued access would be beneficial.

    For the remaining six resources as a group, impacts generally would be low or moderate within the context of the entire project area, but could be high locally. This group included fish, wildlife, existing commercial users, subsistence, visual, and existing recreational users. Of particular importance affecting the level of cumulative impact for a given resource was continued state management under existing land use plans, whether the all-season road would be open for public use, and implementation of appropriate mitigation.

# 4.20 Mitigation, Reclamation, and Monitoring

Mitigation, reclamation, and monitoring measures proposed by the Applicant to reduce environmental impacts of the Pogo Mine project are described in Section 2.3 (Applicant's Proposed Project). These measures, as a minimum, would be used to ensure there would be no unreasonable impacts from project development, operation, and closure.

## 4.20.1 Mitigation

CEQ regulations in 20 CFR 1508.20 define mitigation to include avoiding, minimizing, rectifying, and reducing impacts. These regulations also provide for compensation by providing substitute resources or environments. The Applicant has built into its proposed project many mitigation measures that have been taken into account in assessing the environmental consequences of the alternatives in this chapter. These measures are identified in Section 2.3 (Applicant's Proposed Project) for each project component and are summarized in Table 4.20-1.

## 4.20.2 Reclamation

The overall goal of Pogo Mine closure and reclamation would be to return disturbed land to the designated post-mining land use, defined by the TBAP as public recreation and wildlife habitat (ADNR, 1991). The reclamation plan calls for re-establishing wildlife habitat within 5 to 15 years by stimulating growth of an early successional vegetation.

Section 2.3.27 (Closure and Reclamation) of this EIS summarizes the Applicant's goals and objectives for reclaiming disturbed areas after Pogo Mine closure. That section also summarizes more specifically how nine major mine components would be reclaimed.

The more detailed and site-specific closure and reclamation measures are presented in a separate document titled *Pogo Project Reclamation and Closure Plan* (Teck-Pogo Inc., 2002c).

## 4.20.3 Monitoring

Monitoring is a process by which adherence to various permit standards and stipulations may be assessed. Ultimate monitoring plans for operation, closure, and post-closure would be developed in conjunction with state and federal agencies during the permitting process that would follow the EIS process.

Although many permit requirements may be monitored, water quality is of particular concern. Section 2.3.28 of this EIS summarizes the Applicant's approach to ensure protection of the water quality of the Goodpaster River.

**Table 4.20-1 Summary of Applicant's Proposed Project Mitigation Measures**

| Component or Resource | Mitigation Measure |
|---|---|
| **Milling process** | ♦ Gravity recovery, flotation, and concentrate leach to minimize ore exposure to cyanide (despite up to 2 percent lower gold recovery).<br>♦ Only 10 percent of all ore exposed to cyanide (minimizes sulfide and arsenic mineralization in surface dry stack).<br>♦ Cyanide leach circuit is contained in mill (not leached in outdoor exposed heaps).<br>♦ All exposed tailings undergo cyanide destruction. |
| **Tailings disposal** | ♦ All tailings exposed to cyanide returned underground to mine as paste backfill after cyanide destruction process.<br>♦ Half of all other tailings also returned underground as paste backfill. Minimizes size of surface dry stack.<br>♦ Nonmineralized development rock used for berms.<br>♦ Tailings placed in the dry-stack structural shell during nonfreezing conditions when compaction can be ensured.<br>♦ Dry-stack access/haul road from mill would be progressively buried as tailings are deposited; thus, no rerouting of this haul road would be necessary. |
| **Development rock disposal** | ♦ Mineralized development rock encapsulated within dry-stack tailings pile to minimize oxidation of sulfides and keep all runoff within treatment system.<br>♦ Nonmineralized rock used for general mine facilities construction (roads and pads) or also deposited in dry-stack tailings pile. |
| **Gravel sources** | ♦ Timber more than 8 in. in diameter at breast height would be sawed and used for construction or support activities or would be salvaged for haulage off-site.<br>♦ Organic material consisting of surface vegetation, stumps, and root wads would be segregated and stockpiled.<br>♦ Silt and sand overburden would be segregated and stockpiled.<br>♦ In thawed areas, gravel mining would be conducted by dragline to increase digging depths and reduce the surface disturbance required.<br>♦ Shoreline length and diversity would be maximized to the extent practicable.<br>♦ The gravel pit locations have been selected to provide appropriate setback distances from the Goodpaster River. |
| **Water quality** | ♦ Interception of all noncontact surface runoff and rerouting around facilities.<br>♦ All contact runoff from elevations above the RTP would drain into the RTP for treatment before discharge.<br>♦ Minimization of erosion from tailings dry stack by creating convex face of stack and sloped benches to collect sediment runoff and divert to perimeter ditches.<br>♦ Compaction of the dry-stack surface and use of silt fences if necessary to limit or direct runoff.<br>♦ Recycling of mill process water.<br>♦ Mill with concrete berms to contain and collect all spills inside building for disposal or return to processing tanks.<br>♦ Minimization of volume of water discharge.<br>♦ Reagents transported to site in appropriate packaging inside shipping containers for protection against spills.<br>♦ Cyanide containers tracked from arrival on site until empty containers returned to suppliers for refill.<br>♦ All domestic wastewater treated with ADEC-approved package treatment plants. |
| **Wastes** | ♦ Disposal of settled solids from sumps, ditches, degritting basins, and the water treatment plant in paste backfill and dry stack; and of dewatered water treatment |

**Table 4.20-1 Summary of Applicant's Proposed Project Mitigation Measures**

| Component or Resource | Mitigation Measure |
|---|---|
| | plant sludge (including sludge currently stored underground) in the paste backfill and in the general placement area of the dry stack.<br>♦ Construction of a surface landfill on site near the dry stack to dispose of other nonhazardous waste products such as dewatered sewage sludge, incinerator ash and residue, iron (e.g., drill steel, balls, and empty cans), tires, empty plastic and glass containers, empty triple-rinsed chemical containers, contaminated soils, spill boom, liners used for the containment of spilled materials, chemicals used in the cleanup of spills or other spill cleanup wastes, and construction debris.<br>♦ Use of an incinerator near the kitchen complex to incinerate all kitchen wastes and other cardboard, paper, and burnable wastes from throughout the project.<br>♦ Removal for off site disposal of some waste, including screen material containing wood chips and carbon from the CIP and rougher concentrate screens, semi-autogenous grinding mill liners, acid containers, and cyanide shipping containers that would be returned to the producer for reuse. |
| **Fuel supply** | ♦ Tanker drivers trained in road safety and emergency response.<br>♦ Trucks would carry emergency response equipment.<br>♦ Enforced speed limit appropriate to road conditions.<br>♦ All vehicles in radio contact with mine dispatch center and other vehicles on the road system.<br>♦ Trained environmental response team to respond to spills and other emergencies. |
| **Fuel storage** | ♦ All tanks contained in a bermed area with 110 percent capacity of the largest tank.<br>♦ Mobile vehicle refuelling at self-contained portable stations throughout mine area equipped with catch basins with sufficient fuel spill containment capacity.<br>♦ Fuel piping above ground wherever practicable, with leak detection and collection systems. |
| **Stormwater** | ♦ Design and construction of drainage ditches as required by EPA stormwater regulations, ADEC water quality regulations, and ADNR and COE BMPs.<br>♦ Provision of spill planning, spill control materials, and response teams to rapidly control oil, chemical, or other spills that may affect stormwater.<br>♦ Segregation and stockpiling of organic material (surface vegetation and root wads) and growth media for future use.<br>♦ Protection of these growth media piles from wind and water erosion through seeding and use of BMPs.<br>♦ Reclamation of disturbed areas as soon as practicable after disturbance, including regrading, topsoil establishment, revegetation with approved seed mixes and plantings, and maintenance of reclaimed areas.<br>♦ Maintenance of roads and traveled areas to minimize erosion.<br>♦ Grading of roads and disturbed areas so that flows are directed to appropriate control facilities; maintenance of grading frequently. |
| **Surface disturbance** | ♦ Minimization of facilities' footprint.<br>♦ Power line ROW that closely follows all-season road ROW to minimize construction and maintenance disturbance.<br>♦ Balancing of cuts and fills wherever possible. |
| **Air quality** | ♦ Power supplied by power line, not generated on site.<br>♦ Compaction of tailings dry stack, limiting of surface traffic, and building of silt fences in nonactive areas in low-humidity conditions.<br>♦ Road dust minimized by enforcing low traffic speeds, with surface treatment with water or chemicals as needed. |

**Table 4.20-1 Summary of Applicant's Proposed Project Mitigation Measures**

| Component or Resource | Mitigation Measure |
|---|---|
| **Wetlands** | ♦ To the extent practicable, siting of facilities and the all-season road to avoid wetlands, minimization of wetland impacts where avoidance was not practicable, and mitigation of wetland impacts that would occur.<br>♦ Clearing only within fill footprint on flat wetlands.<br>♦ Use of frequent cross culverts under roads to maximize maintenance of natural drainage conditions.<br>♦ Use of measures to prevent erosion at culvert inlets and outlets.<br>♦ Establishment of vegetation on road cut and fill slopes to minimize erosion.<br>♦ Use of other appropriate techniques in ditches and on cut slopes to prevent erosion. |
| **Fish** | ♦ Bridges over major creeks would be single spans<br>♦ Culverts sized and angled to allow fish passage<br>♦ No fishing policy for employees who were transported to the mine site on company-provided transportation. |
| **Wildlife** | ♦ Gravel pits excavated and maintained with appropriate pit slopes to ensure stability and avoid wildlife entrapment.<br>♦ No hunting and trapping policy for employees and contractor personnel transported to the mine site on company-provided or contractor transportation.<br>♦ Employees must commute to mine by bus or air. No personal ATVs, snowmachines, boats, or planes.<br>♦ Enforcement of appropriate traffic speeds to reduce vehicle collisions with wildlife.<br>♦ An employee education program would be implemented that would include the following policies:<br>◇ Feeding animals would be strictly prohibited.<br>◇ Employees would be instructed in proper food handling and garbage disposal techniques, the personal dangers involved in feeding animals, and the fact that animals often end up being shot when they lose their fear of people and become dangerous.<br>◇ Every employee would receive formal instruction on how to avoid attracting and confronting bears. This would include:<br>+ Reading a handout that spells out the Applicant's bear policies and specifically lists forbidden activities (e.g., feeding wildlife, tossing out lunch wrappings and juice cans, harassing wildlife), and the risks of engaging in those activities (mauling, rabies).<br>+ Watching a video on how to avoid and react to bear encounters.<br>+ Reading ADFG's *Bear Facts* pamphlet.<br>◇ Employees would be instructed that if a bear is shot for reasons attributed to feeding of animals or the improper disposal of food away from camp, and the individual(s) can be identified, they would be disciplined.<br>◇ Employees would be instructed that any bear not shot in defence of life and property would be considered a violation of the Applicant's no hunting policy, the individual(s) would be disciplined, and the matter would be turned over to the Alaska State Troopers for investigation.<br>◇ Employees would be required to sign a statement affirming the employee understands the Applicant's animal feeding and bear policies and the consequences of violating those policies, including possible dismissal.<br>♦ The Applicant would develop and maintain animal-human contact protocols addressing:<br>◇ How to react to the presence of a bear that remains in the project area, |

**Table 4.20-1 Summary of Applicant's Proposed Project Mitigation Measures**

| Component or Resource | Mitigation Measure |
|---|---|
| | whether attracted by food, garbage, or for some other reason.<br>◇ When specific actions are needed, what actions should be taken, by whom, with what equipment, where it is stored, and what role (if any) agency personnel should play (e.g., ADFG).<br>◇ Applicant and agency personnel to be contacted for assistance or to report an incident.<br>♦ Organic and other food-related wastes would be stored in secured areas and then incinerated, with the burned residue buried to avoid attracting bears.<br>♦ Bird-power line collision mitigation includes:<br>◇ Limiting pole height to approximately 70-ft height would mean the lines themselves likely would be below the tops of trees.<br>◇ Horizontal cross member H-pole construction would separate the lines by more than 15 ft laterally and substantially reduce the chance for electrocution.<br>◇ This design also would allow line wires to be strung on one horizontal plane rather than at different elevations vertically.<br>◇ Phase wires would be of the same diameter, and no overhead ground wire is proposed for the lower geographic elevations nearer waterfowl areas.<br>◇ Wires would have daytime visual markers where they crossed Shaw Creek and the Goodpaster River. |
| **Subsistence** | ♦ All-season road open only to Pogo-related vehicles. Gated, video monitored, and patrolled to ensure compliance.<br>♦ No public access to airstrip.<br>♦ No hunting, fishing, or trapping policy for employees and contractor personnel transported to the mine site on company-provided or contractor transportation.<br>♦ Employees must commute to mine by bus or air. No personal ATVs, snowmachines, boats, or planes. |
| **Cultural Resources** | ♦ All activities would adhere to the cultural-resource protection procedures under CFR 800, Section 106.<br>♦ Potential impacts to cultural resources and appropriate mitigation would be addressed under a PA among the EPA, COE, Advisory Council on Historic Preservation, SHPO, and Teck-Pogo Inc. |
| **Safety** | ♦ Enforcement of speed limits on Shaw Creek Road for Pogo project-related vehicles.<br>♦ All-season road limited to seven percent grades.<br>♦ All site roads with berms to conform to MSHA requirements.<br>♦ Explosives stored underground with locked storage magazines for caps, detonating cord, primers, and boosters. |

## 4.21 Effects of Short-Term Uses on Long-Term Productivity

Section 102 of NEPA requires that an EIS include “the environmental impacts of alternatives including…the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity.” Under all alternatives, the Pogo Mine site would be restored to pre-mining conditions and productivity. Surface water hydrology and aquatic habitat, as well as wildlife habitat, would generally be re-established after closure. Revegetation would occur throughout the mine site and should eventually approximate pre-mining conditions. Under all alternatives there would be some permanent wetlands loss. Reclaimed wetlands should provide similar functions and values as those lost. Overall, the reclamation of the site would create a somewhat wider diversity of habitat types (wetland and upland) than currently present.

If the access corridor also were reclaimed for all alternatives, similar revegetated conditions and a return of some reclaimed wetlands to similar functions would occur. If the access corridor were not reclaimed, loss of long-term vegetative, wetland, and wildlife habitat productivity would occur. Continued use of the corridor could result in additional mining or other resource developments that could affect long-term productivity if they were not reclaimed.

## 4.22 Irreversible & Irretrievable Commitments of Resources

An **Irreversible** commitment of resources is defined as the loss of future options. It applies primarily to nonrenewable resources, such as minerals or cultural resources, and to those factors that are renewable only over long time spans, such as soil productivity.

An **Irretrievable** commitment applies to loss of renewable resources and to a situation in which a resource can be irretrievable (temporarily) lost, but the action is not irreversible. For example, some or all timber production from an area would irretrievably lost while an area served as a winter sports site. The production lost is irretrievable, but the action is not irreversible. If the use were to change, it would be possible to resume timber production.

Table 4.22-1 summarizes the irreversible and irretrievable impacts for all alternatives.

**Table 4.22-1 Commitment of Resources**

| Alternative 1 (No Action) | Alternative 2 (Proposed Action) | Alternative 3 | Alternative 4 |
|---|---|---|---|
| **Geology** | | | |
| Minor irreversible and irretrievable impacts due to development rock and ore removed during exploration activity. | Irreversible and irretrievable commitments by mining approximately 11 million tons of ore and 2.3 million tons of development rock. The precious metals would be committed to the market. The resultant surface tailings and most development rock would have no use in the foreseeable future. | Same as Alternative 2 | Same as Alternative 2 |
| **Surface Water Hydrology** | | | |
| No foreseeable or predicted irreversible or irretrievable impacts. | The project would be required to comply with all applicable state and federal water quality regulations. Upper Liese Creek drainage pattern would be permanently altered. No other foreseeable or predicted irreversible or irretrievable impacts. | Same as Alternative 2 | Same as Alternative 2 |
| **Groundwater Hydrology** | | | |
| No foreseeable or predicted irreversible or irretrievable impacts. | The project would be required to comply with all applicable state and federal water quality regulations. No foreseeable or predicted irreversible or irretrievable impacts. | Same as Alternative 2 | Same as Alternative 2 |
| **Water Quality** | | | |
| No foreseeable or predicted irreversible or irretrievable impacts. | The project would be required to comply with all applicable state and federal water quality regulations. No foreseeable or predicted irreversible or irretrievable impacts. | Same as Alternative 2 | Same as Alternative 2 |
| **Air Quality** | | | |
| No foreseeable or predicted irreversible or irretrievable impacts. | Project would comply with the Alaska State Implementation Plan and ADEC air quality regulations. No foreseeable or predicted irreversible or irretrievable impacts. | Same as Alternative 2 | Same as Alternative 2 |
| **Noise** | | | |
| Noise sources currently on site would be removed during reclamation, and there would be no foreseeable or predicted irreversible or irretrievable impacts. | No foreseeable or predicted irreversible or irretrievable impacts. | Same as Alternative 2 | Same as Alternative 2 |
| **Soils, Vegetation, and Wetlands** | | | |
| The current approximately 30 acres of total | Irretrievable commitment of approximately 1,745[1] | Irretrievable | Irretrievable |

**Table 4.22-1 Commitment of Resources**

| | Alternative 1 (No Action) | Alternative 2 (Proposed Action) | Alternative 3 | Alternative 4 |
|---|---|---|---|---|
| | disturbance in the mine area (~26 acres of wetlands) have minor irretrievable commitments of vegetation and wetlands productivity. | acres of soil productivity, of which ~449 acres would be undisturbed wetlands. | commitment of approximately 1,690[1] acres of soil productivity, of which ~365 acres would be undisturbed wetlands. | commitment of approximately 947[1] acres of soil productivity, of which ~324 acres would be undisturbed wetlands. |
| **Fish and Aquatic Resources** | | | | |
| | No foreseeable or predicted irreversible or irretrievable impacts. | The project would be required to comply with all Alaska Statutes Title 16 regulations. Upper Liese Creek aquatic habitat would be permanently lost. No other foreseeable or predicted irreversible or irretrievable impacts. | Same as Alternative 2 | Same as Alternative 2 |
| **Wildlife** | | | | |
| | Irretrievable short-term habitat loss on existing 30 acres of disturbance in the mine area. | Irretrievable short- and long-term habitat loss would occur on 1,745[1] acres. | Irretrievable short and long-term habitat loss would occur on approximately 1,690[1] acres. | Irretrievable short and long-term habitat loss would occur on 947[1] acres . |
| **Socioeconomic Resources** | | | | |
| | No foreseeable or predicted irreversible or irretrievable impacts. | Same as Alternative 1 | Same as Alternative 1 | Same as Alternative 1 |
| **Land Use** | | | | |
| | The wildland character of the exploration area would be restored through reclamation. | The wildland character of the mine area and access corridor would be irretrievably altered during mine construction and operation. This condition would be restored to the mine area following its reclamation, and to the airstrip and access corridor if they were reclaimed. If the road and airstrip were not reclaimed, the wildland character of the access corridor and airstrip area would be irretrievably lost. | Same as Alternative 2 | Same as Alternative 2, except approximately 15-mile shorter access corridor would be affected. |
| **Subsistence** | | | | |
| | No predicted irreversible or irretrievable impacts. | If the all-season road were open only to Pogo-related vehicles, there would be few subsistence resources irretrievably lost. If the road were open to use by other | Same as Alternative 2 | Winter-only access would cause few |

**Table 4.22-1 Commitment of Resources**

| Alternative 1 (No Action) | Alternative 2 (Proposed Action) | Alternative 3 | Alternative 4 |
|---|---|---|---|
| | than Pogo-related traffic, there would be some irretrievable loss of subsistence use for duration of mine operations. If the road were to remain open to such use after mine closure, this irretrievable loss would continue and likely increase in severity. There would be no irreversible loss of subsistence resources. | | irretrievable impacts. |
| **Cultural Resources** | | | |
| No foreseeable or predicted irreversible or irretrievable impacts. | Same as Alternative 1 | Same as Alternative 1 | Same as Alternative 1 |
| **Visual Resources** | | | |
| Minor irretrievable commitments due to exploration disturbance. | Irretrievable and irreversible commitments would occur in the form, line, color, and texture contrast of the dry tailings pile in upper Liese Creek. Irretrievable commitments would occur from borrow areas, roads, power line, and structures during project construction and operation. Reclamation and natural succession of vegetation are expected to eventually mitigate most long-term visual impacts. Long-term irreversible commitments would occur if the road and airstrip were not reclaimed. | Same as Alternative 2 | Same as Alternative 2, except approximately 15-mile shorter access corridor would be affected. |
| **Recreation** | | | |
| No foreseeable or predicted irreversible or irretrievable impacts. | Irretrievable commitments of semi-primitive and primitive recreation opportunities would occur during construction and operation. These opportunities would be restored to the mine area following its reclamation, and to the airstrip and access corridor if they were reclaimed. If the road and airstrip were not reclaimed, these opportunities would be irretrievably lost. | Same as Alternative 2 | Same as Alternative 2, except approximately 15-mile shorter access corridor would be affected. |

[1] Entire alternative minus existing disturbance